Initial opportunities research document

Shire of Merredin, WA

EXCEPTION

Perth, Western Australia, 2002

Index

Appendix:

Introduction

The Shire of Merredin Western Australia has invited us in their search for solutions for environmental problems they have been encountering. Both on macro and on micro level there are vital issues which need to be addressed by the council to ensure longevity and stability of their shire. This document provides at first a quick overview of the problems, their solutions and a global discourse of these solutions.
In the appendix of this document you will find set out the issues as they were presented to us, as well as our own careful examination of the problems. A number of possible solutions will be offered for each of the problems, using 'brainstorming' techniques to extract a broad spectrum of possibilities. The solutions have then been cross-referenced with each other to look for solutions that have a greater scope for solving multiple problems. One or more of these solutions is then chosen and a proposal offered to the council.

The Focus List

The problems presented to us include cultural, social and geographical issues. From these issues five main problems have been selected. These five form the focal point of this research. (These issues are explained in detail in Appendix p.9.)

1 - The Water and Salt issue

A high groundwater level with a very high salt content affecting infrastructure in the centre of Merredin.

2 - The Population issue

A static population but uneven population profile which can cause a big drop in population.

3 - The Employment issue

The large group of under aged in Merredin will need work soon, which is currently not available.

4 - The Pumpstation issue

An old deteriorating first generation heritage pumpstation that resides on the west part of the town which is a hazard to the community.

5 - The Hidden Town issue

The town is hardly visible from the highway, its main source of tourism, due the centers location on the north side of the railway. This brings with it a fragmented community due to the division of the town in parts.

Solutions

A number of solutions have been sought for each problem using ‘brainstorming’ techniques. Also a small list of asset wishes, and possible options for the town were added. These were used, together with the solutions, to reach complex solutions that have a greater scope for solving multiple problems at once..

The process

After a thorough study of the documentation supplied to us by the Shire of Merredin and a few days on site research, a list was compiled with solutions addressing each problem. (A shortened list of these solutions can be found in the appendix p.11).
We cross referenced each solution with all others, and reached a number of interesting solutions. This is a widely used method for reaching solutions for innovation.

The result

The most expanded solution is the *Spirulina plant*. This solution has been found after thoroughly researching the saline-water-using industry, and after elimination of several competing industries such as fish farming, oyster farming and Aloe Vera. Spirulina remains as the most promising and feasible solution.
In addition to this we have chosen, after research, to provide water collection equipment to some inhabitants of problem areas, to diminish rainwater dissipation in the ground and to eliminate additional pipeline water from being used to water plants and getting added to the groundwater.

(The issue of The Hidden Town will be further addressed in another proposal, titled ‘Arcs Curve to Town’, in context with the ‘City as Site’ proposals.)

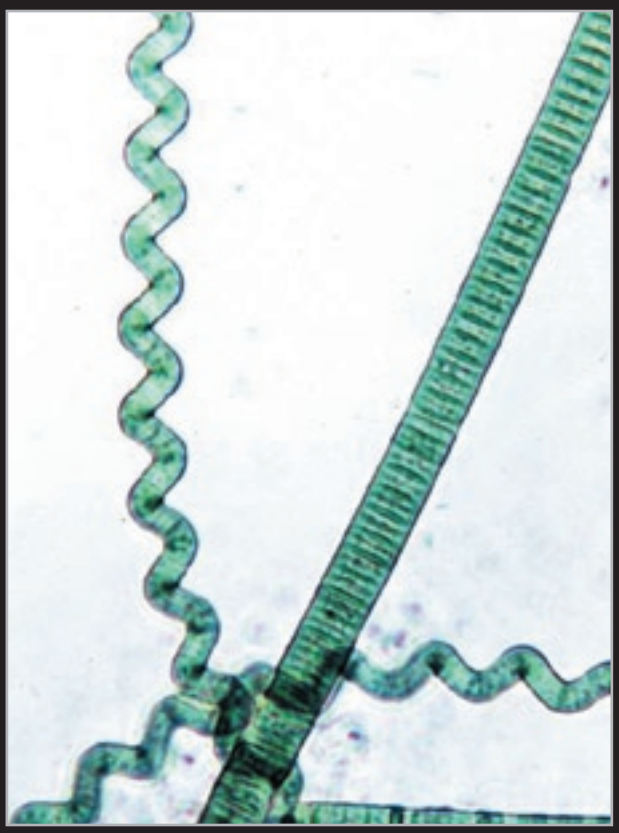
Spirulina Plant Research

The Spirulina Plant idea offers with reasonable confidence, a solution to the salt water problem, the employment problem, the local industries and shire cash flow problem and the tourism problem. Therefore it is clearly worth investigating the viability of it. This became our next step, and we conducted a detailed study on this type of industry. The appendix contains expanded information about the history and applications of Spirulina.

Why Spirulina?

The green algae came to our attention because of it's growing environment. Whilst researching crops that grow in salt water under arid circumstances we found that it is perfectly suited to Merredin. High temperatures, and the salinity within the reach of easy manipulation of water. The farming is done using simple water agitators, like the old water tank next to the pumpstation, but only 50cm high.

Spirulina plants have been used as instruments to revive economically depressed areas. In this proposal the plant functions as a gear in a machine to solve multiple problems at once.



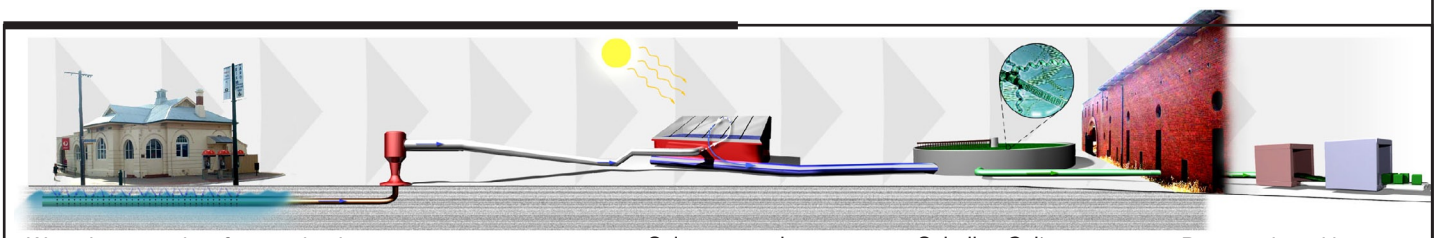
Spirulina Major 400x

Summary of Spirulina

- The only single, natural source providing the highest amount of protein ever known to man is Spirulina (71%). The protein content in Spirulina is three times that of soybean, five times that of meat, and the protein quality is among the best with a good degree of aminogram. The protein yield per unit area per year is the highest compared to other protein yielding crops.
- Like all other microbial cells, Spirulina contains all natural vitamins including the 'B' complex range, minerals and growth factors including gram-linolenic acid (highest after milk and 'evening prime rose oil'). It contains the highest amount of b-carotene, a precursor of Vitamin 'A', 12 times higher than carrots. It is the only vegetable source of vitamin 'B12', containing two and half times that of liver.
- The concentration of nucleic acids is among the lowest recorded for microbial cells considered as food or feed.
- The other micro organisms including those pathogenic to humans and other animals are eliminated in the production process of Spirulina due to its requirement of a very high alkaline growth medium.
- Spirulina's preference for a tropical and sub tropical climatic conditions offers an opportunity to arid areas.

The Proposal

The green health food Spirulina was chosen out of numerous options because it fits so well in the Merredin climate, and its process can be adjusted confidently to help Merredin to solve multiple problems at once.
In the plan, agricultural drains are planted under the town. These drains are simple pipes with little holes that collect water if the groundwater level reaches high levels. The water is then transported, processed by solar desalinators and used in the Spirulina plant. Because the water is used by the Spirulina plant, it is the plants responsibility to provide the means for these works. **Merredin shire, investors and contractors work close together to reach an ultimate symbiosis.**



Water is pumped up from under the town

Solar powered Desalination plant

Spirulina Culture

Pumpstation with Packaging & Drying

Economics & Process

Spirulina has been cultivated very successfully for quite some time now. It's high price, and the willingness of consumers to pay this price makes it an excellent industry for economically depressed areas. Successful operations have already been conducted in declining south African towns which are now thriving. The manufacturing process requires little additives, and Merredin's location on the highway between Perth and Sydney is ideal. Spirulina farming is a highly profitable and very ecologically friendly enterprise.
Spirulina is used for a myriad of applications, but can be consumed pure as well, which is the main target of the plant, and yields the highest profit. The market for spirulina is growing rapidly and is already substantial.
(All process and economics details can be found in the appendix.)

Merredin's advantage

Merredin's location on the trade route between WA and NSW is optimal for transportation of the Spirulina goods.
Merredin's water is already ideally suited for Spirulina growth. This allows the plant to cut back in chemicals needed to allow for an even higher profit.
The factory as calculated has an amazing return on investment of within 3 years, this is with 200% tolerance built in. In Ideal circumstances the investments can be returned within the year.
The factory will provide employment and function as a tourist attraction. Furthermore it will with reasonable confidence eliminate the water problem of Merredin and aid the shire in its economic development, and give it economical and ecological status nationwide.

Costs:

Pumpstation	AU$ 803,000
Plant & Machinery	AU$ 500,000
Office, lab & Visitors	AU$ 400,000
Raw Material cost PA:	*AU$ 81,300*
Energy Cost PA:	*AU$ 20,000*
Labour cost PA:	*AU$ 200.000*
Other costs PA:	*AU$ 100.000*

Gain:
Minimum Cash Flow Per Annum:
AU$1,200,000

Results:
Income after cost deduction: $800.000
Return on investment: Within 3 years (max).

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Conclusion

The plant addresses Merredin's problems as follows:

1. Water and salt issue:

By preventing the water to reach problematic heights and a removal of excess water the town is rid of the water problem. This will also prevent the salt to surface and the destructive effects thereof.

2. The population, employment & growth

The plant will provide employment and gather health-tourism. It provides a stable base for future growth of the town and an influential economic factor. It provides employment for future generations and serves as foothold for marketing Merredin as a health-region (further fortified by the wheat industry). The tourism will provide more work in the rest of town, and infuse money into Merredin.

3. The pumpstation

The pumpstation will have found a stable and fruitful role in Merredin, turning a problem into an advantage.

4. Finances

The shire will reap substantial economical benefits from a successful industry. The shire can initiate this project, and gain an interest in the plants finances and operation, to even further the benefits for the Shire. Our research point to a very successful enterprise, with an unsurpassed return on investment, and growth potential.

This document sets out a possible scenario for a Spirulina plant in Merredin. The limited time offered to us has forced us to focus on the problems at hand, and possible inhibiting factors. In our research we have found no inhibiting factors, and our research shows that a Spirulina plant in Merredin using the town groundwater is a feasible, economical and ecological solution.
The problems of Merredin discussed in the first chapter cannot all be solved by this plant, however, the most important ones, (Groundwater levels, Employment, Tourism, Pumpstation and finances) are all addressed by this solution, and they all solve the problems to a satisfactory extent. This document is a preliminary study of the possibility of a Spirulina Plant but tries to be comprehensive enough to offer a complete and clear overview of the system, and a starting point for a more thorough study.

(The chapters in the appendix will outline each aspect of the proposal in detail.)

Appendix

The following parts of this document contain detailed information about the Spirulina farming process, it's particular implementation in the proposal for Merredin and an insight into the process of developing the proposal.

Appendix Contents:

Problem Definitions

1 - The water and salt problem

This problem consists of two sub problems. These two problems currently pose the greatest threat to Merredin in the short & medium run.
Merredin, based between hills and located at the bottom of Merredin Rock, has a rising ground water table. The natural dissipation of the region used to be able to cope with the annual rainfall but due to a number of factors the terrain is unable to get rid of its excess ground water. These factors include water from the perth-kalgoorlie pipeline being added to the groundwater due to domestic water use and vegetation razing.
The water has a high degree of salt, and the higher the water level rises, the salter it becomes. The salt water breaks down roads, walls and other items of infrastructure. The salt water will inhibit most plant life in Merredin if the ground becomes too salty. Future infrastructure and cultural events get denied government funding because of the future detrimental effects of the salty grounds on plant life and infrastructure.
Currently there are two vapor pond and a small desalination plant. This is a pilot plant, including two wells that have been dug in order to research the water problem and it's scale. The plant has been successful in its setup, does not provide the scale to be a solution for the problem. Also a number of special trees have been planted in a certain area just east of town, which are supposed to bring the water table down. This has only been moderately successful as the water table has only fallen locally at that point, and no effects have been measured further outwards of the planted area.

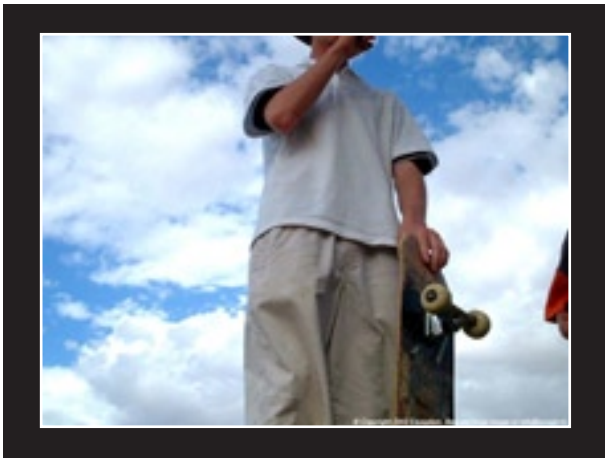
2 - The population

The population of Merredin is around 3600, and can be considered static. One third of Merredin's population is under 15. As history and local polls amongst the youthful in Merredin show this means that in a few years Merredin can expect a big drop in population when all the young people move out of town in search for adventure.
A percentage of these will return in due time, but until then the population will decrease.
A number of newborns can be expected to raise the towns population again, but the statistics indicate that this will not be enough to keep Merredin's population stable. In previous times Merredin was larger, consisting of 5000 people and more. (see appendix for statistics)

Merredin Youth

3 - Employment

Merredin's unemployment rate is very low. At around 5% it is lower than the mean WA unemployment rate. In contrast, a number of industries have shut down or have left Merredin in the last few years. The low unemployment rate can be explained by people moving out of town to seek work elsewhere. Considering that the young population will need a job soon, the absence of work opportunities is worrying. New industries need to be attracted. A higher population will infuse money into the retail sector, health and education sectors, and increased tourism will



benefit all sectors.

4 - The Pumpstation

At the west end of Merredin 3 generations of pumpstations reside on the south side of the highway. The newest station pumps the water through the pipeline from Merredin to Kalgoorlie. Two other pumpstations at the site have been decommissioned. One is slowly decaying, an original pumpstation from the time when the pipeline was built by C.Y. O'Conner in 1904.
This pumpstation is the one closest to the road and provides travellers who come upon Merredin from the west with their first views of the infrastructure of the town. Unfortunately a number of small trees have been planted right in the line of sight, and the pumpstation is hardly visible. The pumpstation is also becoming a danger to the community. Subsidence is evident in cracks in the walls and water that stands in the lower ground level of the building. Research has been conducted on repair and conservation of the pumpstation, that research concluded two things: do the station up so it won't collapse, cost: $200,000,-, or restore it to it's original state and do something with it. Cost: over $800.000,-.
With the pumpstation comes an old concrete water tank of about 30 meters in diameter, and a little brick shack.

5 - The hidden town

When travellers come upon Merredin from either the east or the west a remarkable absence of a coherent town centre strikes the traveller, or rather, does not strike him. This is because the centre of the town is actually on the north side of the railroad. The traveller by car only sees a decommissioned trainstation and a railroad, behind which the actual town lies. Travellers who do come into town only stay for a short while (the motels are very busy), but do not actually spend the time they stay in Merredin outside of their motel room. There is a tourist information centre, at the moment a point of debate in Merredin.

The division of the town, the north side the centre, and the south side previously a railroad worker community, also affects the community spirit. The south part, although less affected by the groundwater problem, is only connected to the north part by two very understated pedestrian passes. The only way to reach the centre by car is either on the west or on the east end of town. This inhibits the town from becoming one community.

The pumpstation

Cummins Theatre in Merredin

Solutions list

This list provides an overview of some of the ideas that came forward from analysis of Merredin, the documentation that was provided by the Shire of Merredin and our brainstorming session. Brainstorm details have been omitted.

1 - The water and salt problem

- Desalination plant / Vapor ponds
- Farmhouse for desalination plants
- Salt factory / Salt selling
- Town centre drainage
- Wind powered pumps
- Catching rainwater from roofs
- Boosting up water price
- Planting special trees / plants (cork trees)
- Attract saline water using industry (fish farm)

2 - The population

- Attract industries
- Increase tourism
- Prevent brain drain
- Offer unprecedented ‘coolness’ to youth
- Pioneer community spirit

3 - Employment

- Attract high labour industries by:
    - Offering special perks for investors
    - Setting up own industry & sell it
    - Create industrial dependencies
- Increase tourism
- Develop current industries
- Advertise Merredin in region
- Build new infrastructure
- Sheep shearing school
- Plane servicing / Factory

4 - Pumpstation

- Restaurant
- Hotel
- Cafe
- Climbing Hall
- Museum
- Agricultural advisory centre
- Library
- Aerobics centre

5 - The hidden town (tourism)

- Theme park
- Good roadside restaurant
- Museum
- Better signage
- Exploit Merredin Rock
- Bicycle hire
- Health resort
- Hobby tourism
- Eco tourism
- ?-tourism

Asset wishes

- Sport complex
- Expanded library
- Go Cart track
- Gliding strip
- Radio station

Spirulina Plant Research Details

The most fertile option that emerged from our brainstorm and subsequent research sessions was an uncommon one. The quite startling result of our idea generation left a big gap in the middle of our confidence in our idea generation, but even after additional checking and brainstorming, this option seemed to be the most viable one. The idea offers with reasonable confidence, a solution to the salt water problem, the employment problem, the local industries and shire cash flow problem and the tourism problem. Therefore it is clearly worth investigating the viability of it. This became our next step, and in the following texts and pages you will find a detailed study relating to the Spirulina Plant proposal.

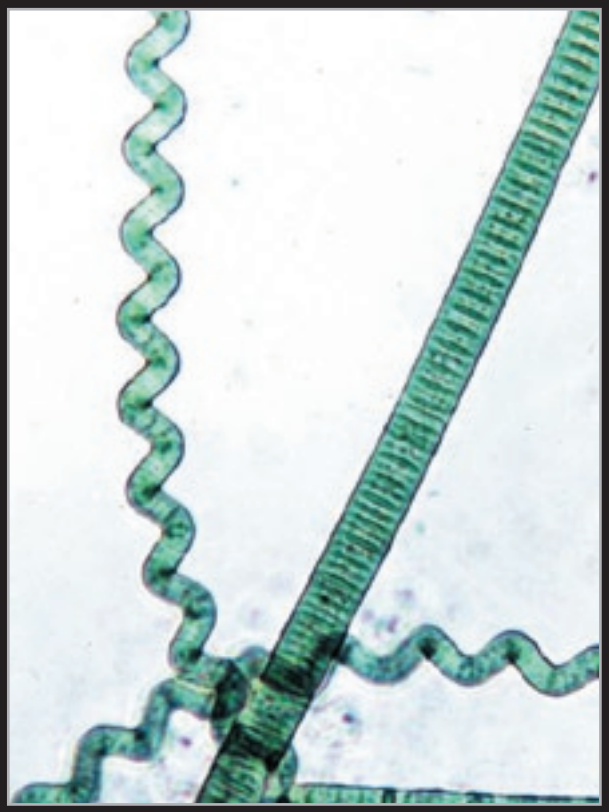
Why Spirulina?

The green algae came to our attention because of it's growing environment. Whilst researching crops that grow in salt water under arid circumstances we found that it is perfectly suited to Merredin. High temperatures, and the salinity within the reach of easy manipulation of water, farming using simple water agitators, like the old one next to the pumpstation.

Spirulina has been a staple in parts of Africa and Mexico for centuries. It is currently one of the most popular dietary supplements in Japan, where it is extensively studied for its beneficial effect on diabetes, ulcers, liver disease, allergies, and cardiac problems.

History:
Archaeologists have even theorized that the ancient Mayan Indians of Guatemala and the Aztecs of Mexico may have used Spirulina. In both civilizations, "traditional" sources of high-quality protein (such as meat and milk) were scarce, and farming was difficult, especially for the jungle-dwelling Mayans. Yet these civilizations thrived and were able to support complex social organizations that had nothing to do with food production. How?

When the Spanish Conquistadors arrived in Mexico almost 500 years ago they reported finding the natives enjoying a mysterious green scum that thrived on Lake Texcoco, located near Mexico City. The green scum, called tecuitlatl by the Aztecs, was probably a form of Spirulina that is still found on Lake Texcoco. And in Mayan country, archaeologists have found carefully designed ponds and waterways that may have been used as algae-growing ponds. Because the area receives more than 300 cm of rain a year and is in general not suited to agriculture, it is unlikely that the waterways were irrigation projects for traditional field crops.



Spirulina Major 400x

When Europeans arrived in parts of Africa, they noticed natives were collecting and eating green scum -Spirulina -- that grew on stagnant, Inland waters. French and Belgian scientists and engineers developed some of the local Spirulina growing and harvesting techniques on Lake Chad for European markets, and they continue to study the feasibility

of wide-scale Spirulina farming as both a food base for poor villages and as a resource for European health food markets. And during the past 20 years, entrepreneurs in California's inland valleys have experimented with algae ponds to supply high-quality Spirulina for the natural foods and supplements market.

Research over the last 10 years has proven that Spirulina contains the most Protein of all plants currently know to man. If you look at food producing in the way of food produced per liter of water, Spirulina produces more than 2000 times as much protein per litre of water than beef, and more than 20 times that of soy beans.
In addition to this Spirulina contains more than ten times the amount of Beta-Carotene as actual carrots. Gamma-linolenic Acid (GLA), commonly only found in mothers milk, is a very essential and healthy acid, and Spirulina is the only other whole food source of this. In addition to all this Spirulina contains loads of Iron, vitamin B-12, B-complex and phytonutrients.

Spirulina Application

Food Supplement:

The World Health Organisation has found Spirulina to be an excellent food for human consumption and Spirulina has the approval of the Food & Drugs Authority of the United States for being sold as a natural food. In Japan and in the United States, business executives take Spirulina tablets to combat stress. Athletes and joggers take Spirulina for quick energy synthesis.

Health & Medicine:

Non insulin dependent diabetes,Cholesterol control, Vitamin A, deficiency & malnutrition, Adjunct to cancer patients undergoing chemotherapy, Formulations with other natural products as a general health supplement., Liver corrective for liver disorder, Burns therapy, skin grafting, Control obesity, Lactating agent for mothers.

Extraction:

Beta-carotene for medicinal & laboratory use, C-phycocyanin coloring agent in food, microbiological areas cosmetics, C-phycocyanin - coloring agent in food, cosmetics, etc. Chlorophyll - coloring agent, Essential amino acids - for microbiological & chemical essays.

In Pisciculture- Speciality:

Feed for aquarium fish, Color enhancement feed for Gold fish, Formulation with existing feeds for augmentation of vitamins, High protein feed for table variety fishes (fresh water), Special feed for shrimp farming.

In Entomology and Sericulture:

Feed to increase yield in mulberry consuming silk worm, Speciality feed for breeding and culturing various insects used for research.

Cosmetics:

Spirulina in pimple lotions, Facial masks, Hair oil, Shampoo, Mineral bath, Skin cleaner, Tooth paste.

Spirulina Market and Process

Spirulina is easy to grow, its hostility towards other microorganisms and the alkalinity of the water inhibit virtually all contamination of the culture. Sunlight and the special water are enough to make the culture grow. Harvesting occurs daily and virtually every day of the year. After harvesting all that needs to be done is for the Spirulina to be dried, crushed and packaged. Optionally it can be stamped into tablets. It then sets out to the various wholesalers around the country, or to the port for shipping. Spirulina can be very well preserved for over three years. From the wholesalers it gets distributed to pharmacies and natropathies. Other big Spirulina consumers are cereal manufacturers such as Kellogs and Uncle Tobys who use it to add nutritious value to their products.

The Market

The market for Spirulina is growing rapidly. Many vegetarians and vegans discover it as the ideal food supplement, and more and more natropaths use it in their recipes. It is used regularly in health foods such as the juices in all the juice-places which are popping up in the CBD's of large cities, and all the natural pharmacies sell it in large quantities.
Not many people know however that Spirulina is often used in cereals as well, to boost the health factor of the otherwise lacking cereals. Other uses are as a fish food for special health shrimp, tropical fish and as a general fertilizer. Research shows that fertilizing with Spirulina will yield 20% more than ordinary fertilizers.

Spirulina is currently rare in the market. It is easy obtainable but the prices are astronomical. For a bottle with 200 grams of Spirulina consumers pay AU$ 30,-. The market is growing faster than the current suppliers can deliver, that is the main reason for it's price, but natropath products never are cheap. The current main suppliers of Spirulina are located in the USA (Earthrise), Hawaii and Thailand.

Earthrise Farms USA

The current Australian market could easily support a small or medium Spirulina plant. The logistics are easy, and Merredin is ideally located for logistic purposes. The only significant flow of products would be out of Merredin as Spirulina does not require any special products to grow besides salt water, sunlight, basic chemicals and basins.

Farming Process

Spirulina farming is done in ponds of about 50cm depth. The top half of the pond contains the Spirulina mass and the bottom the growing medium. The growing medium consists of brackish water ideally between 20 and 70 g/L salinity but 1 to 270 g/L is tolerated. The medium should have a high alkalinity (PH value between 8.3 and 11.0). In addition to this Spirulina requires CO_2 as a carbon source, and some other regulating chemicals are added, but are not necessary.

The Spirulina is brought to the site as a small culture, and is then grown in larger and larger containers until it is ready to plant in the final basins. The culture grows under the influence of sunlight, and to improve growth the culture is slightly agitated using ordinary mechanical agitation equipment (much like the old agitator that currently resides in the tank).
Spirulina grows at an amazing rate of 30% a day under good conditions, and 45% under ideal conditions. Harvesting occurs daily, and is performed by reaping the top layer of the Spirulina, which drifts on top of the water. The Spirulina is then Freeze dried using commercial freeze drying machines, crushed, packed and stored. It is then ready for sale.

The Plant & Merredin

This chapter looks closely at what the effects are that the proposal discussed in this document have on Merredin, and why they occur.

A closer look

Merredin wouldn't have a ground water problem if the excess groundwater would be properly drained and dealt with. Pumping all the water out of the ground is dangerous. Steep changes in water levels will make the levels unpredictable, and if the water level drops too much the stability of the ground and the ecosystem can be seriously affected. Our choice has therefore been the implementation of agricultural drains. These low cost but highly durable drains are pipes with small holes in them, placed under the town at the optimal water level. They will then collect all surplus water and transport it out of town via Concreek. Light pumps might be installed to transport the water adequately to Concreek.

From where the water stops at the lowest point in concreek, west of town, the water gets transported by pumps to a desalination plant which prepares the water for use in the Spirulina plant. The Spirulina plant doesn't need a lot of water (90KL a day for a 30 tonne P.A. plant), but more than the current small desalination plant outputs (17KL a day). If the water from the agricultural drains is not enough, water from the wells can be used, which currently have a surplus. The desalination plant is paid for and maintained by the Spirulina plant and is solar powered. The water is higher in alkalinity after desalination, which is perfect for Spirulina. The alkalinity of Merredin water has a Ph of about 8.3, which is in the bottom range of optimal for Spirulina. After desalination both the Ph and the salt values are optimal. Merredin water has a salt content of (depending on the well) 160-190 g/L, and Spirulina grows optimal in 20-70 g/L, but 1-270 g/L is tolerated (Richmond, 1988). 3.5 Tonnes of Sod. Carbonate 1.8t Sod. Nitrate and 0.4t Pot. sulfate is then added to the water that is used for Spirulina growing, and if there is surplus water from the desalination plants a reverse osmosis pump and filter will further desalinate the water and it will be transported to the neighbors (the Perth-Kalgoorlie pipeline) and sold.

Employment

On a larger economic scale the plant will have profound influence on Merredin. Even a small plant (30T/pA) will provide employment for 2 managerial 10 skilled and 30 unskilled people. A bigger plant of course attracts more jobs. In time the plant can expand to the west, and reach production factors of 100, 150 or 250 Tonnes per annum. The visitors centre we are planning in the smaller space of the pumpstation will provide employment to some more people. In time a health food gourmet restaurant can be setup there, the kitchen can be built behind the pumpstation. This enterprise will have a large potential to grow and to provide more employment.
The plant could be outfitted with a good bioscientists who could do research on improved growth of Spirulina or other microorganisms. Currently the market for bioscientists is lacking, so it should be easy to attract a good scientist.

Tourism

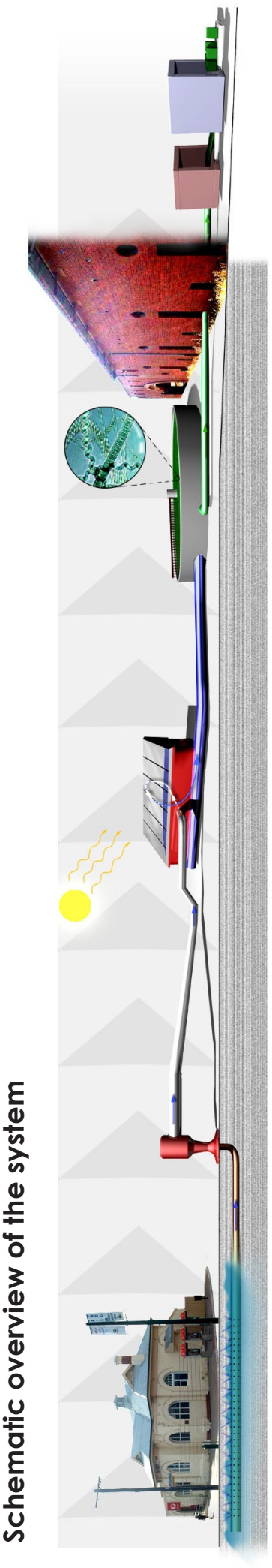
The plant will most certainly attract health tourism. Natural medicine and healing is thriving, and what is a three hours drive from Perth if you want to stay healthy, and save some money by buying your health food directly off the plant? This also gives Merredin a direction to market and exploit their tourism; the health sector. Health tourism will bring more people into town, where small vegetarian and natural eating places can rise up. Together with the locally made bread from Merredin grain (all natural of course), it will be a great place to visit. Push bike rentals to go out and see the Merredin Rock and wheat fields can be estab-

lished to offer a past time.

Financial gain

The plant provides for a desalination plant and disposal of the water problem. Negotiations need to be mutually beneficial to attract investors, or the plant can be exploited by the Merredin Shire itself until it can be sold. In order to be mutually beneficial, the investors must gain something from settling in Merredin. Of course all the factors are right, but it would help if the ground on which the plant will be built would drop in price drastically, or if tax benefits are offered to the investors.
The shire will gain financially from this deal, in two ways. They will save money by not having to implement most of the water disposal equipment themselves, and they will receive money in taxes from the plant, and from the tourism it attracts.
Of course the gain in employment is hard to express in financial terms but invaluable to Merredin.

The pumpstation will have found a reliable and permanent role, and will be restored and outfitted for production and for the visitors centre. There are no special requirements for the areas in which the freeze drying, packaging, and testing takes place. Our current vision of the pumpstation is that the main hall will have a floating mezzanine where the lab and office is placed, and on the granite blocks the machinery is constructed.
Merredin shire will have no financial losses in the pumpstation, and a possibility to gain a stable financial income.



Schematic overview of the system

Economics & Process details

Below you will find details for a plant of 30 Tonnes per Annum. This is the plant size that is used throughout this document. This is only a small scale plant, but with sufficient capabilities to have all the positive effects on Merredin. The plant can be expanded until triple the size without the need to construct another covered area for machinery. The machinery can handle up to 60 Tonnes Per Annum. All machinery details have been gathered from Niro Australia Pty. and Virtus Drying Technologies. The plant data has been collected from a Spirulina Plant manufacturer, the National Research and Development Corporation. All the numbers in this document have been stated using a 25% tolerance above the tolerances already provided. This to provide certainty in the numbers.

The 30 Tonnes Per Annum Plant

For a small plant, the parameters look like this:

Plant Parameters:
- Capacity, TPA 30
- No.of Shifts / day 3
- Working days / Yr 300
- Land Area, m^2 25,000
- Pond area, m^2 22,000
- Covered Area, m^2 180

Manpower:
- Managerial 2
- Skilled 10
- Unskilled 30

Raw Material (Tonne per Tonne of Product)
- Sod. Carbonate 3.5
- Sod. Nitrate 1.8
- Pot. Sulfate 0.4

Utilities (Per Tonne of Product)
- Power, Kwh 13,000
- Water, KL 2,700
- Fuel (LDO), KL 4.0

Plant & Machinery
- Spray Drier Filter press
- Vibro Energy Separator Agitator

Economics
- Plant & Machinery AU$ 500,000
- Pumpstation AU$ 803,000
- Office, lab & Visitors AU$ 400,000
- Cash Flow Per Annum: AU$1,200,000
- Raw Material cost PA: AU$ 81,300
- Energy Cost PA: AU$ 20,000
- Labour cost PA: AU$ 200.000
- Other costs PA: AU$ 100.000

Income after cost deduction: $800.000
Return on investment: Within 3 years.

The following Chemicals are used during the growing of Spirulina. They are cheap and harmless components found everywhere in nature.

Sodium Carbonate:
Na2CO3, (AU$460/tonne) soluble in water and very slightly soluble in alcohol. Pure sodium carbonate is a white, odorless powder that absorbs moisture from the air, has an alkaline taste, and forms a strongly alkaline water solution. It is one of the most basic industrial chemicals.

Sodium Nitrate:
NaNO3, (AU$500/tonne) a colorless, odorless crystalline compound that closely resembles potassium nitrate (saltpeter or niter) in appearance and chemical properties. It is soluble in water, alcohol, and liquid ammonia. Sodium nitrate is also called soda niter or Chile saltpeter. It is found naturally in large deposits in arid regions of Chile, Peru, Argentina, and Bolivia as caliche, a crude, impure nitrate rock or gravel. Natural deposits are the major source of sodium nitrate; it is also obtained in small amounts as a by product of chlorine production by the nitrosyl chloride process, in which sodium chloride (common salt) is reacted with nitric acid. Sodium nitrate is used in making potassium nitrate, fertilizers, and explosives. It was formerly an important raw material for the production of nitric acid.

Potassium Sulfate:
K2SO4, (AU$500/tonne) colorless rhombic or hexagonal crystals; soluble in water and insoluble in alcohol; used as a reagent, in medicine, and in the manufacture of glass. Fertilizer for agriculture.

Plant tanks

The tanks that Spirulina grow in have an optimal depth of 50cm. They are constructed using plain metal framing with biofriendly plastic to retain the water. Concrete pouring is not necessary, leveling of the ground is. Ponds are very cheap and can be added quickly and without major impact on the environment. Each pond has a mechanical agitator. All these costs have been included in the overview at the beginning of this chapter.

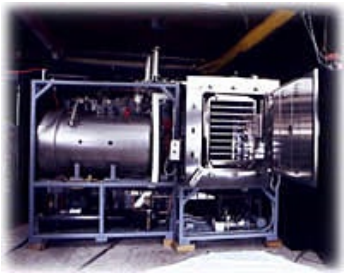
In the plans for the building two types of tanks are used. Large rectangular ones and long narrow ones. They are among the wealth of forms possible for the tanks. The tanks need to have a pond area of at least 22.000 $m^{2,}$ but in the plans 30.000 m^2 is allocated. This includes the already existing tank.
The optimal land coverage that the tanks would have is an area of about 150 by 150 meters, however, a tank this size would be too big, therefore it is split up in smaller tanks, making them less space-effective.
As space does not seem an inhibiting factor, I have been generous with the positioning and dimensioning of the tanks. The plant can be more compact if needed.

The tanks receive their water from the Solar desalinators. The Reverse osmosis plant that is proposed is only used to further desalinate the water for entry into the pipeline. The solar desalinators output their water into the moat that surrounds the complex, preventing unwanted visitors to access the terrain. From the moat the water is stone-filtered and entered into the bassins. The additional chemicals are then added into the tanks directly.

Freeze dry & packaging machines

This equipment can be supplied by Virtis, an American company dealing through Crown SCI in Perth. We also received all the information on Spray drying equipment from Niro Australia. The spray driers are cheaper, but use heat to dry the product which can damage it if applied incorrectly. Niro Australia has experience with successful Spirulina drying, and their proposals are based on their experience. A complete tailored document

Spirulina as it is sold, and it's algae-sister, Chlorella. Chlorella can also be grown just as easy as Spirulina, but has different nutritional value, and is less in demand.



A Virtis Freeze Drying machine

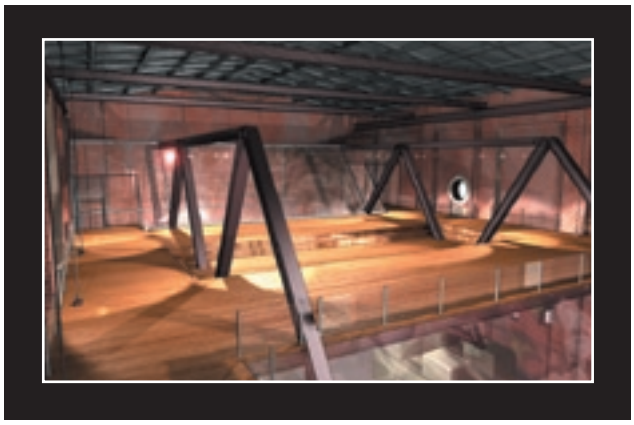
about the machines can be supplied.
The cost of machines for a larger factory will be relatively less than for a small plant. Crown SCI can also supply tablet stamping machines.
The covered area of the plant only needs to be 180 m^2, considering the large room of the pumpstation is considerably larger, there is plenty of space for the lab and storage.

The machines are big, but fit inside the space allocated to the machines under the proposed mezzanine. They are controlled by computers, and need almost no manual labor. They are energy efficient, and environmentally friendly.

The pumpstation and Factory Design Brief

In this section requirements for the factory and plant will be discussed in short. The outcome of this design brief will be visible in the design proposal offered to the Shire of Merredin together with this document. Discussion of the actual design is out of the scope of this document.

What is needed?



The factory mandates a covered area of 180 m^2. The old pumpstation with more than 550 m^2 being discovered as the ideal site for the plant leaves us with a lot of free space. Consideration should be taken into assessing the 180 m^2 requirement. This space would be covered by a small office and all machinery and a small storage area. The brief as planned below allows for a more royal assignment of space, a plant which has more appeal to both public and the direct involved, more space to deal with the preservation of the somewhat awkward objects residing in the pumpstation, and a visitors centre with small kitchen and food preparation area.
Most importantly however the pumpstation provides a confident starting point for future growth.
The factory site needs to be completely sealed off from the outside air, and the surfaces touching the air in the factory site should be treated to be allowed to serve as a food manufacturing area. This is code of practice.

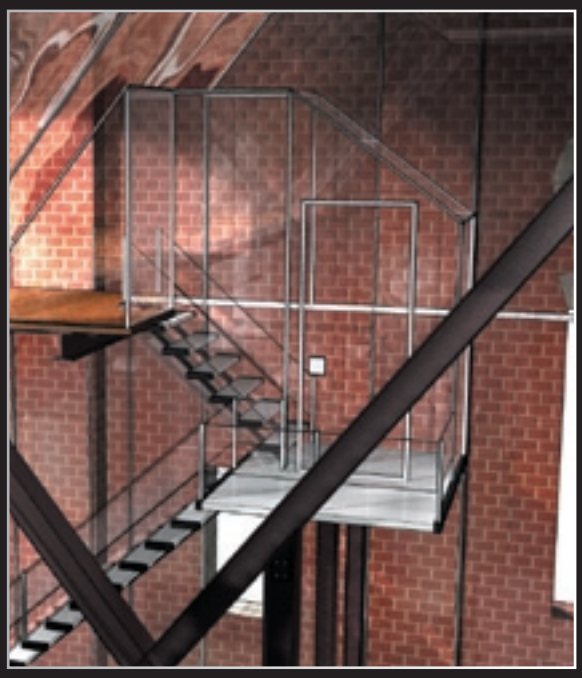
The pumpstation must accommodate the following:

- Completely sealed off Factory site, minimum size 180 m^2.
- Administrative space, minimum space 50m^2
- Conference area (can be integrated into administrative section)
- Storage space capable of sustaining growth
- Visitor centre including kitchen and function-area
- The necessary toilets and plant rooms.

What is the philosophy?

First of all the design will be driven largely by the plants function. Pragmatics receive the most of the initial attention. The factory after

all needs to work smoothly and efficiently. However dealing with the old pumpstation is not just a matter of pragmatics. It is a very distinct space and needs to be taken into consideration from day one in the design process. The pump station is a very powerful building in itself, and the task is to preserve this power. It will be executed by creating the factory inside the pumpstation without altering it in a way that is inappropriate to it, or could be irremovable. The new development will treat the building with minimal intervention, drawing on a number of analogies of temporal buildings, like tree houses, scaffolding and shanties. Furthermore highly transparent design will be applied to preserve the feel of the space as much as possible.
When untransparent items need to be applied, like large structural members, reference will be drawn to the existing structure and the structures of its time frame.
The design cues given to us by the existing building will be used and respected by the new development.



reference to a tree house

The Landscape

The landscape as currently resides around the pumpstation is wild growth bushland. The tanks demand leveling of the ground surface, but it is more suitable to the environment to pick sites for the tanks that are as level as possible. No big changes to the environment are made. The tanks are made easily accessible and some kind of light entry restriction for unwanted visitors will be applied, preferable one that does not interfere with the landscape too much. Tanks of different sizes for different purposes will be used, and oriented and placed in a functional way. The desalinators will be placed as close to Concreek.
The entry to the building will serve as an appropriate entry for the building as well as its new function, but will allow people fast access to the inside due to the climate.

The tanks will have a big impact on the looks of the surroundings. It would be highly preferable to use this as a visual feature. This will be done in conjunction with the ‘Arc Curve into Town’ project, and will determine the final placement of the tanks as visible from the road.

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Sources

New approaches for Plant Production in Arid Lands, A. Richmond, 1988, on Spirulina growing needs.

Spirulina: Food Of The Future, Royal Health Care, www.royalhealthcare.com

National Research Development Corporation, (NRDC India) supplier of plant details.

Virtis (SP Industries) and Niro Australia Pty on machinery

Agricultural Centre Western Australia on water composition

Spirulina Culture Using Reject Brine Water from Desalination Plants, (2000-present, Research team: J. Perret, M. Claereboudt)

Water Desalination, Prof. David Hasson, Government of Israel.