TATTERSALL LANDER PTY LTD

STORMWATER QUALITY AND HYDROLOGY REPORT

for

PROPOSED POULTRY FARM EXPANSION

375 MCRAES ROAD
GOOLGOWI
(LOTS 1 & 2 in DP 749831)

Prepared by

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Contents

List of Figures

List of Tables

1.0 INTRODUCTION

This report has been prepared to support a proposal for the subdivision of land into six rural properties with the construction of five poultry farms. The site of the proposed development comprises two lots, identified as Lots 1 & 2 in DP 749831 and is located at 375 Mcraes Road, Goolgowi.

Figure 1: Locality Diagram

Water quality and quantity standards need to be addressed for the site, in particular any increases in stormwater volumes and pollutant loads. Addressing these objectives has been approached through the construction of a new dam for each proposed poultry farm to capture polluted stormwater runoff, with water re-use for the purposes of the poultry farming operations being the primary treatment measure.

1.1 SITE DESCRIPTION

The subject site is identified as Lots 1 & 2 DP 749831, 375 McRaes Road, Goolgowi, located in the Carrathool Shire Local Government Area. The total area encompassed by the site is 617.7 hectares. There are two (2) derelict dwelling sites on the farm as well as general rural infrastructure like dams, irrigation channels and stock yards.
The existing site catchment is a simple floodplain with all water draining to the Wah Wah Creek approximately 400meters to the south. There are a series of supply channels to the paddocks and stock dams within the property. The main Wah Wah Channel transects the property east/west through the middle of the property.

Photograph 1 – Subject Site

The existing catchment is shown in Figure 2. Specific site constraints and opportunities include;

- A large proportion of the site (approximately 405.9 hectares) drains to the dam on the Northern boundary. In large rainfall events this dam would overflow from the supply channel across the western boundary of the site.
- Approximately 209.4 hectares of the site drains to the western boundary of the site.

In small rainfall events the majority of water is collected in a series of small dams and does not leave the site.

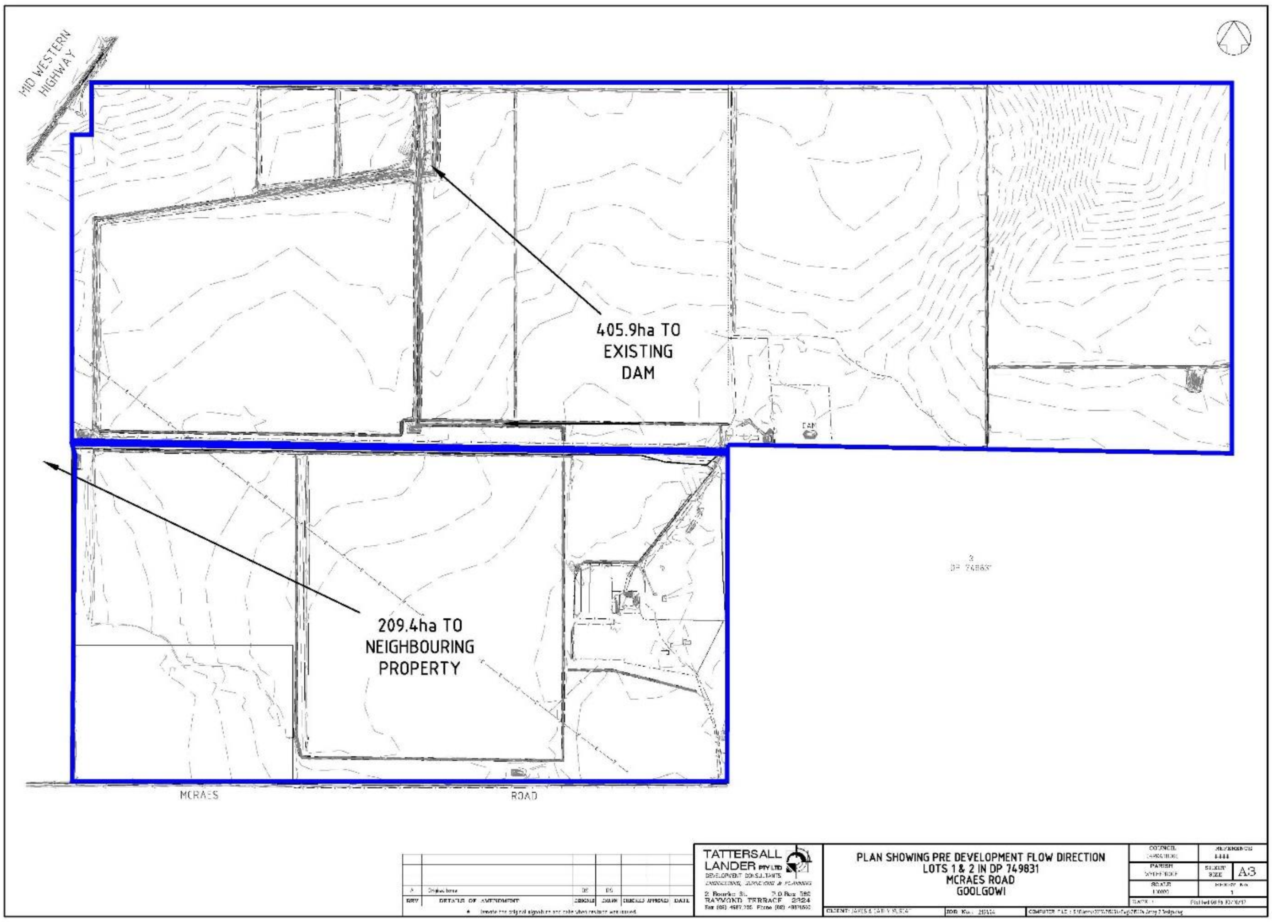

Figure 2: Pre-Development Catchments

1.2 PROPOSED DEVELOPEMENT

The proposal seeks:

- The subdivision of the land into six rural properties in a sequence that replicates the construction of the five individual poultry farms.
- The staged construction of individual farms, each with twenty new tunnel ventilated sheds for the purposes of housing up to 1,200,000 meat (broiler) chickens

Refer to the Proposed Layout plans prepared by Tattersall Lander Pty. Ltd. for further details regarding the proposed shed layout.

The catchment in the proposed developed state is shown in Figure 3 below.

- Each of the five farms involve a total disturbed area of approximately 33 hectares with 28 hectares draining to the proposed dam. The remaining 5 hectares drains into the surrounding paddocks and drains to existing dams and channels then to Wah Wah Creek via neighbouring properties.

- The main treatment measure for the proposed development is reuse from the proposed dams. As all five farms are essentially the same size for hardstand, roof and open space areas, Farm 2 has been modelled for Water Quality purposes as it is the worst-case scenario for the water quality modelling due to a larger area of sealed access road that does not drain to a proposed dam.
- Due to slightly different pipe configurations and channel slopes between the farms all five have been modelled Hydraulically in XP Storm to size culverts and swales to ensure enough capacity that the sheds are not flooded in a 1 in 100 year rainfall event.

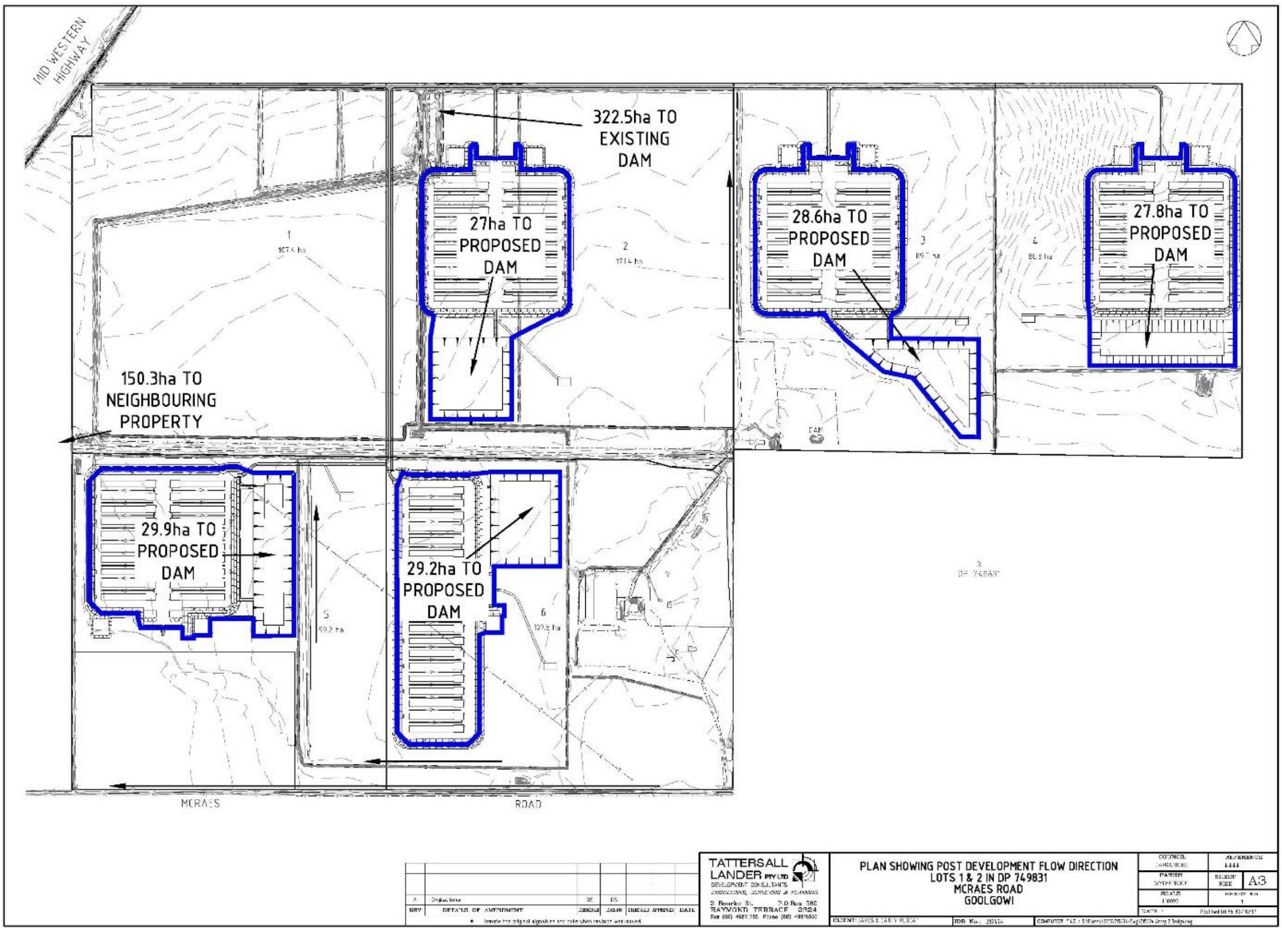

Figure 3: Post-Development Catchments

2.0 WATER QUALITY

2.1 BACKGROUND

Understanding the water quality of runoff generated by the site is important to ensure the preservation of the downstream environments. Changes in landuse and an increased proportion of impervious area can result in an increase in the quantities of suspended solids, nutrients and rubbish in storm water runoff. This section of the report aims to assess the water quality measures proposed as part of this development to confirm that they meet the relevant water quality objectives.

2.2 WATER QUALITY TARGETS

The proposed development site is part of a larger catchment, with further usage downstream. As such, it is important that flows and pollutant loads leaving the site are managed appropriately.

Specifically, current industry standards require the management and assessment of Total Suspended Solids, Total Phosphorus, Total Nitrogen and Gross Pollutants. These are the pollutants most commonly increased by development with the most potential to impact on downstream environments. It is noted that adequate treatment of these pollutants will also mitigate the impacts of a large range of other, less significant pollutants.

For this development a "Neutral or Beneficial Effect" target has been adopted for Total Suspended Solids, Total Phosphorus and Total Nitrogen concentrations. That is, the annual volumes of these pollutants leaving the site after the proposed development are equal or less than those leaving the site in its current state. For the Gross Pollutants, a 90% load reduction target is desired (when compared to the unmitigated development scenario). These targets are in line with industry best practice.

2.3 MUSIC MODELLING

MUSIC is the Model for Urban Stormwater Improvement Conceptualisation, developed by the Cooperative Research Centre for Catchment Hydrology. MUSIC provides the ability to model both quality and quantity of runoff generated by catchments. Therefore MUSIC can simulate annual stormwater volumes, and expected annual pollutant loadings. MUSIC has become the industry standard for stormwater pollutant assessments.

MUSIC is designed to model stormwater runoff systems in urban catchments. It is used to simulate a range of temporal and spatial scales. Catchment modelling can be performed for areas up to 100 km^2, with times steps from 6 minutes to 24 hours to match the range of spatial scale. This enables long term modelling of continuous historical rainfall data from pluviograph sources, and reflects the ability to account for temporal variation in data for an annual rainfall series directly.

MUSIC also has the ability to model a number of treatment devices, and measure their effectiveness in terms of the quantity and quality of runoff downstream. This allows determination of the degree of reduction in annual pollutant loadings.

It is important to note that the MUSIC simulation relies heavily on input variables and it is usually recommended MUSIC models be calibrated to local conditions wherever possible. When calibration is not possible default values can be used, or variables can be sourced from values recommended for stormwater modelling in NSW from a technical report prepared for the DECC by the Co-operative Research Centre titled "*Stormwater Flow and Quality, and the Effectiveness of Non-Proprietary Stormwater Treatment Measures*" (Fletcher et al, 2004).

Given the scale of the proposed development site and hence the MUSIC model, it was determined to be unreasonable to perform a calibration in this instance.

2.3.2 CLIMATE / RAINFALL

To accurately model a site of this size a continuous rainfall record spanning at least five years with a six minute timestep is required. Rainfall data was obtained from the Bureau of Meteorology in the form of historic pluviograph record from the Griffith (CSIRO) rainfall gauge. This station is no longer open but is the nearest station to the site (approximately 50km) that has sufficient data for use in modelling. In this case, eleven years of data was utilised between January 1959 and January 1970, with a mean annual rainfall of 413mm. This is comparable with other Bureau of Meteorology long term average data for the area, including:

- 402.2mm at the Griffith (Airport) weather station (approximately 50km from the site)
- 372.4mm at the Hillston (Airport) weather station (approximately 60km from the site).
- 450mm at the Naradhan weather station (approximately 85km from the site)

2.3.3 EVAPORATION

To accurately model the outcome of water quality treatment measures, monthly potential evapotranspiration (PET) data is required. Monthly average areal potential evapotranspiration values were read from maps in the 'Climate Atlas of Australia, Evapotranspiration' (BoM, 2001), and are shown in Table 1 below.

Table 1: Monthly Average Areal Potential Evapotranspiration Figures

Month	Potential Evapotranspiration (mm)
January	180
February	135
March	120
April	72
May	45
June	29
July	36
August	53
September	75
October	120
November	150
December	165
Total	1178

2.3.4 NODE PARAMETERS

The MUSIC model was used to simulate the pollutant export generated during an eleven year period of average rainfall. Rainfall-Runoff parameters for a “clay” soil type were adopted from Table 5-5 of the Draft NSW MUSIC Modelling Guidelines (2010) and typical pollutant concentrations derived from Fletcher et al. The adopted parameters can be seen in Figure 4 and Table 2 below.

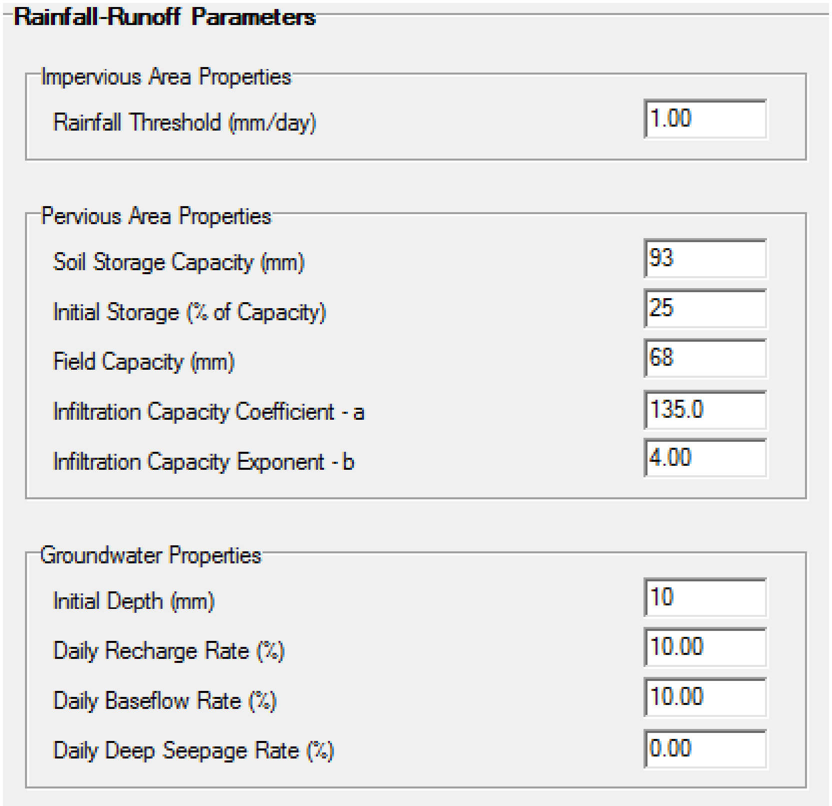

Figure 4: Adopted Rainfall-Runoff MUSIC Parameters

Note that Rainfall Thresholds of 0.30mm/day and 1.50mm/day were adopted for the “Roof” nodes and “Hardstand” nodes (modelled as unsealed roads) respectively per the recommendations in the Draft NSW MUSIC Modelling Guidelines (2010). The Rainfall Threshold of 1.00mm/day shown in Figure 4 was adopted for all other nodes.

Table 2: Adopted MUSIC Pollutant Generation Parameters

			Agricultural	Rural Residential	Unsealed Road	Sealed Road	Roof
TSS	Baseflow (mg/L-log_{10})	Mean	1.30	1.15	1.20	1.2	-
		SD	0.13	0.17	0.17	0.17	-
	Stormflow (mg/L-log_{10})	Mean	2.15	1.95	3.00	2.43	1.30
		SD	0.31	0.32	0.32	0.32	0.32
TP	Baseflow (mg/L-log_{10})	Mean	-1.05	-1.22	-0.85	-0.85	-
		SD	0.13	0.19	0.19	0.19	-
	Stormflow (mg/L-log_{10})	Mean	-0.22	-0.66	-0.30	-0.3	-0.89
		SD	0.30	0.25	0.25	0.25	0.25
TN	Baseflow (mg/L-log_{10})	Mean	0.04	-0.05	0.11	0.11	-
		SD	0.13	0.12	0.12	0.12	-
	Stormflow (mg/L-log_{10})	Mean	0.48	0.30	0.34	0.34	0.30
		SD	0.26	0.19	0.19	0.19	0.19

2.4 EXISTING FLOW & POLLUTANT ANALYSIS

The majority of the existing site is used for large scale irrigated wheat cropping. This has been modelled as a single agricultural node representing the disturbed area of the proposed footprint. This irrigated wheat cropping has a series of small dams and supply channels for operational purposes. As the proposed poultry farms do not replace the entire wheat cropping operations and any disturbed area for the proposed development will still drain to these structures, the existing dams and reuse have not been modelled in either scenario.

Figure 5: Existing Site MUSIC Model

An analysis of the Pre-Development Node reveals the following:

Table 3: Pre-Development Node Analysis

Flow (ML/yr)	3.28
Total Suspended Solids (kg/yr)	479
Total Phosphorus (kg/yr)	1.98
Total Nitrogen (kg/yr)	10.3
Gross Pollutants (kg/yr)	0

2.5 PROPOSED DEVELOPMENT FLOW & POLLUTANT ANALYSIS

The proposed development was modelled to determine expected pollutant loads. The catchment was broken up into different areas depending on their intended use.

It is important to highlight the fact that the poultry sheds operate as a closed system – chickens, feed, water and littler remain inside the sheds and stormwater from outside the shed does not flow into or through the sheds. No pollutants from inside the sheds end up leaving the sheds at all – i.e. in regard to stormwater pollution, the poultry sheds are simply impervious roof area and no different to the roof area of a storage warehouse or commercial centre.

Additional nodes were added to the model to represent the developed state:

- The shed roofs were modelled as urban nodes with 100% impervious area.
- Open areas and batter slopes were modelled as “rural residential” nodes to reflect the change in use from agricultural land.
- Hardstand areas were modelled as “unsealed roads” (50% impervious) with parameters per the Draft NSW MUSIC Modelling Guidelines (2010).
- The proposed dam was modelled as a “pond” as this node type allows a dam volume and re-use parameters to be included. Note that an additional “Dam Area” source node was included for the dam to account for rainfall over the surface of the dam. Reuse figures were also added to the dam nodes to replicate the usage required to operate a poultry farm of this scale.
- The proposed reservoirs have not been included in the model as these are part of the reuse system from the dam and don’t receive direct runoff. Two 5kL tanks have been included with the proposed house sites and reuse estimates have been applied based on recommendations from the Draft NSW MUSIC Modelling Guidelines (2010).

The main treatment mechanism for the proposed development is water re-use. Due to the nature of the development, a large amount of water is required to be extracted from the dams. This water is used for a range of purposes including feeding, cooling and shed cleaning. Appendix A of this report includes a calculation of the pre & post-development re-use on the site. Note that the figures are approximate averages for the purposes of the MUSIC model and were obtained from the experience of other poultry farm operators. The distribution shown in Appendix A was used to model the different amounts of water required depending on the time of year.

Figure 6 below shows the layout of the model:

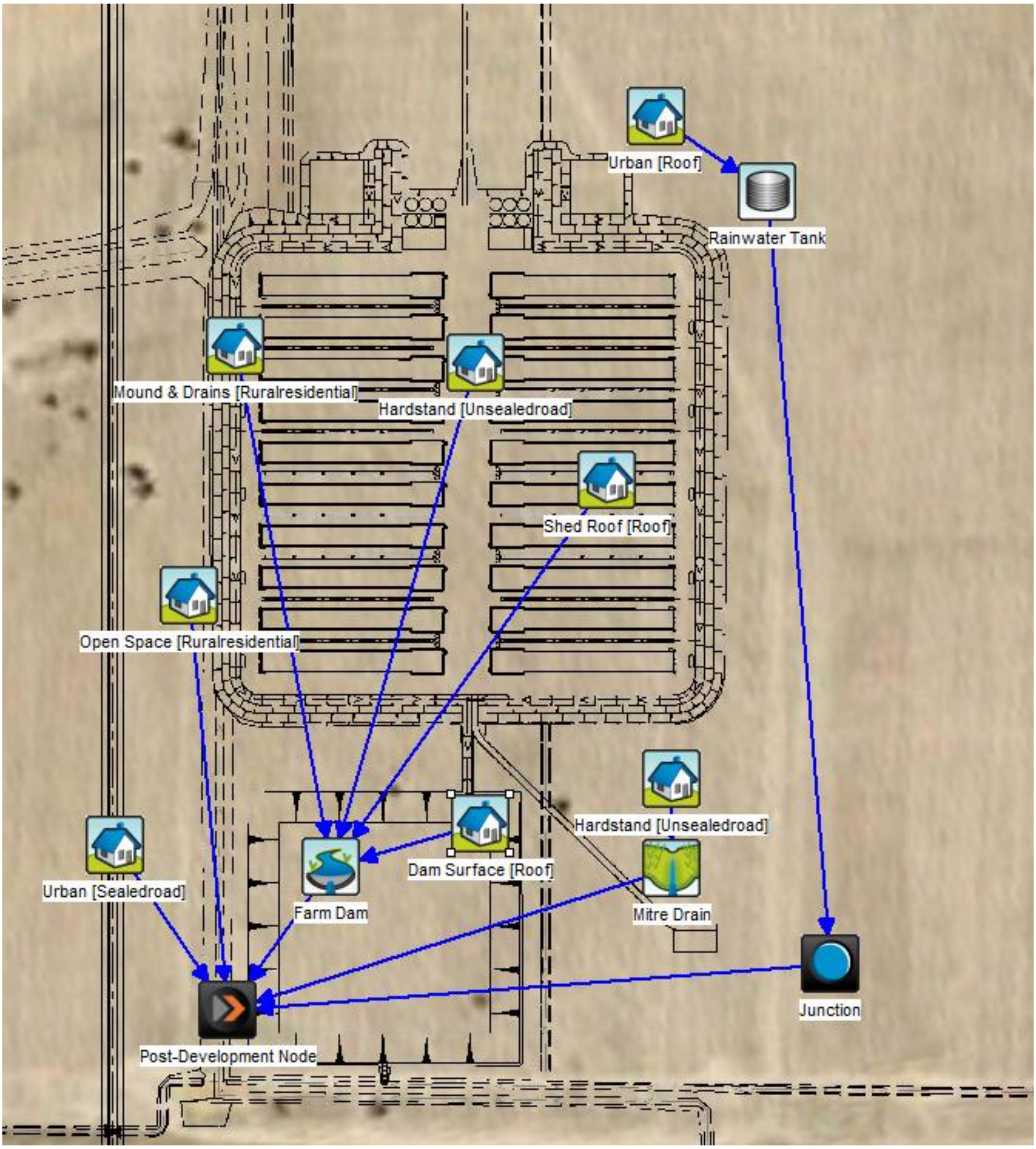

Figure 6: Proposed Development MUSIC Model

An analysis of the Post-Development Node reveals the following:

Table 4: Post-Development Node Analysis

	Proposed Development (Pre-Treatment)	Proposed Development (Post-Treatment)
Flow (ML/yr)	62.7	1.62
Total Suspended Solids (kg/yr)	12500	124
Total Phosphorus (kg/yr)	13.4	0.345
Total Nitrogen (kg/yr)	139	3.39
Gross Pollutants (kg/yr)	2370	0

2.6 SUMMARY OF POLLUTANT RESULTS

Pollutant loads were compared between the existing and proposed MUSIC models and compared to the Stormwater Quality Targets set out in Section 2.2, as summarised in Table 5 below.

Table 5: Comparison of Pre- and Post-Development Pollutant Loads

	Flow (ML/yr)	**Total Suspended Solids (kg/yr)**	**Total Phosphorous (kg/yr)**	**Total Nitrogen (kg/yr)**	**Gross Pollutants (kg/yr)**
Target	-	NorBE	NorBE	NorBE	90% Reduction
Existing Site	3.28	479	1.98	10.3	0
Proposed Development (Pre-Treatment)	62.7	12500	13.4	139	2370
Proposed Development (Post-Treatment)	1.62	124	0.345	3.39	0
Target Met	-	Yes	Yes	Yes	Yes

* NorBE – “Neutral of Beneficial Effect”

The results show the Neutral of Beneficial Effect targets are met in the proposed development - i.e. the proposal will result in an overall decrease in pollutants discharging from the study area, for Total Suspended Solids, Total Phosphorous and Total Nitrogen. This is principally due to the reduction in overall flow discharge from the site by the re-use of water in the poultry farm operations, removing flows that currently discharge pollutants into downstream waterways.

3.0 MAINTENANCE

Regular maintenance is required to allow the installed water quality measures to perform their tasks as designed. Maintenance tasks should involve a regime incorporating the following:

3.2 DISH DRAINS – Dish drains are critical in collecting runoff from around the site and transporting it efficiently to the dams for re-use. As such, dish drains should be inspected regularly and kept free of obstructions.

3.3 PROTECTION DURING CONSTRUCTION – A critical time for increased sediment loads is during construction, and with this in mind, current practice recommends guidelines from Landcom's "Blue Book". Disturbance caused during construction can result in large amounts of sediment in storm runoff, which can have an adverse effect on the efficiency of treatment train components from the very beginning. Care should be taken during the construction phase to limit the amount of sediment entering the dam.

4.0 HYDROLOGY

As a result of this development there will be increases in the amount of impermeable surface in the catchment, which in turn can decrease runoff times and create higher peak flow rates. It is important with new developments that measures are put in place to prevent increases in runoff from the site and resulting downstream flash flooding.

The effects on the development from regional flooding could not be quantitively assessed as there have been no flood studies in the area and Carathool Shire Council was unable to provide any information regarding flood planning levels or historical flood levels. At the January 2017 meeting with Council the Director of Development Services indicated that the property was outside of the flood impacts from the Wah Wah Creek system and as a cautionary position, the development should be raised at least 500mm from the existing levels. Generally speaking, each poultry farm has been designed as a balanced cut/fill operation, with the proposed infrastructure (sheds, roadways, dwellings etc) raised between 1m-2m above the existing ground surface, and a large excavated basin balancing the earthworks volume. This filling lifts the proposed development and further reduces the risk from any potential flood issues. The excavation of the main dam storage will maintain the same flood capacity of the land and mitigate any adjoining impacts.

It is also important to assess the impact the development may have on increasing runoff rates onto adjoining downstream properties. The addition of twenty new poultry sheds per farm and associated structures and pavements will increase the area of impermeable surfaces. The proposed dams are designed to have sufficient detention capacity to maintain predevelopment peak flowrates during a 100yr event.

Each farm has a proposed dam with a capacity of approximately 300,000m^3. These dams will mainly be filled through supply channels under a water licensing agreement. To ensure sufficient capacity to retain storm water for water quality and flood attenuation levels a maximum fill level shall be set to provide approximately 19,000 to 30,000m^3 of detention capacity.

4.1 Total Outflow from Each Poultry Farm

A 1D XP-Storm hydrological and hydraulic routing model has been prepared to quantify the effectiveness of the proposed measures. Rainfall was simulated utilising the Laurenson Method with IFD data sourced from the Bureau of Meteorology. A range of storms were run to determine the critical duration for the catchments (generally found to be between 1 and 3 hours). Sample discharge hydrographs are shown below.

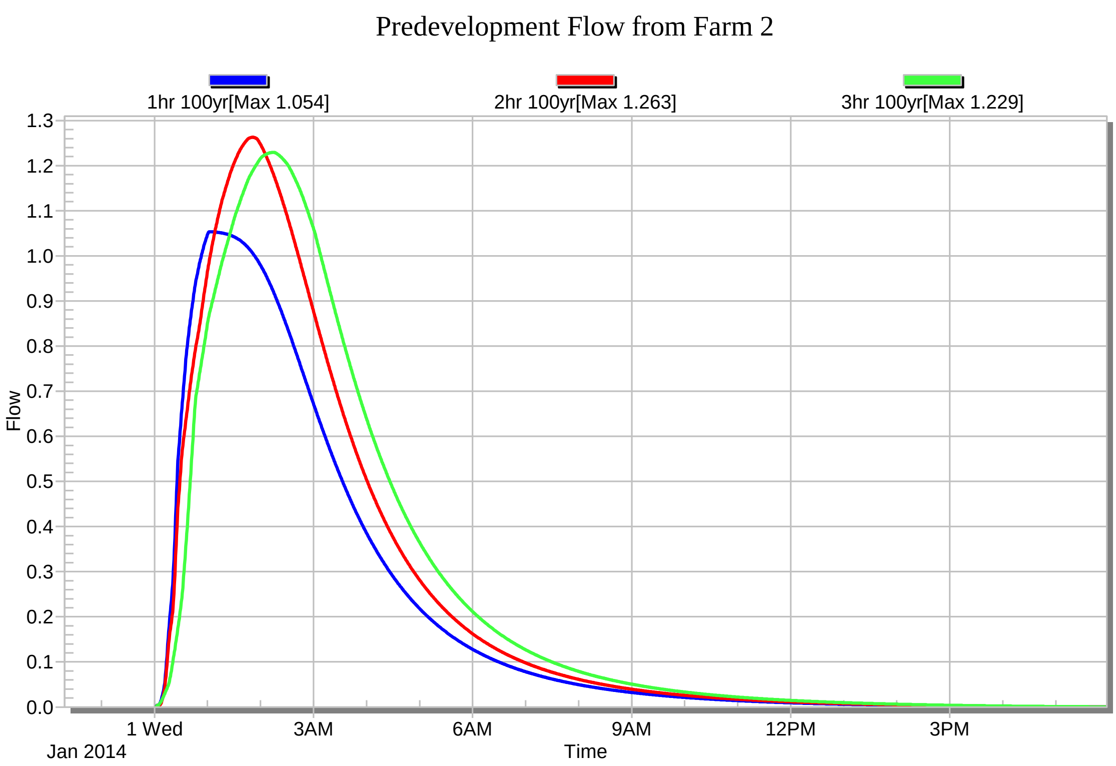

Figure 7: Catchment Pre-Development 100yr Hydrograph Farm 2

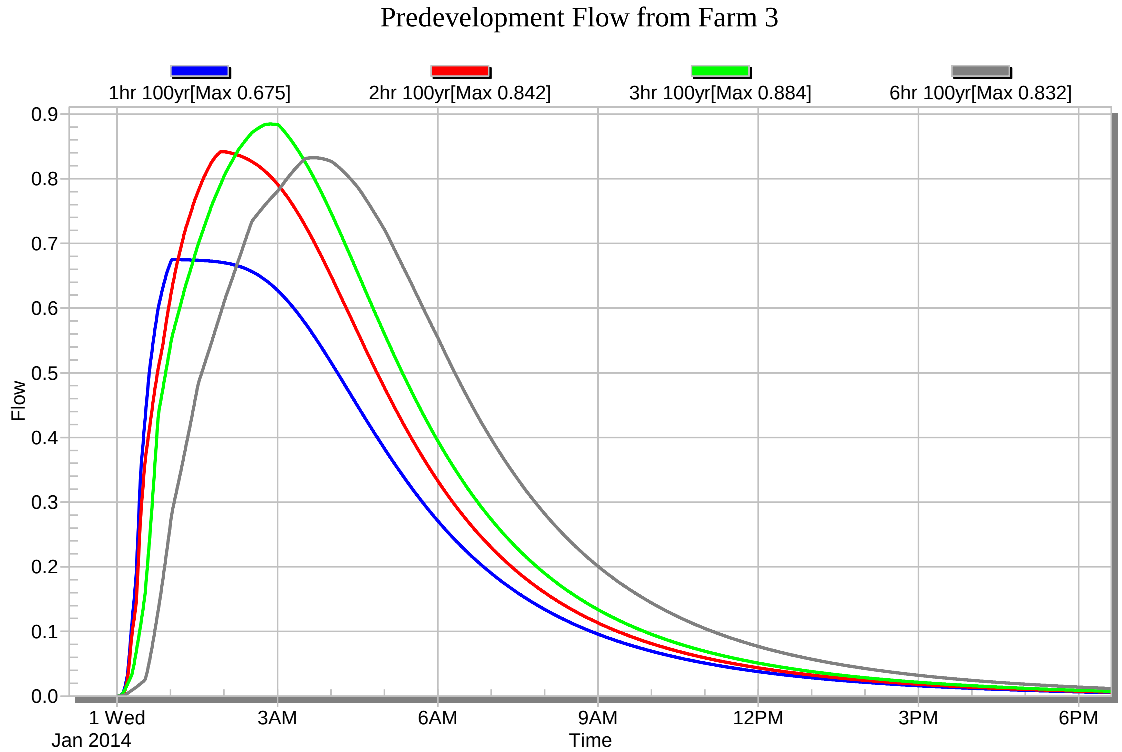

Figure 8: Catchment Pre-Development 100yr Hydrograph Farm 3

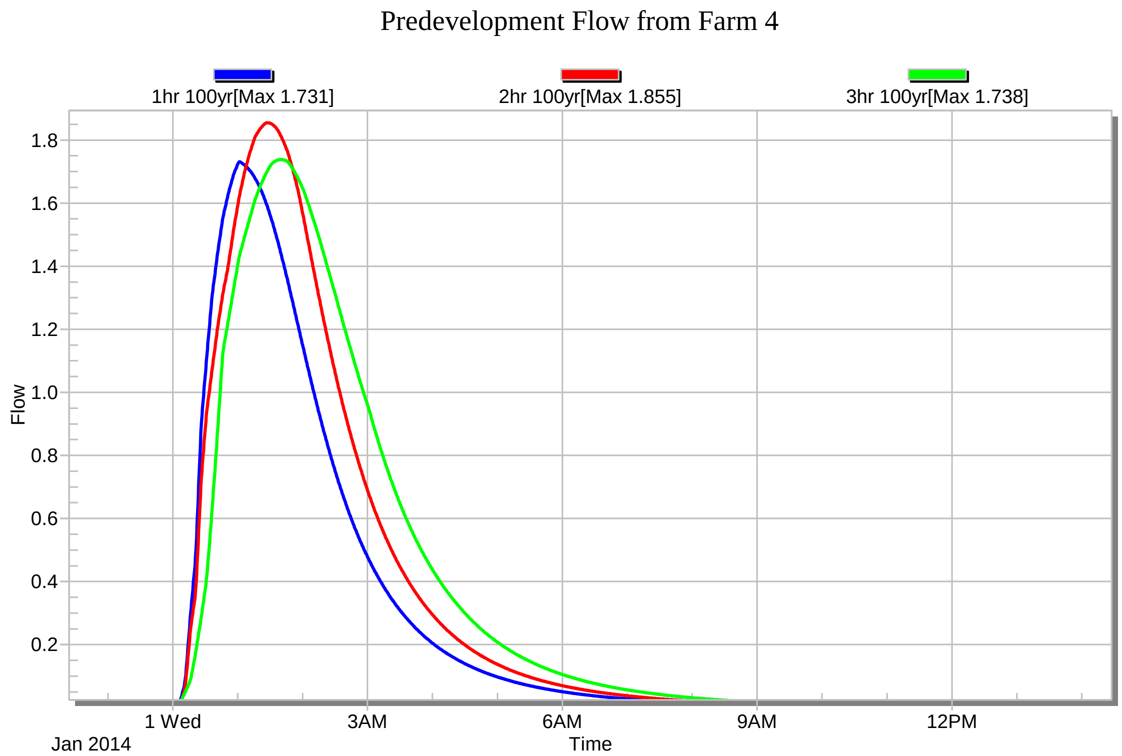

Figure 9: Catchment Pre-Development 100yr Hydrograph Farm 4

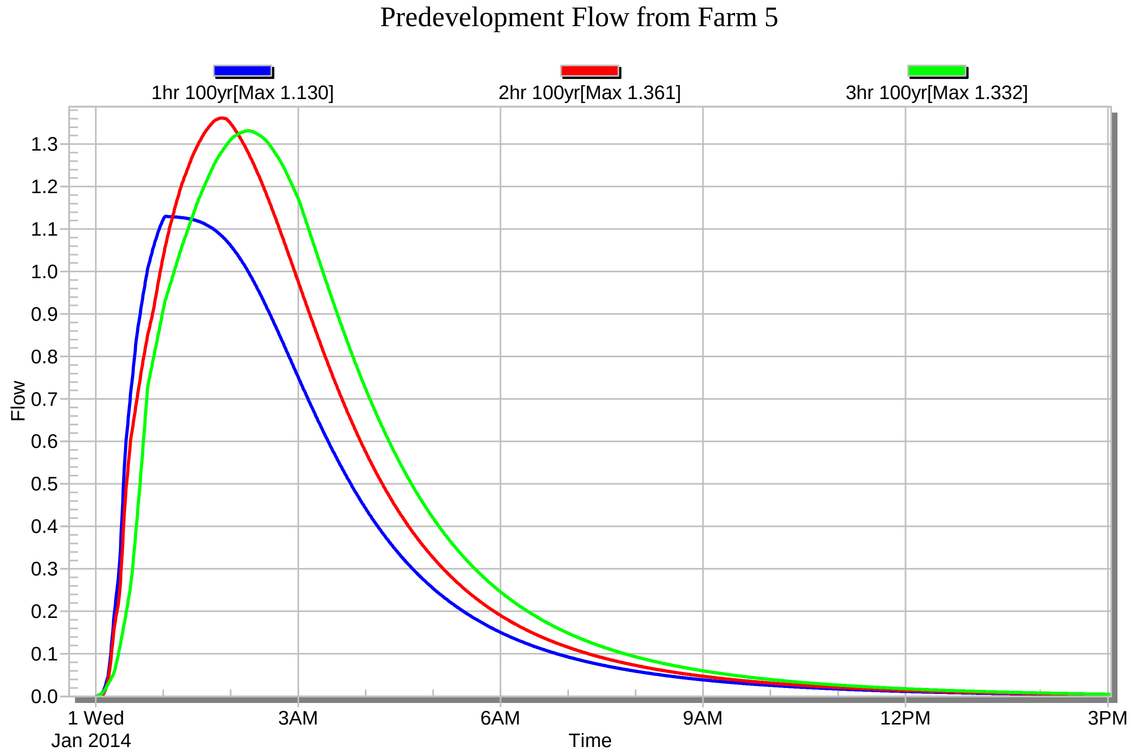

Figure 10: Catchment Pre-Development 100yr Hydrograph Farm 5

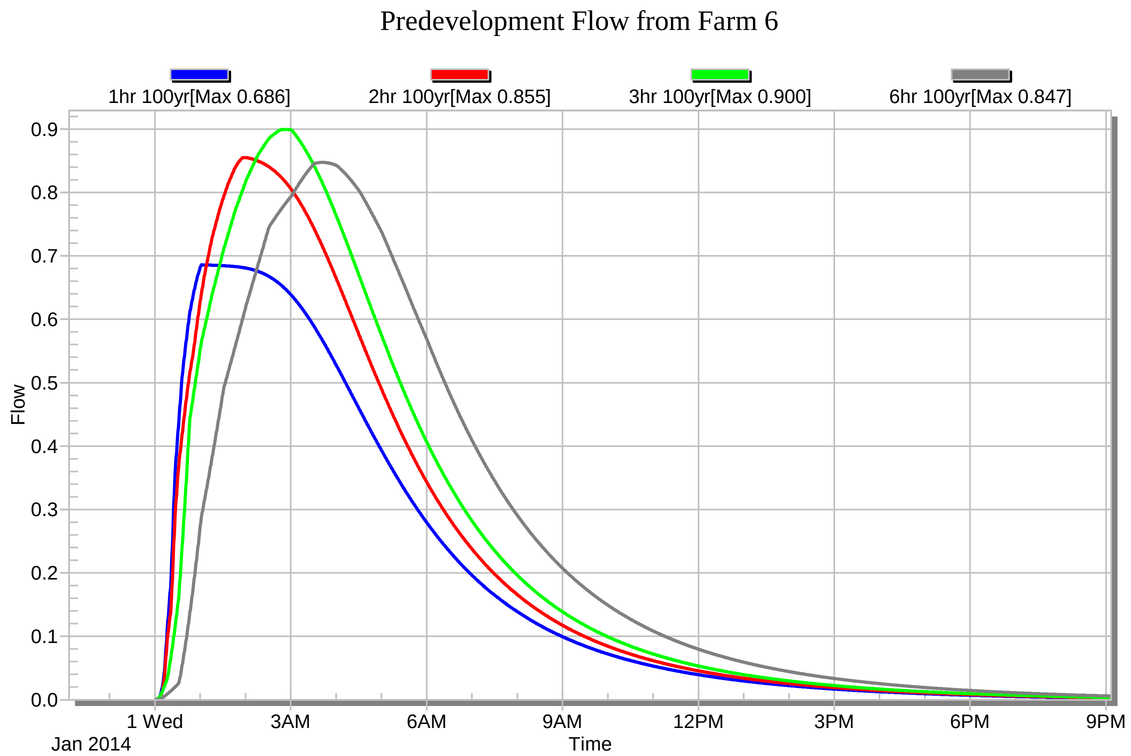

Figure 11: Catchment Pre-Development 100yr Hydrograph Farm 6

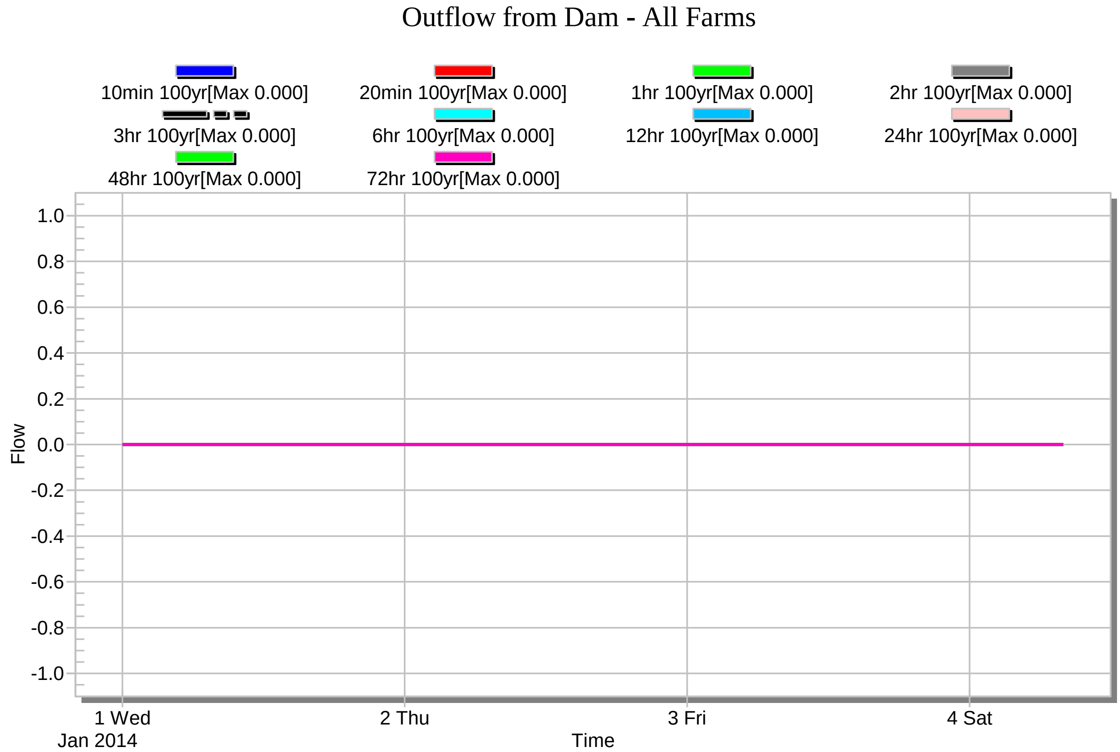

Figure 12: Catchment Post-Development 100yr Hydrograph

Figure 12 illustrates the fact that the available storage capacity in each dam is sufficient to completely contain the peak 100yr event from the Poultry Farm development footprints, thus removing the risk of increase downstream flooding issues. Runoff from the remainder of each property will remain unchanged and flow downstream as it currently does.

The XP-Storm model has also been used to size the culverts and swale flow conveyance system, which has been sized for a 10 year recurrence interval storm event. Additional checks show that the overland flow paths are sufficient to ensure the 100 year event will not reach the floor levels of the proposed poultry sheds.

Table 6: Hydraulic Model Summary

	Catchment Area (ha)		Imperviousness (%)		Detention Volume (m^3)		Peak 100yr Runoff (m^3/s)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Farm 2	27	27	0	35	0	31	1.263	0
Farm 3	29	29	0	33	0	19	0.884	0
Farm 4	28	28	0	34	0	27	1.855	0
Farm 5	30	30	0	32	0	45	1.361	0
Farm 6	29	29	0	33	0	31	0.9	0

4.2 Outflow from Proposed Dams

The XP-Storm hydrological and hydraulic routing model has also been used to model the characteristics of the proposed farm dams. A range of storms were run to determine the critical duration for the storage in the proposed dams.

All dams were modelled so that the water level was at the Maximum Fill Level before beginning the simulation.

Sample Water Elevation Graphs are shown below:

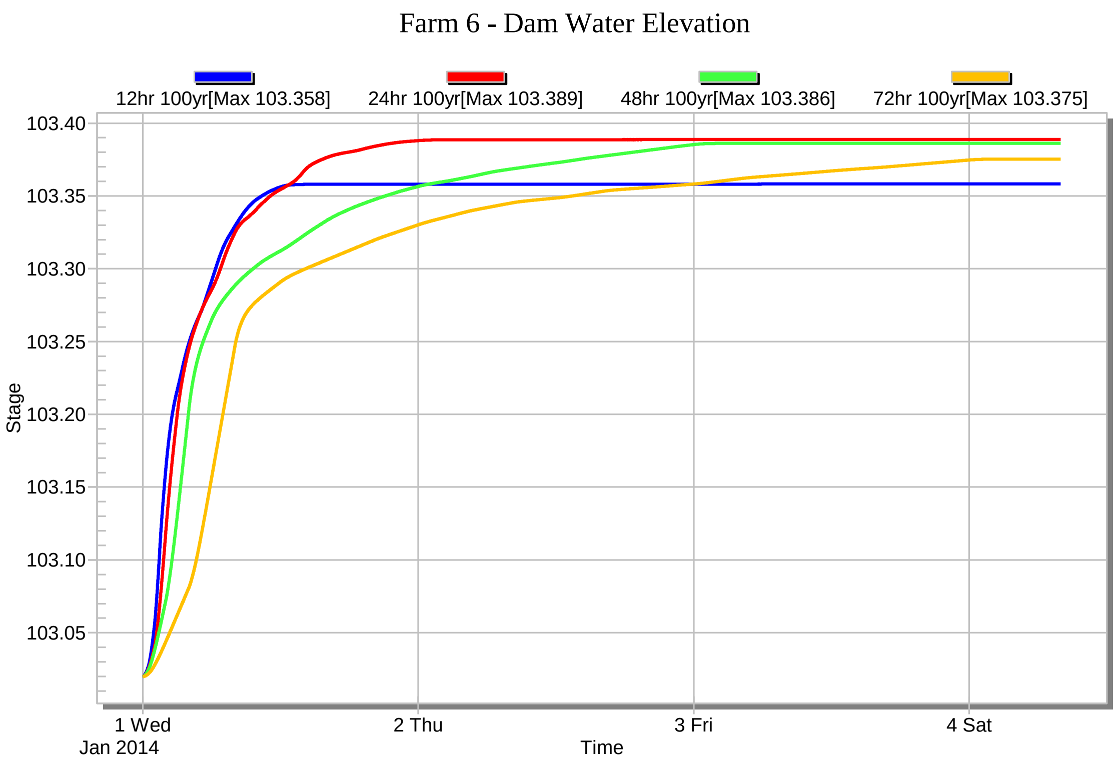

Figure 13: Farm 2 Water Elevation

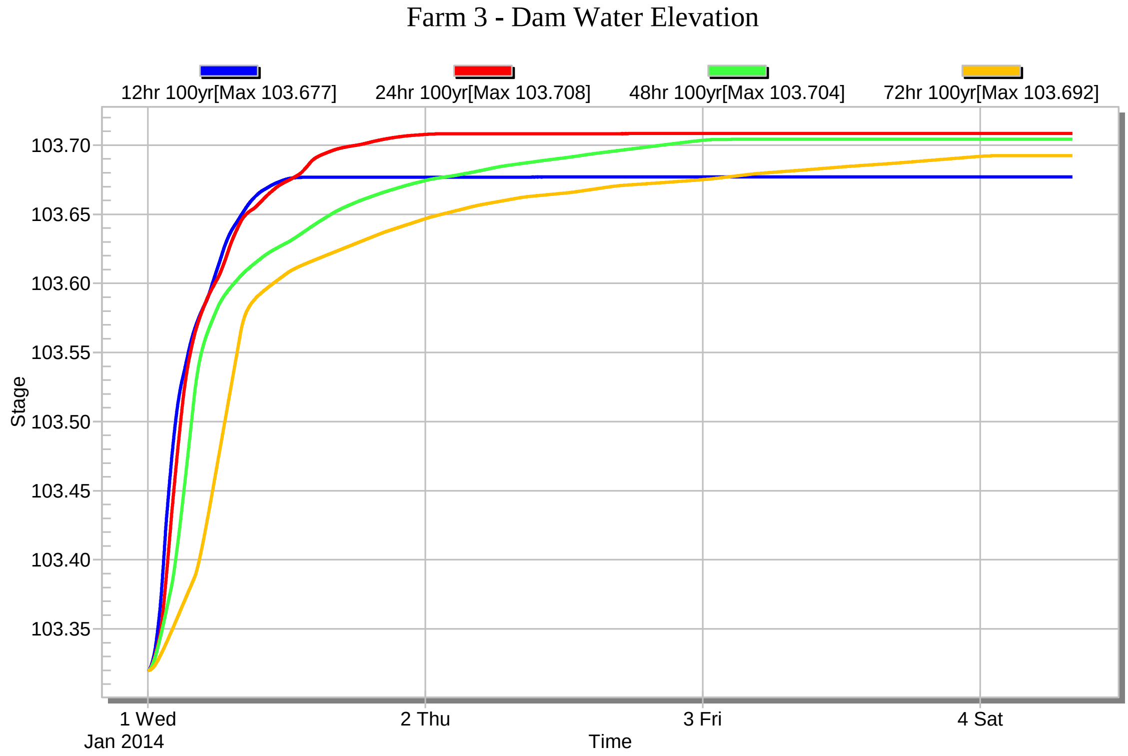

Figure 14: Farm 3 Water Elevation

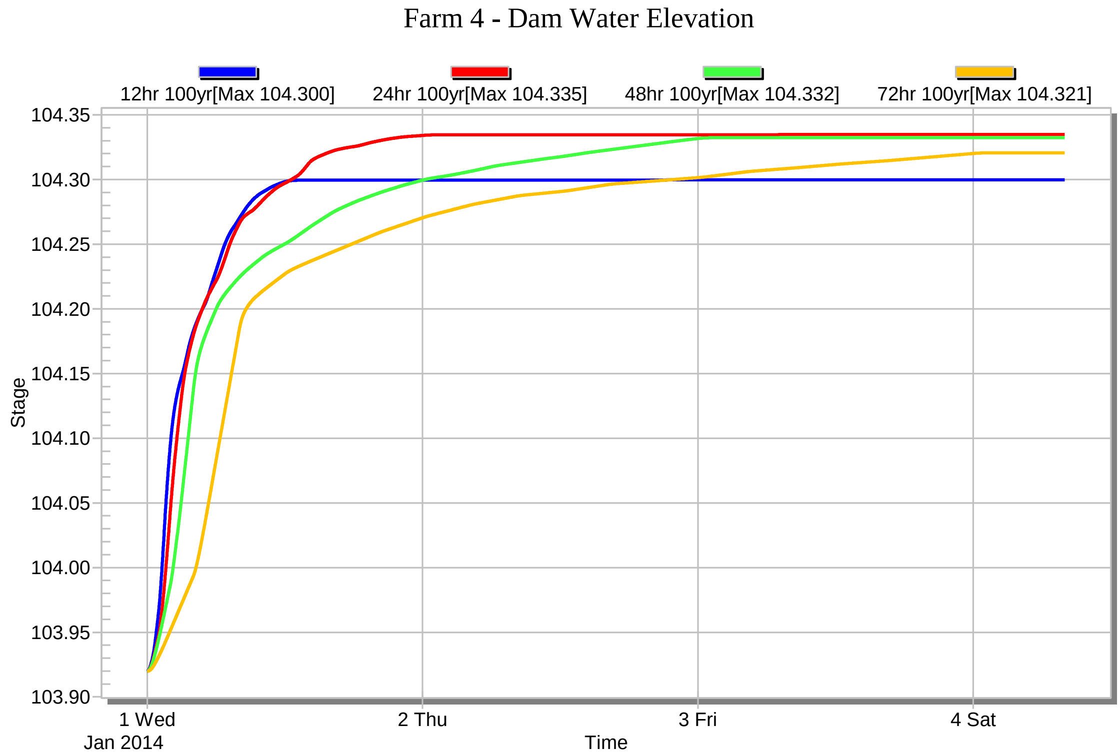

Figure 15: Farm 4 Water Elevation

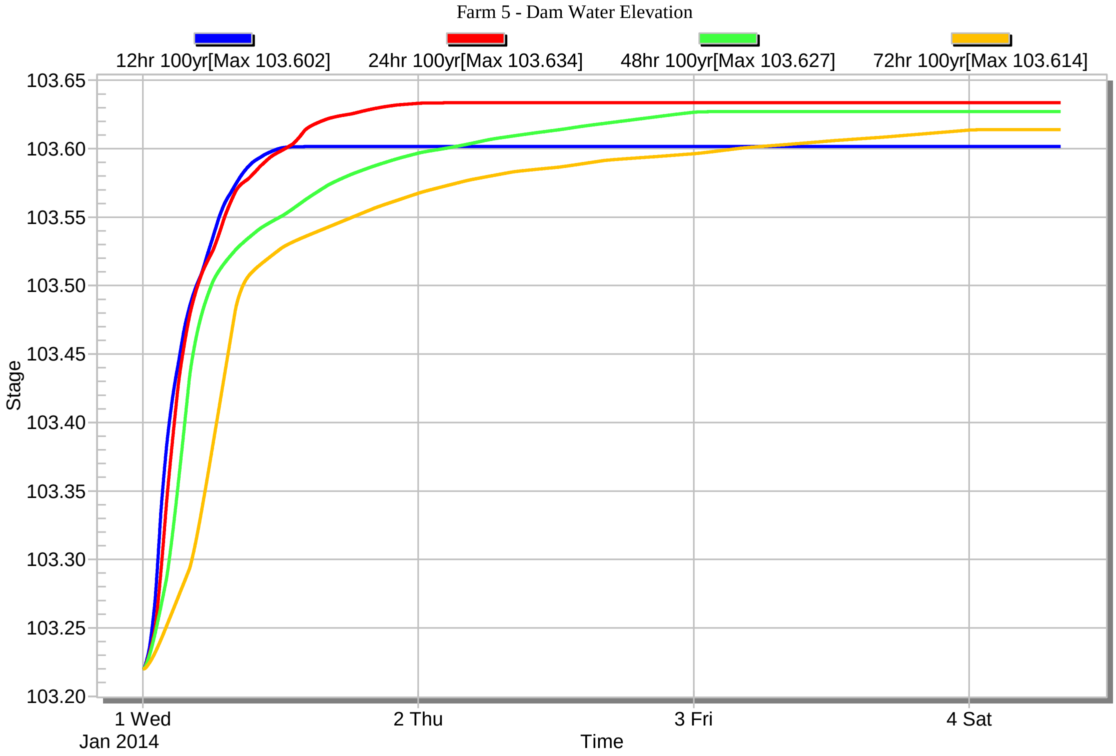

Figure 16: Farm 5 Water Elevation

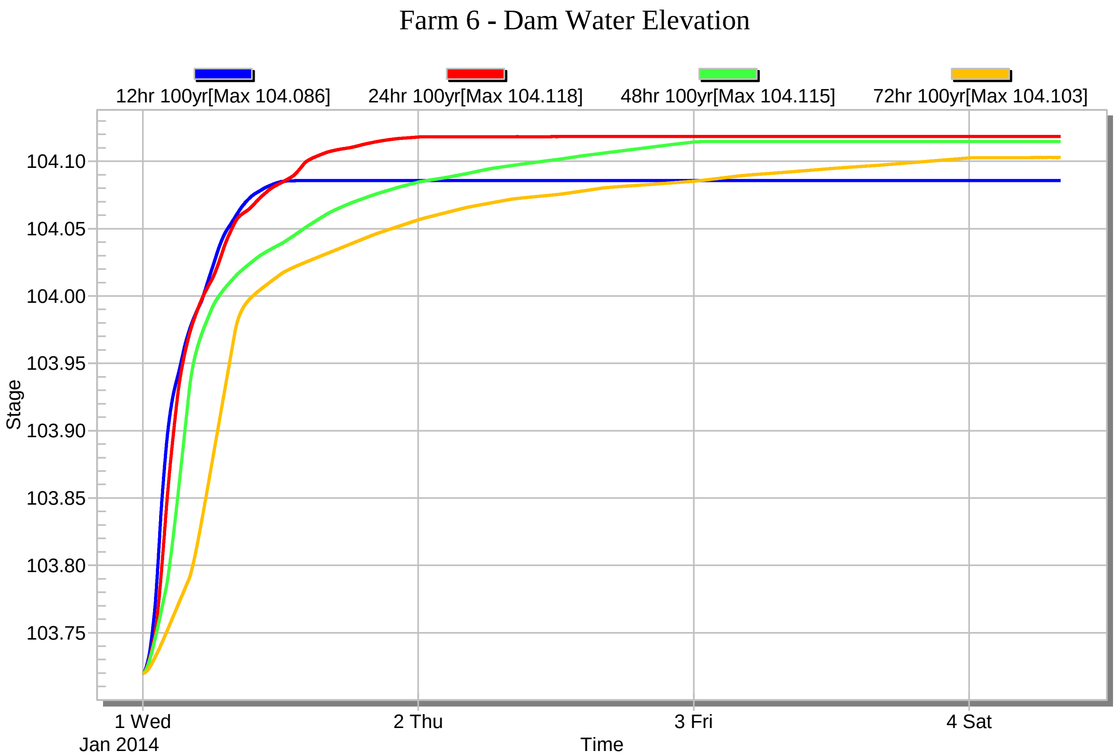

Figure 17: Farm 6 Water Elevation

A brief summary of each dam can be seen below in Table 7. It can be seen for all dams the peak 100yr event does not reach the overflow level.

Table 7: Dam Elevation Model Summary

	Max Fill Elevation	Overflow Elevation	Water Elevation After 100yr Event
Farm 2	103.02	103.52	103.389
Farm 3	103.32	103.82	103.708
Farm 4	103.92	104.42	104.335
Farm 5	103.22	103.95	103.634
Farm 6	103.72	104.22	104.118

5.0 CONCLUSION

The results derived from modelling procedures indicate that long term water quality and quantity constraints are appropriately addressed in the proposed development through the capture and reuse of stormwater runoff, thought the following measures:

- Construction of a new storage dam with each poultry farm - between 280,000 and 350,000cu.m storage volume, as detailed in the Tattersall Lander Detailed DA plans,
- Installation of a 5kL tank with each dwelling site.

More so, the modelling demonstrates that the development will actually have a positive impact on both the stormwater pollutant levels and peak flowrates leaving the site, compared to the existing situation. From a stormwater quality and quantity perspective, approval is recommended.

6.0 REFERENCES

Australian Rainfall and Runoff, 1987, Engineers Australia

Draft NSW MUSIC Modelling Guidelines, 2010, BMT WBM

Music Version 5.0 User Manual, 2011, eWater

Stormwater Flow and Quality, and the Effectiveness of Non-Proprietary Stormwater Treatment Measures, 2004, Fletcher et al

APPENDIX A: ANNUAL RE-USE DISTRIBUTION CALCULATIONS

Goolgowi Poultry Shed Post-Development Re-Use Calculations

Drinking:		0.35	L/bird/day	
		1200000	birds	
	=	420000	L/day	
Cooling (Summer):		120	nipples/shed	
(Tunnel Ventilated		3	gal/nipple/hour	
Sheds)		3.78541	L/gal	
		5	hours/day	
		20	sheds	
	=	136275	L/day	
Cleaning:		8000	L/shed/batch	
		8	weeks/batch	
		20	sheds	
		52	weeks/year	
		12	months/year	
	=	86666.67	L/month	
Drinking:		420	kL/day	
Cooling (Winter):		0	kL/day	(April - October)
Cooling (Summer):		136.3	kL/day	(November - March)
Cleaning:		86.67	kL/month	

Month	**Days**	**Drinking (kL)**	**Cooling (kL)**	**Cleaning (kL)**	**Total (kL)**	**%**
January	31	13020	4225.3	86.67	17332	**10%**
February	28	11760	3816.4	86.67	15663	**9%**
March	31	13020	4225.3	86.67	17332	**10%**
April	30	12600	0	86.67	12687	**7%**
May	31	13020	0	86.67	13107	**7%**
June	30	12600	0	86.67	12687	**7%**
July	31	13020	0	86.67	13107	**7%**
August	31	13020	0	86.67	13107	**7%**
September	30	12600	0	86.67	12687	**7%**
October	31	13020	0	86.67	13107	**7%**
November	30	12600	4089	86.67	16776	**10%**
December	31	13020	4225.3	86.67	17332	**10%**
Total:	**365**	**153300**	**20581.3**	**1040**	**174921**	**100%**