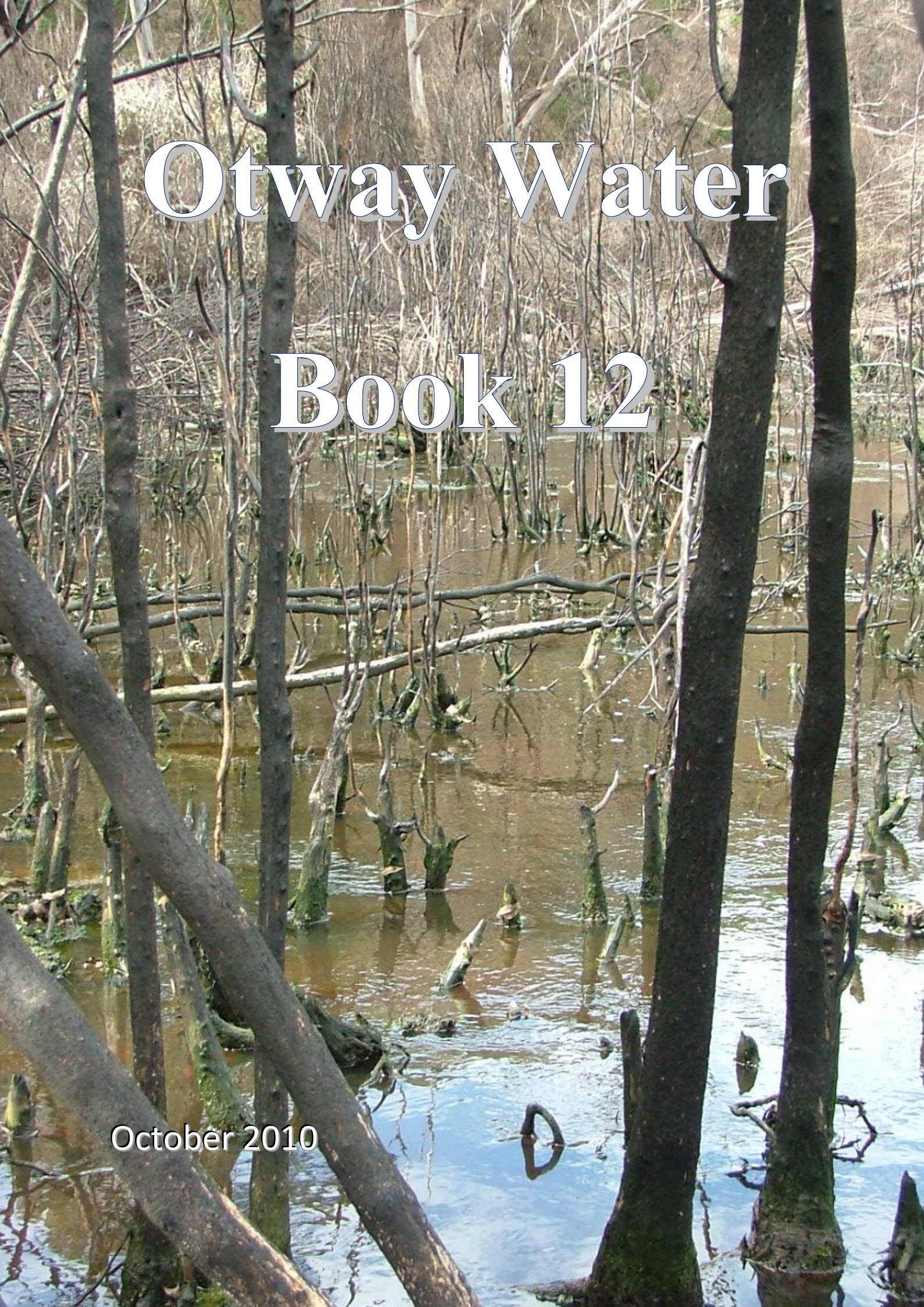


Otway Water

Book 12

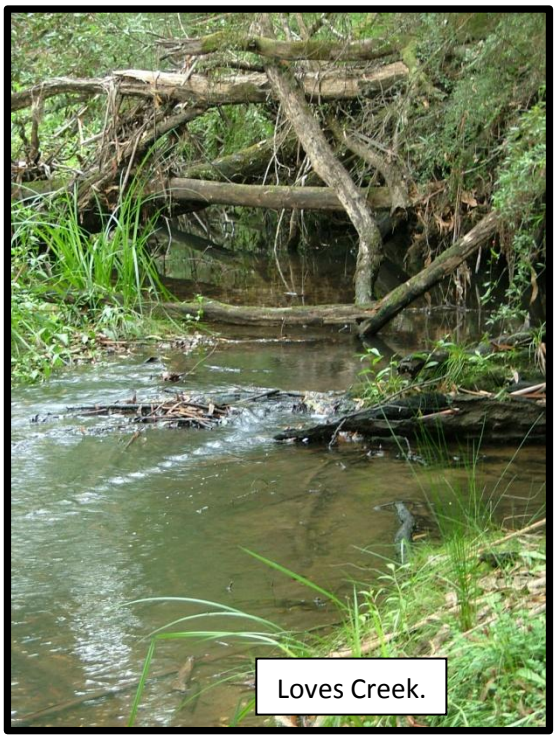
October 2010

POTOGRAPHS TAKEN AROUND the SAME TIME.

The swamp on Ten Mile Creek, a tributary of Loves Creek.

The Big Swamp on Boundary Creek.

Boundary Creek



“THE THREAT TO PERMANENT FRESHWATER PEAT SWAMPS AND WETLANDS OF THE GELLIBRAND RIVER AND BARONGAROOK CREEK CATCHMENTS - OTWAY RANGES .”

Otway Water Book 12

October 2010

Some lines taken from His Holiness the 14th Dalia Lama's "The Paradox of Our Age," that would appear appropriate to many aspects in regard to the management of the freshwater peat swamps and wetlands of the Otway Ranges.

We have more degrees, but less sense;

More knowledge, but less judgement;

More experts, but more problems;

Tall man, but short character;

It's a time when there is much in the window,

but nothing in the room.

Disclaimer

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October 2010

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Introduction

Big Swamp IASS 2009

Inland Acid Sulfate Soils (IASS) is a newly recognised problem for soils on the Australian continent. Coastal Acid Sulfate Soil problems have been part of Australian history for many years. However, because of the severe and extended drought over the last decade previously saturated, innate Inland Acid Sulfate Soils have dried out and been exposed to oxidation causing serious ecological, social and engineering structural problems. Leaders in the area of Inland Acid Sulfate Soils began their serious studies in the 1990s.

When a possible site of Inland Acid Sulfate Soil was recognised in 2008 in a freshwater peat swamp and wetland in the Otway Ranges, a site that appeared to be producing large amounts of sulphuric acid, toxic gases and heavy metals, Victorian State Government authorities were asked to investigate this occurrence.

Concrete cancer from acid waters.

Every indication pointed to groundwater extraction as the culprit. After 15 months of inaction by responsible authorities, a dedicated group of concerned Otway residents decided to seek the necessary expertise to conduct a comprehensive evaluation of the site. The site being situated along Boundary Creek in the vicinity of the Big Swamp freshwater peat wetlands of the Barwon River Catchment, Otway Ranges, Yeodene, Victoria, Australia.

Boundary Creek after March 2010 peat fire in the Big Swamp- supplementary water released from the Colac Otway Pipeline disappears into the depleted wetland.

In an attempt to ascertain the potential risk to permanent freshwater wetlands in the Gellibrand River Catchment of the Otway Ranges, sites outside the direct drawdown effect from the Barwon Downs groundwater extraction, were also included in the Inland Acid Sulfate Soils study. These additional sites are located in the Loves Creek and Barongarook Catchments.

A concerted effort failed to source studies specifically dedicated to freshwater peat swamps and wetlands. Studies that were found on Inland Acid Sulfate Soils were not peat swamps and seemed to concentrate on the causal factor being the extended drought of the late 1990s and early 2000s. However, the major causal factor along Boundary Creek pointed to the extensive extraction/mining of the deep water aquifer at Barwon Downs. It would also appear that the Big Swamp was unique in that it was a freshwater site and as a consequence could reasonably be named as a Freshwater Inland Acid Sulfate Soils site.

Chapter three of this book summarises the scientific research undertaken by the Environment Analysis Laboratory of Southern Cross University (March 2010) in the Big Swamp freshwater peat wetlands. This research also identifies several nearby permanent freshwater peat swamps and wetlands in the Barongarook Creek and Gellibrand River Catchments of the Otway Ranges that would be under threat if other groundwater extractions were to be conducted and managed in the same fashion as at the Barwon Downs Borefield.

The first chapter of this book explores the work of Professor Lance Endersbee and its applicability to the Freshwater Inland Acid Sulfate Soils of the Gerangamete and Gellibrand Groundwater Management Areas. Endersbee presents a radically different explanation for the origins of the water held in deep water aquifers. His convincing arguments challenges the 150 year old theories on which much of today's hydrological work is based.

Three wetlands under threat – in the Barongarook Creek Catchment, within a few kilometres of Colac.

CONTENTS

CHAPTER ONE

The Water Sources of Deep Aquifers

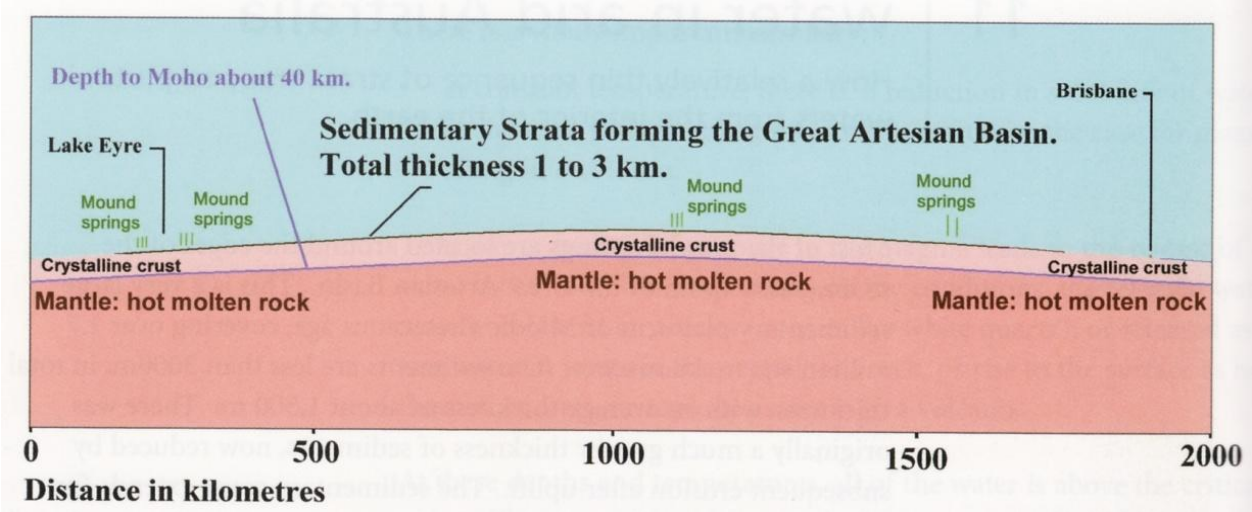
This Chapter looks at some of the writings of Professor Lance Endersbee (AO) found in his book titled "A Voyage of Discovery" 2005. This work throws considerable doubt on the commonly accepted way in which deep aquifers such as the Eastern View Formation (deep water aquifer) in the Otways, are replenished and how they originally gained their water reserves.

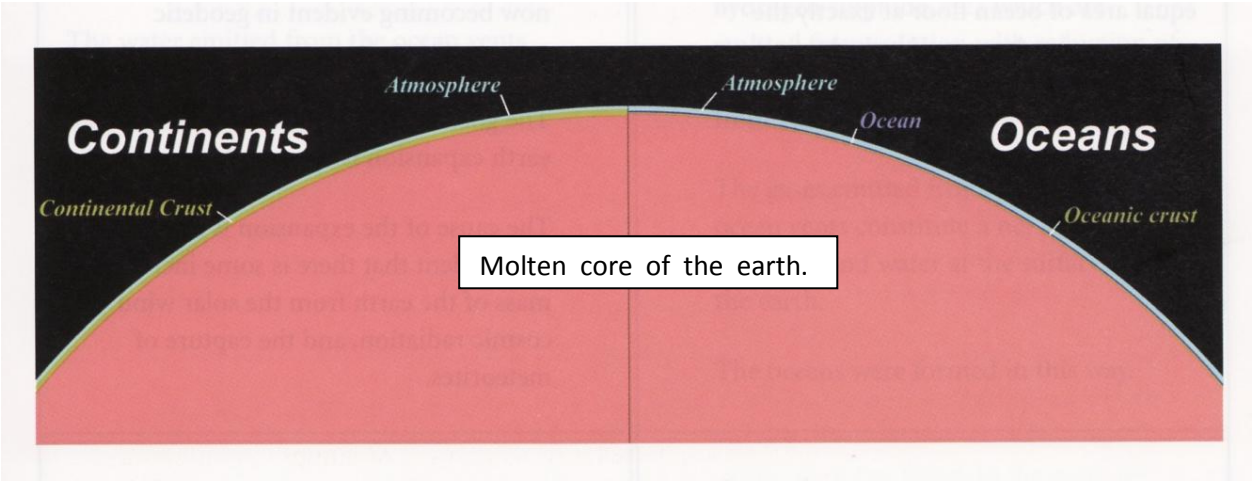
When attempting to understand the unknown, scientific advances are often restricted by a consensus of a popular idea that is steadfastly held even when it is apparent that this position does not answer all of the questions. Those people maintaining a commonly held and popular position often find it easier and convenient to discredit or ignore an alternative. This is especially so when the alternative raises awkward questions that attacks the very foundation of the commonly held beliefs. What in effect happens with many conflicting views is that they are excluded from scientific debate. In this way misconceptions can remain unrecognised for decades and the popular delusion persists.

In Professor Lance Endersbee's book, alternatives are presented for a range of commonly accepted beliefs. One of these beliefs put under scrutiny is the primary source of water in deep water aquifers such as the Eastern View Formation of the Otways (The Eastern View Formation is referred to in the Otway Water books as the deep water aquifer). Endersbee's discussion presents a much more plausible explanation of the origins of the Barwon Downs borefield waters than the one on which the sustainable yield is based. Consulting hydrologists maintain the major source of the deep water aquifer is from rain percolating down through the sandy soils of the Barongarook High. This is called meteoric water. This theory is ardently disputed by Endersbee and his alternative most definitely requires close and considered examination.

Professor Endersbee postulates that the origins of deep aquifer groundwater is plutonic, from the interior of the earth and not from rain water percolating downwards from the surface. The chemical composition among many other considerations presented by Endersbee do indicate a plutonic source.

To begin to accept that a plutonic source for this deep water is plausible and worthy of consideration, the significance that humans place upon their place in the universe must be put in perspective. The depth of the thin layer we call the crust of the earth and on which will live and survive, is relatively insignificant. This is best demonstrated in two of Professor Endersbee's natural scale diagrams.





In relative terms a hen's egg shell is 3 times thicker than the continental crust. A shell is 15 times thicker than the crust on the floor of the oceans. The crust humans populate is tiny in relation to the size of the earth.

From these two diagrams it can be seen that the surface habitat that humans populate is miniscule. 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 in, is really a fragile thin crust surrounding a gigantic molten ball of energy.

Let's consider Professor Endersbee's work with these five points in mind...

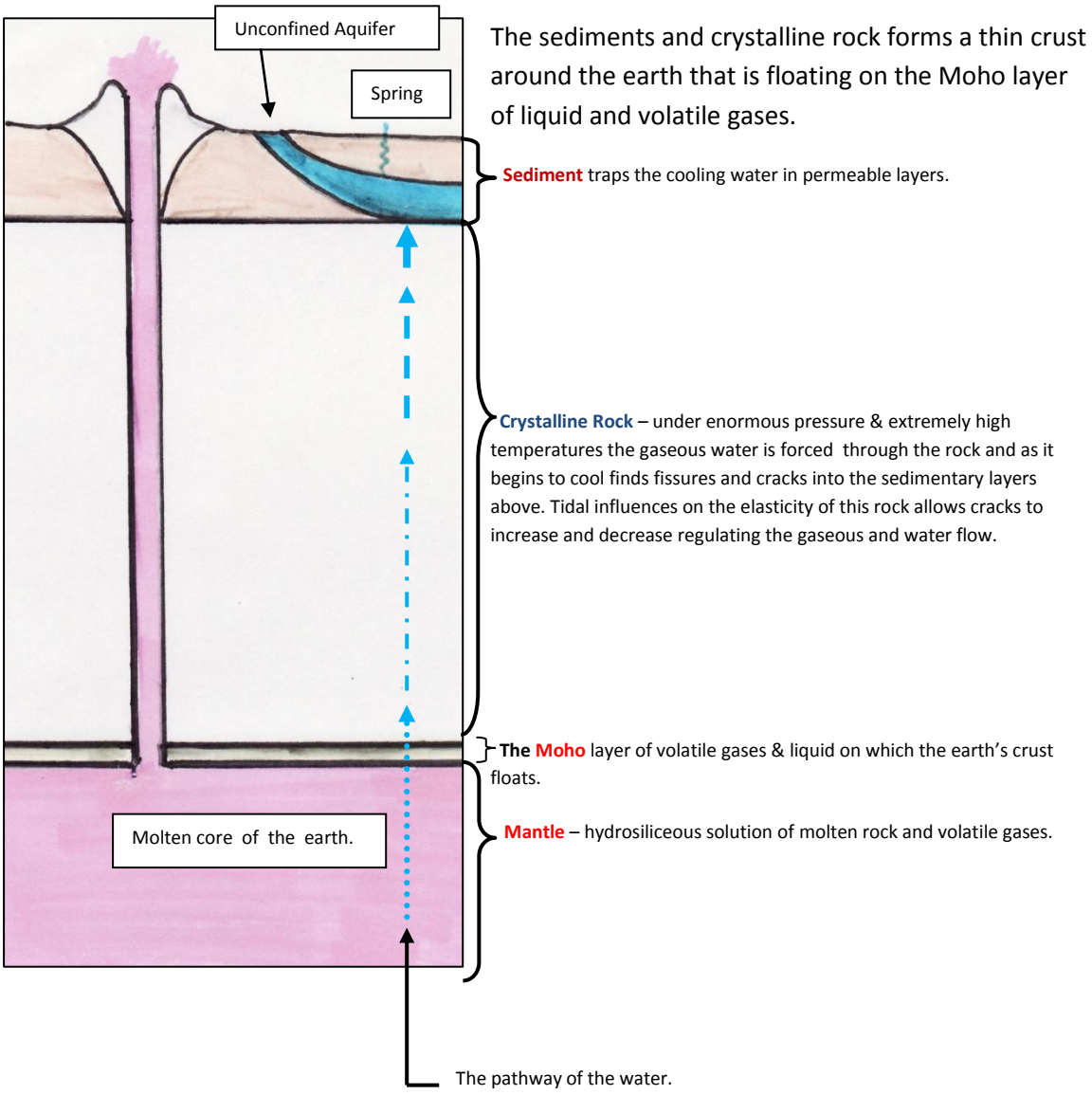
1. His work is summarised, adapted and presented in a simplified form in this Otway Water book.
2. His supporting evidence is not presented.
3. His theory has been applied to the deep aquifer waters of the Otway Ranges.
4. Personal contact with Professor Endersbee confirmed that his theories could reasonably be applied to the deep water aquifers of the Otways, and
5. it is hoped, the basic concepts, presented here are as accurately portrayed as the Professor would have wished.

Quotes and summary from sections of "A Voyage Of Discovery," by Professor Lance Endersbee (AO), 2005, ISBN 0-646-45301-7, available from the Monash University Melbourne bookshop. Page numbers have been included allowing the reader to place the quote and or summary in context, if desired. These quotes merely scratch the surface of the depth of research Endersbee encapsulates in his book. This book "A Voyage Of Discovery" is highly recommended.

- Page 1. "*Around the world, groundwater from deep wells is the main source of drinking water for over three billion people*."
- Page 1. "*These deep water wells cannot be replenished from rainfall. In the book it is shown that the source of the groundwater that supports these three billion people lies in the interior of the earth. There is a continuing release of water from the interior towards the surface of the earth, and we see that in the steam of volcanoes, and the water gushing from deep ocean vents. Over geological time, some of the rising water was trapped in the path towards the surface of the earth, and accumulated as underground reservoirs of water*."
- Page 19. "*The text books on groundwater hydrology appear to be part of the problem: they all show mathematical models of groundwater flow based on the key assumption that the groundwater is recharged from surface rainfall. As a consequence the related computer models of groundwater flow are very seriously misleading*."
- Page 38. "*An integrated view of these natural resources is hampered by the fact that each industry involved,-water, minerals, gas, oil, and each science discipline involved,-engineering, mining, geology, chemistry, biology and so on, do not share or participate in any common learned framework. Each group is isolated from the other, and the boundaries are protected. In these circumstances it is quite understandable that errors and misconceptions arise, and remain unrecognised for decades.*"
- Page 52. Endersbee provides another excellent example of a widely accepted hydrological concept in hydrology that is based on an age old assumption. In regard to the worldwide technique of using radioactive isotope ratios to determine the age of groundwater... "*The procedure specifically excludes the possibility that groundwater was never rainfall. Unfortunately, it is normal for groundwater hydrologists to be quite unaware of the assumptions involved. From their perspective, a date determined by nuclear physics must be right, and they thereby manage to prove that all groundwater is derived from surface rainfall."* As Endersbee explains the isotope ratios of rainfall are known and using the assumption that groundwater was originally rainwater it is then easy to come up with an age for the groundwater based on this assumption. However, Endersbee argues that this argument is a circular one that will always have the same results if it is accepted from the start that all groundwater was originally rainwater.
- Page 56. Darcy's 1850s illustrations and assumption that groundwater was originally rainwater... *"...or a variation of it, is used today, 150 years later, as a basis for entire books on groundwater hydrology. It is now a popular delusion*."
- Pages 83-91 discusses the solubility of water in molten granite; the enormous temperatures and pressure exerted on water turning it to a gas at great depths; the ability of gaseous water to easily diffuse through rock travelling great distances with little loss of energy; as the gaseous water approaches the earth's surface and loses pressure and temperature its permeability decreases and may be trapped in vesicles (as in milky white quartz) or forming a barrier constraining the escape of steam or be released as free water in joints in crystallised rock, rise to the surface as thermal springs or explode as steam in volcanoes. If the water is blocked by overlaying barriers the water would accumulate until pressures are sufficient to penetrate the sedimentary barrier and surface at weak spots.

To reach this state of relative equilibrium would take thousands of years to achieve. However, this perceived state of equilibrium is purely delusional. The process of change within the earth's crust is continual, sometimes dramatic but more often very gradual.

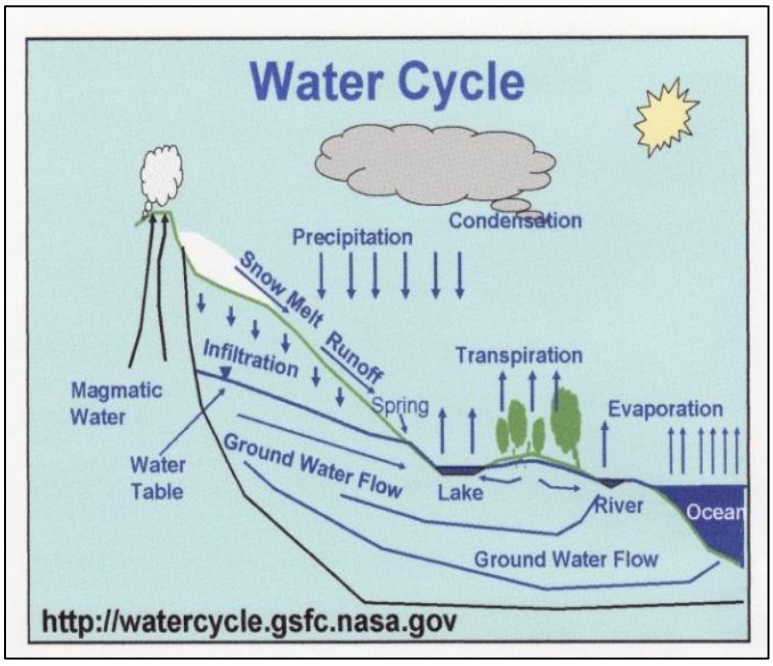
In early times volcanic action and eruptions were numerous. Throughout extremely disruptive periods the earth has been subject to enormous changes and the geology of the Otway Ranges is testament to this. Faults, folds, dislocation and eruptions over eons have left a complex geological jigsaw throughout the Otway Ranges. Even though the subterranean activity is having a decreased influence on the surface, as volcanic action becomes dormant or extinct, plutonic water is still being forced to the surface and or being trapped in sedimentary layers.



Deep within the interior of the earth water is present in the molten liquid. Under great pressure and extreme temperatures the water as a gas, diffuses easily through rock and can travel great distances with little loss of energy. The gaseous water is forced through the crystalline layer of rock and as the pressure and temperature reduces, the water as gas, begins to cool and turns into a liquid. At this stage fractures and fissure in the rock layers provide a pathway for the release of this water into the

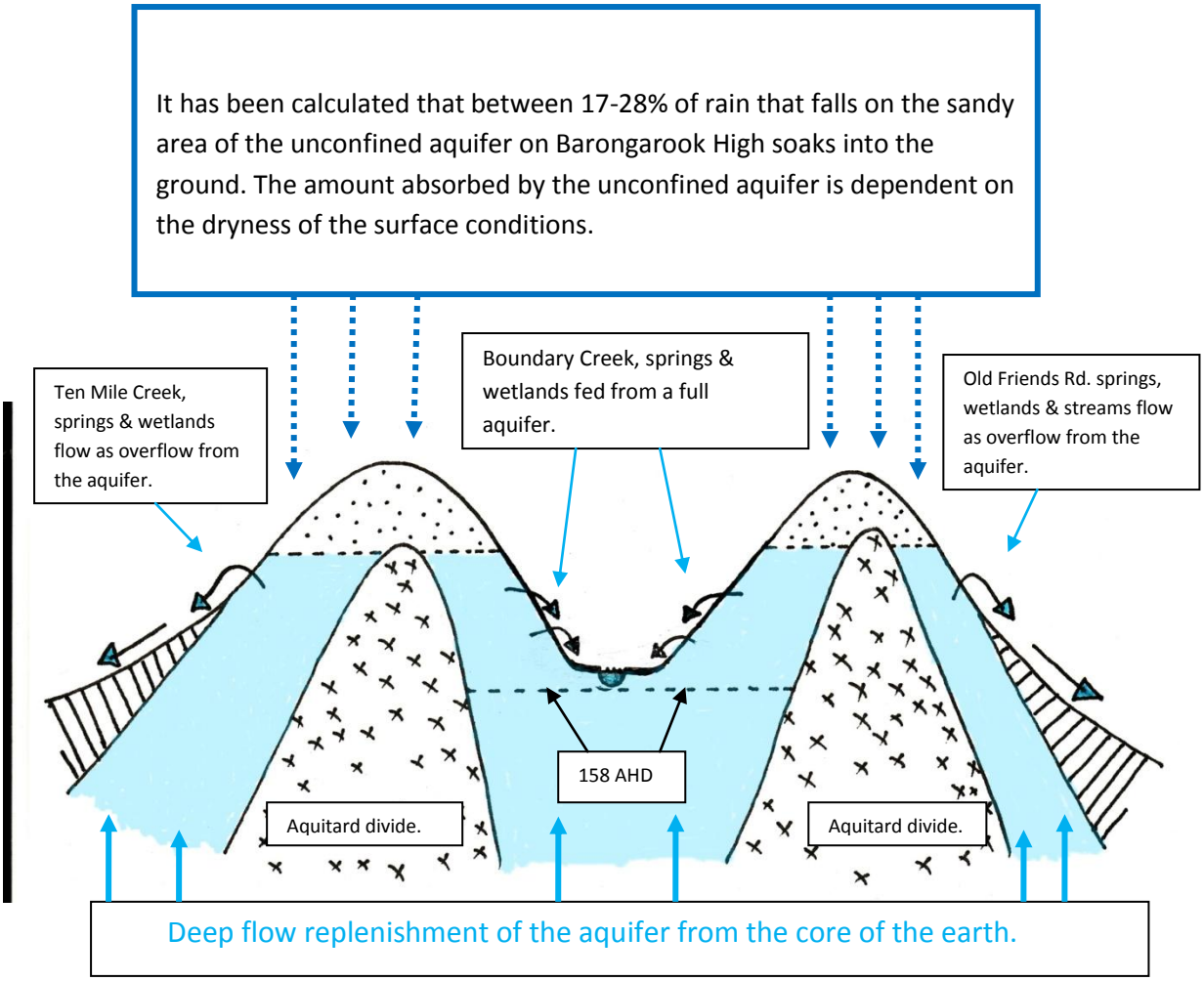
sedimentary surface layers of the earth. The water is still extremely hot and still under enormous pressure. If the pathway to the surface is blocked by an overlaying impervious layers in the sediments the water can be trapped and accumulate as a deep water aquifer. Over thousands of years these confined waters build up pressures sufficient to penetrate the impervious barrier at weak points and discharges to the surface. In other situations the deep water aquifer layer has been forced to the surface as an unconfined aquifer and a natural discharge to surface wetlands, springs, creeks and rivers is possible. For the Gellibrand and Gerangamete Groundwater Management Areas one of these unconfined aquifer areas is known as Barongarook High.

Most of the flow patterns and source of groundwater referred to in the "Otway Water" books are based on the commonly held assumption that deep aquifer waters are replenished from rainwater by way of the Barongarook High. However, if Professor Endersbee's theory is placed into the equation a major rethink needs to take place. It would then be feasible that the replenishing of water into deep water aquifers would then be sourced from both the core of the earth and rainwater percolation. If this were the case then many of the unanswered questions under the percolation theory can easily be explained - questions that have puzzled the proponents of the percolation theory. As more is learnt the modification and even the complete rethink of commonly held beliefs is a possibility.



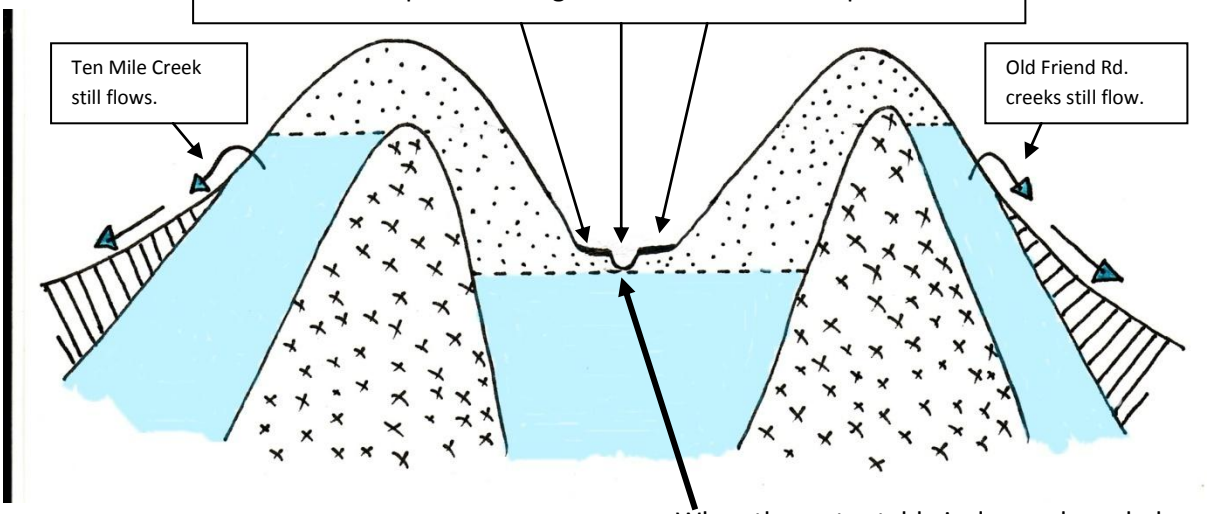
In this diagram it can be seen that NASA recognises that there is a magmatic or plutonic water source.

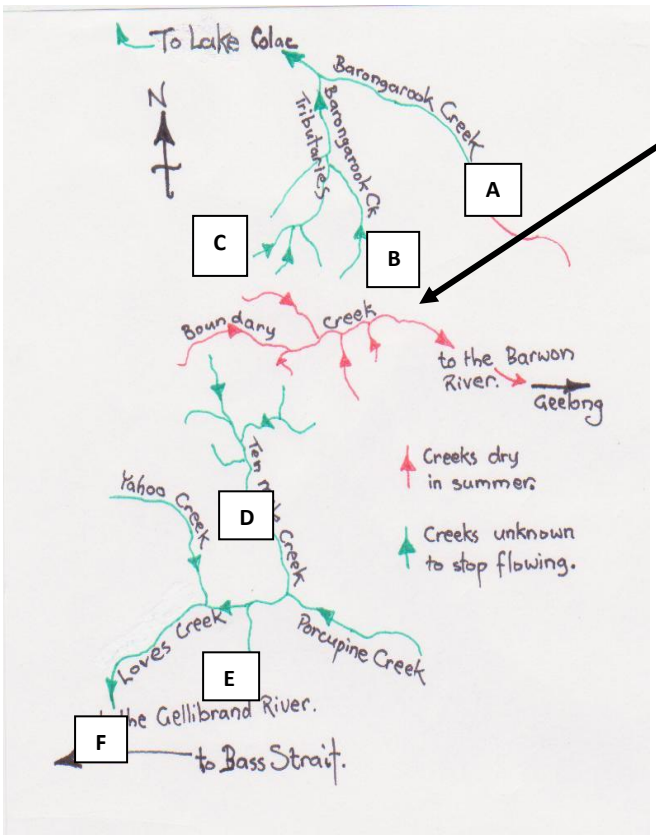
Before groundwater extraction took place from the Barwon Downs aquifer, the surface and groundwater systems had reached a close to equilibrium stage, as represented in the diagram below. This state would have evolved over thousands of years and even though it would appear to be stable it would still be in a state of gradual change. The earth is part of a dynamic system within the universe and in general it is in a state of continuous though barely discernable change. In this region of the earth there has been relative stability for some time. However volcanic eruptions, tsunamis and earthquakes highlight the catastrophic changes that can take place in a very short period.



Until groundwater extraction took place the variables for all three aquifers above, were the same. However, when this state of close to equilibrium was drastically modified by human intervention, the balance was easily upset. The Barwon Downs borefield has had a direct influence on the middle aquifer. The pumping from this middle aquifer is the only known variable to have changed. The extraction of groundwater has been well in excess of the calculated ability of the aquifer to naturally recharge. The diagram on the next page illustrates the concept involved. Pump out more water than is replaced by either or both the plutonic and meteoric sources and the aquifer water table will begin to drop.

Once the water table drops below the 158 metres AHD level, Boundary Creek and its wetlands dry up, permanent water dependent ecosystems cease to exist and the dried out peat oxides, becomes carbon negative and has the potential to produce massive amounts of toxic acid. This acid can then liberate dangerous levels of heavy metals into the environment. The threat from the peat catching fire becomes a serious problem.





When the water table is drawn down below the 158 metres AHD level by the pumping at the Barwon Downs borefield, Boundary Creek ceases to be a gaining stream as the overflow from the aquifer ceases. The creek and surrounding areas begin to dry out.

Pre pumping Boundary Creek had an average daily summer flow of 3.2 ML/day.[33] Since groundwater extraction commenced Boundary Creek has been dry more than 1000 days.[15]

Because of the aquifer divides to the south and north of the Boundary Creek catchment, Ten Mile Creek flowing south, and the Old Friends Road creeks flowing north, have continued to flow.[14] These creeks have not dried up during this worst drought on record.

There has been general agreement on the broad structural framework of the Otways[23] that includes block faults, tilting, vertical & lateral faulting, wrenching, lifting, folding and volcanic action (volcanic action evident at Clancy's Hill near Gellibrand). Where compression has been particularly intense, some of the basement faults have penetrated through to the surface or near surface.

This diagram taken from Leonard[23] amply demonstrates the criss-crossing of faults apparent in the area. Interesting enough to note that there is a fault under Loves Creek and the Barwon Downs borefield.

It is not difficult to agree with and understand how the geological and hydrological work done in the Otways indicates aquifer separation. Taking the research a step further and combining it with Endersbee's work, it is feasible that these same faults and geological complexities create the conduits for plutonic water to reach and deposit in the sediment layers of the Otways.

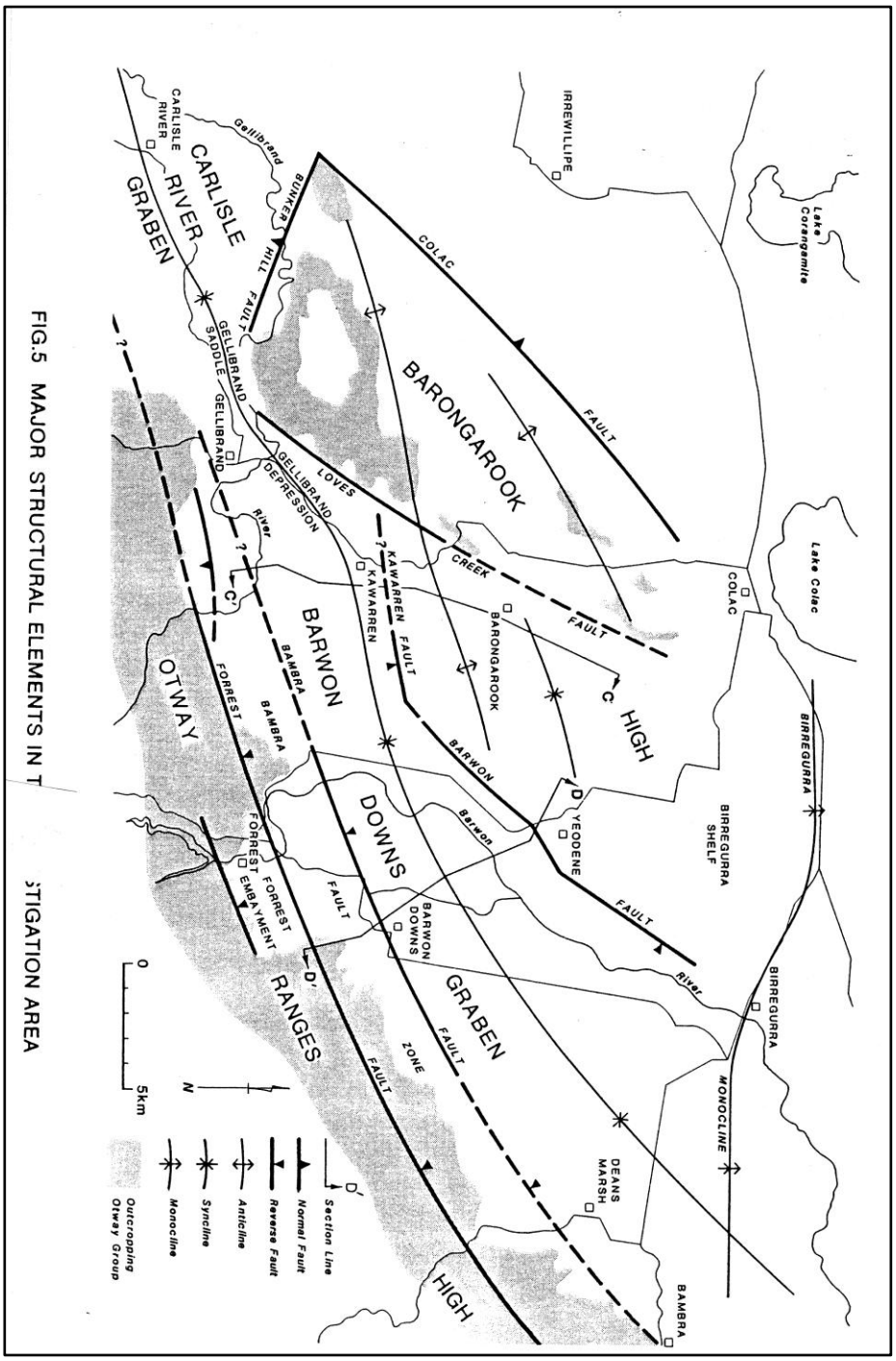


FIG.5 MAJOR STRUCTURAL ELEMENTS IN T STIGATION AREA

Taking into consideration all of the discussion in this chapter the following statements seem as plausible as any presented so far.

1. Deep aquifer waters in the Otways are replenished by way of rainwater surface percolation and core of the earth plutonic sources.
2. The geology of the Otways enables the plutonic water to be deposited in the sediments.
3. As the plutonic water is forced into the sediments it builds up considerable pressure.

4. The pressurised water forces its way to the surface in the unconfined aquifer and or through fault lines.
5. Because of the built up pressure streams, springs and wetlands can be found at heights higher than any surrounding land formations.
6. During one of the worst droughts on record these highland waters in the unexploited aquifers have continued to flow due to the plutonic source.
7. Extract groundwater from an aquifer faster than the rainwater and plutonic sources can replenish it as in the Barwon Downs scenario, and the surface water features will be compromised and begin to dry out.
8. An aquifer depleted faster than rainwater can replenish it will take a proportionately longer period of time by many factors to recharge the depleted water.
9. Untouched nearby aquifers as in the Gellibrand/Kawarren & Barongarook Old Friends Road areas, will continue to flow even when rainwater sources are limited.
10. During a drought and due to the lack of replenishment from the rainwater component a reduction of the flow in all streams will be apparent. However, until the plutonic reserve of pressurised water is reduced below stream bed levels the streams will continue to flow.
11. As an aquifer is drawn down through groundwater exploitation and the pressure head is reduced moist and or saturated overlaying sediments begin to dry out as the moisture soaks down into the depleted aquifer below.
12. All year round surface water baseflow cannot be considered in isolation from its plutonic sources.
13. When calculating a Permissible Consumptive Volume and environmental flow for a surface water and aquifer system, the plutonic component must be taken into consideration.

If ever there needed to be a control study done to put Professor Endersbee's theory to the test then it is doubtful that a better example could surpass the situation that is unfolding in the Otways Ranges here in Victoria, Australia.

- All streams are under the influence of a serious drought,
- one aquifer is being over exploited compromising and drying out the surface features,
- this aquifer is fully or partially separated from adjoining unexploited aquifers, and
- there has been substantial data collected.

CONCLUSION.

There would appear to be compelling argument to support the notion of deep water aquifers being primarily sourced by plutonic water from deep within the earth. It is as feasible to suppose that this process is continuing. If this is the case Prof. Endersbee's work must be taken into consideration when planning the extraction of deep water from aquifers in the Otway Rangers.

Extract groundwater faster than it is able to be replenished from plutonic sources and the surface environment faces a certain impact. The most obvious degradation in the Otway Ranges being the impact on small streams and inland freshwater peat swamp wetlands where the deep water naturally surfaces. Summer flows cease, wetlands dry up and die, acid levels skyrocket, heavy metals and carbon are liberated, poisonous gases are generated, the aquifer and streams are polluted and fire becomes a major concern.

(Professor Lance Endersbee passed away on the first of October 2009, born 1925. An appropriate tribute contained these words, **"*His quest for truth was tenacious, unswerving and incorruptible.*"**)

CHAPTER TWO

The Big Swamp Ablaze Again.

In March 2010 the smouldering peat in the Big Swamp wetlands re-surfaced or spontaneously combusted and once again creates a serious wildfire.

The extended drought of the late 1990s and early 2000s has been attributed with causing the peaty wetlands of the Big Swamp drying out. This is not the case, extensive groundwater extraction is the major contributing factor.[(11)(18)(19))] The first fire in the Big Swamp was in 1996[(13)] at the end of a series of very wet winters. The worst drought on record had only just begun. Serious groundwater extraction began in the summer of 1982-83. In 1984 Boundary Creek that flows through the Big swamp, was dry from the lack of natural flowing water for the first time since 1912[(14)(19)(11)(33)] Since then Boundary Creek and the Big Swamp have changed from an area where the deep water aquifer discharges into them, to an area where surface water from rainfall now flows down into the depleted aquifer.

Before extensive groundwater extraction, the overflowing aquifer kept the Big Swamp in a constant state of saturation and also contributed approximately 3.2 ML/day to the flows of Boundary Creek. For the last several years during the months of no rainfall Boundary Creek and the Big Swamp have been dry. Whenever this situation arises a licence condition of the groundwater extraction requires Barwon Water to release 2 ML/day into Boundary Creek. This water is taken from the Otway to Colac Pipeline. However, because of the drawdown on the water table this 2 ML/day is absorbed into the depleted aquifer. The released water does not pass the Big Swamp. Boundary Creek from this point remains dry [(3)(4)(5)(14)] until there is substantial rainfall. Gibbons et. al [(20)] state that the essential requirement in managing the soils for maintaining the native vegetation is to prevent drainage. The Big Swamp has been drained.

When the Big Swamp peat caught fire local in 1996 residents were aghast. This area had always been saturated. Up to 1991 forestry workers conducting burnoffs around this area had to wear rubber boots when working on the verges of the Swamp (see page 28). This area was a natural wilderness of thriving wetland species and acted as a natural fire break. When the fire-fighters entered the area to combat the 1996 fire they nick named the Big Swamp "*Jurassic Park*" because of its inaccessibility and jungle like growth.

Believing the fire to be extinguished it was a surprise to be confronted with another fire in the next summer of 1997. In 1998 the Big Swamp was once more ablaze and over 600 ha. Of private and public land was burnt. To this stage approximately 40 000 ML of groundwater had been extracted over a 14 year period. From 1998 to 2010 approximately another 100 000 ML was extracted. The Big Swamp was turning into a desert like zone and the pollution being generated in its soils was spreading; killing downstream wetlands and beginning to influence landholder farming enterprises.

1998 burn site.

Acid & aluminium kill.

This is the north eastern edge of the Big Swamp showing the effects of acid and heavy metals as it moved downstream, 2009.

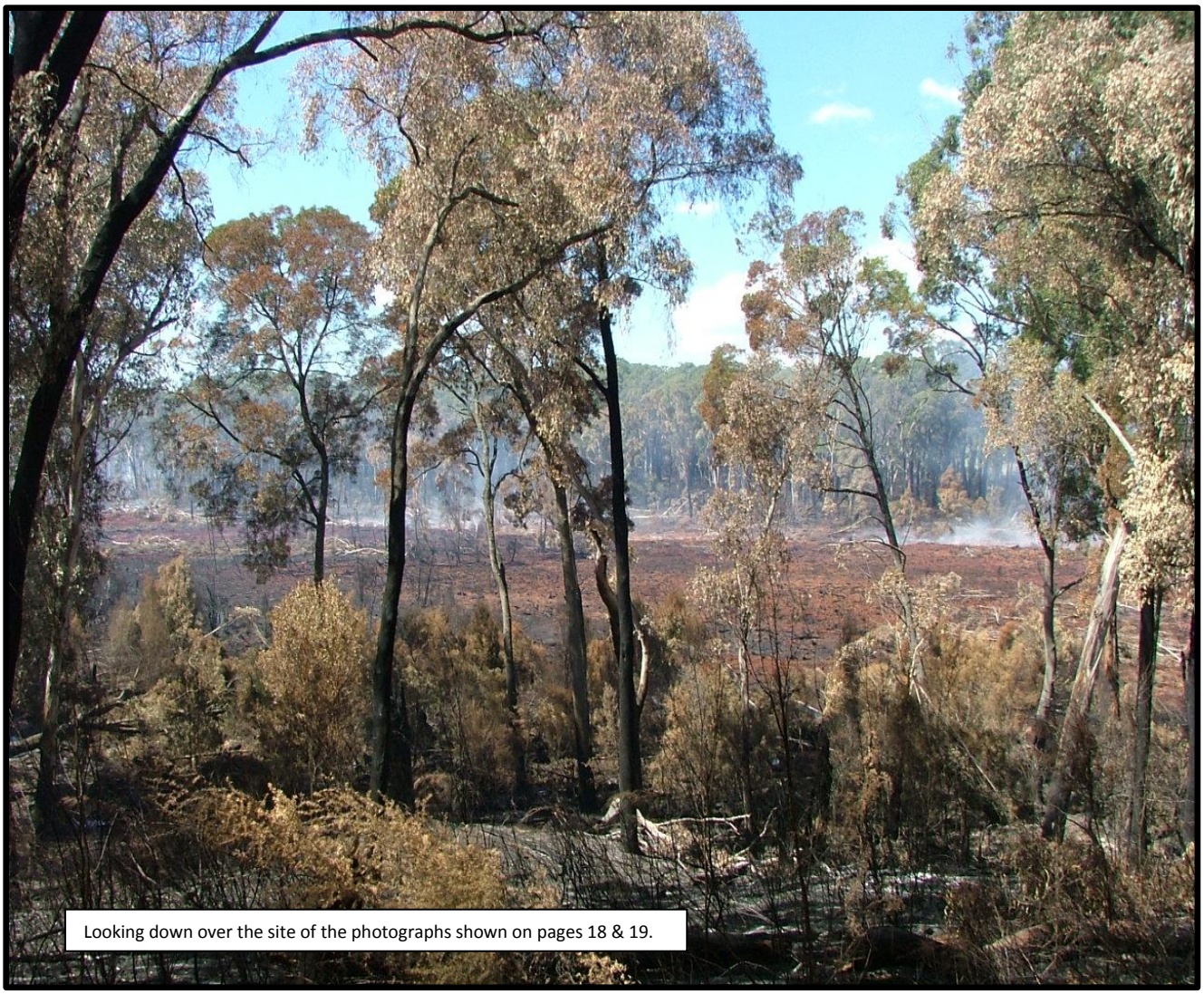
This photograph has been taken after the 2010 fire in the same area as the photograph on page 18.

The photograph shows how the dead vegetation has been burnt away.

It also illustrates the permanent water levels that most probably existed pre groundwater extraction and was photographed after extensive rains during the winter of 2010. The peat is still smouldering underneath.

In March 2010, twelve years later the Big Swamp was once again ablaze.

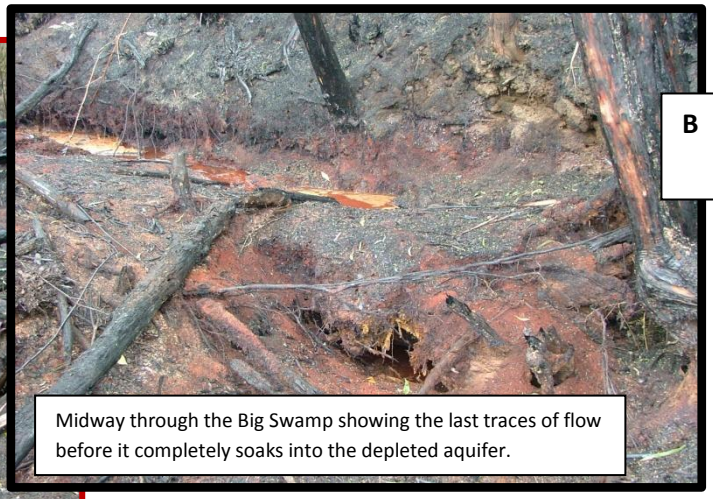
Soils with more than 20% of organic matter in the top 30 cm and a clay content of less than 15%, or with more than 30% organic matter if the clay content is greater, are regarded as peat beds.[20] The Big Swamp has soil several metres deep[11] that is classified as peat. However, it would appear that brown coal (lignite) outcrops in the Big Swamp. Fact Sheet 12, Department of Minerals and Energy Western Australia states that, "*It* (brown Coal) *is highly susceptible to spontaneous combustion,*" and has high oxygen content. Although it is more compact than peat, when exposed to air brown coal crumbles readily. It is possible that this is the reason for the March 2010 outbreak of fire in the Big Swamp rather than the fire having smouldered for 12 years.



Looking down over the site of the photographs shown on pages 18 & 19.

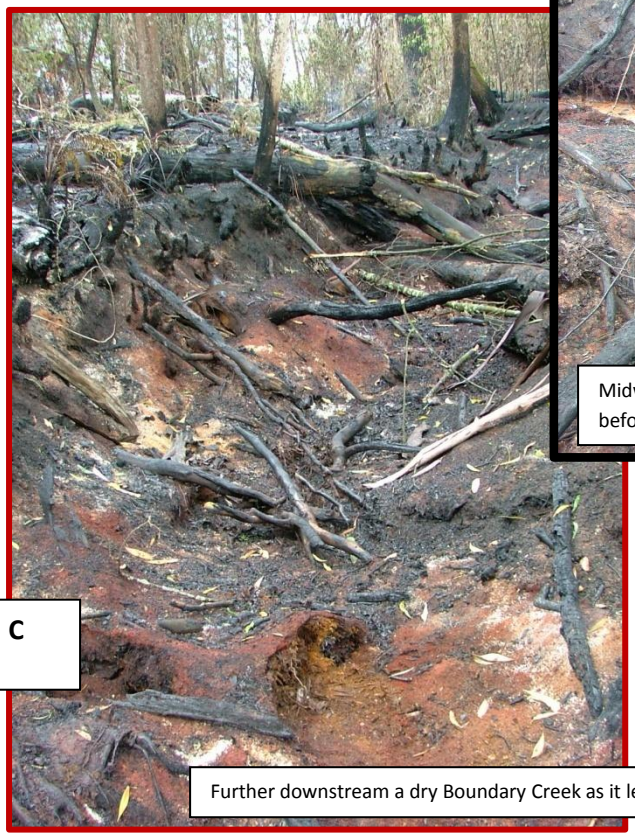
A

Boundary Creek upstream of the 2010 fire, showing the flow of released water from the Otway Colac Pipeline.



B

Midway through the Big Swamp showing the last traces of flow before it completely soaks into the depleted aquifer.



C

Further downstream a dry Boundary Creek as it leaves the Big Swamp before entering farmland.

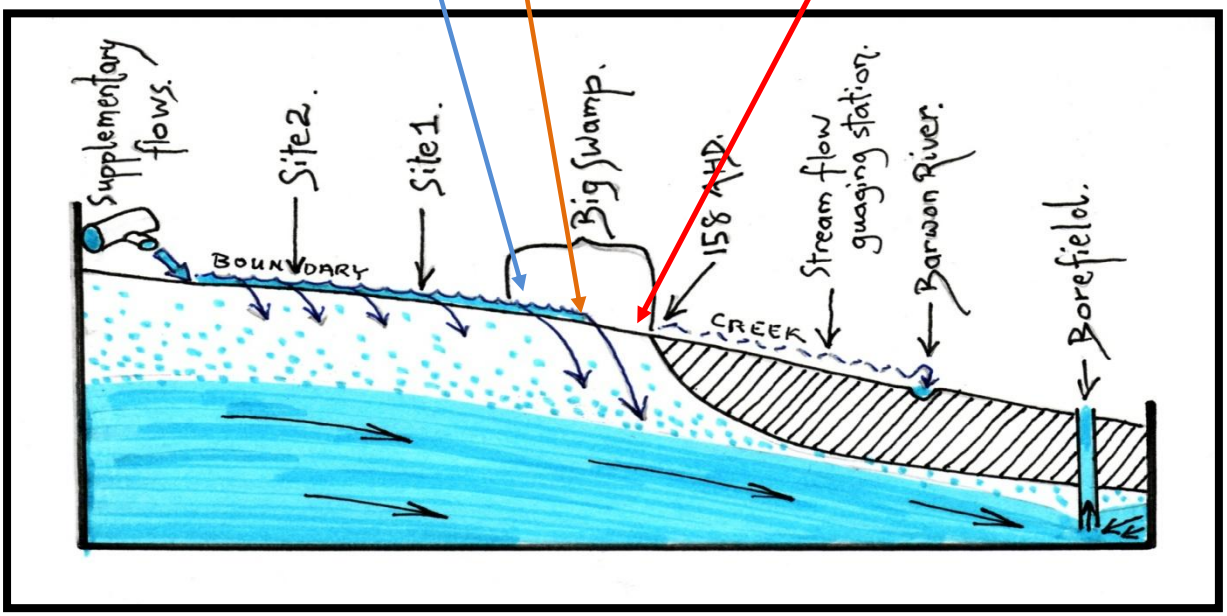
The 2 ML/day supplementary flows released into Boundary Creek from the Otway to Colac Pipeline never pass through the Big Swamp. The Big Swamp water level has been so depleted the supplementary flows are sucked downwards and eventually disappear around the point shown above, mid way through the Big Swamp.

A . Supplementary flows from the Colac Otway Pipeline.

B. Supplementary flows disappear into the Big Swamp.

C. Boundary Creek with no flow.

Photographs on page 22 above showing points A, B and C.



The fire burning in the peat in the Big Swamp is still smouldering away and has been reported to have taken hold in seams of brown coal. In an attempt to quench the fire a trench has been excavated downstream on the eastern side of the Big Swamp. This trench was then extended along the southern boundary. It is approximately three metres wide and extends for approximately one kilometre.

Despite these efforts the peat and brown coal continues to burn.

The following 3 points have been taken directly from references in Wikipedia and are worth some consideration. (Retrieved 19 June 2010.)

1. **Burning Mountain** – Australia.
   The oldest known coal fire and has been burning for 6,000 years.
2. **Coal Seam Fires.**
   - Are particularly insidious because they continue to smoulder underground after surface fires have been extinguished, sometimes for many years.
   - They are a serious problem because hazards to health and the environment include toxic fumes, re-ignition of surface vegetation and subsidence of surface infrastructure such as roads, pipelines, bridge supports, buildings and homes.
   - Can continue to burn for decades even centuries.
   - Are unlikely to be suppressed by rainfall.
   - Some brown coal fires may self-ignite at temperatures as low as 40^{o}C in the right conditions of moisture and grain size.
   - Subsidence may open further seams to oxygen and spawn future wildfires.
   - Cola fires emit a range of gases including carbon dioxide, carbon monoxide, sulphur dioxide and methane.
   - Once extinguished if any remaining dry coal absorbs water, the resulting heat of absorption can lead to re-ignition of a once quenched fire as the area dries.
   - In Colorado, USA, coal fires have arisen as a consequence of fluctuations in the groundwater level, which can increase the temperature of the coal up to 30^{0}C, enough to cause it to spontaneously ignite.
3. **Peat.**
   - Approximately 60% of the world's wetlands are peat.
   - Peat fires can even burn underground, re-igniting after the winter, provided there is a source of oxygen.
   - Carbon dioxide emissions of peat are higher than those of coal and natural gas.
   - Groundwater extraction may affect peat sites.
   - Peat is the home of many rare and specialised organisms.
   - It takes centuries for a peat bog to regenerate.
   - Peat drainage heavily fuels climate change through the release of carbon dioxide as the dried peat oxidises.
   - Peart can burn undetected for long periods of time, months, years and even centuries.
   - Peat fires are emerging as a global threat with significant economic, social and environmental impacts.

It is stating the obvious that groundwater extraction can lower the water table and dry out wetlands of peat. What is not obvious is that the extraction of groundwater at Barwon Downs is creating an oxygen source fanning the Big Swamp peat fire.

Throughout the area of drawdown influence from the Barwon Downs Borefield there are numerous tapped observations bores. Before groundwater extraction these bores where artesian[19] and this is the reason for the gate valves. However, the water level in the majority of these bores is presently well below ground level. [14]

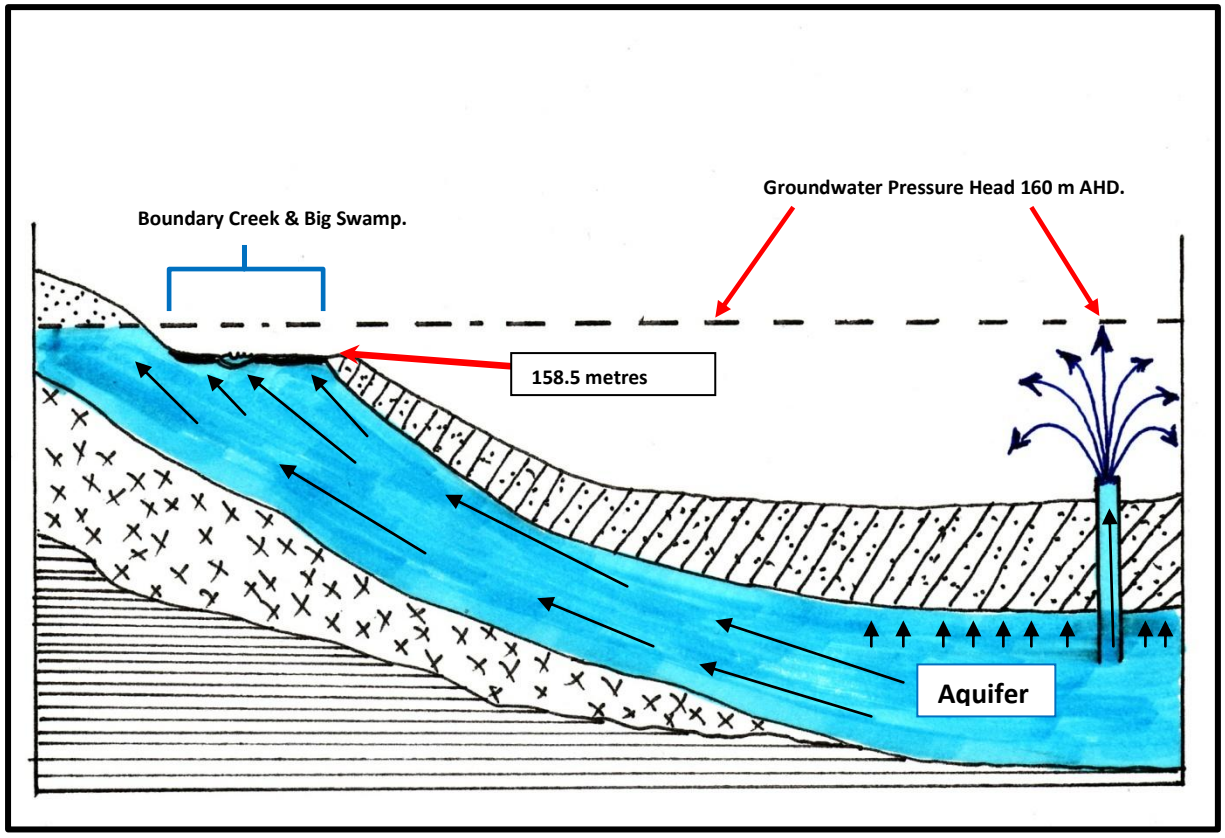
As a consequence when the gate valves are opened, instead of squirting water far into the sky, they suck air down into the vacuum created from the groundwater being extracted at the borefield.

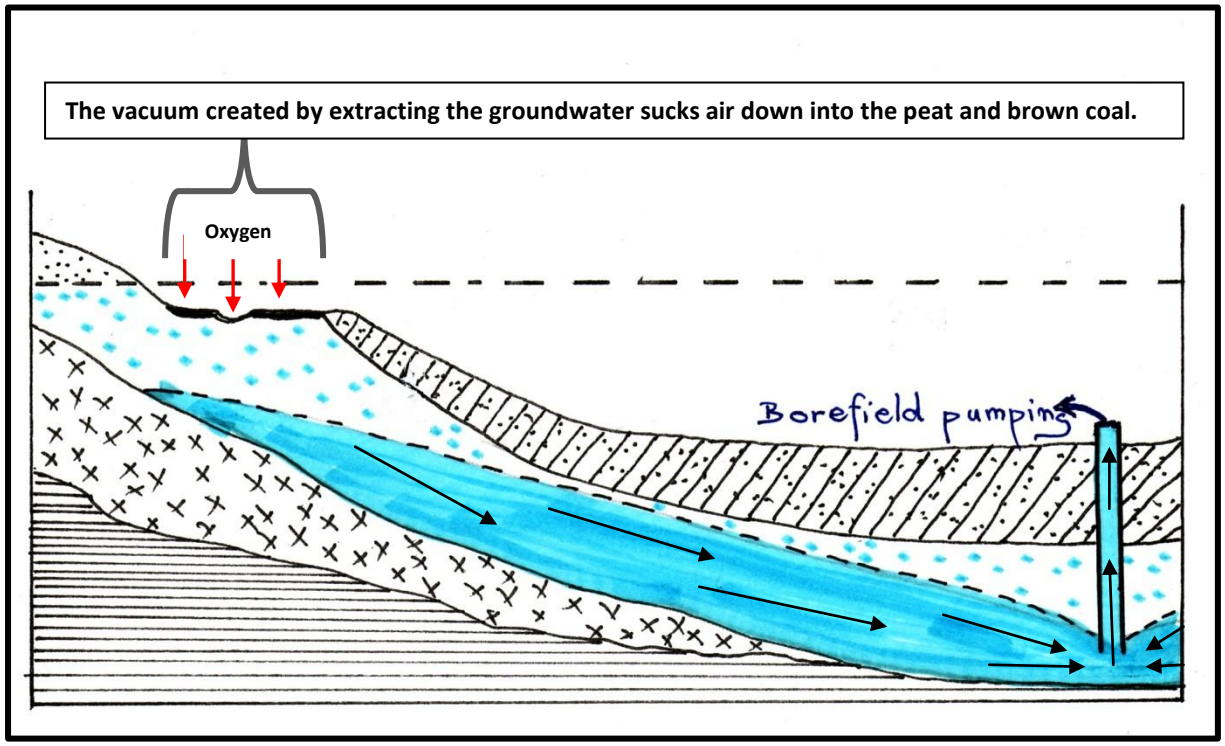
The peat in the Big Swamp sits above a natural vent where the aquifer comes to the surface. As more groundwater is extracted it sucks air down through the burning peat and brown coal into the depleted aquifer below (see next page). This air being sucked through the peat is a most likely source of oxygen continuing to fuel the fire.

The extraction pumps have been turned off for some months but the gate valve sealed observation bores still suck air when they are opened. The cone of depression caused by the groundwater extraction will take some considerable time to flatten out and equalise. Until this relatively stable new water table is reached some observation bores will continue to experience vacuum conditions.

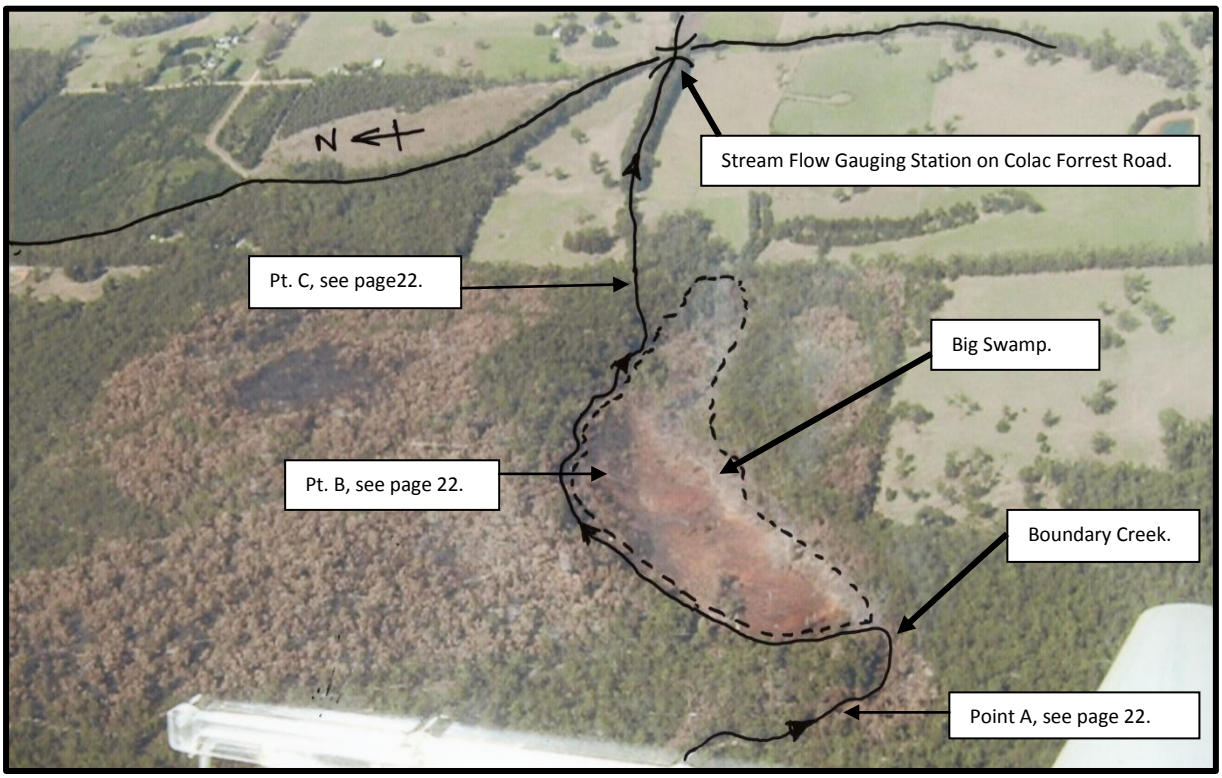
This is an example of an artesian bore in an adjoining groundwater management area. There has been insignificant change in the water table pressure head in this bore at Kawarren.

When the aquifer is full water discharges into Boundary Creek and keeps the Big Swamp saturated. Drill a bore into this aquifer when the aquifer is full and it will squirt water into the air to approximately the 160 metres AHD level.(Australian Height Datum – metres above sea level).

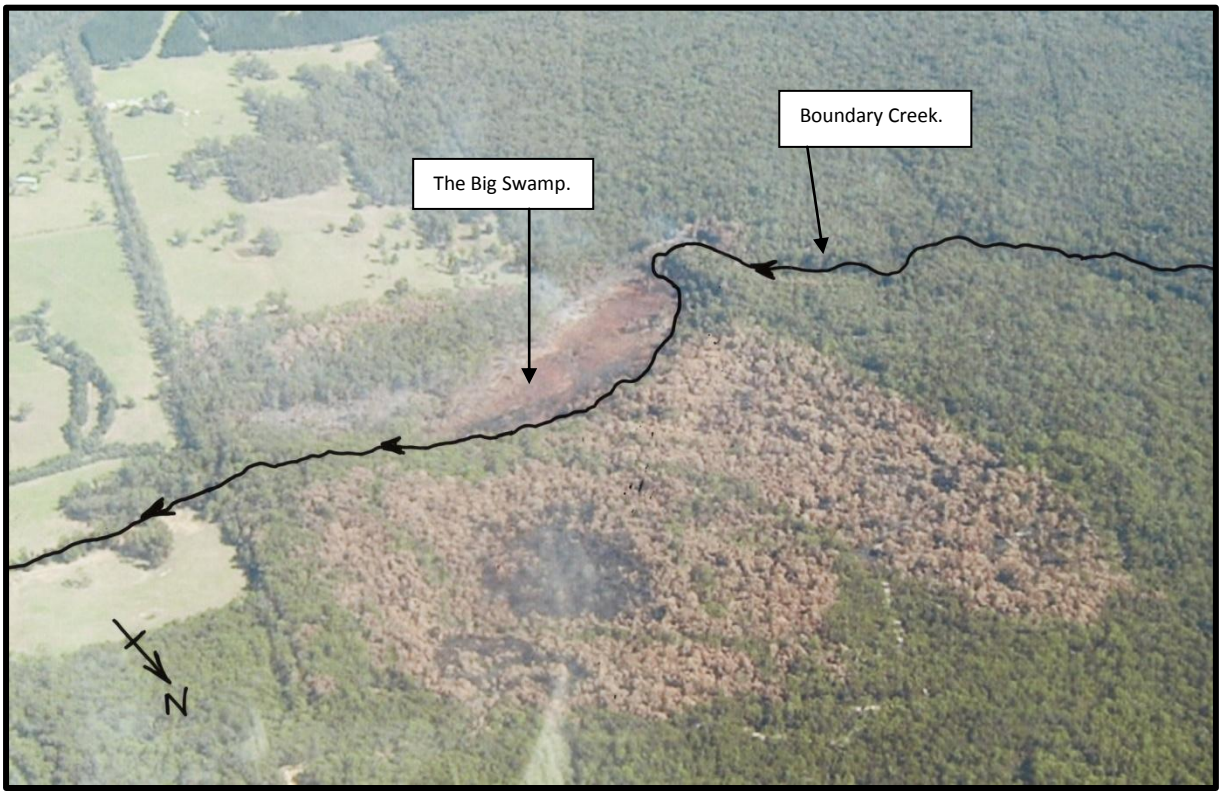




Aerial photographs of the burnt area, March 2010.



Aerial Photographs: John Callahan.



These two photographs show the area burnt in the March 2010 outbreak from the Big Swamp. The smoke coming from the smouldering peat/brown coal can be seen along the southern boundary.

To
Malcolm Gardner.

From
Jim Speirs.
Forrest 3236.
23-6-2010

Dear Malcolm.

In response to your inquiry regarding the area at Boundary Creek, Barongarook, in particular the area known locally as the Big Swamp the following information may be of some interest to you.

I was involved in that area as I was employed by the former Forests Commission from 1952 until my retirement in 1991, firstly building and maintaining the roads and tracks as well as managing the forest produce and the control of fire and hazard reduction burning,

The entire area of the Barongarook forest was hazard reduced with fire from time as required to limit the danger from wildfire.

Hazard reduction burns were carried out either in Spring or Autumn in order protect the soil and over story vegetation from excessive heat damage.

The swampy areas were mostly very wet during these burns, however very good results were obtained as the swamp grass would burn very well after just a few dry days.

A burn during the early 1970,s in particular, in the Big Swamp was carried out by the crew wearing rubber boots as the water was quite deep, rather than just wet at ground level, which was the case mostly during burns.

Newer crew members were surprised to see the swamp grass burn very well down to the water, and complained about being bitten by the large stripped {Tiger} Leaches always present in the swampy areas at Barongarook.

The Big Swamp must have dried out completely in recent years as I understand it is now burning through the peat and into the coal bellow, and for some years the local farmers have been complaining that no water is in the creek at the Boundary Creek bridge on Colac Rd.

Although I am no expert it seems that for some reason the water table most have dropped away considerably for this to be happening.

Regards Jim Speirs.
Retired Forest Officer,

State of Victoria – Evidence Act 1958

[JP/DOJ.1/2000]

STATUTORY DECLARATION

I, FREDERICK JAMES SWAN
[full name]

of 51 CHURCH ST. COLAC VIC. 3250
[address]

FARMER/BUS DRIVER. , do solemnly and sincerely declare that:-
[occupation]

My family has owned the farming land to the south, which directly abuts the area known as the Big Swamp, since 1935. I was born in 1943, attended the Gerangamete School, just down the road, and have recollections of the Big Swamp from around the age of four i.e. 63 years of memories. My father would take me, while fencing our property, into this area and show me various things he had discovered there, such as possum nests and other things. I can recall him telling me that the Big Swamp did not even catch fire when the 1939 fires completely surrounded it.

Until the fires in the 1990's you could not see into or over this swamp area because of its denseness. The ti-tree scrub and paper barks were so tall, close together and thick that it was almost impossible to penetrate them, and, because it was such a wet area, you weren't inclined to go too far into the swamp. Even in the bad drought of 1982/83 this whole area was still covered in water and didn't appear to be any drier because of the drought.

In 1987, I took the quick-fill pump from the local fire brigade down to Boundary Creek to get necessary water to fight a fire in the nearby bush and I was astounded to see the creek was so low, with virtually no flow at all. I quickly had to source an alternative water source. After the first of the 1990's fires in the Big Swamp I was fortunate enough to get a helicopter flight over the swamp. From the air it was amazing to see how much of a jungle and wilderness the swamp was and it was obvious that many areas had dried out. When fighting fires in the Big Swamp area we nicknamed it "Jurassic Park". Excavators and bulldozers were almost useless in trying to get to the seat of the hot spots because whilst the dried out peat on top looked firm the wet peat further down was really treacherous. Considering the wet winters we had had over this time I was amazed that the Big Swamp had dried out so much, and the flows in Boundary Creek were so low.

I still work our family farm and since the fires of 1998 we have been able to look right across the Big Swamp. The fires this year have wiped the area virtually clean of standing vegetation and the area bears no resemblance to the healthy swamp I once knew.

I acknowledge that this declaration is true and correct, and I make it with the understanding and belief that a person who makes a false declaration is liable to the penalties of perjury.

Declared at COLAC

in the State of Victoria, this 5TH day of OCTOBER 2010

F J Swan
Signature of person making this declaration
[to be signed in front of an authorised witness]

Before me,

Signature of authorised witness

(GRAHAM HONEY S/C OF POLICE 2005)

Colac Police Station
Queen Street
COLAC 3250

The authorised witness must print or stamp his or her name, address, and title under section 107A of the Evidence Act 1958 [Vic.]
(eg. Justice of the Peace, Pharmacist, Police Officer, Court Registrar, Bank Manager, Medical Practitioner, Dentist)

Conclusion.

Until the peat and brown coal area of the Big Swamp is returned to its natural saturated state pre groundwater extraction, the Big Swamp will continue to present a major risk as a source of wild fire.

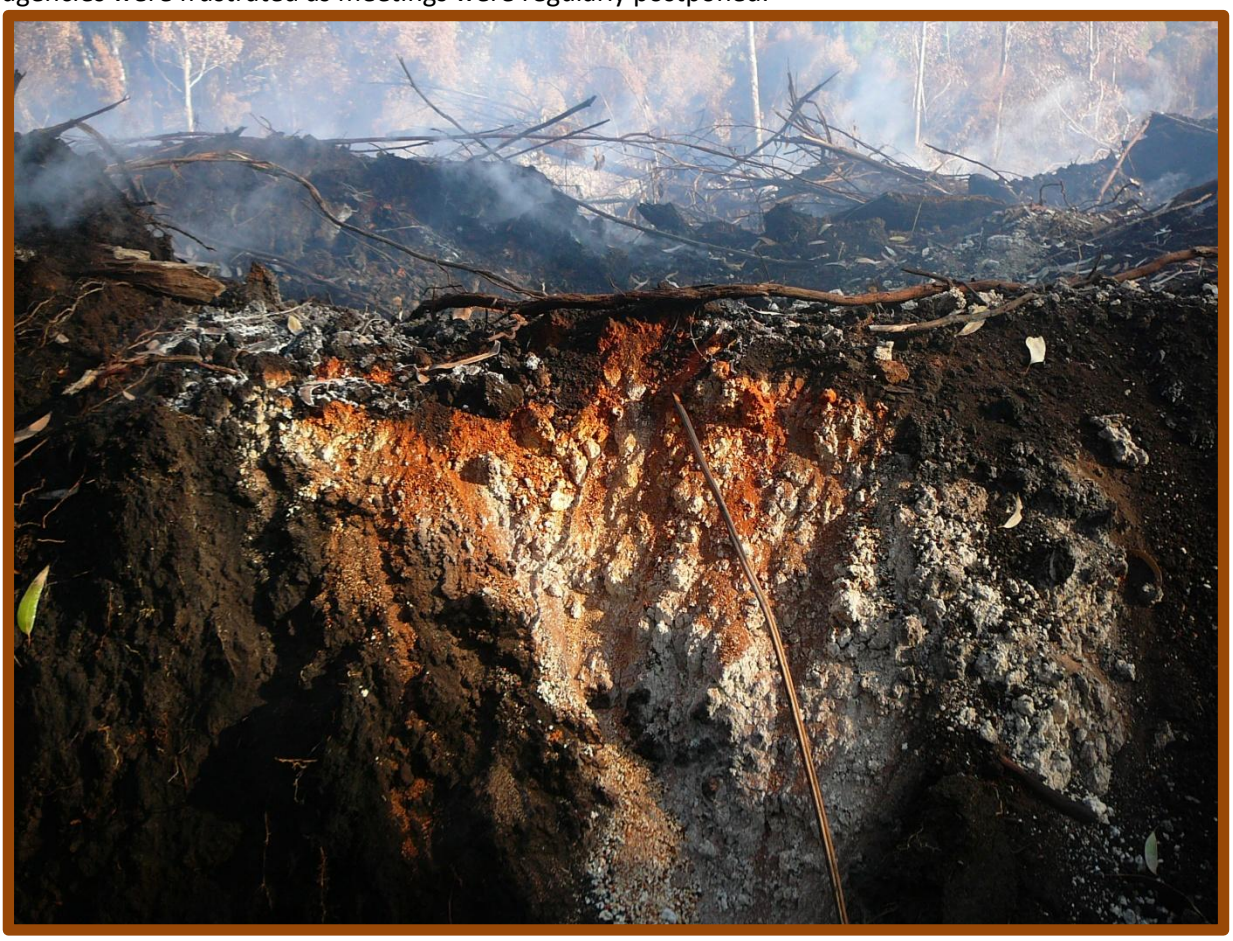
CHAPTER THREE

Toxic Gas Emissions, Acid and Heavy Metals- a disaster.

This Chapter discusses the possibility of toxic gases, toxic dust, acid, heavy metals and metalloids being produced and discharged from the Big Swamp.

Lack of State Government Agency Action.

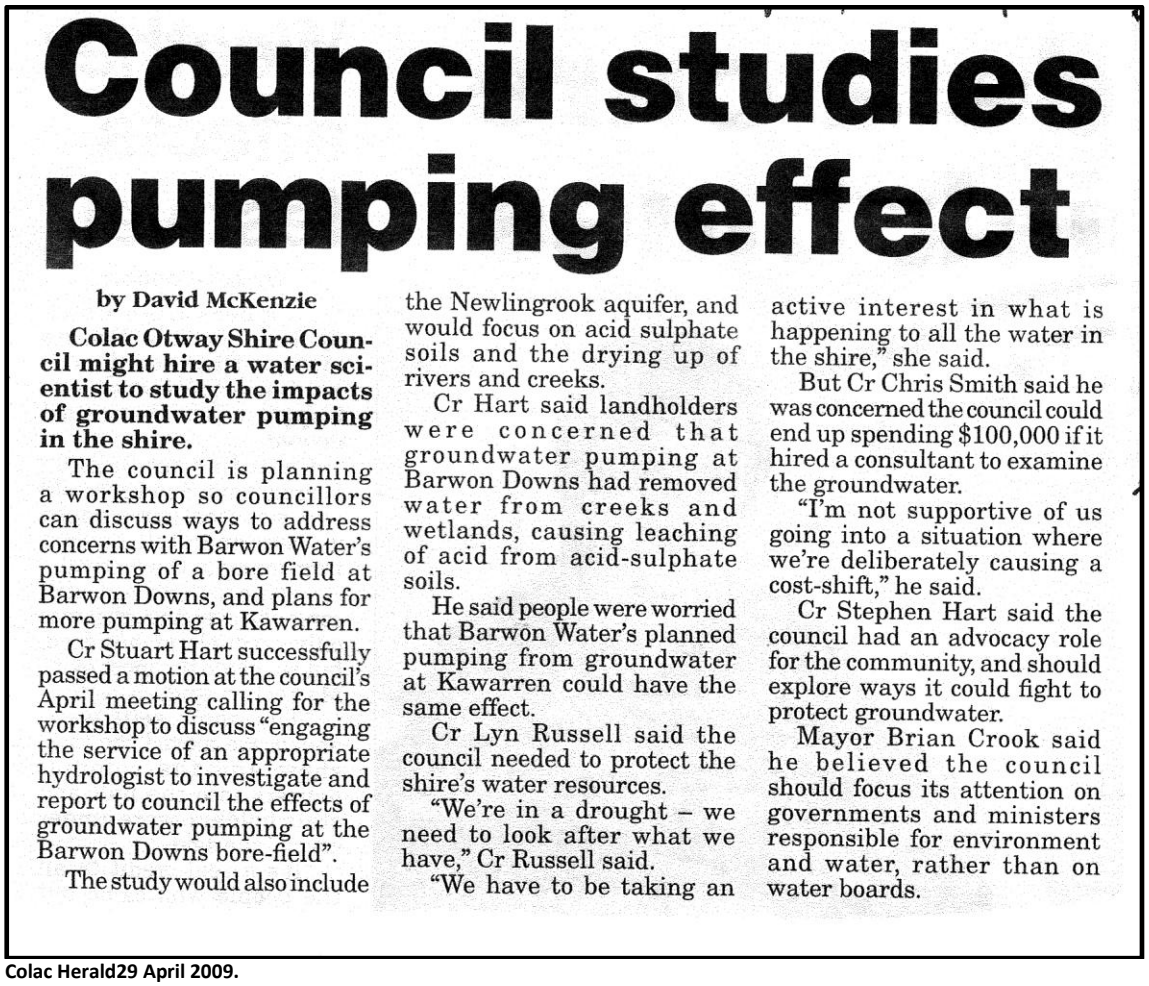
LAWROC Landcare members were extremely concerned that there was a serious problem occurring in the Big Swamp along Boundary Creek in the Yeo locality. Water tests sent to Deakin University in 2008 confirmed these suspicions. However, after 12 months of broken promises, denials that there was an acid problem and exclusion from any informal or formal discussions that may have taken place, LAWROC made the decision that if anything was to be done local community members would have to take the initiative. The only affirmative action during this 12 month period was attempted by Colac Otway Shire's Stewart Anderson. His attempts to convene a meeting of responsible agencies were frustrated as meetings were regularly postponed.



Burnt profile showing in the trench that has been dug along the southern boundary of the Big Swamp.

Considering the seriousness of the problems being generated in the Big Swamp area and the lack of agency action, LAWROC decided to commission an assessment of several Acid Sulfate Soil sites that were under threat from groundwater extraction. Funding for this exercise could not be sourced from any of the Government agencies even though it had been stated at a meeting in the Colac Otway Shire offices that Barwon Water had allocated $50000 to look at acid problems in the lakes areas of the Western District. There had been talk that the Colac Shire was prepared to add to this funding.

It was also reported in the Colac Herald that the Colac Otway Shire Council had passed a motion to discuss employing a hydrologist to carry out an investigation.



Council studies pumping effect

by David McKenzie

Colac Otway Shire Council might hire a water scientist to study the impacts of groundwater pumping in the shire.

The council is planning a workshop so councillors can discuss ways to address concerns with Barwon Water's pumping of a bore field at Barwon Downs, and plans for more pumping at Kawarren.

Cr Stuart Hart successfully passed a motion at the council's April meeting calling for the workshop to discuss "engaging the service of an appropriate hydrologist to investigate and report to council the effects of groundwater pumping at the Barwon Downs bore-field".

The study would also include the Newlingrook aquifer, and would focus on acid sulphate soils and the drying up of rivers and creeks.

Cr Hart said landholders were concerned that groundwater pumping at Barwon Downs had removed water from creeks and wetlands, causing leaching of acid from acid-sulphate soils.

He said people were worried that Barwon Water's planned pumping from groundwater at Kawarren could have the same effect.

Cr Lyn Russell said the council needed to protect the shire's water resources.

"We're in a drought – we need to look after what we have," Cr Russell said.

"We have to be taking an active interest in what is happening to all the water in the shire," she said.

But Cr Chris Smith said he was concerned the council could end up spending $100,000 if it hired a consultant to examine the groundwater.

"I'm not supportive of us going into a situation where we're deliberately causing a cost-shift," he said.

Cr Stephen Hart said the council had an advocacy role for the community, and should explore ways it could fight to protect groundwater.

Mayor Brian Crook said he believed the council should focus its attention on governments and ministers responsible for environment and water, rather than on water boards.

Colac Herald29 April 2009.

In a letter 17 December 2008[14] Chris Hughes, manager Field Operations Compliance of Southern Rural Water, made this statement.

> ***"In accordance with condition 7 of the licence, SRW has required Barwon Water to undertake a detailed Flora Survey. Barwon Water has sought tenders from suitable qualified expert consultants and the successful tender has not yet been appointed. Barwon Water must consult with the Department of Sustainability and Environment regarding suitable consultants. The investigation into Acid Suphate soils will be incorporated into the consultant's analysis and the completed report is expected by mid-2009."***

The Acid Sulfate Soil site at the Big Swamp was not included in this Flora Survey. Another opportunity missed. Another case of disappointment in an agency charged with managing and looking after our natural resources. Some might say a promise broken but at the very best incompetence on someone's part.

The specific reason this Flora survey had been written into the licence conditions was to gauge the reaction of flora within the influence of the groundwater extraction at Barwon Downs. Paradoxically the Big Swamp is much closer to the borefield than many of the other sites surveyed in the flora study. It is most baffling that the suspected Acid Sulfate Soil site at the Big Swamp was not included as it had been a site of contention for many, many months before the survey was conducted. There is no excuse for its omission. Both Southern Rural Water and Barwon Water were most certainly aware of the site and the issues involved.

Media release

100 YEARS SERVING OUR COMMUNITY
Barwo Water
1908 - 2008

December 05, 2008
REF: 226/08

Soil claims 'premature'

Barwon Water today described as "premature and speculative" claims that groundwater pumping at Barwon Downs is responsible for acid sulphate soil in the area.

Acting Managing Director Joe Adamski said a flora investigation currently underway would determine if there was any relationship between the two.

"The study is being undertaken as part of ongoing environmental modelling and a sustainable management program. It will look at the impact or otherwise of groundwater operations on the local flora.

"It would be injudicious to comment until that information is available," Mr Adamski said.

Mr Adamski was referring to a newspaper report in which Barwon Water was accused of creating conditions for the formation of acid sulphate near a local waterway, Boundary Creek.

He said a robust monitoring program had been in place since the borefield began operating in the 1980s. "We currently have more than 60 observation bores monitoring water levels and salinity and there have been a number of significant related investigations. The flora study is another element on that continuous process," Mr Adamski said.

The Barwon Downs borefield is a crucial supply source for Geelong during dry conditions.

Located south of Colac, it has met up to 70 per cent of the region's needs since being brought on line in 2006 when the full impact of the drought hit regional reservoirs.

It is currently meeting around 30 per cent of demand.

The groundwater reserve holds more than more than 500,000 megalitres (million litres). By comparison, Geelong's largest storage at Wurdee Boluc has a capacity of 40,000 megalitres while West Barwon Reservoir can hold 20,000 megalitres.

Mr Adamski said Geelong was in the enviable position of having a major groundwater resource at Barwon Downs. "Indeed, we are one of the few urban areas in Victoria with significant groundwater supplies.

"Barwon Downs has thrown Geelong a lifeline several times over the past 30 years; without it, we would have been in dire straits.

"Because of its importance to our diversified supply network, we are ensuring the resource is respected, protected and sustainable. To do otherwise would be irresponsible."

Mr Adamski said data gathered over three decades dictated the parameters for operating the borefield. These parameters were included in strict licensing conditions set down by Southern Rural Water.

He said Barwon Water had readily acknowledged Boundary Creek was affected by operations at Barwon Downs. But monitoring also indicated Boundary Creek had run dry when the borefield had not been operating.

"We should be mindful of the fact the region is still gripped by drought - and, based on Bureau of Meteorology forecasts, there appears little likelihood of any relief over summer," he said.

Further information: Cassie Milner, Media Liaison Officer.
Telephone: Work (03) 5226 2352 Mobile 0401 857 580

The abundant amount of evidence [14] supporting the assertion that groundwater extraction was the problem was neither "***premature***" nor "***speculative***" as claimed in this media release. Also Mr. Adamski is yet to furnish any evidence supporting his claim that robust monitoring has been in place since the 1980s.

Barwon Water could not afford to lose its right to extract huge volumes of water from the Barwon Downs Borefield. Any evidence presented by LAWROC, and opportunities to investigate the Big Swamp were discarded, overlooked and or ignored.

Media release

100 YEARS SERVING OUR COMMUNITY

Barwon Water

1908 - 2008

December 16, 2008
REF: 233/08

Groundwater use

Barwon Water Managing Director Michael Malouf said while he respected Malcolm Gardiner's right to raise concerns about the possible effects of groundwater use, Barwon Water had no evidence that its borefield at Barwon Downs was responsible for the reported appearance of acid sulphate soils.

"Throughout his campaign against Barwon Water's use of groundwater Mr Gardiner has failed to acknowledge and address one very important aspect; without Barwon Downs borefield, 250,000 Geelong residents would be running very short of water due to the drought," Mr Malouf said.

"Barwon Downs has thrown Geelong a lifeline several times over the past 30 years; without it, we would have been in dire straits."

The borefield is currently meeting around 30 per cent of demand.

"Because of its importance to our supply network, we are ensuring the resource is respected, protected and sustainable. To do otherwise would be irresponsible," Mr Malouf added.

"Barwon Water is developing a diversified supply system that will allow us to scale back our use of Barwon Downs borefield in the coming years. We have the Anglesea borefield coming online next year, followed by the Melbourne-Geelong interconnection, Northern Water Plant and Black Rock recycled water plant over the next five years.

"At the moment the borefield remains a crucial supply source and has, at times, met up to 70 per cent of the region's needs since being brought on line in 2006 when the full impact of the drought hit regional reservoirs."

Mr Malouf said the latest vegetation studies were part of a robust long-term monitoring program.

The program has been in place since the borefield began operating in the 1980s. Currently there are more than 60 observation bores monitoring water levels and salinity and there had been a significant number of related investigations.

"The vegetation monitoring component is an element of that continuous process. It was established in 1994 to improve our understanding of the interaction between groundwater, surface water and the health of native vegetation in recharge areas," Mr Malouf said.

"If soil health is found to be an issue, Barwon Water will investigate. Such an investigation would cover other potential impacts, including drought, weed infestation, fire and other causes of disturbance."

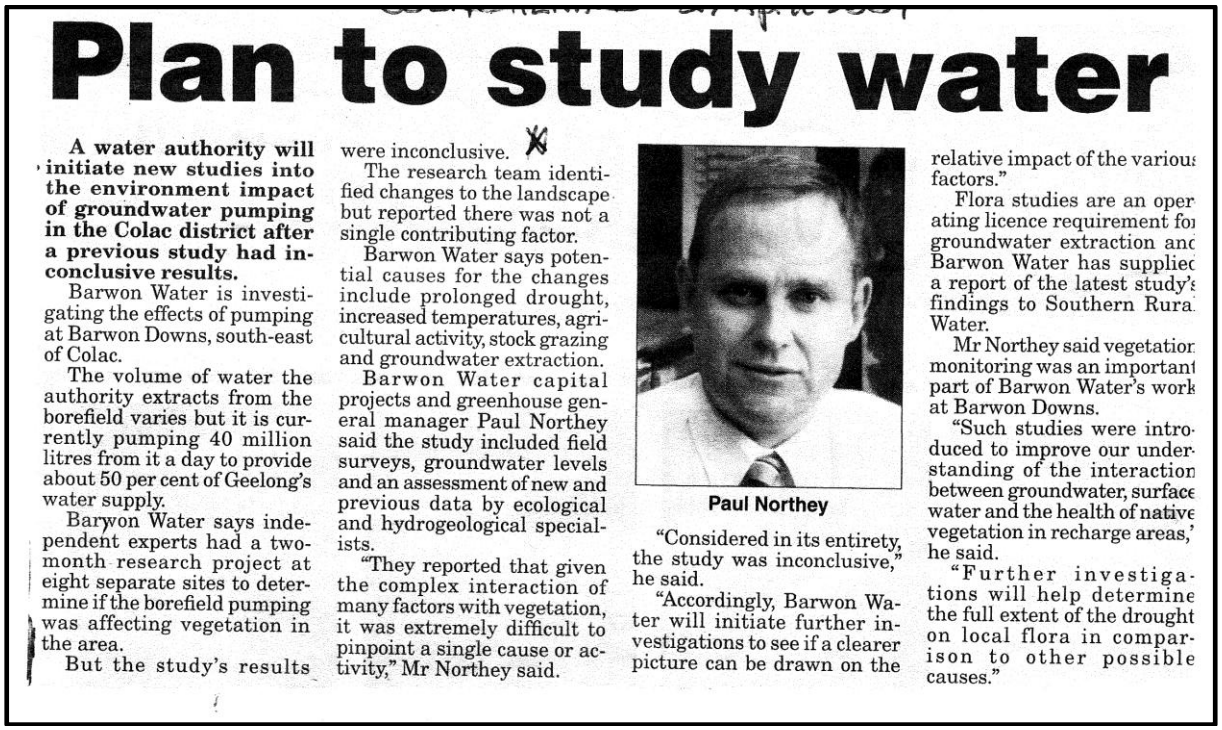
Ends

Contrary to this media release the volume of evidence clearly demonstrates that soil health is a problem. This release also made it clear that Barwon Water is not prepared to investigate the Big Swamp site.

Worse still, Barwon Water's own records contain the evidence showing that groundwater extraction at the Barwon Downs Borefield is the major causal factor degrading the Big Swamp. Michael Malouf would have been closer to the truth if he had stated that Barwon Water had not checked its records for any evidence, rather than state that Barwon Water has no evidence.

Problems in the Big Swamp are Overlooked.

The Flora survey was conducted. The Big Swamp was not included. The flora survey report was written and released. To say it was a mediocre effort would be overstating the quality of the work. Otway Water Book 9[(19)] was written in response to this flora report and is scathing in its criticism. The most disappointing aspect from Barwon Water's flora report besides the inconclusive result, were the recommendations. These recommendations mirrored those made on at least three previous occasions going as far back as 1986. If implemented when first stated it would have been painfully obvious some considerable time ago, that groundwater extraction was causing serious degradation of ecosystems.



Plan to study water

A water authority will initiate new studies into the environment impact of groundwater pumping in the Colac district after a previous study had inconclusive results.

Barwon Water is investigating the effects of pumping at Barwon Downs, south-east of Colac.

The volume of water the authority extracts from the borefield varies but it is currently pumping 40 million litres from it a day to provide about 50 per cent of Geelong's water supply.

Barwon Water says independent experts had a two-month research project at eight separate sites to determine if the borefield pumping was affecting vegetation in the area.

But the study's results were inconclusive.

The research team identified changes to the landscape but reported there was not a single contributing factor.

Barwon Water says potential causes for the changes include prolonged drought, increased temperatures, agricultural activity, stock grazing and groundwater extraction.

Barwon Water capital projects and greenhouse general manager Paul Northey said the study included field surveys, groundwater levels and an assessment of new and previous data by ecological and hydrogeological specialists.

"They reported that given the complex interaction of many factors with vegetation, it was extremely difficult to pinpoint a single cause or activity," Mr Northey said.

Paul Northey

"Considered in its entirety, the study was inconclusive," he said.

"Accordingly, Barwon Water will initiate further investigations to see if a clearer picture can be drawn on the relative impact of the various factors."

Flora studies are an operating licence requirement for groundwater extraction and Barwon Water has supplied a report of the latest study's findings to Southern Rural Water.

Mr Northey said vegetation monitoring was an important part of Barwon Water's work at Barwon Downs.

"Such studies were introduced to improve our understanding of the interaction between groundwater, surface water and the health of native vegetation in recharge areas," he said.

"Further investigations will help determine the full extent of the drought on local flora in comparison to other possible causes."

Colac Herald 27 April 2009.

Otway Water Book 9 clearly demonstrates the "***prolonged drought, increased temperatures***" and "***stock grazing"*** are not the causes for the dramatic changes in the Big Swamp area. As stated in the Paul Northey article above, that only leaves groundwater extraction as the "culprit."

Stalling tactics, incompetence, lack of caring, ignorance of responsibilities, whatever. It is quite clear that investigation of the Big Swamp is an extremely low priority and looks like never being seriously considered as an issue that would be pursued with any vigour.

The LAWROC Study Goes Ahead.

After months and months of denial and inaction by State Government agencies LARWOC decided to go it alone. Scientists from Southern Cross University's Environment Analysis Laboratory were commissioned to conduct field studies and prepare a report on Acid Sulfate Soils.

In March 2010 as core samples were being collected for the LAWROC investigations, the Colac Otway Shire had managed to bring together enough of the Government agencies to draw up a Brief for an action plan.

It was not until months later in May 2010 that it was known that this Brief existed (see Chapter 6). Latrobe University was being paid big money to conduct a study LAWROC had already conducted, a study not one State Government authority was prepared to assist. What a farce. To make matters worse this Brief had been developed and the investigation team employed without the slightest effort to conduct any public consultation. What a farce. What a waste of money.

Looking at a cross section of the trench dug along the southern boundary of the Big Swamp, February 2010. The peat is still smouldering.

Some of the Findings of the Environmental Analysis Laboratory, Southern Cross University Study.

This study is still in draft format but there are aspects that will not change.
Core and water samples were collected from:

1. 4 sites in the Big Swamp area – tributary of the Barwon River Catchment.
2. 2 sites in the headwater tributaries of the Barongarook Creek Catchment.
3. 2 sites in the Porcupine Creek Catchment – tributary of Loves Creek.
4. 2 sites in the Spiny Horn Creek Catchment – tributary of Loves Creek.
5. 1 site in the Yahoo Creek Catchment – tributary of Loves Creek.
   (Loves Creek is a tributary of the Gellibrand River Catchment.)

These samples were stringently processed and the following results ***in regard to the Big Swamp*** samples have been confirmed.

- Extremely high levels of actual and potential acidity exists. The average of 367 molH^+/tonne being well above the action criteria for Acid Sulfate Soils of 62. One sample tested at an extraordinary 11942 molH^+/tonne.
- The average oxidisable sulfur content was 1.59%S_{cr} and this is also well above the trigger level of 0.03%S_{cr}.

- There is considerable acid generating potential still existing in the soils of the Big Swamp. One molH^+/tonne of FeS_2 will produce 4 molH^+/tonne of acid.
- Natural buffering capacity and acid neutralising capacity is zero.
- The Big Swamp acid generating capacity has reached that stage where the chemical reactions are sufficient enough to continue without an oxygen factor required.

The draft document still has to undergo its finalisation but it is also apparent that other sites sampled in the Otway Ranges are in fact Potential Acid Sulfate Soil locations.

Toxic Gas Emissions.

The Big Swamp wetlands contain all of the ingredients and means to bring about chemical and bacterial reactions and microbial oxidations that can produce a multitude of toxic gases and dust. In addition, the burning of the peat has compounded the toxic gas and dust emissions.

In 2008 a CSIRO and CRC LEME Thematic Volume [7] it states that,

> "***The S (sulfur) cycle and, particular the gaseous components of the S cycle have received limited attention in Australian inland wetlands.***"

Consequently a better understanding of sulfur cycling in inland Australia is little known and should be investigated as a priority.

> "***Ambient air measurements indicate H_2S*** (hydrogen sulphide) ***may not be the main gas responsible for the foul smells.***"

It is also stated in this Thematic Volume that sulfur gases represent a potential threat to the ecology and agricultural industries. They have the potential to affect populations of pollinators and also grape wine quality.

In one instance quoted on page 147,[7]

> "***It is also worth noting that the concentrations of hydrogen sulphide observed were relatively low and this gas appears to be a minor component of the gas cocktail.***"

It would appear that there is an extremely limited number of laboratories around the world with the expertise to measure S gas emissions from wetlands.[7, page147]

The three main types of sulfur(S) gases that may be emitted from wetlands are...

1. Hydrogen sulphide,
2. Volatile Organic Sulfur Compound Gases(VOSCG), and
3. Sulfur dioxide.

It is quite significant that on page 144 in this section of the Thematic Volume [7] it states,

> "***To our knowledge, our recent exploratory sampling of ambient air in the Loveday Basin has been the only study of VOSC***(Volatile Organic Sulfur Compounds) ***emissions from Australian inland wetlands.***"

This part of the Thematic Volume suggests that the occurrence and concentrations of these gases warrants further investigation and in particular to the human health effects aspect. The problem is compounded when there have been no studies to determine the environmental control levels of S gas emissions for inland Australian wetlands.[7, page 146]

The implications of this Thematic Volume in regard to the Big Swamp are profound. When the Big Swamp was once again a blazing inferno in March 2010 palls of foul smelling smoke were evident for months afterwards. The Environment Protection Authority (EPA) was extremely slow to respond to complaints of concern regarding the smoke and its smell. From all accounts as stated in the Thematic Volume it would appear that the EPA does not have the experience, expertise or the means to adequately test for noxious and or toxic gases and dust that are most likely generated from the Big Swamp from either the result of dewatering or wildfire.

CHAPTER FOUR

Actual Acid Sulfate Soils and Effects on Life in the Big Swamp.

Toth[29] states, "... ***that moving groundwater is the common basic cause of a wide variety of natural processes and phenomena***." Groundwater is involved in a multitude of bacterial, microbial, chemical, physical and hydro-kinetic processes through which interaction over eons between groundwater and its environment has created a relatively stable state.

The role groundwater movement plays in a locality is complex, important, significant and dependent on a multitude of variables particular to that locality.[29] The manner in which a relatively stable equilibrium has been reached in a locality needs to be understood from a multidisciplinary view point. Too often specialised fields of endeavour often overlook the wider picture of cause and effect relations between regional groundwater flow and the specialised field of study. With specialised and such narrow expertise and study the understanding of seemingly unrelated natural processes and phenomena are quite often overlooked and seldom recognised.[29] It would appear that such a situation has taken place in the upper reaches of the Barwon River Catchment. Taken purely from a hydrological view point it has been determined that the extraction of groundwater at the present level is sustainable. However, taking a wider perspective it is blatantly obvious that the environment in the vicinity of the Big Swamp is being seriously degraded.

Reaction to extended groundwater extraction can be easily visible in the form of land subsidence, water level decline in streams and wetlands, sea water intrusion, gullying, landslides, contamination of aquifers and salinity problems. However, the greater number of associated impacts of groundwater extraction are more often subtle and not readily recognised. Toth[29] in his text mentions numerous natural processes and phenomena generated and or fundamentally shaped by groundwater flow such as; soil salinization, continental salt deposits, regional patterns of groundwater's chemical composition, soil liquefaction, positive and negative geothermal anomalies, lake eutrophication, base flow characteristics of streams, type and quality of plant species and associations, mobilization and depositing of matter and heat, lubrication of discontinuity surfaces rock framework, the generation and modification of pore pressures, chemical reaction and mobilisation - to name a few. The importance of a relatively stable groundwater system cannot be over emphasised. Disturb this balance and the nature of a locality can be dramatically transformed.

There can be no doubt that the Big Swamp was a thriving freshwater wetland up to the 1980s. The vegetation in the swamp was diverse and jungle like. However, Otway Water Books[14,15,18,19] clearly demonstrate that a dramatic transformation of the natural conditions in the vicinity of the Big Swamp has taken place. The Environmental Analysis Laboratory of Southern Cross University Study[28] confirms that there is an Actual Acid Sulfate Soil (AASS) problem existing in the Big Swamp and that there are extreme levels of acidification and heavy metal loads. Whatever the cause of this AASS problem, the transformation of the vegetation from a rich and thriving wetland to a barren and desert like landscape, is abundantly clear. The acid levels and heavy metals have taken their toll.

SOIL BIOLOLGY.

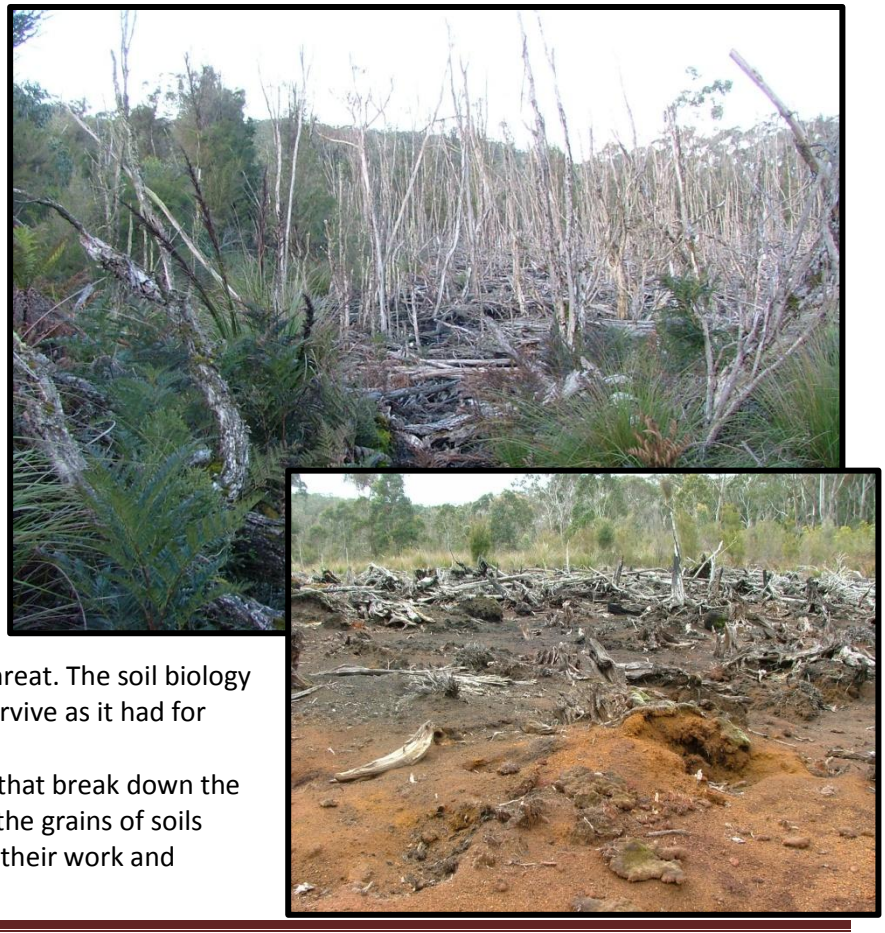
Understanding soil biology is still in its infancy stages. However, it is known that there can be at least 100 000 species with 10 million different individuals, in 1 gram of soil. There are bacteria, protozoa, fungi, nematodes, collembola, acari, isoptera and oligochaeta. These individuals crunch, much, decompose, transport and chemically degrade matter, provide a food source for those predatory

animals with other specific roles, excrete enzymes, alter physical structures including the prevention of hydrophobia and influence rates of nutrient and energy flow.
Under natural conditions these processes although in a constant state of change, over time, maintain a relatively stable environment particular to that locality.

WHY IS A HEALTHY SOIL BIOLOGY IMPORTANT?
All of these animals are soil processers decomposing plant residues, regulating plant nutrient supply, improving soil structure, degrading pesticides and herbicides, binding soil together, regulating water quality and capturing and releasing greenhouse gasses. These soil life forms are vital in the maintenance of a healthy natural system.

SYMBIOTIC FUNGI.
Although there is still much to learn and understand about the processes and functioning of soil biology some of the relationship between fungi and plants is fairly well known. Mycorrhizal fungi form a special bond with the rootlets of trees and other plants enabling them to take up water nutrients and trace elements.[21] In return the plant provides a food source for the fungi. The mycorrhizal fungus that attaches itself to the plant roots sends out hyphae or minute branches into the soil collecting and gathering. A handful of soil could contain kilometres of hyphae. These mycorrhizal fungi also provide protection for the host plants against attack by pathogens and invertebrates. This symbiotic relationship is absolutely essential for the healthy growth and survival of the plants.

ACIDIFICATION and HEAVY METALS.
The removal of a permanent and reliable water source from a natural balance that has evolved over eons will bring about significant environmental change. The Big Swamp is no exception. As the water table began to drop the natural processes taking place in the Big Swamp altered significantly. As the water table dropped the soil dried out and the functioning of the soil biology altered and adapted accordingly. The soil animals and life form species would have changed, altered and or survived as dictated by the different environment. However, whenever the area experienced wet conditions sulphuric acid levels skyrocketed and the acid began to liberate previously locked up heavy metals. The ecological balances and checks that had evolved in the Big Swamp came under serious threat. The soil biology of the area could no longer survive as it had for eons.



- The micro-organisms that break down the waxy, oily coating on the grains of soils were no longer doing their work and

sections of the swamp have become hydrophobic.

- Soluble aluminium, manganese and iron reached toxic levels. Aluminium toxicity limits plant growth; the plants become more susceptible to drought; the outer boundaries of root cells are attacked; the uptake, transport and use of several essential elements are reduced; the uptake of other elements can be increased and morphological damage to plant parts and the reduction of plant respiratory and protein synthesis occurs.
- Mycorrhizal fungi die inhibiting the ability of plants to take up water, nutrients and trace elements.

The ecological footprint in the area has been drastically and dramatically altered. The Big Swamp as it was pre groundwater extraction no longer exists.

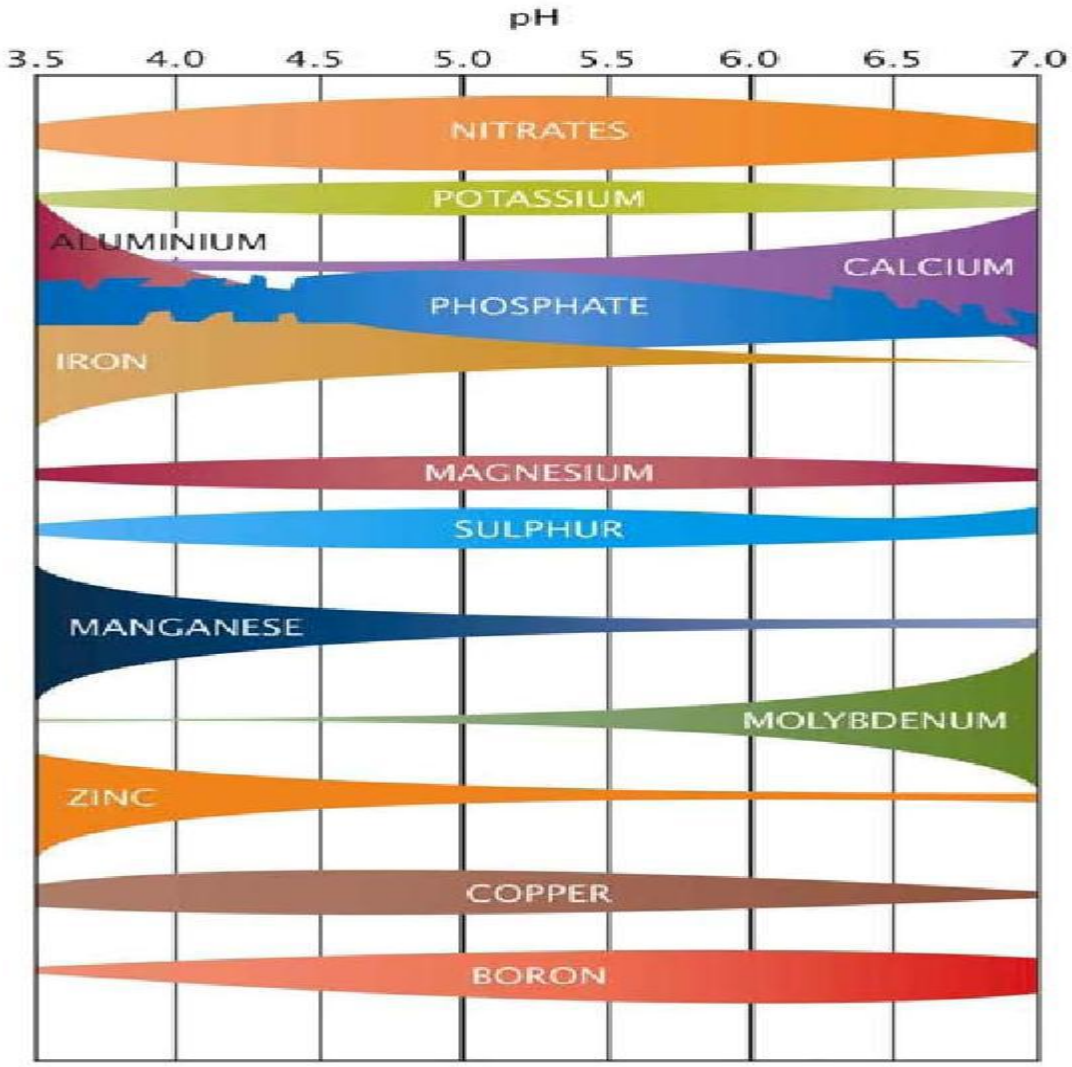


Diagram Source: Acid Soils fact sheet Glenelg Hopkins Catchment Management Authority & Department of Primary Industries, Victoria.

This is an interesting diagram in many ways. As the pH levels drop the aluminium, zinc, iron and manganese levels dramatically rise. Imagine the graphics at the water levels tested in 2008 when the pH was 2.5

A Most Obvious Conclusion.

There can be no doubt that the healthy, thriving ecosystem that had evolved in the Big Swamp over thousands of years, has undergone extreme changes not allowing the natural fauna and flora to survive in conditions alien to their existence. The high levels of acid generated and resulting liberated heavy metals are so toxic that the majority of life forms in the Big Swamp have died out.

CHAPTER FIVE

Threat to Other "Big Swamps."

Accepting it as fact that groundwater extraction from the deep water aquifer at Barwon Downs borefield has caused untold damage to a freshwater inland peat swamp and wetland in the Big Swamp, it can reasonably be assumed that extraction form other areas of the Otway Ranges will have similar effects. An example of the likelihood that this could happen can be found in the adjoining Gellibrand River Catchment.

The 1990s – No Groundwater Extraction at Gellibrand or Kawarren.

During the early decade of the 1990s extensive and comprehensive studies concluded that groundwater extraction from the either of the proposed Gellibrand or Kawarren borefields would have serious impacts on the Gellibrand River Catchment. Streams would cease to flow, springs would dry up and the Gellibrand River could be changes from an accepting river from groundwater to a losing river. Given the magnitude of groundwater that Barwon Water was proposing the Gellibrand River could be sucked dry. Ecosystems would be dramatically altered, stock, domestic and irrigation water supplies compromised and the estuary wetlands decimated.

The final blow stopping any thought of groundwater development on the scale Barwon Water was proposing came from the work of Khouri and Duncan.[(22)] This report determined that many of the Western District towns of Victoria that are supplied from the Gellibrand Catchment, would run dry of water in a drought if the most basic of environmental flows was allocated to the Gellibrand River. Any thought of groundwater extraction was stopped in its tracks. The waters of the Gellibrand River and one of its sources of water being groundwater, were already fully allocated. In fact it was most obvious that the water resource in this catchment was over allocated.

There still hasn't been an environmental flow allocated to the Gellibrand River to this day. The first recommendations date back to at least 1988.

2006 Attempts to Extract Water at Kawarren.

However, these findings in the 1990s were not convincing enough for the present State Government and in 2006 Barwon Water was given the green light to look at the extraction of 16 billion litres of water a year from the Kawarren borefield. This feasibility study was to take place in the midst of the worst drought on record and under the most secretive means possible. Groundwater extraction was the State Government's first option for water supply to Geelong. The second was a pipeline from Melbourne to Geelong providing the same amount of water, 16 billion litres per year. This pipeline would be connected to the same supply system as the desalination plant at Wonthaggi.

In the 1990s residents of the Gellibrand and Kawarren district had presented an extremely convincing case to set up a steering committee to initiate and conduct appropriate studies. This effort showed beyond any doubt that the proposed amount of groundwater extraction could only be possible if the Government was prepared to accept massive environmental degradation. The same evidence was presented and used in the 2006 campaign to stop any groundwater extraction proposals at Kawarren. There were three distinct changes from the 1990s.

1. Local input was sought, listened to and included in decision making in the 1990s. This was not the case in 2006 to 2009. The exact opposite was the case. This had the affect of galvanising community support to fight this issue.
2. Science and technological advances had come a long way in two decades.
3. The increase in population to the area added diversity, knowledge and support.

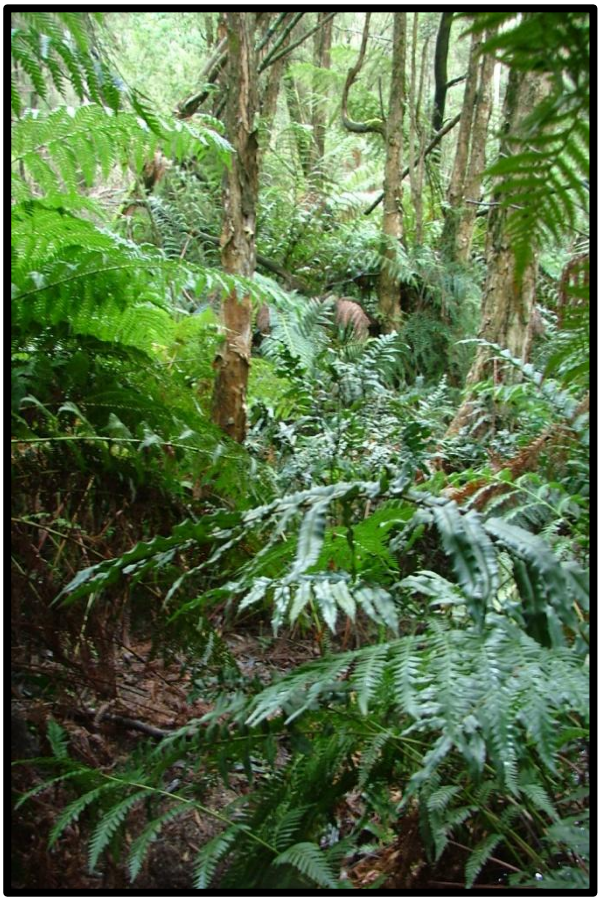
Local Efforts Win the Day.

The Kawarren groundwater extraction proposal was withdrawn 24 hours before it went to the Victorian Council Appeals Tribunal (VCAT). Unfortunately the "case" has not been tested and resolved. However, even though Barwon Water can reapply for a licence at any time the withdrawal of the project by Barwon Water was a significant result.

Freshwater Inland Peat Swamp and Wetland Destruction was One Aspect.

The destruction of the Big Swamp caused by extensive groundwater extraction was one of the arguments that would have been presented at VCAT. It was a compelling and convincing argument that the same amount of groundwater extraction at Kawarren would have had profound influence on swamps, streams and rivers down the full length of the Gellibrand River Catchment.

It is known from the Environment Analysis Laboratory study that there is Potential Acid Sulfate Soil (PASS) in the upper reaches of the Barongarook Creek, Loves Creek, Yahoo Creek and the Porcupine Creek. It is well documented[8] that the estuary of the Gellibrand River is one of the highest Potential Coastal Acid Sulfate Soil sites in Australia. "***...The Princetown area has concentrations of reduced inorganic sulphur that are some of the highest recorded in Australia and these represent an extreme acid sulphate soil risk.***" Between these two extremes , the headwaters and the estuary of the Gellibrand Catchment, there are many, many hectares of freshwater inland peat swamps and wetlands. The probability is extremely high that a large number of these wetlands have the potential to become Actual Acid Sulfate Soil sites if drained.



A Potential ASS site on Ten Mile Creek a tributary of the Gellibrand River.

Conclusion.

Several Potential Freshwater Inland Acid Sulfate Soils sites have been identified in an estuary, the foothills and mountainous area of the Otway Ranges, Gellibrand River Catchment. There is likelihood that other sites exist in the extensive freshwater inland peat swamps and wetlands and are yet to be identified

Drainage, groundwater extraction and drought in isolation or in combination could see these sites turning into another Big Swamp scenario. But by far the biggest influence to date has been extensive groundwater extraction for urban use.

There is at least one Potential Freshwater Inland Acid Sulfate Soil site that has been dewatered and turned into an Actual Acid Sulfate Soil site creating extensive environmental damage and social disruption.

CHAPTER SIX
Work of the Steering Committee Dealing with the Acid Sulfate Soil Problem.

Between June and October in the year of 2008 it appeared that every government authority that was approached regarding a possible Acid Sulfate Soil problem in the Boundary Creek area was content to ignore pleas for affirmative action. In desperation the Australian Broadcasting Company (ABC) was approached. In October 2008 the ABC Stateline television program ran with the suspected Actual Acid Sulfate Soil problem along Boundary Creek. In an attempt to gain a balanced view the Managing Director of Barwon Water, Michael Malouf, and the Mayor of the Colac Otway Shire, Chris Smith, were included in the program. Still no action followed this visually compelling program. As personal contact and voiced concerns continued to be largely ignored the first of many written formal complaints was delivered to the Environment Protection Authority, Geelong, in November 2008. Barwon Water, Southern Rural Water, the Department of Sustainability and Environment indicated that the formal complaints sent to them were frivolous, requiring no immediate action.[14][16][18] The Colac Otway Shire was the only authority not in denial.

Early in 2010 and after many months of persistence, the Colac Otway Shire (COS) successfully convened a meeting of the following statutory authority representatives, at which this group sanctioned a Brief to deal with the issue of an Acid Sulfate Soil problem in the Big Swamp - Department of Sustainability (DSE), Southern Rural Water (SRW), Corangamite Catchment Management Authority (CCMA) and Barwon Water (BW). It had taken 18 months of lobbying and poorly attended meetings to reach this stage. The Department of Primary Industries (DPI) declined to have a representative attend these meetings.

Throughout this period every effort had been made to provide information to these agencies outlining the concerns and suspected seriousness of the acid and heavy metal generation that was taking place in the Big Swamp (see pages 49-51copies of letters for two such examples). Unfortunately this was a one way process and the committee of agencies excluded LAWROC members from any meaningful dialogue.

Community Partnerships.

The 2010 Victorian Government's River Health Program Report Card for 2002-2009[32] states, "***With strong community-input, these strategies aim to protect or improve river reaches with the highest community values,***" and mentions that, "***requirements must be put in place to ensure that river health is not adversely affected by any planned works or activities carried out by agencies or by the communities.***" There is no mention of Acid Sulfate Soils in the Management Priorities 2010-2012. The Corangamite Catchment Management Authority (CCMA) is in charge of implementing these strategies and on the subject of the Big Swamp there has been no Community Partnership.

Of significance, the CCMA finished with a surplus of $641,000 last financial year and has $5.5 million to spend this year under the Caring for Our Country scheme (Colac Herald 22 October 2010.). The Big Swamp is within 13 km of the CCMA headquarters. The ASS appears not to be of much concern and can best be explained by quoting from a letter from the CCMA Chief Executive Officer, Feb. 2009 (CCMA Ref: ADM?05-0013 PT 2). "***Should you resolve to lodge a formal complaint*** (re: ASS) ***then this should be addressed to the responsible authorities. In this case those being the DSE, Southern Rural Water and Barwon Water. The Corangamite CMA, as an interested stakeholder, would be keen to work with those authorities to achieve a better understanding of the matter.***" Perhaps the Acid Sulfate Soil site at the Big Swamp will make the priority list in 2012.

The Investigative Brief.

Not having heard of any development since December 2009 the Colac Otway Shire representative was contacted in late May 2010 in an attempt to ascertain the progress being made with any investigation of the Big Swamp. It was disclosed that a brief of action (called the Brief) had been drawn up and that Latrobe University was being commissioned to conduct a study.
In early June a copy of the Brief was requested. As the request had not been processed by mid June the Colac Otway Shire representative was once again approached. Much was discussed including how this group of representatives from the various agencies was prepared to be open and transparent. Despite this assertion, it was made clear that it may take some time to gain access to the Brief, if it could be released at all. Interestingly it must be noted that the "locals" forcing the issue of a potential and devastating Acid Sulfate Soil problem in the Big Swamp, had still not been consulted. A course of action and Brief had been prepared by the authorities whilst ignoring any local input and consultation. Latrobe University had been commissioned to conduct a study.

During this June discussion the Colac Otway Shire representative suggested that contact be made with the Associate Professor, the PhD student and another member of the Latrobe University team to share ideas. When sharing ideas it became quite obvious that the study being conducted by the Latrobe University would be a high quality piece of work. However, up to four years to complete this work seemed too long a delay for any remediation of the Big Swamp area and any other wetland that may or may not be suffering from the influence of groundwater extraction drawdown. Also the section of the study that included the Big Swamp was limited to the aspect of whether there was an acid problem in the swamp and to what degree it had progressed – nothing else. How disappointing.

Limited Brief.

Even to the casual observation it is has been obvious for some years that there is an environmental degradation problem unfolding in the Big Swamp. The section of the Brief dealing with the Big Swamp appeared to be concentrating solely on establishing what the problem is. Any investigation into the causes or development of a management plan did not appear to be under consideration until the initial 3-4 year project was completed.

A copy of the requested Brief was received in late June 2010. The letter accompanying the Brief requested that the Brief not be circulated widely. The Brief did confirm however, the limited scope of investigations of the Big Swamp. How disappointing.

The Steering Committee is named.

Representatives from SRW, DSE, CCMA, BW, and the Colac Otway Shire(COS) decided that their group should be called the "*Corangamite Inland ASS Study Committee.*"

The stated aim of the Corangamite Inland ASS Study Committee is:

"*To improve the understanding of current and potential future sites at risk of acidification from inland acid sulfate soils (ASS) within the Corangamite Catchment Management Authority (CCMA) region and use this information to develop a risk-based management response.*"

The Latrobe project appeared to be aimed at gaining this understanding. The development of a risk based management response seems a long way off. There was no mention of investigating causes of any problem that may be found to exist.

Being denied the right to widely distribute the contents of the Project makes any further comment impossible. Suffice to say that bureaucracy moves extremely slowly and any investigation into causal factors in the Big Swamp do not appear to have been considered. The common theory for the degradation in the Big Swamp is stress due to the extended drought. Otway Water Book 11[14] convincingly discounts this notion.

Is it a Low Priority???

The question that comes to mind is whether this issue is in fact a low priority and hampered by a slow bureaucracy, or is that the ramifications of confirming an ***Actual*** Acid Sulfate Soil problem caused by groundwater extraction is so dire that the speed and scope of any investigation is being drawn out over many years so that any conclusive outcomes reached are postponed indefinitely. If as suspected the cause is groundwater extraction at the Barwon Downs Borefield, then all of these representatives in the Corangamite Inland ASS Study Committee have one enormous problem to resolve.

THE MEDIA RELEASE.

Late in June there was talk of an impending and important media release that was to be distributed

Page 12 – The Colac Herald, Wednesday, July 7, 2010

Our Environment

Part of an ongoing series of stories presented by The Colac Herald and Colac Otway Shire Council

Acid soil cause for concern

Colac Herald P.12 7 July 2010

Acid sulphate soils are an emerging environmental issue that government agencies across the country are trying to deal with.

Acid sulphate soils occur naturally in coastal and inland areas that are typically waterlogged and rich in iron.

Left undisturbed, these soils are harmless.

But if drained, excavated or otherwise exposed to air, the iron sulphides react with oxygen and form sulphuric acid.

This release of acid is harmful to aquatic environments and can also trigger the release of heavy metals - particularly aluminium - from the soil that can cause further damage to the environment.

Some of the impacts of acid sulphate soils already seen in Australia include fish kills, corrosion of concrete and steel infrastructure and also skin and eye irritations in humans.

by Stewart Anderson, Colac Otway Shire Council environment manager

So what are acid sulphate soils?

They are soils which contain tiny grains of iron sulphides.

Fortunately, most of the areas that contain iron sulphides have not become acidic.

These sites are called potential acid sulphate soil because they have the potential to become acidic.

Actual acid sulphate soil contains sulphuric acid which has been released through oxidation of some or all of the iron sulphides; this occurs when the sulphide grains come into contact with oxygen in the atmosphere.

The main cause of acidification of coastal soils is drainage of wetlands for development, for example for farming or subdivision.

In inland areas, the main risk is believed to be drying of previously waterlogged landscapes as a result of the current period of prolonged drought, new surface water storage or groundwater pumping.

The predicted decrease in rainfall due to climate change across south-eastern Australia, coupled with warmer temperatures and higher evapo-transpiration, is likely to contribute to a general drying of the landscape and wetland areas in particular, increasing the likelihood of acidification of acid sulphate soils.

The National Strategy for the Management of Coastal Acid Sulphate Soils provides steps to better manage acid sulphate soils that might be applicable to the Corangamite region:

- Identify and define the extent of current and potential acid sulphate sites
- Avoid disturbance of those sites
- Mitigate impacts when disturbance is unavoidable
- Rehabilitate disturbed acid sulphate soil and acid drainage.

Acid sulphate soils are most commonly found in coastal areas.

Accordingly, more work has been done on managing acid sulphate soils in coastal areas compared to inland areas.

The Department of Sustainability and Environment released a strategy for coastal acid sulphate soils in 2009.

The strategy's objective is to protect the environment, humans and infrastructure from the harmful effects of these soils and identify ways to manage it.

Although more detailed mapping is required along the coast in order to help councils to effectively address this issue when considering any proposed development, the strategy is a significant step forward. The strategy can be viewed at www.dse.vic.gov.au

No strategy exists for inland acid sulphate soils, however CSIRO conducted a snapshot assessment of potential acid sulphate soils in the Corangamite region in 2007.

This highlights the need for more research to be done in inland areas.

One of the challenges is that no single agency is responsible for managing this complex issue.

Key agencies, including Southern Rural Water, Colac Otway Shire Council, Corangamite CMA, Barwon Water, Department of Sustainability and Environment, Department of Primary Industries and the Environment Protection Authority, are working together to improve understanding of inland acid sulphate soils within the Corangamite region and to use this information to develop a risk-based management response.

Clearly land and natural resource managers need to better understand the characteristics in the landscape that increase the likelihood of an acid occurrence, and the potential environmental, social and or economic consequences.

By working together, these agencies will be able to help the community better manage this complex environmental problem.

If you would like more information on any of these events contact Colac Otway Shire on 5232 9400.

by the Corangamite Inland ASS Study Committee. By July 7 there was an excellent and informative article published in the Colac Herald(see article above). Was this the media release?
The most interesting quote from this article that is relevant to the Acid Sulfate Soil issue in the Big Swamp, is the following,

"One of the challenges is that no single agency is responsible for managing this complex issue."

(The challenge being Inland Acid Sulfate Soils)

What a indictment and abdication of responsibility by the Colac Otway Shire, the Environment Protection Authority, the Department of Sustainability & Environment, Barwon Water, the

Department of Primary Industries, the Corangamite Catchment Management Authority and Southern Rural Water. Not one agency will take the initiative and act in an authoritive manner. Are there any agencies left to do such a "job" that is required along Boundary Creek and in the Big swamp? It would appear not.

However, another quote in this article is quite revealing. Perhaps the management of the Big Swamp; the acidification; the toxic heavy metals and the burning brown coal and peat are the community's responsibility.

"By working together, these agencies will be able to help the community better manage this complex environmental problem."

If it was not for the "*community,*" the issues along Boundary Creek could have gone unnoticed indefinitely. It is not harsh to say that these agencies should have recognised the danger signs decades ago. To have done little to nothing for 19 months after the first formal complaint was lodged with the Environment Protection Authority, is alarming.

Sometime after this newspaper article was published a copy of the official media release was obtained (see the next page). The media release was sent out to a multitude of media dated 30 June 2010.

MEDIA RELEASE 30 June 2010

STUDY OF INLAND ACID SULPHATE SOILS IN CORANGAMITE REGION

An investigation into the occurrence of a phenomenon known as acid sulphate soil is to take place in the inland areas of the Corangamite region.

The study will be carried out by LaTrobe University PhD student Fiona Glover under the supervision of Associate Professor John Webb. Studies have been carried out into the occurrence of acid sulphate soils in coastal areas, but more work is required to understand the risks in inland areas.

The project's objective will be to improve understanding of current and potential future sites at risk of acidification from inland acid sulphate soils within the Corangamite region, and use this information to develop a risk-based management response.

Acid sulphate soils are found in a variety of inland and coastal environments in areas where the soils are waterlogged and organic-rich. Left undisturbed these soils are harmless, but if drained, excavated or otherwise exposed to air, acid is released that is harmful to the environment.

It is envisaged that this comprehensive project will take two years or more to complete. The project is being overseen by a steering committee comprising representatives from Colac Otway Shire Council, Southern Rural Water, Department of Sustainability and Environment, Corangamite Catchment Management Authority, Barwon Water, the Environment Protection Authority and the Department of Primary Industries.

Steering Committee Chair, Mick Fennessy of Southern Rural Water said "we are responding to an issue that has the potential to affect a range of stakeholders in the Corangamite region."

"The study is a significant step in answering questions about acid sulphate soils in inland areas. It may well not provide the solution in one simple step but it will advance our knowledge of the subject and our capacity to deal with it in the future," he said.

"The study will look at a number of sites across the region in an endeavour to identify characteristics that identify areas with potential acid sulphate soil.

"The project and the cooperative approach of the steering committee is a demonstration of government agencies and local government working together for a community benefit."

Contact: Mick Fennessy, Manager Assessments – West, SRW, Warrnambool 5564 1700

Colac Otway SHIRE · CORANGAMITE CMA · EPA VICTORIA · LA TROBE UNIVERSITY · Southern Rural Water Managing Water. Serving Communities. · State Government Victoria · Department of Sustainability and Environment

It is difficult to find even the slightest bit of comfort or assurance in these words. It is easy to state that Government agencies and local government are working together for a community benefit

while at the same time excluding community input and participation in the development of this project. Also, Steering Committee Chair, Mick Fennessy, should be well aware that the Acid Sulfate Soils problems in the Big Swamp have gone past the "***potential to affect***" and have seriously impacted on stakeholders.

Public Health.

Whose responsibility is it to ensure the safety and health of the general public in regard to the risks associated with the dangers initiating from the Big Swamp and along Boundary Creek? Surely the agencies involved in the Corangamite Inland ASS Study Committee have this responsibility. The burning brown coal and peat in the Big Swamp site is extremely dangerous not to mention the acidification and the heavy metals. Little has been done to warn walkers, hikers, horseback riders, motor cyclist etc. of the dangers when entering this area.

- Holes not apparent at ground level that have been and possibly are still burning underneath creating a cavity that one could easily fall into.
- Noxious gasses – hydrogen sulphide, sulfur dioxide and volatile organic sulphur compounds.
- Water in the area is extremely acidic and full of toxic metals. Can't be used for stock or human consumption.
- Signs have not been erected. Tracks lead right up to the burning peat.
- A kilometre straight sided trench up to three metres deep has been dug around the Big Swamp. Much of it has filled with highly acid water. Anything falling into this trench would be in serious trouble – impossible to crawl up the straight sides.

The site after this latest fire is now quite accessible and poses an extreme public hazard for the unwary.

This burning brown coal and peat wetland is another Black Saturday waiting to take place in the Otway Ranges. Burning and channelling underground this peat fire could vent in a number of ways into the surrounding country side. This is a monumental and serious concern.

The fire in 1998 (the last time this peat fire surfaced) was so serious that the residents of the Otway Ranges were to be evacuated but were saved the impossible effort, by a wind change.

The precedent is there, the 1998 fire, that this issue has the potential to be catastrophic for the Otways sometime in the future if it is not managed properly.

From the restricted and limited knowledge of the how the Corangamite Inland ASS Steering Committee functions, it would appear that its investigations fall a long way short of a comprehensive coverage of the problems, the cause and the management of the issues of Actual Acid Sulfate Soil in the Big Swamp.

Duty of Care.

"***Land managers have the responsibility to manage their land appropriately and not cause impact to others (duty of care). This responsibility is supported through both common and statute law.***"[(8)]
"***Typical duty of care legislation requires all persons to take* all reasonable and practical steps to prevent harm *arising from their activities (Young, M., Shi, T. And Crosthwaite, J. 2003)***." [(8)]
Apparently this duty of care applies only to private land holders AND not to the guardians of our public land and resources.

Malcolm Gardiner
1805 Colac Lavers Hill Road
Kawarren
Vic 3249
18-02-2009

Stewart Anderson
Colac Otway Shire
Rae Street
Colac
Vic 3250

Dear Stewart,

It was very good of you to participate in the tour of the Acid Sulfate Soils along Boundary Creek yesterday. Charlie and I really appreciated your enquiring mind and direct and pertinent questioning of most things we were saying. Hopefully we were able to convey to you the seriousness of the ASS and the fact that there appears to be no authority prepared to investigate this situation.

I include in this package:

1. *A CD of Books 1-8*
2. *Hard copy of the Content Pages of these books for easy reference*
3. *Another CD containing a multitude of material*
    - *Two formal complaints to the EPA*
    - *The EPA reply to the first complaint*
    - *April 1977 aerial map of the area*
    - *ASS booklet*
    - *Mycorrhiza info*
    - *Excel sheets and graphs of the pH levels in Boundary Creek and comparative ones with Loves Creek*
    - *Vegetation and fire history maps*
4. *Copy of a letter sent to Chris Smith 24-06-2008. Page three may be worth a read - as highlighted*
5. *A copy of the Shire resolution that you mentioned yesterday. There was another similar one BUT they both refer to the Kawarren/Gellibrand groundwater pumping scenario NOT the ASS. The ASS has not been dealt with yet by the Shire.*
6. *I have taken the liberty to include some pages of the Colac Otway Shire Planning Scheme Overlays. These include:*
    - *Protection of significant vegetation and need to protect and enhance*
    - *Protection of water quality and quantity*
    - *Wildfire management and inappropriate practices increasing this risk*
    - *Section on Barongarook High and other Groundwater Areas*
    - *The protection and enhancement of wetlands*
    - *The need to consider Barongarook Creek and its rare or threatened species or high biodiversity*
    - *Ditto for Boundary Creek*
    - *Protection of catchments, waterways and groundwater.*

It is Charlie's and my belief that the Shire should not have to "foot" any bills for any investigative work on the ASS as the Shire has not caused the problem. The most obvious investigation that is

appropriate in our view is to conduct a Hydrological Assessment. It is, we believe, in the Shire's power to insist that this be done.

Now that the Shire is aware of the problem we believe that the Shire now has a responsibility to follow this through and insist that the responsible authorities investigate this serious concern. The Shire up to this stage, was not aware of the acid levels, the elevated heavy metals levels nor the biota and human health implications.

Just like to reiterate problems with the ASS as we see them:

1. *Toxic polluted surface water discharging down Boundary Creek a tributary of the Barwon River – potential catastrophic influence as far as and out into Bass Strait*
2. *Toxic polluted water seeping into the aquifer Barwon Water is extracting groundwater for human consumption*
3. *This toxic mix killing off an ever increasing area of significant wetlands*
4. *Bridge concrete and metal corrosion*

Stewart, I am presently tracking down a case near Perth W.A. where there have been deaths as a result of ASS, among other problems created. I will get it to you as soon as possible.

We would appreciate being kept informed of developments and copies of any reports that may result.

Thanks again.
Yours sincerely,

Charles Kohout.

Malcolm Gardiner.

Malcolm Gardiner
1805 Colac Lavers Hill Road
Kawarren
Vic 3249
11-03-2009

Graham Hawke
Southern Rural Water
Maroondah Highway
Ringwood
Vic 3134

Dear Graham,

Re: Acid Sulfate Soils Complaint.

Please find enclosed:

1. *A copy of the Stateline(Victoria) 10 October 2008 programme, and*
2. *my slant to the ASS on the same DVD.*
3. *A CD containing Otway Water Book 8 that has a chapter on ASS. (Leonard in the 1980s talks about abundant pyrites in the upper Dilwyn formation), and*
4. *a letter to Stewart Anderson –Colac Otway Shire, on the same CD.*
5. *Hard copy of the chapters of each of the Otway Water books 1-9.*

Hope that this information helps to resolve the issue.

Yours sincerely,

Malcolm Gardiner.

When talking with Stewart Anderson in May I requested the opportunity to talk to the Corangamite Inland Acid Sulfate Soils Steering Committee. This happened at the Committee's second meeting for the year on 12 August 2010. During this meeting an invitation was extended to be on the Committee and to attend the next meeting in November 2010 as a representative of LAWROC (Land And Water Resources Otway Catchments Landcare group.) This invitation was discussed at the following LAWROC meeting and the invitation was accepted. Interestingly this invitation came after the Corangamite Inland ASS Committee had set its direction of investigations and the Brief had been finalised.

When asked at the meeting why the cause of the Actual Acid Sulfate Soil problem wasn't being investigated the answer was that this would be a distraction from the present study being conducted by Latrobe University. It would appear that the proceedings of the Corangamite Inland ASS Study Committee will be a long and protracted affair. Until the causes of the problem in the Big Swamp is recognised as a priority and is investigated, it is difficult to see how a successful implementation of a remediation action plan can be implemented.

At this meeting it was also discussed that the Department of Primary Industries had declined to have a representative on this committee. This seemed ludicrous as the DPI was a major contributor to any Acid Sulfate Soil work being conducted in the State. Still not being a member of the Corangamite Inland ASS Steering Committee at this stage, a formal complaint was sent to the DPI and reads as follows.

From: Mal Gardiner (otwaywater@yahoo.com.au)
To: troy.clarkson@dpi.vic.gov.au;
Date: Tue, 17 August, 2010 7:02:08 PM
Cc:
Subject: IAASS

Malcolm Gardiner
1805 Colac Beech Forest Road
KAWARREN
Vic 3249

17-08-2010

Troy Clarkson
DPI
Geelong
Vic 3220

Dear Troy,

Re:

- **High levels of acidic water and polluted water discharging into Boundary Creek and the deep water aquifer (Dilwyn) at Yeodene**
- **The acidity resulting from Actual Acid Sulfate Soils brought about by unsustainable extraction of groundwater at the Barwon Downs borefield.**
- **The high and unacceptable levels of heavy metals being generated from this site, and**
- **the threat of uncontrolled fires in the Otway Ranges resulting from the smouldering peat and or the spontaneous ignition of the brown coal presently burning as a result of the wetlands in the Big Swamp being dewatered.**

This is a formal complaint.

The DPI does not appear to be concerned nor involved with the issues currently taking place in the vicinity of the Big Swamp on Boundary Creek, a tributary of the Barwon River. I urge the DPI to become involved in an appropriate investigation of the Big Swamp Inland Actual Acid Sulfate Soil site.

This complaint is also directed to the fact that the decimation of the Big Swamp does not appear to be a natural phenomena. This reason for the situation must be investigated and if there is human duplicity the "culprit" be brought to account.

I believe there is a committee called the Corangamite Inland ASS Steering Committee dealing with this issue and the DPI is not represented on this body. This seems a most unusual development and should be addressed, especially when the Secretary of the DSE, Peter Harris, had this to say last year, "*Assessing the impacts of ASS in the region falls under the responsibility of the Department of Primary Industries (DPI).*"

I would appreciate being kept informed of progress and courses of action being undertaken in regard to this IAASS problem along Boundary Creek.

Yours sincerely,
Malcolm Gardiner.

From: Troy.Clarkson@dpi.vic.gov.au (Troy.Clarkson@dpi.vic.gov.au)
To: otwaywater@yahoo.com.au;
Date: Tue, 21 September, 2010 10:08:34 AM
Cc:
Subject: Re: IAASS

Hi Mal,

Thanks for your email.

I would like the opportunity to reply to your comments and state the facts about how DPI responds to acid sulfate soils.

- DPI predominantly invest in soils where there is a strong productive focus for agriculture, while DSE invests into soils where threats associated with soils are impacting public environmental assets. Because ASS mostly impacts public assets it is seen as the responsibility of DSE, not DPI. This is strongly supported by legislation and each Organisations strategies and service offers. EPA is responsible for the management of pollutants, so if acid sulfate soils was to cause an impact, EPA should step in.

- The above definition does not mean that DPI is not involved or interested. DPI has skilled soil scientists and extension officers, so DSE often uses them as providers to deliver their projects. DPI also delivers farm planning services on private agriculture land and part of this processes is helping farmers identify risks (ie. ASS could be one) and ways of managing them.

- I have spoken to a number of DPI staff working in soils and no one knows of an invitation from Corangamite Inland ASS requesting a DPI representative. If requested, a representative would be provided if seen relevant.

- I would suggest you speak with Rebecca Price (rebecca.price@dse.gov.au), from DSE, who is currently responsible for implementing the Victorian Coastal ASS Strategy, she may be able to provide some guidance. At this stage there is no Victorian Inland ASS strategy, but soon a national inland ASS Strategy will be released.

I hope this helps and please get back to me if you have any other unanswered questions.

Cheers

Troy

Troy Clarkson
Acting Program Manager Dryland
Sustainable Landscapes/FSV
Dept. Primary Industries

P.O. Box 103, Geelong. Vic. 3220
DX: 2106048
Phone: 5226 4604
Mobile: 0417 680 416
Fax: 5226 4725
Email: troy.clarkson@dpi.vic.gov.au

Mal Gardiner <otwaywater@yahoo.com.au>

17/09/2010 05:05 PM

To troy.clarkson@dpi.vic.gov.au
cc
Subject Re: IAASS

1 of 4

21/09/2010 7:25 PM

This letter confirms the impression given that the issue of the Big Swamp is anybody's responsibility but the various Government agencies whose responsibility it is. Is Rebecca Price the next step in "*the progressive barn dance*" of passing the "buck" or is this issue still on the "*merry-go-round*."

Conclusion.

The Corangamite Inland ASS Study Committee is progressing slowly but appears to be hampered by a restrictive Brief and lack of commitment from Government Agencies. At the 12 August meeting Colac Otway Shire, Southern Rural Water and Barwon Water were the ***only*** Government representatives present. No Department of Sustainability Environment, Environment Protection Authority, Parks Victoria or Corangamite Catchment Management Authority representatives. This was the second of three meetings scheduled for the year. Definitely a low priority.

CHAPTER SEVEN

A Hydrogeological Assessment.

In 2006 the Environment Protection Authority tabled a document headed "Hydrogeological Assessment (Groundwater Quality) Guidelines."[9] In the foreword it states that, "*Few Victorians would deny the importance of protecting our environment for current and future generations.*"

The foreword concludes with this statement.

> "*A hydrogeological site assessment that follows these guidelines will provide good quality information to aid owners, developers, potential purchases and regulators to identify the risk of health and environment from potential contamination.*"

In 2007 Evans[10] reported in his Senior Research Fellowship study that...

a. *"Between the start of pumping and an impact in the stream, the lag can be hours, weeks, years, or even centuries. When pumping ceases, it may take decades before stream flow returns to its previous norm."*
b. *"Another example is from Geelong, where the predicted drying up of Boundary Creek by Baron Downs bore field five kilometres away occurred after a lag of about one year."*

There seems little doubt that groundwater extraction at Barwon Downs is responsible for the catastrophic impacts being experienced in the Big Swamp wetlands and the resulting pollution of the aquifer and surrounding area. This is clearly a case of pollution from human activities upsetting natural processes that have impacted on beneficial uses of the groundwater resource.

Beneficial Uses-Victorian State Government Definitions.[31]
Maintenance of ecosystems,
Potable water supply,
Potable mineral water supply,
Agriculture, parks and gardens,
Stock watering,
Industry water use,
Primary contact recreation, and
Building and structures.

The State Environment Protection Policy (Groundwaters of Victoria), December 1997,[31] quite clearly states a hydrogeological assessment as a process,

> *"...to determine any*
> a. *Existing groundwater contamination and resulting risk to beneficial uses of groundwater, and*
> b. *Potential risk to groundwater quality and beneficial uses of groundwater."*

The following quotes pertinent to the Acid Sulfate Soils issue have been taken from the EPA Hydrogeological Assessment Guidelines.[9] It may be argued that having these quotes taken out of context is inappropriate. However, the manner in which they have been presented here forms a most convincing case that a hydrogeological assessment is an appropriate course of action to take.

1. *"Hydrogeological Assessment (HA) is a systematic study of geology, hydrogeology, geochemistry and contamination at a site. An essential component of an HA is the development of a clear conceptual model of hydrogeology, the contamination and the potential human health and ecological risks."*

2. *"An HA may be required in relation to the risk to the groundwater environment, including past, present and future activities..."*
3. *"All HAs should provide the basis for making decisions and address the :*
    a. *Potential for past, current, and proposed activities to affect groundwater quality and protected beneficial uses*
    b. *Extent and degree of existing contamination*
    c. *Risk that groundwater contamination poses to human and/or the wider environment."*
4. *"Undertaking an HA requires a range of skills derived from a multidisciplinary team..."*
5. *"An HA may also be required by EPA in:*
    a. *a Notice to assess contamination and clean-up required from past activities*
    b. *in a Notice requiring ongoing management or monitoring of groundwater."*
6. *"Other organisations may also request an HA when implementing other legislation of regulations. Here are three examples: Local government has obligations to consider environmental protection, including groundwater..."*
7. *"Many activities can cause groundwater contamination. Contamination sources can be sudden releases from spills or accidents, gradual releases from long term leaks, or industrial or agricultural practices since the 1800s."*
8. *"To develop an understanding of how contamination sources may impact on the groundwater system, the underlying questions are asked:*
    a. *Where does the groundwater occur at the site?*
    b. *What are the likely sources of contamination?*
    c. *Is the groundwater polluted?*
    d. *Is the groundwater likely to be polluted?*
    e. *What is the level of risk posed by the pollution?"*
9. *"Where the contamination source is above the water table, contaminants have to migrate through the unsaturated zone to the water table. The gas phase in the unsaturated zone above the water table also presents another potential significant risk to human health and safety due to upward migration of volatile contaminants. Hence, study of the unsaturated zone often needs to be included in the HA."*
10. *"One of the most neglected areas of an HA is identifying how and where groundwater interacts with the land surface and with surface water."*
11. *"Sufficient spatial and temporal data must be collected to determine the protection segment to which groundwater belongs."*
12. *"Regardless of the scale and complexity of the task, the HA includes assessment of the:*
    a. *hydrogeology of the site and surrounding region*
    b. *aquifer properties and groundwater flow directions, paths and rates*
    c. *potential for activities to cause groundwater contamination*
    d. *distribution and concentration of existing contamination*
    e. *expected transport and fate of groundwater contaminants*
    f. *risk to human health and/or ecological receptors in the environment."*
13. *"Beneficial uses – of groundwater and potential receptors such as wetlands, streams and groundwater users, and likelihood of these uses becoming realised."*

Another example of contamination of a wetland from water extraction in Victoria is extremely difficult to find and as a consequence guidelines for such a specific case have not been contemplated let alone written. In spite of this and considering that the Big Swamp has been degraded and polluted beyond recognition, government authorities must not be allowed to use this excuse for inaction. The issues at the Big Swamp wetlands clearly include severe contamination of the surface waters, groundwater aquifer and the surrounding countryside. Under the state government legislation the beneficial uses are being dramatically affected and as a consequence a Hydrogeological Assessment is a most appropriate action to be taken.

Conclusion.

As with other discussions with government statutory authorities, the mention of affirmative action instigating a comprehensive Hydrogeological Assessment of the Big Swamp has fallen on "deaf ears." Ironically, if a Hydrogeological Assessment was conducted as described in the guidelines [(9)] the full ramifications of groundwater extraction in the Barwon Downs region would be apparent. Argument and counter argument as to the merits or otherwise for groundwater extraction would cease. Future political and management groundwater resource decisions would be based on a solid, thorough and comprehensive knowledge base.

Lower reach of the Big Swamp after the March 2010 fires followed by extensive winter rains. This lying water will have begun "brewing" the next toxic mix of acid and heavy metals.

CHAPTER EIGHT

Wurdee Boluc Inlet Channel & Reservoir.

The Wurdee Boluc Inlet Channel (WBIC) is approximately 58 kilometres of mostly open earthen delivery channel stretching from the West Barwon Dam (Otway Ranges) to the Wurdee Boluc Reservoir (WBR). This system is subject to seepage and evaporation losses. Attempts in the past to accurately ascertain these losses have met with resistance and failure.[15]

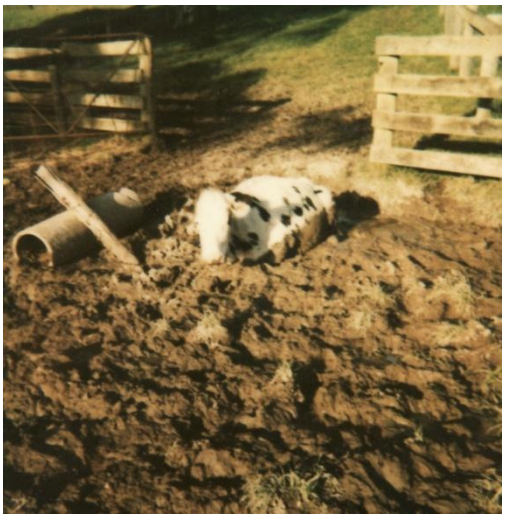
This chapter has been included for three reasons.

FIRSTLY.

The evaporation and leakage from this system has been an ongoing issue of contention going back to the 1970s.

A summary of the detail covered in Otway Water Book 6,[15] is found below.

- farmers living beside the channel tell of huge losses from evaporation and seepage.



- The seepage from the WBIC in the 1990s was severe. This cow is standing in mud up to its stomach as a result of seepage. The adjoining photo shows seepage from the Channel (WBIC).

- In 1989 Barwon Water justified an average 2.8% loss from the Wurdee Boluc Inlet Channel (WBIC) during the period 1980 to 1987.

- During this period the losses per month ranged from 2.1% to 31.4% with periods of gain from 0.9% to 9.9%.

- During the 1982 drought losses were reported to be 9.7% for the year.

- In the 1980s the fully piped Wannon Water system was running at a yearly loss of between 8 and 13%. This system is of comparable length to the WBIC.

- At the Natural Resources and Environment Committee (NREC) hearings in the late 1980s Barwon Water convinced this committee to accept annual losses of 2.8%.

- By 2002 Barwon Water was quoting losses of 3 to 4% even with gaping holes in sections of the few areas that are concrete lined.
- In 2008 Barwon Water was asked for the losses from the WBIC during the period 2000 to 2007. The reply stated that, "*...Barwon water is not able to provide a specific response to your enquiry...*"

Even today Barwon Water maintains the stance that losses from the WBIC cannot be accurately determined.

SECONDLY.

Secondly the following information and research needs to be placed on record for easy reference at a later date. John Callahan compiled much of this data many years ago and because its relevance fell on "deaf ears" much of the material was misplaced and had to be newly researched.

Using the Bureau of Meteorology Pan evaporative method figures, it can be shown that there is an annual average loss by evaporation of 1390mm. The Wurdee Boluc Reservoir is approximately 420 hectares. Calculating the loss on 400 hectares equates to an annual loss of 5.56 GL/year.

The Wurdee Boluc Inlet Channel of approximately 58 kilometres, 8 metres wide, would lose 920mm from evaporation when ¾ full. This equates to around 368ML/year.

If the seepage losses were calculated and added to these evaporative figures the losses overall would be significant. Why Barwon Water is not inclined to accurately ascertain these losses is a mystery.

and THIRDLY.

Technology is presently available that can drastically reduce the amount of seepage and evaporation losses from the Wurdee Boluc delivery channel and the Wurdee Boluc holding system.

- Pipe the full length of the Wurdee Boluc Inlet Channel.
- Windbreak the Wurdee Boluc Reservoir.
- Make use of surface covering such as AquaCaps that save up to 85% of evaporation and would be ideal for the Wurdee Boluc Reservoir (and the West Barwon Dam and any other holding reservoir, for that matter).
- 

Conclusion.

To maintain the stance that the losses from the Wurdee Boluc Inlet Channel and the Wurdee Boluc Reservoir cannot be accurately calculated is nonsense. This lack of concern indicates that Barwon Water is inclined to regard the losses from seepage and evaporation as insignificant and therefore is not interested in making an effort to save these losses.

It is interesting to note however, that many of the public seen sections of the Channel have been concreted giving a false impression that the full length of the Channel has been lined.

CHAPTER NINE

The Importance of Primary Contact & Recreation with the Environment.

The Victorian State Government includes the term "Beneficial Uses" in a number of its documents. These references to beneficial uses and the accompanying statements are made in an effort to ensure the protection of existing and potential uses of groundwater throughout Victoria. One of these beneficial uses is Primary Contact and Recreation with the environment and its association with surface and groundwaters.[31][30]

In 2010 Lewis[24] had this to say regarding the critical link between health and our environment, "...*river creatures and plants are dependent on healthy river systems to survive and flourish. Less obvious or often completely taken for granted, is the fact that humans also need such places to not only survive but flourish. This is not only because we need clean drinking water, healthy air and tree growth to clean up the CO_2, or water for our various businesses. Many of us live here* (Otway Ranges) *for the same reasons people visit– it is beautiful, interesting, invigorating and healthful. Research in fact shows that, despite the fact that most of us live in increasingly artificial places, human evolution over millions of years has genetically wired us to need contact with nature for optimal wellbeing; study after study shows that we heal faster in contact with nature, our mental health improves as well as our physical health...*

Two of the most significant likely future public health issues, with huge costs to individuals and governments, are steep rises in depression and obesity. Activities that encourage contact with nature can very directly address both issues. It is clear that as a society we need to cherish our natural and especially our wild places as never before."

Parks Victoria.

These very same sentiments are voiced, echoed and strongly emphasised throughout Parks Victoria, State Government of Victoria's, latest campaign justifying its slogan of *"Healthy Parks, Healthy People."*

"Healthy Parks, Healthy People."

A 2008 joint initiative between Parks Victoria and Deakin University produced a literature review[25] of 343 references dealing with the human health benefits of contact with nature. This research indicated that "...***humans may be dependent on nature for psychological, emotional, and spiritual needs that are difficult to satisfy by other means***..." This review also finds that access to nature plays a vital role in human health, wellbeing, and development that has not been fully recognised. "***That the natural environment is a key determinate of health is unquestioned***."
"***Contact with nature is defined as viewing natural scenes, being in natural environments, or observing, encountering or otherwise interacting with plants and animals.***"

The Healthy Parks Healthy People study[25] concluded that research shows contact with nature has a multitude of benefits to humans, including,

- reducing crime,

- fostering psychological healing,
- reducing stress,
- boosting immunity,
- enhancing productivity,
- promoting and facilitating healing,
- improving concentration, and
- improving mental capacity.

"***Parks and other natural environments are a fundamental health resource, particularly in terms of disease prevention***." Initial evidence indicates positive effects on,

- blood pressure,
- cholesterol, and
- outlook on life.

There is a very clear message that parks and other natural environments are fundamental settings for health promotion and the creation of wellbeing for public health.

The Affect on the beneficial use of Primary Contact and Recreation in the Boundary Creek and Big Swamp Location.

Up to the time when the effects of the degradation of the Big Swamp became apparent numerous people have used the Big Swamp and Boundary Creek location for a multitude of recreational and contact purpose.

- Horseback riding.
- Walking activities for,
    - exercise and physical health,
    - outlook on life, and
    - observation and beauty of nature
- Photography.
- Relaxation.
- Peacefulness.
- Contemplation.
- Nature rambles for specific contact with,
    - birds,
    - animals,
    - fish,
    - platypus, and
    - orchid, ferns and other flora.
- Fresh air.
- Motorbike riding.
- Fishing.

From a wellbeing and health promotion aspect the majority of these beneficial uses have, for the foreseeable future, been degraded, ruined and or destroyed in the Big Swamp area. There is every indication that the Actual Acid Sulfate Soils problems will persist for many decades.

The many people who have gained health and wellbeing benefit from access to this unique environment no longer enjoy such benefits.

The Big Swamp area was not developed because of its saturated state, uniqueness, natural beauty and attraction as a wilderness. John McCready, a long time owner of the majority of the Big Swamp wanted this area to be preserved in its natural state and resisted all attempts to allow human intervention on an area he regarded as priceless.

Conclusion.

There can be no doubt that the Big Swamp has undergone massive degradation ruining its status as a “wilderness” area. Any beneficial uses as a recreational and contact with nature location have been compromised for an extremely long period. Even in one’s wildest dreams the Big Swamp can no longer be regarded as a “Healthy Park” or natural environment. Its beneficial uses promoting “Healthy People” no longer exists.

CHAPTER TEN

The Bridge Over Boundary Creek.

The concrete bridge over Boundary Creek on the Colac to Forrest Road is worthy of comment. If this bridge is suffering from acid attack that is generated out of the Big Swamp and similar Big Swamp scenarios are created in other areas of the Otway Ranges then it is reasonable to assume that concrete bridges in these areas will also be affected in a similar fashion.

There are two questions that need to be answered regarding the Colac to Forrest Road Bridge over Boundary Creek.

- Is the concrete structure being degraded, eaten away and or weakened, possibly by acid?
- Is the bridge safe and structurally sound?

In an effort to gain the answers to these questions it seemed a reasonable approach to contact the local Member of Parliament based his Colac office within 12 kilometres of the bridge site. Terry Mulder, MP State Government, Shadow Minister for Public Transport & Roads, inspected the site 14 July 2010. Understandably Terry could not answer the above questions but did agree that he would ask for an engineer's report to be conducted. Terry wrote to the Minister for Roads and Ports, the Hon. Tim Pallas, asking that an engineer be instructed to inspect the bridge. In due course the following letter arrived.

5/5 (89)

Minister for Roads and Ports

PO Box 2797
Melbourne, Victoria 3001
Telephone: (03) 9655 6210
Facsimile: (03) 9655 6651
www.vic.gov.au
DX 210410

Our Ref:

13 SEP 2010

Ref: DOT 097502
(File No PC007488)

Mr Terry Mulder MP
Member for Polwarth
115A Bromfield Street
COLAC VIC 3250

Dear Mr ~~Mulder~~ Terry,

BOUNDARY CREEK BRIDGE

Thank you for your letter dated 12 August 2010, requesting that a structural inspection of the above bridge be undertaken by VicRoads.

An inspection was undertaken on 23 August 2010 which identified staining of the lower columns in the wet/dry zone, that is, at water level. This marking may have been misinterpreted as corrosion of the columns. I am advised that the bridge has been found to be structurally sound.

I am further advised that this bridge has been regularly inspected in accordance with VicRoads' Bridge Inspection Manual which requires both six monthly routine inspections and a more detailed inspection every 2, 3 or 5 years depending on the condition and nature of the structure.

Yours sincerely

Tim Pallas MP
Minister for Roads and Ports

Victoria
The Place To Be

At least one of the questions was answered. The bridge was reported as structurally sound.

This photograph was taken around the same time as the inspection on the bridge. The wet/dry zone does indicate staining of the lower columns as the Hon. Tim Pallas's letter refers to.

However, the wet/dry zone is dictated by the amount of rainfall that falls in the catchment area. The wet/dry zone does rise and fall throughout the seasons. This photograph is very close to the height Boundary Creek would have been on the 23 August 2010. There is no dispute that the pylons had a distinct staining visible at this time. There was no evidence of corrosion ***at*** or ***above*** water level on these columns. This is quite obvious as seen in the photograph above.

It could be expected that any inspection by an engineer who had been specifically asked to check for corrosion would have completed a thorough and exhaustive investigation. It seems doubtful that this was done. The Hon. Tim Pallas indicated in his letter that he was aware that there had been a question of whether there was any corrosion present. However, the engineer doing the inspection found none. One wonders how thorough the investigation was.

This photograph was taken at a time when Boundary Creek had stopped flowing and depicts a different perspective in regard to outer layers of the pylons and the degree of staining. It tends to indicate a little more than staining. Given that inspections were carried out as per the Vic Roads Inspection Manual every 6 months, it is a wonder that the scene as depicted in this photograph did not prompt a closer inspection and investigation. Adding to the puzzle, regular State Government water sampling indicated a sharp drop in pH levels at this site since the early 1990s. It is of concern that a more concerted effort to discover the cause of this "staining" of the outer layers of the pylons was not undertaken.

The above vision would have been evident during many of the 6 monthly inspections. Boundary Creek has often been at this water level for several months in the last few years. The state of the columns at this lower level would have been most obvious especially to an engineer doing a regular inspection as indicated by Tim's letter.

The report stating that these columns have been inspected and noted as structurally sound and is no threat to life or property has to be taken on face value. The fact that an engineer conducted this special inspection specifically to determine the state of the bridge cannot be denied. However, these

photographs indicates that there is a case that corrosion is taking place and that the structural integrity of this bridge requires extremely close inspection in the future. The bridge may be structurally sound at this stage but there would appear to be some grounds for concern in the future. When the inspection was conducted on 23 August 2010 these sections of the columns were some distance under the water level.

It is understandable that the corrosion could have gone unnoticed by the untrained observer as I had been at the site many times over the last few years and had not realised the significance of the aggregate showing. However, the same excuses cannot be afforded for a trained engineer. Until seeing a picture (see 69 page) in an Acid Sulfate Soil book that looked similar to the corrosion at the Colac to Forrest Road bridge, did the realisation occur that there may be a connection between this corrosion and the acid water and heavy metals coming out of the Big Swamp.

These photographs at the Colac to Forrest Road Bridge show considerable more than stains as the engineer who prepared the report for the Hon. Tim Pallas would like all to believe.

Taken 3 October 2010.

(See page 46 for another photograph)

The Environmental Analysis Laboratory report [28] had this to say regarding these pylons, "***These materials were observed in association with obvious indications of iron flocculation coating exposed sediments, as well as concrete corrosion of infrequently submerged bridge pylons.***"

This photograph has been copied out of the Natural Heritage Trust's "An Introduction to Acid Sulfate Soils."[26]

"***Sulfuric acid produced by acid sulfate soils corrodes concrete, iron, steel and certain aluminium alloys. It has caused the weakening of concrete structures and corrosion of concrete slabs, steel fence posts and sewerage pipes.***"[26]

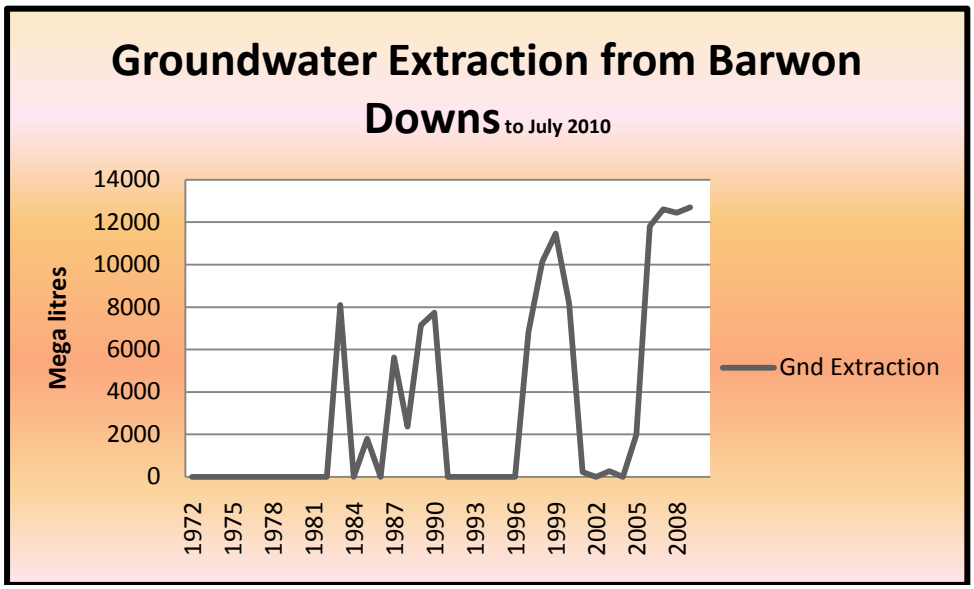
Conclusion.

One conclusion is that the corrosion problem on the Colac to Forrest Road Bridge has been overlooked. If this is the case and with every possibility that the acid concentrations in the water flowing out of the Big Swamp will increase, the inspecting engineers need to be very mindful of the possibility of concrete cancer being a problem.

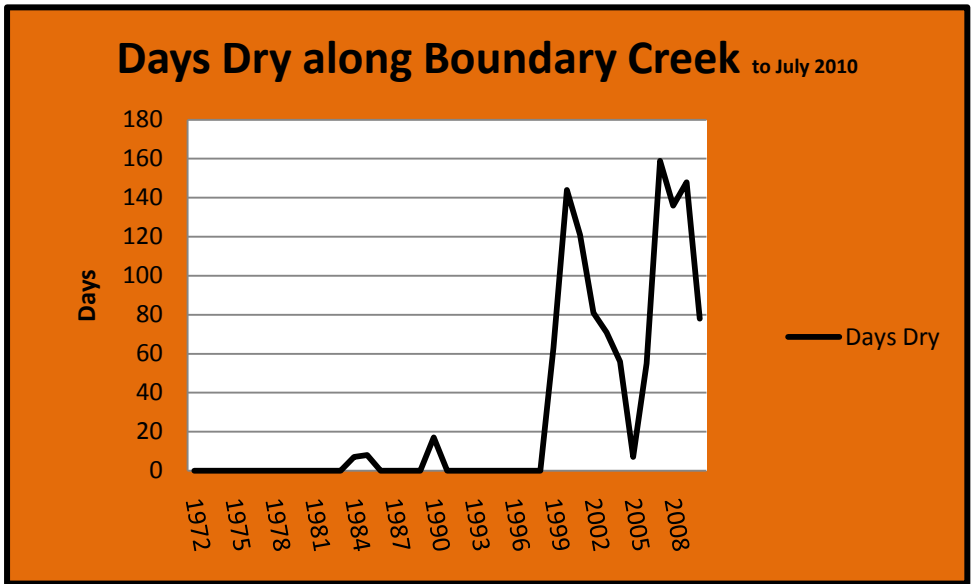
(At the Bushfire Royal Commission recommendations discussion and meeting, 9 August 2010, in the Colac Otway Shire meeting room earlier in the year, I spoke with Tim Pallas for some considerable period after the meeting. We discussed the possible corrosion problems at the Colac to Forrest Road Bridge. This was before the bridge inspection had been conducted as per Tim's letter.)

CHAPTER ELEVEN
Borefield Data to July 2010.

This Chapter updates graphical data on the Barwon Downs Borefield area of influence to July 2010. The additional data has been extracted from the 2009-10 financial year report prepared by Barwon Water.[5]



The extraction rate's graph has remained above the 12000 ML/year level.



Days dry at the Colac to Forrest Road Bridge gauging station.

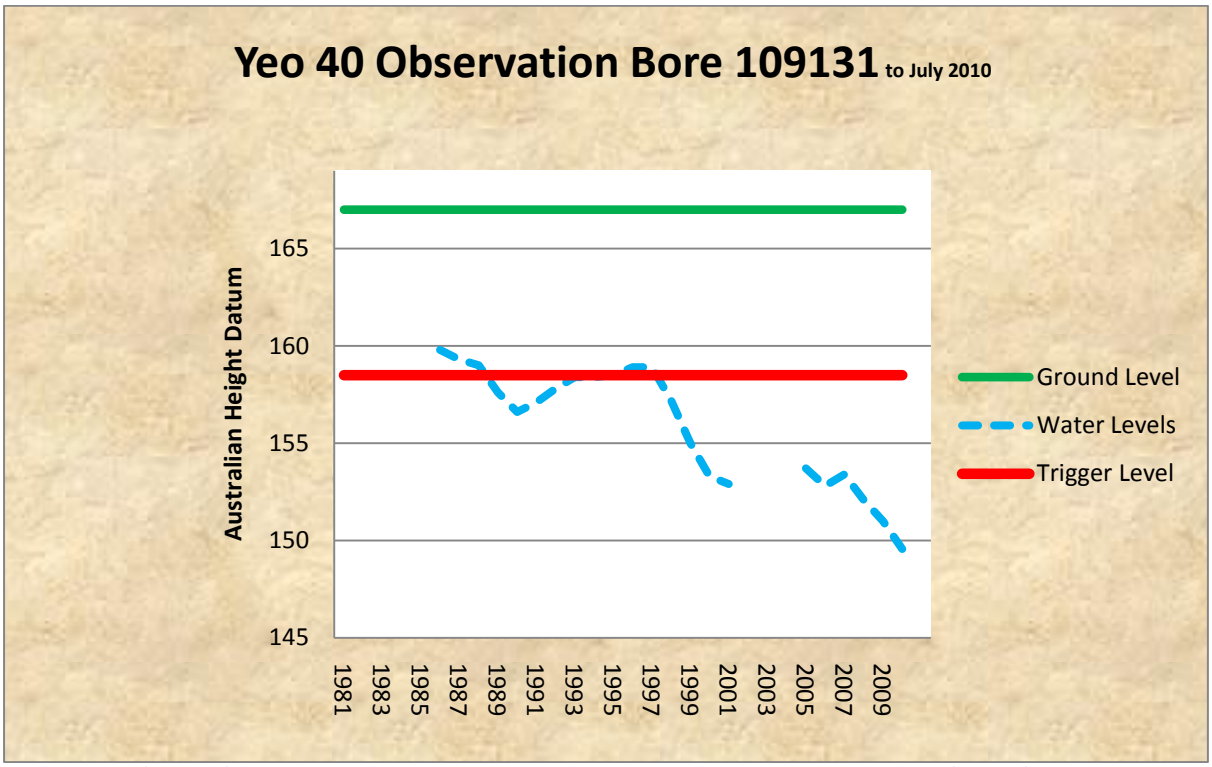
The days Boundary Creek did not flow at the Colac to Forrest Road Bridge stream flow gauging station on Boundary Creek (see page27) have declined and appear to indicate that there is some degree of recovery happening. This is not the case. When considering the following facts it is most apparent that the Days Dry graph tells only half the story:

- The Department of Natural resources (now called the Department of Sustainability) tabled a report[33] in 1995 stating that the average daily summer flow in Boundary Creek used to be 3.2 ML.

- In a Sinclair Knight Merz report for Barwon Water[27] it was calculated that the daily average flow from groundwater had most likely been 2 ML.
- During this last financial year there were 97 days when the flow was greater than zero but less than 1 ML. These flows can be accounted for from rainfall events NOT groundwater outflow.
- 21 of these 97 days had a flow less than 0.1 ML. This is one twentieth of a 2 ML/day flow.
- Zero flow for 78 consecutive days occurred during January, February and March 2010.
- Throughout these 175 days of flow less than 1 ML there were 14 days in April that Barwon Water ***was not*** releasing its compulsory 2 ML/day out of the Otway to Colac Pipeline (see page 72). Not that this flow ever reaches the stream flow gauging station as it disappears into the groundwater depleted Big Swamp.
- However, this pipeline release combined with rainfall events would have had an elevated effect on low flow days. The 2 ML/day release into Boundary Creek from the Otway to Colac Pipeline plus a rainfall event could combine on occasions to have a passing flow at the stream flow gauging station. It must be kept in mind that pre pumping daily average summer flow from the aquifer without rainfall, was calculated to be between 2 and 3.2 ML. This groundwater outflow ceased years ago.

If the extra 97 days when the flow in Boundary Creek was below 1 ML, was added to the above graph the plotted line would have continued its steep gradient upwards.

At no stage during this last financial year did the deep water aquifer replenish enough to overflow into Boundary Creek and or saturate the Big Swamp. As can be seen in the next graph the groundwater level (blue line) continued to fall further below the critical Maintenance of Stream Flow Level of 158.5 metres AHD(red line), At the end of June 2010 the water table was approximately 9 metres below the critical level. The Big Swamp's dilemma is compounding.



The water level (blue line) is approximately 10 metres below the Supplementary Stream Flow Trigger Level (red line).

Supplementary Stream Flow Water Releases into Boundary Creek for 2010.

As part of the Licence conditions set down for the extraction of groundwater at the Barwon Downs Borefield, Barwon Water has to provide a supplementary flow of 2 ML/day into Boundary Creek if the flow in Boundary Creek at the Colac to Forrest Road Stream flow Gauging Station falls below 1 ML flow a day. This 2 ML/day has to be maintained until there is a flow of 1 ML/day at the gauging station. For the last few years the supplementary flow has been required for extended periods of the year. 2010 has been no exception.

Appendix F

Flows in Boundary Creek at Yeodene Stream Gauge 233228 (ML/day)

Date	July-09	August	September	October	November	December	January	February	March	April	May	June-10
1	1.13	5.98	72.50	18.67	1.27	4.40	0.02	0.00	0.00	1.98	0.24	2.60
2	2.28	8.35	43.98	12.71	1.30	2.91	0.03	0.00	0.00	1.87	0.22	2.73
3	3.19	9.40	27.82	9.54	1.26	1.83	0.03	0.00	0.00	1.89	0.21	2.57
4	4.27	9.68	19.15	8.17	0.95	1.31	0.00	0.00	0.00	1.91	0.18	2.20
5	2.79	10.63	14.32	6.79	1.07	0.78	0.00	0.00	0.00	1.85	0.19	1.96
6	2.19	8.87	11.57	5.75	1.16	0.52	0.00	0.00	0.00	1.82	0.17	1.78
7	1.95	7.05	10.45	5.25	1.08	0.39	0.00	0.00	0.00	1.96	0.14	1.73
8	1.81	6.37	10.91	5.28	0.83	0.32	0.00	0.00	0.00	3.66	0.11	1.69
9	1.66	6.16	15.82	5.64	0.60	0.26	0.00	0.00	0.00	2.57	0.13	1.65
10	1.58	6.40	19.29	5.47	0.48	0.21	0.00	0.00	0.00	1.29	0.15	2.02
11	1.53	6.24	15.90	4.34	0.41	0.18	0.00	0.00	0.00	0.84	0.19	2.93
12	2.18	6.13	11.43	3.58	0.34	0.15	0.00	0.00	0.00	0.68	0.46	3.93
13	2.71	6.36	8.87	3.16	0.27	0.13	0.00	0.00	0.00	0.56	0.63	4.24
14	4.30	6.93	7.27	3.35	0.27	0.11	0.00	0.00	0.00	0.45	0.73	3.94
15	5.71	7.35	5.98	4.65	0.19	0.10	0.00	0.00	0.00	0.36	0.64	3.07
16	5.66	7.24	4.94	9.41	0.12	0.08	0.00	0.00	0.00	0.28	0.64	2.14
17	4.93	7.18	4.09	30.95	0.08	0.07	0.00	0.00	0.00	0.22	0.58	1.30
18	4.78	7.75	8.58	30.31	0.07	0.14	0.00	0.00	0.00	0.26	0.86	1.41
19	4.07	9.35	32.03	16.14	0.05	0.15	0.00	0.00	0.00	0.25	1.13	1.90
20	3.46	8.14	30.49	9.68	0.04	0.18	0.00	0.00	0.00	0.20	1.13	2.96
21	3.11	7.55	17.65	6.85	0.04	0.17	0.00	0.00	0.00	0.17	1.17	3.15
22	2.90	18.28	12.00	4.87	0.05	0.20	0.00	0.00	0.00	0.17	1.20	2.88
23	2.92	55.90	18.73	3.52	0.07	0.23	0.00	0.00	0.10	0.23	1.24	2.74
24	3.68	30.38	32.72	3.16	0.06	0.18	0.00	0.00	0.62	0.44	1.24	2.01
25	5.48	18.77	20.43	2.90	0.07	0.15	0.00	0.00	0.60	0.48	1.24	1.39
26	5.94	21.35	19.55	2.61	0.07	0.11	0.00	0.00	0.76	0.65	1.24	1.14
27	5.27	66.29	58.73	2.25	0.08	0.08	0.00	0.00	0.91	0.45	1.31	1.17
28	4.87	57.13	56.82	1.90	0.09	0.07	0.00	0.00	1.31	0.38	1.35	1.12
29	4.63	36.20	47.67	1.65	0.10	0.06	0.00	0.00	2.15	0.39	1.37	1.48
30	4.43	43.78	30.51	1.44	2.41	0.06	0.00		2.88	0.56	1.66	1.49
31	4.53	101.60		1.29		0.05	0.00		2.29		2.19	
Total	109.90	608.76	690.20	231.28	14.87	15.55	0.08	0.00	11.62	28.81	23.95	67.33

Release to Boundary Creek (ML/day)

Date	July-09	August	September	October	November	December	January	February	March	April	May	June-10
1	0.00	2.13	2.21	2.02	3.35	2.04	2.06	2.07	2.09	2.07	2.06	2.13
2	1.23	2.15	1.09	2.03	3.36	1.26	2.09	2.07	2.22	2.07	2.06	2.13
3	2.07	2.15	0.00	2.00	3.35	0.00	2.09	2.07	2.23	2.06	2.06	2.13
4	2.12	2.14	0.00	1.98	3.30	1.31	2.09	2.07	2.23	2.06	2.07	2.13
5	2.12	2.13	0.00	1.99	2.84	2.09	2.08	2.06	2.22	2.06	2.10	1.97
6	2.12	1.77	0.00	1.99	2.07	2.09	2.07	2.06	2.22	2.06	2.10	2.14
7	2.11	0.05	0.00	0.74	2.07	2.06	2.07	2.06	2.22	2.06	2.10	2.14
8	2.08	0.00	0.00	0.00	2.07	2.06	2.04	2.05	2.22	2.06	2.10	2.14
9	2.05	0.00	0.00	0.00	2.07	2.06	2.01	2.05	2.22	1.87	2.10	2.14
10	2.08	0.00	0.00	0.00	2.07	2.02	2.02	2.06	2.23	0.00	2.11	2.14
11	2.08	0.00	0.00	0.00	2.09	2.04	2.03	2.04	2.15	0.00	2.11	2.05
12	2.08	0.35	0.00	0.00	2.08	2.09	2.02	2.06	2.08	0.00	2.11	2.01
13	1.88	2.11	0.00	0.00	2.04	2.08	2.03	2.05	2.09	0.00	2.11	0.01
14	2.08	2.02	0.00	0.00	2.02	2.06	2.03	2.05	2.09	0.00	2.11	0.00
15	2.06	2.10	0.00	0.00	2.05	2.05	2.03	2.05	2.08	0.00	2.11	0.00
16	2.07	2.18	0.00	0.00	2.04	2.17	2.03	2.06	2.09	0.00	2.11	0.00
17	2.06	2.18	0.00	0.00	2.06	2.32	2.03	2.06	2.08	0.00	2.11	0.00
18	2.06	2.18	0.00	0.00	1.99	2.21	2.08	2.06	2.08	0.00	2.11	0.00
19	2.05	2.19	0.00	0.00	1.37	2.08	2.09	2.05	2.08	0.00	2.11	0.00
20	2.04	2.15	0.00	0.00	0.56	2.07	2.07	2.06	2.07	0.00	2.11	0.00
21	2.05	2.19	0.00	1.27	2.09	2.07	2.07	2.05	2.08	0.00	2.12	0.00
22	2.05	2.18	0.91	3.33	2.03	2.07	2.05	2.06	2.08	0.00	2.13	0.00
23	2.06	2.19	2.08	3.33	2.05	2.07	2.02	2.06	2.08	0.00	2.13	0.00
24	2.06	2.20	2.04	3.33	2.10	2.07	2.01	1.92	1.98	0.73	2.13	0.00
25	2.07	2.20	2.03	3.33	2.14	2.07	2.01	1.78	0.68	1.87	2.12	0.00
26	2.07	2.20	2.03	3.33	2.19	2.07	2.04	1.77	1.42	1.84	2.12	0.00
27	2.06	2.20	2.03	3.33	2.21	2.07	2.07	1.95	2.07	2.08	2.13	0.00
28	2.05	2.20	2.04	3.33	2.15	2.07	2.07	2.08	2.06	2.08	2.13	0.00
29	2.05	2.20	2.04	3.34	2.04	2.07	1.81		2.07	2.08	2.13	0.00
30	2.05	2.20	2.03	3.34	2.04	2.07	2.06		2.06	2.08	2.13	0.00
31	2.08	2.20		3.35		2.07	2.07		2.06		2.13	
Total	61.07	54.13	20.51	47.35	65.91	60.94	63.33	56.81	63.63	31.15	65.31	25.26

Taken from Appendix F of the Barwon Water 2009-2010 Report to southern Rural Water[5]

The 14 days of no supplementary flow releases between the 11th and 27th of April has been a non compliance to the Licence No. 893889 conditions. This is no surprise and can no doubt be easily explained away by both Southern Rural Water and Barwon Water, as they have on numerous other occasions. (18)
When doing a quick analysis of the data found in the Supplementary Flow Releases and the flows in Boundary Creek, some interesting figures stand out. It is difficult to explain why there would be releases from the Colac to Otway Pipeline in periods of extremely high rainfall flow events down Boundary Creek such as at the end of August 2009. As with much to do with the management of the Barwon Downs Borefield one can only wonder.

Month	Year	Days Water Released	Days when there were releases and there was no licence requirement to do so.	Days when the licence requirements stipulated releases needed & weren't released	Megalitres released that wasn't compulsory
July	2009	30	30		61.07
August	2009	27	27		54.13
Sept.	2009	11	11		20.51
Oct.	2009	18	18		47.35
Nov.	2009	30	7		14.94
Dec.	2009	30	3	1	4.46
April	2010	16	9	14	18.67
May	2010	31	13		17.47

The 2009-10 financial year report (5) states that approximately 615 ML of water was released for the year. Approximately 385 ML of this amount did not have to be released as per the licence conditions. The significance of this data may do no more than highlight the manner in which the borefield operation is managed. No doubt Barwon Water would argued that this 385 ML not required to be released, is of no consequence in the scheme of things.

Some Other Comments Worth Making.

There are five other comments worth making regarding Barwon Water's Report(5) on the Barwon Downs Borefield for the Financial year 2009-2010.

1. Under the "Groundwater Salinity" section it states,
   "***The five years of salinity data shows there is not a current risk of groundwater salinity increasing due to pumping.***"
   This may be the case in the deep water aquifer but it must be noted that NO salinity monitoring studies are being conducted into pumping effects on the sediments, aquifers and soil structure above the aquifer being pumped from. If local farmer's anecdotal stories are any indication, then there does appear to be a strong case that salinity levels above the deep water aquifer have been disrupted in some way. Considering that there was a recommendation made by Witebsky et al.(33) in 1995 that the upper layers be monitored, perhaps 15 years later would be a good time that this was done. It is then likely that an accurate and comprehensive study of salinity trends could be gained.

2. The section dealing with flows in the East and West Barwon branches of the Barwon River are interesting.
   In regard to the East Branch the Report states,
   "***The gauging results continue to indicate there is no loss of river flow to the aquifer as a result of pumping over the last twelve months***."

At the time of measuring the three stream gauging sites had increases of flow as the river moves downstream. Where does this increase in water come from? Is it from creeks and stream joining the flow? Is it groundwater discharge into the East Branch of the Barwon River? Data from an earlier report in 2006-07[(2)] shows a decrease in flow between the three stream gauges.
There would appear to be considerable doubt that the data being collected is an accurate reflection of the connectedness between the flows in the East Branch of the Barwon River and the groundwaters the River passes over.

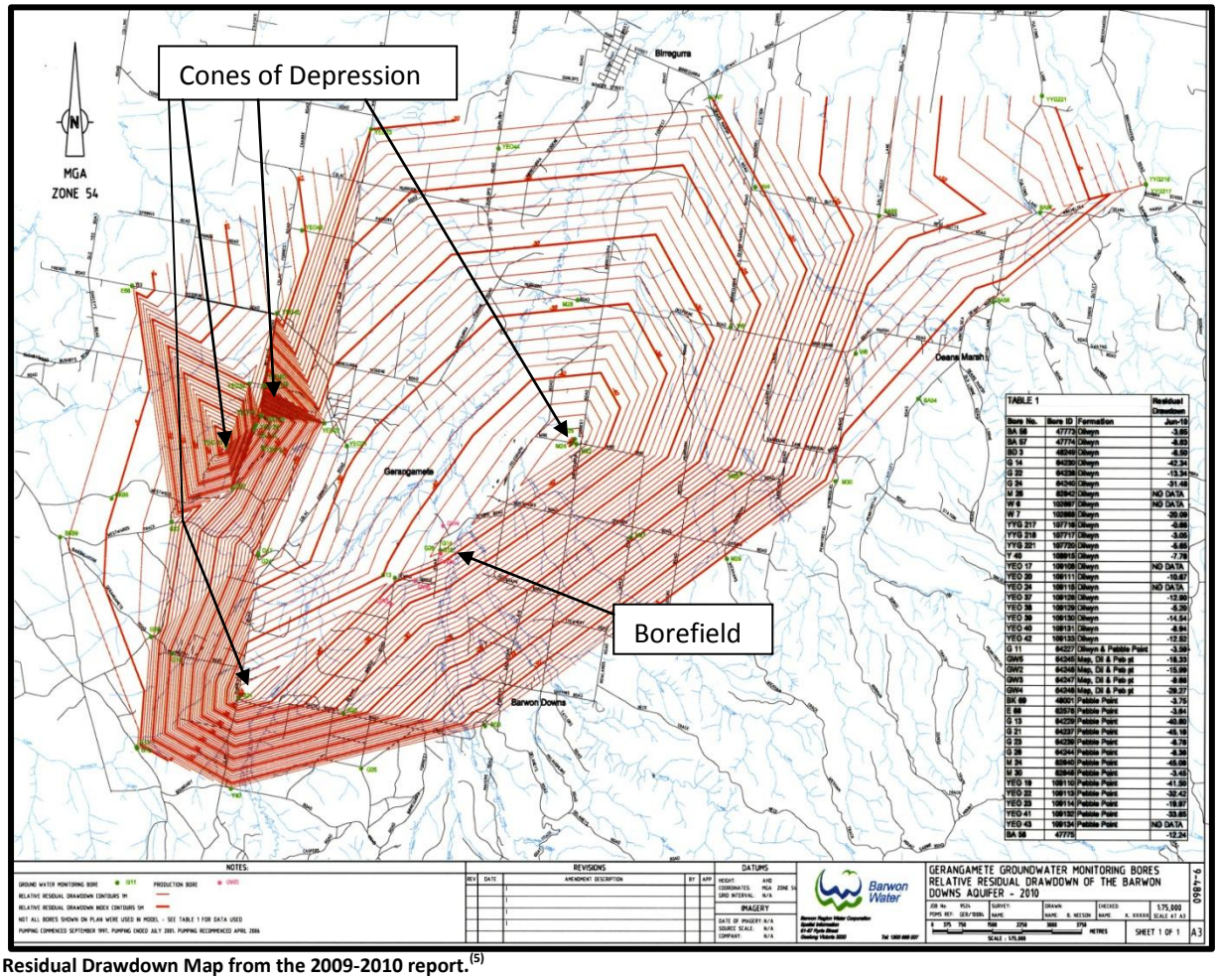
3. Thirdly it has always been intriguing how it has been calculated that there is no potential for groundwater to discharge to the West Branch of the Barwon River. Blind faith in the data, explanation and conclusions drawn in the yearly reports appear plausible. However, on closer scrutiny the results stated do not make sense.
   Observation bore Y41 was specifically installed to measure the depth of groundwater on the east side of the West Branch of the Barwon River. It must be noted that this was done years after serious pumping had been commenced. Before pumping the pressure head of water in the deep water aquifer was in the vicinity of 160 to 165 metres AHD. The water table level in Y41 in the last 12 months was between 126.735 and 127.735 metres AHD. The 2009-10 report[(5)] states,
   "***This indicates there is no potential for groundwater to discharge to the West Barwon River.***"
   The residual drawdown maps in the same report indicate a drawdown of 3 to 4 metres. Subtracting 3 metres from 160 m gives a water table level in Y 41 at approximately 157 m AHD. There appears to be a considerable discrepancy in these two lots of reporting, in the magnitude of approximately 30 m.
   In the 2006-07 report[(2)] the discrepancy was in the order of approximately 80 metres.
   No doubt that these discrepancies can be explained away as administrative errors similar to the explanation given to the multitude of other errors found in earlier reports. [(15)(16)]
   Whatever the outcome and explanation given for these discrepancies, the manner in which the above conclusion is drawn, needs some detailed explanation. The question also has to be asked why Southern Rural Water, charged with the responsibility of scrutinising, reviewing and policing of the licence and its management missed such obvious mistakes.

   In 2003 Blake [(6)] presented a discussion paper to the review panel overseeing the renewal of the Barwon Downs groundwater licence. Blake was convinced that the bed of the West Barwon River was lower than the pressure head of the aquifer Barwon Water was pumping from. He argued that the West Barwon River was an accepting stream. Given the discrepancies above, perhaps this issue needs to be revisited. It would appear most likely that Blake is correct and Barwon Water has inadvertently made mistakes in its calculations when stating that there does not appear to be any possibility of discharge from the aquifer into the West Barwon River.

4. Up to this point in time I have blindly accepted that the residual drawdown maps provided in the Barwon Water yearly reports [(1)(2)(3)(4)(5)] are a true representation of the drawdown affect from the pumping at the Barwon Downs Borefield. By all accounts there are some unusual twists to the way the data has been presented. The residual drawdown map seen on the next page, as with earlier maps, has some peculiarities.
   - There should be only one cone of depression, not four, unless there are more borefields in operation at each site of the cones lowest point. In this location of the Otway Ranges there are no other borefields that could be causing this type of drawdown effect.

- There does not appear to be a cone of depression's lowest point at the actual borefield. It is extremely unusual and unheard of for drawdown lowest points to occur away from the borefield site.

Something would appear to be seriously wrong with the presentation of this data. However, Southern Rural Water has repeatedly stated that these reports[1][2][3][4][5] prepared by Barwon Water are acceptable.



Residual Drawdown Map from the 2009-2010 report.[5]

5. In the "Community Engagement" section this Report states, "***Barwon Water is engaged in studies with a number of stakeholders who have an interest in inland sulphate acid soils and managing fire risks in the Gerangamete area.***" LAWROC and its members have most definitely shown an interest in the Acid Sulfate Soils issue and will be in the direct line of any fire that escapes from the Big Swamp and heads in a south westerly direction. This surely entitles LAWROC members to be regarded as "stakeholders." Up to this time LAWROC participation and community engagement in Inland Acid Sulfate Soils has been denied.

AT NO STAGE HAS BARWON WATER BOTHERED TO INCLUDE ANY LAWROC MEMBER IN THE COMMUNITY ENGAGEMENT PROCESS.

This is perhaps an appropriate time in the saga of the threat to the freshwater peat swamps and wetlands in the Otways, to refer back to the Dalia Lama's words on page 4.

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