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COIMBRA

Nidia Giselle Machado Fernandes

Green Invasion

Biophilic design meets a new mobility infrastructure in Coimbra

**Dissertation within the scope of the Integrated Master in Architecture,
guided by Professor Nuno Alberto Leite Rodrigues Grande
and presented to the Department of Architecture of the Faculty of Science and Technology
of the University of Coimbra.**

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Long distances we've endured, but the end of the suffering and the wait is almost here.

For all the help and support through all these years, and with this dissertation, I appreciate you infinitely.

I love you and adore you,

Endlessly.

Abstract

This dissertation explores the design and development of a new urban infrastructure in Coimbra, while applying the concept of biophilic design. The project focuses on the design of the new Coimbra Intermodal Station and its impact on the surrounding city and urban fabric. The aim is to create a safe and sustainable urban environment that integrates the new High-Speed Railway system in Portugal.

Both the group and individual projects detailed in this dissertation were present at different exhibitions, with the aim of making the community more aware of environmentally friendly design. The group intervention developed in Studio Design I (API – *Atelier de Projeto)* was submitted to the Lisbon Architecture Triennale 2022 (TAL – *Trienal de Arquitetura de Lisboa*), titled *Terra*, and successfully advanced to public phase of the competition that was presented at the Museum of Art, Architecture and Technology (MAAT) in Lisbon. Additionally, the railway station was exhibited at Anozero '21-22 Biennial of Contemporary Art of Coimbra, under the title of "Midnight Train. Three proposals for the new Coimbra intermodal station".

The group proposal focuses on designing an urban intervention that incorporates the construction of mobility infrastructures, multiple types of housing, a multipurpose building, a sports complex, and a rehabilitation for a co-working space. Additionally, urban agriculture fields, irrigation canals, parks, and elevated linear gardens that connect the different buildings are also included.

The individual project develops further the architectonic and constructive solutions of the new railway station, the bus terminal, and the biological market. As a joining concept of these three constructions, biophilic design is used to better adapt these buildings to their rural-urban context, connecting architecture with nature.

The concept of "green invasion" emphasizes the integration of nature in urban design to enhance human and environmental well-being. The proposal aligns with the principles of biophilic design and considers the existing flora of the Choupal National Forest.

Keywords: Coimbra, connection, mobility infrastructure, biophilic design, rural-urban

Resumo

Esta dissertação explora o desenho e desenvolvimento de uma nova infraestrutura urbana em Coimbra, aplicando o conceito de desenho biofílico. O projeto centra-se na conceção da nova Estação Intermodal de Coimbra e no seu impacto na cidade envolvente e tecido urbano. O objetivo é criar um ambiente urbano seguro e sustentável que integre o novo Sistema Ferroviário de Alta Velocidade em Portugal.

Tanto a proposta de grupo como o projeto individual detalhados nesta dissertação estiveram presentes em diferentes exposições, com o objetivo de sensibilizar a comunidade para o desenho de baixo impacto ambiental. A estratégia de grupo desenvolvida em Atelier de Projeto I foi submetida à Trienal de Arquitetura de Lisboa 2022, intitulada Terra, e avançou com sucesso para a fase pública do concurso, exibida no Museu de Arte, Arquitetura e Tecnologia (MAAT) em Lisboa. Adicionalmente, a estação ferroviária esteve presente na Bienal de Arte Contemporânea de Coimbra Anozero '21-22, sob o título "Comboio da Meia-Noite. Três propostas para a nova estação intermodal de Coimbra".

A proposta do grupo foca-se na conceção de uma intervenção urbana que incorpora a construção de infraestruturas de mobilidade, várias tipologias habitacionais, um edifício multiusos, um complexo desportivo e a reabilitação de um espaço de coworking. Além disso, campos de agricultura urbana, canais de irrigação, parques e jardins lineares elevados que conectam os diferentes edifícios também estão incluídos.

O projeto individual desenvolve ainda as soluções arquitetónicas e construtivas da nova estação ferroviária, do terminal rodoviário e do mercado biológico. Como conceito de junção dessas três construções, o desenho biofílico é usado para melhor adequar esses edifícios ao seu contexto rural-urbano, conectando a arquitetura com a natureza.

O conceito de "invasão verde" (do título "Green Invasion") enfatiza a integração da natureza no desenho urbano para melhorar o bem-estar humano e ambiental. A proposta alinha-se com os princípios do desenho biofílico e considera a flora existente na Mata Nacional do Choupal.

Palavras-chave: Coimbra, ligação, infraestruturas de mobilidade, desenho biofílico, rural-urbano

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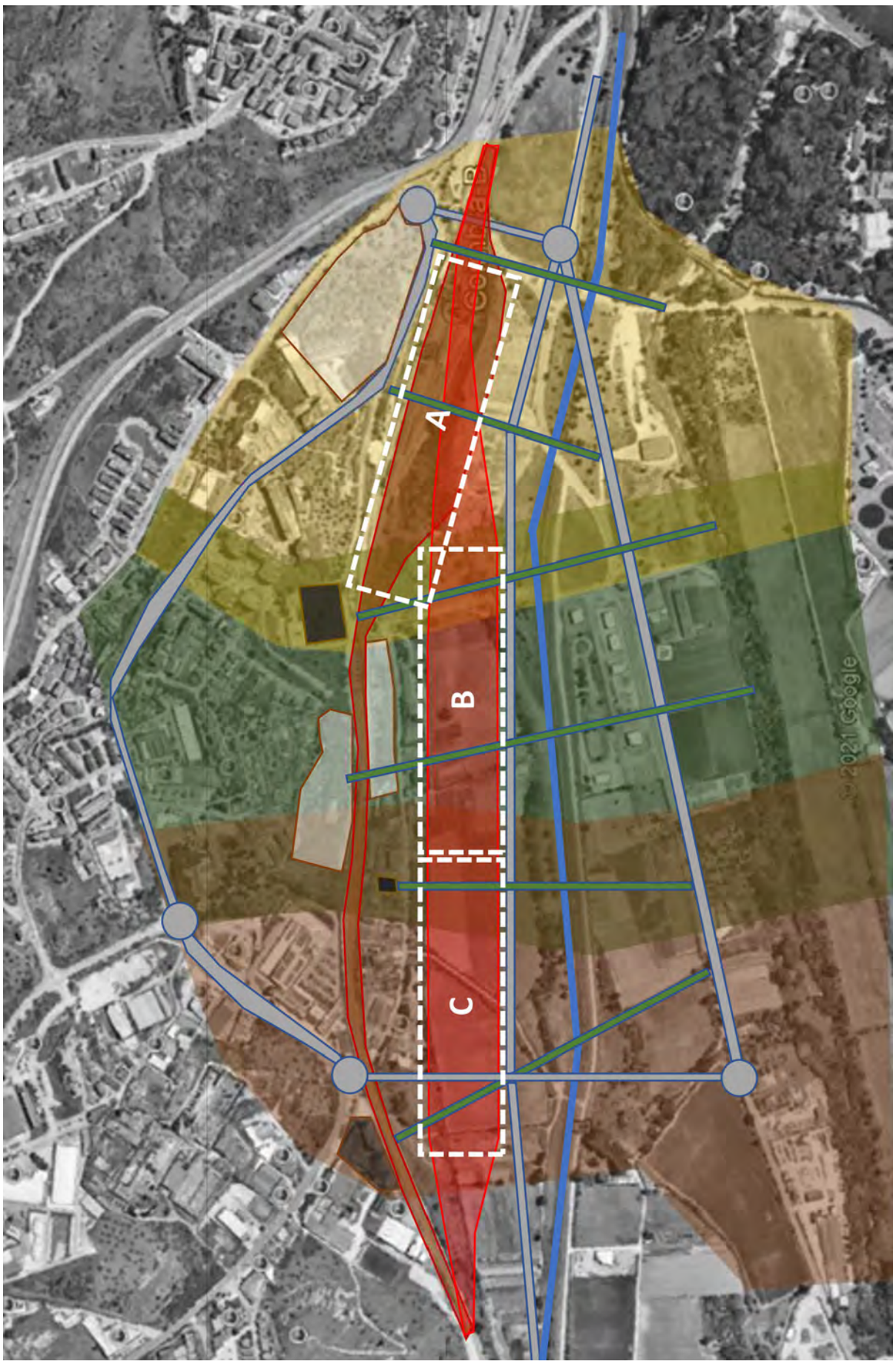


Figure 1: Diagram for groups A, B and C - Different placements for the railway station.

Introduction

This dissertation is within the scope of the Integrated Master in Architecture of Department of Architecture at the Faculty of Science and Technology at the University of Coimbra, specifically in Design Studio B (4th and 5th year), guided by Professor Nuno Grande. The thesis is integrated in the studio proposed subject – "Fast! Slow! Far! Close! The Multiple Cities Generated by the new Coimbra Railway Station," – in which the relations between the city and the urban infrastructures are studied and worked with. The initial premise was to develop a new urban design for the north entrance of Coimbra, given that the city will be part of the line that connects Lisbon and Porto in the new High-Speed Railway (HSR) system. This new infrastructure for Portugal seeks to offer "efficient transportation of people and goods, ensures access to jobs and services, and enables trade and economic growth"[1] inside the European Union.

As a starting point for the development of the students' strategies, the class was divided into three groups (A, B, and C, as seen in Figure 1, previous page), each with a different starting location for the train station. Each group assumed a unique urban metric and basis for the designs and their proposals were then submitted to the University Award Competition of the Lisbon Architecture Triennale 2022 (TAL – Trienal de Arquitetura de Lisboa), titled Terra. My group proposal detailed later in this dissertation (Group B) succeeded in advancing to the public phase of the competition and was part of the "Retroactive" exhibition, one of the TAL events presented at the Museum of Art, Architecture and Technology (MAAT) in Lisbon.

Through the evolution of the work, attendance at several conferences, open lectures, and public debates motivated important decisions in those strategies. As each group were initiating the design of urban proposals, the open lectures of Professor Luis Miguel Correia, and Professor Carlos Martins (both professors of DARQ/FCTUC) showed elements that needed to be taken into consideration for the following study of the group proposals and could also serve as inspiration. Correia presented a project for a train station under the Mondego River, which was developed in the Coimbra Architecture Summer Atelier 2021 (CASA), and Martins spoke, at the same event, about the Mondego River and how the hydrography impacts in the definition of the urban structure.

At an early stage of the group proposals, Ana Paula Vitorino, Chairwoman of the Board of Directors of the Mobility and Transport Authority (2021 – present), gave a lecture titled "The Influence of Transport in the Configuration and Performance of the Territory", in which she highlighted topics like the fight against climate change, inclusive territorial systems, and economic competitivity, linked to people and goods transport methods.

Joan Busquets, Catalan urban planner and architect, had designed a project for the new Coimbra train station in 2009. Busquets was invited to the University of Coimbra to present his latest book[2], and give a lecture on his project for a new railway station in Delft, Holland. In both presentations, Busquets focused on the importance of seeing the city as several layers that interact to generate a dynamic urban fabric.

In a conference organized by students of a previous cycle of the master's program, Silvia Claudia Benedito, architect and landscape architect currently teaching at the Department of Landscape Architecture at the

Harvard Graduate School of Design, talked about the connections between architecture and landscaping, in which there is a need to make the inside and the outside cohesive.

To incentivize discussion about the HSR system and the new station that Coimbra will need, the three proposals of each group were exhibited at the Anozero '21-22 Biennial of Contemporary Art of Coimbra, under the title of "Midnight Train". As part of this exhibition, weekend sessions guided by students and a public debate were held at the event's site: Lufapo Hub. The debate happened on June 2nd, 2022, and the guests were Ana Bastos, Coimbra City Council for Urbanism and Transport (2017 – present); Jorge Delgado, State Secretary of Urban Mobility (2019 – present); and José Reis, Professor at the Faculty of Economy at the University of Coimbra. The most relevant points of the debate were the uncertainty of which rail gauge would be used for the high-speed train, if in fact Coimbra would receive a 300+ kilometer per hour bullet train that would bring security and noise problems, and how the ecological and agricultural reserves would be safeguarded in this urban transformation.

As a conclusion of the class's participation in the TAL, a conference was planned by the students of Design Studio B on the discipline of Research Seminar[3]. For this conference, architects Cristina Veríssimo and Diogo Burnay were invited to present a summary of the TAL program and their experience as curators, followed by a Q&A session. An important takeaway from the Q&A session, common to all the students, is that even though the manufacturing of some stigmatized materials, like concrete, releases large emissions of CO2, the life expectancy and reduced renovations of the material can make it more environmentally friendly.

Adding to the theoretical development that conferences and open lectures offered to the project, many study excursions were done as a class and individually. As a first exposure to high-speed trains, the class journeyed to Spain, visiting Barcelona and Madrid. In Barcelona, the visited facilities were mostly directed for stablished communities and social housing cooperatives. The visits were to co-living complexes (La Borda by LaCol, and La Chalmeta by Pau Vidal and Vivas Arquitectos), a civic center (Lleialtat Santsenca by HARQUITECTES), a sport complex (Parc Esportiu Llobregat by Álvaro Siza), and the Barcelona Sants railway station. The high-speed train ride then led to Madrid, where we visited railway facilities and museums: the Atocha Station[4], ICO Museum, Caixa Forum, Matadero, and the Railway Museum. As part of a personal trip to the United States of America, a relevant visit was made to the High Line Park[5], in New York. This visit reinforced the importance of this case study and gave a clear example of how to deal with this kind of places which combine infrastructure, public space, and green areas. In Portugal, our Master class made daytrips to Lisbon and Porto. The most pertinent visit was to the Campanhã Intermodal Terminal[6], as this is also a built example of the combination of green rooftops within a transport facility.

The group B proposal was tasked with designing the train station in a new location, about 600 meters north from the current Coimbra-B station. The urban design we developed departs from a strip matrix that generates the sizing of facilities and public spaces, unifying their common aesthetic and functioning. The main goal of the group was to offer the Loreto neighborhood a safe and pleasant connection to the Campos do Mondego and the Choupal National Park via elevated linear parkways, and green accessible rooftops. With the train station in place and a standard organizing array for the urban intervention, the new strategy could then include a multipurpose building, several types of housing (co-living, co-housing, and single-family homes), co-working spaces, a sports complex, and three Metro Bus stops, a market, and a bus terminal also connected by elevated parkways.

The title of this dissertation "Green Invasion" refers to the takeover of nature in a large scale of the urban and architectural conception. Contemporary urban and architectural design disregard nature and its benefits to human and environmental wellness, opting for the proliferation of paved surfaces, lack of public green spaces, and giving priority to private road transport. The concept of "biophilic design" is on the rise following the global concern about environmental issues and with better knowledge of the human psyche. The nature planned for this place is not of invasive species which are not native, but that of already established species and plants that will benefit the environment and the residents alike. The cataloguing of the trees and plants present in the Choupal National Park helps us to reduce uncertainty around what type of greenery to place and helps integrate this new urban development into the existing surroundings.

Train stations are nodes of different networks, so it is logic to assume them as the connection between

other infrastructures, services, and activities. In this dissertation, the facilities to be developed, within my individual proposal, are the train station, the bus terminal, and a biological market, but also the pedestrian connections between those facilities and the agricultural activities of the Campos do Mondego, including the linking of two green parks – the existing Mata do Choupal and the proposed Loreto Park. That is also the reason why our group strategy, exhibited at the Lisbon Architecture Triennale, was labeled: "Connecting Loreto to Choupal: an urban-rural continuum".

This dissertation is structured into six chapters: 1. Key questions, Goals and Methodology; 2. State of Art; 3. Case Studies; 4. Site Analysis; 5. Project; and 6. Conclusion. In the first chapter, issues, restrictions, and conditions will be defined and solutions presented, along with how those solutions were devised. The second chapter contextualizes this thesis in the most recent and relevant literature. The case studies are organized by scale of the intervention and the time in which they were visited, except for Parc de la Villette since the project by OMA was not built. In the fourth chapter, I present the analytical work, developed by the Master class, compiling municipal guidelines and site maps which accurately classify and diagnose the project site. The fifth chapter is organized into two main parts: Group Strategy and Individual Project. This second part is additionally divided into the architectural proposal, the construction solutions, a flora catalogue, and an analysis of the environmental impact of the intervention. Lastly, in conclusion, a personal reflection of the project and the work developed will take place.

The work developed in other Master units during the two academic years of 2021-22 and 2022-23 aided in the project solutions and decisions. The Unit of Project Organization and Professional Practice (OPPP – Organização de Porjeto e Pratica Profissional) helped in the application of universal design and accessibility requirements in the project. In the Virtual Architectures Unit (VA), digital models were designed as to test different shapes and forms of the distinct buildings in the project. The units of Research in Architecture (IA – Investigação em Arquitetura) and Research Seminar (SI – Seminário de Investigação) were essential for the theoretical conceptualization of both the design process and project thesis, which was the base for this dissertation. In Construction of Buildings – Conditions for Design and Constructive Practice I (CEI – Construção do Edificado I) the project reached the materialization stage, where construction details helped to show how the project would be built. Lastly, in Design Studio I and II (AP – Atelier de Projeto), the group strategy and the individual proposal were developed from an architectural standpoint. At the end of each of the three semesters, the work at each stage was presented to a critics' jury. For the first session in February 2022, Councilor Ana Bastos, and Prof. José António Bandeirinha were invited; in the second session in July 2022, the works were presented to Prof. Carlos Martins and Prof. Guilherme Vaz, and for the final session in February 2023, the guests were Prof. José Fernando Gonçalves, Prof. Teresa Novais, Prof. Jorge Carvalho and Prof. Alexandre Dias.

[1] "Trans-European Transport Network (TEN-T)," European Commission, accessed April 11, 2023, https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t_en
[2] Joan Busquets, *Urban Grids* (Novato, California: ORO Editions, 2019)
[3] Further information later in text.
[4] See chapter 3.2 Atocha Station, Madrid, Spain, Rafael Moneo, 1992
[5] See chapter 3.3 High Line Park, New York, Diller Scofidio + Renfro, 2009
[6] See chapter 3.4 Campanhã Intermodal Terminal, Porto, Nuno Brandão Costa, 2021

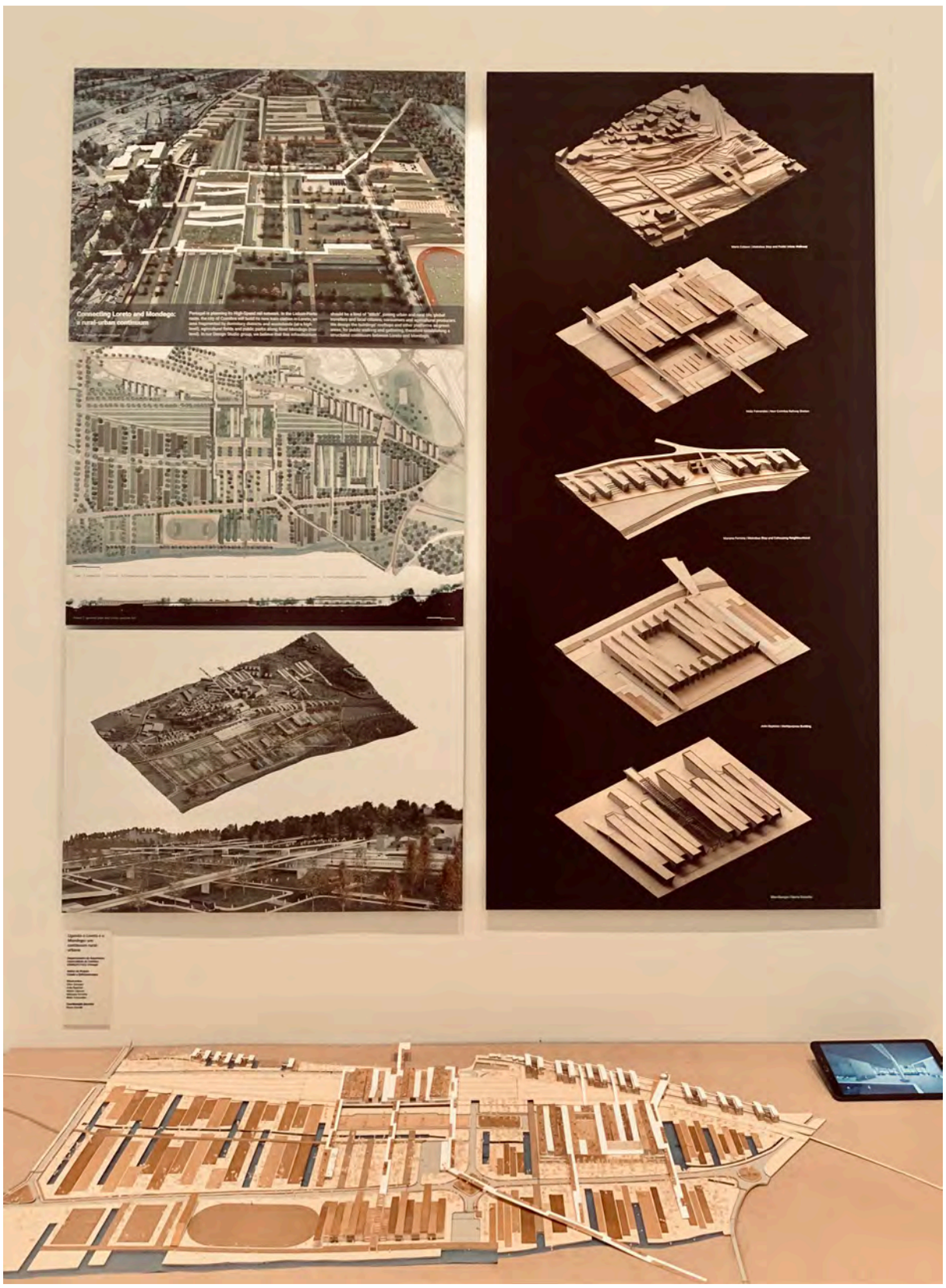


Figure 2: Exhibition of the group work at the Lisbon Architecture Triennale 2022 at MAAT.

1. Key questions, Goals and Methodology

With the arrival of the High-Speed Railway (HSR) System in Portugal, how can mobility infrastructures, railway, road, and trade, maintain an interconnection between the rural-urban surroundings? And for that, can we use a biophilic urban and architectonic design, promoting a sustainable revitalization of the north of Coimbra?

The National Railway Plan 2021-2030 (PFN – Plano Ferroviário Nacional), presented in April of 2021, proposed the construction of a HSR between Lisbon and Porto to cut the trip time from two hours and forty-nine minutes to an hour and fifteen minutes. In final documents of the PFN, published in November of 2022, the Ministry of Infrastructure proposes that 50% of all road traffic be changed to railway use by 2050, which will reduce emissions by 60%. This intervention, phased into two parts, forces Coimbra to restructure the whole of the current station, moving it north so that the train can cross Mondego and make a larger curve to get into the new platforms. In the new station, 2 new platforms and 4 railway lines must be added, to the current service, to include the HSR.

Architecture and construction contribute to 37% of greenhouse gas emissions into the atmosphere[7], which then lead to aggravated symptoms of climate change. Many buildings of the last century were at fault of being mono-functional and notwithstanding the evolution of the population for different applications, leading to demolition for the reuse of the same land lot. As urban areas become more densely populated, constructions must be flexible in their purpose so as not become obsolete.

The Lisbon Architecture Triennale 2022[8], provoked the reflection on architecture's role in the relationship between humans and the environment, which is evident at multiple levels, such as the territory, the city, and landscapes. The Triennale was sectioned into four categories: Multiplicity, Retroactive, Cycles, and Visionaries. The "Retroactive" exhibition referred to "broken cities", curated by Loreta Castro Reguera and José Pablo Ambrosi, like those that have seen a spike in the population but have not grown to accommodate them. The outskirts of those cities continue to deteriorate, and in this way, they need self-reflective infrastructures that may "retroactively" introduce cohesion in their urban fabric.

As examples of "broken" areas, Loreto and Pedrulha, in the north of Coimbra, need to be "sutured" or "stitched" to accomplish that urban cohesion. The arrival of new transport infrastructures and networks to those areas may constitute a good trigger for that urban "stitching". For that purpose, our group started by analyzing the Municipal Master Plan (PDM – Plano Diretor Municipal); and then mapping the current state and use of built and non-built spaces in the study area, as well as the evolution of the built areas. Finally, we made research on demography, identifying localized problems and undesirable realities, and providing perspectives into the guidelines foreseen for the city of Coimbra and its outskirts, especially for Loreto and Pedrulha.

In the PDM, specific areas are delimited for the organization and application of territorial goals. These areas are designed as Operational Planning and Management Units (UOGP – Unidades Operacionais de Planeamento e Gestão). UOPG 3 relates to the north entrance of Coimbra and the new city station,

englobing a large part of our study zone and pointing some of the requirements for our urban intervention. Apart from the new train station planned for this area, it is envisioned that there will be the construction of a multipurpose building, new road connections, economic facilities and housing spaces, aiming to the urban cohesion with the surroundings. Although this periphery of Coimbra counts as a large green infrastructure, composed of agricultural fields and woods, the municipal goals do not mention the need for urban agriculture to settle here.

The protection of existing agriculture fields and irrigation canals adjacent to the Mondego River, the conservation of permeable ground, making the pedestrian and soft mobilities a focal point for the better use of public space by residents and people coming into Coimbra, and making public space welcoming for multiple activities are some of the starting points of our urban intervention. When first confronted with the work site, the abundance of greenery and the lack of people utilizing these spaces, as well as the difficult circulation of pedestrians, caught a lot of attention as these areas hold immense leisure potential.

The individual goals for this dissertation and its architectural proposals – new the train station, a bus terminal and a biological market – seek: to promote the connections of these with the rural-urban surroundings; to apply the concept of biophilic design into the proposed buildings; to catalogue the existing flora that must be protected and suggest others that would be beneficial to residents; and also to demonstrate the possibility of large buildings and urban interventions to have minimal environmental impact. These goals come from a personal desire to develop the mentioned facilities as multi-functional "monuments" of the contemporary city, adapted to the evolution of the population and of the place; or, as described by Reguera and Ambrosi, designing them as "retroactive" infrastructures.

To solve the mentioned problems and goals, the design process went through three stages along the three semesters from 2021-2023. In the first semester of work, class and group projects were developed; in the second semester, the individual work was focused on architectural solutions; in the third semester detailed solutions were refined related to the building construction. As a class, the making of a 1:1000 scale model took place at the start of the master's program. This model assisted in the understanding of the topology and urban building typologies present in the study area. Later that same semester, the site analysis was compartmentalized into actions that required the compiling of existent maps, the making of new maps, and the examination of censuses data, assigned to the different groups[9].

In the group stage, simultaneously with the making of the class model, each group (A, B, and C, as seen in Figure 1, page 8) was tasked with arriving at a logic for the urban strategies. Group B opted on design-based research, where many drawn proposals were discussed together with the professor. For the submission to participate in the University Competition of the TAL, three panels were put together, the first being a photo montage of the group model, the second with a plan and section of the proposal, and the third with an exploded axonometry and a rendered image of the train station.

After submitting to the competition, the different building proposals were distributed to the different members of the group. As said, the author of this dissertation received the responsibility of designing and detailing the new railway station as well as the market and the connections between the three constructions. The individual project had its start through design-based research and virtual models, that were then tools for discussion with the professor in Design Studio. The construction of a 1:300 model of the train station facilitated the grasp on interior organizations, circulations, and distribution of green areas along the rooftop and elevated ramps. Floor plans, cross sections, an exploded axonometry, a split axonometry, and renders were produced until the end of the 2021-2022 academic year. Simultaneously, the thesis project was being worked on as part of the Investigação em Arquitetura class. The class trip to Spain also happened in this semester, and the trip to the USA happened during the summer vacations.

The final semester of Design Studio was focused in reviewing situations that needed to be fixed from the involvement of the unit Construção do Edificado I. The detailing of structure and building materials demanded changes in the project developed the previous semester. A section of the railway station was detailed in design at 1:50 and 1:10 scales, and a 1:20 constructive model. Based on the section detailed, an analysis of the CO2e emissions of the building materials took place[10]. An initial groundwork into the local trees and plants of the study area, as well as an interview with landscaped architect Duarte Natário, were part of a research activity presented in the practical component of the unit Seminário de Investigação.

[7] United Nations Environmental Programme, "2022 Global Status for Buildings and Construction", NA: UNEP, 2022, https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction
[8] Lisbon Architecture Triennale, "2022 — Terra", Trienal de Lisboa, December 5th, 2022, https://www.trienaldelisboa.com/programa/trienais/2022 (Accessed on April 11, 2023)
[9] See chapter 4. Site Analysis
[10] See chapter 5.2.4. Environmental Impact

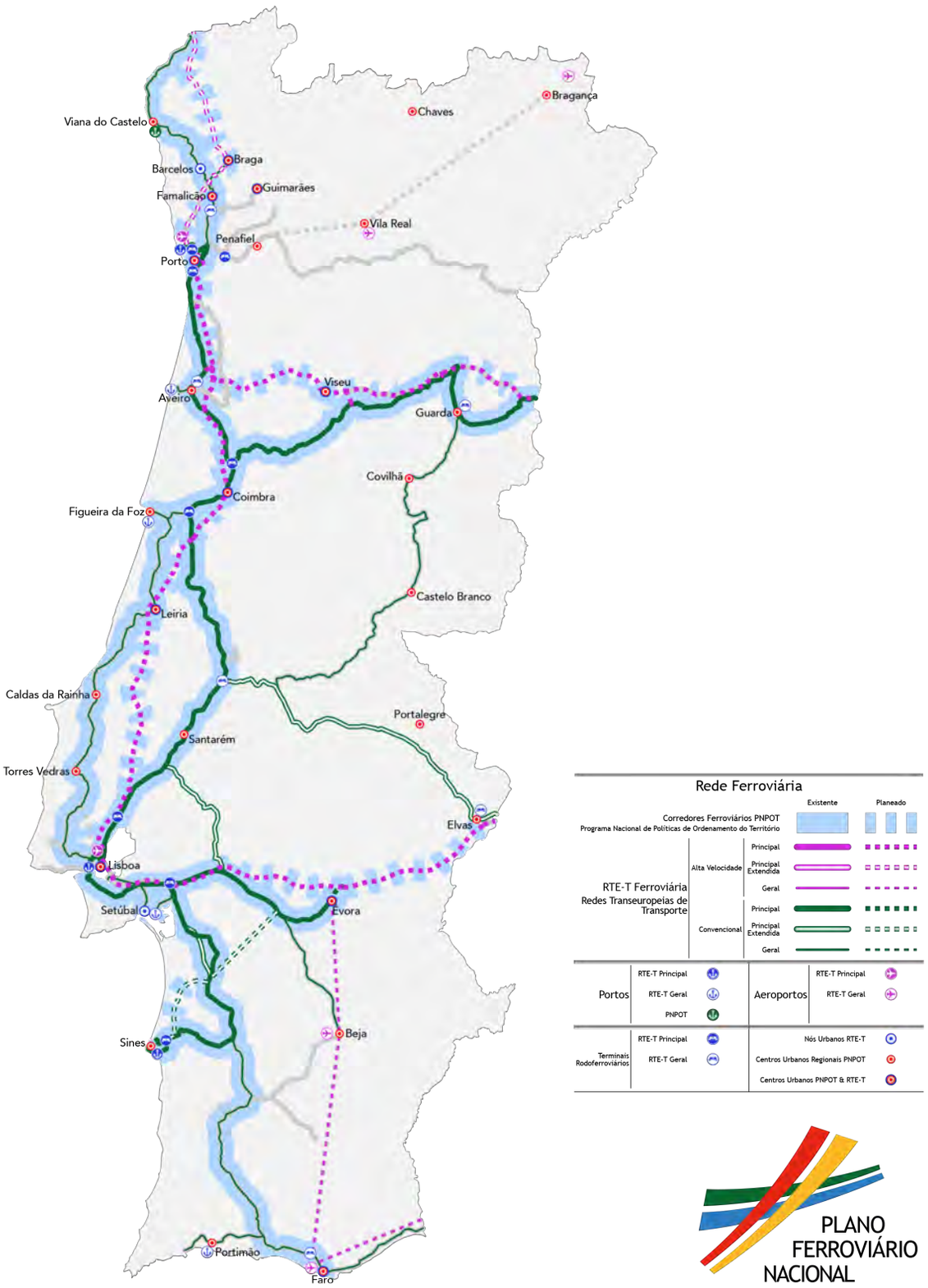


Figure 3: National Railway Plan - Diagram of existing and foreseen railway lines.

2. State of Art

The European Commission proposes a Sustainable and Smart Mobility Strategy in which the goal is to reduce transport-related greenhouse gas emissions by 90% by 2050. For this the Commission suggests increasing the uptake of zero-emission vehicles, making sustainable alternative solutions available to the public and businesses supporting digitalization and automation improving connectivity and access.

For Portugal to advance in reaching the European goals, the National Railway Plan (Plano Ferroviário Nacional – PFN) proposes to increase the modal quota of passenger transport to a 20%[11] securing quality connections to the 28 most relevant urban centers. One of the objectives of the PFN is the introduction of the High-Speed Railway (HSR), that would serve 10 cities of the previously mentioned 28, eventually connecting Portugal and Spain in a 3-hour train ride. The first stage consists in building a new line that travels between Lisbon and Porto, with stops in Leiria, Coimbra, and Aveiro. This new railway line is denominated as the Atlantic Axis.

The need for this new line has been identified since the start of the 21st century, studied and discussed until the present day. The most discussed subject is where the line will pass through and in what type of gauge. The Iberian Peninsula has a wider gauge (1668 mm), and the international standard gauge (1436 mm) is most used in other high-speed trains across Europe. This difference means that if Portugal chose standard gauge, the new trains would not be able to use the existent train lines and the connection to Leiria, Coimbra, and Aveiro would be more difficult. In the PFN of 2022 it is finally reported that the Iberian gauge would prevail and the connection to the previously mentioned cities would be done in the current train stations, using the Northen Line (Linha do Norte) path.

The Atlantic Axis has been known about since the early 2000's, and in Coimbra the delimitation of an Operational Planning and Management Unit (Unidades Operativa de Planeamento e Gestão – UOPG) was set for the requalification of the area around the Coimbra-B Station and the insertion of the new railway line. In 2009, Joan Busquets was invited to design this new entrance into Coimbra. The Catalan architect is currently the first Martin Bucksbaum Professor in Practice of Urban Planning and Design at the Harvard University Graduate School of Design. In the project, Busquets proposed new housing, a business center, office compounds, a multipurpose building, and a new train station with connection to buses, all these integrated in a new urban design. The new train station needed to be built more than a kilometer north of the current, foreseeing that the high-speed train needed to slow down a longer distance in advance. With the economic crisis in 2011 the project was never applied but the need to rethink this area of the city and create a new centrality lingered.

Themes mentioned in Urban Grids: Handbook for Regular City Design (2019) by Joan Busquets, can be implemented into the requalification of the entrance of Coimbra. The grid is praised as "an idea not of weak thinking, but of inclusive comprehension, capable of responding to social and environmental demands of varying scales and maintaining its operative capacity in the long term." The grid has been used in many different settings, with very different cultures and in different time periods. This urban design strategy

comes from social interactions between people of different backgrounds, that then come to consensus on rules and conventions. Although it may seem like a rigid structure, the potential for variation is huge. As technologies develop and societies change, the grid is flexible enough to accommodate to those changes. A defining element in the implementation of the grid design is that built space and public space are regulated and strongly interlinked.

The potential for expansion and densification of the urban fabric is more practical when there is proper public space, that dignify interpersonal interactions. Loreta Castro Reguera and José Pablo Ambrosi point out in their text "Retroactive infrastructures in the broken city" (2022) that for a successful public intervention in urban settings there needs to be "healthier outdoor areas" that then encourage the population to engage their urban, natural and culture contexts and allow people to interact physically.

To offer healthier outdoor areas, the presence of pollution, insecurity and grey structures must be kept in check. Many urban ills come from improper aeration, heat islands, proliferation of water-resistant pavements, food insecurity and water pollution, that then contribute to Climate Change and deteriorate human health in all levels. A very effective way to restore and repair these situations is by creatively inserting nature back into the urban fabric. Humans are hardwired to need a connection to nature and other beings since it is the environment in which we have evolved and historically thrived. There has been scientific research that shows that our exposure to nature can reduce stress, enhance positive mood, improve cognitive skills and academic performance, reduce healing times, and lower the likelihood of obesity. Edward O. Wilson (1986), biologists, naturalist, ecologist, and entomologist, popularized the term "biophilia" to describe the innate connection humans have to nature and other forms of life. In this way, Timothy Beatley (2011) talks about the concept of "biophilic city" as "an outdoor city, a physically active city, in which residents spend time enjoying the biological magic and wonder around them."[12]

Another important factor in the biophilic city is the sustainability of architectural interventions. Historically, architecture looks to be monumental, imposing and sometimes intimidating in its grandness. As of 2022, architecture and construction contribute in 37% of greenhouse gas emissions into the atmosphere.[13] To add to this, James Wines (2000) mentions that buildings also "consume one-sixth of the world's fresh water supply, one-quarter of its wood harvest, and two-fifths of its fossil fuel and manufactured materials. As a result, architecture has become one of the primary targets of ecological reform."[14]

Wines uses the term "environmental architecture" to describe the buildings that show an effort to be "eco-centric" instead of "ego-centric". Some buildings are portraited as environmentally friendly because of the technologies like "recycled materials, thermal (smart) glass, energy efficient construction methods, and photovoltaic solar collectors." These so-called environmentally friendly solutions in poorly designed new buildings make these mere exposition spaces for the new technologies. Aesthetic value of constructions is very important because "without art, the whole idea of sustainability fails. People will never want to keep an aesthetically inferior building around, no matter how well stocked it is." People need to be incentivized to connect to nature and "address the deeper social conflicts caused by a collective state of denial." A designer's place is that of connecting cultural diversity, societal changes, the tangible environment, and the growing importance of ecology.

The above-mentioned readings are very well reflected in the paper by Phillip Roös, David S. Jones and Joshua Zeunert, titled "Biophilic-Inspired Railway Stations: The New Frontier for Future Cities".[15] In this paper the authors explain that railway stations are generators of high human circulation, and these are evolving to not only be "purely functional transit spaces" but also activity and congregation places. For the benefits of biophilic design to be effective, train stations are the perfect platform for repeated exposure to nature for the travelers and residents around the building. An example of some of the elements of biophilic design that were observed and that can be implemented in new constructions are the "Environmental features", "Light and space", "Place-based relationships", and "Evolved human-nature relationships."

Each of these references comes to be important in the context of the study area and architectural interventions. The PNF sets a political purpose to the north entrance of Coimbra, while understanding that this area is a periphery of the city and there is a need for a retroactive infrastructure to help revitalize it. The application of grids contributes for the structuring of this urban group strategy and biophilic design "stitches" the intervention together with the local context of the residential areas (Loreto and Pedrulha),

the human-built infrastructure to be implanted, and the existing natural strata (Campos do Mondego and Choupal National Forest).

[11] República Portuguesa. *Plano Ferroviário Nacional*. Page 6. 2022.
[12] Timothy Beatley, *Biophilic Cities: Integrating Nature into Urban Design and Planning* (Washington, DC: Island Press, 2011)
[13] United Nations Environmental Programme, "2022 Global Status for Buildings and Construction", NA: UNEP, 2022, https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction
[14] James Wines, *Green Architecture* (Hohenzollernring, Köln: Taschen, 2000)
[15] Roös, Phillip, David S. Jones and Joshua Zeunert, *Biophilic-Inspired Railway Stations: The New Frontier for Future Cities*, ResearchGate, 2016, https://www.researchgate.net/publication/310047442_Biophilic_Inspired_Railway_Stations_The_New_Frontier_for_Future_Cities

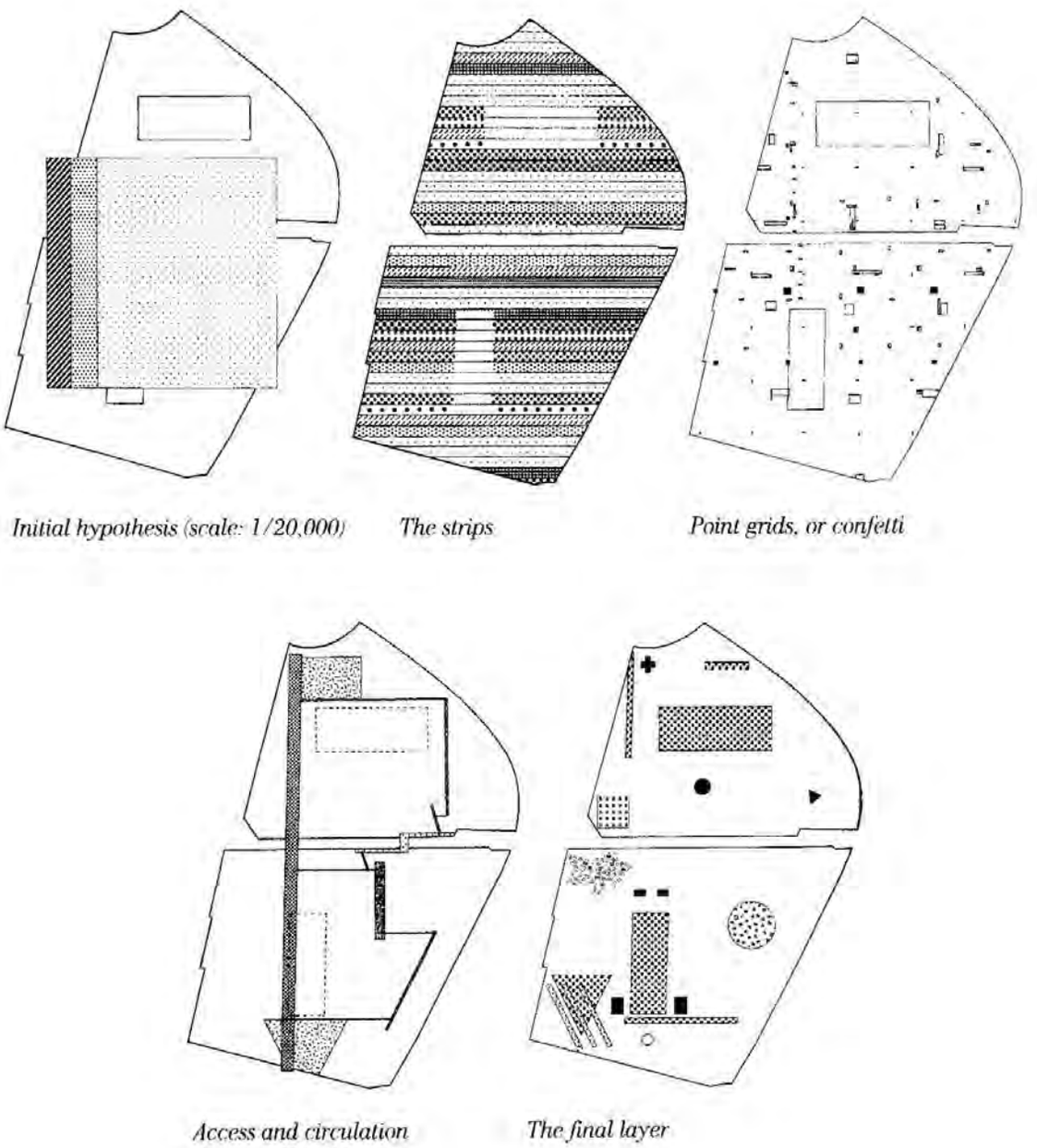


Figure 4: Diagram of Parc de la Villette. Proposal by Rem Koolhas, OMA.

3. Case Studies

3.1. Parc de la Villete, OMA, 1982, Paris, France

La Villette is a neighborhood in Paris, that in the 19th century became an important intersection and transportation point. Because of this the neighborhood grew from a suburban zone into a centrality and problems of urban scale and culture started to emerge.

In 1982-83 an international competition was open to revitalize the abandoned and undeveloped land from the French national wholesale meat market and slaughterhouse in Paris, France. The main goal was the creation of a new public park in the area. One of the 470 entries was from the OMA studio with Rem Koolhaas.

OMA's project did not define a definitive green area but a "method" that could be applied to the vacant lot to generate the future park. The proposal was versed of five principles: the first idea was that "the major programmatic components are distributed in horizontal bands across the site, creating a continuous atmosphere in its length," the second idea talks about other facilities being "distributed mathematically;" the third idea mentions a "round forest" as architectural elements; and the fourth and fifth ideas are about connection and superimpositions, respectively.

The group's strategy evokes the mentioned proposal for the Parc de la Villette as both intervention sites were undergoing rapid population growth, and both projects required the integration of new infrastructures into the urban fabric. The group takes on the general structure of "bands," distributing the different components in vertical strips. The concept of connection is applied when designing ramps and catwalks that provide easy access to all the different purposed buildings. And finally, the superimpositions are present when elevating the strips allowing for different foot and motorway passages at different levels.

Figure 5: Photo of Atocha Station - Indoor tropical garden.

3.2. Atocha Station, Rafael Moneo, 1985, Madrid, Spain

The railway complex of Madrid Atocha, also known as Madrid Puerta de Atocha, is in the Arganzuela neighborhood, just south of the center of Madrid.

Atocha was Madrid's first railway station inaugurated on 9th of February of 1851. Initially the station was built as a private luxury for royals but slowly had to expand and adapt its facilities to a larger number of passengers. After an unexpected fire in 1864, that destroyed large part of the wooden building, a competition was open for the new building. The winning design of the architect Alberto de Palacio y Elissagne, collaborator of Gustave Eiffel, was elected in 1883 and the new station was inaugurated in 1892. The train platforms were covered with a roof in the shape of an inverted hull with a height of approximately 27m and a length of 157m.

With the passage of time and the evolution of technology, the train station needed to expand and update its railway lines, causing further remodeling. In 1985, Rafael Moneo started a new urban and architectural renewal project, using an adjacent terrain to accommodate High Speed trains (AVE trains), regional (Cercanias), local commuter lines (Metro) and buses. In 1992, the original industrial revolution building was repurposed to house shops, cafés, and a nightclub. Additionally, inside the large open area of the old station, a 4,000m2 covered tropical garden was implemented. This reform of the old station building into a meeting place with a garden feature turned Atocha into a multipurpose and more enjoyable place.

Even though the Atocha Station is near large parks and gardens, the implementation of greenery in the close vicinity or even on the inside of the building makes the daily interaction with nature more accessible to the users of the different types of transport. This aspect of the building will be evoked in the individual intervention detailed later in this dissertation.

Figure 6: Photo of High Line Park - W 30th Street, New York.

3.3. High Line Park, Diller Scofidio and Renfro, 2004 New York, USA

High Line Park in New York is located on the Manhattan Island, south of Central Park, and it was built over an old, elevated railway system that used to cross the West Side area. The park now has an extension of 2.37km, is elevated 9m off the ground and in most parts in 12m wide.

In 1847 the City of New York authorized the construction of train lines at street level to transport products to Manhattan by freight train. Theses trains were dangerous to pedestrians and caused many deaths. It was only in 1924 that the line was elevated off the streets to ensure people's safety. In the mid-late 1900's the railway was discontinued due to the increased use of trucks to transport those same products through the city. The railway system was left neglected until the community took responsibility, in 1999, to repurpose and maintain a public space on the top of the infrastructural platforms. The park strategy and design were coordinated by a multidisciplinary task force which included the office Diller Scofidio + Renfro (architectural design), James Corner Field Operations (landscape design) and Piet Oudolf (planting designer).

The park was designed and inaugurated in three different phases. In 2009 the first segment of the park was opened from Gansevoort St to 20th St. which accounts for 820m; in 2011 the second segment was an additional 850m from 20th St. to 30th St.; and in 2014 the last segment was open, from 30th St. to 34th St. making up the last 700m.

The High Line Park has a large variety of plants, such as grasses, shrubs, and trees chosen for their hardiness and sustainability. The plants are changed every season, to offer different moods and compositions.

Inspiring the interventions detailed in this dissertation, this park exhibits a safe way for people to enjoy the city and still have motorized transportation below. It also helps insert green infrastructure into the urban fabric, allowing people to enjoy a change of scenery and a clean-feeling environment as they walk through the city. On a contrary practice, the vegetation planned for the green rooftops, ramps and catwalks in this dissertation are meant to keep all year around and support the wellbeing of residents and travelers, as well as expand their knowledge of what exists in the surroundings of the intermodal station.

Figure 7: Photo of Campanhã Intermodal Terminal - Entrace coming from railway station.

3.4. Campanhã Intermodal Terminal, Nuno Brandão Costa, 2022, Porto, Portugal

The Campanhã Intermodal Terminal is in Porto, Portugal, more specifically between the parishes of Campanhã and Bonfim, east of the Campanhã train station.

On August 26 of 2016 the Town Hall of Porto opened the international contest for the construction of a new bus terminal, connected to other transport modes. The place for the construction was chosen on the outskirts of Porto, making it easier for buses to arrive without having to enter the busy city center and have an easy connection to the railway station and metro infrastructure. The winning proposal was known in February of 2017, being that of Nuno Brandão Costa. The construction only started in September of 2019, and it was finalized and inaugurated in 2022.

The terminal is designed in two main levels: the top level has services, and the bottom level has the bus docks and parking lot. On the top-level, people arrive from the train station meeting different services: toilets, cafés, waiting rooms, administrative, and support offices. These have glass fronts so that people can still see the gardens on the other side of the connecting hallway, which leads to the lifts, stairs, and escalators to access the bus docks. The arrival of passengers to the terminal is done at the "kiss and ride" roundabout on the bottom floor. The roundabout is populated with plants and is illuminated via zenith light. The terminal includes extensive green roofs, which stand in contrast to the concrete construction. This makes the building bend into the topography of the place and repurposes the abandoned land into a park.

This building inspires the railway station in this dissertation in multiple aspects. The separation by levels of users from motorized transport offers safety as well as different environments. The concrete construction provides a strong support for the green roofs and gardens.

4. Site Analysis

A series of thorough analyses were conducted to strengthen both the group and individual proposals. These analyses help to understand the work site, uncovering situations that can be solved by design-based research. The tools used for the analyses were the Municipal Master Plan (PDM – Plano Diretor Municipal), direct observation of the site, along with census data.

The Territorial Management Instruments (Figure 8, page 36) shows the territorial organization and different development areas of the County of Coimbra. The study area has important transport infrastructure like the Northen Line (Linha do Norte), important roads, namely the Complementary Route 2 (IC2) and the National Road 111-1 (EN 111-1) and incorporates three Operational Planning and Management Units (UOPG – Unidades Operativas de Planeamento e Gestão): UOPG 1 - City of Coimbra, UOPG 3 - West Entrance and New Coimbra Central Station and UOPG 4 - Estaco and Surrounding Area.

The National Agricultural Reserve (RAN – Reserva Agrícola Nacional) and the National Ecological Reserve (REN – Reserva Ecológica Nacional) (Figure 9, page 37) highlight the importance of the presence of agricultural spaces, of green areas for recreation and leisure, of green areas of protection and framework, areas of maximum infiltration and areas threatened by floods. These areas influence the decisions of the group proposal to guarantee the lowest environmental impact on the area from the large infrastructures foreseen in the PDM.

Given that the work site is on a city periphery, the study of what type of green areas is important to properly intervene on the place. The map of green spaces (Figure 10, page 38) shows that inside the study area there is both rural and urban greenery, both with protection conditions. The Choupal National Forest and the Campos do Mondego are both the largest areas of rural green in Coimbra. The group strategy carefully maintains as much vegetation as possible.

The analysis also looked at the foreseen housing spaces, economic activity spaces and special use spaces that are present in the study area (Figure 11, page 39). This analysis helps to clarify what types of services are needed and should be included in the group proposal.

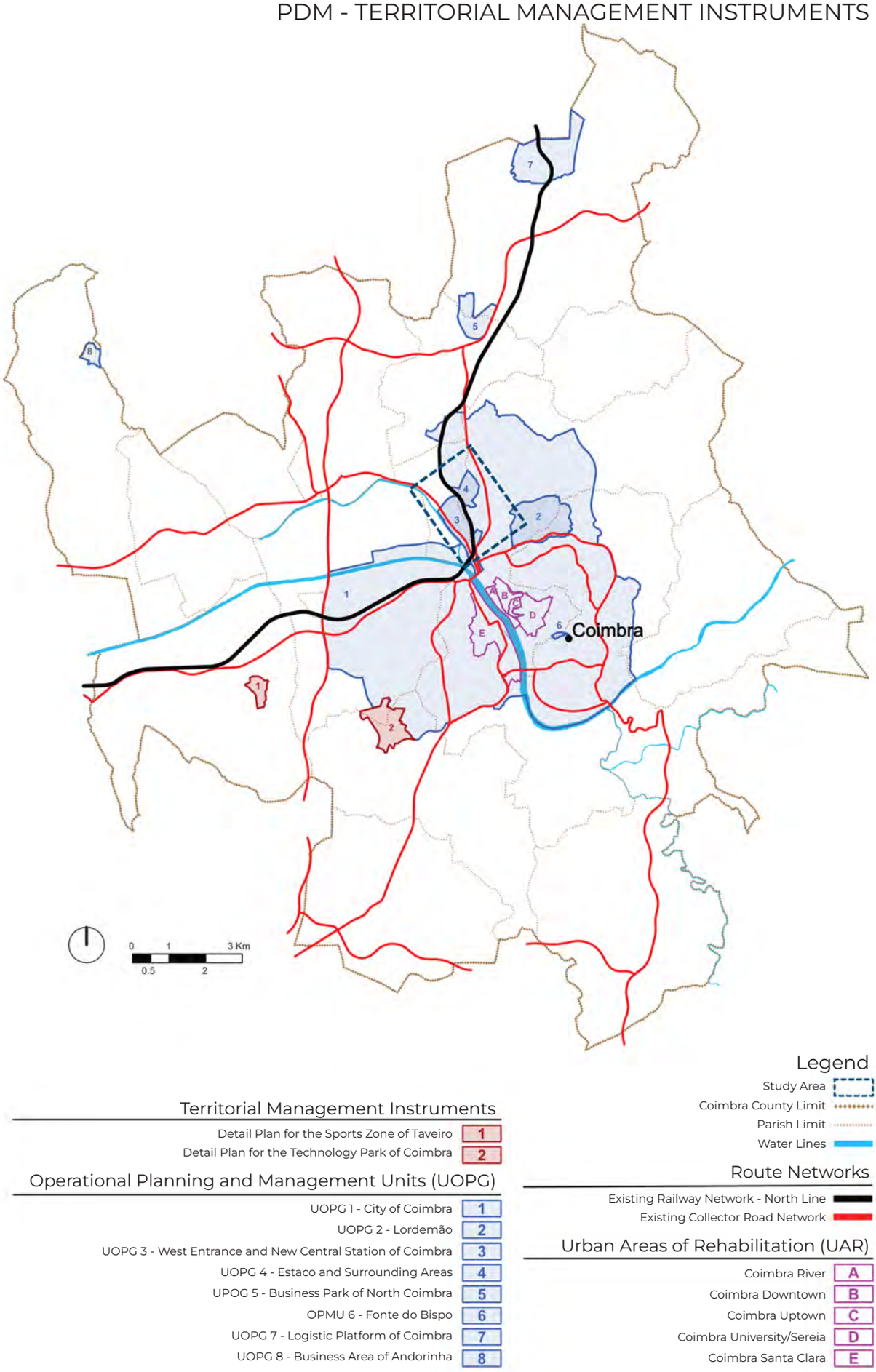


Figure 8: Analysis map of Territorial Management Instruments.

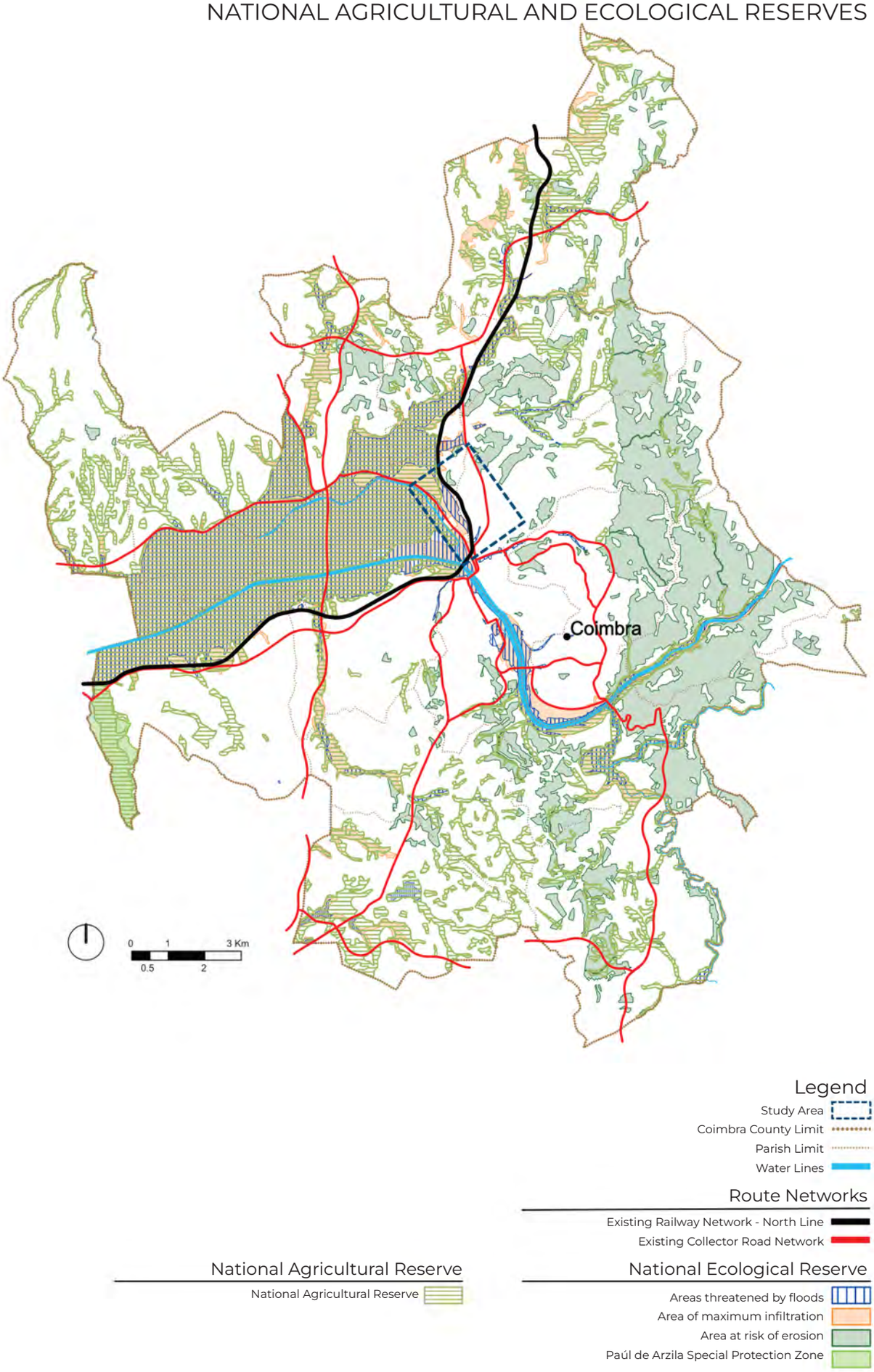


Figure 9: Analysis map of National Agriculture and Ecological Reserves.

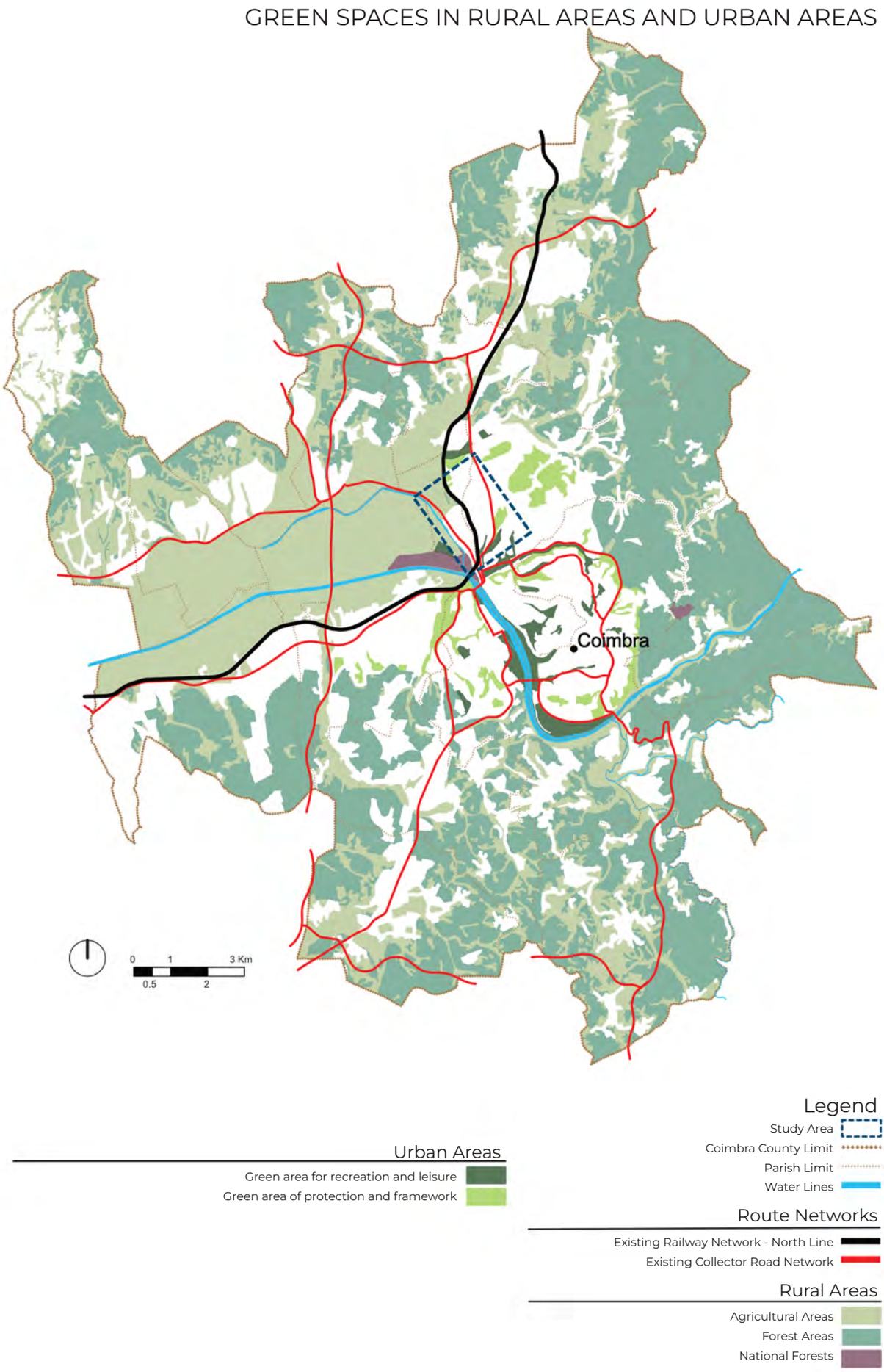


Figure 10: Analysis map of green spaces in rural areas and urban areas.

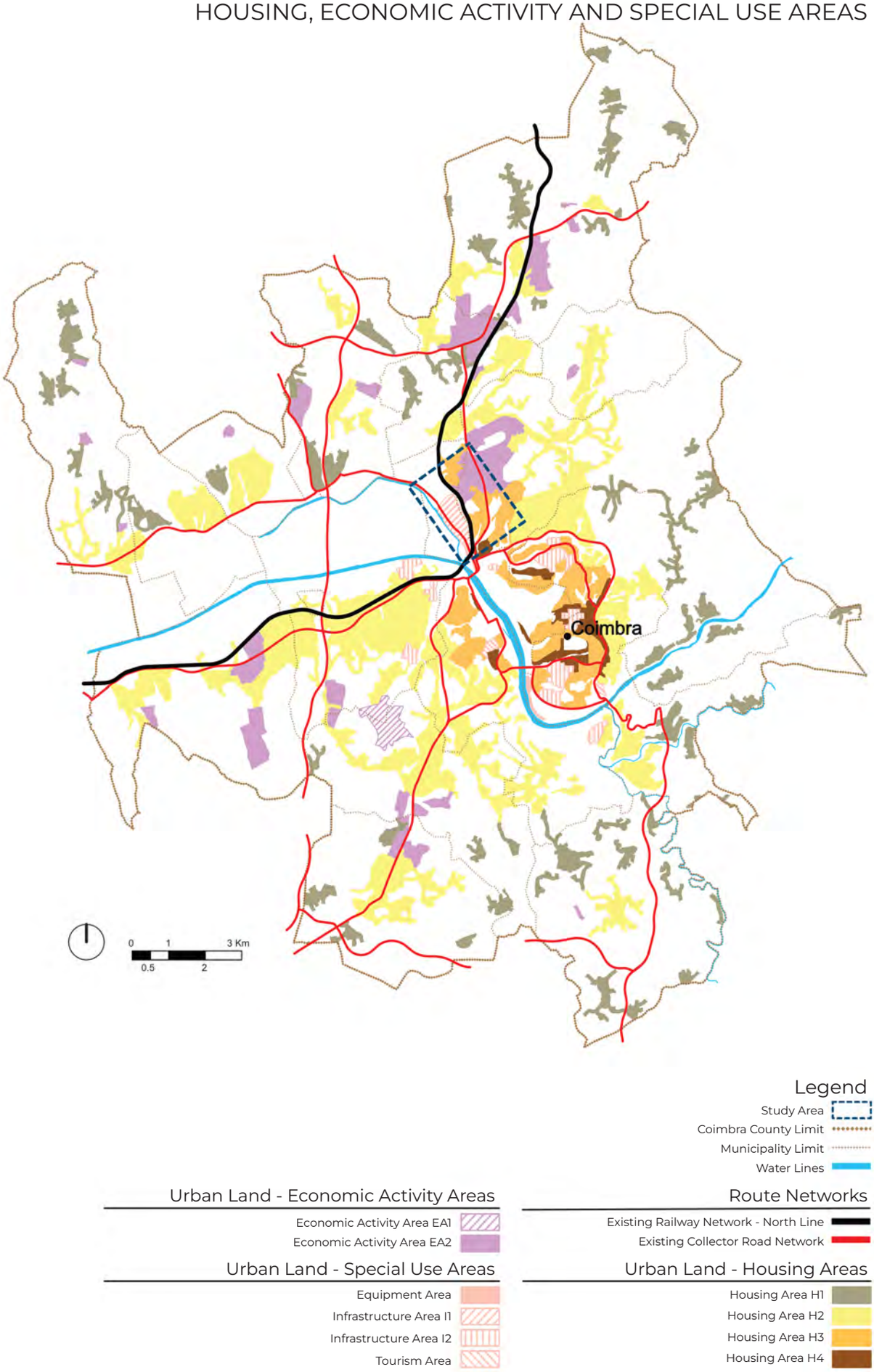


Figure 11: Analysis map of housing, economic and special uses areas.

Land use regulations

As mentioned before, the study area includes three UOPGs, but the group intervention mainly coincides with the UOPG 3 (Figure 12, page 42). The main objectives are: to promote the integration of the Choupal National Forest and the areas of Campos do Bolão, Loreto, and Pedrulha with the historical city center; to reinforce the natural environments; to construct an intermodal station that combines different forms of railway and road transportation; to promote different uses that are complementary to the station; to construct a multipurpose building with the capacity for five thousand seats; to promote parking lots with "park & ride" characteristics; to promote accessibility; and to ensure all buildings are constructed starting at a minimum of 15.20 meters above sea level, avoiding possible floodings; and the integration with the UOPG 1. It is important to mention that urban agriculture is not mentioned in the objectives, but there is available natural infrastructure to support it and it is considered an essential activity that needs to be integrated for the benefit of the citizens.

For a closer analysis, the study area was defined by the class, to the south by the Coimbra Bridge Dam, to the north by Triunfo Factory, to the west by the Choupal Wastewater and Sewage Treatment Company (ETAR do Choupal) and the Choupal National Park, and to the east by the IC-2 and Monte Formoso. The land classification by the Coimbra municipality shows that the area designated for the building of the new train station and dependencies (area of infrastructures I1) is in confrontation with large, easily flooded areas. Comparing the I1 area with the previously mentioned RAN and REN maps, there is an intersection that would require the removal of large areas from these protections, in the name of "urban development."

The proposed High-Speed Railway (HSR) will use the actual Northen Railway (Linha do Norte) canal. The new infrastructure for the MetroBus is going to be included in this development, with three existing stops that already lead to the station. There is a possibility of extending the MetroBus to Pedrulha. The construction of new motorways is also planned, with the design of an avenue that will connect the Rua Manuel Madeira to the EN 111-1. Adjacent to the main intervention area, housing areas H2 and H3 require buildings to be under 3 to 5 floors, respectively.

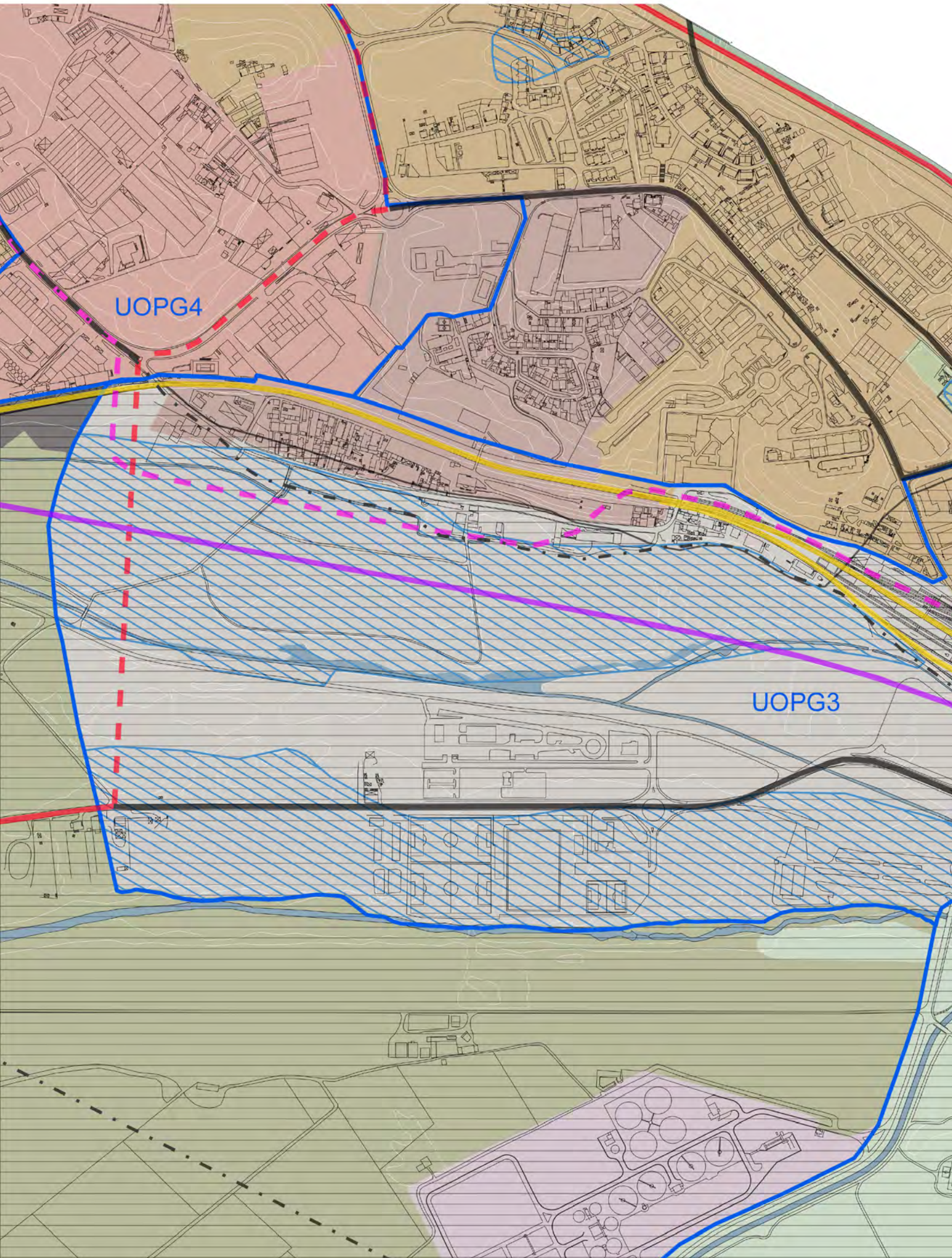
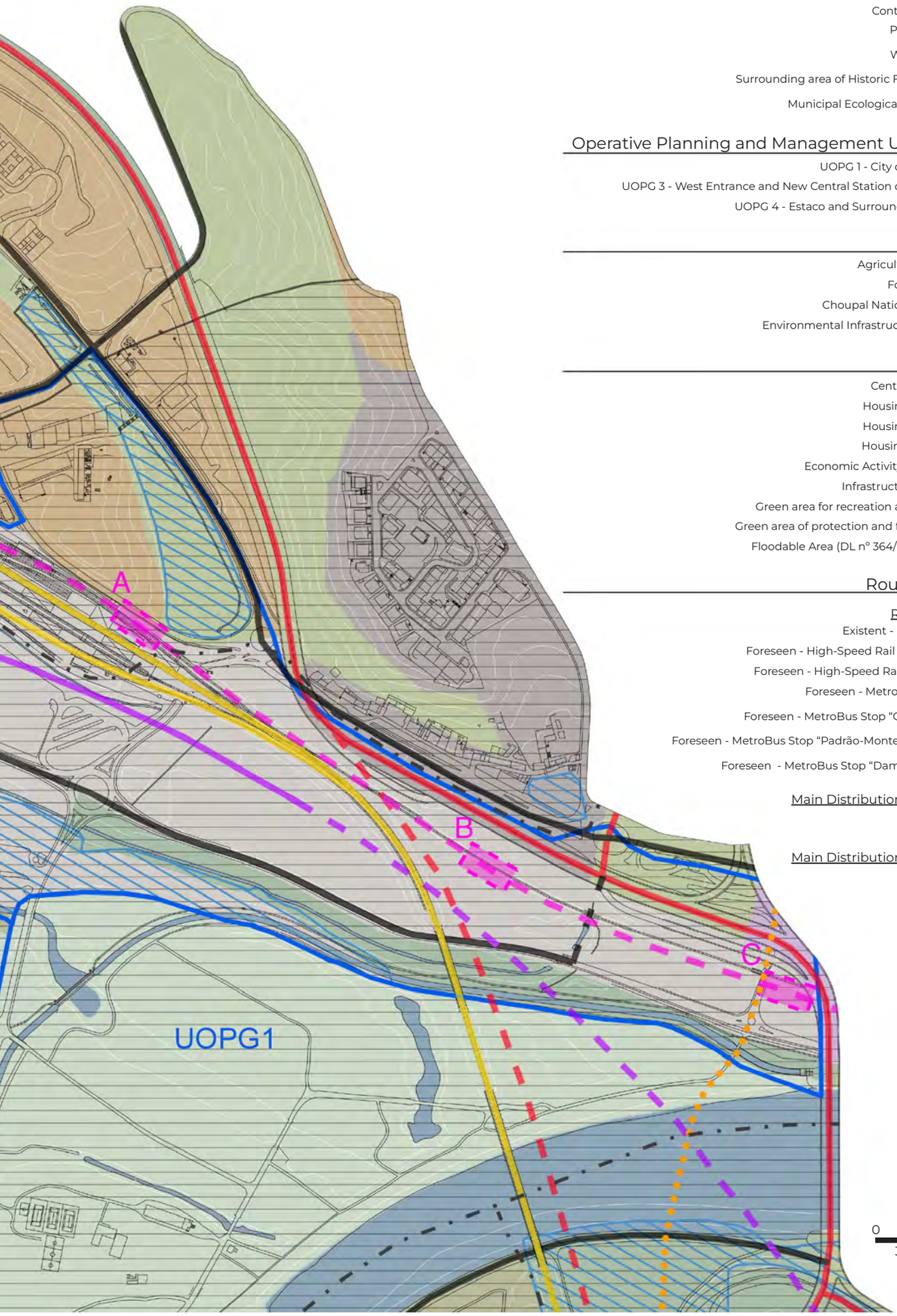


Figure 12: Analysis map of the UOPG3 territorial management instruments proposed by the Municipal Master Plan (PDM).

PDM - TERRITORIAL MANAGEMENT INSTRUMENTS



Legend

Contour lines every 5m

Parish Limit

Water Lines

Surrounding area of Historic Framework

Municipal Ecological Structure

Operative Planning and Management Units (UOPG)

UOPG 1 - City of Coimbra 1

UOPG 3 - West Entrance and New Central Station of Coimbra 3

UOPG 4 - Estaco and Surrounding Areas 4

Rustic Soil

Agricultural Areas

Forest Areas

Choupal National Forest

Environmental Infrastructure Areas

Urban Land

Central Area C2

Housing Area H2

Housing Area H3

Housing Area H4

Economic Activity Area EA2

Infrastructure Area I1

Green area for recreation and leisure

Green area of protection and framework

Floodable Area (DL nº 364/98, of 21/11)

Route Networks

Railway Network

Existent - North Line

Foreseen - High-Speed Rail on surface

Foreseen - High-Speed Rail in tunnel

Foreseen - MetroBus Route

Foreseen - MetroBus Stop "Coimbra B" A

Foreseen - MetroBus Stop "Padrão-Monte Formoso" B

Foreseen - MetroBus Stop "Dam-Choupal" C

Main Distribution Road Network

Existent

Foreseen

Main Distribution Road Network

Existent

Foreseen

0 60

30 120m

Open Spaces

The topography map (Figure 13, page 46) was developed to better understand the terrain heights and the presence of the water lines. Immediately, it is seen a very substantial contrast of heights between the Loreto neighborhood and the Campos do Mondego, with a fifty-meter difference. The railway line is levelled at about five to ten meters above the expected flood level.

The railway line acts like a barrier between the high and low parts of the study area, essentially dividing the residents from the agricultural fields and leisure green areas. Evidenced by Figure 14 on page 48, there are many cul-de-sacs or otherwise disconnected roads because of the train line that divides the area. Bike lanes in this zone do not connect properly or end suddenly, which makes this transport method undesirable. Sidewalks are also lacking on many of the roads, especially to cross the railway lines. The shortest pedestrian route to the Choupal must be made through the train station, that subsequently has pedestrians cross at the level of the railway, forcing them to walk up and down the train platforms.

Complementary to the previous analysis of agricultural, ecological, housing, and service areas, an analysis is made to understand the current use and state of the undeveloped spaces surrounding and in between existing buildings (Figure 15, page 50). Green spaces are categorized into four types: public, private, agricultural, and wild. It is perceived as wild green space that which is not under any specific care, even though it may be protected under the REN (Figure 15, Wild Green Area). The largest area of public green space relates to the Choupal National Park that is currently surrounded by unused agriculture space and wild nature. The lack of green spaces that are for community use captured special interest. Additionally, impermeable ground is mostly related to sporting services and the surrounding of housing (Figure 15, Paved Ground).

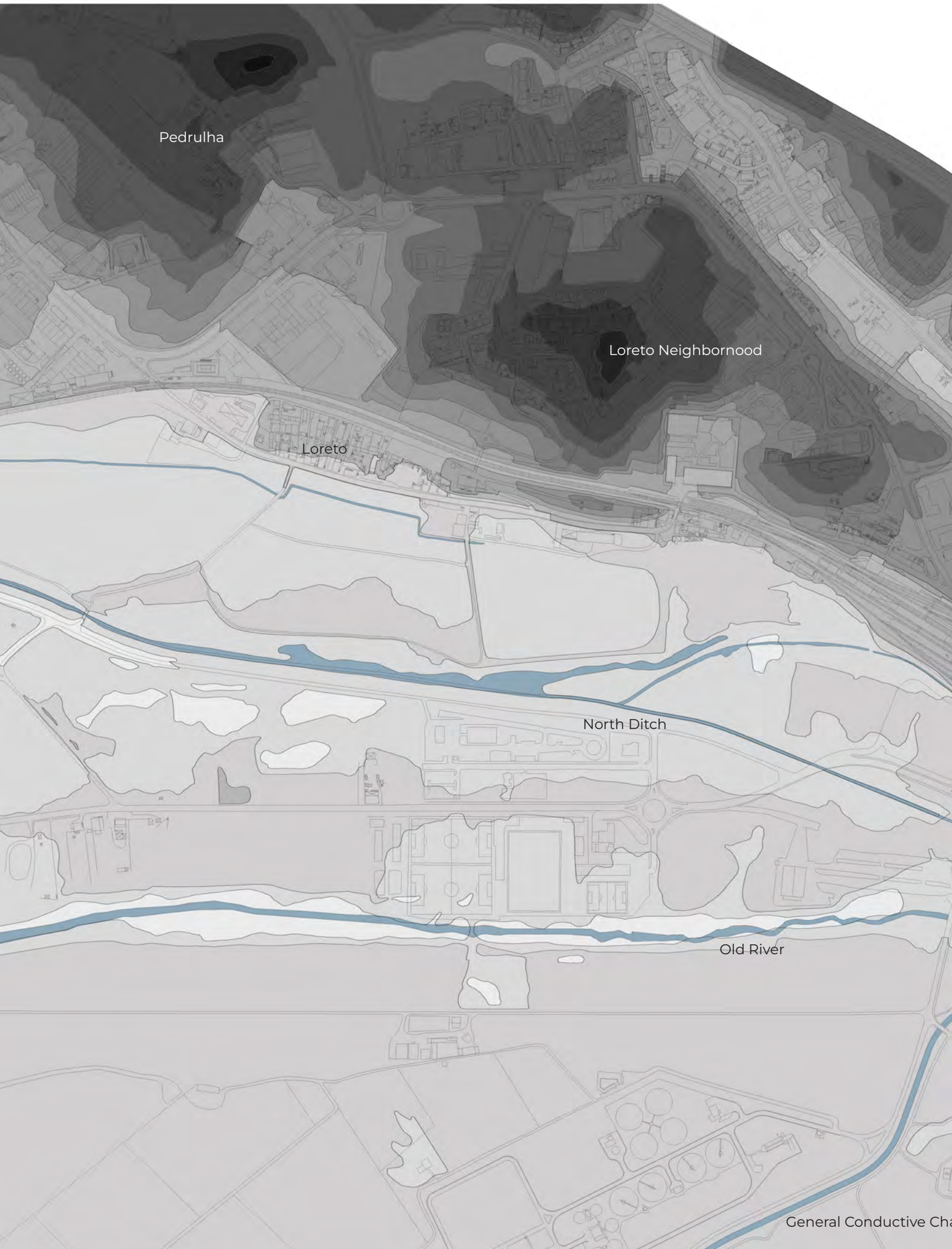


Figure 13: Analysis map of the terrain morphology.

TERRAIN MORPHOLOGY

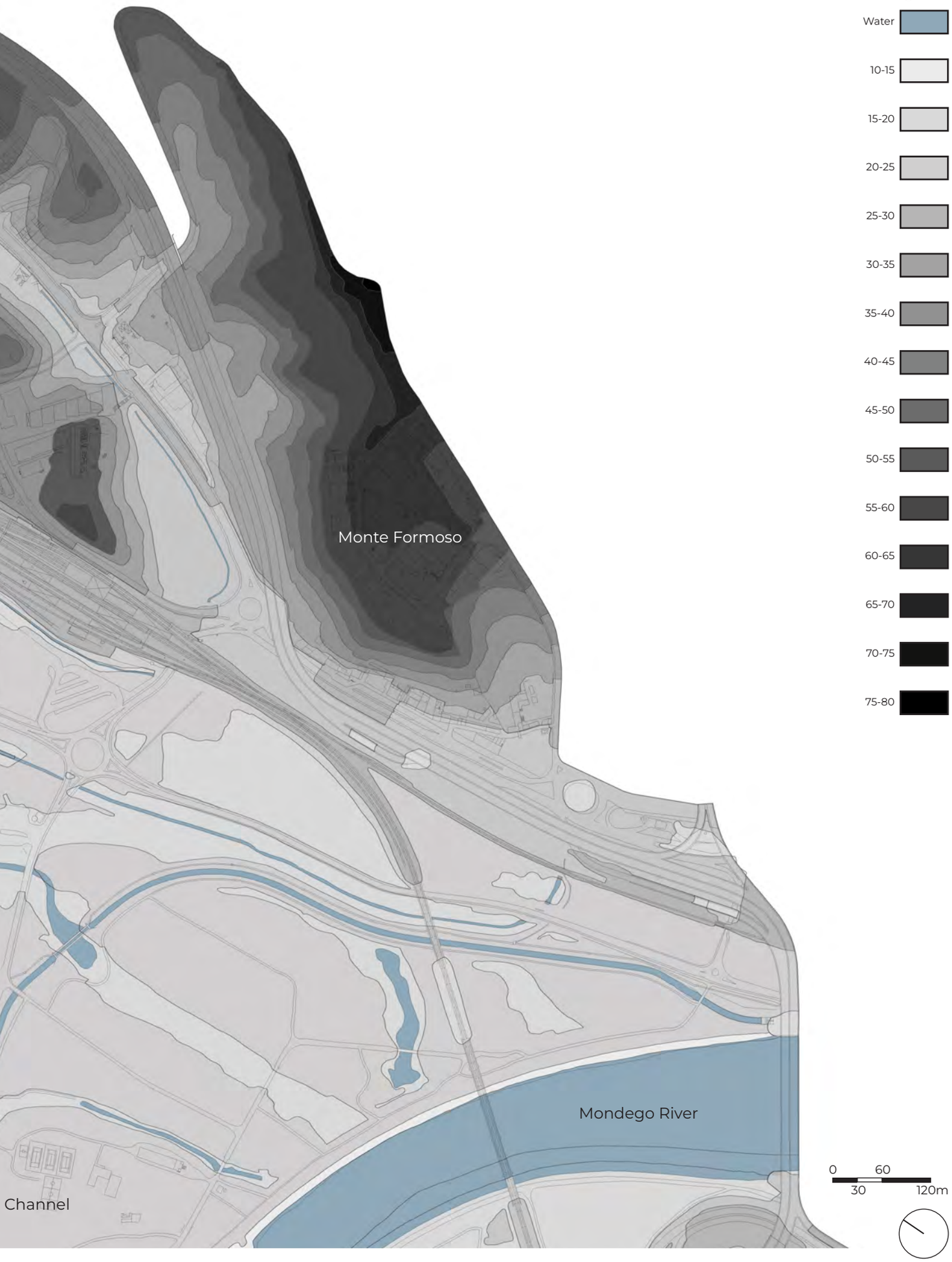


Figure 14: Analysis map of the mobility networks in the study area.

MOBILITY NETWORKS

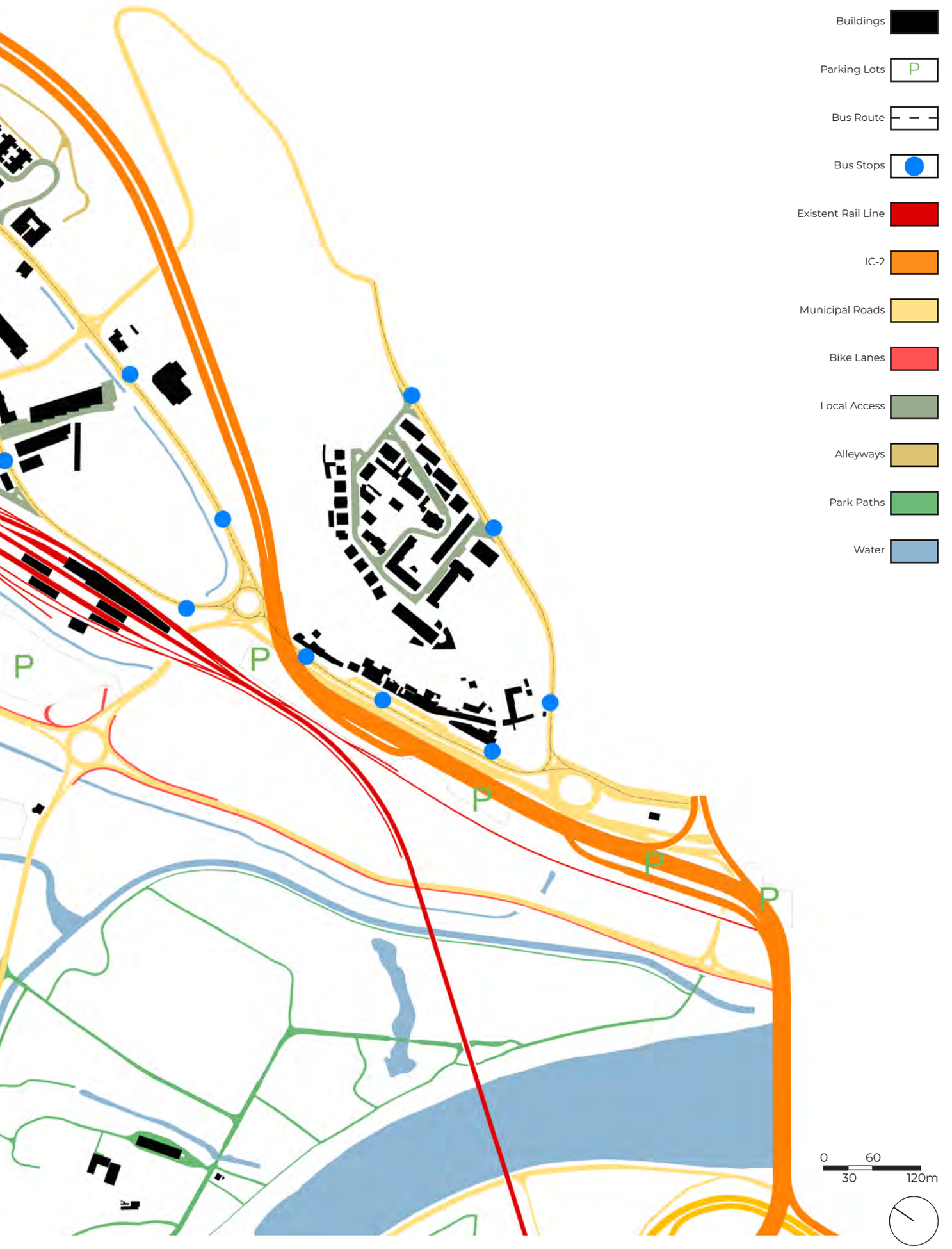


Figure 15: Analysis map of the non-built spaces in the study area.

NON-BUILT AREAS

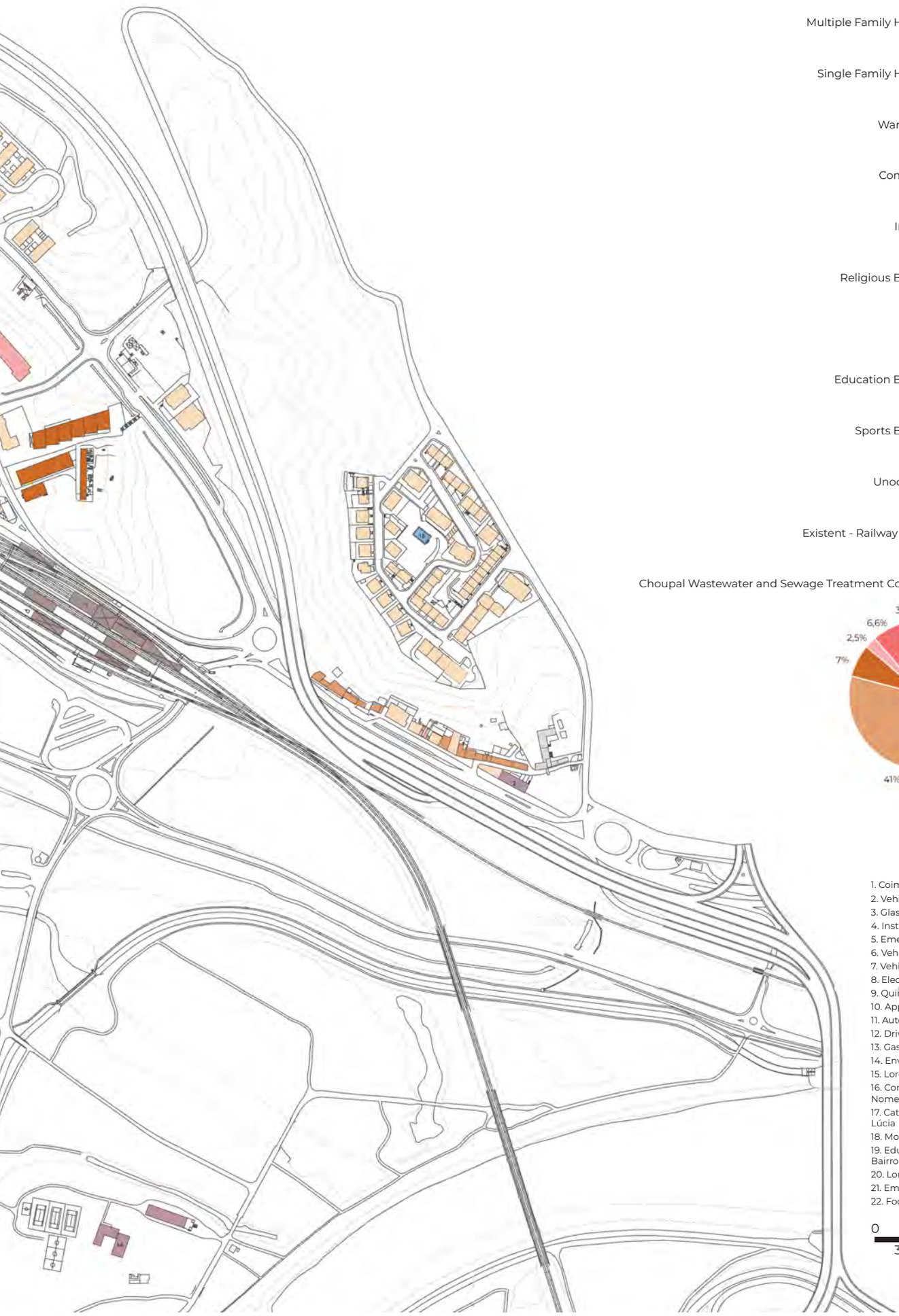
In our study area there is an abundance of single-family and collective housing with some services and industrial buildings around. Furthermore, the services offered are related to the industrial sector. Evidently, there is a lack of services related to education, leisure, well-being, and commerce. With this analysis it is confirmed that the study area serves mainly as an additional residential zone of the city, instead of being an urban center linked to the entrance of the city and public transport facilities (Figure 16, page 54).

In terms of the urban evolution and year of construction (Figure 17, page 56), the train station, built in 1864, is distinguished as the earliest settlement of the area. According to census data from 2011, it is clear there are few houses that were built before 1947. In the 1960s, there was an industrial boom, which fueled the construction of different types of housing. Most of the residential development of this area happened between the 1970s and the 1990s. Most of the built areas are in good condition with minimal instances where the maintenance is needed. When it comes to industrial facilities, the maintenance is lower, with many in a bad or ruined condition. This demonstrates that the houses and apartment buildings have proper maintenance and are inhabited. In contrast, the industry sector of Coimbra has migrated elsewhere, and the buildings have been left to deteriorate with time (Figure 18, page 58).

The map on building volumetry (Figure 19, page 60) helps identify the conglomerates of different buildings heights. When cross-referencing this map to the previous ones, it can be concluded that there was a spike of apartment buildings from 5 to 12 floors, through the last quarter of the 20th century, and since they are active residential condominiums, they are still kept in good conditions.

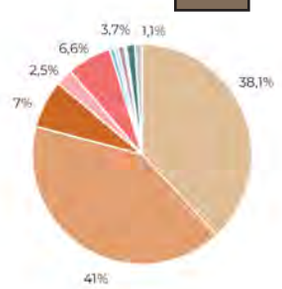
Figure 16: Analysis map of the building uses in the study area.

BUILDING USES



Legend

- Multiple Family Housing
- Single Family Housing
- Warehouse
- Commerce
- Industry
- Religious Buliding
- Service
- Education Building
- Sports Building
- Unoccupied
- Existent - Railway Station
- Choupal Wastewater and Sewage Treatment Company



1. Coimbra-B Railway Station
2. Vehicle Stand: ONDACoimbra
3. Glass and Ceramic Factory: Lufapo Hub
4. Institute of Technology: Aemiteq
5. Emergency care physician: INEM
6. Vehicle Stand: Auto Maran
7. Vehicle Stand: Sodicentro
8. Electric Central
9. Quinta do Loreto
10. Appliance repair service: STE
11. Automobile club: CAC
12. Driving exam center: IMT Coimbra
13. Gas station: Repsol
14. Environment office: ICNF
15. Loreto Chapel
16. Congregation: Noviciado do Santíssimo Nome de Jesus
17. Catholic church: Centro Pastoral Irmã Lúcia
18. Monte Formoso Chapel
19. Educational institute: Instituição do Bairro do Loreto
20. Loreto School Center
21. Employment center: IEFP
22. Football club: Academia Briosa XXI

0 60
30 120m

Figure 17: Analysis map of the building evolution in the study area.

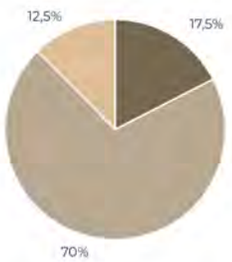
BUILDING EVOLUTION

Legend

Built until 1969

Built until 1999

Built until 2021



0 60
30 120m

Figure 18: Analysis map of the building maintenance conditions in the study area.

BUILDING MAINTENANCE CONDITIONS

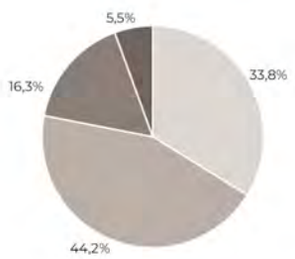
Legend

Good

Fair

Bad

Ruin

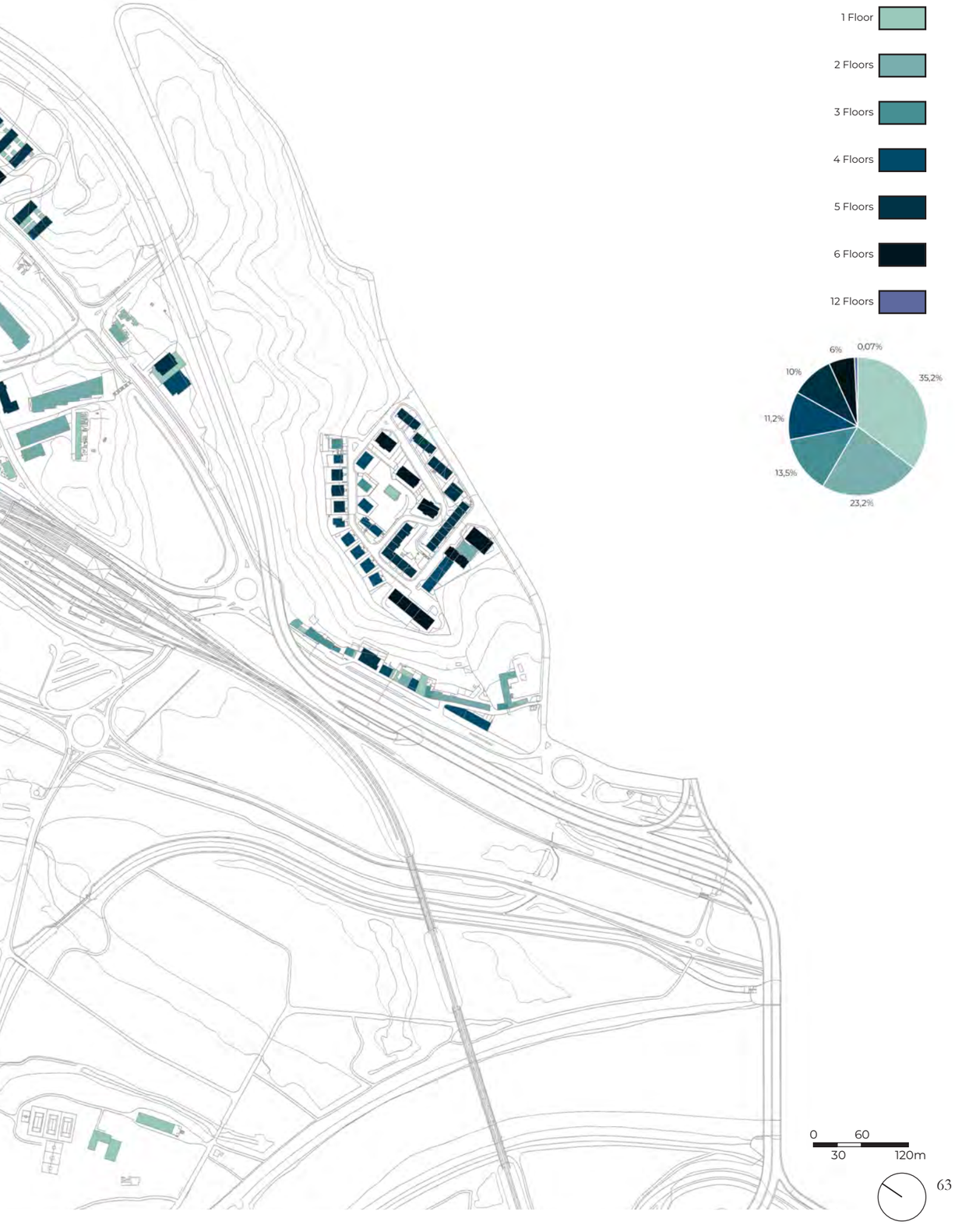


0 60
30 120m

Figure 19: Analysis map of the building volumetry in the study area.

BUILDING VOLUMETRY

Legend



DEMOGRAPHIC SUBSECTIONS

Figure 20: Subsections to be analyzed in the study area, based on the Census of 2011.

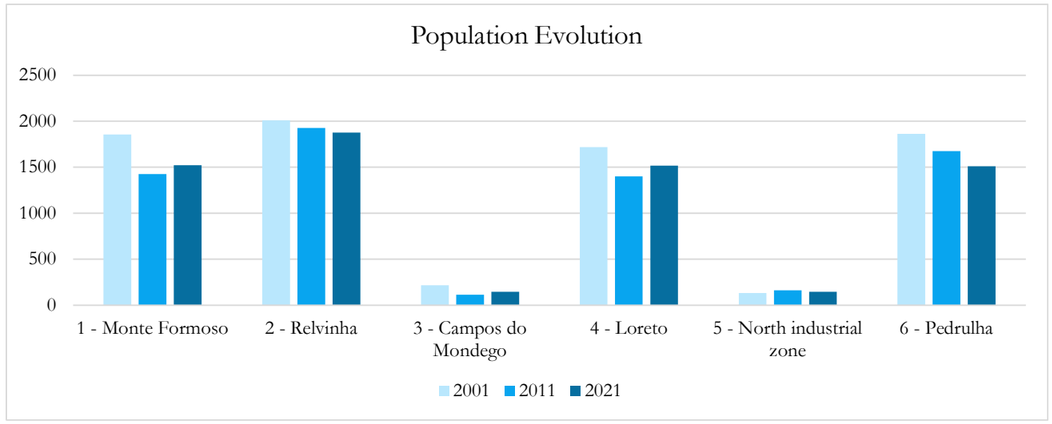


Figure 21: Graph of population evolution of residents in the study area, based on the Census of 2001, 2011 and 2021.

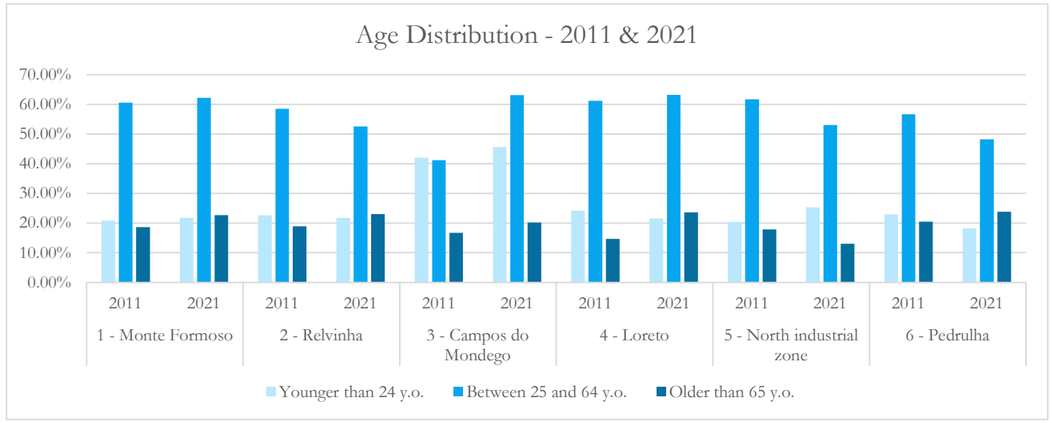


Figure 22: Age distribution of residents in the study area, based on the Census of 2011 and 2021.

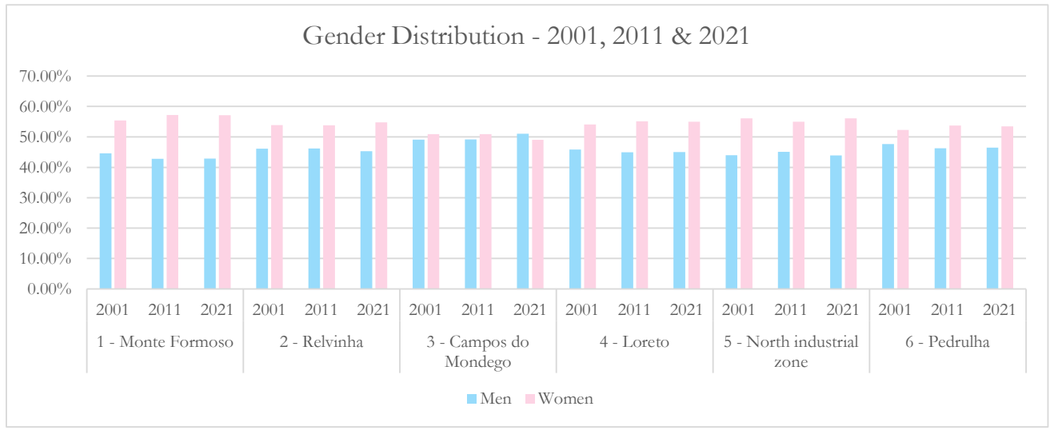


Figure 23: Graph of gender distribution of residents in the study, based on the Census of 2001, 2011 and 2021.

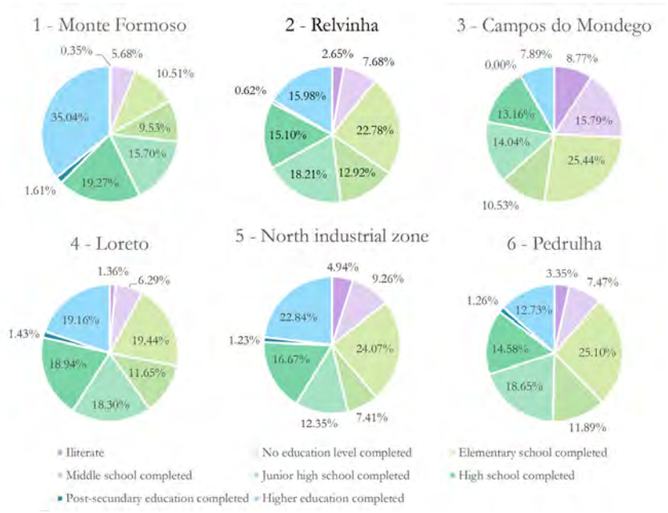


Figure 24: Graph of education level completed by residents in the study area, based on the Census of 2011.

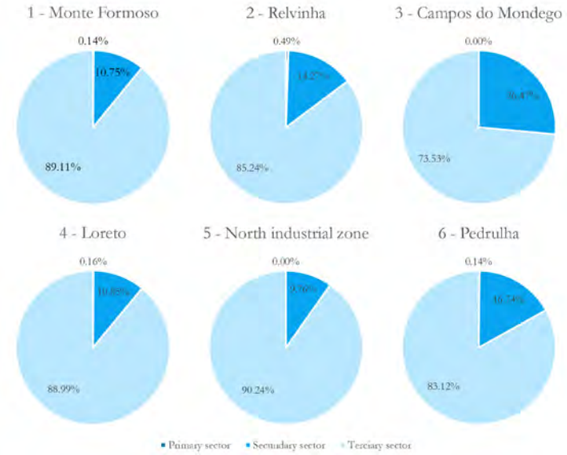


Figure 25: Graph of economic sector in which residents of the study area work at, based on the Census of 2011.

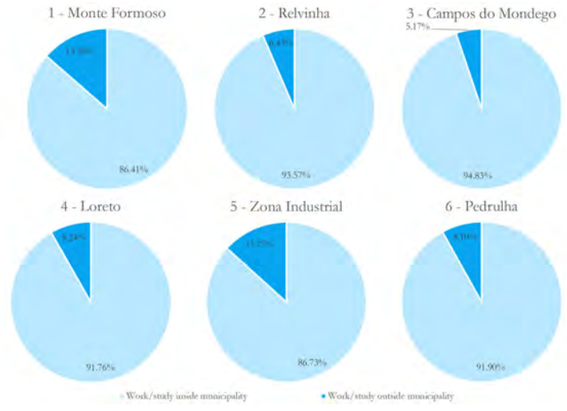


Figure 26: Graph of pendulum movements done by residents in the study area, based on the Census of 2011.

Demography

To properly design the urban intervention, an analysis of the demographics was completed by looking at six parameters of the resident population: gender, age group, level of education, economic sector of work, commuting movements, and population changes over time. All six of these parameters are present in the 2011 census, but the 2001 and 2021 censuses were also consulted to assess the evolution and aging of the resident population. To gather the data for the census, Statistics Portugal (Instituto Nacional de Estatística – INE) delimits the territory in subsections and links the data to then attribute the demographics of specific areas. The class joined multiple of these subsections to represent six main areas: Monte Formoso, Relvinha, Campos do Mondego, Loreto, North industrial zone, and Pedrulha (Figure 20, page 61).

Comparing the censuses of 2001, 2011, and 2021, in general the population has been decreasing at a national level. More specifically, Loreto and Monte Formoso have seen a drastic decrease in population between 2001 and 2011, but these areas began to grow again through 2021. On the other hand, Pedrulha has maintained a steady decrease throughout the studied years.

The parameter for the age distribution of the population shows a constant aging at a national level. With this, it can be concluded that there are less births, with more families opting to have less children or none, and the life expectancy has risen, caused by medical advancements.

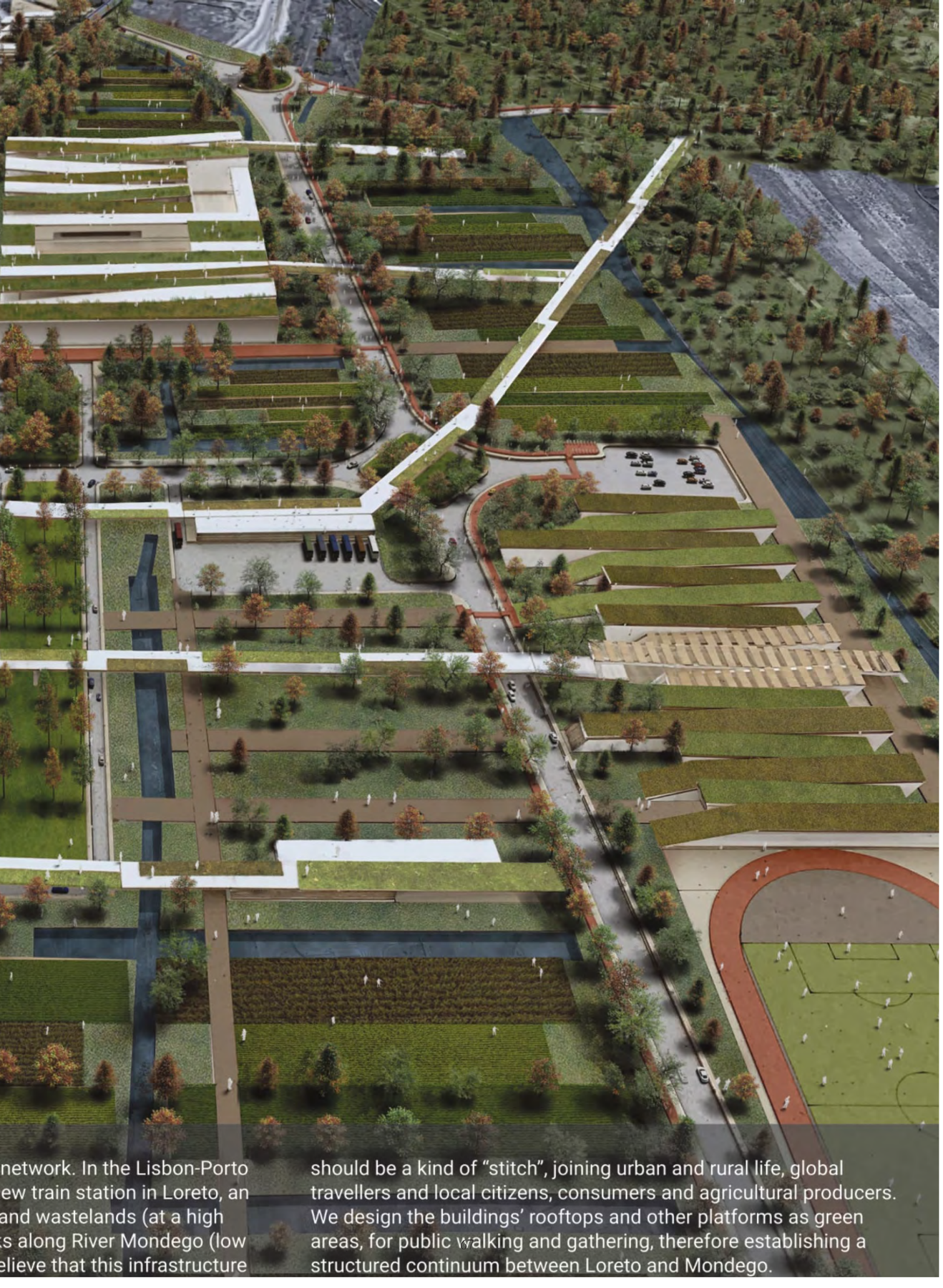
In terms of the gender distribution, it came be seen through the graph in page 62 that in general there are more women than men. In subsection 3 – Campos do Mondego the population is the most balanced between men and women. In subsection 5 – Zona Industrial there is a slight increase of men in 2011 but returns to almost the same percentage as 2001 by 2021.

For most of the study area the distribution of residents having completed different levels of education is balanced. The zones that diverge most from the balance are at subsection 3 – Campos do Mondego and subsection 1 – Monte Formoso. In Monte Formoso there is a higher percentage of residents that have completed higher education, which englobes degrees like undergrad, Masters, and PhD. By contrast, in Campos do Mondego there is a large percentage of people that only completed elementary school.

The large proportion of the population with a high educational level is also apparent in the analysis of the residents' economic sector, which illustrates the transformation of this peripheral area of the city from an area predominantly inhabited by industrial service workers to an area inhabited by citizens who work in the tertiary economic sector. Given that a large area being studied is considered agricultural, the percentage of workers in the primary sector is low for it means that there is no direct relationship between the inhabitants and the agricultural activities that surrounds their neighborhoods.

The commuting movements of the residents for work and education cross-referenced with the uses of the buildings within the study area helped to conclude that inhabitants work and study inside the municipality of Coimbra but not in the immediate surroundings, leading to the need for private or public heavy transport.

Figure 27: Group model photomontage - Panel 1 of 3 submitted to the Lisbon Architecture Triennale 2022.



network. In the Lisbon-Porto
ew train station in Loreto, an
and wastelands (at a high
s along River Mondego (low
elieve that this infrastructure

should be a kind of “stitch”, joining urban and rural life, global travellers and local citizens, consumers and agricultural producers. We design the buildings’ rooftops and other platforms as green areas, for public walking and gathering, therefore establishing a structured continuum between Loreto and Mondego.

Figure 28: Group master plan and cross section. (See Panel 1 in annex for full size)

5. Project

5.1. Group Strategy

Given that there is a necessity for a new railway station in Coimbra, as explained in earlier chapters, the urban design and group strategy prioritized the location and connections of the station with its surroundings. For this, the group that I'm part of (Group B), started the development of the urban intervention with design-based research, guidance from our professor of Design Studio I (AP – Atelier de Projeto), and the analysis of case studies. The title of our proposal is "Connecting Loreto and Mondego: A Rural-Urban Continuum" since we deal with an area that needs a balance between the agricultural and urban dimensions.

Based on the case study by the design studio OMA for the Parc de la Villete[16], the group planned the different parts that would be needed to meet the requirements of the work site. The first step was to devise a matrix or grid that could be repeated and used to structure the urban design. We decided to use a strip matrix of twelve meters, a measurement that could be subdivided or multiplied to adapt to different purposes and we directed them northeast southwest. The strips are related to the slow movements of people, be it by foot or soft mobilities, and help give aesthetic cohesion to the different buildings and urban-rural elements.

In the north-south orientation, perpendicular to the matrix mentioned before, fast mobilities like cars, buses, normal and high-speed trains, are inserted into the urban intervention. In our group strategy, the train station is moved 600 meters north of the current location of the Coimbra-B station. The new railway station is positioned in the middle of the study area, by Campos do Mondego, and in close interaction with the Loreto neighborhood. With the relocation of the train station, a new path for the rail lines had to be designed, causing the removal of the current canal of the Northen Line (Linha do Norte) that had severed the connection between Loreto and Campos do Mondego. Through that canal, the group routes the MetroBus to offer a more efficient link between the city center, Loreto, and Pedrulha. Based on municipal plans for several MetroBus stops, the group strategy proposes three new stops, with a middle one associated to the new train station and a park on the slope of Loreto (the proposed Loreto Park). As part of the intermobility between different types of public transport to this area, a new terminal for long course buses was also projected.

Even though this area was detected to be a peripheral residential area of Coimbra, there is a presence of many wastelands, underdeveloped agriculture fields, discontinued bike lanes, and a large easily floodable zone. To control the floods, various water mirrors were installed along the Rio Velho (old river) and the Vala do Norte (north trench), which branches out from the Mondego River. The existing bike lanes ended at the entrance to the Choupal Park, and the proposal is to extend them to the north and to the east through the study area. To take advantage of the wastelands and underdeveloped areas, elements like housing complexes, the new Loreto Park, and different urban agricultural strips were designed.

The construction of a multipurpose building is planned in the PDM, intended to take advantage of the new

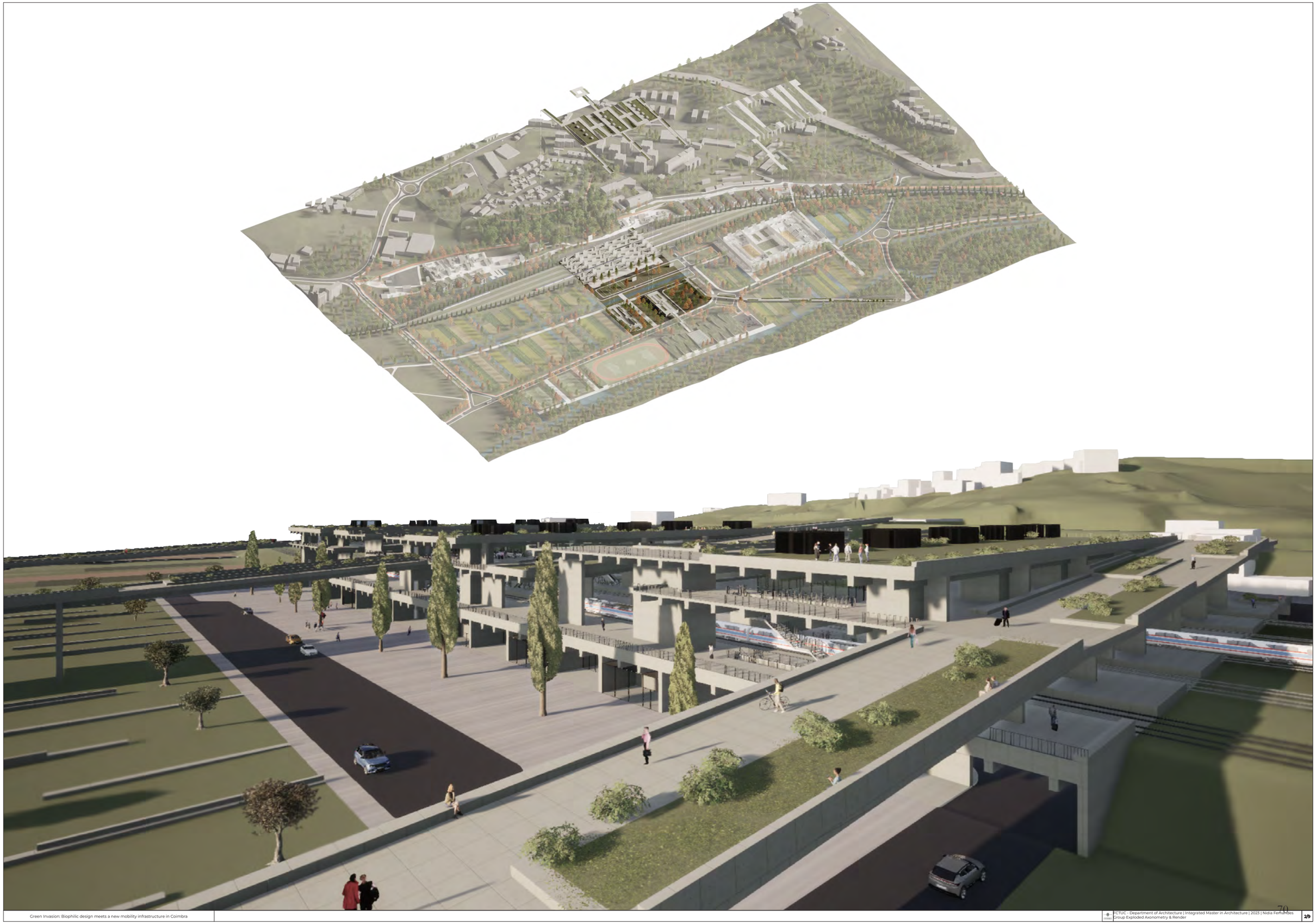


Figure 29: Group exploded axonometry and render of the Intermodal Station. (See Panel 2 in annex for full size)

train station, as this would encourage people to attend sport, cultural, and leisure events. To complement those events, the group also proposes a sports complex, near the Mondego River, including new fields, and platforms for water related sports. To complement the urban agriculture new spots, a biologic market was designed adjacent to the fields for the commercialization of local products, reducing the transportation needed, and enhancing the local economy.

The group members share an awareness and concern for environmental issues that reflect on many different scales of design. At an urban scale, to offset the environmental (and visual) impact, of constructions like the train station, the multipurpose pavilion, the multiple housing buildings, and the sports complex, green roofs and linear parks cover a large part of the urban intervention, following the proposed strips' pattern that the group created for the whole urban design. The green rooftops and linear parks help to solve problems in the present state of the site and those that would arise with the erection of all those new infrastructures. The permeability of rainwater is maintained in the living roofs and passageways, aiding in the flood control. Covering the large concrete constructions prevent the absorption of sunrays, thus not reflecting it and causing heat islands. The disturbance to the local environment is diminished; and the connection between people and nature, residents and users to the Choupal Park becomes easy and pleasant.

Once the group strategy was established, the further development of different parts of the intervention were distributed by the members of our group. Eline Georget, an Erasmus student, designed the sports complex, that englobes two indoor sports fields, three indoor pools, an outdoor field, and racetracks. The complex also includes services like a spa, and a café. João Baptista projected the multipurpose pavilion that is equipped to receive 5.000 users. The pavilion has two covered areas that allow for simultaneous events, and through the middle outdoor square a larger event can also hosted. Mariana Ferreira develops a sustainable and shared residential complex, in both cohousing and coliving type housing, the MetroBus stop "Loreto-Pavilhão Multiusos" (Loreto – Multipurpose Pavilion), and various services along these buildings. Maria Calouro focuses on the rehabilitation of the Lufapo factory (now Lufapo Hub), and the design of a public urban park on the slopes of Loreto, with the perspective of rehabilitating and re-naturalizing this area, and articulating it with the design of the MetroBus stop "Parque do Loreto-Estação" (Loreto Park – Station).

[16] See Chapter 3.1 Parc de la Villete, Paris, France, OMA, 1983

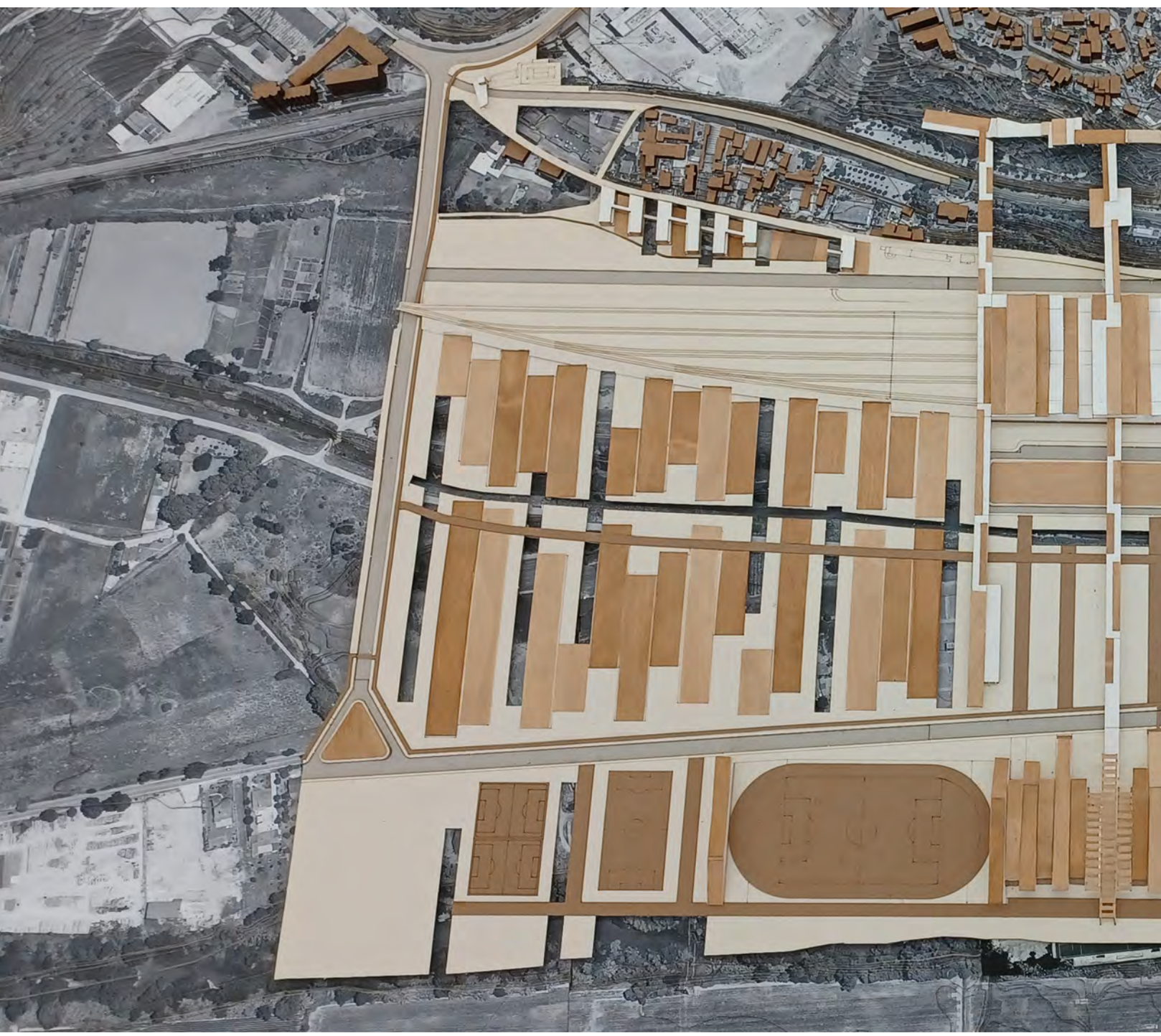


Figure 30: Group model developed in 2021/2022.

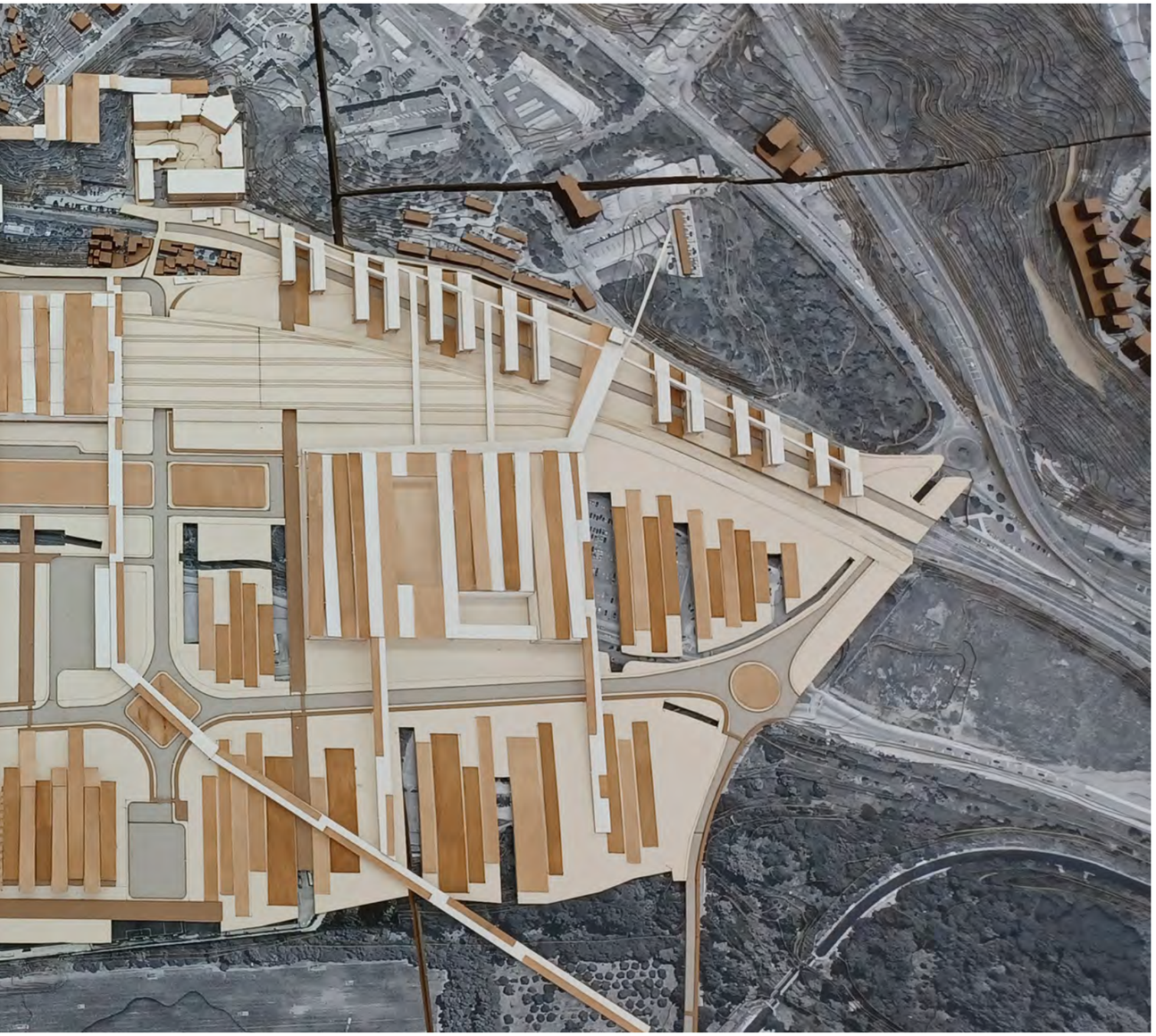


Figure 31: Render - Main entrance of the Intermodal Station.

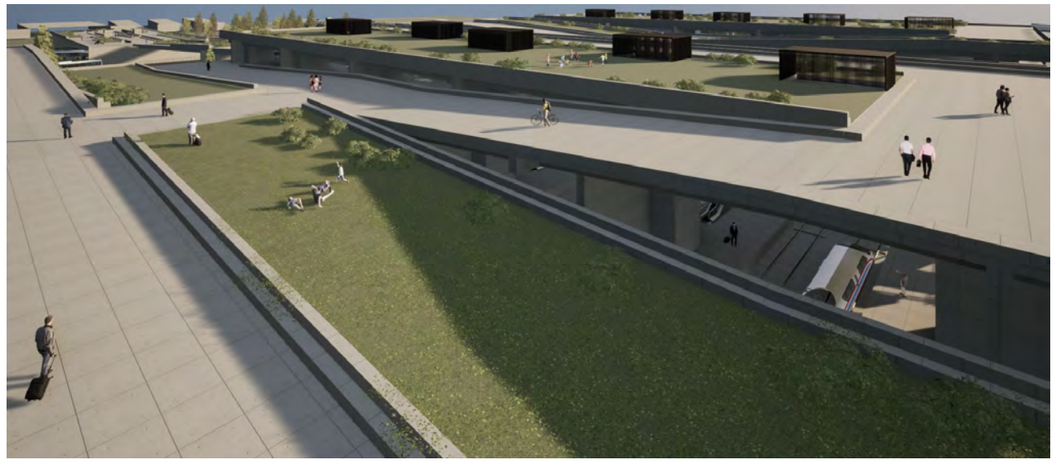
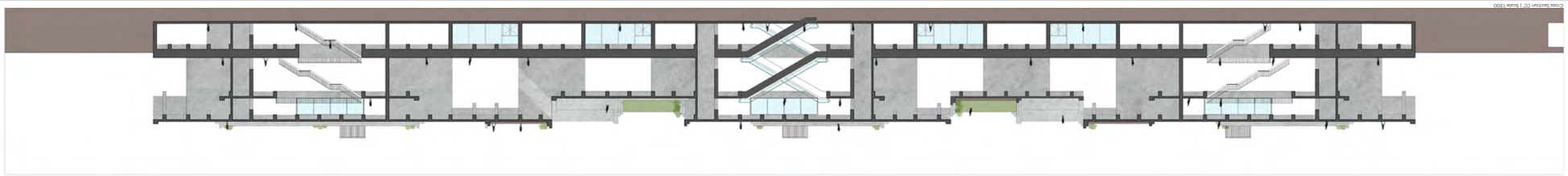


Figure 32: Render - Rooftop view of the Intermodal Station.

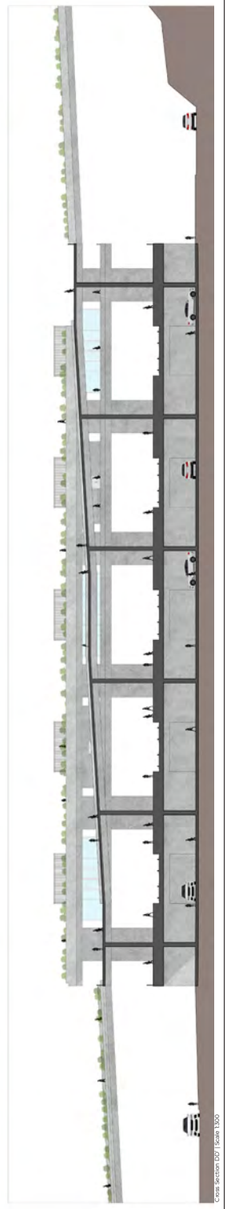
Figure 33: Render - Secondary entrance of the Intermodal Station.



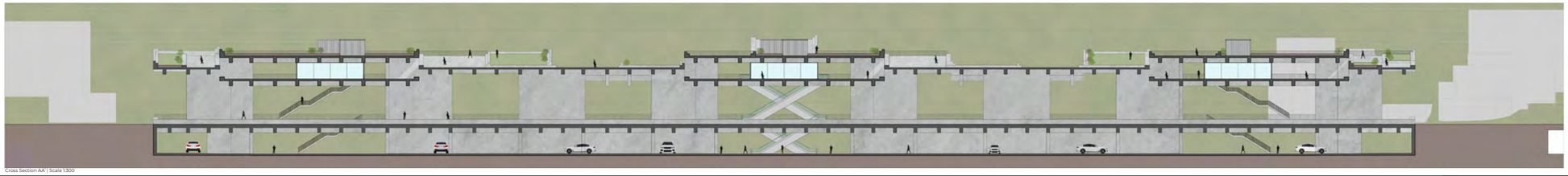
Cross Section CC' | Scale 1:300

Cross Section DD' | Scale 1:300

Groun Level Floor Plan | Scale 1:300



Cross Section EE' | Scale 1:300



Cross Section AA | Scale 1:300

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Ground Level Floor Plan & Cross Sections | Scale 1:300

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Figure 34: Ground level floor plan and cross sections. (See Panel 3 in annex for full size)

5.2. Individual Project

5.2.1. Architectonic Solution

My individual project – the new Coimbra intermodal station, integrating the railway station, the bus terminal, and a food market – has been designed as a kind of "stitch" between the urban and agricultural dimensions of the place, between its residents and travelers, between its agricultural producers and consumers. In addition, I created pedestrian connections in between the different proposed facilities, as well as the link from the Choupal National Park and the new Loreto Park[17], creating a pleasant and undemanding path for those users. To give cohesion to that "stitch" or "suture", I apply the concept of "biophilic design", promoting the sustainable revitalization of this north area of Coimbra.

The main entrance of the train station faces west, to the Mondego River, and to Campos do Mondego. The "kiss & ride" roundabout allows for user to be dropped off safely and close to the station, without disturbing the rest of the local traffic. Before and after the drop-off area there are entrances into the parking lots, with exits at the opposite facade. Pedestrians can also arrive via the elevated ramps and catwalks, on either west or east side of the station. The ramps on the west side are connected directly to the second floor of the station, while the ones on the east give access to the rooftop.

The railway station works in three main levels so that the building can be better correlated with the nearby steep topography and offer variety in the circulation through its inner core. Additionally, the railway lines were kept at a relatively elevated height (+21m) as to prevent from floods, which then allowed for space under the train lines to be used. The construction in multiple floors also prevents from needing to impermeabilize more ground area.

On the ground floor, at about (+16 m), a parking lot, ticket offices, stores, and services are available. The parking has capacity for 360 cars, and is divided into two sectors, with a pedestrian reception area in the middle, which facilitates the arrival of users to the different train platforms above. The sixteen stores operate independently from the railway services. The east stores, like a pharmacy or a post office, are directed to serve the residents of Loreto. The west stores, like a souvenir store or café, are linked to the transport/trip experience and needs. There are also four ticket offices and two staff rooms. For a user to approach the platforms on the floor above, there are three vertical access areas. The middle reception area is equipped with escalators, while the parking lot areas have stairs, and elevators are distributed throughout.

On the first floor, the station has six train platforms that give access to ten train lines. Four of those lines are reserved for the high-speed tracks, while the rest are for Alfa Pendular, Intercidades, Regional, and Urban trains. The ramped roof over the platforms level is designed according to a topographic composition, which offers the space different sensations of compression and grandness. The light coming through the ramps' gaps illuminate the platforms, and it differs according on the time of day. With this control from the sun exposure, users are protected from extreme temperatures as they wait near the train. Evoking the Atocha Station[18], plants are left to grow down between the gaps to offer users visual contact with nature even while

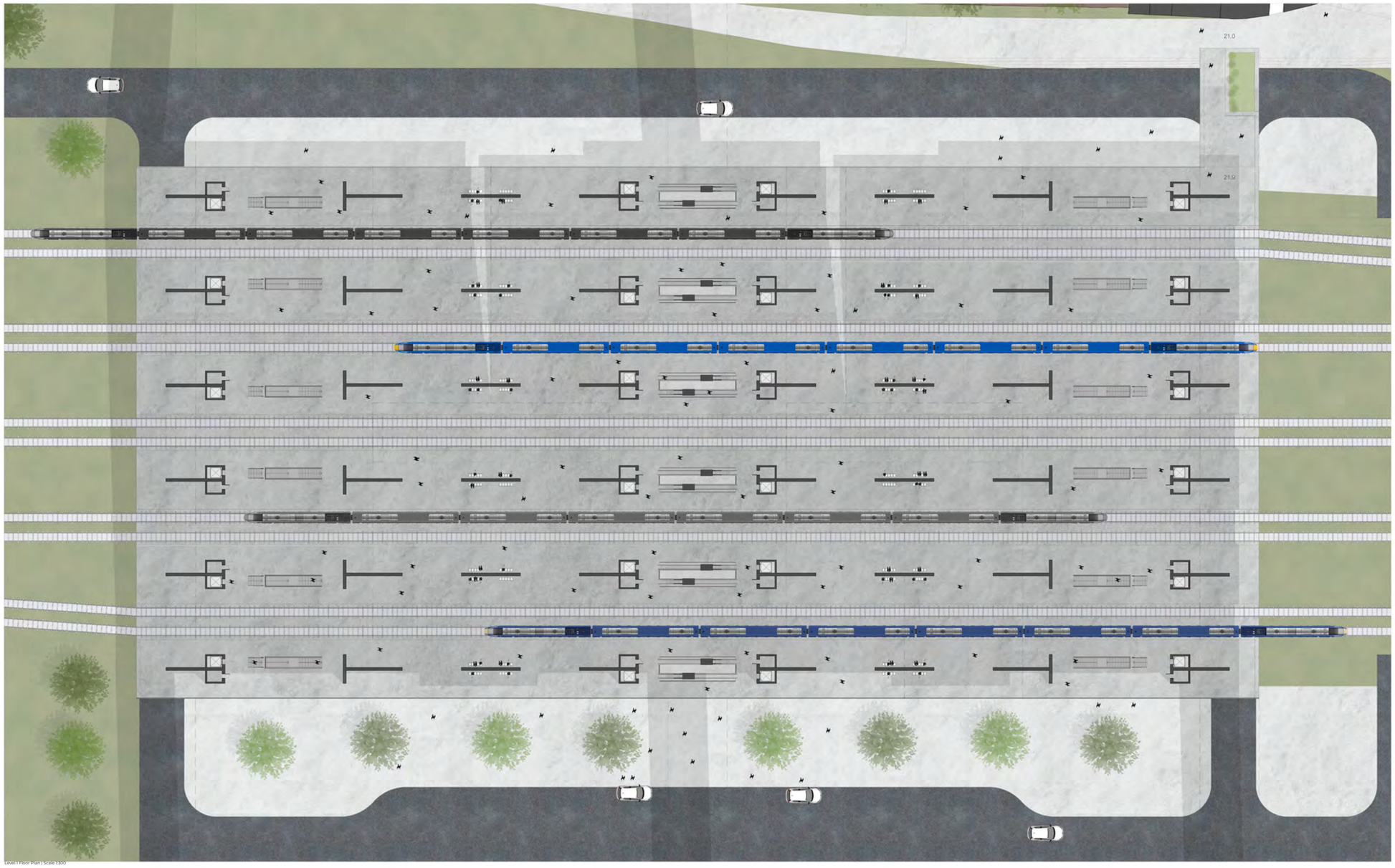
Figure 35: Render - Waiting room on Level 2 of the Intermodal Station.

Figure 36: Render - Train platform on the Level 1 of the Intermodal Station.

Figure 37: Render - Central main entrance on the Ground level of the Intermodal Station.

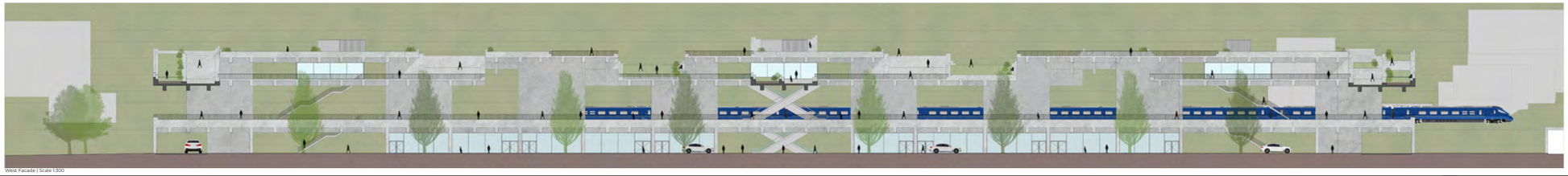
East Facade | Scale 1:300

North Facade | Scale 1:300



Level 1 Floor Plan | Scale 1:300

South Facade | Scale 1:300



West Facade | Scale 1:300

Figure 38: Level 1 floor plan and facades. (See Panel 4 in annex for full size)

on the inside.

The second floor is divided into three areas, each related to a vertical access. The three areas are equipped with climate controlled "containers" that have services such as bathrooms, storage rooms, and waiting rooms. In the middle of each area, the ramps present a pattern of functional pavement, allowing travelers to change between zones and circulate above the trains freely. The station's topographic roof follows the stripped pattern logic presented by the group strategy, offering users different walking and resting areas. The flat roofs of the three top entrance areas are easily accessible by both users of the train station and residents, as a normal public green area. Like in the Campanhã Intermodal Terminal[19], the relation between a transport interface and a public park makes it accessible to any person, and more likely to be cared for and maintained as time goes on.

The bus terminal connects to the train station via the central west elevated ramp and catwalk, which links the second floor of the station to the rooftop of the bus terminal. Continuing the path west, the ramp that comes down from this rooftop ends at the sports complex. To access the buses the users can go down through elevators or the stairs. The bus terminal has the capacity for 34 buses to be parked and boarding passengers simultaneously.

The northern ramp of the station links to the market, which can be entered by descending a center ramp. Underneath the ramp, the market has a central water mirror that helps keep a cooler environment for people and products. On the two longer sides of the market, 32 stores are available for producers to sell and display local and biological products, highlighting the connection to the urban agriculture fields.

The ramps that connect all the buildings, as well as the two parks mentioned in the group strategy – the ancestral Choupal Forest and the proposed Loreto Park – are designed as linear gardens. The concepts applied to the rooftops and the ramps are similar, encouraging people to move through nature and interact with it more often. An example of this succeeding strategy is the High Line Park[20], which we analyzed on chapter "3. Case Studies". The contrast between the natural and the built environment, the slow enjoyment, and the fast pace, or between form, function and fruition, can make this intervention more agreeable to the population, hopefully creating a sort of new collective self-esteem.

Figure 39: Render - View of the Intermodal Station and Bus Terminal from the roof of the Biologic Market.

Figure 40: Render - Ticket office inside the Bus Terminal.

Figure 41: Render - Water mirror inside the Biologic Market.

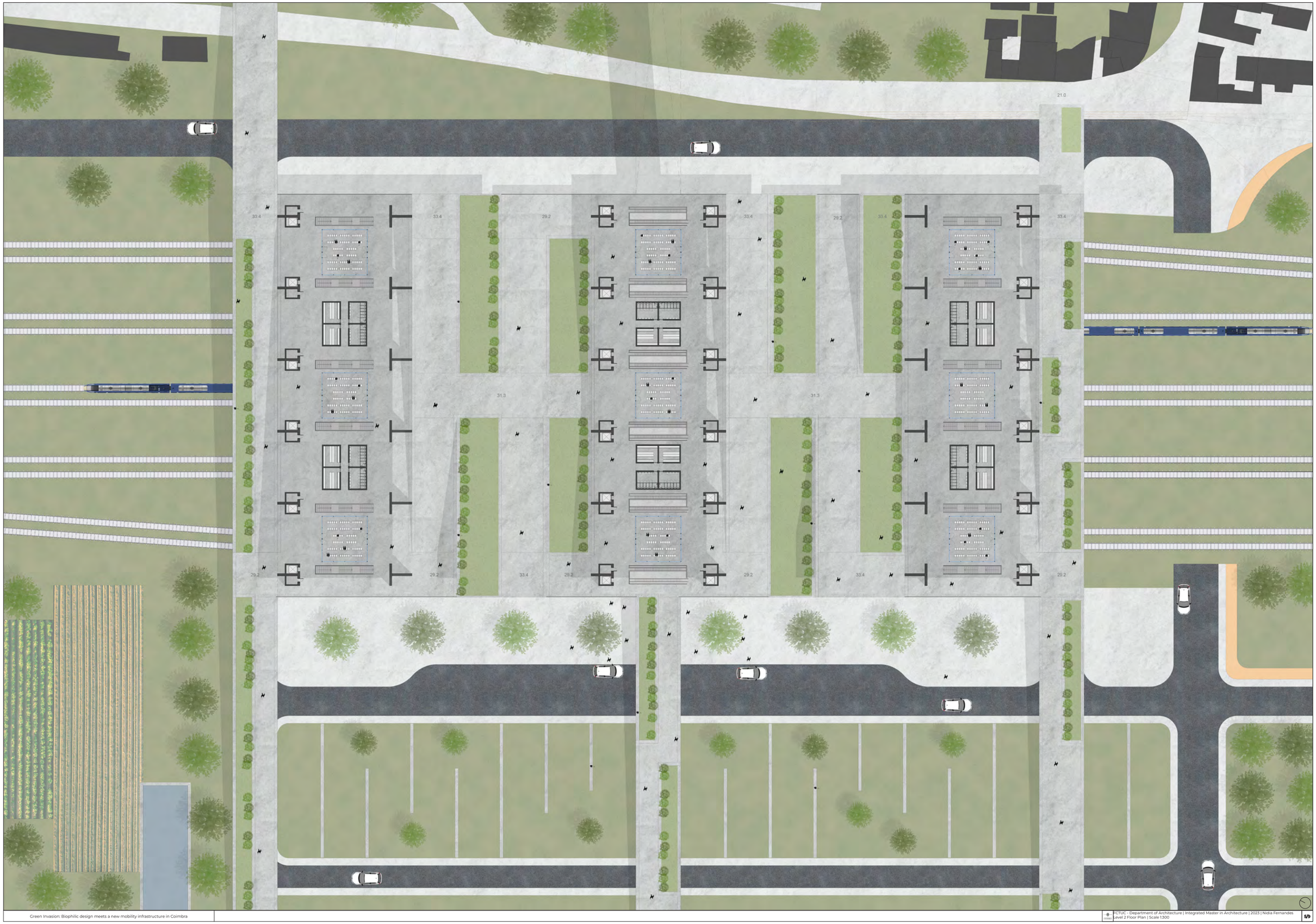


Figure 42: Level 2 floor plan. (See Panel 5 in annex for full size)

[17] The new park proposed in group: designed and detailed by Maria Calouro
[18] See chapter 3.2 Atocha Station, Madrid, Spain, Rafael Moneo, 1992
[19] See chapter 3.4 Campanhã Intermodal Terminal, Porto, Nuno Brandão Costa, 2021
[20] See chapter 3.3 High Line Park, New York, Diller Scofidio + Renfro, 2009

Figure 43: Exploded axonometry. (See Panel 6 in annex for full size)

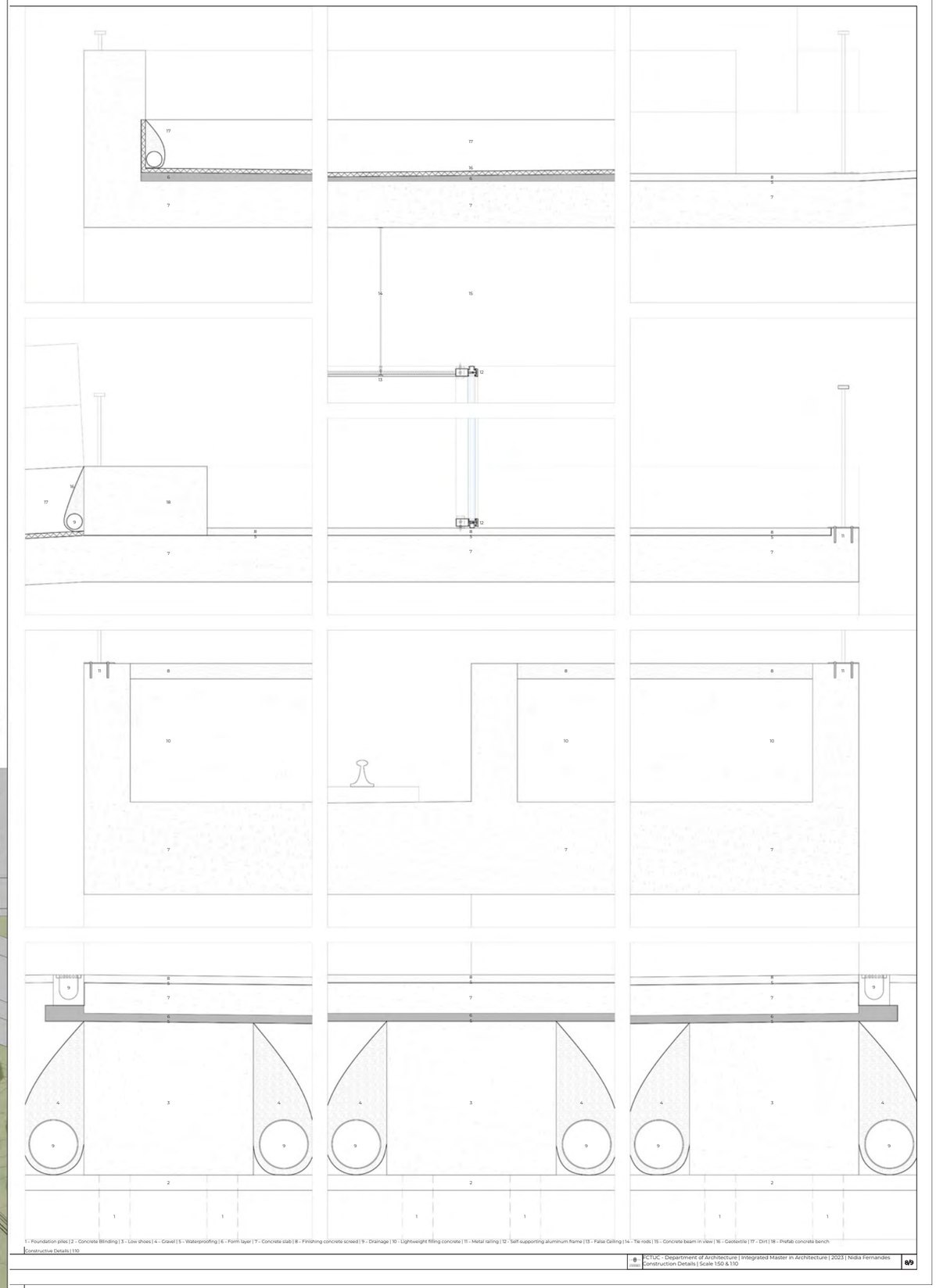
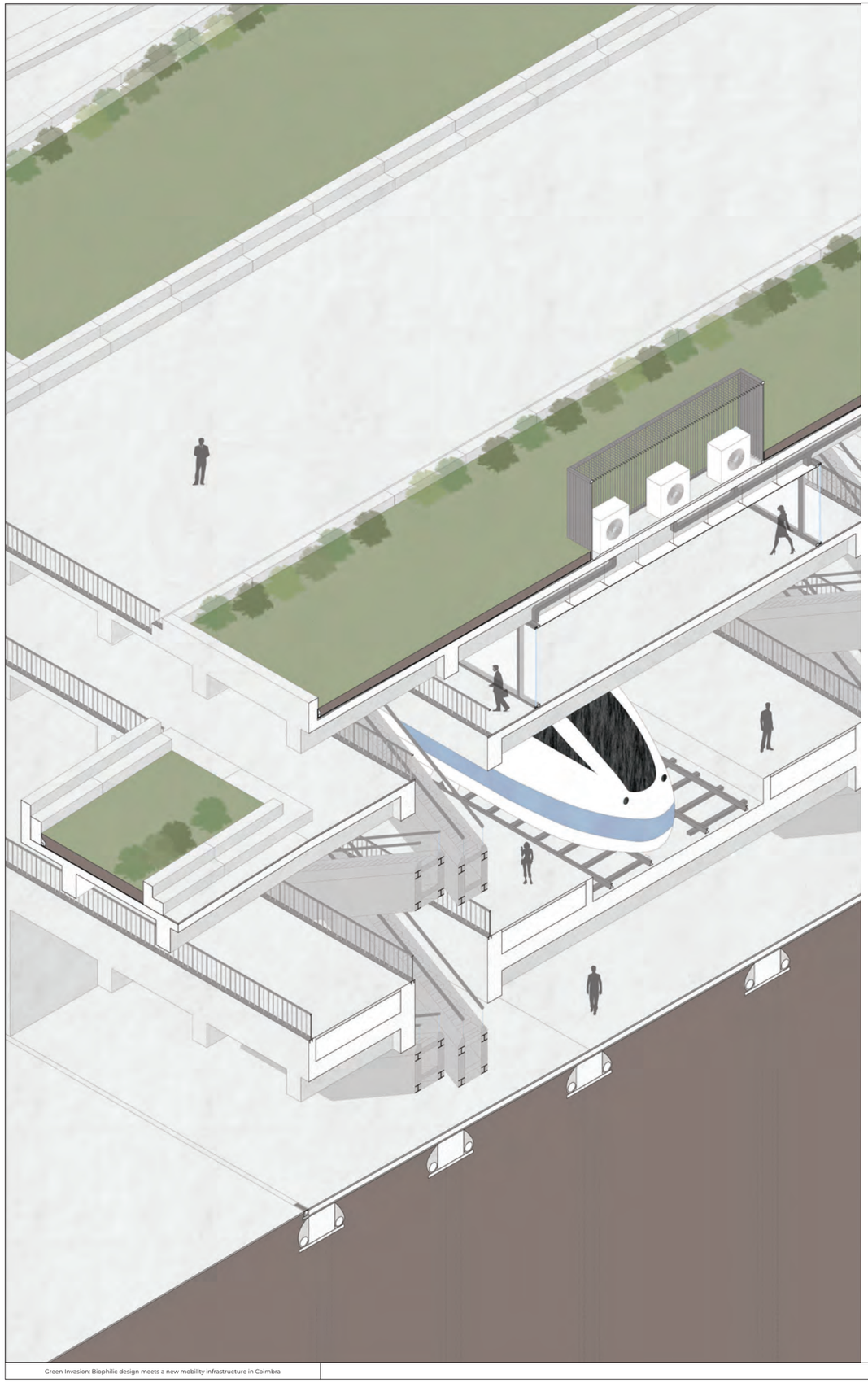
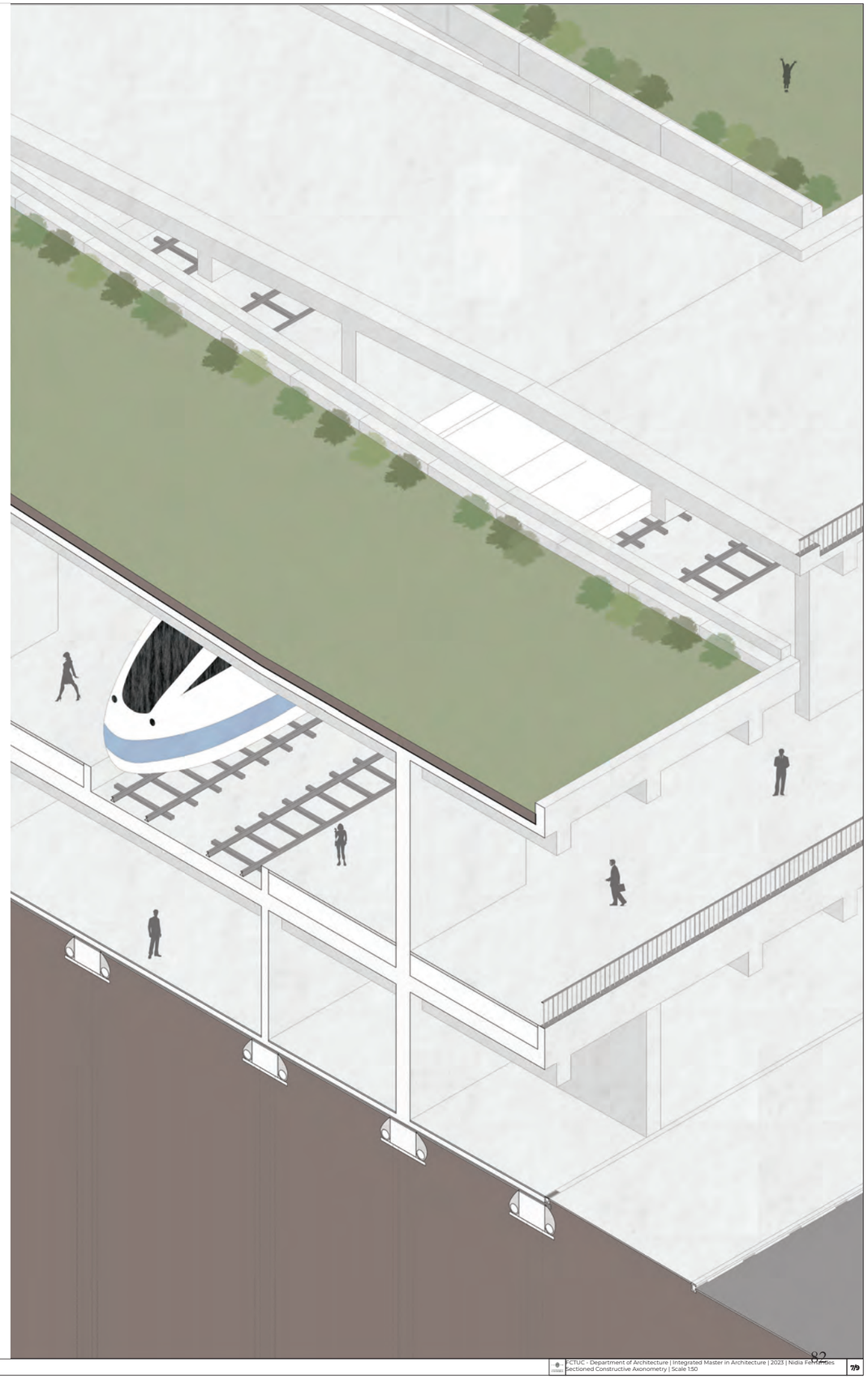


Figure 44: Constructive details (See Panel 8 in annex for full size)





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Sectioned Constructive Axonometry | Scale 1:50

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Figure 45: Sectioned constructive axonometry. (See Panel 7 in annex for full size)

5.2.2. Building Materiality

As the architectural concept for the new Coimbra Intermodal Station was being finalized, the constructive requirements were studied in the class of CEI (*Construção do Edificado I*), as well as sustainability aspects of the project, all through the first semester of 2022-2023. This chapter looks to explain the building materials used throughout the design of the station and in the chapter "5.2.4 Environmental Impact" the aspect of sustainability is detailed further.

The main material used in the project is concrete for its resistant properties to weight and vibrations caused by the trains, easy adaptation to different shapes, aesthetic contrast with the green roofs, minimal maintenance, and the expected long life of the building. The main structure is made up of blade pillars with a section of 12m x 60cm, beams with a vertical section of 90cm x 60cm, and continuous slabs that go from 60cm at the level where the trains cross the station, and 30cm in all other slabs.

Given that the station is to be built on a floodable zone, the base starts with foundation piles that are considered to reach the hard strata and prevent the building from sinking or sliding out of place. The drainage of the foundation is essential for the longevity of the building. The use of gravel and waterproof membranes protect the shallow foundation and the structural slab from underground water as well as potential flooding of the ground floor.

As a measure of economic and material savings, most of the station is designed and treated as exterior space, allowing air to flow through naturally. The floors are coated with finishing concrete screed, to offer smooth continuous surfaces and protection to the structure from water. On the first floor, the platforms for users are mostly mass concrete to not overload the structure with the requirement of keeping users at a safe distance from the railway lines and provide easy entrance into the trains. The handrails used on stairs, edges of the building and empty spaces for escalators are designed in metal and fixed to the floor.

The waiting rooms and the bathrooms on the second level are thermally and acoustically treated for the comfort of the users. Both services are design to be perceived as "containers", separate from the main structure of the building, that could be removed easily. The waiting rooms are glass containers with self-supporting framing, allowing, from the interior, a visual interaction with walking passengers, as well as with the planted vegetation on either side of the service areas. The bathrooms containers, which also serve as storage, are built in screed and exposed concrete blocks. The heating, ventilation and air conditioning ducts are inserted through the suspended ceilings of these waiting rooms and connect with the technical rooms at the top of the station's roof.

Following the group strategy, I maintain the proposal of green roofs and walkways. For the building to be appealing to the residents the gardens should at least support bushes and small trees, preferably edible and medicinal. To accomplish this, the dirt was projected to have 40cm at the lowest depth. The plants to be placed on the different parts of the project are detailed in the chapter "5.2.3 Flora Catalogue." Most of the elements that make up the sitting areas, limiting the rooftop gardens, are made of prefab concrete blocks. Those are installed after the main concrete structure is built in situ.


Image 1


Image 2


Image 3

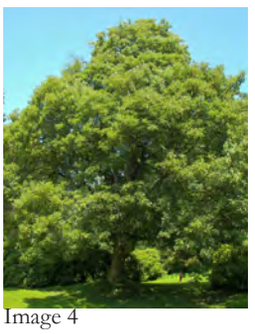
Image 4


Image 5


Image 6


Image 7


Image 8


Image 9


Image 10


Image 11


Image 12


Image 13


Image 14


Image 15


Image 16

Image 17


Image 18

Figure 46: Graphic flora catalogue.

5.2.3. Flora Catalogue

The title of this dissertation, Green Invasion, refers to the introduction of greenery into the architecture design. For the benefit of the local environment, new and invasive plants should not be introduced. To benefit residents, the plants I propose in this chapter are edible, aromatic, and medicinal.

The selection of flora for the green rooftops, garden walkways, and surrounding vegetations went through an analysis of the Forestry Management Plan and Guidance for the Public Use of the Choupal National Forest (Plano de Gestão Florestal e Orientação da Utilização Pública da Mata Nacional do Choupal)[21], given the proximity and importance of the park. I also took expert advices from landscape architect Duarte Natário, and biochemist Ana Zita Fernandes.

The trees chosen for the buildings' surrounding areas are Mediterranean cypress (Image 1: Cupressus sempervirens), Olive tree (Image 2: Olea europaea L.), Black poplar (Image 3: Populus nigra), and Sycamore maple (Image 4: Acer pseudoplatanus). In the order presented previously, these trees are planted gradually from the train station to the river. This method takes in consideration the root depth and the water requirements for each type of tree, as well as the size of the canopy, using cypresses to direct the user's eyes to the entrance of the station or using maple to offer more shade at a safe distance from the railway lines.

The dirt depth of 40cm was decided from an aesthetic and construction point of view, as there was a desire to keep the structure and the parapet relatively slim and still be able to support diverse uses on top of the building, separate from the main purposes of transportation or retail.

With this, the types of flora selected are categorized into bushes, herbs and medicinal plants, bulbs, and ground cover. The bushes chosen to be planted on the green roofs and elevated line parks are Bay laurel (Image 5: Laurus nobilis), Blueberries (Image 6: Myrtus communis), Oregano (Image 7: Origanum vulgare), Lavender (Image 8: Lanvadula stoechas), High mallow (Image 9: Malva sylvestris L.), and Rosemary (Image 10: Rosmarinus officinalis). These plants will serve as garden limits and visual direction. The herb and medicinal plants chosen are Wild sage (Image 11: Salvia verbenaca), Greater celandine (Image 12: Chelidonium majus L.), Herb robert (Image 13: Geranium robertianum L.), and Fleaworts (Image 14: Plantago sp.). These plants are smaller than the previous category of bushes but can still be identified over common grass. Bulbs are good plants to have in less irrigated areas as this can withstand the seasons with minimal or no maintenance. Adequate bulbs for the Coimbra area are Round-headed garlic (Image 15: Allium sphaerocephalon), and Tassel grape hyacinth (Image 16: Muscari comosum). Additionally, these species are edible. As ground cover the plants selected are Creeping thyme (Image 17: Thymus serpyllum), and Greater periwinkle (Image 18: Vinca major L.). The thyme works as a good substitute to common grass as it does not require a lot of water to thrive and even traps moisture in the ground. Periwinkle is a vine, that apart from offering ground cover, it can grow enough to extent out of its planting area and hang over, being visible from underneath ceilings of the project.

[21] Departamento de Gestão Áreas Classificadas Zonas Húmidas, Plano de Gestão Florestal e Orientação da Utilização Pública da Mata Nacional do Choupal (2012), https://www.icnf.pt/api/file/doc/5df9343734da0d02

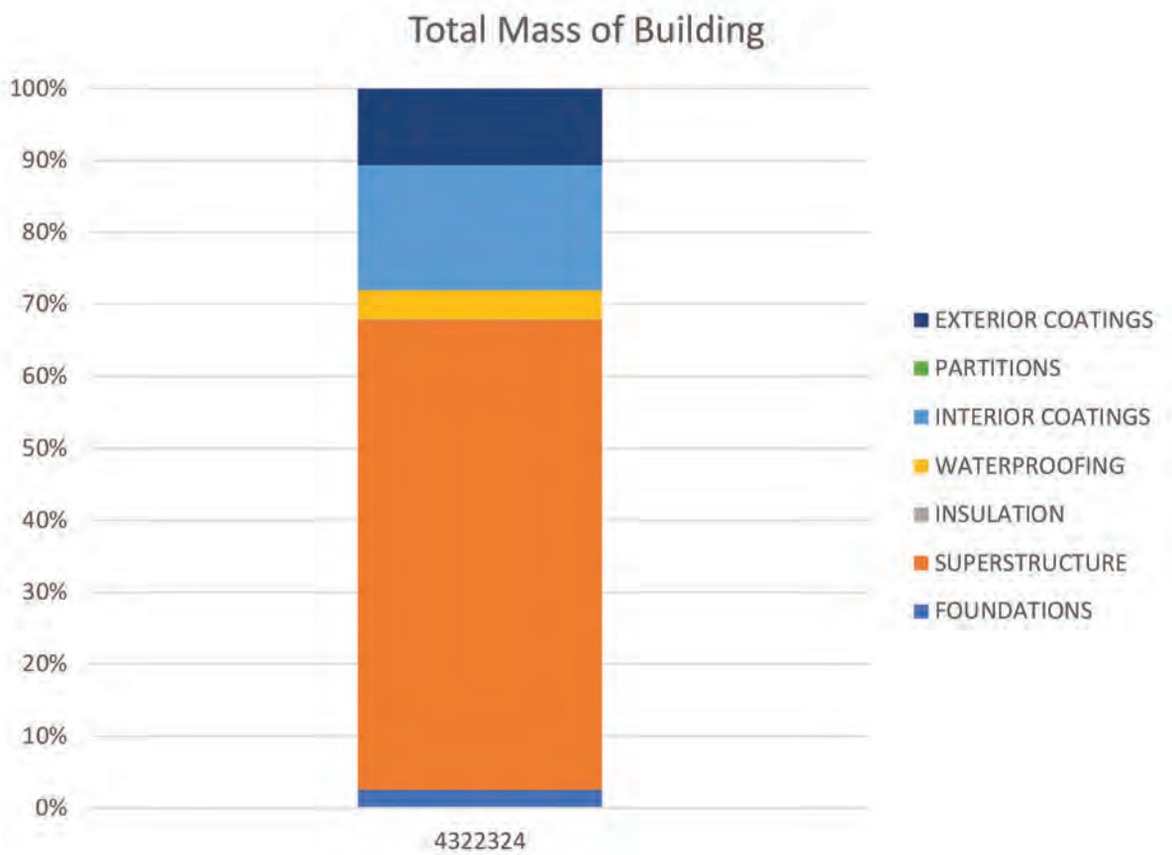

Figure 47: Total mass of the building section per category of material.

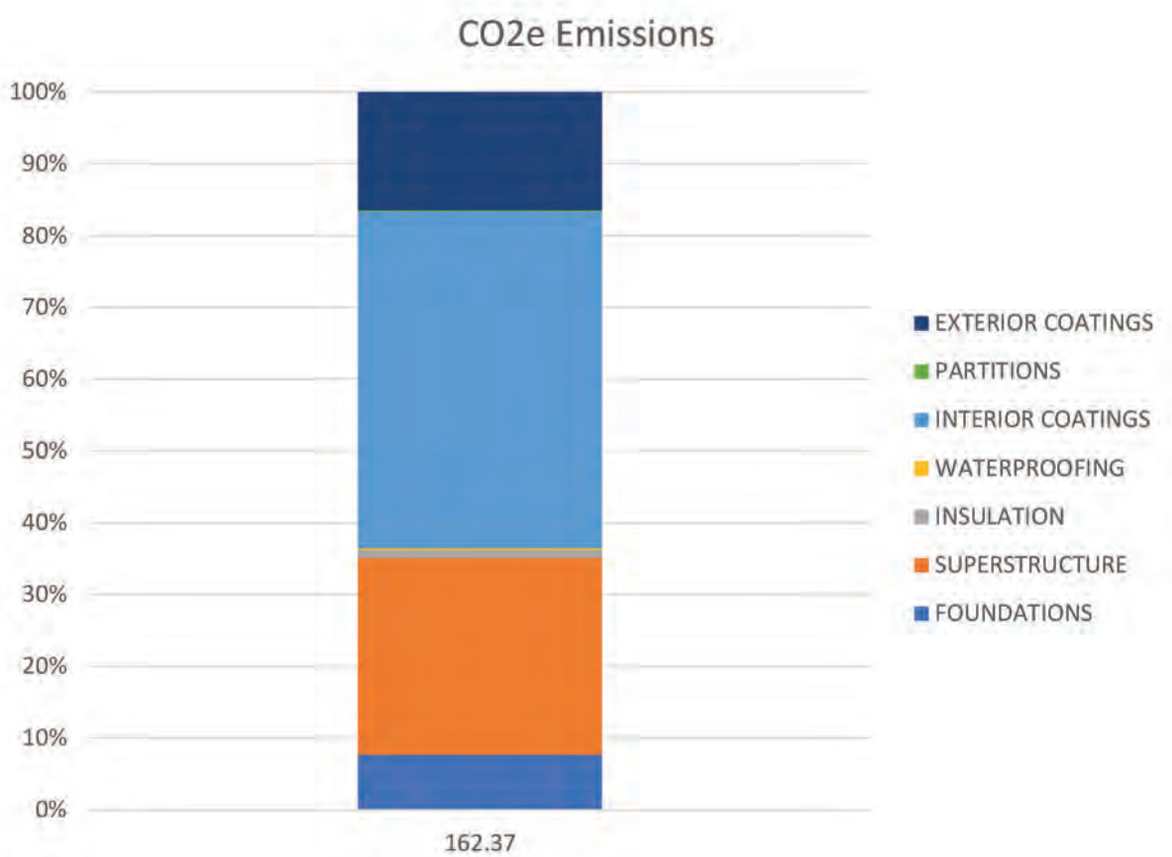

Figure 48: CO2e emissions per square meter per year, of the building section by category of material.

5.2.4. Environmental Impact

Climate change is caused by the large concentration of greenhouse gases, such as nitrous oxide, methane, or carbon dioxide. These gases, in balanced concentrations, keep Earth from being too cold. Ever since the Industrial Revolution, the release of these gases from human activities has increased, causing global temperatures to rise. For these gases to be measured and compared, the metric CO2e (carbon dioxide equivalent) was officially defined by Eurostat, that converts the amount of greenhouse gases to the equivalent amount of carbon dioxide.[22] Architecture and Construction contribute to 37% of greenhouse gas emissions as of 2022,[23] so it makes sense that for future buildings there needs to be greater awareness and action to mitigate the impacts.

All materials go through a life cycle of stages of raw material extraction, manufacture and processing, transportation, retail, use, and waste disposal. A useful tool for measuring the impact of each stage and comparing materials is the Life Cycle Assessment (LCA), which involves the calculation of potential environmental impacts using CO2e. As part of the CEI class, a section of the project was analyzed using the LCA rating of the building materials. The CO2e units utilized for the assessment are found in the Inventory of Carbon and Energy (ICE)[24], provided by the professor.

The section studied relates to the central entrance of the railway station, as well as corresponding levels above, an area of roughly 30m x 18m. For each material I calculated the volume, density, their transport distances, and CO2e/Kg -respective to the material and transport-, and this data was categorized in Excel. The categories are Foundations, Superstructure, Insulation, Waterproofing, Interior Coatings, Partitions, and Exterior Coatings. The resulting graphs (Figure 1 and 2) help to visualize and compare how each material category impacts the environment. The total potential impact on climate change is 162.37kg of CO2e per square meter per year.

The foundations and superstructure are projected in reinforced concrete, and we can see that the relative impact over a 100 year-period is very low. Concrete is often portrayed as an environmentally unfriendly material, but this is because the impact measurement most known is the one at the moment of manufacturing. When looking at the life expectancy of the material, as well as the amount of maintenance required for the material to be functional, the environmental impact is less than in materials like wood and metal.

Lastly, the previous chapter also looks to help in offsetting the environmental impacts of the construction. A tree absorbs from 10kg to 40kg of CO2 per year[25] and green roofs absorb approximately 1.889kg of CO2 per square meter per year.[26] With this, in the corresponding section of building the area of green rooftop should absorb 430kg of CO2e per square meter per year.

[22]Olga Rabo, "What is CO2e and how is it calculated?", Cooler Future, Accessed July 3, 2023, https://www.coolerfuture.com/blog/co2e

[23] United Nations Environmental Programme, "2022 Global Status for Buildings and Construction", NA: UNEP, 2022, https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction

[24] Geof Hammond and Craig Jones, Inventory of Carbon and Energy (V2.0) (Bath, UK: University of Bath, 2011)

[25] "How much CO2 does a tree absorb?", Ecotree, Accessed July 5, 2023, https://ecotree.green/en/how-much-co2-does-a-tree-absorb#:~:text=A%20tree%20absorbs%20approximately%2025kg%20of%20CO2%20per%20year&text=But%20really%20a%20tree%20absorbs,a%20whole%20host%20of%20factors.

[26] Takamori Kuronuma, Hitoshi Watanabe, Tatsuaki Ishihara, Daitoku Kou, Kazunari Toushima, Masaya Ando and Satoshi Shindo "CO2 Payoff of Extensive Green Roofs with Different Vegetation Species", Sustainability, June 30, 2018, https://www.mdpi.com/2071-1050/10/7/2256

6. Final Conclusions

The project presented in this master's dissertation was developed in the understanding that the initiative to install the High-Speed Railway (HSR) in Portugal will not only make the trips inside the country more efficient and enjoyable but will connect Portugal to the rest of Europe in a more environmentally friendly way, being the next great step into carbon neutrality. The world is becoming more urbanized and city centers need to expand to accommodate the rise of population; the implementation of new and better infrastructure allows people to appropriate the available territory and have more choices of development.

The HSR will connect Porto to Lisbon, with a bypass through Coimbra (as well through Aveiro and Leiria), which leads to the need to revitalize the area around the new train station. The north periphery of Coimbra – specially the area of Loreto and Pedrulha neighborhoods – is a very susceptible part of the city that deserves to be protected from invasive interventions. The ecological and agricultural reserves are the first to suffer when the growth of a city is impeded, but future developments should have an elevated awareness to the situations of the city and of the world, especially with climate change at our door. The placement of the current train station and railway lines inflicted a drastic cut in the territory, that then reflects on the lack of desire of the residents, not only of the Loreto neighborhood but of central Coimbra, to take advantage of the Campos do Mondego and enjoy more of the Choupal National Forest.

Although this dissertation didn't have participation from the community this project is aimed for, the group work and interaction with classmates made the urban intervention more carefully adapted for the present conditions and a potential future development. To encourage the holistic approach in architecture, the input of different specialties is also crucial. The group work and the individual project look to offer a balance between the new extension of the city and the careful preservation of the urban agriculture and safe connections to soft mobilities.

The individual project – Coimbra Intermodal Station – is a social platform, where people can enjoy the benefits of nature, transport facilities and local commerce. The many instances of parks, railway platforms, bus terminal and market on their own are locations where social interactions can take place, so by joining them and making them easily accessible, the dynamics are enhanced. The multiple uses of this transport intermodal make this building very versatile and useful in many situations that may arise with the passage of time.

Green spaces are still dominant because we humans are part of nature and the environment, and having buildings and artificial environments that ignore this fact harms our physical and mental health. We need to find a balance, as a society, between the built and natural environment that can benefit both. In a sense, cities need to "retroactively" degrow from being solely urban and have some roots for a healthy development.

Biophilic design encourages people to enjoy a space, even if there is no purpose to be fulfilled in the moment. The elevated linear catwalks and parks offer safe and healthy passageways, away from cars and pollution, encouraging healthy lifestyles. With this, the buildings that implement this type of nature-orientated design are more likely to be maintained and their purpose to change over time, reusing the space.

Through the concept of biophilic design it was possible to reduce the visual impact of such a big construction, as well as the significantly reduce the environmental impacts. This project enhances the large green infrastructure on the north periphery of Coimbra by making it accessible to residents and any user of the railway station, bus terminal or biological market. The urban agriculture pushes people to understand where their produce come from and how they can interact differently with their surroundings. By planting edible plants on the green roofs, people can be curious and interact with the building using more of their senses.

The previous chapter helped to bring into perspective an important discussion point of the project since its materialization, be it at an urban level and at a building level. Concrete is a material that has been used for a long time because of its longevity and ease to build with but has the reputation of being damaging for the environment. This is in part because the mining for the cement takes a toll on the planet's resources. At the same time, it is because a lot of buildings with this material were demolished before the lifetime of the construction could offset the extractive impacts, leaving polluting and hard to dispose of wastes.

Indeed, the concrete can be developed to have less impacts when manufacturing, and the results of demolition can be reused, but the material as is, in lengthy multi-use lifetime, emits comparably little impact, as seen by the graphs (Figure 1 and 2). In any case, the urban rise to implementing more green rooftops, walls, balconies, and nature-based solutions can help mitigate more effects.

Comprehensively, the HSR, the various interconnected buildings, the multi-functional and biophilic design, and sustainability help revitalize this peripheral area of Coimbra and connect Loreto to the consolidated city center, transforming it into a comprehensive neighborhood where residents not only sleep at but live in. These elements act as a "stitch" in this "broken city", reversing the stigmatization of its social and urban fabric.

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1 - Loreto Park | 2 - Lufapo Hub | 3 - "Parque do Loreto-Estação" MetroBus Stop | 4 - Residential Complex | 5 - "Loreto-Multiusos" MetroBus Stop | 6 - Multipurpose Pavilion | 7 - Irrigation water canals | 8 - Urban agriculture | 9 - Elevated walkway | 10 - Railway Station | 11 - Bus Terminal | 12 - Biological Market | 13 - Sports Complex | 14 - Sports fields | 15 - "Pedrulha" MetroBus Stop | 16 - Choupal National Forest

- Individual proposal area

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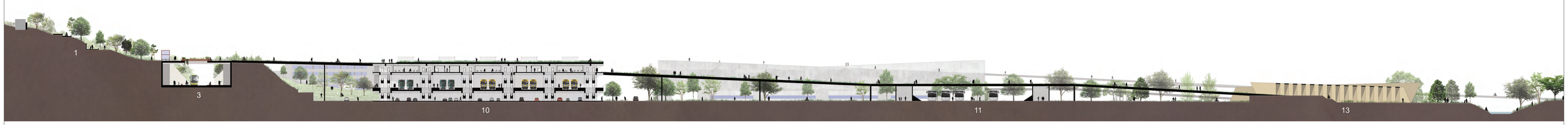

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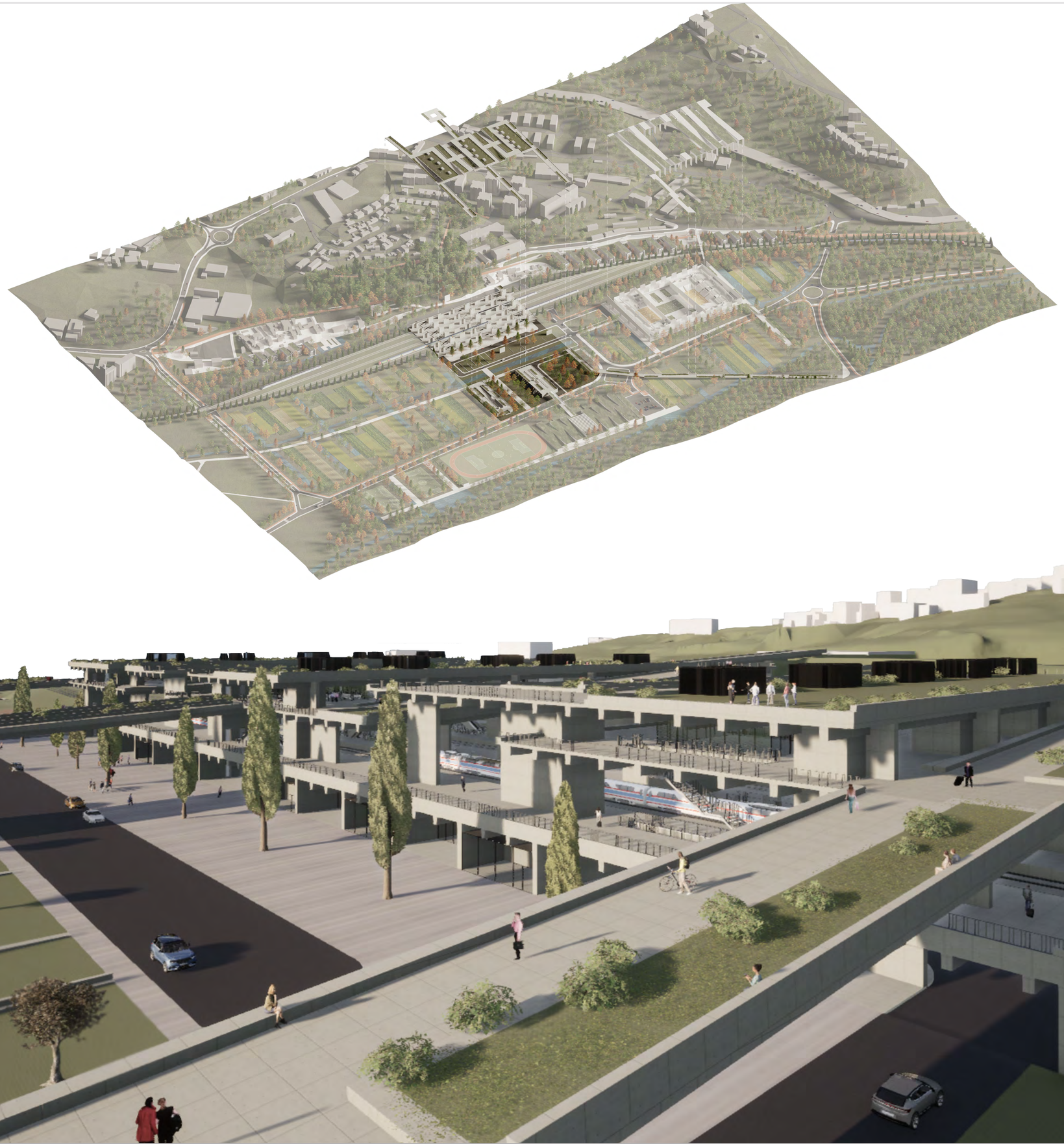

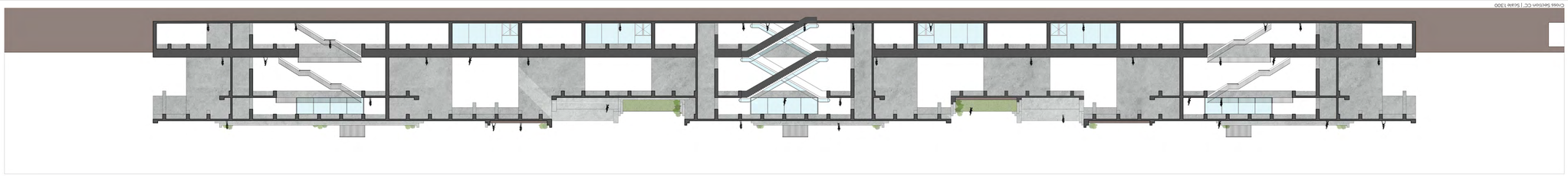

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Cross Section BB' | Scale 1:300

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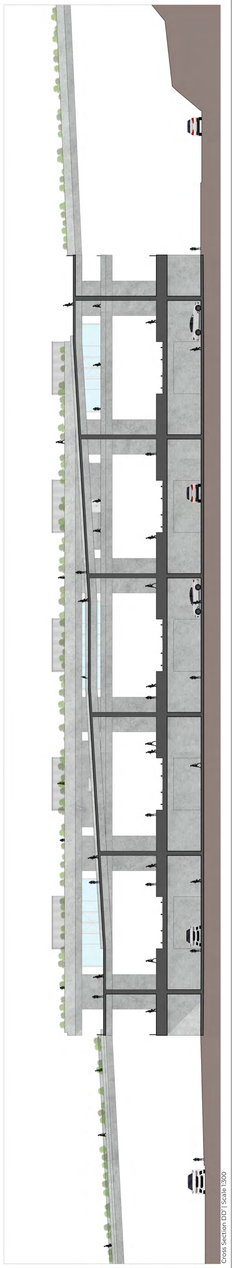

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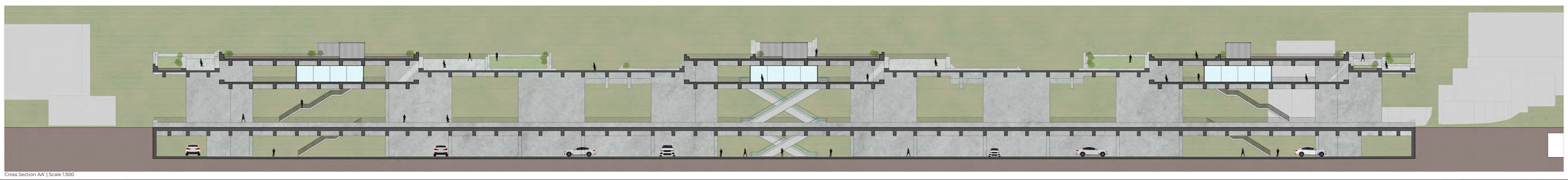

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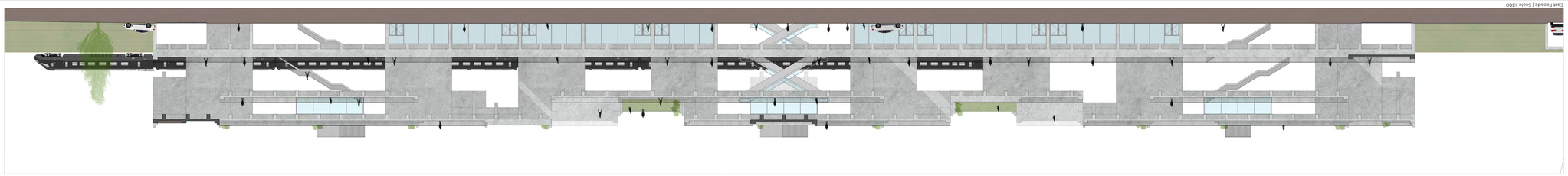

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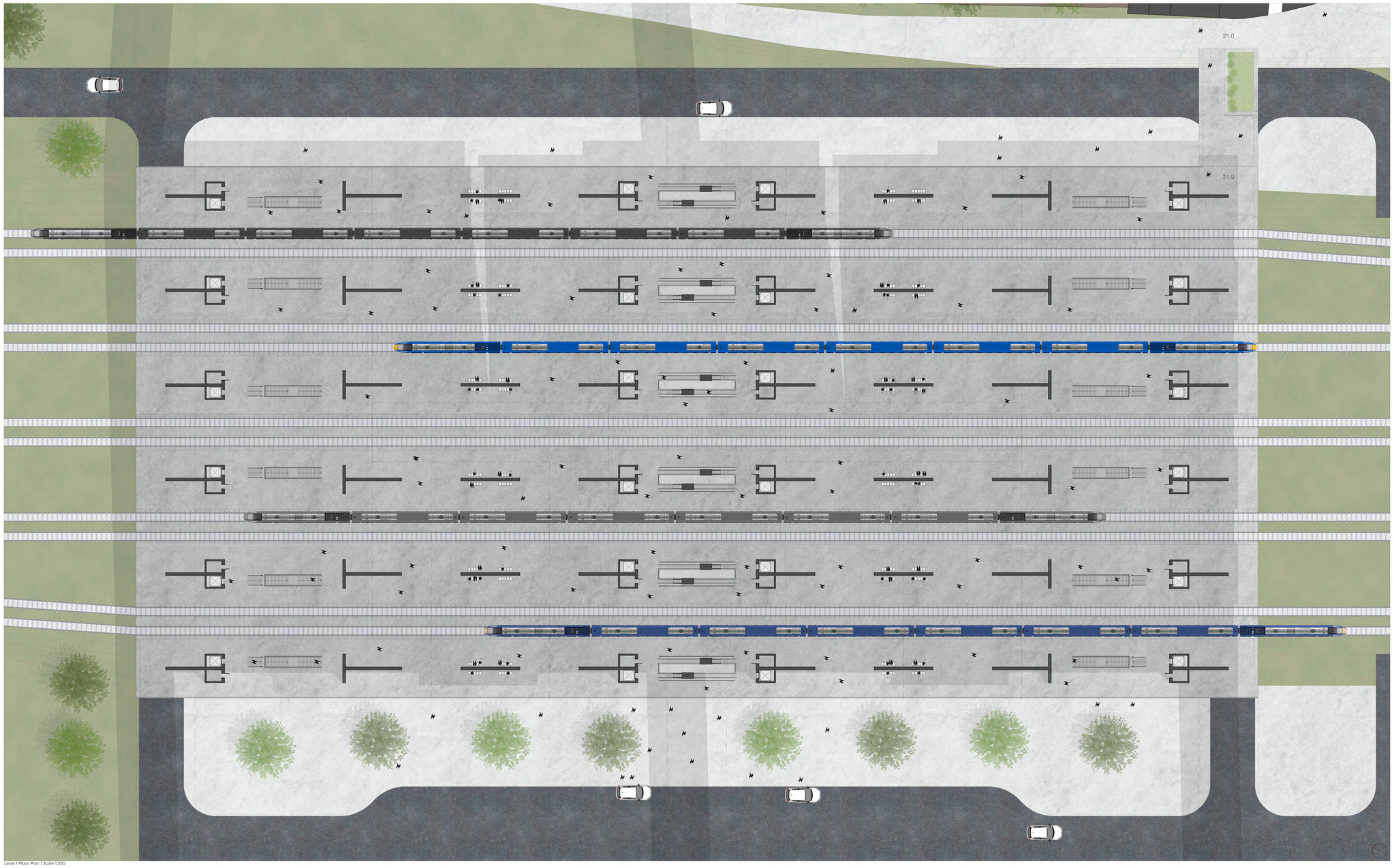
North Facade | Scale 1:300



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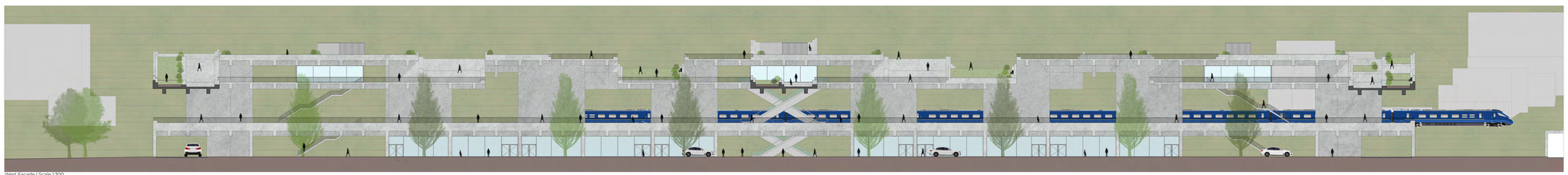

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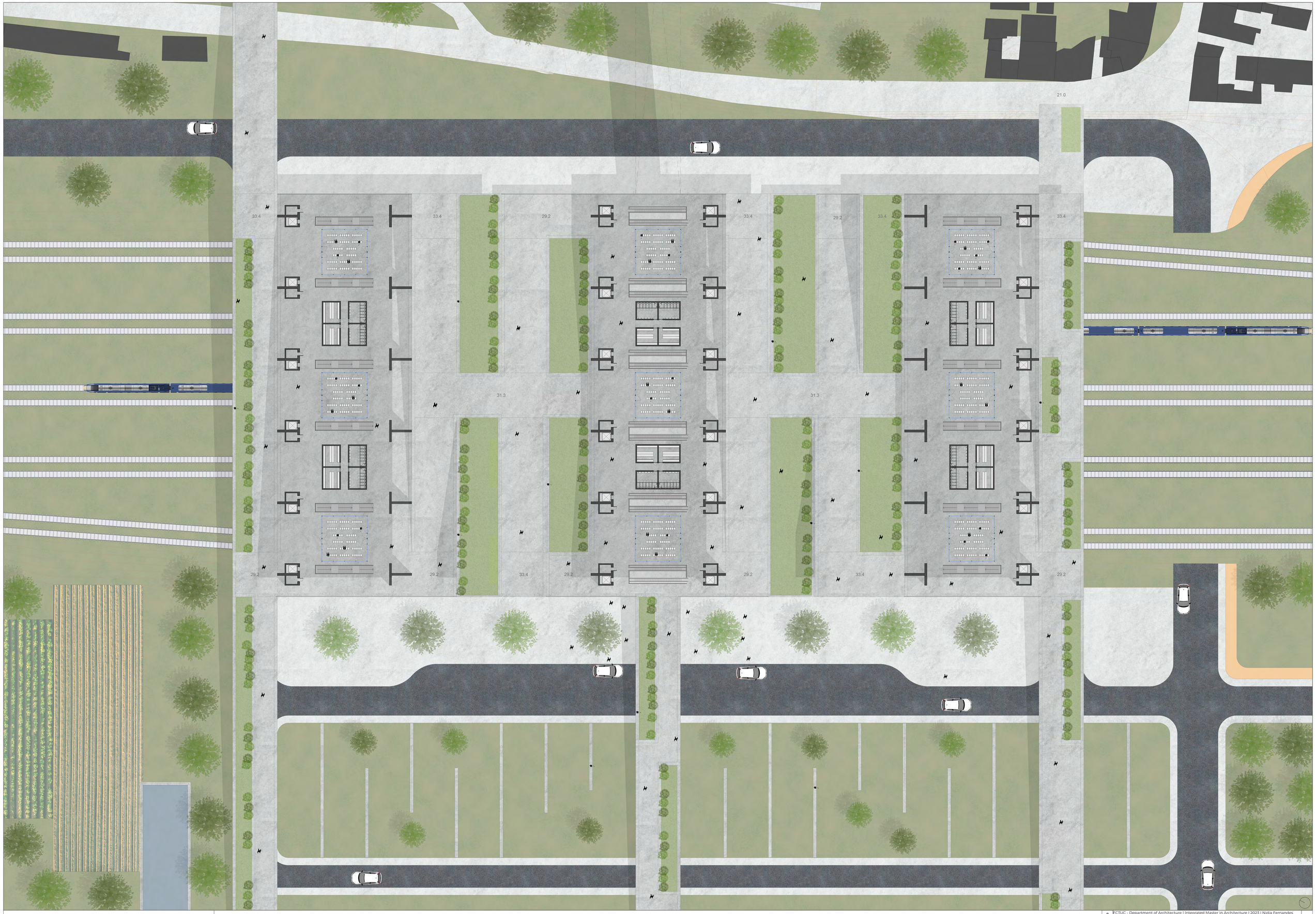
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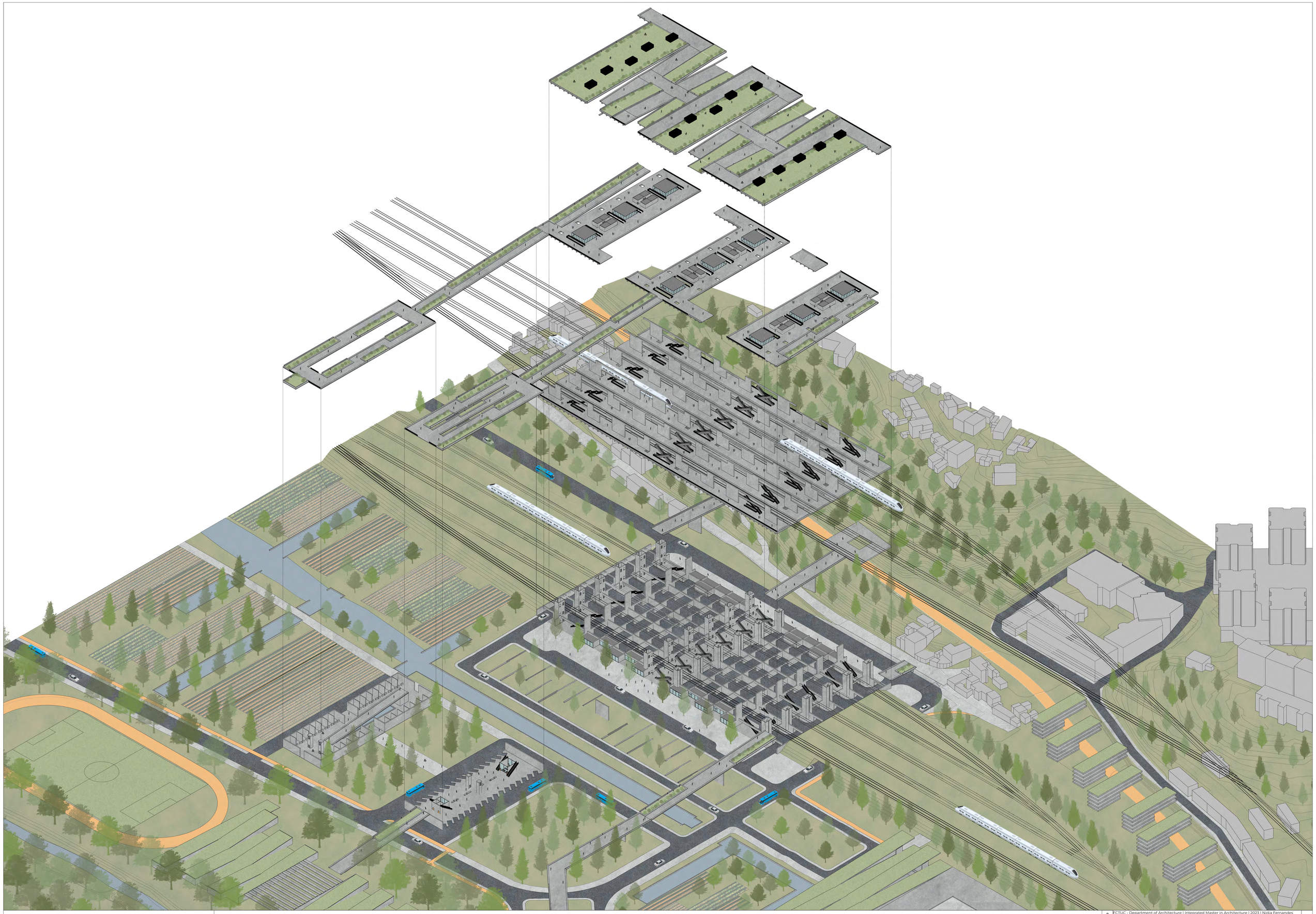

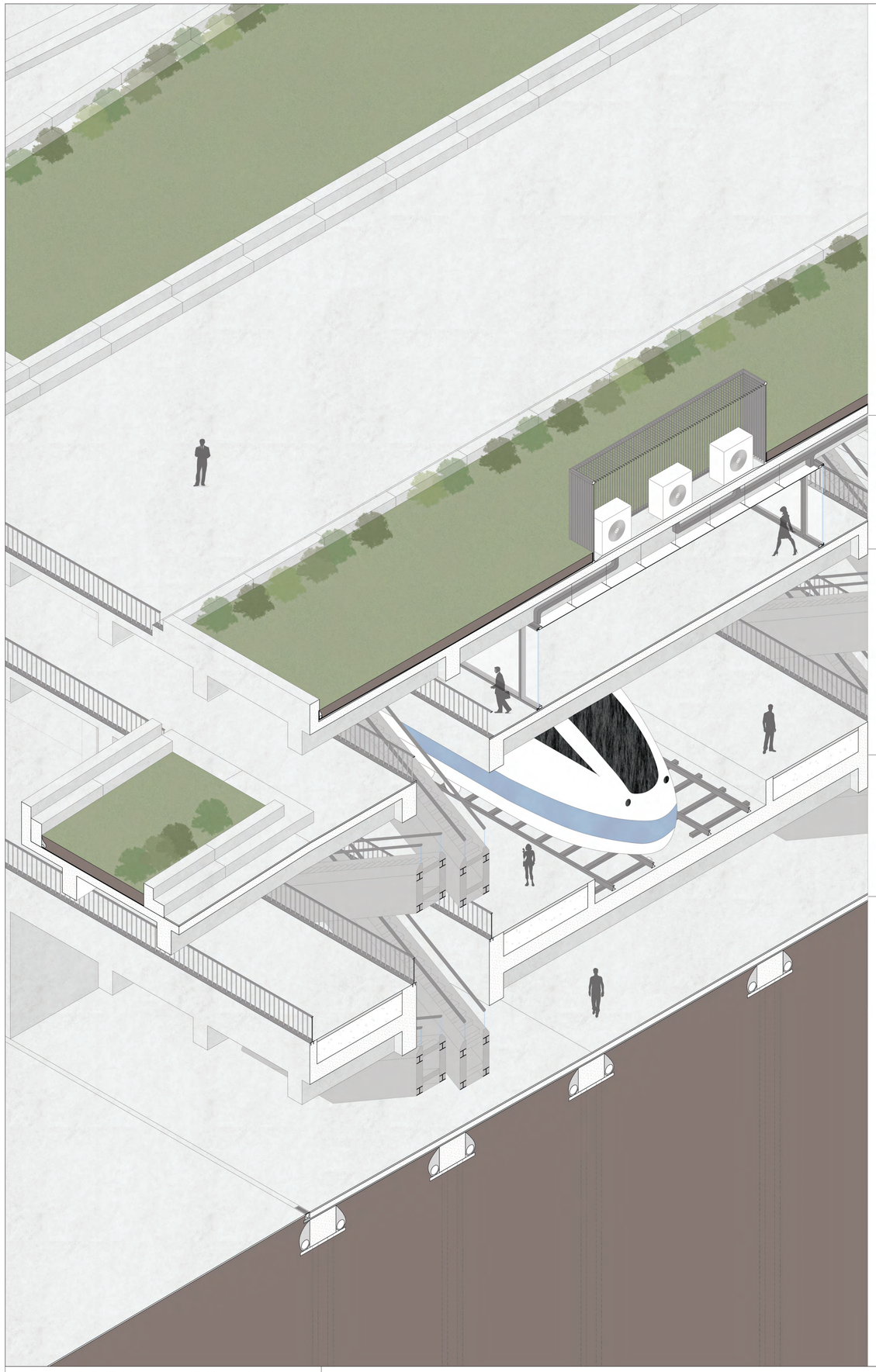

Dirt
Geotextile
Drainage layer
Waterproofing
Machine room
Structural slab
Air conditioning pipes
Concrete beams
False ceiling
Self-supporting aluminum frame

Dirt
Geotextile
Drainage layer
Waterproofing
Structural slab
Concrete beams

Self-supporting aluminum frame
Finishing concrete screed
Waterproofing
Structural slab
Concrete beams

Finishing concrete screed
Lightweight filling concrete
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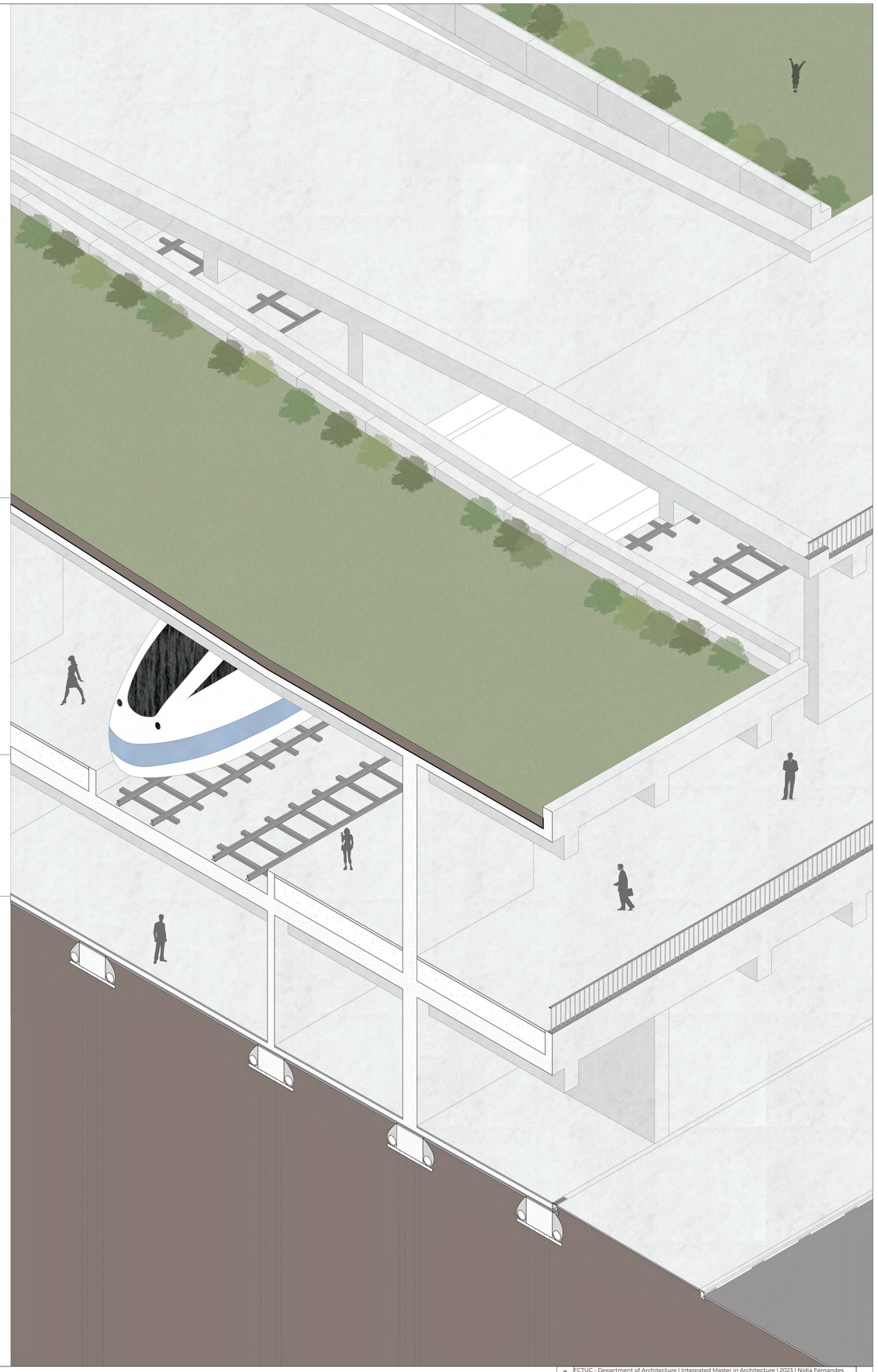

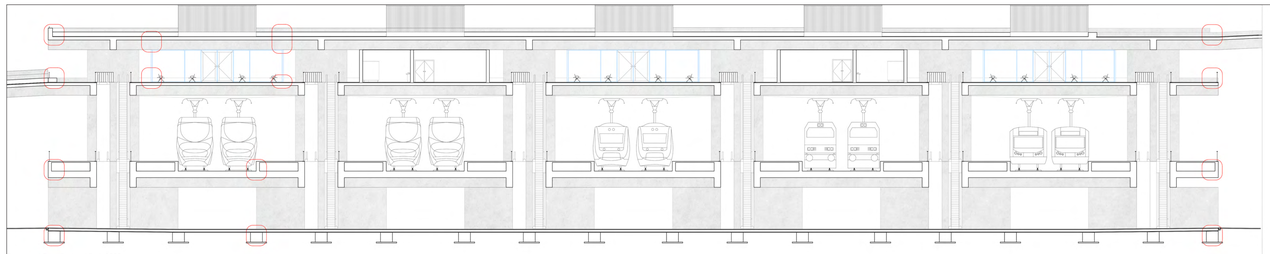

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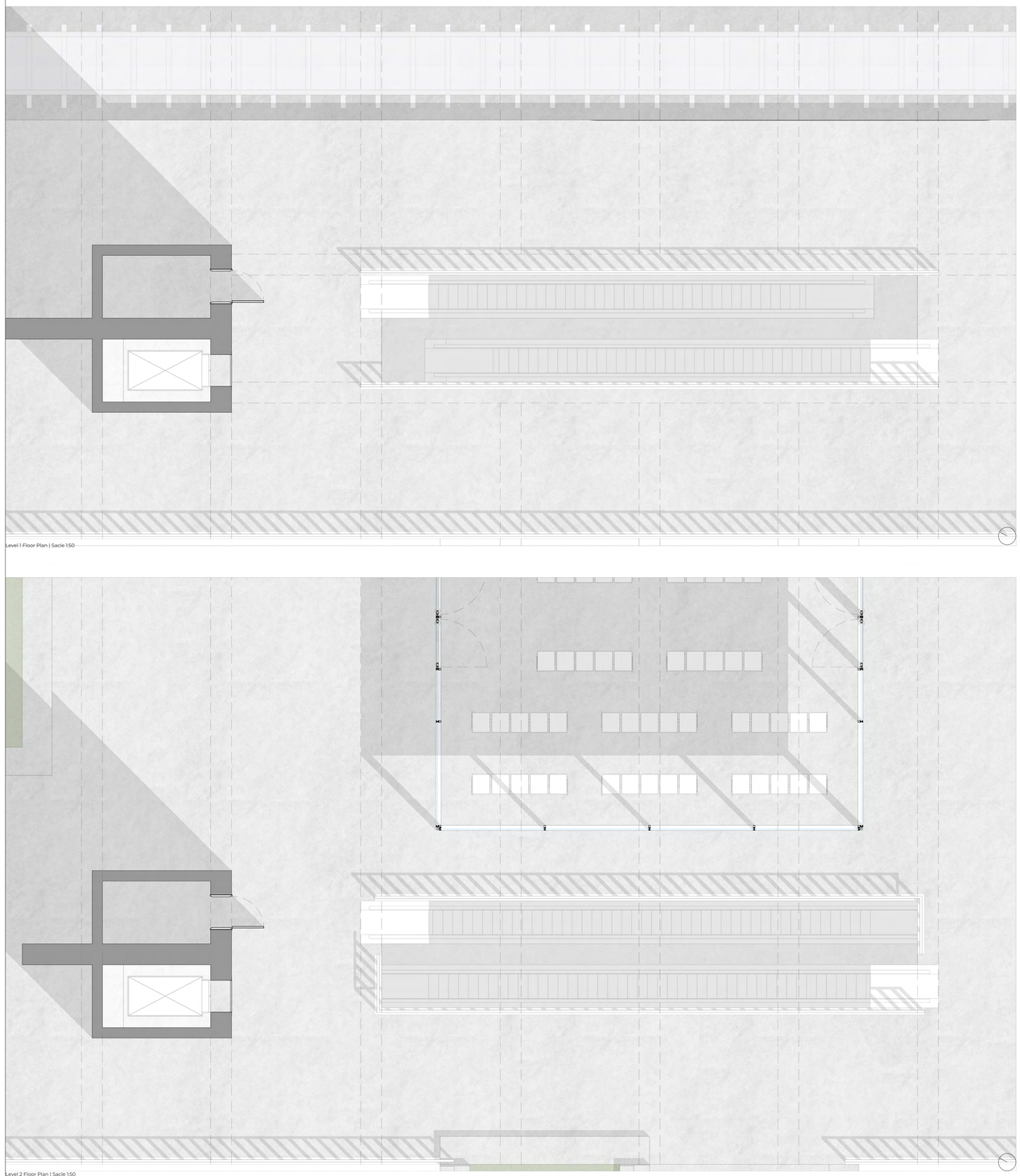

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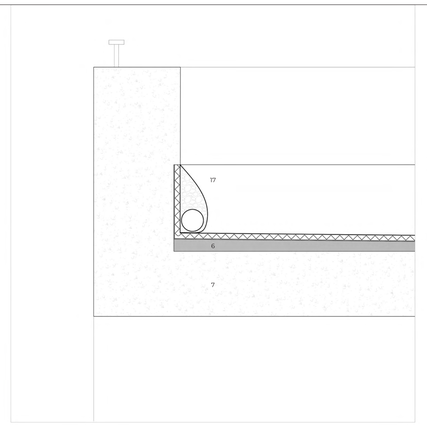
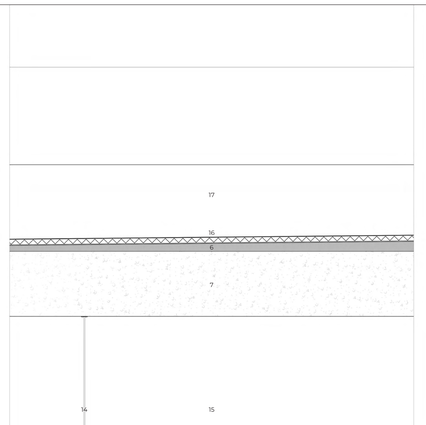
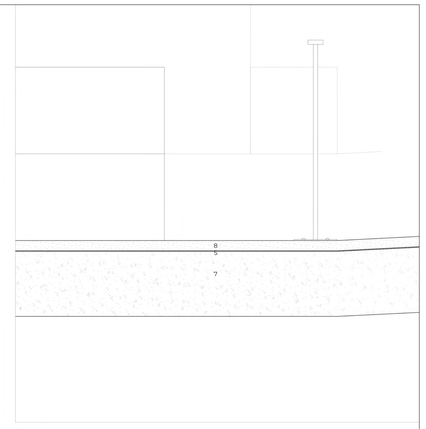
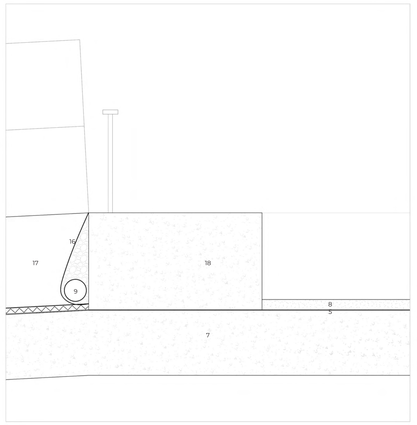
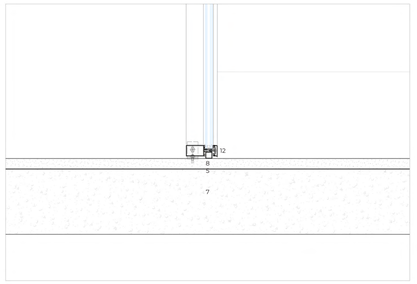
Level 2 Floor Plan | Sacle 1:50

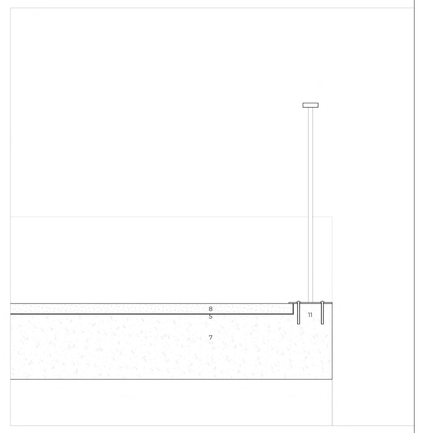


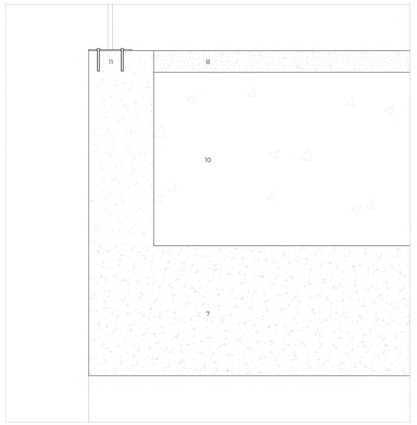


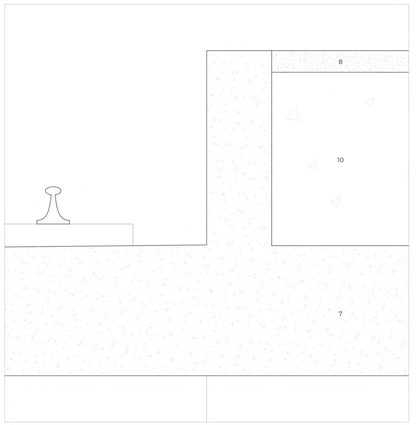


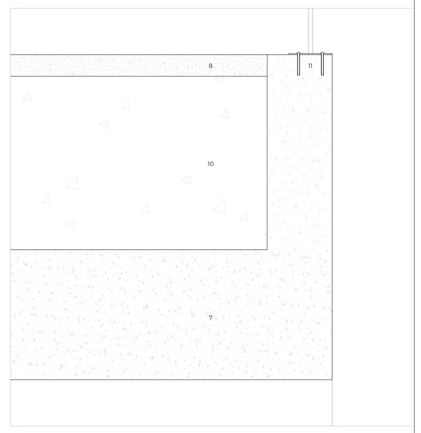


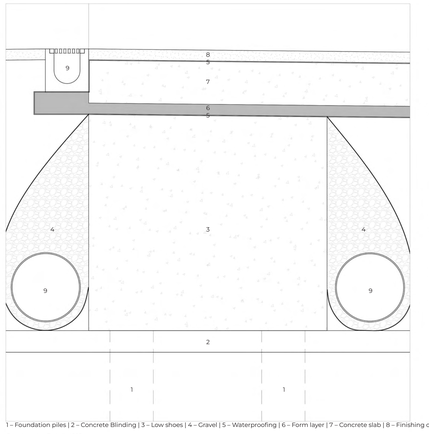


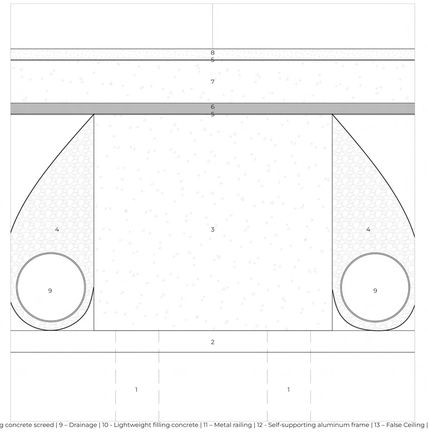


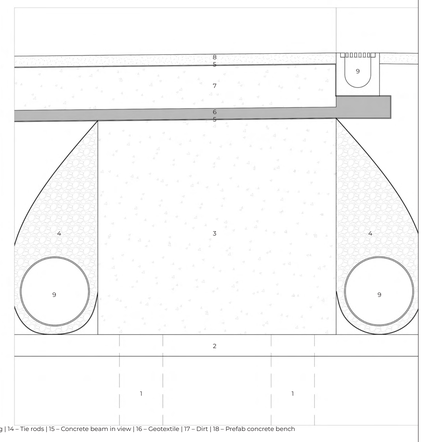












1 – Foundation piles | 2 – Concrete Blinding | 3 – Low shoes | 4 – Gravel | 5 – Waterproofing | 6 – Form layer | 7 – Concrete slab | 8 – Finishing concrete screed | 9 – Drainage | 10 - Lightweight filling concrete | 11 – Metal railing | 12 - Self-supporting aluminum frame | 13 – False Ceiling | 14 – Tie rods | 15 – Concrete beam in view | 16 – Geotextile | 17 – Dirt | 18 – Prefab concrete bench

Constructive Details | 1:10

Main entrance of the Intermodal Station | Aerial view of the west facade looking north

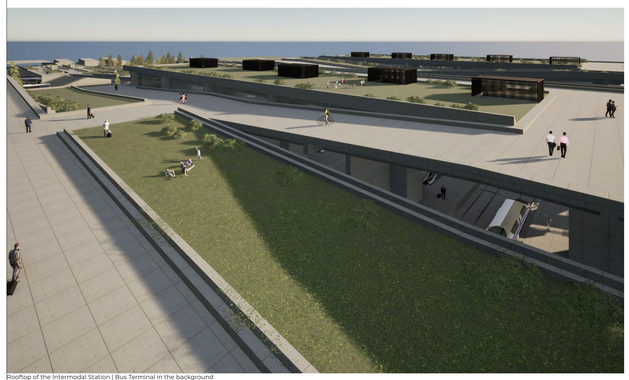
Intermodal Station | Connection between railway station, bus terminal and market | Relation with housing complex, multipurpose pavilion and sports complex

Main entrance of the Intermodal Station | Kiss & ride plaza and entrance into the parjing lot

Railway Station | Service area | Waiting room and WC

Bus Terminal | Rooftop view to the railway station

Biologic Market | Rooftop view to the railway station and bus terminal

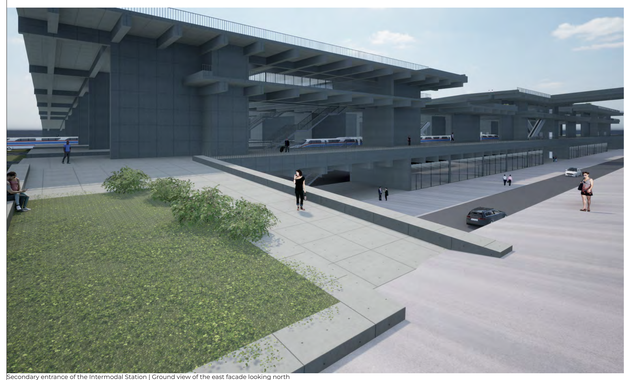


Rooftop of the Intermodal Station | Bus Terminal in the background

Railway Station | Train Platform | Arrival of the High-Speed Train

Bus Terminal | View to the waiting room

Biologic Market | Central access ramp



Secondary entrance of the Intermodal Station | Ground view of the east facade looking north

Railway Station | Central Entrance | Connection to all the train platforms and the parking lot

Bus Terminal | View to the ticket office

Biologic Market | Water mirror