

OTWAY WATER BOOK 57.

*Are the Otway Ranges
Threatened by Wildfire
resulting from
Subterranean Water, Oil
and Gas
Extraction just like
Gippsland?*



*It is a worry I know.
Colonies of platypus
have already been
wiped out by these
practices.*

*I can tell you there is
every indication that
our species is under
serious threat in the
Otway Ranges.*

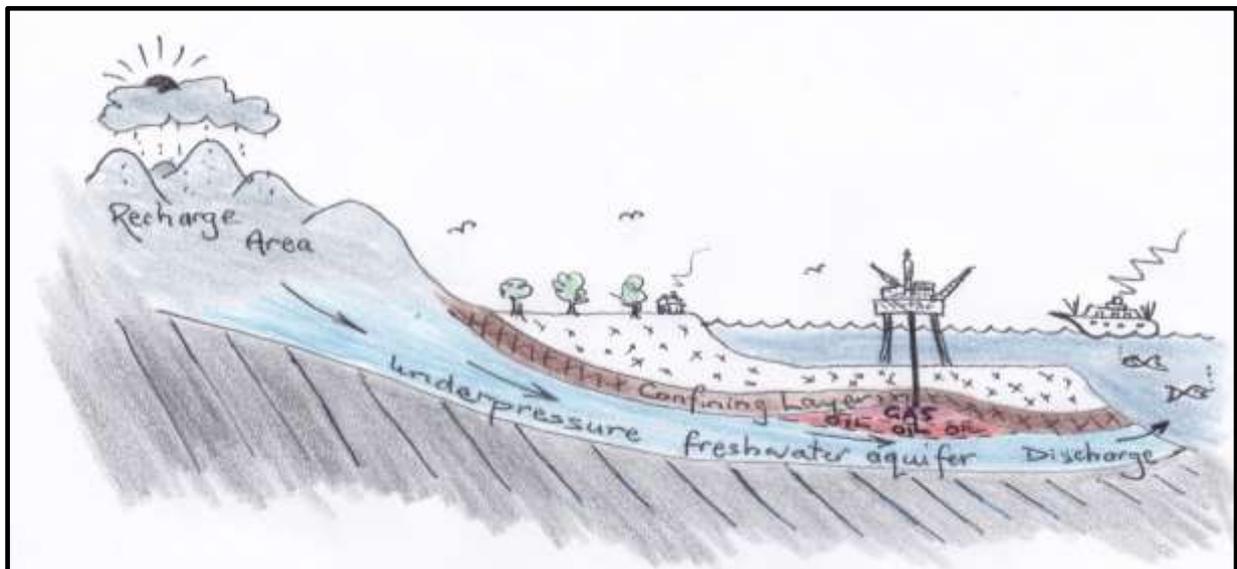


OTWAY WATER

BOOK 57

*“Are the
Otway Ranges,
Threatened by
Wildfire*

**Resulting from Subterranean
Water, Oil and Gas Extraction,
Just Like in Gippsland?”**



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November 2020
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www.otwayrangessubterraneannationalpark.org.au

CONTENTS.

Otway Water Book 57. INTRODUCTION Page 5.

Chapter One. An Easy to Understand Conceptualisation. **Pages 6-12.**

- pressure head – impact area – vertical leakage – recharge – discharge – cone of depression – water cycles – salt intrusion
- Multiple use of the word “likely”
- Summary

Chapter Two. Conventional Gas & Oil Extraction. **Pages 13-14.**

- Mick Osborne, offshore gas platform supervisor - gas, oil, water layers – wet gas – offshore causing impacts onshore

Chapter Three. Impacts that result from subterranean liquid extraction. **Pages 15-16.**

Chapter Four. Gippsland. **Pages 17-33.**

- Maps of flood plains, river systems and geology.
 - Aquitard water holding capacity – leakage – recharge up country – discharge offshore – rock as an aquifer – farmer compensation – hydrographs declining – data gaps – lots of inference, assumptions, guesswork.
- CSIRO 2004 report
 - Findings – climate change/irrigation/land use not the major causal factor
- Yarram Water Supply Protection Area (WSPA)
 - Water table level still declining – elevated fire risk – historical mental image of Gippsland – climate change and land use discounted as an influence
- Comments made in the Yarram WSPA document.
 - Present extraction level sustainable – major influencing factor on onshore water table drop is fluid extraction offshore – salinity problems – no environmental studies done or being done
- Summary

Chapter Five. Local Knowledge. **Pages 34-40.**

- Jack Whadcoat (Lake Tyers)
- Further investigation needed
- Compilation of local knowledge needed
- Summary

Chapter Six. Gippsland Peats. **Pages 41-46.**

- Coastal and Upland-knowledge & data gaps. CFA has begun this work
- Peat fire fighters require training based on research findings

Chapter Seven. Wy Yung Ground water Management Area. **Pages 46-52.**

- Lack of data to verify decisions taken
- Permissible Annual Volume (PAV)
- Consultative Committee
- Groundwater Management Plan as recommended does not appear to be adopted
- Geoffrey Johnston’s local knowledge
- Acid waters impacting on pasture -artesian bores declining
- 75% baseflow in Tarra River reduced.

Chapter Eight. Map of the 2020 Gippsland Fires. **Page 53.**

Chapter Nine. Victorian Gas Program. **Pages 54-57.**

- Little likelihood of viable conventional gas in Gippsland.
- Gas extraction has not had an environmental impact over the last 100 years.
- Onshore conventional gas exploration to proceed
- Tight, coal seam and shale exploration still banned.
- Onshore and offshore modelling etc. dealt as two distinct systems

- Recommended in 2004 to combine as one system – recommended again in 2020
- Science appears to be inadequate
- Was the consultation adequate?
- Assumptions not included in the report
- Subsidence could be a “distant” problem
- Reasonable probability of happening – critical period/threshold will be 2035 – California subsidence example

Chapter Ten. Otway Ranges Heightened Fire Risk. **Pages 58-60.**

- List of indicators
- Impacts on the Barwon River Catchment
- Impacts on the Gellibrand River Catchment
- Gippsland drawdown is many times greater

Chapter Eleven. Local Knowledge Otway Ranges. **Pages 61-64.**

- Johanna River

Chapter Twelve. Stygofauna Studies in Southern Victoria. **Pages 65-84.**

- This stated as the only baseline study done on subterranean Groundwater Dependent Ecosystems in Victoria
- Reasons for the study – very first attempts at monitoring subsurface GDEs – however, in 1882 Australia was in the forefront on aquifer organisms
- More than observation bore water column stygofauna needs to be studied
- Stygofauna Disruptors
- Huge data gaps
- Comments on the Otway Ranges stygofauna study
- Considerable work to be done – a narrow and limited context used
- Future use of study results of doubtful value
- Summary

Chapter Thirteen. Social Engineering. **Pages 85-90.**

- Background to the study
- Definition used – phone survey – measured only attitudes and perceptions – no survey of knowledge or understanding of the subject surveyed
- Stated aim of to inform and educate not done
- Was fracking mentioned as an influencing factor in the survey?
- Were the results skewed in favour of exploration
- Summary

Chapter Fourteen. Extended Reach Drilling. **Page 91.**

- Will offshore extended reach drilling reach under the onshore areas of the Otways?

Chapter Fifteen. Environmental Baseline Studies. **Pages 92-93.**

- Victorian Gas Program environmental baseline studies narrow and limited
- As yet not available even though the final report has been completed.

Conclusion. **Pages 94**

Acknowledgements. **Page 95.**

Appendix One. Media release of \$5 million compensation. **Page 96.**

Appendix Two. Groundwater extraction Impacts are world wide. **Page 97.**

Appendix Three. Letter from DELWP to Ben Sheppard. **Pages 98-99.**

Appendix Four. Onshore gas exploration to begin. **Pages 100-102.**

Appendix Five. Age article – Australia out of step with the rest of the world regarding gas exploration. **Page 103.**

Appendix Six. Summary of Wy Yung Groundwater Management Plan recommendations. **Pages 104-105.**

References. **Pages 106-108.**

INTRODUCTION.

There are examples throughout the world where wildfires have been associated with the impact of human induced speeding up of Climate Change. Although the climate on earth has always been in a state of constant change it is unfortunate that for a multitude of reasons human intervention has altered the speed and type of change that is taking place.

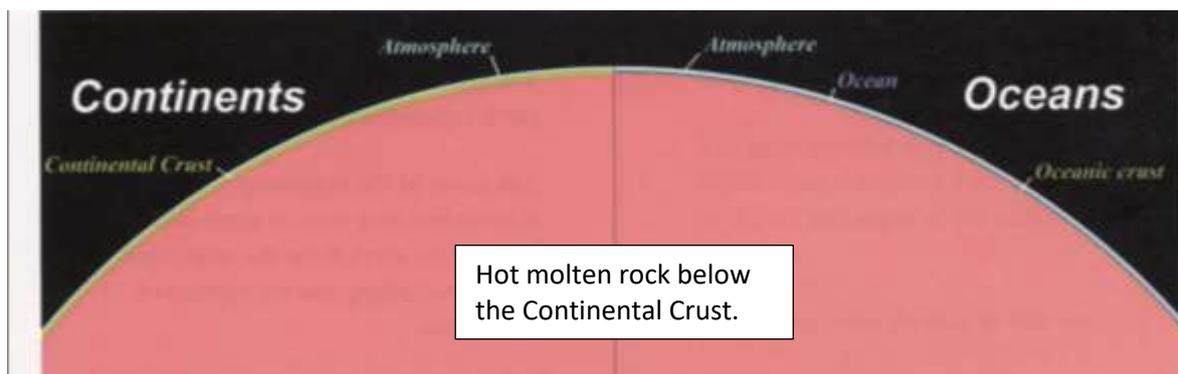
One detrimental influence that appears to have slipped under the radar is the over extraction of subterranean gas and fluids. This book takes a cursory look at this influence where there is a direct connection between surface ecosystems and subterranean extractions impacts contributing to the risk, intensity and duration of wildfire.

There is a very strong case that can be put indicating the Otway Ranges is following the same trajectory that Gippsland fires have taken regarding the influence gas and liquid extraction from the subterranean has contributed to surface wildfire. This book looks at the similarities and poses the question, are the Otway Ranges the next Gippsland?

Another thread of major concern woven into this book is the manner in which the Victorian Gas Program has used social engineering and poor scientific and technical practice to influence and justify onshore gas exploration in the Otway ranges.

Worth Considering.

It is worth noting as you read through this book just how delicate and miniscule the earth's crust is.



SOURCE: Professor Lance Endersbee "A Voyage of Discover."⁽²⁷⁾

Only when this is understood can one begin to grasp the idea of the enormous forces at work influencing the surface conditions of our earth. What humans have come to perceived as a stable safe and relatively secure world we live on, is really a fragile thin crust surrounding a gigantic molten ball of energy. It does not take a great deal of

imagination to understand how this balance can be upset. In relative terms a hen's egg shell is 3 times thicker than the continental crust humans inhabit.

CHAPTER ONE

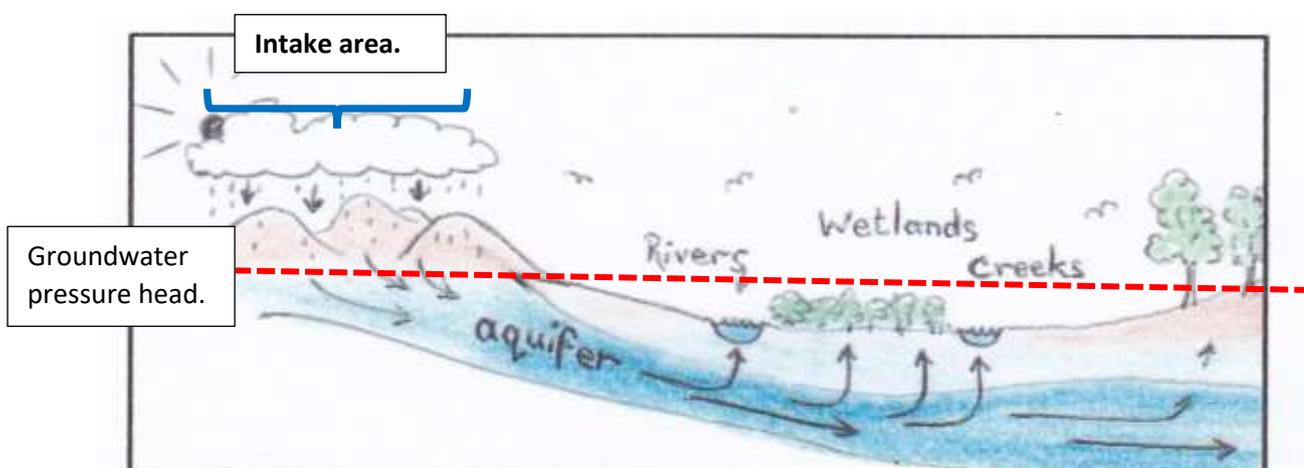
An Easy to Understand Conceptualisation.

The interrelation between surface and groundwater connectedness knowledge has advanced enormously in the last few decades. It can no longer be denied the importance of baseflows from aquifers supporting surface ecosystems around springs, creeks, rivers and wetlands. However, a difficult concept to understand is that the groundwater ecosystem influences can extend way out beyond the area of the springs, creeks and rivers.

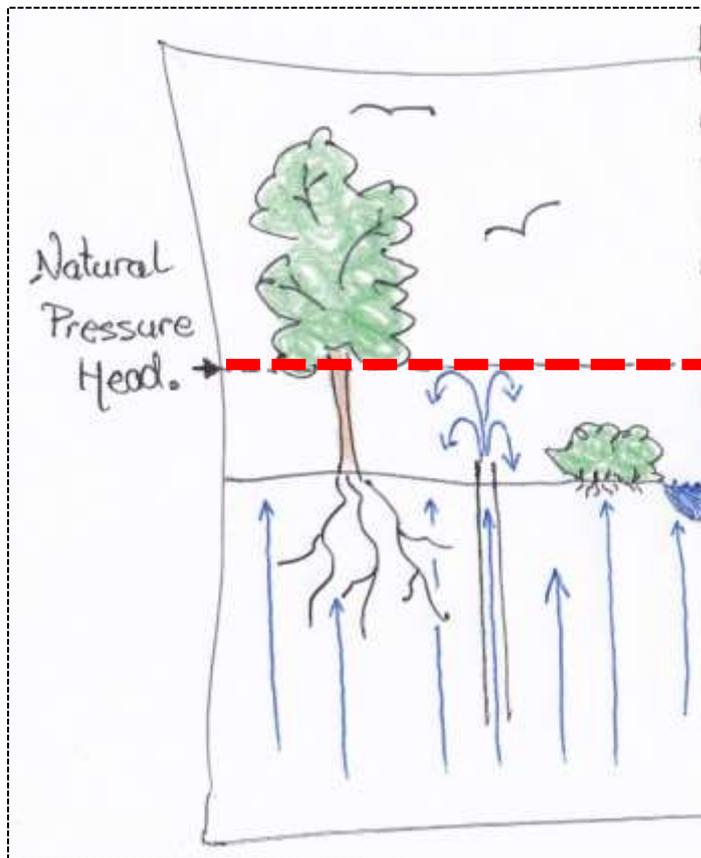
Uniqueness of Each Region.

Also, there is still a great deal to be learnt regarding the way groundwater systems evolve and how human interference with this resource impacts on the subterranean and the surface ecosystems. Added to the guess work and assumptions that are applied to the science of hydrogeology and hydrology is the need to take into consideration the uniqueness of each particular region. Generalisations applied to an area such as the size of Victoria can be misleading. For example, during 2018 and 2019 there was constant "chatter" regarding the decline in rainfall for this state. However, during 2018 the Kawarren district of the Otway Ranges had 1200 mm of rain. During 2019 there were 960 mm. This highlights the fact that any discussion regarding an area must be based on data and intellect from that particular area.

With this in mind, the remainder of this chapter attempts to show, in simplistic terms, the relationship between surface ecosystems and those of the subterranean with an emphasis on groundwater drawdown in the high rainfall areas of Gippsland and the Otway Ranges.



The pressure head from the aquifer is shown as the dotted red line. The intake for an aquifer can be kilometres away and in the Gippsland and Otway Ranges cases cited here, the recharge intake areas are generally accepted as being located in the hills, mountains and higher country.



In this scenario when the ecosystem is in its natural state the underground healthy ecosystems connect and interact with and maintain healthy surface ecosystems.

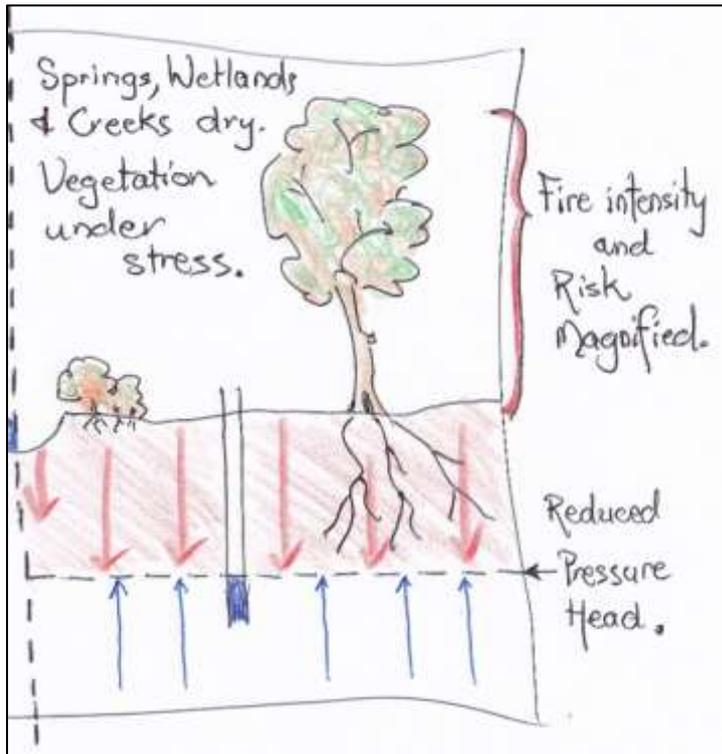
With no human manipulation or interference a fairly equilibrium state in nature has been established. If nature is allowed to take its course any change in this state is, in most cases, slow. In days gone past this change was barely recognised from one human generation to the next. Of course, volcanic, earthquake and other natural disasters are the exception.

Thrown into Turmoil.

But, once man begins to interfere with the underground ecosystems the balance established over eons is thrown into turmoil. Subterranean gas and fluid extraction at any level begins to upset this natural balance and the fluctuations in groundwater levels are thrown out of balance. Upward vertical leakage into the surface ecosystems can be reversed and surface waters will then leak downwards. Not only is there a change in the direction of the vertical leakage, impact can spread horizontally out over an area distant from any springs, wetlands, creeks and rivers.

Impact Spreads.

In the case of groundwater extraction from the Barwon Downs Borefield in the Otway Ranges the area of impact has spread over an area of at least 480 km². As for the Gippsland area, the area of impact from groundwater extraction and or depressurisation has not been calculated.



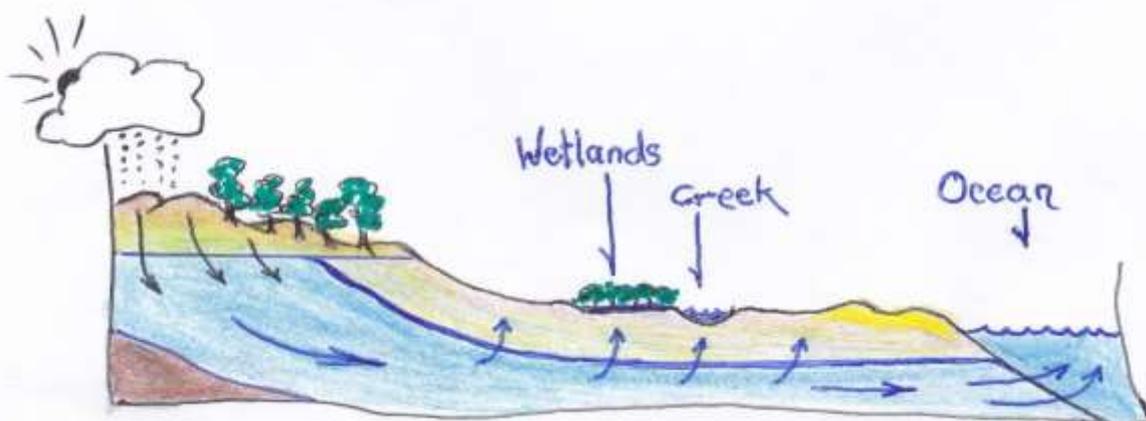
Reversal of Leakage.

When the upward vertical leakage is reversed downward, a multitude of problems at the surface can manifest. Chapter Three (see page 15) lists some of these.

Changes that take place can start within hours or may take decades, and, may not manifest until long after human interference ceases.⁽⁵⁾

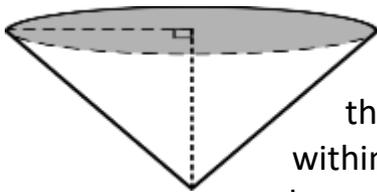
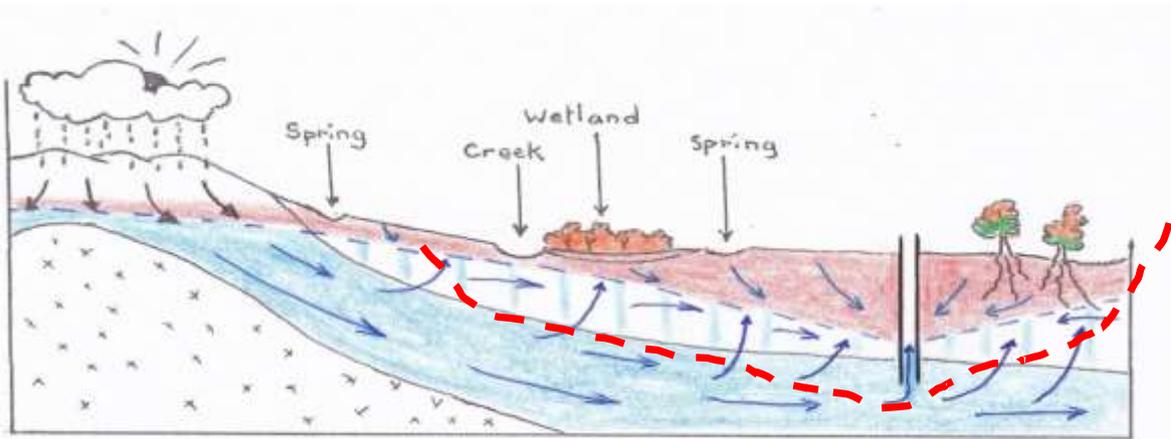
As a matter of consequence the groundwater levels throughout the area of

drawdown influence begin to drop, depressurise and the depth of the unsaturated zone increases. The natural balance of the surface and subterranean ecosystems in the recharge areas begin to change and if the process is allowed to continue this is the first step to desert creation. The recharge areas can be distant and are usually at a higher level to discharge points.



Discharge Offshore.

Besides the discharge from aquifers to springs, creeks, rivers and wetlands onshore, the Gippsland and Gellibrand Basin aquifers discharge freshwater offshore into the ocean.



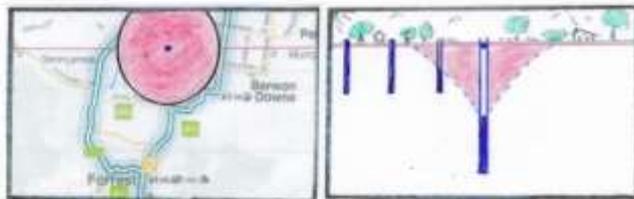
The area of impact from groundfluid extraction can spread out like an ice-cream cone and has an impact on the **surface** and **subterranean underground** ecosystems area within this cone. The ever changing pressure head follows the underground verges of the cone of depression (red line above).

Surface waters that no longer flow out of the area can have far reaching impact.

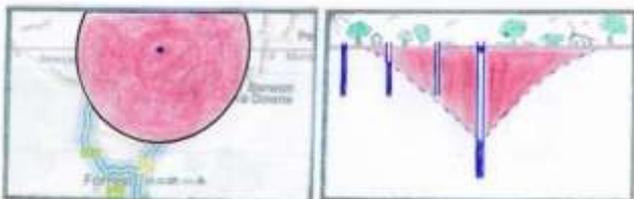


Initial Low level of impact.

Extraction bore.



Water Vapour density.
The atmospheric water vapour density within the surface cone of depression is reduced as the area dries out. None more so than the density around forests and other vegetation. This mini water cycle where vegetation takes in moisture and then releases it later to the atmosphere, is disrupted (see page 8).

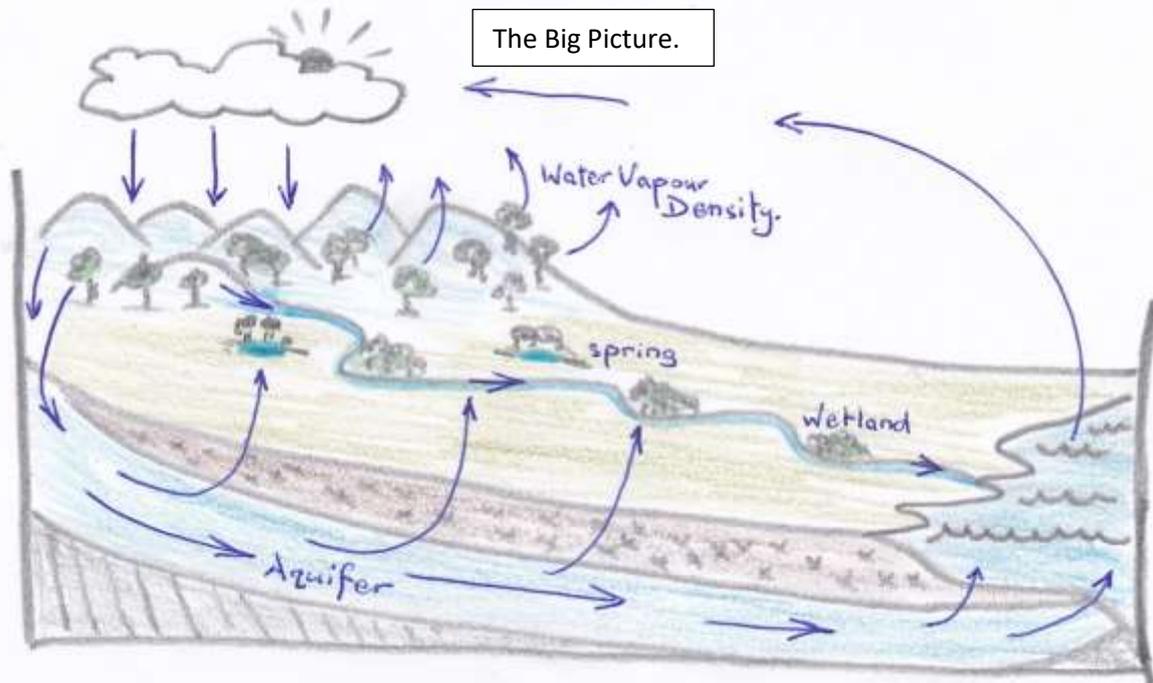


The subterranean impact increases with every extraction that is greater than the recharge ability of the aquifer.

The surface area and level of impact also increases as more fluid is extracted.

The Water Cycles.

At school we learn about the water cycle and the impression given in the most rudimentary fashion is that there is only one water cycle. In fact there are numerous mini water cycles that contribute to the “big picture” water cycle.



In this picture the water falls from the sky replenishing aquifers, surface lakes, creeks and rivers that flow to the sea. Evaporation from surface structures, vegetation and the ocean rise into the air and form clouds. The clouds then condense and start the cycle again.



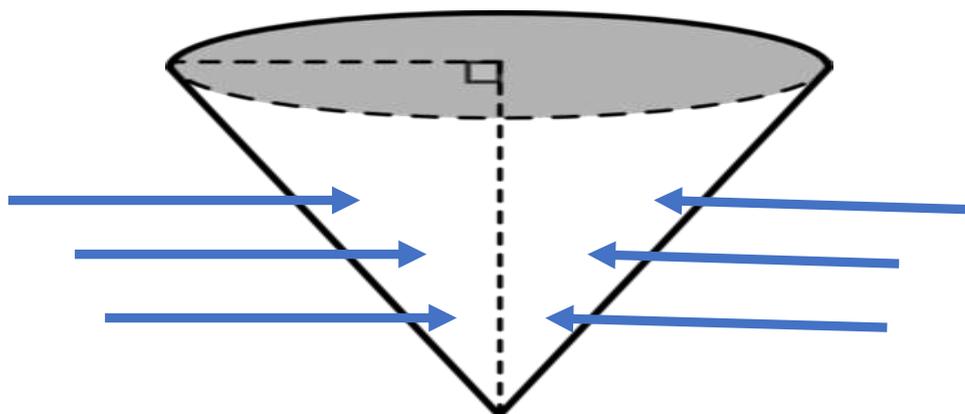
A mini water cycle that can be disrupted and relevant to fire, is the one involving vegetation. Decreased rainfall and or the lowering of an aquifer changes this cycle creating stressed and vulnerable vegetation susceptible to disease, pathogen attack, death and a shift to a drier opportunistic vegetation class. This changing vegetation community increases the likelihood of fire, elevates risk, intensity and duration and alters wildfire behaviour patterns.

Stressed and Changing vegetation; decreasing atmospheric water vapour density; with wetlands, springs and creeks drying up, creates a toxic fire prone cocktail.

The following letter looks at this part of the water cycle from a very similar angle.



Salt Water Intrusion and An Ever Expanding Surface Area of Impact.



Even after groundwater extraction ceases water is drawn into the depleted aquifer from all subterranean ecosystems around the cone. In the Gippsland case the fluid extraction is continuing and the cone of influence is expanding with the likelihood of salt water intrusion becoming a distinct possibility. The

cone of depression could be spreading kilometres out to sea. The surface area of impact increases and may continue to do so for decades even after liquid extraction ceases.⁽⁵⁾

How far the cone of depression extends onshore and offshore in the Onshore Natural Gas Studies of the Gippsland and Otway Basin regions, is anyone's guess, as there appears to be no monitoring or reporting of this phenomenon.

Numerous Data Gaps Exist.

As late as 2015 these reports made mention of numerous data gaps.⁽²⁾⁽³⁾

“This assessment has identified a number of areas of data uncertainty and data gaps.”

“Throughout the report many areas of uncertainty have been discussed. Relatively little is known of the hydraulic properties of...”

“The risk of land subsidence is evaluated based on parameters for compaction. These parameters are known at few locations.”

“There has been limited investigation into the hydraulic connection between...”

“...may suggest a conduit for upward groundwater movement.”

“...possible interaction between the aquifer and the lakes.”

“...there has been little investigation...”

“...is not well known...”

In the 2015 Onshore Natural Gas Study - Gippsland Region Assessment of Potential Impacts on Water Resources,⁽³⁾ the word “*likely*” is used 66 times and the word “*unlikely*” mentioned 19 times. Huge data gaps exist and little has been done to fill these gaps.

The Onshore Natural Gas Studies also relied heavily on inference, assumption and informed guesswork. Much of the research was conducted in very localised areas and results then generalised across the region.

SUMMARY of Chapter One.

A relative stable equilibrium with onshore and offshore groundwater parameters is reached after eons of time. Any human activity that upsets this balance begins to have detrimental impacts. The impact can be isolated, small or large and manifested over an ever increasing surface and subterranean area.

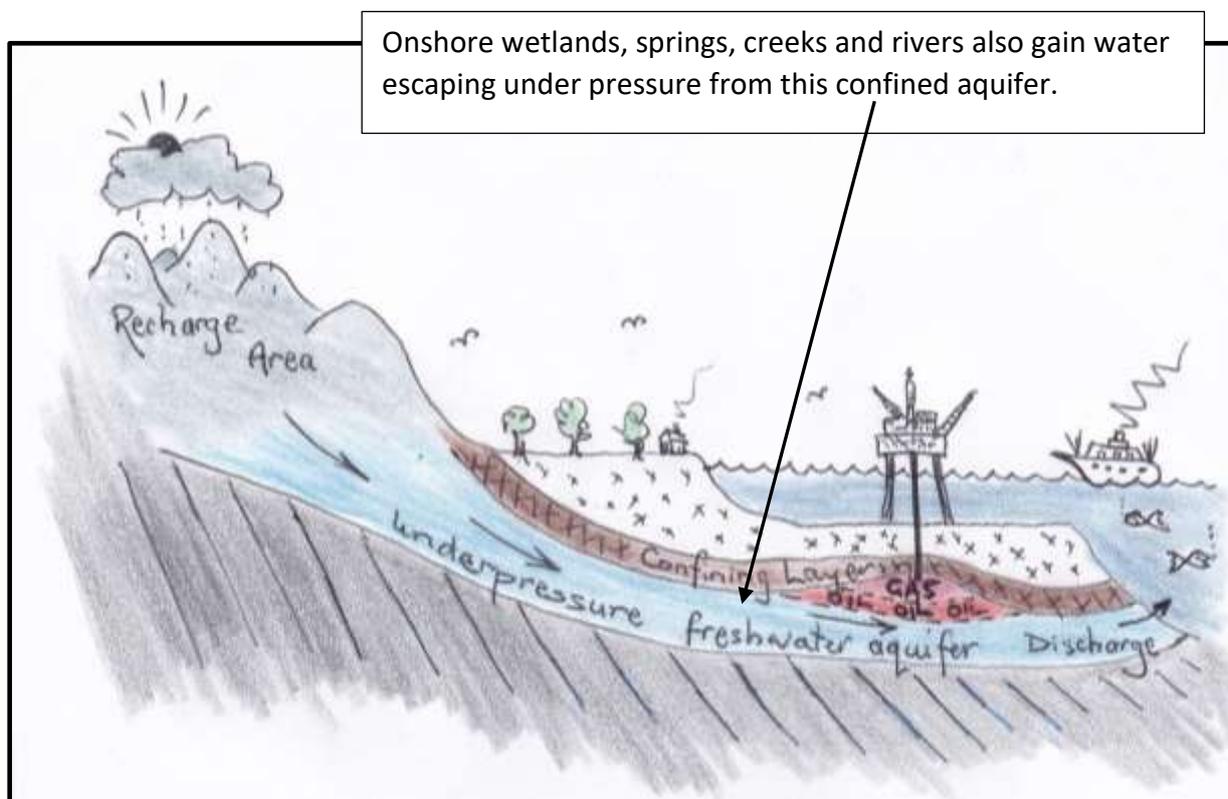
Drawdown and depressurising of aquifers increases the risk, the intensity and duration of fire. Where there is a salt-water interface salinity contamination of the freshwater aquifer will occur. Subsidence is also a distinct possibility.

The science of hydrogeology and hydrology of subterranean ecosystems has an element of guess work and assumption making this a relatively inaccurate science.

CHAPTER TWO

– Conventional Gas & Oil Extraction.

Much has been written about the problems with unconventional gas (fracking being one form with tight, shale and coal seam gas extraction) but conventional gas impacts seem to have “slipped under the radar” and been granted status as an acceptable alternative. This chapter attempts to explain some of the processes taking place with offshore conventional gas extraction and how it has impacts onshore.



Offshore in Bass Strait, pockets of gas and oil have been trapped under confining layers of earth. In general terms if oil and water are also confined under this layer the gas sits on top of the oil and the oil sits above the water. In most cases the gas, oil and water are under enormous pressure. Extract the gas and or oil and the water pressure decreases as it moves into the void created by the removal of gas and oil. This causes the water levels to depressurise or fall throughout the aquifer’s range both onshore and offshore. Also, the interface between the fresh aquifer water and salt water will change (see Chapter 3, page 15).

Conventional gas is extracted using traditional drilling, pumping and compression techniques. The gas can be extracted either through naturally occurring pressure or via pumping mechanisms.

Local Knowledge.

Long time onshore drilling contractor with 37 years on the offshore rigs, Mick Osborne, retells some of his offshore experiences as Platform Supervisor. *“Initially the offshore wellfield extracted close to pure oil and surfaced under enormous pressure at around 3300 pounds per square inch at 215°F. This came from 3-4 km down. As time went by the ratio of oil to water decreased. Even at around 99% water and 1% oil it was profitable, although this has nearly come to an end. Around 1985 100 ML/day of water was being processed 365 days a year and dumped into the sea after processing.”*

Wet Gas.

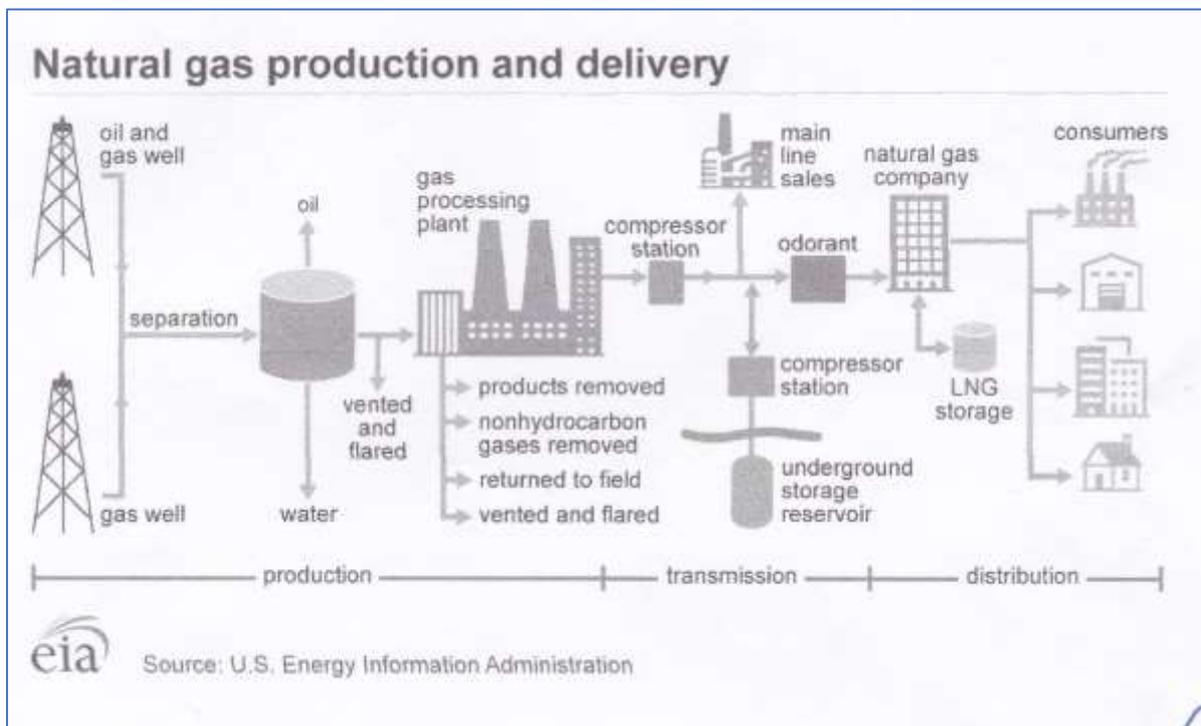
Wet gas contains little water and gets its name from the ethane, propane and butane that is present with the methane gas. Wet gas contains approximately 85% methane and other liquid natural gases that make the gas wet. Wet gas is much more valuable than straight methane.

There may be some condensate or water that can be present in the methane and or wet gas that is removed.

“Methane occurs naturally in groundwater...”⁽¹⁸⁾

“Methane occurs in very low concentrations in Otway Basin groundwater.”⁽¹⁸⁾

The following diagram displays the production, transition and distribution processes of gas and oil.



CHAPTER THREE

Impacts that Can Result from Subterranean Gas and Liquid Extraction.

Any subterranean extraction of water, gas or oil has an impact.

“All forms of natural gas development have the potential to impact groundwater users, surface water users and ecosystems as a result of aquifer depressurisation.”⁽²⁾ Whether the impacts resulting are regarded as sustainable depends on the degree to which humans are prepared to accept the resulting impacts. Consequently, whether extraction is regarded as sustainable or as a mining operation will depend on man’s tolerance to the impacts.

Some of the known impacts include:⁽¹¹⁾

1. Potential Acid Sulfate Soils turning into Actual Acid Sulfate Soil sites.
2. Wetlands, springs, creeks, streams and rivers drying up.
3. Stock and Domestic bore levels dropping.
4. Loss of artesian (free flowing) conditions.
5. Vegetation in the riparian zone that suffers mild to severe stress while hunting for moisture.
6. Water in the unsaturated zone beginning a downward movement following the falling water table level.
7. The sub soil moisture levels dropping; drying out and taking much longer to re-wet.
8. The creation of a *“Green Belt Delusion”* in peoples’ minds where spring and winter rains give an appearance at the surface that all is OK.
9. Changes that are often not recognised from one generation to the next. As described by Sir David Attenborough the Shifting Baseline Syndrome takes effect.⁽²⁸⁾ (See the definition on page108)
10. Land begins to subside. Land around the Hazelwood and Loy Yang coal mines has subsided by 2m as at 2015.⁽²⁾
11. Coastal subsidence may be involved.
12. Underground dynamics are disrupted and impact on stygofauna and subterranean ecosystems begins.
13. The relatively stable and equalised underground flowpaths and pressure system is disrupted creating different movement of waters including saline waters.
14. Underground flow paths of water can be changed and even reversed.
15. Any interface between seawater and fresh water will change polluting the freshwater aquifer. Saline intrusion. This seawater freshwater interface disruption can best be explained by this extract taken out of a paper written by W. J. Humphreys in a Special Edition of the Australian

Journal of Botany 2006,⁽¹⁾ where Humphreys describes the ***Ghyben Herzberg effect***.

“This expresses the relationship which occurs in near-coastal porous aquifers where fresh water overlies sea water; the depth below the sea level of the fresh water-salt water interface is c. 40 times the height of the water table above sea level. Thus, a minor drawdown of the groundwater can lead to a major intrusion of sea water into an aquifer where it may impinge on stygofauna as well as overlying or downstream groundwater-dependent ecosystems.”

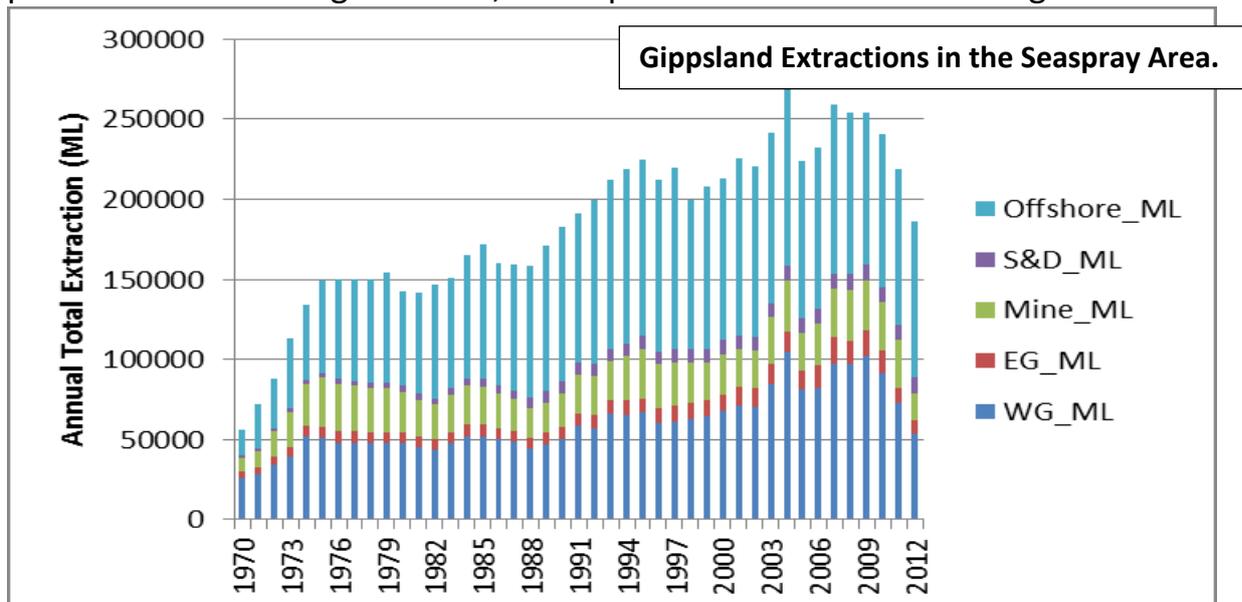
Not only would a minor drawdown create such a problem but so would the depressurisation of the fresh water aquifer.

16. Problems can begin immediately once groundwater extraction/disruption starts but may take decades to appear, even decades after extraction has ceased.
17. The buffering capacity of wetlands, springs, creeks and rivers against drought and climate change will be reduced and or eliminated.

Unfortunately, how these things interrelate, compounding impacts, are not yet fully known. Also, the full extent of problems created, solutions and knowledge of the subterranean, remain in the realm of a lot of scientific and technical guesswork and assumption.

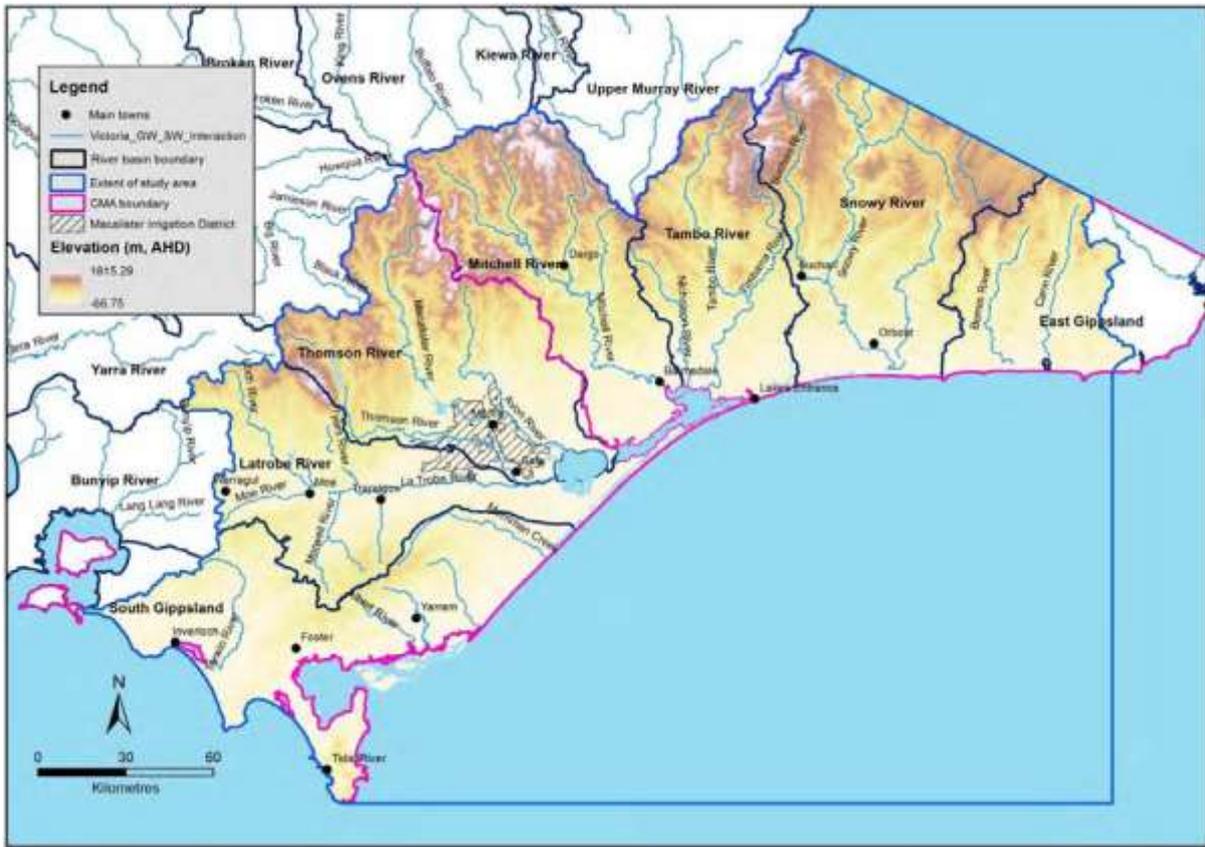
SUMMARY of Chapter Three.

Impacts that result from subterranean gas and liquid extraction. Some insight is gained into why the science of subterranean ecosystems including groundwater parameters relies on guesswork, assumptions and inexact modelling.

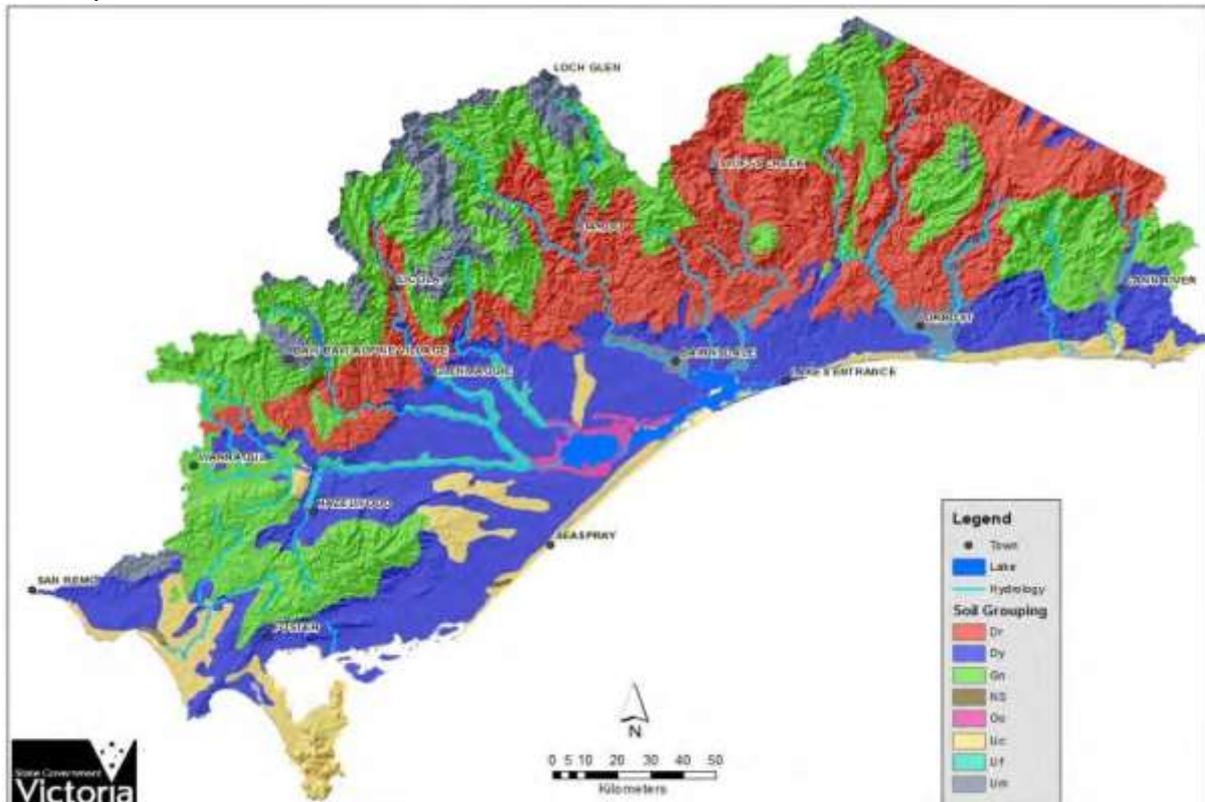


Annual total extraction (ML/yr) by contribution incorporated into the model.⁽⁴⁾

CHAPTER FOUR – Gippsland



River Systems⁽⁴⁾



Soil types⁽⁴⁾

Recharge – Discharge Processes in the Gippsland Region.

The diagram below on page 19, is a simplification of the geological structure of the Gippsland region taken from a Southern Rural Water document dated August 2016.⁽¹⁴⁾ The major subterranean water movements have been covered in this document.

1. The upward and downward vertical leakage movement of water,
2. the elevated recharge area of the deep Lower Tertiary Aquifer (LTA),
3. the discharge of the freshwater aquifers offshore, and
4. an explanation of what an aquifer and aquitard are.

One omission however, that should have been explained is that an aquitard can also be full of water. In which case the difference between a saturated aquifer and a saturated aquitard is that the aquitard **does not** release its water fast enough to suit man's bulk needs. Any water held in an aquitard is released very slowly. This release can be in an upward movement or it can release water in a downward motion when an aquifer below is depressurised or depleted. This slow movement of water in an aquitard is one reason why impacts can take some time to manifest.

In a water deprived surface region it could be argued that an aquitard even though it is slowly releasing small amounts of groundwater into a well, could be regarded as an aquifer.

An example of the water holding capacity of an aquitard can be demonstrated in the Otway Ranges. It was regarded that if the Lower Tertiary Aquifer (LTA) at the Barwon Downs Borefield was lowered enough the Narrawaturk Marl (aquitard) above, would be the major contributing factor replenishing the depleted LTA below. Water in the aquitard would begin to leak downwards.

“Leakage from the overlaying marls is likely to be the major source of recharge under stressed conditions.”⁽²³⁾

In a 2015 Gippsland region synthesis report⁽²⁾ it is interesting to note that a layer of rock holding groundwater can also be regarded as an aquifer.

“Groundwater is water that is stored under the ground within aquifers and aquitards. An aquifer is a layer of rock that is porous enough to hold groundwater and permeable enough to allow the groundwater to flow. An aquitard is a layer of rock that may hold groundwater, but is less permeable than an aquifer and therefore restricts groundwater flow. Groundwater can vary in quality from fresh to saline.” Perhaps this statement should have read ***“One form of aquifer is....”*** as there are many different forms of aquifers.

Aquifers in the Central Gippsland and Moe Groundwater Catchments

Groundwater is found in aquifers. An aquifer is a layer of fractured rock, gravel, sand or limestone below the ground that is porous enough to hold groundwater and allow it to flow. An aquitard is a layer of rock or clay that may hold some groundwater but is not porous enough to allow it to flow significantly.

The Gippsland Groundwater Atlas (SRW 2012) identifies and clearly describes the resources across the Gippsland groundwater catchment. The catchments can be broadly subdivided into three layers; the upper, middle and lower aquifers. The aquifer layers are generally separated from one another by aquitards. A cross section showing the relative position of the aquifer layers is provided in Figure 2.

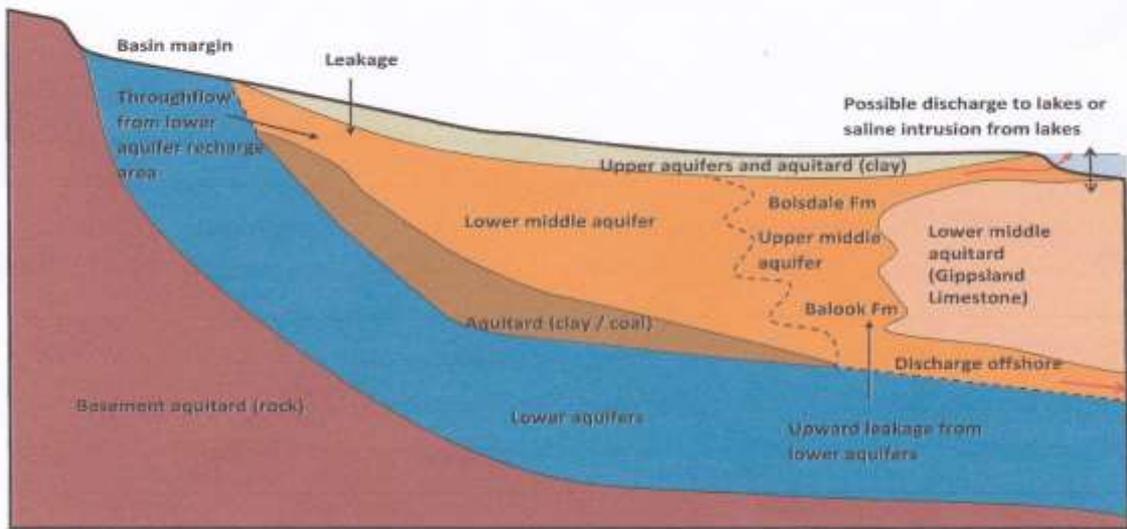
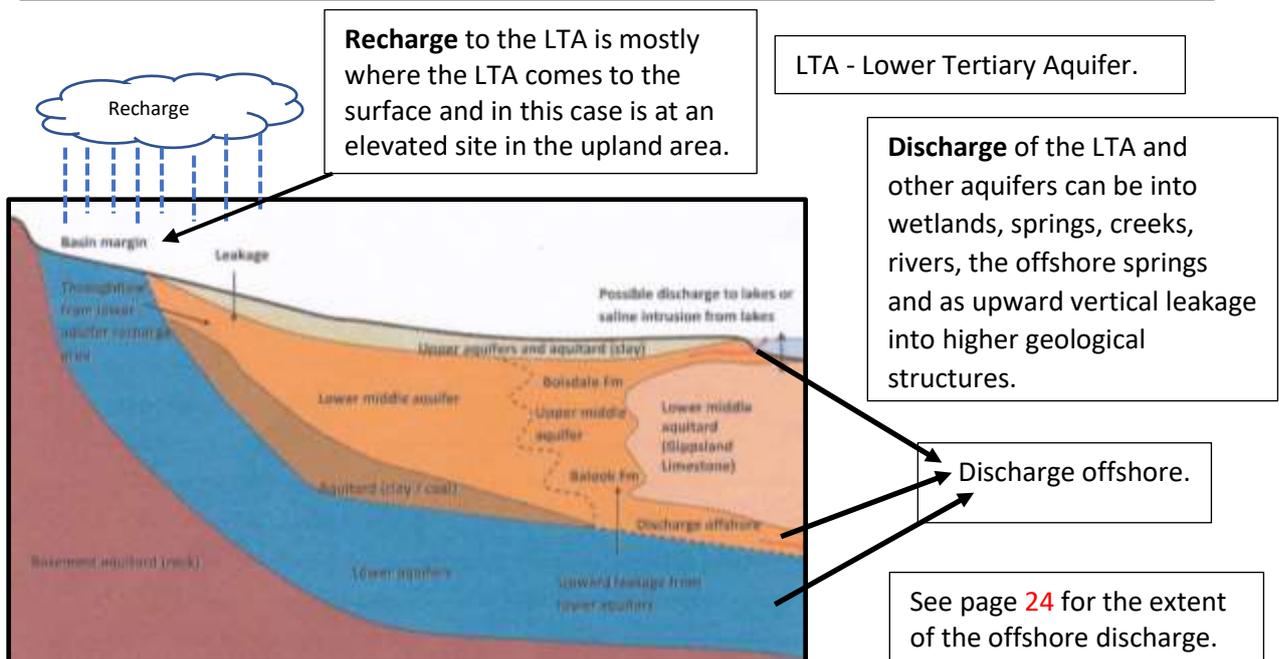
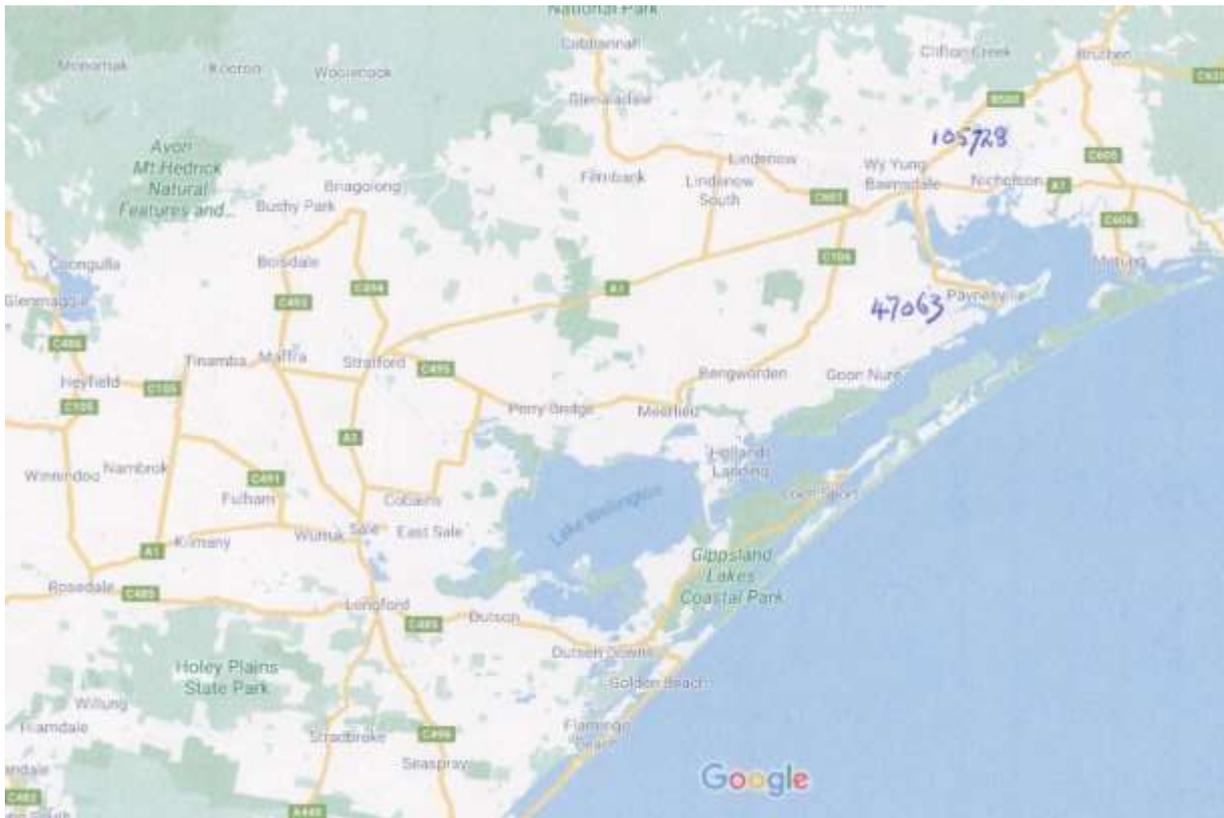


Figure 2 –Cross-section showing the relative position of the aquifer layers (taken from the "Gippsland Groundwater Atlas", p45, SRW, 2012)



Gippsland: showing the observation bore sites for bores 47063 and 105728.



Gippsland is an area of Victoria that has suffered from intensive gas and fluid extraction since the 1960's resulting in de-watering and de-pressurisation of the water tables in the onshore recharge and lowland areas, and, in the unsaturated zone of the subterranean. In effect the drying out of onshore surface and subterranean ecosystems has contributed to the impacts of drought and climate change adding to the susceptibility, intensity and duration of the fire risk period in the Gippsland region.

Compensation to Farmers.

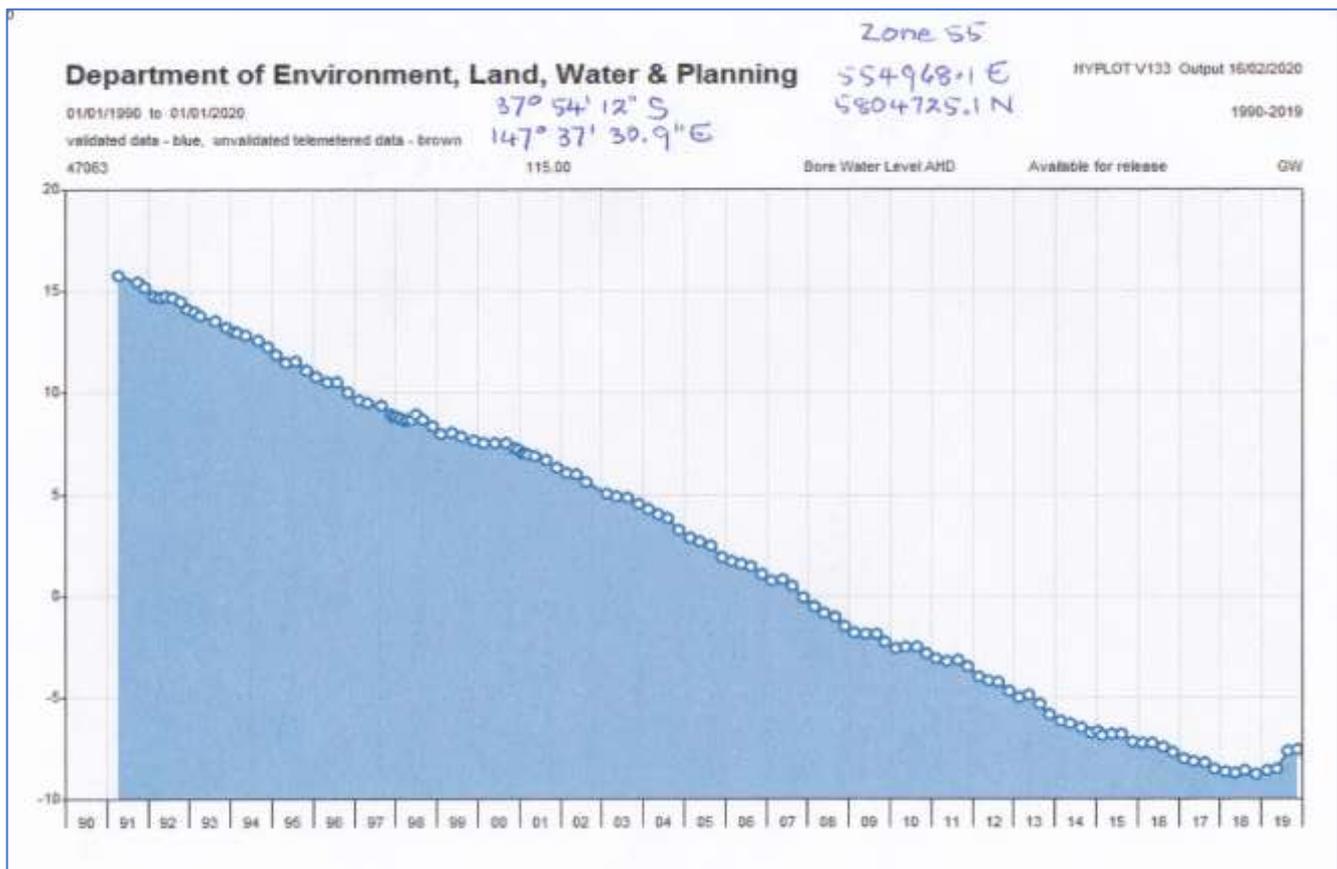
In 2008 the Victorian State Government Minister for Water, distributed a Media Release (Tuesday, 9 September) announcing a \$5 million dollar assistance package for Yarram Farmers (see Appendix One, page 96). It was seen as more economic to compensate the farmers to lower their infrastructure below the dropping water levels, than it was to have the gas and oil extractors re-pressurise the aquifers kilometres out to sea. One of the farmers involved in the compensation negotiations was told that the practice of offshore gas extraction overseas involved injecting the water separated from the gas and oil back into the subterranean structures. To do this in Bass Strait after the fact, would be far too costly. Gas extraction began in **1965**.

In a 2018-19 Southern Rural Water report the water was stated as still dropping at least a metre a year.⁽¹⁵⁾ This same farmer was told that when fluid extraction in Bass Strait/ stops, the aquifers will start to recover. But who knows how accurate this is as the same farmer was also told back in the early 2000's when compensation negotiations first started, that gas and oil extraction had created no impact on onshore aquifers. This same sentiment still exists today in some resource managers minds (see pages 54-55).

The 2008 compensation press release included these statements.

“Groundwater levels in the Latrobe Aquifer have been falling by approximately one metre annually for 30 years.”

“A CSRIO study found that the major cause of the falling groundwater levels was off-shore oil and gas extraction activities from the Commonwealth Government.” (See Appendix One, page 96)



This hydrograph for observation bore 47063 (see map location page 20) shows the type of fall the water table is experiencing. A downward trending decline.

In the Onshore Natural Gas Study, a Gippsland region synthesis report of 2015 states massive amounts of liquid were still being extracted offshore.

“...offshore oil and gas production extracts a water equivalent volume of approximately 100 000 ML per year.”⁽²⁾

Except for a few bores around Orbost, the hydrograph seen on this page, is on the extreme eastern edge of the data being collected in Gippsland (Observation Bore 105728). From here to the border there is an enormous data black hole.



Data Gaps and Inference.

There has been little data collected east along the coastal plains past this Observation Bore Number 105728. Even in the areas where data has been collected it is sketchy and full of gaps whereby statements and conclusions are too often based on speculation, inferences, assumptions and guesswork, with a notable absence of local knowledge and experience contribution.

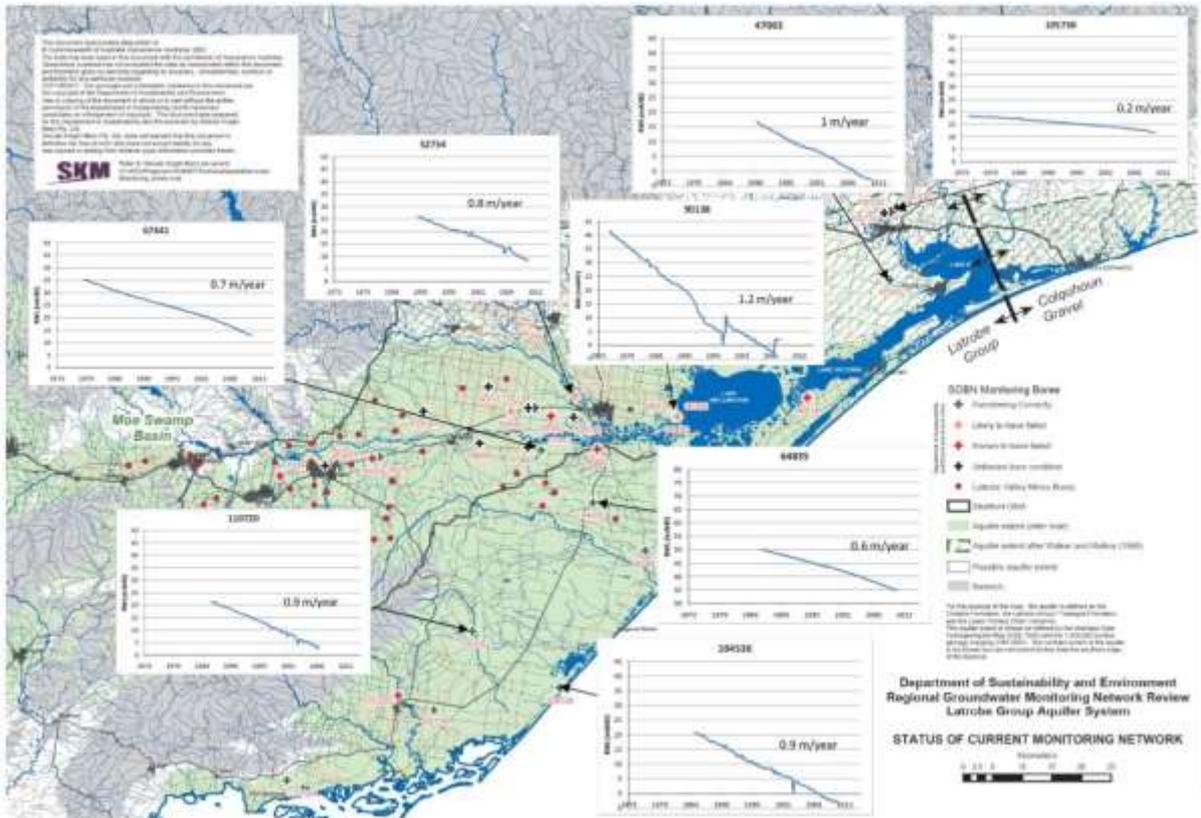


Figure 24: Location of hydrographs for the Lower Tertiary Aquifer, showing a consistent decline in potentiometric surface across the Gippsland Basin. (Source: Evans, 2011.)⁽⁶⁾

This figure dated 2011, shows a multitude of observation bore hydrographs showing the steady downward trend.

The 2004 CSIRO Report.

Before jumping forward to 2010 and looking at the Groundwater Management Plan for the Yarram/Seaspray area, it is important to go back to the 2004 CSIRO report⁽⁷⁾.

This 37 page CSIRO report⁽⁷⁾ was prompted due to concern for the dramatic water level falls over earlier decades in the Gippsland Basin district that was impacting on a number of industries including irrigators and other farming practices. It was also recognised that there was a potential impact on the wider community through land subsidence.

The Gippsland Basin extends, in equal proportions, onshore and offshore and there are three main aquifer systems within this basin with the potential to be impacted.

The CSIRO report makes it quite clear throughout the report that a lot more observable data needs to be collected and as a consequence my reading of the report suggests that some of the statements are “rubbery,” but, important

enough to justify a \$5 million compensation packet for farmers. It is also important to keep this “rubberiness” in mind when reading the following material taken from the CSIRO document.

Quite Disturbing.

However, despite this rubberiness the picture painted is quite disturbing.

- Liquid extraction estimates from the three major aquifer systems total approximately 120,000 ML/year.
- Inputs or recharge from rainfall to the same formations may be in the order of 80,000 ML/year. More liquid being extracted than replaced. This means groundwater has been mined for decades.
- Over the decade 1994-2004 discharge of freshwater from the aquifers to the continental shelf is assumed to be nil due to the reversal of aquifer flow. Fresh water is no longer discharging into Bass Strait. This seems quite amazing and hints at a salinity intrusion problem into the freshwater aquifers.
- Artesian levels have been lowered.
- When aquifer pressure levels were well above sea level there would have been upward vertical leakage. This upward leakage is part of the natural recharge mechanisms to overlying strata, but once the vertical leakage is reversed and is downwards, the overlying strata begins to dry out.
- Since extraction, certain amounts of upward leakage have been reversed to a downward vertical leakage depleting the water in these layers. Surface layers begin to dehydrate.
- In 1992 it was determined there was a freshwater/saltwater interface 40km offshore. No apparent recent report available.
- Impacts over time include:
 1. Coal mine dewatering
 2. Onshore water extraction for agricultural and industrial use, and
 3. Offshore hydrocarbon production.
- The high topography in the recharge areas appears to be a driving force influencing fluid flow.

Possible Explanations for Water Level Decline.

The 2004 CSIRO report discusses:

1. *Climate Change.*

The hypothesis that climate change was part responsible was looked at and the,

“...result fails to support the hypothesis of climate change” impact.

2. *Abstraction for Irrigation.*

“...indicates the extremely low likelihood that irrigation abstraction is influencing water levels at the regional level.”

3. Land Use Change leading to a reduction in aquifer recharge.

The report looked at the relationship between rainfall and land use with an emphasis on vegetation types, namely forests or plantations and annual pasture. The conclusion was that impact on recharge under these circumstances, would be minimal.

4. Open Cut Coal Mine Dewatering.

Although there are mine dewatering impacts on groundwater levels, it was found there was little likelihood that these declines in water tables were associated with the falls in the study area of the Seaspray Depression or the Yarram area. However, the mine dewatering has lowered the water table with a corresponding lowering of the pressure head in the recharge areas.

5. Offshore Extraction.

“Based on regional analysis, the widespread changes in the aquifer pressures and water levels, both in magnitude and pattern, are clearly associated to some large but geographically variable degree with offshore oil gas production. At locations such as Bairnsdale and the onshore part of the Seaspray Depression, no other hypothesis seems to even remotely explain observed declines.” Some of the findings this statement is based on pre-dates the development of significant irrigation extractions.

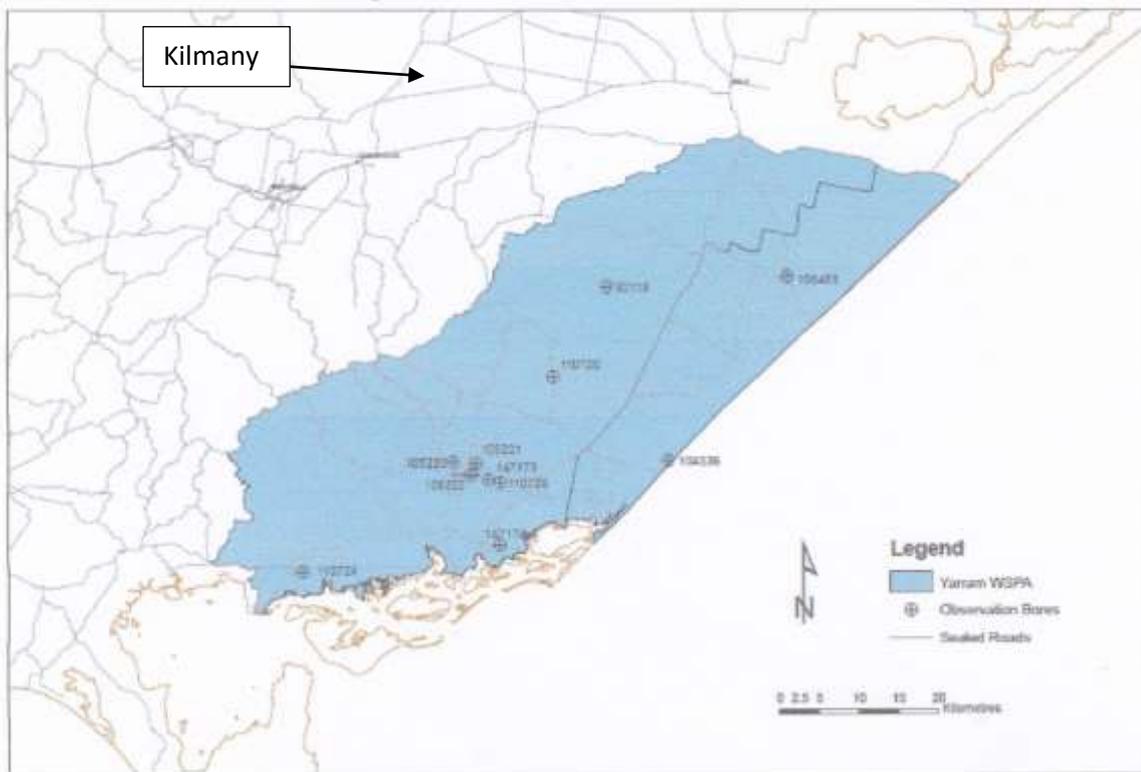
The Yarram Water Supply Protection Area (YWSPA).

Whatever the shortcomings placed on the 2004 CSIRO report due to any sparsity of data, the following things are beyond dispute.

- Water tables have significantly dropped.
“Groundwater levels in the WSPA have been in decline for approximately 40 years, mainly as a result of offshore fluid extraction from oil and gas production.”⁽¹³⁾ (WSPA – Water Supply Protection Area signed off by Minister Holding 14 October 2010).
- *“Water level declines are expected to continue in the WSPA, irrespective of the activities of groundwater users, due to offshore fluid extractions.”*⁽¹³⁾
- Recharge areas have been impacted proportionately.
“The WSPA also incorporates forested areas along the Strzelecki Ranges...”⁽¹³⁾
“The aquifers rely on recharge from rainfall and stream bed infiltration along their outcrops.”⁽¹³⁾

Schedule 3

Location of water monitoring bores within the Yarram WSPA



- 120,000 ML/year of fluid is being extracted from the region.
- Recharge back into the aquifer does not even come close to this level.
- Flowpaths of vertical water movement have been reversed.
- Subsidence has occurred.

The committee preparing the WSPA “*...was presented with sufficient evidence to conclude that over the last few decades the extraction of fluids (oil, gas and water) offshore for petroleum production has made a significant and consistent contribution to the decline of groundwater levels onshore.*”

The hydrograph from bore 105134 on the next page clearly shows this decline from an observation bore inland on the north east edge of the Yarram Water Supply Protection Area near Kilmany.



Water table Drop and Elevated Fire Risk.

Fluid extraction offshore from the Yarram/Seaspray region has been the major causal factor responsible for dropping the regional water table by one metre every year since the 1960s. This throws the natural balance of both the surface and subterranean ecosystems into turmoil. The interactions between microsystems and ways of functioning that have developed and stabilised over eons, get thrown into a state of chaos. As the sub soil dries out in the recharge areas the vegetation is placed under stress and begins to change. Forests in the high country and other intake recharge areas start to lose their ability to resist pathogen and insect attack. Basically their immune systems begin to break down. The evapotranspiration process changes contribute to the forested ecosystem drying out. The induced downward vertical leakage sees wetlands, springs, creeks and streams experience a gradual decrease in base flows. Over this 50 year period of change the fire risk rises as the water tables fall.

Mental Image of Gippsland.

People who can remember Gippsland back in the 1960s will no longer automatically create a mental image of *floods, always wet and some of the best dairying country in Victoria*. Fires and such destruction as witnessed in the summer of 2019/2020 would never have entered one's mind.

Climate Change and Land Use.

The argument being put in this book is that gas and fluid extraction have been significant contributing factors in the 2020 fire storms in Gippsland, through the drying out of subterranean and surface layers. This impact has to be included as one of the human induced factors with climate change.

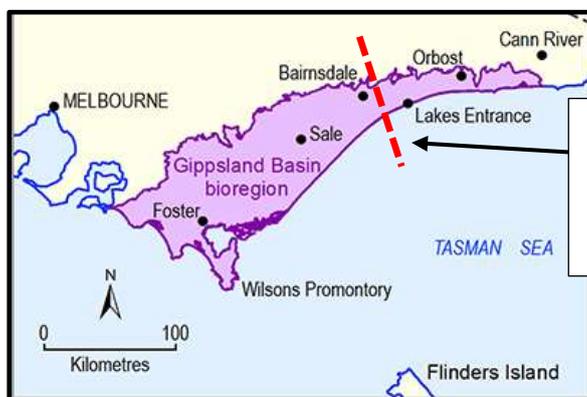
In 2010 this statement was written as part of the Gippsland Water Supply Protection Plan.⁽¹³⁾

“Other potential causes of groundwater level decline have been considered, such as climate change and land use change, but were found to have a relatively less a significant impact on groundwater recharge over the long term at a regional scale than fluid extraction.”⁽¹³⁾

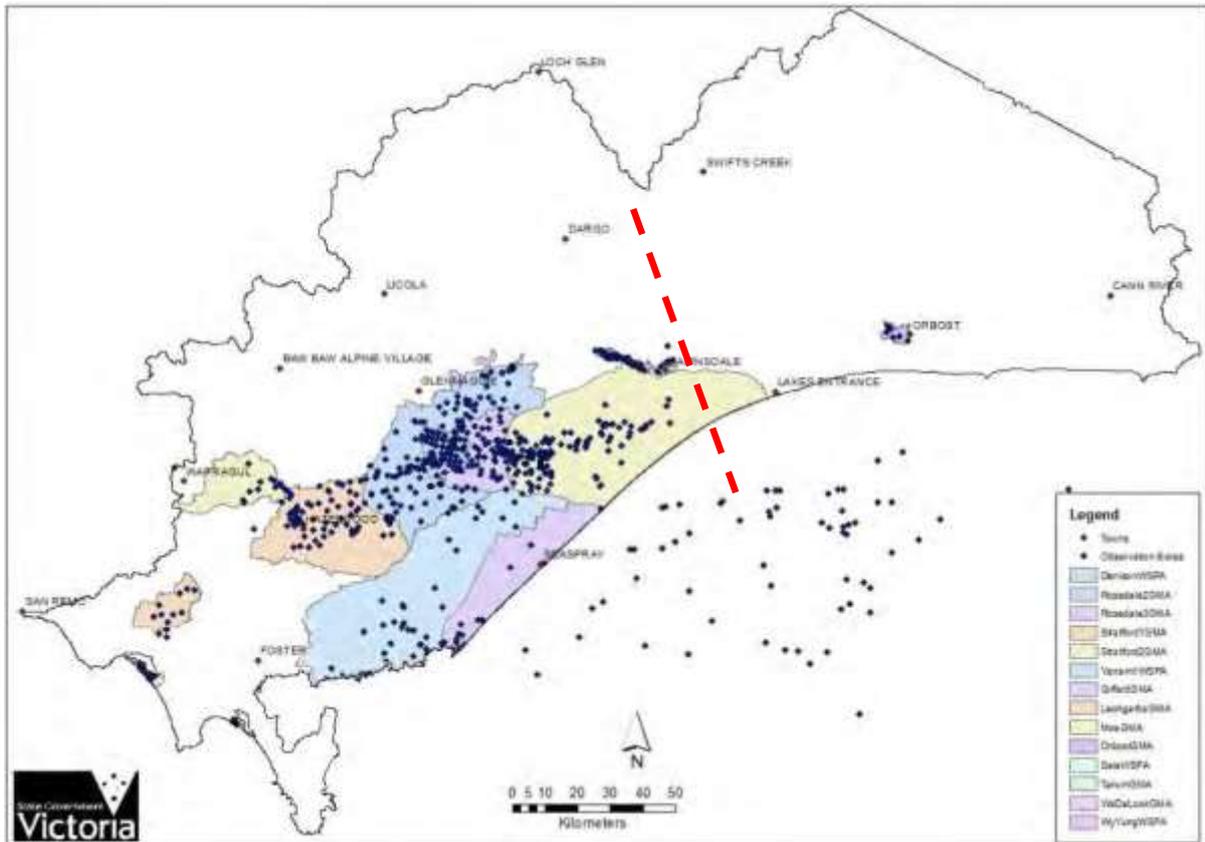
The Yarram/Seaspray drawdown impacts may seem removed from the fires in the easterly regions of Gippsland, but two things need to be kept in mind.

1. Studies have never been done along all of the onshore areas of the Gippsland Basin, and
2. ***the impact from fluid extraction does not stop at man made boundaries.***

What is being proposed here is subterranean fluid extractions from the Gippsland Basin is a contributing factor that heightens fire risk, intensity and duration. It may appear to be an oversimplification but the warning signs of a similar fate happening to the Otway Ranges is unfolding and subterranean gas and fluid extraction has to be recognised as a major contributing factor.



Very little observation bore data is taken past this point and as a consequence very little research if any has been conducted on groundwater drawdown in this area.



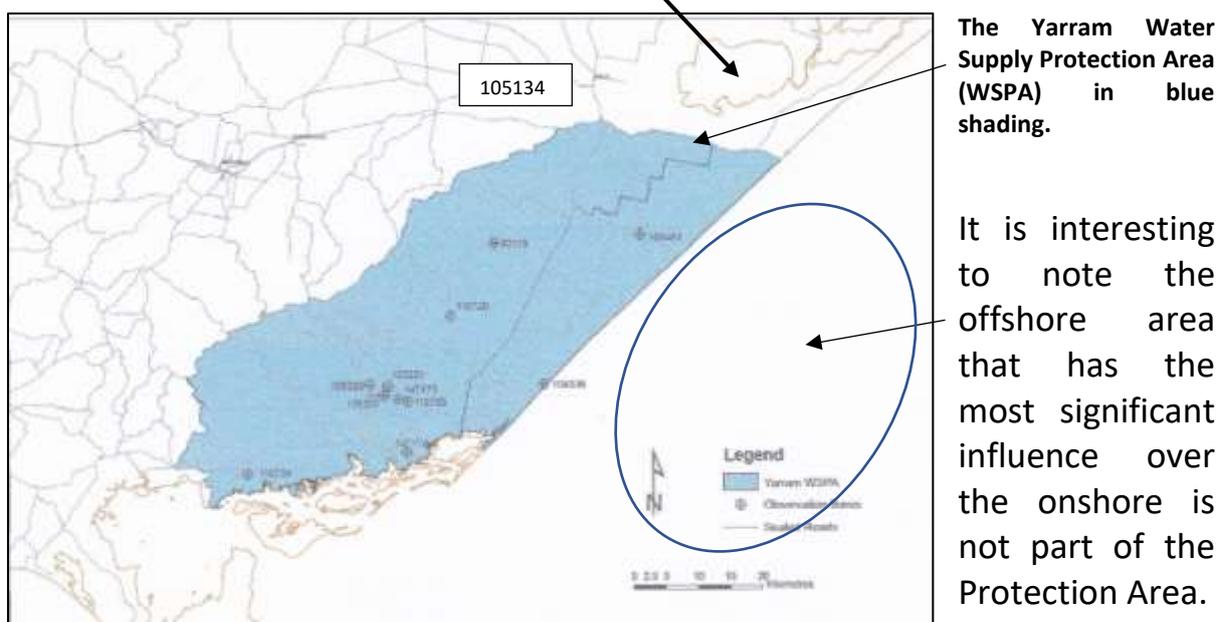
2015 Location of observation bores used for model calibration.⁽⁴⁾

“East Gippsland groundwater extraction estimates for the period 1970 to 1990 were derived based on the relative change as observed in the West Gippsland extraction for the same period with allowance for bore construction dates and entitlement volumes. This was required as limited monitored groundwater usage data was available for East Gippsland bores for the period 1970 to 1990.”⁽⁴⁾

The Figure above shows the observation bore network used for modelling purposes in 2015 and indicates very few observation points beyond Lakes Entrance. This type of extrapolation is extensively used when discussing East Gippsland. Local knowledge would have some chance of providing some accuracy, filling the data gaps regarding what has taken place in East Gippsland. Sadly little data gathering, no research and or collection of local knowledge and experience is being done.



This map gives an indication of the Bass Strait fluid extraction sites in the Gippsland Basin area of influence.



The Yarram Water Supply Protection Area (WSPA) in blue shading.

It is interesting to note the offshore area that has the most significant influence over the onshore is not part of the Protection Area.

A Few Short Comments on the 2018-2019 Yarram WSPA report.

1. ***“Monitoring and metering indicate no significant changes in the condition of the resource or water usage patterns, therefore, it is considered that the groundwater resources of the Yarram WSPA are being managed sustainably.”*** Amazing.

The water table is being drawn down one metre every year yet it is claimed that this is sustainable (see point 3 below). It would appear that the authors of the Yarram WSPA report are using the same definition of sustainable that used to be used by Barwon Water. This definition included the following as one of the criteria - ***if an***

extraction bore continues to produce water then it is sustainable irrespective of the consequences this extraction may be causing to other parts of the earth. Carrying out this type of extraction under this “old” definition has to be regarded as mining of the resource.

2. *“The objective of a management plan, as set out in the Act, is to make sure that the water resources of the area are managed in an equitable manner to ensure the long-term sustainability of those resources.”*

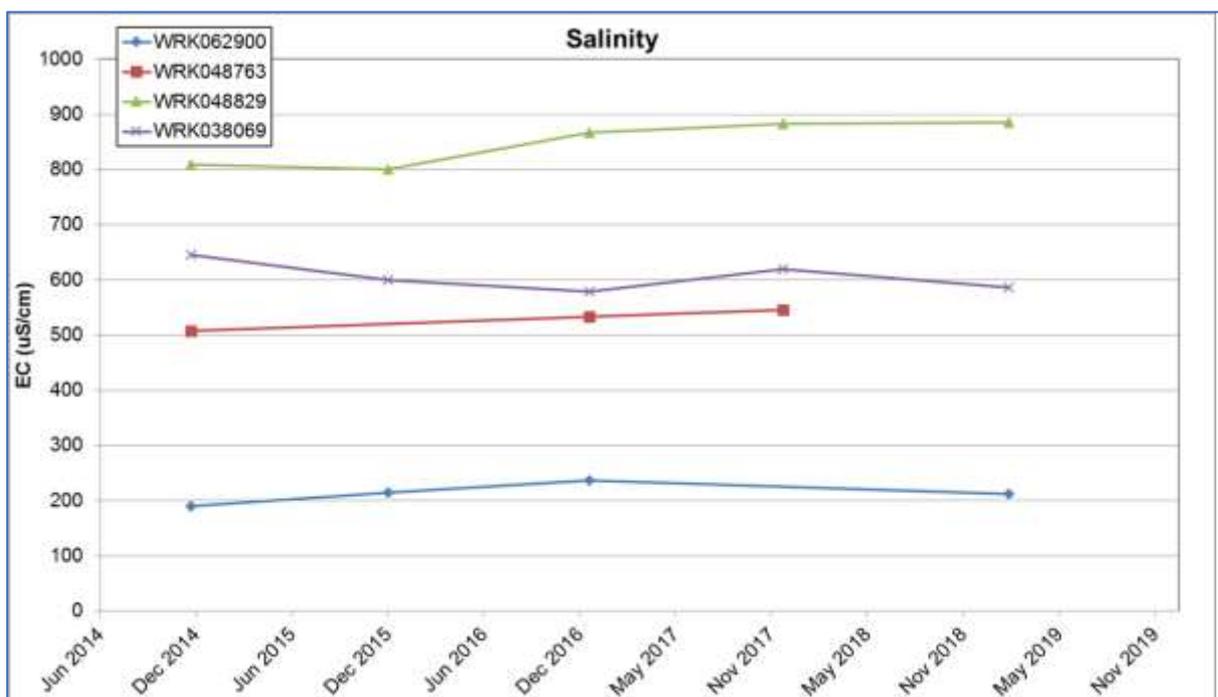
It would seem impossible to mount a convincing argument the environment is receiving an equitable share with a metre drop every year.

There would also appear to be a complete lack of regard for the intergenerational principle. It would also appear successive governments have failed to consider the long term ramifications of their decisions.

3. *“Groundwater levels in the Latrobe aquifer are primarily influenced by offshore extraction, with a secondary influence from localised groundwater pumping. Levels have been falling steadily by up to 1 metre per year since at least the early 1980’s.”*

This works out to be something in the order of 30-40 metres drawdown with no commentary on the surface area impacted from this drawdown.

4. *“Salinity is stable in three of the four bores. Bore WRK048763 is increasing trend over time, however the quality of this water is still very good, with no indication of issues from saline intrusion. This site*

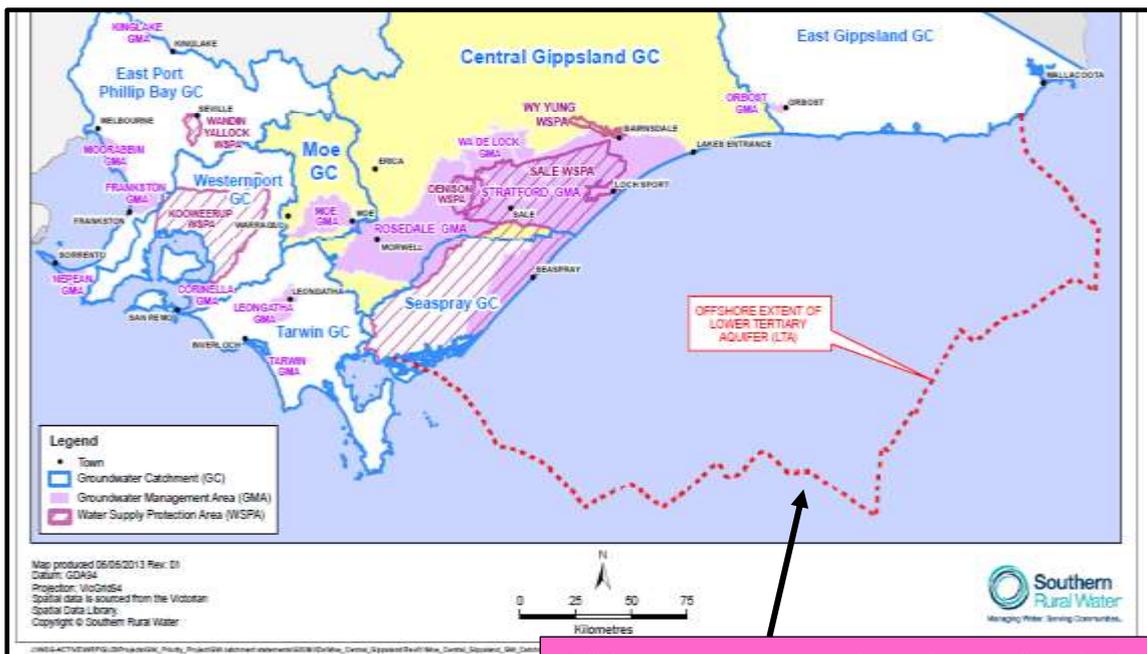


was not sampled this year due to OH&S issues with collecting a sample. SRW are considering options for future sampling events at this site.” (SWR - Southern Rural Water) The saline intrusion problem would first manifest in the aquifer kilometres out to sea. This is in an area not being monitored.

Also, there is at least another way to view this graph. Bore WRK048829 would appear to have a much stronger trend upwards in the salinity “stakes” than does the WRK048763. Why hasn’t this been commented on? It would appear this bore should have been the one focussed upon.

Also, what the OH&S problem was with the WRK048763 bore has not been explained. An OH&S problem seems quite unusual and does require some specific explanation.

Also, the question has to be asked is it adequate there are only four **onshore** bores measuring salt intrusion? There is no monitoring of the aquifers in the 40 km offshore section of the sea bed out to where the aquifers discharge. Salt intrusion would start there.



Taken from Southern Rural Water August 2016⁽¹⁸⁾

Offshore extent out to where the aquifers discharge. A DELWP officer Says this boundary could be **100-120km** offshore. See Appendix 3.

5. The Yarram Water Supply Protection Area only covers an onshore area.
6. The 2018 report states the following “...**examine interaction between groundwater, surface water and groundwater dependent ecosystems.**” However, there is nothing being reported or action

being proposed to carry out any such examination. This seems incredible considering the Yarram WSPA states that *“Declining groundwater levels may also impact on groundwater dependent ecosystems such as streams and wetlands.”* Chapter Five presents a case that the “may also” in this statement should actually be a *“definitely.”* No baseline data has been collected and places a further emphasis on why local knowledge and experience must be recorded.

7. *“Monitoring and metering indicate no significant changes in the condition of the resource or water usage patterns compared to previous years. The steady decline in pressures resulting from offshore extraction is continuing, however there are no reports of bore or groundwater access issues.”*

Considering there was a 5 million dollar payout to drop onshore bore infrastructure way below the dropping water table it is doubtful that there will be any groundwater access issues to those accessing the resource. The question remains what are the far reaching consequences and what are the environmental indicators suggesting? Reading the statements made by local identities emphasis the very narrow area of concerns referred to in the Yarram Water Supply Protection Area. Concerns other than bore or groundwater access within the Yarram WSPA should include the health of ecosystems and any other impact created within and outside the boundary indicated by the WSPA. *The consequences of fluid extraction do not conveniently follow man made boundaries.*

There would appear to be little argument that could be mounted against the claim that offshore gas extraction has and is continuing to have a dramatic impact on onshore environments.

SUMMARY of Chapter Four.

The extraction of gas and oil offshore along the Gippsland coast has created observable onshore impact and in one area has resulted in a \$5 million compensation to farmers. Onshore water tables have been and are continuing to drop one metre a year for over half a century. In 2004 climate change, farmer extractions and land use change were determined to have little influence on the one metre declines.

In 2019 State Government regulators, Southern Rural Water, maintain that groundwater resources are being managed sustainably and that salinity intrusion is not a problem.

CHAPTER FIVE

-Local Community Knowledge and Comment Around Lakes Entrance.

This Chapter looks at the area around Lakes Entrance and Lake Tyers where there is a significant absence of a State Observation Bore Network. Consequently local knowledge and experiences have to be called upon to make some judgement on the historical and long term conditions of wetlands, springs, creeks and rivers in the region. Sadly, to date very little to no acknowledgement, record or reference to local knowledge and experience can be found in any scientific or technical report on which Government policy has been based.

Page | 34

One way an environment can continue to be abused is to state that as there is no baseline data, reliable or otherwise, a “fresh” start is the only way to proceed. And, so kicks in the Shifting Baseline Syndrome. ⁽²⁸⁾ This is a disregard for what has happened in the past and the beginning of data collecting from the present day. Disregard for what has happened in the past allows the abuse to continue until some time in the future when the “fresh start” baseline data comparison results show an obvious and extreme impact, impacts that can not be ignored. Perhaps appropriate action will follow – perhaps.

Jack Whadcoat.

Eighty four year old Jack Whadcoat has lived in the Lake Tyers, Gippsland, Victoria region for his entire life (84 years) and has a very comprehensive historical “baseline” memory of surface water behaviour going back many decades. Jack sent the following text as an email.

1. *Nowa Nowa Township* At Nowa Nowa the creek is *Boggy Creek* which flows from the North through the Township out of the forest commencing in the foothills west of Buchan South. This creek was a permanent creek up to around the 1970's only ceasing to run in very dry years. Good quality water was stored in a small reservoir built on the creek North of the township and was reticulated to the town for their water supply. The creek gradually became unreliable in flow quantity around late 1970's. Over more recent years the flow into the reservoir gradually became intermittent and contaminated and consequently was replaced by a pipeline from the Lakes Entrance town water supply out of the Mitchell River. unsure of the date but probably about late 1990's.. Currently only substantial flows are happening after heavy rainfall. This creek flows into the headwaters of Lake Tyers waterway and during heavy rains is the main supply of flood water to break the lake open to the sea for a short time until the sand bar closes up and the lake rises again.

2. **Ironstone Creek.** This creek East of Nowa Nowa enters the Lake Tyers waterway approx. 2klm downstream of the township its source is to the East of Nowa Nowa in the foothills near Wairewa settlement. Flowing strongly only after heavy rains it did in earlier years flow almost constantly but of little consequence to filling Lake Tyers waterway. It has become drier I believe starting also around the 1970's
3. **Stoney Creek.** This creek flows into Toorloo Arm of Lake Tyers waterway which is the western branch of this system. Up until probably the 1970's, the creek flowed all year round except during drought years and was used sparingly to water the farms and animals around the Toorloo Arm settlement.
4. **Casey Creek.** Where Stoney Creek enters Lake Tyers at Toorloo Arm it joins with **Casey Creek** a small creek of little consequence flowing from the south out of forest country. Only a minor creek it did though supply a farm with a small amount of water for irrigation on a limited timeline. Sometimes flowing more substantially during heavy rains. It is now almost constantly dry.
5. **Ewing's Marsh.** A wetland of Heritage importance and Gazetted as a Nature Reserve. Situated between the sand hummocks of the Ninety Mile Beach and the hinterland hills east of Lake Tyers waterway. Fed by several small creeks from the north it had remained moist most of the year and is still considered of importance as habitat for many water birds migrating into the Ramsar site at Lake Tyers. In early times it was wet mostly all year round but since the late 1970's it is more often now dry. This marsh during flood times can flow East towards the Snowy river wetlands near Marlo but can overtop into Lake Tyers and more likely simply drains through the sand barrier directly into the ocean at Pettman's Beach where access to the beach is provided for pedestrian traffic and camping.
6. **Bunga Creek.** This is a separate tributary between Lake Tyers and Lakes Entrance townships and is to the east of the Bunga Creek Township. It was a venue for good Black Bream and Flathead fishing in the early years and the water was of high quality. Now the system is very small and the water appears of low quality with low fish

numbers. The township is built parallel to the creek and overlooking the steep banks west of the waterway. Town storm water and runoff going directly to the lake. It is only spasmodically open to the sea. Before the Manmade entrance to the Gippsland Lakes was built, the mouth of Lake Bunga ran directly into the old Gippsland Lakes channel mouth. The lake is fed by **Bunga Creek** which feeds out of the Colquhoun forest North of Lakes Entrance township. Springs fed this creek in amongst the forest and mostly trickled constantly into the lake system below the Princess highway. The rubbish tip for the local town here is situated approx. 1½ kmls above the Princes Highway and is built over the actual creek bed. Runoff from the tip is contained within earthen banks and is automatically pumped back up stream over the tip site when filled. The creek in early times ran lightly, fed by springs within the forest but now has mostly dried since the 1970's except after heavy rains. Most of the springs now are dry. A farm owner in the 1970's built a large dam below the tip property which is used for irrigation over their farm and is filled from runoff from Bunga Creek.

7. **Lake Tyers Beach Township.** A private bore was put down when the owners of a small Camping Park and Resort, was built at the entrance to the town of Lake Tyers Beach on the coast side of the Lake Tyers Beach Road. Used for all but drinking water it also supplied by agreement water to a neighbour for farm use such as cattle watering. Believed to be still operating but cannot be sure.
8. **Water Bore overlooking No 2 Boat Ramp Lake Tyers Beach.** On a farming property overlooking the channel to the sea at Lake Tyers Beach known as Kent's farm the owners in the 1950's put down a water bore to irrigate a passionfruit orchard. There they struck potable water for their project at what I believe to be 450ft depth. When the orchard failed, they used this water for cattle after turning the farm to grazing. The bore was capped during a government campaign to reduce the number of bores in use around the 1970's.

Fisherman's Landing Arm and catchment. In the 1950's my wife and I share farmed for seven years, a property of 50 Dairy cows for the Kent family business along the Mill Point Road of Lake Tyers, (Toorloo Arm). It was part of the area where my family settled after arriving

here from England and Scotland in 1912. I recall the interesting stories being told about the regions wonderful bushland setting with lush vegetation and gullies with running water having bird and animals abounding. Bushland towards the beach area had rich forest vegetation. The trees were spaced fairly open allowing a horse rider to gallop through chasing wallabies with ease. The undergrowth was low and little bracken fern existed. Seasons were mostly well fed with rain however exceptions did bring droughts but not often. Regular deliberate firing over the years has changed that forest to a bracken fern and low scrub dominated understory and now the larger trees of Stringy Bark are gradually dying out. The Western most branch of the Lake Tyers Waterway is called Fisherman's Landing Arm and is fed by a catchment heading North into what is now the Lake Tyers State Forest. In early years the small permanent creek had small deep pools along its length which held Black fish. I remember having to cross a small bridge to get the dairy cow's home for milking when I share farmed that 50 head with the Kent family. This creek was the main source of water for the cows in those times of the 1950's. From around the 1970's this creek (no name) is now dry most of the year except in flood times.

9. **Spring waters.** A high quality fresh water spring was running high quality cold water all year situated on the bush block opposite the Toorloo Arm school on what is now the Lake Tyers Beach recreation reserve. In the 1940'/50's era when my father who was farming close by, he was able to collect fresh potable water from this spring in the summer months. A horse drawn sledge with a 44-gallon drum attached was filled quite quickly for home and farm animal purposes. Around the spring grew thick Ti-Tree. The 1970's, saw subdivision and clearing around this spring and now has caused it to cease running completely and the vegetation has gone.

Closing comments.

From my observation, seasons have changed and become much dryer, especially around the December/January periods. Where I was able to grow a good home garden of vegetables and flowers with just rain water collected in galvanised iron tanks this is now untenable as good rains are very unreliable.

As the gas and Oil industry constantly drain off their product it seems to me that the rock structure will crush and this could (most probably will) result in coastal subsidence. It will also cause the water table inland to drop as they empty the reservoir to the south of the mainland.

Certainly, my observations indicate a much drier region for this East Gippsland area which in turn must result in extended fire regimes. Even the extent of forest reduction by logging will lower the rainfall resulting in probable more severe conditions for the remaining forests and drier catchment inevitable less runoff to the Gippsland Lakes.

All this must result in the water table being drastically stressed. Popular talk within the communities is Climate Change related in many circles and unless drastic measures are implemented then our future prosperity is greatly threatened.

*There are several studies and reports on land subsidence, township inundation, along the eastern seaboard which are publicly available on the internet. **Coastal Towns subsidence reports** start in 1993 and have continued up to the present.*

Mal, I hope some of the above information is of assistance to you in your project and would be interested to keep in touch.

Thank you for your welcome contact.

Kind regards

Jack Whadcoat.

(01-03-2020)

Accounts such as Jack's need to be recorded and should play a significant part in the composition of baseline data on which present day decisions are made.

As of October 2019 there were 23 platforms operating in Bass Strait with more scheduled to begin extraction of fluid in 2021. The first rigs began extraction in the 1960s and as determined in the 2004 CSIRO report⁽⁷⁾ the resulting impact on onshore groundwater levels has been significant.

There may well be very little "official" groundwater level data that has been collected around the Lake Tyers area, but, after reading the account of Jack Whadcoat's historical knowledge there would appear to be many pointers indicating impact on receptors reliant on the pre Bass Strait oil and gas extraction groundwater levels.

Historically Jack recalls that decades earlier there was:

“...lush vegetation and gullies with running water having bird and animals abounding.”

“...had rich forest vegetation.”

Springs in the area maintained a “trickle” and or “A high quality fresh water spring was running high quality cold water all year...”

“In the early years the small permanent creek had small deep pools along its length.” And, the creeks maintained a permanent flow.

By the late 1970s-1980s changes were observable.

As the water table was dropped *“It is now almost constantly dry.”*

“...wet mostly all year round but since the late 1970’s it is more often now dry.”

“From around the 1970’s this creek (no name) is now dry most of the year except in flood times.”

“Most of the springs are now dry.”

FIRE.

What is most pertinent in relation to heightened fire risk is Jack’s reference to the high country vegetation.

“Springs fed this creek in amongst the forest...”

“...hinterland hills...”

“...fed by springs within the forest...”

“...commencing in the foothills...”

“...and now larger trees of Stringy Bark are gradually dying out.”

As the water table drops all vegetation within this area of influence begins to be impacted. The longer the water table drop is maintained and or increased the bigger the impact. Vegetation changes could be immediate or may be gradual and take decades to materialise. As the vegetation goes from a “*lush vegetation*” in gullies and forest with water flowing from permanent springs and creeks to a drier and ephemeral one, the conditions and the dynamics of fire behaviour change.

Further Investigation.

There are a multitude of things that require further investigation and can best be highlighted posing questions such as:

1. How have the fire dynamics changed?
2. How has the Lake Tyers RAMSAR site been impacted from outside influences?
3. Is there any “officially” accepted data on water table levels from this area.

4. Has local knowledge other than Jack's been recorded?
5. Has "elderly" forestry workers' (State employed & timber industry) knowledge been recorded?
6. Should this local knowledge be collected?
7. Has any local knowledge that has been collected been analysed and reported upon?
8. Where exactly is the recharge area to the water tables in the area?
9. What changes have taken place in vegetation over the years in the recharge area?

In light of the Gippsland wildfires of 2019-2020 the answers to the above questions are applicable to the whole of Gippsland not just where the fires impacted. It is important that fluid extraction onshore and offshore in the Gippsland area is either recognised as one of the contributing factors to climate change, or ruled out as a factor.

Difficulty Recognising Gradual Change.

Gradual change is much harder to recognise and almost impossible for successive generations to notice. However, when changes do materialise it is easier to ignore the change and or explain the situation in such a way that it masks the problem. The best example of this is providing Yarram Water Supply Protection Area farmers with a \$5 million package to drop their groundwater infrastructure low enough to withstand the one metre a year drop in water tables. Their pumps can keep pumping and the immediate concerns and difficulties for the farmers are "bandaided." But, is the problem resolved?

SUMMARY of Chapter Five.

This Chapter relates one man's historical knowledge and experiences of surface and groundwater decline in the Lake Tyers region going back decades, with a sharp decline observed shortly after offshore gas extraction began in Bass Strait.

The Chapter also argues that local knowledge and experience should be recorded and be instrumental in future water resource and fire management decisions.

Chapter Six – Gippsland Peat Wetlands.

A. Coastal Peat Wetlands.

http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/soil_acid_sulfate_soils

This website discusses and identifies peat sites along the Victorian Gippsland coastal areas up to an elevation of 10 metres. With the exception of some Alpine peats the in between inland peat wetland sites have not been investigated, or mapped. However,

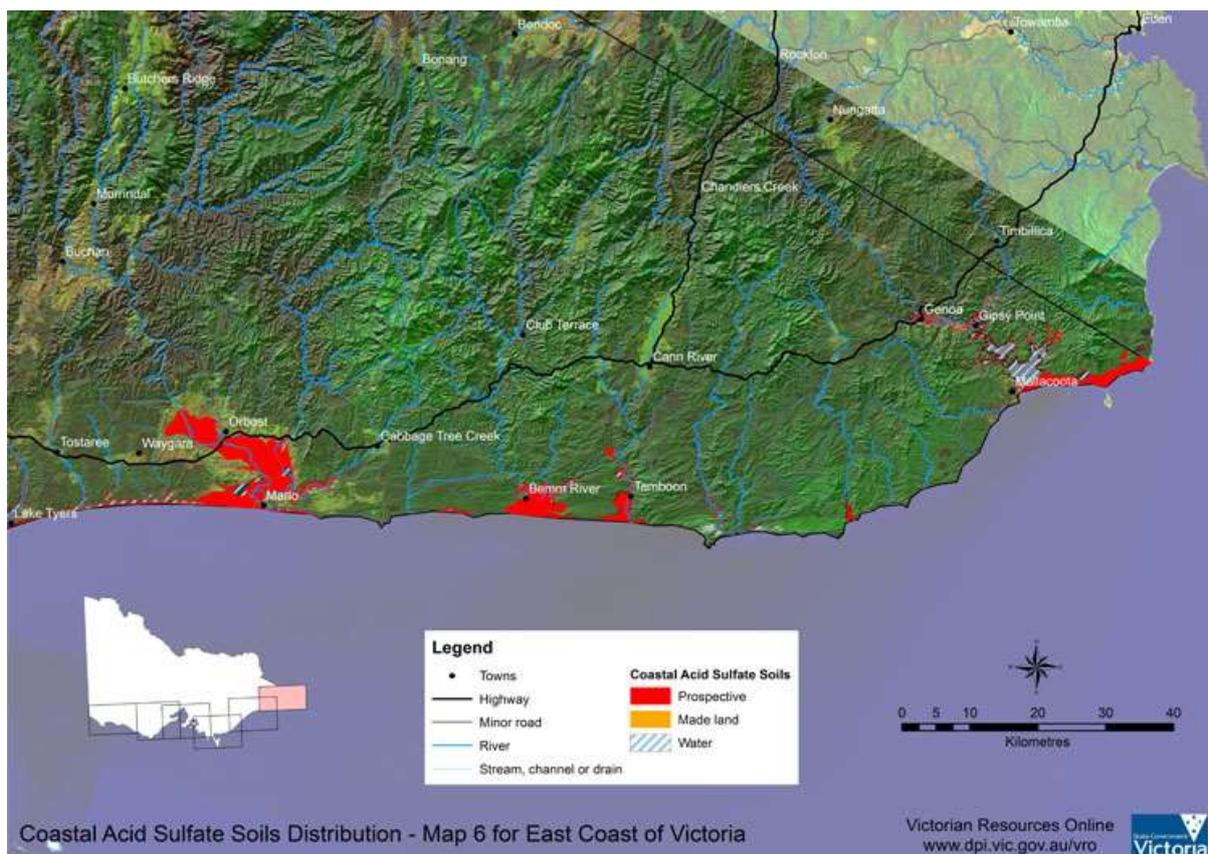
Coastal East Gippsland has 2,615 hectares of peatland,

Coastal Southern Gippsland has 4,582 hectares, and

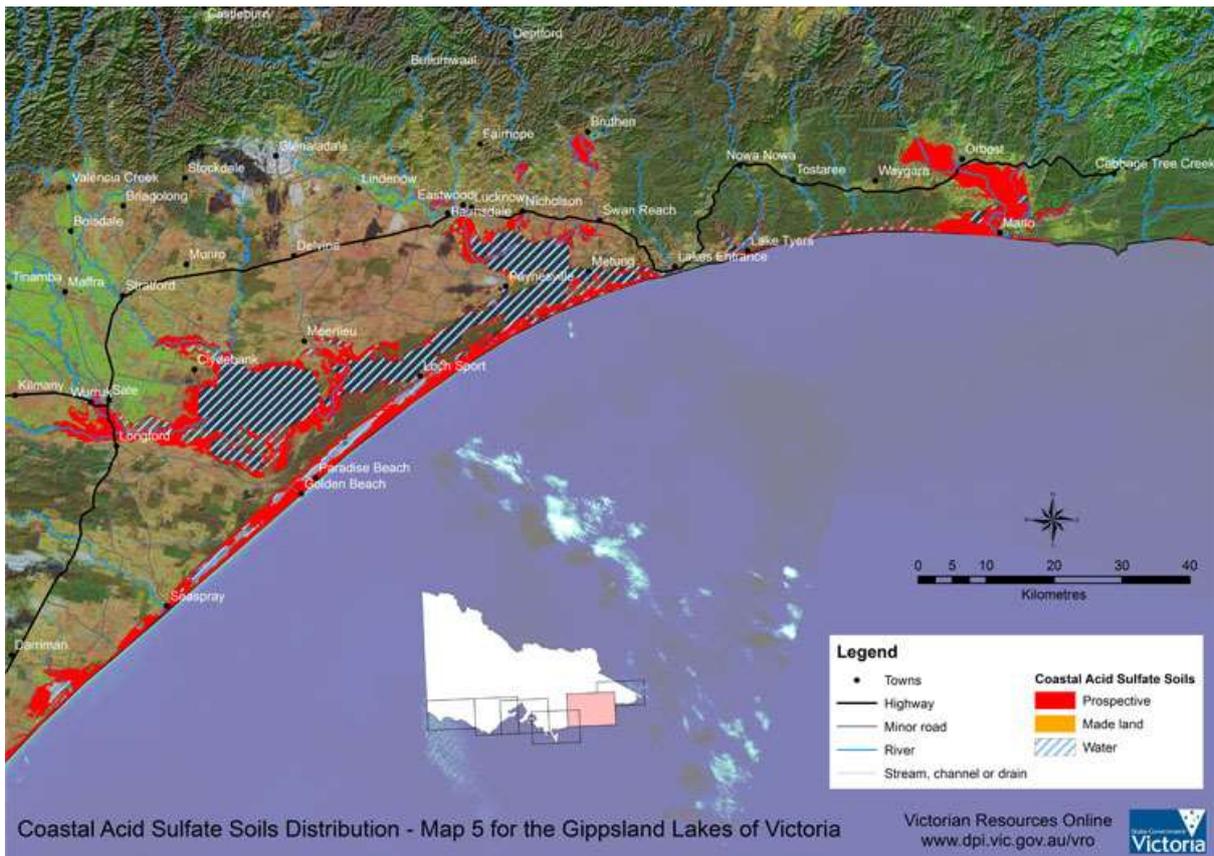
Coastal West Gippsland has 19,666 hectares of peatland.

This adds up to 26,863 hectares of peat along the Gippsland coastline.

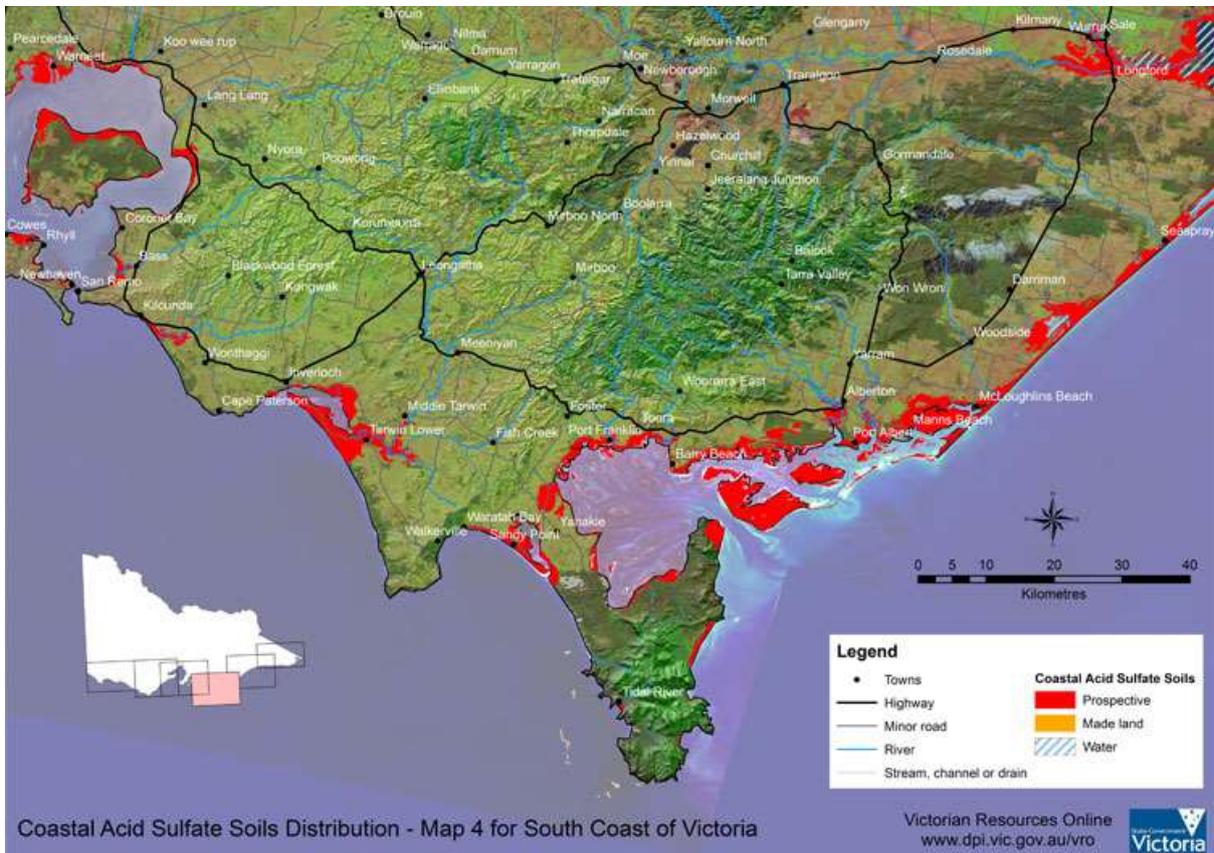
If groundwater depletion across the region is a problem then these coastal peats will be the last to be impacted. Peat wetlands in the higher recharge areas of the aquifers will be the first to fall under the drying effect of lowering water tables.



Source. http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/soil_acid_sulfate_soils



Source. http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/soil_acid_sulfate_soils



Source. http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/soil_acid_sulfate_soils

Otway Water Book 57 *“Groundwater, Gas and Oil Depletion and Surface Wildfire”*

B. Lack of Knowledge.

Other than locating and mapping the coastal peat wetlands very little else is known about things such as the depth, composition and sources of saturation for these peats.

With the exception of some alpine peat areas the extent of inland peat in the elevated areas of Gippsland have never been actively located or mapped.

Another huge data gap in the East Gippsland region is the lack of a Groundwater Observation Bore network. To the east of Bairnsdale there are only a few observation bores in the Orbost area. Little else. Unlike in the Yarrum/Seaspray area where the falling water tables have been well documented, scant data exists past Bairnsdale. As discussed the Yarrum/Seaspray groundwater data was critical when determining the compensation package for farmers disadvantaged from offshore gas and oil extraction activities.

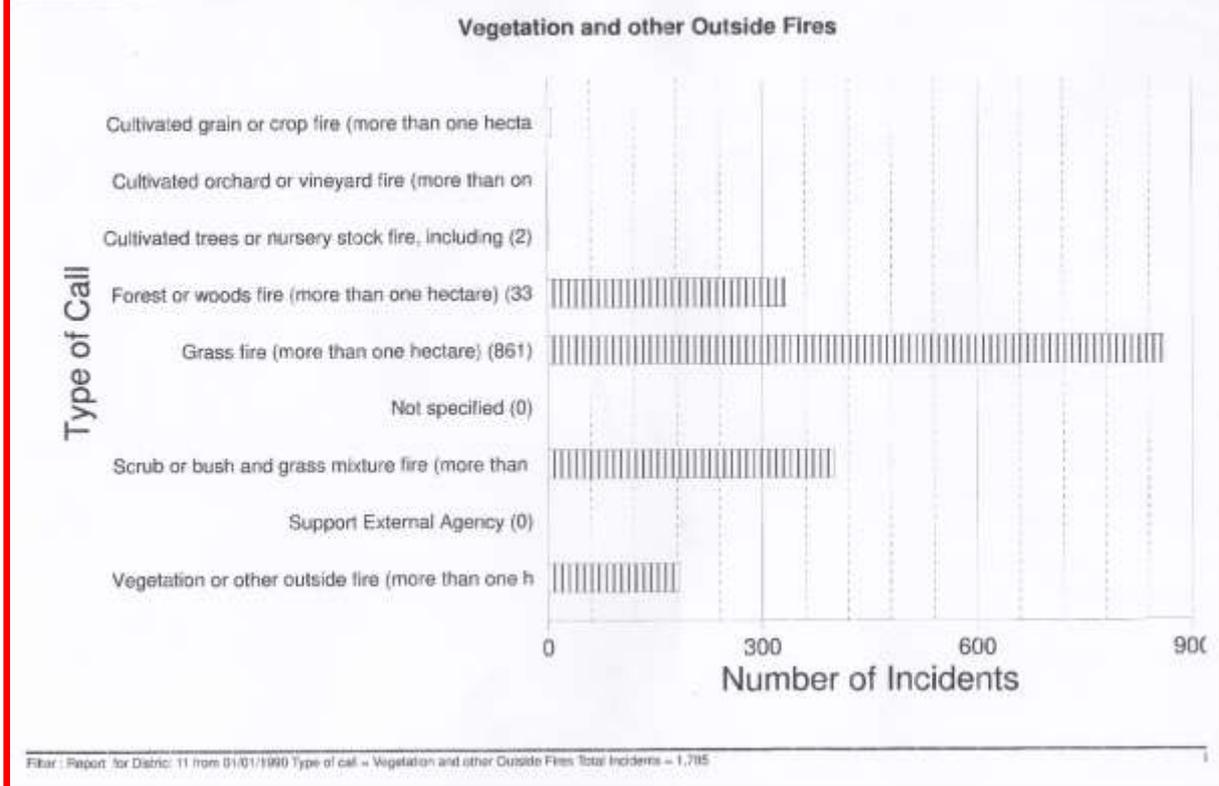
C. Victoria Fire Rescue & Department of Environment, Land, Water & Planning (DELWP) Records.

It would appear that there is no separate fire record category for peat fires. Any peat fire is imbedded amongst the following categories.

- Forest or wood fires.
- Scrub or bush and grass mixture.
- Vegetation or other outside fire, etc.

This makes researching peat fires most difficult.

The chart on the next page is an example of the way CFA records fires. This chart resulted from attempts to gain a list of peat fires in the Gippsland CFA District 11. There is no category for peat fires. As with DELWP, peat fires are imbedded against the primary land use category. This would suggest that the extent, significance and incidence of peat fires is relatively new, especially if the peats are only recently beginning to dry out. This underreporting is an area that requires investigating and some research. It would appear that the CFA on its own initiative is seriously looking at the categorising and recording peat fire incidence.



SOURCE. Country Fire Authority - Categories and fire incidents for CFA Region 11.

D. Prediction and Control of Peat Fires is Extremely Difficult without the Benefit of Adequate Research.

A lack of records makes it extremely difficult to ascertain:

- historical peat fire facts,
- the regularity of peat fires,
- the type of peat burning,
- the location of potential fire, and
- the source of saturation for these peats.

Any analysis of trends and determination of causes of peatland fires resulting from drying out becomes an almost impossible task.

E. Fighting Peat Fires is an Extremely Risky Exercise.

Without this knowledge it makes fighting a wildfire a hazardous operation.

- Stumbling into an unmapped peat could be life threatening.
- Not knowing the depth of dryness of the peat would make fire fighting strategies difficult and dangerous to employ.
- As would knowing the composition and emission ramifications as the peat burns.

- Until specialist monitoring equipment is utilised, not knowing the types of toxic gases and heavy metals produced and emitted in the burning process could be life threatening.

Gavin Parker, Country Fire Authority Senior Station Officer, discusses these inherent problems in the July and October 2020 issues of the Asian Pacific Fire Magazines – www.apfmag.com .

F. Intuitively Speaking.

- “...*in my experience in the eastern side of the state, the frequency of peat fire is increasing...*” (Gavin Parker pers com.)
- “...*some of the areas of peat fire we have experienced are normally very swampy/boggy areas that have dried out...*” (Aaron Worcester, Country Fire Authority, pers com.)
- “...*there is a lot that is not understood about peat.*” (Gavin Parker, citing local experience and knowledge gained from research trips to the United States of America.)
- In recent years the peat fires of Gippsland have generally been first time events. These peat fires are a relatively new phenomenon for Gippsland.

As with the peat wetland fire in the Big Swamp at Yeodene in the Otway Ranges many of the upland swamp and boggy areas had until recent times, remained saturated.⁽²⁶⁾

G. Research the Data Gaps.

Due to this lack of knowledge and existing huge data gaps, it would suggest the task State Fire Fighters face when dealing with peat fires, could be likened to fighting the fires blindfolded.

H. Are Peat Fires an Emerging Problem.

At this stage it would appear that the majority of the Gippsland peat fires have burnt to a relatively shallow level. Around 50 cm. But, is this an indication of “deeper” fires to come as water tables drop and climate change accelerates? Most probably. This makes the fire fighters’ task of minimising social, economic and environmental damage extremely difficult and confronting.

Three things are abundantly clear:

- the causal factors and reason for an increase in peat fires must be researched,
- fire fighters must be better informed and made aware of the many and varied conditions when fighting peat fires, as distinct from “normal” wildfire conditions, and
- the fire fighter must be trained to handle these conditions.

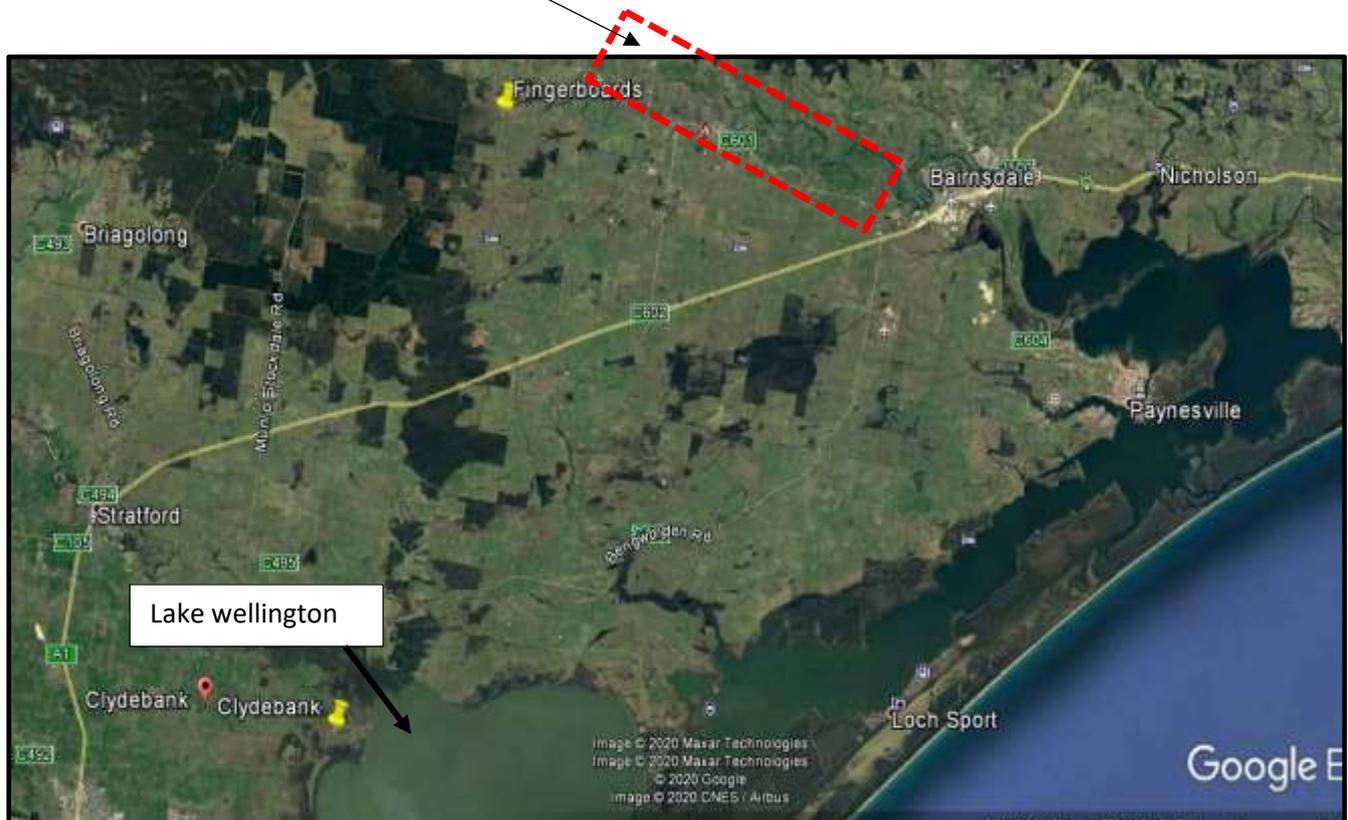
I. The Country Fire Authority Starts the Process of filling the Data Gaps.

The Country Fire Authority (CFA) recognises that there is much to learn about fighting peat fires. A focus of its 2020-2021 pre-summer briefings was information on identifying peat; peat fire fighting operations and the inclusion of health and safety issues. The shortfall in reporting peat fires as a separate category is being addressed with some reports and after action reviews being written. However, these reports are difficult to obtain. It is recognised that much has to be addressed to fill the knowledge gaps, and, efforts made to understand the complexities of peat fires. Valuable lessons are being learnt.

Chapter Seven – Wy Yung Groundwater Area.

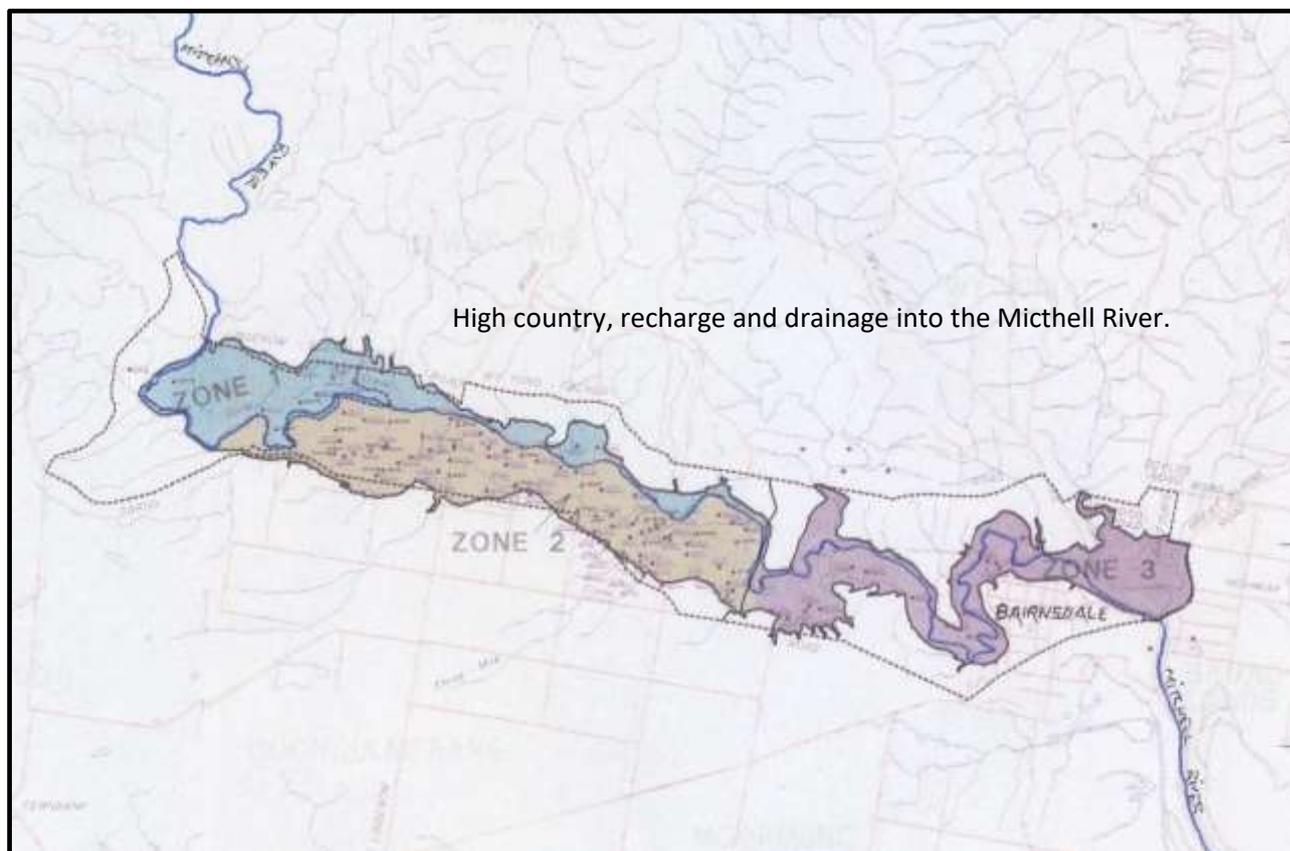
Groundwater supply issues in the Wy Yung Groundwater Management Area led to the legislation of a Wy Yung Groundwater Supply Protection Area on 6 May 1999.

Wy Yung Groundwater Management Area.



The Wy Yung Groundwater Supply Protection Area bounds both sides of the Mitchell River valley as the river emerges from the mountains and flows along rich fertile country below the highland escarpment to the north. The Mitchell River flows on into the Lakes Entrance lakes system near Paynesville.

The dotted line outlines the Wy Yung Groundwater Supply Protection Area declared in 1999.



The coloured three zones outline the change of boundary recommended in the draft Groundwater Management Plan prepared in 2000.

Once this Groundwater Supply Protection Area had been declared a method of managing this area needed to be drawn up. This is called a Groundwater Management Plan and the Minister for Agriculture and Resources appointed a Consultative Committee to prepare a draft plan. By December 2000 the consultative committee had drawn up such a plan.⁽²⁵⁾ This document involved local participation.

Permissible Annual Volume.

Around the same period a Permissible Annual Volume (PAV) for groundwater extraction had been determined to be 5,000 ML/year. Although the groundwater extraction licences that had previously been allocated added up to over 7,000 ML/year, it was estimated from Southern Rural Water records of 1997-98, that the actual extraction rates were likely to be around 2,800

ML/year.⁽¹⁷⁾ *“Despite this, difficulties have been experienced in extracting groundwater in dry times...”*⁽²⁵⁾ Also and unfortunately, up to 2000 the observation bore data knowledge base on which the Consultative Committee was basing its recommendations was at the very best extremely limited.

“There is little data to substantiate groundwater extractions or to verify the accuracy of the PAV...”⁽²⁴⁾ (PAV -Permissible Annual Volume.) Not only was the PAV determined using assumptions and guesswork regarding the recharge amount, it was reported in the draft Groundwater Management Plan little was known about water movement, water levels, water quality and interaction with surface water.

Another and limiting variable was that each of the three zones within the Groundwater Supply Protection Area had its own Permissible Annual Volume (PAV). And, the PAVs in Zones 1 and 3 were not fully allocated whereas *“Zone 2 is well over allocated...”*⁽²⁴⁾ making the task of preparing a groundwater management plan that more difficult. This is one of the reasons why the Consultative Committee strongly recommended follow up data gathering and consultation on a regular basis. There were too many data gaps on which to make truly informed decisions.

The two most positive and significant aspects of the Consultative Committee composition were:

1. the involvement of local community participants, and
2. the acknowledgement of local historical knowledge and expertise.

But, for some reason the Wy Yung Groundwater Management Plan⁽²⁵⁾ appears to have not been officially formalised. However, a Wy Yung Groundwater Management Plan Summary sheet of the Plan was produced in 2001(see Appendix 6, page 104), but the detailed 35 page draft recommended plan⁽²⁵⁾ does not appear to have been accepted. In its place, a 3 page Wy Yung Local Management Plan can be found in the Catchment Statement for Central Gippsland and Moe Groundwater Catchments, Version 2, August 2016.⁽¹⁴⁾ Nothing like the 35 page Groundwater Management Plan as recommended by the Consultative Committee. Is this a case of dumbing down local participation?

Geoffrey Johnston – Farmer of Long Standing in the Wy Yung Area.

Geoffrey Johnston was a member of the Wy Yung Groundwater Management Plan Consultative Committee and brought to the “table” his extensive years of experience and knowledge of the area including his involvement with groundwater extraction activities and observations. Not being able to find any reference to Geoffrey’s extensive knowledge I approached him and asked that

he record some of this knowledge. Below is his account of a few experiences gained from years of working the land in the Wy Yung district. His knowledge abounds and should be recorded under the heading citizen scientist.

Historical & Local Knowledge as related by Geoff Johnston. April/May 2021.

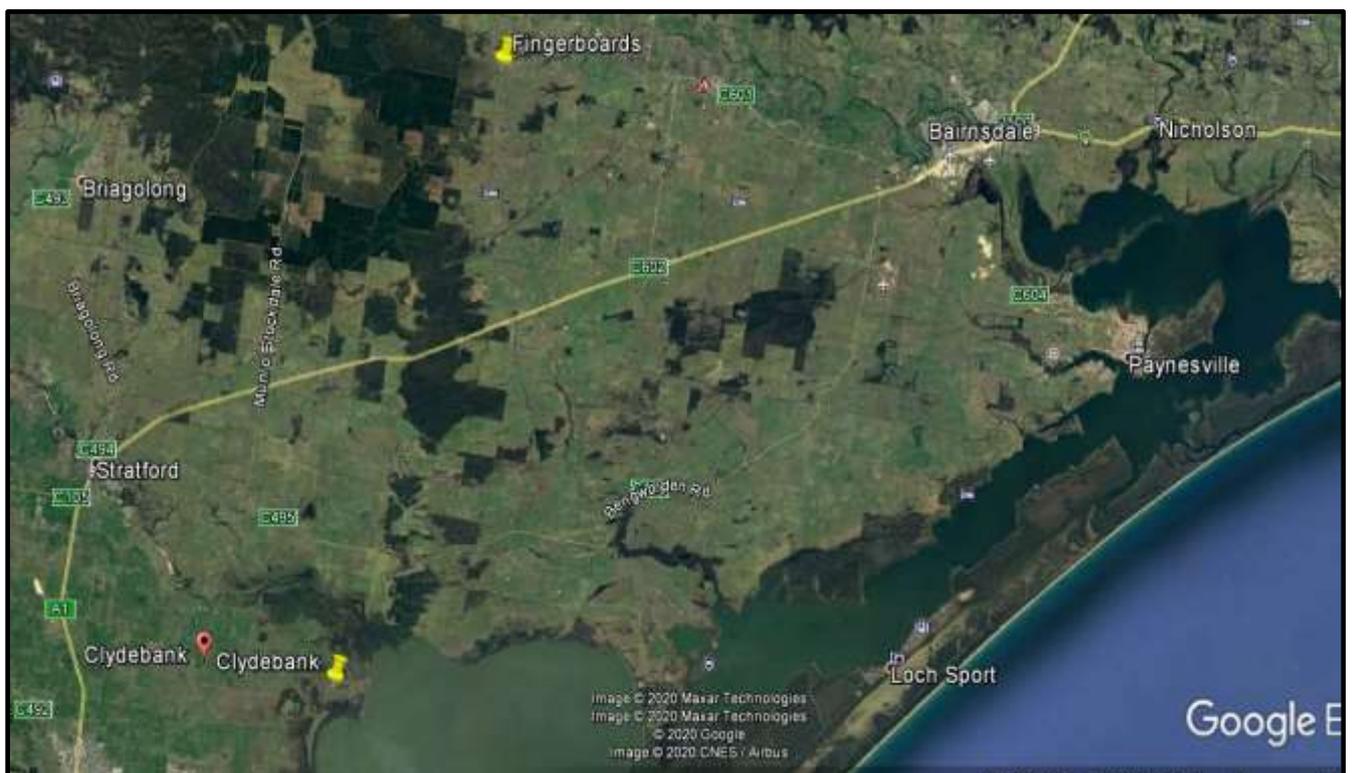
My name is Geoffrey Johnston of 2000 Bairnsdale-Dargo Road Walpa 3875, 67 years old, fourth generation farmer Lindenow – Glenaladale area.



Generations before us selected this land because it had good carrying capacity and had good, reliable rainfall, knowledge passed down through these generations in pasture management, dam building and groundwater management have established our farming enterprise.

Land owned by various members of the family includes extensive flood plain pastures which have been impacted by varying levels of inundation from the Mitchell River and its tributaries. Changes in river flow paths and geomorphology has vastly altered the flood plain. The 2007 flood - a high flow major flood has taking over 13 years to bring the land back into production because of the silt load from the fire impacted land in the Alpine blazes has been so acidic that viable pastures have taken years to establish. Our property is the first land that allows the river to spill across the flood plain when we are heavily impacted with debris and silt.

Leo Sosti from Melbourne University came to the area after the 1998 major flood and formed a group of local farmers (representing vegetable, dairy, irrigators) with knowledge in local river conditions and adjoining hill country). These River Wardens were formed to get a more reliable record of rainfall, river levels over a wider area. Including putting on extra river gauges in different localities on feeder tributaries streams which determined the level of downstream flood inundation. This data gave the lowland users a more accurate warning of the impending impact. Locals reported on rainfall and observed stream flow in feeder Creeks.



Over the years many local Creeks and swamps have diminished, there were many swamps in the higher country that held permanent water. Creeks would flow and have ponds (1950-1960's) an example is Skull Creek whose catchment is from the elevated area of surround foothills. Now these streams only flow after a heavy rainfall event, these ponds supply the recharge of groundwater and subsequently flow onto the Mitchell River. On the river flats back in the 60-70's many pondages and lagoons on the river flats had permanent water in them, today 90% of this water has disappeared.

My Grandmother's family had a property at Clydebank (3-4 k's west of Marley Point on Lake Wellington) in the early 60's. I can remember some of

the first Artisan bores free flowed and I can remember them running 200 metre irrigation spray line with no pump running at about 22 pound pressure. Over the years since ESSO and more intense agriculture developments in the area more bores have drilled into this aquifer and over time the pressure has diminished. Some of the bores still flow most years in winter.

My observations of changing weather patterns.

When Esso's gas plant was established in the late 60's and a few years later the Loy Yang power station developed in the Latrobe valley our south westerly weather systems I believe became shielded from us in the Gippsland area.

These developments create an uprising of heat - our weather now goes east or west putting us in a weather shadow reducing our rainfall substantially as the south westerly systems used to be very significant bringing us more rainfall. These two industries combined with Yallourn, Hazelwood, Maryvale power industries complete the weather shield from the south-west and west, storms come to about the Latrobe valley and either veer east or west and miss this area unless they are really driven by intense systems.

East coast lows and thunderstorms are only our real weather systems bringing useful rainfall.

Having been a contractor (1970-1990) ploughing and discing the local soils, when ploughing I noticed when you had 2-3 hectares of ground ploughed and there was thunderstorm coming it wouldn't rain where I was ploughing for about 1/2 to 3/4 of a K around me unless it was a really intense wind driven storm. This happened regularly giving me this theory of a heat shield going up buffering this area relating this to the industry in the Latrobe valley.

Where we farm at Walpa and the fingerboards area (4 k west) my father always said that we were on the edge of the artesian basin. Recently a mining company have put down several exploration bores in a southerly direction (3-4 k's) from the fingerboards area - striking the water bearing gravels of this aquifer from approximately 230m to 400m in depth and getting at the furthest points out of this exploration, approximately 12-13 litres per second tested, and by moving approximately 500m yielding no water at all.

Over the years I estimate the extremities of the aquifer have moved back approximately 3-4 k's since the early 60's .

Acidic Waters.

Geoff wrote about flood waters down the Mitchell River being so acidic that viable pasture took some years to recover. He mentioned that swamp areas had dried in the high country and artesian pressure heads on the flood plains had dropped considerably. Similar experiences in an upland swamp along a Barwon River tributary in the Otway Ranges led to massive amounts of acid being sent down the Barwon River. Cause – depressurization and lowering of groundwater due to unsustainable groundwater extraction allowing previously benign peat releasing volumes of acid and heavy metals.

Page | 52

Baseflow Impacted.

Although the Tarra River is some distance to the South West from the Mitchell River and where Geoff has spent most of his life, the following extract highlights how significant groundwater level drops can impact on river flow.

“The Tarra River flows across outcropping Lower Tertiary Basalts west of Yarram which are likely to be recharge areas for the Latrobe Group Aquifer (part of the Lower Tertiary Aquifer). It has been speculated that declines in pressure in the Latrobe Group Aquifer impact river flow in these recharge areas. For instance, SKM (2004) identified 46km of rivers and streams (including the Jack, Albert and Tarra Rivers) which cross these Latrobe Group recharge areas. SKM (2005b) suggested that declining groundwater levels in the region are likely to have contributed to the calculated 75% reduction in baseflow in the Tarra River since the early 1950s.”⁽³⁾

Local Knowledge Should be Compiled.

Geoff Johnston and other elderly and local identities in the Gippsland region have many historical experiences and knowledge that should be recorded, verified, substantiated and then referred to when decisions by water resource managers are being made.

CHAPTER EIGHT – Gippsland Fires

This map shows the extent of the 2019-20 Gippsland fires.



Map courtesy of the ABC.

The fires were horrific in tinder dry forests after three years of drought. No doubt the lack of rain and climate change were the major contributing factors but there can be little doubt that extensive fluid extraction offshore dropping the water tables in the region to unprecedented levels, was also a factor. The young children of this generation will only recall Gippsland as a dry summer place susceptible to wildfire. Long gone are the childhood 1950's memories of greenness, rain, floods and great dairying country.

CHAPTER NINE – the Victorian Gas Program (VGP).

The VGP document is titled the *final report* of the VGP and would have played a significant role resulting in the State Government lifting the moratorium ban on onshore conventional gas extraction exploration and development in Victoria (See Appendix Four, 18/03/2020). Conventional gas is presently being extracted from the offshore sections of the Gippsland and Otway Basins in Bass Strait. The ban on onshore unconventional gas (tight, coal seam & shale - fracking) is to remain.

Little Prospect of Onshore Conventional Gas in Gippsland.

Why pursue onshore gas extraction if this quote taken from the 4th 2020 report of the Victorian Gas Program (VGP)⁽¹⁸⁾ is anywhere near the truth? In 2015 Onshore Natural Gas Water Science Studies concluded... *“There appears from the geological data available to be little prospect for viable conventional gas resources to occur onshore.”*⁽³⁾ In the present climate of renewables why this option would be pursued is difficult to understand.

All Baseline Investigations NOT Available.

Chapter Eight deals with one of the 2020 Victorian Gas Program investigations, a baseline stygofauna survey, that influenced the final VGP report⁽¹⁸⁾. It is a most disturbing report and it is hoped that the other seven baseline documents mentioned are of a much better quality. Unfortunately, these documents are unavailable for review.

Baseline Studies and investigations mentioned in the 4th VGP report include:

1. Social assessment.
2. Groundwater chemistry.
3. Atmospheric condition measurements.
4. Air quality.
5. Environmental studies.
6. Risks, benefits and impacts.
7. Dissolved methane.
8. Stygofauna (the only report available).

Hard to Believe.

Page 26 of the VGP. *“Environmental impact investigations were conducted to assess the current and potential impacts of historical oil and gas drilling operations on groundwater and atmospheric conditions now and into the future. This investigation is the first of its kind undertaken in Victoria. The potential groundwater impact was considered in the Port Campbell Embayment (Otway Basin) and the Seaspray Depression (Gippsland Basin).*

Results found there is no evidence that the environment has altered as a result of these drilling activities over the past 100 years.” (18)

Gas Drilling Has had No Environmental Impact Over the Last 100 Years.

Having read this paragraph one could be excused for coming to the conclusion that water and fluid extraction from these areas has had no environmental impact in the past 100 years. Intentionally or not it would appear that the 2004 CSIRO report resulting in a \$5 million compensation for farmers in the Seaspray area gains no mention. The CSIRO report was either wrong, disregarded or forgotten.

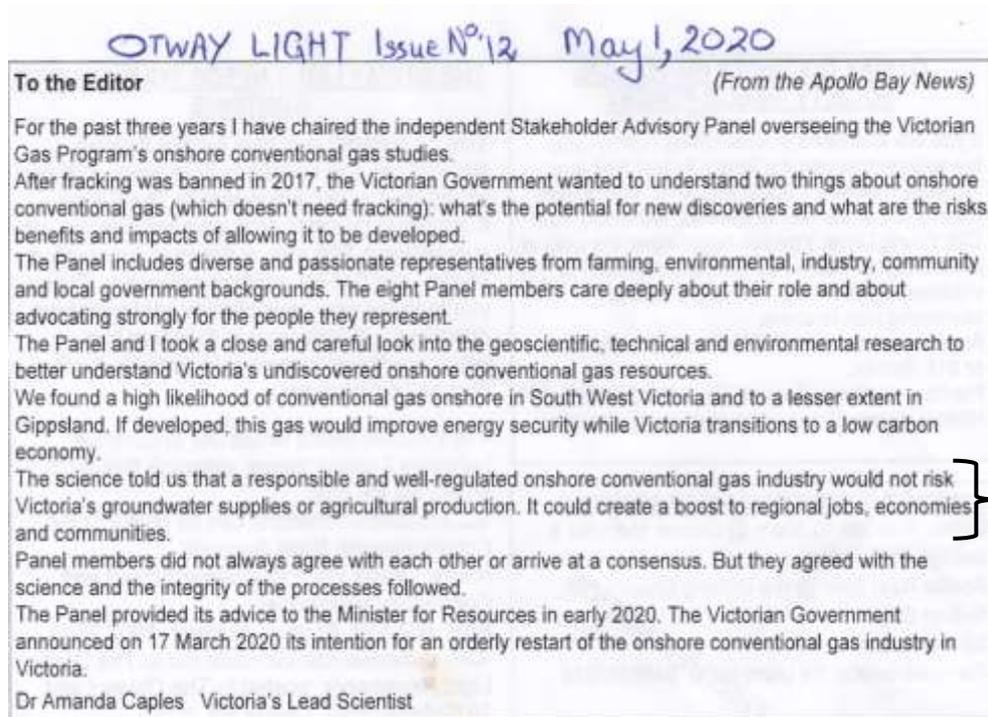
Page | 55

Onshore and Offshore Regarded as Two Distinct Systems.

Another cunningly devised concept that comes to mind when reading the 4th Victorian Gas Program (VGP) report is the separation made between onshore and offshore activities, impacts and consequences as though they are two completely different “beasts.” If nothing else can be learnt from the 40 years of offshore Gippsland extraction of gas and oil is that the onshore and offshore are intricately interwoven. However, perhaps the VGP has come to realise this in some small degree when in the 3rd VGP report, page 27, it states that a refined 3D geological framework model will “...***seamlessly join the new onshore map with the existing offshore Gippsland Basin 3D geological model.***”

Not that this instils any confidence in the Victorian Gas Program. This very thing was muted 16 years ago in the 2004 CSIRO report recommending a “...***coupling the offshore and onshore reservoir and aquifer models...***”⁽⁷⁾ that would go a long way to better defining the sustainability of local water supplies and impact on the environment. Not done 16 years ago, and, there is no evidence that it has been done as at October 2020.

The article below includes a statement on science and how it tells the story that responsible and well-regulated onshore conventional gas exploration would not



Otway Water Book 57 challenges this statement. The science or lack of it, tells us to be especially wary due to the massive data gaps. The science also indicates that the Precautionary and Intergenerational Principles should be adhered to as a matter of course.

place at risk groundwater or agricultural production. Does this include coupling the offshore and onshore reservoir and aquifer models? Does this mean evaluating the onshore impacts from offshore extractions? Was the CSIRO science wrong? Does responsible and well regulated exploration include filling the data gaps?

Is the Currently Accepted Science Up to "Speed."

Is the present day science as good as it is made out to be? Reading earlier and following chapters of this book would suggest otherwise.

Was the Consultation Adequate?

In the final VGP report consultation is mentioned 11 times in relation to stakeholders, community, landholders, social, environmental, and economic receptors. Workshops and independent reviewers were involved. This reads very well and portrays a confidence that this task has been adequately covered. Combined with all the stated benefits to the community and safeguards being put into place how can it be anything but a win win situation all round. But, is this really the case?

Assumptions Left Out.

In any project of this size there are usually assumptions being accepted as part of the process. The only mention of assumptions in the VGP 4th report is found in section 3.2.1.2, page 36. It would be good to have these assumptions detailed.

3.2.1.2 Consultation and workshops in South-West Victoria

The engagement program was delivered during October and November 2019, targeting key government agencies and stakeholders, subject matter experts and South-West region residents. It was designed to test methodology assumptions and capture local issues, values and insights.

Page | 57

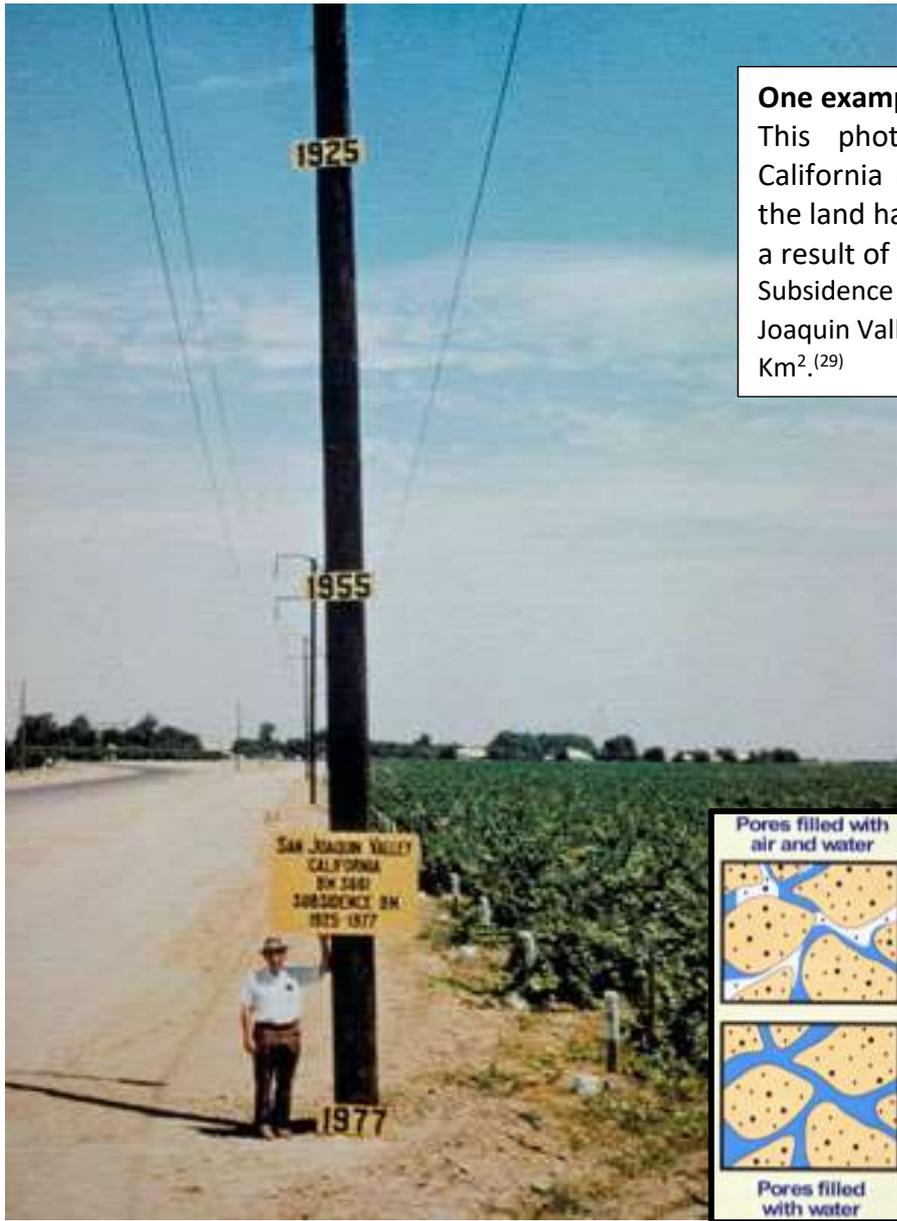
These methodology assumptions have not been detailed or referenced making review extremely difficult.

Subsidence.

The 2004 CSIRO report⁽⁷⁾ recommended regional 4D subsidence modelling and concluded that “...*the potential scale of subsidence is significant and warranted detailed technical investigation.*” An SKM⁽¹²⁾ report quoted in the CSIRO report concluded that “...*there was a 50:50 chance that this critical threshold (of subsidence) would be exceeded within 30 years and thus subsidence would accelerate.*”⁽¹²⁾ The same SKM report stated a “...*pre-consolidation stress has yet to be reached through aquifer depressurisation...*”⁽¹²⁾ and “...*there is a reasonable probability of significant subsidence occurring.*”⁽¹²⁾ The critical threshold outlined in the CSIRO document will not be exceeded until 2035. Gas extraction continues unabated and there is not one mention of subsidence in the 4th Victorian Gas Program final report. Perhaps there is nothing to report as yet because 2020 is only half way through the 30 year probability cycle, after which subsidence is predicted to accelerate.

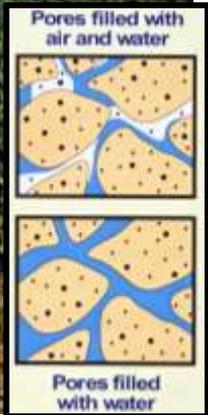
The reduction of pore water pressure can lead to subsidence.

“Effective stress increases when water is pumped from an aquifer, because the pumping reduces pore water pressure P. Withdrawals of oil and gas also reduce pore fluid pressures in the formation being pumped, and reduced P in nearby water-bearing zones.”⁽²⁹⁾



One example of Subsidence.
 This photograph was taken in California (1977) showing how far the land has subsided since 1925 as a result of groundwater extraction. Subsidence in this part of the San Joaquin Valley covers roughly 2,000 Km².⁽²⁹⁾

This is an example of subsidence in California that took place over a period of 52 years. And, this amount of subsidence cannot be reversed.



Originally the upper saturated levels contain air & water in the gaps between earth particles.

Below the water table the gaps between earth particles contain only water.

Remove the water and the earth particles begin to close together filling the gaps the water occupied and the surface level drops accordingly. The amount of subsidence depends on the amount of the fluid loss and the soil structure. Creating this amount of subsidence in California would have an enormous impact on springs, soaks, streams and rivers. Ecosystems would be placed under massive stress and change. Drier, heightened fire risk and intensity would become the new norm.

CHAPTER TEN – the Otway Ranges

Heightened Fire Risk.

This chapter looks at the heightened levels of wildfire risk due to a similar mismanagement of the surface and subterranean ecosystems in the central area of the Otway Ranges, Victoria, Australia. The potential risk, intensity and duration of wildfire in the Otway Ranges is an ever present risk. If protections and better water resource management procedures are not enacted immediately then the Gippsland fire experiences will be repeated in the Otway Ranges. One way to help achieve part of a positive outcome is to declare the two Groundwater Management Areas, Gerangamete and Gellibrand, as a Subterranean National Park.⁽¹⁰⁾

Page | 59

The references made to Otway Water Books in this chapter contain the supporting documentation to the statements made. Otway Water Books can be found on the web site www.otwaywater.com.au and be downloaded free. Referencing, for example “B12P34” stands for Otway Water Book 12, Page 34.

Elevated Fire Risk Indicators Resulting from Fluid Extraction in the Otway Ranges.

Boundary Creek.

1. Boundary Creek was a permanent flowing stream between 1912 and 1984. Summer flows stopped after the 1982-83 groundwater extractions began and the periods of no flow have escalated with every consecutive fluid extraction.
B19P41,46-49. B30P7.
2. Numerous observation bores that were drilled in the area of the Barwon Downs Borefield went from artesian, squirting 10s of metres into the air, to water levels 40 metres below ground level.
B8P9,64. B18P23. B42JP7.
3. Water tables that once were stable, with little variation between seasons and years, began wild fluctuations between fluid extractions never returning to pre pumping levels. B23P91-112. B28
4. 1980s environmental flow recommendations were impossible to achieve due to over allocation of water resource. B2P13,31. B11P40.
5. Local knowledge of elevated fire risk gathered through years of observation. B15.
6. Since 1995 fluid extraction rates were allowed many times above the recommended Permissible Annual Volume (PAV). In 1995 the rate was

- 3 times the PAV and in 2004 the fluid extraction rate was raised to 5 times the recommended PAV. B1P54,66,69. B2P11-12,25-27. B10P61.
7. The area of drawdown influence drying out the surface layers, has spread over at least 480 km² and the impact area continues to widen. B18P45-60. B20P19. B42
 8. Platypus, blackfish, trout and other water dependent species are no longer found in a multitude of tributaries of rivers in the region. B3
 9. A 30 km fish kill down the Barwon River in 2016 with a follow up one in 2018. B32
 10. Wetlands have dried out with vegetation deaths and fuel build up as a result. B8. B11. B18. B31
 11. Opportunistic drier tolerant vegetation has moved into these wetlands. B18. B31.
 12. Fire caused serious problems in two of these dried out wetlands in 1997, 1998, 2006 and 2010. B15. B31. B35.
 13. Artificial supplementary flows into Boundary Creek taken from the Otway to Colac Pipeline have failed to maintain flows in the upper reaches of the Barwon River system. B3P78. B11P64-67. B42J.
 14. Applying the Rick Evans Response Ratio confirms that creeks and rivers in the area are drying up as a response to fluid extraction. B9P15. B11P42. B26P30. B19P62,100.
 15. The Rassam et al. findings suggest that this impact could be many times worse than that calculated by Evans. B13P7. B19P100.
 16. The toxins and heavy metals will continue to kill vegetation for numerous years into the future.
 17. As with the Gippsland Basin subterranean, offshore fluid extraction is taking place from the Otway Basin.

What is Alarming is...

Gippsland drawdown impacts are many times greater than those experienced in the Otway Ranges.

Impacts on Barwon River Catchment.

There can be no doubt that the reaches of the Barwon River and its tributaries in the Barwon Downs area were a thriving, healthy and stable water system before water extraction took place. This area supported a diverse collection of water dependent flora and fauna. Platypus and blackfish were abundant, animals high in the food chain. The Big Swamp wetlands on a tributary of the Barwon River, were “jungle” like supporting many water dependent species. Farmers downstream had a secure and reliable source of fresh water. The flood

plains maintained a green summer pick for stock and the stream banks maintained their stability. The boggy dense wetlands did not have to be fenced out as domestic stock would not enter these wetland areas. Numerous attempts to drain the peaty Big Swamp wetlands along Boundary Creek, had failed. These things were known to have remained relatively stable since 1912. Until 1984 the waters of Boundary Creek and other tributaries of the Barwon River had been the salvation to farmers through many serious droughts.

Up to 1986 groundwater levels had varied very little. From this time on the Barwon Downs area has seen a dramatic decrease in water tables.

Impacts in the Gellibrand River Catchment.

By 2017 tributaries of the neighbouring Gellibrand River system were being seriously impacted. Loves Creek summer base flow was depleted by 50%.⁽²⁵⁾ By 2019 this had dropped to 60%.⁽²⁴⁾ A cone of depression had formed under the township of Kwarren and the flows in the Gellibrand River were being impacted. The drying out and area of fluid extraction was continuing to spread a decade after the last serious fluid extraction ceased.

In the Upper Barwon River, catchment river flats began to dry out and a summer pick for stock disappeared. Creek banks began to crumble and farmer's stock water became unreliable and or unpalatable to drink. Acid levels skyrocketed as did heavy metal content.

Supplementary flows released from the Otway to Colac pipeline disappeared into the depleted water table layers as quickly as the water was released.

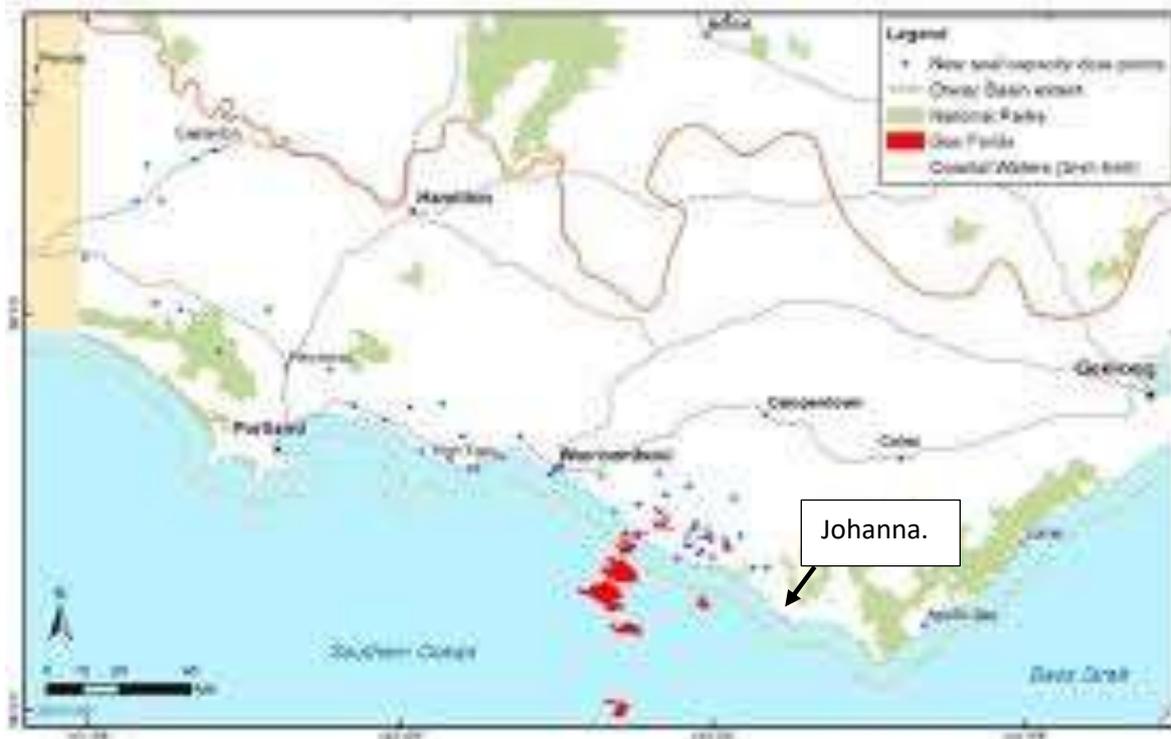
50, 40 and 30 metre drops of the water table in bores in the Barwon Downs Borefield impact area indicated the surface layers were starting to dry out.

Acid levels were rising, the creeks were drying up, vegetation was dying, farmers were running out of otherwise reliable water, summer feed on the flats was diminishing, creek banks were crumbling and at least one other adjoining groundwater management area was similarly being impacted, all indicators that fire risk was on an upward spiral.

CHAPTER ELEVEN – Local Knowledge Otway Ranges

Johanna River.

Johanna River flows south of the Otway Ranges ridge into Bass Strait.



Offshore fluid extraction sites in the Otway Basin region.

Back in 2014 Joy Evans who had lived at Johanna for many decades, asked for some help regarding what could possibly be affecting the Johanna River to such a dramatic degree. I sent off an email (see email below, page 63).

At the time, Joy unbeknown to me, was struggling with health problems and as I was busy with other issues I let the water issue Joy was trying to resolve slip by. Unfortunately, the next time I heard anything about Joy was that she had died (2017) and once again the issues she was pursuing went to near the bottom of a range of priorities. In 2020 after reading the CSIRO 2004⁽⁷⁾ report a re-kindling of an interest in Joy's concerns surfaced. While tracking down the email I sent to Joy I came across a letter from Ben Sheppard that I had also sent to Joy. Ben's letter (see Appendix Three, pages 98) resulted from discussion he had with State Government officers who were providing education to local citizens at a community meeting in Colac at the time. This meeting was in regard to onshore and offshore gas and oil extraction in the Otway Basin – the Victorian Gas Program.

From: Malcolm Gardiner <otwaywater@yahoo.com.au>
Date: 14 April 2014 12:55:04 AEST
To: "info@johannanseaside.com.au" <info@johannanseaside.com.au>
Subject: River flow

Hi Joy,

It was good to talk with you.

You are doing a marvellous task of getting your oral history down on paper.

I have had a look at Google Earth and there does not seem to be any dams upstream that would cause a problem.

Some things to consider...

Has the water in the Spafford Creek, Spates Creek and the Johannan been tested to see whether it is the same type of water?

Write down changes noted with dates and examples of the change.

Get as many people who have noted the same changes. They may have more in fact. Get them to write them down also.

Gather rainfall records and have the collector of these records write up a summary of what the records say to cover the same period you have experienced.

Write e everything down because something not significant now may be valuable later on. Anything to do with water write it down. Have as many people as possible do the same thing.

BUILD A PICTURE of words from people's oral history.

1/2

And of course photographs are worth a million words, not a thousand. You can place a lot of value on old photographs. That is a job in itself, maybe a grandchild would scroll through photos for river and water shots.

Keep copies and records of everything, including phone conversations.

Don't trust any authority's spoken word. It must be in writing.

Type up one letter asking the authorities the same question. Why has the Johannan River gone from a free flowing river to a dribble of a creek?

Southern Rural Water, in Maffra Victoria

Corangamite Catchment Management Authority in Colac.

Department of Environment and Primary Industries in Colac

Terry Mulder

Would be a good start for the same letter but different destination.

Put all of the written history down on a Statutory Declaration form as a true and accurate recollection of experiences.

I Can send you a pro-forma if you like for a stat dec.

Possible causes...

Gas extraction

Depleted aquifer. This is the most likely.

Forestry activities

Combination of things

Hope this is of help.

Cheers,
 Malcolm.

Unfortunately, after numerous enquiries no records of Joy's work has materialised. However, another local identity has provided a glimpse into historical knowledge.

Archie Speight now in his mid eighties lived in the Johanna Valley until recent times, retiring and moving into Apollo Bay. His early day recollections paint a

JOHANNA RIVER

My memories of Johanna River began in the mid 1940's when the war finished. The headwaters are at Laven Hill it and runs through Melba Gully and over the Johanna Falls and out to sea at Johanna Beach. It flowed through forest and bush and was fed by gullies and springs along the way also Hides Creek down to the Johanna flats. It was a small reliable stream that ran quite well all the year round. The water was used by adjoining landholders for domestic and stock use. There were plenty of Minnows, Eels, some yabbies and quite a few platypus (the Blackfish), later trout were introduced. There were pools at the Falls that people swam in and down on the flats some small swimming holes. Summer time saw plenty of campers mainly from Melbourne who had their favourite spots to pitch their tents and buy milk, cream and vegetables off the local farmers.

by Archie Speight

thriving and healthy lifestyle and environment.

CHAPTER TWELVE

-*Stygofauna* in Southern Victoria (a Victorian Gas Program Baseline report).

Stygofauna -subterranean fauna associated with water.

“Stygofauna are Aquatic animals that inhabit subsurface waters for their entire life cycle.”⁽¹⁶⁾ (Victorian Gas Program)

Why Discuss Stygofauna?

Why include a discussion on stygofauna in this book that is dealing with the heightened level of fire impact resulting from fluid extraction? The answer is quite simple.

- Stygofauna live in water saturated subterranean earth structures.
- Water, gas and oil extraction has impact on stygofauna habitat.
- If stygofauna is present in the areas under the threat of more onshore and offshore water, gas and oil extraction, then this fauna must be catered for in any fluid extraction regime.
- Comprehensive baseline studies need to be conducted and an appropriate follow up monitoring program implemented.

And,

it is too coincidental that results of the Victorian Gas Program found a scarcity of stygofauna in the areas that are under investigation for more onshore and offshore gas exploration.

And,

these results influenced the decision to allow onshore conventional gas extraction exploration as of July 2021 (see Appendix Four, page 100).

And,

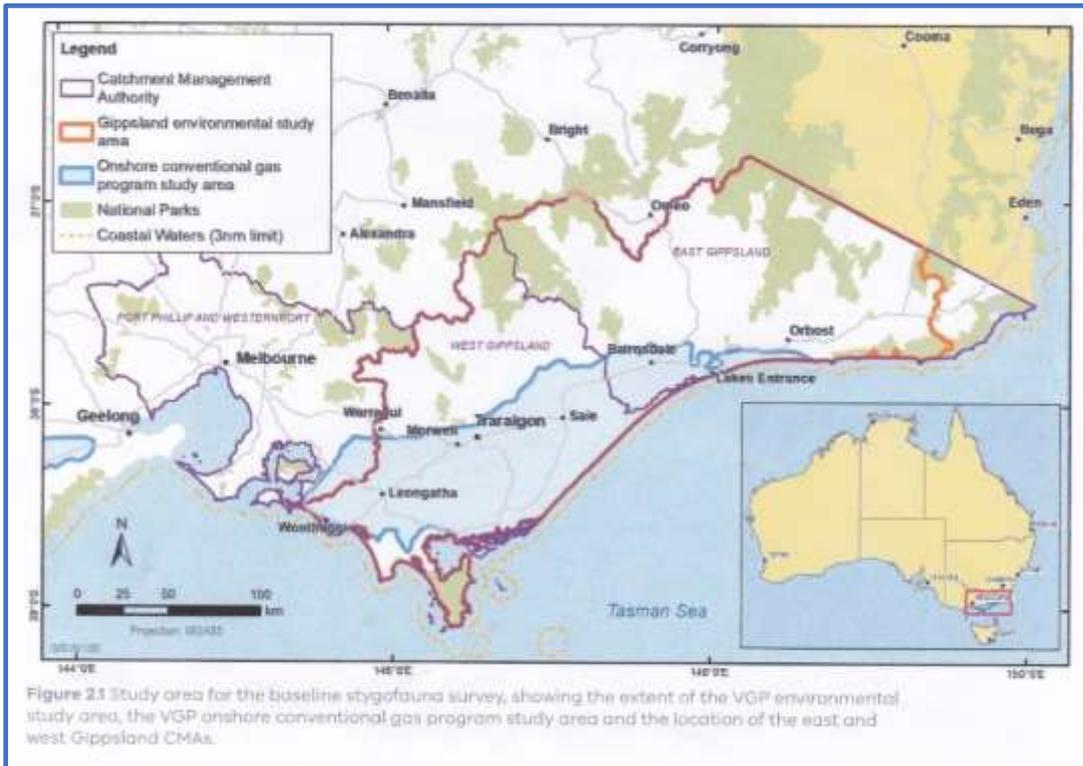
the bottom line is especially alarming when the results show every indication of being based on poor research and bad scientific procedure. This Chapter discusses this research.

The Victorian Gas Program Research Areas.

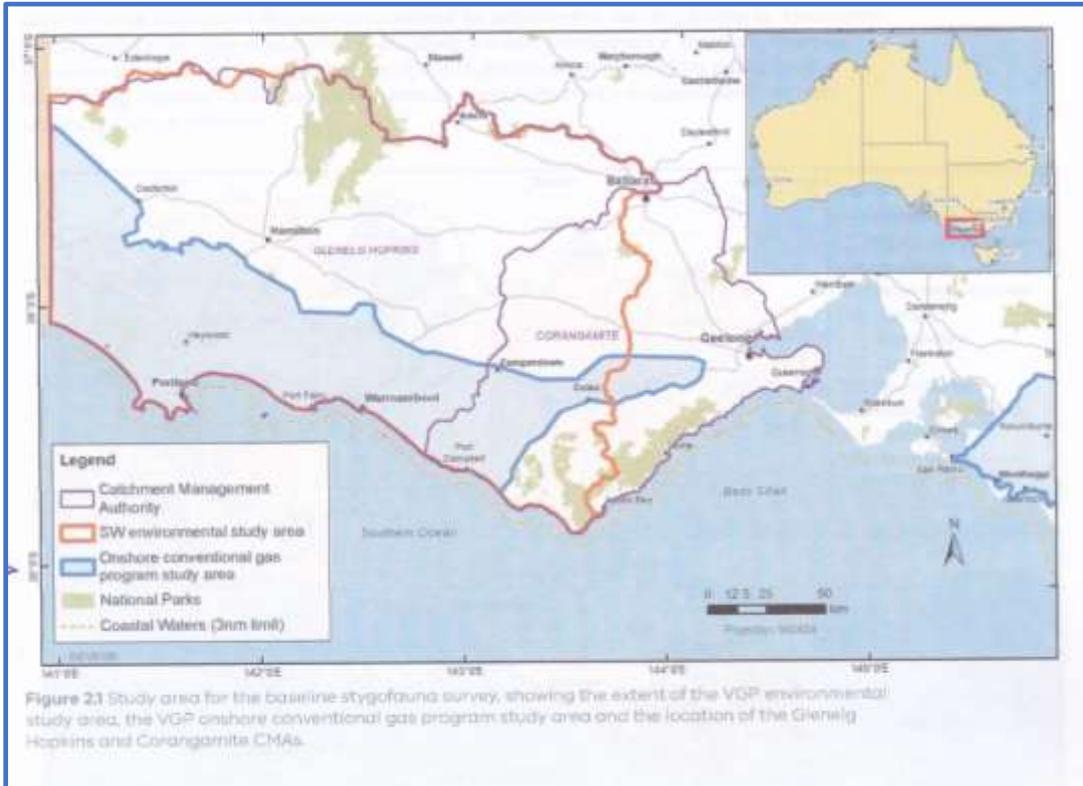
The Victorian Gas Program (VGP) stygofauna investigations and surveys involved withdrawing water from bores in the Gippsland Basin⁽¹⁷⁾ and Otway Basin⁽¹⁶⁾ regions (see next page).

The areas coloured in **light blue** are the onshore conventional gas program investigation study areas. The areas outlined with the **orange** boundaries are the environmental study areas.

(Chapter Fifteen discusses the other environmental studies, see page 92).



SOURCE: Final Report Victorian Gas Program (VGP).



Why Conduct these Stygofauna Surveys?

It is claimed in the VGP that these “...*stygofauna surveys provides a baseline data set to assist in the identifying subsurface groundwater dependent ecosystems.*”⁽¹⁶⁾ and the Victorian Gas Program (VGP) includes the following objectives:

1. “...*assessing the petroleum prospectivity...*”
2. “...*estimating the prospective gas resources of the Otway and Gippsland geological basins...*”
3. “...*is also looking at the risks, benefits and impacts associated with onshore conventional gas to inform decisions made by Government.*”

(Page 1 VGP Technical Report No 13⁽¹⁶⁾)

The stygofauna surveys assist with looking at the **risk** component in relation to impacting upon subsurface subterranean Groundwater Dependent Ecosystems (GDEs). The more stygofauna found the higher the risks involved. Whatever the results, the stygofauna can be used as the “canary in the mine.” Few numbers, few worries. Large numbers more concern. However, all this relies on sound scientific and technical research. At best these surveys can only be described as “flimsy.”

A Nonsense Claim.

It would also appear that these stygofauna surveys are regarded as *the very first attempts at establishing whether there are any subsurface Groundwater Dependent Ecosystems (GDEs) in Victoria.*

“*Currently there are no known subsurface GDEs across Victoria.*” Page 9 VGP.⁽¹⁶⁾

This seems an extraordinary statement with profound implications. Surely the Government has not taken this statement and the stygofauna survey results as the only justification of subsurface GDEs present in Victoria to the exclusion of everything else. To state there are no known subsurface GDEs across Victoria defies all logic.

The Only Baseline Study Conducted on Subterranean Ecosystems.

The stygofauna surveys results appear to be the major environmental factor influencing the decision to allow onshore conventional gas exploration. Chapter Fifteen has more to say regarding the rest of the VGP Environmental Baseline Studies. Studies that are not currently available for public scrutiny.

The Stygofauna Survey.

The VGP definition of stygofauna is...

“*Stygofauna are Aquatic animals that inhabit subsurface waters for their entire life cycle.*”⁽¹⁶⁾

Stygofauna live in subsurface obligate Groundwater Dependent Ecosystems.

“...obligate GDEs are below-ground ecosystems that rely on groundwater and have only recently been recognised to be as complex and dynamic as surface aquatic ecosystems (Gilbert et al. 1994).”⁽¹⁶⁾

Gilbert et al. recognised this 26 years ago. Members of the LAWROC Landcare Group have been fully aware of this and have been asking for stygofauna studies to be conducted in the Gellibrand River catchment for 20 of those years. So, it is gratifying that finally some effort has been made to study stygofauna. The Victorian Gas Program released two Regional Baseline Stygofauna Surveys in February 2020. One covers the onshore Otway Basin⁽¹⁶⁾ and the other the onshore Gippsland Basin.⁽¹⁷⁾ Needless to say these reports have been prompted by gas extraction companies’ desires to mine gas and oil from both onshore and offshore in these regions.

In 1882 Australia was in the Forefront of Aquifer Organism Studies.

The quote above from the Victorian Gas Program stygofauna survey report gives the impression that stygofauna interest is only a relatively recent development. It is interesting to note that Hurley et al.⁽⁹⁾ in 1990, stated that in 1882 Australia was at the forefront of research on aquifer organisms. However, since this date an appreciation of the diversity and extent of aquifer ecosystems has declined leading to a severe underestimation of the extent and significance of groundwater dependent ecosystems (Humphreys 2006).⁽⁸⁾

What must also be Said when discussing subterranean biodiversity and ecosystems is stygofauna are not the only things that live in subterranean groundwater dependent ecosystems.

Unfortunately, other lifeforms and ecosystems that are as complex and dynamic as surface ecosystems have been dismissed. Unless the fauna exist in the water column of an observation bore, the VGP has taken no account of them.

Some of these other lifeforms include:

- Microorganisms including:
 - Mites,
 - Fungi,
 - Bacteria, and

those lifeforms called stygophiles that have a varying degree of affinity for groundwater, inhabiting it on a permanent or temporary basis (Humphreys 2006).⁽⁸⁾

For example:

- Burrowing Crayfish
- Mudfish
- Snails

What also needs to be said is the paucity of knowledge regarding subterranean food webs, highlighting the narrowness of concentrating on stygofauna surveys in observation bore water as an indicator of what is happening in the subterranean ecosystems.

Some interesting quotes from the Stygofauna VGP reports include:

1. Stygofauna “...**are predominately found in shallow aquifers.**”
2. Their “...**diversity generally decrease with both depth and distance along groundwater flowpaths...**”
3. “...**subsurface restrictions allow for a high degree of genetic isolation (endemism)...**”
4. “**Stygofauna activity such as burrowing and feeding assist in maintaining aquifer flow paths...**”

Is the burrowing crayfish classed as stygofauna? Bill Humphreys, who has been referenced numerous times in the two Victorian Gas Program stygofauna surveys, had the following to say when I emailed him this... “**We have burrowing cray mounds up here at our house way above any wetland, creek or dam. They dig little volcano type mounds and sometimes seal them off. Would these creatures be classed as stygofauna because they obviously live underground and in the damp soils and are never seen?**”

Bill’s reply included this... “**Your burrowing cray mounds raise an interesting question. If they are obligate inhabitants of groundwater they would be stygofauna by definition. They had not crossed my horizon so well done.**” (Tuesday 17 March 2020).

5. “**The effects of a change in water pressure have not been studied: however, it is also likely to alter the suitability of habitats...**”
6. “**Stygofauna are sensitive to environmental changes and therefore are threatened by any activity that alters the quality or quantity of groundwater, disrupts connectivity between the surface and the aquifer, or reduces the pore space of an aquifer.**”
7. “**Natural fluctuation in water parameters such as seasonal water levels, EC and temperature are tolerated (Tomlinson et al., 2007)...**”
8. “**Changes in groundwater quality may occur when groundwater levels and flow systems are altered allowing inflow of poorer quality water.**”
9. “**Groundwater quality may also be contaminated by seepage of acids and heavy metals...**”

Earlier Chapters show that gas exploration and fluid extraction has already impacted in ways described above in both Gippsland and the Otway Ranges. The documentation regarding these impacts should have formed part of a desk top

study and then been incorporated into the VGP environmental studies documentation.

Comment on the Otway Ranges and the Stygofauna Study.

It has been proven beyond any doubt that the Otway Basin subterranean system has been severely impacted in the Gellibrand and Gerangamete Groundwater Management Areas.⁽⁷⁾⁽¹¹⁾⁽²⁴⁾ This would tend to suggest that any stygofauna have found life a little difficult to sustain. So much so that not one individual stygofauna was found out of 13 bores surveyed in the Gellibrand and Gerangamete Groundwater Management Areas (see red rectangle on the map below).

Stygofauna Disruptors.

Impacts that have taken place in these two Groundwater Management Areas recognised as stygofauna disruptors are:

- Flowpaths of groundwater have been altered, And at least one flowpath has been reversed.
- There is contamination of acid water and heavy metals from the Big Swamp at Yeodene, seeping into the subterranean ecosystems.
- At the Barwon Downs Borefield water levels have been reduced by 50 plus metres.
- The impact of water level drop out to the 4 metre drawdown covers a surface area of at least 480 km².
- The impact of pressure reduction has spread over a wide area.
- Subsidence has occurred.

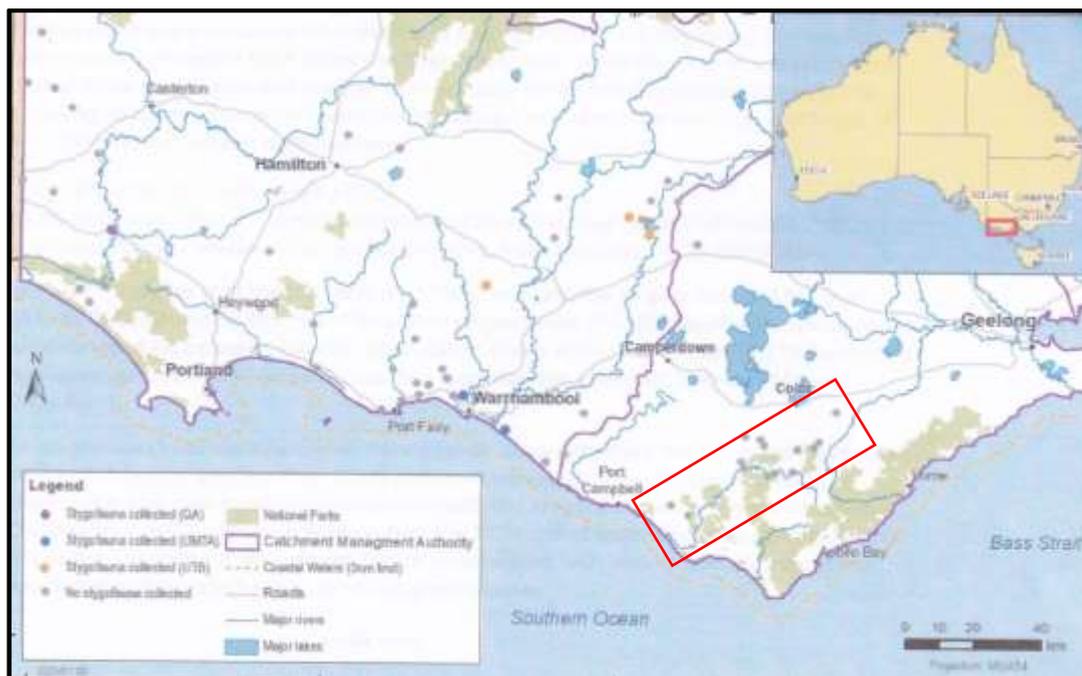


Figure 5.1 Victorian Gas Program onshore Otway Basin page 17.

The results of the Onshore Otway Basin stygofauna survey⁽¹⁶⁾ included the following: (Taken from page 16, Technical Report Number 13, VGP)

Table 5.1 Stygofauna survey results.

Bore ID	Order	Family	Size (mm)	Abundance (# of animals)	Date sampled	Aquifer
58587	Copepoda	Cyclopidae	0.5	39	21/12/2018	QA
	Syncarida	Koonungidae	5.0	1		
	Isopoda	Oniscidae	1.5	2		
95073	Copepoda	Cyclopidae	0.5	2	04/10/2017	UTB
95057	Tubificida	Enchytraeidae	2.0	40	27/03/2018	UTB
110108	Tubificida	Enchytraeidae	3.0	27	20/06/2019	UTB
	Copepoda	Cyclopidae	0.5	36		
141230	Amphipoda	Melitidae	4.0	1	16/01/2018	UMTA
141315	Copepoda	Cyclopidae	0.5	1	16/01/2018	UMTA

Table 5.2 Stygofauna repeat survey results.

Bore ID	Order	Family	Size (mm)	Abundance (# of animals)	Date sampled	Aquifer
141315	Copepoda	Cyclopidae	0.5	5	09/05/2019	UMTA
95057	Tubificida	Enchytraeidae	2.0	4	10/05/2019	UTB
58587	Copepoda	Cyclopidae	0.5	29	18/06/2019	QA

(Only 6 out of 80 bores tested contained stygofauna.)

Observation bore 110108 had 63 individual stygofauna when first surveyed and none were found when re-surveyed. This alone confirms one of the points made in the conclusion of this onshore Otway Basin survey. That is, future studies are needed and that this survey only establishes a starting point; a very basic of basic baselines.

Also, when 5 of the 6 bores containing stygofauna in the onshore Otway Basin investigation area were resurveyed only 3 of them contained individuals. The implication of this dramatic reduction in individuals has not been commented on in the conclusion of the VGP report.

The onshore Gippsland Basin stygofauna⁽¹⁷⁾ fared much worse.

1. 20 bores sampled.
2. Only 1 bore found to contain stygofauna with 5 individuals, 4 crustacea and one worm.
3. No stygofauna were found when this bore was resampled three months later.

Worth Some Thought.

Perhaps it is worth considering that the minimal individuals of stygofauna found in the Gippsland investigation area and the complete lack of stygofauna found in the Gellibrand Groundwater Management Area could be attributed to massive fluid and water extraction carried out over past decades.

“Stygofauna are sensitive to environmental changes and therefore are threatened by any activity that alters the quality or quantity of groundwater, disrupts connectivity between the surface and the aquifer, or reduces the pore space of an aquifer.”⁽¹⁶⁾ All of these things have happened in the Gippsland, Gerangamete and the Gellibrand areas.

Considerable Work to be Done.

All that can be said is there is some considerable work to be done to gain a true picture, a comprehensive baseline, of the historical and present status of stygofauna in the two areas that the Victorina Gas Program investigated. And, as with so many situations isn't it a shame that “baseline” investigations are conducted years after initial environmental damage and impact is known to have occurred. Worse still, the very first surveys of subterranean ecosystems started in 2017 and only included stygofauna, with the exclusion of all other subterranean ecosystem lifeforms.

A Narrow and Limiting Context.

Unfortunately, the context of the VGP's Subsurface Groundwater Dependent Ecosystems is extremely narrow and limited if stygofauna is the only criteria for establishing and determining the status of subterranean ecosystems.

Concluding Statement in the Otway Basin Stygofauna Survey.

The concluding statement in the Otway Basin Stygofauna Survey has many unsubstantiated statements that attempt to justify this stygofauna survey as a sound baseline data set on which sound resource management decisions can be made. The rest of this Chapter challenges the concluding statement found in the Otway Basin stygofauna survey document.⁽¹⁶⁾

Conjectures without supporting statistical data and other aspects of the stygofauna's onshore Otway Basin survey “Conclusion” are highlighted in **dark blue** below. Each of these highlighted quotes is then commented upon in the boxed table following each quote. There are many gross misrepresentations made in this technical report.

1. ***“The report has established a baseline of stygofauna taxa across the onshore Otway Basin.”***

True	False	NO Evidence Provided	Insufficient Data	Conjecture

Comment.

The purpose of a baseline assessment is to provide an information base against which to monitor and assess an activity’s progress and effectiveness during implementation and after the activity is completed. This Otway stygofauna survey fails to do this.

The statistical data results (see page 71) present an enormous number of inconsistencies and questions that should have been covered in the most basic of baseline assessments.

1. 80 observation bores were initially tested for stygofauna over an extended period of time (14 months) that covers several seasons. In the initial survey the seasonal variation is not viewed as significant but is suggested as an important influence in the follow up survey.
2. The time periods between all testing and results gained, need to be analysed. Resurveyed bores varied in time between 6 months and 16 months.
3. 80 bores were initially tested. Six contained stygofauna. Five of this six were retested. Why only five? Two of these 5 returned zero stygofauna. This indicates that all 80 bores should have been retested. How many of the original 80 would have resulted with specimens in the follow up surveying? This is particularly relevant when bore 110108 initially had 63 individual stygofauna and when retested it had none. That is if in fact it was one of the 5 retested.
4. The six bores that contained stygofauna were initially tested over a 14 months period. Considering later testing results the time periods of testing require investigation.
5. It has not been explained why only 5 of the 6 bores that initially contained stygofauna were resurveyed. Which bore was left out and not retested? Why was this done? Which bores when retested had zero specimens?
6. Bore 110108 that contained 63 individuals in the initial testing, 21 more than the next highest tally, and either was not retested or contained no stygofauna on the retesting. What has happened to this data?
7. Only 3 out of the 5 bores retested contained any individuals. Which bores of the original 6 contained no individuals when resurveyed?
8. The resurveying was done for bore 58587 six months after the initial testing; for bore 95057 fourteen months later and for bore 141315 sixteen months later. Why such a spread of time and of what significance is this?
9. Page 16 states that each of the six bores had an abundance of animals ranging from 1-40. However, bore 110108 actually had 63.
10. Further down on page 16 it states bore 110108 had 67 animals identified. Still wrong if Table 5.1 is correct.
11. There does not appear to be any statistically validation.

All that can be said from this report is that there are stygofauna individuals living in the subterranean ecosystems in the investigation areas. On the data collected there can be no claim that this survey can be used as a baseline to assess how conventional gas exploration and or extraction progress will impact on stygofauna. Neither can these results be used to determine whether stygofauna have been impacted during or after exploration and or extraction of gas.

2. ***“Variability in porosity and water quality within the unconfined aquifers also suggests the possibility of genetic isolation...”***

True	False	NO Evidence Provided	Insufficient Data	Conjecture

Comment.
 It cannot be found to be true or false as this is a conjecture.

Another possibility is that the fauna has already been affected by earlier human activities.

It is also possible that many more of the 80 observation bores would have yielded stygofauna if retested around the same time of the year that bore 110108 was found to have 63 individual stygofauna. Bore 110108 was surveyed in June while the other 5 bores were tested late or early in the year. The variability may be determined by a seasonal variation. The dates on which the initial 80 bores were tested is not included in the report.

Isolation has not been established as a cause of variability of porosity and water quality. There is insufficient data to draw any such conclusions.

3. **“The low number of bores where stygofauna were identified does not suggest the groundwater environment is of poorer ecological health. Rather the fine grain nature of sediments is suggested to be the likely limiting factor for the presence of stygofauna.”**

True	False	NO Evidence Provided	Insufficient Data	Conjecture

Comment.

1. This sentence contains a double negative that implies good ecological health with no evidence.
2. This is misleading English.
3. The lower number of stygofauna in the resurvey could logically suggest that the ecology health is decreasing and poor. The initial number of fauna was 149 individuals, whereas the resurvey found 38, a decrease of around 75%. That is extremely significant.

4. *“The low number of bores where stygofauna were identified does not suggest the groundwater environment is of poorer ecological health. **Rather the fine grain nature of sediments is suggested to be the likely limiting factor for the presence of stygofauna.**”*

True	False	NO Evidence Provided	Insufficient Data	Conjecture

Comment.

1. This sentence is just a conjecture with no evidence provided.
2. It is just as likely that significant groundwater level declines and subsidence are as likely a cause of low stygofauna numbers.
3. It is a fact it has taken many thousands of years to evolve a relative stability of groundwater and pressure levels.
4. There is an alternative reasonable conjecture. Sudden changes caused by fluid extraction has resulted in a dramatic decline in the number of stygofauna.

5. *“The taxa identified in the upper aquifers indicate that suitable habitats exist for stygofauna within in the upper unconfined aquifers of the onshore Otway Basin. However, the variety of the aquifers found to support stygofauna highlights the need for future studies to continue to assess all aquifer types and the potential for greater diversity.”*

True	False	NO Evidence Provided	Insufficient Data	Conjecture

Comment.

1. The fact that stygofauna were found in some of the upper aquifers investigated does indicate survivable habitat was present at the time of the testing. But this does not imply that habitat is suitable or sustainable (now). Because of this, there is an urgent need for more rigorous studies because there is no statistical support which suggests the presence of stygofauna is sustainable. The opposite seems possible.
2. Without further studies the data suggests there has been a significant decline over a 16 month period. Going from 149 individuals in the initial survey down to 38 in the retesting is quite significant.
3. Of the 5 bores that were retested 3 of these had stygofauna and 2 did not. This is also quite significant, especially so if bore 110108 retested with none.
4. It is also significant that it has not been shown whether bore 110108 was one of the bores that was retested or left out of the resurvey? What can be said however, is that bore 110108 may have been retested and zero individuals were found, or that bore 110108 was not even retested.
5. Which 2 bores had zero individuals when retested?
What can be said is that the data collected and presented is a shambles and of little use in any follow up survey.

6. *“The taxa identified in the upper aquifers indicate that suitable habitats exist for stygofauna within in the upper unconfined aquifers of the onshore Otway Basin. **However, the variety of the aquifers found to support stygofauna highlights the need for future studies to continue to assess all aquifer types and the potential for greater diversity.**”*

True	False	NO Evidence Provided	Insufficient Data	Conjecture

Comment.

1. It is true that follow up studies are needed.
2. In this statement there is a underlying assumption and implication that the current studies are adequate. In fact the implication is false as the studies are grossly inadequate.
3. From the scarce data collected to date there is an urgent need to carry out these future studies post haste. And, any studies must include all subterranean geological layers and be done before any further fluid exploration and or extraction.
4. Future studies must be significantly broader than the context of the initial studies as outlined on page 12 of the Technical report⁽¹⁶⁾ Table 4.1, which states the base selection criteria was:

“Preference on Lower Tertiary Aquifer (LTA), Cretaceous Permian Sediments Aquifer (CPS) and Basement Aquifer (BSE) in relation to gas potential.”

These three aquifer types were the ones chosen from within the Gellibrand and Gerangamete Groundwater Management Areas. All other geological formations were ignored. However, above the LTA, the CPS and the BSE examples that were chosen from these two Groundwater Management Areas, there are numerous other saturated layers. For example not only should the LTA have been surveyed in the Kwararren area, so should the alluvial, Quaternary and Clifton aquifers, the Narraturk Marl and the Gellibrand Marl. The Kwararren/Gellibrand region also has Karstic exposed limestone outcrops that were not surveyed.

The “...*focus on geographic regions relating to conventional gas potential and deeper hydrogeological units.*”⁽⁸⁾ overlooked many of the shallower upper confined and unconfined aquifers. (Page 15 ⁽¹⁶⁾)

7. *“The survey identified a total of 149 individual animals from five stygofauna taxa at six groundwater bores. These samples were collected from three upper aquifers (QA, UTB and UMTA). Five of the bores found to contain stygofauna were repeat sampled at least six months later to assess temporal variability.”*

True	False	NO Evidence Provided	Insufficient Data	Conjecture

Comment.

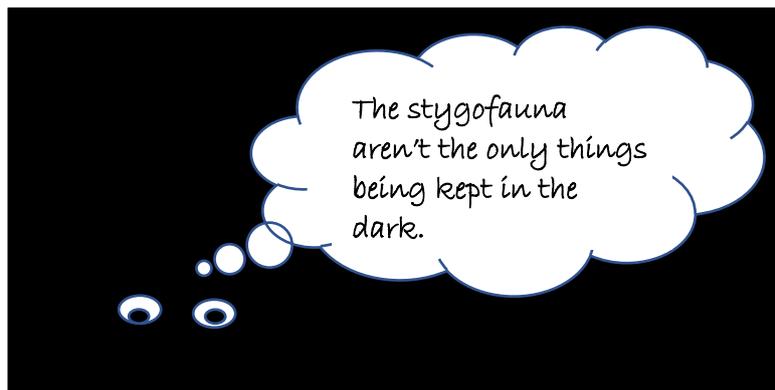
1. True, but how many taxa were missed because of the very limited geological layers investigated?
There appears to be an assumption that the various geological layers act totally independent of one another. This is not the case. For example there is upward and downward vertical leakage taking place that is influenced by pressurisation, porosity and other influences that can be easily upset by exploration and extraction activities. This is why an appropriate baseline study must include all geological layers.
2. Also, from the data presented there is every possibility that if all of the 80 bores were resampled then more stygofauna would have been found.
3. The data also suggests the timing of the testing may well have a significant influence on the collection of stygofauna and raises many questions.
 - Do the stygofauna migrate away from the observation bore water columns?
 - Does air pressure have an influence?
 - Why are the stygofauna found in the water columns?
 - Does the food source in these columns vary?
 - Does breeding have something to do with numbers found?
 - Does daytime surveying influence results? Even early or late in the day.

8. *“The survey identified a total of 149 individual animals from five stygofauna taxa at six groundwater bores. These samples were collected from three upper aquifers (QA, UTB and UMTA). **Five of the bores found to contain stygofauna were repeat sampled at least six months later to assess temporal variability.**”*

True	False	NO Evidence Provided	Insufficient Data	Conjecture

Comment.

1. Possibly true re temporal variability, but this tells only a fraction of the story and raises many basic questions. Is six months the ideal time to test variability?
2. No records including dates, have been given when the 2 bores with zero individuals were retested. Were they tested within six months?
3. Was the time of the year important? Was this, and how could this have been relevant? The 3 bores with individuals were retested 6 months (58587), 14 months (95057) and 16 months later (141315). These factors are worth pursuing?
4. Why were only 5 of the 6 bores resampled?
5. Which two of those 5 did not contain stygofauna?
6. When were these two samples taken?
7. Also, the retesting of the 3 bores containing individuals was done during winter whereas the initial testing was done during summer. Was this a significant and influencing variable?
8. Other answers that may well be pertinent is in what seasons or on what dates were the initial 80 bores surveyed? Another variable that is pertinent.
9. A question that has to be answered also is it good enough to just test for stygofauna in the water columns in observation bores? Are there stygofauna that live and stay in the aquifer layer but not in the column of water? Are there adequate conditions to sustain all species of stygofauna in the water columns?
10. The very small number of bores that were repeat sampled were not sufficient enough to indicate the existence of sustainable stygofauna? The sample is far too small to give any statistical credibility.
11. The data has not been collected using any scientific method that takes into account and records the most basic variables.
12. In summary there is insufficient data to assess temporal variability.



9. *“The Victorian Gas Program conducted a regional baseline stygofauna survey to determine whether any stygofauna taxa exist within the aquifers of the onshore Otway Basin, and if possible, determine distribution ranges for potential conservation value. The information collected within this report will provide a guide to likely stygofauna populations and subsurface groundwater dependent ecosystems throughout the onshore Otway Basin.”*

True	False	NO Evidence Provided	Insufficient Data	Conjecture

Comment.

1. Yes, the survey did determine that stygofauna was in fact present within some of the aquifers of the onshore Otway Basin.
2. However, unless all aquifers were tested within the onshore Otway Basin area this is of little value and cannot be claimed as a baseline data set.
3. In any baseline study there must be a component establishing the degree of sustainability of the stygofauna.
4. But, without clearly defining and describing what is meant by baseline this report is meaningless.
5. When things are written as spin with a smidge of truth giving it an image of competence, and, without supporting data, places the whole statement in the realm of conjecture.

10. *“The Victorian Gas Program conducted a regional baseline stygofauna survey to determine whether any stygofauna taxa exist within the aquifers of the onshore Otway Basin, **and if possible, determine distribution ranges for potential conservation value.** The information collected within this report will provide a guide to likely stygofauna populations and subsurface groundwater dependent ecosystems throughout the onshore Otway Basin.”*

True	False	NO Evidence Provided	Insufficient Data	Conjecture

<p>Comment.</p> <ol style="list-style-type: none"> 1. This statement does not say anything true. What exactly does it say? 2. With only three positive results and two negative results when resampling, the data cannot claim to have established a distribution range or potential conservation value. 3. Insufficient and huge data gaps must be filled to go even close to determining the distribution range of the stygofauna. Does the stygofauna have a wider range in which it moves than just in observation bore water columns? 4. Is the observation bore water a suitable habitat for stygofauna to remain in throughout the seasons? 5. Does the quality of the water vary seasonally or after extraction activity?

11. *“The Victorian Gas Program conducted a regional baseline stygofauna survey to determine whether any stygofauna taxa exist within the aquifers of the onshore Otway Basin, and if possible, determine distribution ranges for potential conservation value. The information collected within this report will provide a guide to likely stygofauna populations and subsurface groundwater dependent ecosystems throughout the onshore Otway Basin.”*

True	False	NO Evidence Provided	Insufficient Data	Conjecture

Comment.

1. As stated earlier to gain a true indication of the sustainable subterranean flora and fauna it would have been much more appropriate to concentrate on subterranean ecosystems not just ground water dependent ecosystems.
2. It has not been made clear how the onshore Otway Basin stygofauna survey has contributed to providing a guide to subsurface groundwater dependent ecosystems as stated above.
3. A thorough scientific and technically rigorous survey would have had a better chance of providing a guide and baseline of stygofauna populations. The survey results as present in the 13th Technical report failed to do this.
4. Considering the number of variables and unknowns it is difficult to understand how it can be claimed that this survey is applicable as a guide to an area throughout the onshore Otway Basin.

Future Use of this Study Results.

It has not been shown how this stygofauna study will be used in the future. Will another survey be done at some future date in an attempt to determine whether the onshore exploration has had an impact on the status of stygofauna? Possibly. Perhaps it will be used as an indication that gas extraction can proceed. Based on the quality of this 2020 survey anything is possible.

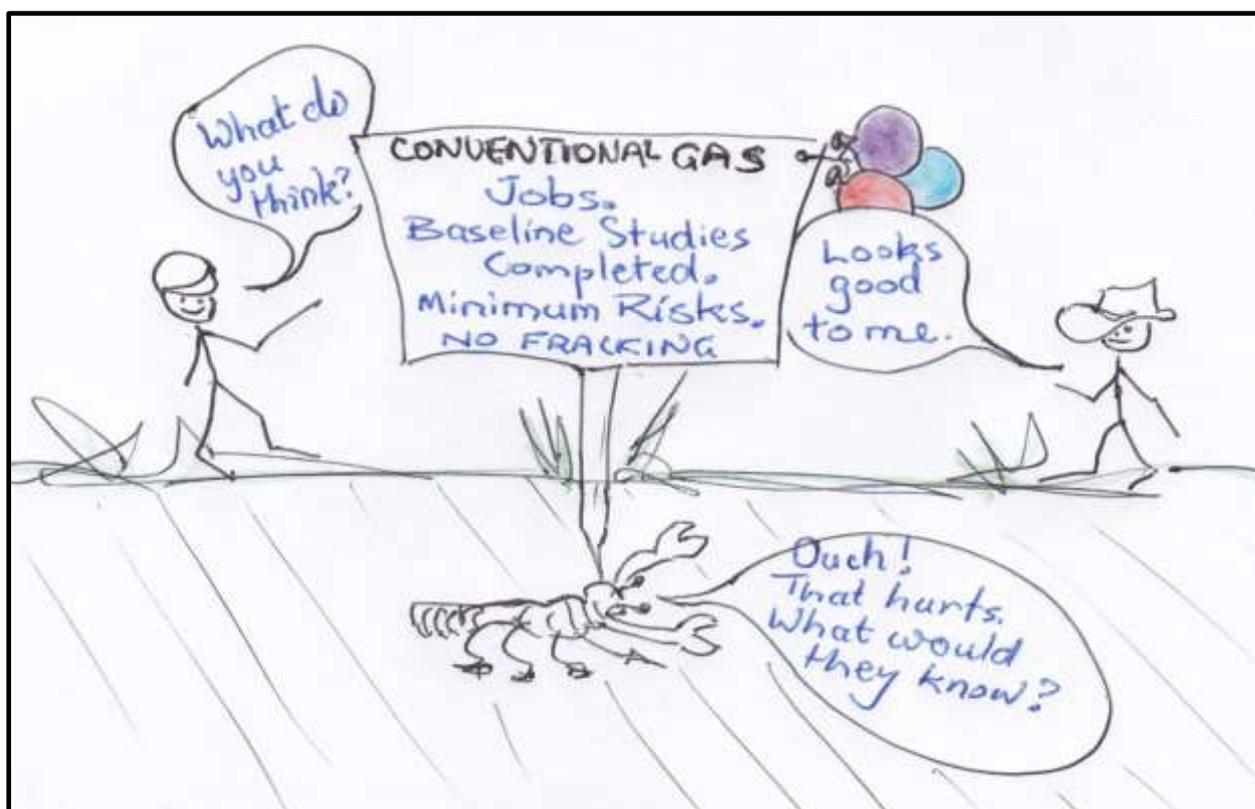
SUMMARY of Chapter Twelve.

It is a sorry state of affairs that the conclusions drawn from an Otway Basin stygofauna report have been used to inform and justify the granting of exploration rights for onshore conventional gas exploration.

1. A very narrow and limited number of subterranean geological structures were involved in the stygofauna survey,
2. of the 80 bores surveyed none of them are nested in the same location so that ALL structures within that area were investigated,
3. the scant data that has been collected contradicts the conclusions,
4. there is no data presented that supports the conjectures,
5. data gaps are enormous,
6. there is no evidence of any scientific assessment of the data or statistics,
7. the onshore Otway Basin survey does not provide a stygofauna baseline on which informed decisions can be made,
8. the Otway Basin stygofauna report provides no assessment of benefits, risks and dangers to stygofauna or the groundwater dependent ecosystems they live in, and

there is no information about benefits, risks and dangers that can assist with informed decision making.

Ouch!!



CHAPTER THIRTEEN

- Social Engineering by the VGP?

A phone survey was conducted by CSIRO on behalf of the Victorian Gas Program (VGP) in an attempt to gain what the communities of the Gippsland and Otway Basins felt about onshore gas exploration. This chapter discusses aspects of the results as presented in the VG Program's final report.⁽¹⁸⁾

For purposes of this Chapter I have defined Social Engineering as...

"the use of centralised planning in an attempt to manage social change and regulate the future development and behaviour of a society."

Pages 31-35 of the VGP Report No.4,⁽¹⁸⁾ discusses and summarises the results of a survey conducted by the CSIRO on a randomly selected and representative sample of 801 residents from the Otway Basin and Gippsland Basin areas. The VGP's analysis of the CSIRO report has been presented in such a way that it can only be described as manipulating the results in favour of onshore conventional gas exploration.

To Measure Attitudes and Perceptions.

"The survey comprised more than 160 questions designed to measure residents' perceptions of community wellbeing, as well as local attitudes towards on shore conventional gas."⁽¹⁸⁾ Note: to measure perceptions and attitudes.

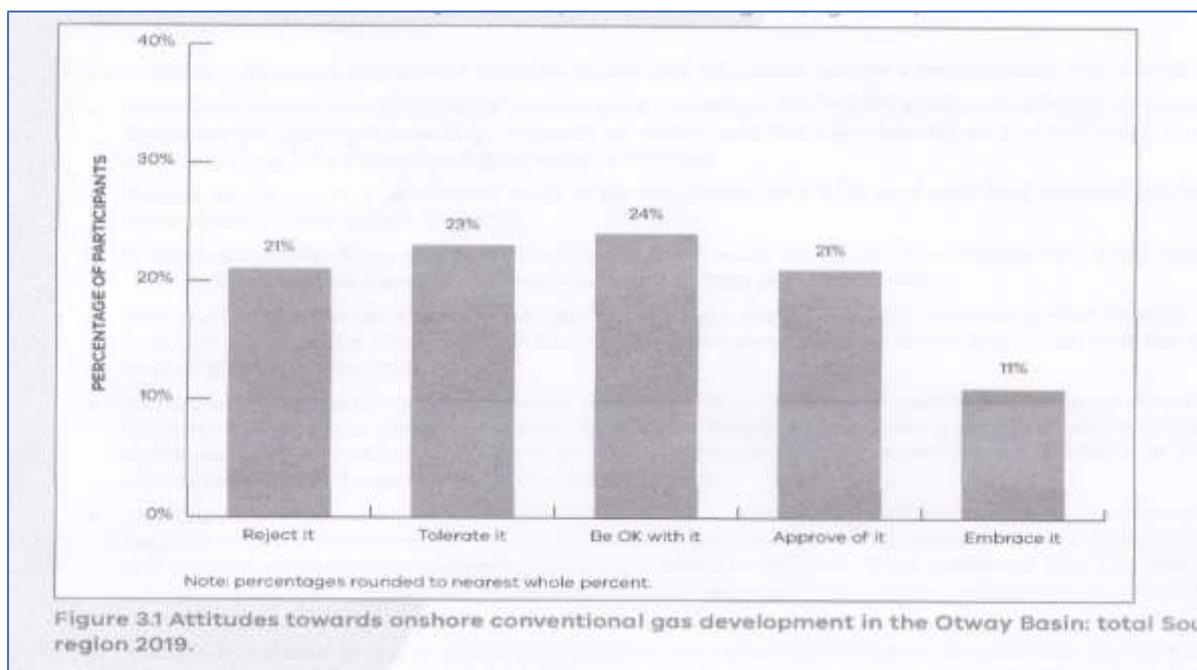
The Survey did not Query Knowledge and Understanding.

And, the aim of the survey was...

"...to provide a statistically robust understanding of community wellbeing and regional attitudes to onshore conventional gas development in the Otway and Gippsland basins."⁽¹⁸⁾ Note: no mention of any attempt at determining community levels of knowledge and understanding of conventional gas exploration and or possible risks.

Start of the Engineering.

Regarding the Otway Basin region, the VGP authors combined and summarised responses in the CSIRO report and concluded that 79% of people would *"Tolerate"* *"Be OK with"* *"Approve of"* or *"Embrace"* onshore conventional gas development in the region (see Figure 3.1 below).



This lumping together of “*Tolerate it*” “*Be OK with it*” “*Approve of it*” or “*Embrace it*” and stating nearly 80% of people are prepared to accept onshore conventional gas gives the impression the majority of people would be “happy” to see onshore conventional gas go ahead.

Without any manipulation the graph indicates 21% would “*Reject*” the idea while only 11% would actually “*Embraced it.*”

Adapting to onshore conventional gas development

Fifty-nine per cent of residents in South-West Victoria thought their community would adapt or do something better in response to onshore conventional gas development (Figure 3.2).

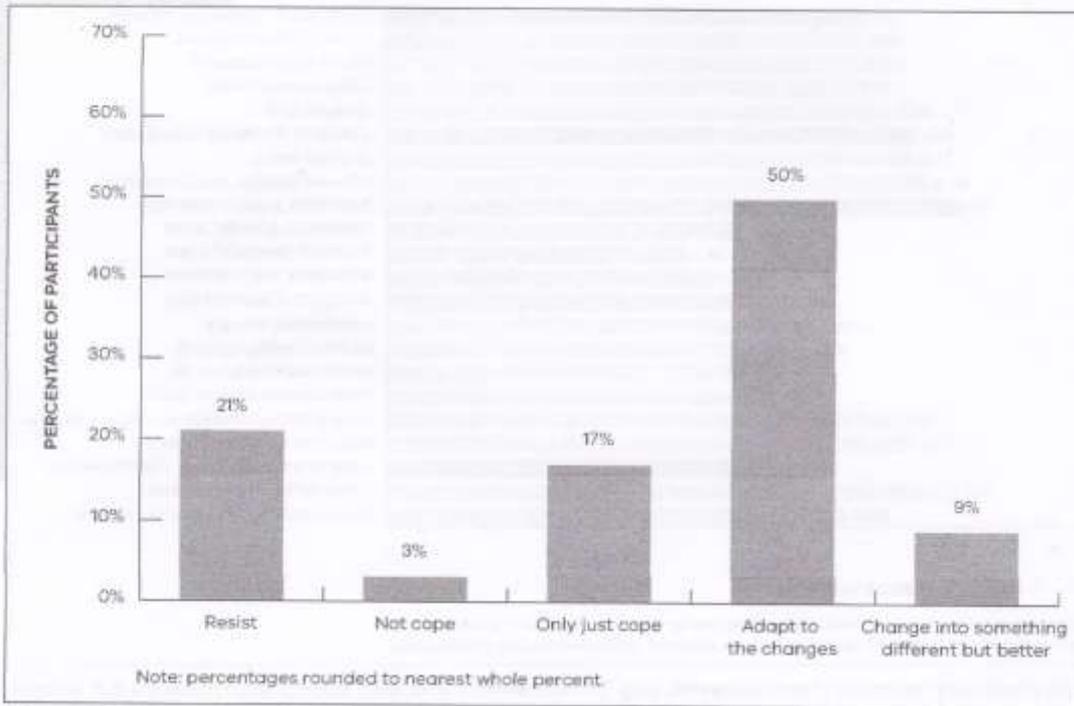


Figure 3.2 Perceptions of community adapting to onshore gas development: South-West region, 20

More Manipulation of the Results.

The graph, Figure 3.2, is interpreted by the VGP authors in a similar way, combining responses together to arrive at 59% of the community being prepared to adapt or “*Change into something different but better*”. This 59% is loaded towards accepting change especially when the change leads to and suggests something “*better*.” After all who would not adopt a change to something “better”?

Whatever that means.

The VGP summary fails to highlight that 41% would “*Resist*” “*Not cope*” or “*Only just cope*.” More importantly the VGP summary does not compare the two extremes of this graph. Only 9% thought the community would “*Change into something different but better*,” whereas 21% would “*Resist*.”

When categorising people’s responses under these headings, what were the interviewees actually asked? Under what conditions would they “*Adapt to*” or “*Tolerate*” onshore gas development? Also, what does “*adapt*,” “*tolerate*,” or “*cope with*” mean? What actually did the survey ask?

No Evidence of Robustness.

The VGP⁽¹⁸⁾ states that the CSIRO survey is “robust,” adequately covering community wellbeing, regional attitudes and perceptions. Simply stating that a survey provides a statistically robust result does not make it so. In the VGP final report⁽¹⁸⁾ there is no clear evidence to support the notion of robustness.

No Qualitative Research for Understanding and Knowledge of the Issues.

Also, this community survey was a “*Quantitative research*” project with the stated aim that it would...

“provide a statistically robust understanding of community wellbeing and regional attitudes to onshore conventional gas development.”

However, quantitative research of community wellbeing and attitudes is not always amenable to ‘robust’ statistical analysis. Such analyses/surveys can be carefully constructed to limit the often more rigorous qualitative understanding of attitudes and perceptions. Why didn’t the VGP authors insist on a qualitative aspect to the survey as well? One could question the ‘depth’ and ‘rigour’ of a social-oriented study that just relies on quantitative analyse gained over the phone.

Graphed results indicate that there are a range of views and perceptions about onshore conventional gas, and, lumping varying attitudes under a positive 80% statement appears to indicate a weakness in using the CSIRO’s quantitative research without a qualitative component.

Robust research surveying such social or psychological variables generally requires at least a strong qualitative component. Open-ended questions and exploring what participants *actually base* their attitudes and perceptions on is required.

Knowledge and Understanding Limited.

Figure 3.3 below shows that knowledge levels of onshore conventional gas development and an understanding of the differences between conventional and unconventional gas was limited. The Figure shows an extremely high level “*Need for more information*”. This is an important point. How can government be influenced to approve something on the basis of people’s limited understanding (see Figure 3.3 below)? It was made quite clear by those being surveyed there was a demand for more information. They lacked knowledge to make an informed comment. Resource management decisions made by a Government need to be based on more than perceptions and attitudes. Perceptions and attitudes based on a limited knowledge too often lead to disastrous decisions.

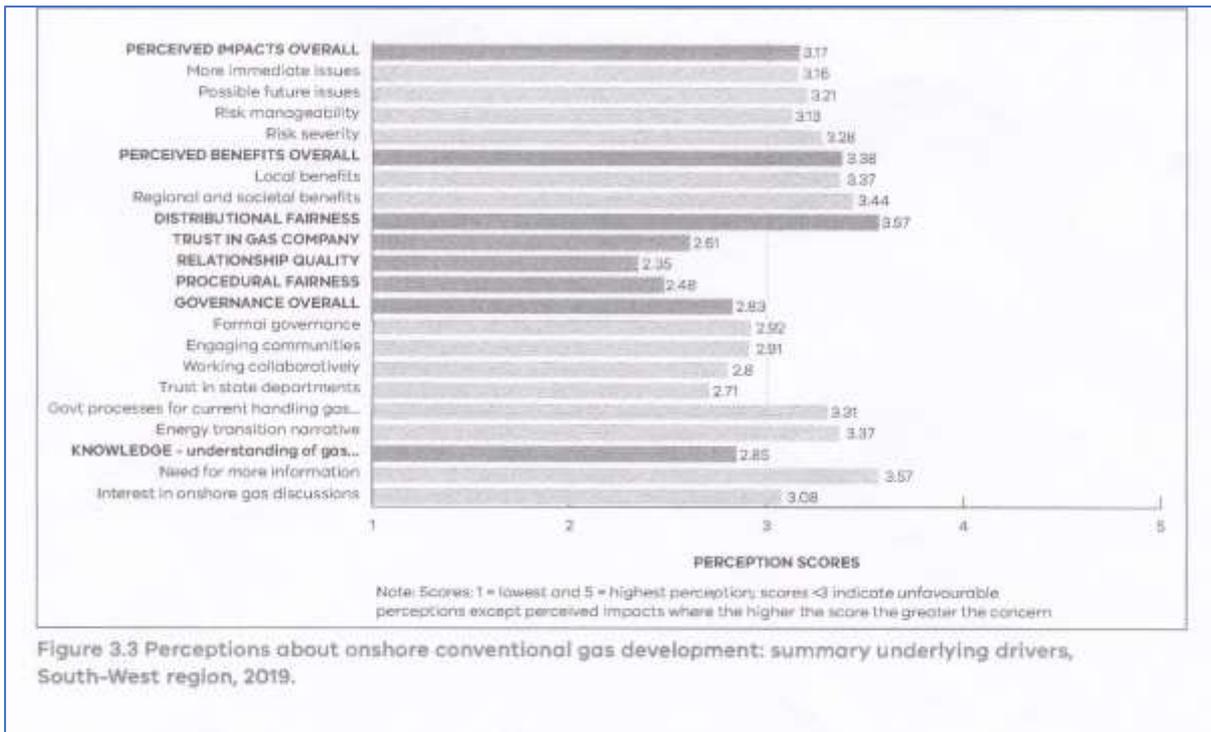


Figure 3.3 Perceptions about onshore conventional gas development: summary underlying drivers, South-West region, 2019.

Was Fracking Mentioned?

Another question that needs to be answered is whether participants were told that fracking was definitely not being contemplated (see Appendix 5, page 103). In many sectors of the community the notion of fracking or unconventional gas extraction is seen as extremely detrimental to the environment and to be avoided at all cost. Would this “soften” any negative thoughts, perceptions and attitudes about onshore conventional gas development?

Difficulty Accessing the CSIRO Report.

To view and study the CSIRO report would be desirable but could be difficult. The 4th and Final Victorian Gas Program report does not reference or detail how the CSIRO telephone survey report can be accessed.

An Aim of the Victorian Gas Program’s Community engagement is “To Inform and Educate”.

As stated earlier this survey does not cover the level of knowledge the community has regarding gas and oil extraction activities within Victoria. For example are they aware of the onshore impacts caused by gas and oil extraction off the Gippsland coast? What about the oil and gas activities offshore in the Otway Basin? Has the onshore Otway Basin been impacted in a similar fashion? What does gas extraction do to aquifer pressures and what impact does this have on the onshore and offshore subterranean ecosystems? On page 31 of the VGP 4th and Final report,⁽¹⁸⁾ one of the aims of the community engagement program was to “*inform and educate.*” Has this been done? It doesn’t appear that way. Do those people surveyed have the knowledge on which sound

perceptions and attitudes are based? From what has been presented in the Final 4th VGP report, this seems doubtful.

Were the Results Skewed?

Section 3.1.1 of the 4th VGP Final report is skewed by the VGP authors in favour of gaining an overall positive community response to onshore conventional gas development.

These concluding words at the end of the VGP report under “Summary of Findings” highlights this skewedness, and reads as follows:

“About 80 per cent of the South-West and Gippsland communities would embrace, support or tolerate onshore conventional gas development. Community support would be enhanced by providing genuine engagement opportunities and more information about industry activity and how the community’s interests are being managed.”

This is a case of social engineering based on mis-information in an attempt to claim social licence.

“the use of centralised planning in an attempt to manage social change and regulate the future development and behaviour of a society.”

SUMMARY of Chapter Thirteen.

The 2020 4th Victorian Gas Program Final report summarises the telephone survey conducted by the CSIRO and includes inappropriately, a statement of conclusion that...

“About 80 per cent of the South-West and Gippsland communities would embrace, support or tolerate onshore conventional gas development.”

The CSIRO report was surveying community perceptions and attitudes. From the VGP summarisation of this report there was no mention of attempts to determine the communities’ knowledge of processes, risks and impacts that accompany conventional gas exploration and extraction. Nothing indicated that an attempt was made to determine whether the communities’ perceptions and attitudes were reached from an informed basis.

The VGP section on social aspects of the program is an attempt at social engineering favouring onshore conventional gas extraction.

The social engineering and manipulation of results by the VGP should not be accepted by and influence decisions made by government resource managers to proceed with onshore conventional gas exploration in Victoria.

CHAPTER FOURTEEN – Extended Reach Drilling.

This article in the Colac Herald on 27 April 2020 could well be regarded as an



example of why attitudes, perceptions and thoughts of wellbeing need to be knowledge based (see Chapter 13). This is especially so if governments make decisions on attitudes and perceptions.

Page | 91

In this article it is reported that Beach Energy will begin “**extended reach drilling**” 6 km offshore of the Port Campbell National Park in the second half of 2020. If one is not overly concerned with offshore exploration but has serious doubts over onshore activities, this article could pass unnoticed. However, if one researches the definition of “**extended reach drilling**” any perceptions, attitudes and initial thoughts of wellbeing may change. Levels of concern would be aroused and suspicions of transparency would be heightened.

Some of the definitions of “*extended reach drilling*” found on the web are:

1. It is directional drilling of a very long horizontal well.
2. It is drilling a well horizontally from a borehole that is begun as a vertical bore.
3. It is drilling a well horizontally to at least twice its vertical length.
(In 2015 the record horizontal length of extended reach drilling was 12 km)

In which direction is the horizontal reach drilling intending to go? Will the 6km offshore extended reach drilling reach as far as the shoreline of the Port Campbell National Park? Will the drilling extend further inland? All of these questions focus on the degree of transparency and the knowledge levels that influences the perceptions, attitudes and thoughts of wellbeing of a community.

See page 108 – Beach Energy struck gas 3.5 km offshore in the Otway Basin.

Otway Water Book 57 “*Groundwater, Gas and Oil Depletion and Surface Wildfire*”

CHAPTER FIFTEEN

- Environmental Baseline Studies (VGP).

In the 4th VGP Final report⁽¹⁸⁾ a two page summary of the Environmental Impacts for the Otway Basin were discussed. The impacts dealt with in the VGP program were:

Page | 92

1. Greenhouse gas emissions,
Results for all scenarios found “*...all scenarios are expected to deliver a minor negative impact on absolute greenhouse gas emissions.*”
2. Groundwater and surface water quality and quantity,
“*The groundwater impact modelling showed that impacts on groundwater quantity and quality would be negligible...*”
3. Affected native flora and fauna.
“*No benefits or impacts were identified for this receptor.*”

There would appear to be a significant mismatch between these statements and observable and real impacts experienced in the onshore Gippsland Basin area. And how these statements apply to the onshore Otway Basin region is anybody’s guess. But, what can be said is that if a full scale environmental impact investigation is mounted the resulting statements made above would be markedly different.

The 3rd VGP report⁽¹⁹⁾ also included these statements:

- “*Previously, the Victorian Water Science Studies (State Government Victoria, 2015) carried out a regional scale assessment of conventional development in the Otway Basin and found the potential impacts to ecosystems and water use were low.*”
- “*All environmental data collected as part of this study (the VGP study/final report) will be publicly available upon completion of the program.*”

Request For Environmental Data Referred to in the Final VGP Report.

A request for a copy of the environmental data and studies as mentioned above prompted the following reply. (See also page 54, for the list of baseline studies not made available as of June 2020.)

RE: Environmental studies

From: VGP (DEDJTR) (vgp@ecodev.vic.gov.au)
 To: otwaywater@yahoo.com.au; vgp@ecodev.vic.gov.au
 Cc: emma.vagg@ecodev.vic.gov.au
 Date: Wednesday, 8 April 2020, 12:51 pm AEST

Hi Mal

Thank you for your email.

The Victorian Gas Program has undertaken a number of environmental studies in both the Otway Basin and Gippsland Basin. These include regional stygofauna sampling, groundwater sampling and chemistry analysis, air methane and carbon dioxide surveying. The project also undertook a groundwater review and modelling of the impact of potential that a potential onshore conventional gas industry may have on regional groundwater systems.

These reports are progressively being published and will be available on the VGP webpages on the earth resources website.

Your contact details are on the Victorian Gas Program (VGP) stakeholder database, and we'll provide regular updates as the scientific studies conclude.

regards

Grant

Grant Clarke | Manager, Community Engagement
 Geological Survey of Victoria | Resources Branch
 Department of Jobs, Precincts and Regions

It is Now November 2020.

It would appear despite the Final report being completed in March 2020 there are still scientific reports yet to be released, reports containing the environment data that were asked for. This seems to be the wrong way around; finish and publish the final report and then release the data on which this report has been based.

SUMMARY of Chapter Fifteen.

This Chapter discusses the lack of publicly available environmental data on which the 4th and Final Victorian Gas Program bases its environmental studies.

Otway Water Book 57 *“Groundwater, Gas and Oil Depletion and Surface Wildfire”*

CONCLUSION.

There can be no doubt that one of the contributing factors elevating the Gippsland fires to catastrophic levels has been the lowering and depressurisation of the onshore groundwater levels resulting from the offshore fluid extraction in Bass Strait. The tell-tale warnings should have been ringing alarm bells decades earlier. Local historians and citizen scientists' observations of a slow and insidious decline in wetlands, spring and stream flow have largely been ignored. Even the results of the proven case that prompted a \$5 million compensation package to farmers because of offshore gas extraction lowering groundwater levels, is only a band aid solution; a form of reactive management and has been totally focused on the decline in groundwater availability for farming enterprises. Masking of and compensating for the continued decline in onshore groundwater levels ignores future consequences of groundwater depletion. There is no long-term disaster plan other than to rely on groundwater levels returning once offshore fluid extraction ceases. However, considering new offshore fields are planned to come into production in 2021 this seems some way off. And, onshore conventional gas exploration is set to return late in 2020 to mid 2021.

It also defies all logic that Southern Rural Water in a 2018-19 report, accepts it as sustainable when the Gippsland Basin groundwater levels are continuing to drop one metre a year. Anywhere else, such as in the Gerangamete and Gellibrand Groundwater Management Areas of the Otway Ranges, declines where extraction exceeds recharge have been recognised and regarded as groundwater mining creating massive surface ecosystem impact - an impact rigorously denied for decades by those stakeholders benefitting from the fluid extraction.

The results of onshore and offshore subterranean fluid extraction in the Otway Basin are showing symptoms that indicate a similar fire dilemma fate as has been experienced in Gippsland. If the situation remains as it is, it is just a matter of time before the Otway Ranges bursts into flames.

But what is most alarming, is that the problems and impacts experienced in the Gippsland and Otway Basins are to be compounded with the allowing of onshore conventional gas exploration and extraction. The Victorian Gas Program in its 4th and Final report, denies there has been any environmental impact from conventional gas extraction over the last 100 years. This is an astounding statement but is an understandable conclusion when baseline studies lack social, scientific and technical rigour and are skewed in a manner supporting the advancement of future onshore conventional gas exploration and extraction.

ACKNOWLEDGEMENTS.

To Kitti who keeps me on the straight and narrow and drags me out of the abyss that I sometimes start to fall into when thinking of the way we treat this planet; to Charlie Kohout for his scientific and technical expertise and to Dr. Marina Lewis for her insight into social justice.

Appendix One.



The Place To Be

Media release

From the Minister for Water

Page | 96

Tuesday, 9 September, 2008

\$5 MILLION ASSISTANCE PACKAGE FOR YARRAM FARMERS

Yarram farmers affected by falling groundwater levels in the Latrobe Aquifer will benefit from a \$5 million financial assistance package.

The Victorian Government will contribute \$1.4 million to the package and the Commonwealth Government will contribute \$3.6 million.

Mr Holding said the assistance package would help minimise the financial impact of declining groundwater levels on local irrigators.

"Gippsland irrigators who have been affected by falling groundwater levels in the Yarram area will now be able to access financial assistance," Mr Holding said.

"Groundwater levels in the Latrobe Aquifer have been falling by approximately one metre annually for the last 30 years.

"This significant decline has meant irrigators have had to deepen bores, lower their pumps or drill new bores, and faced increased pumping costs.

"This assistance package has been several years in the making and is a good outcome for farmers in the region.

"A groundwater management plan is also being developed to manage the aquifer on a long-term sustainable basis."

Decisions about funding levels and the components of the assistance package were made following investigations into the falling groundwater levels and impacts on users by expert consultants.

A CSIRO study found that the major cause of the falling groundwater levels was off-shore oil and gas extraction activities from the Commonwealth Government.

A community engagement process was administered by the Latrobe Aquifer Reference Group, which included consultation with farmers and other stakeholders, as part of the study.

Mr Holding said financial assistance for irrigators would be administered by the Rural Finance Corporation and commence in the coming months.

"Irrigators will receive a letter from the Rural Finance Corporation advising them of the next steps," he said.

Appendix Two.

The information in this Appendix has been taken from Professor Lance Endersbee's book "A Voyage of Discovery," (2005)⁽²⁷⁾

- *"There are resources of groundwater underlying most of the flat lands of the world."*
- *"Well over one half of the peoples of the world depend on groundwater for part or all of their water supply, in India, China, Bangladesh, Pakistan, the Middle east, North Africa, Europe, and America."*
- Due to mechanisation and water demand from around the 1950's *"Almost simultaneously, all around the world the wells began to dry up."*
- *"The groundwater rush was like a gold rush, it was a great uncontrolled bonanza."*
- *"In the natural state, prior to intervention to exploit the resources, the underground reservoir was filled to the brim, and overflowed naturally at springs, and into lakes and streams."*
- In China *"... groundwater is being extracted for water supply for cities, industries and agriculture"* *"The northern agriculture areas of China are virtually drying: the major rivers have ceased to flow in the dry season."*
- *"The pumping in the North China Plain has resulted in the entire area subsiding."*
- Endersbee believed that the groundwater extraction in the 13th Century is part responsible for the lean on the Leaning Tower of Pisa.
- *"India is mining aquifer waters in virtually all states, and water tables are steadily falling, in some cases by 1 metre each year."*
- *"Half of the country's (India) traditional hand-dug wells have already run dry, as have millions of bored wells."*
- Endersbee discusses groundwater problems in the USA, Libya, Mexico, Iran, Yemen and explains that *"...the present understanding of the origins of groundwater by professionals is not consistent with what is actually happening. The theory is not working out in practice. There is a global disaster, and the key experts are silent."*

Appendix Three.

From: "Ben Sheppard" <bens323@bnpbond.com>
To: <[redacted]@dadbl.vic.gov.au>
Date: 03/07/2014 06:42 PM
Subject: Impacts of oil and gas extraction.

Hello Mark, Thanks for taking my phone call today, and for your openness and honesty on the Community Consultation Day in Colac, on Thursday 26th June. I did tell you that in the late 2000s I was introduced by a friend to a man called Tom ("Call me Tom the Pom") who at that time was one of the managers of BP's eastern Bass Strait oil and gas field. Tom told me that one of the

13/02/2020 Yahoo Mail - Fwd: Impacts of oil and gas extraction.

biggest issues his team faced was a problem; as the oil and gas was being extracted from the seabed, so the levels of water in dams and lakes on the adjoining landmass were falling: presumably draining in to fill the spaces created by the oil/gas extraction. This is a serious issue. In the Colac Herald approximately two years ago I spotted that four petroleum extraction permits were being sought, covering roughly the top of the Otways from Lavers Hill to Beech Forest. The West Barwon Dam, near Barramunga, supplies water to Geelong. Given the inter connectedness of the subterranean aquifers, is it possible that gas/oil mining on the Otway ridge could pose a threat to Geelong's water supply?

For a successful gas/oil well to be drilled (on shore) in the Otways there would be little water produced (<5 ML/year) and the prospective geology is tight and is not significant water bearing unit (not an aquifer). In Bass Strait and Otway off-shore fields however, the geology is different, the gas/oil is located in the same geology as Gippslands' deep aquifer (Latrobe Group aquifer - a significant water resource). In short, gas/oil mining in the Otways would not extract water volumes anything like the Bass Strait fields.

I do a lot of coastal and ocean sailing, so I know there are two gas rigs west of Cape Otway. I understand these rigs supply gas from Portland to the west, and Colac to the East. So is there a difference between oil extraction and gas extraction on their potential to lower aquifer levels on the land mass?

Good question. I wondered the same thing a few months ago. From review of all deep groundwater monitoring bores near the Cape Otway coast there is no indication of falling water levels due to off-shore extraction. In time, the on-shore deep aquifer maybe impacted, but the Otway off-shore extraction volumes are nothing like the volumes extracted in Bass Strait, so the water level impact would be small (probably falls of <1 - 5 cm/year - at a guess - compared to 30 cm/year in Gippsland)

The only other rig in Bass Strait that I know of is roughly on a line between Low Head (entrance to the Tamar river) and Port Phillip Heads. Maybe 40 to 50 miles south of the Victorian coast. I do not know whether this rig is doing oil or gas. Given that the average depth of Bass Strait is about 80 metres, I guess all of it is very accessible for exploitation. I have never seen swells any bigger than 6 to 8 metres in Bass Strait, but encountered 18 to 20 metre swells sailing across to NZ in April of last year on a 12 metre sailboat. In early August 2011, I was navigator on a 52 foot yacht sailing from Melbourne to Southport. We sailed around the bottom of Wilson's Prom, then left Clifty Island to port (on our left hand side), from there it is a straight run through the rigs to a position south east of Tuna rig. Not this time. Geo surveying vessels pushed us right down to the edge of the exclusion zone, somewhere I have never sailed before. So the march is obviously on to exploit as much gas/ oil as possible in eastern Bass Strait. From a hydrogeologist point of view, does this extended exploration/exploitation pose further threat to water levels of dams, reservoirs and large masses of water on the SE coast of Victoria?

The further the gas/oil extraction goes off-shore the less the impact maybe felt. Having said that, there is a lag time between off-shore groundwater extraction and on-shore water level change which depends on the distance from the coast. In short, yes it may impact Gippsland, but no other areas due to the basin the gas/oil is located in.

How far south of the coastline do you have to go so that oil/gas extraction does not have a deleterious affect on water basins on the mainland?

That's a hard one...the further away the lesser the impact. Based upon current extraction rates, it's more a function of time to impact rather with a sub-dued impact.

How far from the coast do the aquifers travel under the seabed?

In Gippsland and the Otways, generally 100-120 km.

To Tasmania?

No

2/3

13/02/2020

Yahoo Mail - Fwd: Impacts of oil and gas extraction.

I listened to an ABC radio program some time back that maintained that rain that fell in New Guinea flowed under the continental land mass of Australia, and exited south of South Australia into the Southern Ocean.

That's a wives tail - not true.

Thanks for your patience, Mark.I look forward to your reply. Ben Sheppard.



GAS BACKFLIP

Colac Herald 18/03/2020

Activist angry as Victoria looks to resume gas drilling

A Victorian Government fossil fuel policy backflip has angered environmentalists but could provide an economic boost to the Colac district.

The government introduced bills in Parliament yesterday that would allow onshore conventional gas exploration from July next year, after a moratorium banned the practice in 2017.

The proposed legislation would

permanently outlaw unconventional exploration methods such as fracking.

Deans Marsh resident and Doctors for the Environment Australia member Lis Bashford said the move flew in the face of the State Government's commitment to bolstering the renewable energy sector and addressing climate change.

"I think any government that is

serious about addressing climate change cannot be approving fossil fuel expansion; it does not make sense," she said.

"They're trying to please the fossil fuel companies on one hand and they're trying to look as though they're doing something about climate change. I don't think they can be taken seriously."

Ms Bashford also criticised the timing of the government's decision

and said panic surrounding COVID-19 would deflect pressure away from the government for its shift in policy.

The government based its decision from three years of research from its Victorian Gas Program, which it said "found an onshore conventional gas industry would not compromise the state's environmental and agricultural credentials".

But Ms Bashford said the government's justification missed the bigger picture.

"It's very short-sighted to not look at the global picture, to say Victoria's okay so we can dig up more gas," she said.

But the decision has backing from business leaders and the Colac district could be one of the biggest financial beneficiaries.

CONTINUED ON PAGE 2

Mixed reaction to State Government revival of gas exploration

CONTINUED FROM PAGE 1

Corangamite Shire mayor Neil Trotter advocated for scrapping the ban in January and said the shire missed the economic boost from previous exploration projects.

He said earlier this year that he expected Co-

rangamite to be a popular exploration site for gas prospectors, and companies could use the shire's existing wells for underground gas storage.

The Victorian Government estimated gas exploration projects could generate up to \$310 million per year and create 4400 jobs

across the state.

"We're backing the science to create jobs, boost energy supply and support regional communities across the state," Premier Daniel Andrews said.

The Victorian Chamber of Commerce welcomed the move and said removing the moratorium had

been a "long-standing priority".

"We have strongly advocated for it to be replaced with a regime to manage the risks of individual gas supply projects on a case-by-case basis," chamber chief Paul Guerra said.

The government said it would work with indus-

try and communities to develop "rigorous engagement and transparency obligations, and improve the regulatory framework" and support landholders to negotiate access rights and compensation for exploration projects.

The bill appears certain to pass as legisla-

tion because of its support from both sides of parliament.

The State Opposition said the decision was overdue, after Coalition MPs ramped up pressure on the government to lift its moratorium last month to create jobs, boost reliability and slash power bills.

Colac Herald 19 June 2020

State's now open to gas exploration

BY BILLY HIGGINS

South-west Victoria could be a big winner from the resumption of onshore gas drilling in Victoria from next year after State Parliament lifted a ban on exploration.

The state's upper house passed a petroleum legislation bill this week with support from both sides of parliament, with the changes mooted to boost rural economies.

Energy companies can resume exploration and development from July next year once the government establishes regulations, with its process to include community consultations.

Corangamite Shire mayor Neil Trotter supported the move and said gas provided a reliable energy source for homes and the region's energy-hungry dairy industry.

"Our view is there's a big need for energy in this area and at the moment renewables can't meet the need, and won't for a number

of years," he said.

Cr Trotter said the shire could reap substantial economic benefits if exploration resumed within its borders, with energy companies being significant employers and ratepayers and contributing heavily to businesses and community organisations during previous projects.

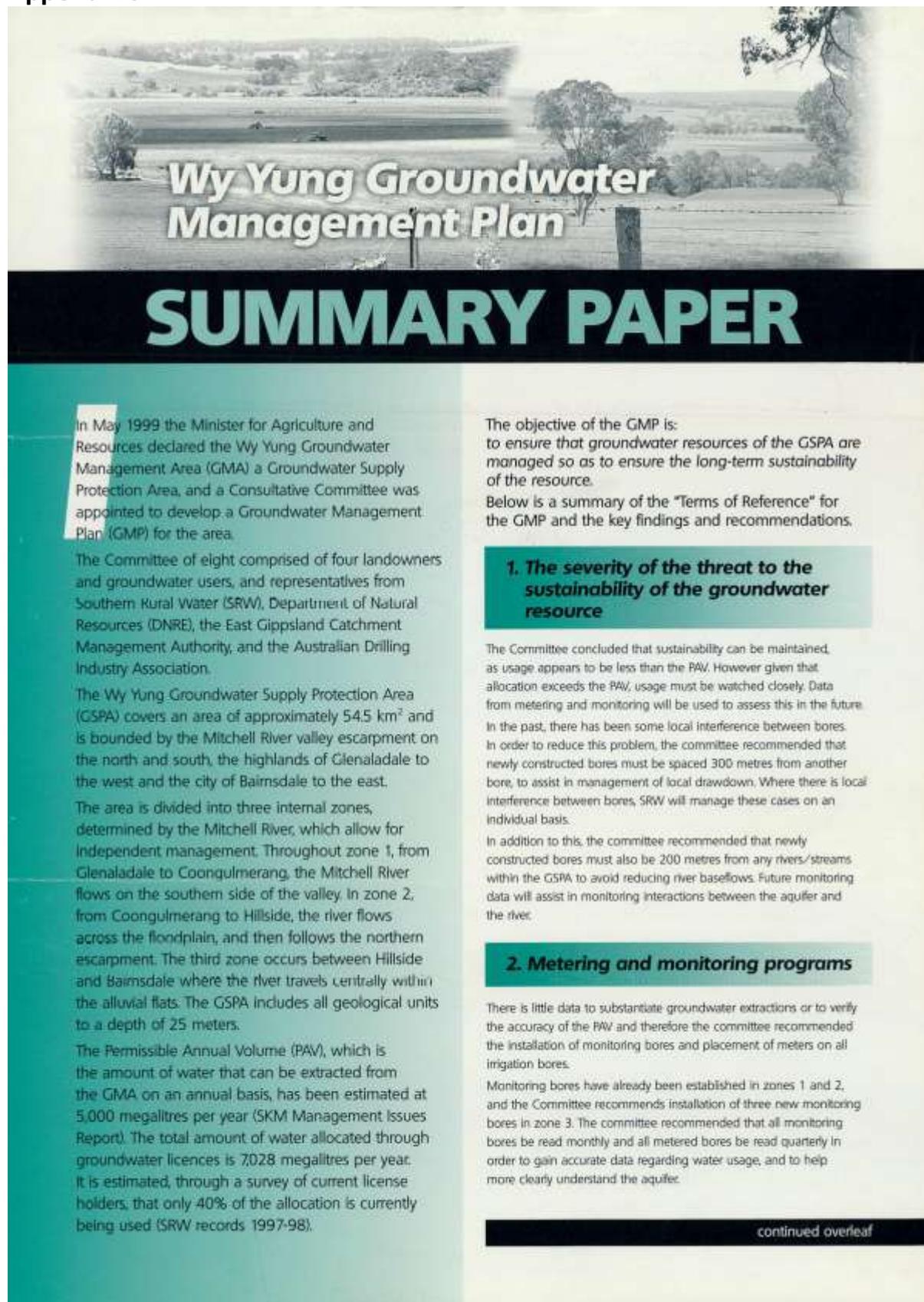
An exploration site at Waarre, near the Otway Gas Plant, was nearly ready for drilling when the State Government imposed a moratorium on exploration in 2017 while it investigated the impacts of the practice.

Opponents believe the move would pump the brakes on Victoria's transition towards renewable energy sources, but the State Government this week insisted gas would play a role in its commitment to a cleaner energy future.

The bill would permanently ban unconventional exploration methods, including fracking.

Appendix Five.





In May 1999 the Minister for Agriculture and Resources declared the Wy Yung Groundwater Management Area (GMA) a Groundwater Supply Protection Area, and a Consultative Committee was appointed to develop a Groundwater Management Plan (GMP) for the area.

The Committee of eight comprised of four landowners and groundwater users, and representatives from Southern Rural Water (SRW), Department of Natural Resources (DNRE), the East Gippsland Catchment Management Authority, and the Australian Drilling Industry Association.

The Wy Yung Groundwater Supply Protection Area (GSPA) covers an area of approximately 54.5 km² and is bounded by the Mitchell River valley escarpment on the north and south, the highlands of Glenaladale to the west and the city of Bairnsdale to the east.

The area is divided into three internal zones, determined by the Mitchell River, which allow for independent management. Throughout zone 1, from Glenaladale to Coongulmerang, the Mitchell River flows on the southern side of the valley. In zone 2, from Coongulmerang to Hillside, the river flows across the floodplain, and then follows the northern escarpment. The third zone occurs between Hillside and Bairnsdale where the river travels centrally within the alluvial flats. The GSPA includes all geological units to a depth of 25 metres.

The Permissible Annual Volume (PAV), which is the amount of water that can be extracted from the GMA on an annual basis, has been estimated at 5,000 megalitres per year (SKM Management Issues Report). The total amount of water allocated through groundwater licences is 7,028 megalitres per year. It is estimated, through a survey of current license holders, that only 40% of the allocation is currently being used (SRW records 1997-98).

The objective of the GMP is: to ensure that groundwater resources of the GSPA are managed so as to ensure the long-term sustainability of the resource.

Below is a summary of the "Terms of Reference" for the GMP and the key findings and recommendations.

1. The severity of the threat to the sustainability of the groundwater resource

The Committee concluded that sustainability can be maintained, as usage appears to be less than the PAV. However given that allocation exceeds the PAV, usage must be watched closely. Data from metering and monitoring will be used to assess this in the future. In the past, there has been some local interference between bores. In order to reduce this problem, the committee recommended that newly constructed bores must be spaced 300 metres from another bore, to assist in management of local drawdown. Where there is local interference between bores, SRW will manage these cases on an individual basis.

In addition to this, the committee recommended that newly constructed bores must also be 200 metres from any rivers/streams within the GSPA to avoid reducing river baseflows. Future monitoring data will assist in monitoring interactions between the aquifer and the river.

2. Metering and monitoring programs

There is little data to substantiate groundwater extractions or to verify the accuracy of the PAV and therefore the committee recommended the installation of monitoring bores and placement of meters on all irrigation bores.

Monitoring bores have already been established in zones 1 and 2, and the Committee recommends installation of three new monitoring bores in zone 3. The committee recommended that all monitoring bores be read monthly and all metered bores be read quarterly in order to gain accurate data regarding water usage, and to help more clearly understand the aquifer.

continued overleaf



3. Restrictions or prohibitions on the issue of further licences

Although the GSPA as a whole is over-allocated, each zone has an independent PAW and volume of allocation. Zone 2 is well over-allocated, but zones 1 and 3 are not allocated up to their respective estimated PAWs of 1,300 ML/yr and 1,700 ML/yr.

Therefore, the committee recommends that the issue of future licences be prohibited in zone 2 whilst the PAW is exceeded, but that further licences could be issued in zones 1 and 3, providing the PAW is not exceeded.

4. Transferable Groundwater Entitlements

The committee has determined that Transfer of Water Entitlement (TWE) is appropriate for the GSPA and trading of licence volumes can only occur within zones (so long as the transfer does not affect the supply to other licence holders or have any adverse effect on the aquifer or the environment), as each zone has a separate PAW and is managed individually. If future monitoring data indicates that there is a threat to sustainability, then TWE policy should be reviewed.

5. Cost sharing arrangements

Government will fund the capital cost of the construction of the monitoring bores and 50% of the metering costs, with the balance of metering funded by SRW without cost to licence holders. The costs of implementing the "Plan" is required to be funded by licence holders. These costs involve recurrent metering costs such as meter reading, meter maintenance and meter replacement, eight of the 12 monthly bore readings (the cost of four readings will be picked up by Government), GMP support, on-going monitoring of the "Plan" and annual reporting.

The Committee recommended that the recurrent costs for data collection and implementation of the "Plan" be recovered by the introduction of an additional fixed annual charge of \$142.00 per licensed bore.

6. Need for, and timing of, review

It is quite clear that groundwater monitoring and usage data is required prior to deciding whether an "Advanced Plan" is necessary. The committee recommended that the "Plan" be reviewed within five years from the date of its endorsement, at a time to be decided by an on-going Consultative Committee.

7. Plan implementation and on-going consultative arrangements

The committee recommend that, once the "Plan" has been endorsed, the committee meet four times a year in the first year, and twice a year thereafter, or as required. All licence holders and other stakeholders will receive an annual report with a newsletter inviting feedback.

8. Annual reporting

An annual report will be developed and distributed to the Minister, groundwater users and other stakeholders. The report will contain information on monitoring bore levels, any new allocation, transfers of water entitlements, problems implementing the "Plan", any minor amendments that have been made, any failure to comply to the "Plan" and any difficulties in extracting water from the aquifer.

If you would like to receive a full copy of the Groundwater Management Plan, please contact Penny Neumann at Southern Rural Water on (03) 5139 3137

Submissions on the Draft Plan close on 12 February 2001.

**Wy Yung
Groundwater
Management Plan**

**SUMMARY
PAPER**

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Shifting Baseline Syndrome is defined as...

The tendency for the concept of what is “normal” or “natural” to change over time due to the experiences of subsequent generations.

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How far and in which direction did the extended reach drilling go?

As at 19 Nov 2020 it has been brought to my attention that the Otway Basin gas fields are deeper than the gas fields off Gippsland. This needs to be confirmed as does the notion that Otway Basin extraction “risk” is much lower. The extraction is done at a much deeper and out of the way location.

Researching and comparing the differences of these two gas fields opens the door to an important research endeavour.

