Final Architectural Studio
International Undergraduate Program
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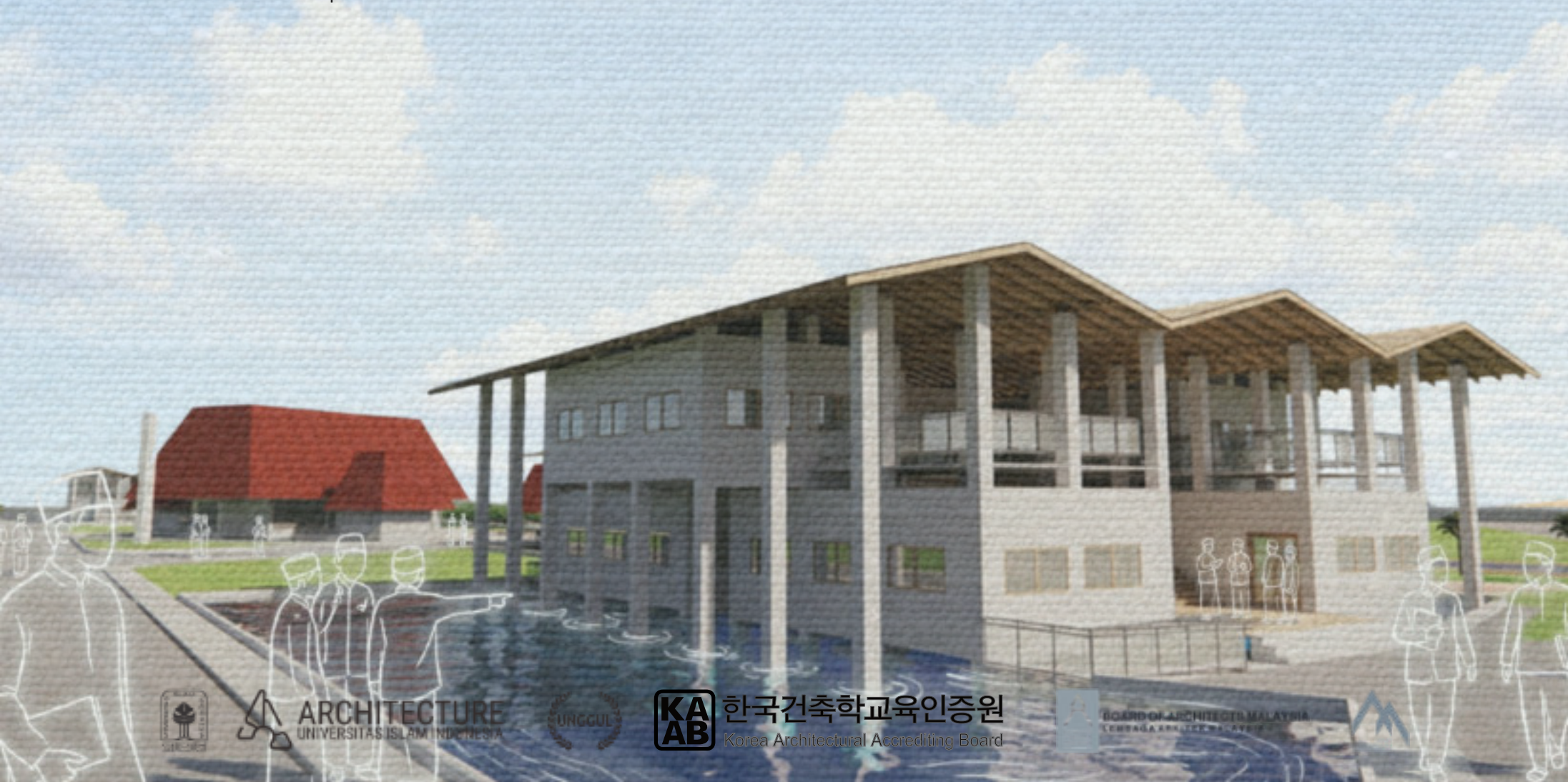
Laboratorium Pemodelan Arsitektur & Perkotaan

DESIGN OF
ECO PESANTREN
A SPONGE ARCHITECTURE APPROACH IN KENDAL

Student:
Nabiel Manggala Hamdi 20512025

Supervised by:
Ar. Faiz Hamdi Suprahman, S.T., M.A., IAI.



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Design of Eco Pesantren: A Sponge Architecture Approach in Kendal

Perancangan Eco Pesantren: Pendekatan Arsitektur Spons di Kendal

Nabiel Manggala Hamdi | 20512025
Supervised by: Ar. Faiz Hamdi Suprahman, S.T., M.A., IAI.

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Final Architectural Design Studio Entitled:

Design of Eco Pesantren: A Sponge Architecture Approach in Kendal

Student's Full Name	: Nabiel Manggala Hamdi
Student's Identification Number	: 20512025
Has Been Evaluated and Agreed on	: 28 July 2026

Supervisor	1st Jury	2nd Jury
Ar. Faiz Hamdi Suprahman, S.T., M.A., IAI.	Ir. Fajriyanto, M.T.	Johanita Anggia Rini, S.T., M.T., Ph.D.

Acknowledged by:
Head of Architecture Undergraduate Program

UNIVERSITAS ISLAM INDONESIA
FAKULTAS TEKNIK DESAIN INOVASI
YOGYAKARTA

Arif Budi Sholihah, S.T., M.Sc., Ph.D

STATEMENT OF AUTHENTICITY

By signing this form, I:

Student's Full Name	: Nabiel Manggala Hamdi
Student's Identification Number	: 20512025
Study Programme	: Architecture
Faculty	: Faculty of Civil Engineering and Planning
University	: Universitas Islam Indonesia

State that all parts of this thesis work/final project entitled:

Design of Eco Pesantren: A Sponge Architecture Approach in Kendal

I hereby declare that all parts of this work are my own, except where references are cited. No external assistance, either wholly or partially, has been involved in its creation. I also affirm that there is no conflict of intellectual ownership regarding this work; all ideas and writings con-tained herein are attributed to the main author and super-visor. The final results are submittedto the Department of Architecture, Universitas Islam Indonesia for use for educational and publication purposes, but the intellectual property rights are still owned by the author.

Yogyakarta, July 28 2026

Author

Nabiel Manggala Hamdi

PREFACE

Bismillahirrahmanirrahim
Alhamdulillahirobbil alamin washolatu wassalamu ala asrofil anbiya wal mursalin
Sayyidina wa Maulana Muhammadin wa ala alihi wa shohbihi ajma'in

0. I would like to thank myself first, a manifestation and belief that with Allah's will. Allah SWT said He will not change the condition of a people until they change what is in themselves (Q.S. Ar-Ra'd: verse 11). Which facilitated the writing of this Bachelor's Final Project with not easy but I get it with blessings.
1. Allah SWT, for His mercy and grace, who has always answered my prayers and He always hears (Q.S. Ibrahim: 39) and Prophet Muhammad SAW, for every prayer and blessing I have been able to send upon him in the night. (Doa Jami)
2. My Parents, Mamah Nanik Priyantiningsih and Papah Irwin Suryono for their prayers every single day, especially the tahajjud prayer and for the recitation of Surah Yasin. Thank you for the countless trips from Kendal to Jogja just to see me, and thank you for the scholarship throughout my education, which allowed me to reach this bachelor.
3. My Siblings, Salsabila Suci and Mas Adib Java, support through all the laugh from the day I was born until now.
4. My Supervisor, Ar. Faiz Hamdi Suprahman, S.T., M.A., IAI, who believed in me from the very beginning for his guidance, motivation, input, direction, and patience, which were crucial to the completion of this project. I'm grateful we could always laugh together at every meeting.
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8. Close friends in architecture, Cokro Susanto and Hajid Samudro, the three of us are weird but so funny tho. Thank you for all the help and let's go on another trip together soon.
9. Fellow friends under the same supervisor: Ibnu, Dewi, Aqsa, Justine, and Surya, thank you for always helping each other, brainstroming ideas, and sharing so many laughs.
10. Memorable moment trip to Istanbul, Turkey, the most inspirational moment that made me want to finish my architecture degree.
11. Fellow friends during as a head of the Ulil Albab Mosque takmir, especially the 2020 batch. Thank you for every moment and for the best lessons I learned during that time.
12. Fellow friends during as a teaching assistant, even when I was the one who asked to teach, I ended up learning far more and it only motivated me further.
13. Fellow friends I have hang out with since the start of college until now: Acad, Ammar, and the rest of the Jamaah Pesona Taaruf group.
14. To nature, people, and to every other living being who cannot all be named individually, but who taught me something along this journey.
15. Last but not least, I want to thank me. I want to thank me for believing in me. I want to thank me for doing all this hard work. I want to thank me for having no days off, for never quitting, and for just being me at all times.

Mottos I discovered throughout the journey:
- No matter what happens, **show up every day**.
- There are only two things that can happen: **pass or pass**.
- When my chances of graduating were only 50/50, I told myself:
  even if I only have a 1% chance, I'll take it and I believe I will win.

Abstract

Global education systems face growing pressure to produce graduates who are academically competent, resilient in character, and environmentally aware. Indonesia, the world's largest Muslim-majority nation with 3.5 million active santri across 43,943 pesantren, holds unmatched civilizational potential to answer this challenge. Yet in Kendal, known as the "City of Santri," this potential is under direct threat from coastal tidal flooding (rob). Data from BPBD Central Java and local studies record rob inundation reaching 30 cm in coastal settlements such as Kendall damaging housing and infrastructure, disrupting sanitation, and halting daily activities. Driven by land subsidence, coastal erosion, and mangrove loss from Special Economic Zone expansion, this recurring flooding places coastal pesantren at risk of physical damage and declining learning quality yet no adaptive coastal pesantren design prototype currently exists.

This study proposes an Eco Pesantren architectural design through Sponge Architecture strategies as a direct response to tidal flooding in coastal Kendal. Sponge architecture principel “Living with water” such as retention ponds and mangrove based buffers are integrated with Islamic spatial values, translating ecological principles into a lived, experiential part of santri education.

The output of this research is an architectural design (site concept, zoning, and building details) for a flood-adaptive coastal pesantren, intended as a reference prototype for other coastal pesantren in Indonesia and a model for shaping santri as agents of change toward Indonesia Emas 2045.

Abstrak

Sistem pendidikan global menghadapi tekanan yang semakin besar untuk menghasilkan lulusan yang kompeten secara akademik, tangguh secara karakter, dan berwawasan lingkungan. Indonesia, negara berpenduduk muslim terbesar di dunia dengan 3,5 juta santri aktif di 43.943 pesantren, memiliki potensi peradaban yang tak tertandingi untuk menjawab tantangan ini. Namun di Kendal, yang dikenal sebagai "Kota Santri," potensi ini berada di bawah ancaman langsung dari banjir pasang air laut (rob) pesisir. Data dari BPBD Jawa Tengah dan studi-studi lokal mencatat genangan rob mencapai 30 cm di permukiman pesisir seperti Kendal, merusak permukiman dan infrastruktur, mengganggu sanitasi, dan menghentikan aktivitas sehari-hari. Didorong oleh penurunan muka tanah, abrasi pantai, dan hilangnya mangrove akibat perluasan Kawasan Ekonomi Khusus, banjir berulang ini menempatkan pesantren pesisir pada risiko kerusakan fisik dan penurunan kualitas pembelajaran, namun belum ada prototipe desain pesantren pesisir yang adaptif saat ini.

Studi ini mengusulkan desain arsitektur Eco Pesantren melalui strategi Sponge Architecture sebagai respons langsung terhadap banjir pasang di pesisir Kendal. Prinsip sponge architecture "living with water" seperti kolam retensi dan penyangga berbasis mangrove diintegrasikan dengan nilai-nilai spasial Islam, menerjemahkan prinsip ekologis menjadi bagian yang hidup dan nyata dari pendidikan santri.

Hasil dari penelitian ini adalah desain arsitektur (konsep tapak, zonasi, dan detail bangunan) untuk pesantren pesisir yang adaptif terhadap banjir, dimaksudkan sebagai prototipe rujukan bagi pesantren pesisir lain di Indonesia dan model untuk membentuk santri sebagai agen perubahan menuju Indonesia Emas 2045.

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INTRODUCTION

01

Challenges of Education System

Education is one of the most fundamental pillars of human civilization. On a global scale, the world is facing major challenges in building an education system that not only produces graduates with academic competence, but is also capable of nurturing a resilient generation with strong character and awareness of environmental sustainability. International organizations such as UNESCO consistently emphasize that educational transformation is key to addressing the major crises of the 21st century, from climate change to widening social inequality (UNESCO Global Education Monitoring Report, 2024/2025).

This paradigm shift requires every country to reformulate its educational approach from a mere transfer of knowledge toward the formation of whole individuals who are adaptive to the changing times and responsible as global citizens. Within the framework of the Sustainable Development Goals (SDGs), quality education is positioned as the fourth goal (SDG 4), serving as a prerequisite for achieving all other goals. This means that the quality of people produced by an education system will directly determine a nation's capacity to confront and resolve the challenges of its era.

Figure 1. Map
Source: Autho

The quality of human resources produced by an education system will directly determine a nation's ability to face 21stcentury challenges. (SDGs Framework, Goal 4)

Figure 2. Diagram SDG
Source: SDG

Regeneration of Indonesian Human Resources

1st

As a country with the largest Muslim population in the world

4th

As the world's fourth most populous country

of Indonesian
or, 2026

Indonesia occupies a highly strategic position in responding to the global education crisis. As the world's fourth most populous country with a population reaching 288.3 million by the end of 2025 (Menpan, 2026), and simultaneously the country with the world's largest Muslim population estimated at over 242 million people or approximately 87% of its total population (World Population Review, 2026), Indonesia possesses invaluable demographic potential, both in terms of quantity and civilization.

This potential is further strengthened by the demographic bonus phenomenon currently being experienced by Indonesia. Data shows that 69.03% of Indonesia's population is of productive age (15–64 years), a condition projected to last until 2030 (Tempo, 2025). However, this demographic bonus is double edged: it can become a driving force for national progress if managed well, but conversely, it will turn into a heavy social burden if not balanced with adequate human resource quality. Therefore, the need to produce a generation with moral integrity, social sensitivity, and readiness to become agents of change is increasingly urgent.

Grand vision of Golden Indonesia 2045, Indonesia aims to become a developed country. This vision is not merely an economic ambition, but rather a civilizational project that demands a foundation of character and intelligence in a generation.

Amanah UUD 1945: Article 31 (Education)
[1] Every citizen has the right to education.
[3] The government shall manage and develop a national education system, which increases faith, piety, and noble character in order to educate the life of the nation, as regulated by law.
[5] The government shall advance science and technology by upholding religious values and national unity for the advancement of civilization and the welfare of mankind

Pesantren as Critical Mass of National Education

In various educational institutions in Indonesia, Pondok pesantren occupy a highly strategic position in responding to these regeneration needs. Based on data from the Ministry of Religious Affairs for 2024, a total of 43.943 pesantren are recorded as being spread across Indonesia (satudata.kemenag, 2025), with the number of santri registered in the odd semester of 2025/2026 reaching approximately 3.454.364 people (Kemenag, 2025). This figure makes it the largest network of community based educational institutions, even in the world.

To understand how strategic the position of pesantren is, we need to compare it with data on formal schools. Basedon data. kemendikdasmen.go.id in 2026 Indonesia had a total of around 281.947 formal schools (elementary, junior secondary, senior secondary, vocational). This means that the number of pesantren is equivalent to nearly one sixth (16%) of the total formal schools in Indonesia. This is not a small number; pesantren occupy a position as a critical mass within the national education ecosystem, with a large capacity to produce human resources.

Pesantren are not only superior because of their numbers, but also because of the quality of their complete and integrated educational ecosystem integrating spiritual (ruhiyah), intellectual (fikriyah), and social (ijtima'iyah). Their existence is formally recognized through Law No. 18 of 2019, which establishes three functions: education, preaching, and community empowerment

"Pesantren have an important role in environmental preservation, particularly through the development of education that integrates religious knowledge with knowledge of ecosystem conservation in a balanced manner. Pratikno, Menteri Koordinator PMK

وَإِذْ قَالَ رَبُّكَ لِلْمَلَٰٓئِكَةِ إِنِّي جَاعِلٌ فِي ٱلْأَرْضِ خَلِيفَةً

Remember when your Lord said to the angels, I am going to place a successive "khalifah" authority on earth.... QS. Al Baqarah:30
This verse explains khalifah or humanity's mandate as stewards of the earth, tasked with upholding God's provisions, prospering the earth, and maintaining ecological balance, not causing destruction.

43.943
Pesantren

281.947
Formal Schools

≈16%
Ratio to Formal Schools

Students called Santri

Indonesia has a strategic on 3.5 million santri spread across indonesia. If each santri is equipped with ecological insight, a deep understanding of the relationship between humans, nature, and moral responsibility toward the earth, then they will be agents of environmental change firmly rooted in Islamic values.

Every santri who returns to their community carries that awareness, influencing family, neighbors, and residents around the pesantren, an immeasurable multiplier effect. Imagine millions of points of change spreading organically to every corner of the nation, from coastal villages to mountain slopes, building a grassroots culture of living in harmony with nature. This is the pesantren's tangible contribution to Indonesia Emas 2045, not only producing a generation that is intelligent and virtuous, but a generation that understands that caring for the earth is an inseparable part of worship and civilizational responsibility.

3.454.364
Santri Active in 2024

53.913.063
Formal students

↓

Ecological Insight
Landscape as pedagogy

↓

Agent for community change
Santri influence

↓

Multiplier effect

↓

Regeneration Golden Indonesia 2045
A generation with morals and environmental awareness

The Ministry of Religious Affairs of the Republic of Indonesia, in the program "Akselerasi SDM Pesantren: Santri Unggul dan Mendunia" (2024), explicitly positions pesantren as key institutions in producing excellent human resources with international competitiveness, by integrating scientific competence, 21st century skills, and moral spiritual strength.

This distinctive educational model is not possessed by other formal educational institutions, and it also makes santri strong candidates to become the agents of change envisioned by the nation, especially in confronting the pressing challenges of the present time.

Pesantren a massive educational instrument with significant capacity to produce superior human resources as Santri for Indonesia's future.

Java Island: 73,58% of All Pesantren

Historically, Java has been the epicenter of the growth of pesantren in Indonesia. Data from satudata.kemenag.id show that more than 32.335 pesantren or around 73,58% of all pesantren in Indonesia, are concentrated on this island, with West Java, East Java, and Central Java as the three most densely populated provinces. Central Java itself has 5.231 pesantren with 439.514 active santri.

The term "pesantren" derives from the root word "santri," prefixed with "pe " and suffixed with " an," meaning the place where santri live. The term "santri" refers to students who study Islamic religious knowledge, and etymologically comes from the Sanskrit word "shastri" (a person who studies sacred texts) or the Javanese word "cantrik" (a person who follows his teacher). The dominance of pesantren in Java reflects the strength of Islamic cultural networks that have been deeply rooted since the era of the spread of religion by the Walisongo.

The dominance of pesantren in Java reflects the strong Islamic cultural networks that have taken root since the era of the Walisongo's da'wah. Pesantren in Java do not function merely as boarding schools for education; rather, they have developed into centers of community life. The position of the kiai as the highest leader provides influence

32.335
Pesantren in Java Island

5.231
Pesantren in Central Java

Source: data.kemendikdasmen.go.id

Why Santri can be Agents of Change?

Indonesia's education system produces graduates.
Pesantren produces people.

The difference is formation. Santri do not simply study they live their values, 24 hours a day, inside a system that builds moral discipline, collective responsibility, and a deep sense of stewardship rooted in khalifah fil ardh: the Islamic obligation to care for the earth. No other education system in Indonesia operates at this depth, at this scale.

This is why santri must be preserved, not as a cultural relic, but as a living engine of human formation. A nation facing the civilisational demands of Indonesia Emas 2045 cannot afford to lose its most powerful character-building institution.

A santri generation shaped by religious based education,have collective energy to drive real change not just inside pesantren but beyond into the city.
Cities fail ecologically not because of a lack of technology, but a lack of people who genuinely care. Santri, shaped by khalifah fil ardh from the ground up, are exactly that, people who care, at scale.

118
Pesantren in Kendal

2.218
Teacher in Pesantren

16.439
Santri Active

Source: Badan Pusat Statistik Kabupaten Kendal

In Kendal, the "City of Santri," 16,439 active santri represent exactly this potential. But the coast they inhabit is collapsing beneath them. And that is where the ecological crisis becomes an architectural urgency.

Kendal in Central Java's "City of Santri"

Kendal, known as the "City of Santri," is one of the regencies in Central Java with a significant concentration of pesantren. The massive physical expansion of pesantren in this area is unfortunately often not accompanied by spatial planning that is adaptive to climate change and industrialization. (RPJMD Kabupaten Kendal 2021–2026)

Kendal faces a range of serious ecological threats. According to an official statement by the Kendal Regency Secretary on 12 November 2022, the rate of land subsidence in the coastal area of Kendal reaches 2.5 to 3 centimetres per year. The main contributing factors include uncontrolled groundwater extraction for industrial needs, building loads exceeding the soil's bearing capacity, and the regional geological conditions of Java, which tends to slope northwards. This subsidence has resulted in permanent tidal flooding that is damaging building infrastructure and disrupting educational activities within the pesantren community.

Mangrove ecosystems, which function as natural coastal protection, continue to degrade due to land conversion for aquaculture ponds and industry. The presence of industrial expansion in the Kendal Special Economic Zone (SEZ) has triggered an ecological crisis in the form of massive coastal erosion and the loss of green open spaces. Data from the Indonesian Hydrographic Journal records that over a 30 year period (1990–2020), the area affected by coastal erosion in Kendal reached 470,484 hectares, far exceeding the area of accretion, which stood at just 385,161 hectares. An analysis by Mongabay (June 2025) also revealed an increase in land surface temperature (LST) in Kaliwungu from 42.2°C to 45.1°C due to the loss of mangrove ecosystems and the conversion of land into industrial concrete. The dual impact of physical damage and rising temperatures has created a learning environment that is no longer conducive to the future development of students.

Figure Area Pemanguna Kawasan Ekonomi Khusus Tahun 2014
Source: Google Earth

Kisah dari pesisir Kendal: 'Akar permasalahannya alih fungsi lahan'

Pesisir Kendal yang tadinya kawasan mangrove, menurut Wasito, telah berubah menjadi kawasan industri.

MONGABAY

Kawasan Industri Kendal: Jan

Januar Wijaya*
17 Jun 2025 jawa tengah

BBC
NEWS INDONESIA
Berita Tonton
Indonesia | Dunia | Viral | Liputan Mendalam | Majalah

'Ekosida' di Pantura: 'Kongkalikong' yang menggerus ruang hidup warga pesisir utara Jawa

Fargon Ulya Himawan, Pulitzer Center Grantee dan Ayomi Amindoni, Jurnalis BBC Indonesia

Kendal Crisis Ecology

Figure Area Pemanguna Kawasan Ekonomi Khusus Tahun 2025
Source: Google Earth

Behind the massive ecological pressure, Kendal holds great potential for transformation. Its coastal areas still possess remnants of mangrove ecosystems that can be restored. The strong culture of mutual cooperation (gotong royong) within the pesantren environment makes this community an effective agent of change kiai and santri can serve as the spearhead of community based conservation movements.

Economically, the Kendal Special Economic Zone (SEZ), with trillions of rupiah in investment, brings infrastructure modernization that, if managed wisely, can synergize with environmental preservation efforts. Kendal's strategic position on the northern coast of Java also places it as an ideal laboratory for developing resilient pesantren architectural models that can be replicated across the northern coast of Java.

Without adaptive design interventions, pesantren in Kendal's coastal areas face risks of physical damage, declining learning quality, and the threat of forced relocation.

ji Investasi, Krisis Ekologi

BBC
NEWS INDONESIA
Berita Tonton
Indonesia | Dunia | Viral | Liputan Mendalam | Majalah

'Ekosida' di Pantura: Pengembangan industri ancam pesisir utara Jawa makin cepat tenggelam – 'Banjir sudah puluhan tahun, ini pembiaran sistematis'

Furqon Ulya Himawan, Pulitzer Center grantee dan Ayomi Amindoni, Jurnalis BBC Indonesia

7 Oktober 2025

↑ **Flooding**
Effect of Ecocide

Flooding


BERITA KENDAL
TANPA INTERVENSI SERIUS, ALUN-ALUN KENDAL BERPOTENSI TERENDAM ROB SEBELUM 2030
Kendal - Ancaman banjir rob di Kendal terus meluas. Jika tidak ada intervensi besar melalui pembangunan infrastruktur pengendali rob, perbaikan drainase, dan pengendalian penurunan muka tanah, kawasan Alun-Alun Kendal berpotensi masuk wilayah terdampak rob.
KENDAL_ID


CNN

Data on tidal flooding (rob) in Kaliwungu reveal significant variation in inundation depth across recorded events. According to data from the Regional Disaster Management Agency (BPBD) of Kendal Regency, the tidal flood event of mid-November 2021 affected 1,359 households across three coastal sub-districts—Kaliwungu, Patebon, and Kendal—with inundation depths ranging from 10 to 60 cm depending on location. In Wonorejo Village, Kaliwungu Sub-district, 70 households were reported affected with water levels of 10–50 cm, while Mororejo Village recorded inundation of up to 50 cm. A comparable event recurred in May 2022, when an early-warning advisory issued by the Meteorology, Climatology, and Geophysical Agency (BMKG) regarding heightened tidal activity again triggered inundation in Mororejo Village and other coastal areas.

This recurring pattern indicates that tidal flooding in Kaliwungu is not an incidental occurrence but a seasonal phenomenon that recurs with a consistent inundation range of approximately 10–60 cm per event—a magnitude which, if it were to occur within classroom spaces or student dormitories, would be sufficient to disrupt educational activity even without reaching disaster-scale proportions.

Long-term projections indicate a considerably more severe escalation of risk. Inundation modeling for the Kendal coastal zone under 110 cm and 190 cm scenarios—accounting for projected sea-level rise and land subsidence—forecasts that between 41 and 49 villages will be submerged, with Wonorejo Village in Kaliwungu Sub-district identified as among the areas of highest vulnerability: up to 98.32% of the village's land area (924.16 hectares) is projected to be inundated. These findings situate the project site—located within Kaliwungu—squarely within a zone explicitly identified as high-risk in coastal vulnerability assessments for Kendal.

↑ **Flooding 0-50 cm**

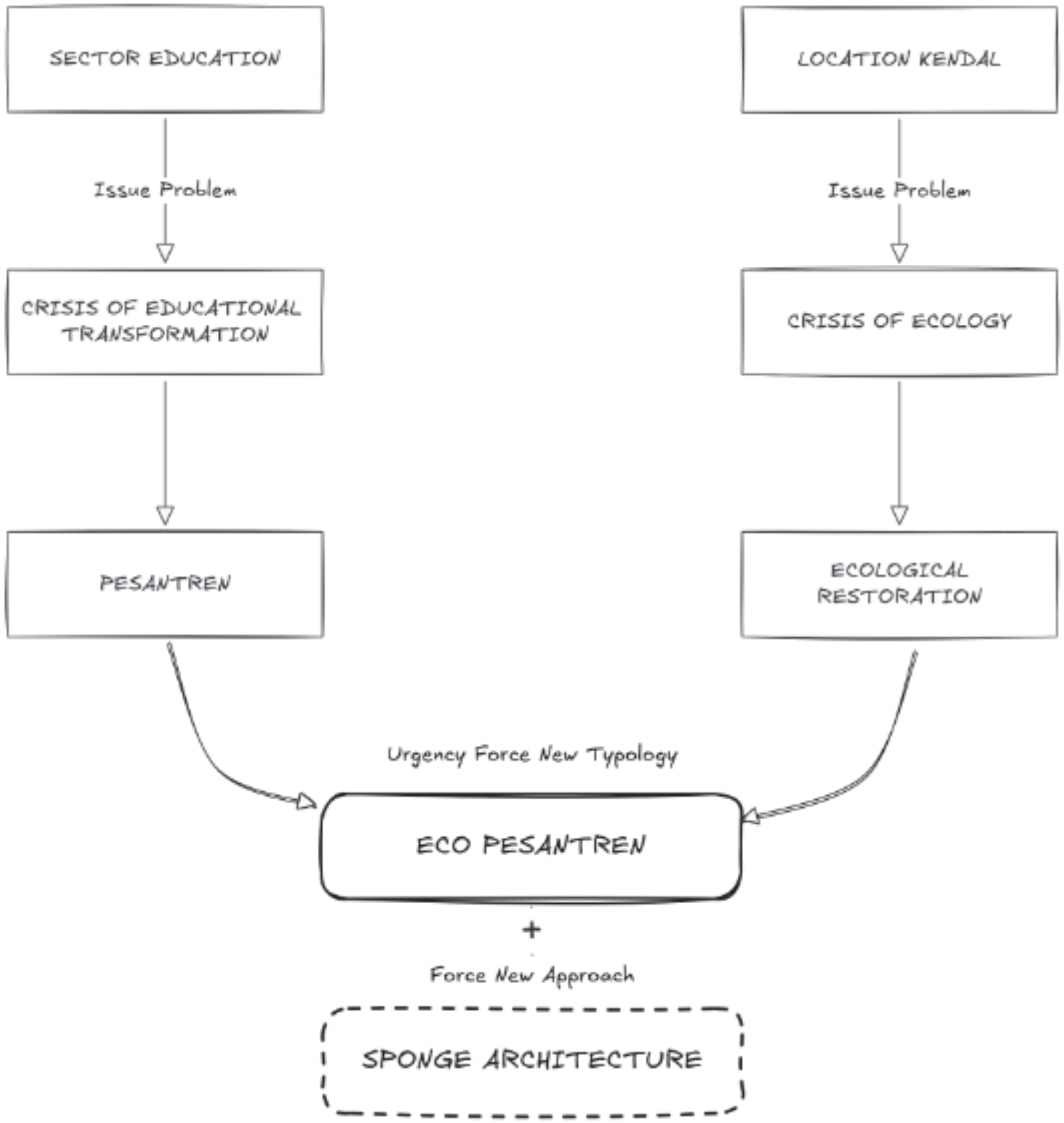
Design Problem Thinking Matrix of Lawson

	Formal Problem	Practical Problem	Symbolic Problem	Radical Problem
Regulations	Kendal RPJMD 2021–2026: coastal spatial planning mandate UU No. 18/2019 Pesantren: 3 functions (education, da'wah, community empowerment) 10 Eco Pesantren Programmes (KLHK/PPI UNAS) as regulatory design guidelines UNESCO GEM Report 2024/2025: Educational Transformation as Climate Response	Kendal RPJMD 2021–2026: land-use zoning for pesantren in coastal area PMA No. 31/2020: MA level requirements Permendiknas No. 24/2007: building standard for educational facilities	UU No. 18/2019 mandates pesantren as agent of community empowerment, the building must embody this mission spatially 10 Eco Pesantren Programmes position the pesantren as living environmental curriculum, not merely a school	No existing prototype of adaptive coastal pesantren in Indonesia Current regulations do not account for hydrological risk in pesantren spatial planning that demands a radical new typology that absorbs water as architecture
Users	Santri (full-resident students MA level) Kiai & Ustadz Local community Kendal (ecology programme)	Santri need safe, healthy, and ecologically conducive learning environments Kiai & Ustadz require spaces for teaching, worship, and community leadership Local community requires access to ecological restoration benefits	Santri are not merely students, they are khalifah fil ardh in formation; the building must actively cultivate this identity through spatial experience "Landscape as Pedagogy": every ecological element of the site is simultaneously a learning tool	Cities fail ecologically not from lack of technology, but lack of people who genuinely care Santri shaped by khalifah fil ardh are agents of change at scale, the design must produce this If the building itself teaches ecology, 3.4 million santri nationally become a multiplier of ecological transformation
Clients	Kendal Regency Government KLH Kementerian Lingkungan Hidup (Ministry of Environment) Kemenag (Ministry of Religious) Pesantren Institution (co-initiator)	Developing resilient coastal educational infrastructure as a prototype model for northern Java coastline Responding to land subsidence (2.5–3 cm/year), tidal flooding (rob), and 470,484 ha coastal erosion	Regenerating Kendal coastal spatial quality through the 10 Eco Pesantren Programme as a model of co-governance between government and pesantren A contribution to Indonesia Emas 2045: producing a generation with ecological awareness rooted in Islamic values	The pesantren must survive the coastal crisis Reframe the client's goal: not building a school on a damaged coast, but designing a living coastal infrastructure that happens to educate
Designers	Redefine the Eco Pesantren Typology as an architectural category Establish formal parameters derived from 10 Eco Pesantren Programmes Apply forced-based GIS mapping to identify ecological pressure zones	Ecology Restoration Open/landscape for landscape pedagogy External spaces into Internal spaces	Architecture as curriculum: the spatial sequence of the pesantren is the ecological lesson The courtyard faces the sea not as vulnerability but as confrontation and dialogue with the ecological crisis Building edges form a defensive pedagogical wall: students study in the crisis, not away from it	**Sponge Architecture (Prof. Kongjian Yu) emerges here as the necessary** **The coastal crisis is fundamentally hydrological (rob, subsidence, erosion)** **Eco Pesantren values require the site to absorb, slow, store, and cleanse water** **Sponge Architecture's provides the technical framework to operationalize ecological** **Result: a self-sufficient ecological unit and replicable prototype**

Table of Abductive Reasoning Based on Lawson's Book

WHAT Describe "imaginative" building that fulfills the most important design problem in the matrix	HOW Describe the design strategies / framework (pattern, force, and concept-based)	VALUE Describe expected value / additional value, goals with your design
Alternative 1 **An adaptive Eco Pesantren that grows organically along the coastal buffer zone, functioning simultaneously as an educational facility, a hydrological infrastructure, and a mangrove restoration laboratory**	• Forced-Based Mapping (GIS): Mapping vacant areas scattered throughout the city with the elemental boundaries of industrial, green blue areas, and etc • Integration of 10 Eco Pesantren Programmes: All 10 programmes are translated into spatial zones and building mass • Sponge Architecture Strategies as prinsip desain	• A self-sufficient ecological unit and living laboratory of resilient coastal architecture • Demonstrates that Eco Pesantren is not merely a "green school" it is a hydrological and pedagogical infrastructure simultaneously • A replicable prototype for pesantren across Java's vulnerable northern coastline, contributing to SDG 4 and Indonesia Emas 2045
Alternative 2 A modular adaptive Eco Pesantren complex with reconfigurable structural units that respond to shifting coastal morphology		

Framework Problem



Framework Thinking

Tittle

Design of Eco Pesantren: A Sponge Architecture Approach in Kendal

General Problem

How can the ecological crisis of Kendal's coastal ecology, driven by tidal flooding (rob), and mangrove degradation from industrialization, be responded to through the design of an Eco Pesantren through a Sponge Architecture approach that forms a resilient coastal learning environment producing santri as agents of change?

Specific Problems

- How to choose site can the coastal site's ecological crisis be responded to so it functions both as an ecological buffer and a learning site for santri?
- How can the pesantren zoning be designed to accommodate santri who will to learn about the environment, particularly water?
- How can the buildings survive to fulfuill 10 eco pesantren program and within a flood-prone environment?

Study Variabel

Tipology: Eco Pesantren | Approach: Sponge Architecture | Contextual: Site and Local

Design Element

Tata Massa | Tata Ruang | Landscape | Selubung Bangunan | Sistem Utilitas | Struktur | Sirkulasi | Kondisi Eksisting

Design Conceptual

Design Schematic

Design Evaluation

Final Design

Urgency

Starting from the global education crisis, the need for regeneration of Indonesia's human resources, the strength of pesantren as the largest educational institution, the threats posed by urban industrial and environmental issues, through the strategic role of architecture in shaping ecological awareness, one urgency emerges: the typology of the Eco Pesantren.
Eco Pesantren is a concept for transforming pesantren into educational institutions fully integrated with principles of environmental sustainability. It is not merely about adding "green" elements to buildings, but rather about redesigning the entire architectural approach of pesantren, from site planning, building orientation, construction materials, water and waste management, to the integration of green open spaces as part of an ecological curriculum.
Within this framework, pesantren is designed to function as Landscape as Pedagogy for santri: a place where ecological principles are not only studied in the classroom, but also directly experienced through interaction with an ecologically designed landscape.

However, in the specific context of Kendal, a coastal urban area facing compounding hydrological crises including tidal flooding (rob), coastal erosion, and land subsidence, an ecologically oriented design vision alone is insufficient. These conditions demand a technical, water-based spatial strategy that goes beyond general sustainability principles.
This is where Sponge Architecture becomes essential as a design approach. Sponge Architecture by Sponge City (Kongjian Yu) treats the built environment as an active water management system: absorbing, filtering, storing, and gradually releasing water back into the ecosystem. Applied within the Eco Pesantren framework, it bridges the gap between ecological ideology and hydrological resilience, ensuring that the pesantren is not only environmentally conscious, but physically adaptive to the crisis conditions of its site.

Architectural design of Eco Pesantren with a Sponge Architecture approach becomes an urgent and relevant necessity, a tangible contribution of the architectural discipline in shaping santri as Indonesia's golden generation of 2045: a generation grounded in ecological restoration, strengthened by an Islamic moral foundation, and ready to become agents of socio-environmental transformation for Indonesia and the world.

Design Problem Study

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Goals and Objectives

Goals

Design of an Eco Pesantren prototype in Kaliwungu Kendal aims to be a resilient coastal Islamic educational environment for santri, organized through three integrated zones integrating the 10 Eco Pesantren Programmes and Sponge Architecture strategies as a design approach, restoring the coastal landscape, protecting the educational community from ecological crisis, and producing santri as agents of environmental and civilizational change toward Indonesia Emas 2045 and SDG 4.

Objectives

- Mapping ecological pressure zones through force-based analysis, to determine the site location.
- Designing the pesantren with a Sponge Architecture concept, proven through the completion of the site plan.
- Designing buildings with an elevated structure, proven through the completion of the school, dormitory and mosque.

Excellence, Originality and Novelty

Perancangan Pondok Pesantren dengan Pendekatan Permakultur di Petung Ulung, Nganjuk
Yusril Muzakki (2021)
Universitas Islam Indonesia
Differences:
- Ecological Approach: The reference project utilises permaculture (food self sufficiency/energy cycles), whereas this project employs an 'Eco Pesantren' model combined with a 'Sponge City' approach to ensure hydrological resilience.
- Site Response: The reference tends to focus on stable land, whilst this project addresses a critical site experiencing massive erosion over 470 hectares.

Similarities:
- The building typology is the same, namely an educational institution (Pesantren) with an environmental focus.

Perancangan WaliSongo Islamic Schools degan Pendekatan Bangunan Hijau pada autonomy energy
Naufal Dzaki Nastikawa Putra (2023)
Universitas Islam Indonesia
Differences:
- Design Paradigm: The reference focuses on the historical value and traditionalism of the pesantren space, whereas this project offers a modern Adaptive Architecture transformation that responds to the climate crisis.
- Technology Integration: This project incorporates blue green infrastructure systems, which are not addressed in traditional typological studies.

Similarities:
- Both share a common focus on preserving the values of spirituality and Islamic education as their primary functions.

Perancangan Pusat Eko Wisata Mangrove dengan Pendekatan Arsitektur Ekologi di Pangkal Babu, Kuala Tungkal, Jambi
Lysa Listiani (2025)
Universitas Islam Indonesia
Differences:
- The former focuses on the conservation of mangrove ecosystems in general, whereas this project applies to the specific context of Islamic boarding schools (Pesantren).
- The reference project is more focused on nature conservation, whilst this project is an adaptive settlement approach that integrates student accommodation with flood risk management.

Similarities:
- Both utilise mangrove vegetation as the primary means of coastal protection.

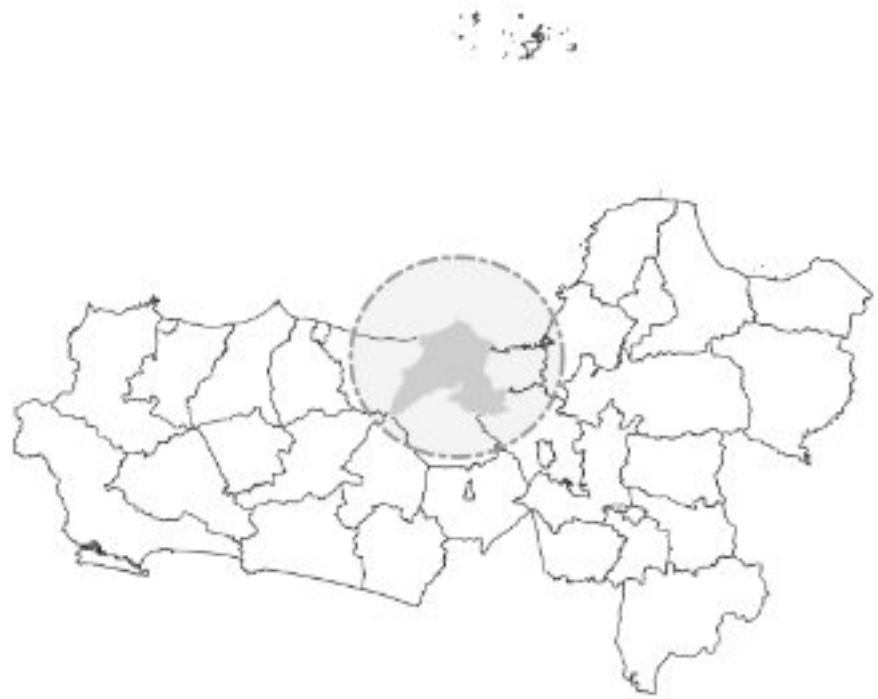
Problem Limitations

This design is redefined the typology of an "Eco Pesantren", which integrates the formal education curriculum and ecology restoration by guided by the 10 Program Eco Pesantren framework (Ministry of Environment and Forestry/PPI UNAS) through the Sponge Architecture strategies by Sponge City (Prof. Kongjian Yu).

PROBLEM STUDY

02

Java Island

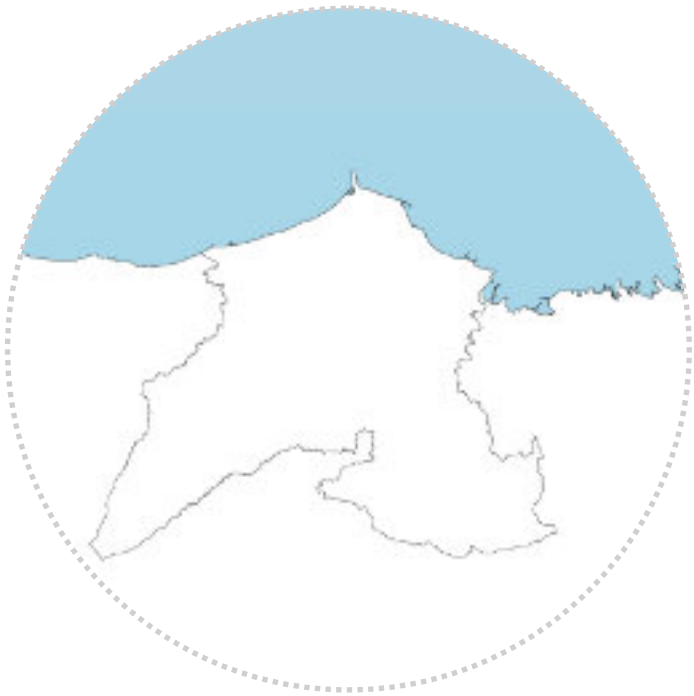


Jawa Tengah Province

Site Location

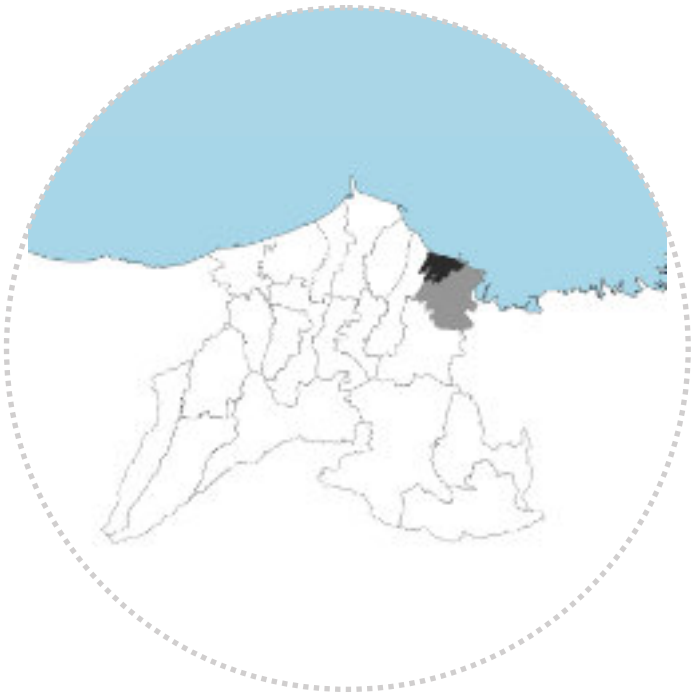
Kendal Regency is situated in Central Java Province and covers an area of 1,002.23 km^2. Kendal Regency borders the Java Sea to the north, the city of Semarang to the east, Semarang Regency and Temanggung Regency to the south, and Batang Regency to the west.

Design Framework: Force Based
By Plowright



"Context"

The topography of Kendal Regency is divided into three zones: mountainous terrain in the southernmost region, undulating hills in the central area, and low-lying coastal plains along the northern shoreline. The site is situated within the northern coastal corridor of Central Java.

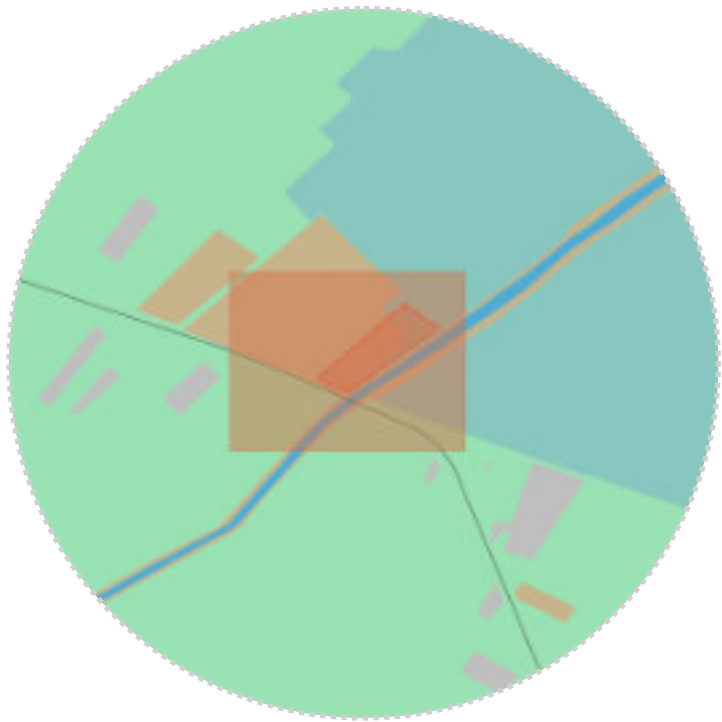


"Force Identifications"

Kendal Regency is home to the Kendal Industrial Estate, designated as a National Strategic Project (Proyek Strategis Nasional/PSN) since 2016 and subsequently established as a Special Economic Zone (Kawasan Ekonomi Khusus/KEK) in 2019 through Government Regulation Number 85 of 2019. The Kendal Industrial Estate is located in Kaliwungu Sub-district. Kaliwungu Sub-district also serves as the primary center of the region colloquially known as Kota Santri. This location is the primary source of the ecological degradation issues.

Site "Proposal"

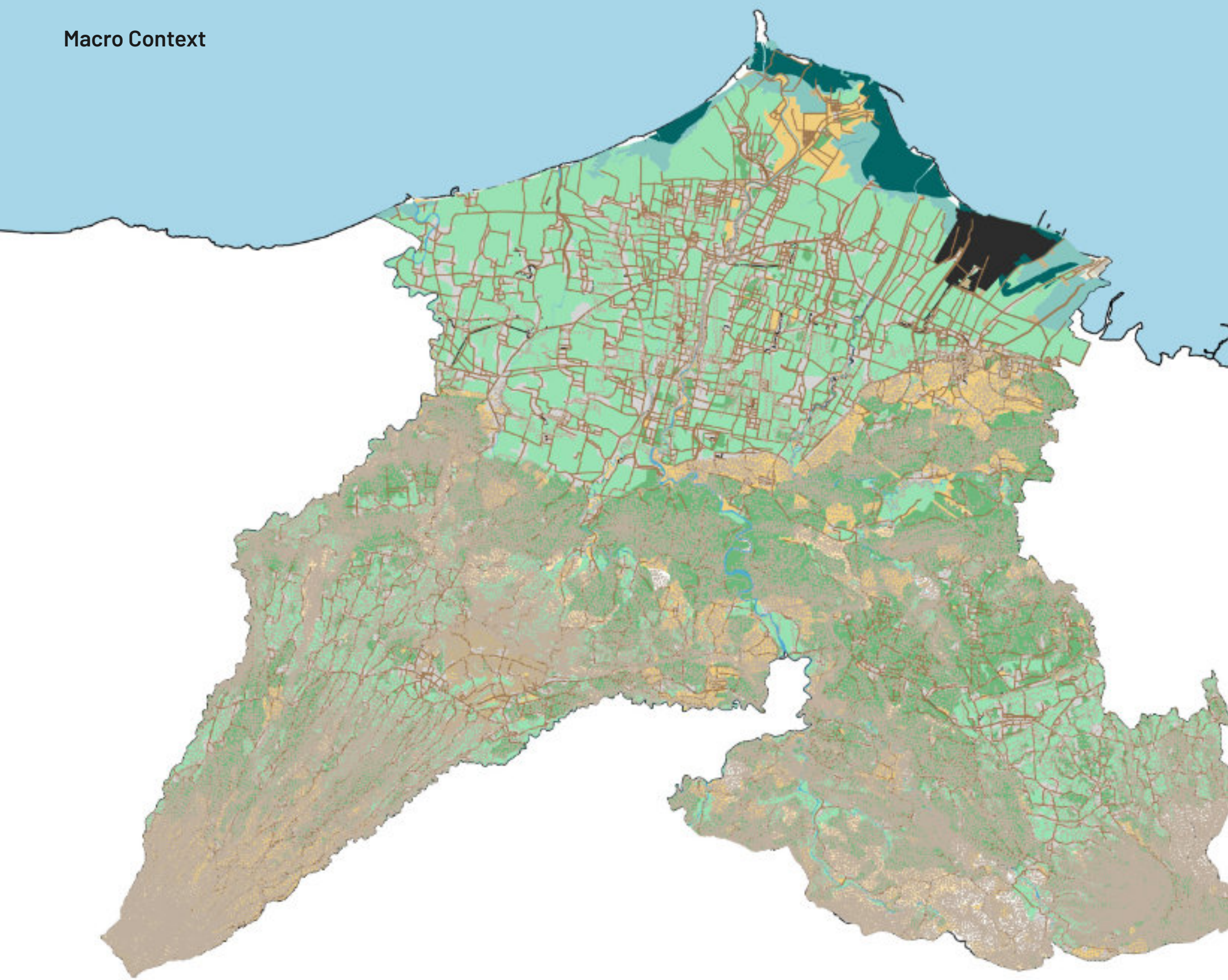
Approaching the primary source location of the issue to resolve and provide an ecological solution through the Eco Pesantren. There are 2 proposed site options with criteria of proximity to wetlands and formerly unproductive land.



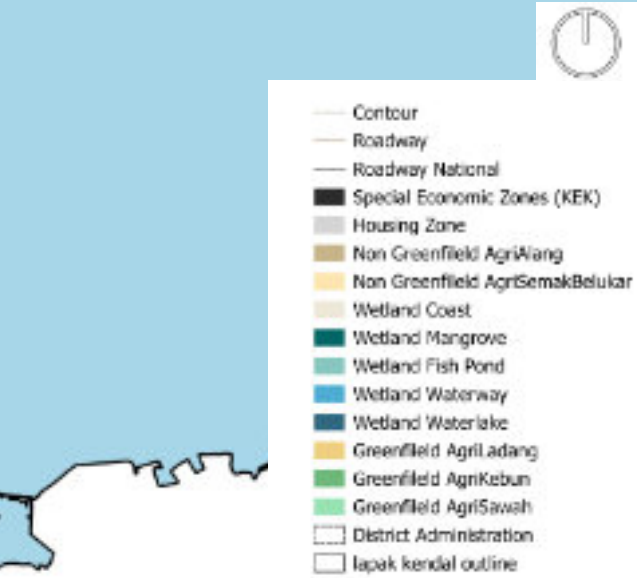
"Assembly"

Finally, one of the selected site will be used as the project site location. Dengan assembly with Sponge Arechitecture as approach.

Macro Context

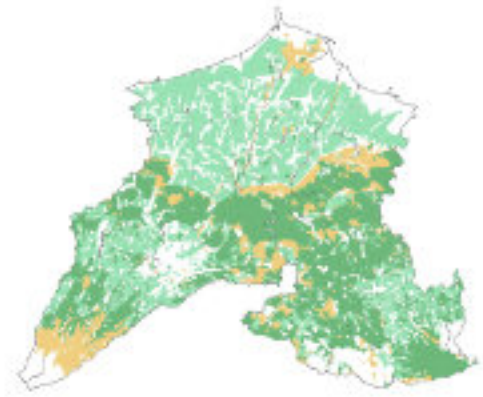


Map of Kendal District



Special Economic Zone (KEK)

Wetland



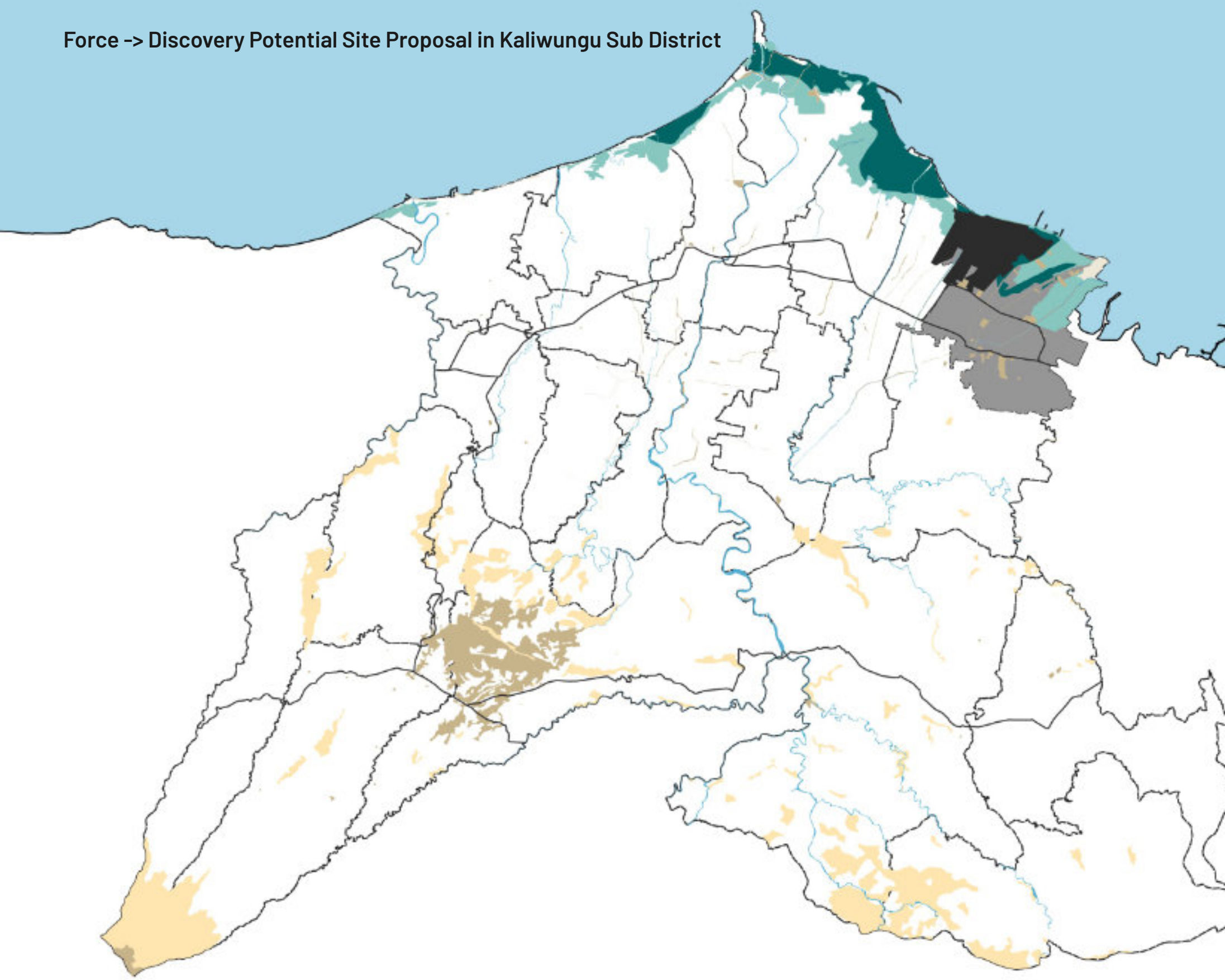
Greenfield

Non Greenfield

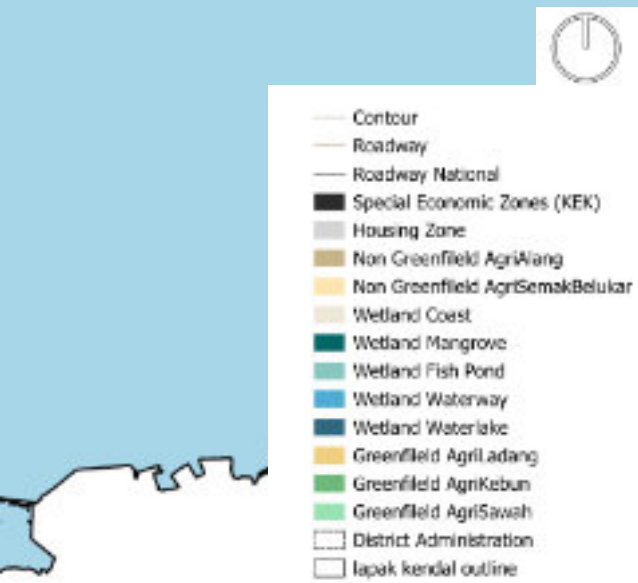
Housing

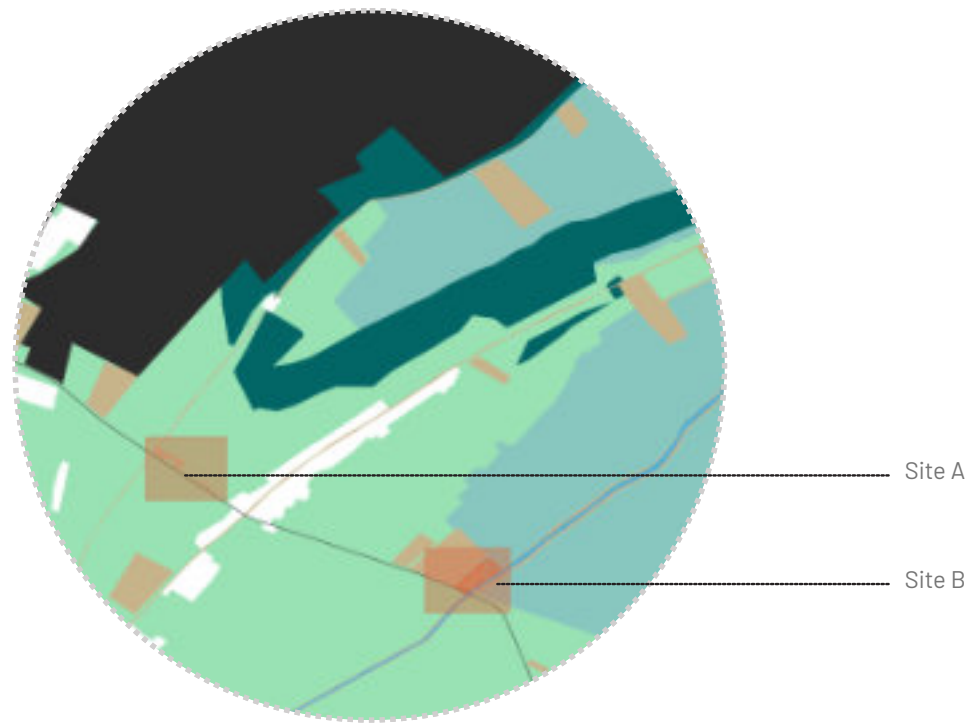
Roadway and ConturE

Force -> Discovery Potential Site Proposal in Kaliwungu Sub District



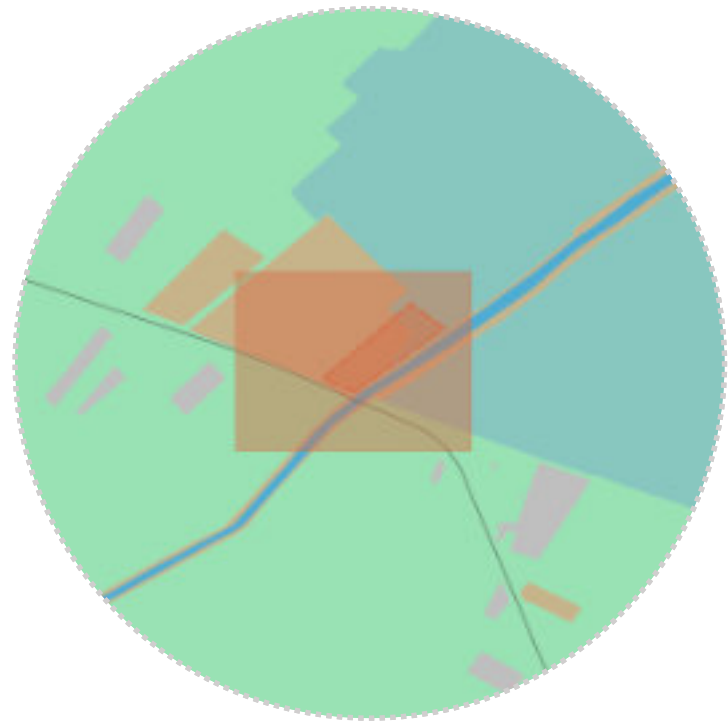
Map of Kendal District





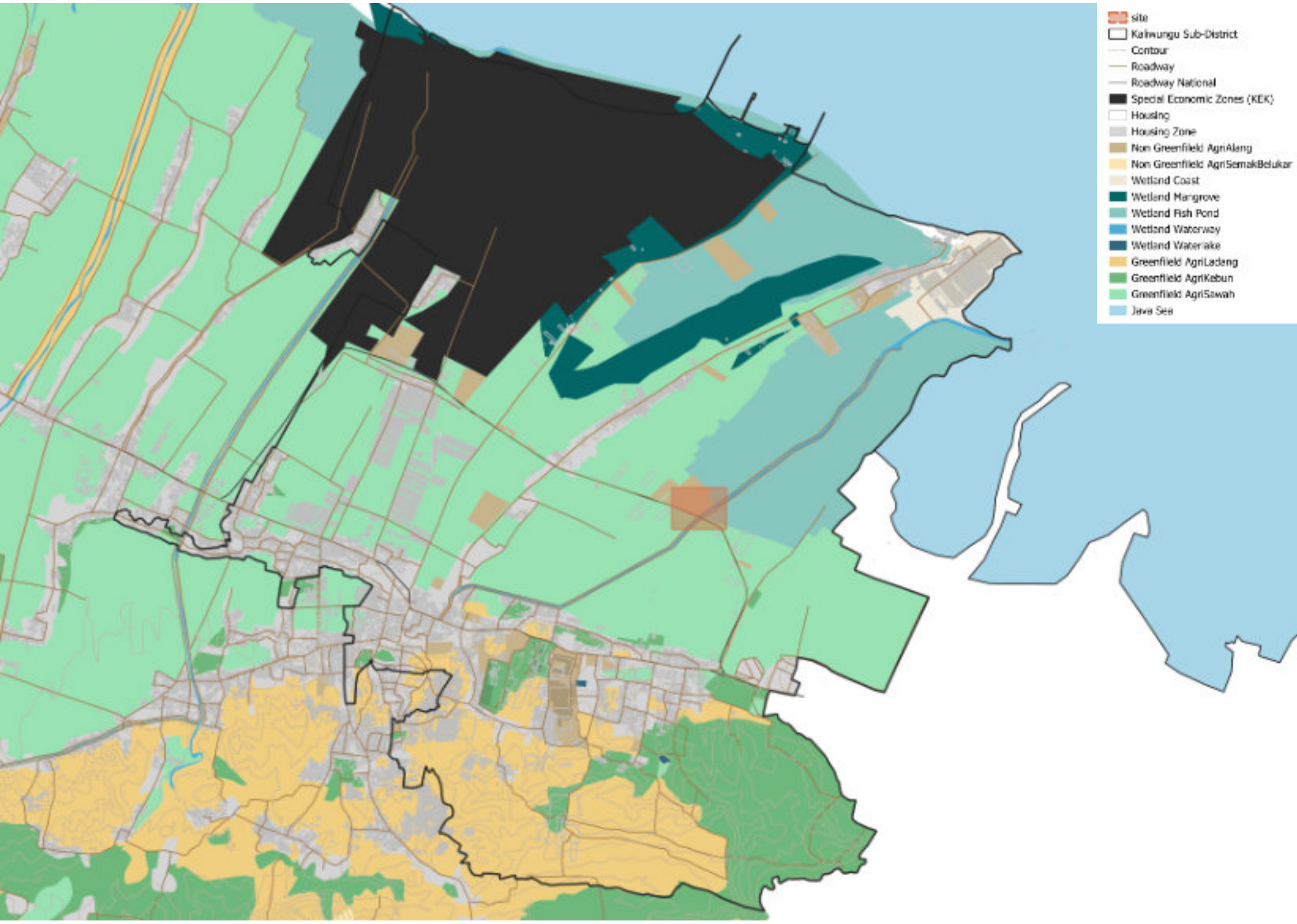
Site criteria:

- Wetland Area (Close River Bendo)
- Non Greenfield - Unproductive land



Choosen Site B

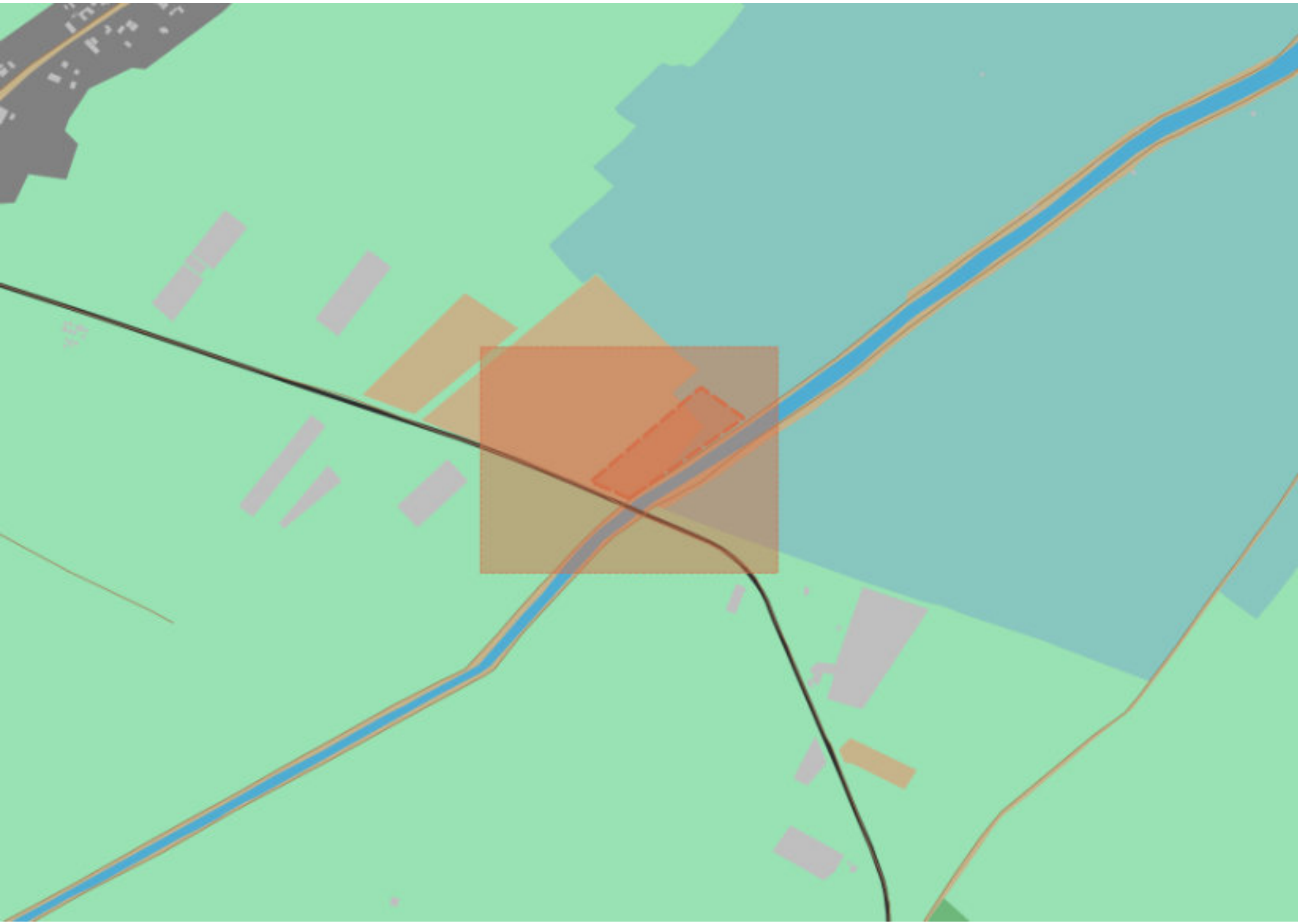
Meso Context



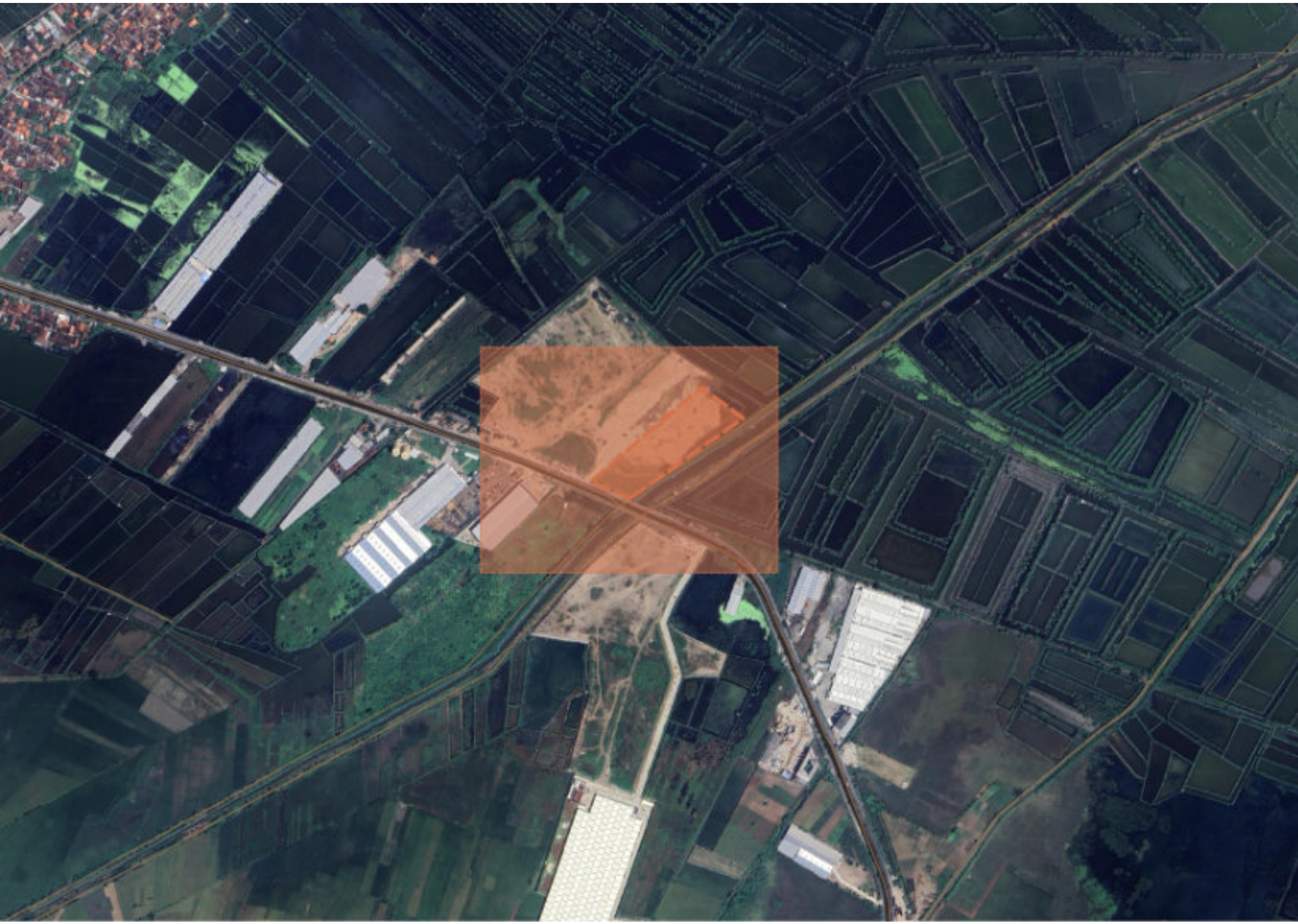
Map of Kaliwungu Sub District

Map of Kaliwungu Sub District
(Earth View)

Micro Context - Site

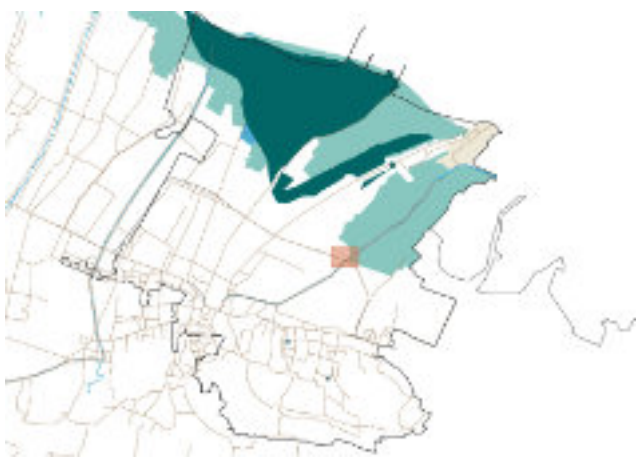


Site Location

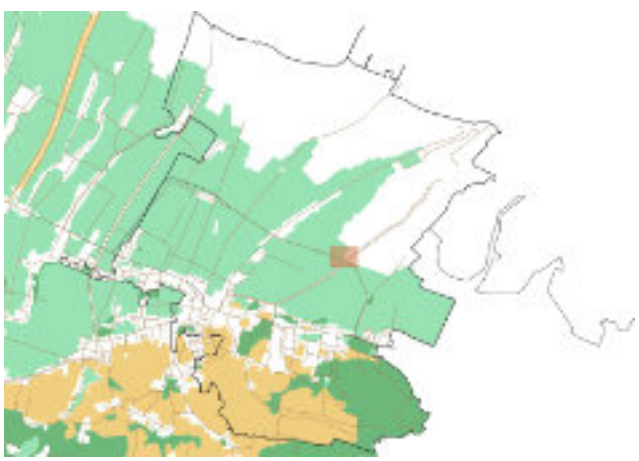


Site Location
(Earth View)

Special Economic Zone (KEK)



Wetland



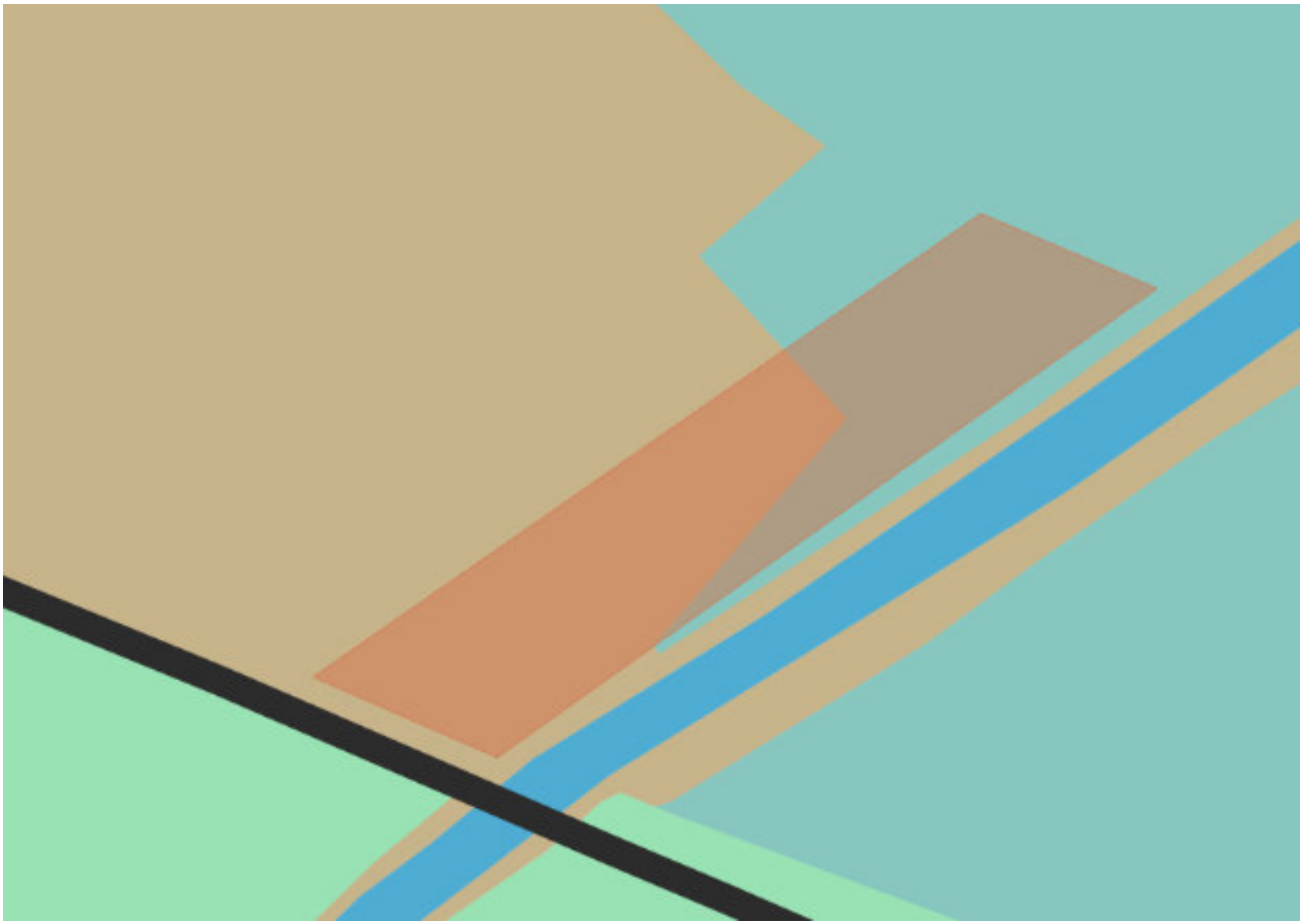
Greenfield

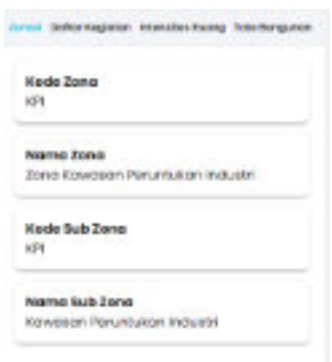
Non Greenfield

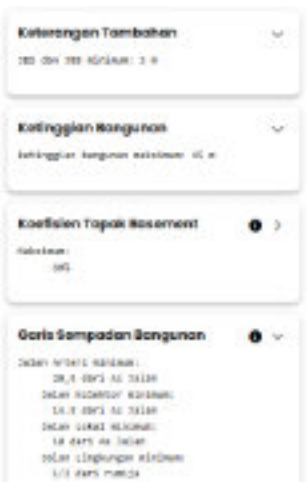
Housing

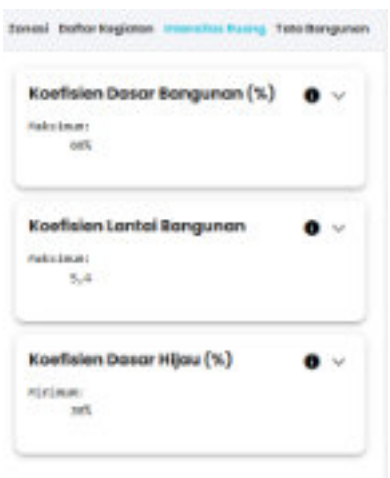
Roadway and Conture

Land Use





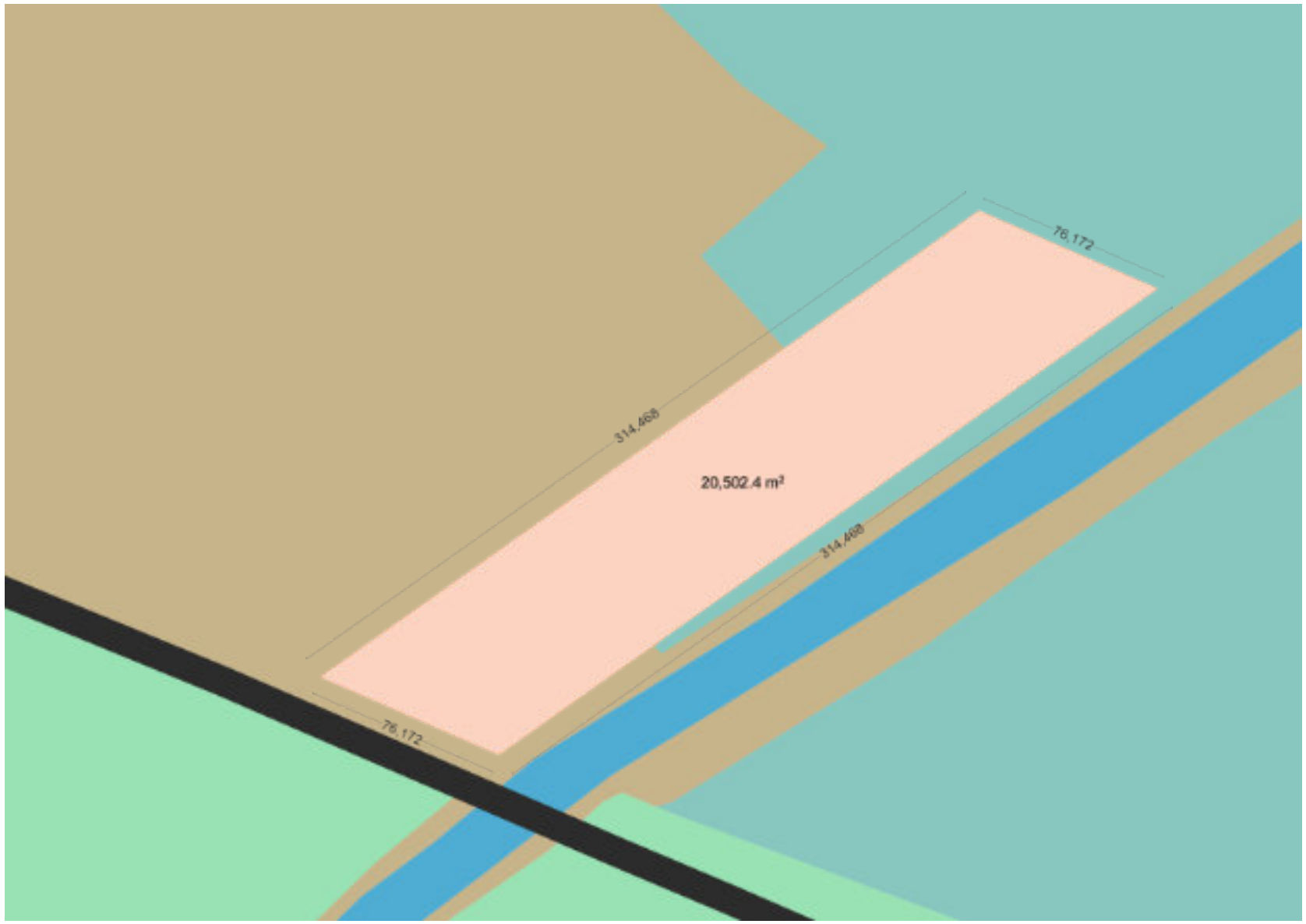




Source: Gistaru ATRBPN

Based on the Kendal Regent Regulation Number 62 of 2023, private secondary education activities (aliyah) are included among the permitted uses within the Kaliwungu KPI Zone, so that the establishment of an Eco Pesantren with a Madrasah Aliyah (MA) educational unit on the selected site is in accordance with the applicable spatial planning provisions.

Dimension Site



Detail Administrasi

Provinsi
Jawa Tengah

Kecamatan
Kecamatan Kaliwungu

Kelurahan/Desa
Desa Kutoharjo

Nama Jalan
Jalan Lingkar Kaliwungu

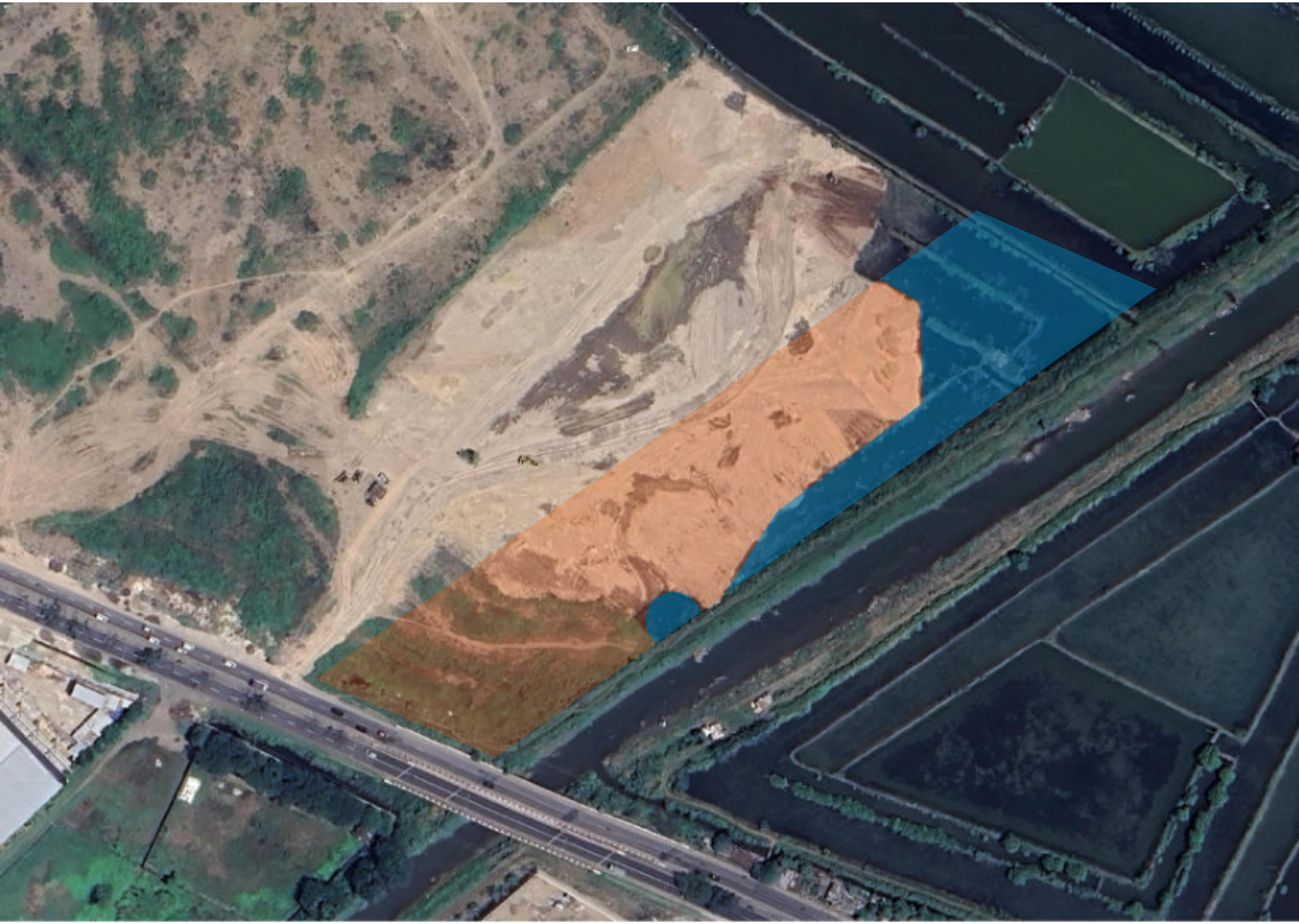
Kode Pos
51372

-6.952170696099155, 110.27857409646693

Kutoharjo, Kec. Kaliwungu, Kabupaten Kendal, Jawa Tengah

The selected site covers an area of approximately 2 hectares or 20.502 sqm, located in close proximity to the industrial area and experiencing environmental degradation characterized by mangrove deterioration.

Topography

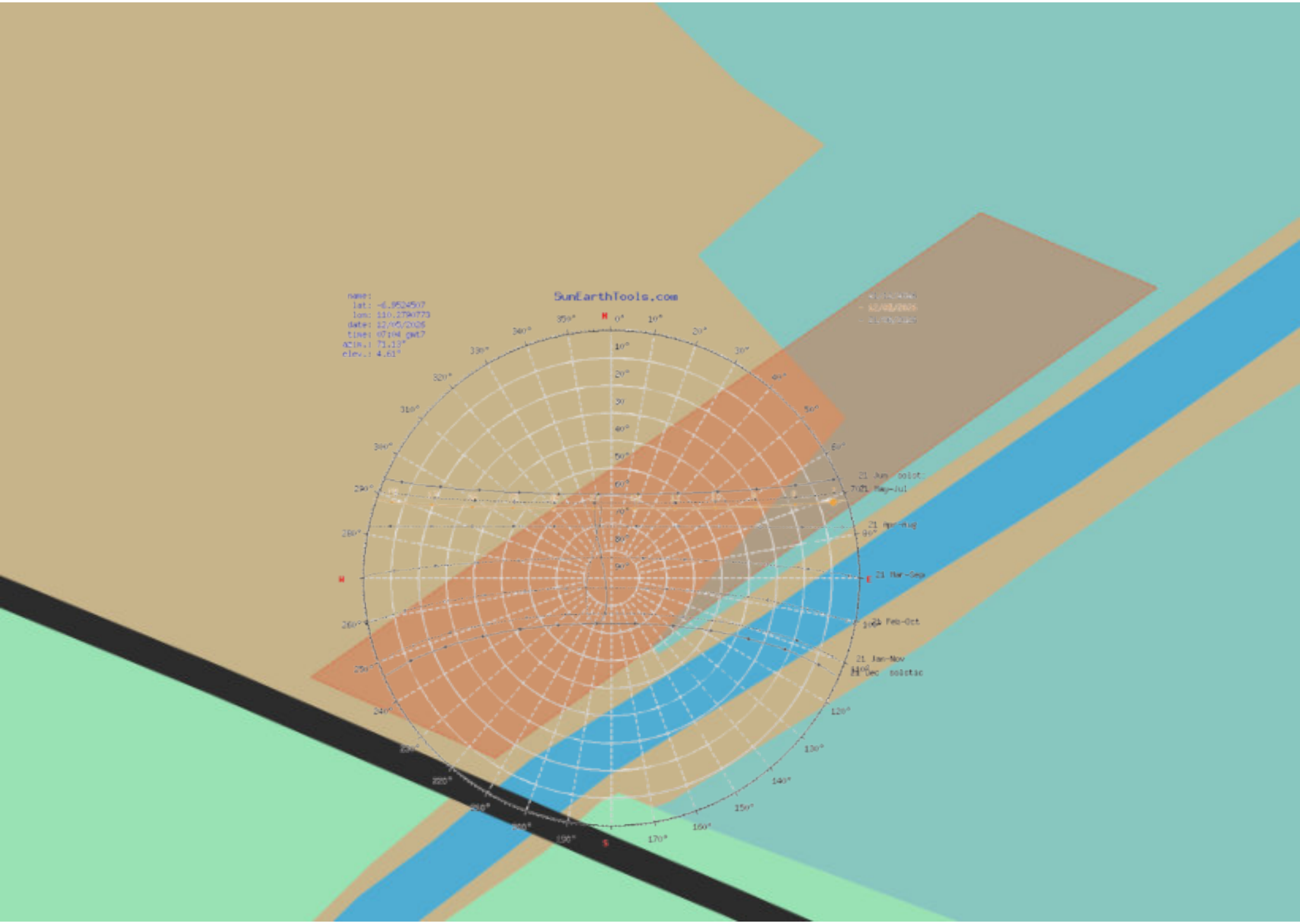


The site presents a distinctive topographic condition, characterized by the presence of former fish pond land and water bodies, with the Kali Bendo river situated along its eastern boundary.

Circulation

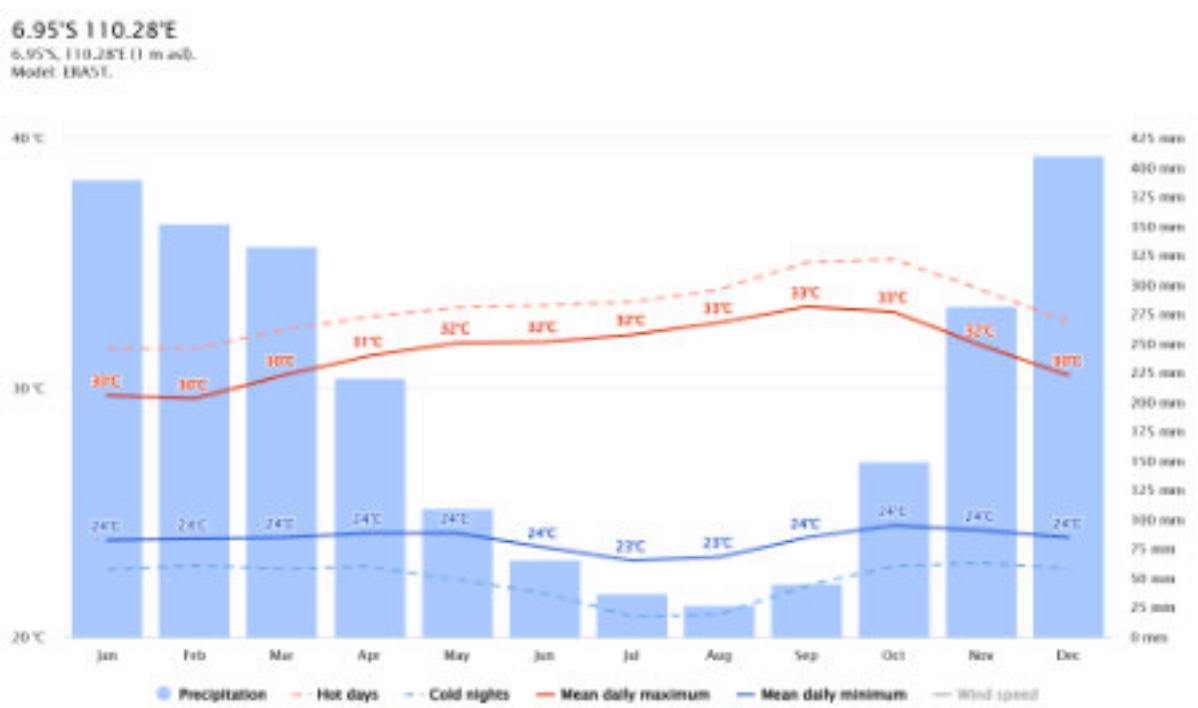
National Road - Ring Road Kaliwungu

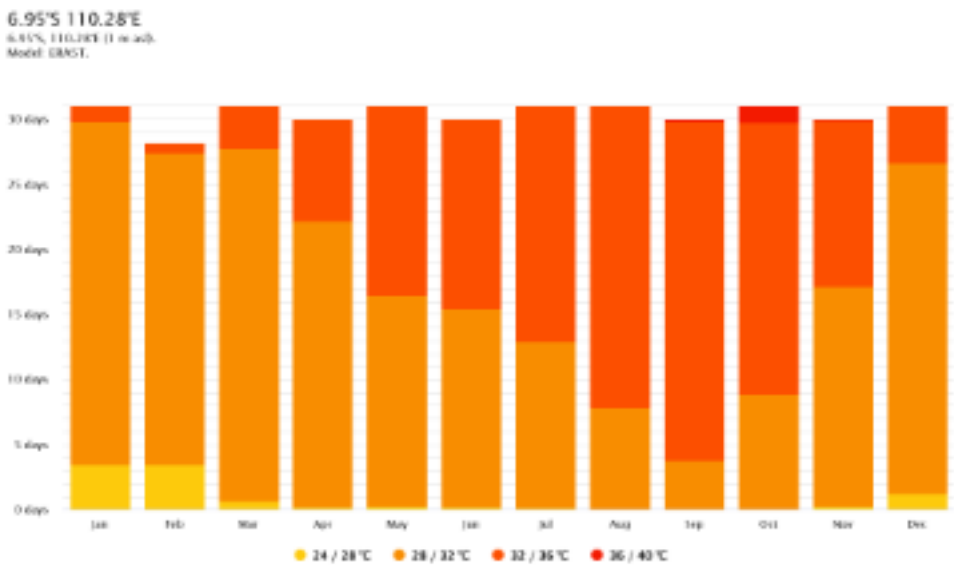
Sun Earth Data

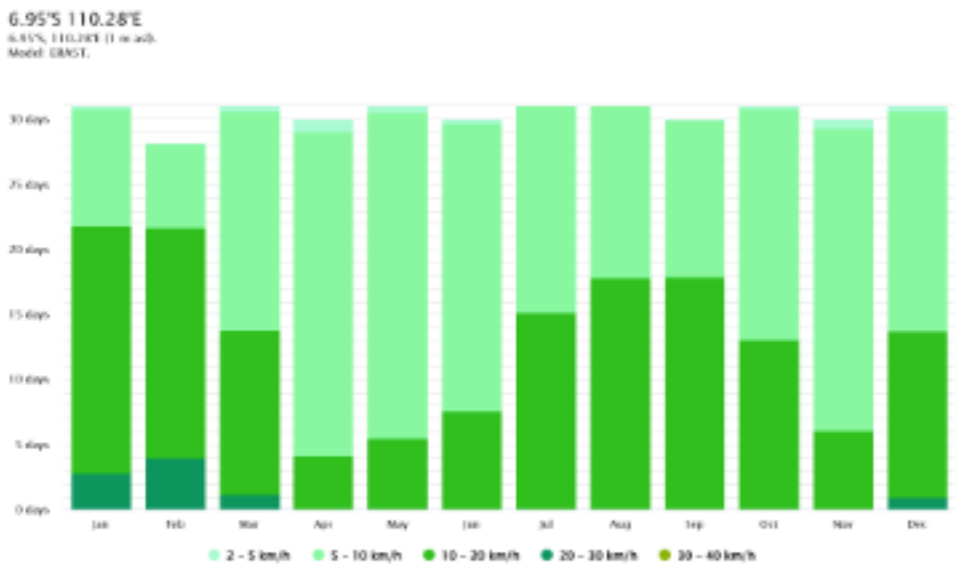


Wind Rose Data

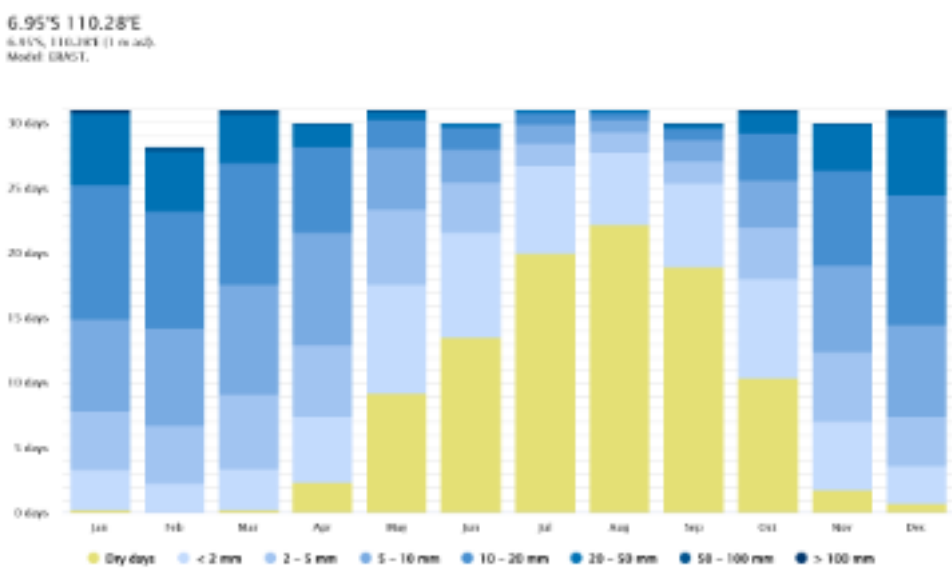
Climate Weather Data: Temperatures and Precipitation and Wind speed

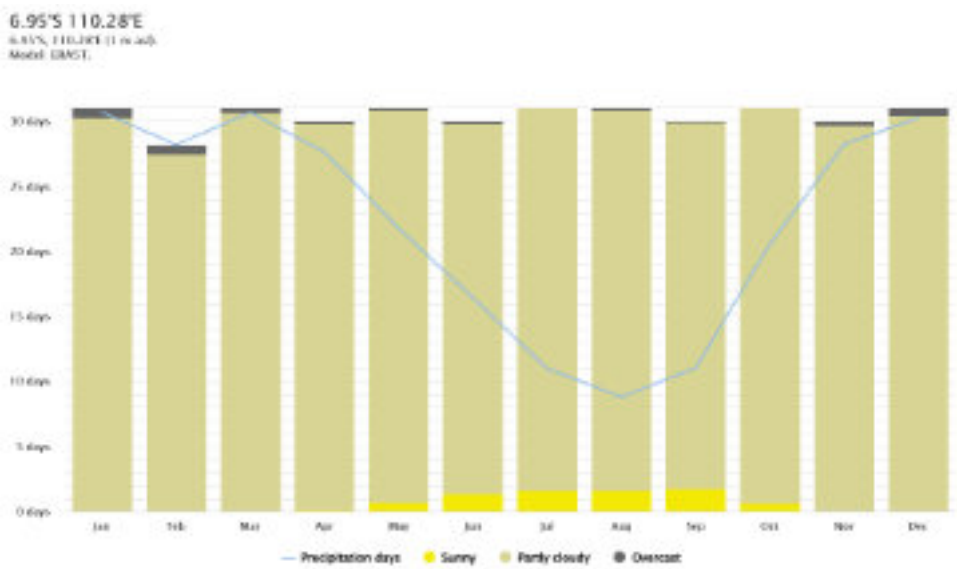






Climate Weather data Precipitation





Ricefiled - Fishpond

Ratusan Hektare Tambak Ikan dan Udang di Kendal Terdampak Banjir Rob

by **Hanief Sallendra** 28 Mei 2022, 7:44 pm

Terdampak Kekeringan, 17 Hektare Lahan Pertanian di Kendal Gagal Panen

by **Ulfa Puspa** — Selasa, 29-Agu-2023 In **News, Kendal Hari Ini**

Mangrove


1.500 Mangrove Ditanam di Pidodokulon, Bupati Kendal Harap Warga Ikut Merawat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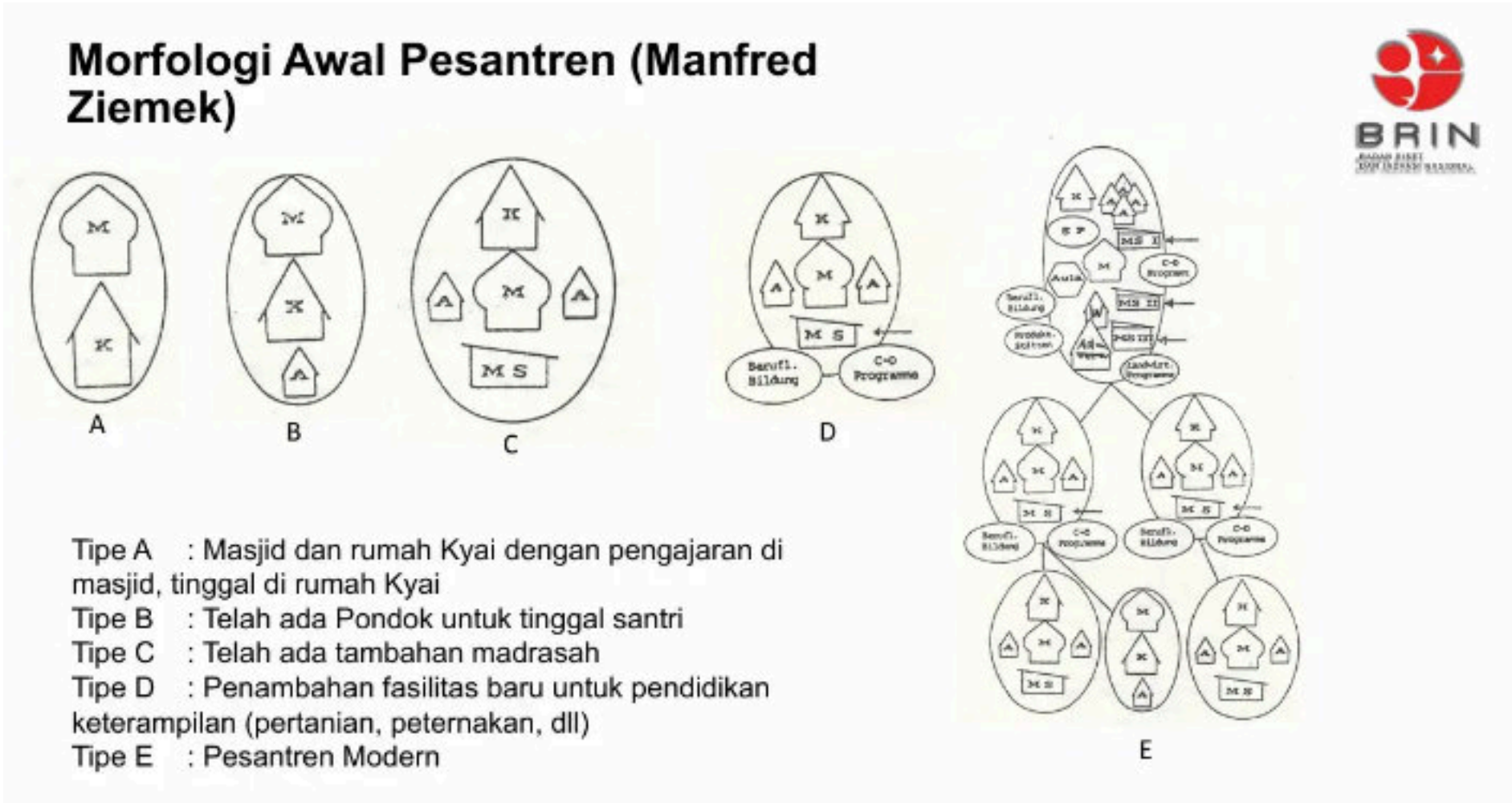
Home
Beranda > Berita > Berita Daerah > Kabupaten Kendal
Wilayah Pesisir Kendal Menjadi Salah Satu Pengembangan Ekosistem Karbon Biru Nasional
02 February 2026



Jakarta – BRIN Public Relations. The architecture of traditional Islamic boarding schools (pesantren) in Eastern Indonesia presents a unique character, distinct from the general image of pesantren in Java or Sumatra. Behind their simplicity, the buildings of these pesantren record a long history of interaction between Islam, local culture, and the natural environment.

Typology Pesantren

According to Law Number 18 of 2019 on Pesantren, Chapter I, Article 1, a pesantren is defined as: "A community-based institution established by individuals, foundations, Islamic civil society organizations, and/or communities that instill faith and devotion to Allah SWT, cultivate noble character, and uphold the teachings of Islam as a mercy for all creation (rahmatan lil'alamin), as reflected in the attitudes of humility, tolerance, balance, moderation, and other noble values of the Indonesian nation, through education, Islamic da'wah, exemplary conduct, and community empowerment within the framework of the Unitary State of the Republic of Indonesia."

Based on Ministerial Regulation of the Ministry of Religious Affairs (PMA) Number 30 of 2020 on the Establishment and Operation of Pesantren, the classification of pesantren consists of:
(1) pesantren that provide education in the form of classical Islamic text study (kitab kuning),
(2) pesantren that provide education in the form of Islamic Studies (Dirasah Islamiah) under the Muallimin educational model, or
(3) pesantren that provide education in other forms integrated with general education.

In practice and in the categories used by the Ministry of Religious Affairs, these three classifications are known by more commonly used terms. Pesantren are grouped into three categories, namely Salafiyah Pesantren, Khalafiyah/Ashriyah Pesantren, and Kombinasi Pesantren. Salafiyah Pesantren are pesantren whose curricular content focuses on mastery of Islamic religious sciences (tafaqquh fiddin) through the study of classical texts (kitab kuning) using the methods of sorogan, bandongan, wetonan, and halaqah, without any general subject instruction. Khalafiyah/Ashriyah Pesantren, often referred to as Modern Pesantren, are pesantren in which learning is designed in a modern manner using a classroom-based system and an Islamic studies curriculum designed according to the needs of the pesantren, with instructional materials drawn from various classical textual references (kitab kuning). Meanwhile, Kombinasi Pesantren are pesantren that, in addition to implementing the pesantren-based learning system, also operate various educational units and/or programs, such as early childhood education (RA/TK), madrasah or general schools, and even Islamic or general higher education institutions.

Redefine: Eco Pesantren

Eco-pesantren is a compound term derived from two words: eco and pesantren. The word eco is closely related to the word ecological. Ecological is the science that explains the relationship between living organisms and their environment, while pesantren is an Islamic educational institution with distinctly Indonesian characteristics that possesses several elements such as a dormitory, classical text study, a mosque, students (santri), and the boarding house elder or kiai. Based on the above description, eco-pesantren is an Islamic educational institution that contributes to the protection and preservation of the environment.

Eco-Pesantren is a program of the Ministry of Environment that was launched in 2008. This program aims to encourage the improvement of knowledge, concern, awareness, and active participation of pesantren residents in efforts toward environmental conservation based on the teachings of Islam. The Eco-Pesantren program simultaneously represents a form of empowerment of the pesantren community in improving environmental quality, as mandated by Law Number 32 of 2009 on Environmental Protection and Management.

Pesantren in its general sense (Law No. 18/2019) places its primary function on three pillars: education, Islamic da'wah, and community empowerment, with a curricular focus on strengthening faith, character, and Islamic teachings. Meanwhile, eco-pesantren is an educational model that integrates Islamic values such as tawhid, amanah, and ihsan with ecological practices in pesantren life, where these values are internalized through the curriculum, the exemplary conduct of the kiai, the lifestyle of the santri, and environmental programs such as water conservation, organic farming, and waste management.

Thus, the fundamental difference is: conventional pesantren emphasizes Islamic education and social community empowerment without a structured environmental dimension; whereas eco-pesantren denotes an Islamic educational institution (pesantren) that places emphasis on activities responsive to environmental issues, positioning the pesantren as an environmental learning center for its surrounding community. In summary, eco-pesantren is a developed model of the existing pesantren that remains grounded in the same Islamic foundation but adds the dimension of ecological awareness and action as an inseparable part of its curriculum and living culture.

Goals of Eco Pesantren

The objectives of Eco-pesantren according to the Ministry of Environment are as follows:
1. Important guidelines in Islamic teachings for environmentally friendly behavior as a form of increased awareness
2. Carrying out daily activities by applying Islamic teachings
3. Pesantren activities that have been socialized through environmental subject matter
4. Goodness, cleanliness, and health within the pesantren area
5. The Quran and al-Sunnah serve as the basis for improving environmental quality in an Islamic manner through the empowerment of pesantren
6. Increased activities encompassing ecological, social, and economic dimensions
7. Realizing a center of excellence for communities and society surrounding the pesantren area

The indicators of Eco-pesantren are as follows (Ministry of Environment, 2008):
1. The realization of environmentally friendly policies in the development of pesantren
2. Nature serves as the basis for developing the environmental curriculum
3. Nature exploration becomes the target in developing extracurricular activities
4. Managing facilities and infrastructure that develop pesantren programs

10 Eco-Pesantren Program Guidelines

Ekopesantren has been an program initiative by the Center for Islamic Studies at the National University in Jakarta that is further developed in 2021. These program is a strategy to improve the quality of Islamic education. Pesantren have the potential to actively participate in responding to the country's and the world's biggest challenge of climate change and environmental issues. Ekopesantren aims at integrating Islamic teachings and environmental science within the Islamic boarding school education system, confirming the principle that Islam is a blessing to the universe. There are 10 Program Ekopesantren.

1. Environment Based Curriculum
Environmental problems are not only related to natural science lessons. Their resolution can also be carried out through various activities, both social initiatives and environmental actions.

2. Environmental Fiqh
Enriching students' knowledge about the environment. An Islamic boarding school can provide additional or specialized lessons on the environment linked to Islamic teachings (Environmental Fiqh).

3. Enhancing Human Resources in the Environmental Sector
Educators in pesantren strongly need to understand environmental challenges and their problems, both the social environment and the natural environment around the boarding school.

4. School land use
Utilization of boarding school land, whether extensive or limited in area, can be managed as optimally as possible so that it is beneficial, both in terms of aesthetics and the environment.

5. Water resources
Water programs to provide knowledge and serve as educational material in boarding school activities. For example, saving water for ablution, and water management using rainwater (water harvesting).

6. Healthy living - Self sufficient
Pesantren schools with large plots of land can demonstrate activities related to environmental initiatives, such as organic farming for the consumption of the boarding school community and the students.

7. Waste and Waste Management
The boarding school community greatly needs to be provided with some knowledge about waste management so as not to cause pollution.

8. Energy Resources
Saving electrical energy and using renewable energy, such as solar energy, hydropower, and wind power, can meet energy needs. Boarding schools can serve as examples of effective and efficient energy use.

9. Transport and Mobility
Transportation is an important means of supporting human mobility; students as well as academic members can shift to environmentally friendly transportation, for example by using bicycles more often or walking.

10. Biodiversity
Biodiversity programs are not only for those with sufficiently large land areas, but are also necessary for participating in nature conservation activities, for both flora and fauna.

The ten eco-pesantren programs demonstrate that this concept does not focus solely on educational aspects, but also encompasses the management of space, resources, and sustainable living behavior within the pesantren environment. However, these programs are operational and behavioral in nature and have not yet answered a fundamental question: how should the built environment of the pesantren itself be designed so that it is physically capable of supporting, and even teaching, these ecological values?

This is where an architectural design strategy is needed that is not merely aesthetically environmentally friendly, but one that actively responds to the ecological conditions of the site in a concrete and measurable manner.

The design site is located in the coastal area of Kaliwungu Kendal, a region that hydrologically faces three simultaneous pressures: increasingly intensive tidal flooding due to sea level rise, degradation of the mangrove ecosystem as a natural buffer, and the lack of ecology-based water management infrastructure. These conditions demand a design approach that is specifically capable of responding to the water cycle as the primary design variable, rather than merely accommodating it as a technical constraint.

Approaches such as Green Architecture or Biophilic Design, although ecologically relevant, focus on visual quality and user comfort and do not directly address the hydrological problems of a coastal site. Meanwhile, Sponge Architecture as a derivative and scalar reduction of Sponge City (Yu et al., 2016), reinforced by the ecomimicry principles of Ecological Architecture (Yeang, 2006), is explicitly designed to integrate water management systems into the physical structure and spatial program of buildings. It does not merely respond to water, but positions water as a pedagogical medium in alignment with the eco-pesantren philosophy that treats the environment as a living curriculum.

Accordingly, Sponge Architecture is chosen not solely for its technical relevance to site conditions, but because it is the only approach capable of simultaneously addressing two demands: responding to the coastal hydrological crisis, and operationalizing eco-pesantren values into spaces that can be experienced, studied, and inhabited by santri on a daily basis.

Ecological Architecture

Ken Yeang (1995) defines ecological architecture as a design approach that positions the building as part of a broader ecosystem, rather than as a self-contained object separated from its living environment. Within this framework, the building is understood as a built organism that must interact actively and responsively with the bioclimatic, hydrological, and ecosystem conditions of the site upon which it stands (Yeang, 1994).

This approach departs from a critique of conventional architecture, which treats the environment as a passive backdrop rather than as a living system that determines the logic of design. Yeang argues that an ecological building is not merely a building that "looks green," but rather one that actively participates in local ecological processes ranging from the water cycle and energy flows to biodiversity chains (Yeang, 2006).

Yeang (2006) in Ecodesign: A Manual for Ecological Design formulates the principles of ecological architecture as follows:

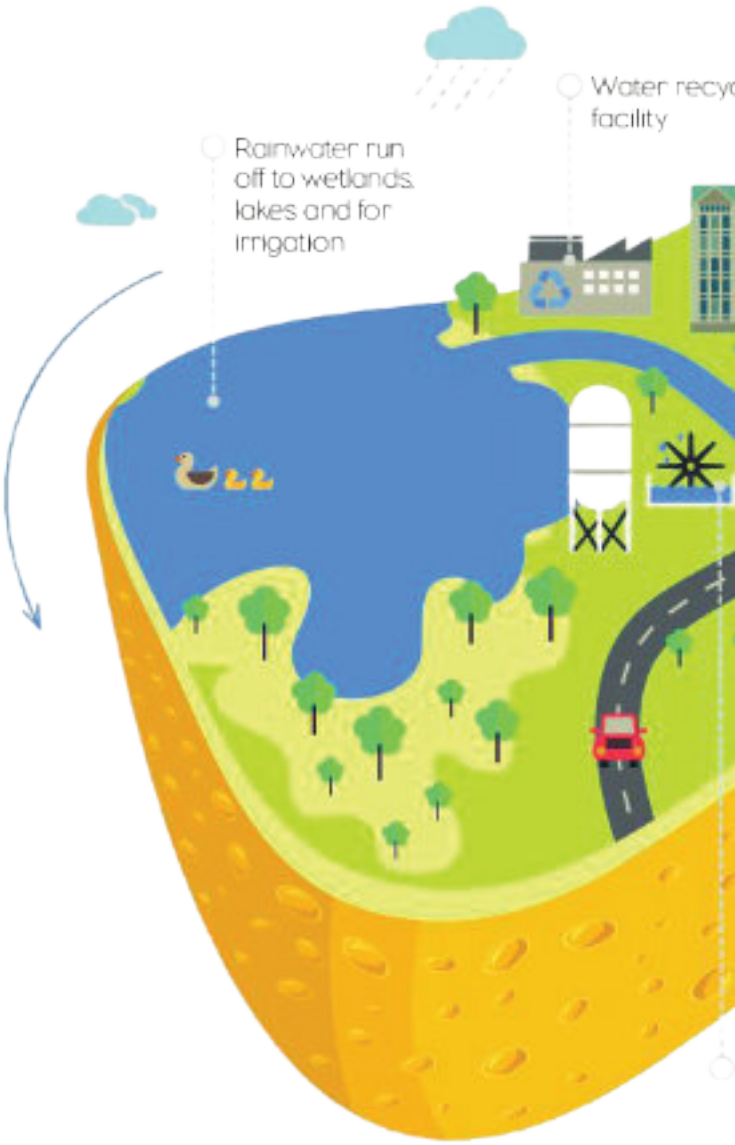
Passive Low-Energy Design
Buildings are designed to minimize dependence on mechanical energy by optimizing orientation, natural ventilation, and passive shading in accordance with the bioclimatic conditions of the site. Yeang (1994) asserts that "the building's form and its systems must work with the climate, not against it."

Bioclimatic Integration
Design must respond directly to the local climate including wind patterns, solar intensity, rainfall, and humidity as determinant variables of building form, rather than merely as aesthetic considerations (Yeang, 1994).

Green Connector
Yeang (2006) introduces the concept of green connectors, a vegetation system that connects exterior and interior spaces of the building both vertically and horizontally, so that the building becomes part of the broader ecological corridor of the site.

Ecomimicry
This principle directs designers to design buildings and precincts as artificial ecosystems that reflect natural ecological processes and structures, rather than merely imitating their visual appearance (Yeang, 2006). Ecomimicry serves as the conceptual foundation that bridges Ecological Architecture with the Sponge Architecture approach.

Integration of Built and Natural Systems
Buildings are not designed as closed entities, but as open systems that integrate building infrastructure with the ecological infrastructure of the site, including natural drainage systems, endemic vegetation, and local hydrological cycles (Yeang, 2006).



Sponge CIty

The Sponge City was formally introduced as a theoretical framework by Prof. Kongjian Yu, a landscape architect and founder of Turenscape, through his works from the early 2000s, and was later codified in **Sponge City: Theory and Practice** (Yu et al., 2016). Yu defines the Sponge City as a planning model that emphasizes the implementation of **nature-based hydro-ecological infrastructure**, with the primary objective of managing rainwater through natural processes absorption, storage, purification, and reuse rather than relying on conventional drainage systems designed to discharge water as far and as quickly as possible (Yu et al., 2016).

Yu's Sponge City concept is a nature-based approach to urban water management, designed to mitigate flooding, improve water quality, and enhance biodiversity. Instead of relying on concrete drainage systems, Sponge Cities use wetlands, permeable surfaces, and green spaces to absorb, filter, and store rainwater.

The concept's earliest articulation came from ecology: Yu and his team used the concept of a sponge to describe the flood-control capacity of natural systems, pointing out that "the natural wetlands along rivers can function like sponges to retain water during flooding and recharge water during drought."

3 Core Principles
Yu consistently articulated three foundational principles in his own words:

1. Retain water at the source
Whenever precipitation happens, keep the water on the slope, on the ground, in the city, and in the village. Do not let it leave immediately.

2. Slow down the flow
Whenever you have creeks, rivers, or streams, let the water slow down do not channelise it or flush it away, as conventional engineering has done everywhere in the world.

3. Embrace water (don't fight it)
When water accumulates within a natural sink, give it more space instead of building walls to contain it.

In his words: "All modern cities are based on grey, industrial, inflexible technologies based on reliable climates. In contrast, the green technology of the sponge city is based on three principles: hold water in place as much as possible, slow down its flow, don't fight against water."

Sponge Architecture

Sponge Architecture is a derivative and scalar reduction of Sponge City to the level of the building and precinct. In the context of this research, Sponge Architecture is defined as a synthesis of two approaches: the hydrological logic of Kongjian Yu and the ecological principles of Ken Yeang, namely a building design approach that integrates systems of ecological water absorption, storage, purification, and reuse into the physical structure and spatial program of the building, so that the building functions like a sponge that responds to the natural water cycle at the micro scale, rather than merely channeling water away.

From the perspective of architectural ecology, Yeang (2006) reinforces this paradigm through the principle of ecomimicry, designing buildings as artificial ecosystems that reflect natural ecological processes and structures, rather than merely imitating their visual appearance. It is the combination of Yu's sponge logic and Yeang's ecomimicry principle that forms the foundation of Sponge Architecture: buildings that are not merely green in an aesthetic sense, but that actively participate in local hydrological and ecological cycles.

If Ecological Architecture (Yeang) establishes the philosophical foundation that buildings must actively participate in the ecosystem of their site, then Sponge City (Yu) provides the operational mechanism, particularly in the context of coastal sites vulnerable to tidal flooding and hydrological degradation such as those found in Kaliwungu Kendal.

These two approaches do not stand independently, but rather complement one another: Yeang's ecomimicry provides the biological logic for design, while Yu's absorption–deceleration–adaptation principles provide a measurable hydrological logic. The synthesis of both produces what in this research is defined as Sponge Architecture, a building design approach that integrates ecological water management systems into the physical structure and spatial program of the building.

Spatially, Sponge Architecture operates from the macro to the micro scale: from the landscape and external spaces as the primary zones of water absorption and deceleration, toward the internal spaces of the building that are designed to respond to and make use of that water cycle. This design direction from external spaces into internal spaces becomes the primary spatial principle to be operationalized in the design process.

Using Sponge City as the stages of water management:

6 Operational Measures

These six measures were codified in China's Technical Guideline for Sponge City Construction (2014), the national policy framework shaped by Yu's decades of work. They translate the three principles into actionable engineering and design interventions. Methods such as discharge reduction at the source, runoff control, rainwater regulation, and storage are combined with measures including infiltration, detention, storage, purification, use, and drainage of rainwater to improve the water cycle in sponge cities.

1. Infiltration *(渗)*
Increase permeable surfaces, including permeable pavements, green roofs, and rain gardens, so that rainwater seeps into the ground rather than running off.

2. Detention / Retention *(滞)*
Slow and hold water temporarily on-site using bioswales, detention basins, and constructed wetlands to delay peak runoff.

3. Storage *(蓄)*
Capture and store rainwater in ponds, underground cisterns, or wetland systems for later use.

4. Purification *(净)*
Filter pollutants from stormwater using vegetation, soil, and wetland systems before it enters waterways.

5. Use / Reuse *(用)*
Harvest stored rainwater for irrigation, landscape water features, toilet flushing, or groundwater recharge.

6. Drainage *(排)*
Manage remaining excess runoff safely through improved but downsized drainage infrastructure when volumes exceed retention capacity.

These six key processes, namely retention, infiltration, storage, purification, discharge, and utilization, form the operational backbone of sponge city practices.

Landscape as Pendagogy

"Landscape as Pedagogy — where ecological principles are not only studied in the classroom, but also directly experienced through interaction with an ecologically designed landscape." (hal. 11)

"Living with Water (Kongjian Yu) — absorption, deceleration, adaptation: menyimpan, memperlambat, dan merangkul air sebagai sumber daya, bukan ancaman." (hal. 49)

Landscape as Pedagogy (also called Landscape Pedagogy or Pedagogy of Place) is an educational framework that treats the physical landscape natural, cultural, and social as an active agent and primary medium of learning, rather than merely a backdrop or setting for instruction.
The foundational approach of landscape pedagogy uses actual places as classrooms, emphasizing how specific locations contribute to broader landscape patterns. This pedagogy highlights the role of place in the teaching and learning process.

More broadly, landscape pedagogy is proposed as a framework that is both relational fostering human connections and a sense of belonging within the natural world and responsive acknowledging the responsibilities that arise from this belonging.

Landscape as Pedagogy offers a compelling theoretical basis for designing the pesantren grounds — particularly the retention pond at Kali Bendo — not just as hydro-ecological infrastructure, but as a living learning environment where santri engage directly with water, ecology, and land stewardship as part of their formation (tarbiyah).

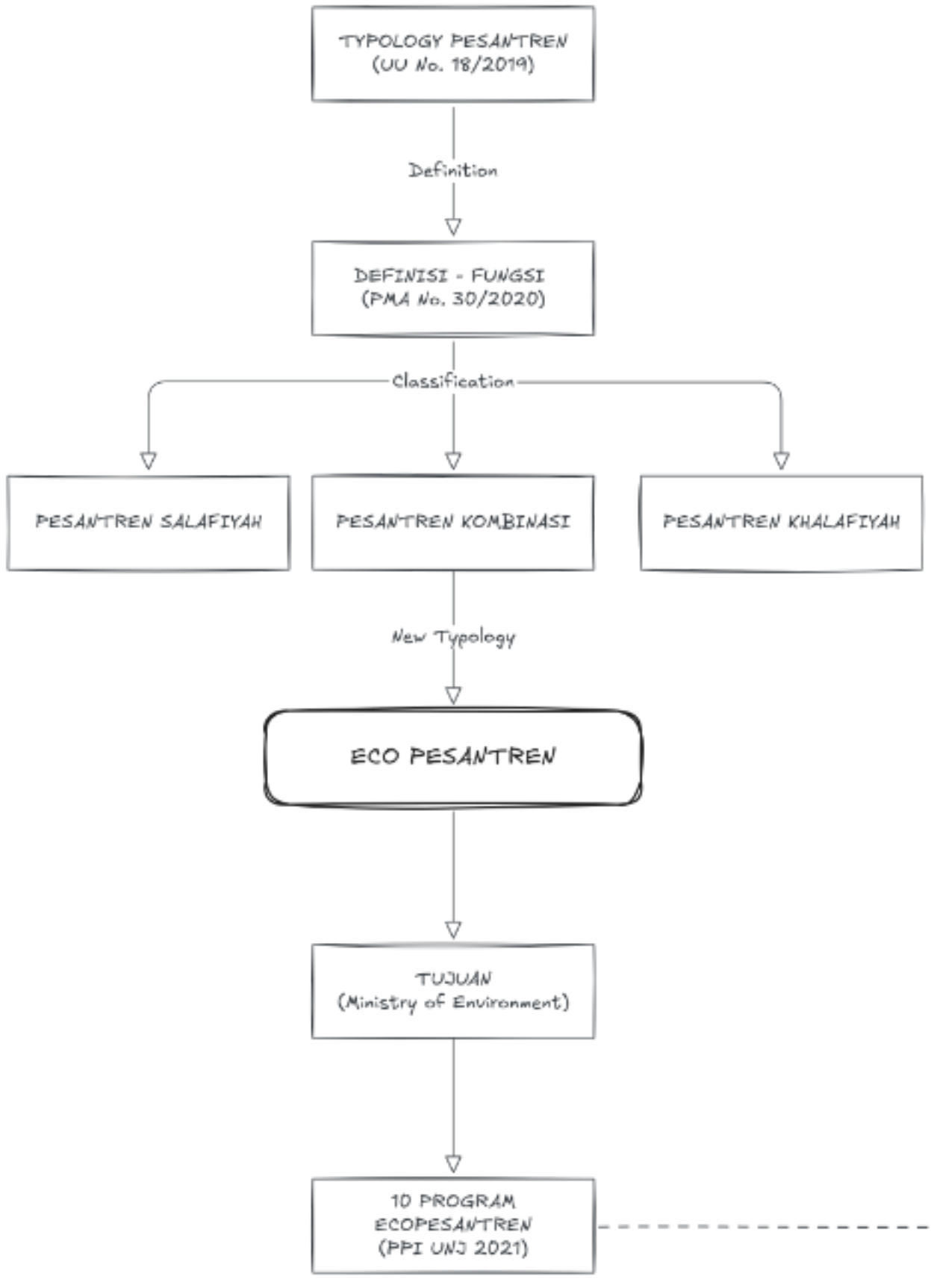
The term pedagogy derives from the Greek words pais (child) and agogos (to lead or guide), literally denoting the art and science of guiding the learning process. However, the modern definition extends considerably beyond the act of teaching children: pedagogy is the theory and practice of how knowledge is transmitted, constructed, and internalized through methods, environments, relationships, and experiences.

Landscape as Pedagogy therefore claims that the landscape itself is a teaching agent, not merely a backdrop against which learning takes place.

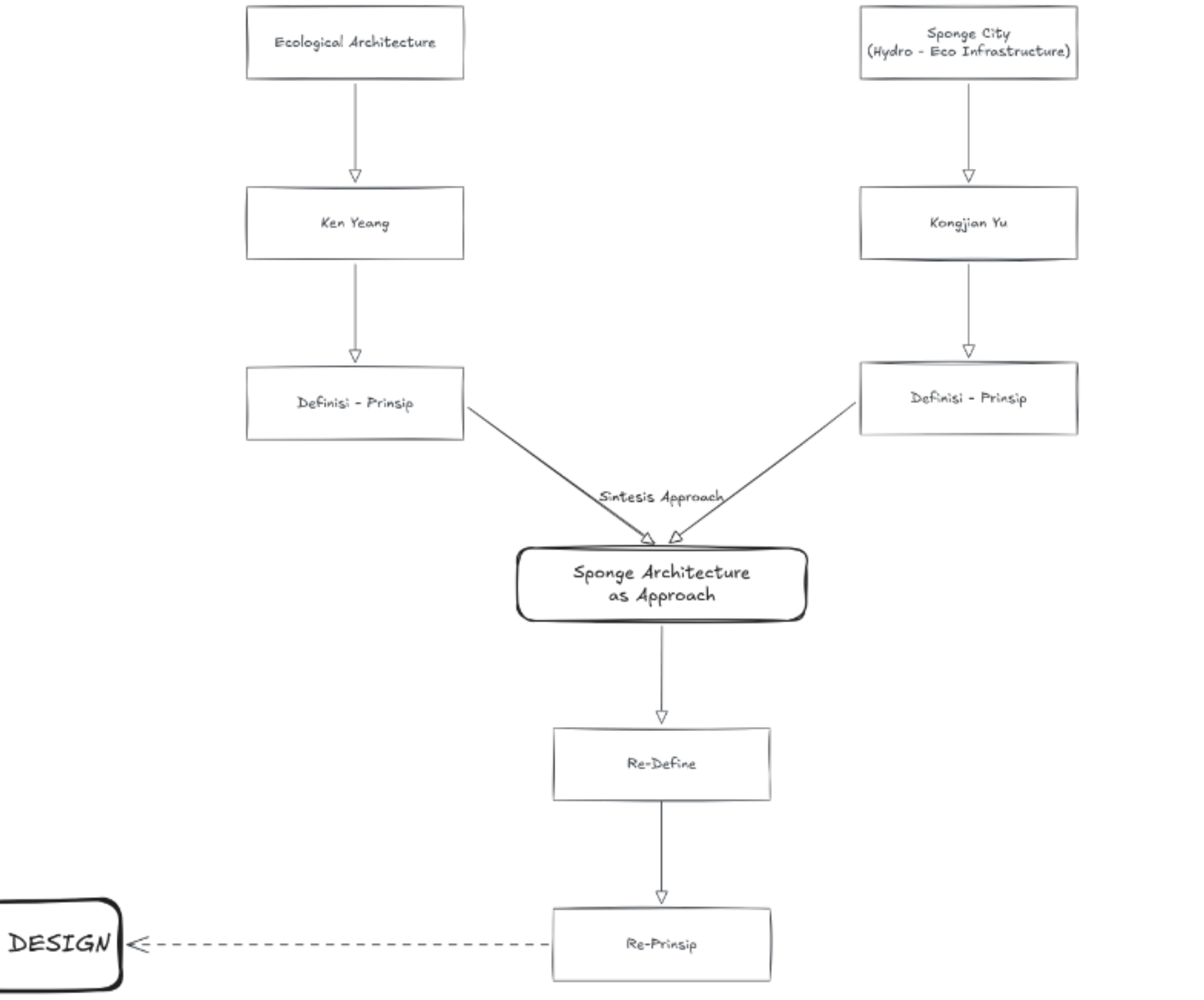
Landscape as Pedagogy must answer the following concretely: where does pedagogy occur? Through what means? What activities engage santri with water, soil, and vegetation, rather than merely placing them in proximity to it?

A santri who walks past rice fields every morning, observes changes in water levels, and then engages in classroom discussion about the water cycle — that is pedagogical — because a connection exists between lived experience and reflective understanding.

Framework Study Typology: Eco Pesantren



Framework Study Approach: Sponge Architecture



Pondok Pabelan — Pesantren Pedesaan

Magelang, Jawa Tengah — 1970-an, Aga Khan Award for Architecture

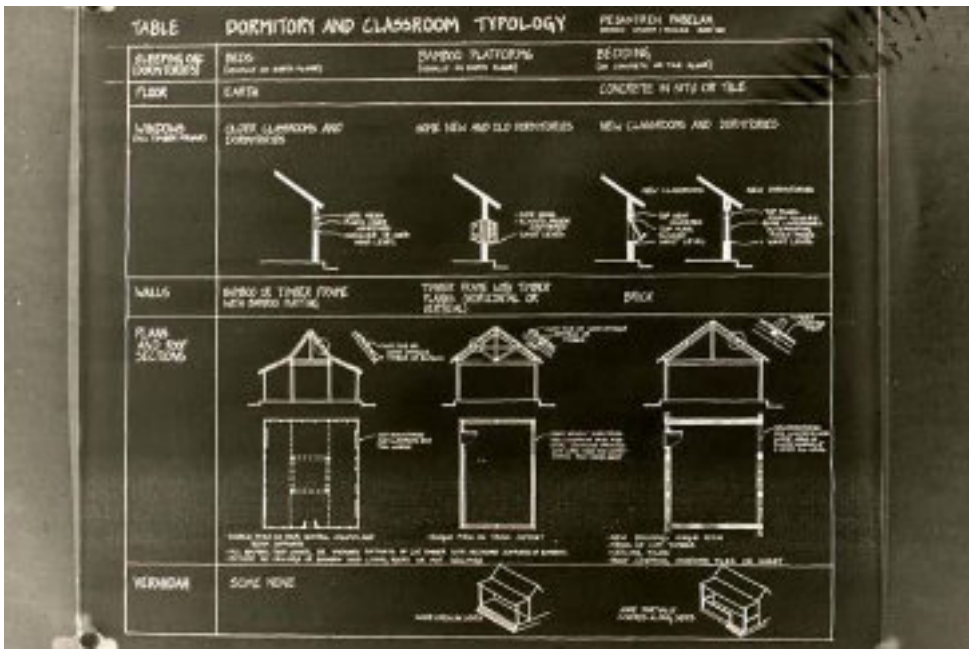
Pondok Pabelan was founded out of the awareness that rural poverty and massive urbanization to Jakarta could in fact be prevented if local communities were empowered from within. This pesantren is not merely a traditional Islamic educational institution; it is a center for village recovery. In addition to general and religious education, Pabelan offers agricultural and medical services, as well as building construction training using local resources, materials, and technologies. Its architecture grows organically from the needs of the students and village residents, integrating elements of traditional Javanese rural design with modern systems to produce an architectural expression that is authentic, responsive, and grounded.

- Function of the Pesantren Building as an Integrated Spatial System From the Pabelan study, the fundamental spatial needs of a pesantren can be mapped: worship space (the mosque as the center of orientation), student residential space (dormitories on an intimate scale), formal learning space (classrooms), informal learning space (gardens, verandas/corridors, transitional spaces), production and training space (workshops, agricultural land, clinics), as well as communal space that connects students with village residents.

- Zoning Arrangement among Building Masses: Public–Semi-Public–Private Hierarchy Pabelan shows a clear zoning pattern: the public zone (mosque, reception area, village service facilities) is located at the edge of the site and easily accessible to outsiders; the semi-public zone (learning spaces, training workshops) is located in the middle as a space for student–community interaction; the private zone (dormitories, rest areas) is located deepest within the site and is protected.

- Relationships among Building Masses: Circulation as a Community-Forming Element In Pabelan, building masses do not stand as solitary objects; rather, they are connected by a system of corridors/verandas, courtyards, and transitional spaces that serve as places for everyday social interaction. The relationships among masses are semi-open—not hermetically sealed like modern buildings—so that wind, light, and the sounds of nature flow between buildings.

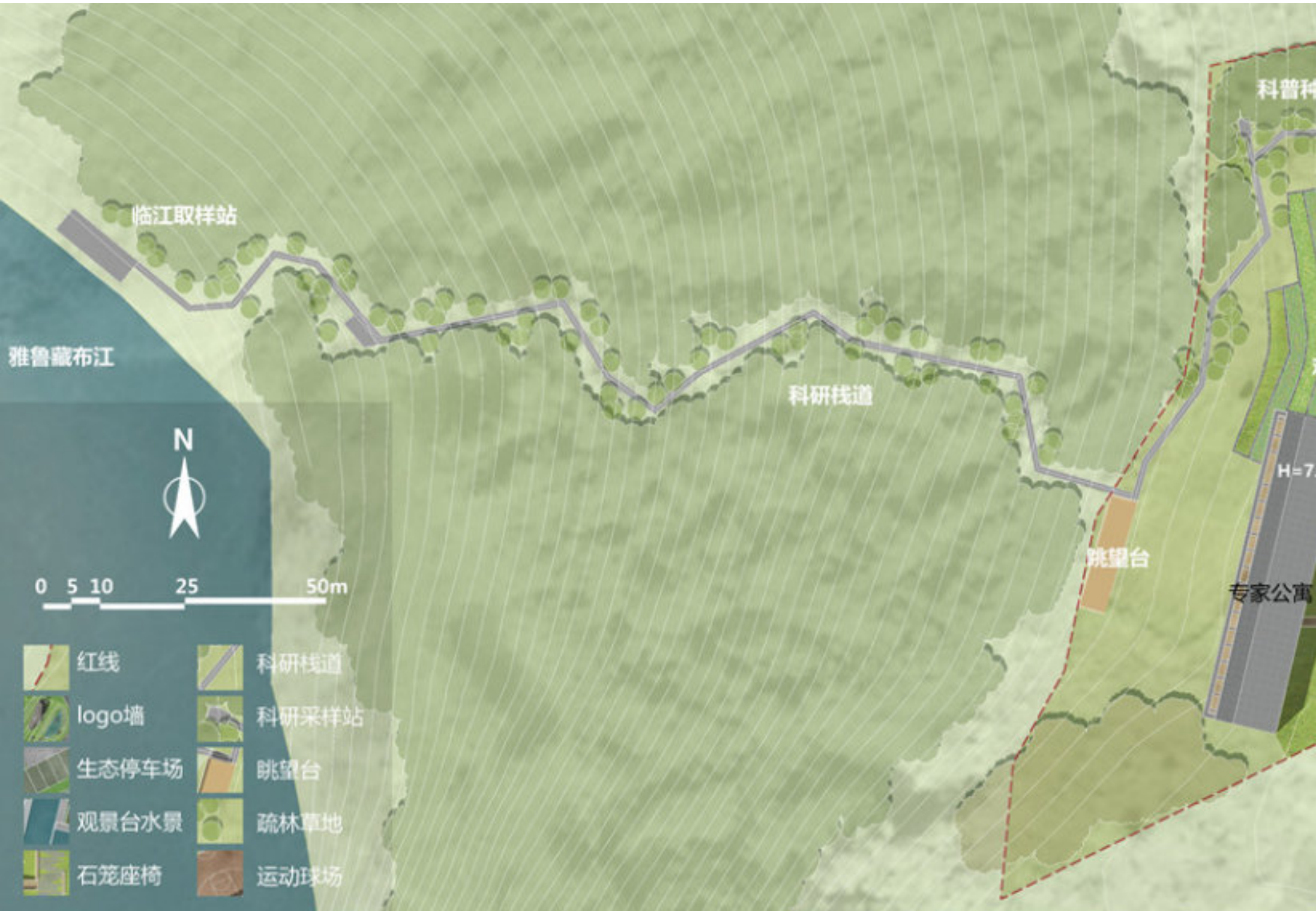
- Local Materials and Technology as Architectural Identity Pabelan explicitly trains students and village residents to use local materials and integrate them with modern construction systems—not rejecting modernity, but negotiating it with local wisdom. The Aga Khan jury assessed this as an “authentic architectural expression responsive to the needs of the modern rural environment.”



Chinese Academy of Sciences Mêdog Observation Station

Linzhi, Tibet 2018, Turenscape

This observation station is located on a steep slope near the Great Bend of the Yarlung Tsangpo River, facing the threats of landslides, debris flows, more than 200 rainy days per year, and budget limitations. The design response is minimal intervention: building as little as possible and blending with nature as much as possible.



- Minimal Intervention Principle as a Site Strategy Mêdog teaches that on ecologically critical and disaster-prone sites, not all areas must be built; your pesantren must determine built zones vs. ecological zones very carefully, placing buildings at points that instead stabilize the site

- Local Materials as an Ecological and Economic Response Mêdog uses bamboo and local stone to reduce costs and lower the carbon footprint of material transportation

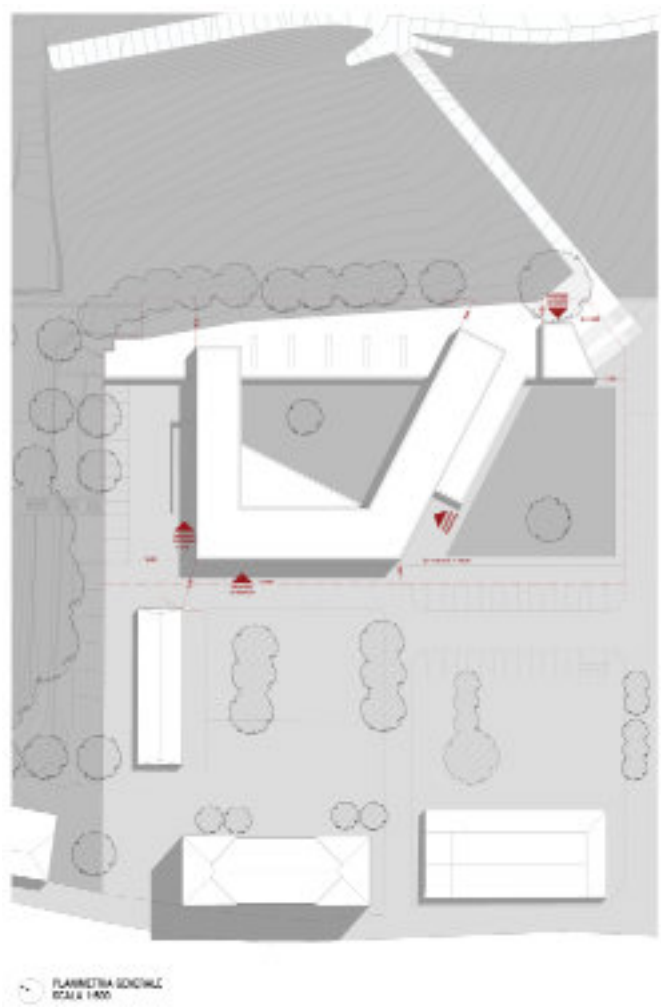
- Building Orientation toward Views and Natural Ventilation The principle of "creating scenic viewpoints within the natural environment" can be translated into your context as building orientation that opens views toward the sea and mangroves

Design a new boarding school in Malle

Bozen, Italy 2019, AM3 Architetti Associati

This boarding school was built on the edge of the Alps, facing Mount Stelvio and the Mustair Valley. The challenge was the sharp difference in elevation between the mountain slope and the building site. AM3's response is an open "U" form that creates three distinct outdoor spaces, with retaining walls serving as a topographic resolution as well as an architectural element.

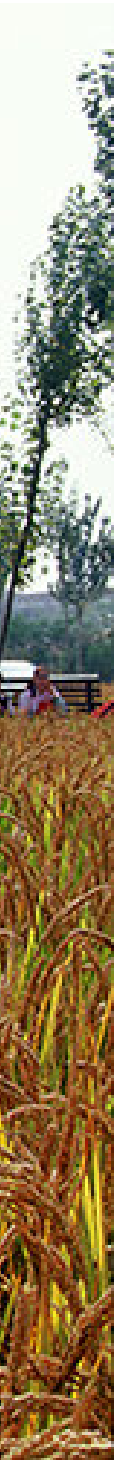
- “U Shape” or Courtyard for the AM3 Islamic boarding school demonstrates that an open “U”-shaped massing is highly effective for residential/boarding institutions because it creates a private courtyard in the middle (semi-public) and opens views to nature on the outer side.
- Clear and Tiered Functional Zoning Strategy AM3 clearly separates the functions of the fitness room, canteen, and study lounge on the ground floor, while the residential area is placed in a separate volume on the upper floor.
- Passive Ventilation and Solar Orientation The AM3 building is strategically oriented to maximize direct sunlight in each room throughout the year, while also using external screens and concrete walls to reduce heat gain.
- Thresholds as an Indoor–Outdoor Relationship AM3 specifically emphasizes “a focus on the relationship between indoors and out is evident in building thresholds” the large glass wall in the sports room that “dissolves” the boundary with nature. This is relevant to the concept of Landscape as Pedagogy



Shenyang Architectural University Campus

China Shenyang, Liaoning, 2003, Turenscape

This project demonstrates how agricultural landscape can become part of the urbanized environment and how cultural identity can be created through an ordinary productive landscape. The overwhelming urbanization of China is encroaching upon much arable land. With a population of 1.3 billion people and limited tillable land, food production and sustainable land use is a survival issue that landscape architects must address.




01. Central Pond
02. Dry Crop Area
03. Rice Fields
04. Library
05. Laboratory
06. Classroom
07. Architectural corridor
08. Student Dormitory
09. Sports Center
10. Cafeteria

Sayembara Desain AAS Islamic International School and Desain Masjid Raya Puspemkab Serang
Panaikang, Makassar and Serang, Banten, 2025, Joso Architect

Floating mosque Amirul Mukminin
Makassar, Sulawesi Selatan, 2012, Ramadhan ‘Danny’ Pomanto

Material Structure

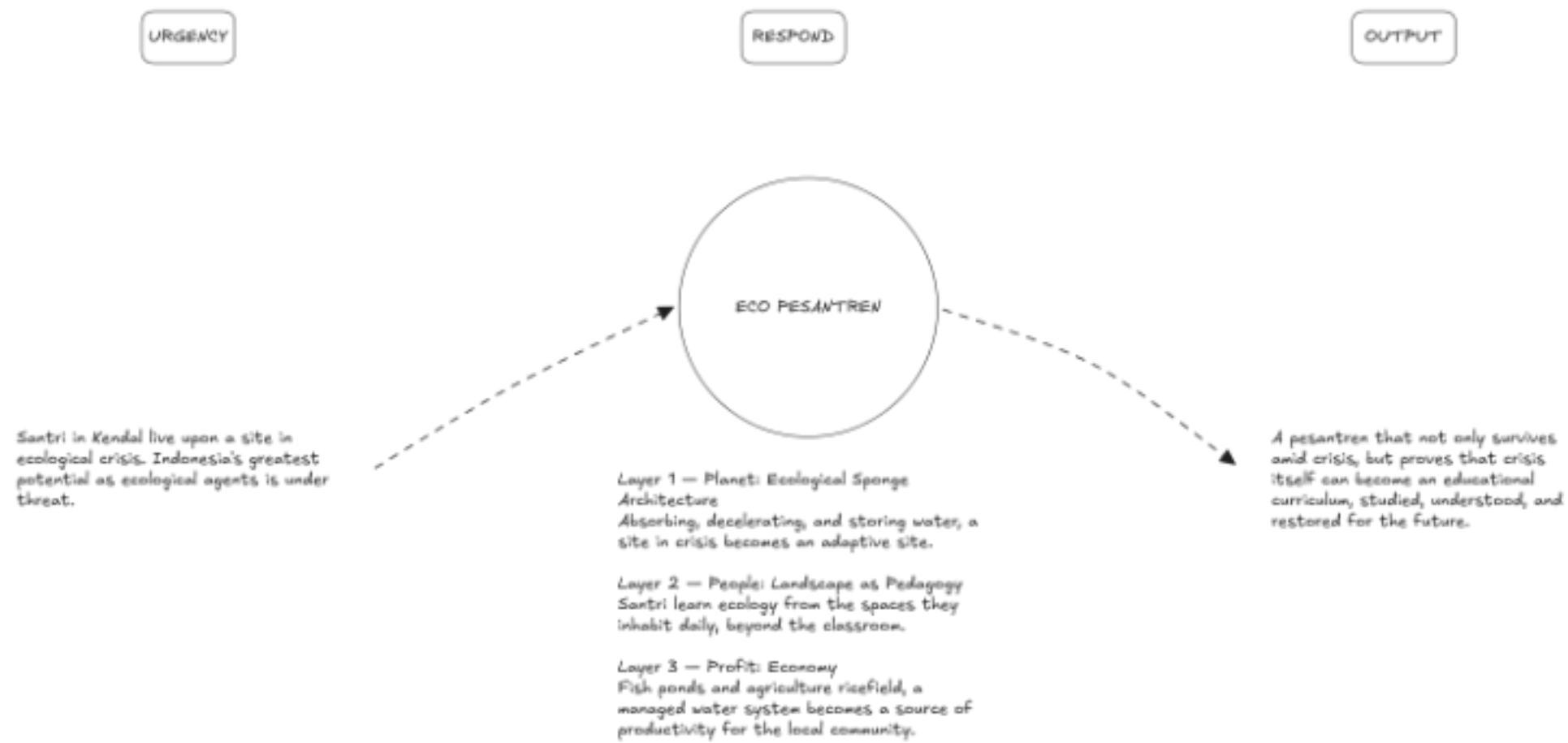
Materials response:
Reinforced concrete → foundation, columns, beams
wet-dry resistance

Timber → roof nusantara - Tropic Climate
lightweight/reduces load, local material sustainability

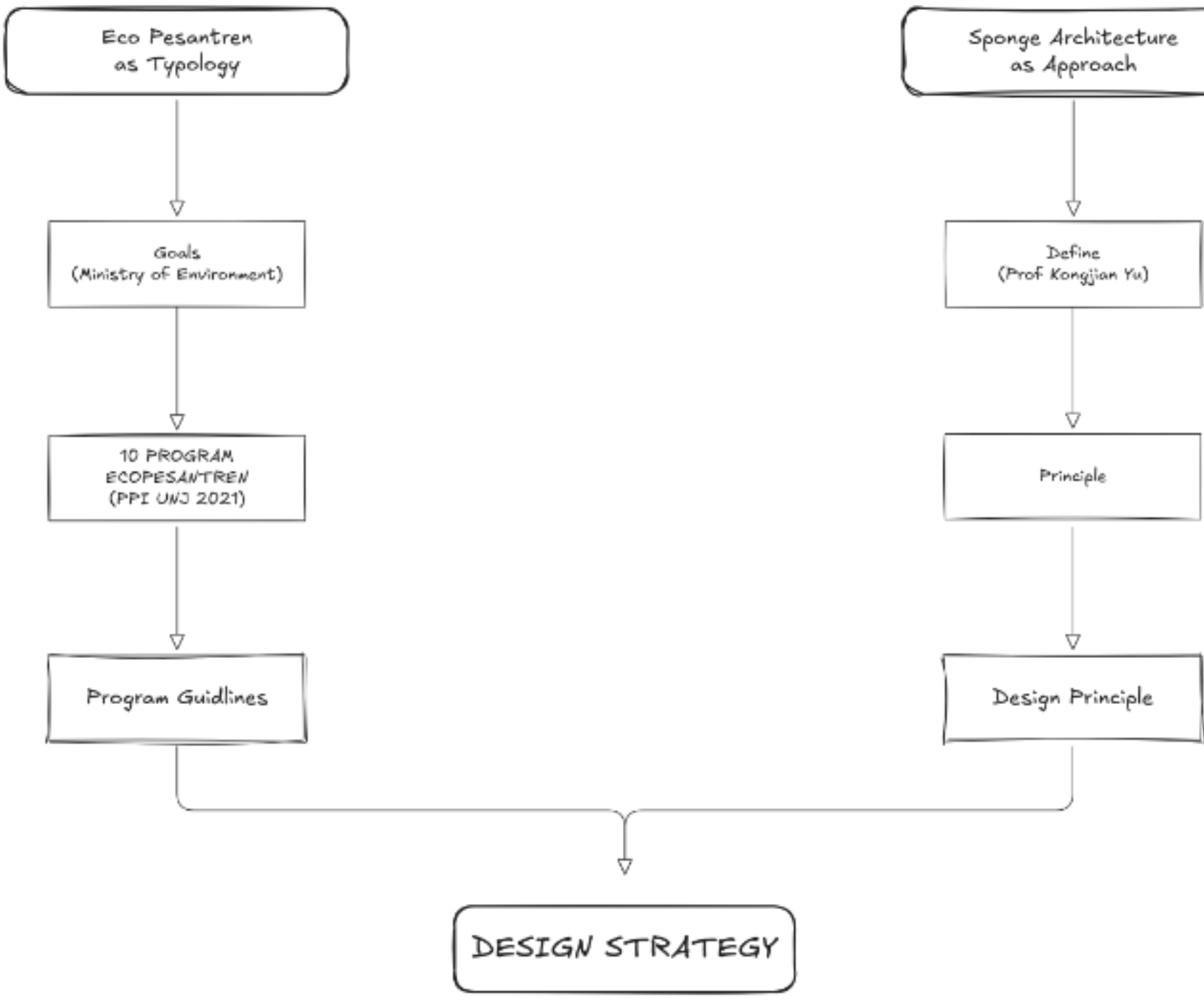
DESIGN PROBLEM SOLVING

03

Framework Solution



Framework Design Strategy



Sponge Archite

This approach is used as a guideline

Educated santri can become agents of change. They learn directly from nature, especially water, while helping to protect and improve the ecology.

Educated Santri (Students)

Ecocide make it worst and Flooding happens every year on the North Coast.

Environmental Problem: Flooding

Where should the site be located

Site Selection

The site is chosen through urban mapping analyzed.

Site criteria:
Wetland area
(close to coastal or River)
Non greenfield
Unproductive land

Where does the water come from?

Understanding water

Water comes from rainfall and tidal flooding from the Bendo River.

Where doe
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Water
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Where does the water used after it is captured?

Principle Sponge city by Kongjian Yu

The idea is "living with water". Instead of removing water from the site, it is kept and used through three principles: Retain, Slow, and Embrace. This lets santri learn about water directly, through:

Fish pond
General plant irrigation
Rice field irrigation
Building use (ablution water)
Toilet flushing

What is the design strategy?

Strategy Design (parameters)

The design combines Kongjian Yu's sponge city principles with the Ministry's Eco Pesantren guidelines, along with an education activity curriculum.

Explore Design ideas through:

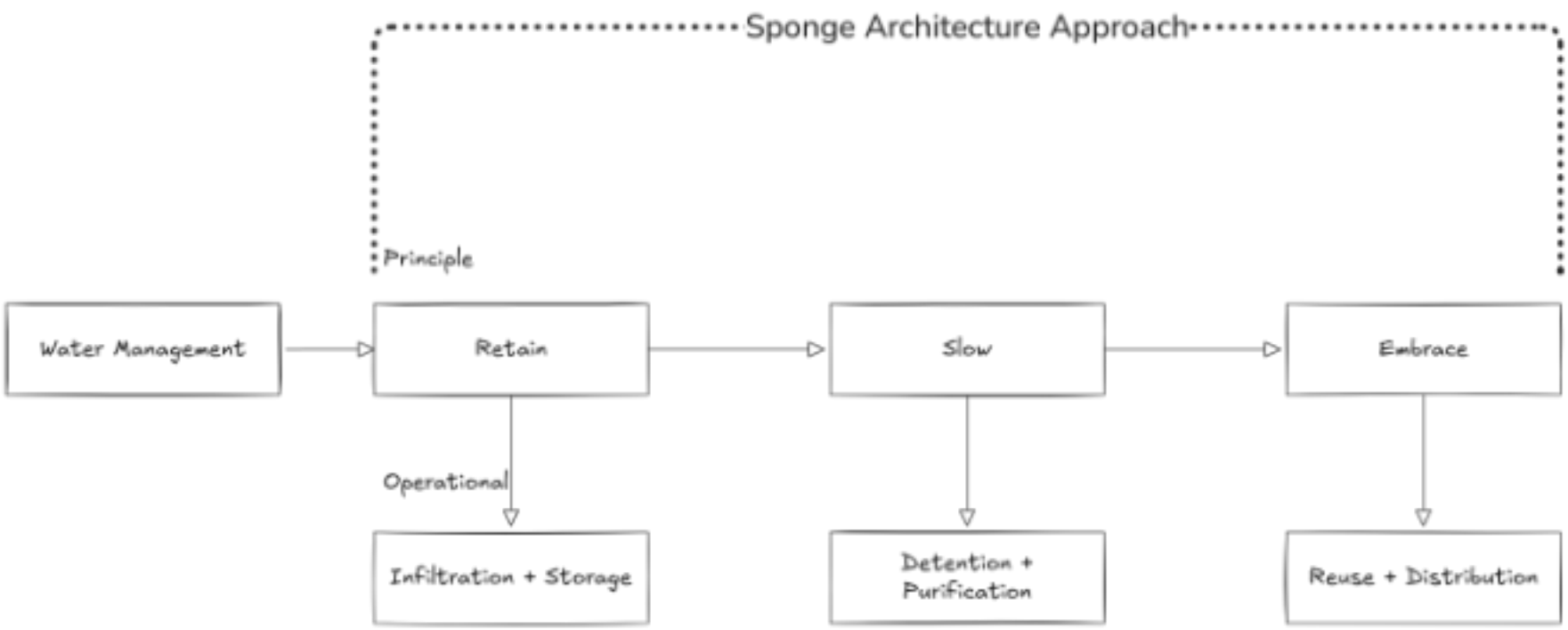
Site planning
Building design

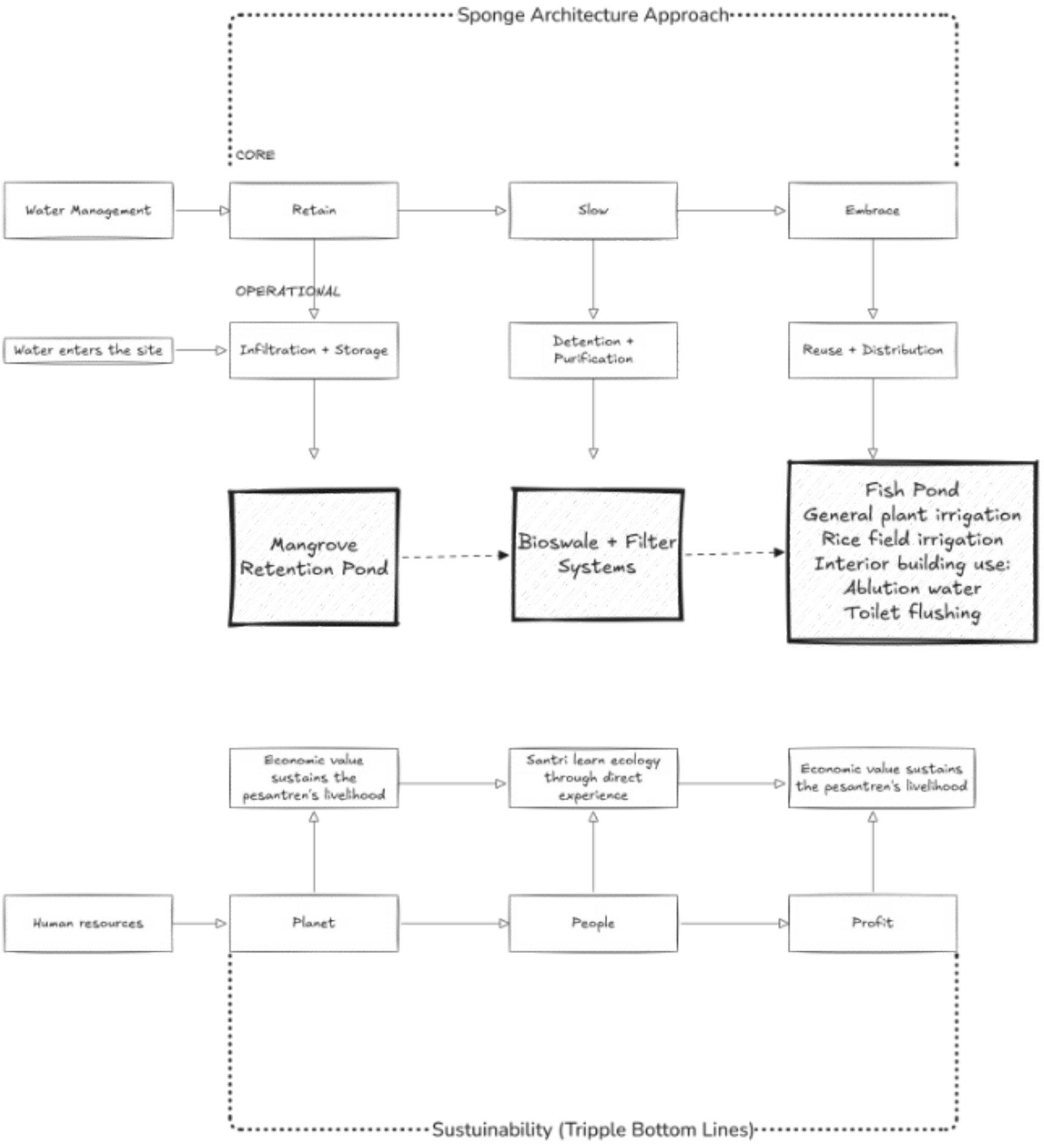
Graduating santri

Creates a golden generation for the future

Impact Environment

The ecology becomes better and better


Sponge Architecture Approach
Principle
Water Management
Retain
Slow
Embrace
Operational
Infiltration + Storage
Detention + Purification
Reuse + Distribution

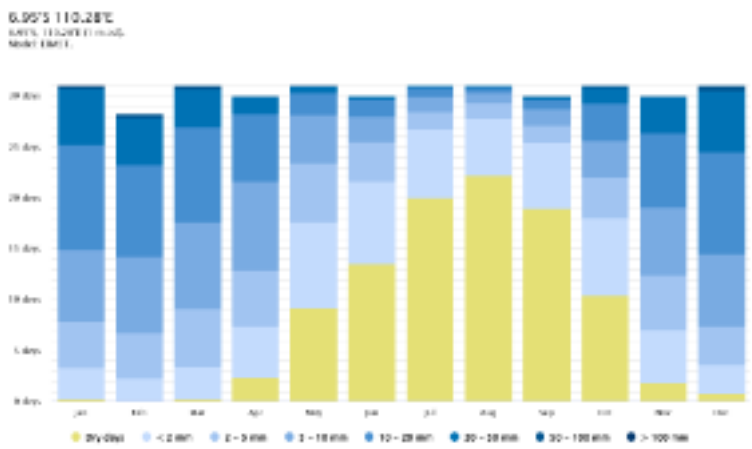

Sponge Architecture Approach
CORE
Water Management
Retain
Slow
Embrace
OPERATIONAL
Water enters the site
Infiltration + Storage
Detention + Purification
Reuse + Distribution
Mangrove Retention Pond
Bioswale + Filter Systems
Fish Pond
General plant irrigation
Rice field irrigation
Interior building use:
Ablution water
Toilet flushing
Economic value sustains the pesantren's livelihood
Santri learn ecology through direct experience
Economic value sustains the pesantren's livelihood
Human resources
Planet
People
Profit
Sustuinability (Tripple Bottom Lines)

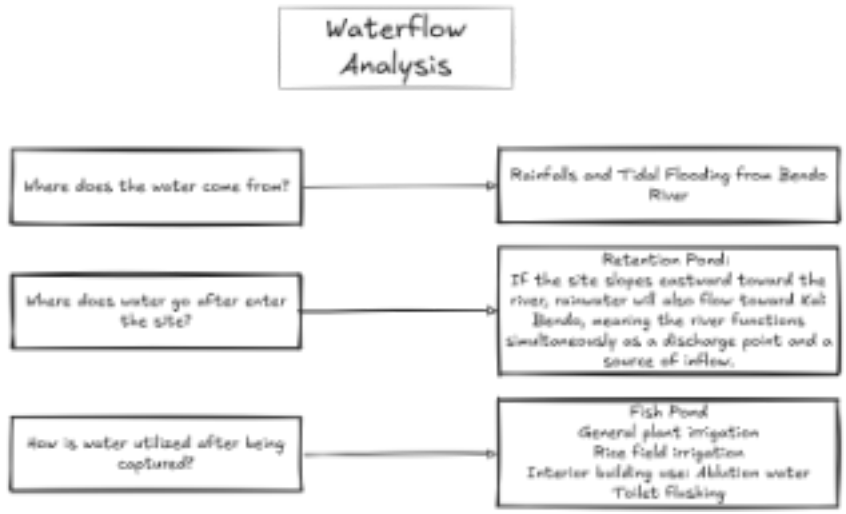
Design Parameter

Eco-Pesantren Program Guidelines	**Design Variable**	Design Element	Theoretical Reference	**Design**
School land (4) Biodiversity (10) Healthy living (6)	**Land Use** **Biodiversity** **Healthy Living**	Site Conditions Site Infrastructure Landscape Building Mass Organization	Ken Yeang Kongjian Yu	**Land Us**
Environment Based Curriculum (1) Environmental Fiqh (2)	**Indoor Classroom** **Outdoor Learning Class**	Site Infrastructure Landscape Building Structure Building Utility Building Envelope Spatial Organization	Ken Yeang	**Learnin** **Indoor-**
Water Resources (5)	**Water Management**	Site Conditions Site Infrastructure Landscape	Kongjian Yu	**Living w** **Retain** **Slow** **Embrac**
Energy Resources (8)	**Passive Design Strategy**	Building Structure Building Utility Building Envelope	Ken Yeang	**Passive**
Transport and Mobility (9)	**Circulation & Mobility**	Site Conditions Site Infrastructure Landscape Building Mass Organization	Ken Yeang	**Low-Ca**

Principle	Design Parameters
se Optimization	Minimum Green Coverage Ratio (GCR): 30% Maximum Building Coverage Ratio (BCR): 60% Minimum building setback from river edge: 15 m Minimum building setback from road: 20 m Min. Ecological Buffer Zone 30% of total area Mangrove corridor along all site edges bordering Kali Bendo River Min. Productive land 10% of total landscape zone
g Space: Outdoor	Minimum floor area 2 m^2/student; minimum classroom width 5 m per classroom; maximum classroom capacity 32 students Each classroom directly connected to ecological zone and productive landscape zone Corridor through ecological zone and productive landscape zone as daily santri circulation path in outdoor learning Direct visual connection to landscape from each classroom
with Water: ce	Retention system capacity designed to accommodate average tidal flood discharge of Kali Bendo River Retention pond volume calculation based on Meteoblue climate data Documented Water flow schme Create Artificial Retentian Pond Documented water recycling on site plan
-First Energy System	Documented energy flow scheme Shading building by design form specially dirmitory Natural daylighting through courtyard configuration Building mass orientation along kakbah axis and others to mosque axis Material structure sustuinable for water contextual
rbon Mobility System	Guest vehicle parking located at front/peripheral zone of site Pedestrian pathway from main entrance to all zones Documented evacuation route on site plan

Understanding Water





Calculation Size Retention Pond for hold water on site
Step 1 Data Rainfall
December is the peak month at 420 mm/month. This becomes the base design rainfall.

Step 2 Apply Return Period Factor
The pesantren is an important structure, so we design for a 25-year return period. The factor for 25 years is 1.25.
$R_{design} = 420 \text{ mm} \times 1.25 = 525 \text{ mm}$

Step 3 Define the Catchment Area
The total site area is 2 hectares. Since the existing pond is the central receiving pond for the entire site, the full 2 ha is used as the catchment. Runoff from all surfaces drains toward the central pond, so no area deduction is made.
$A = 2 \text{ ha} = 20{,}000 \text{ m}^2$

Step 4 Runoff Coefficient
The site is a mixed surface — partial buildings, pathways, and green areas typical of a pesantren layout.
$C = 0.60$

Step 5 Calculate Total Runoff Volume
Using the volumetric rational method:
$V_{runoff} = C \times R \times A$
$V_{runoff} = 0.60 \times 0.525 \text{ m} \times 20{,}000 \text{ m}^2$
$V_{runoff} = 6{,}300 \text{ m}^3$

Step 6 Required Pond Volume
The pond is sized to detain 50% of the total runoff event while the remainder drains continuously through a controlled outlet.
$V_{required} = 6{,}300 \times 0.50 = 3{,}150 \text{ m}^3$

Step 7 Assess Existing Pond Capacity
The site already has an existing pond which will serve as the central retention pond.
Existing pond footprint = $6{,}000 \text{ m}^2$
Effective depth = 1.5 m
$V_{existing} = 6{,}000 \text{ m}^2 \times 1.5 \text{ m} = 9{,}000 \text{ m}^3$

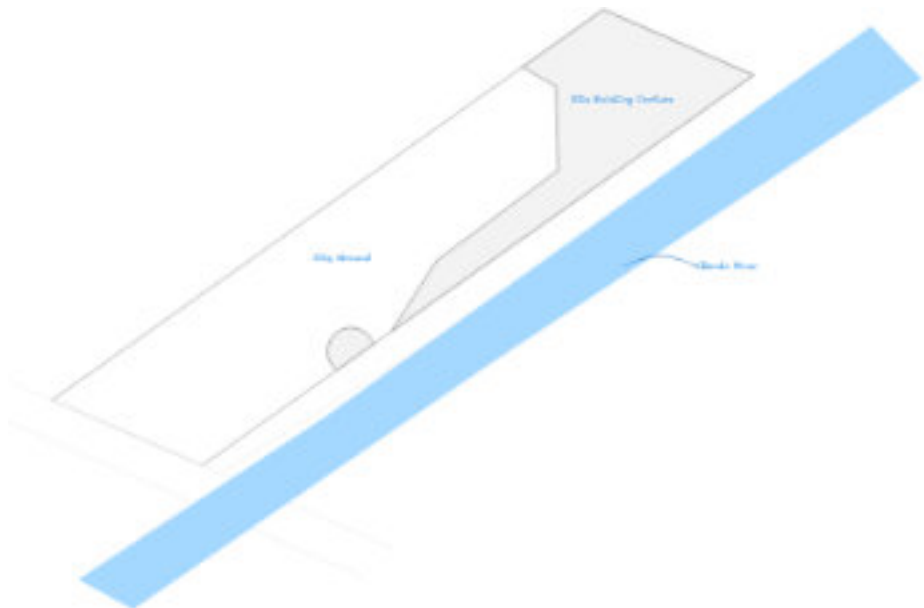
Step 8 Compare Required vs Available Volume
$V_{required} = 3{,}150 \text{ m}^3$
$V_{existing} = 9{,}000 \text{ m}^3$
Surplus = $5{,}850 \text{ m}^3$

The existing pond provides 2.86 times the required detention volume. No additional pond construction is needed.

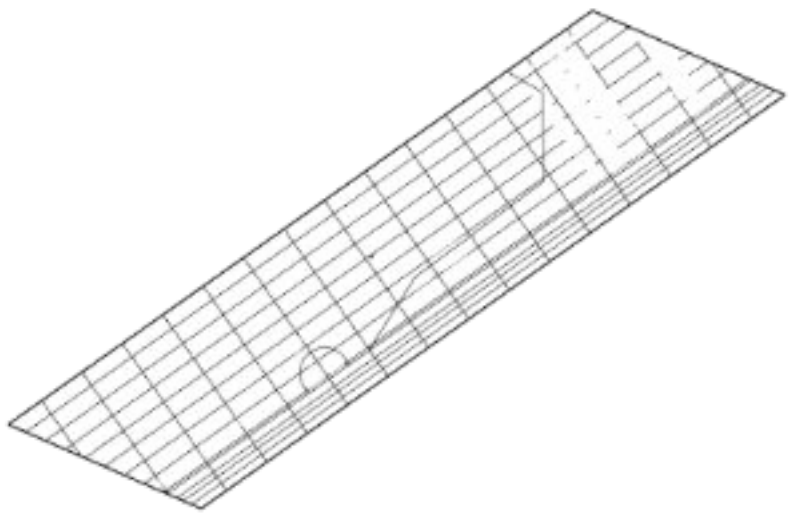
Final Summary
Design rainfall: 525 mm (420 × 1.25, 25-year return period)
Total runoff volume: $6{,}300 \text{ m}^3$
Required detention volume: $3{,}150 \text{ m}^3$
Existing pond volume: $9{,}000 \text{ m}^3$ ($6{,}000 \text{ m}^2 \times 1.5 \text{ m}$)
Deficit or surplus: $+5{,}850 \text{ m}^3$ surplus
New pond construction required: None

Waterflow Analysis by Simulation Computational

1 Contextual Site Existing



2 Base Site and Contured



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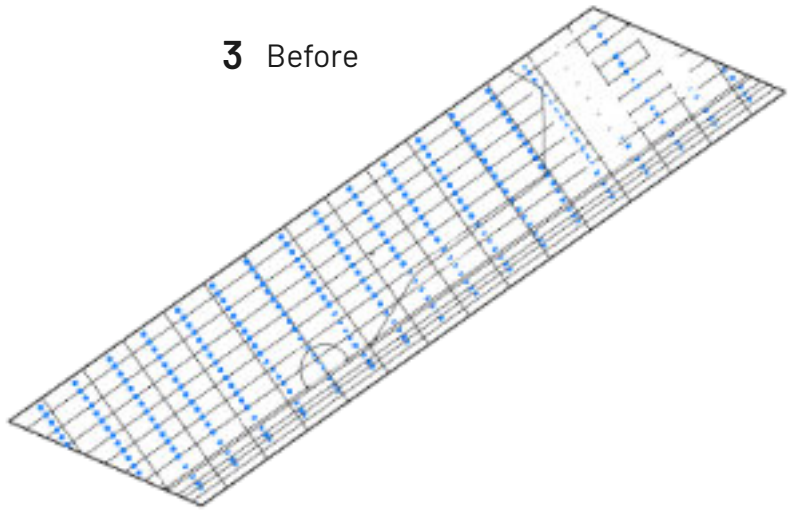

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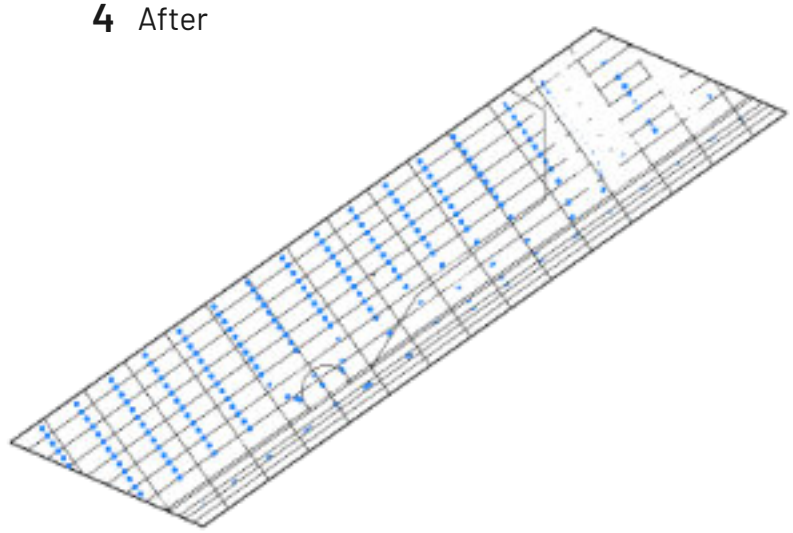


If rain falls within the site, not all of it can be accommodated by the existing retention pond, so an artificial retention pond is required.

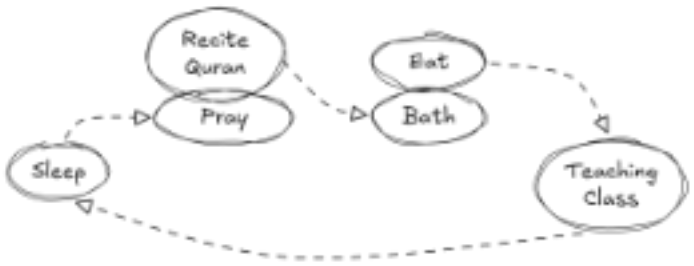
This also applies to flooding. As the site is located next to the Bendo River, rainwater may flow down into it, or conversely, flooding may come from that direction. According to the data, the water level could rise by 30 cm and cause flooding.

Users Analysis Room and Space

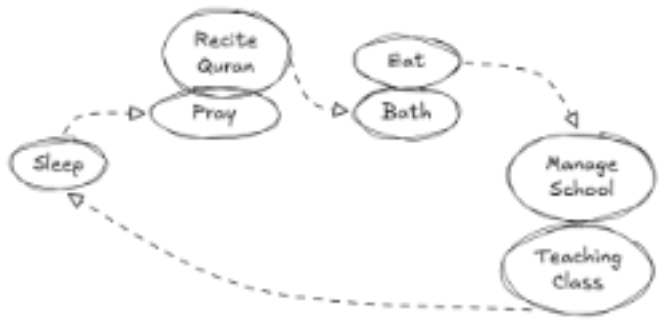
Users	Activity	Room
Ustadz/Ustadzah	Sleep, Pray, Recite the Quran, Bathe/Shower, Eat, Teach a class	Bedroom, Bathroom, Dining Room, Teachers'/Ustadz Room, Mosque, Classroom
Pengurus Pondok	Sleep, Pray, Recite the Quran, Bathe/Shower, Eat, Manage the School (Pondok), Teach a class	Bedroom, Bathroom, Storeroom, Office Room, Dining Room, Kitchen, Mosque, Classroom
Santri Putra	Sleep, Pray, Recite the Quran, Bathe/Shower, Cook, Eat, Exercise, Study Ecology, Formal High School (SMA) Study	Male Dormitory, Bathroom, Canteen, Mosque, Classroom, Field, Fish Pond, Rice Field
Santri Putri	Sleep, Pray, Recite the Quran, Bathe/Shower, Cook, Eat, Exercise, Study Ecology, Formal High School (SMA) Study	Female Dormitory, Bathroom, Canteen, Mosque, Classroom, Field, Fish Pond, Rice Field

Santri

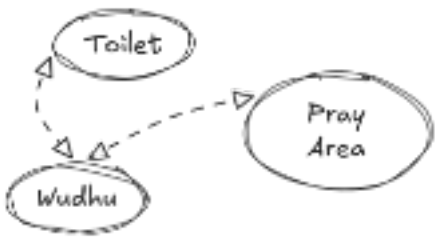
Ustad



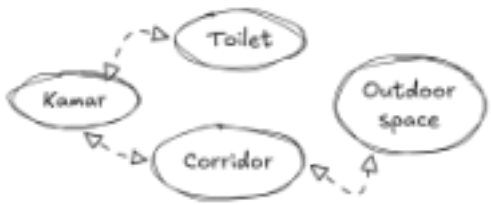
Staff School (Pondok)



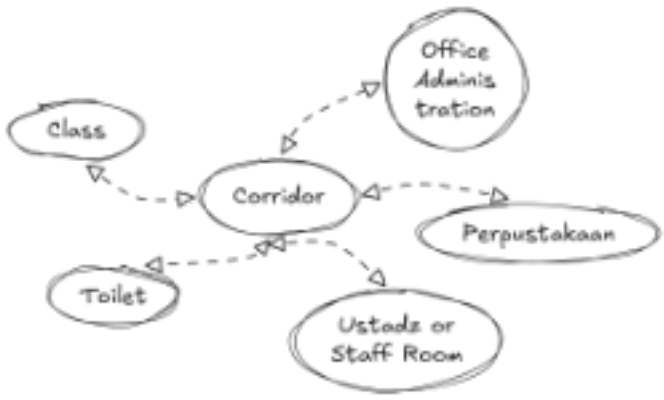
Mosque



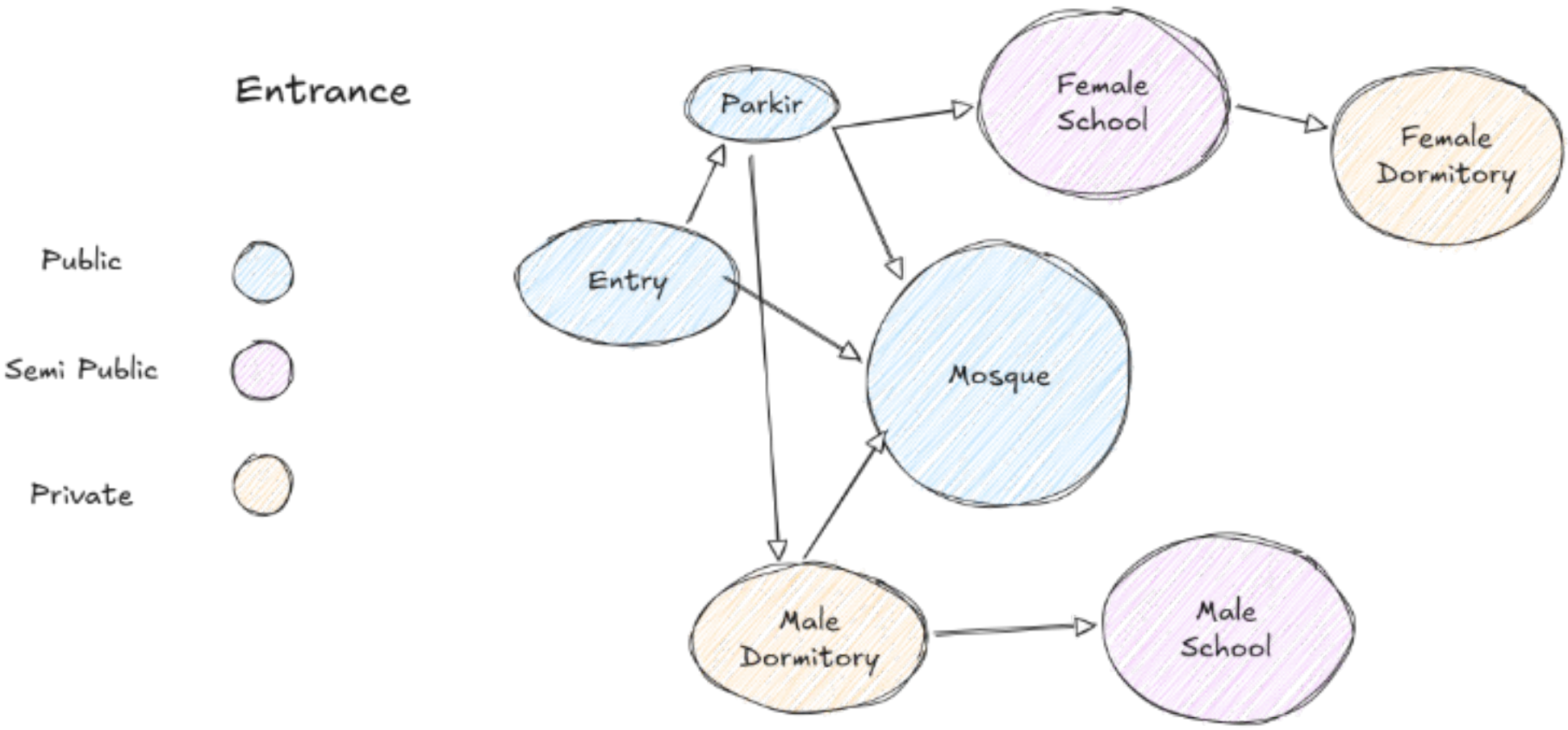
Dormitory



School



Users Activities Flow



Calculation Scheme

Average in Kendal: 200 students per school
Max. 36 students (regulation)

30 people per class (1 study group/rombel)
1 cohort (batch) = 60 people
There are grades 10, 11, and 12
1 school = 180 people (90 male students and 90 female students)

Teaching Staff
Teachers
Subject teachers → calculated based on the curriculum workload (teaching hours), not based on the number of boarding students.
The minimum workload that still applies as a reference for face-to-face teaching is 24 teaching hours (JP)/week (Teacher & Lecturer Law, maintained in Permendikdasmen 11/2025).
With the data: 3 cohorts × 2 study groups (Male & Female) = 6 study groups.
If the standard MA/SMA (high school) curriculum is ±48-51 teaching hours/week per study group:
Total teaching hours = 6 × ~50 = 300 teaching hours/week
Teachers required (rough estimate) = 300 ÷ 24 = ~12-13 teachers

Dormitory Teaching Staff
Musyrif (Dormitory Supervisor)
Musyrif/musyrifah (dormitory caretakers) → calculated based on the 24-hour care ratio, and their function is to accompany students (in worship) and daily discipline.
There is no binding government standard for this, unlike the study group (rombel).
Common practice uses a caretaker:student ratio of approximately 1:10 - 1:15.
With 90 male students + 90 female students (assuming 3 cohorts × 30 per gender):
Male: 90 ÷ 10 ≈ 9 musyrif (male caretakers)
Female: 90 ÷ 10 ≈ 9 musyrifah (female caretakers)

Typical Bedroom Dormitory
1 room = 4 people
23 rooms × 4 people = 92 people, with 1 room housing 2 people

Musyrif total = 10
1 room = 2 people
5 rooms × 2 people = 10 people

Total rooms needed = 28 rooms
1 module = 4 rooms
28 ÷ 4 = 7 modules

Curriculum Education Eco Pesantren

Definition of Curriculum (in an architectural context)
The curriculum here is not a formal educational document, but rather a framework of structured activities that serves as the basis for determining spatial requirements.

Taba (1962) — Curriculum Development: Theory and Practice
Taba initiates the curriculum process from the identification of learners' needs space and concludes it with evaluation.

Types of Pesantren

	Pesantren Salaf	**Pesantren Modern**
Curriculum	Kitab kuning, non-formal	**Formal + integrated religious education**
Time Structure	Not strictly structured	**Daily scheduled**
Spatial Implication	Flexible, mosque-centred	**Requires formal classrooms**

Choice: Modern Pesantren + Madrasah Aliyah
because it is precisely this scheduled time structure that allows for the mapping of activities → spaces with accuracy.

Regulatory Basis:
PMA No. 31 of 2020 on Pesantren Education, and
Permendiknas No. 24 of 2007 on spatial standards for Madrasah Aliyah.

Users — Each Male - Female (Grades 10–12)

Group	Number	Description
Grade X	30 santri	1 class group
Grade XI	30 santri	1 class group
Grade XII	30 santri	1 class group
Total	**90 male santri + (90 female santri)**	**Full Boarding**
Total Students	**180 Santri**	

MA Curriculum Structure from Kemenag (KMA No. 450 of 2024)

Kurikulum Merdeka for Madrasah Aliyah divides its structure into two phases:

Grade X: compulsory general subjects
Grades XI and XII : the structure is divided into compulsory general subject and elective subject groups

Madrasah are granted space to develop local content according to regional needs or the characteristics of the institution, and project-based learning or Projek Penguatan Profil Pelajar Pancasila dan Profil Pelajar Rahmatan lil Alamin (P5P2RA) is assessed through descriptive achievement, not numerical grades.

This is the regulatory gap to introduce the ecological programme. Local content and P5RA serve as the channels of legitimacy for ecological curriculum

Eco Pesantren MA Curriculum Framework — Integrated Structure
Three Horizontal Layers

Layer	Content	Regulatory Anchor
A Worhsip and Daily Life	Prayer, Qur'anic recitation, tahfidz, sleep, eat, bathing, physical exercise	Law No. 18/2019 on Pesantren
B Formal MA Education	Compulsory subjects + elective subjects	KMA No. 450 of 2024
C Ecological Education	Phased ecological programme per grade	Local content + P5RA within KMA450/2024

Three Vertical Phases (per grade)

	Grade X	Grade XI	Grade XII
Santri Role	**Passive → active learner**	**Practitioner**	**Facilitator + entrepreneur**
Focus on	Theoretical foundation	Applied on Practice	Produce Processing
Ecology	Observation	Production practice	Production, Processing and Teaching

Layer A — Worship & Daily Life (all grades, every day)

Activity	Space	Standard
5 daily prayers	Mosque	1 m^2/person
Qur'anic recitation / Tahfidz	Mosque	1 m^2/person
Sleep & rest	Dormitory room	3 m^2/bed
Bathing	Bathroom	1 toilet : 4 persons
Physical exercise	Sports field	-

Layer B — Formal MA Education

	Compulsory Subjects	Elective Subjects	Space	Standard
Grade X	Al-Qur'an Hadith, Aqidah, Fiqh, Islamic History, Arabic, Indonesian, Mathematics, Natural & Social Sciences, Physical Education, Informatics	None	Classrooms @ 30 santri	2 m^2/student, min. 60 m^2
Grade XI	Same	Min. 2 from elective subject groups	Same	Same
Grade XII	Same	Min. 2 from elective subject groups	Same	Same
Total			6 Classrooms @ 30 santri	

Layer C — Ecological Education (per phase, scheduled)

Grade 10 — Observation

Activity	Description	Space	Space Character
Hydrology introduction	Reading river water patterns, tidal rhythms	Retention Ponds	Outdoor
Ecosystem identification	Mangrove flora-fauna, fish ponds, rice fields	Mangrove area, fish ponds, rice fields	Outdoor
Micro lab introduction	Basic water/soil sample identification	Micro lab	Indoor, lab equipments

Grade 11 — Production Practice

Activity	Description	Space	Space Character
Fish pond management	Feeding, water quality monitoring, harvesting	Fish pond area	Productive outdoor
Rice field management	Planting, tending, harvesting	Rice field area	Productive outdoor
Production Log	Harvest data, ecological journal	Micro lab	Indoor, lab equipments

Grade 12 — Produce Processing

Activity	Description	Space	Space Character
Produce processing	Converting harvests into products (processed fish, rice, goat)	Production kitchen - Micro Lab	Semi Outdoor - Indoor
Ecological economics	Recording production value, distribution to internal canteen	Storage Area - Micro Lab	Indoor
Near-peer teaching	Guiding Grade 10 observation and Grade 11 practice	-	-

Property Size

The determination of spatial dimensions according to the needs of the Islamic boarding school (pondok pesantren) refers to standard design references, including:

LSB (Building Standard Literature): Architect's Data and Time Saver (standards)
SKP (Government Regulatory Standards): Regulations of the Ministry of Education and Culture
AP (Personal Assumption)
The standard size for flow circulation refers to Time Saver for Building Types:
5–10%: Minimum standard
20%: Requirement for circulation flexibility
30%: Requirement for physical comfort

Classroom
The classroom is used for santri (students) to receive instruction from teaching staff (ustadz/ustadzah), covering both general subjects and Islamic religious studies. Based on Regulation of the Minister of National Education of the Republic of Indonesia Number 24 of 2007, the minimum area ratio for a classroom is 2 sqm per student. For a study group with fewer than 15 students, the minimum classroom area is 30 m^2. The minimum width of a classroom is 5 m (Indonesia, 2007).

Layer A — Worship & Daily Life (all grades, every day)

Space	Capacity	Standard	Area	Source	**In Design**
Mosque — prayer hall	180 santri + 59 other residents = 239 persons	1 m^2/person	239 m^2	LSB	**307 m^2**
Wudhu Ablution area	149 ÷ 20 = 8 taps	0.8 m^2/tap	6.4 m^2 x 2 (Male and Female)	LSB	**11m^2 each male and female**
Storage and Service Audio room	-	-	6 m^2	AP	**8.7 m^2**
House of kyai					
Main Bedroom	-	-	12	AP	**14 m^2**
Bedroom	-	-	9	AP	**9 m^2**
Kitchen	-	-	3.2	AP	**3.2**
Toilet	-	-	2	SKP	**2.3 m^2**
Living Room	-	2 m2 / orang + sirkulasi 20% x 4 orang	10	LSB	**11.2**
Mosque Total					**377.4 m^2**

Space	Capacity	Standard	Area	Source	**In Design**
Santri dormitory rooms	90 persons, @4/room = 23 rooms	3 m^2/bed × 4	12 m^2/room	SKP	**15 m^2 each rooms, 1 modul = 4 rooms, total 6 modul = 360 m^2 (each male and female)**
Dormitory bathrooms	90 ÷ 4 = 22 units	2 m^2/unit	44 m^2	SKP	
Communal Learning Space	90 santri	0.16 m^2/person	14 m^2	AP	**19**
Teacher dormitory rooms	10 persons, @2/room = 5 rooms	3 m^2/bed × 2	6 m^2/room	SKP	**15 m^2 each rooms, 1 modul = 4 rooms, total 1 modul = 60 m^2 (each male and female)**
Teacher dormitory bathrooms	90 ÷ 4 = 22 units	2 m^2/unit	44 m^2		
Dormitory Total					**439 m^2 x 2 (male and female) = 878 m^2**

Layer B — Formal MA Education

Space	Capacity	Standard	Area	Source	**In Design**
Classrooms	3 classes × 30 santri	2 m^2/student	3 × 60 m^2 = 180 m^2	SKP / Permendiknas 24/2007	**60 m^2 each classroom x 3 = 360 m^2**
Library	Min. 1 class	Min. 60 m^2, min. width 5 m	60 m^2	SKP	**60 m^2**
Classroom toilets	Male only	1 unit : 4 persons	4 m^2	SKP	**4 m^2 x 2 = 8 m^2**
Teachers' / ustadz room	15 ustadz	4 m^2/person + 20% circulation	60 m^2	LSB	**60 m^2**
Office Administration room	-	-	0 m^2	AP	**60 m^2**
Micro Lab	-	Laboratiorum and Processing	30 m^2		**37 m^2**
School Total					**405 m^2 x 2 (male and female) = 810 m^2**

Sports Field					**125 m^2 x 2 = 250 m^2**

Property Size per Layer

Layer C — Ecological Education

C1 — Observation (Grade 10)

Space	Capacity	Standard	Area	Source	**In Design**
Mangrove Area	-	-	-	Condition	**5.220 m²**
Water Observation Area - Retention Pond	-	-	-	Artificial Pond	**1.000 + 920 + 830 + 850 + 750 = 4.350 m²**

C2 — Production Area (Grade 11)

Space	Capacity	Standard	Area	Source	**In Design**
Fish ponds	30 active santri	Min. functional area per pond unit	400 m^2 (2 plots)	AP	**780 m²**
Rice field area	30 active santri	Min. functional area per pond unit	300 m^2	AP	**750 + 825 = 1.575 m²**

C3 — Produce Processing Area (Grade 12)

Space	Capacity	Standard	Area	Source	In Design
Product processing room - Storage	_	_	_	_	Micro Lab in School Area

Total Spatial Programme Recap

Layers	Sub Total Area	Total Area
A — Worship & Daily Life	Mosque 377.4 m^2 + Dormitory 878 m^2 + Sports field 250 m^2	1.505,4 m^2
B — Formal MA Education	School 810 m^2	810 m^2
C — Ecological Education	Mangrove area 5.220 m^2 + Retention pond 4.350 m^2 + Fish ponds 780 m^2 + Rice field area 1.575 m^2	11.925 m^2
Total		**14.240,4 m^2**

Daily Learning Flow — Three Grades in One Day

Time	Grade X — Observation	Grade XI — Production practice	Grade XII — Produce processing
04-05 dawn	**5 daily prayers** Mosque, all grades together		
05-06	**Qur'anic recitation, tahfidz** Mosque, all grades together		
06-07	**Physical exercise** Sports field, all grades together		
07-08	**Bathing + eat** Bathroom + dining room, all grades		
08-11 morning	**Formal MA education** Classroom, compulsory subjects	**Formal MA education** Classroom, compulsory + elective subjects	**Formal MA education** Classroom, compulsory + elective subjects
11-12	**5 daily prayers + eat** Mosque + dining room, all grades		
13-15 afternoon	**Formal MA education** Classroom, session 2, compulsory subjects	**Formal MA education** Classroom, session 2, elective subjects	**Produce processing** Production kitchen + micro lab
15-16	**5 daily prayers** Mosque, all grades		
16-17 ecology	**Observation** Hydrology introduction, ecosystem identification, micro lab introduction	**Production practice** Fish pond management, rice field management, production log	**Ecological economics** Storage area + micro lab, near-peer teaching
17-18	**Eat** Dining room, all grades		
18-19	**5 daily prayers + Qur'anic recitation** Mosque, all grades		
19-20	**Communal learning space** Dormitory, all grades		
20-04	**Sleep and rest** Dormitory room		

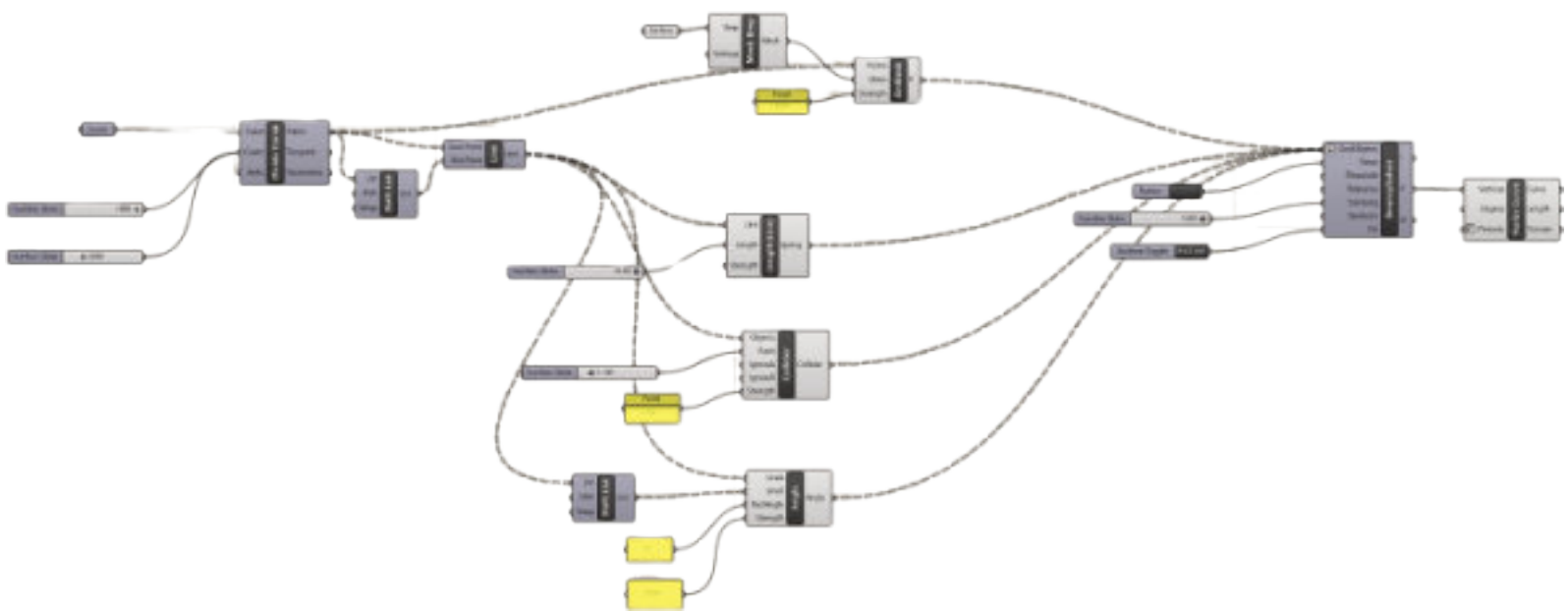
Curriculum Evaluation / Validation

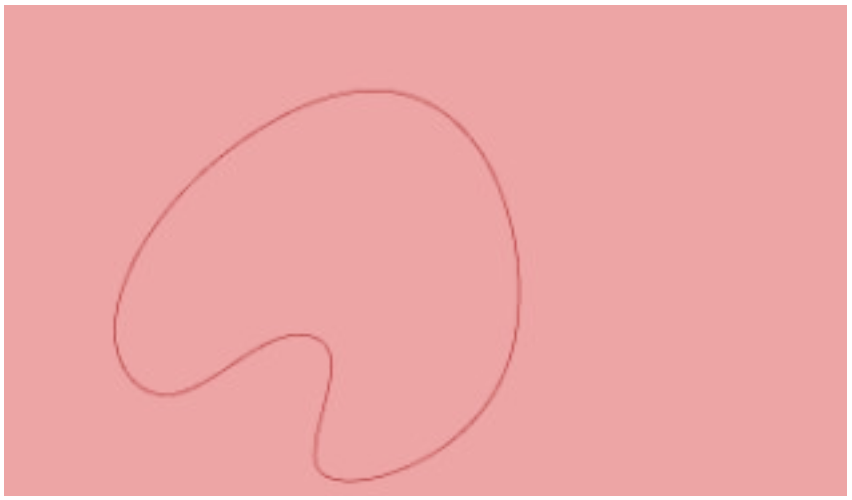
Curricular Activity	Required Space	Status	Notes
5 daily prayers (90+ persons)	Mosque 162 m^2	✓	Standard 1 m^2/person
Qur'anic recitation / Tahfidz	Mosque + Terrace	✓	
Morning physical exercise	Sports field 270 m^2	✓	Standard 3 m^2/santri
Sleep & rest	Dormitory 12 rooms	✓	3 m^2/bed
Independent study / free time	Dormitory communal room	✓	
Formal MA — classrooms	3 classrooms @60 m^2	✓	Permendiknas standard
Library & reference	60 m^2	✓	Permendiknas standard
Water observation (Grade 10)	Retention Pond Artificial	✓	
Mangrove observation (Grade 10)	Mangrove area + Corridor	✓	
Fish pond practice (Grade 11)		✓	
Rice field practice (Grade 11)		✓	

ANALYSIS RESPOND AND SCHEMATIC

04

Design Exploration



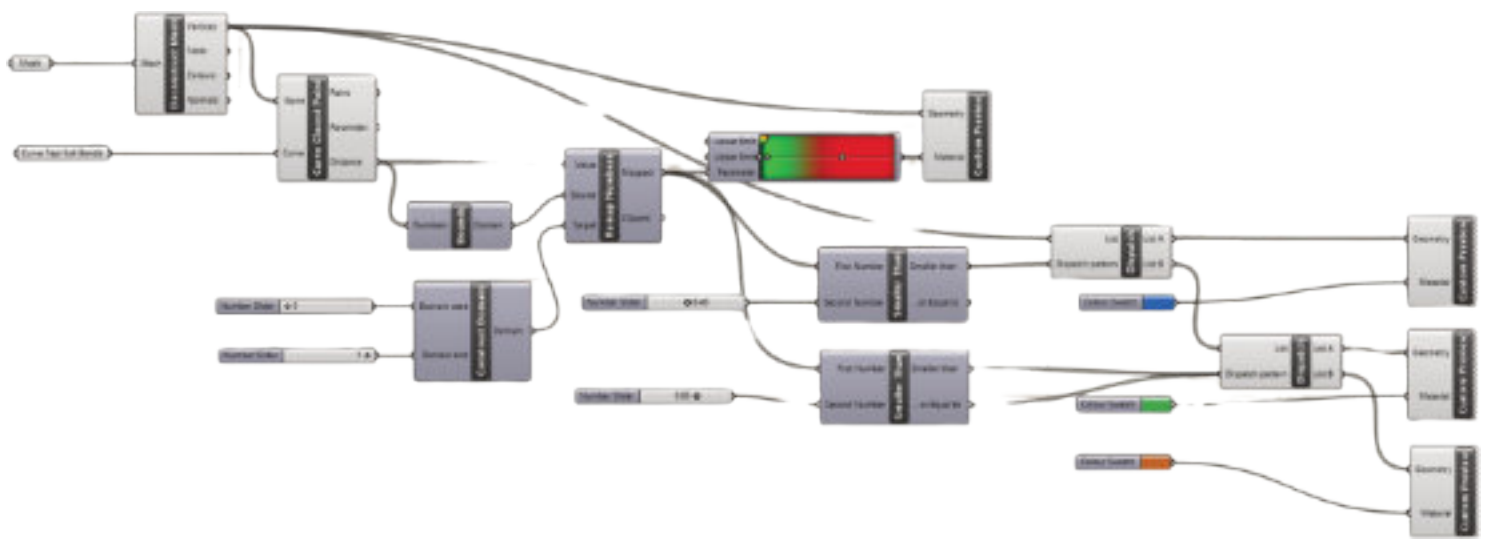


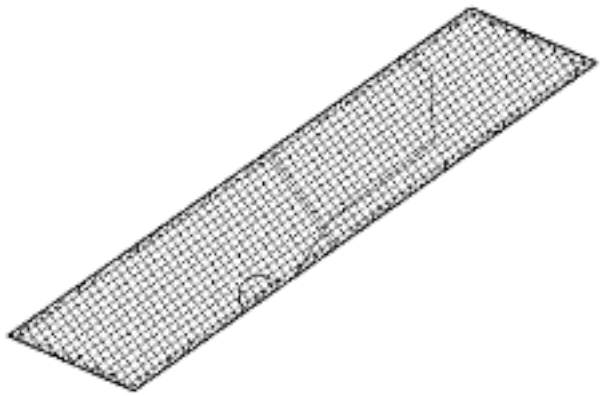
Result of Exploration 1 with Kangaroo

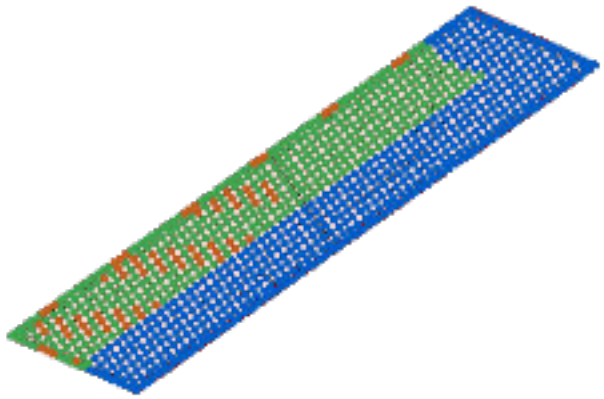
The landscape pattern is generated from an organic form; the target moves smoothly within the site boundaries and produces a pattern, which then fills the zones of sponge architecture.

Exploration of Site Variations

By using Computational and Parametricism



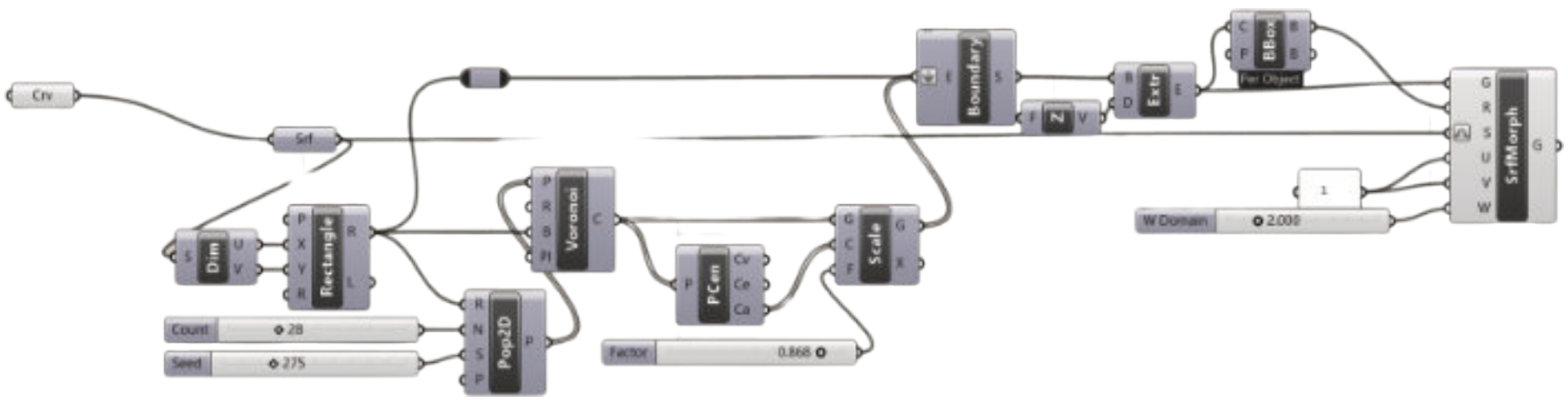


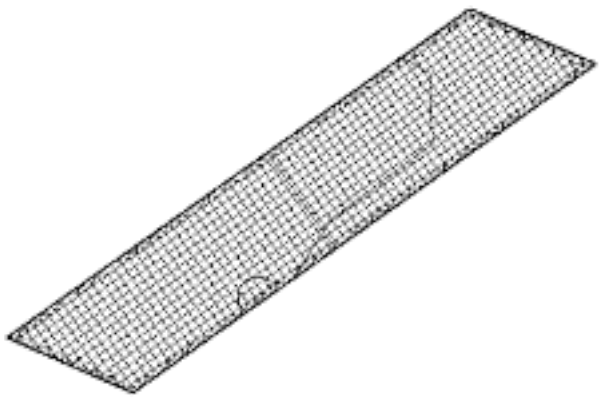


Result of Exploration 2 with Distance-Based Field

The boundaries between zones are determined and generated from a distance gradient relative to Kali Bendo (Bendo River). The closer to the river, the higher the water pressure, and the wider the absorption zone. Water becomes the spatial generator that determines the organization of the site.

Design Exploration

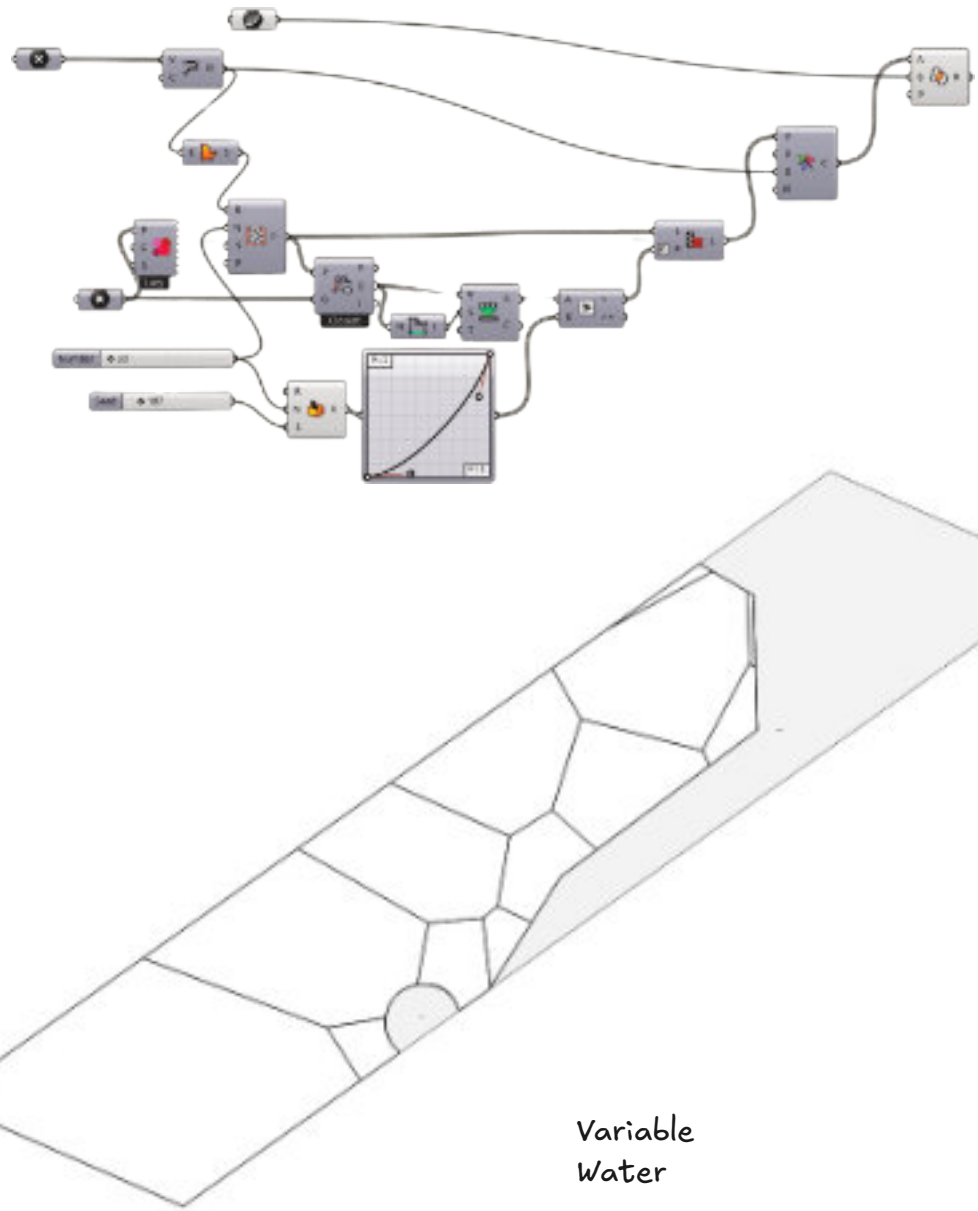




Result of Exploration 3 with Voronoi

The landscape pattern is generated through the engineering of water from Kali Bendo (Bendo River).

The objective is to estimate the channel of water entering the site as a basis for water engineering design.



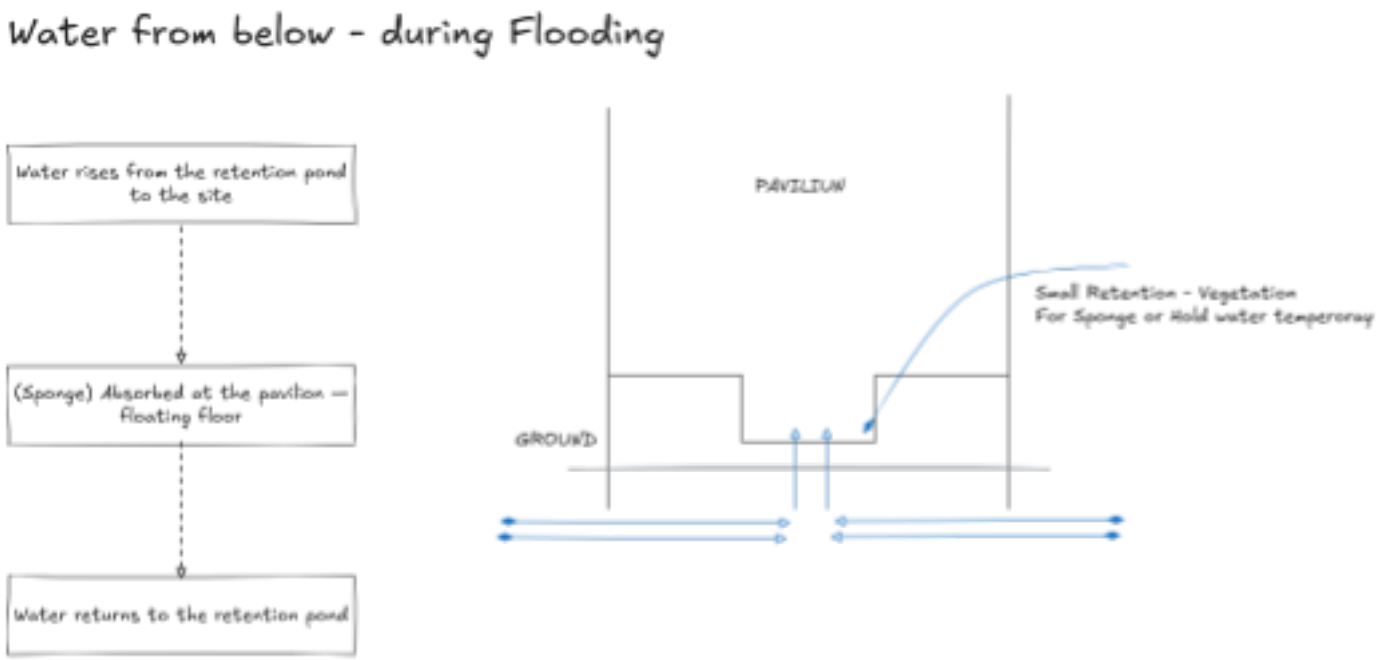
Exploration 4 Results with Voronoi
Water Engineering

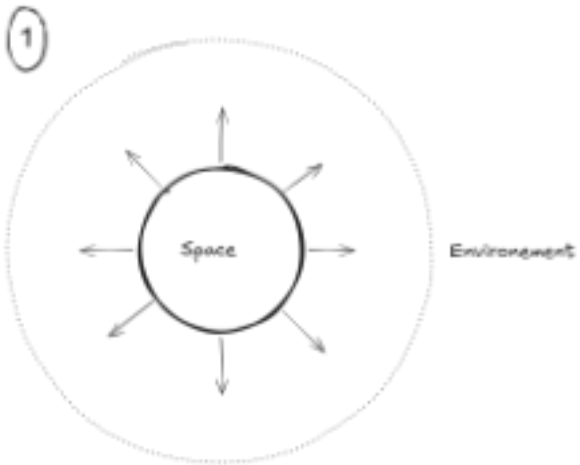
Variable
Water

Parameter
Points closer to water are more susceptible to flooding

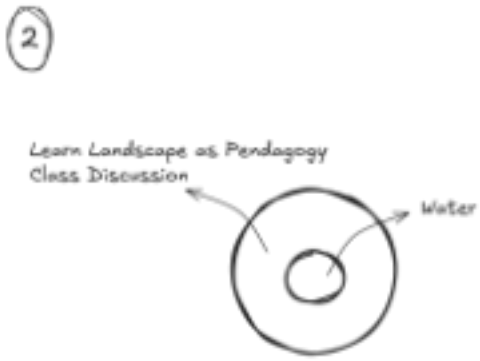
Indicator
The resulting Voronoi pattern shows denser cell distribution near the water edge compared to areas further from it

Design Exploration - Respond Water





Looking in all directions to learn from the surrounding environment.

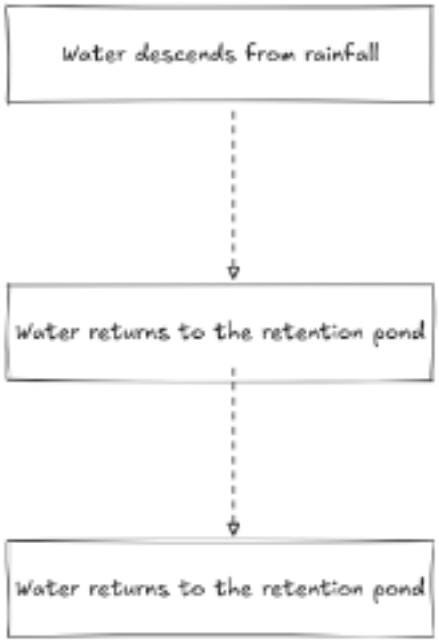


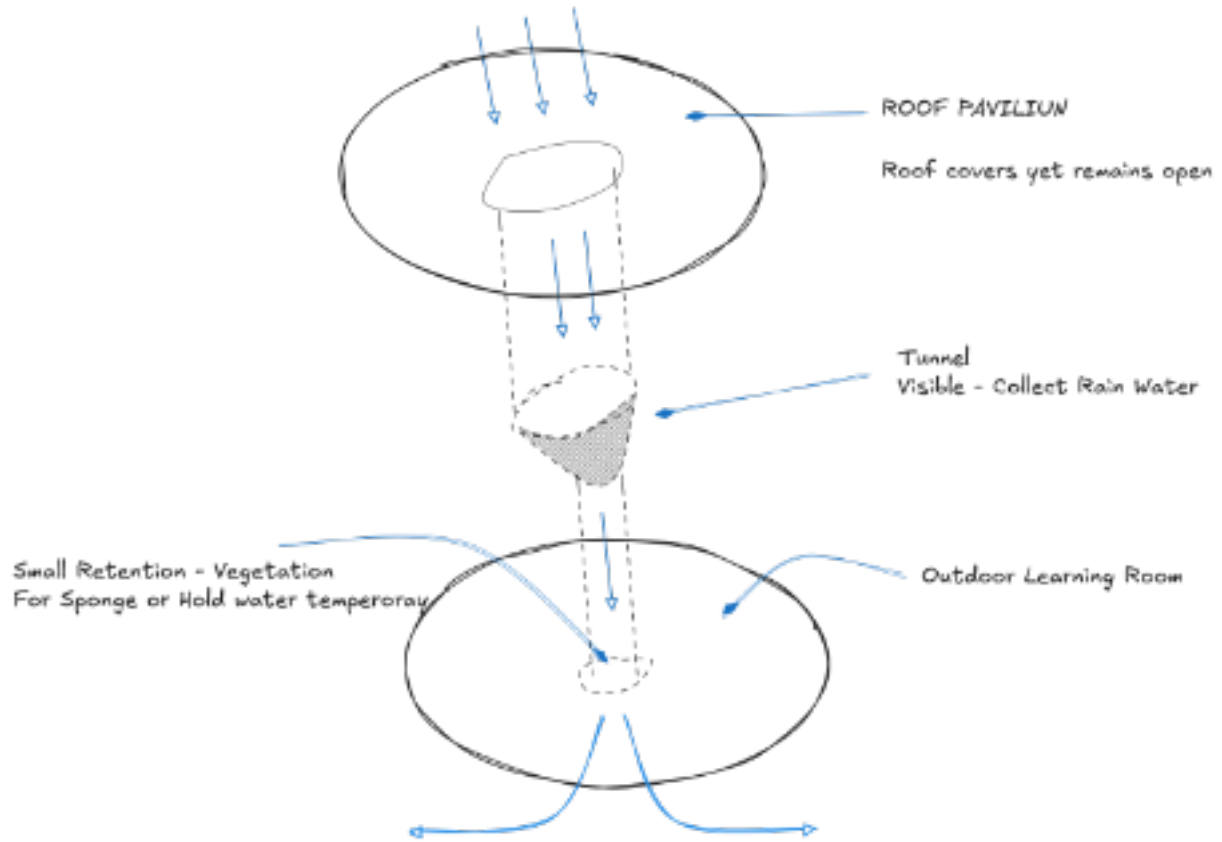
What kind of structure makes people feel they are within the ecology, rather than observing it from the outside?
- Openings facing all directions to learn by directly observing the environment
- A roof that shelters without walls
- A roof that shelters without blocking sunlight

Water Scheme at the Pavilion

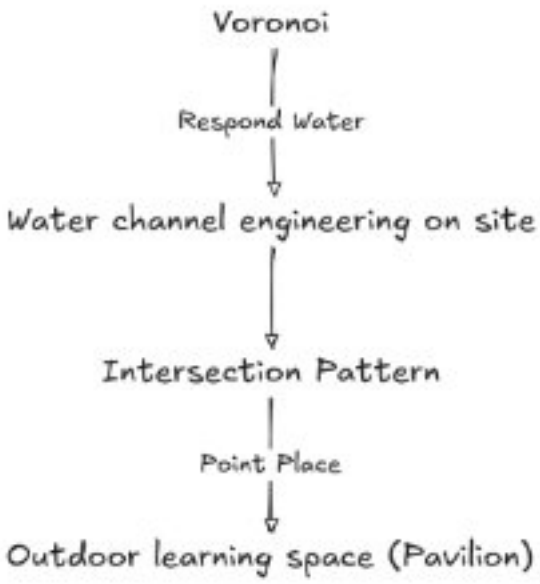
Water from above during Normal Conditions — Rain

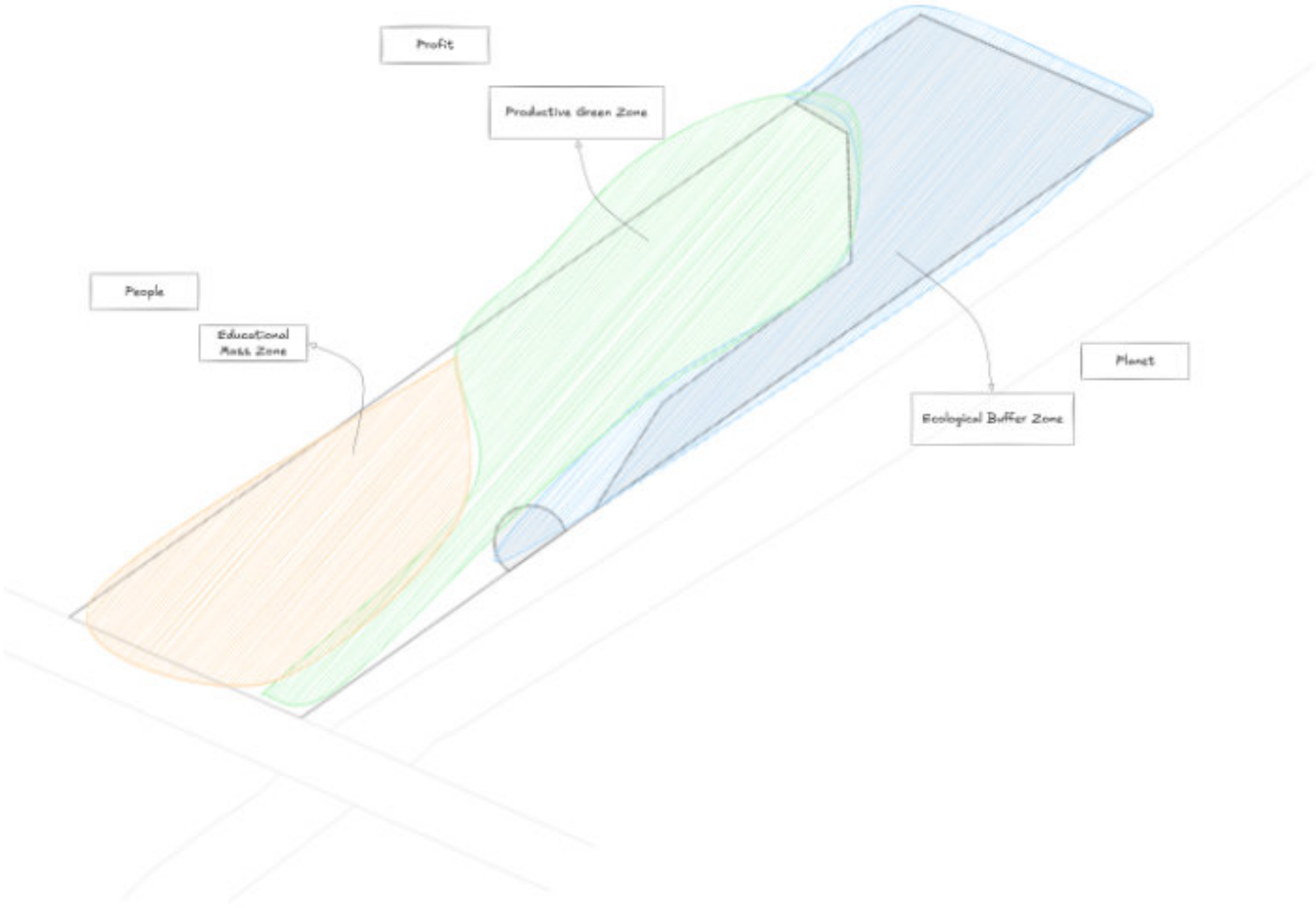
Thus, water does not rise and there is no inflow movement, so rainwater is drawn from above.



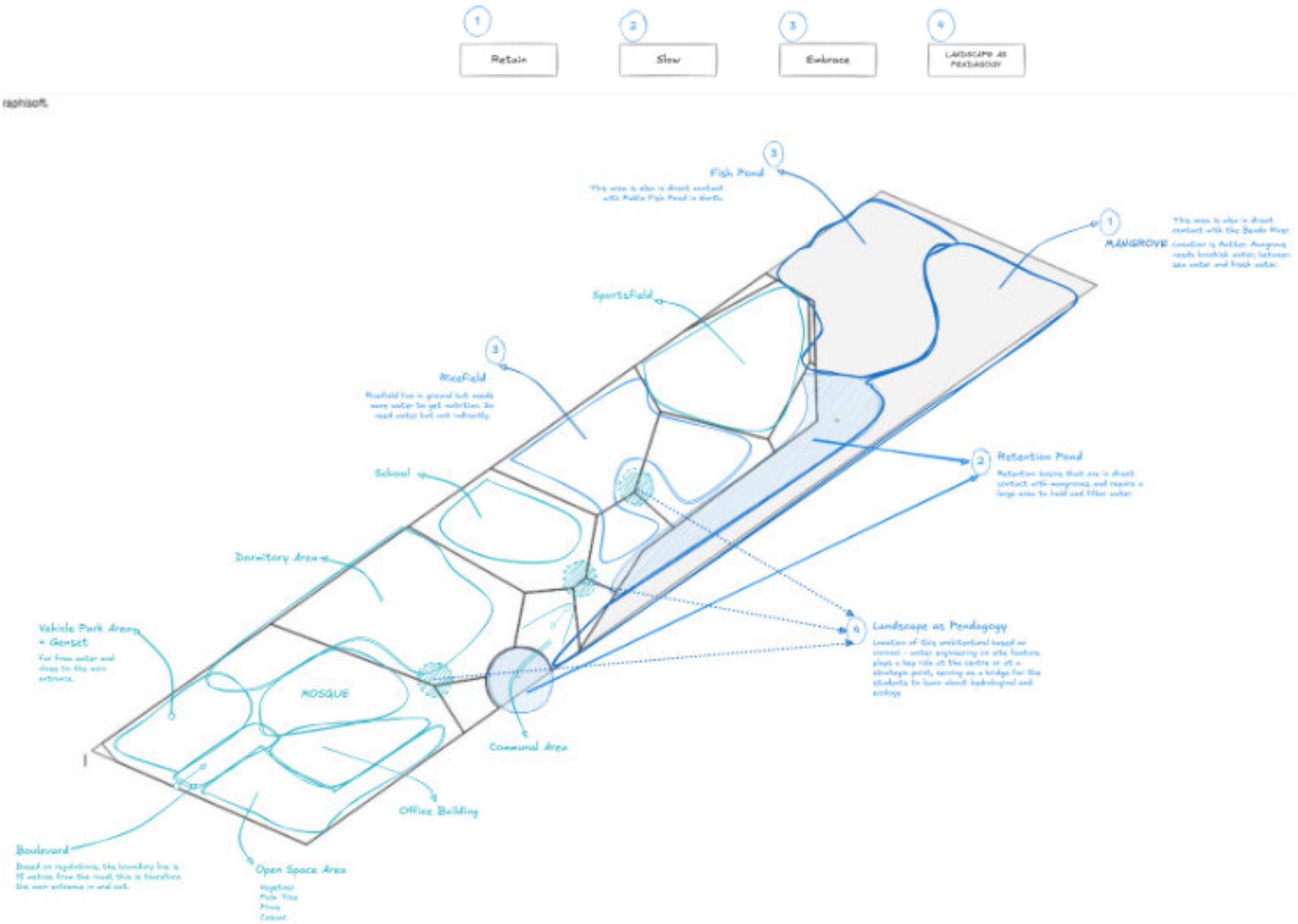


Design Exploration - Sketch

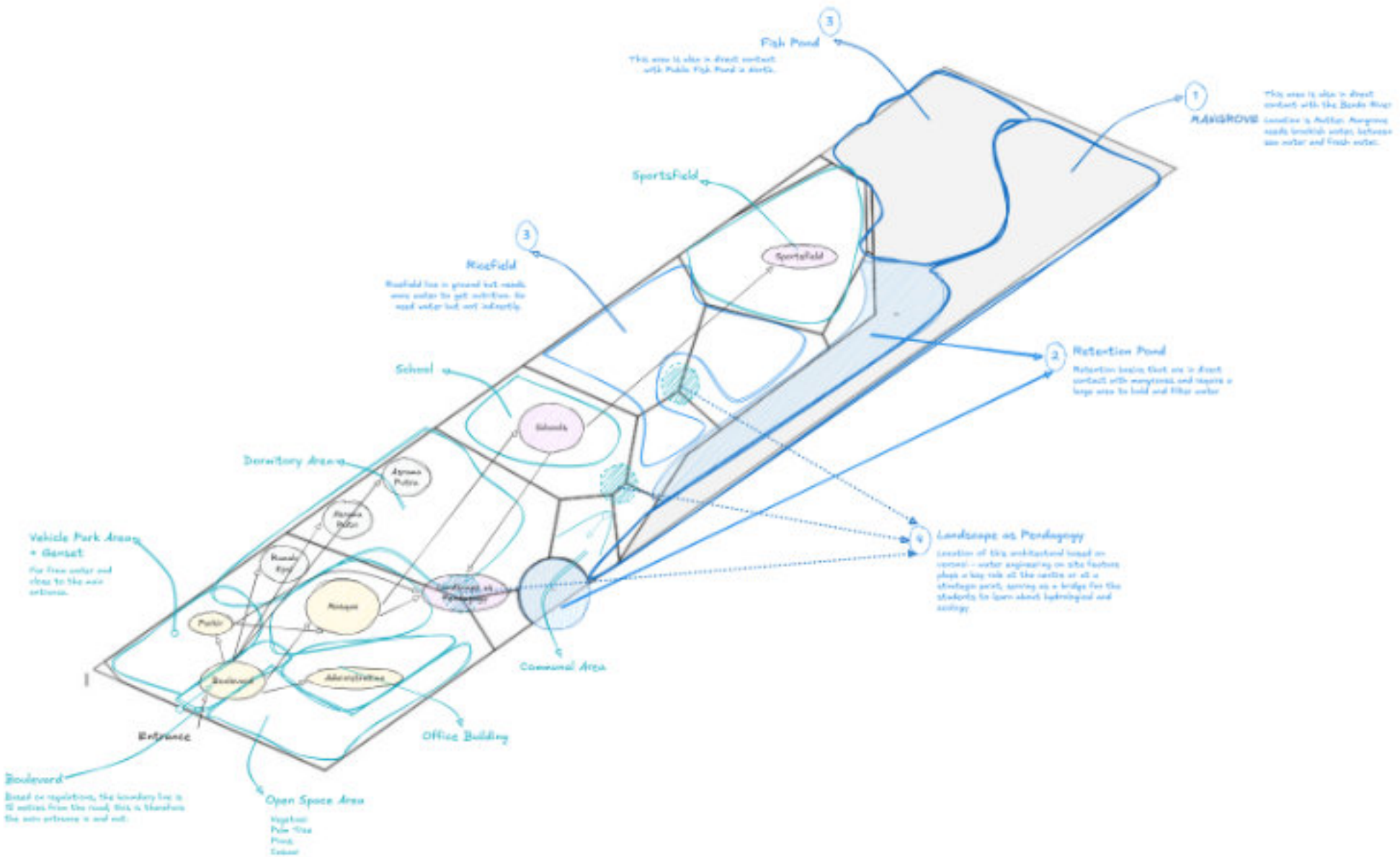



Profit
Productive Green Zone
People
Educational
Mass Zone
Planet
Ecological Buffer Zone

Design Exploration - Sketch

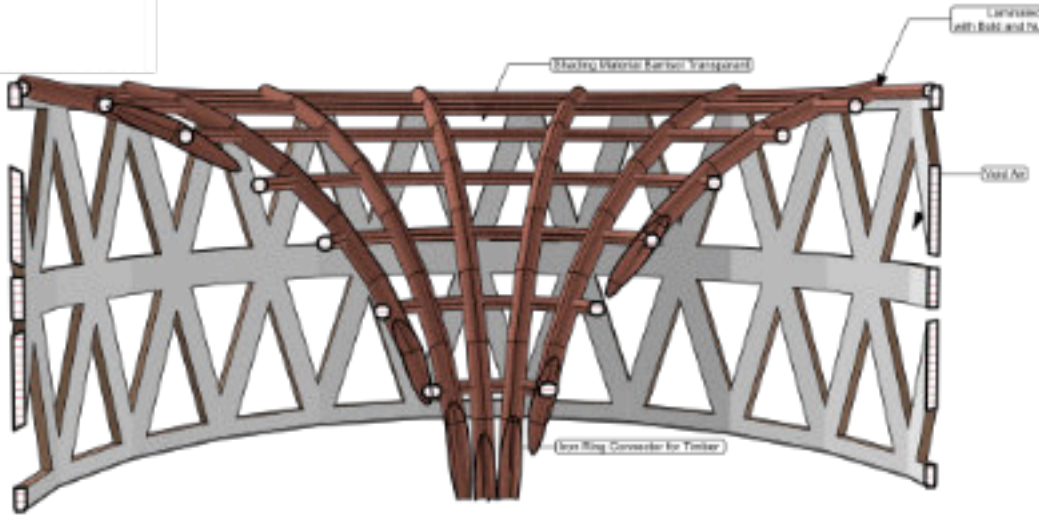



1
Retain
2
Slow
3
Embrace
4

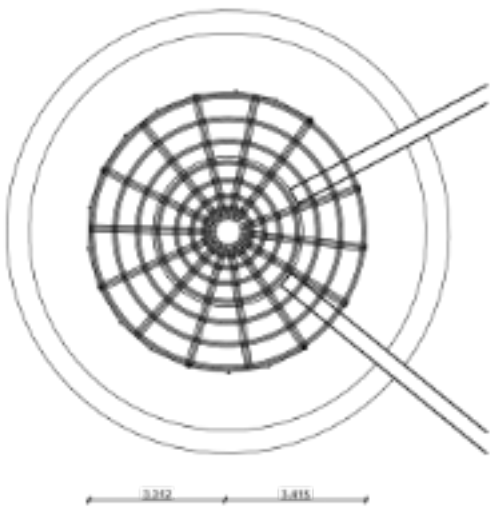

3
Fish Pond
This area is also in direct contact with Public Fish Pond in Kerto.
1
MANGROVE
This area is also in direct contact with the Bondo River
SportsField
Sportsfield
3
Ricefield
Ricefield has a ground but needs more water to get nutrition. So need water but not directly
2
Retention Pond
Retention basin that are in direct contact with mangroves and require a large area to hold and filter water
School
Schools
Dormitory Area
Asrama Putra
Asrama Putri
Vehicle Park Area + Genset
For free water and close to the main entrance.
Rumah Kyai
Mosque
Landscape as Pendagogy
Putri
Boulevard
Administration
4
Landscape as Pendagogy
Location of this architectural based on context - water engineering on site feature plays a key role at the centre or at a strategic point, serving as a bridge for the students to learn about hydrological and ecology
Communal Area
Entrance
Office Building
Boulevard
Based on regulations, the boundary line is 15 meters from the road, this is therefore the main entrance in and out.
Open Space Area
Vegetasi
Pole Tree
Plants
Cabaret

Design Schematic

3D Pavilion



3D Pavilion Section



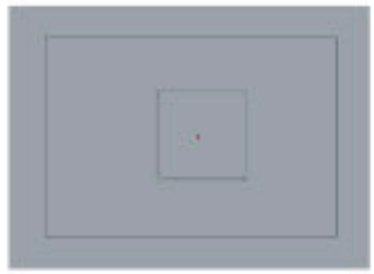
Pavilion Plan
1:100

1

Windows
Dormitory
Needs Privacy
anfd also
respond solar
exposure

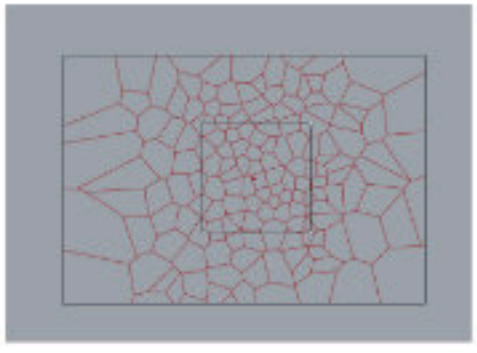
Building Envelope

2



Vorcnoi -
Point
Attracttor

3

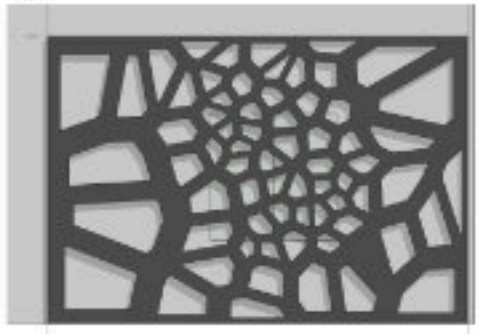


Variable
Solar Exposure and Privacy

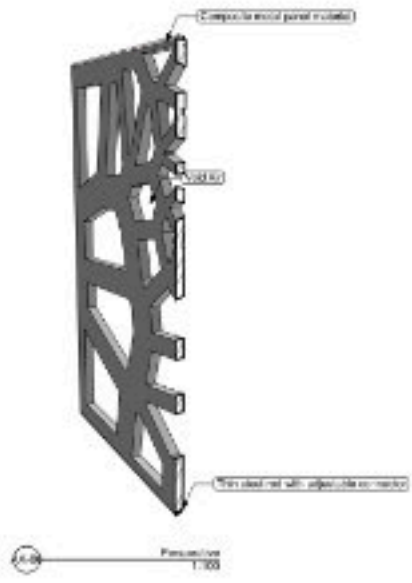
Parameter
Points closer to the facade are more susceptible to solar exposure and require a higher degree of privacy

Indicator
The resulting Voronoi pattern shows denser cell distribution in areas with greater solar exposure and higher privacy requirements compared to areas further from the facade

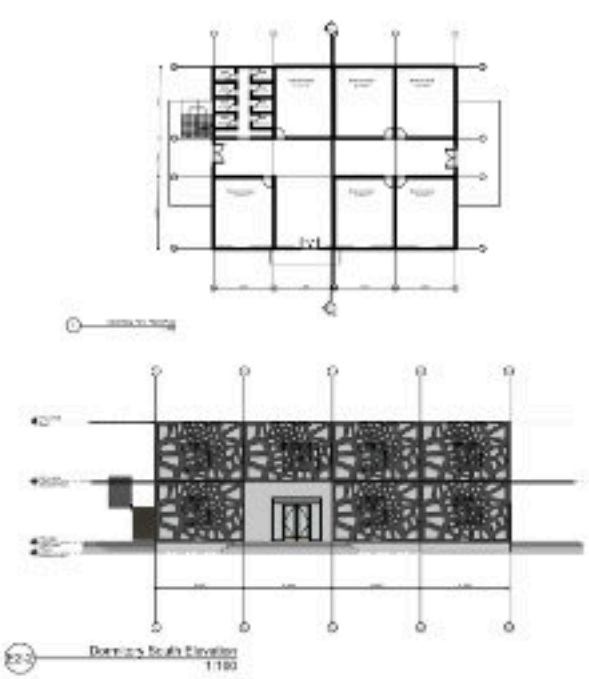
4

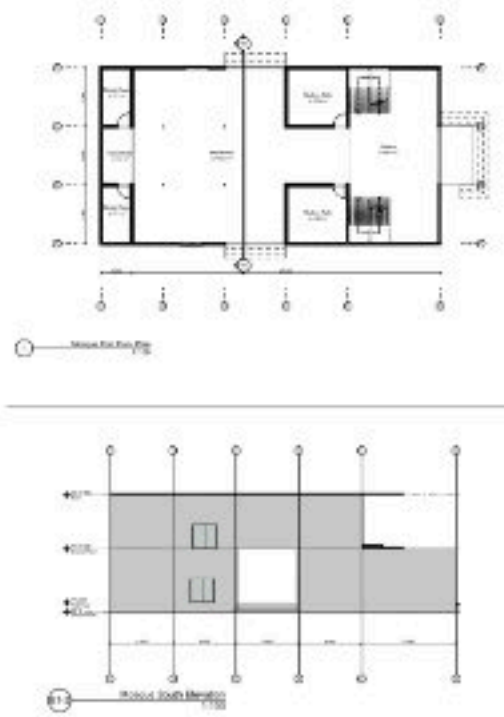


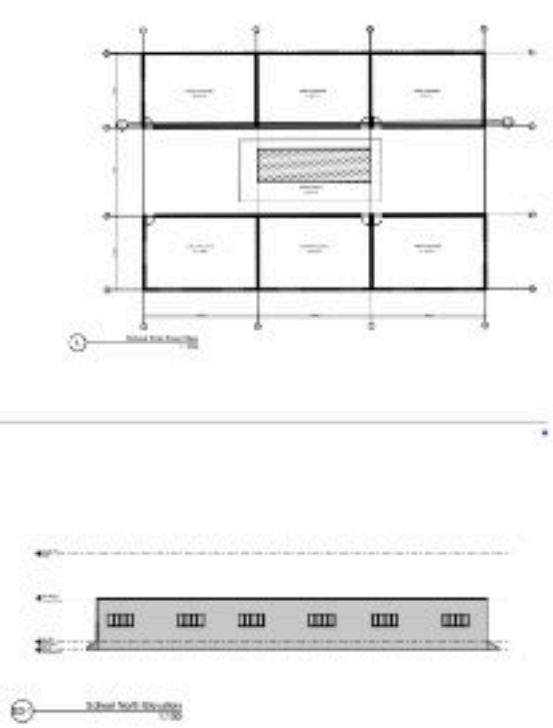
Result
Exploration -
Application on
windows

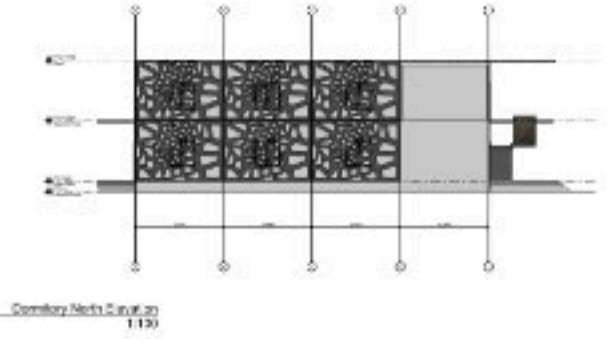


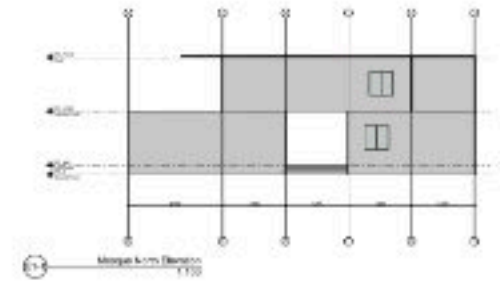
Design Schematic



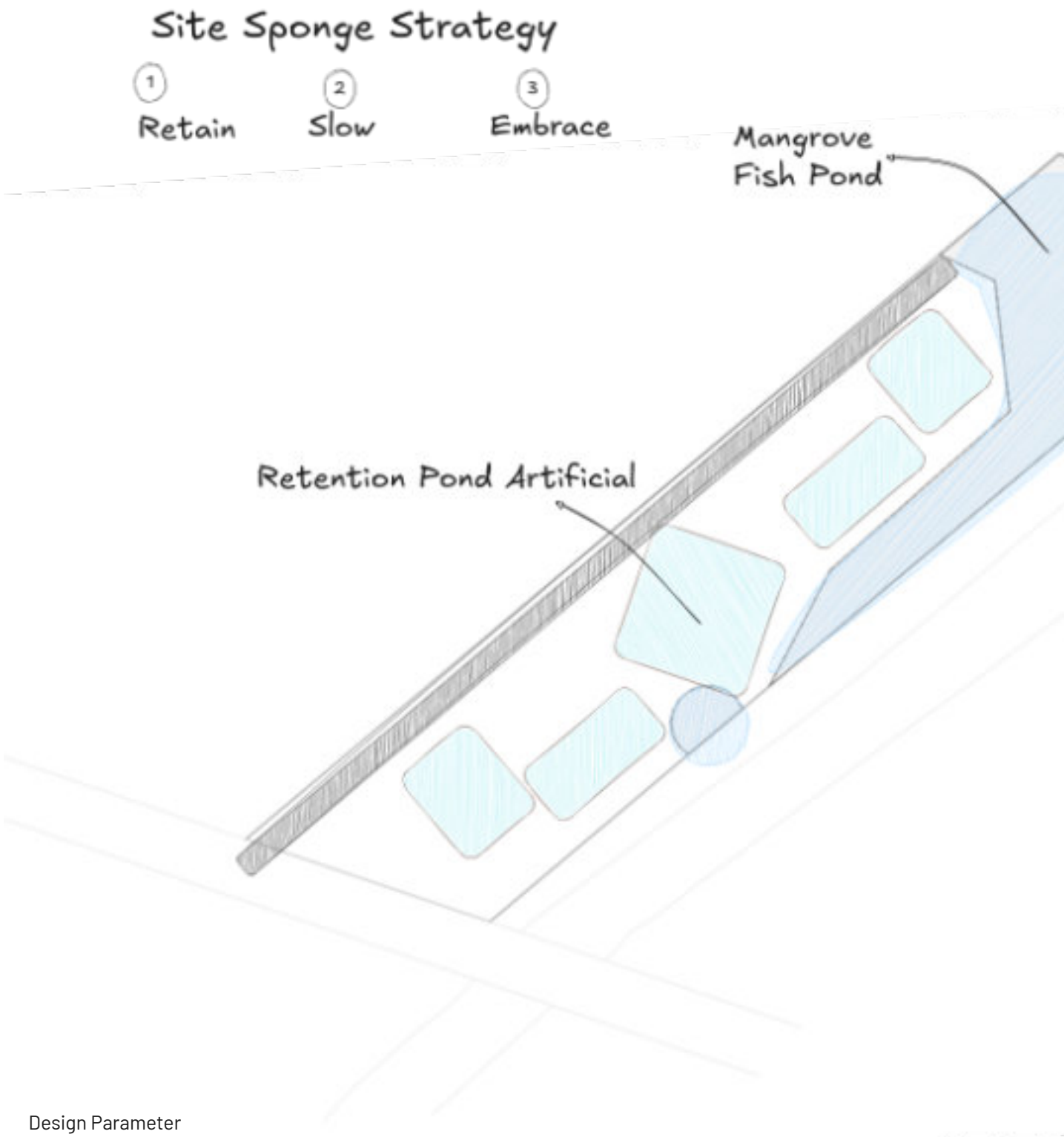








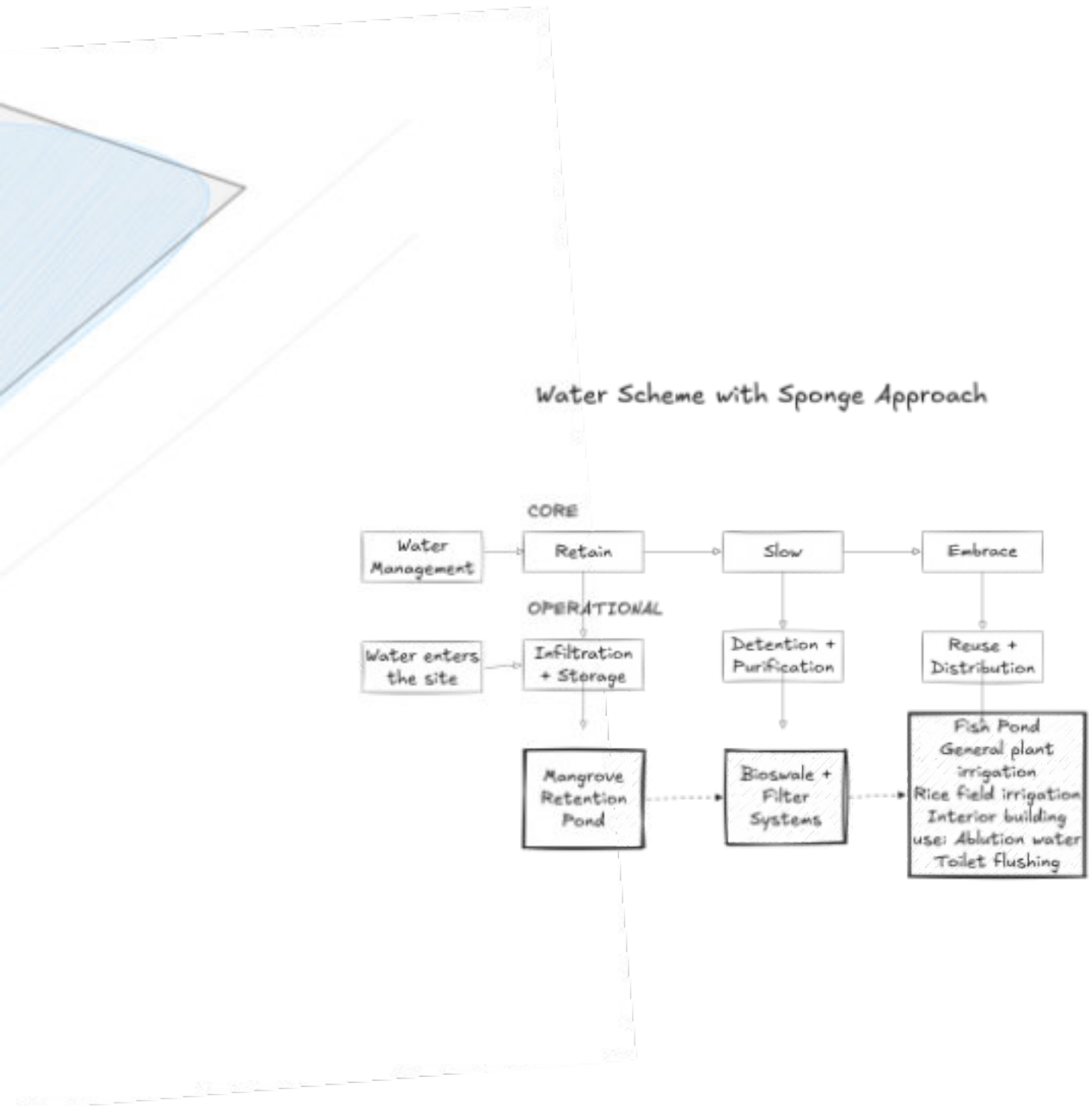
Design Exploration into Development - Site



Design Variable
Water Management

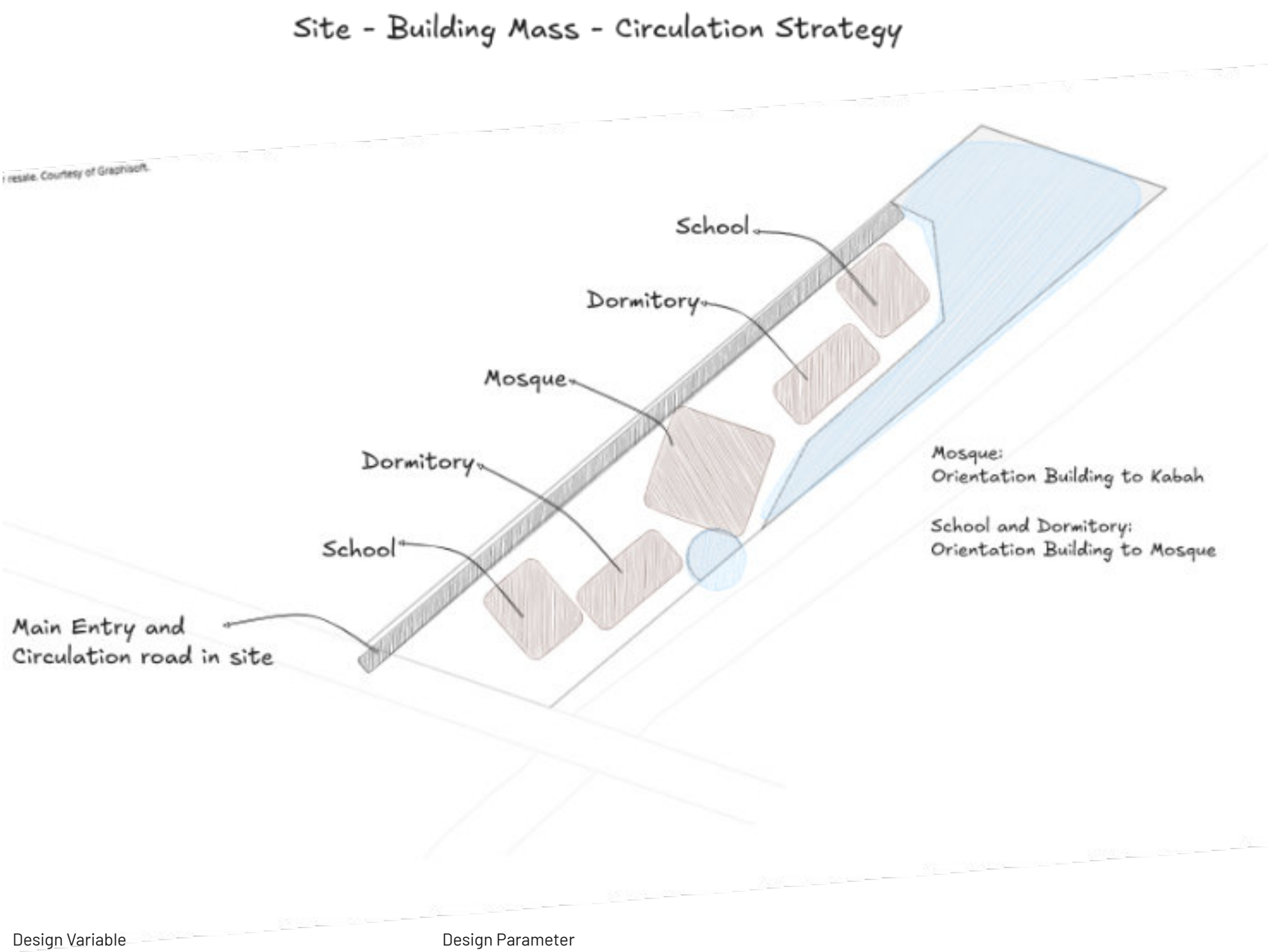
Design Parameter
- **Retention system capacity designed to accommodate average tidal flood discharge of Kali Bendo River**
- **Retention pond volume calculation based on Meteoblue climate data**
- Documented Water flow schme
- **Create Artificial Retentian Pond**
- Documented water recycling on site plan

Design Exploration into Development - Site



The site water management strategy is implemented through the retain-slow-embrace principle, in which constructed retention ponds and mangrove areas accommodate the tidal discharge of the Bendo River amounting to 9,000 m^3

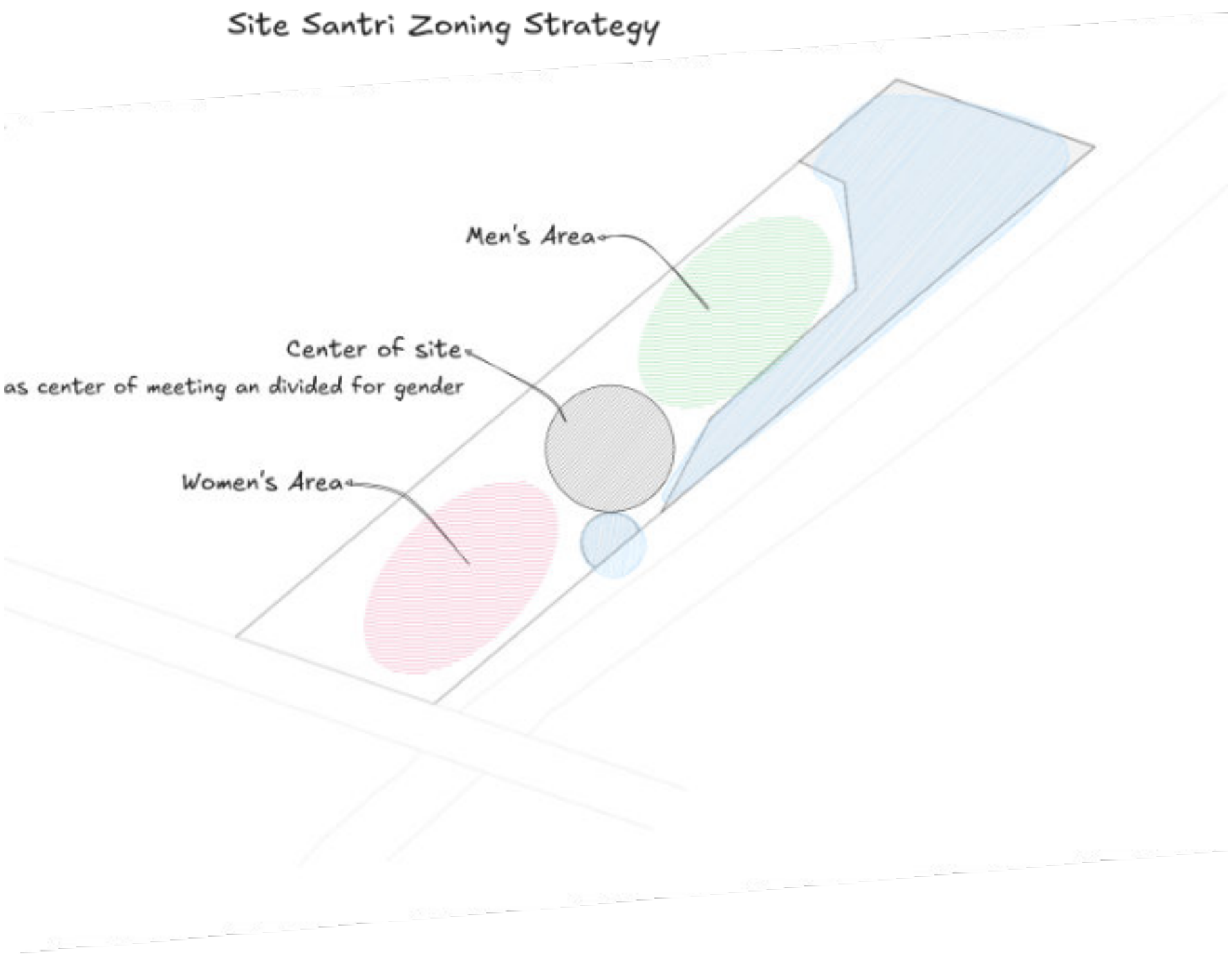
Design Exploration into Development - Site



Design Variable
Passive Design Strategy

Design Parameter
- Documented energy flow scheme
- Shading building by design form specially dirmitory
- Natural daylighting through courtyard configuration
- **Building mass orientation along kakbah axis and others to mosque axis**
- Material structure sustuinable for water contextual

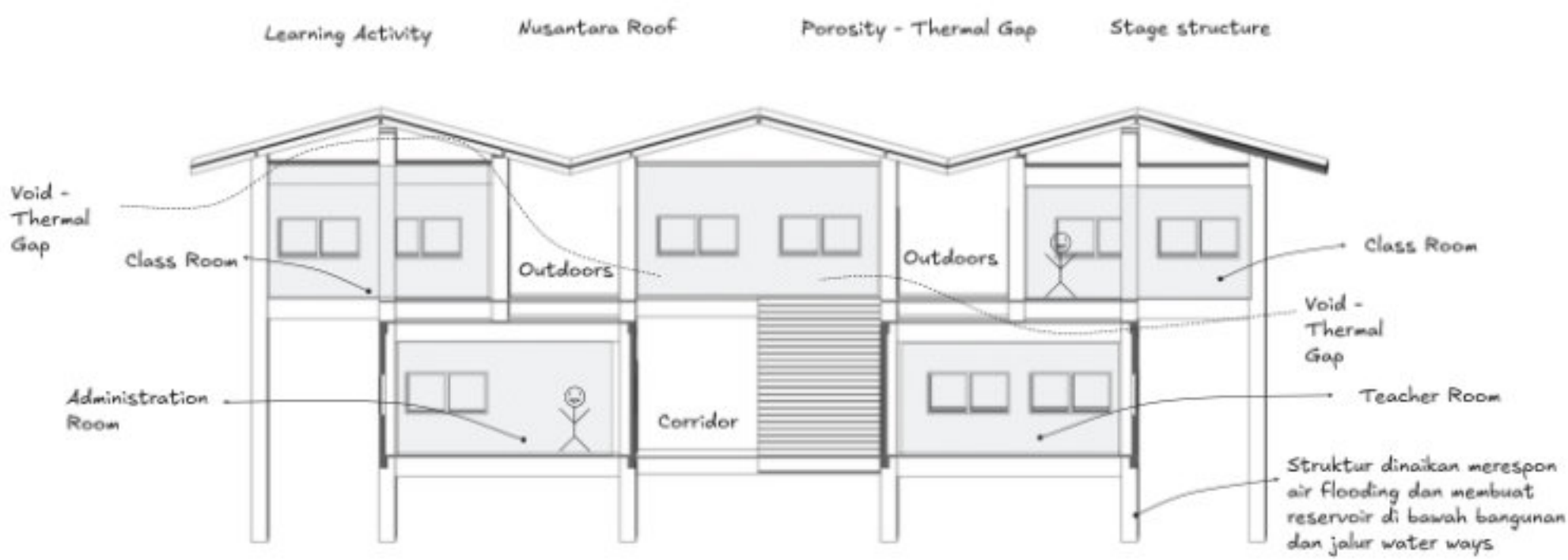
Design Exploration into Development - Building Mosque



The arrangement of mass and site circulation is oriented toward the mosque facing the qibla as the main node, with the dormitory and school oriented toward the mosque along the site's main circulation path.

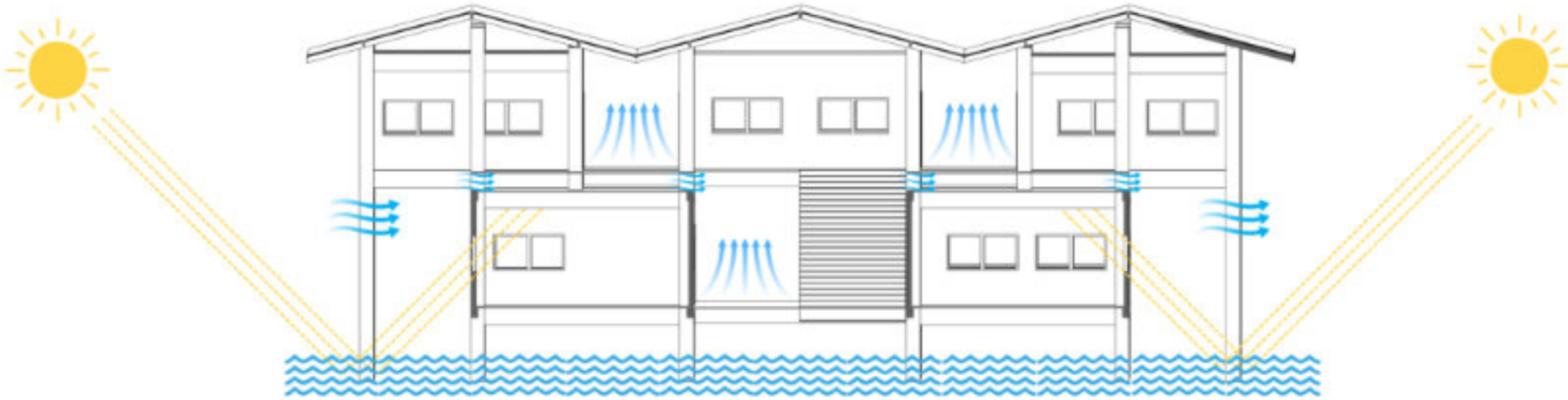
The zoning of santri is then divided based on gender, with the center of the site functioning as a shared meeting point, spatially separating the male and female areas while remaining connected through the mosque's assembly space as the center of site.

Design Exploration into Development - Building School



Design Variable
Passive Design Strategy

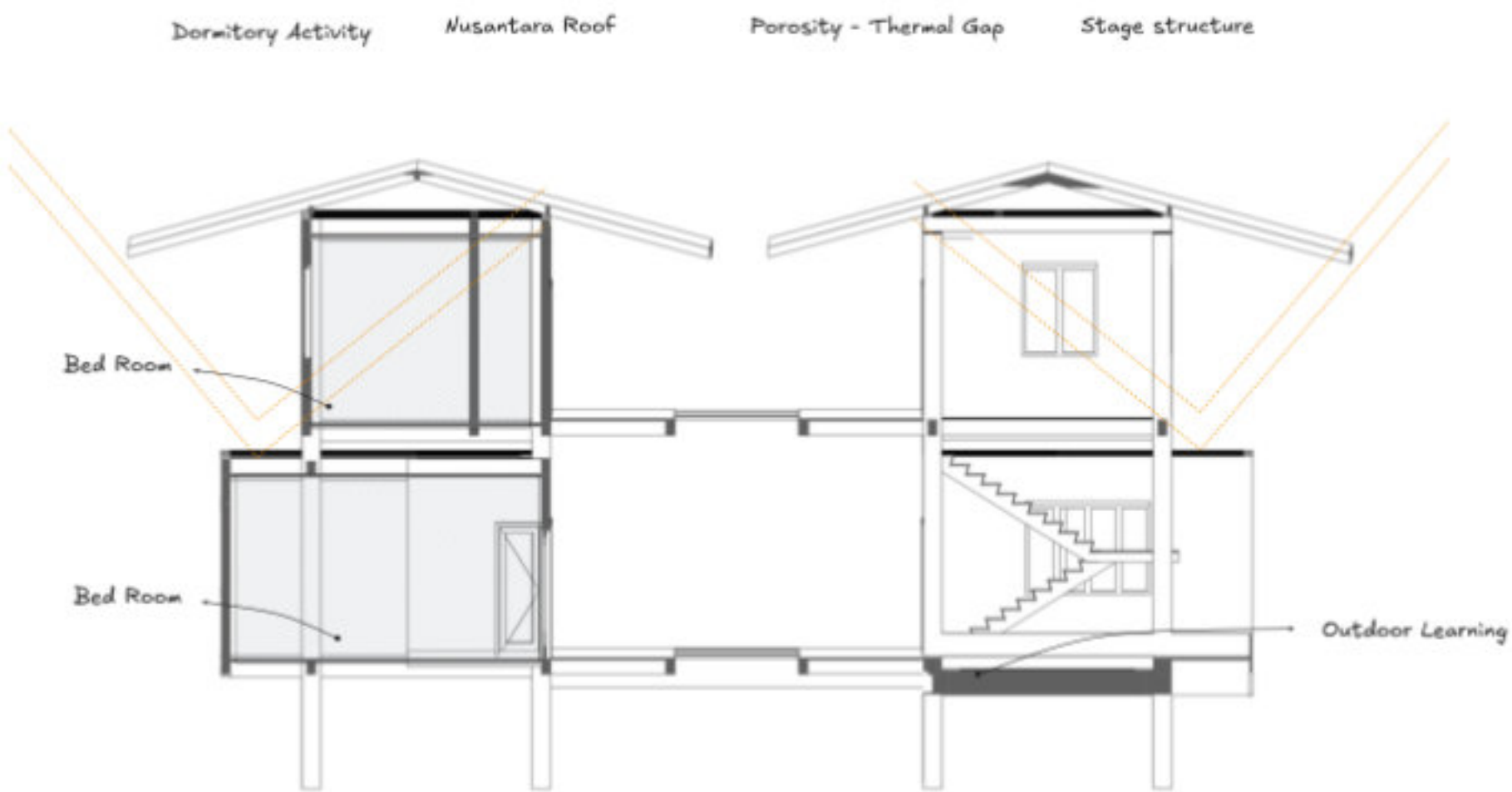
Design Parameter
- **Documented energy flow scheme**
- **Shading building by design form specially dirmitory**
- **Natural daylighting through courtyard configuration**
- Building mass orientation along kakbah axis and others to mosque axis
- **Material structure sustuinable for water contextual**



Each building typology on the site applies a consistent passive design strategy through three main elements: the Nusantara roof as a response to the tropical climate, porosity gaps as a thermal gap, and the elevated structure as an adaptation to the waterlogged site condition.

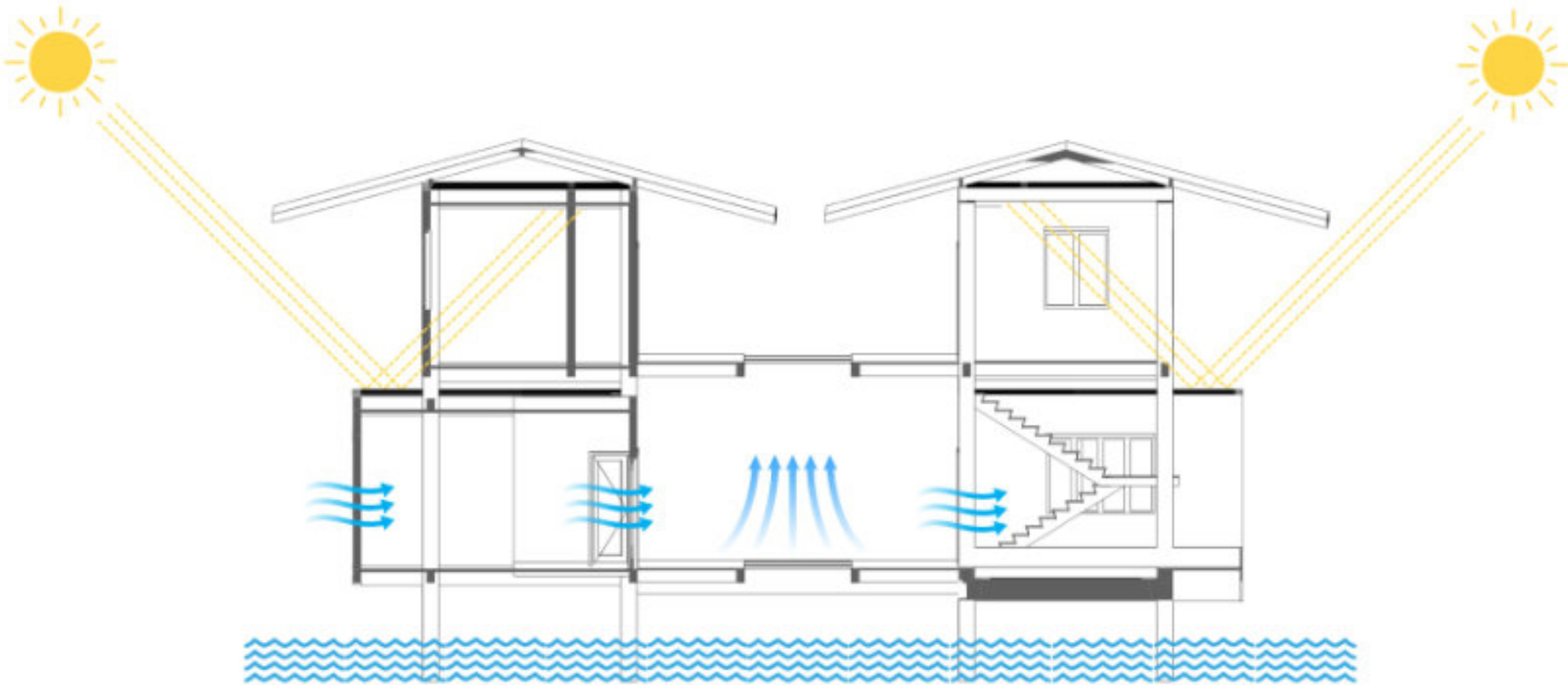
In the school building, a double roof with a thermal gap void between the classroom masses allows hot air to rise and exit naturally, while the stilt structure is elevated to respond to potential flooding and simultaneously forms a water reservoir beneath the building connected to the site's waterway paths.

Design Exploration into Development - Building Dormitory



Design Variable
Passive Design Strategy

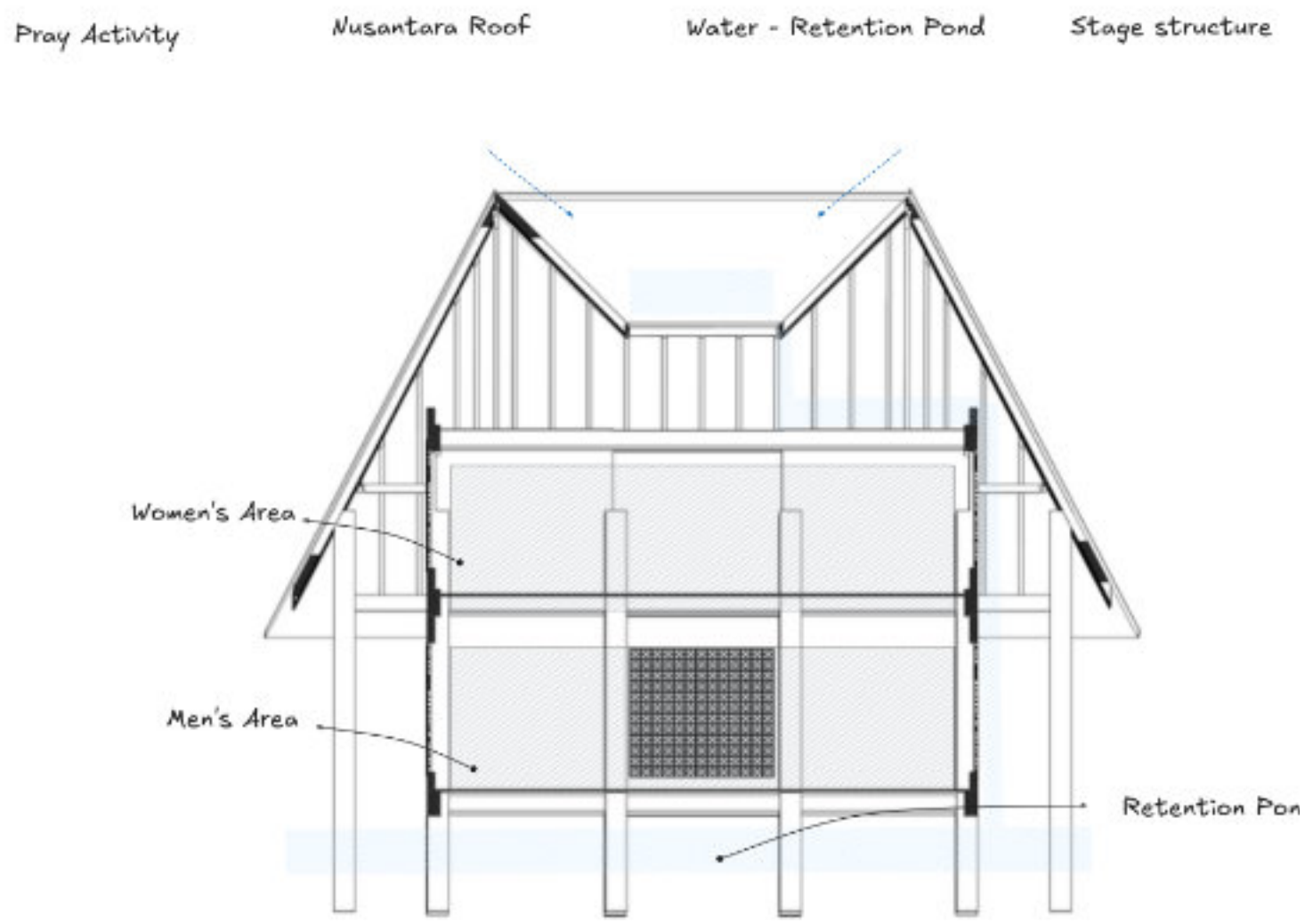
Design Parameter
- **Documented energy flow scheme**
- **Shading building by design form specially dirmitory**
- **Natural daylighting through courtyard configuration**
- Building mass orientation along kakbah axis and others to mosque axis
- **Material structure sustuinable for water contextual**



Each building typology on the site applies a consistent passive design strategy through three main elements: the Nusantara roof as a response to the tropical climate, porosity gaps as a thermal gap, and the elevated structure as an adaptation to the waterlogged site condition.

In the dormitory building, windows on the outer walls of the bedrooms are combined with thermal gap openings between two bedroom masses to create cross ventilation, while the orientation of the openings is directed away from the direct angle of sun incidence as a passive shading strategy.

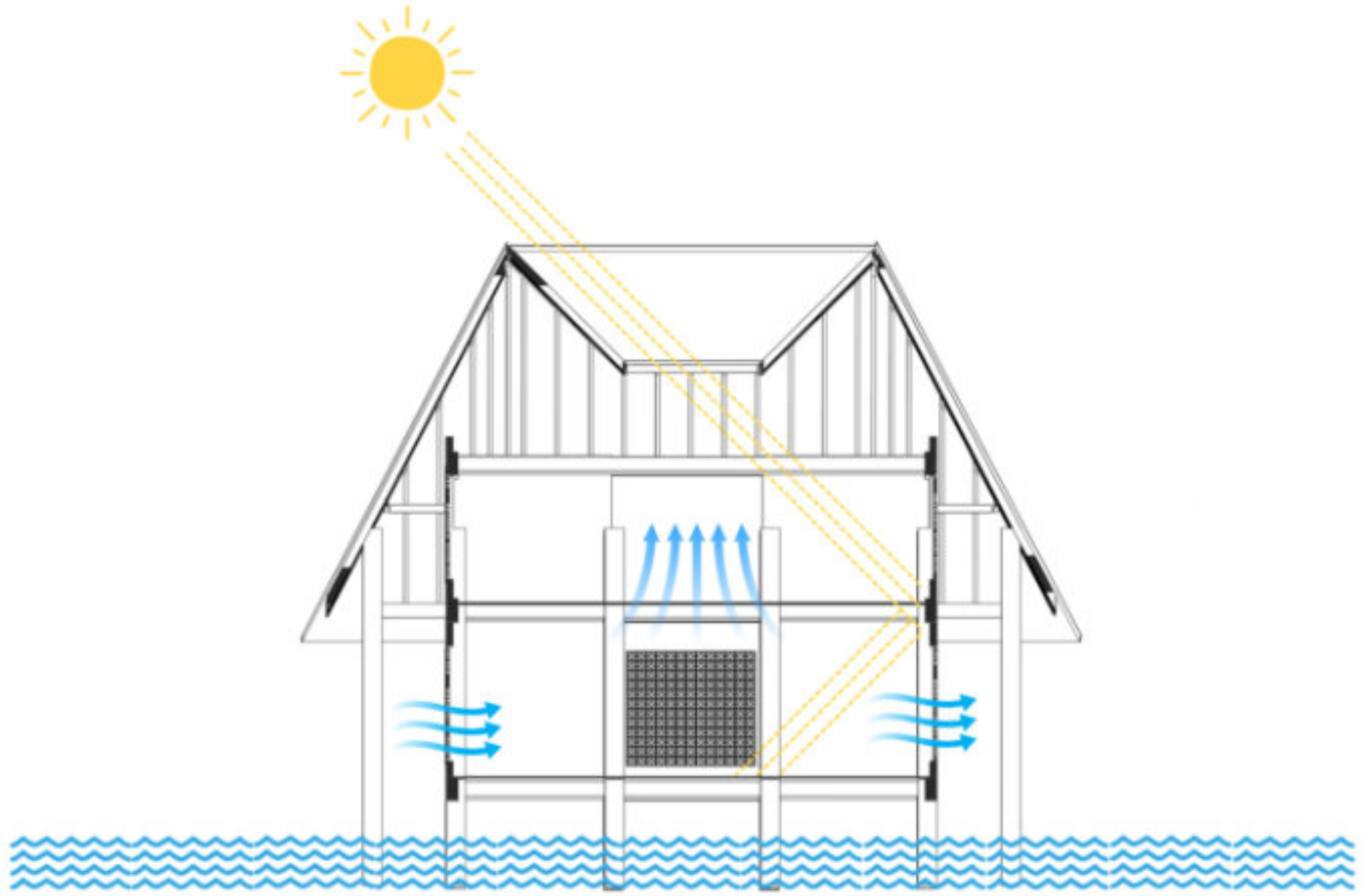
Design Exploration into Development - Building Mosque



Design Variable
Passive Design Strategy

Design Parameter

- **Documented energy flow scheme**
- **Shading building by design form specially dirmitory**
- **Natural daylighting through courtyard configuration**
- Building mass orientation along kakbah axis and others to mosque axis
- **Material structure sustuinable for water contextual**



Each building typology on the site applies a consistent passive design strategy through three main elements: the Nusantara roof as a response to the tropical climate, porosity gaps as a thermal gap, and the elevated structure as an adaptation to the waterlogged site condition.

In the mosque building, the orientation of the mass follows the qibla axis as well as the axis of the other buildings on the site, with the retention pond placed directly beneath the prayer hall as a passive cooling element through evaporation, and the lattice (kisi-kisi) wall separating the male and female areas functions dually as a natural light filter and a vertical air circulation path toward the roof void.

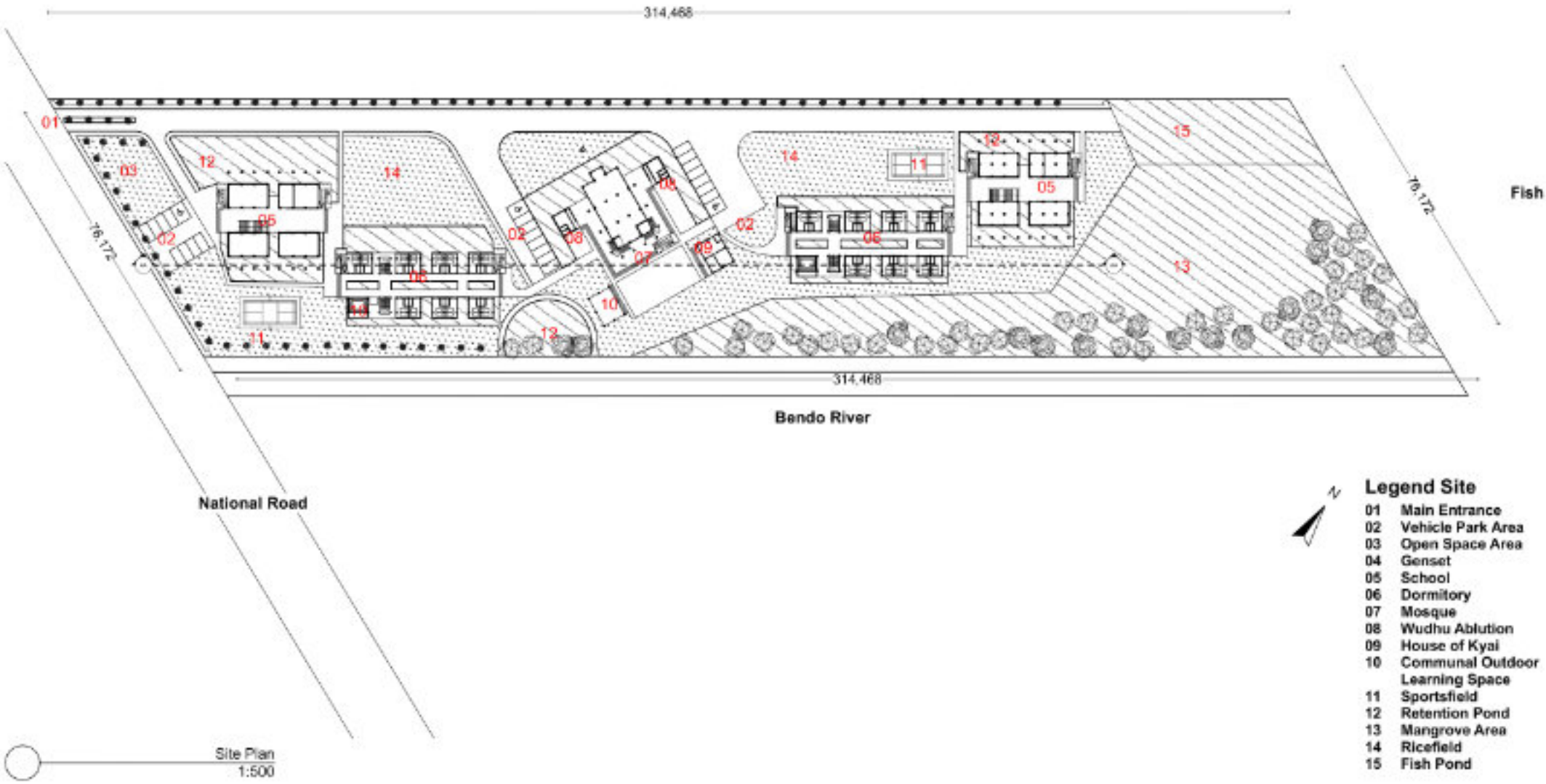
DESIGN DESCRIPTION AND DEVELOPMENT

05

Site Plan

Design Variable
Land Use
Biodiversity
Healthy Living

Design Parameter
- **Minimum Green Coverage Ratio (GCR): 30%**
- **Maximum Building Coverage Ratio (BCR): 60%**
- Minimum building setback from river edge: 15 m
- Minimum building setback from road: 20 m
- **Min. Ecological Buffer Zone 30% of total area**
- **Mangrove corridor along all site edges bordering Kali Bendo River**
- **Min. Productive land 10% of total landscape zone**

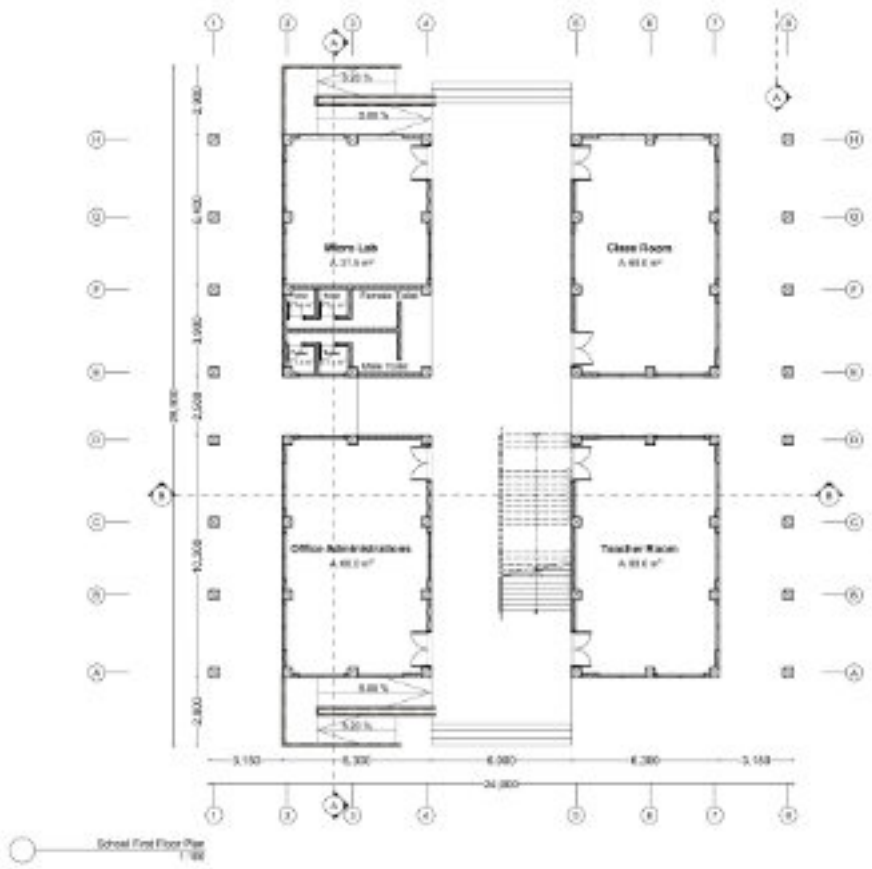


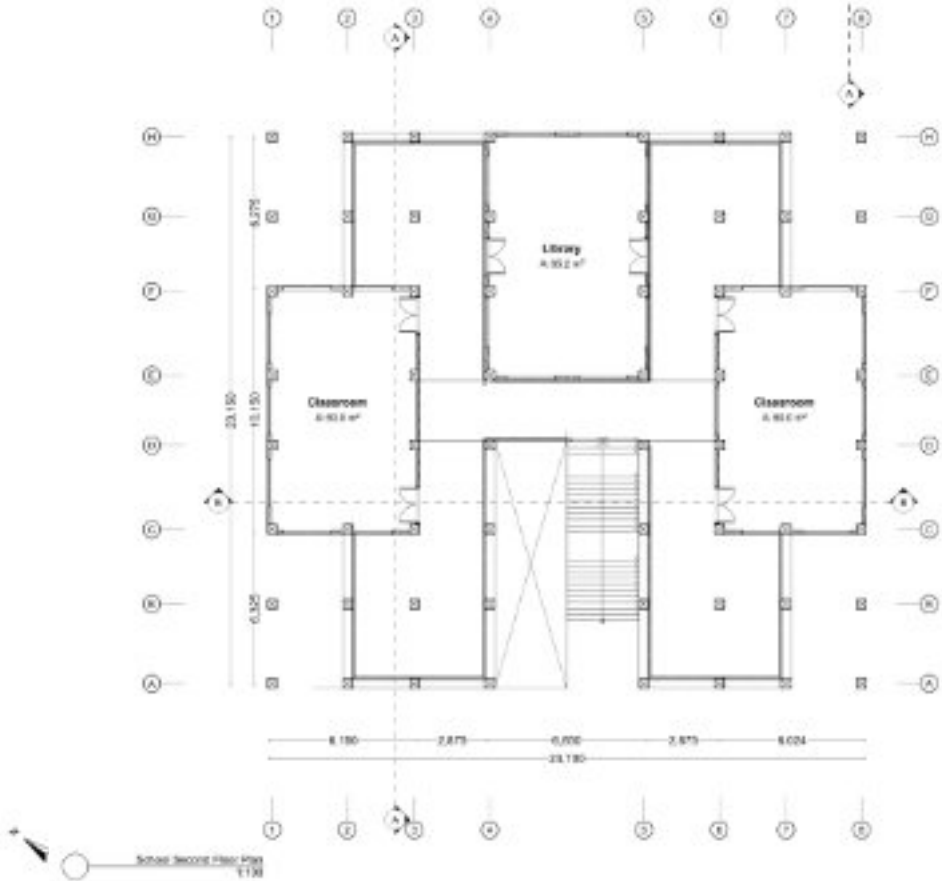
Land use on a total site area of 20.502 m², the total building footprint of 2.315,4 m² (Layers A and B) results in a **Building Coverage Ratio of only 11,3%**, well within the 60% maximum, while the remaining open and green area of 18.186,6 m² yields a **Green Coverage Ratio of 88,7%**, far exceeding the 30% minimum requirement confirming that the design fully complies with the site's land use regulation.

The biodiversity principle as the mangrove area and retention pond together cover 9.570 m², **equivalent to 46,7%** of the total site area, surpassing the minimum 30% ecological buffer requirement and reinforcing the site's ecological resilience in a tidal-flood-prone context.

The Ecological Education landscape zone (Layer C), comprising mangrove area, retention pond, fish ponds, and rice fields, totals 2.355 m², or **11,5%** of the total site area, substantially exceeding the 10% minimum threshold and affirming that the design satisfies all applicable spatial regulations and design principles.

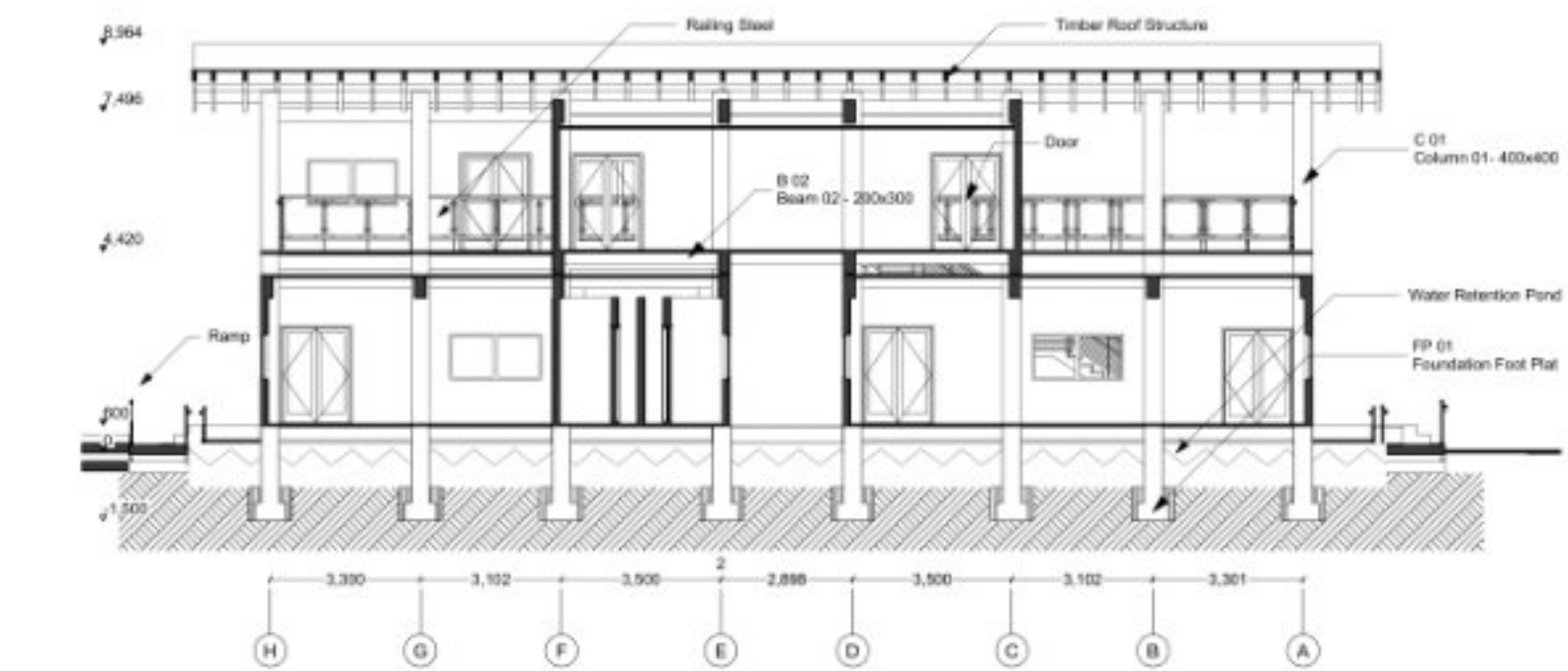
School





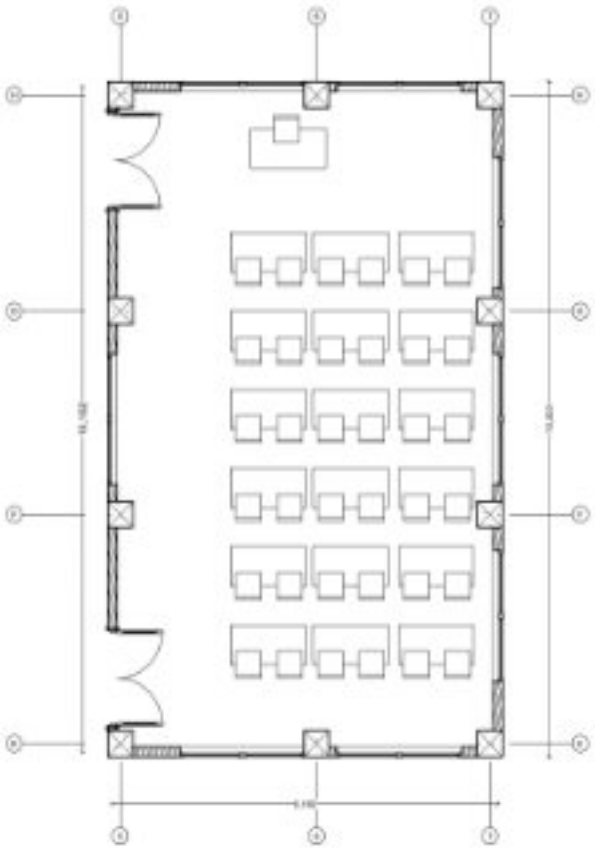
Design Variable
Indoor Classroom
Outdoor Learning Class

Design Parameter
- **Minimum floor area 2 m²/student; minimum classroom width 5 m per classroom; maximum classroom capacity 32 students**
- Each classroom directly connected to ecological zone and productive landscape zone
- Corridor through ecological zone and productive landscape zone as daily santri circulation path in outdoor learning
- Direct visual connection to landscape from each classroom

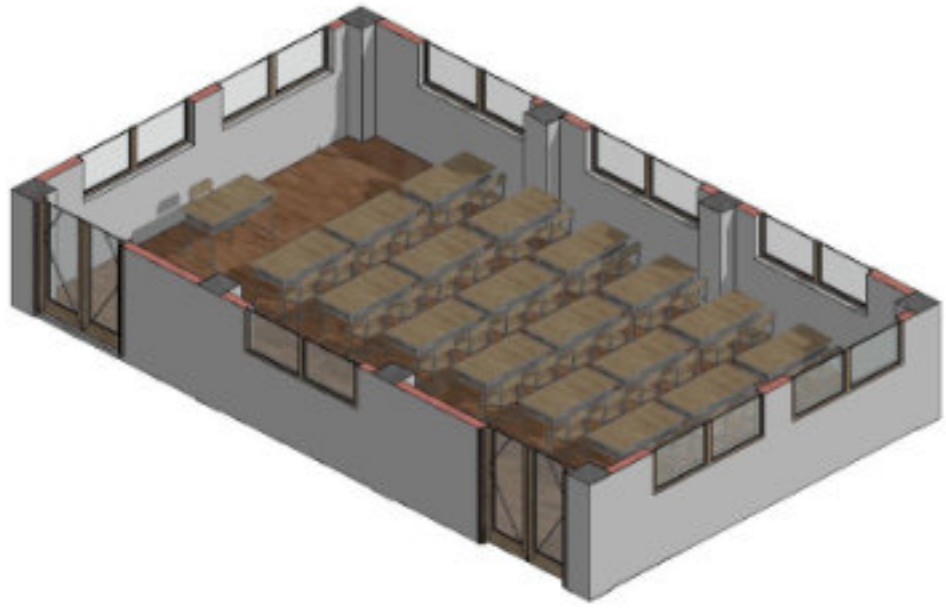


School Section A-A
1:100

School Typical Room



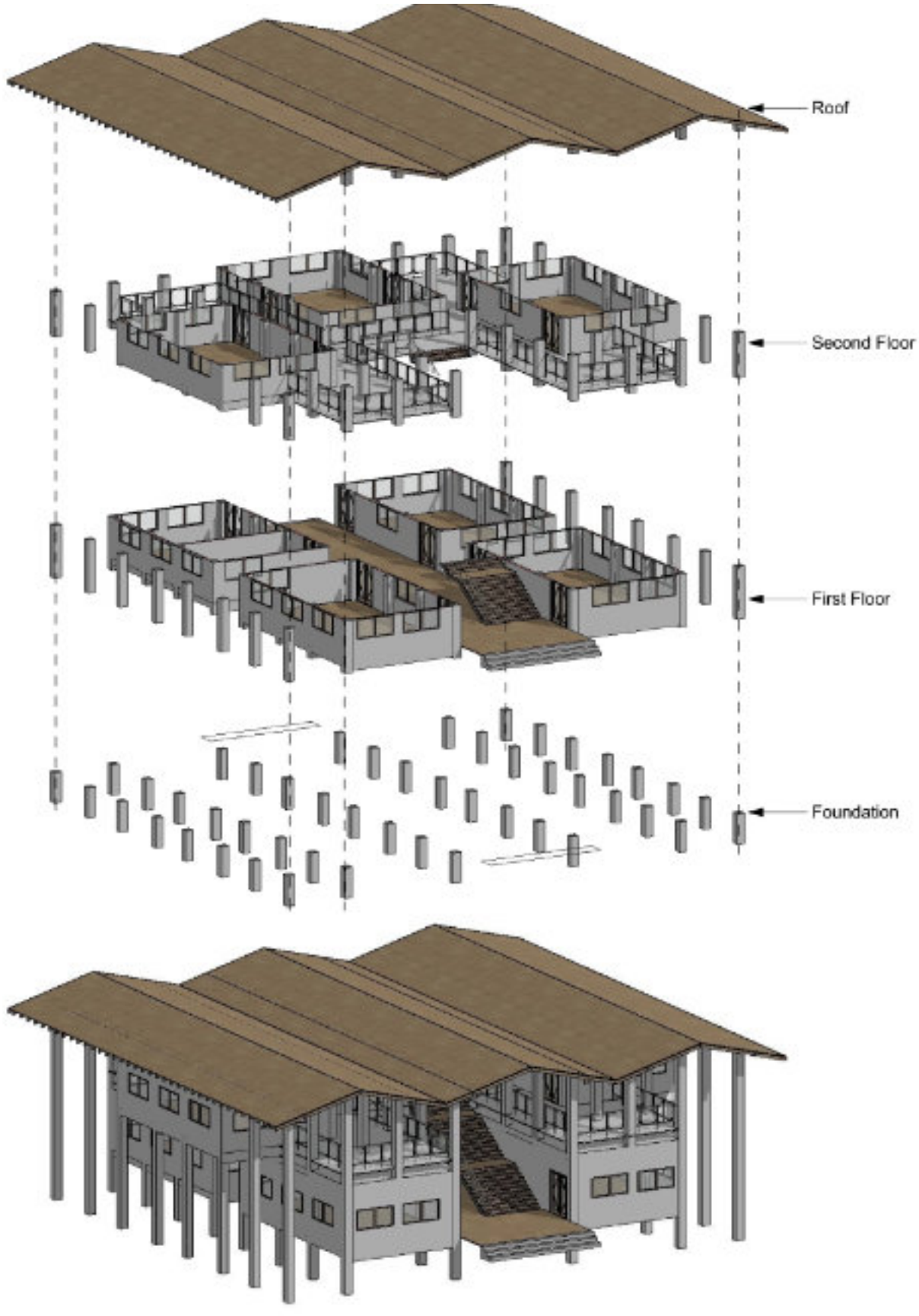
School Typical Classroom Plan
1:50



School 3D Typical Classroom
1:100

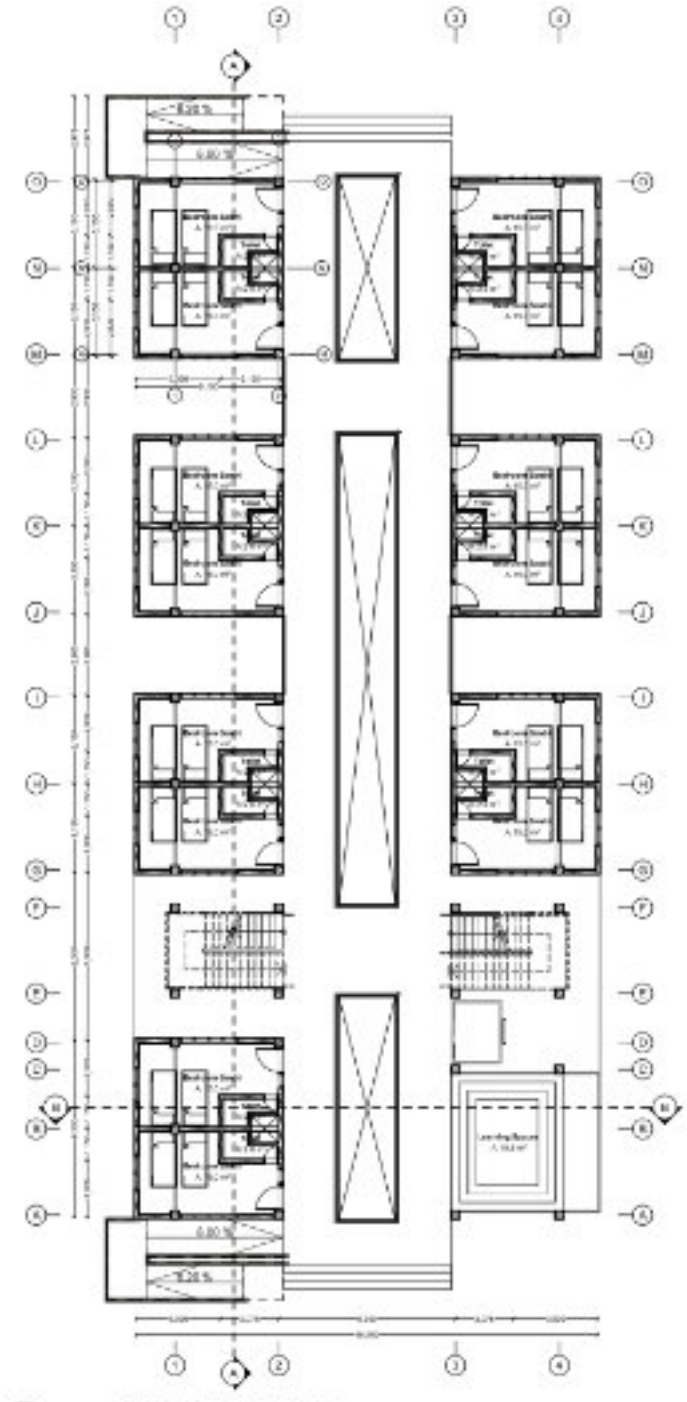
The indoor classrooms are designed to learning space while applying formal education standards within the elevated school building. Each classroom is also designed with a direct visual connection to the surrounding landscape area, as a strategy for connecting the learning space with the surrounding ecological environment.

The structural system of the school building is visualized through an exploded axonometric approach. This arrangement also serves as an expression of the transparency of the stilt construction system, consistently applied across all building typologies on the site.

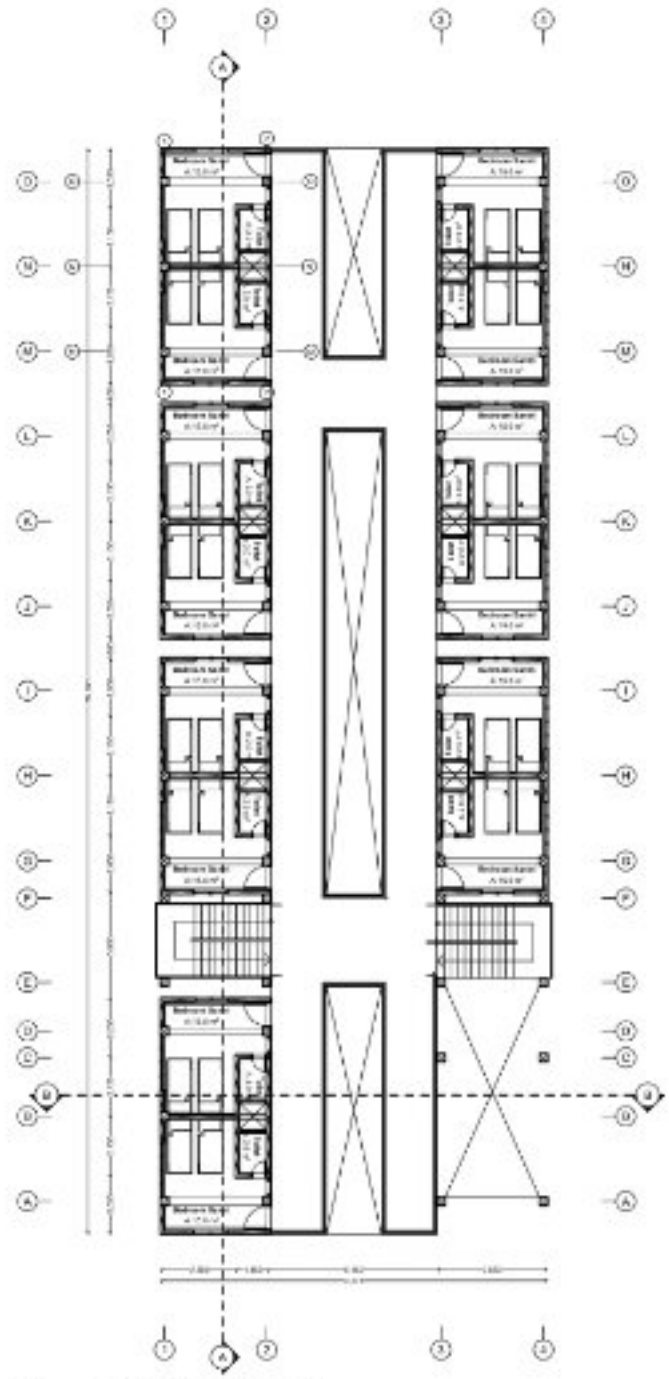


School Exploded Axonometry

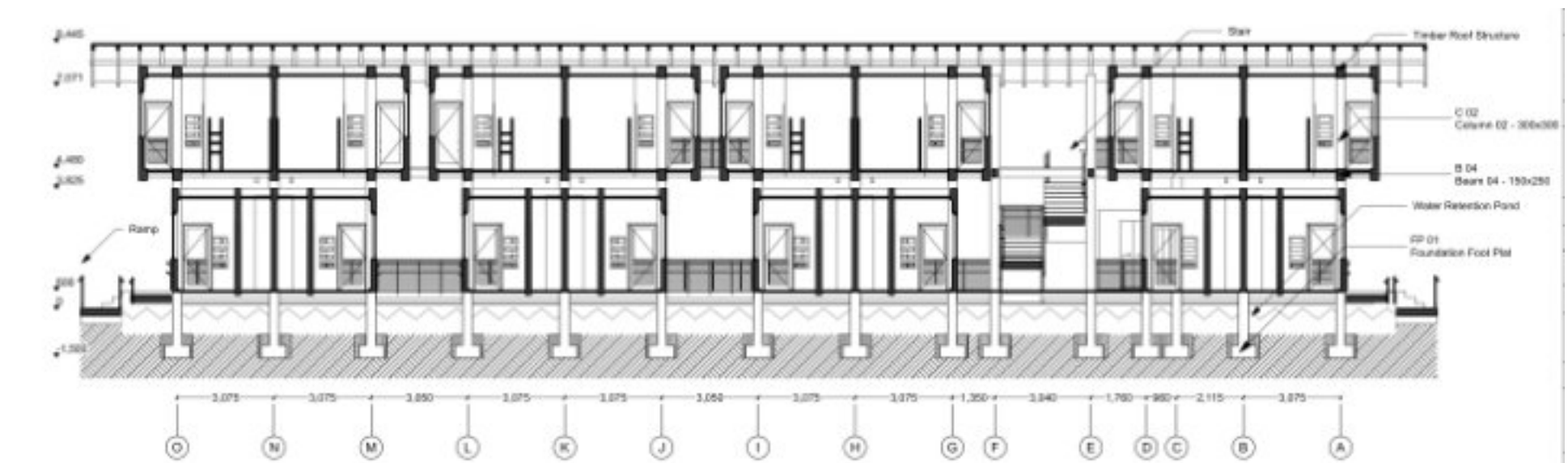
Dormitory



Dormitory First Floor Plan
1:100

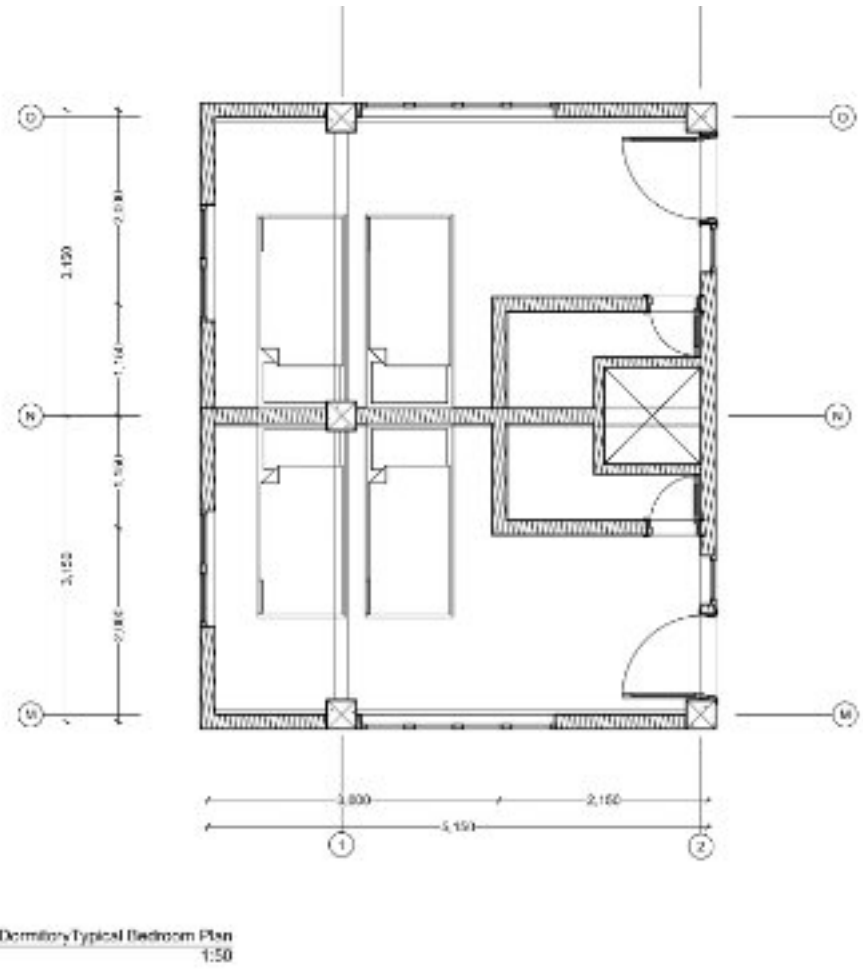


Dormitory Second Floor Plan
1:100

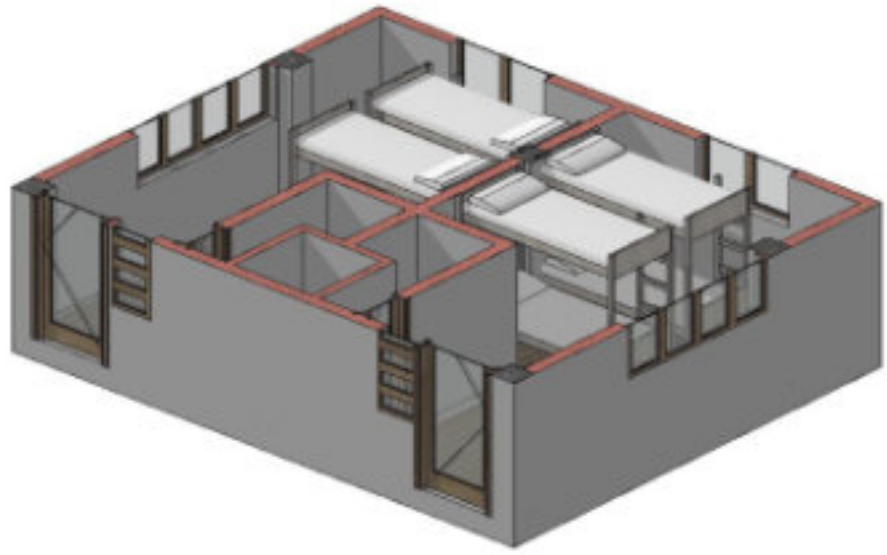


Dormitory Sections A-A
1:100

Dormitory Typical Room



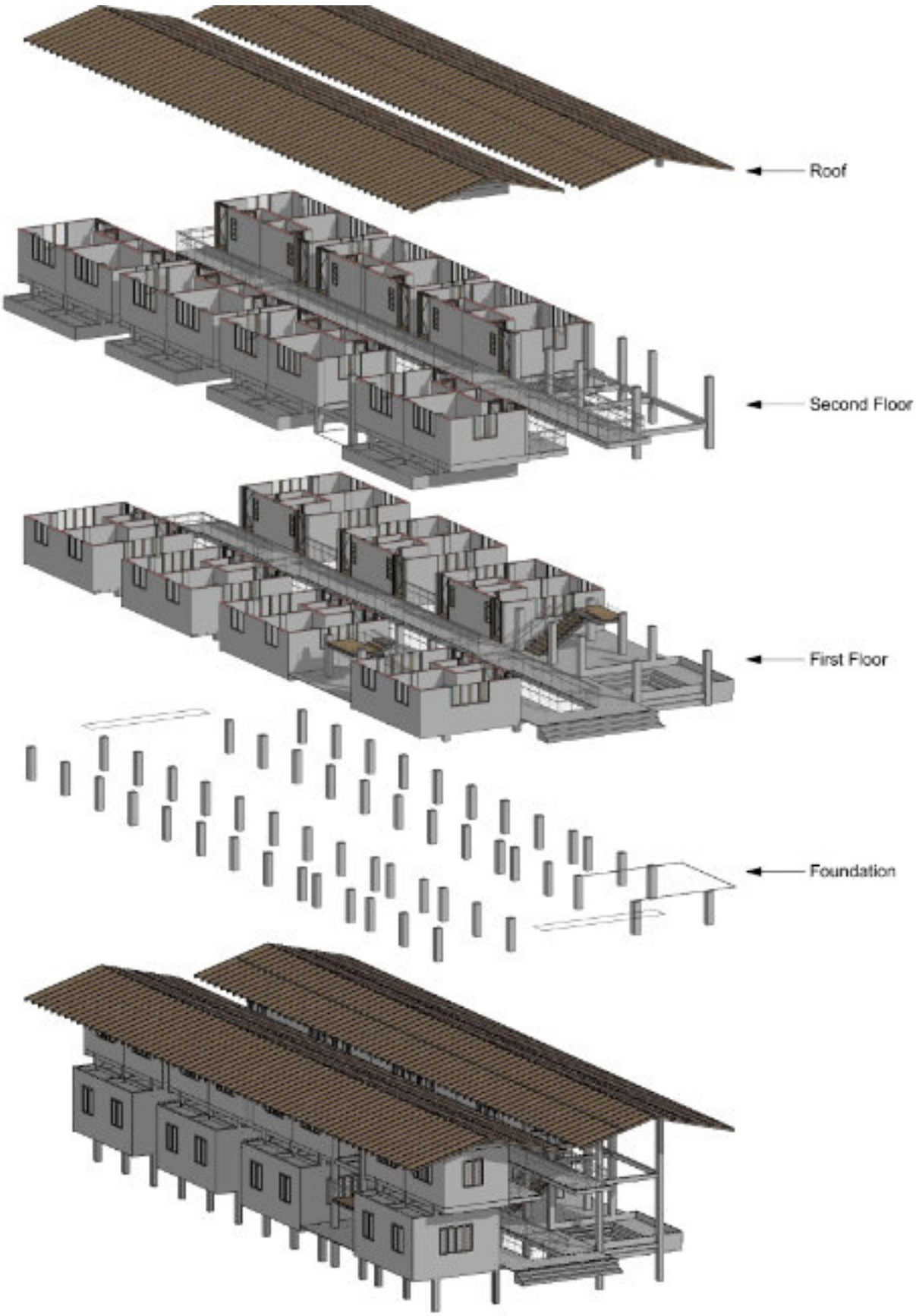
Dormitory Typical Bedroom Plan
1:50



Dormitory 3D Typical Bedroom
1:100

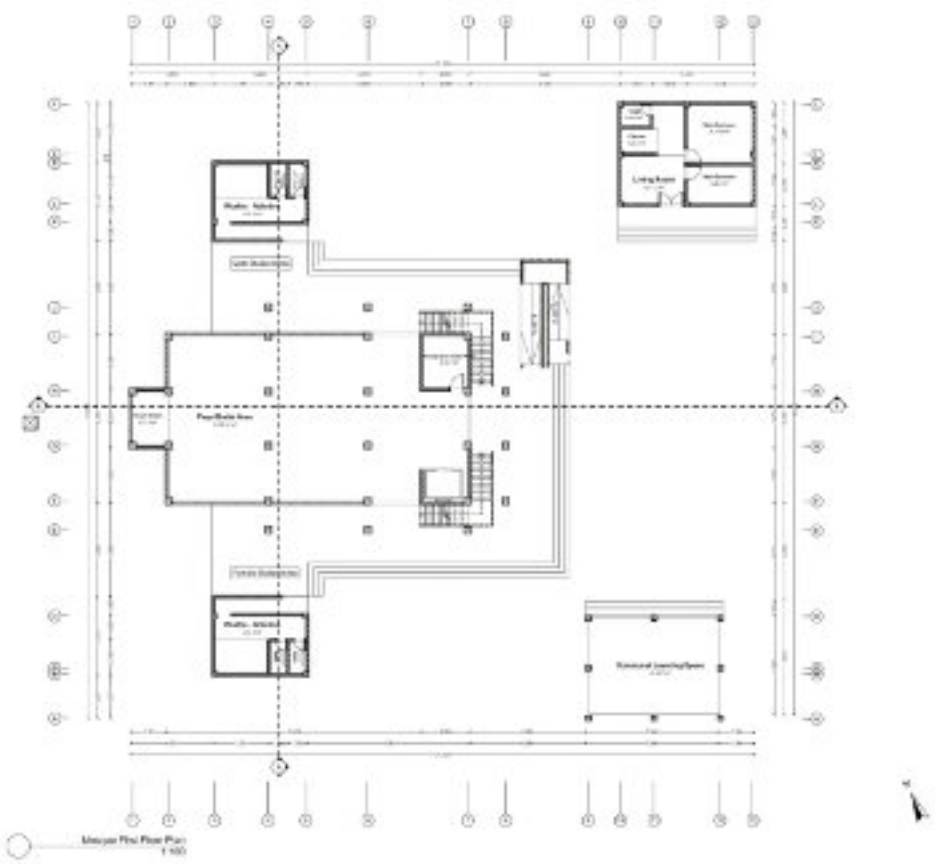
The student dormitory room units are designed with a bunk bed and window openings on the exterior walls serving as a strategy for natural ventilation and lighting. Each room is equipped with a private toilet connected to the sponge architecture water recycling system.

The structural system of the dormitory building is visualized through an exploded axonometric as an expression of the consistent stilt construction system applied uniformly across all building typologies within the pesantren area.

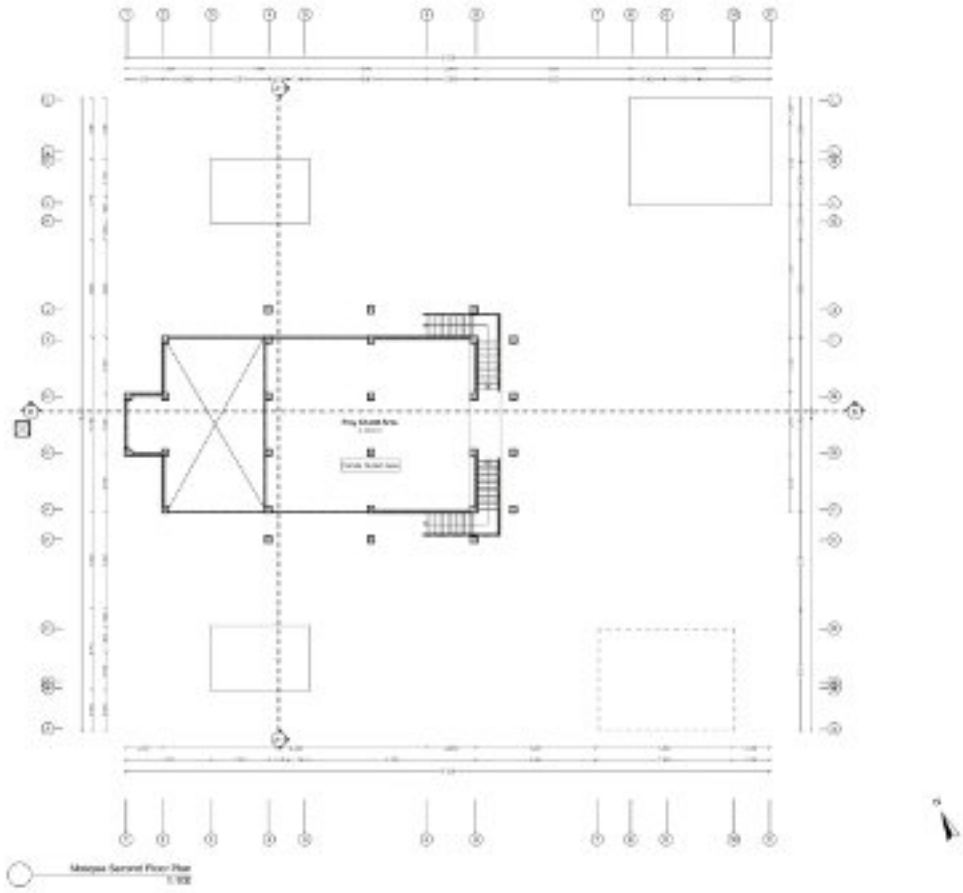


Dormitory Exploded Axonometry

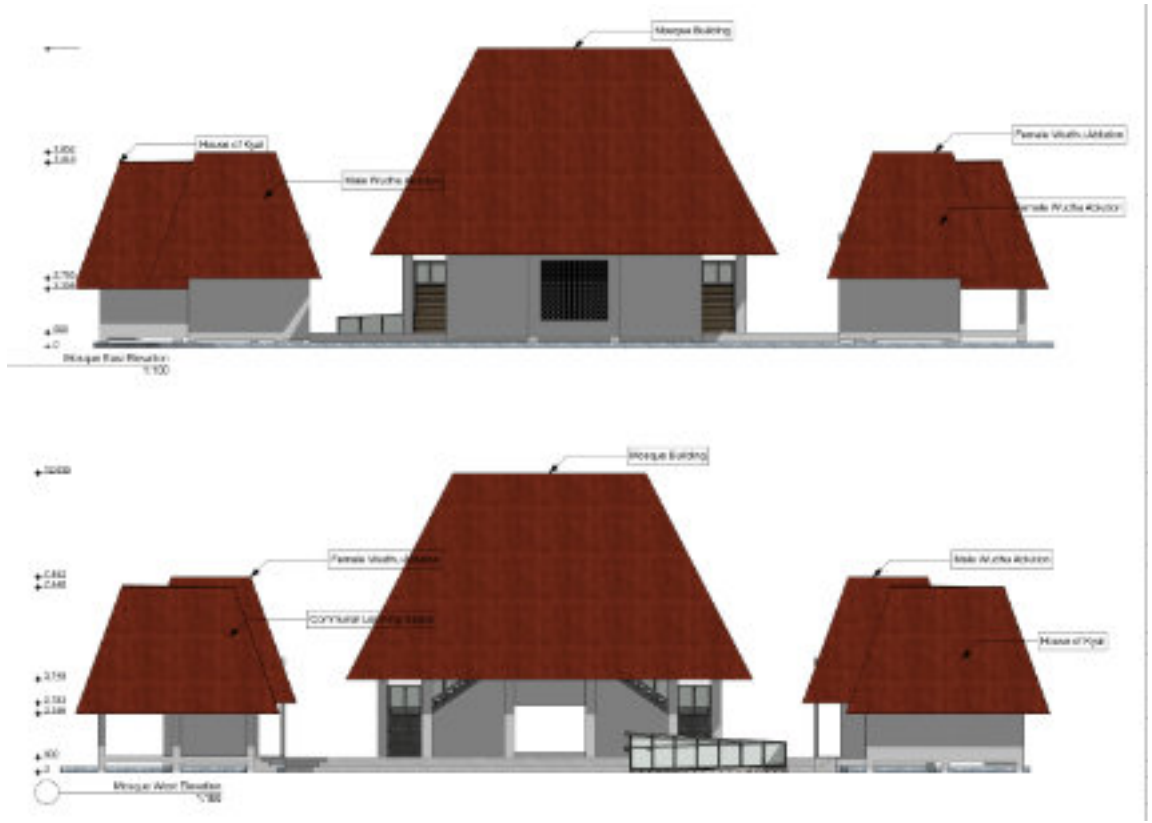
Mosque

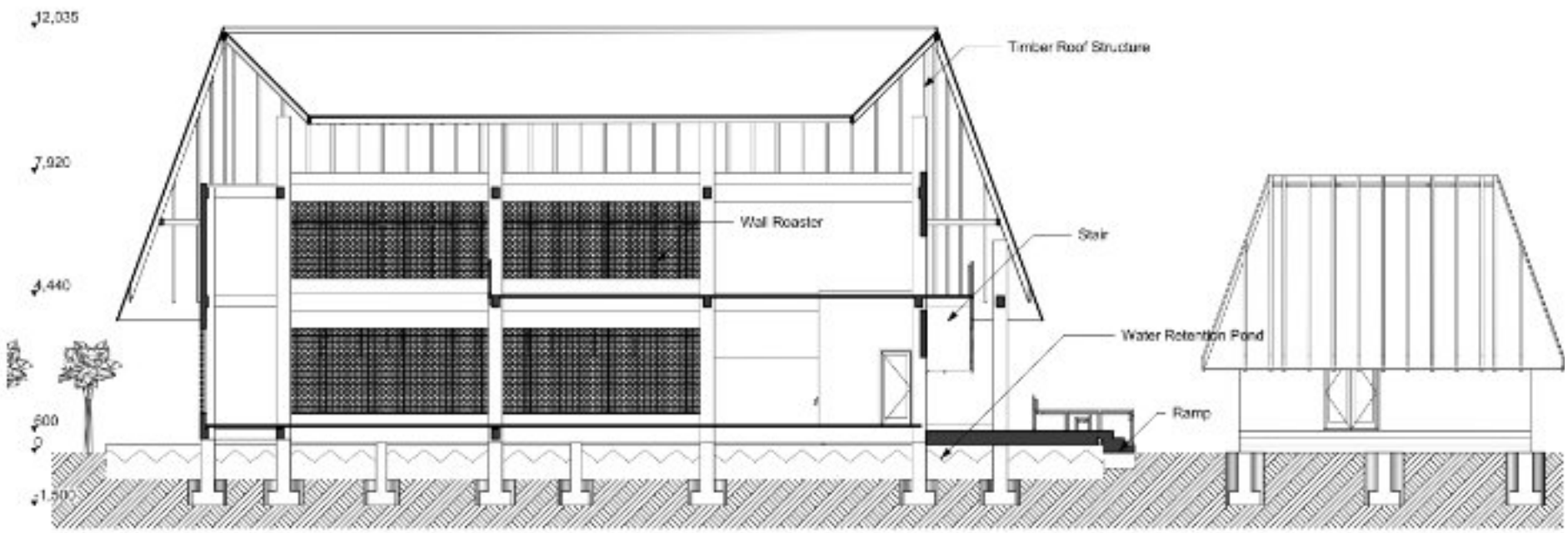


Masjid First Floor Plan
1:100



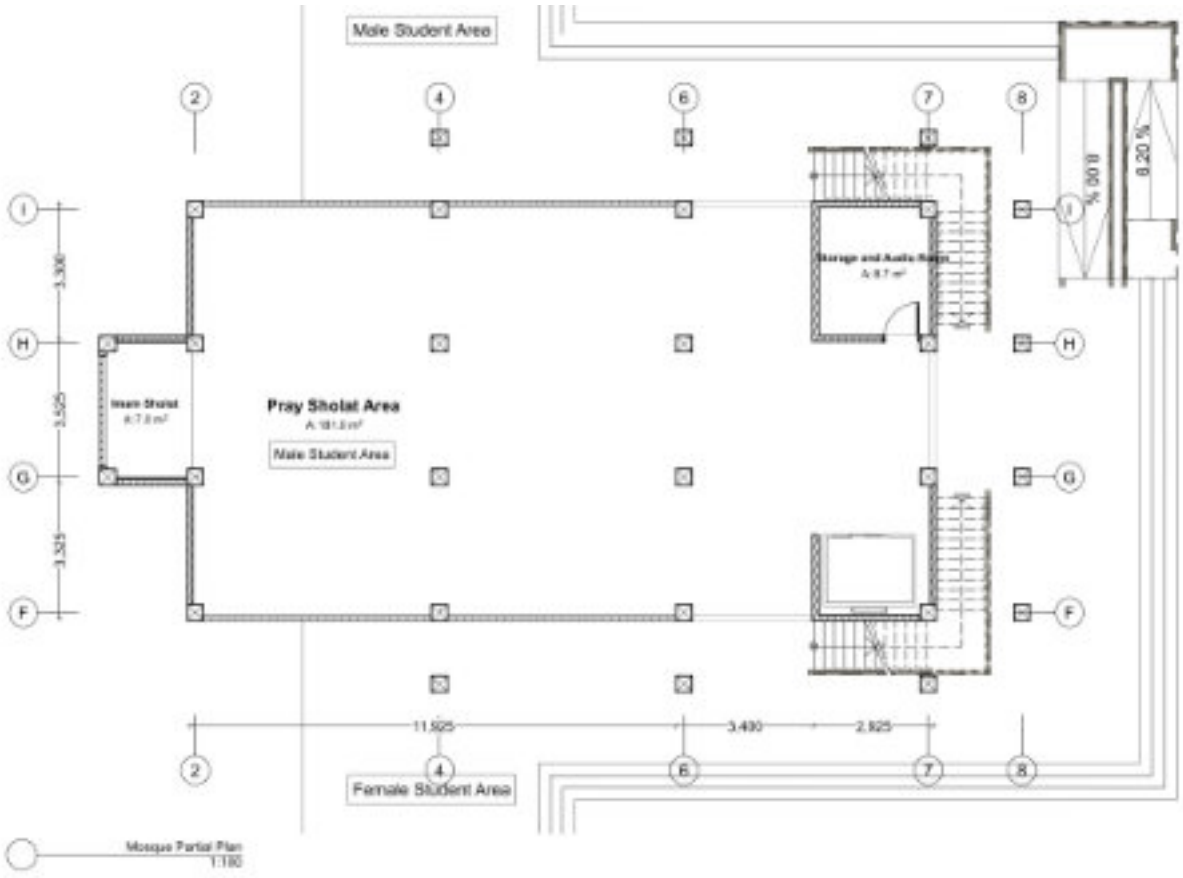
Masjid Ground Floor Plan
1:100

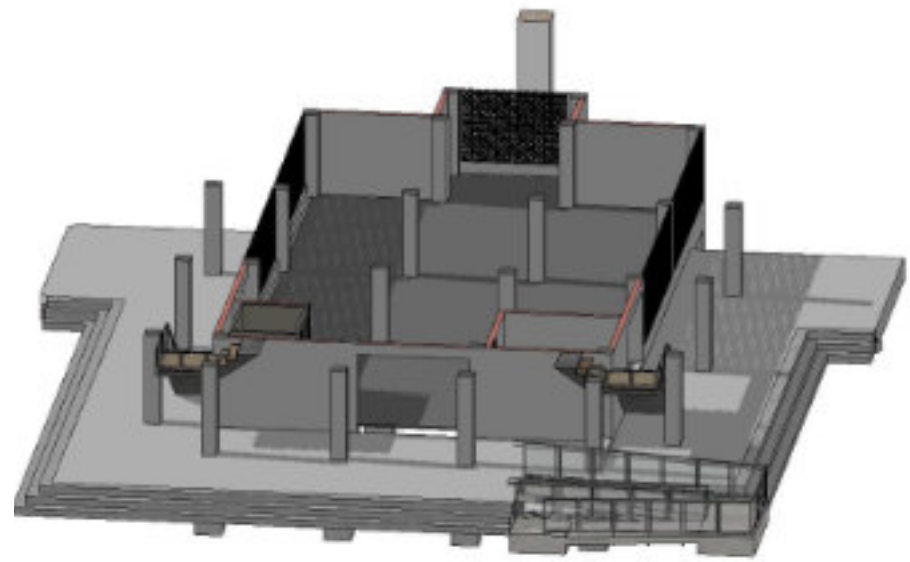




Mosque Section
1:100

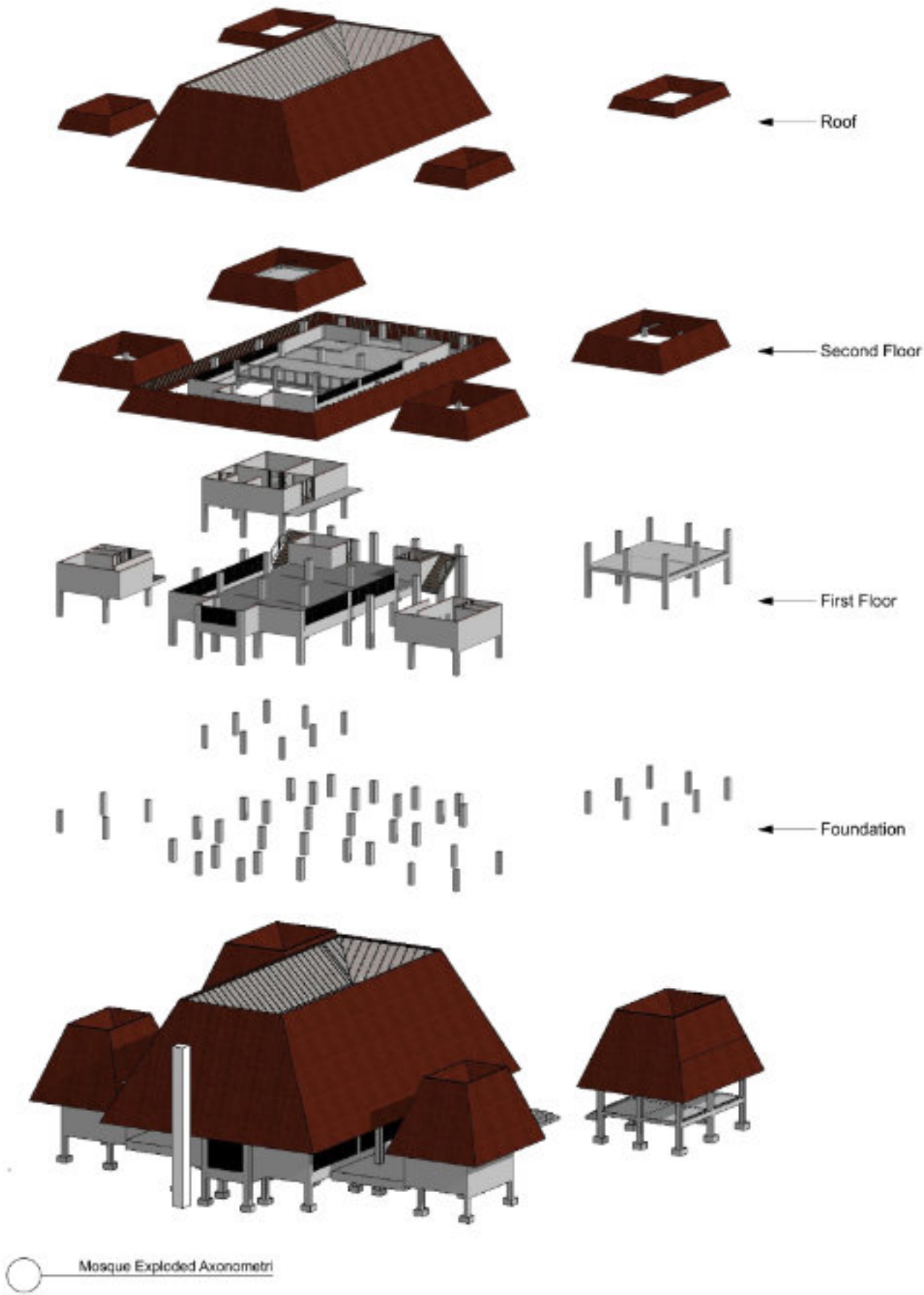
Mosque Partial Room





The mosque's pray sholat area is designed as the central communal space with a raised roof structure that creates vertical volume above the prayer hall, while maintaining gender-segregated access through separate male and female student areas. The building also incorporates a storage and audio room adjacent to the imam sholat area, supporting operational needs during collective worship activities.

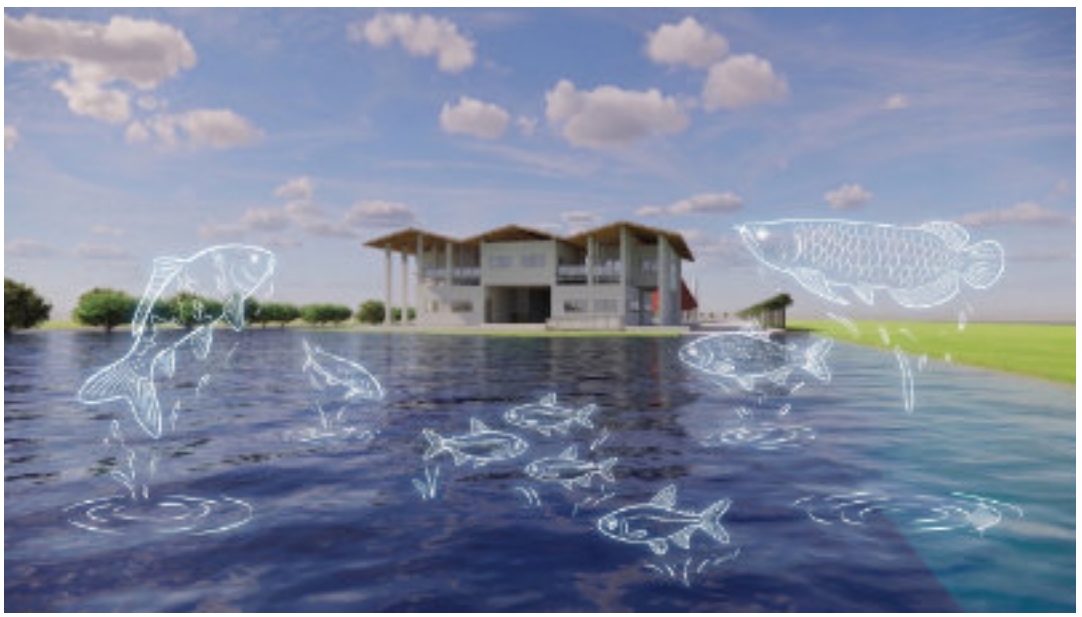
The structural system of the mosque building is visualized through an exploded axonometric. This arrangement also serves as an expression of the transparency of the stilt construction system, consistently applied across all building typologies on the site.



Mosque Exploded Axonometri

Render Exterior

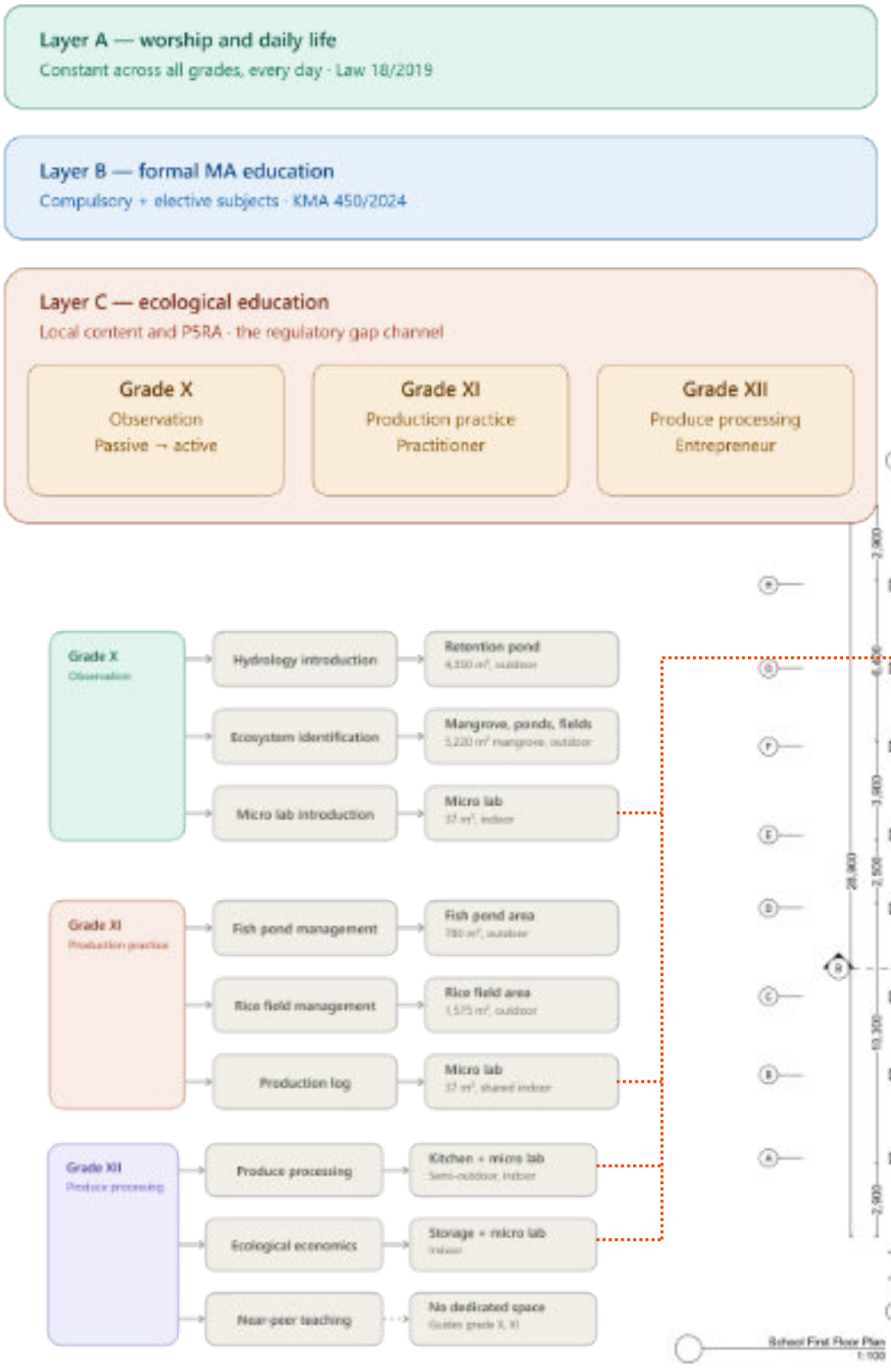
Render Interior

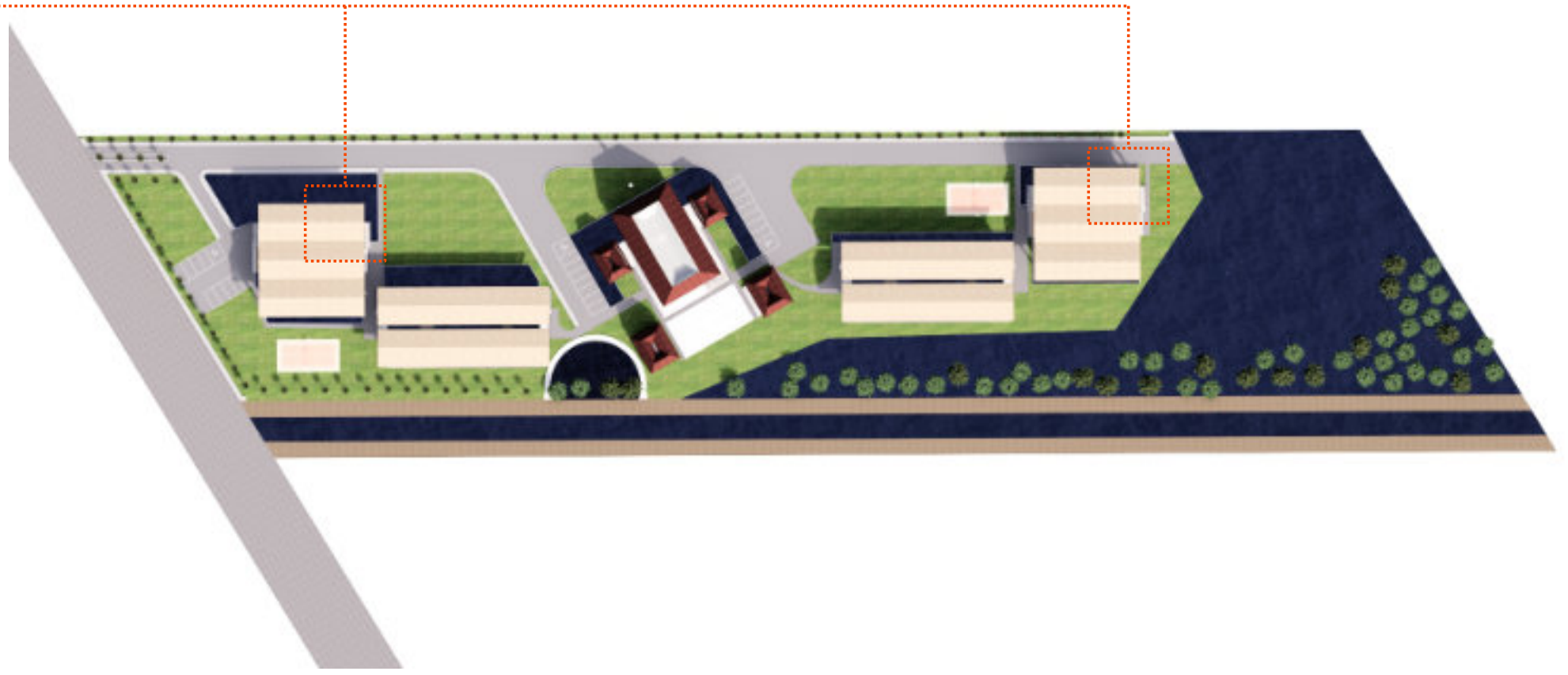


DESIGN EVALUATION

06

What are the schemes of Education of Eco Pesantren and how do they apply into design?



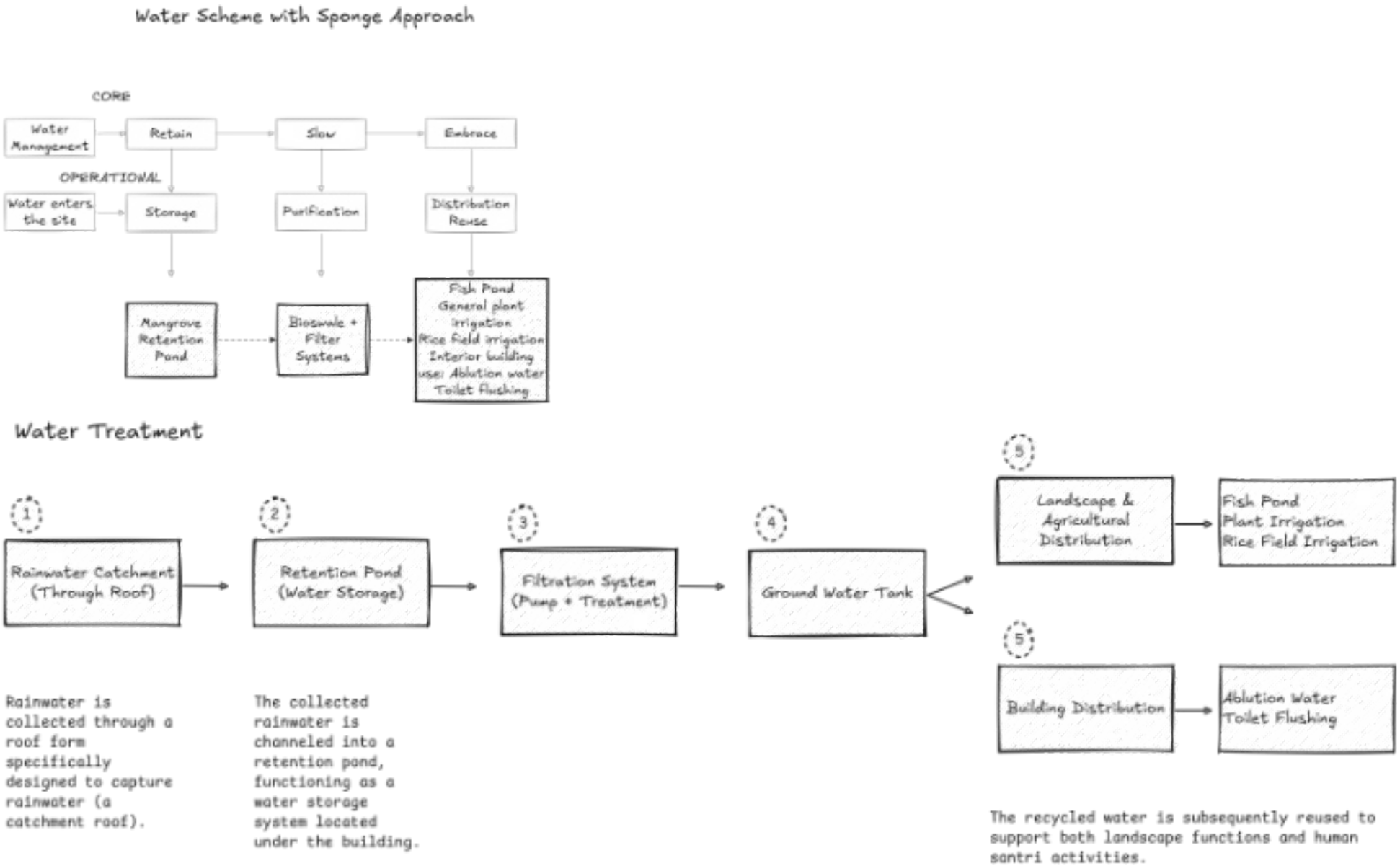


The educational scheme of the Eco Pesantren is structured into three tiered layers: the layer of worship and daily life, the layer of formal MA (Madrasah Aliyah) education, and the layer of ecological education.

This ecological progression is translated directly into space: grade X students at the observation stage use the retention pond and mangrove area as an outdoor laboratory, grade XI students at the production practice stage utilize the fish pond and rice field area, while grade XII students at the processing stage use the kitchen and storage integrated with the micro lab as a shared learning center across grade levels.

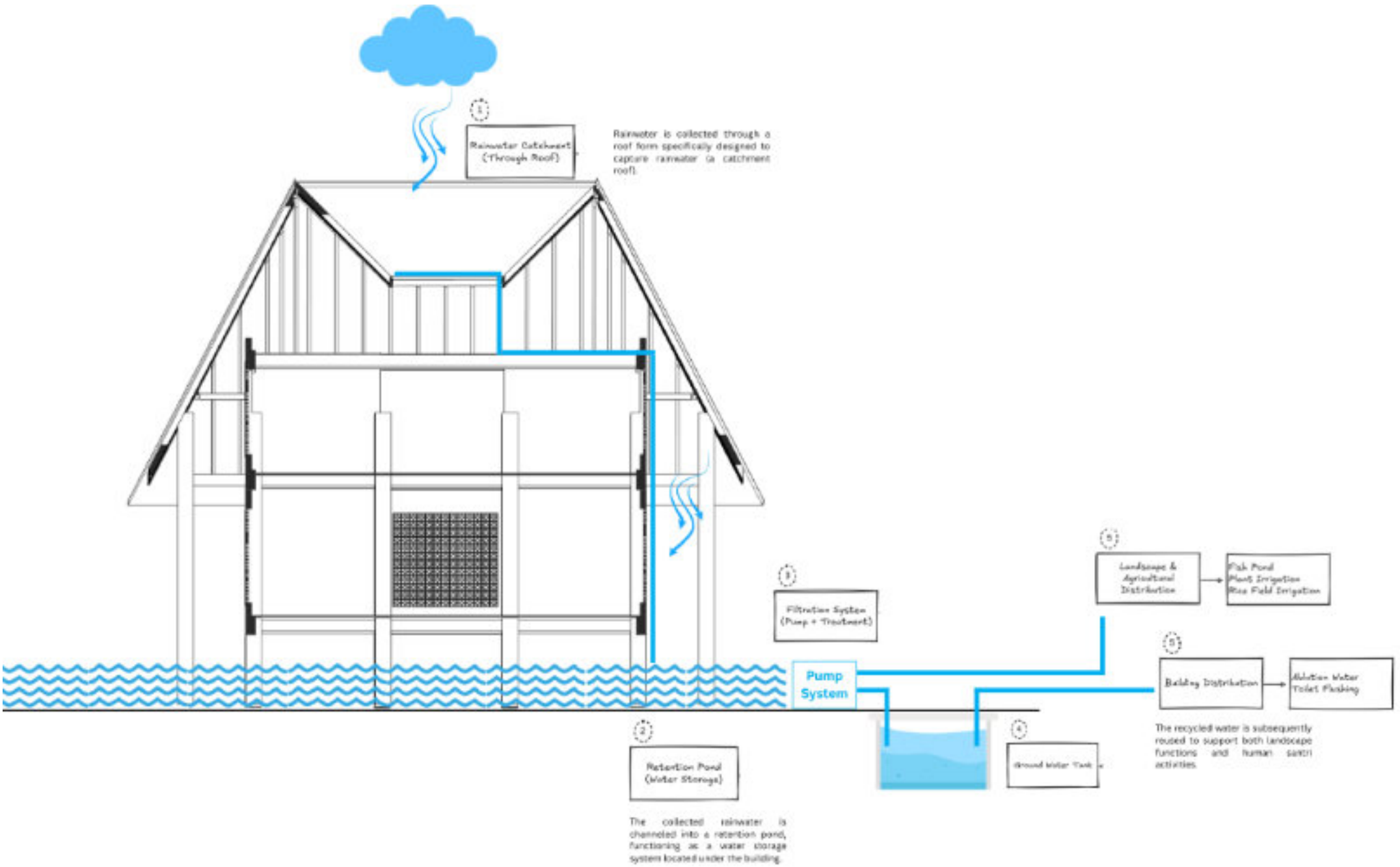
This linkage is evidenced in the ground floor plan of the school, where the 37.5 m^2 micro lab is placed adjacent to the classroom and positioned within the building that faces directly toward the water's edge of the site, connecting classroom activities with ecological learning objects in the field.

What is the water system scheme in architecture design and how does it work, including water infiltration?



Design Variable
Water Management

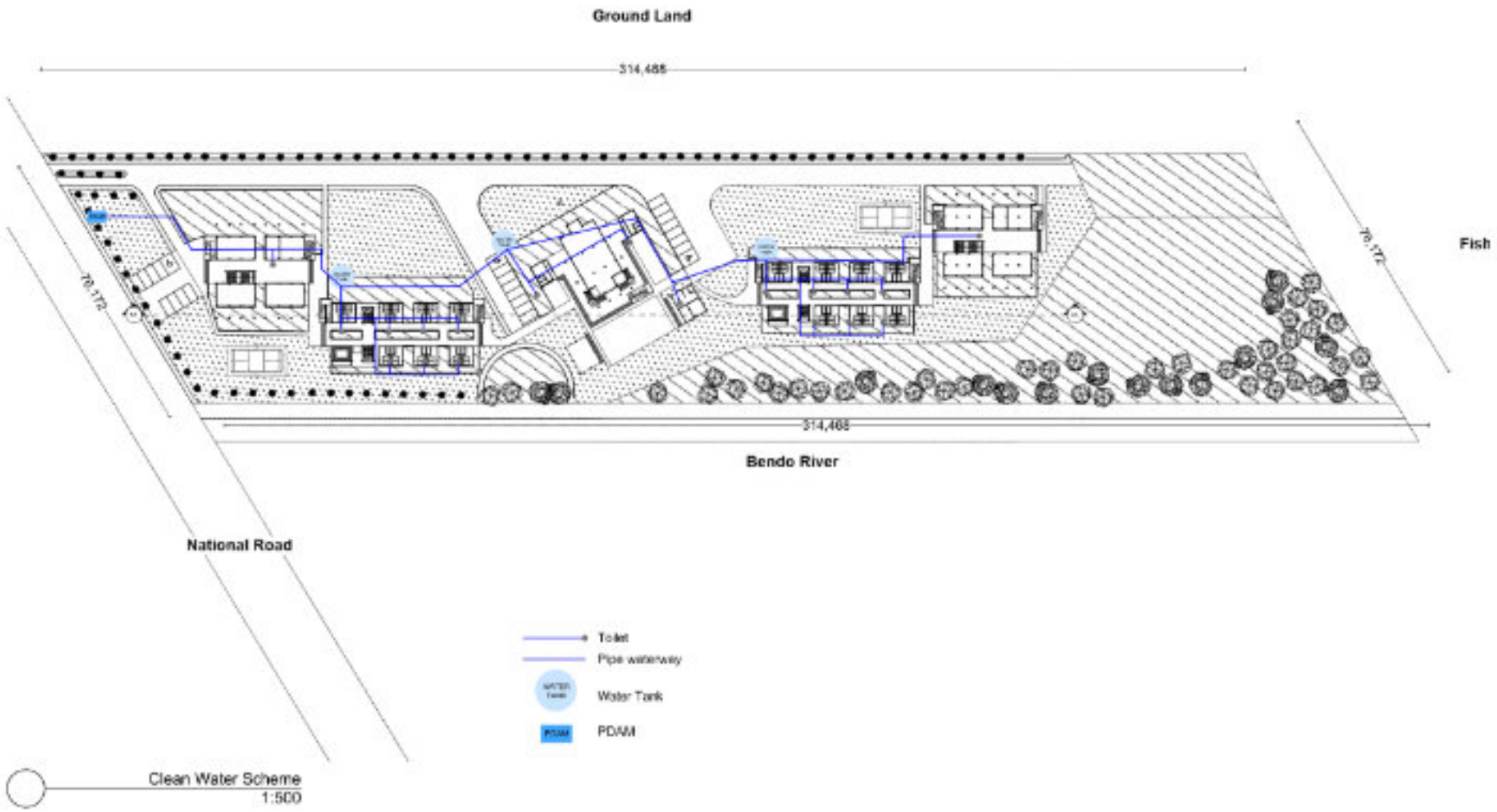
Design Parameter
- Retention system capacity designed to accommodate average tidal flood discharge of Kali Bendo River
- Retention pond volume calculation based on Meteoblue climate data
- **Documented Water flow schme**
- Create Artificial Retentian Pond
- Documented water recycling on site plan



The water scheme in the building operates through five steps: rainwater is captured through a roof form specifically designed as a catchment roof, then channeled down and stored in a retention pond positioned beneath the elevated building as a response to the tidal site conditions, so that water does not need to be discharged far away while simultaneously utilizing the empty space beneath the structure. The collected water then passes through a filtration and pump system toward the ground water tank as the main distribution point, before being channeled into two utilization pathways: landscape and agricultural irrigation (fish ponds, rice fields, general planting) and in-building distribution for ablution (wudhu) water needs and toilet flushing.

Thus, rainwater that would have potentially become a runoff burden instead becomes a circular resource for the productive and worship activities of the santri.

Scheme water on site



Design Variable
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Design Parameter
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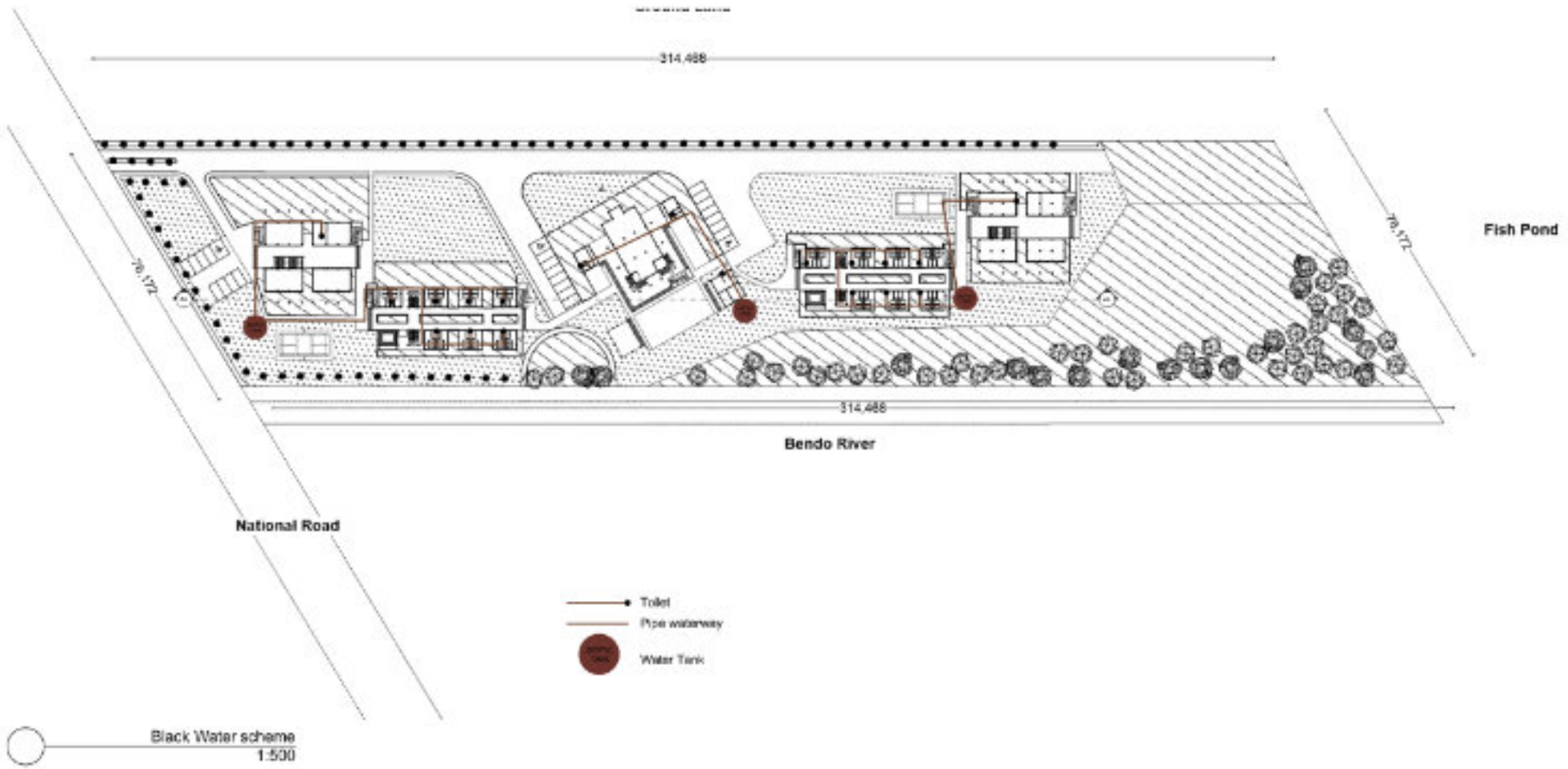
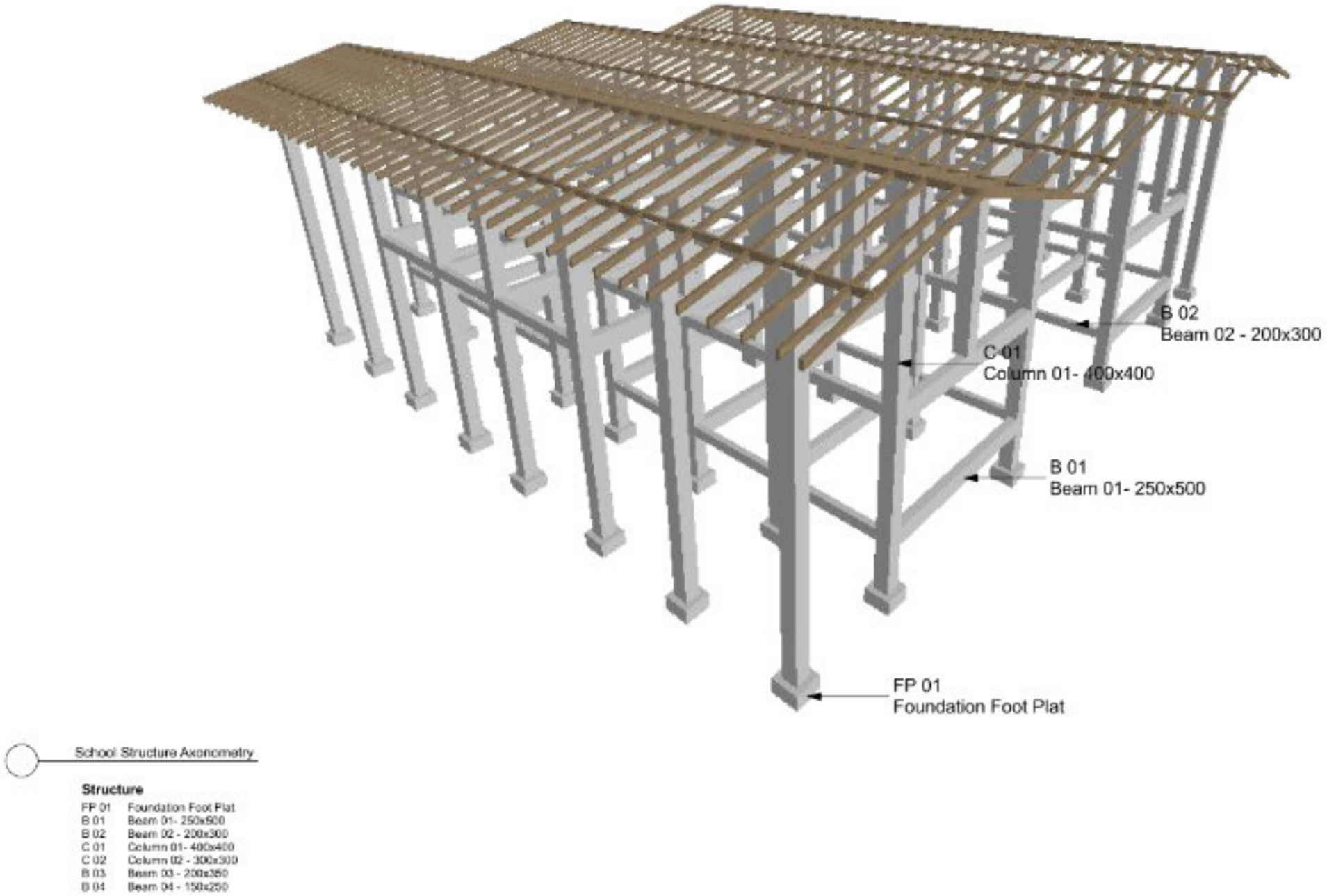


At the site level, this system is documented through two separate pipe networks: the clean water scheme, which connects the PDAM (municipal water) source and water tank to every toilet throughout the building masses, and the black water scheme, which channels waste from the toilets to the septic tank at separate points.

What is the structural building system scheme and how is it reflected in the roof plan of a building?



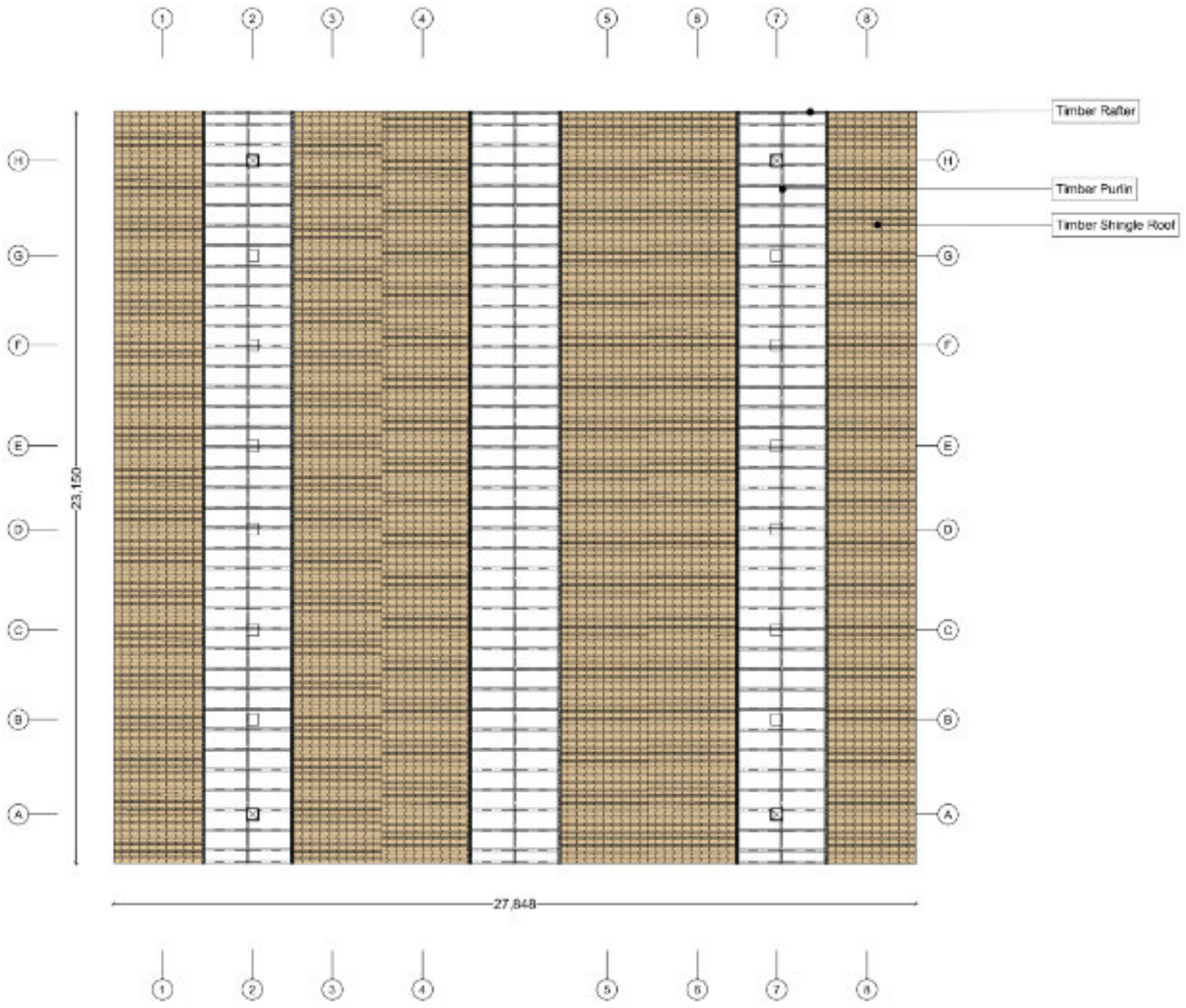
School Structure Axonometry

Structure

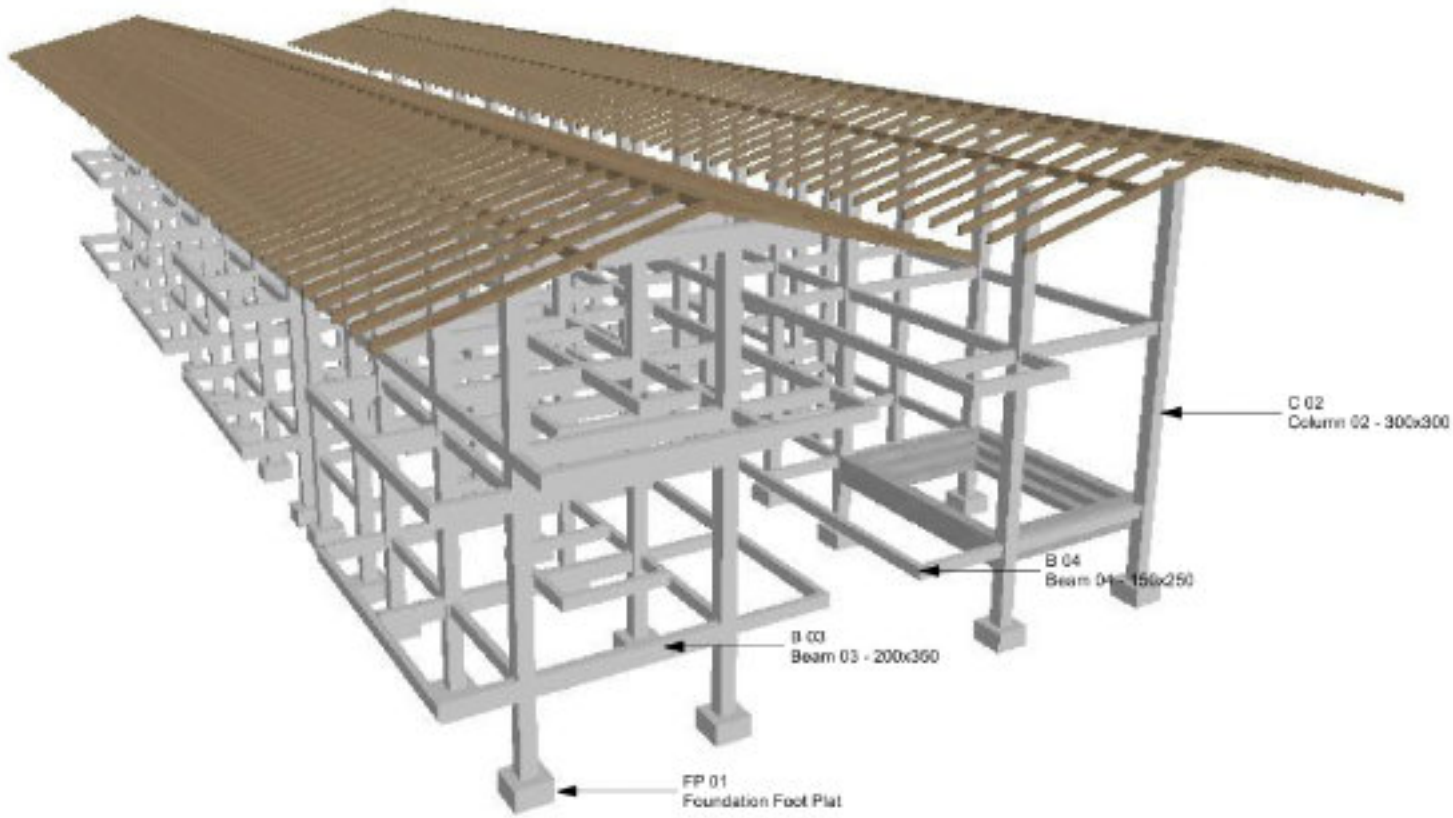
FP 01	Foundation Foot Plat
B 01	Beam 01- 250x500
B 02	Beam 02 - 200x300
C 01	Column 01- 400x400
C 02	Column 02 - 300x300
B 03	Beam 03 - 200x350
B 04	Beam 04 - 150x250

The building's structural system applies a hybrid reinforced concrete and timber strategy, in which the substructure in the form of pedestal columns and reinforced concrete beams supports a timber roof superstructure, as a response to the durability requirements in the tidal zone as well as material efficiency for the roof span, such that elements in direct contact with damp and inundation conditions use water-resistant materials while the lighter elements above utilize local timber.

School Structure



School Structure Roof Plan
1:100



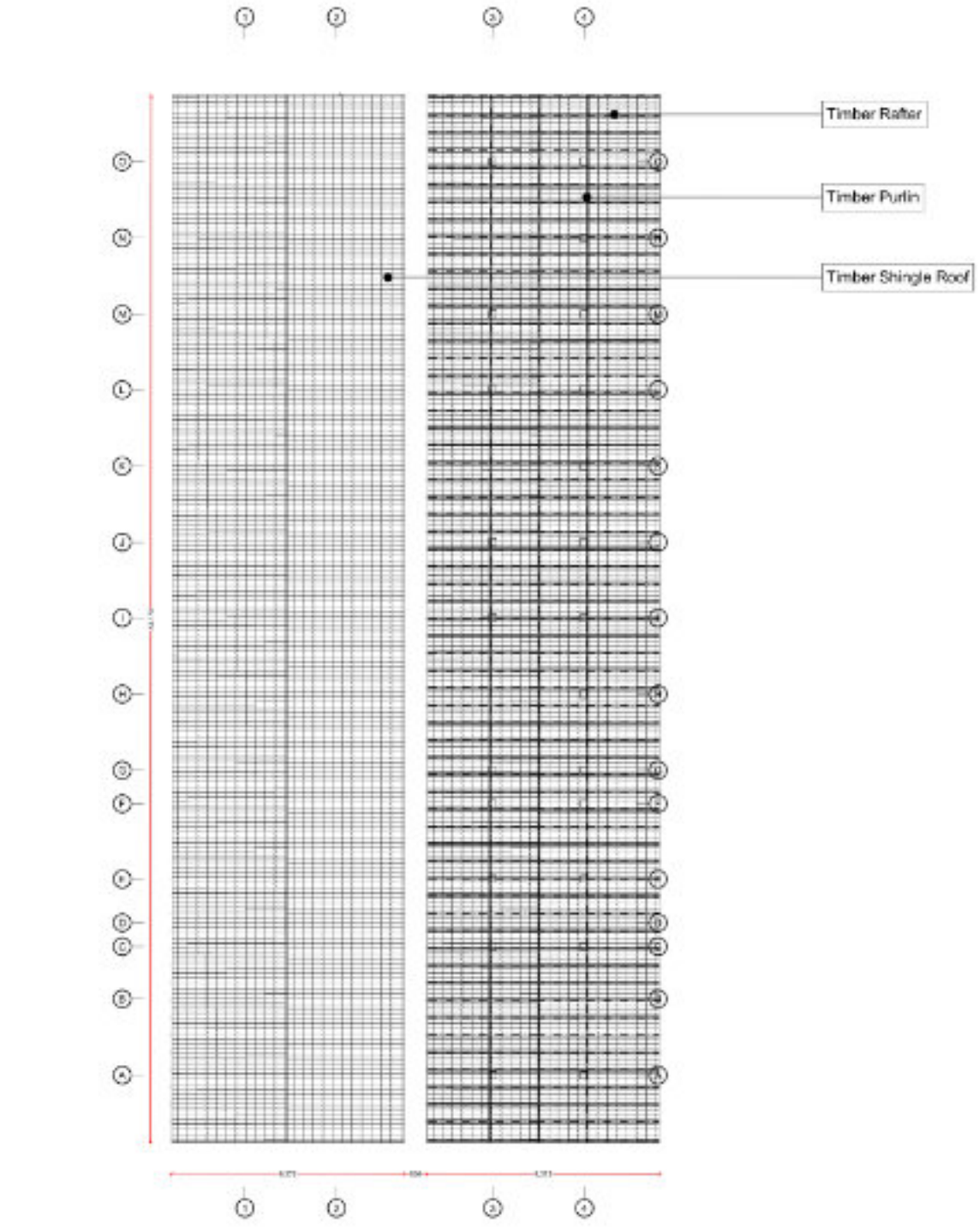
Dormitory Structure Axonometry

Structure

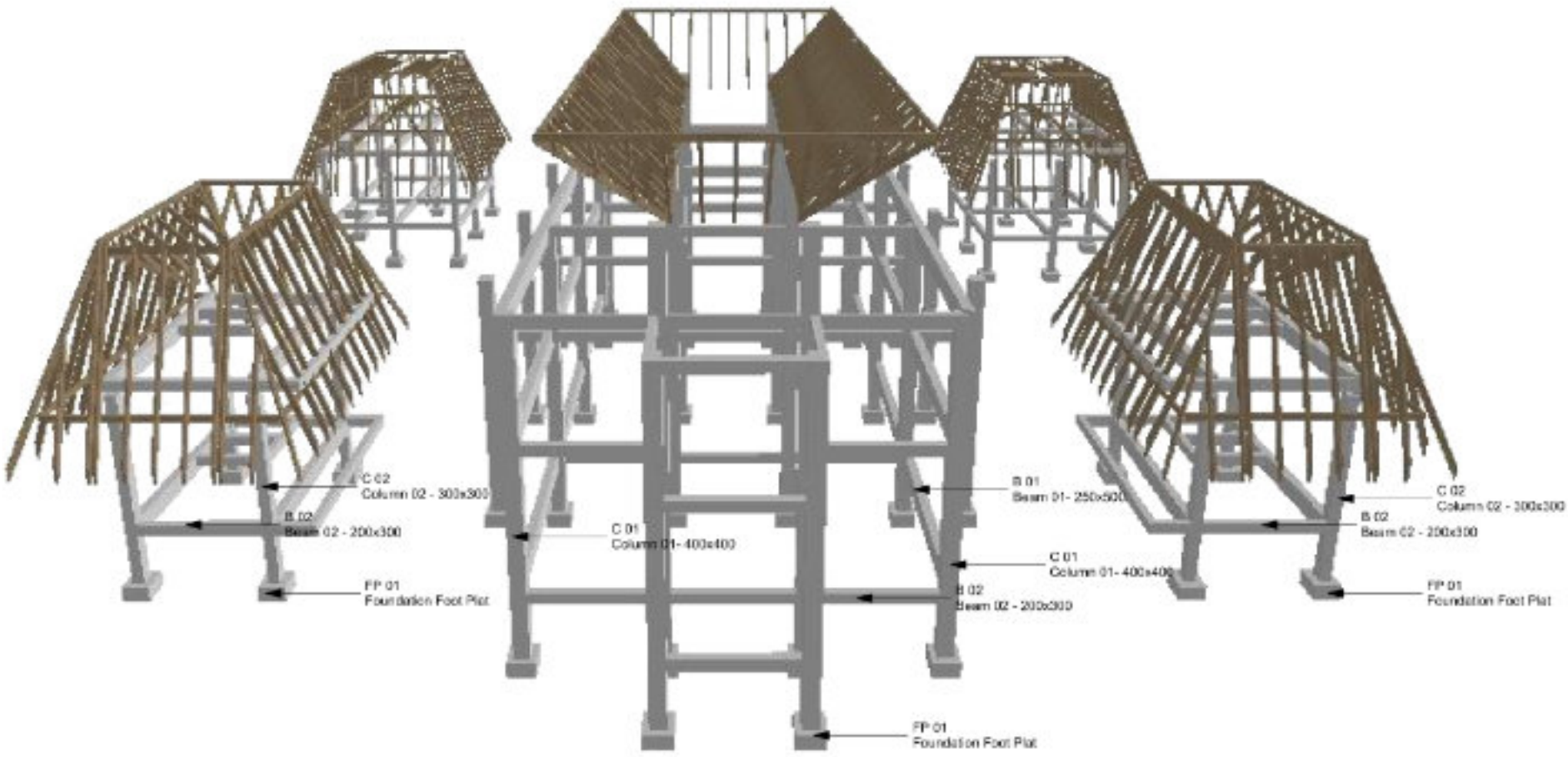
FP 01	Foundation Foot Plat
B 01	Beam 01- 250x500
B 02	Beam 02 - 200x300
C 01	Column 01- 400x400
C 02	Column 02 - 300x300
B 03	Beam 03 - 200x350
B 04	Beam 04 - 150x250

The dimensions of the structural elements columns of 400×400mm and 300×300mm, beams ranging from 250×500mm to 150×250mm, and footplate foundations — are determined empirically and applied consistently across the three building typologies (school, dormitory, mosque) as evidence of a repeatable modular system

Dormitory Structure



Dormitory Structure Roof Plan
1:100

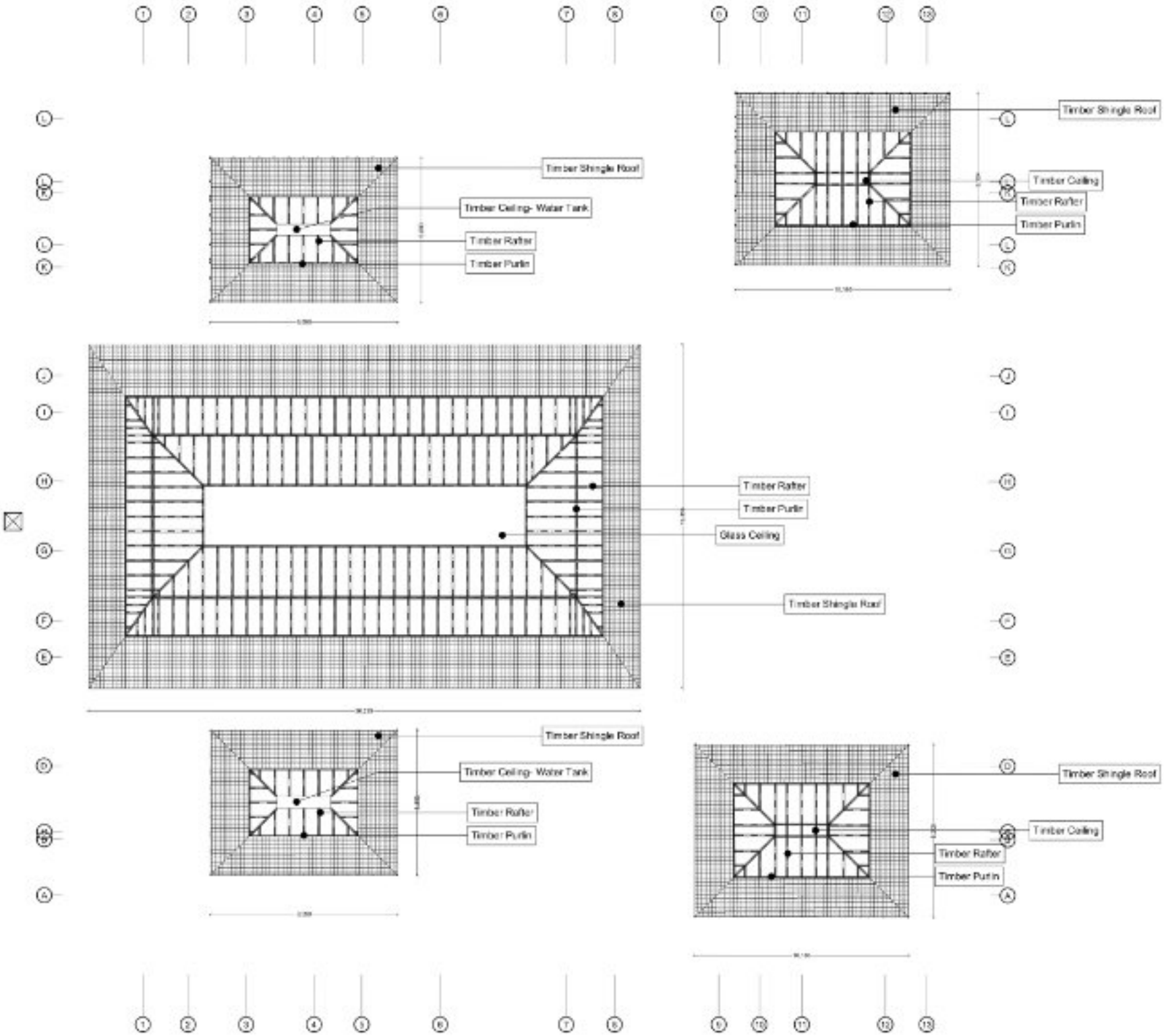


Mosque Structure Axonometry

Structure

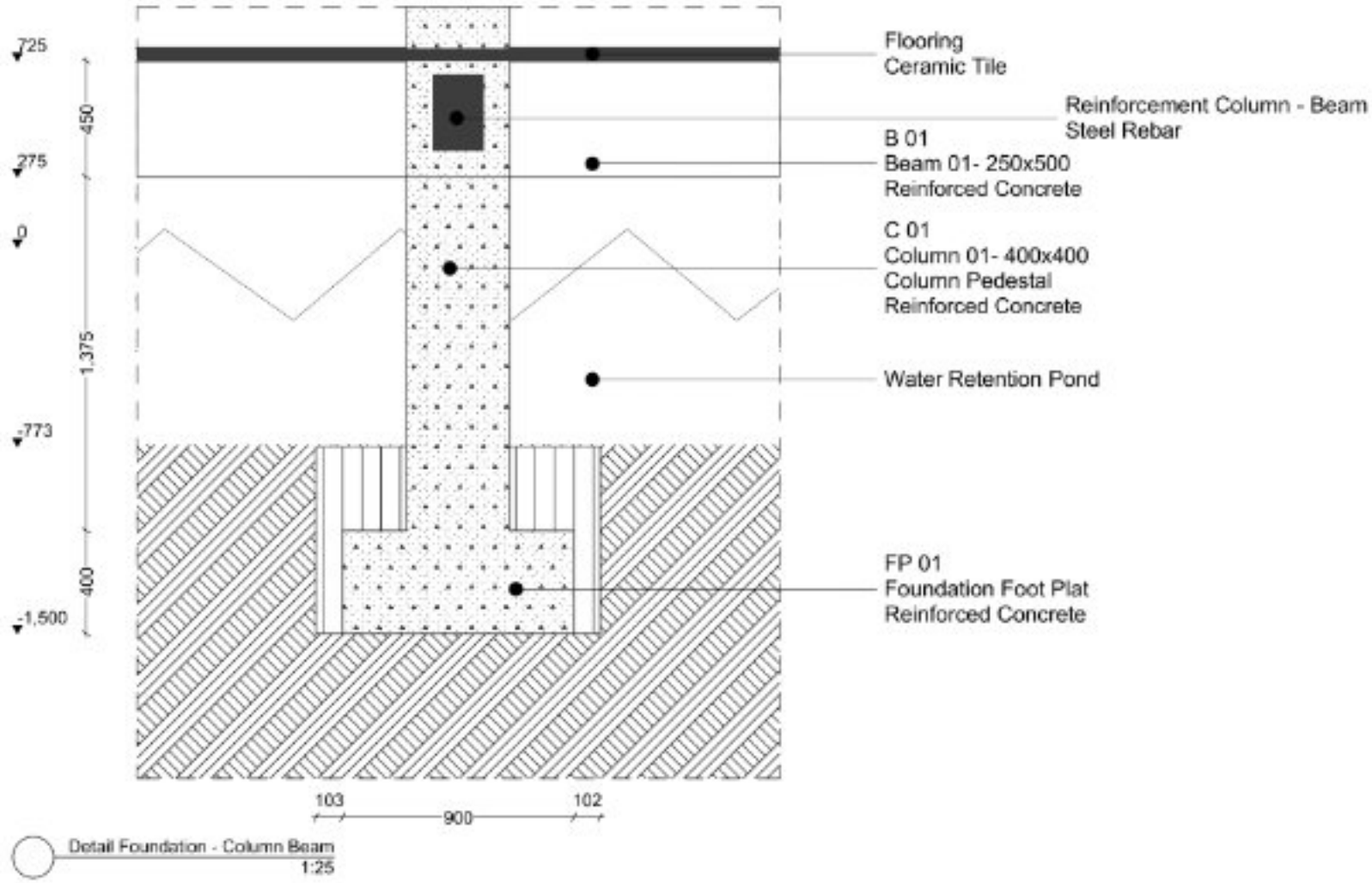
FP 01	Foundation Foot Plat
B 01	Beam 01- 250x500
B 02	Beam 02 - 200x300
C 01	Column 01- 400x400
C 02	Column 02 - 300x300
B 03	Beam 03 - 200x350
B 04	Beam 04 - 150x250

Mosque Structure

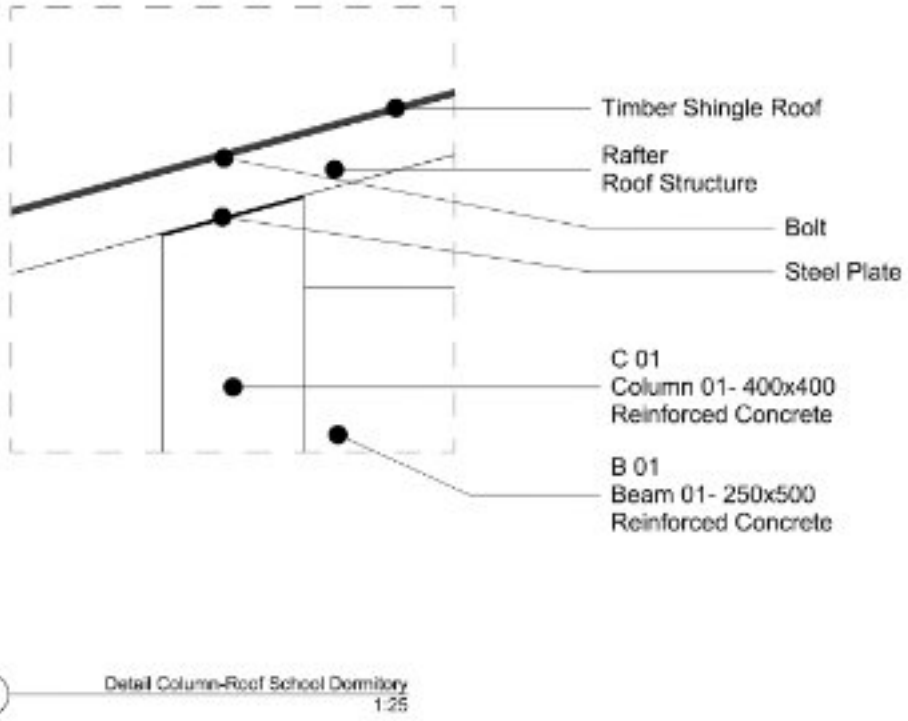


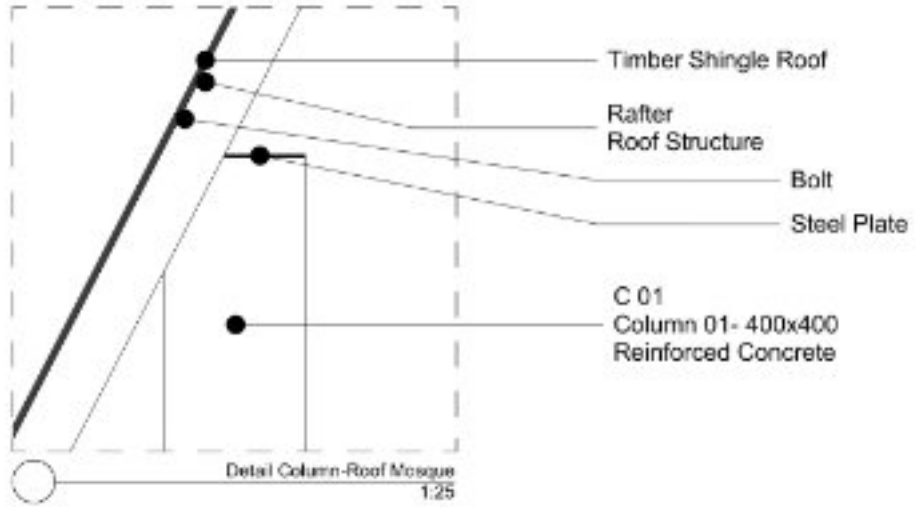
Mosque Structure Roof Plan
1:100

Detail Structure Building



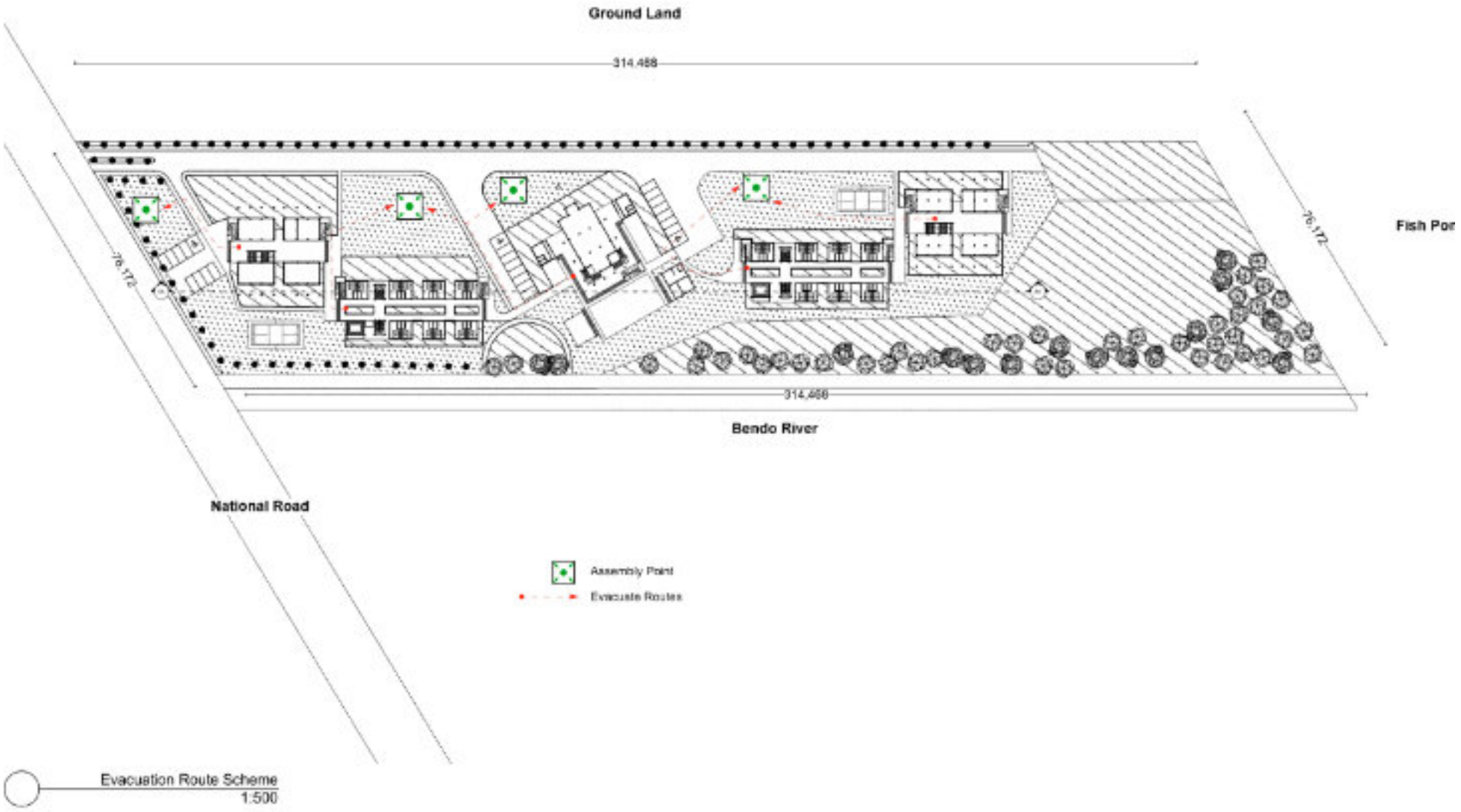
At the column-beam-foundation connection detail, the load transfer from the roof to the foundation is depicted to ensure it is technically visualized and structurally verifiable.





At the the column-roof connection detail using steel plates and bolts as a transition from the concrete material to the timber truss frame above it.

What is the infrastructure system scheme in design? (Exclude water)



Design Variable
Circulation & Mobility

Design Parameter
- **Guest vehicle parking located at front/peripheral zone of site**
- **Pedestrian pathway from main entrance to all zones**
- **Documented transportaional vertical on site plan (Barrier Free Design)**
- **Documented evacuation route on site plan**

Evacuation routes are designed toward five assembly points distributed evenly among the building clusters, with routes directed outward from the building masses toward the nearest open area, so that the evacuation travel time of the santri can be minimized under emergency conditions.

Vertical accessibility between buildings is realized through a combination of stairs, ramps, and one lift unit as an application of the barrier-free design principle, with ramps placed at the main entry point of every two-story building mass to ensure equal accessibility for all users, including persons with disabilities.

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Assalamualaikum Wr. Wb.

Dengan ini, menerangkan bahwa:

Nama	: Nabiel Manggala Hamdi
Nomor Mahasiswa	: 20512025
Pembimbing	: Ar. Faiz Hamdi Suprahman, S.T., M.A., IAI.
Fakultas / Prodi	: Teknik Desain Inovasi/ Arsitektur
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Karya ilmiah yang bersangkutan di atas telah melalui proses cek plagiasi menggunakan **Turnitin** dengan hasil kemiripan (*similarity*) sebesar **1 (Satu) %.**

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Wassalamualaikum Wr. Wb.

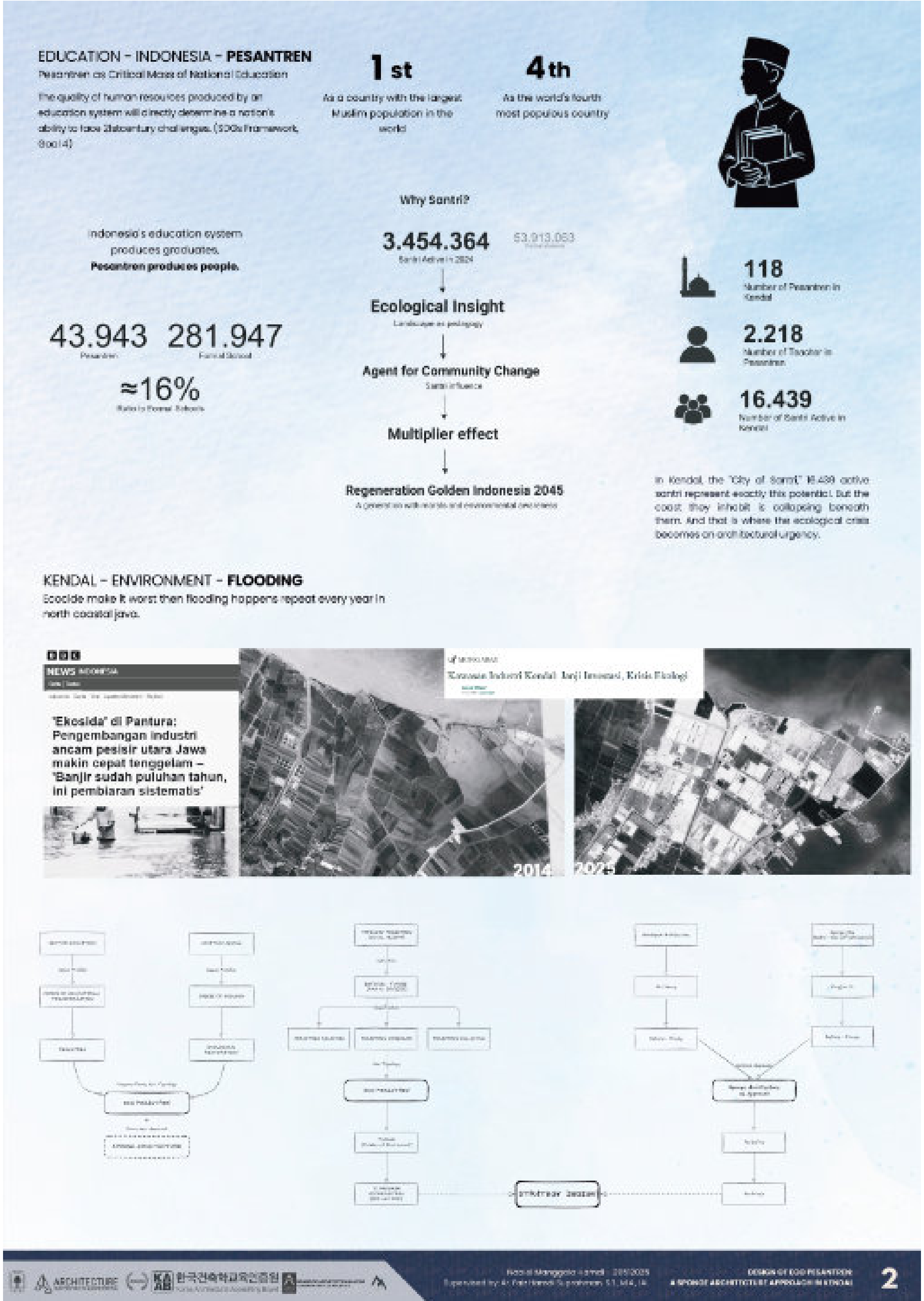
Yogyakarta, 06/08/2026
Direktur

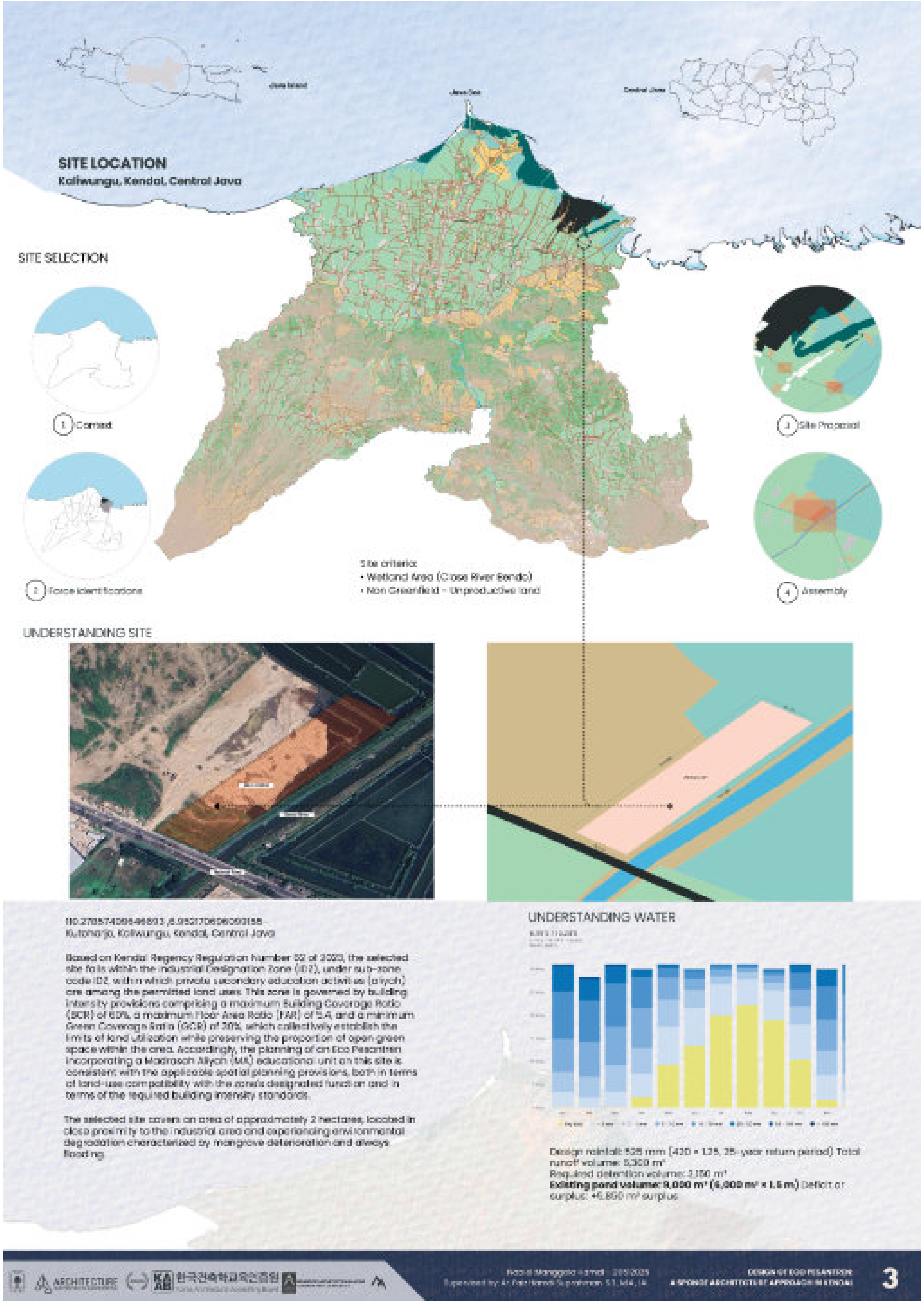
UNIVERSITAS ISLAM INDONESIA
DIREKTORAT PERPUSTAKAAN
YOGYAKARTA

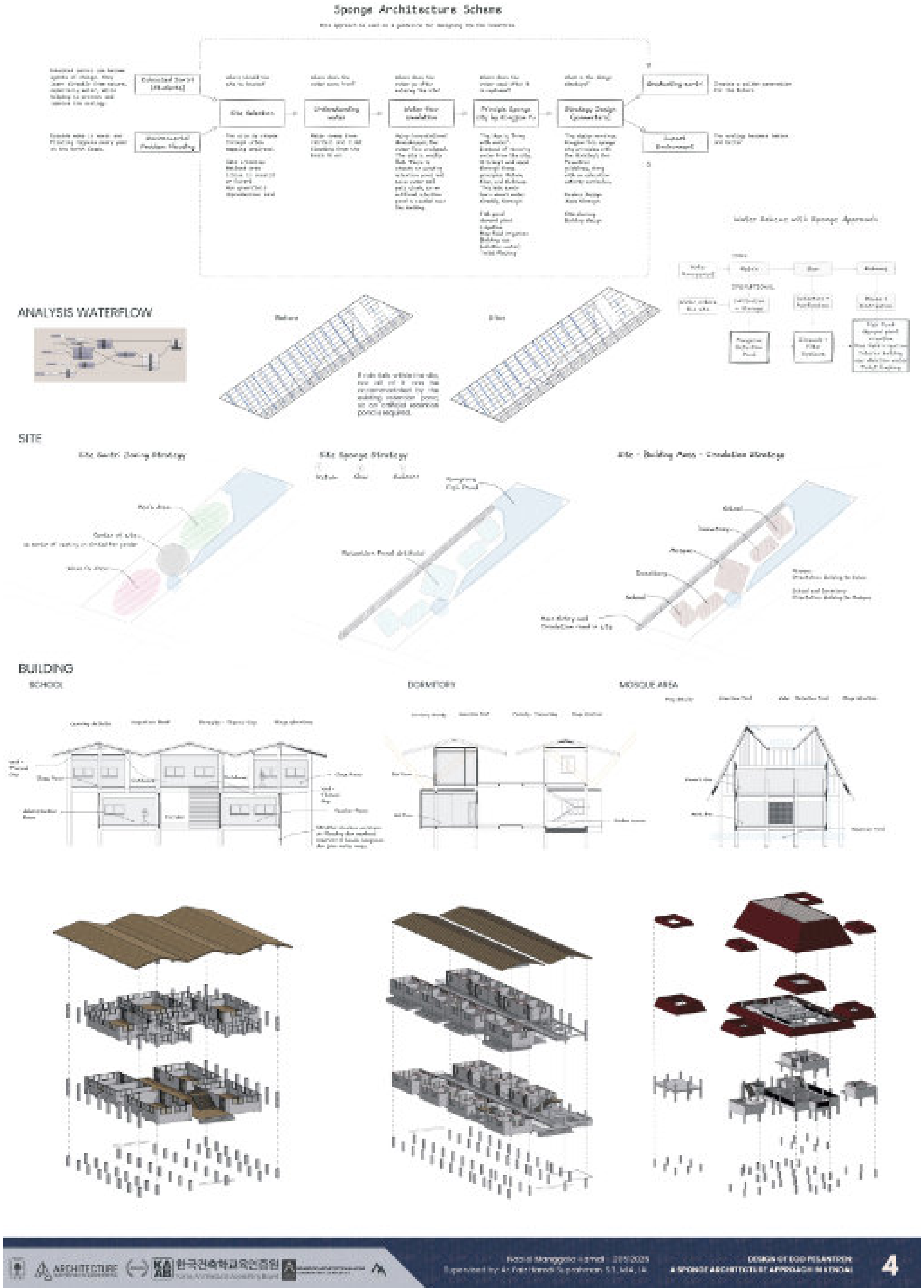
Muhammad Jamil, SIP.

Poster - APREB

QR Digital Link:
APREB
3D Model
Technical Drawing
Design Report

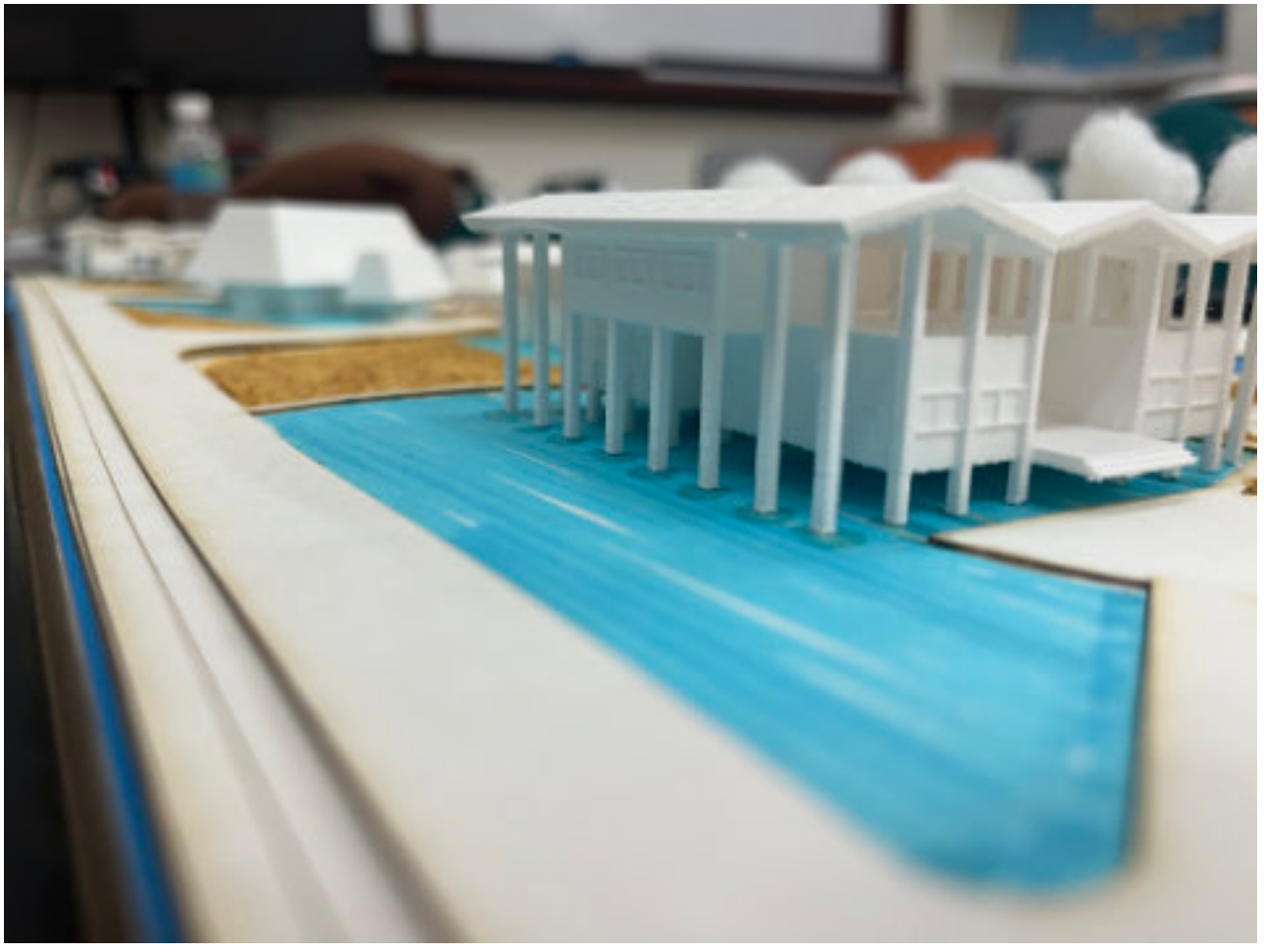

EDUCATION – INDONESIA – PESANTREN
Pesantren as Critical Mass of National Education
The quality of human resources produced by an education system will directly determine a nation's ability to face 21st-century challenges. (SDGs Framework, Goal 4)
1st
As a country with the largest Muslim population in the world
4th
As the world's fourth most populous country
Why Santri?
Indonesia's education system produces graduates.
Pesantren produces people.
3.454.364
Santri Active in 2024
53.913.063
43.943
Pesantren
281.947
Formal School
≈16%
Ratio to Formal Schools
Ecological Insight
Landscape as pedagogy
Agent for Community Change
Santri influence
Multiplier effect
Regeneration Golden Indonesia 2045
118
Number of Pesantren in Kendal
2.218
Number of Teacher in Pesantren
16.439
Number of Santri Active in Kendal
In Kendal, the "City of Santri," 16.439 active santri represent exactly this potential. But the coast they inhabit is collapsing beneath them. And that is where the ecological crisis becomes an architectural urgency.
KENDAL – ENVIRONMENT – FLOODING
Ecocide make it worst then flooding happens repeat every year in north coastal java.
BBC NEWS INDONESIA
'Ekosida' di Pantura: Pengembangan industri ancam pesisir utara Jawa makin cepat tenggelam – 'Banjir sudah puluhan tahun, ini pembiaran sistematis'
Kawasan Industri Kendal, Janji Investasi, Krisis Ekologi
2014
2025
한국건축학교육인증원
DESIGN OF ECO PESANTREN
A SPONGE ARCHITECTURE APPROACH IN KENDAL
2


SITE LOCATION
Kaliwungu, Kendal, Central Java
Java Island
Java Sea
Central Java
SITE SELECTION
1 Context
2 Force identifications
3 Site Proposal
4 Assembly
Site criteria:
• Wetland Area (Close River Bendo)
• Non Greenfield - Unproductive land
UNDERSTANDING SITE
110.2785740996466603 ,6.952170608093155 -
Kutoharjo, Kaliwungu, Kendal, Central Java
Based on Kendal Regency Regulation Number 32 of 2023, the selected site falls within the Industrial Designation Zone (ID2), under sub-zone code ID2, within which private secondary education activities (aliyah) are among the permitted land uses. This zone is governed by building intensity provisions comprising a maximum Building Coverage Ratio (BCR) of 60%, a maximum Floor Area Ratio (FAR) of 5.4, and a minimum Green Coverage Ratio (GCR) of 30%, which collectively establish the limits of land utilization while preserving the proportion of open green space within the area. Accordingly, the planning of an Eco Pesantren incorporating a Madrasah Aliyah (MA) educational unit on this site is consistent with the applicable spatial planning provisions, both in terms of land-use compatibility with the zone's designated function and in terms of the required building intensity standards.
The selected site covers an area of approximately 2 hectares, located in close proximity to the industrial area and experiencing environmental degradation characterized by mangrove deterioration and always flooding.
UNDERSTANDING WATER
Design rainfall: 525 mm (420 × 1.25, 25-year return period) Total runoff volume: 5,300 m³
Required detention volume: 3,150 m³
Existing pond volume: 9,000 m³ (6,000 m² × 1.5 m) Deficit or surplus: +6,850 m³ surplus
DESIGN OF ECO PESANTREN
A SPONGE ARCHITECTURE APPROACH IN KENDAL
3


Sponge Architecture Scheme
ANALYSIS WATERFLOW
SITE
BUILDING
SCHOOL
DORMITORY
MOSQUE AREA
4

MASTER PLAN
Render

Maket - 3D Model - Mockup



Final Architectural Studio
International Undergraduate Program
Department of Architecture
Faculty of Civil Engineering and Planning
Universitas Islam Indonesia
2026

Laboratorium Pemodelan Arsitektur & Perkotaan

DESIGN OF
ECO PESANTREN
A SPONGE ARCHITECTURE APPROACH IN KENDAL