GRAPHITE ENERGY

Lake Sustainable Energy Precinct

Water Services Strategy

DOCUMENT GE109-RPT-58003

Lake Sustainable Energy Precinct

Water Services Strategy

REVISION AND ISSUE HISTORY

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Water Services Strategy

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GE109-RPT-58003

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CONTENTS

1 Document Purpose

The purpose of this document is to calculate the total capacity of stormwater storage and detention at the proposed Lake Sustainable Energy Precinct at 212 Lake Cargelligo Road, Lake Cargelligo. It also calculates the maximum demand for water usage at the Lake Sustainable Energy Precinct, as a means of demonstrating the water storages at the precinct have capacity to sustain all operations and activities proposed, even under sustained drought conditions.

2 Background

The existing Lake Cargelligo Solar Thermal Power Generation and Research Facility was first developed by Lloyd Energy Systems in 2009, which has since been renamed Graphite Energy.

The existing solar thermal facility was approved by Lachlan Shire Council on 19 November 2008 in accordance with Development Consent DA 2008/0063, the facility has the following buildings and infrastructure in place:

- Grid connection to the Essential Energy network.
- Electrical plant buildings.
- Steam turbine generator plant building.
- Electrical transformers and equipment.
- Mechanical storage sheds and workshop.
- Office and amenities.
- Car port (open sided awning).
- Water storage tanks (~500kL).
- Laydown areas.
- Security fencing (2.5m high) around the perimeter of the existing site.

Figure 1 - Site Location (Lake Cargelligo NSW)

This property is owned by Peter and Elizabeth Skipworth and zoned RU1 Primary Production under the Lachlan Local Environmental Plan.

In partnership with the landowners, Graphite Energy intends to develop the Lake Sustainable Energy Precinct to provide a source of renewable energy and energy storage to power new and existing agricultural operations at the site and to export surplus energy to the grid. The purpose of the development is to establish a circular economy to produce clean, green food for the benefit of the proponents as well as providing broader community benefits.

Graphite Energy wishes to develop its sustainably powered agricultural precinct at Lake Cargelligo – true to five guiding design principles:

1. **Environmental Sustainability** – through design initiatives and solutions that achieve low carbon emissions, energy storage and water efficiency performance in farming systems, buildings, worker facilities and travel strategies.
2. **Circular Economy** – by sharing, leasing, storing, reusing, repairing, refurbishing, and recycling power and water supplies, gases, materials, and products generated at place as long as possible.
3. **Design and Innovation** – to lower carbon emissions by generating renewable electricity and using thermal properties of graphite, water, soils, and controlled farming systems to store energy for reuse, using technology and innovation and to lead on industry investment in the local context.
4. **Social and Cultural** – with deep respect for people and place to create positive impacts on social health, happiness, relationships, well-being, and connection to Country as well as to create products valued by others in the wider region.
5. **Financial Return** – adding value to achieve healthy fiscal returns to Graphite Energy and its partners as well as stimulating economic uplift, industry innovation, employment, and training in the local and regional context.

Sustainable storage of roof water from buildings for use and recycling of water is at the heart of these guiding design principles.

3 Rainfall Data – Lake Cargelligo NSW

The average rainfall data for Lake Cargelligo Has been examined in this section, based on data obtained from the weather station at the Lake Cargelligo Airport. In addition, Graphite Energy has over 10 years of high-quality meteorological data from an onsite weather station that supports this BOM data.

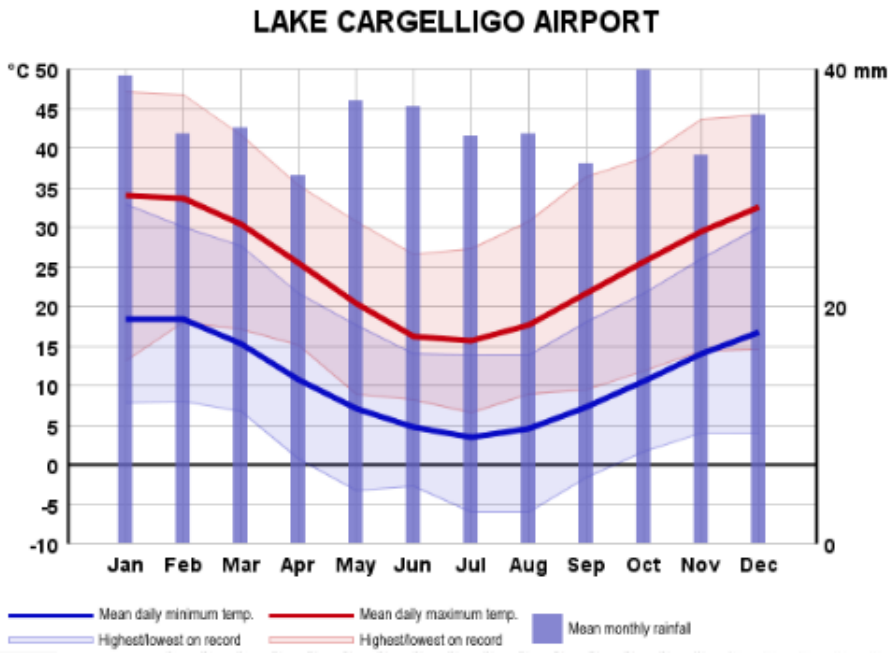


Figure 2 - Annual Rainfall Diagram

Table 1 - Lake Cargelligo Airport Station

Closest BOM Station	Lake Cargelligo Airport
Station ID	075039
Latitude	-33.28
Longitude	146.37
Height	169.0m
Data Frequency	10min
Annual Mean Rain (mm)	422.0
Annual High Rain (mm)	620.0
Annual Low Rain (mm)	140.0
Annual Mean Rain Days (# off)	60.7

4 Total Rainfall Predictions

The Lake Sustainable Energy Precinct has an objective to be self-sufficient with water supply, by capturing roof water for storage in tanks and adopting water wise and recycling strategies throughout its business operations.

Three annual rainfall predictions have been calculated to form the basis of the Water Services Strategy, as follows:

- Average annual rainfall catchment – total of 340mm per annum
- Below average annual rainfall catchment – total of 115mm per annum
- Above average annual rainfall catchment – total 495mm per annum

5 Proposed Lake Sustainable Energy Precinct

The proposed development will include sustainable energy and agriculture components.

The energy components include:

- Solar photo-voltaic fields will be installed at 4m in height to allow an adequate split between space, sun, and shade for agricultural processes to continue underneath. This process is known as Agri-voltaics.
- The solar field will be used to generate electricity which will be used in and stored in a variety of renewable energy storage systems to meet the electrical, thermal and process requirements of the new primary production systems, with the balance be exported to the grid.

The agricultural components include:

- Indoor Fish Farm producing Lachlan River native species Murray Cod at a volume of ~50t / annum.
- Greenhouse – producing high value leafy greens, taking advantage of the benefits a greenhouse provides on yield, especially in a variable climate future, produced at ~30t / annum.
- High value vines underneath the solar panels that benefit from partial shade including juniper berries which are currently being considered.

Figure 3 - Proposed Land Use (Agri-voltaics, Fish Farm and Greenhouse) supported by Electricity Generating Works (Renewable Energy Storage Systems)

Both the energy and agricultural systems require water inputs in numerous forms and conditions. The report herein will detail the expansion of Graphite Energy's existing water strategy to encompass the needs of the new facilities.

6 Water Supply Storage

6.1 Use of Groundwater Resources

No water will be extracted from groundwater resources for any activities related to the Lake Sustainable Energy Precinct.

6.2 Surface Water Resources

The Lake Sustainable Energy Precinct has an objective to be self-sufficient with water supply, by capturing roof water for storage in tanks and adopting water wise and recycling strategies throughout its business operations.

It is therefore not proposed to access surface water supplies to sustain the operations at the Lake Sustainable Energy Precinct.

An existing water licence, with both high security and general entitlements is owned by Peter and Elizabeth Skipworth and available to the 'Burnlea' property for agricultural use. Peter and Elizabeth will be the operators of the agricultural components and this water licence can be made available to the Lake Sustainable Energy Precinct if required. This supply would only be accessed to cover any shortfall from on-site catchment. Consultation with Water NSW indicates that water sourced from the existing high security water licence is permitted for the proposed development.

6.3 Existing & Proposed Water Tank Storage

Graphite Energy's existing water strategy consists of 550kL and services all current domestic, ancillary and process water usage. This is stored across 4 x 100kL tanks and 3 x 50kL tank.

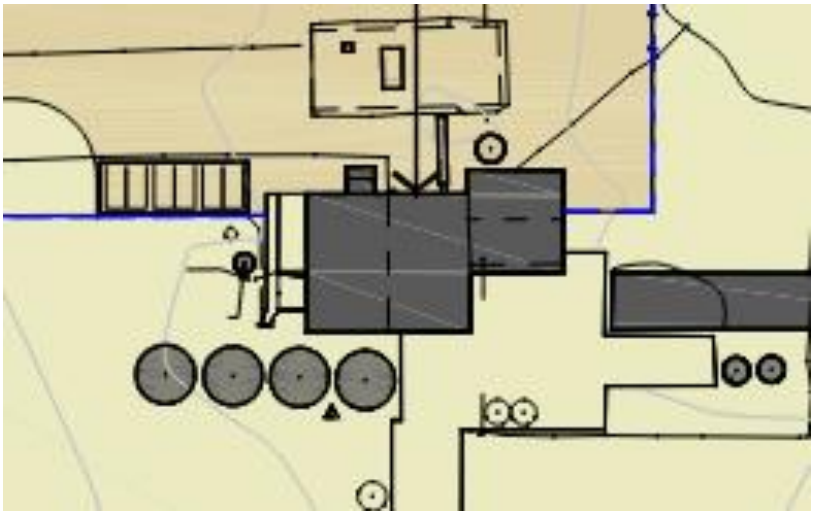


Figure 4 – Existing Water Storage Areas

6.4 Total Roof Water Catchment Areas

The Lake Sustainable Energy Precinct proposes to connect the main existing and proposed buildings to roof water storage tanks.

The location of existing / proposed buildings, water storage tanks and catch-dams is shown on Nettleton Precinct Plan - 12543_DA-0002.

The total roof area to be connected to onsite water tanks is 17,380m^2, in stages as follows:

- Existing - existing buildings comprising 860m^2 of roof area connected to existing water tanks totalling 550kL.

- Stage 1 – proposed buildings comprising 2,200m^2 of roof area connected to existing water tanks totalling 500kL.
- Stage 2 – includes no buildings that catch rainwater, PV field installation only.
- Stage 3 – proposed buildings comprising 12,400m^2 of roof area connected to existing water tanks totalling 1,000kL.
- Stage 4 – proposed buildings comprising 1,920m^2 of roof area connected to existing water tanks totalling 500kL.

Water tank storage will total 3,050kL on the site.

Catch dams are designed to store up to 3,500kL on the site, excluding the freeboard capacity of 600kL that has been designed to manage stormwater runoff from onsite storages in large storm events.

6.5 Predicted Water Storage Volumes

Applying annual rainfall predictions, total water storage volumes and a runoff coefficient of 80% (Lancaster, 2006) annual volume of water available from roof water is predicted as follows:

- Average annual rainfall – 5,900kL total catchment
- Below average annual rainfall – 2,000kL total catchment
- Above average annual rainfall – 8,600kL total catchment

6.6 Storage for Emergency Fire Fighting

As defined by the NSW RFS, the following items need to be defined to inform the correct amount of stored on-site water for bushfire usage.

- Land Use
    - Managed land is defined as reduced vegetation areas such as actively grazed pastures and crops. The areas surrounding the proposed site are and continue to be highly disturbed and managed for primary production.
- Slope
    - The slope of the property is between 0-5degrees.
- Catchment
    - Situated within the Northern Riverina.
- Proximity from Buildings to Vegetation
    - ~15-20m minimum

The above inputs for a preliminary analysis categorise the proposal facilities as FDI 80 where the recommended storage requirements are designated below in Figure 5.

Development type	Water requirement
Residential Lots (<1,000m²)	5,000 l/lot
Rural-residential Lots (1,000 – 10,000m²)	10,000 l/lot
Large Rural/Lifestyle Lots (>10,000 m²)	20,000 l/lot
Dual Occupancy	2,500 l/unit
Townhouse/Unit Style (eg Flats)	5,000 l/unit up to 20,000 l maximum.

Figure 5 – RFS NSW Dedicated water supply requirements

The water storage strategy will meet these requirements and hold 40kL in reserve for use in bushfire management by RFS or other services as needed. RFS and emergency services will have easy access to each tank on site via an installed regulation 65mm Storz fitting.

Figure 6 - Regulation RFS 65mm Storz Fitting

In addition to the bushfire compliance, a dedicated supply for general firefighting for the site will be installed in compliance with the BCA.

It is proposed to install a dedicated 250kL firefighting supply and dual fire pump set and hydrant to service both the bushfire compliance and the general firefighting compliance.

The water balance allows for an annual allocation of 40kL to top this supply up. If for some reason more than the 40kL is required to maintain dedicated firefighting supply, any shortfall will be provided from (in order of priority):

1. The 3,300kL (1,320% of total 250kL reserve) surplus available in average and above average rainfall years
2. The 4,150kL (1,660% of total 250kL reserve) stormwater overflow detention
3. Trucked in from town water supply (standpipe)
4. From the high security water supply licence of the landowners.

6.7 Stormwater Overflow Detention

In the event of multiple overflow events, a stormwater overflow catch-dam will be constructed on the South-Western side of the property at a capacity of ~4,100kL. These dams are within the maximum harvestable rights dam capacities as dictated by WaterNSW. The maximum nominated for an 83ha lot in Lake Cargelligo is 4,150kL.

Figure 7 - Proposed Catch Dam South-West of PV Installation

7 Water Demand and Usage

7.1 Primary Production – Intensive Agriculture

7.1.1 Fish Farm

The proposed Murray Cod fish farm is intended to have ~7ton of fish in the tanks at any one time. In the growing of Cod, a rule of thumb estimate of 26L/500g is used to size any water requirements for the tanks and ancillary use.

A total of 345kL per annum is required to support the fish farming operations at the Lake Sustainable Energy Precinct.

7.1.2 Greenhouse

Out of the total Greenhouse area, 8,000m^2 will be usable growing space for production. An allowance of 115L/m2 is used to calculate the annual expected consumption for the facility.

A total of 920kL per annum is required to support the greenhouse operations at the Lake Sustainable Energy Precinct.

7.1.3 Liquid Fertiliser

It is assumed that the primary agriculture will have a total waste stream attributed to 5% of the annual production tonnage. A total yearly production of ~75 ton / annum across the greenhouse and fish farm gives ~4 tons of solid waste / annum. Typical liquid fertiliser converter requires a 22:1 water to solid waste ratio. This stored liquid fertiliser will remain on-site for agricultural use.

A total of 90kL per annum is required to support the fertiliser processes at the Lake Sustainable Energy Precinct.

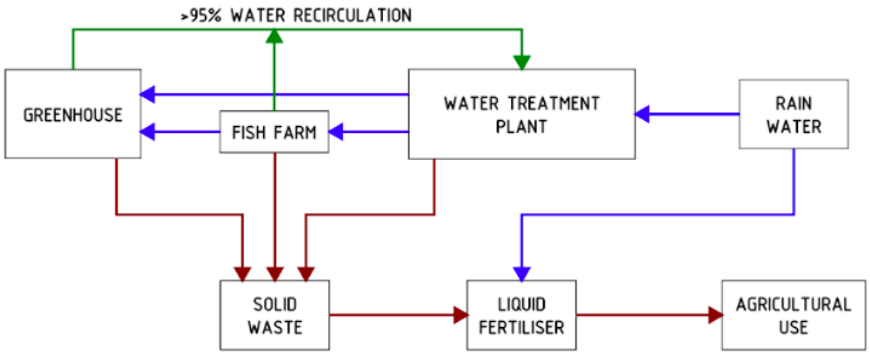


Figure 8 - Liquid Fertiliser Flow Chart

7.1.4 Stormwater Catch Dams

In the event of large storm events all overflow from water tanks will be directed into storage dams as discussed in Section 0.

A total of 4,100kL is capable of being stored in the catch dams, within the WaterNSW maximum harvestable dam rights.

7.2 Renewable Energy Storage

Energy Storage in its various forms assists in taking renewable energy when it is available for use when it is required. Thermal and hydrogen energy storage require water as part of its processes. For reference,

Figure 9 below depicts a visual representation of the decoupling of process heat and intermittent renewables.

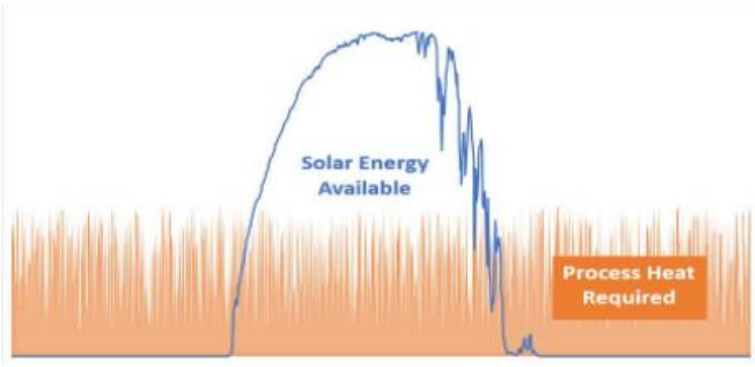


Figure 9 - Decoupling of Process Heat vs. VRE

7.2.1 Thermal Energy Storage

Standard steam output flow rates for a thermal energy storage system lie in the order of 120kg/h for feedwater flow rates. This TES system is expected to operate 5 days a week, 48 weeks a year.

A total of 345kL per annum is required to support the TES at the Lake Sustainable Energy Precinct.

7.2.2 Hydrogen Energy Storage

A hydrogen energy storage system will be installed on-site and requires a feedwater flow rate of ~105kg/h. This system is expected to run 12hrs a day, 48 weeks a year.

A total of 420kL per annum is required to support the hydrogen system at the Lake Sustainable Energy Precinct.

7.3 Steam Turbine Operations

The existing steam turbine produces a steam flow rate of 17t/hr. The associated makeup water is 170L/h. This system is expected to run 4hrs a day across the peak, 5 days a week, 48 weeks a year.

A total of 165kL per annum is required to support the steam turbine electricity generation at the Lake Sustainable Energy Precinct.

7.4 Domestic & Ancillary

Domestic and ancillary daily usage is estimated as per the below figures in Table 5. Annual consumption is based off site attendance 6 days a week, 48 weeks a year.

A total of 280kL per annum is required to support ancillary operations at the Lake Sustainable Energy Precinct. Daily water consumption table can be seen in Appendix B, Table 5.

7.5 Total Water Usage

Totalling each of the above water usage streams, the Lake Sustainable Energy Precinct is predicted to use 2,595kL annually, which includes an annual allowance of 40kL for topping up firefighting supplies. A more detailed split by Area and Project Construction Stages can be seen in Appendix B, Table 4.

7.6 Total Roof Water Volume Storage Predictions

The Lake Sustainable Energy Precinct is predicted to use approximately 2,600kL of water per annum across the variety of facilities and operations. This annual usage was compared against three rainfall scenarios, average, above average and below average, as detailed in Section 4.

Table 2 - Usage Scenario Summary

	Average 'Figure 10'	Above Avg 'Figure 11'	Below Avg 'Figure 12'
Total Rainfall (kL)	7,300	10,800	2,450
Total Caught in Tanks (kL)	3,050	3,050	2,000
Total Caught in Catch Dam (kL)	2,850	3,500	0
Sub-Total Rainfall Caught (kL)	5,900	6,550	2,000
Annual Usage (kL) **Excluding firefighting supply**	2,555	2,555	2,555
Annual firefighting supply (top up)	40	40	40
Contribution from Storage (kL)	Nil	Nil	595
Spare / Deficit (kL)	3,305	3,955	0
	127% Surplus	153% Surplus	
Firefighting Reserve (kL)	250		
Comments	More than sufficient rainfall in both scenarios, remainder to flow into stormwater catch dam. Surplus rainfall distributed to ongoing storage.		595kL used from stored reserve.
There will be a one off 250kL fill of the firefighting supply. The proponent has sufficient current supplies stored on site to provide this initial fill quantity. *Above table does not include any contribution from the landholders existing water licence entitlements.*			

8 Conclusion

The above information demonstrates that there is more than adequate water supplies available to service this development during all climatic conditions including average, above average and below average annual rainfall conditions. Available from (in order of priority);

1. On-site water storage tanks
2. Overflow catch dam
3. Existing irrigation water entitlements. This supply would only be accessed to cover any shortfall events.

APPENDIX A – SANKEY DIAGRAM ANNUAL CATCHMENTS

ANNUAL CATCHMENT, STORAGE AND END USAGE [AVERAGE RAINFALL SCENARIO]

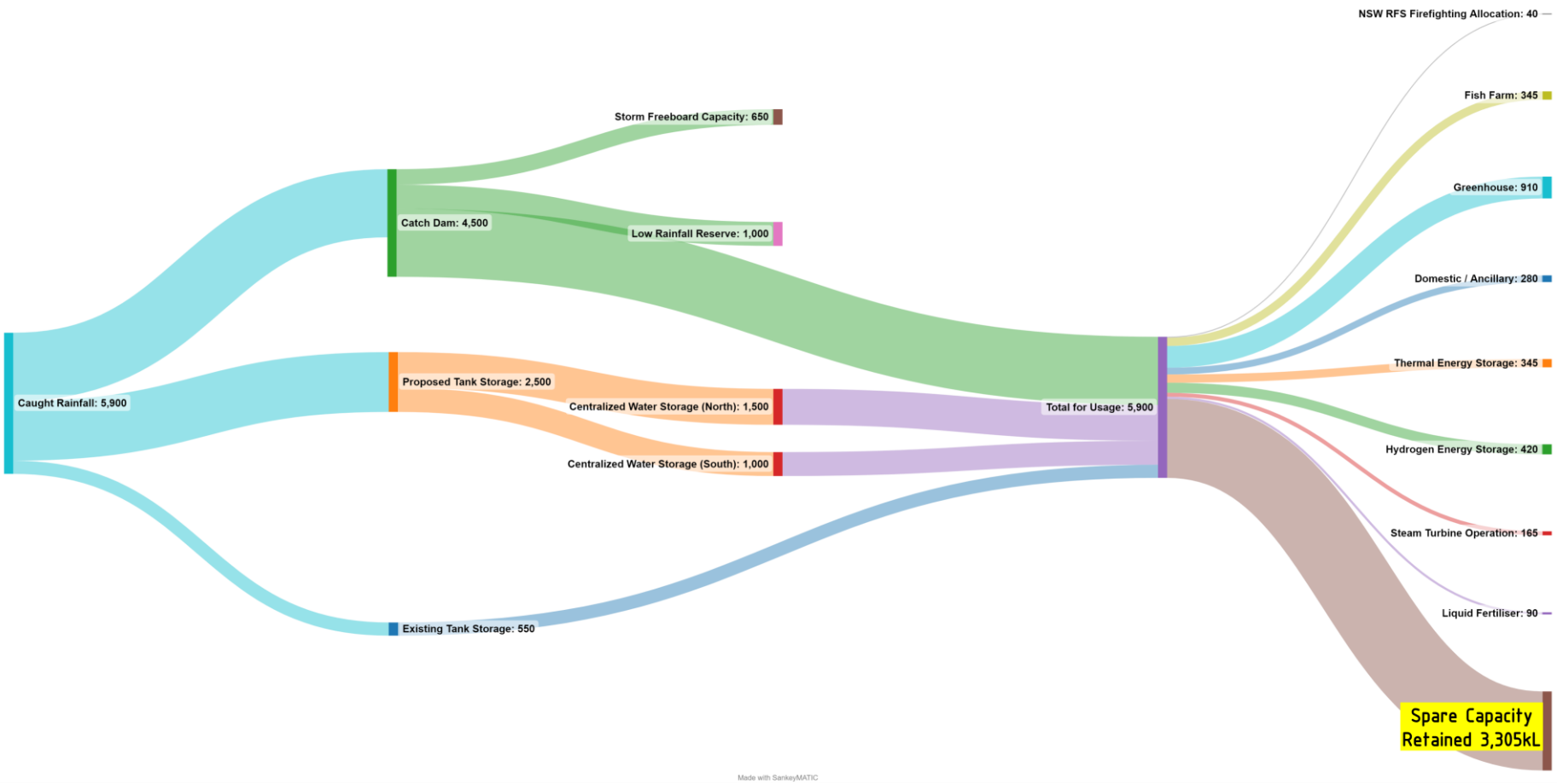


Figure 10 - Sankey Diagram AVERAGE Rainfall

ANNUAL CATCHMENT, STORAGE AND END USAGE [ABOVE AVG RAINFALL SCENARIO]

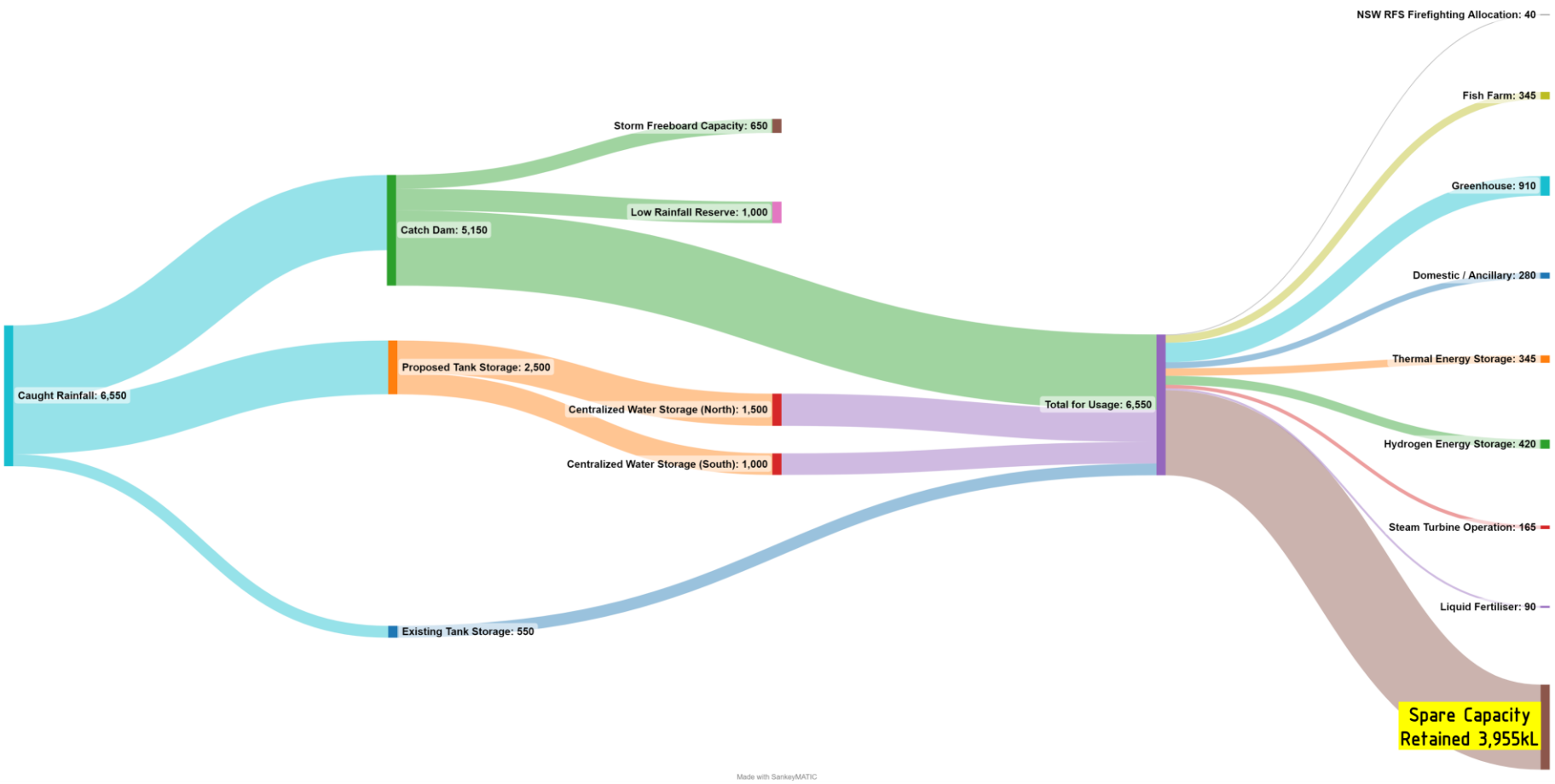


Figure 11 - Sankey Diagram HIGH Rainfall

ANNUAL CATCHMENT, STORAGE AND END USAGE [BELOW AVG RAINFALL SCENARIO]

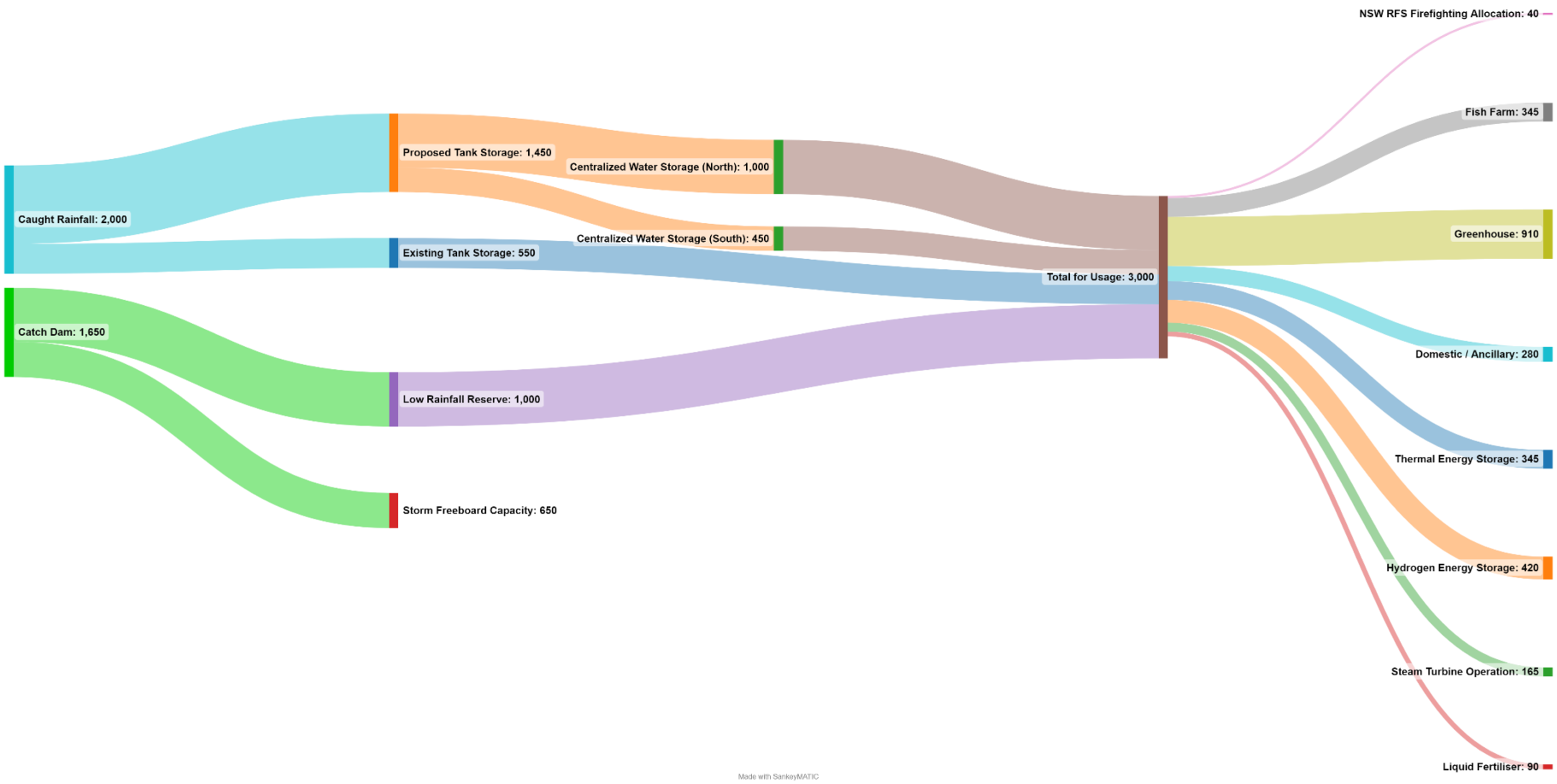


Figure 12 - Sankey Diagram LOW Rainfall

APPENDIX B – SUPPORTING DATA

USAGE INFORMATION

Table 3 - Summary Usage

Description	Sub-Totals (kL)
Annual Firefighting Allocation (Top Up)	40
Fish Farm	345
Liquid Fertiliser	90
Greenhouse	910
Domestic / Ancillary	280
Thermal Energy Storage	345
Hydrogen Energy Storage	420
Steam Turbine Operation	165
Annual Consumption	**2,595**
Annual Water Storage	**3,050**

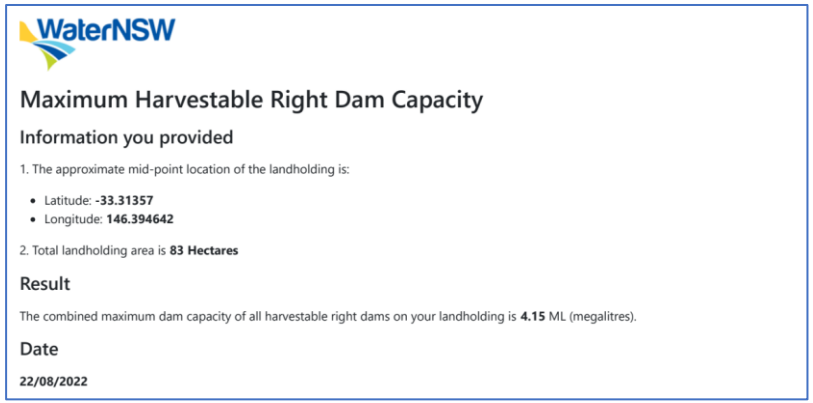
Table 4 - Summary Usage vs. Storage by Stages

Description	Existing (kL)	Stage 1 (kL)	Stage 2 (kL)	Stage 3 (kL)	Stage 4 (kL)	Sub-Totals (kL)
Annual Firefighting Allocation	40					40
Fish Farm	0	0	0	345	0	345
Liquid Fertiliser	0	0	0	90	0	90
Greenhouse	0	0	0	910	0	910
Domestic / Ancillary	80	40	0	100	60	280
Thermal Energy Storage	100	50	0	0	195	345
Hydrogen Energy Storage	0	0	0	0	420	420
Steam Turbine Operation	0	0	0	0	165	165
Total Usage	**220**	**310**	**310**	**1,755**	**2,595**	**2,595**
Total Water Storage	**550**	**1,050**	**1,050**	**2,050**	**3,050**	**3,050**

Table 5 - Daily Domestic / Ancillary Water Consumption

Domestic Consumption (Drinking, sanitary and cooking) FTE	300L
Domestic Consumption (Drinking, sanitary and cooking) Casual/Visitor	50L
Ancillary Cleaning	240L
Ancillary Workshop	380L

RESOURCE INFORMATION


WaterNSW

Maximum Harvestable Right Dam Capacity

Information you provided

1. The approximate mid-point location of the landholding is:

- Latitude: **-33.31357**
- Longitude: **146.394642**

2. Total landholding area is **83 Hectares**

Result

The combined maximum dam capacity of all harvestable right dams on your landholding is **4.15** ML (megalitres).

Date

22/08/2022

Figure 13 - WaterNSW Harvestable Right Dam Capacity

Table 6 - Usage Scenario Summary

	Average 'Figure 10'	Above Avg 'Figure 11'	Below Avg 'Figure 12'
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