

# Carnarvon irrigation district short-term response plan



**CARNARVON IRRIGATION DISTRICT  
SHORT TERM RESPONSE PLAN  
November 2013 to April 2014**

**Carnarvon Ministerial Advisory Committee  
4 March 2014**

# CARNARVON IRRIGATION DISTRICT – SHORT TERM RESPONSE PLAN

November 2013 to April 2014

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## Executive Summary

1. The combination of a number of factors since the Gascoyne River flood of Christmas 2010/2011 has resulted in the short supply of water suitable for irrigation in the Lower Gascoyne. These include:
  - 1.1 the intrusion of saline water into the Lower Gascoyne in 2012 limiting the amount of low salinity water available for irrigation from subarea A;
  - 1.2 three successive dry seasons 2011, 2012 and 2013 that resulted in:
    - the saline-tainted groundwater in subarea A not being flushed from the system;
    - an absence of unrestricted water normally available during river flow events; and
    - the limited replenishment of all aquifers.
  - 1.3 incomplete infrastructure in the Northern Borefield (NBF) to enable the full allocation to be extracted placing greater reliance on abstraction from the SBF; and
  - 1.4 limitations of the new irrigation pipeline in terms of configuration, subsection controls and all parties getting used to manage this infrastructure to its full specifications that has resulted in a management decision to only deliver water to each side of the river on alternate days.
2. Concern from the growers as well as an awareness of future development plans for the area, prompted the Ministers for Water, and Agriculture and Food, to establish the Carnarvon Ministerial Advisory Committee (CMAC) with a mandate to advise and assist with resolving key issues pivotal to progressing the Carnarvon irrigation sector over the next five years. Specifically this included the delivery of short term actions needed to optimise existing conditions and water supply, and further to advise on a longer term plan and strategy for the management of water for progressing the Carnarvon irrigation district.
3. The Committee recognises that the 2011 Lower Gascoyne Water Management Plan (Plan) is current and soundly based. It incorporates all of the appropriate information for setting water allocations at an acceptable level of security and provides detailed procedures for managing the Plan. In due course particularly with the availability of further detail on water resources in the area, it will be prudent to review and modify the Plan accordingly.
4. Based on anticipated water requirements and an awareness of current water availability, in December 2013 the Gascoyne Water Cooperative (GWC) made a Seasonal Announcement of 50 per cent of allocations for C Class shares for the 2014 calendar year. C class shares are the shares members of the cooperative have in the consumptive pool (100 per cent equates to 8.6 gigalitres per annum [GL/a]).
5. This report by the Committee describes the actions taken and those considered to be taken to address the current short term (November 2013 to April 2014) water management issues and also recommends that a more strategic longer term approach (April 2014 to April 2019) is needed to provide greater security and understanding of supply and delivery for an expanded agricultural sector in the Gascoyne irrigation district.

6. Between November 2013 and February 2014 a number of specific initiatives were implemented to alleviate the immediate water supply situation, including:
  - 6.1 The provision of relief water to growers in subarea A. In October 2012 to September 2013 this was a total of 2 GL and for 2013/2014 this allocation was for a total of 1.5 GL. In total 1.5 GL of this allocation was used. It is noted that this relief water was available to all members of GWC and not dependent on recipient growers holding a subarea A groundwater licence which are slightly broader conditions than in the policy settings under the allocation plan;
  - 6.2 The provision of an additional allocation above licence limits to growers in subarea A who were close to their full entitlement and with access to suitable water;
  - 6.3 The maximum salinity of water allowed to be extracted from the river bed sands of some areas of subarea A was raised from 1000 to 1200 parts per million (ppm). This resulted in 21 000 kL of additional abstraction by three licensees. Raising this salinity ceiling above 1200 ppm was considered but not implemented as there are high levels of risk in elevating the salinity threshold further. The need to further consider this strategy was negated by small flows occurring in the Lower Gascoyne River in early 2014;
  - 6.4 Development and implementation of procedures for providing additional scheme water to the irrigation pipeline during “extreme weather” events;
  - 6.5 Provision of up to 2 GL/a of additional water from new bores in the Northern borefield (NBF) following an emergency drilling program by Gascoyne Foodbowl Initiative (GFI) and the commissioning of bores by the Department of Agriculture and Food (DAFWA) and Gascoyne Water Asset Mutual Co-operative Limited (GWAMCO) in early 2014;
  - 6.6 These actions were further aided by a small flow into the Lower Gascoyne in early January 2014 generated by Tropical Cyclone Christine and a follow up 3 metres flow in early February; and
  - 6.7 Simultaneously the GFI has been proceeding with the electrification of the existing line to bores managed by GWAMCO in the NBF for mid-2014 and also further exploring water resources along the extension of the NBF with the latter not expected to be completed until at least mid-2015.

**7. Initiatives considered but not implemented included:**

- enhancement of water storage capacity on properties to allow for management of pressure fluctuations in the system and to enable blending of waters of higher salinity;
  - opportunistic extraction of water from pools for scheme supply after low river flows;
  - greater flexibility of managing water allocations in subarea A; and
  - procuring water from other sources, such as desalination or trucking.
8. The Committee recognises that the set of measures taken, aided by the opportune availability of additional water from the NBF and further supplemented by some timely rain has largely aided in re-establishing water supplies and easing the crisis. However the Committee also recognises that the collaboration and communication among stakeholders and the Low Aquifer Status (LAS) Working Group in the period especially from July 2013 in the knowledge of a period of likely water shortage, was fragmented and lacked strategic direction, leadership and purposeful implementation.

9. Additional rain in late January 2014, early February 2014 and any further rain in this cyclone season will continue to ease the situation.
10. Additional water supplies will be increasingly available from existing bores pending aquifer recharge from river flows and new production bore establishment in the NBF. However agricultural expansion planned under the GFI will result in all of these additional supplies from the NBF being allocated and likely to be used, with little or no spare capacity for provision of additional water during extended dry periods that are likely to occur in the future.
11. The Committee strongly recommends that efforts now be directed to the development of a Medium Term Response Plan (5+ years) to manage water infrastructure and governance associated with the existing irrigated agriculture and proposed development in the Lower Gascoyne in a far more strategic and purposeful manner. It is generally accepted that the scale of agricultural operations in the Lower Gascoyne must be expanded to allow agriculture to be more efficient and effective. To achieve these goals it is recognised that the water supply and delivery processes will need to be streamlined and rationalised, and far more interaction and collaboration between agencies, growers and water cooperatives will need to take place. In addition GWAMCO and the GWC will need to enhance their structures and operational capacity to meet grower requirements for the supply of irrigation water.
12. Specific matters that will need to be addressed in the Medium Term Response Plan are:
  - 12.1 structure, ownership, capacity and Governance of the water irrigation supply system;
  - 12.2 improved understanding of the resource and limits through updated analysis of the current water resource model to extraction to improve management responses;
  - 12.3 the development of a comprehensive plan for emergency response such as extended dry periods or a significant failure of the water supply system; and
  - 12.4 continuous improvement in agricultural practice and water use.

The Plan will need to be developed with Government endorsement providing very clear and unambiguous delineation of roles, responsibilities and leadership tasks for the main participants, especially Department of Water (DoW), DAFWA, Water Corporation (Corporation) and the Department of Regional Development (DRD). In addition the Plan will need to be developed in close association with the Cooperatives. This is essential if further development in the Gascoyne is to be successful.

13. Addressing the issues associated with the current dry conditions has nurtured a far greater level of collaboration and interaction between parties. Albeit largely successful it has been undertaken somewhat ad hoc and not within a broader framework. In a future sequence of dry seasons the same set of interventions may not be appropriate, but the need for strong partnerships between government agencies, the water cooperatives and growers will be essential.



## **Introduction**

The town of Carnarvon and its horticulture industry are reliant on a water supply from the shallow aquifer system adjacent to the Lower Gascoyne River. An extended period of no-flow conditions in the river has adversely affected the volume of fresh water available for abstraction. In November 2013 water supplies in the Carnarvon Groundwater Area and the Carnarvon Water Reserve made available for irrigated agriculture were at their lowest levels in Carnarvon since records began. This follows the largest ever flooding sequence in 2010/11 and the introduction of saline water in late 2011 and early 2012.

This low water availability coupled with the highest ever water use by the industry in 2012, and an over-reliance on limited areas of the aquifer to supply irrigation water, has required the introduction of water rationing in late 2013. The rationing was expected to be necessary until a river flow event of sufficient size occurred to fully recharge the aquifer system.

The management framework for the Carnarvon groundwater area is detailed in the Lower Gascoyne Water Allocation Plan (2011) and its supporting documents.

The Carnarvon Groundwater Area and the Carnarvon Water Reserve covers significant, yet finite, water resources comprising the Lower Gascoyne River that have supplied the town of Carnarvon, as well as the surrounding horticultural district with a relatively fresh and constant water supply since the town was founded in 1883. However, constant growth of the Carnarvon Horticulture District combined with variable and unreliable river recharge events has placed an increasing amount of pressure on the resource, with water quality and quantity being the major limitations to the system.

Fortunately, water resources of the Lower Gascoyne River have been subject to an array of research by the DoW, its predecessors and partner agencies dating as far back as the 1950's, including hydrology/hydrogeology modelling, bore exploration, water quality monitoring, Aerial Electromagnetic assessment, water use monitoring, climate prediction, soil and erosion studies, drought studies and water allocation planning.

## **Carnarvon Ministerial Advisory Committee**

The Carnarvon Ministerial Advisory Committee was established and an independent chairperson, Dr Des Lord, was appointed on 20 November 2013 by the Ministers for Water and Agriculture & Food in response to the current situation with a mandate to assist with resolving key issues pivotal to supporting the Carnarvon irrigated agriculture sector over the next five years. Specifically, this included the delivery of:

1. coordinated implementation of short term actions needed to optimise availability and supply of water resources and minimise impacts on the horticulture industry; and
2. coordinated resolution of other key issues pivotal to progressing the Carnarvon agriculture sector over the next five years, including strategic coordination of infrastructure projects implementation (e.g. including the Corporation's pipeline project, GFI projects.)

Refer to the Terms of Reference and the Committee membership in attachment 1.

This report documents the delivery of the first (1 above) of the Terms of Reference for the Committee with information current to 20 February 2014.

The Committee met on two occasions in Carnarvon on 17 December 2013 and 21 January 2014. A second report, to be the Medium Term Response Plan is proposed for release in April 2014.

## Section 2: Lower Gascoyne water allocation plan

The Carnarvon Ministerial Advisory Committee recognises that the DoW 2011 Lower Gascoyne Water Management Plan is current and soundly based. It incorporates all of the appropriate information for setting water allocations at an acceptable level of security and provides detailed procedures for managing water resources at a local level through the Plan.

The Lower Gascoyne River aquifer system comprises two distinct aquifers that are hydraulic connected:

1. **Riverbed Sand Aquifer** – a highly transmissive, sandy, superficial, unconfined aquifer typically restricted to the existing river channel. The water quality of this aquifer is fresh (<500 mg/L Total Dissolved Solids – TDS).
2. **Older Alluvium Aquifer** – an underlying sequence of alluvial deposits containing low permeability clays and silts interspersed with high permeability sandy zones. Water quality in this aquifer is variable and typically varies between 1000 and 6000 mg/L TDS with values increasing with greater distance from the river channel.

For a full description of the aquifer system see WRC 2004; SMEC 2001 and DoW 2010a.

The Lower Gascoyne Water allocation plan (2011) divides the aquifer system into management subareas. Subarea A is where water is privately abstracted by individual growers. Subareas B–L is where the town water supply and irrigation scheme water are drawn and delivered via a reticulated scheme. Within subareas B–L, water is abstracted by the Corporation on the south bank of the river for town and irrigation supply. The Gascoyne Water Cooperatives abstract water for irrigation on the north bank of the river.

The plan also specifies rules that restrict pumping in subarea A in response to elevated salinity. In the event that abstraction is seriously hindered in subarea A, the plan allows for temporary increases in the allocation of subareas B–L to help offset the reduced availability. The plan also allows for temporary reductions in the allocation limit of subareas B–L in the event of an extended period of low flow conditions in the river that may compromise the availability of water for public supply or pose a risk to in-situ values.

Allocation limits suggest there is more water available however, licenced abstraction is conditional upon salinity values not being exceeded at each production well.

Table 1 in Section 5 describes the allocation limits and water currently licenced for abstraction. These limits are set at the yields that are estimated to have an 80 per cent reliability of supply.



## Section 3: Short Term Response Actions

### Water Supply

**Action 1:** To identify every drop of useable water that can be provided to growers without causing permanent long term damage to the aquifers.

#### Subarea A – Grower self-supply bores (licensing managed by the DoW)

- (a) The DoW to allow access to up to 1.5 GL of tainted water (1000–1200 ppm TDS) from subarea A to growers on application.

The 1000 ppm threshold to stop pumping by water licensees in subarea A has been a long-standing management arrangement to limit lateral movement of saline movement from bank storage. However, the current saline conditions were driven by unusual salinity intrusion from upstream sources which have affected aquifer condition and thus many growers' supplies from subarea A.

The DoW, through regular monitoring, was able to characterise the location and quantity of this tainted intrusion water. With advice from the Carnarvon Water Allocation Advisory Committee (CWAAC), the DoW made provisions from 8 November 2013 for growers to make application to pump groundwater from subarea A with TDS levels up to 1200 ppm to assist in removing the estimated 1.5 GL of this tainted water. Since informing licensees of this opportunity on the 8 November 2013 there has been limited interest expressed and only three licenses granted tainted water licenses to the end of January 2014. These licensees took approximately 21000 kL which contributed significantly to their farm water budget during the alternate water day period. The CWAAC have advised that the policy set developed should be included in the allocation plan for future events.

- (b) The DoW to assess (and if supported determine rules for) the sustainability of taking higher salinity water to remove tainted water from the riverbed sands.

After assessment of bore water samples, a number of growers were found to have tainted water above 1200 ppm TDS making them ineligible for the new 1200 ppm TDS licences. As there is a limited geographical spread and interest by growers to uptake groundwater with a salinity threshold above 1200 ppm it may not contribute significantly to the district's water budget. Raising this salinity ceiling above 1200 ppm was considered but not implemented as there are high levels of hydrological and agronomic risk in elevating the salinity threshold further. The need to further consider this strategy was negated by small flows occurring in the Lower Gascoyne River in early 2014.

- (c) For the 2013 water year temporarily increase subarea A entitlement for growers with good quality water and high use.

At the beginning of December 2013 a number of growers who were close to using their full subarea A license entitlement still had good quality water available. The DoW, with advice from CWAAC, allowed the one-off take of an extra 5000 kL in subarea A under a special licence that allowed four growers to finish their vegetable crops and/or keep perennial crops producing during a crucial time. This scheme has now been completed with the start of the new water year on 1 January 2014.

- (d) Fast track the development of new subarea A infrastructure licensing and groundwater assessment.

As has been normal practice by the DoW in times of lower water access, it has made available extra resources to fast track the provision of licensing advice and hydrogeological expertise to bring on new infrastructure in a timely manner to access every drop of water in the short term. This includes licensing of subarea A new bores developed by growers to replace older systems and those destroyed in the 2010/11 flood. Also any water quality testing and licence assessments have been fast tracked.

- (e) Trading of Groundwater Water License entitlements in subarea A.

Provisions for water trading exist in subarea A under the allocation plan, but this has generally not been well supported by the industry in the past nor is it practical as it is not a "basin" where water can be moved around efficiently, except to a neighbouring property. Trading requests would be assessed in a timely manner in accordance with the legislation and allocation plan. However, in 2013/2014 some growers have chosen not to fully utilise their GWC C Class shares and have temporarily traded them to a neighbour or another grower through the GWC rules.

#### **Southern Borefield – managed by the Water Corporation**

- (g) Within the constraints of the licenced annual volume, determine what variation in daily abstraction might be accommodated to allow for an 'extreme weather' rate of water provision for short events; and for long duration weather events (>4 days).

On 11 November 2013, the LAS steering group decided to allow additional water to be made available for irrigation from the southern borefield on extreme weather days that would impact the current plantation plantings. This would require some short term increase in irrigation flow to prevent long term impacts to the growers under a protocol agreed by the GWC, the Corporation and the DoW. The first version of the extreme weather policy was agreed by the three parties on 22 November 2013 and worked well for the event over 3-4 December. The procedure was updated in late December 2013 and is as follows:

1. the Corporation Operations Manager and GWC General Manager will monitor on a weekday basis the short/medium weather predictions to determine extreme weather events;
2. extreme weather events are determined to be predicted days where the temperature at the Carnarvon Bureau of Meteorology (BoM) site at the Carnarvon airport is forecast to be equal to or greater than 38 degrees Celsius;
3. where these events are predicted, GWC will provide the Corporation written request by email confirming the operational flows of their northern borefield and requesting the supply from the Southern Borefield to the irrigation scheme will be increased from ~15 ML/day to ~18 ML/day. This increased supply will start approximately 12–18 hours the day before the predicted extreme weather prediction;
4. the increased flow rate of ~18 ML/day will only be maintained for a maximum of 4 days and the supply will then decrease back to the licenced limit of ~15 ML/day;
5. the cooperative will continue to maintain its alternate day demand management;

6. the Corporation will notify DoW of this arrangement when agreement is reached between GWC and the Corporation including the proposed start day and duration;
7. should the predicted model indicate greater than 4 days duration all parties will be required to meet and work together to achieve a solution;
8. if forecast predictions fall below the trigger level then supply will revert to 15 ML/day; and
9. if actual temperature exceeds the 38 degrees Celsius trigger level there is very little that can be done to increase water availability due to system latencies.

The Carnarvon Bureau of Meteorology (BoM) site at the Carnarvon airport was the preferred station as it is the only reliable forecast station in the local area and is used by all management authorities, including FESA, to make weather predictions. The 38 degrees Celsius trigger was used as this provided a correlation to the higher temperatures that would be experienced on the plantations.

The implementation of the 'extreme weather' arrangements occurred on three occasions. In mid-January to mid-February 2014 although there were two 'extreme weather' events water demand from the system was much lower than 15 ML/day from the southern borefield so no extra water was required by growers to meet demand. Discussion was held on requests to review the policy and three issues were listed for further consideration, but not finalised prior to this report:

- correlate the BoM site predictions with the DAFWA site weather readings;
- determine whether the policy needs to account for variations between forecast (predicted) and actual; and
- review the way in which requests can be made and responded too, to account for weekends, public holidays and after hours

- (h) Continue delivery of 1.5 GL of relief water to system (October 2013 to October 2014) for Cooperative distribution

After declaration of LAS by the Minister for Water in October 2012, the DoW established a LAS Working Group to share information and provide a common understanding for managing communication around water availability (see background on LAS in Attachment 3). Members were from DoW (Chair), CWAAC, Water Corporation, cooperatives, Carnarvon Growers Association and the DAFWA. The Minister for Water made an announcement in October 2012 for 2 GL and in October 2013 a further 1.5 GL of relief water to be made available to growers with subarea A groundwater licenses impacted by tainted water.

Relief water was abstracted under a temporary license by the Corporation from their southern borefield, piped to the irrigation pipeline and distributed by the GWC to growers. The relief water was distributed quarterly by GWC through an Expression of Interest process (not through the usual C Class share process) and incurred a usage charge. There was some confusion and disconnect between the allocation plan and the GWC policy that will be addressed by the parties once the LAS period is finalised.

The LAS Working Group has been meeting regularly to undertake the aquifer review, ensure information flow between each organisation, and agree the management

actions needed to ensure water availability during this growing season, such as the release of relief water. It has also considered contingency planning for a no-flow situation in 2014, demand management strategies for the co-operatives to implement, and information availability for stakeholders and customers of each organisation.

Following the 3 metre river flow starting on 1 February 2014 and a review of its impact on recharge, the DoW consulted with the Carnarvon Water Allocation Advisory Committee and the LAS working group and they recommended revoking the LAS declaration. On 14 February the Minister for Water, the Hon Mia Davies, announced the LAS period to be cancelled. The cancelling of the LAS normalises the district water budget.

- (i) Determine sustainable water rate provision for irrigated agriculture to cooperatives to April 2014.

In September 2013 the DoW assessed the capacity of the Southern Borefield and a proposed increase in the volume of groundwater drawn by the Corporation from the SBF. A full hydrogeological review of the subarea B–L aquifers was undertaken, based on all available monitoring and historical pumping information up to that time. Current salinity trends and water levels indicate that the SBF was showing abstraction stress. The internal review indicated that the water licenced was the largest amount possible without unacceptable risk to the aquifer, the river environment and the town water supply.

Subsequently the DoW and the Corporation had a combined team of senior hydrogeologists conducted a thorough review of the volume of water licenced for abstraction by the Corporation for town supply and irrigation supply to confirm whether an increase in licence volume maintains an acceptable level of risk to the degradation of aquifer water quality is viable. This group set the Southern Borefield abstraction rate to be constrained to 15 ML/day in 2014 until an effective recharge event. This equals approximately 5.3 GL of which 3.8 GL was for irrigation C Class shares and 1.5 GL for relief water.

The DoW continued to review data monthly since the licencing decision in November 2013 and there has been no ability to allow increased abstraction from the southern borefield without having unacceptable consequences on the aquifers. Further increases in allocations from the southern borefield were not supported to the end of February 2014. The next review will be conducted in March 2014.

#### **Northern Borefield – being developed by the DAFWA**

- (j) Develop additional borefield capacity – ‘emergency drilling’ (2 ML/day or 0.8 GL/a) to be incorporated into GFI borefield DAFWA and temporarily loan use to GWAMCO

The DAFWA has, through the Royalties for Regions funding to the GFI and support funding from the DoW, conducted an aerial electromagnetic survey of the northern borefield with a view to establish a new production borefield to produce approximately 3–4 GL/a for 400 hectares of new land releases for irrigated agriculture. The Minister for Agriculture and Food, the Hon Ken Baston, in late November 2013 announced that

infill drilling would be brought forward to locate 2 ML/day (0.8 GL/a) for emergency water to assist the Carnarvon irrigation district.

In December 2013 DAFWA drilled 12 exploratory bores in and around the GWAMCO borefield. That programme resulted in one production well being developed by DAFWA with a yield of 1.0 ML/day and all production would be provided through the cooperatives until there is a major river flow. This bore then would be used as part of the GFI borefield. Final bore testing is still to be verified by DoW and licensing adjusted.

- (k) Progress borefield extension and electrification in a timely manner.

The DAFWA has prepared the tender for electrification of the GWAMCO northern borefield to normalise the cost of abstraction replacing the more expensive diesel generators run by GWAMCO and the tender is proposed to be released in February 2014. Funding is through the Royalties for Regions GFI and it is estimated construction of this section of the power line would be completed by mid-2014.

#### **Northern Borefield – managed by GWAMCO**

- (l) Maintain production from existing infrastructure (6 ML/day or 2.8 GL/a) GWAMCO.

GWAMCO has an existing water license to extract 2.8 GL/a from the subarea B–L northern borefield from existing infrastructure developed during the last dry period in 2010. To date this volume of water has yet to be extracted over a significant length of time. However, from October 2013 GWAMCO has been running their bores in the northern borefield at full operational capacity on diesel generators. This is estimated at producing approximately 6 ML/day (2.1 GL/a) to the irrigation system. GWAMCO has agreed to maintain this level of extraction through 2014. This is dependent on the bores maintaining similar yield and the development of mains power to the borefield early in 2014 under the Gascoyne Foodbowl Initiative administered by DAFWA.

- (m) GWAMCO to develop additional borefield capacity – emergency commission new production bores (2 ML/day or 0.8 GL/a)

GWAMCO has water reserved against their existing license to extract an additional 0.8 GL/a from the subarea B–L northern borefield but will need to develop more infrastructure to access the reserve. The December 2013 emergency drilling by the DAFWA in the northern borefield identified three prospective production bores that would be made available to GWAMCO to test and commission.

GWAMCO has drilled two of these as new production bores. Test pumping has commenced and a hydrogeological assessment will be complete in February 2014. While the assessment is being prepared all water produced is being provided to the reticulated irrigation supply. The DoW will license new borefield infrastructure from existing GWAMCO 0.8 GL/a reserve as pump tests and aquifer information are finalised and assessed.

In addition, GWAMCO are assessing the cost/benefits of bringing online 2–3 low yielding bores in their existing borefield. Strategic siting of the new emergency bores close to existing low producing bores will allow both to be serviced by the one

generator set or mains transformer. This will become more economic once the mains power has been installed.

### Other options regarding water access

A review of alternative freshwater resources in the vicinity has been undertaken, with particular attention focussed on the possibility of transporting (likely “trucking”) water from other areas to the Carnarvon Horticultural District. A report was developed from a desktop assessment of the groundwater attributes of the location based upon available data (see summary in Attachment 4).

## Distribution system

**Action 2:** Ensure that whatever water is available is distributed equitably among growers

### Gascoyne Irrigation Pipeline (GIP) – managed by GWC

- (a) Establish and maintain a demand management system – determine if the whole pipeline can be operated continuously or retain alternate days north and south during low demand periods.

The cooperatives introduced a ‘water demand management’ trial of providing water to the irrigation pipeline on alternate watering days starting with north of the river on 18 November and the south for 19 November. The pipeline has been provided with 15ML/day by the Corporation from the southern borefield and 6 ML/day by GWAMCO from the northern borefield (average total 21 ML/day). This three-month arrangement has provided better water pressure, equitable distribution of available water to all parts of the system and a much reduced number of complaints by growers.

On the 7 February 2014 with the reduced demand due to increased private take of water during the unrestricted period, the GWC switched from alternate day supply to constant supply for its members. Supply from the southern borefield increased to 11 000 kL/day during the first few days but by the 12 February had normalised back to around 8 000 kL/day which is similar rate of supply to just before alternate days were discontinued.

- (b) Make the seasonal announcement for 2014 and review based on new information

On 18 November 2013, the Board of the GWC gave written notice to its members that commencing on 1 January 2014 all members’ annual allocations for the 2014 season will be 50 per cent in the advent of no recharge. This formally notified all its members following a verbal announcement at the GWC annual general meeting in November 2013.

The GWC on 14 February 2014 updated the seasonal announcement to its members to 80 per cent. This decision was based on predicted aquifer recharge and response following assessment of historical monitoring information in response to recharge events of a similar magnitude that led to the Minister for Water cancelling the LAS. Further changes to the seasonal announcement may be made once monitoring information has been collected and confirms the predicted response. This is likely to be March/April 2014. It is important to note that peak daily restrictions will stay in place for the southern



bore field at between 15–20 ML/day. This figure will be determined by the Corporation and DoW as monitoring information becomes available.

As part of the seasonal announcement the GWC requested members provide information about their demand over the 2014 water year to determine when demand management would need to be in place.

(c) Do cooperatives require expert advice or capacity building for their operation team?

The cooperatives are assessing the needs for increased capacity by its staff and boards. The first step in building the capacity is to appoint a new CEO in early 2014. A skills audit against operating requirements for the boards and staff will be undertaken and suitable capacity building identified by mid-2014. This may also include structural changes to the organisation and the board. [This subject will be further explored in the Medium Term Response Plan.]

(d) Establishment of a hydraulic model for Carnarvon supply scheme.

The Corporation are setting up a hydraulic model of the entire Carnarvon water supply scheme including all the GWC assets. This model can be calibrated and then used to determine the optimum way to operate the scheme under normal unrestricted conditions. Various operating scenarios can also be examined to study how the scheme will operate in restricted conditions. This information can be used to modify the current operating scenarios and will form a part of the Medium Term Response Plan.

### Individual Responsibility

The Carnarvon irrigation district is one of the most efficient horticultural precincts in Australia in terms of value of production for each gigalitre of water used. However, growers need to remain vigilant in terms of their own water usage systems and remain current in their understanding of water efficiency technology available to them. The timing of planting and crop selection will impact on their own and the district's water budget month-in month-out. The restricted water availability over recent months has resulted in growers making extremely hard decisions on letting crops go and delaying seedling planting.

It is important that growers understand the water balance for the Carnarvon irrigation district and how it is impacted by the recharge or otherwise of the various aquifers and within subareas. Also to manage their own water requirements between property-based self supply licences in subarea A (both surface and groundwater licences) and their purchased share allocation from the GWC from the scheme supplied from subareas B–L.

During late 2013 it became evident from the complaints received by the Gascoyne water cooperatives that not all members had sufficient water storage capacity during the demand management period or for a prolonged failure of the scheme water system. It is important for individual growers to examine their on-farm water storage to ensure they have suitable volumes to ensure:

- Domestic Supply. The GWC does not provide potable water to the plantation area. It is the responsibility of the individuals to ensure that there is suitable and sufficient house supply, including storage for multiple days of disrupted supply;
- Irrigation Supply. Ensure there is sufficient irrigation water supply to allow the demand for water to be spread over 24 hours and have sufficient storage in case of an outage.

Action: Investigate mechanisms to promote sufficient on farm storage.

## Crop and Grower Demand

**Action 3:** Determine the crop demand in terms of areas planted and water demands for each crop type and crop finish dates.

- I. Provide growers through 'Dollar for your drop' program (DAFWA) with up-to-date and accurate advice for them to make planting and watering decision

The DAFWA ran two half-day 'Dollar for your drop' seminars in Carnarvon on the 10 and 11 December 2013. One was run for Vietnamese growers with the vegetablesWA and DAFWA-funded Vietnamese officer in attendance to lecture and interpret. This was well attended with 24 businesses being represented and was a good opportunity for Vietnamese growers to get firsthand knowledge of the current and predicted water supply issues. The GWC cooperatives were not in attendance to answer water demand management so a follow up meeting was organised later in that week. The English language workshop had only one attendee due to a conflicting meeting, so a follow up workshop was organised with the banana cooperative where eight attended. Introductions to the workshops were attended by the two agencies (DAFWA, DoW).

- II. Determine monthly water demand based on historical cropping data and crop type water use (DAFWA). Is there a water supply gap and what is its magnitude?

The LAS Working Group gathered information from a number of sources to determine the crop water demand. The DAFWA provided monthly crop data for 2011 and 2012, through the 'Carnarvon Plantation Industry Production Figures' report which provided a guide to annual crop amounts and peak harvest times. The DAFWA also made an estimate in mid-November 2013 of potential crop and income loss if scheme water was to be stopped on 15 December 2013 for the remainder of the month.

However, it appears that the role in Carnarvon of monitoring and predicting crop areas in the ground at any time is not the responsibility of any agency or water co-operative. Such information would have been extremely useful over the past four months to determine crop areas, water demand and to determine the predicted shortfall. There is a requirement for any future period of water restriction to establish and maintain a demand management system to manage to the water demand-supply gaps.

## Water Resource Monitoring

**Action 4:** To monitor short and medium term actions for their short and long term impact on the aquifer systems and growers.

### Subarea A – Grower self supply bores (licensing managed by the DoW)

(e) Tailor frequency of water quality monitoring to risk of aquifer.

The DoW on average undertakes monitoring of salinity for subarea A groundwater licenses approximately four times per year. As salinity levels increase above 850 mg/L TDS monitoring frequency increases. With the use of specific high risk groundwater licences to remove the tainted water in subarea A monitoring of these licenses occurred between weekly to monthly.

The DoW, the Corporation and GWC undertake quarterly aquifer monitoring. During periods of LAS more frequent monitoring was undertaken as does higher risk activities such as take of water over 1000 ppm. To this end these organisations undertook to increase frequency to monthly to allow a more frequent review of the performance and response of the aquifer as the LAS period extended. The DoW will prioritise and resource this additional monitoring work.

The DoW provides an update on the status of the Gascoyne River alluvial aquifer system consisting of the shallow 'River Bed Sands' and the deeper 'Old Alluvial Aquifer' approximately quarterly throughout the year. The aim of the 'Aquifer Status Update' is to provide growers, the general public and other interested parties information on the condition of subarea A groundwater resources. The DoW provided updated aquifer reports to the industry in October 2013 (for the June to September 2013 quarter) and in February 2014 (for the October to December quarter).

### Northern Borefield – managed by GWAMCO

Displayed daily, GWAMCO borefield and distribution information is updated online on the GWC website [www.gascoynewater.com.au](http://www.gascoynewater.com.au) to include information relevant to the abstraction from the Northern Borefield. Including, but not limited to: daily consumption; pressure at McGlades Road; flow rates at McGlades Road; and salinity at McGlades Road. Also to be developed and displayed is information relating to the distribution system including pressure, flow rate and salinity at multiple locations.

## Section 4: Impacts of Gascoyne River flows in January–February 2014

On 31 December 2013 Tropical Cyclone Christine produced significant rainfall in the upper-mid Gascoyne river catchment. This resulted in a 0.4 metre (m) flow at Nine Mile Bridge on the 10 January 2014. This flow followed the low flow channel and did not provide enough bed coverage to benefit many growers nor enough pressure to effectively recharge the deeper older alluvium aquifer (OAA).

In late January 2014, further rain in the upper catchment followed by widespread thunderstorms, resulted in a flow reaching Nine Mile Bridge on 1 February 2014. This flow peaked at 3 metres (m) and maintained a height of >1 m for a further two weeks. At this peak height and duration the river is predicted to providing widespread recharge of the river bed sand (RBS) aquifer and enough pressure to start recharging the OAA.

Under the *Lower Gascoyne water allocation plan 2011*, Local Licensing Rule 4 unrestricted pumping periods are declared at the discretion of the DoW for pumping from the RBS formation. This allows groundwater licensees to make use of the abundant water flowing out to sea. Water taken during unrestricted pumping periods is not counted against the annual groundwater entitlement nor are licensees constrained by other license conditions such as restriction to 10 000 kilolitres per month. Licensees and the community were notified on 4 February 2014 of the unrestricted pumping declaration through the online River Flow Advice, flyers at local businesses and a Ministerial media statement.

Assessment of similar historical flows indicated a 3 m flow will provide recharge to the RBS aquifer and enough pressure to start recharging the Older Alluvium Aquifer (OAA). Hydrogeological assessment predicts that this flow will recharge the RBS in subarea B–L by approximately 3–4 GL and the OAA by approximately 1.0–1.2 for the same subareas. In practical terms there is limited recharge of the OAA in subarea B–L from which the irrigation scheme supply is abstracted. This means that the peak daily output from the borefields will be approximately 25–30 ML/day.

Following this review, the DoW consulted with the Carnarvon Water Allocation Advisory Committee and the LAS working group and they recommended revoking the LAS declaration. On 14 February the Minister for Water, the Hon Mia Davies, announced the LAS period to be cancelled. The cancelling of the LAS normalises the district water budget, i.e. the unused component of the 1.5 GL of relief water will be made available to the GWC for distribution to its members against their C Class share holdings.

On 14 February the GWC reviewed its Seasonal Announcement from 50 per cent access to water for C Class shareholders to 80 per cent. Further upward reviews are likely in the event for future recharge events and/or if the review of monitoring data after the February flow confirms the predicted recharge. There is still a need for monitoring of the aquifers to confirm the predicted response, this will occur by DoW and other stakeholders in March 2014.

Maximum daily production from the southern borefield will remain between 15–20 ML/day until further recharge of the older alluvium occurs.

## Section 5: Lower Gascoyne River Water Budget

The water budget for the horticulture industry is derived from private abstraction in subarea A and Irrigation Scheme Supply from subareas B–L abstracted by the Corporation and GWAMCO and distributed by GWC. The water resources available are groundwater, surface water and unrestricted pumping. A summary of the sustainable limits based on the best available science and management is provided in the Lower Gascoyne Water Allocation Plan (2011). The reliability of all sources of water to the horticulture industry is 80 per cent, similar to other irrigation areas in the world.

The DoW maintains a summary table during periods of LAS that shows predicted draws versus actual draws (Table 1). The Carnarvon Ministerial Advisory Committee has found this an excellent summary of water availability and use for each area and part of the Lower Gascoyne River system. It was the basis for much of the discussion on the impact of various short (and medium) term actions on water availability to growers. The Committee sees Table 1 as an essential tool for all water users and managers in the Lower Gascoyne.

The last two columns titled 'Estimated 2014' show the estimated take at the beginning of December 2013 and the updated estimate (as of 20 February 2014) after the short term actions described in this report, including the cancellation of the LAS and the two small river flows in January and February 2014.

**Table 1 – Lower Gascoyne River Water Allocation Summary – 6 February 2014**

Source	Sustainable yield <sup>1</sup>	Reserved amount	Licensed amount	Average take	Actual 2012	Actual 2013	Estimated 2014 (Dec 2013) <sup>11</sup>	Estimated 2014 (Feb 2014)
Subarea A (grower self-supply)	6.1	0.0	8.2 (2.1 over allocation limit) <sup>2</sup>	4.5	3.0	2.5	2.0	3.8
Subarea A – Unrestricted pumping from flowing river	∞	0.0	NA	1.0	0.4	0.0	0.0	0.8
Subarea A – tainted water <sup>8</sup>	NA	NA	NA	NA	0.0	0.02	0.5 <sup>8</sup>	0.0 <sup>8</sup>
Subarea B–L South Borefield Irrigation Scheme (Water Corp) <sup>3</sup>	5.0	0.0	5.0	5.0	6.3	6.1	3.8	5.0
Subarea B–L Unrestricted pumping South Borefield Irrigation Scheme (Water Corp) <sup>3</sup>	NA	NA	NA	NA	0.6	0.0	0.0	0.8
Subarea B–L South Borefield Irrigation Scheme (Water Corp) LAS Relief Water <sup>4</sup>	0.0	NA	NA	NA	0.1	1.4	1.5	0.2
Subarea B–L GWAMCO North Borefield <sup>3</sup>	3.6	0.8	2.8	1.0	1.5	0.9	2.0 <sup>5</sup>	2.7 <sup>5</sup>
Subarea B–L GFI North Borefield <sup>6</sup>	3.3 <sup>7</sup>	3.3	NA	NA	NA	NA	NA	0.3
<b>Subtotal Irrigation Supply</b>	<b>18.0</b>	<b>4.1</b>	<b>NA</b>	<b>11.5</b>	<b>11.9</b>	<b>10.9</b>	<b>9.3</b>	<b>13.6</b>
Subarea B–L South Borefield Town Water Supply (Water Corp) <sup>10</sup>	3.6	1.8 <sup>9</sup>	1.8	1.2	1.1	1.2	1.0	1.2
Yandoo surficial	0.1	0.0	0.0	NA	0.0	0.0	0.0	0.0
<b>Subtotal Other</b>	<b>3.7</b>	<b>1.8</b>	<b>NA</b>	<b>1.2</b>	<b>1.1</b>	<b>1.2</b>	<b>1.0</b>	<b>1.2</b>
<b>Total</b>	<b>21.7</b>	<b>5.9</b>	<b>NA</b>	<b>12.7</b>	<b>13.0</b>	<b>12.0</b>	<b>10.3</b>	<b>14.8</b>



## Footnotes

<sup>1</sup>The sustainable yield (limit) was determined following extensive consultation with industry and other stakeholders. It relied on the GASFAMS model for the lower Gascoyne area and assessed different scenarios of salinity and abstraction rate against recorded river flow lengths of 10 years. The model was peer reviewed using the adopted Australian standard by Dr Merrick and was seen as fit-for-purpose. The allocation limits also equate to an 80 per cent reliability (8 out of 10 years), an international benchmark. Higher sustainable limits resulted in medium to long term damage to the aquifer and less water for the industry in the lower salinity range required. The salinity threshold also matches DAFWA advice about maintaining soil health.

<sup>2</sup> 2011 Lower Gascoyne Water Allocation Plan outlines pathway to recover historical over allocation in subarea A.

<sup>3</sup> Water provided by (a) the Corporation from the southern borefield to the irrigation industry and (b) the GWAMCO northern borefield to be used to meet C Class shares held by members of the Gascoyne water cooperatives.

<sup>4</sup>Low Aquifer Storage (LAS) period declared in September 2012 by Minister for Water. LAS relief water licenses for this LAS period run from October to September as per the water licence year. LAS relief water license October 2012 to September 2013 for 2.0 GL of which 1.2 GL used, October 2013 to September 2014 is for 1.5 GL with all to be used at a rate of no more than 0.375 GL/quarter.

<sup>5</sup>Current emergency drilling and production bore development by the DAFWA and GWAMCO may increase this amount in 2014. The table can be modified depending on the results of the production bore development.

<sup>6</sup>Identified for horticulture expansion under the Gascoyne Foodbowl Initiative (GFI) and reserved for horticulture purposes at the request of the Minister for Water and the Minister for Agriculture and Food.

<sup>7</sup>Allocation limits will be reviewed periodically as information is collated by DAFWA as set out in Table 7 (pg 26) of the allocation plan. The next planned review will use the AEM and GFI drilling data to update the GASFAMS model and rerun the allocation scenarios. This is currently scheduled for early 2015

<sup>8</sup>The “tainting” of the river bed sands aquifer occurred in 2012 as a consequence of the major 2010–11 flood and smaller flow in 2012 and is considered to be a once-in-50-year event. There is approximately 1.3 GL of tainted water available for abstraction from the RBS aquifer in subarea A. The uptake of licenses to abstracted against this tainted water have been limited, with three ground water licenses issued to date. Monitoring will confirm any changes to tainted water amounts out of early 2014 river flows.

<sup>9</sup>The reserved town water supply is not available for another use, even temporarily, as outlined in the allocation plan

<sup>10</sup>Additional information is covered by Carnarvon Water Source Protection Plan.

## Chapter 6: Carnarvon Irrigation Scheme – Mid-term Review

The Committee strongly recommends that efforts now be directed to the development of a Medium Term Response Plan (5+ years) to manage water infrastructure and governance associated with the existing irrigated agriculture and proposed development in the Lower Gascoyne in a far more strategic and purposeful manner. It is generally accepted that the scale of agricultural operations in the Lower Gascoyne must be expanded to allow agriculture to be more efficient and effective. To achieve these goals it is recognised that the water supply and delivery processes will need to be streamlined and rationalised, and far more interaction and collaboration between agencies, growers and water cooperatives. In addition GWAMCO and the GWC will need to enhance their structures and operational capacity to meet grower requirements for the supply of irrigation water.

The scope will include the entire Carnarvon water source regardless of current management arrangements. It will also include an assessment of the entire water supply transfer system including the distribution pipeline system.

The overall aim will be to determine the optimal way to develop, maintain and operate the whole irrigation water supply scheme to meet future customer demands.

Specific matters that will need to be addressed in the Medium Term Response Plan are:

- structure, ownership, capacity and Governance of the water irrigation supply system;
- improved understanding of the resource and limits through updated analysis of the current water resource model to extraction to improve management responses;
- the development of a comprehensive plan for emergency response such as extended dry periods or a significant failure of the water supply system; and
- continuous improvement in agricultural practice and water use.

The Plan will need to be developed with government endorsement providing very clear and unambiguous delineation of roles, responsibilities and leadership tasks for the main participants, especially DoW, DAFWA, the Corporation and the DRD. In addition the Plan will need to be developed in close association with the Cooperatives. This is essential if further development in the Gascoyne is to be successful.

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Thomson, Y. (2001). *Groundwater Resource Identification for Horticultural Development in the Gascoyne Murchison Region*. Waters & Rivers Commission; Perth, WA.

## Attachment 1: The Carnarvon Ministerial Advisory Committee Terms of Reference and membership.

### Terms of Reference:

- Coordinated implementation of short term actions needed to optimise availability and supply of water resources and minimise impacts on the Carnarvon horticulture industry; and
- Coordinated resolution of other key issues pivotal to progressing the Carnarvon agriculture sector over the next five years, including strategic coordination of infrastructure projects implementation (e.g. including the Water Corporation pipeline project, Gascoyne Foodbowl Initiative projects.)

This includes:

- coordinated implementation of agreed short-term management actions including optimisation of existing resources and identification and delivery of additional resources, and demand management;
- development and agreement to a contingency plan for a no-flow situation in 2014 and coordinated implementation (if needed);
- development and delivery of effective, regular and coordinated communication with growers and other stakeholders;
- identification of all other key issues impacting on the development of the Carnarvon horticulture sector, and development and oversight of implementation of an agreed plan for resolution; and
- provide advice on for local capacity-building.

### Members:

Independent Chair: Des Lord

Executive Director Department of Agriculture and Food

Executive Director Department of Water

Executive Director/Director Department of Regional Development

Director Water Corporation

CEO Shire of Carnarvon

Chair Gascoyne Development Commission

Chair Gascoyne Water Cooperative

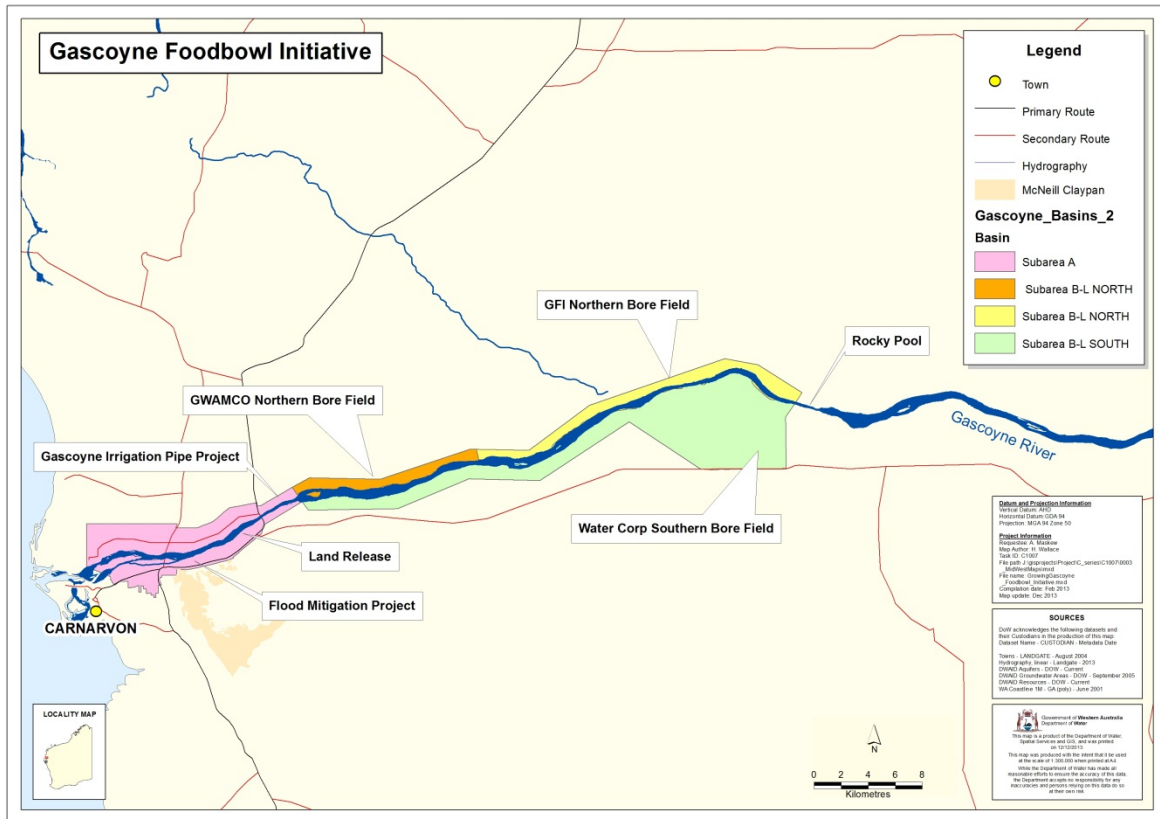
Chair GWAMCO

Carnarvon Water Advisory Committee grower representative

Grower

**Executive Support** Department of Water

## Attachment 2: Gascoyne Foodbowl Initiative – SubArea Map



## Attachment 3: What is Low Aquifer Storage?

### Intent of Low Aquifer Storage policy

Provide water security for horticulture production in Carnarvon by replacing water unable to be drawn from properties within subarea A with water from subarea B–L during periods declared by the DoW. Effectively a kilolitre for kilolitre water replacement at the property level to alleviate Low Aquifer Storage in subarea A.

### What is Low Aquifer Storage

Low Aquifer Storage (LAS) is announced when storage in the river bed sands in subarea A:

- has not been recharged by a river flow for 18 months; and
- when monitoring indicates storage of water >176 mS/m at 25°C (1,000 mg/L TDS) is approaching 1.5 GL as determined by the DoW and in consultation with the CWAAC.

### Initial Management Response

Following the declaration of LAS the DoW will temporarily increase the allowable draw in subarea B–L by 2 GL for a period of one year from the date of declaration. The abstraction of this water will ideally be undertaken by the owners of assets in subarea B–L and delivered by a water service provider to effected properties.

To monitor and respond to the situation a LAS working group is formed by DoW when LAS announcement is imminent comprising members from:

- Department of Water (Chair)
- Carnarvon Water Allocation Advisory Committee
- Water Corporation
- Gascoyne water cooperatives
- Carnarvon Growers Association
- Department of Agriculture and Food

The frequency of monitoring and reporting on aquifer condition may be increased from the three month period as determined by the DoW and the LAS working group.

### Greater than 12 months Management Response

If the LAS conditions persist for greater than 12 months the DoW will assess the hydrogeological and environmental information and using a risk based approach announce further LAS relief water if appropriate. The assessment may also lead to reduced access to entitlements for irrigation from subarea B–L. The preservation of the Town Water Supply will be the priority when making decisions with the intent for the TWS to retain access to 100 per cent of the entitlement.

### End of Low Aquifer Storage

The DoW will declare the end to LAS when a river flow is recorded at the Nine Mile Bridge Gauging Station, Carnarvon. One the date LAS is declared ended the temporary increase for draw in subarea B–L will be cancelled.



**Attachment 4: Summary of the DoW review of alternative freshwater resources** in the vicinity has been undertaken, with particular attention focussed on the possibility of transporting (likely “trucking”) water from other areas to the Carnarvon Horticultural District (CHD).

### Hydrogeology

Fresh water is located within associated saturated alluvial systems to the east of the Gascoyne River (south of the Lyons River). An example of this is the Quaternary alluvial sequence associate with the Gascoyne River RBS, from which the Gascoyne Junction (approximately 150 kilometres to the east of the CHD) obtains the town water supply. This groundwater resource is portraying increases in salinity similar to what is occurring in the Lower Gascoyne River alluvial aquifer developed for the CHD. The groundwater supply from the alluvial aquifer systems is limited, and over pumping may cause salinisation of current supply and decrease in the quality of the drinking water source. Additional alluvial sequences south of the Gascoyne River, such as those associated with the Wooramel River, are currently suppling horticultural activities at Wooramel Station.

The Birdrong Sandstone and the Moogooloo Sandstone are primary targets for freshwater systems. Lithology of the Birdrong Sandstone is defined as glauconitic and friable sandstone with silty sandstone of Cretaceous age, and is a unit of the Winning Group. Significant bore yields of brackish groundwater are expected to be gained from this unit, and estimated thickness of this unit is 20–30 metres.

The Permian age Moogooloo Sandstone is comprised of coarse-grained quartz arenite and quartzwacke, with minor siltstone and conglomerate facies, formed within a fluvial depositional environment. Estimated thickness of the unit is 30–70 metres. The unit forms part of the Wooramel Group, overlain by sediments of the Byro Group. Abstraction from the Moogooloo Sandstone is expected to furnish water of variable quality, and over abstraction may incur saltwater intrusion.

### Groundwater Availability

A series of groundwater resources were evaluated for potential abstraction and transportation to the CHD. Evaluation was based on a number of factors comprising water quality, current infrastructure for water abstraction, and distance from the horticultural district.

#### Carnarvon Artesian Basin Project – Artesian Bores

A number of bores were drilled during the Carnarvon Artesian Basin Project. While some of these bores have been decommissioned, some are still in operation and may present viable options for groundwater supply. Although many of these bores present salinity greater than 3000 mg/L TDS, bores at Callagiddy Station present salinities of between 2000–3000 mg/L, with water temperature around 26–28 degrees Celsius. Callagiddy Station is approximately 50 kilometres from Carnarvon, and is therefore relatively accessible. Bores with salinities greater than 3000 mg/L were not considered appropriate, and therefore not included as part of the study.

### Alluvium

The Wooramel River is located at an approximate distance of 110–115 kilometres south-southeast of Carnarvon. Water supply from the station is likely from Quaternary alluvial sediments of the Wooramel River. Salinities are in the order of 500–1500 mg/L TDS (Thomson, 2001). Rockwater (1996) estimates a renewable volume of 1.8 GL/a, under 1000 mg/L TDS is available from the Wooramel–Meado locality, in the alluvial sequence of the Wooramel River, with an additional 30 GL of the same quality in storage. Water from this alluvial system is used by Wooramel Horticultural Producers (GWL96940; 0.3 GL/a), for the irrigation of crops. A recent salinity sample taken in September 2013 provided a value of 1341 mg/L TDS, which is consistent with previous estimates.

### Birdrong Sandstone

The alluvial sediments of the Wooramel River are found in the Wooramel–Meado locality, which are suggested to serve as a recharge area for the Windalia–Birdrong Sandstone (Rockwater, 1996). Thomson (2001) indicates the presence of an unconfined resource within the saturated Birdrong Sandstone (Windalia/Birdrong Aquifer), which subcrops a thin surficial veneer of Aeolian sediments in the area (approximately 5 kilometres south of the Wooramel River, south of Pimbee Road). An estimate of water quality from Thomson (2001) in this area is approximately 1500–3000 mg/L TDS. The outcrop, located immediately south of Wooramel station and Wooramel Horticultural Producers, is a recharge area for the Birdrong Sandstone. An additional outcrop/recharge area of the Birdrong Sandstone can be found in the Mooka Area, 23 kilometres northwest of Gascoyne Junction (Rockwater, 1996). This site, however, is also at considerable distance from the CHD.

### Moogooloo Sandstone

The Moogooloo Sandstone, in the vicinity of Wooramel River, possesses variable salinity, ranging from 500 mg/L TDS, to greater than 3000 mg/L TDS (Thomson, 2001). The Moogooloo Sandstone is not present within the area of the Gascoyne River, but is present in southern and eastern areas, featuring largely in the Merlinleigh Subasin. Yields are relatively high, with an expected yield of 800 m<sup>3</sup>/day (Thomson, 2001). Other sites, however, suggest that salinities within this unit vary between 1000 to 3000 mg/L TDS (Rockwater, 1996). Given the salinity of these bores, this unit is unlikely to provide a viable water supply for the CHD.

### Gascoyne Junction

Gascoyne Junction is at an approximate distance of 150 kilometres east of the CHD. The Corporation abstracts approximately 34 ML/yr from the Upper Gascoyne River alluvial aquifer system, for the purpose of Gascoyne Junction's town water supply. Additional information can be found in DoW's document entitled Gascoyne Junction Water Reserve – Drinking Water Source Protection Plan – Gascoyne Junction Town Water Supply. Salinity within the Gascoyne Junction P1 area range from 51 to 300 mg/L TDS.

The area is currently experiencing a period of “no-flow” in the Gascoyne River system with increased abstraction that may result in higher salinity waters resulting in

increasing water demand and reduced supply. The Protection Plan corroborates this, in stating that “It appears that over-extraction of groundwater from the aquifer contributes to salinity problems within the water reserve” (page 2). This is particularly pertinent in periods of no river flow.

### **Transportation**

Estimated water transportation cost per kilometre were provided by Neil Westlake from Brown Range Alliance. This estimate is based on the assumption that water would be transported by a semi-trailer with 20,000L (20 kL) capacity . The hire rate for the semi-trailer is estimated at \$180/hr. As average speed to transport the 20 000 L is estimated at 90 km/hr, then the total estimate rate per kilometre for transportation is \$2.00.

Table 1 below shows estimated costs for water transportation from various resources at distance from the CHD. Costings were only undertaken for resources where salinity estimates were <1000 mg/L TDS, as these are considered most viable for horticultural practices in the CHD. Current infrastructure was also considered in this review. Estimates on distance from Carnarvon, salinity and renewable quantities available were derived from Rockwater (1996).

### **Conclusion and Recommendations**

Significant aquifers – such as alluvial aquifer system in Wooramel River, the Windalia–Birdrong Sandstone and the Moogooloo Sandstone – are present either in Carnarvon, or within a 150 kilometres radius from the Carnarvon Horticultural District (CHD), constraints are placed on both water quality and supply.

Groundwater availability is constrained by lack of appropriate infrastructure and freshwater resources in the immediate environs of the Gascoyne River. Water quality in the majority of aquifers is estimated to be greater than 3000 mg/L TDS. Crops grown in Carnarvon require freshwater such that development of these resources will not provide an appropriate water supply.

Transportation (trucking) of this water over distances greater than 100 kilometres may be expensive, and therefore detailed costing should be undertaken to evaluate this as an effective mechanism for water supply. Desalination provides a cheaper alternative by treating brackish/saline water at source, although initial costs to establish the operation may be expensive.

Table 1 Proposed Alternative Water Sources with estimated transportation costs (\$/kL)

Aquifer	Locality	Distance from Carnarvon (km)	Estimated available quantity <1000 mg/L (kL)	# of Trips (20 kL Tank)	Distance Travelled km	Travel Time Hours /20 kL Load	Total Cost (\$)	Cost \$/kL
Alluvium	Wooramel–Meedo & Upper Wooramel	112	1800	90	10080	1.24	\$20 160.00	\$11.20
Windalia–Birdrong Sandstone	Coastal/Meado	120	300	15	1800	1.33	\$3 600.00	\$12.00
Windalia–Birdrong Sandstone	Mooka	140	12400	620	86800	1.56	\$173 600.00	\$14.00

Calculation of cost per kilolitre (\$/kL) shows that the most economic resource is within the Wooramel River, at \$11.20 per kilolitre. Costs were calculated on the assumption that the entirety of the renewable resource would be extracted.

#### Alternative Options for Freshwater supply

Desalination of water from the Windalia–Birdrong Aquifer may be a consideration for water supply. Brackish resources are available within the vicinity of the CHD, although use of this water for irrigation purposes is not considered acceptable, due to poor quality. Treating of this water by a desalinisation facility (e.g. a reverse osmosis plant) may reduce costs of transportation, and may provide a future option for alternative water supply. A study undertaken by CSIRO indicates that cost to desalinate brackish and saline waters is approximately \$1.25/kL, with a 61–95 per cent water recovery rate (CSIRO, 2009). This figure is significantly lower than the \$11.20/kL cost imposed by trucking water from the Wooramel River, the closest supply of groundwater <1000 mg/L TDS.

