WASL وَصل

AMMAN, JORDAN

Transforming Streets into Living Systems

Sustainable Mobility through Green, Connected Pathways

Team Name : Urban Purifiers

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1. Introduction

Climate change poses an existential threat to cities globally, which produce over **70%** of greenhouse gas emissions (IPCC, 2022). Amman, Jordan faces particularly severe challenges due to extreme water scarcity with unreliable piped supply (Abu-Qdais et al., 2023), limited rainfall (**300-400mm annually in Amman**; less than 100mm in most of Jordan see fig.1), deteriorating water situation from climate change and population growth and **challenging topography (seven hills with steep slopes)** that creates barriers to pedestrian movement, fragments neighborhoods and encourages car dependency despite relatively low vehicle ownership compared to Western countries (Liu et al., 2022)

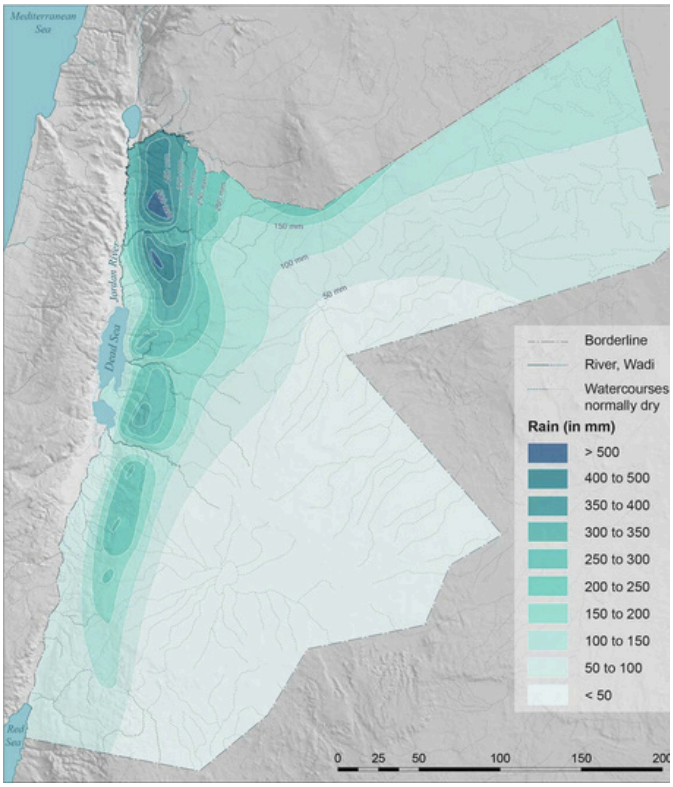


Fig 1. Precipitation and waterways in Jordan, mapped in the most recent available graphic, 1977. (Atlas of Jordan: History, Territories and Society (2013), ed. Myriam Ababsa)

The Amman Southern Gate site, spanning **1994.50 dunams (200 hectares)** across the **Khreibet Al-Souq**, **Jawa**, and **Al-Yadouda** districts, represents **a strategic opportunity to address these challenges.** Located at the intersection of **two major arteries—Madaba Street and Airport Road**—this largely undeveloped area serves as a critical southern gateway to the capital. Its selection for redevelopment is significant due to its strategic location, connectivity potential, and capacity to demonstrate how climate-responsive urban planning can transform underdeveloped areas into vibrant, sustainable neighborhoods that align with **Amman's 2025 vision** of becoming a world-class city **harmonizing cultural heritage with modern urban development.**

Sustainable Mobility System

Cultural Heritage Integration

Our proposal introduces a concept transforming streets and pedestrian pathways into living systems that support sustainable mobility while enhancing urban quality of life. This approach creates continuous, interconnected pedestrian routes enriched with natural elements and responsive technologies that actively manage stormwater, mitigate urban heat, and improve air quality while fostering social interactions. Following the competition framework, our response addresses **the design concept with focus on our integrated sustainable mobility system**, **cultural heritage integration**, and **climate-responsive design**; provides **environmental assessment** of the project's ecological benefits; and evaluates **the community benefits** examining social and economic advantages for Amman Southern Gate residents and the broader community.

2. Site analysis

2.1.Site location

The site selection is positioned in Al-Jubeiha, leveraging natural terrain features and accessibility to enhance visitor experience while promoting wildlife conservation and education.

JORDAN

Fig2. Located in the Middle East, bordered by Saudi Arabia, Iraq, and Palestine.(Jordan, 2019)

AL- JUBEIHA, AMMAN

Fig3. Located in north-central Jordan and inner south of Amman. (Jordan, 2019)

SELECTED SITE

Fig4. Amman, specifically in the Al-Jubeiha area. (Jordan, 2019)

2.2.Climatic analysis

2.2.1.Temperature & Humidity

- Semi-arid climate with hot, dry summers (up to 40°C) and cold winters (down to 2°C).
- Low relative humidity year-round (30–50%).

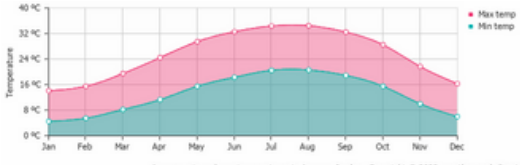


Fig5. Amman temperature range (Weather and Climate, 2024)

Fig6. Amman humidity (Weather and Climate, 2023)

2.2.2. Precipitation & Wind

- Annual precipitation often below 200 mm. The terrain becomes more arid, transitioning toward desert.
- The average wind speed over the year ranges from 2 m/s to 4 m/s.

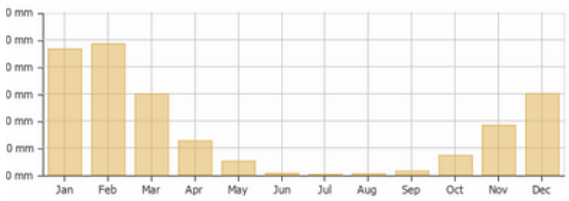


Fig7. Amman precipitation (Weather and Climate, 2023)

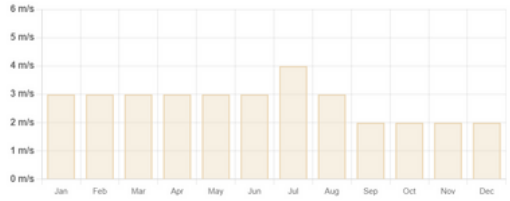


Fig8. Amman wind speed (Weather and Climate, 2023)

2.3. Socioeconmic context Analysis

- **Population:** The area has a young population of around 186,000, with Khreibet Al-Souq (~46,000) and Al-Yadouda (~11,000) included.
- **Education:** Public schools are accessible, especially in Al-Yadouda, with community support seen in Khreibet Al-Souq.
- **Employment:** Residents work mainly in services, trade, and local industry, with some informal and agricultural jobs.

2.4. Existing Infrastructure

Challenges in infrastructure

- **Water Shortages:** Amman faces water scarcity due to high demand and limited resources.
- **Geopolitical Constraints:** Water sources from neighboring countries are restricted.
- **Water Management:** Advanced systems exist, but supply remains unreliable.
- **Rainwater Harvesting:** A potential solution to enhance water supply resilience.

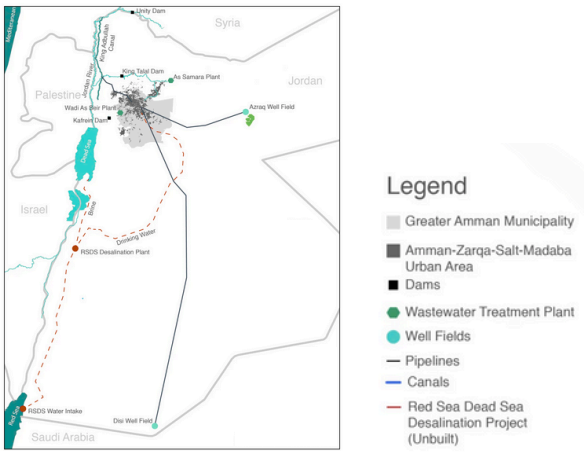
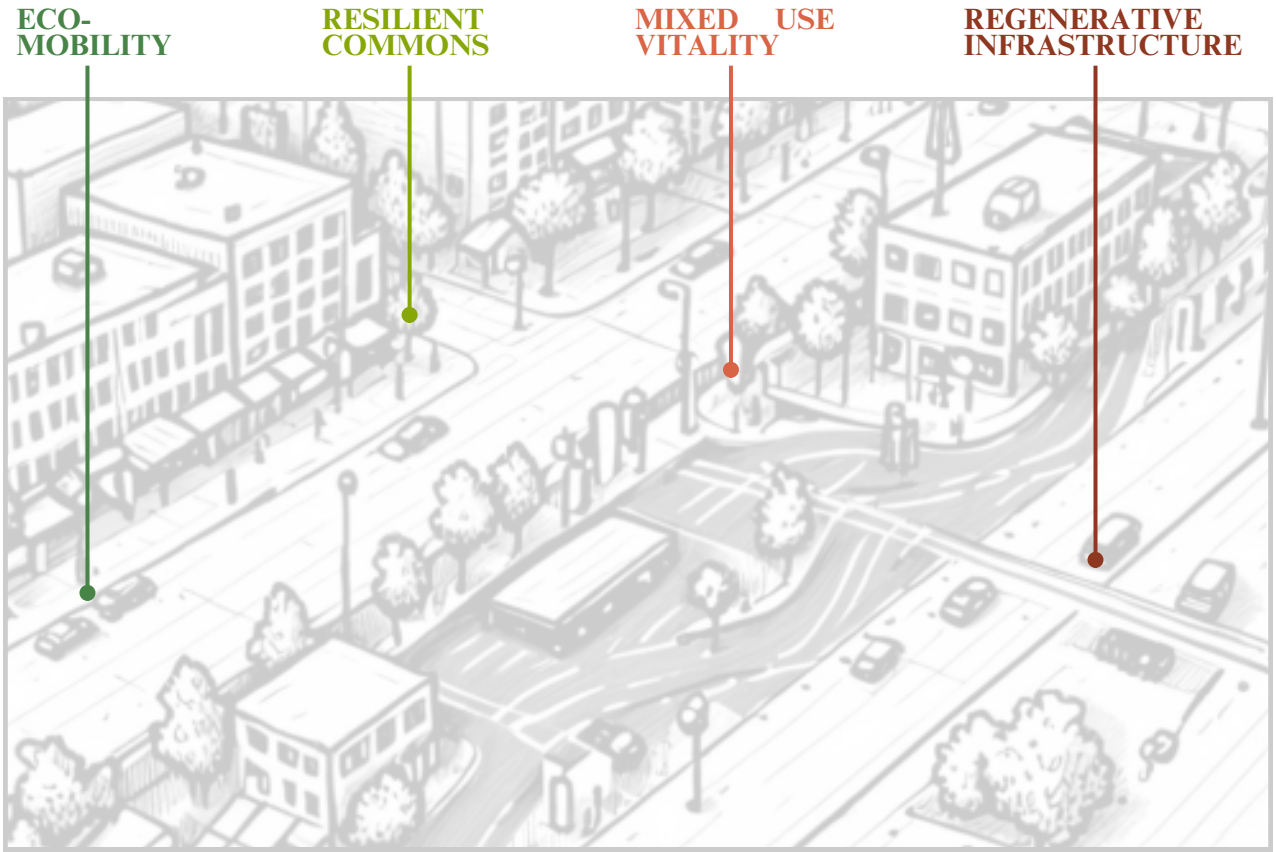


Fig9. Diagram of Amman's water system (urban water atlas, 2019)

3. Design Keywords based on Priority Areas & Main Expectations:

- Create a compelling sustainable and inclusive neighborhood vision promoting environmental, social, and economic well-being.
- Balance residential, commercial, and recreational spaces to strengthen the local economy.
- Develop pedestrian-first transportation with wide sidewalks, cycling infrastructure, and eco-friendly public transit.
- Implement sustainable energy practices and green building standards.
- Design accessible public spaces fostering community engagement.
- Prioritize interconnected green spaces and tree-lined paths.
- Integrate climate adaptation strategies for weather resilience.
- Incorporate sustainable water management through SUDS and Nature-Based Solutions.
- Ensure participatory planning reflecting community needs.



4. Design concept

4.1. Dynamic Eco-Pedestrian Network

This network transforms streets and pathways into living, dynamic systems that support sustainable mobility and enhance urban quality of life. The focus is on continuous, interconnected pedestrian routes that are enriched with natural elements and responsive technologies. These networks are "dynamic" because they evolve with community needs and environmental conditions, actively managing issues like stormwater, urban heat, and air quality while fostering social interactions. Building and Urban Aesthetics are Inspired by areas like **Rainbow Street in Amman** that have become popular spots for social gatherings, enhancing the city's social fabric.

The urban plan promotes a connected, inclusive and sustainable city through "**story paths**" that share elders' oral histories, **interactive play areas** for all ages, and "**generational gardens**" cared for by mixed age groups. The design is organized around **a green corridor**, linking residential and service zones, and prioritizing walkability over vehicle access.

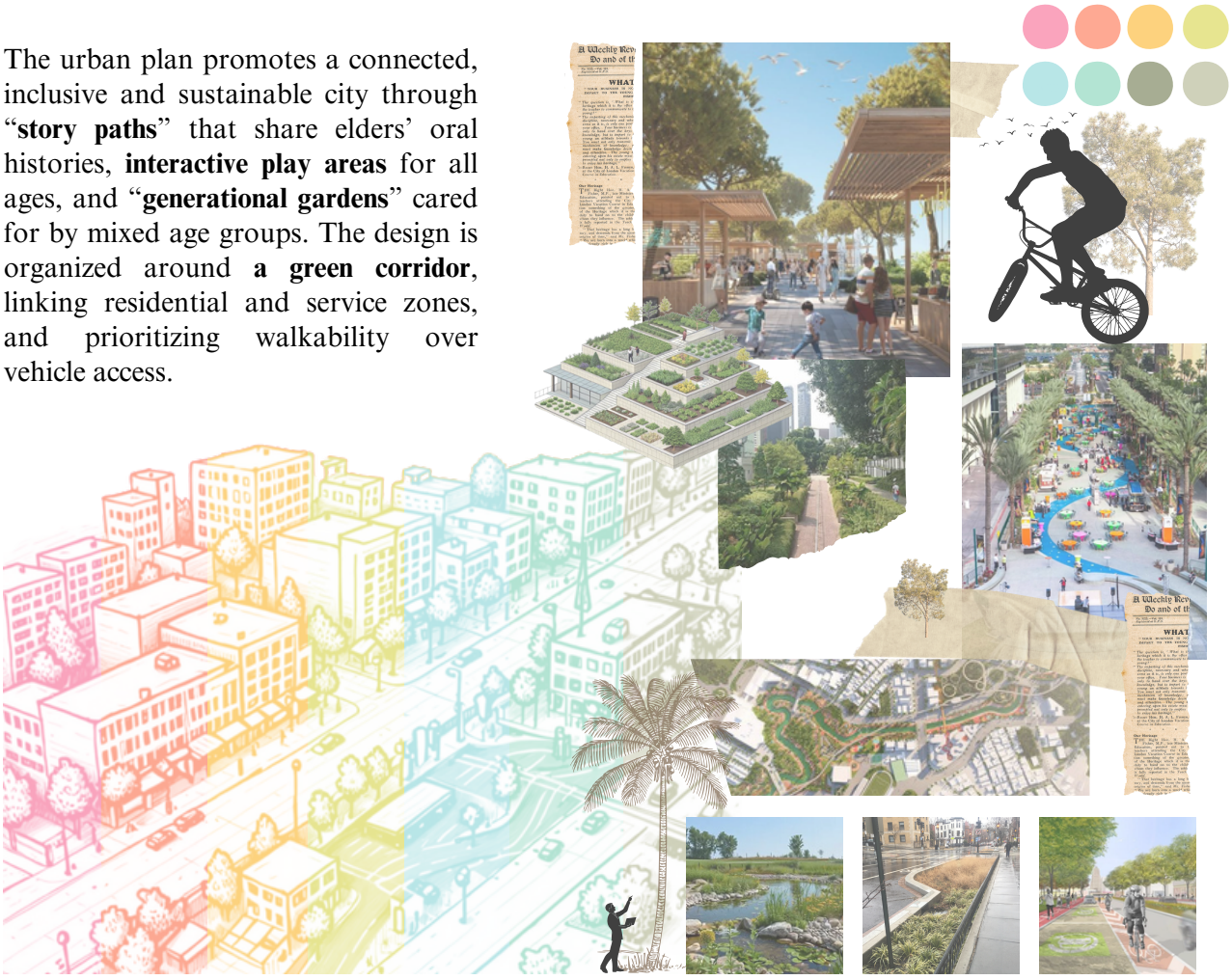


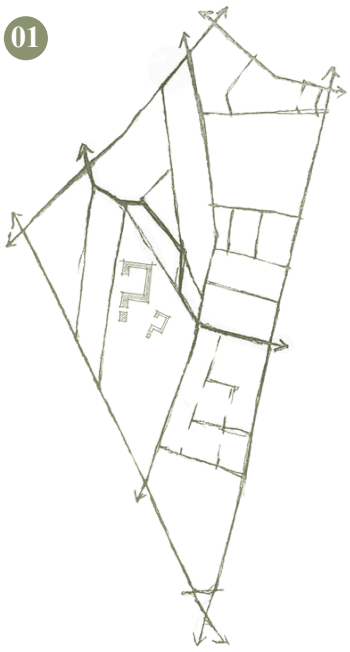
Fig 10. Dynamic Eco-Pedestrian Network Concept Mood Board (By Authors)

4.2. Design Framework

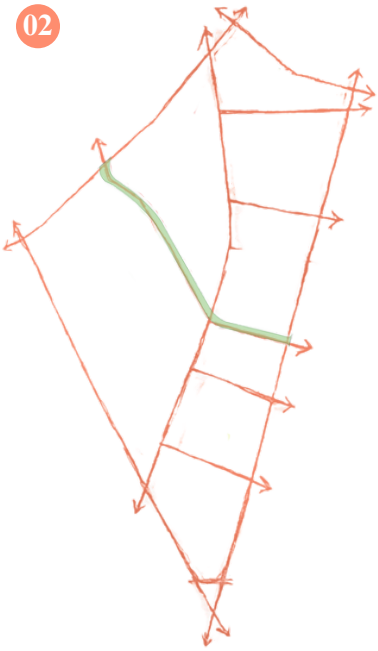
Based on the Dynamic Eco-Pedestrian Network concept, We Focused on specific implementation strategies for Amman. This framework cultivates a city where walking becomes the preferred mode of movement, environmental systems are visible and celebrated, and streets evolve into dynamic platforms for community life—establishing Amman as a regional leader in sustainable urban design.

- **Integrated Sustainable Mobility System.**
- **Cultural Heritage Integration.**
- **Social Interaction Nodes & Community Spaces.**
- **Circular Resource Management.**
- **Climate-Responsive corridors design and water smart urban design.**

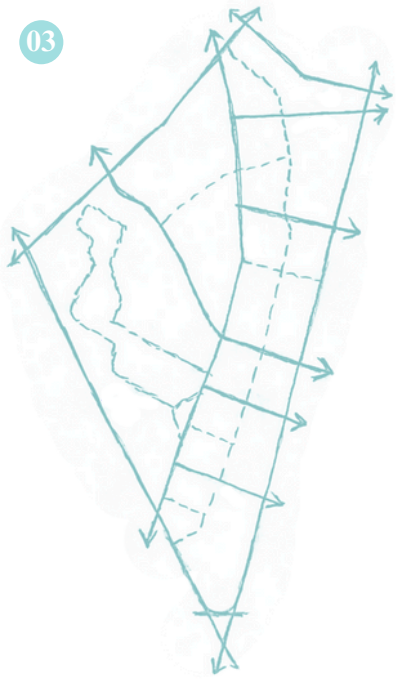
4.3. Form Generation



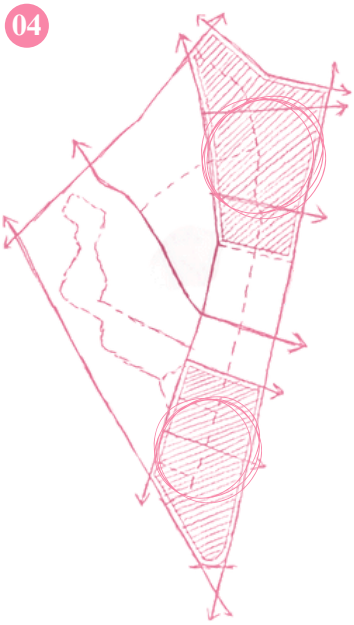
- Site with hierarchical road network - primary roads, secondary roads, branch roads, and collective roads **defining the initial site structure**.



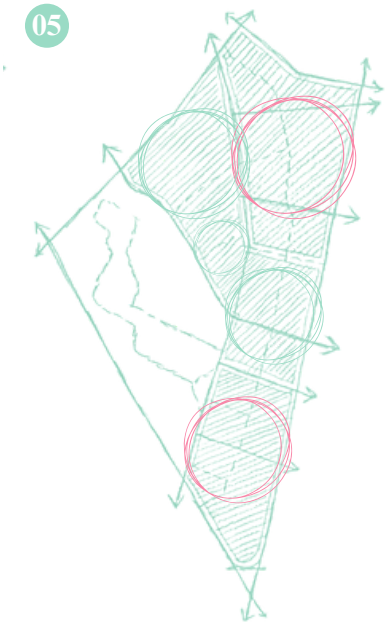
- **Refinement of the horizontal main road** to establish a **green corridor** as a primary axis, preservation of the vertical main axis, and development of secondary axes branching from these primary routes.



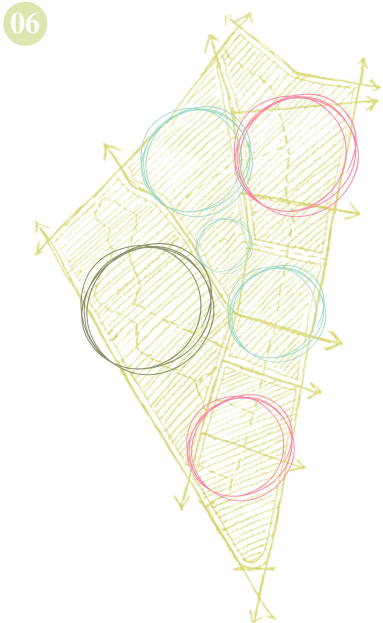
- Implementation of **pedestrian tertiary pathways** to connect zones and **facilitate smoother circulation throughout the site.**



- **Strategic preservation of the two residential zones** with access points designed both from outer perimeter roads and inner connecting areas.



- **Development of a commercial heart** positioned to connect and **serve the two residential zones, creating a central activity hub.**



- **Integration of an agricultural zone** located between the residential and commercial areas, with accessible entry points **designed to serve residents, provide educational opportunities, and support trade activities.**

4.4. Project zones

4.4.1.Agricultural zone

Converting the agricultural lands into a multifunctional community-focused area that promotes environmental, educational, and social engagement. The proposed features include:

- **Farm Fields and Wetland:** to support agriculture and ecology.
- **Showcase Gardens and a Farm Restaurant & Café :** for education and leisure.
- **Gathering Area and Community Practicing Zone:** for social and farming activities.
- **Children's Discovery Zone:** for environmental learning and play.
- **Dog Shelter:** for animal care and adoption.

Fig11. Agricultural zone (by author,2025)

Organic farming cultivates crops without synthetic pesticides or fertilizers, prioritizing ecological balance and soil health through natural processes.

4.4.2.Green corridor

The **green corridor** integrates natural landscapes, pedestrian and cycling paths, and biodiversity-supporting features. It connects key zones such as residential areas, public spaces, and ecological sites, acting as a linear park that supports both recreation and environmental functions.

Fig12. Green corridor (by author,2025)

4.4.3. Commercial zone

Surrounded by the green corridor and branching from it the pedestrian paths, Its zones area:

- **Retail & Leisure Zone:** A dynamic shopping destination featuring malls integrated with cinemas, arcades, and bowling alleys to create a complete leisure experience.
- **Mixed-Use Lifestyle Hub:** A vertical mix of functions, combining ground-floor commercial and entertainment spaces with upper-level office areas to support work-life integration.
- **Entertainment Strip:** A vibrant corridor hosting clubs, bars, comedy lounges, e-sports arenas, interactive museums, and adjacent retail for fashion and novelty goods.
- **Family-Friendly Entertainment Zone:** A safe and engaging area designed for families, offering age-appropriate attractions and inclusive recreational activities (to be detailed further).
- **Cultural and Art District:** A creative zone dedicated to art galleries, theaters, live music venues, and cultural events, promoting artistic expression and community engagement.

Fig13. Commercial zone (by author,2025)

4.4.4. Residential zone

The residential area is divided into two main zones, each shaped by surroundings and functional needs.

- **Upper Residential Zone:** This zone was expanded due to the existing residential presence, reinforcing and growing the established community.
- **Lower Residential Zone:** Located near a zoo and a primary school, this zone places residential units strategically around key services, enhancing accessibility and daily convenience.

Fig14. Residential zone (by author,2025)

4.5. Nature Based Solutions Implementation:

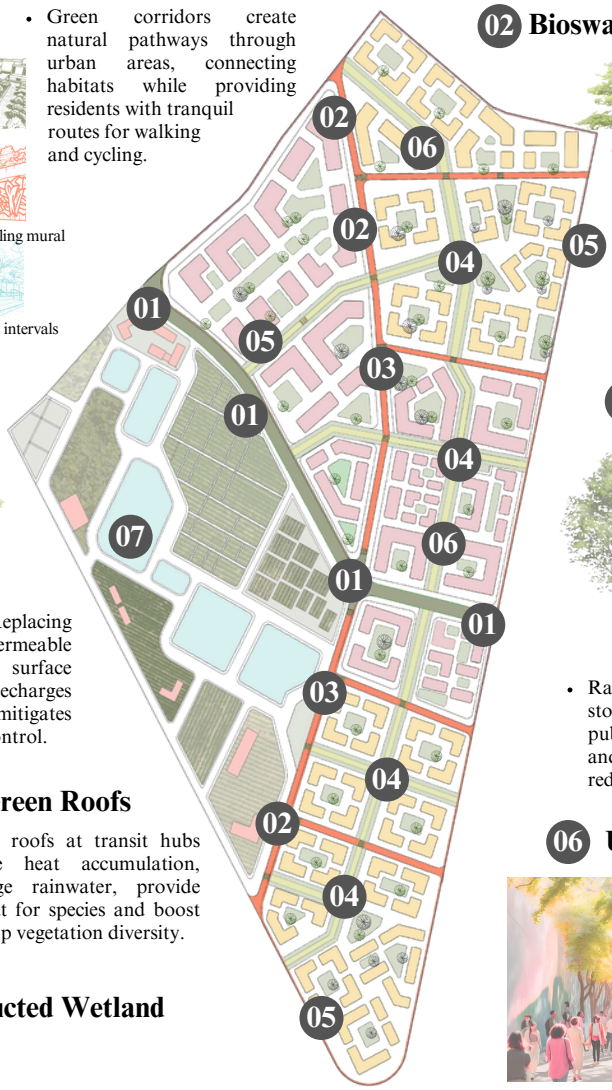
01 Green Corridor

Pocket Park

cultural storytelling mural

rest spots at key intervals

- Green corridors create natural pathways through urban areas, connecting habitats while providing residents with tranquil routes for walking and cycling.



02 Bioswales

- Bioswales along transportation corridors help manage urban runoff and reduce flash flooding by filtering pollutants and improving water cycles.

03 Permeable Pavement

- Permeable Pedestrian Surfaces Replacing impervious paths with permeable materials reduces runoff, cools surface temperatures, and recharges groundwater. This strategy also mitigates urban heat and supports flood control.

04 Rain Gardens

- Rain gardens at pedestrian nodes enhance stormwater capture and biodiversity in public areas, offering irrigation savings and supporting native plant life while reducing localized flooding.

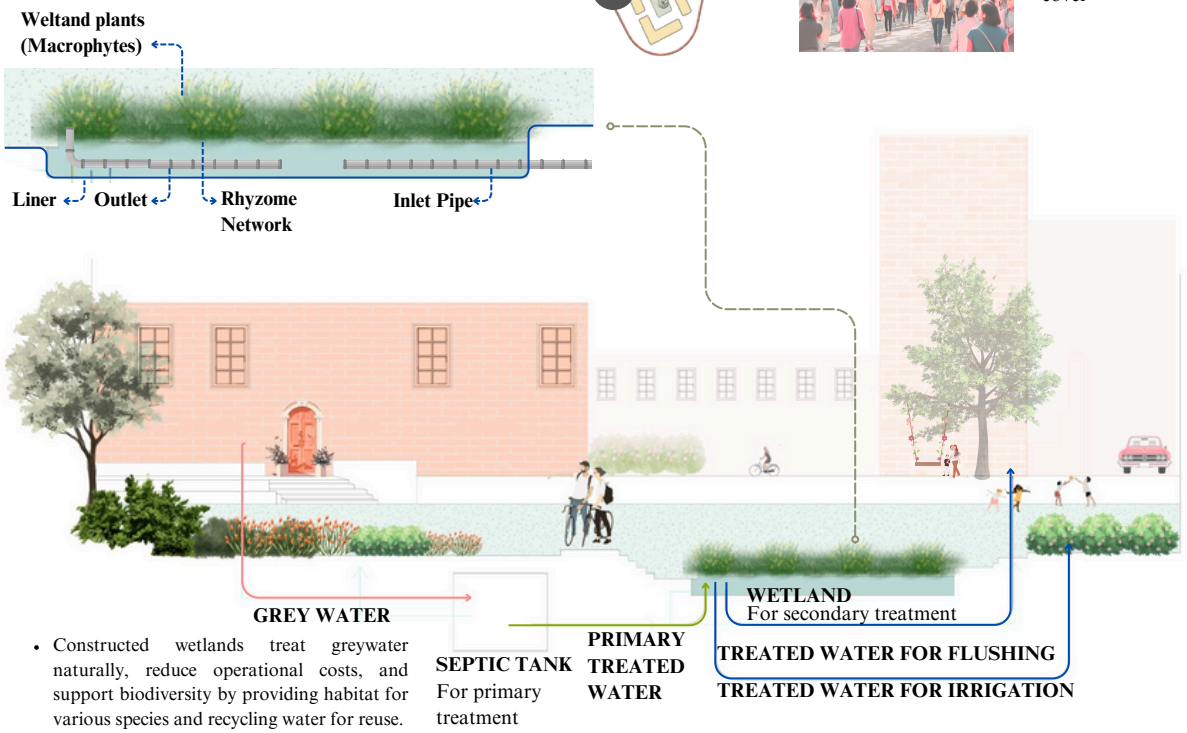
05 Green Roofs

- Green roofs at transit hubs reduce heat accumulation, manage rainwater, provide habitat for species and boost rooftop vegetation diversity.

06 Urban Forest Corridors

- Connecting zones, restore biodiversity, sequester carbon, and reduce urban heat by planting trees and expanding green cover

07 Constructed Wetland



- Constructed wetlands treat greywater naturally, reduce operational costs, and support biodiversity by providing habitat for various species and recycling water for reuse.

5. Environmental assessment of the project

	1.Stormwater Management – Bioswales	2. Permeable Pedestrian Surfaces	3.Urban Forest Corridors	4.Rain Gardens at Pedestrian Nodes	5.Green Roofs at Transit Hubs	6.Constructed Wetlands for Greywater Treatment
IMPLEMENTATION						
PURPOSE	Manage urban runoff and reduce flash floods using green infrastructure	Reduce runoff and recharge groundwater while cooling surfaces	Increase shade, sequester carbon, and restore biodiversity	Capture rainwater and support biodiversity in visible public areas	Improve energy efficiency, manage rainwater, and boost biodiversity	Treat greywater naturally and support urban ecosystems
BEFORE IMPLEMENTATION	• Uncontrolled surface runoff • Frequent localized flooding • No pollutant removal	• 100% impervious paths • Surface runoff • Urban heat buildup	• Sparse green cover • Fragmented ecology • Hot urban microclimate	• No localized stormwater control • Inefficient water use	• Concrete rooftops • Heat accumulation • Zero ecological function	• Conventional centralized treatment • No reuse • High operational cost
AFTER IMPLEMENTATION	• 12 km bioswales • 18,000 m² area • 540,000 L capacity • 4.32 million L/year treated	• 35% pathways made permeable • 157,500 m² area • 1,575 m³/hr infiltration • 236,250 m³/year recharge	• 8.5 km green corridors • 51,000 m² area • 2,040 trees planted	• 35 rain gardens • 1,400 m² total area • 84,000 L retained	• 8,500 m² green roofs • 59,500 L rainwater retention	• 5,000 m² wetlands (3 sites) • 450 m³/day capacity • Serves 6,000 residents
ENVIRONMENTAL IMPACT	• **TSS removed: 85%** • **Phosphorus: 65%** • **Nitrogen: 50%** • **Improved local water cycles**	• **Reduced surface temps by 2–4°C** • **Enhanced groundwater levels** • **Flood mitigation**	• **40.8 tons CO_2/year sequestered** • **Temp drop of 3.5–4.5°C** • **Improved air quality & walkability**	• **30% flood peak reduction** • **1.12 million L/year irrigation savings** • **4,200 native plants supported**	• **30% energy savings** • **2–3× increased roof lifespan** • **45–60 plant species added**	• **BOD removal: 95%** • **Solids: 85%** • **Nitrogen: 40%** • **Habitat for 25–30 bird species and 12–15 aquatic species** • **60% lower cost than traditional systems**

Implementation	Bioswales (Stormwater Management)	Permeable Surfaces	Urban Forest Corridors	Rain Gardens	Green Roofs	Constructed Wetlands
Before	✗	✗	✗	✗	✗	✗
After	✓	✓	✓	✓	✓	✓
Estimated Coverage percentage	~0.9% (18,000 m² of 2,000,000 m²)	~7.9% (157,500 m² of pedestrian areas)	~2.6% (51,000 m²)	~0.07% (1,400 m² total)	~0.43% (8,500 m² on transit hubs)	~0.25% (5,000 m² total)

The environmental assessment demonstrates that the project successfully implemented six sustainable urban design strategies—bioswales, permeable surfaces, urban forest corridors, rain gardens, green roofs, and constructed wetlands—transforming **previously deficient infrastructure into effective green solutions that manage water, improve biodiversity, reduce heat, and create healthier urban ecosystems.**

6. Evaluation of The Community Benefits:

6.1. Enhanced Community Connectivity and Social Cohesion:

Our **Cross-Generational Engagement** approach incorporates "**story paths**" that digitally preserve elders' oral histories, interactive multigenerational play and exercise equipment, **"knowledge exchange points"** for skill-sharing, and "generational gardens" maintained collaboratively by different age groups. These strategies address the current social fragmentation while respecting and elevating local cultural heritage, creating spaces where intergenerational knowledge transfer occurs naturally, strengthening community cohesion and resilience. (See fig.11)

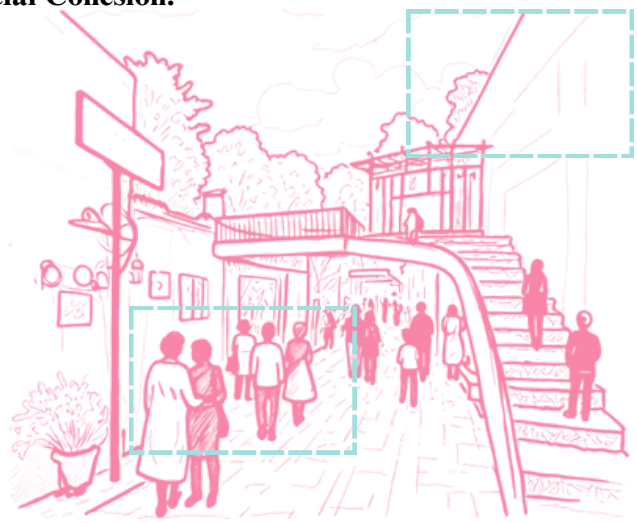
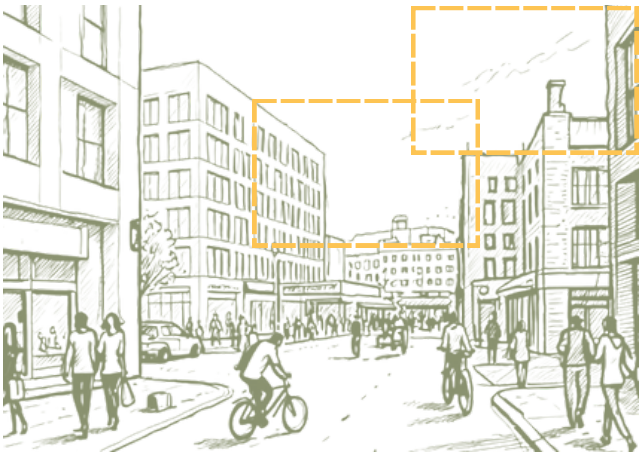


Fig. 11 A perspective illustration showing one of the proposed social interaction nodes with cross-generational activities taking place, including elements of the "story paths," knowledge exchange points, and multigenerational exercise equipment, all within a green setting

6.2. Economic Revitalization Through Sustainable Development:

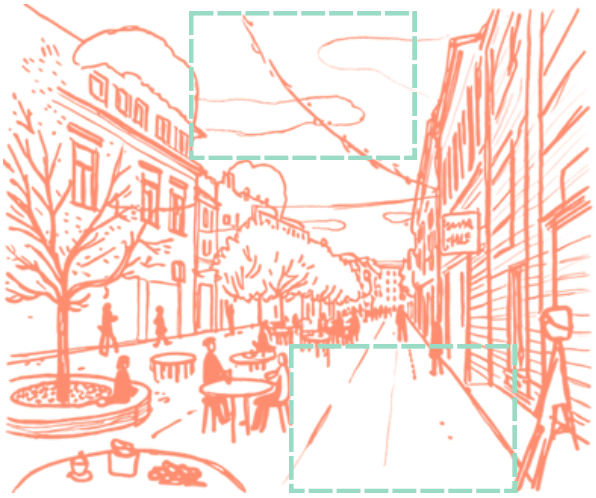


The economic benefits of our proposal extend beyond traditional metrics by embracing circular economy principles. The Transit-Oriented Development nodes create mixed-use areas around transportation hubs, stimulating local business growth and creating nearby employment opportunities. This **15-minute city model** reduces transportation costs while creating vibrant commercial centers supporting small businesses. Our Circular Resource Management strategy creates skilled **jobs in green construction and waste upcycling while reducing materials costs.**

6.3. Economic Revitalization Through Sustainable Development:

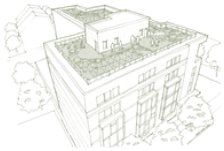
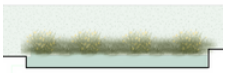
The proposal combines active mobility, green infrastructure, and water management to deliver health and economic benefits. Urban forest corridors and bioswales encourage **physical activity while improving air quality, reducing healthcare costs by 3-8%**. Constructed wetlands address water shortages, support biodiversity, and serve as educational and recreational spaces.

The Constructed wetlands become living laboratories for environmental education, fostering ecological awareness while **providing recreational amenities that enhance quality of life.**



7. Appendix:

This appendix provides detailed technical specifications and quantitative analysis for our proposed green infrastructure solutions across the 200-hectare development site. The calculations presented here demonstrate the environmental impact, resource efficiency, and performance metrics for the 6 Nbs:

	1. Bioswales Along Transportation Corridors	2. Permeable Pedestrian Surfaces
IMPLEMENTATION	 • Installing **12 km of bioswales along primary and secondary streets** within the 200-hectare site: • Focusing **on Airport Street and Madaba Street corridors (4.5 km)** • **Secondary street network bioswales (7.5 km)**	 • Converting **35% of pedestrian pathways to permeable surfaces across the network** • Focusing on **tertiary streets/pathways** and transit-oriented development nodes
CALCULATIONS	• **Average bioswale width: 1.5m** • Total bioswale area: 12,000m × 1.5m = 18,000 m² • Stormwater capacity: 30 liters/m² = 540,000 liters total retention • Annual water treatment capacity: 4,320,000 liters **(based on Amman's 400mm annual rainfall)** • Estimated Pollution removal efficiency: **85% TSS, 65% phosphorus, 50% nitrogen removal**	• Estimated total pedestrian surface: **45 hectares (22.5% of site area)** • Permeable surface area: 45ha × 35% = 15.75 hectares (157,500 m²) • Water infiltration capacity: 10mm/hr = 1,575 m³/hr **during peak rainfall** • Groundwater recharge potential: **236,250 m³ annually** • Heat island reduction: **2-4°C surface temperature reduction**
	3. Urban Forest Corridors	**4. Rain Gardens at Pedestrian Nodes**
IMPLEMENTATION	 • Creating **8.5 km of urban forest corridors connecting neighborhoods** • Planting **native drought-resistant species** with minimal irrigation needs • Integrating with pedestrian pathways to **provide shade and cooling**	 • Instaling **35 rain garden systems at transit nodes and public gathering spaces** • Target size: 30-50 m² per installation • Focusing on **high-visibility areas to demonstrate stormwater management**
CALCULATIONS	• **Average corridor width: 6m** • Total forest corridor area: 8,500m × 6m = 51,000 m² • Tree planting density: **1 tree per 25 m² = 2,040 trees** • Carbon sequestration: 40.8 tonnes CO_2/year (20kg per tree annually) • Cooling effect: **3.5-4.5°C ambient temperature reduction** • Water demand: 265,000 liters/year (130 liters per tree annually)	• **Total rain garden area: 1,400 m²** • Water retention capacity: 84,000 liters (60 liters/m²) • Flood peak reduction: **30% for localized 10-year storm events** • Irrigation water savings: 1.12 million liters annually • **Supports 4,200 native plants (3 plants/m²)**
	5. Green Roofs at Transit Hubs	**6. Constructed Wetland for greywater treatment**
IMPLEMENTATION	 • Installing **8,500 m² of green roof systems** on transit hub structures and adjacent buildings • Focusing on lightweight extensive systems **(10-15cm substrate depth)** • Integrating with **rainwater harvesting**	 Horizontal Subsurface Flow • Develop a **constructed wetland (5,000 m² total)** • Positioning in natural drainage areas **visible from pedestrian network** • Connecting to **surrounding buildings for greywater treatment**
CALCULATIONS	• Water retention capacity: 59,500 liters (7 liters/m²) • Thermal insulation: **30% reduction in cooling energy needs** • Lifespan extension of roof membranes: 2-3× standard roofing • Maintenance requirements: 3-4 visits per year (12 labor hours/100m² annually) • Biodiversity increase: **45-60 plant species supporting urban pollinators**	• Treatment capacity: 450 m³/day • Serves equivalent of 6,000 residents (75 liters per person daily) • Estimated Pollutant removal: 95% BOD, 85% suspended solids, 40% nitrogen • Habitat creation: **Supports 25-30 bird species and 12-15 aquatic species** • Construction cost efficiency: **60% less than conventional treatment**

This diagram shows the performance of our integrated urban water management system that combines conventional wastewater treatment with nature-based solutions to create a sustainable water cycle for urban and agricultural use:

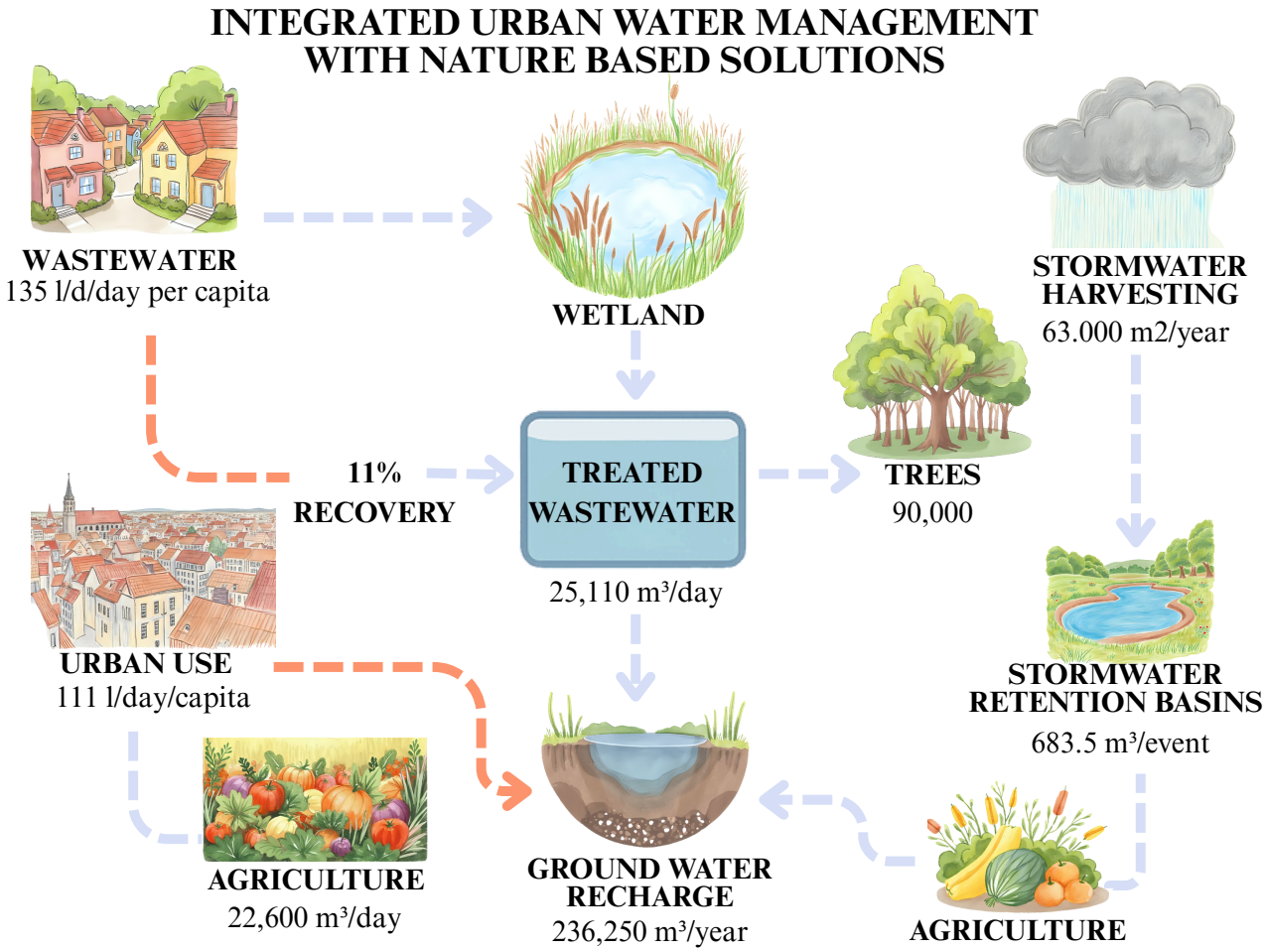


Fig. 12 Schematic diagram illustrating the water resources and outputs for the proposed Project (by authors)

Combined System Performance

- Water Management for Total Population: Total wastewater generated (at 135 L/person/day): 186,000 residents × 135 L/day = 25,110,000 L/day = 25,110 m³/day
- Current wetland capacity: 450 m³/day (handles 1.8% of total wastewater)
- Additional treatment needed: 25,110 m³/day - 450 m³/day = 24,660 m³/day

Total Stormwater Management

- Combined stormwater retention capacity: Bioswales: 540,000 liters + Rain gardens: 84,000 liters + Green roofs: 59,500 liters +Total capacity: 683,500 liters (683.5 m³)
- For a site of 1,994,500 m²: This provides capacity to handle a rainfall event of: 683.5 m³ ÷ 1,994,500 m² = 0.00034 m = 0.34 mm rainfall
- For Amman's 400mm annual rainfall, this represents: (0.34 mm ÷ 400 mm) × 100% = **0.085% of annual rainfall in one-time capacity**

Total Ground Coverage of Green Infrastructure

- Bioswales: 18,000 m² (0.9% of site)
- Permeable surfaces: 157,500 m² (7.9% of site)
- Urban forest corridors: 51,000 m² (2.56% of site)
- Rain gardens: 1,400 m² (0.07% of site)
- Green roofs: 8,500 m² (0.43% of site)
- Constructed wetland: 5,000 m² (0.25% of site)

Total green infrastructure area: 241,400 m² , Percentage of total site area: (241,400 m² ÷ 1,994,500 m²) × 100% = 12.1%

Per Capita Green Infrastructure, Per capita provision: 241,400 m² ÷ 186,000 residents = **1.3 m² per resident**

Carbon Impact

- Carbon sequestration from urban forest: 40.8 tonnes CO_2/year.
- Additional sequestration from other vegetation (estimated): Green roofs: 8,500 m² × 0.5 kg CO_2/m²/year = 4.25 tonnes CO_2/year Wetlands: 5,000 m² × 0.3 kg CO_2/m²/year = 1.5 tonnes CO_2/year **Total carbon sequestration: approximately 46.55 tonnes CO_2/year**

8. References:

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