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*18 January 2010,*

*Committee Secretary*
*House of Representatives*
*Standing Committee on Regional Australia*
*PO Box 6021 Parliament House*
*CANBERRA ACT 2600 AUSTRALIA*

Dear Secretary,

My company Australian Rain Technologies (ART) has been conducting rainfall enhancement trials in Australia using a technology called Atlant. After four years of trialing of the technology's effectiveness in enhancing rainfall, we are at the point where the results achieved, though inevitably containing some residual uncertainty, justify the government's engaging in the funding of further trials of Atlant's potential contribution to water supply, the agricultural and associated economies including food production and the environment.

Further positive trials and any resultant long-term deployment of the technology would significantly assist the Government in meeting its undertakings to the peoples of the regions in regard to the development of infrastructure, securing sustainability of food production and farming, the associated regional communities and the environment.

Attached is a summary briefing note on ART's Atlant technology, trials to date in Australia, and proposed further trials for the Murray Darling Basin.

Also attached is the full proposal submitted to the departments of Environment and Water, Regional Development and Infrastructure in December 2010 and an economic analysis to support policy decision-making under the inevitable uncertainty around the measurement of such rainfall enhancement. These documents are included in case you need further detail. A copy of the report on the 2009 Mt Lofty Ranges Trial is also available should you require it.

The Economic Analysis referred to in the briefing paper (and attached) is presented in the context of the expected economic return from such trials as in the SEWPAC/MDB proposals and longer term, less expensive commercial operations. It indicates that such trials might be expected to more than return their cost, even at enhancement levels far lower than those estimated for our trials to date. Longer-term deployment would yield net returns in double-figure multiples.

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We are preparing a full menu of areas for potential trial applications of Atlant in the Murray Darling Basin with show high expected returns. This will be available in early February.

We would like the opportunity to come to Canberra and present to the committee the results of our trials to date and our proposal for further trials in regional areas of Australia where water security is a major issue.

Yours sincerely

Matt Handbury
Chairman and Chief Executive



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# Australian Rain Technologies (ART)

*Briefing to House Standing Committee on Regional Australia on trialling the potential contribution of ART's Atlant rainfall enhancement technology in the Murray Darling Basin*

**January 2011**

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*Note: The presentation of the attached document in no way implies any endorsement at this stage by the Scientific Reference Panel.*

# 1 Summary

This briefing is in support of an application for Commonwealth funding, with potential state government and/or industry support. The complete submission to the Departments of Environment and Water, Infrastructure and Regional Development is attached. While there are many opportunities for further trials of Atlant technology nationally, four sites were chosen to allow the Government to meet stated regional and environmental objectives, while pursuing water security for the future of Australia, and its food production.

This document focuses on the potential benefits of Atlant rainfall enhancement technology in the Murray Darling Basin.

ART holds an exclusive licence to operate Atlant technology in Australasia. Atlant is an on ground ionisation-based system designed to increase the proportion of cloud moisture that falls as rainfall downwind of the device.

The Atlant technology is an experimental "green" technology: low cost, environmentally friendly, flexible, targetable and adds water to the whole environment.

ART has completed four trials in Australia over the past three years. Statistical analysis of these trials has shown highly significant measured enhancement effects. In the most recent 2009 Mount Lofty Ranges trial, using a randomised cross over design requested by our independent scientific reference panel (SRP), the estimated average enhancement effect was calculated at 9.4 per cent, with a 90 per cent confidence level. (See Appendix B, for results from all four trials).

Based on the trial results, one machine produces around 300 gigalitres of additional rainfall over a downwind area of 4,200 $km^2$. The value of the additional water depends on the area of application, but would be between $1 million and $5 million or beyond (See Appendix A for an explanation of yield volumes and values).

While the Atlant contribution is substantial in terms of rainfall, it does not significantly impact the general abundance of overall atmospheric moisture. Analysis has revealed no detectable rain shadow effect.

ART has also funded the development of a new statistical analysis methodology that enables the results of trials, or commercial applications, to be evaluated in an effective time frame, something that has eluded and disadvantaged the application of cloud seeding in Australia for decades. The analysis has been peer reviewed, and accepted for publication and is subject to a patent application.

The ART trials have been conducted on limited space largely with publically available measurements of rainfall and other meteorological conditions. The extraordinarily high potential benefits from Atlant indicated by the trials clearly justifies the immediate funding of its widespread and more sophisticated trialling to ascertain and harvest its enormous potential in the context of water scarcity issues, both in Australia and globally.

The company has also developed new designs, manufacturing methods and control systems for efficient and economical rollout of the technology and ease of monitoring and field management. This applied research should deliver a more effective technology at a lower cost.

ART believes any remaining levels of uncertainty around the results of its trials to date are more than outweighed by the net economic, environmental and social benefits of such enhancement. Further trials to explore Atlant's applicability to other areas of water scarcity, the more thorough exploration of the physical processes involved and the gathering and analysis of more refined meteorological data, are beyond ART's financial capacity. We believe it is now time for government to fund the further investigation of this Australian-developed potential quantum leap in approaches to world water scarcity. This document contains outlines for two such trials in the Murray Darling Basin, which could be run in 2011.

The current attention to the Murray Darling Basin Authority's plan for restoring environmental flows in the basin highlights the appeal of any effort which might serve these environmental needs at less expense and with less socioeconomic disruption.

This proposal outlines two areas for trialling Atlant at a total cost of $11 million – the Hume-Dartmouth catchments and the Copeton Dam catchment. The selection of areas for initial trialling was based on relative comparative advantage and varying geography.

A more comprehensive investigation of the possible areas of significant benefit from the Atlant technology will be available for presentation to committee members in early February.

Such trials would allow the company to carry out and evaluate selected scientific trials to determine, with a high level of confidence, the efficacy of Atlant in the individual locations.

ART has prepared a detailed Economic Analysis (attached) which allows for the impact of uncertainty in calculating expected economic return from such trials. It shows returns of multiples of trial costs in value of additional rainfall at enhancement levels below those achieved in ART's trials to date.

For example, the proposed $6.5 million year-long trial in the Hume/Dartmouth catchments presented in this document shows an expected return on investment of more than 150 per cent should five per cent rainfall enhancement be experienced, a far lower level of enhancement than our trial results to date. The expected return against anticipated lower long-term costs rises to nearly seven times costs with a 69 per cent probability of a return on investment of more than three times cost. Again this is at the five per cent enhancement level. At enhancement levels experienced in previous trials the r.o.i. goes well into double figures.

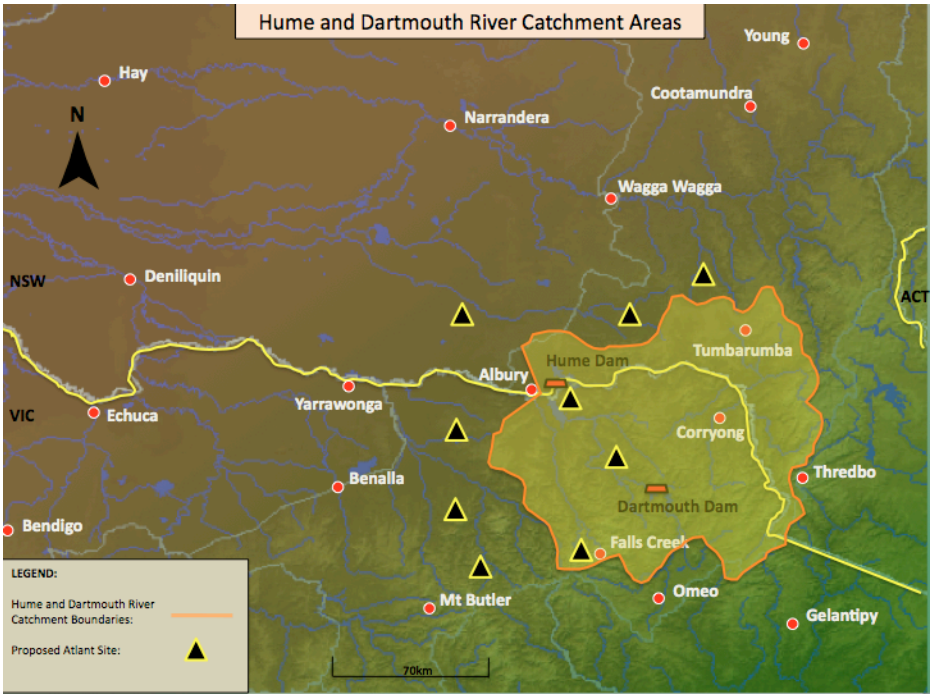
The comparable figures for the Gwydir proposal are a 100 per cent net return on costs for a $4.5 million trial achieving five per cent enhancement, while returns for longer term applications are in the double figures at the enhancement levels experienced in previous trials.

# 2 Areas of potential application in the Murray Darling Basin

## 2.1 Hume/Dartmouth catchments

The Hume Dam is a major operating storage of the Murray River system. The storage regulates the Murray River and re-regulates water discharge from the Snowy Mountains hydro-electric scheme. Releases supply downstream irrigation, domestic, stock and urban demands. Reductions in rainfall have seen the dam drawn-down significantly over recent years. The use of the Atlant over the Hume and Dartmouth catchments could assist regulators in adapting to these reduced rainfalls, and return rainfall averages close to long-term trends. A potential Atlant array placement is displayed in Figure 1.

**Figure 1 Potential Atlant array placement over Hume/Dartmouth catchment.**




Additional water assists in securing sustainable economic, social and population growth in the regions and counters carbon dioxide emissions through increasing forest growth and assisting in restoring biodiversity to the region.

Increased reservoir inflows will also allow further drawdowns with increasing benefits to downstream parties and an opportunity to maintain higher capacities throughout the cycle, providing numerous social and economic benefits. Table 1 and Table 2below show the returns for varying levels of enhancement.

**Table 1 Summary of operations and benefits of one year trial for the Hume/Dartmouth dam catchments.**

| **Trial costs $6.5m** | | | | |
|---|---|---|---|---|
| **Mean Enhancement Level** | **2.0%** | **5.0%** | **10.0%** | **15.0%** |
| Reservoir inflow (GL) | 67.8 | 169.5 | 339.1 | 508.6 |
| NPV ($m) | $0.35 | $10.62 | $27.75 | $44.87 |
| E(BCR) | 1.05 | 2.63 | 5.27 | 7.90 |
| B/even enhancement | 0.02 | 0.02 | 0.02 | 0.02 |
| Prob (b/even) | 0.51 | 0.67 | 0.71 | 0.73 |
| Prob (ROI) 3 times | 0.21 | 0.57 | 0.67 | 0.70 |

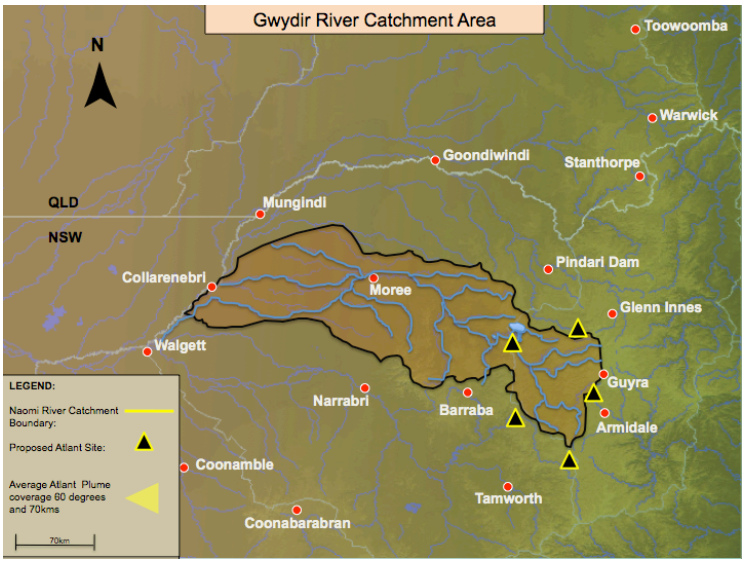
**Table 2 Summary of operations and benefits over 20 years for the Hume/Dartmouth dam catchments.**

| **Long-term costs $1.8m** | | | | |
|---|---|---|---|---|
| **Mean Enhancement Level** | **2.0%** | **5.0%** | **10.0%** | **15.0%** |
| NPV ($m) | $58.45 | $186.48 | $399.86 | $613.25 |
| E(BCR) | 3.17 | 7.93 | 15.86 | 23.79 |
| B/even enhancement | 0.01 | 0.01 | 0.01 | 0.01 |
| Prob (b/even) | 0.70 | 0.73 | 0.74 | 0.75 |
| Prob (ROI) 3 times | 0.63 | 0.69 | 0.72 | 0.74 |

## 2.2 Gwydir Valley

The Gwydir Valley is an important dryland grazing region, with many small farmers running beef and sheep. The major storage is the Copeton Dam. Releases supply downstream irrigation, domestic, stock and urban demands. 85,000ha of irrigated cotton were grown within the valley in 2000. Reductions in rainfall have seen the dam drawn down significantly over recent years. The use of the Atlant over the Copeton Dam catchment could assist regulators in adapting to these reduced rainfalls, and return rainfall averages close to long-term trends. A potential Atlant array placement is displayed in Figure 2.

**Figure 2 Potential Atlant array placement over Copeton Dam catchment.**




Additional water assists in securing sustainable economic, social and population growth in the regions and counters carbon dioxide emissions through increasing forest growth and assisting in restoring biodiversity to the region.

Increased reservoir inflows will also allow further drawdowns with increasing benefits to downstream parties, including the Ramsar wetlands of the floodplain of the lower Gwydir River, and an opportunity to maintain higher capacities throughout the cycle, with numerous social and economic benefits. The tables below show the returns for varying levels of enhancement.

An analysis of the agricultural land values of NSW and rainfall show land values increase with average rainfall. This increase in land value is a proxy for production of additional food and increased profitability of farm businesses in regions with higher rainfall. A simple linear regression of regional land values and average rainfall in NSW shows that a 10 per cent increase in average rainfall, with all other variables remaining constant, would increase land values by 21.7 per cent. An extrapolation this figure to a regional change in rainfall should be treated with caution but it does provide an order of magnitude estimate of the impact of a long term change in precipitation. Extrapolating land values for the NSW North West Slopes and Plains to the Gwydir Valley region, it is presumed that a 10 per cent increase in rainfall would result in a $32.18 per hectare increase in land value per year, or $17.25 million in land values across the trial area on an annualised basis.

The projected benefits of a 10 per cent enhancement are scaled to explore the benefits of a range of enhancement levels from two to 15 per cent (Table 3 and Table 4).

**Table 3 Summary of operations and benefits at trial costs for one year for the Copeton dam catchments.**

| **Trial costs $4.5m** | | | | |
|---|---|---|---|---|
| **Mean Enhancement Level** | **2.0%** | **5.0%** | **10.0%** | **15.0%** |
| Reservoir Inflow (GL) | 4.4 | 11.0 | 22.0 | 33.0 |
| NPV ($m) – inflow + land increase | -0.59 | 5.3 | 15.1 | 24.9 |
| E(BCR) | 0.87 | 2.17 | 4.35 | 6.52 |
| B/even enhancement | 0.03 | 0.03 | 0.03 | 0.03 |
| Prob (b/even) | 0.49 | 0.66 | 0.71 | 0.72 |
| Prob (ROI) 2 times | 0.10 | 0.54 | 0.65 | 0.69 |

**Table 4 Summary of operations and benefits over 20 years for the Copeton dam catchments.**

| **Long-term costs $1.0m** | | | | |
|---|---|---|---|---|
| **Mean Enhancement Level** | **2.0%** | **5.0%** | **10.0%** | **15.0%** |
| NPV ($m) – inflow + land increase | 32.97 | 106.11 | 228.02 | 349.93 |
| E(BCR) | 3.09 | 7.72 | 15.44 | 23.15 |
| B/even enhancement | 0.01 | 0.01 | 0.01 | 0.01 |
| Prob (b/even) | 0.71 | 0.75 | 0.76 | 0.77 |
| Prob (ROI) 2 times | 0.64 | 0.71 | 0.75 | 0.76 |

# 3 Proposal

ART has made significant progress to date in developing, understanding and analysing Atlant technology's efficacy, and with the development of the design, manufacture and control of the equipment. Our particular focus has been on the development of new spatial statistical methodologies to enable the detection of relatively small variations against the background of the dramatic spatial and temporal variability of meteorology.

ART seeks government funding to continue this ground-breaking and expected high economic return activity. Trial funding will be used for:

- The evaluation of Atlant technology in previously un-trialled geographies, employing supplementary rain gauges and more sophisticated meteorological monitoring.
- The further research of the physical science behind electrical influence on rainfall, and other meteorological conditions
- The further development of the technology and assessment of its effects.

We are seeking $11 million in trial funding to cover trials in the Hume/Dartmouth and Copeton catchments. Other areas of water scarcity in the Murray Darling Basin might be preferred for such trials. We will be presenting a complete menu of possible trial applications in early February.

ART would be willing to meet with Federal and State governments and private interests to discuss options for joint financial or other interests in such trials.

# Appendix A Yield

Each Atlant unit is capable of generating around 300 gigalitres of additional rainfall across an area of 4,200 km$^2$ with a value of, depending on the area of application, from $1 million to $5 million and beyond (assumes 10 per cent enhancement, 700 mm annual rainfall). See **Error! Reference source not found.** below.

The enhanced rainfall from the Atlant converts into water on the ground, of which only a small percentage will run off into streams, creeks, rivers and eventually reservoirs. The runoff volume is a function of the enhancement percentage, the underlying natural rainfall, the runoff coefficient and the angular sweep and depth of the arc of coverage.

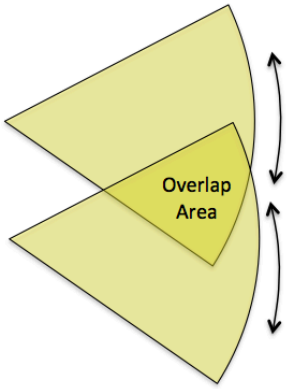
The example in Figure 3 shows two 60 degree arcs, based on 700mm of rain (average annual rainfall for Australia) extending 90km from the Atlant installations. The additional rainfall that would be generated is listed for enhancement levels of five, 10 and 15 per cent.

**Figure 3 Value model for a two Atlant operation.**

**Value Model - Two Atlant's overlaping (60$^O$arc)**

*(Assumes all rain falls over useful area/catchment)*

| | | | |
|---|---|---|---|
| No. Of Atlants | 2 | | |
| Outer Limit of influence (km) | 90 | | |
| Degree of sector (degrees) | 60 | | |
| Overlap discount(%) | 20% | | |
| Area of sector (km$^2$) | 7,634 | | |
| Average Annual Rainfall (mm) | 700 | | |
| Yield (Runoff) | 10% | | |
| Enhancement | **5%** | **10%** | **15%** |
| Total additional rainfall (GL) | 267 | 534 | 802 |
| Effective rain (Catchment inflow) | 27 | 53 | 80 |




One can envisage a network of Atlants 100 km apart targeting Australia's catchments and key agricultural and environment areas.

# Appendix B Results from four Australian trials

Trial results to date indicate that the Atlant technology has a potential major contribution to make in incrementing water supplies and water security and generating significant additional water in a cost-effective and environmentally responsible manner.

Four trials have been conducted in Australia so far, with all trials returning positive results. The development and deployment of Australian Rain Technologies' spatial analysis methodology to the three most recent trials has shown highly statistically significant rain enhancement:

- Paradise Dam, Bundaberg, January-May 2008: Statistical analysis by the CSSM showed a 17.6 per cent increase above anticipated rainfall in a 30 degree downwind arc from the Atlant system, significant at the 99 per cent confidence level.
- Mt Lofty Ranges, Adelaide August-November 2008: Analysis by the CSSM showed an increase of 15.8 per cent in a 120 degree arc downwind from the Atlant system, significant at the 80 per cent confidence level.
- The statistical confidence of the above results was queried by independent reviewers, resulting in further analysis of standard errors in the analysis of the 2009 trial to account for correlation across space and time. As noted in the 2009 trial report, the methodology employed was targeted at reducing the standard errors of the results rather than most accurately measuring actual effect. Our aim at all stages has been to produce results acceptable to a sceptical audience, rather than maximising our estimated enhancement effect.
- Mt Lofty Ranges, Adelaide August-December 2009: Analysis by CSSM using a gauge level analysis showed an increase of 9.4 per cent over an area roughly twice the size of the previous trials (alternate operation at two locations), significant at the 90 per cent confidence level. The 2009 trial report has been independently reviewed by Dr John Hensdstridge of Data Analysis Australia and is currently before the SRP. We expect a combined statement from the SRP supporting funding for further trials in the near future. Dr Henstridge has recommended the funding of further trialling of Atlant in Australia at previously un-trialled locations, on the basis of the results to date and the very high benefit-cost ratio of any enhancement achieved.

**During our trials we have also made major advances in:**

- the deployment of Atlant over differing geographical and climatological areas;
- the materials, design and production of Atlant systems; and
- remote operating, monitoring and control devices.

# Appendix C Rain shadow analysis

The data from the Mt Lofty Ranges 2008 trial were used to explore the issue of whether rainfall enhancement in one location reduces rainfall in another location (Beare and Chambers, 2010). The aim of the analysis was to determine if a noticeable reduction in rainfall offset the measured rainfall enhancement. The analysis found there is a strong physical argument that the effects of rainfall enhancement technologies are unlikely to generate observable downwind rain shadow effects. This is simply a reflection of the fact that evaporation and precipitation account for only a small proportion of total atmospheric moisture. An investigation of the data from the 2008 Mount Lofty Ranges trial did not find any evidence of any rain shadow effects. However, this issue is still under investigation given the general difficulties of detecting and measuring human-induced changes in local weather patterns.

# Appendix D Environmental impact

Previous trials in Queensland and South Australia have shown that the Atlant system is a low-risk system. It is environmentally friendly. Ionisation is a basic natural process that presents no harm for humans, animals or ecosystems and it does not interfere with radio or other frequencies. In addition there are no chemicals or any fallout that would be opposed to the interests of fauna and flora. A study by Prof. Brian Lovell from University of Queensland has confirmed this. A further independent analysis was also conducted by Dr. Franco D'Alessandro (D'Alessandro, 2009), which found the Atlant would have no harmful effects on: (1) people, (2) local flora and fauna, (3) communication systems and air traffic. It is believed that any effect of the Atlant on the balance of water in the atmosphere will be negligible.