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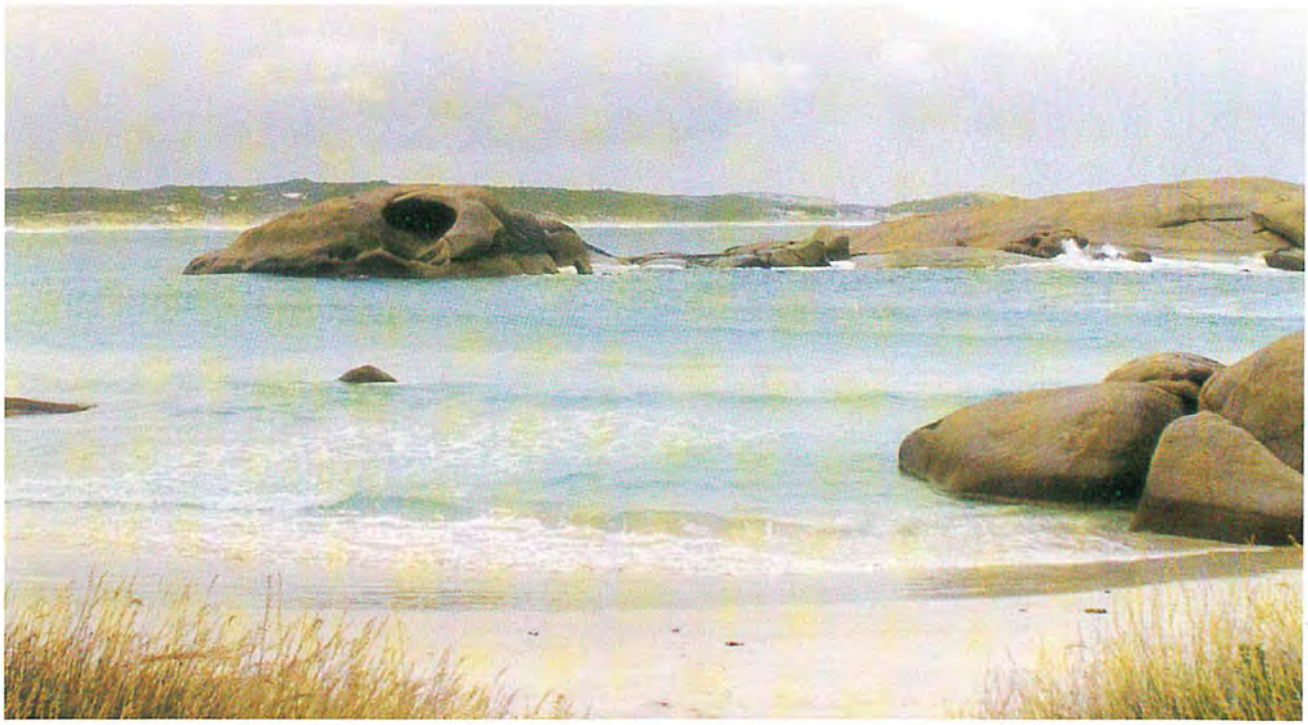
GOVERNMENT OF WESTERN AUSTRALIA

ESPERANCE REGION WATER RESOURCES REVIEW AND DEVELOPMENT PLAN SUMMARY REPORT 1997



WATER RESOURCE ALLOCATION AND PLANNING SERIES

WATER & RIVERS COMMISSION REPORT WRAP 5 1997

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Bandy Creek (north east of Esperance)

Esperance Region Water Resources Review and Development Plan Summary Report 1997

A pamphlet designed to provide the community with an outline of the water resources in the Esperance Region and the probable future usage of that water in the Region

Water and Rivers Commission
Policy and Planning Division

Water and Rivers Commission
Water Resource Allocation and Planning Series
Report No WRAP 5 1997

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Summary

Introduction

This booklet provides a concise outline of the existing and potential water resources as well as an insight into the possible future growth rates of population, industry and agriculture in the Esperance Region. More detail may be found in the main report entitled *Esperance Region Water Resources Review and Development Plan (1997).*

The Esperance Region is experiencing significant growth. The town of Hopetoun, with an annual growth rate of almost 5%, is one of the fastest growing towns in Western Australia. The town of Esperance is also experiencing significant growth. This growth, coupled with the increasing salinity uptake in the water resource, means that a strategic understanding of the development of the Region and the resulting impact on the Region's water resources is essential. This booklet is intended to contribute to that understanding.

The study area comprises two river basins (AWRC, 1987). They are the Esperance Coast (601) and part of the Salt Lake (024) River Basins. The total area of these two basins is 49 400 km^2. The towns of Esperance, Hopetoun, Ravensthorpe, Munglinup, Gibson, Salmon Gums, Grass Patch and Condingup are contained within the study area. The Shires of Esperance and Ravensthorpe are assumed to be completely contained within the study area.

A large proportion of the study area has been cleared for agriculture, particularly in the Esperance catchment. This has resulted in significant degradation of water and soil resources

The study area of the *Esperance Region Water Resources Review and Development Plan* is shown in Figure 1.

Water Resources

Water resources in the Region can be divided into two components; surface water and groundwater.

The surface water resources include the Region's rivers, streams, wetlands, pools, lakes and associated estuaries, plus lakes and wetlands which are not associated with any river. The Region has many surface rivers and streams, most of which do not have the potential to be diverted for potable use due to a lack of quality and suitable yields.

The Region's fresh groundwater resources are constrained to the Esperance Coastal Plain. The Region does not conform precisely to the groundwater area boundaries, as it contains the Esperance, Hopetoun and part of the Kondinin - Ravensthorpe Groundwater Areas.

The Esperance Region possesses high environmental values. Investigations suggest that water resource development will need to take into consideration the sensitivity of these values.

Water Use Projections

Population and water demand projections were undertaken. Service projections for each town were undertaken to form the basis of the town water supply projections. Based on these water demand projections, water source development options for each water supply were offered. In addition, water demand projections for industry and agriculture were undertaken.

Water Resource Development Plans

An outline of the potential development of water resources in the study area for future town water supply, industrial and agricultural use are proposed. The proposals are preliminary and do not address social, cultural, environmental or any other constraints regarding the development of resources.

The demand from the town of Esperance is likely to exceed locally available groundwater before 2026. This will require development of a new source for Esperance such as the Railway Dam or desalination of brackish resources.

One supply option for the Eastern Goldfields is to pipe desalinated seawater from Esperance to Kalgoorlie. If this option is developed it may meet the shortfall of supply to the town of Esperance.

Conclusions

Currently the potential available surface water is mostly fully allocated and there is limited development potential. The potential surface water supply and likely demand within the Region is presented in Figure 7 and Figure 8.

Currently, groundwater is the largest available resource in the Region. However, the availability of fresh groundwater for diversion is variable and unreliable throughout the Region. In some cases the available resources are fully allocated and require further investigation to determine the extent of possible expansion of the source.

In 2026, the current groundwater resources may be sufficient to supply the future overall demand. Further investigative drilling will be required to substantiate quantities before development and or expansion of the sources.

The only other apparent source available is the desalination of brackish water resources.

The potential groundwater supply and likely demand within each basin is presented in Figure 9 and Figure 10.

Phillips River (south of Ravensthorpe)


Shire of Yilgarn
Shire of Kondinin
Shire of Kulin
Shire of Lake Grace
Shire of Ravensthorpe
Shire of Kent
Shire of Jerramungup
Shire of Dundas
Shire of Esperance
NORSEMAN
Balladonia
Newdegate
Lake King
Mt. Madden
Ravensthorpe
Salmon Gums
Grass Patch
Munglinup
Gibson
Condingup
ESPERANCE
Hopetoun
Bremer Bay
024
022
601
602
N
10 0 20 40
Kilometres
LEGEND
Study Area
River Basin
Local Authority
WATER AND RIVERS COMMISSION
Esperance Water Resource Review
STUDY AREA
Figure 1

Surface Water Resources

The surface water resources include the Region's rivers, streams, wetlands, pools, lakes and associated estuaries, plus lakes and wetlands which are not associated with any river. The Region has many rivers and streams, most of which do not have the potential to be diverted due to a lack of quality and suitable yields.

Surplus available surface water will be foregone for development where the diversion development, such as a dam, would have an unacceptably adverse impact on environmental or social consequences. Specific constraints will be determined for each development according to the downstream environmental or social needs and other issues through the environmental impact assessment process. This is administered by the Department of Environmental Protection (DEP) and the Environmental Protection Authority (EPA). Development of any surface water resources must pass through this process before it is implemented.

The following is a summary of the surface water resources of the Region.

Esperance Coast River Basin (601) & Salt Lake River Basin (024)

The surface water resources of the Esperance Coast River Basin are generally good, although diversion of the rivers would be constrained due to environmental requirements. The Region has 1 050 ML/year available for withdrawal use of which approximately 315 ML/year is reserved for in-situ uses.

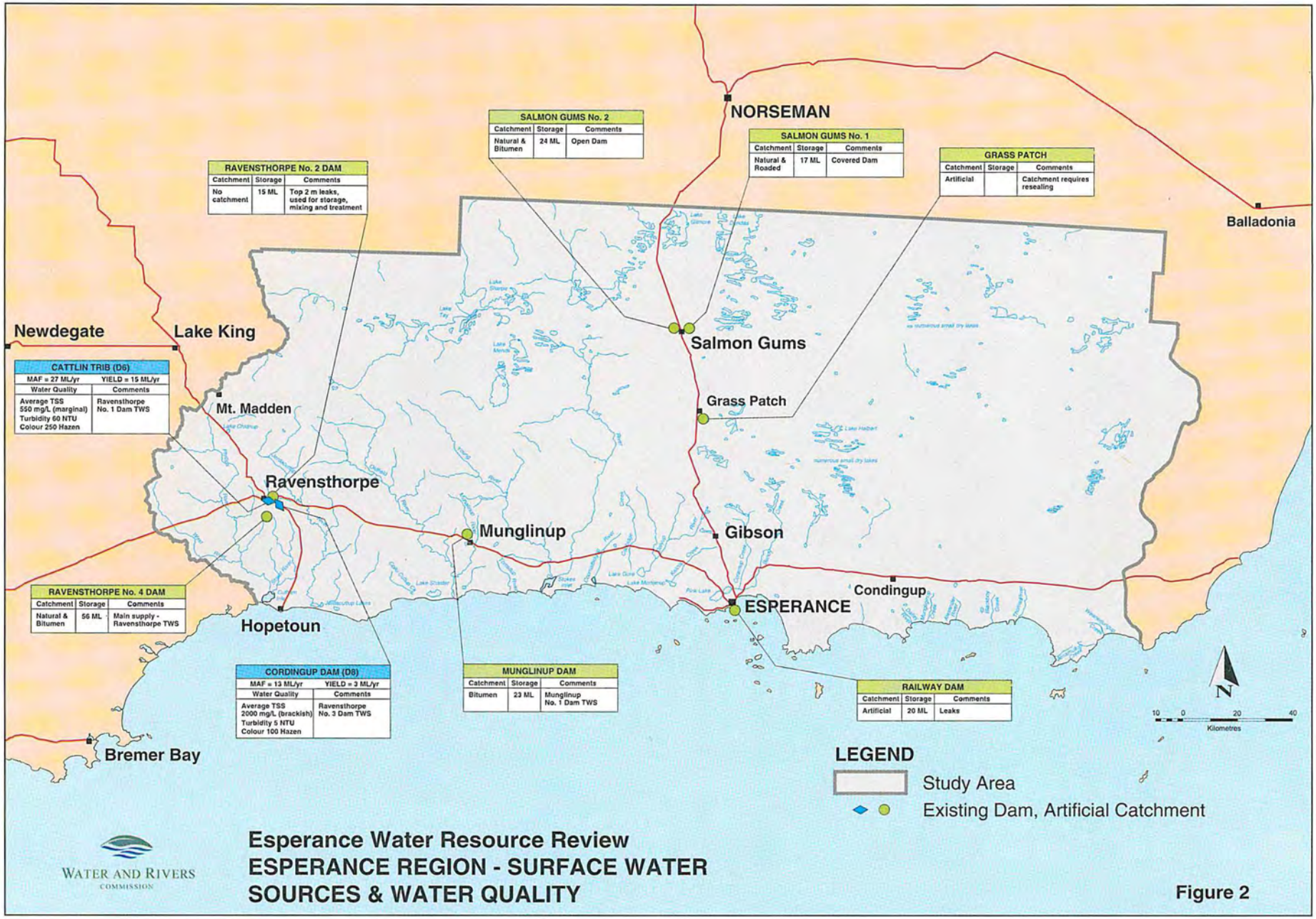
Catchment Area (km²): 49 400
Mean Annual Flow ML/year): 3 000
Amount Reserved For In-situ Uses (ML/year): 315
Amount Available For Withdrawal (ML/year): 1 050
Annual Divertible Yield (ML/year): 735

Table 1

Dam/Pipehead Site	Average Streamflow (ML/year)	Storage Capacity (ML)	Divertible Yield (ML/year)
Cordingup Creek (D8)	13	107	3
Cattlin Creek Tributary (D6)	27	40	15

In addition, a number of artificial catchments exist within the Region, harnessing direct runoff for Town Water Supplies (Figure 2).

Railway Dam overlooking Esperance town.


NORSEMAN
Balladonia
Newdegate
Lake King
Mt. Madden
Ravensthorpe
Hopetoun
Bremer Bay
Munglinup
Salmon Gums
Grass Patch
Gibson
ESPERANCE
Condingup
SALMON GUMS No. 2
Catchment | Storage | Comments
Natural & Bitumen | 24 ML | Open Dam
SALMON GUMS No. 1
Catchment | Storage | Comments
Natural & Roaded | 17 ML | Covered Dam
GRASS PATCH
Catchment | Storage | Comments
Artificial | | Catchment requires resealing
RAVENSTHORPE No. 2 DAM
Catchment | Storage | Comments
No catchment | 15 ML | Top 2 m leaks, used for storage, mixing and treatment
CATTLIN TRIB (D6)
MAF = 27 ML/yr | YIELD = 15 ML/yr
Water Quality | Comments
Average TSS 550 mg/L (marginal) Turbidity 60 NTU Colour 250 Hazen | Ravensthorpe No. 1 Dam TWS
RAVENSTHORPE No. 4 DAM
Catchment | Storage | Comments
Natural & Bitumen | 56 ML | Main supply - Ravensthorpe TWS
CORDINGUP DAM (D8)
MAF = 13 ML/yr | YIELD = 3 ML/yr
Water Quality | Comments
Average TSS 2000 mg/L (brackish) Turbidity 5 NTU Colour 100 Hazen | Ravensthorpe No. 3 Dam TWS
MUNGLINUP DAM
Catchment | Storage | Comments
Bitumen | 23 ML | Munglinup No. 1 Dam TWS
RAILWAY DAM
Catchment | Storage | Comments
Artificial | 20 ML | Leaks
N
10 0 20 40
Kilometres
LEGEND
Study Area
Existing Dam, Artificial Catchment
WATER AND RIVERS COMMISSION
Esperance Water Resource Review
ESPERANCE REGION - SURFACE WATER SOURCES & WATER QUALITY
Figure 2

Groundwater Resources

The major groundwater resources in the Esperance Region (Figure 3) are contained in regional, catchment-controlled flow systems, where it slowly migrates under gravity towards the rivers and oceans. A schematic cross section showing the occurrence of groundwater in the Region is illustrated in Figure 4. The regional distribution of groundwater salinity in the Esperance Region is closely related to rainfall and evaporation with a general trend of increasing salinity towards the north (Figure 5). Fresh to marginal groundwater is limited to an area near the coast beneath groundwater divides and thick sandplain deposits, as a result of groundwater recharge.

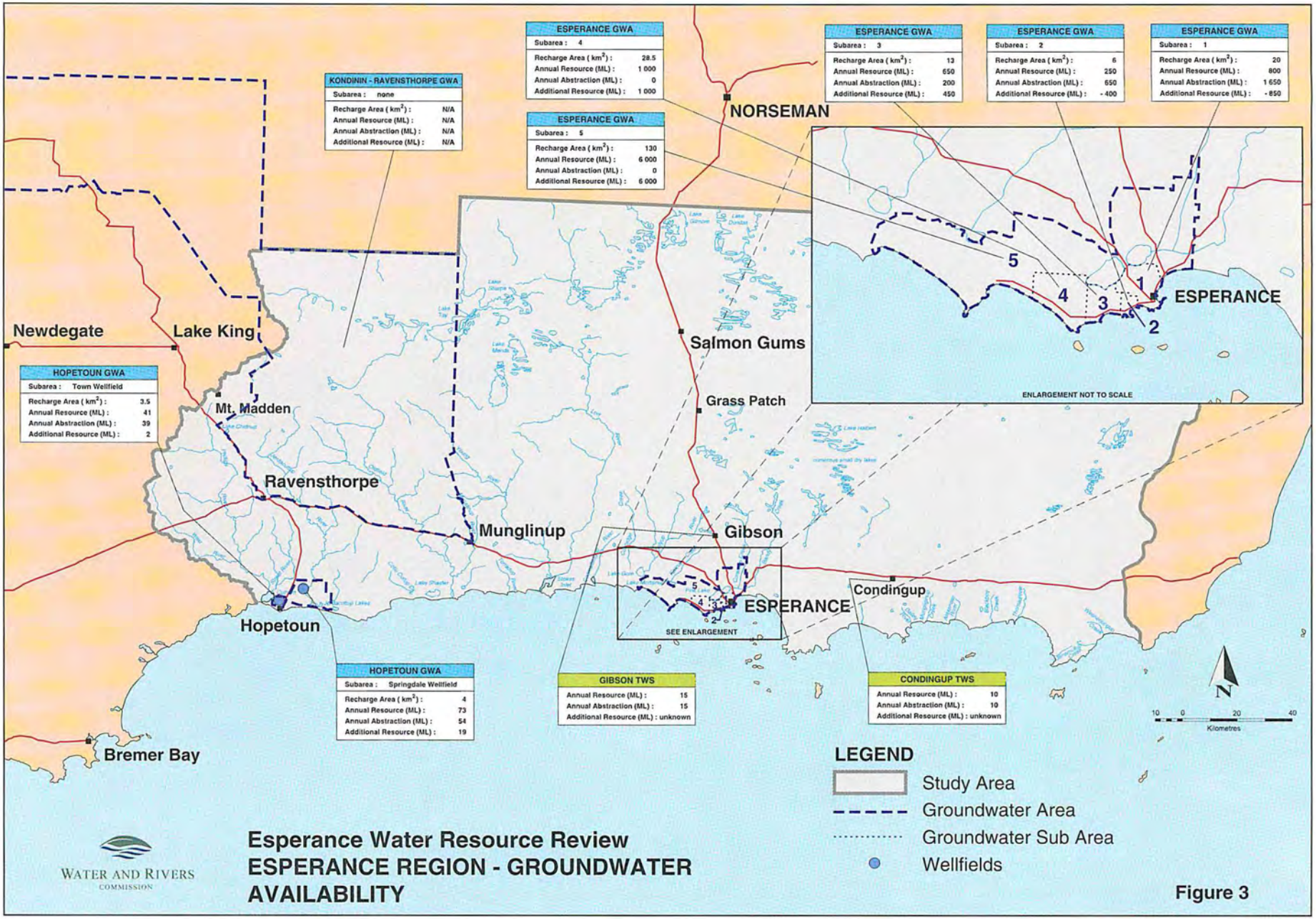
In the study area, the amounts of unconfined groundwater needed to maintain the saltwater interface appear to be sufficient to maintain the wetlands. Hence, the "surplus available" volume approximates the "environmentally sustainable" volume. This will need to be further assessed and monitored as the resources are developed.

To facilitate long term management of the groundwater resources part of the Region covering these basins has been proclaimed as *Groundwater Areas* (GWA's) under provisions of the Rights in Water and Irrigation Act (RIWI) 1914. A substantial portion of the study area (north of Gibson) has minimal fresh groundwater resources and consequently has not been proclaimed as a GWA. The location of existing GWA's and the estimated availability of fresh groundwater resources within the study area are illustrated in Figure 3 and Figure 5.

There are four known groundwater wellfields within the Region, at Esperance, Hopetoun, Gibson and Condingup, and all are exploited for public water supply. The largest is the Esperance wellfield which has a sustainable annual yield of 2 100 ML.

Groundwater resources within the Esperance Region suitable for town water supply development are limited due to the lack suitable aquifers and high groundwater salinities. However, there exists significant sources of lower grade water within the Region. These include brackish to saline land based water sources as well as seawater. These resources could be used as industrial process water in some applications or for users who do not require potable sources, alleviating the stress of the existing schemes. In addition, desalination of brackish water sources could be developed.

Gibson Town Water Supply Tower


ESPERANCE GWA
Subarea : 4
Recharge Area (km²) : 28.5
Annual Resource (ML) : 1 000
Annual Abstraction (ML) : 0
Additional Resource (ML) : 1 000
ESPERANCE GWA
Subarea : 3
Recharge Area (km²) : 13
Annual Resource (ML) : 650
Annual Abstraction (ML) : 200
Additional Resource (ML) : 450
ESPERANCE GWA
Subarea : 2
Recharge Area (km²) : 6
Annual Resource (ML) : 250
Annual Abstraction (ML) : 650
Additional Resource (ML) : - 400
ESPERANCE GWA
Subarea : 1
Recharge Area (km²) : 20
Annual Resource (ML) : 800
Annual Abstraction (ML) : 1 650
Additional Resource (ML) : - 850
KONDININ - RAVENSTHORPE GWA
Subarea : none
Recharge Area (km²) : N/A
Annual Resource (ML) : N/A
Annual Abstraction (ML) : N/A
Additional Resource (ML) : N/A
ESPERANCE GWA
Subarea : 5
Recharge Area (km²) : 130
Annual Resource (ML) : 6 000
Annual Abstraction (ML) : 0
Additional Resource (ML) : 6 000
NORSEMAN
ESPERANCE
ENLARGEMENT NOT TO SCALE
Newdegate
Lake King
Salmon Gums
HOPETOUN GWA
Subarea : Town Wellfield
Recharge Area (km²) : 3.5
Annual Resource (ML) : 41
Annual Abstraction (ML) : 39
Additional Resource (ML) : 2
Mt. Madden
Grass Patch
Ravensthorpe
Munglinup
Gibson
ESPERANCE
SEE ENLARGEMENT
Condingup
Hopetoun
HOPETOUN GWA
Subarea : Springdale Wellfield
Recharge Area (km²) : 4
Annual Resource (ML) : 73
Annual Abstraction (ML) : 54
Additional Resource (ML) : 19
GIBSON TWS
Annual Resource (ML) : 15
Annual Abstraction (ML) : 15
Additional Resource (ML) : unknown
CONDINGUP TWS
Annual Resource (ML) : 10
Annual Abstraction (ML) : 10
Additional Resource (ML) : unknown
Bremer Bay
N
10 0 20 40
Kilometres
LEGEND
Study Area
Groundwater Area
Groundwater Sub Area
Wellfields
WATER AND RIVERS COMMISSION
Esperance Water Resource Review
ESPERANCE REGION - GROUNDWATER AVAILABILITY
Figure 3

Environmental, Social and Cultural Issues

This very preliminary assessment has indicated that in some cases environmental values are likely to be significantly affected by water resource development, while other potential developments may remain relatively unconstrained. The environmental and social values of river basins are outlined below.

Table 2: Environmental Values of the Esperance Region (601) & Part of (024)

Environmental Value	Comments	Percentage (%)
Total Basin Area	49 400 km²	
Waterways	Primary catchment: Oldfield River Secondary catchment(s): Young & Lort	
Wetlands	Numerous permanent & intermittent lakes; Lake Shaster, Stokes & Barke Inlets, Pink and Waden Lakes, Lakes Mortijimup, Lake Dundas, Lake Sharpe, Lake Mends	
Conservation Park	0 km²	0
National Park or Proposed National Park	3 354 km²	7
Nature Reserve	4 383 km²	3
State Forest	0 km²	0
Water Reserves	Esperance, Condingup, Hopetoun	-
Catchment Area	Salmon Gums (4 km²)	-
Marine Reserve	0	0
Coastal Environment	496 km	-
CALM Freehold	0.6 km²	0
CALM Leasehold	0	0
Native Title Claims	7	-
Miscellaneous Reserves	38 km²	0
Area Cleared	20 040 km²	41

Pink Lake (west of Esperance)

Environmental Values

Rising watertables and land salinisation

Watertables have been steadily rising over most of the Esperance Region since the clearing of native vegetation for agricultural activities. The replacement of deep rooted native vegetation with shallow rooted crops and pastures has altered the water balance, with less evapotranspiration resulting in increased infiltration of rainfall to the watertable. Groundwater recharge rates have increased by several per cent of annual rainfall per year, and in most areas groundwater flow has not been able to drain the additional water, resulting in rising water levels as the water is stored within the ground. Figure 5 illustrates the Regional groundwater salinity of the Region.

Social and Cultural Issues

Aborigines have occupied the Esperance Region for at least 50 000 years with the Nyungar speaking people in the west and the Ngadjumaya and Mirning in the east. Aborigines of the Region migrated seasonally between coastal areas and inland forests.

The Njuda consisted of six families at the time of European settlement in Esperance. The Njuda lands were bounded by the Wudjari in the east (Ravensthorpe area), Kalaako to the north (Grass Patch north to the Goldfields) and Ngadjunmaia and Mirning to the west (Israelite Bay and desert tribes).

Within 50 years of European settlement, there were virtually no full blood Aboriginals in the Esperance Region. Aboriginal people currently residing in the Region originate from all areas of the State (GEDC, 1996).

Conservation and CALM

The Department of Conservation and Land Management (CALM) provides direct management of national parks, reserves and marine parks. The scope of CALM's responsibilities is to conserve Western Australia's wildlife and manage public land and waters entrusted to the department for the benefit of present and future generations.

Major Conservation Reserves of Regional significance are:

- Stokes National Park
- Young and Lort River corridors and associated crown land linkage
- Lake Gore Wetland system
- Mortijinup - Nambarup Wetland System
- Esperance Lakes Nature Reserves (including wetlands of international importance)
- Cape Le Grand National Park
- Cape Arid National Park

Wetlands located within the coastal parks and reserves are Lakes Shaster, Gore and Monjingup, Lake Bannitup, Ewerts Lake and Boolenup Lake. The Esperance Lakes Nature Reserves surround the townsite and include Lake Warden, Woody Lake, Mullet Lake, Shark Lake and Pink Lake Nature Reserves. The first three mentioned contain wetlands which are referred to as the Lake Warden System, and are listed under the Ramsar Convention[1], as Wetlands of International Importance. The Lake Warden System also protects at least 17 species of waterbirds cited in the Japanese - Australian Migratory Bird Agreement and in the Chinese - Australian Migratory Bird Agreement.

The Lake Warden system and the Lake Mortijinup system are of national significance having been listed on the National Estate. Hence, any diversion or interaction with the watercourses feeding into the systems must be of a minimum.

Water Demand

The superficial coastal aquifer around Esperance is the most important divertible water resource in the Esperance Region. It must be adequately protected from saline intrusion which could result from over abstraction. Similarly, the surface water resources need to be protected from overuse and the environmental water requirements conserved.

Environmental groundwater requirements are incorporated into the groundwater calculations. Due to the sensitivity of the Esperance environment, coupled with the poor quality of resources, no large developments of the surface water resources is foreseeable without further extensive investigations into the environmental water requirements.

=> Environmental/Cultural/Social Water Requirement = 315 ML/yr.

[1] An Inter-governmental treaty which provides the framework for international cooperation for the conservation of wetland habitats.

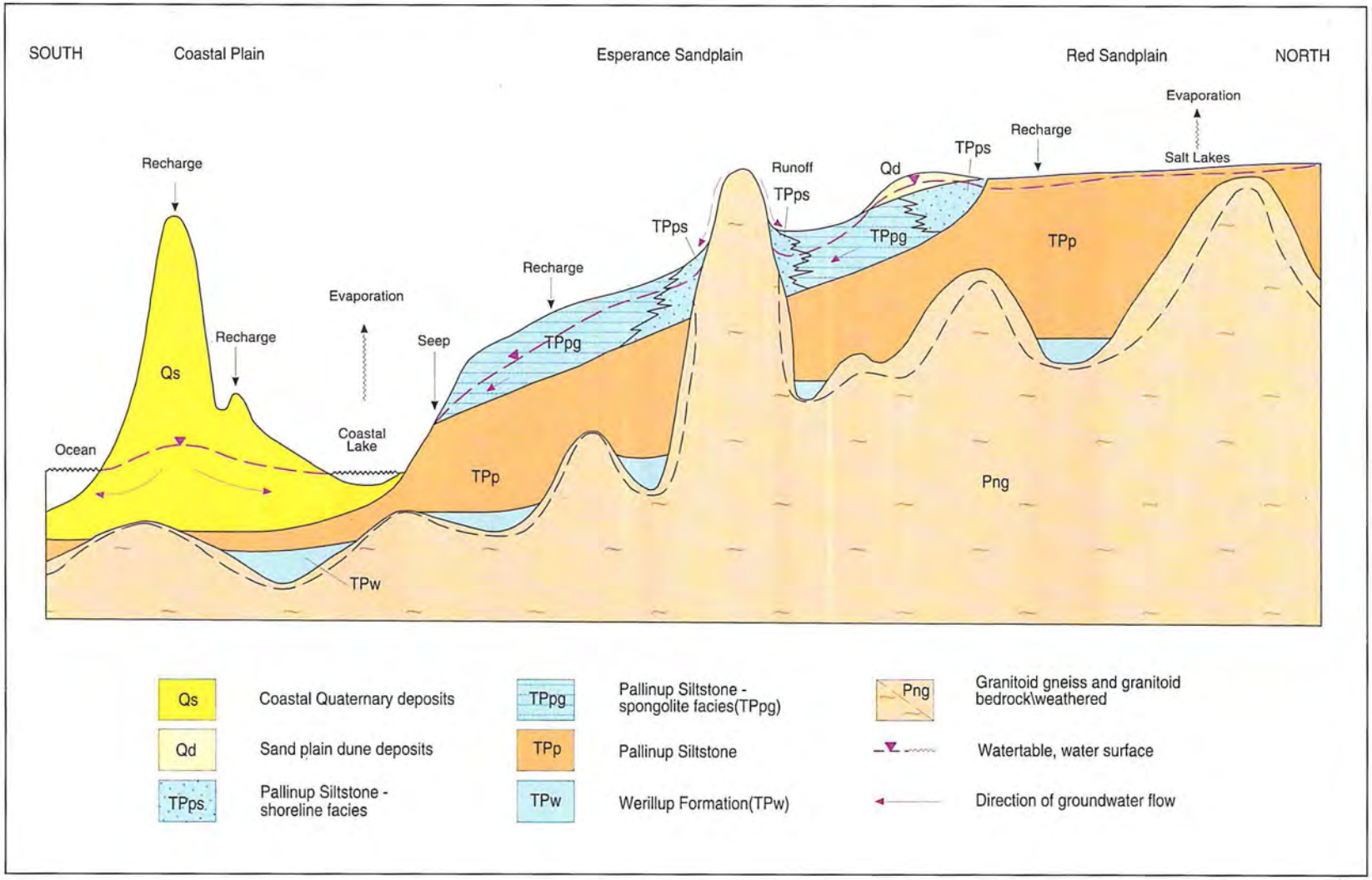


Figure 4 . Schematic cross section showing the occurrence of groundwater

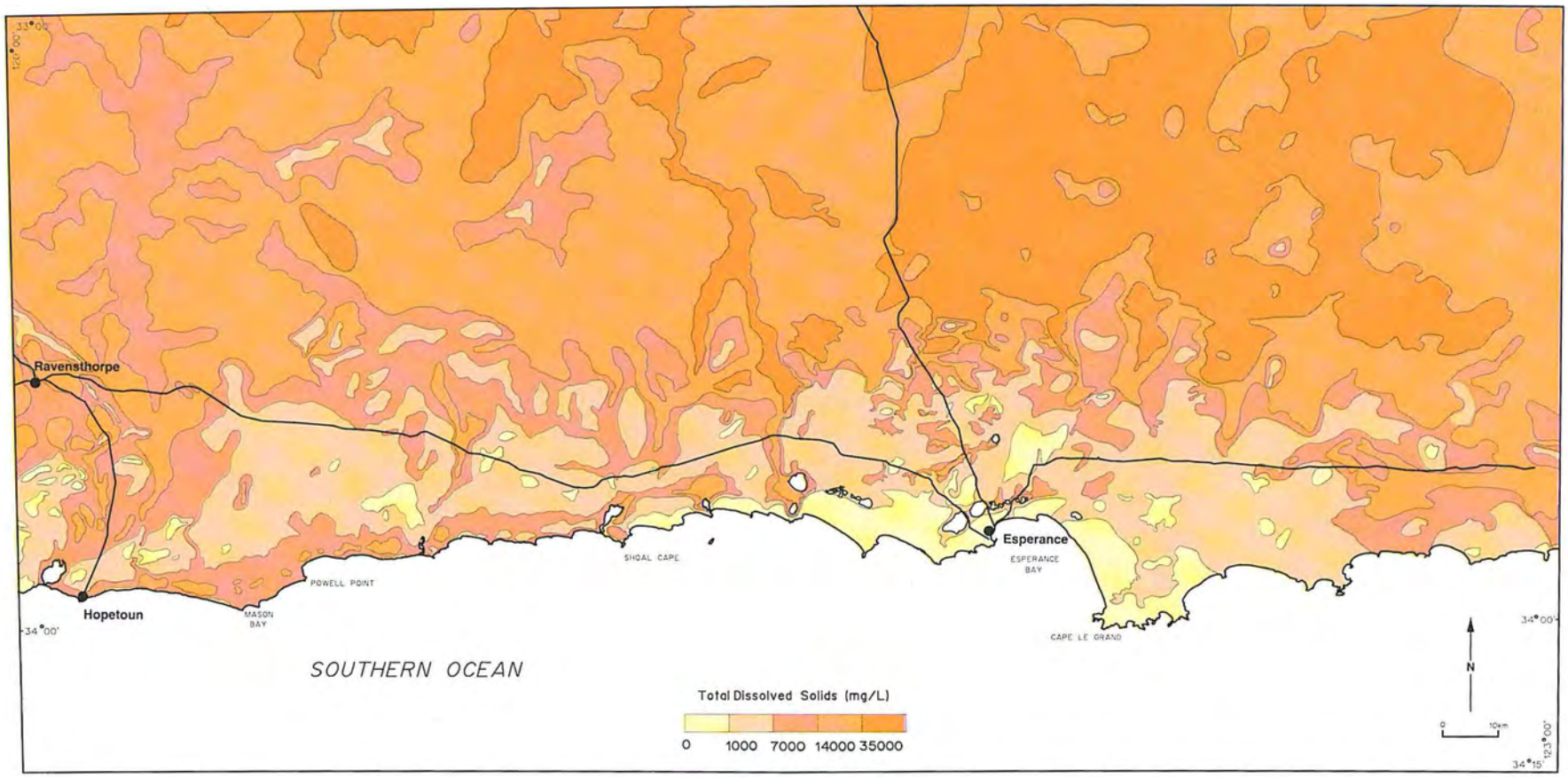


Figure 5. Regional Groundwater Salinity

Town Water Supply Projections and Water Source Development Options

The Esperance Region is experiencing significant population growth. The town of Hopetoun, with an annual growth rate of almost 5%, is one of the fastest growing towns in Western Australia. To cater for future water demand, population and service increases have been projected to the year 2026, along with the corresponding increases in water consumption. Future increases in water demand from town water supplies will place further pressure on the existing water sources. Based on the expected water demand in the year 2026, as well as the current availability of water from the sources, water source development options have been offered. These development options range from extension of the existing borefields (groundwater) to the desalination of brackish resources.

Two population growth scenarios have been developed; 'Low' and 'High'. The 'Low' scenario is referred to as 'projected population'. The 'High' scenario is referred to as the 'feasible population' and is used to demonstrate the likely maximum needs in the respective areas. Growth scenario projections of water demand to the year 2026 and development options for each town water supply scheme are summarised in Figure 6 and Table 3.

Figure 6: Water Demand Projections

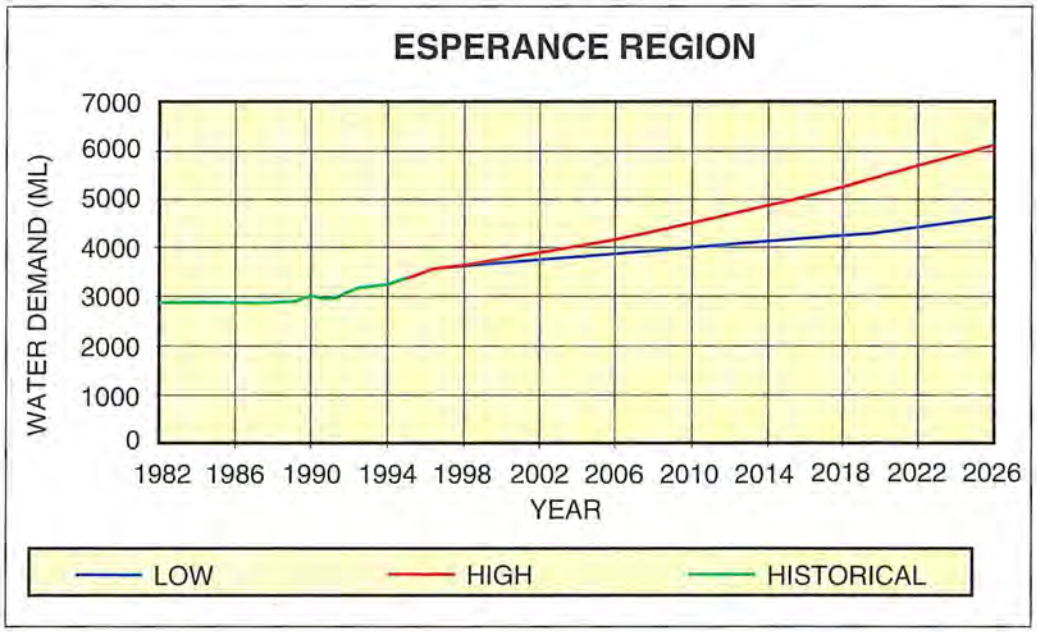


Table 3: Town Water Supply Projections and Water Source Development Options

Town Water Supply Scheme	Source	Current Licence (ML)	Demand 2026 (low) (ML)	Demand 2026 (high) (ML)	Estimated Availability (ML)	Development Options
Condingup	Condingup wellfield - Superficial formaton	10	11	14	10	• groundwater on south eastern side of the Condingup Hills • artificial catchment • quantification of available resource
Esperance	Esperance Borefield - Superficial formation	2 000	4 095	4 578	6 200	• extension of borefield • upgrade railway dam • desalination of brackish water • pipeline to goldfields - desalination
Gibson	Gibson wellfield - Superficial formation	15	14	19	15	• exploration & quantification of resource • carting from Esperance • quantification of available resource
Grass Patch	artificial catchment - 2 dam system	5	4	5	5	• carting from Esperance • increase artificial catchment
Hopetoun	Hopetoun & Springdale wellfields - Superficial formation	120	221	348	114	• groundwater exploration
Munglinup	2 dam system	10	9	12	10	• carting from Hopetoun or Esperance
Ravensthorpe	4 dam system	65	82	110	60	• desalination of brackish water sources including Dam 3 • carting from Hopetoun
Salmon Gums	2 dam system	9	12	16	9	• carting from Esperance • utilising quarry

Industrial Development and Growth Potential

All recent studies, including the South East Coast Regional profile (GEDC, 1996), acknowledge that future industrial development of the Region is of prime importance for the growth of the Region.

Esperance does not have any substantially large industries, other than the CSPB Fertiliser Works which manufactures fertiliser to the local agricultural community. Local mineral resources around Esperance are graphite in the Munglinup Area, vermiculite in the Cascade area, granite at Mt Merrivale and lignite which is found extensively around Salmon Gums, Scaddan and Balladonia. In addition, there are also deposits of minerals sands located east of Esperance which have been identified by companies such as Rennison Gold, CRA and BHP.

Future Development

Future industrial growth in Esperance is expected to be based upon development of the mineral resources in the Region or local beneficiation of ore shipped through the port.

Tourism is fast becoming a significant industry. The future of tourism within the Region appears promising and is anticipated to grow as an industry providing millions of dollars to the Region's economy.

Increased tourist numbers and a general increase in the number of permanent residents will also result in an increased demand on water resources. Periods of high water consumption during the peak holiday season may place pressure on existing water sources and promote the need for the development of new sources. The quality of water resources may also be affected by tourism development within the Region or by increased pressure brought about by demand.

Water Demand

The current industrial demand is satisfied by the existing potable supply and groundwater allocations within the superficial formations. The main industrial users in the Region are the Port Authority and the fertiliser works at CSPB. At present the future water demand for industry is difficult to predict but future projects will demand significant quantities of water. A preliminary projection of the major industries, indicates that in 2026 a demand of 395 ML, approximately 4 per cent increase on current demand, will be needed. This figure is currently adequately catered for in present licences.

The development of water resources by individual industries will need to be sanctioned by the Water and Rivers Commission. Incorporated as part of the review process the Commission will assess the impact on the urban community by the extraction of fresh water to supply future industry. If the assessment reveals that there is insufficient water from the known groundwater and inferred fresh water reserves, then an additional option is to utilise brackish water or seawater. Brackish water could be desalinated to produce potable water if so required.

Esperance Port

Agricultural Development and Growth Potential

The agricultural sector is the key industry in the Region. Currently, around 20 per cent of farm area is used for crops and the remaining 80 per cent used for pasture and grazing. Relative percentages in crops and grazing vary depending on enterprise economics and rainfall.

Future Development

Numerous research studies are being conducted in the area to increase agricultural production. Current projects include research into salt tolerant plants and rehabilitation of saline areas.

Intensive land uses such as horticulture, viticulture, floriculture and intensive animal industries are largely limited by adequate supplies of suitable quality water. Low salinity surface waters and groundwater are mostly associated with areas underlain by siltstone close to the coast as a result of high rainfall leaching the salt from the relatively coarse-textured soil profile. Bores need to be screened in coarse-textured zones in the sediments. Agriculture WA and the Water and Rivers Commission are investigating the potential of coastal areas in the sub-region for supplying water for intensive industries (South Coast Regional Land and Water Care Strategy, 1996).

Water Demand

Farming activities within the Region are reliant upon either surface water or water from private borefields if the water is fresh or marginal.

Agricultural activities within the Esperance Region are severely affected by drought and require immediate attention with respect to emergency supply. Historically, farmers have been granted access to standpipes at Gibson, Salmon Gums, Hopetoun and Esperance. However, reliable and accessible sources need to be allocated to the agricultural community. A preliminary investigation into agricultural demand suggested that by 2026 approximately 15 ML for drought deficiencies alone, would be needed. The Western Australian Farm Water Plan is attempting to satisfy dryland farming requirements for the Esperance Region and hence, is beyond the scope of this study. (Refer to the Farm Water Planning Section of the Office of Water regulation for further information concerning the Farm Water Planning Strategy).

Lake Warden (north of Esperance)

Conclusion

Surface Water

Utilisation of streamflow from surface water in the Esperance Region is limited. The rivers of the Region are highly variable and nearly always saline. As a consequence, the resources are unreliable and do not provide large potable yields.

A significant proportion of the in situ water resources are required for environmental in situ uses to sustain rivers and wetlands. This is extremely important in the Esperance Region due to the threat of salination.

Figure 7 and 8 illustrate the existing surface water supply and likely demand within the Region. Demands for surface water resources are relatively small from the town water supplies and the industrial sector. A significant portion of the surface water is allocated to sustain the environmental values of the Region.

Currently, the surplus surface water available is almost half of the total estimated surface water resources of the Esperance Region. However, this amount is less than 700 ML/year.

Demand for surface water for town water supplies, agricultural and the industrial sectors are expected to increase marginally by the year 2026. Surface water will continue to be allocated to sustain the environmental values of the Region. Although there exists a small surplus, the availability of the surface waters for diversion is unreliable and is found in small quantities at various locations throughout the Region. Many of these sources are not strategically located and hence costly to develop.

Due to the environmental in situ demands and lack of potable quality water, **potential surface water developments** are limited.

Bandy Creek Outflow (east of Esperance)

Figure 7: Existing Surface Water Supply and Demand Within the Study Region

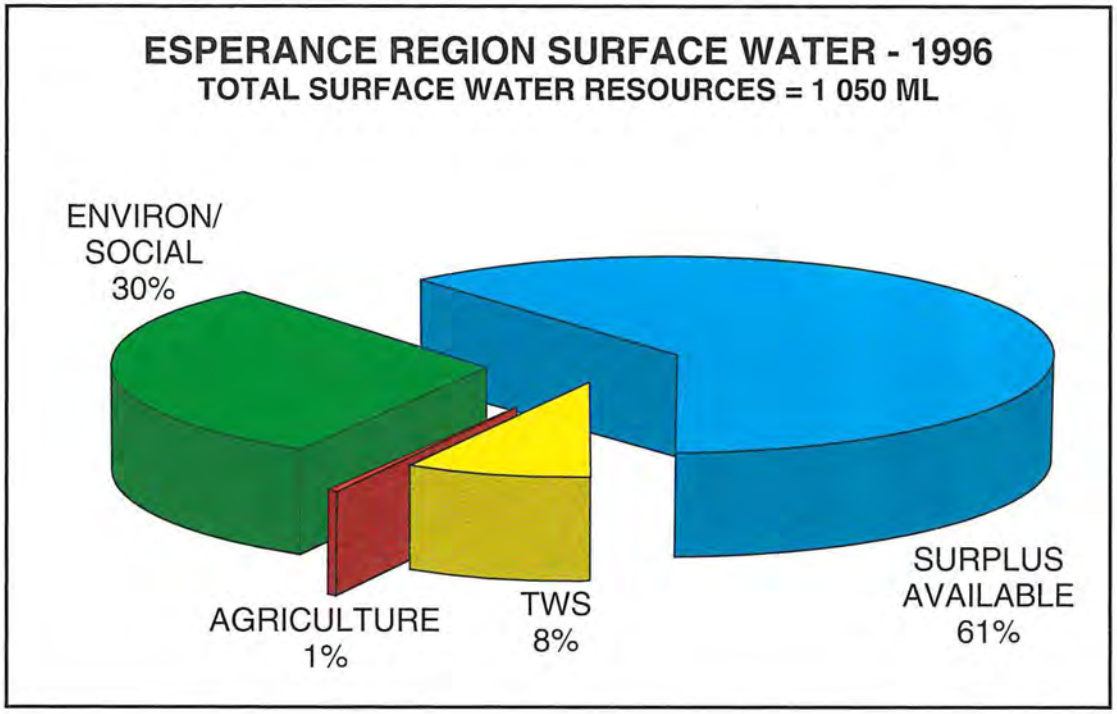
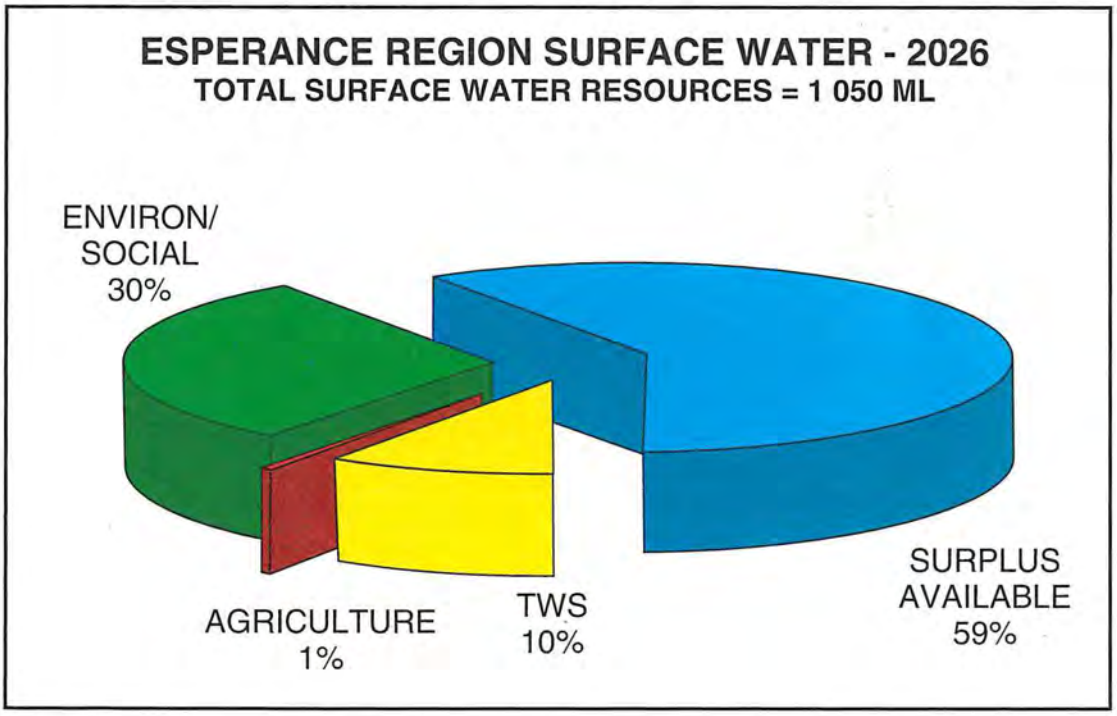


Figure 8: Potential Surface Water Supply and Demand Within the Study Region



Groundwater

Groundwater is the major water resource of the region and approximately 20 per cent is currently being exploited. However, potable groundwater resources within the Esperance Region are limited due to a lack of suitable aquifers and high groundwater salinities.

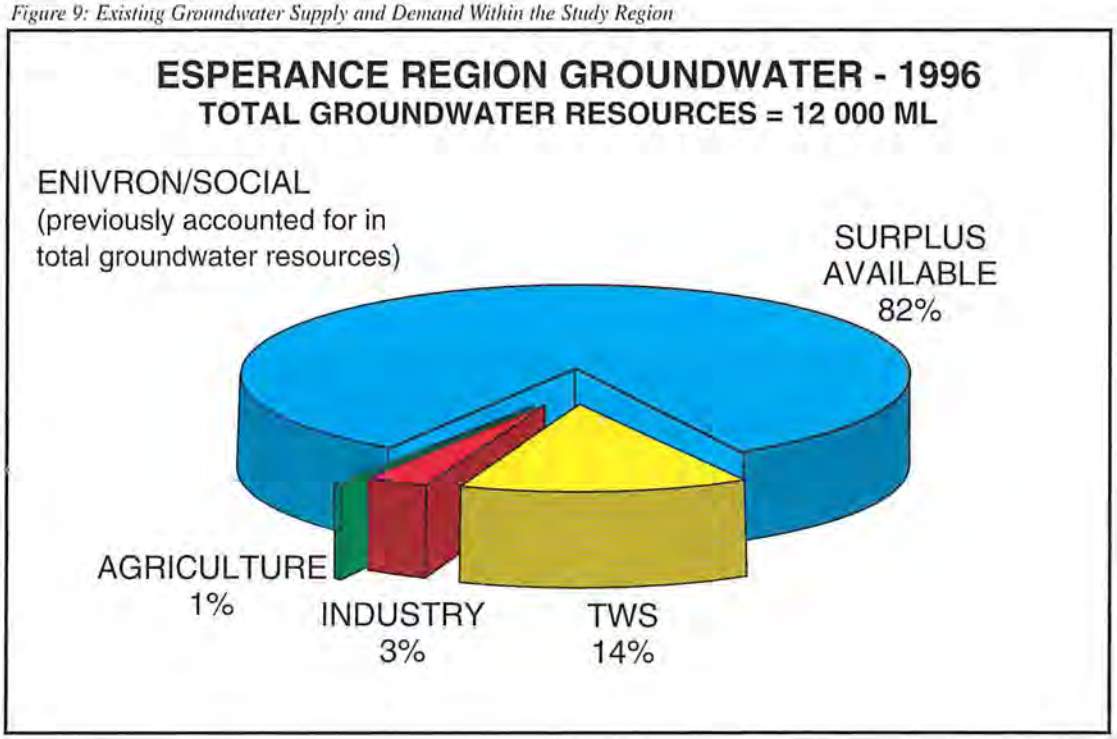
Groundwater allocations are based on sustainable yield. This means that environmental constraints are accommodated before estimating groundwater yields. This is particularly important to prevent saline intrusion.

Figures 9 and 10 illustrate the existing groundwater supply and likely demand within the Region. Town water supplies, while only accounting for 14 per cent of total potable resources, are the largest users. The Esperance township accounts for approximately half of all town water supplies. Currently, the surplus groundwater available is over three-quarters of the total available groundwater resources in the Esperance Region.

Groundwater within the Esperance Coastal region consists of a thin layer of low salinity groundwater overlying saline water. Consequently, use is more suited to individual users abstracting small quantities from bores spread throughout the groundwater areas.

Demands for groundwater from the agricultural and industrial sectors are expected to increase marginally by the year 2026. Town water supplies are anticipated to increase substantially, approximately 50 per cent by the year 2026. Groundwater allocations will continue to be based on sustainability, which will allow for environmental requirements. In 2026, the current resource may be sufficient to supply the overall future demand. The availability of groundwater for diversion is variable and unreliable throughout the region and requires further investigations to substantiate quantities before development.

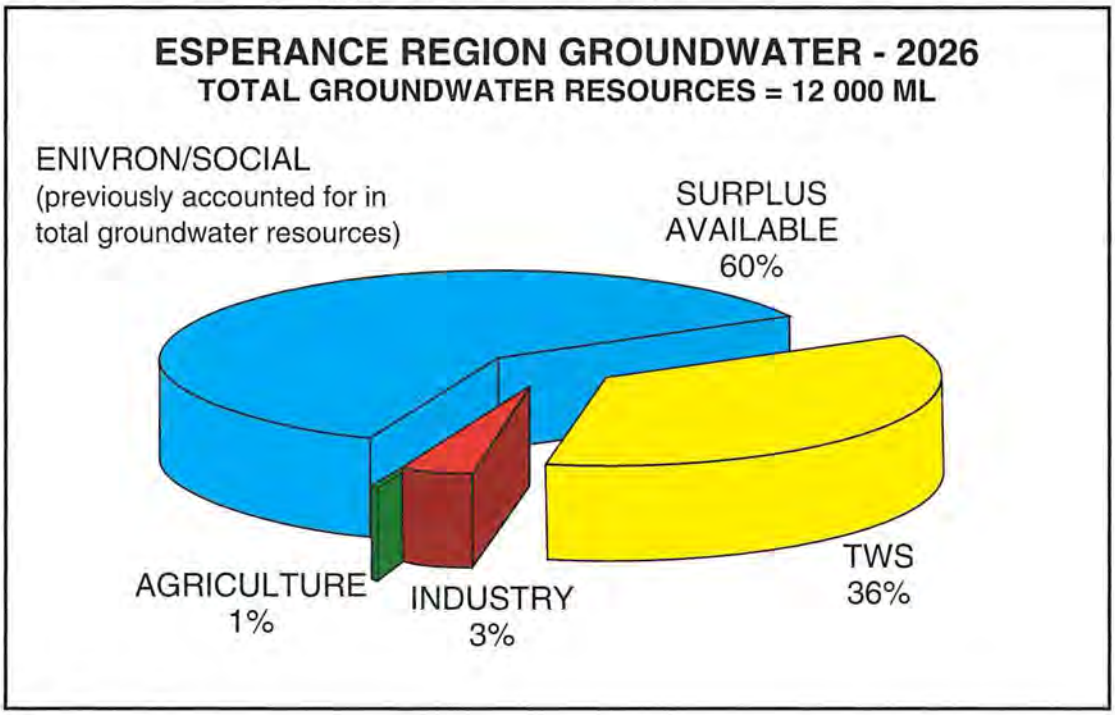
Figure 9: Existing Groundwater Supply and Demand Within the Study Region



Substantial quantities of brackish groundwater and surface water resources exist for development potential. These sources could possibly provide low grade process water for many industries. In addition, brackish water desalination could be developed to produce potable supplies.

As demand increases and resources become exhausted, desalination, to provide potable water, may exist as the only viable solution. The fresh local groundwater resources should be exploited before the concept of desalination is considered. The latter will represent a substantial additional investment, not only in capital cost but also for the operational costs associated with desalination.

Figure 10: Potential Groundwater Supply and Demand Within the Study Region



Recommendations

- Efficiency programs should be implemented for town water supplies to reduce wastage and for residents to reduce demand.
- The agricultural community should be adequately catered for under drought conditions.
- The development and implementation of sub-catchment plans should be undertaken to assist in the sustainable management of catchments.
- Assessments should be carried out on individual projects concerning their sustainability merits and environmental impacts.
- The monitoring of streamflow and water quality of streams, inlets and wetlands should continue and be expanded to enable a statistically rigorous (long term) record of data for subsequent investigations. The data should then relate to management principles.
- Water resource estimates for the region should be re-evaluated periodically.
- A water resource management plan for the Esperance Region should be completed and implemented immediately.
- Further sources require investigation into their development potential for future water supply.
- The use of marginal to brackish water for some consumers needs to be investigated.
- Research into cost structure and feasibility of desalination at Esperance needs to be undertaken.
- Further investigation into the quantification and availability of brackish water resources.

Bandy Creek Outflow (east of Esperance)

Glossary

aquifer	A geological formation or group of formations capable of receiving, storing and transmitting significant quantities of water.
beneficial use	The current or future uses for a water resource which have priority over other potential uses because of their Regional significance to the community. Beneficial use designations provide guidance in determining the management and protection of the quality and quantity of the resource.
bore	A hole dug or drilled from the ground surface into a groundwater aquifer to monitor or to withdraw water. Household wells are commonly termed bores.
brackish	Water of salinity 1500-5000 mg/L TSS.
catchment	The surface area from which run-off flows to a river or a collecting reservoir such as a lake or dampland.
confined aquifer	A permeable geological formation saturated with water under pressure and underlying a relatively impervious layer.
demand	The amount of water required from the water supply system.
divertible yield	The average annual volume of water which could be removed from developed or potential sources on a sustainable basis.
drainage basin	The catchment of river(s) as defined by the Australian Water Resources Council for presenting hydrological data.
fresh	Water of salinity less than 500 mg/L TSS.
groundwater	Water which occupies the pores and crevices of rock or soil.
horticultural	Irrigation water use in intensively cultivated situations.
kilolitre (kL)	1 000 litres.
marginal	Water of salinity 500-1500 mg/L TSS.
megalitre (mL)	1 000 kilolitres.
permeability	A measure of the rate at which water passes through soil or rock.
potable	Fresh and marginal water generally considered suitable for human consumption.
raw water	Process water of salinity about 1500-3000 mg/L TDS.
recharge	Water arriving at the water-table.
Region	Tract of land having more or less definitely marked boundaries or characteristics.
reservoir	A structure constructed across a river valley to store stream flow and allow it to be diverted for water supply use and for release in a controlled manner for downstream use.
river basin	The catchment of river(s) as defined by the Australian Water Resources Council for presenting hydrological.
riverine	Of or on a river or its banks.
runoff	The discharge of water through surface streams into larger water courses.
saline	Water resources of salinity greater than 5000 mg/L TSS.
salinity	The measure of the total soluble (or dissolved) salt, ie. mineral constituents in water. Water resources are classified on the basis of that salinity in terms of milligrams per litre Total Soluble Salts (mg/L TSS).

source	An actual water source such as a new dam, expansion of existing dams or development of groundwater which will contribute to meeting water needs.
strategy	A set of policies or means aimed at a set of objectives designed to bring various actions under unified direction in order that the organisation's or community's objectives may be effectively served. It may consist of one or more source options, water efficiency policies, as well as a commitment to research and develop "environmentally friendly" options.
supply schemes	Water diverted from a source (or sources) by a water authority or private company and supplied via a distribution network to customers for urban, industrial or irrigation use.
surface water	Water flowing or held in streams, rivers and other wetlands in the landscape.
sustainable yield	The rate of water extraction from a source that can be sustained on a long-term basis without exceeding the rate of replenishment. Sustainable groundwater use limits extraction to no more than the recharge rate and requires sufficient throughflow to prevent significant ocean water intrusion into aquifers.
treatment	Application of techniques such as settlement, filtration, chlorination, to render water suitable for drinking purposes.
upconing	When an aquifer containing an underlying layer of saline water is pumped by a well penetrating only the upper freshwater portion of the aquifer, a local rise of the interface below the well occurs.
watertable	The surface of the unconfined groundwater, which may be above ground as swamps or lakes in low-lying areas. Measured as the level to which water rises in a well tapping an unconfined aquifer.
water conservation	Water should be conserved so that these resources can be developed, used and managed in such a way as to provide the greatest possible social, environmental and economic benefit for the community of Western Australia, now and into the future.
water use efficiency	Minimising growth in demand for consumptive use of water by making the most efficient use of available supplies.
water reserve	An area proclaimed under the metropolitan water Supply Sewerage and Drainage Act or Country Areas water Supply Act to allow the use of water on or under land for public water supplies.
water resources	Water in the landscape (above and below ground) with current or potential value to the community and the environment.
wellfield	A grouping of wells to extract large volumes of groundwater, generally for scheme supply.
wetland	Area of seasonally, intermittently or permanently water logged soils or inundated land, whether natural or otherwise, fresh or saline.