AGRICULTURAL ECONOMIC CONSIDERATIONS RELEVANT TO POTENTIAL SITES FOR THE AUGMENTATION OF THE WESTERN CAPE WATER SUPPLY SYSTEM

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Prepared for:

REVIEW REPORT
Date: *June 2009*

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1 INTRODUCTION

This report deals with relevant agricultural economic issues that are associated with potential sites for the augmentation of the Western Cape Water Supply System (WCWSS). Seven Sites are relevant for potential strategies in this regard:

- *Raising of Lower Steenbras Dam*
- *Further Phases of the Palmiet Transfer (Upper Campanula Dam)*
- *Augmentation of Voëlvlei Dam*
- *Upper Molenaarsriver Diversion*
- *Michell's Pass Diversion*
- *Upper Wit River Diversion*
- *Brandvlei Dam*

1.1 Problem Statement

Water is a scarce resource in South Africa. The WCWSS serves both the Cape Metropole and the agricultural irrigation industry with water. Water demand in the Cape Metropole increases rapidly, mainly due to increased demand from a growing population (mainly influx from neighbouring provinces) as well as from demand linked to industrial development. It thus follows logically that any strategy to increase the water supply to the Cape Metropole from scarce surface water sources (i.e. rivers and dams) may be seen as a threat to the expansion of irrigation farming. Favourable demand conditions exist for the produce of the relevant irrigation farming areas of the Western Cape. The irreversible nature of a possible reallocation of the yield of scarce surface water sources away from agriculture is thus seen as a threat to future irrigation farming development. Ample land of good irrigation potential is available in major agricultural regions of the Western Cape from where surface water originates for the supply of the Cape Metropole (Laubscher and Ellis, 1992).

1.2 Literature relevant to water- issues regarding the Cape Metropole

City of Cape Town (CTM Administration) 2001. *Integrated water resource planning study. Ninham Shand in association with Arcus Gibb.*

City of Cape Town: Water Services (2002). *Integrated water resource planning and CMA bulk water supply studies. Ninham Shand and CSIR, Report No: unknown, Cape Town.*

Joubert A, Stewart TJ & Eberhard R (2003). *Evaluation of water supply augmentation and water demand management options for the City of Cape Town. Department of Statistics, University of Cape Town, Cape Town.*

Kleynhans S (2002a). *CMA bulk water supply study: Main report. Ninham Shand Consulting Services, Report No: 3245/9531, Cape Town.*

Kleynhans S & Schutte C (2002). *The potential for utilising seawater as a potable source. Ninham Shand Consulting Services, Report No: 3245/9531, Cape Town.*

Van Zyl H & Leiman A 2002 *Development of a framework for the economic evaluation of water conservation/water demand management measures with specific application to decision-making in Cape Town. Water Research Counsel, Report nr 1275/1/02.*

1.3 Literature relevant to irrigation water demand

Laubscher J. & Ellis F. 1992*. Estimation of the irrigation water needs in the Eersteriver- and Bergriver valleys Vyeboom- and Villiersdorp regions and Riviersonderend valley at 2010. Research Report, Department of Water Affairs, Pretoria.*

Laubscher J. 2003*. Breede River Basin Study: Financial viability of Irrigation farming. Directorate of Water Resources Planning, Department of Water Affairs and Forestry, Report nr. PH00/00/2802.*

Lambrechts J Schloms B & Ellis F 2001 *Breede River Basin Study: Evaluation of soil and climate suitability for irrigated agriculture. DWAF Report.*

1.4 Focus of report

The agricultural economic perspective will thus focus on the implications for current and potential irrigation farming of the envisaged surface water development options with the aim to augment the water supply to the Cape Metropole. Land of high potential is very scarce in South Africa. The agricultural production potential of the land to be given up via the relevant water development options should thus obviously be part of cost-benefit analysis to support policy decisions in this regard.

2 STUDY APPROACH

A multi-disciplinary approach is implemented to handle the multi-faceted content of the issues that are related to the development of the WCWSS. Possible Sites and accompanying strategies regarding each site were identified by the engineering component of the research team. The agricultural economic issues that may be associated with the various water development options are the point of focus of this part of the project review. A literature review combined with a field trip in February 2009 with other members of the research team to the relevant development sites serve as an information-base for this review.

3 AGRICULTURE IN THE STUDY AREA

The agricultural industry is an integral part of the social-economic set-up in the Western Cape **(refer to Table 3.1)**. *Apart from the direct economic contribution of the farming segment, agriculture also has significant linkages with the industrial segment (i.e. processing and input supplying industries), while it also serves as an important employer. Agriculture in the Western Cape is also an important exporting industry. Approximately 48% of the Western Cape export earnings is from agriculture (mainly irrigation farming). It thus follows logically that any disruption of farming activities will also impede the mentioned industrial activities.*

Table 3.1: Gross Geographic Product, Exports, Imports and Employment for the Agricultural sector of the Western Cape relative to that for the whole of South Africa, 2005

	S A	Western Cape	% of Total
Total Gross Geographic Product (R mil)	*1 352 952*	*190 977*	*14.1*
Agricultural Gross Geographic Product (R mil)	*34 441*	*7 453*	*21.6*
Total Export of Goods (Rmil)	*347 673*	*37 937*	*10.9*
Agricultural Export (Rmil)	*15 874*	*7 604*	*48.0*
Import of Goods (Rmil)	*359 678*	*70 132*	*19.5*
Agricultural Import (Rmil)	*4 755*	*783*	*16.5*
Total formal employment	*8 776 744*	*1 351 633*	*15.4*
Agricultural employment	*742 750*	*176 065*	*23.7*

Source: Department of Agriculture, Western Cape Province, Elsenburg (Quantec Research)

4 AGRICULTURAL ECONOMIC ISSUES

It was indicated in Section 3 that the irrigation farming industry is an indispensable part of the Western Cape socio-economic set-up. Irrigation farming, in general, is a capital intensive and thus risky, expensive activity. The costly nature of irrigation farming is further enhanced when perennial cropping is practiced. Perennial cropping like vines and deciduous fruit is common farming activities in the relevant irrigation farming areas of the Western Cape.

It is evident that, inter alia, the following issues will be determining as far as the success of current irrigation farming activities is concerned:

- *Security as far as the listed supply of irrigation water is concerned*
- *Moderate price levels for irrigation water*

Potential irrigation development will be determined by, inter alia, the following aspects:

- *The political leverage of irrigation farmers as far as national water allocation goals is concerned. The perception exists that farmers have a relative weak competitive advantage relative to that of the City of Cape Town as far as the allocation of scarce water sources is concerned.*
- *Availability of ample irrigation water at moderate price levels (i.e. farming profitability)*
- *The affordability (i.e. financial viability) of expanding irrigation farming*
- *Availability of good-potential soils for irrigation development.*

Ample land of good irrigation potential is available in major agricultural regions of the Western Cape from where surface water originates for the supply of the Cape Metropole. Favourable future marketing conditions are expected for the produce from the relevant irrigation areas of the Western Cape. The major limiting factor, as far as the expansion of irrigation farming is concerned, is thus the availability of additional irrigation water.

4.1 Literature relevant to water-policy issues

Carmichael SS, Forsyth D & Hughes DA (2001). *Decision support system for the development of rural water supply schemes. Water Research Commission, Report No: 837/1/01, Pretoria.*

Crafford JG; Hassan RM; King NA; Damon MC; de Wit MP; Bekker S; Rapholo BM; Olbrich BW 2004 *An analysis of the social, economic, and environmental direct and indirect costs and benefits of water use in irrigated agriculture and forestry. Water research Councel, Report nr 1048/1/04.*

Davis G (1996). *Consultation, public participation and the integration of multiple interests into policy making. OECD, Report No: unknown, Paris.*

Dudley NJ (1992). *Water allocation by markets, Common property and capacity-sharing: Companions or Competitors? Natural Resources Journal 32(4):757-778.*

De Lange W J 2006 *Multi-criteria decision-making for water resource management in the Berg Water Management Area. Ph D dissertation, Dept of Agricultural Economics, University of Stellenbosch.*

Du Plessis J, Kleynhans S & Shelly A (2001). *Integrated water resource planning study: Main report. Ninham Shand Consulting Services, Report No: 3216/9026, Cape Town.*

Easter KW, Dinar A & Rosegrant M (1998). *Markets for water: Potential and performance. Kluwer Academic Press, Massachusetts.*

Eberhard R & Joubert A (2001). *An evaluation of alternative water supply augmentation and demand management options for the City of Cape Town using Multi Criteria Decision Analysis. Palmer Development Group and University of Cape Town, Report No: 3216/9026, Cape Town.*

Fisher FM, Arlosoroff S, Eckstein Z, Haddadin M, Hamati SG, Huber-Lee A & Jarrar A (2002). *Optimal water management and conflict resolution: The middle east water project. Water Resources Research 38(1):1-16.*

Louw DB (2001). *Modelling the potential impact of a water market in the Berg river basin. PhD dissertation, Department of Agricultural Economics, University of the Orange Free State, Bloemfontein.*

Louw DB (2002). *The development of a methodology to determine the true value of water and the impact of a potential water market on the efficient utilisation of water in the berg river basin. Water Research Commission, Report No: 943/1/02, Pretoria.*

Nieuwoudt WL (2000). *Water market institutions: Lessons from Colorado. Agrekon 39(1):58-67.*

Stewart TJ, Joubert AR, Scott L & Low T (1997). *Multiple criteria decision analysis: Procedures for consensus seeking in natural resources management. Water Research Commission, Report No: 512/1/97, Pretoria.*

4.2 Literature relevant to the 'supply versus demand' issue of water in the Western Cape

4.2.1 General

City of Cape Town: Water Services (2002). *Integrated water resource planning and CMA bulk water supply studies. Ninham Shand and CSIR, Report No: unknown, Cape Town.*

DWAF (1991-1999)*. Western Cape System Analysis. Ninham Shand in association with BKS Inc.*

4.2.2 Supply

Dweiri SF & Badran MI (2003). *Desalination: an imminent solution for the future water needs in the Aqaba Special Economic Zone (ASEZ). Desalination 152(1-3):27-39.*

Kleynhans S & Schutte C (2002). *The potential for utilising seawater as a potable source. Ninham Shand Consulting Services, Report No: 3245/9531, Cape Town.*

Midgeley DC; Pitman WV; Middleton BJ 1994. *Surface Water Resources of South Africa 1990 Volume IV: Western Cape (Appendices) Water Research Councel, Report nr 298/4.1/94.*

Midgeley DC; Pitman WV; Middleton BJ 1994. *Surface Water Resources of South Africa 1990 Volume IV: Western Cape (Appendices) Book of maps Water Research Councel, Report nr 298/4.2/94.*

Shand M, Sparks A & Kleynhans S (2003). *Challenges in managing and developing the region's water resources to meet the demands of Cape Town and other users. Ninham Shand Consulting Services, Report No: unknown, Cape Town.*

4.2.3 Demand

Veck GA & Bill MR (2000). *Estimation of the residential price elasticity of demand for water by means of a Contingent Valuation Approach. Water Research Commission, Report No: 790/1/00, Pretoria.*

Van Vuuren DS, Van Zyl HJD, Veck GA & Bill MR (2004). *Payment strategies and price elasticity of demand for water for different income groups in three selected urban areas. Water Research Commission, Report No: 1296/1/04, Pretoria.*

It is thus accepted that policy decisions, as far as the allocation of scarce water-sources between irrigation farming activities and the needs of the Cape Metropole is concerned, will be conducted in an equitable way. Sound issue-related research, combined with a participative approach, as far as stake-holders is concerned, should serve as a base for decisions in this regard.

5 POTENTIAL STRATEGIES FOR THE AUGMENTATION OF WATER SUPPLY

5.1 RAISING OF LOWER STEENBRAS DAM

5.1.1 Scheme description

This scheme entails the raising of the existing Lower Steenbras Dam by 20 m to the same Full Supply Level as that of the Upper Steenbras Dam (370 m asl), effectively creating one Greater Steenbras Dam. This would increase the storage capacity by about 120 million m^3.

The scheme would rely on the existing transfers from the Palmiet Pumped Storage Scheme as well as runoff into the dam from within its own catchment area.

5.1.2 Agricultural economic implications

No obvious agricultural economic issues are relevant in this regard. Should water sources to augment the additional capacity of the envisaged larger dam however impede the expansion of irrigation farming in relevant areas, proper investigation will be necessary.

5.2 UPPER CAMPANULA DAM

5.2.1 Scheme description

This scheme is a **further augmentation of the Lower Steenbras Dam Raising***, and is dependent on that dam being raised. The Campanula scheme itself has two possible alternatives.*

Alternative 1

This involves the construction of a small dam (50 million m3 capacity) on the Lower Palmiet River at the Upper Campanula site, close to the northern boundary of the Kogelberg Biosphere Reserve. This scheme would inundate some existing orchards, riparian and Critically Endangered Elgin Shale vegetation. To reduce the extent of environmental impacts, the main storage component would be the raised Lower Steenbras Dam although the construction along the water evacuation route would have significant environmental impacts.

Alternative 2

A further potential phase includes a possible abstraction weir just upstream of the Palmiet River estuary. This would enable full advantage to be taken of the surplus flow in the tributaries downstream of the Campanula Dam site. Water would be pumped from the weir into the Campanula Dam, via a tunnel or a pipeline.

5.2.2 Agricultural economic implications

Only limited encroachment of existing established irrigated land (i.e orchards) will be realised.

5.3 AUGEMENTATION OF VOëLVLEI DAM

5.3.1 Scheme description (Phase 1)

This scheme involves the pumped abstraction of winter water from the Berg River. Three potential diversion sites have been considered namely:

- *Spes Bona;*
- *Sonquasdrift, and*
- *Lorelei.*

Abstraction rates of 2, 4, 6 and 10m^3/s have been assessed as well as various pumping rules which determine how much water is left in the river for meeting the EWR. The water would be pumped via a proposed pipeline to the Voëlvlei WTW where it would either be:

- *Pre-treated for storage in the existing Voëlvlei Dam, or*
- *Treated to potable standards for direct delivery to CCT.*

The key characteristics of the scheme are that:

i) Only surplus winter water would be abstracted;

ii) 20 million m^3/a would be available to take up the spare capacity in the existing Voëlvlei WTW and pipeline to CCT.

iii) Any surplus yield (over and above ii) could be used to improve the assurance of supply to other users currently reliant on Voëlvlei Dam (current shortfall of about 30 million m^3/a).

iv) When river flows are too low to permit abstraction, water will be drawn directly from Voëlvlei Dam.

5.3.2 Agricultural economic implications

If the abstraction of surplus winter water from the Berg River does not impede irrigation activities downstream, the mentioned strategy seems acceptable due to its low-cost nature.

5.3.3 Scheme description (Phase 2)

A further phase of the Voëlvlei Augmentation Option would involve the abstraction of water as described in Phase 1, namely at 6m^3/s, with additional storage being made available in Voëlvlei Dam by means of a low raising (2m) of the existing dam wall. Approximately 50 ha of low potential agricultural land, inter alia renosterveld will be inundated by the enlargement of Voëlvlei Dam.

Increased pumping and pipeline conveyance capacity to Voëlvlei Dam would be required. Abstraction would be restricted to winter months (to allow for the ecological water requirements). The existing infrastructure would not be sufficient and the Water Treatment Works would need to be expanded, as would the pumping capacity of the pump station on the delivery line to Cape Town. A second pipeline to Cape Town would also be required.

5.3.4 Agricultural economic implications

The construction of new pipelines to the Cape Metropole and Voëlvlei Dam, as well as an additional Water treatment Works may also impact on farming activities on the pipeline-route. Claims for expropriation of land and/or loss of income will be costly.

If the additional water to Voëlvlei Dam is transferred from other areas (i.e Breede River system), it may impede irrigation activities in those areas. A comprehensive cost-benefit analysis should be done to inform decision-making in this regard.

5.3.5 Literature relevant to the augmentation of Voëlvlei Dam

DWAF Project Planning 2001 *Voëlvlei Augmentation Scheme Feasibility Study.*

5.4 UPPER MOLENAARS RIVER DIVERSION

5.4.1 Scheme description

This option consists of a sump and pump station in the Molenaars River, just downstream of the confluence with the Elandspad River (in close proximity to the east portal of the Huguenot tunnel). Surplus winter water would be pumped to the east portal of the tunnel and conveyed under gravity through the existing 1,2 m dia. pipeline in the tunnel to the west portal. From here the water would be conveyed under gravity via a new pipeline of approximately 26 km to Wemmershoek Dam. The diversion capacity previously considered was about 5 m^3/s. As an alternative, a similar option would be possible for gravitating the water to the Berg River Dam via the Berg River Supplement Scheme, either in a new separate pipeline or in a larger supplement scheme pipeline.

5.4.2 Agricultural economic implications

This option will have a negative impact on the yield of the Brandvlei dam and thus on potential further irrigation development in the Breede River Valley. It thus involves a transfer of potential irrigation water from the Breede River Valley to the Cape Metropole. Further investigation from a cost-benefit point of view is recommended.

5.4.3 Literature relevant to the Upper Molenaars River Diversion

DWAF Planning Division 1980 *Elandsrivier – Theewaterskloof uitkering: Moontlike uitkering van surplus water uit die Elandsrivier via die du Toitskloof Padtonnel na die Theewaterskloof projek.*

DWAF design Services 1991 *ROIP: Klein-Drakenstein Dam: Bo-Molenaarsrivier uitkering.*

5.5 MICHELL'S PASS DIVERSION

5.5.1 Scheme description

The Michell's Pass diversion would consist of a gravity diversion across the catchment divide to the Klein Berg River catchment and hence via the Boontjies River, Klein Berg River and present day Voëlvlei diversion infrastructure to Voëlvlei Dam. According to the information provided by the engineers the pipeline will have a length of 6.92 km and would cut through agricultural land. The construction footprint would be 14 -15 m wide on both sides of the pipeline

The Breede River Basin Study assessed three diversion capacities at Michell's Pass, namely 4, 8 and 12 m^3/s, but did not consider the impacts on downstream users and on the abstraction into Greater Brandvlei Dam at the Papenkuils Pumpstation. A 1m^3/s diversion has also recently been evaluated as well as the downstream implications thereof.

5.5.2 Agricultural economic implications

The proposed scheme involves a transfer of potential irrigation water from the Breede River Valley (Brandvlei Dam) to the Cape Metropole, the rapidly expanding West Coast regions as well as the possible supply of Berg River irrigators in exchange for their allocations out of Theewaterskloof Dam. If the reduced yield of the Brandvlei Dam is not reinstated, this will have significant adverse impacts on irrigators reliant on the Brandvlei Dam. Further investigation from a cost-benefit point of view is recommended.

The pipeline may have negative implications for current farming activities in the envisaged construction area thereof. Farming activities may range from year-cropping like vegetable

production to perennial-cropping like fruit and winegrape production. Mitigation measures should, inter alia, include:

- *Construction of the pipeline in the 'off-season' in order to minimize farm revenue losses, as far as year-cropping activities is concerned.*

- *Avoidance, as far as possible, of blocks of land where perennial-cropping is practiced when the alignment of the pipeline is planned. Compensation costs for the farms involved, in terms of future revenue loss and the re-establishment of perennial crops can be significant.*

Possible cost implications in this regard should thus be investigated.

5.5.2 Literature relevant to the Upper Molenaars River Diversion

DWAF Design Services 1994 *ROIP- Michell's Pass Diversion.*

5.6 UPPER WIT RIVER DIVERSION

5.6.1 Scheme description

This scheme essentially serves as an alternative option to a dam on the Upper Wit River, which has previously been investigated and found to be environmentally undesirable. The diversion scheme would comprise a low weir on the Wit River (Breede River catchment) and one of the following alternatives:

- *Enlargement of the Gawie-se-Water diversion channel which was originally constructed in about 1900 and currently diverts water (5 million m^3/a) across the catchment divide into the Kromme River tributary of the Berg River (for irrigation);*
- *A new diversion channel constructed adjacent to the original channel if it is decided that the existing channel should be preserved as a heritage site;*
- *Construction of a tunnel through the mountain to divert flow in excess of the Reserve from the Wit River into the Kromme River.*

For each alternative above, the water would be diverted during periods of surplus flow (winter) and stored in a proposed dam on the Kromme River, for which a possible site was initially identified at the farm, Doolhof. However, a new site was identified on the adjacent Riverlands Farm just upstream of the Doolhof Farm after a field trip in 2009. The water could be treated and reticulated to Wellington and Paarl, in exchange for allocations out of Wemmershoek Dam. Alternatively, the water could be released from the dam into the Berg River, utilised by Upper Berg River irrigators in summer, in exchange for their allocations out of Theewaterskloof Dam.

5.6.2 Agricultural economic implications

This scheme will reduce the yield of the Brandvlei Dam and will thus limit further irrigation development in the Breede River Valley. The inundation of the developed farm Doolhof will be costly and employment opportunities will be lost for farm workers (approximately one job for every 3 ha of winegrapes).

The Riverlands Farm is currently utilized for horse-breeding. Horse-breeding, when practiced successfully, can be a very profitable enterprise. It is, however, not a common agricultural enterprise in the relevant farming area that is better known for intensive crop production. The agricultural potential of Riverlands for intensive crop production, like that what is taking place on the adjacent Doolhof-farm will, inter alia, be determined by the following factors:

- *The suitability of the soils for intensive crop production*
- *The availability of ample irrigation water of an acceptable quality*

The mentioned factors should thus be further investigated to determine the agricultural production potential of the Riverlands Farm, as well as cost-benefit considerations.

All the relevant factors, as far as the envisaged Doolhof Dam is concerned, will necessitate an investigation in terms of cost-benefit considerations.

5.6.3 Literature relevant to the Upper Wit River Diversion

Paarl Municipality 1991 *Wit River Water Supply Scheme. Ninham Shand.*

5.7 BRANDVLEI DAM

5.7.1 Scheme description

This scheme would increase the use of available capacity (no additional capacity is envisaged) in the Brandvlei Dam by drawing water either directly from the Breede River or from both or one of the nearby tributaries, i.e. the Smalblaar (includes Molenaars) and Holsloot Rivers, to compensate for water taken from other Breede River tributaries (i.e. Upper Wit, Molenaars or Dwars Rivers). Water would be abstracted by pump during the winter months. Flow would be released back into the Breede River in summer.

5.7.2 Agricultural economic implications

This relatively low-cost strategy should obviously increase the irrigation potential of the Breede River Valley downstream of Brandvlei Dam.

5.7.3 Literature relevant to the Breede River valley / Brandvlei Dam (irrigation perspective)

Departement Waterwese (Beplanningsafdeling) 1981 *Groter- Brandvleiskema: Geraamde toekomstige waterbehoeftes en die Leweringspotensiaal van die Skema.*

DWAF (Water resource planning) 2003 *Breede River Basin Study. Ninham Shand in association with Jakoet and Associates.*

Laubscher J. 1990. *Ondersoek na die finansiële lewensvatbaarheid van die Nuwe Koekedou Besproeiingskema in die Ceres-P.A. Hamlet omgewing. Navorsingsverslag, Koededou Besproeiingsraad.*

Laubscher J. 1991. *Ondersoek na die finansiële lewensvatbaarheid van die beoogde uitbreiding (meesterplan) van die waterwerke van die Groothoek besproeiingsraad in die De Doorns distrik. Navorsingsverslag, Groothoek besproeiingsraad.*

Laubscher J. 1994. *Ondersoek na die finansiële lewensvatbaarheid van die beoogde besproeiingsprojek van die Boesmanspad- (te stigte) besproeiingsraad. Navorsingsverslag, Direktoraat Besproeiingsingenieurswese, Departement van Landbou.*

Laubscher J. 1996. *Ondersoek na die finansiële lewensvatbaarheid van die beoogde besproeiingsprojek van die Titusrivier Besproeiingsraad. Titusrivier Besproeiingsraad, Ceres.*

Laubscher J. 2003. *Breede River Basin Study: Financial viability of Irrigation farming. Directorate of Water Resources Planning, Department of Water Affairs and Forestry, Report nr. PH00/00/2802.*

Laubscher J & Ellis F. 1992. *Evaluasie van die ekonomies-finansiële omstandighede van lede van die Prinsrivier besproeiingsraad. Navorsingsverslag, Direktoraat Besproeiingsingenieurswese, Departement van Landbou-ontwikkeling.*

Murray Biesenbach and Badenhorst Inc 1989 *A pilot study of the irrigated areas served by the Breede River (Robertson) irrigation canal. Part I : Technical Report Nr 184/1/89, Water research Counsel.*

6 CONCLUSION

The increasing water needs of the Cape Metropole and rapidly developing West Coast region necessitates continuous investigation of additional water supply options. All of the mentioned options, except for the 'Raising of Lower Steenbras Dam/ Upper Campanula Dam' option involve a decrease in water for irrigation purposes and thus a threat for future irrigation development in relevant irrigation farming areas.

It should, however, be kept in mind that the increasing needs of a growing and developing population in the Western Cape will necessitate increasing volumes of agricultural produce. Should the allocation of water sources away from agriculture be irreversible, it presents a permanent threat to future irrigation farming development in the relevant regions. The relative impact on future irrigation farming of the different options for the augmentation of the Western Cape Water Supply System thus needs to be investigated comprehensively. Such an investigation should inform which of the options are 'agriculturally better or worse'.

It is thus recommended that alternative water sources for the Cape Metropole should also be investigated. In this regard, inter alia, the following options can be mentioned:

- *The desalination of sea-water*
- *The utilization of ground-water sources in the sandy soils of the Cape Flats.*

7 OTHER LITERATURE (ECONOMIC-FINANCIAL/IRRIGATION PERSPECTIVE)

Bergriver

DWAF (Water resource planning) 2003 *Berg WMA: Water resources situation assessment. Ninham Shand in association with Jakoet and Associates.*

Gorgens AHM; de Clercq WP 2006 *Research on Berg river water management: Summary of water quality information system and soil quality studies (Integrated Catchment Management: ICM). Water Research Councel Report nr TT252/06.*

Department of Water Affairs and Forestry (1997). *Skuifraam feasibility study: Main Report. Department of Water Affairs and Forestry, Report No: G100/00/0596, Cape Town.*

Theewaterskloof

Laubscher J. & Stander J.L. 1990. *Ondersoek na die finansiële lewensvatbaarheid van 'n besproeiingskema vir die Helderberg Besproeiingsdistrik. Navorsingsverslag, Helderberg Besproeiingsraad.*

Laubscher J. 1991*. 'n Ekonomies-finansiële ondersoek na die lewensvatbaarheid van 'n besproeiingskema vir die Stellenbosch besproeiingsdistrik. Navorsingsverslag, Stellenbosch besproeiingsraad.*

Laubscher J. 1992*. Ondersoek na die finansiële lewensvatbaarheid van die beoogde besproeiingsprojek van die Banhoek besproeiingsdistrik. Navorsingsverslag, Direktoraat Besproeiingsingenieurswese, Departement van Landbou-ontwikkeling.*