WATER REGENERATION

Vila Pinherio's – Water Self-sufficiency Design

Water Is Life's Blood, A Partner In Regeneration, Turning Scarcity Into Abundance And Ensuring All Life Flourishes.

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Diploma In Applied Permaculture Design

Design No. 5:

Vila Pinheiro – Water self-sufficiency

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EXECUTIVE SUMMARY

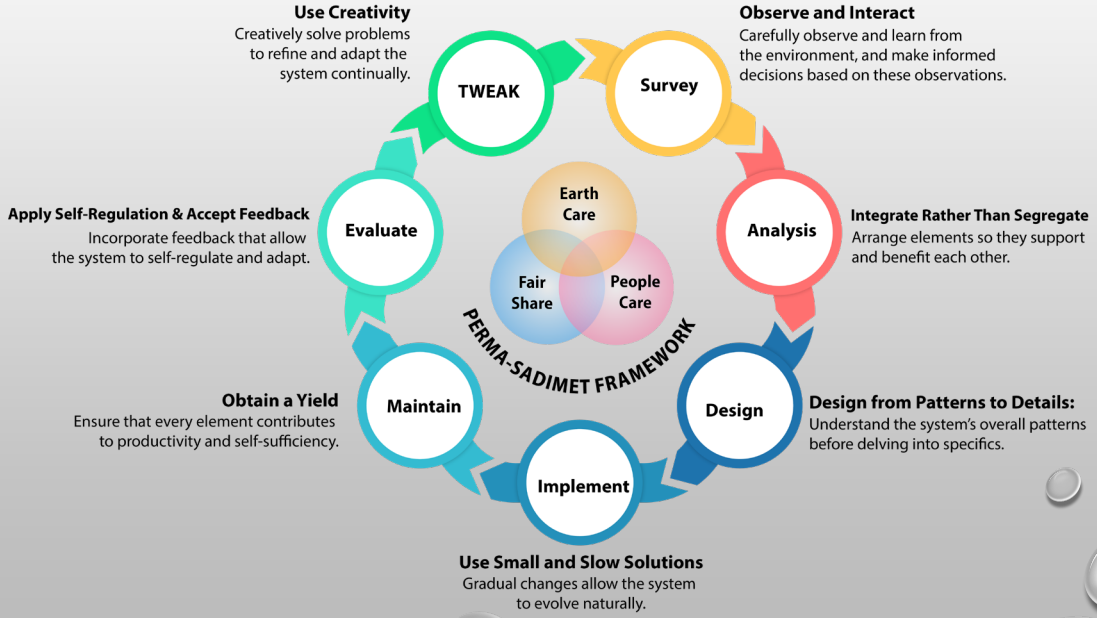
- **Overview:** the project aims to achieve water management self-sufficiency for The D'Cruz Family (clients) at Vila Pinheiro, Caldas da Rainha, Central Portugal, by reducing reliance on external sources and increasing resilience to climate variability. It focuses on securing long-term water availability through innovative, regenerative practices.
- **Framework And Tools:** the design employs the PERMA-SADIMET Framework, an infusion of SADIMET (survey, analysis, design, implementation, maintenance, evaluation, tweak) with permaculture principles. This iterative approach creates self-sustaining systems that restore and enhance local ecosystems. Tools used include Swales, Strategic Zoning PMI and FSE to optimise resources and minimise waste.
- **Key Findings:** The design offers benefits such as improved water security, cost efficiency, and reduced environmental impact. Challenges include high initial costs, system complexity, and the need for specialised maintenance. The approach encourages a shift from a scarcity mindset to one of abundance by integrating natural water cycles and boosting ecosystem resilience.
- **Conclusion:** The water self-sufficiency design is an adaptive forward-thinking strategy focusing on regeneration rather than just sustainability. Integrating diverse systems and practices aims to enhance resource efficiency, lower environmental impact, and ensure long-term water and ecosystem health, supporting overall planetary well-being.

WHY WATER SELF-SUFFICIENCY

- Water self-sufficiency ensures effective homestead resource management, reducing waste, preserving the environment, and supporting long-term planning.
- It decreases dependency on external sources, enhancing reliability and cost efficiency, particularly during crises.
- Additionally, it improves homestead resilience to climate variability, ensuring water security during droughts and even heavy rainfall.

PERMA-SADIMET
EMPOWERING REGENERATION: SADIMET & PERMACULTURE

The iterative application of the structured process of SADIMET, in conjunction with the Ethical Framework and Principles of Permaculture, fosters the creation of systems that not only sustain themselves but actively restore and enhance the surrounding ecosystems, promote environmental feedback, continuously enhancing their capacity to support life and maintain ecological harmony, support biodiversity and contribute to the long-term health of the planet*.

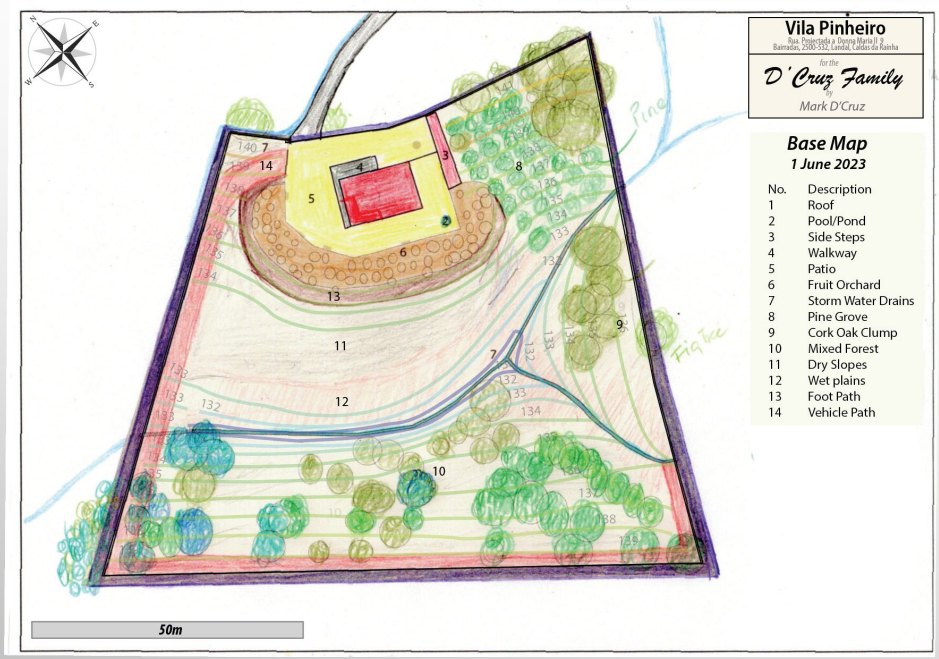


*Appendix -1- Empowering Regeneration Through SADIMET and Permaculture

SURVEY >> GOALS

- **Achieving Full Water Autonomy:** By mimicking natural processes, creating systems that are autonomous and resilient. Where all homestead water needs are met through independent, sustainable methods without reliance on external sources. (*People Care*)
- **Utilising Natural Water Resources:** Harness and store rainwater and groundwater efficiently, aligning with the natural water cycle to ensure a consistent year-round water supply. (*Earth Care*)
- **Optimising Water Conservation:** By adopting water conservation techniques and practices, we aim to minimise water waste and ensure that every drop is used effectively to support the homestead's needs. (*Fair Share*)

SURVEY >> OBSERVATION AND INTERACTION



Topography Map of Vila Pinheiro

Climate: Vila Pinheiro experiences hot, dry summers and mild, wet winters. It has moderate to heavy rainfall over winter and almost none over June, July and August.

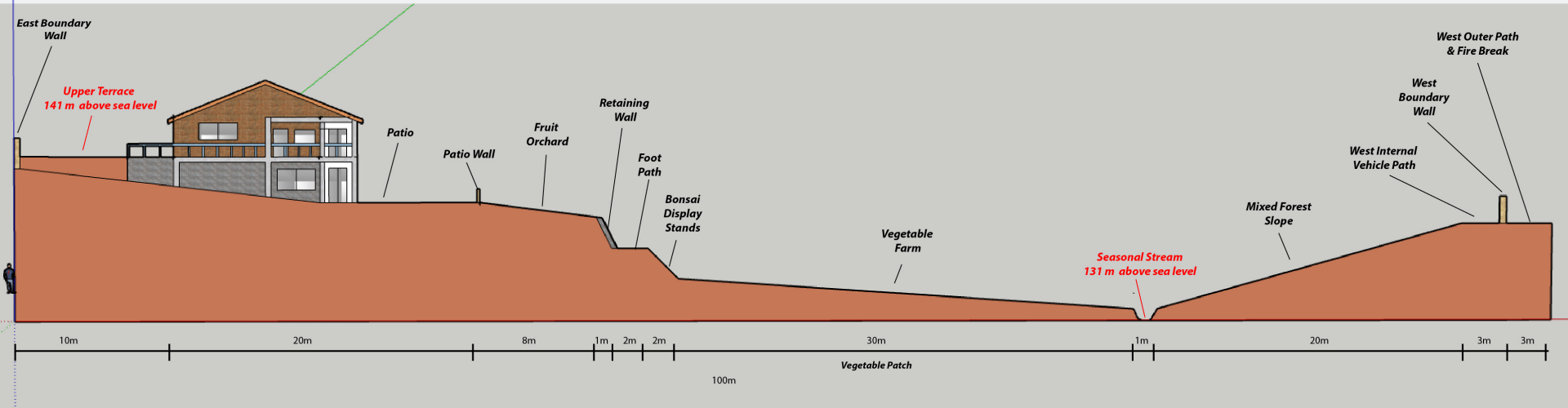
Topography: The land's slopes, has natural water flows, as shown in the topography map, from 141m to 131m above sea level.

Water Needs Of Homestead*: during the summer month, water needs could be as high as 26000 litres per day with the bulk of it being for farming.

*Check Appendix 2: Homestead Water Requirements Workings

SURVEY >> OBSERVATION AND INTERACTION (CONTD.)

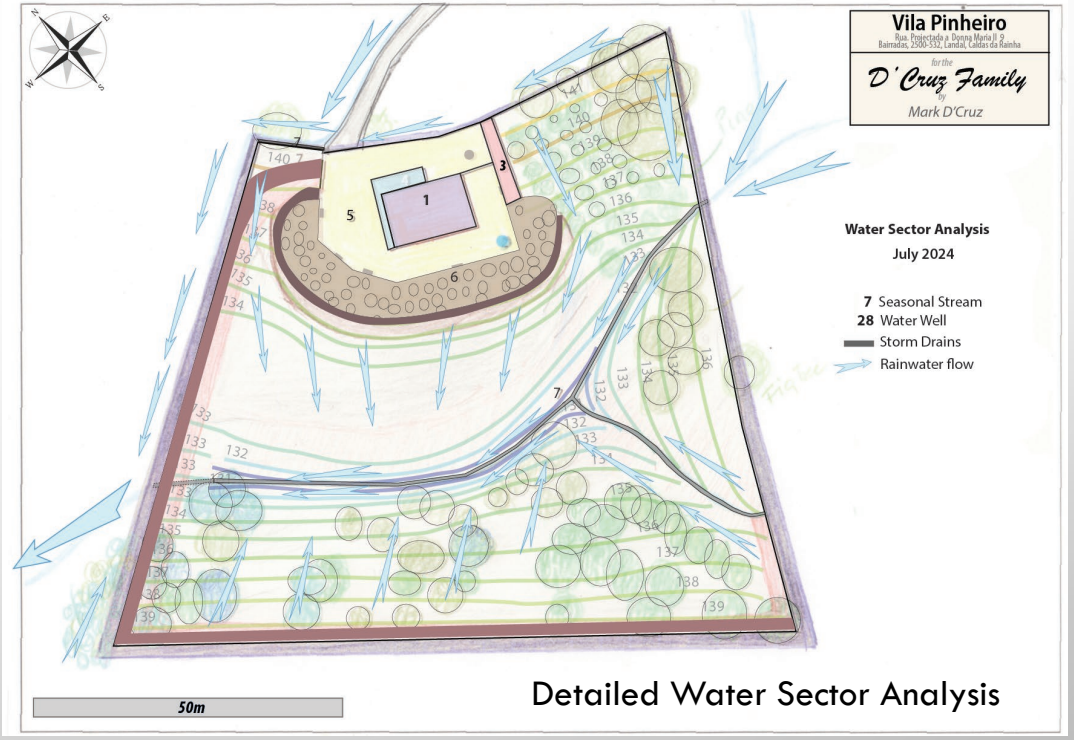
diagrammatic cross-section



SURVEY >> OBSERVATION AND INTERACTION (CONTD.)

The site has a natural abundance of water flowing*:

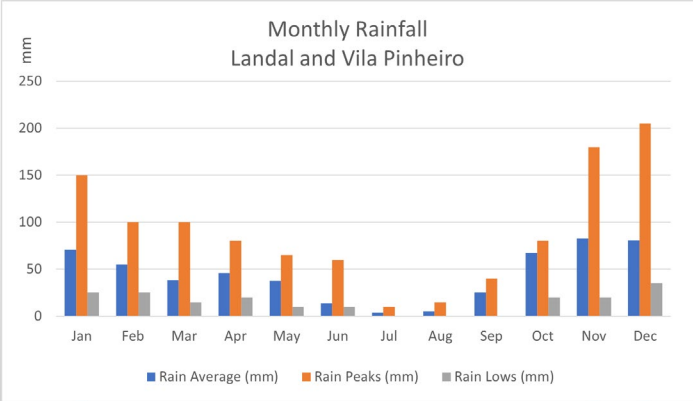
1. The site benefits from a natural abundance of water flowing through it, with a seasonal stream present for over 9 months, driven by runoff from the surrounding catchment areas, as indicated in the Topography Map.
2. The site's location in a valley is advantageous, receiving substantial rainfall and runoff from adjacent areas, which infiltrates and percolates into the soil, enhancing water availability.
3. The presence of substantial subterranean water on the southwest of the property, indicated by vegetation, suggests active infiltration and percolation processes.
4. There is significant groundwater at the bottom of the valley, as evidenced by the well, supported by continuous infiltration and percolation of rainwater.
5. The site experiences abundant rainfall runoff over 9 months of the year, ensuring a continuous supply of water.
6. High levels of fog and humidity during summer, driven by sea breezes, contribute to transpiration and condensation processes, enhancing the site's moisture levels.



*For a detailed Sector Analysis, refer to Design 3 – Vila Pinheiro Sustainable Homestead

SURVEY >> OBSERVATION AND INTERACTION

- **VILA PINHEIRO: MONTHLY RAINFALL**
  - **Rainfall Peaks**: The graph shows that the highest rainfall peaks occur in January and December, reaching up to 200 mm, suggesting significant rainfall events during these months.
  - **Rainfall Averages**: The average rainfall (in blue) remains relatively moderate throughout the year, with higher averages observed in the rainy season (from October to March) ranging between 35 mm to 84 mm.
  - **Rainfall Lows:** The lowest recorded rainfall (in grey) indicates minimal precipitation during the drier months, particularly from June to September, where it drops to as low as 3 mm monthly.
- **KEY OBSERVATIONS**
  - **Seasonal Variation**: The estate experiences significant seasonal variation in rainfall, with a pronounced rainy season peaking in winter (December and January) and a dry period during summer (June to August).
  - **Water Management Potential**: The abundant rainfall during the wet season supports rainwater harvesting systems, irrigation, and possibly minor hydroelectric generation, while the presence of a seasonal stream for about nine months offers additional water collection opportunities.
  - **Sustainable Practices**: The year-round availability of underground water on the southwest boundary supports lush grasslands and can sustain local biodiversity, promoting ecological balance on the estate.



SURVEY >> OBSERVATION AND INTERACTION

VILA PINHEIRO RAIN-WATER CATCHMENT AREA

- Vila pinheiro lies at the mouth the Bairradas Vale (valley)
- The seasonal stream that runs through the property is fed by a catchment area of about 75000 sqm.

ANALYSIS >> INTEGRATE RATHER THAN SEGREGATE

- **Multiple Uses:** Ponds can be used for irrigation water storage for both irrigation and aquaculture. *(Obtain a Yield)* (*Earth Care*)
- **Water Buffer Zones:** Using keyline swales, create buffer zones with deep-rooted vegetation that helps to stabilise the water table and protect water resources. (Use Edges and Value the Marginal) (*Earth Care*)
- **Value Diversity:** These zones can act as natural barriers against pollution while also supporting wildlife and improving soil health. *(Use and Value Diversity)* (*Earth Care*)

ANALYSIS >> RAINWATER AVAILIBILITY

FACTORS DETERMINING WATER RUNOFF/CATCHMENT

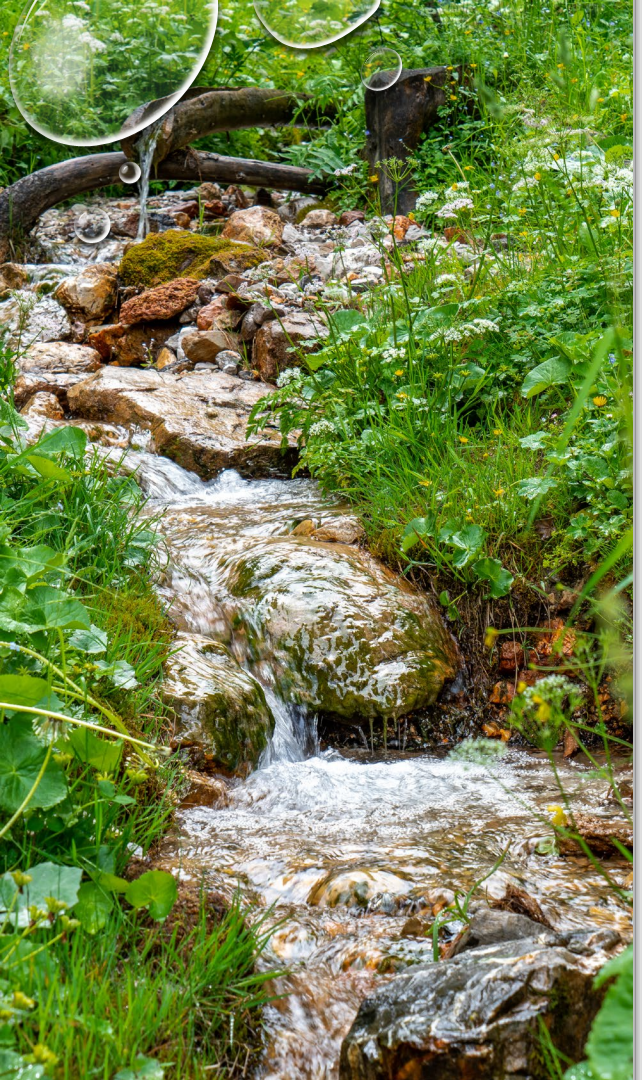
- **CLIMATE AND RAINFALL PATTERNS:**
  - **MEDITERRANEAN CLIMATE:** HOT, DRY SUMMERS; MILD, WET WINTERS.
  - **WINTER (OCT-MAR):** HIGH RAINFALL (50-200 MM/MONTH), HIGHER RUNOFF RATES.
  - **SUMMER (JUN-SEP):** LOW RAINFALL (<10 MM/MONTH), MINIMAL RUNOFF.
- **FACTORS INFLUENCING RUNOFF:**
  - **TERRAIN AND TOPOGRAPHY:** STEEPER SLOPES = HIGHER RUNOFF; FLAT AREAS = MORE INFILTRATION.
  - LAND COVER:
    - URBAN AREAS WITH IMPERVIOUS SURFACES: 70-90% RUNOFF.
    - AGRICULTURAL AREAS: 20-40% RUNOFF.
    - FORESTED AREAS: 10-20% RUNOFF.
  - **SOIL TYPE:** CLAYEY SOILS = HIGHER RUNOFF; SANDY/LOAMY SOILS = BETTER INFILTRATION.
- **KEY TAKEAWAYS:**
  - **URBAN AREAS:** HIGH RUNOFF DUE TO IMPERVIOUS SURFACES.
  - **AGRICULTURAL AREAS:** MODERATE RUNOFF, INFLUENCED BY LAND MANAGEMENT.
  - **FORESTED/NATURAL AREAS:** LOWEST RUNOFF DUE TO HIGH INFILTRATION AND ABSORPTION.
  - **MOUNTAINOUS REGIONS:** VARIABLE RUNOFF; HIGHER DURING INTENSE RAINS.

Conclusion: effective water management requires an understanding of local runoff dynamics to prevent flooding and ensure sustainable water use.

ANALYSIS >> RAINWATER CATCHMENT

- Roof Rainwater: 200,000 litres
  - Catchment: ~90% can be captured in IBC and Concrete Storage Tanks
- Vila Pinheiro: 7 million liters
  - Wooded Area 60% - 4.3 m liters
    - Runoff: 10-20% runoff
    - **Catchment: 3 million litres**
  - Farmed Area 30% - 2.1 m liters
    - Runoff: 20-40%
    - **Catchment: 800k – 1.6 m liters**
  - Urban: (Patio-Roads) - 10% - 700 k litres
    - Runoff: 70-90%
    - **Catchment: 70-210k liters**

Month	Rain Avg. (mm)	Rain Avg (m)	Roof Harvest Potential (Litres)	Vila Pinheiro Potential (Litres)	Vila Pinheiro Stream Catchment (Litres)
Jan	84	0.084	25,200	840,000	6,300,000
Feb	70	0.07	21,000	700,000	5,250,000
Mar	67	0.067	20,100	670,000	5,025,000
Apr	55	0.055	16,500	550,000	4,125,000
May	55	0.055	16,500	550,000	4,125,000
Jun	37	0.037	11,100	370,000	2,775,000
Jul	3	0.003	900	30,000	225,000
Aug	6	0.006	1,800	60,000	450,000
Sep	50	0.05	15,000	500,000	3,750,000
Oct	80	0.08	24,000	800,000	6,000,000
Nov	100	0.1	30,000	1,000,000	7,500,000
Dec	120	0.12	36,000	1,200,000	9,000,000
	727		218,100	7,270,000	54,525,000
Roof Area	300	sqm			
Vila Pinheiro Area	10000	sqm			
Catchment Area	75000	sqm			



ANALYSIS >> RAINWATER CATCHMENT (contd.)

Rainwater From Seasonal Stream Catchment Area

- Total: 54 Million Litres
  - **Wooded Area**: 27 million liters
    - Runoff: 10-20% Runoff
    - Catchment: 21-24 million litres
  - **Farmed Area**: 14 million Liters
    - Runoff: 20-40%
    - Catchment: 8-11million litres
  - **Urban**: 10 million litres
    - Runoff: 70-90%
    - Catchment: 1-3 million Litres
- **Vila Pinheiro Total: 30 – 38 million liters**

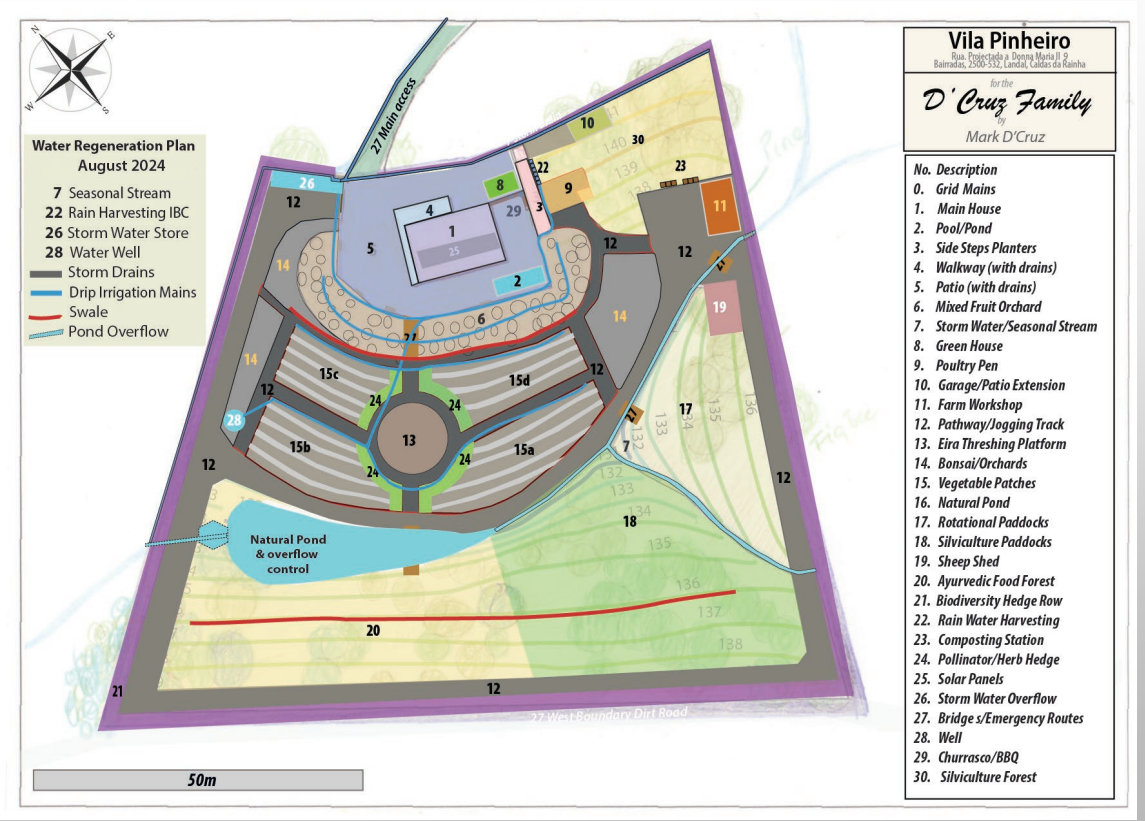
WATER REGENERATION AT VILA PINHEIRO

The **Water Regeneration Plan** for **Vila Pinheiro** is designed to optimise water use and create a resilient ecosystem. It integrates natural and built systems to efficiently capture, store, and distribute water across the landscape.

Key elements include rainwater harvesting, swales, storm drains, and a natural pond with overflow control.

Together, these components minimise water wastage, prevent erosion, and maintain soil moisture, supporting orchards, gardens, and paddocks.

By using seasonal streams and rainwater, the plan fosters a sustainable water cycle that promotes both agriculture and biodiversity.



ANALYSIS >>
FUNCTIONAL, STRUCTURAL, ELEMENTAL (FSE) ANALYSIS

Functional Analysis

- **Storm Drains (Grey Lines):** These drains are placed strategically to capture rainwater from paved areas like the *Main Access (27)* and direct it to the *Stormwater Storage Tank (26)*. The storm drains help prevent waterlogging and erosion and ensure that water is channelled to the *Biodiversity Hedge Row (21)* and for storage or absorption areas like swales or ponds.
- **Drip Irrigation Mains (Dark Blue Lines):** The irrigation system provides A highly efficient means of delivering water to specific areas like The *Mixed Fruit Orchard (6), Bonsai/Orchards (14), Vegetable Patches (15)*; and By focusing on water delivery, it reduces wastage and maximises water conservation efforts.
- **Stormwater Storage (26):** Collects water from the *Storm Drains (Grey Line)* and connects to the *Drip Irrigation Mains (Dark Blue Lines)* as an additional source of water. The excess is channelled back into storm drains for use downstream.
- **Swales (Red Lines):** These swales slow down water runoff and encourage infiltration into the ground. This supports the recharge of groundwater, prevents soil erosion, and helps maintain moisture for the *Vegetable Patch (15)* and *Pollinator/Herb Hedge (24)*. They also direct excess water towards the *Natural Pond (16)* for long-term storage.
- **Natural Pond (Light Blue Oval Shape):** The *Seasonal Stream (7)* captures rain from the catchment area and directs it towards the natural pond, providing A supplementary source of water for when rainfall is low.
- **Pond Overflow (Light Blue Line):** The overflow system manages water levels in the *Natural Pond (16)*, directing excess water safely out of the system to prevent flooding during heavy rains. This ensures a controlled release of water into surrounding areas via the *Stormwater overflow (26)*.
- **Water Well (28):** The Well Acts As A Stable Source Of Water, Particularly During Dry Periods When Surface Water Sources Are Depleted. It Can Feed The Irrigation System, Supplement Household Water Use, And Provide Backup Water For Animals In The *Rotational Paddocks (17)* And *Silviculture Paddocks (18)*.
- **Rainwater Harvesting (22):** This system collects rainwater from the rooftop of the *Main House (1)* and channels it into IBC storage tanksstern. This Harvested Water Can Then Be Used For Irrigation, Household Needs, Or Filling The Pond.

ANALYSIS >> FSE ANALYSIS (CONTINUED)

Structural Analysis

- **Storm Drains**: Positioned around the *Main Access Road, Boundary Walls*, and structures to capture water runoff from impervious surfaces. Their placement ensures that water is channelled away from areas that are vulnerable to erosion or flooding.
- **Swales**: Located along the contour lines to intercept water as it moves downhill, helping slow down and capture runoff. Their design indicates careful consideration of slope and elevation, optimising water absorption into the ground near key agricultural areas.
- **Natural Pond and Overflow**: Located at the bottom of the slope, the pond captures runoff from the higher areas of the property, including storm drains and swales. The pond is placed in a key location to maximise its water collection potential and control overflow safely.
- **Drip Irrigation Mains**: Distributed across the productive growing areas like the orchards, vegetable patches, and pollinator/herb hedges to ensure efficient water delivery. The layout minimises the need for extensive irrigation infrastructure in other parts of the property.
- **Rainwater Harvesting**: Located near the *Main House (1)* at a higher elevation than the orchards and gardens, this system collects water from rooftops. The harvested water is stored for future use and directed to key areas, such as the orchards and gardens, for efficient irrigation..
- **Water Well**: Centrally located on the property for easy access to provide water for various needs, from household use to irrigation and livestock.
- **Paddocks and Food Forest**: The *Rotational Paddocks (17), Silviculture Paddocks (18)*, and *Ayurvedic Food Forest (20)* are designed with irrigation systems and runoff management in mind. The paddocks benefit from water from swales, storm drains, and well irrigation.

ANALYSIS >> FSE ANALYSIS (CONTINUED).

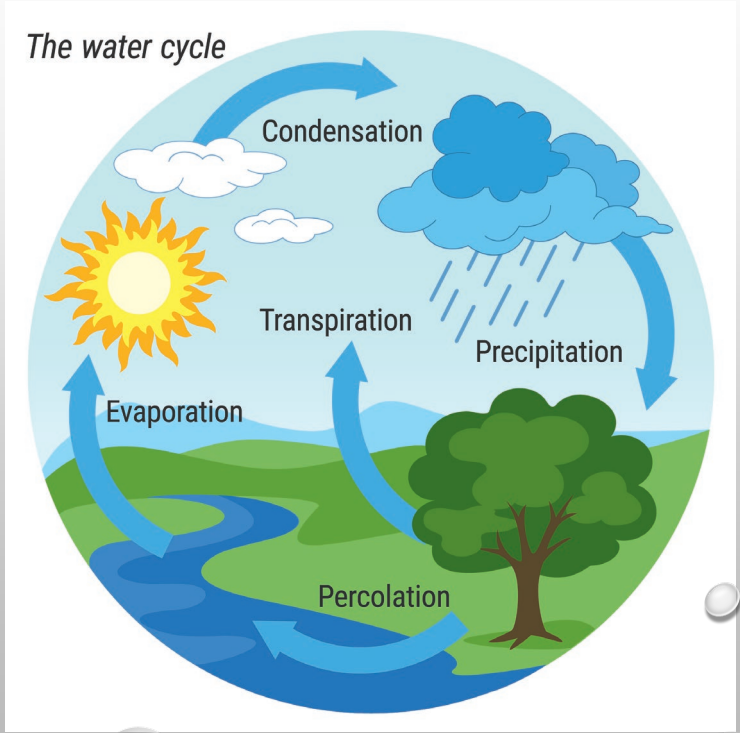
Elemental Analysis

Each element in this water management system interacts in ways that are critical to the design's functionality and sustainability. Here's a breakdown of inputs and outputs:

- **Storm Drains:**
  - **Inputs:** Water runoff from paved areas (walkways, patio, etc.).
  - **Outputs:** Water is redirected to the swales, pond, or other drainage areas.
- **Drip Irrigation Mains:**
  - **Inputs:** Water from the rainwater harvesting system, storm water store, or well.
  - **Outputs:** Direct, slow-release watering of plants in designated areas like orchards and vegetable patches.
- **Swales:**
  - **Inputs:** Surface runoff from rain and storm drains.
  - **Outputs:** Water infiltrates into the ground, supporting soil moisture levels and recharging groundwater, with some water flowing to the pond.
- **Natural Pond and Overflow:**
  - **Inputs:** Water from swales, storm drains, and seasonal streams.
  - **Outputs:** Stored water is available for future use; the overflow system manages excess water during high rain events.
- **Rain Water Harvesting:**
  - **Inputs:** Rainfall collected from rooftops.
  - **Outputs:** Stored water for household or irrigation use.
- **Water Well:**
  - **Inputs:** Groundwater supply.
  - **Outputs:** Water for irrigation, livestock, and other needs, especially during dry periods.
- **Seasonal Stream:**
  - **Inputs:** Rainfall and water from higher elevations during wet seasons.
  - **Outputs:** Water is channelled to the pond or absorbed by swales.

DESIGN >> FROM PATTERNS TO DETAILS

- **Rainwater Harvesting:** Create a roof rainwater harvesting system using IBCs. Collect patio water runoff into IBC tanks for irrigation and pond works. *(Catch and Store Energy)*
- **Zoning:** Using Permaculture Zoning places water-intensive plants and activities closer to the water source and resilient, drought-tolerant species further away. *(Integrate Rather Than Segregate)*
- **Pattern Recognition:** Use the Water Cycle and natural flow patterns to guide the layout of swales and ponds to distribute water effectively. *(Observe And Interact)*
- **Earthworks:** Create a swale just above the dry terraces to slow, spread, sink and retain water into the landscape, recharging groundwater and reducing runoff. *(Use Small and Slow Solutions)*
- **Soil Enrichment:** To make the soil in the dry zones more retentive by topping up with mulch and organic matter. *(Obtain A Yield)*
- **Water Well:** Reactivate the water well to act as a reserve over summer periods or when demand is high. *(Catch And Store Energy)*



DESIGN: BRIEF

To Create A Resilient, Self-Sufficient Water System That Captures, Stores And Efficiently Distributes Water. The Design Will Incorporate Natural Water Cycles, Seasonal Rainfall, And The Site's Topography To Ensure Water Availability Throughout The Year While Supporting Agricultural And Household Needs.

DESIGN: SYSTEM COMPONENTS AND WATER CATCHMENT

- **RAINWATER HARVESTING (22):**
  - IBC TANKS (1000L EACH) COLLECTING 180,000L/YEAR FROM 300M² ROOF.
  - POSITIONED AT A HIGHER ELEVATION FOR GRAVITY-FED IRRIGATION.
- **SWALES (BLUE LINES):**
  - 1M WIDE, 50M LONG TRENCHES ON CONTOUR.
  - CAPTURE 600M³/YEAR RUNOFF PER SWALE, AIDING GROUNDWATER RECHARGE.
- **STORM DRAINS (GREY LINES):**
  - 100–150MM PVC DRAINS AROUND PATIO AND WALKWAYS.
  - DIRECT WATER INTO SWALES AND PONDS, PREVENTING EROSION.
- **NATURAL POND (16):**
  - 40,000L CAPACITY WITH OVERFLOW SYSTEM.
  - COLLECTS RUNOFF FROM SWALES, STORM DRAINS, AND SEASONAL STREAMS.
- **DRIP IRRIGATION (RED LINES):**
  - COVERS ORCHARDS AND GARDENS; 4L/HOUR PER EMITTER.
  - EFFICIENT, LOW-EVAPORATION WATERING, CONNECTED TO TANKS AND PONDS.
- **WELL (28):**
  - 20–30M DEPTH WITH SOLAR PUMP.
  - BACKUP WATER SUPPLY FOR DRY PERIODS (5,000–10,000L/DAY).
- **WATER CATCHMENT:**
  - TOTAL CAPACITY: OVER 1.2 MILLION LITRES/YEAR THROUGH COMBINED SYSTEMS.

*For Details see Appendix - 04 - Water Regeneration Design - System and Components

DESIGN: Source, Store & Distribution

Roof Rainwater Harvesting (Main House)

- **Source: Roof (1)** Rainwater Harvesting
  Storage IBC Tanks (22) Near the House to store up to 180,000 litres annually.
- **Distribution: Pumped and Gravity-Fed Distribution** To Vegetable Patches, Orchards, And Gardens Via Drip Irrigation.

Swales For Water Capture And Ground Recharge

- **Source:** Swales **(Red Lines)** along contour lines to capture rainwater runoff,
- **Store:** Allowing it to infiltrate the **soil and recharge groundwater** while reducing erosion.
- **Distribution:** Water captured by the swales will slowly infiltrate the ground, replenishing the groundwater table and providing moisture to nearby plants. In case of overflow, excess water will be directed towards the **Nature Pond (16)** for long-term storage.

Seasonal Stream And Natural Pond System

- **Source:** The **Seasonal stream (7)** runs through the property for over 9 months.
- **Store:** The **Nature Pond (16)** at the bottom of the slope will store excess water, with a capacity of 150,000 litres, ensuring availability during dry periods.
- **Distribution:** Water from the pond will feed into the Drip irrigation system **(Blue Lines)** , particularly during the dry summer months.

Stormwater Collection

- **Source:** Storm drains **(Grey Lines)** will collect runoff from impervious surfaces such as walkways, patios, and roads.
- **Storage:** In the underground **Tank (26)** by entrance
- **Distribution:** Connected to a drip system **(Blue Lines)** with overflow directed to swales for slow absorption and redistribution into the groundwater or irrigation systems.

Groundwater well

- **Source:** The **Well (28)**
- **Source:** Taps into groundwater reserves, providing a stable water supply even during droughts.
- **Distribution:** The well supplements the drip irrigation system **(Blue Lines)** and provides water during dry periods.

DESIGN: SITES OF CONSUMPTION

- **Orchards And Gardens:** These areas will be prioritised for water distribution, especially during dry months, using an efficient **drip irrigation system (blue lines).** Water will be sourced from the rainwater harvesting system and the pond.
- **Vegetable Patches:** Similar To The Orchards, Vegetable Patches Will Receive Drip Irrigation From Stored Rainwater, Pond Reserves, And Groundwater Wells.
- **Ayurveda Food Forest:** These zones will rely on water from the swales and stormwater drainage systems. Slow-release irrigation from the swales will help keep the soil moist and support plant growth.
- **Animal Husbandry Paddocks:** Supplied by Well
- **Household Use:** Rainwater harvesting will also support household needs, especially during the rainy season, and will be filtered for non-drinking purposes to reduce reliance on external water supplies.

IMPLEMENT >> USE SMALL AND SLOW SOLUTIONS

Phased Initial Trials: Begin by implementing the IBC system to collect rainwater and create swales below above the drier section of the vegetable patch. (*Small and Slow Solutions*)

Incremental Expansion: Gradually expand the system to west SWALE and expand DRIP primaries, allowing time to observe its performance before making further adjustments. (Apply Self-regulation And Accept Feedback)

Scaling Up: As confidence in the design grows, the system will gradually expand with larger earthworks, ponds, and well and stormwater storage systems. (*Use And Value Diversity*)

KEY IMPLEMENTATION STEPS

Vila Pinheiro - Water Self-Sufficiency

Select a period to highlight at right. A legend describing the charting follows.

Period Highlight: 3

Plan Duration | Actual Start | % Complete | Actual (beyond plan) | % Complete (beyond plan)

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Phase 1: Rain Water Harvesting (Months 1-3)	1	3	1	4	25%
IBC Aqusition	1	1	1	3	100%
Aqusition of fittings	2	3	2	3	100%
System Setup	4	1	1	1	80%
Phase 2: Reviatalise Drip system (Month 4)	4	1	0	3	0%
Setup new pipe	4	1	0	0	0%
Setup new elctronic solinodes	4	1	0	0	0%
Connect to IBC	4	1	0	0	0%
Phase 3: Pation Rainwater Runoffs (Months 5)	5	1	0	6	0%
Submerged Tank excavation	5	1	0	0	0%
IBC Submerging	5	1	0	0	0%
Solar Powered Underwater pump Installtion	5	1	0	0	0%
Connecting to Dip system	5	1	0	0	0%
Phase 4: Swales (Months 6)	6	1	0	6	0%
East Swale	6	1	0	0	0%
West Swale	6	1	0	0	0%
Phase 5: Concrete Pond (7-8)	7	2	0	3	0%
Bulldozer Excavation of Pond	7	1	0	0	0%
Carcasing and Steel Setup	7	1	0	0	0%
Concrete pouring	7	1	0	0	0%
Concrete curing	7	2	0	0	0%
Test filling	8	2	0	0	0%
Phase 6: Well Recreation (Months 9-12)	9	3	0	3	0%
Well excavation with Bulldozer	9	1	0	0	0%
Well Lining concrete rings	10	2	0	0	0%
Solar Well Pump setup	11	2	0	0	0%
Well Piping	12	2	0	0	0%
Phase 6: Nature Pond (Months 12-24)	12	12	0	3	0%
Pond Excavation with Bulldozer	12	1	0	0	0%
Pond Claying	12	2	0	0	0%
Pond filling	14	2	0	0	0%
Pond Planting	16	2	0	0	0%
Pond filteraions/areation	16	2	0	0	0%
Pond Population	18	6	0	0	0%

PERIODS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

THE RAINWATER HARVESTER

IBC And Connector Kit, All Acquired After A Mammoth Hunt, Are Now Ready To Assemble

MAINTAIN >>
OBTAIN A YIELD

- **Aquaculture:** Check water Quality, create a natural pond by introducing caters to fish and ducks and enhance water fertility and food. *(Earth Care)* *(Obtain a Yield)*
- **Diverse Planting:** Study diversity and select drought-resistant plants with minimal water requirements to provide food, fuel, and fibre. (Earth Care) *(Integrate Rather Than Segregate)*

MAINTENANCE PLAN*

Rainwater Harvesting: Monthly inspections for debris; quarterly tank cleaning; annual filter replacement and structural repairs.

Aquifer and Groundwater Management: Quarterly groundwater monitoring; seasonal checks on recharge areas and vegetation.

Water Storage Ponds and Swales: Weekly water level checks; biannual dredging for silt; annual structural inspections for integrity.

Irrigation Systems: Weekly checks for leaks; monthly flushing of drip lines; seasonal irrigation schedule adjustments.

Water Quality Monitoring: Monthly testing for contaminants; post-rainfall quality assessments; biannual plan reviews.

Vegetation and Soil Management: Monthly health inspections of vegetation; biannual soil testing; seasonal planting of drought-resistant species.

Monitoring Systems: Continuous data collection on water levels and usage; biannual evaluations and adjustments based on data and feedback.

* Appendix - 03 - Vila Pinheiro - Maintenance Plan

EVALUATE >>

APPLY SELF-REGULATION AND ACCEPT FEEDBACK

- **Monitoring Systems:** Instal simple monitoring systems for rainfall. Track and log water quality, usage, and storage levels. Ensuring that adjustments can be made in real-time. (**Apply Self-regulation And Accept Feedback)**
- **Homesteader Education:** Teach residents about sustainable water use and the importance of conserving water, especially during dry periods. (*People Care*)

TWEAK >>
CREATIVELY USE AND RESPOND TO CHANGE

- **Climate Adaptation:** Size pond storage and IBC for future climate changes, such as more intense droughts or sudden heavy rains, by incorporating flexible systems that can handle these extremes. *(Earth Care)* *(Creatively Use and Respond to Change)*
- **Resilient Design:** Regularly review and adjust the water management system as conditions change, ensuring long-term sustainability. *(Apply Self-Regulation and Accept Feedback)*

EVALUATION OF THE WATER REGENERATION DESIGN

PLUS (POSITIVES)

Promotes environmental sustainability, maximises resource efficiency, reduces costs, minimises environmental impact, increases supply resilience

MINUS (NEGATIVES)

High initial costs, complexity requiring specialised knowledge, resource-intensive maintenance, potential contamination, and limited public awareness.

INTERESTING (ASPECTS WORTH NOTING)

Innovation potential, scalability, synergy with sustainable systems, educational opportunities, and long-term viability in water management.

PERMACULTURE ETHICS IN THE WATER SELF-SUFFICIENCY DESIGN

Earth Care:

- **Water Regeneration:** The design aims to restore and enhance water ecosystems by replenishing aquifers, using rainwater harvesting, and creating ponds and swales to stabilise water tables and reduce runoff.
- **Sustainable Water Management:** Efforts to reduce waste, conserve water bodies, and protect groundwater sources align with the Earth Care ethic by ensuring the environment is preserved and nurtured.

People Care:

- **Ensuring Water Security:** By achieving full water autonomy and optimising water conservation, the design ensures that the community has a reliable water supply, even during times of drought or climate variability.
- **Education and Involvement:** The plan includes educating residents about sustainable water use, emphasising the importance of conservation and encouraging community involvement in maintaining water systems.

Fair Share (also known as "Return the Surplus")

- **Resource Efficiency:** By efficiently using natural resources like rainwater and groundwater, the design reduces waste and promotes a fair distribution of water resources.
- **Promoting Abundance Mindset:** The approach encourages a shift from a scarcity mindset to one of abundance, ensuring that water resources are used effectively and shared equitably within the community.

REFLECTION: DESIGN EVOLUTION AND DESIGNER LEARNING

Evolution of the Design:

- **Initial Focus:** Systems for efficient water collection and storage.
- **Realisation:** Success in water regeneration is more than just collection; it involves a deep understanding of the water cycle and soil, flora and fauna water retention too.
- **Shift in Approach:** From passive systems to active regeneration, integrating natural processes.

Learning as a Designer:

- **Holistic Perspective**: Importance of a comprehensive, integrated view in designing sustainable systems.
- **Framework vs Ethos**: While frameworks streamline workflows, permaculture ethics and principles are essential for true success.
- **Beyond Sustainability:** Focus on regeneration — conserving, restoring, and revitalising water and soil to support a resilient ecosystem.

REFLECTIONS: KEY TAKEAWAYS AND CONCLUSION

Key Takeaways:

- **Understanding the Water Cycle:** Regenerating water resources requires a comprehensive understanding of natural water processes.
- **Integration of Systems:** Synergistic water systems enhance biodiversity and soil health.
- **Continuous Feedback and Adaptation:** Iterative design allows for real-world adjustments and resilience.
- **Empowering Regeneration:** Shifting from scarcity to abundance mindset. (*Fair Share*)

Conclusion:

- While frameworks streamline workflows, permaculture principles ensure a successful water regeneration system.
- It is not just about collecting and storing water but regenerating it by understanding and using the water cycle.

WATER IS LIFE'S BLOOD

A PARTNER IN REGENERATION, TURNING SCARCITY INTO ABUNDANCE AND ENSURING ALL LIFE FLOURISHES

EMPOWERING REGENERATION THROUGH SADIMET AND PERMACULTURE

Regenerative practices are vital in today's world, where environmental sustainability is a necessity. Regeneration goes beyond mere sustainability, focusing on revitalising ecosystems, communities, and economies. The SADIMET framework, combined with permaculture principles, offers an effective approach to creating systems that are not only sustainable but also capable of self-renewal and evolution.

SADIMET'S ROLE IN REGENERATION

The SADIMET framework—Survey, Analysis, Design, Implementation, Maintenance, Evaluation, and Tweak—provides a structured approach to system design and management. Its emphasis on continuous improvement and adaptability makes it ideal for fostering regeneration:

1. **Survey**: Involves observing and understanding the site's natural characteristics and identifying areas for improvement to support healthier ecosystems.
2. **Analysis**: Interprets data to identify ecosystem relationships and leverage points for regeneration, focusing on enhancing energy, nutrient, and resource flows.
3. **Design**: Articulates a vision for regeneration, integrating permaculture principles to create a self-sustaining system that restores and enhances ecosystem health.
4. **Implementation**: Bring the regenerative design to life through practical actions like planting and building, aimed at enhancing the system's self-renewal.
5. **Maintenance:** Ensures ongoing care and enhancement of the system's regenerative capacities, such as improving soil health and managing water resources.
6. **Evaluation:** Assesses the system's performance, focusing on regenerative outcomes and providing feedback for further improvement.
7. **Tweak:** Involves making adjustments based on evaluation to enhance the system's regenerative potential, such as altering planting strategies or redesigning elements.

PERMACULTURE PRINCIPLES AS A FOUNDATION

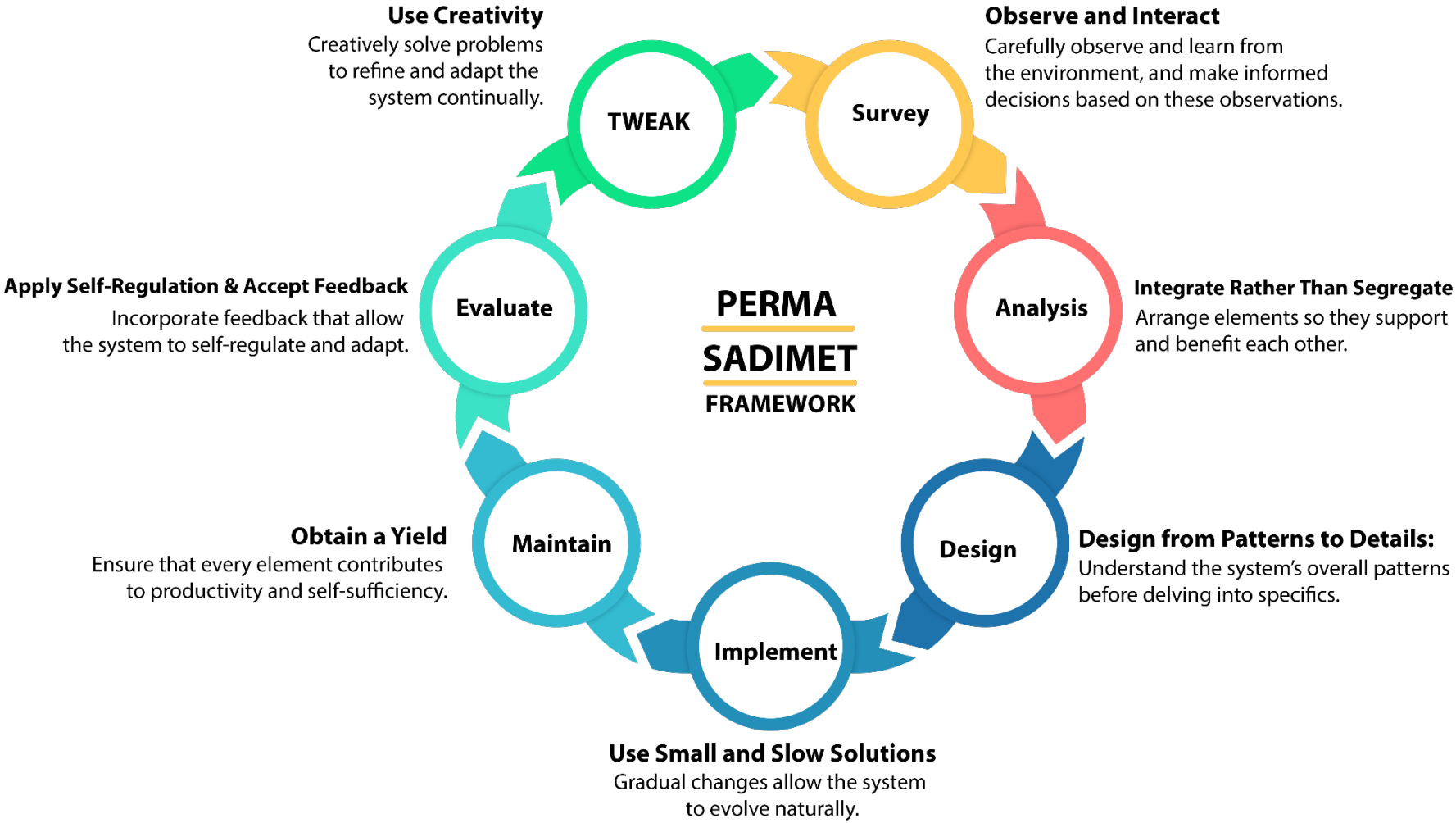
Permaculture principles provide the ethical and practical tools needed for true regeneration. By integrating these principles into SADIMET, systems can actively regenerate their environments:

- **Observe and Interact:** Emphasises understanding and harnessing natural processes for renewal.
- **Catch and Store Energy:** Ensures systems capture and store energy effectively to fuel ongoing regeneration.
- **Use and Value Diversity**: Promotes resilience and adaptability through diverse system elements.
- **Design from Patterns to Details**: Understand the system's overall patterns before delving into specifics.
- **Use Small and Slow Solutions:** Gradual changes allow the system to evolve naturally.
- **Obtain a Yield:** Ensure that every element contributes to productivity and self-sufficiency
- **Apply Self-Regulation and Accept Feedback:** Encourages systems to adapt and improve continuously.
- **Creatively Use and Respond to Change:** Supports flexibility and creativity in addressing new challenges.

THE SYNERGY OF SADIMET AND PERMACULTURE

The synergy of combining permaculture principles with the SADIMET framework creates systems that actively restore ecological balance, enhance biodiversity, and build resilience. This integrated approach ensures that every step, from the initial survey to the final tweaks, is rooted in a commitment to regeneration, resulting in systems capable of self-renewal and continuous evolution. By embedding permaculture principles within the SADIMET process, we can design systems that not only meet current needs but also

restore and enhance the natural world for future generations. This approach is essential for building a regenerative future where ecosystems, communities, and economies thrive in harmony with nature.



VILA PINHEIRO - WATER AND FOOD REQUIREMENTS ANALYSIS

Our homestead in Landal, Central Portugal, supports 4 residents and occasionally accommodates 2 additional visitors (30% of the time). This report outlines the daily water and food requirements, including water usage for baths, showers, laundry, a washing machine, and maintaining a dog and a cat. Additionally, the homestead includes a small swimming pool.

WATER REQUIREMENTS

HOUSEHOLD WATER USAGE

1. **Daily Drinking Water:**
   - Residents: 4 x 2.5 litres = 10 litres
   - Visitors: 2 x 2.5 litres x 30% = 1.5 litres
   - Total Drinking Water: 11.5 litres per day
2. **Baths/Showers:**
   - Average water usage per shower: 90 litres
   - Total for 4 residents: 4 x 90 litres = 360 litres
   - Total Showers: 360 litres per day
3. **Laundry (Washing Machine):**
   - Average water usage per load: 70 litres
   - Estimated loads per week: 7 (1 load per day)
   - Total Laundry Water: 70 litres per day
4. **Dog and Cat Water Needs:**
   - Dog: 1 litre per day
   - Cat: 0.5 litres per day
   - Total Pets: 1.5 litres per day
5. **Swimming Pool Maintenance:**
   - Pool capacity: 8 cubic metres (8,000 litres)
   - Monthly evaporation/refill: 5% of total capacity
   - Daily Pool Water: 8,000 litres x 0.05 / 30 = 13.33 litres per day

TOTAL DAILY WATER REQUIREMENTS

- Household:
  - Drinking Water: 11.5 litres
  - Showers: 360 litres
  - Laundry: 70 litres

- Pets: 1.5 litres
- Swimming Pool: 13.33 litres

Total Household Water: 456.33 litres per day

WATER USAGE FOR FARMING

Water usage for an acre of land can vary widely depending on the crop type and time of year.

WATER USAGE FOR VEGETABLES

Vegetable crops typically require a significant amount of water. Using drip irrigation, which is more efficient, the average water requirement can range between 1 " (2.5 cm to 3.8 cm of water per week per acre. This translates to approximately:

- 1 inch of water per acre = 27,154 gallons (102,780 litres)
- 1.5 inches of water per acre = 40,731 gallons (154,170 litres)

To find the daily water usage:

- 1 inch per week: 102,780 litres / 7 = 14,683 litres per day
- 1.5 inches per week: 154,170 litres / 7 = 22,024 litres per day

Considering an average, we will use 18,353.5 litres per day for vegetable crops.

WATER USAGE FOR FRUIT TREES

Fruit trees require less water than vegetable crops but need regular irrigation, especially during the establishment phase and dry periods. A common estimate is about 1 inch of water per week per acre for mature fruit trees.

For half an acre:

- 1 inch of water per acre per week = 27,154 gallons (102,780 litres)
- For half an acre: 102,780 litres / 2 = 51,390 litres per week

To find the daily water usage:

- 1 inch per week for half an acre: 51,390 litres / 7 = 7,341 litres per day

SUMMARY OF AVERAGE WATER USAGE

Combining both the vegetable crops and the fruit trees:

- Vegetables: 18,353.5 litres per day
- Fruit Trees: 7,341 litres per day
- Total Daily Water Usage for the Farm: 18,353.5 + 7,341 = 25,694.5 litres per day

ADJUSTED TOTAL DAILY WATER NEEDS

Incorporating the farm's water needs into the previously calculated total daily water needs:

- Household Water Needs
    - Drinking Water: 8 litres
    - Additional People: 1.5 litres
    - Laundry: 70 litres
    - Showers: 360 litres
    - Dog: 1 litre
    - Swimming Pool: 13.33 litres
- Farming Needs
    - Farm (Vegetables + Fruit Trees): 25,694.5 litres

Total Water: 26,148.33 litres per day

This total provides a comprehensive overview of the daily water requirements for a family of four, including additional household members, laundry, showers, farm irrigation for vegetables and fruit trees, a dog, and maintaining a swimming pool in Central Portugal.

APPENDIX XXX: MAINTENANCE PLAN FOR VILA PINHEIRO WATER SELF-SUFFICIENCY

1. **Rainwater Harvesting System**
    a. **Monthly Inspections**: Inspect gutters, downspouts, and tanks for debris, leaves, or blockages. Ensure all components are clear to maximise rainwater capture.
    b. **Quarterly Cleaning**: Clean out storage tanks and first flush systems to prevent contamination. Check for algae growth or sediment accumulation.
    c. **Annual Maintenance**: Inspect and repair any structural damages to the tanks or collection surfaces. Replace filters and check seals for any leaks.
2. **Aquifer Recharge and Groundwater Management**
    a. **Quarterly Monitoring**: Measure groundwater levels in wells to ensure the recharge rate is sustainable. Adjust water extraction rates based on these measurements to prevent over-extraction.
    b. **Seasonal Assessments**: Before the dry season, evaluate the aquifer recharge areas to ensure proper infiltration and percolation are occurring. Enhance vegetation in buffer zones to improve water retention and soil stability.
3. **Water Storage Ponds and Swales**
    a. **Weekly Checks**: Monitor water levels in ponds and swales, especially during dry periods. Ensure swales are effectively distributing water across the landscape.
    b. **Biannual Dredging**: Remove accumulated silt from ponds and swales to maintain capacity and prevent overflow or breaches during heavy rains.
    c. **Annual Structural Inspections**: Check pond liners, berms, and swale structures for integrity. Repair any cracks or weaknesses to prevent leaks and erosion.
4. **Irrigation and Drip Systems**
    a. **Weekly System Checks**: Inspect drip lines and emitters for clogs or leaks. Ensure even water distribution to plants.
    b. **Monthly Maintenance**: Flush out drip systems to prevent salt build-up and clogs. Replace any damaged or worn-out components.
    c. **Seasonal Adjustments**: Modify irrigation schedules based on plant needs and seasonal water availability.
5. **Water Quality Monitoring**
    a. **Monthly Testing:** Conduct water quality tests on all stored and groundwater sources for contaminants, pH levels, and other key indicators.
    b. **Post-Rainfall Assessments**: Test water quality after significant rainfall events to detect any potential contamination from surface runoff.
    c. **Biannual Reviews**: Review and update water quality management plans based on test results and any observed trends in water quality degradation.
6. **Vegetation and Soil Management**
    a. **Monthly Inspections**: Check the health of deep-rooted vegetation in water buffer zones. Replace any dying plants to maintain soil stability and water retention capabilities.
    b. **Biannual Soil Testing**: Conduct soil tests to monitor moisture levels, organic content, and nutrient balance. Adjust mulching and composting practices accordingly.
    c. **Seasonal Planting:** Introduce drought-resistant and water-efficient plant species during planting seasons to optimise water usage.
7. **Monitoring and Feedback Systems**
    a. **Continuous Data Collection**: Install monitoring systems for rainfall, water usage, and storage levels. Ensure real-time data is collected and reviewed regularly.
    b. **Biannual Evaluations**: Conduct comprehensive evaluations of the water management system, incorporating data analysis and community feedback to adjust practices and strategies.

By implementing this maintenance plan, Vila Pinheiro can ensure the long-term sustainability and resilience of its water self-sufficiency systems, aligning with the principles of permaculture.

WATER REGENERATION DESIGN - SYSTEM SPECIFICATION

To provide detailed specifications for the Water Regeneration Plan systems and components while integrating them with water catchment principles, we will focus on the following key systems:

1. **Rainwater Harvesting System**
2. **Swales**
3. **Storm Drains**
4. **Natural Pond and Overflow System**
5. **Drip Irrigation System**
6. **Well System**
7. **Water Catchment Calculations**

1. RAINWATER HARVESTING SYSTEM

Components:

- **IBC Tanks (22):**
  - **Capacity:** 1000 litres (customisable based on need).
  - **Material:** Food-grade, UV-resistant plastic to prevent algae growth and contamination.
  - **Placement:** Positioned near the Main House (1) and other key structures at a higher elevation than the gardens and orchards, allowing for gravity-fed irrigation.
  - **Quantity:** 4-8 tanks, depending on estimated water needs.
  - **Connections:** Guttering and downspouts from the rooftops of the Main House and other structures.
- **Catchment Area & Water Yield Calculation:**
  - **Roof Catchment Area:** *Main House (1)* has an approximate surface area of 300 m^2.
  - This system could potentially collect 200,000 litres per year, making the IBC tanks a vital component for storing and distributing this water.
- **Distribution:**
  - **Water from the IBC tanks will be routed to**:
    - **Fruit Orchard (6)**
    - **Vegetable Patches (15)**
    - **Bonsai/Orchards (14)**
    - **Mixed Fruit Orchard (6)**

The system is designed to supply the drip irrigation system for direct and efficient watering.

2. SWALES

Components:

- **Swale Trenches (Red Lines):**
  - **Dimensions:** Each swale is about 1 metre wide and 50 cm deep, with berms formed on the downhill side using excavated soil.
  - **Length:** Depending on the contour, swales will vary in length, typically around 50 metres per swale.
  - **Gradient:** Built on contour to slow down water movement and allow for infiltration.
- **Functionality:**
  - **Water Capture:** Swales capture and store surface runoff from rains, allowing it to percolate into the soil, enhancing groundwater recharge slowly.
  - **Vegetation Support:** Swales will be planted with nitrogen-fixing plants and grasses to stabilise the soil and further improve water retention.
- **Water Catchment Calculation:**
  - For a swale of 50 metres in length, capturing runoff from a 1000 m^2 catchment area:
  - Runoff Potential: For every 600 mm of rainfall, the swale can capture 600 cubic metres of water per year, providing significant moisture for soil and vegetation.

3. STORM DRAINS

Components:

- **Storm Drain Network (Grey Lines):**
  - **Material:** concrete or packed clay, depending on load-bearing requirements.
  - **Size:** Typically 60-100 cm in width, designed to carry surface runoff from hardscaped areas and forested areas
  - I**nlets and Outlets:** Grated inlets to prevent debris from entering, with outlets directed towards swales and the natural pond.
- **Functionality:**
  - **Water Management:** Collects runoff from impervious surfaces (e.g., Patio (5) and Walkways (12)) and channels it into swales or the natural pond.
  - **Erosion Control:** Helps prevent erosion by channelling water away from vulnerable areas.

4. NATURAL POND AND OVERFLOW SYSTEM

Components:

- **Pond (16):**
  - **Dimensions:** 50 m^2 surface area with a depth of around 2–3 metres.
  - **Capacity:** Approximately 100,000–150,000 litres when full.
  - **Lining:** Clay-lined or synthetic liner to minimise water loss through infiltration.
- **Overflow System (Green Lines):**
  - Piping: 100 cm diameter Concrete Pipe connected to the overflow tank at base level.50
  - Spillway: Graded spillway with vegetation to slow down overflow water and prevent erosion.
- **Water Catchment Calculation:**
  - The pond collects water from:
    - **Storm drains,**
    - **Swales,**

- **Seasonal stream (7).**
- **30** million liters
- The pond can store only a small portion of this, with excess being handled by the overflow system, directed to safe drainage areas.

5. DRIP IRRIGATION SYSTEM

Components:

- **Drip Lines (Dark Blue Lines):**
  - **Material:** PVC or polyethylene tubing with emitters.
  - **Emitter Spacing:** Emitters are placed 30 cm apart, releasing water slowly to plant roots.
  - **Water Source:** Connected to the IBC tanks and the pond.
  - **Flow Rate:** Each emitter delivers around 4 litres per hour.
- **Coverage:**
  - Orchards (6, 14), Vegetable Patches (15), and Pollinator/Herb Hedges (24).
  - Designed to supply slow, consistent water to the root zone, minimising evaporation and water wastage.
- **Water Demand Calculation:**
  - Assuming the orchards and gardens cover 2000 m^2:
  - The drip irrigation system, delivering around 4 litres/hour/emitter, would use 80,000 litres/month if run for 1 hour/day across the entire area.
  - This is well within the capacity of the rainwater harvesting and pond systems combined.

6. WELL SYSTEM

- **Components:**
  - **Well (28):**
    - **Depth**: Estimated at 20–30 metres, depending on the groundwater table.
    - **Pump:** Submersible pump with solar panels (24) to provide sustainable energy.
    - **Flow Rate**: 5,000–10,000 litres per day, depending on aquifer conditions.
- **Functionality:**
  - Acts as a backup water source during dry periods when rainwater and surface runoff are insufficient.
  - The well supplies water to the drip irrigation system and can also be used for household needs.

7. WATER CATCHMENT INTEGRATION

The entire system is designed to maximise the water catchment potential of Vila Pinheiro:

- **Rainwater Harvesting**: Utilises rooftop surfaces and stores up to 100,000 litres annually.
- **Swales and Storm Drains**: Capture surface runoff from across the property, contributing to groundwater recharge and reducing erosion.

- **Natural Pond:** Serves as a water reservoir and overflow control system, collecting seasonal excess water for dry periods.
- **Well:** Provides a steady source of groundwater, ensuring long-term water availability.

SUMMARY

By combining rainwater harvesting, swales, storm drains, natural ponds, drip irrigation, and a well system, the Water Regeneration Plan ensures sustainable and efficient water use across Vila Pinheiro. Each component is carefully integrated into the landscape to maximise water capture, minimise wastage, and support the agricultural and ecological goals of the property. The overall catchment and storage capacity will provide sufficient water to meet the needs of the gardens, orchards, and paddocks, even during periods of low rainfall.