FUNDAÇÃO OSWALDO ARANHA
CENTRO UNIVERSITÁRIO DE VOLTA REDONDA - UNIFOA
MESTRADO PROFISSIONAL EM CIÊNCIAS DA SAÚDE E DO MEIO AMBIENTE - MECSMA

# RECYCLING AND URBAN SOLID WASTE: PROJECT-BASED LEARNING PROPOSAL FOR ENGINEERING COURSES

**ROBSON DE OLIVEIRA BASTOS**
**ANDRÉ BARBOSA VARGAS**
**FRANCISCO JÁCOME GURGEL JÚNIOR**

# INDEX

INTRODUCTION 03

Class 1: Introduction to Solid Waste Management 04

Class 2: Implementation of the Municipal Solid Waste Sorting and Recycling Shed 10

Class 3: Study of the implementation area and project presentation 17

Class 4: Case study 19

know more 22

About the authors 23

References 24

# INTRODUÇÃO

This educational product was designed based on the author's experience and focuses on the areas of Engineering. We are excited to present a summary of the four classes that made up our learning journey about sustainable solid waste management. At each stage, we explore fundamental concepts and apply knowledge to develop a comprehensive and practical understanding of the topic.

**Class 1: Fundamentals of Solid Waste Management**

We address the identification and classification of waste, urban cleaning and selective collection, in addition to the legislation and standards applied to solid waste management. We provide a solid foundation for our journey.

**Class 2: Feasibility and Requirements for Implementing the Warehouse**

We analyzed the feasibility of implementing the sorting and recycling warehouse, as well as the requirements necessary for project approval, including legal, regulatory and technical aspects.


**Class 3: Study of the Implementation Area and Project Presentation**

We explored the study of the implantation area using tools such as Google Earth. We present examples of projects with floor plans to understand the internal structure of the unit.

**Class 4: Case Study and Practical Application**

we consolidate our learning with a practical case study.
We apply all the knowledge acquired to solve a real problem, considering legal, environmental and technical requirements.
These four classes represent a journey of meaningful discovery and learning. We are confident that the knowledge acquired will be valuable not only in our academic environment, but also in practical and professional life.

*Robson de Oliveira Bastos*

# CLASS 1 - INTRODUCTION TO SOLID WASTE MANAGEMENT

Dear students,

Welcome to our first class on Solid Waste Management. Today, we will explore the identification and classification of waste, the importance of urban cleaning and selective collection, in addition to related legal regulations.
We are ready to delve into this crucial topic for the preservation of the environment and public health. Let's go together on this journey of learning and action towards a cleaner and more sustainable future.

## SEQUENCE OF THE 1ST CLASS


# SOLID WASTE MANAGEMENT

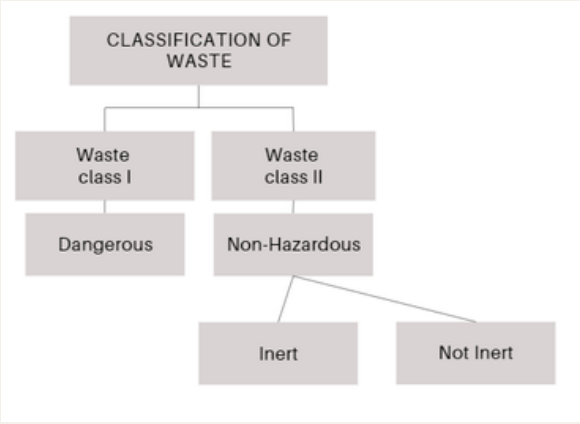

Água Brasil Program - river basins - Solid Waste Management - Basic Concepts" Link: YouTube - Solid Waste Management, available at https://youtu.be/MiulckYJfQY, accessed on 03/29/2024.

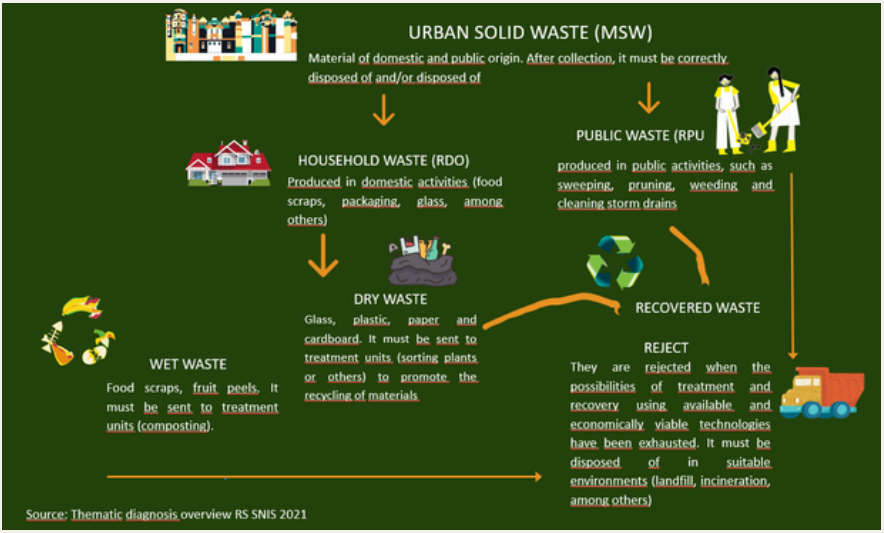
## SOLID WASTE MANAGEMENT

Law No. 12,305/2010 identifies solid waste originating from households, urban cleaning, industrial waste, health services, civil construction, agroforestry, transport services and mining. They fall into two categories of dangerousness:

(1) non-hazardous; It is

(2) dangerous, which pose a risk to public health or environmental quality due to characteristics such as flammability, corrosiveness, toxicity, pathogenicity, carcinogenicity.






## Urban Cleaning and Selective Collection

**Urban cleaning** is the management of solid waste and is one of the four components of basic sanitation. This service is essential to eliminate environments for the spread of disease vectors (rats, cockroaches), polluting sources of surface and underground waters and obstruction of rainwater drainage infrastructures.

**Selective collection** is a strategic process for increasing recycling rates and involves the separation of solid waste by those responsible for generating it.


**Convergence of the SDGs with Urban Solid Waste Management**

Urban solid waste management has a strong convergence with several Sustainable Development Goals (SDGs), especially with SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production).

SDG 11: Sustainable Cities and Communities
Urban solid waste sorting and recycling actions promote the sustainability and resilience of cities, making them more inclusive and safe. Proper waste management reduces negative environmental impacts, improves residents' quality of life and promotes a cleaner and healthier urban environment.
SDG 12: Responsible Consumption and Production
Urban solid waste management is directly linked to the promotion of sustainable consumption and production practices. Recycling and reusing materials encourages the circular economy, reducing the need for new natural resources and reducing waste generation.

In addition to these, urban solid waste management also contributes to other SDGs:

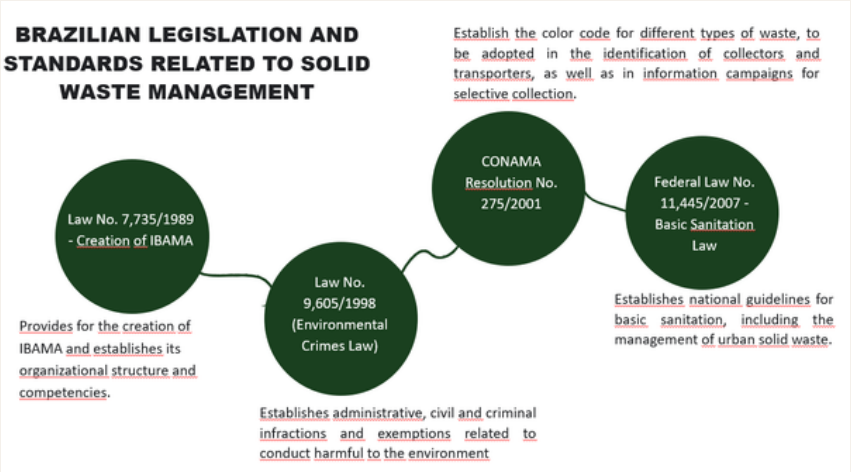
• SDG 3: Health and Well-Being • SDG 6: Clean Water and Sanitation

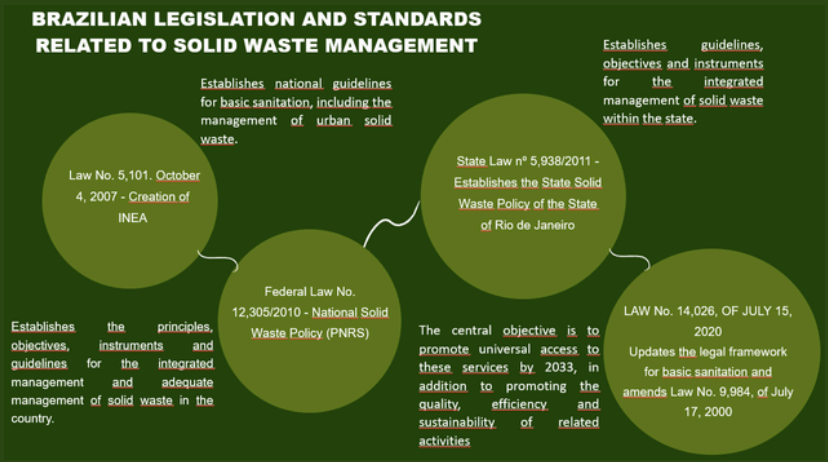
• SDG 8: Decent Work and Economic Growth

• SDG 13: Action Against Global Climate Change

• SDG 14: Life in Water • SDG 15: Life on Land


## LEGISLATION AND STANDARDS RELATED TO SOLID WASTE MANAGEMENT





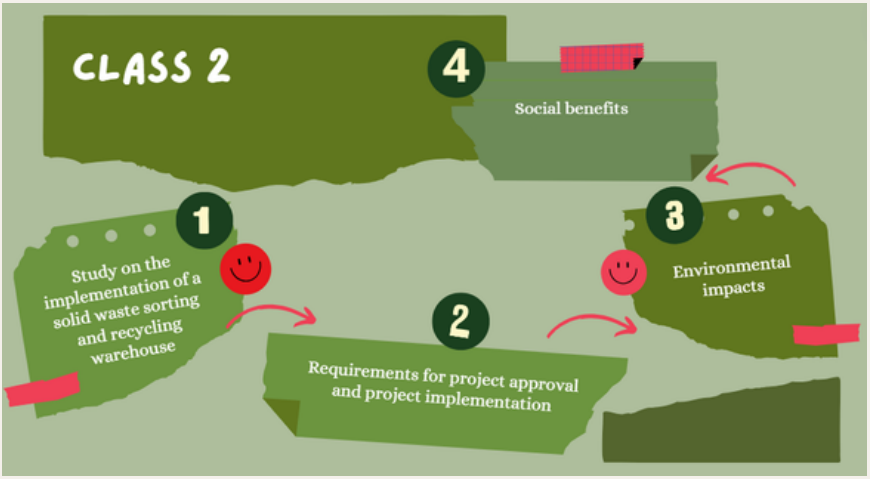

## REFLECTION ON THE TOPIC COVERED IN CLASS 1


Água Brasil Program - river basins - Solid Waste Management - Basic Concepts" Link: YouTube - Solid Waste Management, available at https://youtu.be/KlV3ASpM19M, accessed on 03/29/2024.

# CLASS 2 - IMPLEMENTATION OF THE URBAN SOLID WASTE SORTING AND RECYCLING SHED

**Presentation**

In this class, we will discuss the feasibility of implementing a warehouse for sorting and recycling urban solid waste. We will address the requirements necessary for project approval, including legal and regulatory aspects. Furthermore, we will analyze the potential environmental impacts resulting from the warehouse's operation and the social benefits that its implementation can bring to the local community. We look forward to the active participation of all students in this discussion.

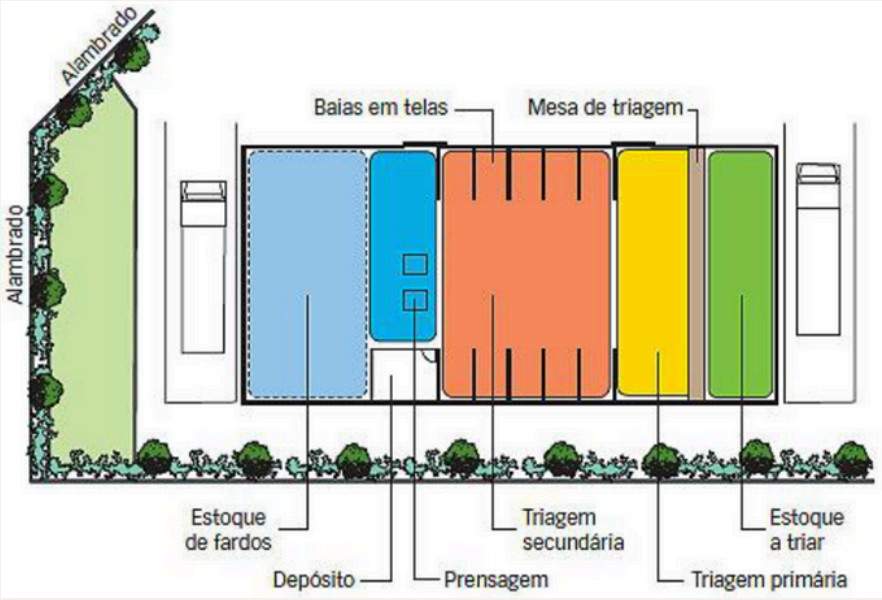



**RECYCLING WARE IMPLEMENTATION STUDY**

The feasibility study is an essential stage for the technical, economic and environmental assessment of a project, covering various aspects, from location and infrastructure to the analysis of costs and benefits.

REQUIREMENTS TO BE OBSERVED:
1. Location
2.Infrastructure: Space, physical, Layout, 3. Equipment,
4. Basic infrastructure,
5. Cost analysis, among others

# Installations




Source: SOLID WASTE SORTING AND COMPOSTING CENTRAL – Technical Specifications and Technical Drawings. 2nd Edition. CURITIBA, November 2013

For a small warehouse, with approximately 300 m² built, we recommend purchasing a vertical baling press with a capacity of 20 tons, a mechanical scale with a capacity of 1,000 kg and a two-axle platform cart.

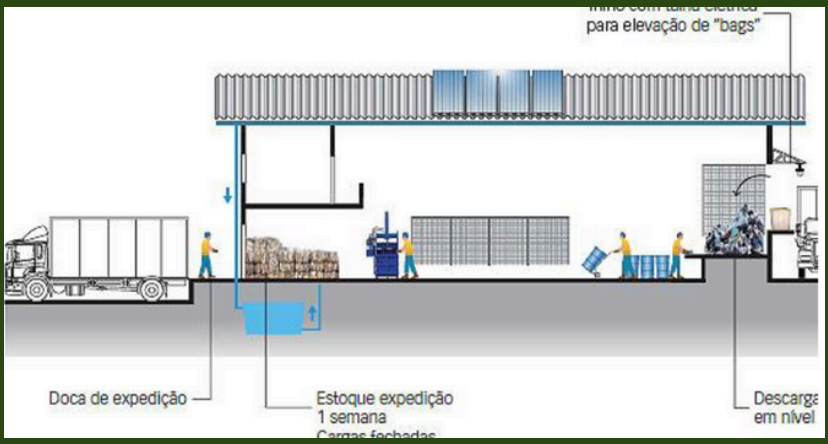
For a medium-sized warehouse, around 600 m² built, in addition to the equipment mentioned above, it will be necessary to purchase a simple forklift with a capacity of 1,000 kg, manual displacement and electric lifting power.

These structures will enable efficient sorting and recycling of solid waste, contributing to environmental and economic sustainability.

## Sheds on flat land

There are two options for sorting centers: those made up of silos and tables and those with additional equipment. Plants composed only of silos and tables do not require additional equipment, installation and maintenance costs. Furthermore, they have a process reject rate of just 5% and allow each person to work at their own pace.
These plants also have advantages in terms of storage capacity and employment of people, as evidenced by the table.

## Use of small equipment to aid work

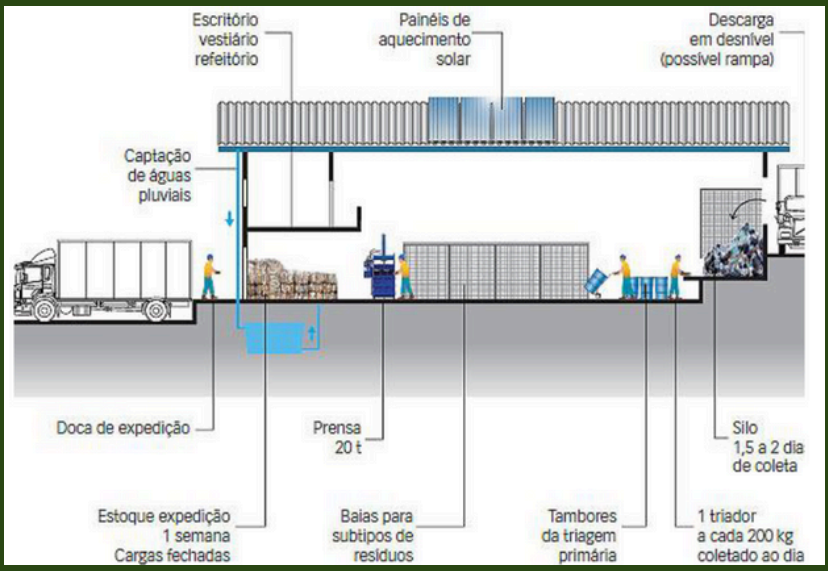



Source: SOLID WASTE SORTING AND COMPOSTING CENTRAL - Technical Specifications and Technical Drawings. 2nd Edition. CURITIBA, November 2013

## Project example - warehouse


Engineering Channel - INDUSTRIAL WAREHOUSE PROJECT. Available at: https://youtu.be/Da2Rpb2efw8. Accessed on 03/29/2024.

## Using gravity to define work zones




Source: SOLID WASTE SORTING AND COMPOSTING CENTRAL - Technical Specifications and Technical Drawings. 2nd Edition. CURITIBA, November 2013

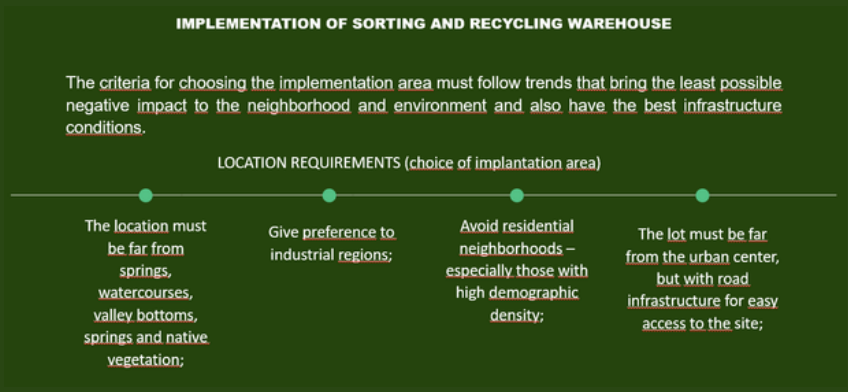
For a small warehouse, with approximately 300 m² built, we recommend purchasing a vertical baling press with a capacity of 20 tons, a mechanical scale with a capacity of 1,000 kg and a two-axle platform cart.
For a medium-sized warehouse, around 600 m² built, in addition to the equipment mentioned above, it will be necessary to purchase a simple forklift with a capacity of 1,000 kg, manual displacement and electric lifting power.
These structures will enable efficient sorting and recycling of solid waste, contributing to environmental and economic sustainability.

## REQUIREMENTS FOR PROJECT APPROVAL

## IMPLEMENTATION OF SORTING AND RECYCLING WAREHOUSE

The criteria for choosing the implementation area must follow trends that bring the least possible negative impact to the neighborhood and environment and also have the best infrastructure conditions.

## LOCATION REQUIREMENTS (choice of implantation area)



## Environmental impacts

**Reducing the amount of waste sent to landfills:**

The recycling warehouse allows the separation and reuse of recyclable materials, reducing the amount of waste that is discarded in landfills. This contributes to preserving the environment and minimizing soil and water pollution.

**Natural resource economy**

By recycling materials such as paper, plastic, glass and metal, the recycling warehouse avoids the extraction of natural resources such as trees, ores and oil. This promotes the conservation of natural resources and contributes to environmental sustainability.

**Mitigation of greenhouse gas emissions**

Recycling materials reduces the need for production from virgin raw materials, which implies lower energy consumption and greenhouse gas emissions. This contributes to combating climate change and reducing environmental impact.

## Social benefits

### Generation of jobs in the recycling sector

The implementation of a recycling warehouse generates direct and indirect jobs, mainly in the collection, sorting and processing of recyclable materials. This initiative promotes social inclusion and contributes to local economic development.

### Promotion of social inclusion

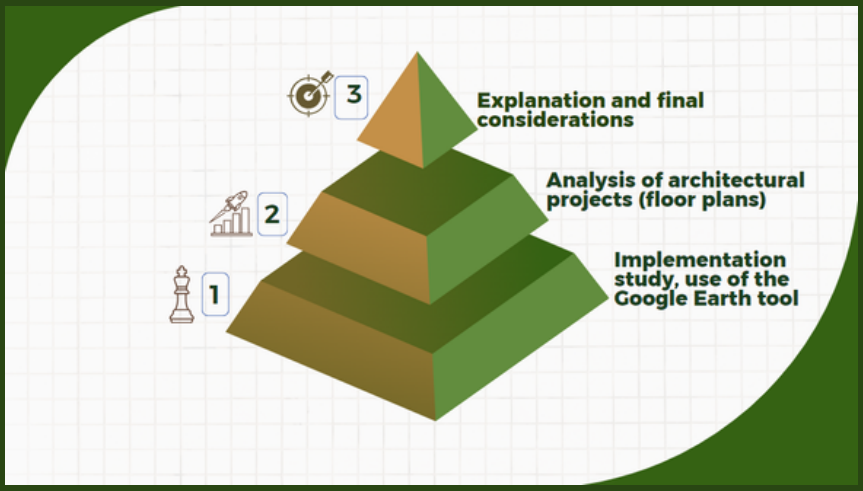
occurs through the implementation of cooperatives of recyclable material collectors associated with the recycling warehouse. This initiative provides work and income generation opportunities for people in socially vulnerable situations, such as waste pickers. Cooperatives contribute to social inclusion, improving the quality of life and dignity of these workers.

### Generation of jobs in the recycling sector

The creation of jobs in the recycling area goes beyond activities inside the warehouse. In addition to providing direct employment in the collection, sorting and processing of recyclable materials, the warehouse also plays an important role in raising community awareness about the importance of recycling and proper waste separation. Educational campaigns and awareness programs are implemented to involve the population and promote behavioral changes in relation to the consumption and disposal of materials, contributing to a more sustainable society.

# CLASS 3 - Study of the implementation area and project presentation

In Class 3, we will delve into the study of the implementation area for the recycling and solid waste warehouse project. We will highlight the use of the Google Earth tool to analyze and study the project's intervention areas, providing a comprehensive view of the location.
In addition, we will present two project examples (floor plan) to demonstrate the internal structure of the unit. These examples will provide valuable insights into the organization and layout of spaces within the warehouse, aiming to optimize the flow of materials and sorting and recycling operations.
We count on the participation of all!




**Study of the implementation area**

The design and sizing of the recycling warehouse requires an analysis of several requirements, including the space necessary for storing and separating recyclable materials, the arrangement of sorting equipment and infrastructure, among other aspects.
To assist in this preliminary analysis of the unit's location, we will use the Google Earth tool. The objective is to obtain essential data for the study of the project to be implemented in the Municipality of Rio Claro/RJ.
This approach will allow for a more accurate and efficient analysis, contributing to the successful implementation of the recycling warehouse.

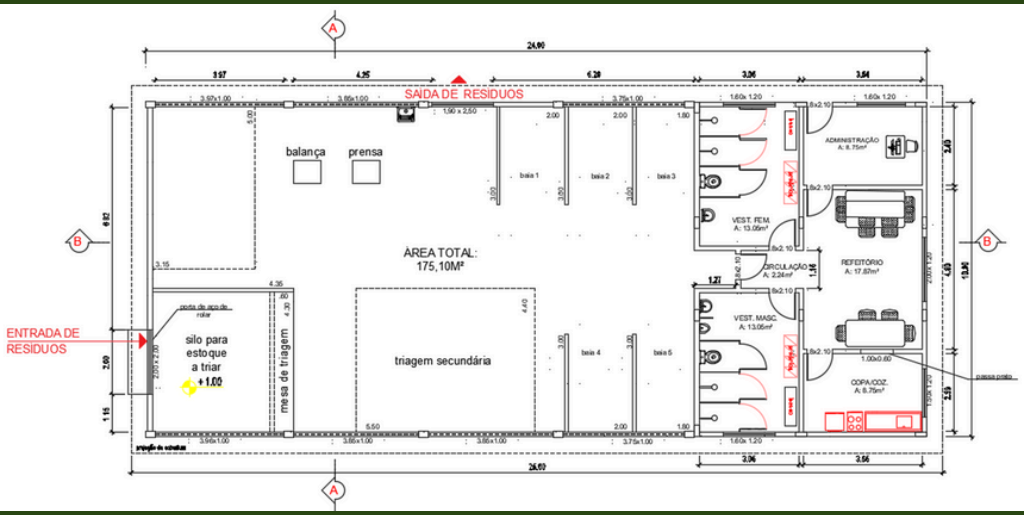
Data from the Municipality of Rio Claro/RJ:
https://cidades.ibge.gov.br/brasil/rj/rio-claro/panorama

CLICK HERE to access the deployment areas on Google Earth

Note: Google Earth must be installed.

## PROJECT EXAMPLE

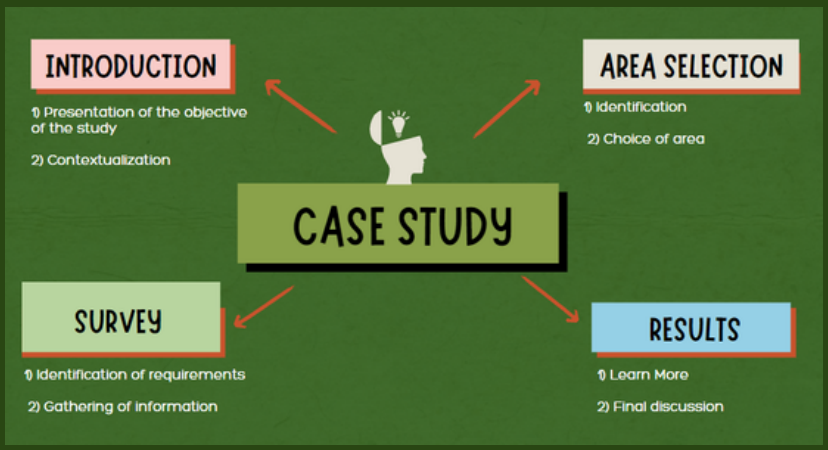
### Sorting and recycling warehouse – FLOOR PLAN




# Class 4 - Case study

## Presentation

In Class 4, we will apply the knowledge acquired in previous classes, where we cover legal requirements, waste classification, types of collection, legislation and technical aspects of implementing the recycling and solid waste warehouse. We used project examples and the Google Earth tool to select the deployment area.
Now, we will take it a step further with a practical case study. We will work as a team to solve a real problem, applying our knowledge to meet the legal, environmental and technical requirements for the implementation of the warehouse.



CASE STUDY

1. Introduction

1.1 - Presentation of the objective of the case study: select the appropriate area for the implementation of a warehouse for sorting and recycling urban solid waste.

1.2 - Contextualization of the importance of adequate solid waste management and the role of recycling warehouses in this process.

2 - Requirements gathering

2.1 - Identification of the technical, environmental and social requirements necessary for the implementation of the warehouse

2.2 - Gathering information on processing capacity, required area, infrastructure, accessibility, legal clearances, among others.

3 - - Selection of the ideal area

3.1 - Identification of the most suitable area for installing the warehouse based on the results of the analysis and evaluation.

3.2 - Justification for the choice of the selected area, highlighting the positive points and compliance with the requirements.

## 4 - Data

4.1 - According to the 2021 Solid Waste Panorama in Brazil, the national average of per capita generation of urban solid waste is approximately 1.04 kg per day. It is important to highlight that this average considers municipalities of different sizes and characteristics.

In small municipalities, this rate may be slightly lower, varying between 0.8 kg and 1 kg per day. This is due to the lower population concentration and lower industrial and commercial activity compared to large urban centers.

These data are fundamental for the adequate planning of sorting and recycling units in different locations, allowing the adoption of efficient strategies for the sustainable management of solid waste.

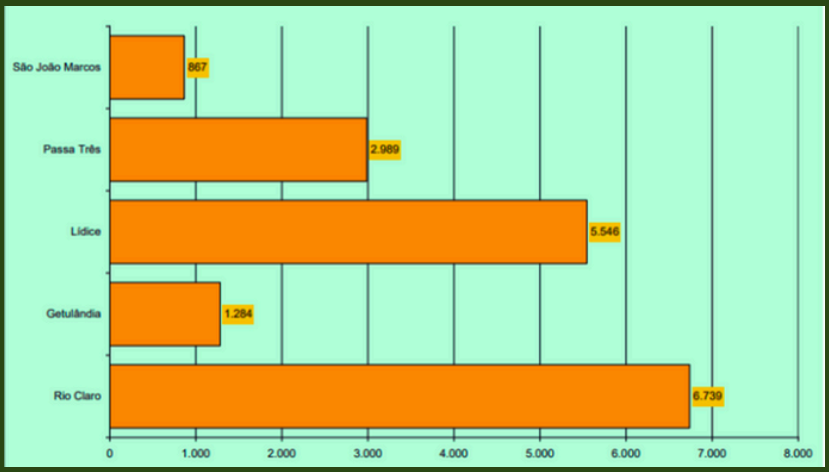
4..2 - According to data from the 2021 Panorama of Solid Waste in Brazil, prepared by the Brazilian Association of Public Cleaning and Special Waste Companies (ABRELPE), it is estimated that approximately 20% to 25% of urban solid waste generated in Brazil are subject to recycling. This percentage mainly refers to materials such as paper, cardboard, plastics, glass and metals, which are the main recyclable materials.

4.3 - The Study of the Brazilian Association of Public Cleaning and Special Waste Companies - ABRELPE, 2012):
A minimum area of 300 to 500 m² is suggested for a small sorting and recycling warehouse, capable of processing up to 10 tons of waste per day. These dimensions can be adjusted according to the volume of waste to be processed and the technologies adopted.

4.4 - Areas - google earth

https://drive.google.com/file/d/12HdL453LNawGWqb1qO6JKcEF4vdRUblc/view?usp=drive_link

4.5 - Population data - RIO CLARO - RJ




**Fonte: https://www.tcerj.tc.br/portalnovo/publicadordearquivo/estudos_socioeconomicos; acesso em 30/06/2023**

https://www.tcerj.tc.br/portalnovo/publicadordearquivo/estudos_socioeconomicos

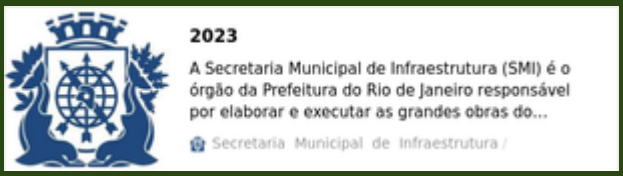
## PROPOSED ACTIVITIESS

**BELOW ARE THE ACTIVITIES RELATING TO THE APPLICATION OF THE PROPOSED STUDY:**

https://docs.google.com/forms/d/e/1FAIpQLSeW24Oj4_pZRG33x1uqXPjuKeQEld3uoAaDFKYfAW7-RT5alA/viewform?usp=pp_url

## SAIBA MAIS

**BUDGET IN CIVIL CONSTRUCTION**
**Service cost table:**
**SCO RIVER.**




**SINAPI/RJ**

https://www.caixa.gov.br/site/Paginas/downloads.aspx#categoria_656

Sustainable Constructions Booklet

https://www.caixa.gov.br/Downloads/sustentabilidade_biblioteca/Cartilha_Construcoes_Sustentaveis.pdf

# ABOUT THE AUTHORS

**Robson de Oliveira Bastos - Master's student**

He has a degree in Civil Engineering from Centro Universitário de Volta Redonda (UniFOA) (1995) and a degree in Mathematics from Fundação Educacional Rosemar Pimentel (FERP), Volta Redonda (1995). Master's student in Teaching in Science, Health and Environment at Centro Universitário de Volta Redonda (UniFOA), research focused on the theme of "Recycling and Urban Solid Waste. Specializations: Sanitary and Environmental Engineering from the Federal University of Rio de Janeiro (UFRJ) in 2003 , with an emphasis on hydraulic projects for Sewage Treatment Plants. In 2013, specialization at Universidade Federal Fluminense (UFF), in new technologies in mathematics teaching, the application of the R.e.C software for metric demonstrations in the context of the right-angled triangle. Since 1999, he has held a permanent position as a Civil Engineer at the Rio Claro/Rio de Janeiro City Hall and since 2005, he has been a permanent Professor at the State Department of Education of Rio de Janeiro, working at Colégio Estadual Fagundes Varela between 1998 and 1999, from 1998 to 1999. From 2001 to 2008, he held the position of Municipal Secretary of Works and Public Services at Rio Claro City Hall, managing projects and agreements. In 2017, he held the position of Undersecretary of Urban Planning, Public Works and Services and from 2018 to date, he holds the position of Municipal Secretary of Urban Planning, Public Works and Services at the Municipal City Hall of Rio Claro/RJ working in project management, agreements, budgets and execution of public works.

**André Barbosa Vargas - Advisor**

Biologist graduated with a Full Degree from Centro Universitário de Barra Mansa (2002), Master in Animal Biology (2006) and PhD in Environmental and Forestry Sciences (2011) from the Federal Rural University of Rio de Janeiro. He was a teacher in elementary and high school, teaching Science, Physics, Chemistry and Biology classes. With experience in entomology and ecology, he organized short courses, covering topics such as Ecology, Entomology and Myrmecology. He worked as a technical consultant carrying out monitoring and environmental impact studies, using ants as bioindicators. He is currently a professor at the Centro Universitário de Volta Redonda - UniFOA, working on undergraduate courses in Biological Sciences, Nursing and Design and on the Professional Master's Degree in Teaching Health and Environmental Sciences (MECSMA).

**Francisco Jácome Gurgel Júnior - Advisor**

He is a full professor at the Centro Universitário de Volta Redonda (UniFOA - Campus Três Poços) working on the Environmental Engineering and Civil Engineering course, professor at the Centro Universitário Geraldo Di Biase/UGB (Campus Volta Redonda) linked to the Biological Sciences and Geography course and professor graduated from the University Center of Barra Mansa (UBM- Campus Barra Mansa). He is a visiting professor at the Postgraduate Program in Environmental Science and Technology at Master's level at the Centro Universitário Estadual da Zona Oeste (UEZO). He holds a master's degree in Geography (concentration area: Environmental Planning and Management) from the Federal University of Rio de Janeiro (UFRJ) and a PhD in Environmental and Forestry Sciences from the Federal Rural University of Rio de Janeiro (UFRRJ). He has a bachelor's degree in Law and a degree in Social Studies (Specialization in Geography) and the titles of specialist in Urban Regional Planning (UBM) and Fiscal Education and Project Development (UCAM).

## References

CAIXETA-FILHO, J. V.; BARTHOLOMEU, D. B. Logística Ambiental De Resíduos Sólidos. 1a edição ed. [s.l.] Atlas, 2011.

CHEIDA, L. E.; GIACOIA, G. SECRETARIA ESTADUAL DO MEIO AMBIENTE E RECURSOS HÍDRICOS. p. 58, [s.d.].

DECRETO No 11.043, DE 13 DE ABRIL DE 2022 - DECRETO No 11.043, DE 13 DE ABRIL DE 2022 - DOU - Imprensa Nacional. Disponível em: <https://www.in.gov.br/en/web/dou/-/decreto-n-11.043-de-13-de-abril-de-2022-393566799>. Acesso em: 8 jul. 2022.

DECRETO No 11.044, DE 13 DE ABRIL DE 2022 - DECRETO No 11.044, DE 13 DE ABRIL DE 2022 - DOU - Imprensa Nacional. Disponível em: <https://www.in.gov.br/en/web/dou/-/decreto-n-11.044-de-13-de-abril-de-2022-393553968>. Acesso em: 8 jul. 2022.

DIAGNOSTICO_TEMATICO_GESTAO_ADMINISTRATIVA_FINANCEIRA_RS_SNIS_2022.pdf. , [s.d.]. Disponível em: <http://www.snis.gov.br/downloads/diagnosticos/rs/2020/DIAGNOSTICO_TEMATICO_GESTAO_ADMINISTRATIVA_FINANCEIRA_RS_SNIS_2022.pdf>. Acesso em: 29 jun. 2022

DIAGNOSTICO_TEMATICO_GESTAO_TECNICA_DOS_SERVICOS_RS_SNIS_2022.pdf. , [s.d.]. Disponível em: <http://www.snis.gov.br/downloads/diagnosticos/rs/2020/DIAGNOSTICO_TEMATICO_GESTAO_TECNICA_DOS_SERVICOS_RS_SNIS_2022.pdf>. Acesso em: 29 jun. 2022

DIAGNOSTICO_TEMATICO_VISAO_GERAL_RS_SNIS_2021.pdf. , [s.d.]. Disponível em: <http://www.snis.gov.br/downloads/diagnosticos/rs/2020/DIAGNOSTICO_TEMATICO_VISAO_GERAL_RS_SNIS_2021.pdf>. Acesso em: 29 jun. 2022

DO_SNIS_AO_SINISA_RESIDUOS_SOLIDOS_SNIS_2019.pdf. , [s.d.]. Disponível em: <http://www.snis.gov.br/downloads/cadernos/2019/DO_SNIS_AO_SINISA_RESIDUOS_SOLIDOS_SNIS_2019.pdf>. Acesso em: 29 jun. 2022a

DO_SNIS_AO_SINISA_RESIDUOS_SOLIDOS_SNIS_2019.pdf. , [s.d.]. Disponível em: <http://www.snis.gov.br/downloads/cadernos/2019/DO_SNIS_AO_SINISA_RESIDUOS_SOLIDOS_SNIS_2019.pdf>. Acesso em: 29 jun. 2022

L9795. Disponível em: <http://www.planalto.gov.br/ccivil_03/leis/l9795.htm>. Acesso em: 12 jul. 2022.
LOUREIRO, C. F. B. Educação ambiental: dialogando com Paulo Freire. 2a edição ed. [s.l.] Cortez, 2018.
LOURENÇO, J. C. GESTÃO DOS RESÍDUOS SÓLIDOS URBANOS NO BRASIL: Panorama, Conceitos, Aplicações e Perspectivas. [s.l: s.n.].

NBR-12.980-Coleta-varrição-e-acondicionamento-de-resíduos-sólidos-urbanos.pdf. , [s.d.]. Disponível em: <http://licenciadorambiental.com.br/wp-content/uploads/2015/01/NBR-12.980-Coleta-varri%C3%A7%C3%A3o-e-acondicionamento-de-res%C3%ADduos-s%C3%B3lidos-urbanos.pdf>. Acesso em: 8 jul. 2022

POISSON, E. (ED.). Gestão de resíduos sólidos – Volume 1. [s.l.] Editora Poisson, 2020.
RIBEIRO, J. C. J. et al. Logística Reversa: Um Desafio Para Gestão De Resíduos Sólidos - 2020. 1a edição ed. [s.l.] Lumen Juris, 2020.

RODRIGUES, M. H. Q.; CARVALHO, M. R. Práticas de educação ambiental: metodologia de projetos. 1a edição ed. Place of publication not identified: ApprisEditora, 2016.