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PUMPS : a method of financially assessing groundwater pumping used to mitigate salinity in south-western Australia

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Pumps, A Method of Financially Assessing Groundwater Pumping Used to Mitigate Salinity in South-Western Australia

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Disclaimer

The contents of this report were based on the best available information at the time of publication. It is based in part on various assumptions and predictions. Conditions may change over time and conclusions should be interpreted in the light of the latest information available.

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Prologue

PUMPS is a spreadsheet model of the financial aspects of groundwater pumping systems used to reclaim salt affected land. The model was developed out of a need to give farmers and land managers the ability to assess the economics of individual or group ventures without the need for expensive preliminary investigations.

The model suggests that groundwater pumping is economic in cases where large areas are reclaimed per pumping bore system, where the landholder has a high nett income per hectare and has a high taxation rate. It is also an advantage to be able to dispose of the saline effluent without expensive siteworks, be able to reclaim the land quickly and use multi-well single bore pumping systems.

The model can be used both for an initial appraisal of the groundwater pumping method and for a detailed assessment of the longer term costs.

In the first stage the assessment will provide the information required to be able to justify contracting hydrogeological consultants to prepare a plan. In the second stage it will highlight the costs involved in developing and operating the project, and point towards objectives which must be met to ensure the project is economic.

In the future it is hoped that PUMPS can be upgraded to allow the user to add hydrogeologic data. It should then be able to help estimate the design of the pumping and disposal programme, the area able to be reclaimed and the speed of reclamation. However, the role of groundwater pumping and drainage is seen predominantly as a short-term alternative to the reduction of recharge by the establishment of sustainable land use systems based on an integrated catchment management approach.

1. Introduction

Deep drainage, using both groundwater pumping and tube or trench techniques were considered by P.R. George (unpublished data) to be of some benefit, however, usually such schemes were uneconomic. Therefore, it was concluded that even when significant areas showed the potential for reclamation, the problems associated with the disposal of the effluent and long term operating costs would outway any future economic benefits.

Since these studies were conducted (1978-1986) an increased awareness of the potential for groundwater pumping has developed. This has mainly been attributed to the work of private consultants and is currently unpublished. However, with the purchase of a rotary air drilling rig and the development of the wheatbelt regional drilling and geophysics programmes, it has been noted that in many cases groundwater pumping is a technically feasible method of salinity management.

The drilling of 250 observation bores and production wells in the eastern wheatbelt has revealed the existence of two materials which have the ability to behave as good aquifers, suitable for the establishment of groundwater extraction well systems. The information gained from the pumping tests also reveals that the transmissivities (5-10 mZ/day) and storage co-efficients (0.01-0.0001) of predominantly semi-confined aquifers (George 1989a), lend themselves towards the effective drawdown of large areas from bores with low pumping rates (50-100 kl/day/bore). Modelling of the existing pumping test data suggest that significant watertable drawdowns (0.5-1.5 m) are possible from distances of 100-1000 m from the production bore (George 198gb).

Favourable hydrogeologic characteristics of aquifers are not always likely to be found in required locations. Irregularities in the weathering sequences, bedrock profile variability and origin, can lead to a large degree of spatial variability in both the transmissivity, hydraulic conductivity and storage co-efficients of the aquifers. This in turn results in the predicted drawdowns achieved by the modelling being an overestimate, since barrier-boundaries are often encountered.

Other difficulties experienced are related to the quality of the discharge waters which often range from 10,000-50,000 mg/L (TSS). Disposal of these waters through non-saline areas downstream is likely to lead to increased recharge and soil salinisation. However the disposal into nearby playa-lakes may provide an option for disposal, although it should also be recognised that the lake may change its status from being a groundwater discharge to recharge area.

The changing nature of Soil Conservation funding and tax concessions has also led to drainage programmes being able to be claimed as 100 per cent tax deductions in the year of expenditure (Anon 1989). In years of recent high farm income this has provided an added incentive for farmers to attack their land degradation problems.

1.1 The Development of Pumps

In order to be able to offer farmers considering a large investment in a groundwater pumping scheme, Michael Lowe (previously the Rural Economist at Merredin) and I designed a computer based economic analysis programme to indicate whether such a venture would be profitable or not, and if so, over what timescale. The following notes are designed to allow the users of PUMPS to be able to understand the assumptions on which it is based and be able to adequately operate the model.

An example of the input data structure is given in Appendix 1 and should be referred to while reading this report.

2 The Operating System

PUMPS is a spreadsheet programme which runs on an MSDOS 3.1-3.3 operating system on the LOTUS-123 programme. It can be run on most IBM compatible personal computers. PUMPS will fit on one 5.25 inch floppy disc and presently has a size of 280 kilobytes.

2.1 Beginning PUMPS

After installing PUMPS and loading the programme (Lotus 123) onto the computer, call up Lotus 123 and select the main menu programme of PUMPS which is called MI4PUMP.WKl. This loads the programme and prompts the user (after a period of 40-60 seconds) with a general introduction to the programme. Make sure the programme files are on the same directory being used to the default directory of the particular user. Salarian and McFarlane (1987) outline an introuduction to LOTUS 123 spreadsheets and can be referred to for additional information.

After four introductory pages the user is asked to either select an option; review current data, print current data or quit to the system. However, in most cases select is chosen.

The screen then appears with the options of:-
1. Conventional pumping
2. Solar pumps
3. Airwell pumps .... enter selection.

Select the appropriate pumping option (in most cases ..1) and press return. After a period of approximately 10-15 seconds the section under conventional pumps is displayed and brief comments made. The prompt then asks the user to press return.

The evaluation section, or final analysis page will appear with the options to choose the initial assumptions, final economics (evaluation) of your data set (only relevant if you have already loaded the data and saved it previously) and the ability to move around the cashflow section. This can be used to modify the economic analysis to a greater degree than the menu driven system currently allows. Return will send the user back to the options system to again choose one of either the conventional, solar or airwell options.

In mosts cases the assumptions section is chosen so that new data can be analysed. Once selected a series of secondary options are available. They are the drilling (drill), power, (1 and 2), site, pumps, reclamation time-scale and general assumptions sections. Select drill to begin the analysis.

In all of the following sections alterations can be made to the highlighted numbers by placing the cursor bar over the number to be altered and typing the change required. Press the return key and the new highlighted number will appear.

3.0 PUMPS – Assumptions Used to Run the Model

3.1 Assumptions for Drillings Costa

On this page the user is asked to supply information on the number of bores required, the total depth of the bores and the appropriate drilling costs per metre.

The number of bores required will depend on the selection of the type of pumping system required. Single bore systems with one pump in each borehole are needed for achieving working drawdowns of greater than 8-9 m. Multipoint well systems (several bores and one pump) can be used where drawdowns of 8-9 m or less are required. This is a cheaper option. It should be remembered that when PUMPS later asks for the number and costs of pumps used, the default should be changed so as to only charge once for power.

As a guide to the number of bores required, the available information at present suggests that 1-3 multiple well-single pump systems are required per 100 ha to be reclaimed. This is based on a series of 3-5 wells connected to a surface mounted, electric (or diesel) pump. In the case of single well-single pump system the number required may be of the order of one bore per 10-20 ha to be reclaimed.

It should be noted that these estimates are simply “best-guesses” based on available information and are related to “valley floor” systems which include both permeable sedimentary and saprolite aquifer systems. To be effective the transmissivity of the sedimentary and saprolite aquifers should be high while storages co-efficients should be low to achieve the optimum drawdown at the greatest distance possible from the pumping wells.

The depth of bores required will depend on the selection of the multi-well or single well systems. In the first case minimum bore depths of 10-20 m are suggested, while in the second, depths of 30-40 m are considered appropriate. In the later case the bores should be installed into the bedrock to a depth of 5-10 m and screened over bedrock, the saprolite and sedimentary systems using appropriate screen, aperture and filter pack selection criteria (Driscoll 1986).

The cost per metre will be dependant on the contractor used, casing choice, depth drilled, screen and development technique chosen and sundry drilling and drillers costs.

It is suggested that quotes be obtained as the drillers often quote the cost per metre ($30-100 p/m) and do not include some of the above charges that may actually increase costs to $300-500 per metre.

There is usually a need to install observation bores to monitor the effect of the pumping programme and determine whether or not the watertable is being lowered over the designed reclamation area. It is recommended that observation bores be initially placed radially from the pumping wells at distances of 30, 100, 500 and 1,000 m. In this case, the option requires 16 observation bores, drilled to between 5-10 m deep (with the deep ones closest to the pumping bores).

Drilling costs are reduced for small diametre, shallow holes, however, once again quotes should be sought to allow the calculations to be based on reliable estimates. In many cases, fewer observation bores may be required, however, until sufficient data is obtained, the maximum requirement should be fulfiled.

Once the appropriate changes to the page have been made press the ~ key to calculate the total drilling costs and check that they are equal to the estimates quoted. Press the page down key to continue.

3.2 Assumptions for Power Costs

In the first section PUMPS asks the user to determine the costs needed to bring power to the site by calculating the distance of power lines required, the number of transformers appropriate and also include other costs such as the connection charge. The cost of supplying power, per kilometer, should be determined by contacting the State Energy Commission of W.A. (S.E.C.W.A.). They will also be able to quote on the current energy cost per kilowatt hour.

In the second section PUMPS asks the user to select the power rating of the pump being considered for the particular situation required. Pump capacities will probably range from 0.35-1.5 kilowatts. The energy needs will vary as suggested above and should be determined in consultation with the pump manufacturers or retailers and S.E.C.W.A. Press F9 to recalculate the page. Press the page down key for more power assumptions.

The power assumptions section on the following page indicates the options available to determine power costs based on the annual running requirements. In most cases there will be no need to reduce the operating time to less than 24 hours a day or from pumping over the 365 day period. In these situations the default situation will be valid.

The annual power cost totals should be the related to the costs per pump (addressed on page 1 of the model drilling costs), and not the number of drill-holes. The selection can be ammended in the section headed capital costs of pumps.

Press the ~ key and check the calculations then page down to the next section.

3.3 Assumptions for Site Coats and Disposal

In the section under the heading site costs the programme PUMPS gives the user the option to include all of the miscellaneous initial capital costs not prompted by the model.

The disposal of the saline effluent from the bore network should initially be varified as a legal and environmentally sound option for the particular site before any further work is conducted. There are presently six Acts/Laws which regulate landholders causing land degradation or changing the natural flow of water in a catchment. In some areas issues relating to water supply catchments are valid and increasing stream salt loads is illegal. The relevant Acts/Laws and administrative authorities are the:-

1. Soil Conservation Act* (Dept. of Agriculture)
2. Land Drainage Act (W.A.W.A.)
3. Country Areas Water Supply Act* (W.A.W.A.)
4. Effluent Control Act (E.P.A.)
5. Environment Protection Act* (E.P.A.)
6. Common Law* - (Federal and State Governments).

 * Most relevant Acts/Laws controlling the wheatbelt areas.

Advice should be sought from the Commissioner of Soil Conservation if there is likely to be any degradation or if a dispute arises between landholders. The Department of Agriculture and the Environmental Protection Authority can also be requested to provide a field inspection and advise on disposal options.

Given that disposal is both legal and environmentally acceptable the model requires the user to select one of either the pipeline, or evaporation basin options. If no disposal works are needed (following inspections and approval) place zeros in the appropriate places. In the case of the pipeline being selected it is likely that the water would be pumped or gravity fed from the point of extraction to a suitably large salt lake or saline drainage line. In the second case the saline drainage lines should preferably be those which have been described as the ancient river systems and are recognised by a number of salt lakes and meandering saline channels within the large groundwater discharge complex.

In the case that a gravity feed system is used it may be necessary to include the cost of a suitable sized storage tank in the miscellaneous section described above. If the water is to be pumped downstream the pump selection criteria and, therefore, kilowatt rating will need to be changed. Pump manufacturers and distributors should be consulted on this issue and also asked to advise on the pipe diameter required and cost per kilometre.

In the second case PUMPS allows the user to estimate the cost of constructing evaporation basins. No detailed guide is given here, as in the cases modelled to date the initial cost makes groundwater pumping, uneconomic. However, in order to estimate the likely costs required it is suggested that basin costs of $10,000-50,000 be considered in a sensitivity analysis.

The areas of the basins are likely to be of the order of 1-10 ha and must be included in the general assumptions section below. It must also be recognised that the basins are likely to be recharge areas and will reduce the potential area for reclamation. In cases where more detailed information is required contact the author, or other officers of the Salinity and Hydrology Research Branch. No benefit or economic adjustment has been given in cases in which the groundwater is recognised as useful water resource. However, the cashflow can be amended to take this into account.

3.4 Assumptions for Capital Coats of Pumps and Repairs

In this section the user is asked to supply information on the number and capital costs of the pumps used, repair costs and a replacement period. In most situations pumps will cost of the order of $1,000-$2,500, repairs should be at least 5% of the capital cost of the pump and the pump considered to have a life of 5-20 years. In some cases it may be advisable to have a spare pump as periods of long pump failure will cause significant amounts of water level recovery and may restore saline conditions.

3.5 Assumptions for the Rate of Reclamation per Year

The rate of reclamation is dependant on a wide variety of soil physical, hydrologic and agronomic factors. The model asks the user to estimate the timescale to reclamation, which is many cases maybe as described by the standard format. Again it is suggested that the user conducts sensitivity analysis on this section, using a range of 3-10 years as the basis for full reclamation (100%).

The percentage reclaimed can either be interpreted as the percentage of the site reclaimed or the percentage of the final nett production figure (Gross margin per hectare) of the farm used in the evaluation section below. To key in the estimates required follow the instructions on the page.

Press page down for more assumptions.

3.6 General Assumptions

In the general assumptions section the final costs, constraints and guidelines are presented in order to take account of issues such as preliminary investigations, future impacts of the rate of encroachment and taxation concessions.

Preliminary investigations are always likely to be required prior to contemplating the design and implementation of a groundwater pumping scheme. In the case of the model presented, it is appropriate to use PUMPS as both an initial indication of the likelihood of success of the project (design stage) and a means of analysing all of the major costs (implementation and assessment stage). In this capacity the likely costs of conducting a site investigation, using available hydrogeological consulting companies may range from $5,000-20,000 depending on the degree and complexity of the investigation. Again it is suggested that a range of costs be used to determine the sensitivity of the assumptions being investigated.

The range of functions and investigations available from the consulting firms will depend on their hydrogeological experience, staff expertise and structure. The suggested minimum requirement for a satisfactory investigation should include a regional survey of the available existing hydrological data, site geophysics to determine likely geologic controls, drilling and pump-testing and finally computer modelling to predict the longer term effect of the works. Other project works which maybe necessary are, an Environmental Impact Statement (EIS) on the effects of various disposal techniques, an economic analysis of the operations, a final report explaining the history and rationale behind the conclusions and a monitoring programme to follow the project through to the stated reclamation scenario.

The rate of encroachment per annum section is presented as an option to determine the future advantages of the pumping scheme for currently productive land. This assumes that the saltland is still developing and that the rate of spread can be accurately estimated. The section also assumes that the rate of encroachment has a linear relationship with time. However, it is controlled by the following data entry requirement on the limit to the affected area. The limit to the total salt affected area is equivalent to the capacity of pumping system, in that the use of this section is only valid if the area of influence of the bores if greater than the current salt-affected area.

In the next section the model asks for the number of hectares required for the construction of the evaporation basins since the model subtracts this area from the total reclaimed. At this stage no account is made for the negative effect of recharge from the basins and longer term management costs, however, both can be included by adding appropriate data directly to the cashflow section.

The second last input is designed to allow users of PUMPS the option to be able to manipulate the costs previously calculated as a means of rapid sensitivity analysis designed to cope with what if questions. It can be used for example to ask, what if the total costs were 200% of the initial estimate?

The final section is a statement of the ability of the land manager to be able able to write of f the works as a taxation deduction in the year in which they were incurred.

At this point the user of PUMPS will have put in all of the basic information needed to move on to the evaluation section. However, before pressing the "ALT M" keys simultaneously to move to that section it is worth pressing F9 to recalculate all of the above and then press the page down key again, to see the final breakdown of the costs selected for the model run. At this point the user can also press "ALT M" to bring up the menu.

The menu will prompt the user to choose one of four options. In most cases select the review key by either using the space bar or arrow keys. Once the selection has been made press the return or enter keys and select the evaluation page in the same manner.

4. EVALUATION

The evaluation section also requires the user to input data. However, in this section the data requirements are primarily related to the four key factors (4.1-4.4) affecting the eventual economic viability of the venture.

4.1 Area Reclaimed

Select the area which the designed pumping system has been estimated to be able to reclaim. As it is difficult to be precise about the number of hectares to be reclaimed, it is strongly recommended that a sensitivity approach be used. However, if no data is available, try 10, 20 and 100 ha as starting points depending on whether the salinity is caused by a hillside seep, small valley floor seep and large valley floor seep respectively.

4.2 Real Discount Rate

The real discount rate is defined as the difference between the interest charged on borrowings and the inflation rate. In the model 5 per cent is chosen despite the fact that this is well below the current real interest rate (A. Peggs pers comm. 1989). However, since PUMPS is evaluating and investment over a long term it is appropriate to use a real rate of interest which is likely to prevail over that period.

4.3 Gross Margin ($/ha)

The gross-margin estimate is defined from a long term (about **10** year) average of the farming enterprise being reviewed. The range of values suggested for this section will probably range from $10 ha/yr to over $100 ha/yr. In cases where little is known about the production figures, best estimates and sensitivity analysis is again justified.

Other computer aids such as ZACK and MIDAS may be considered to determine the most appropriate estimates in cases where precision is required. The Division of Agricultural Economics and Marketing (W.A. Department of Agriculture) can be consulted for advice when necessary.

4.4 Marginal Tax-Rate

The marginal tax rate is that rate which the farmer who is considering the operation will pay in the year the works are conducted. The maximum rate is currently $0.49, however, the current Federal Government will reduce this rate to $0.47 as of 1 January 1990. This figure will influence significantly the economic profitability of the operation as soil conservation works are 100% tax deductable in the year in which they are undertaken

4.5 Land Value

The land value section is included to show the production losses of saltland in the terms of the capital lost if it assumed that salt-affected land has no economic value. This assumption may no longer be valid with the advent of more productive halophyte species for saitland agronomy systems. However, it should also be noted that saltland has a negative effect on farm values and resale potential.

4.6 Nett Present Value

The nett present value technique has been used as the basis of the economic model to provide the framework on which to build PUMPS. The table located below the initial assumptions lists the economic returns or losses from the system over the period of 0-75 years. The user can select any combination of years over the period by placing the cursor on the highlighted numbers, however, in most cases the default periods will be adequate.

To the right hand side of the years column, the discounted cashflow figures are presented. If the numbers are in brackets the scenario being reviewed is not profitable and if the values increase with time the option will never be economical. Below the table the year in which the discounted cashflow breaks even is given. However, if it does not become economical over the 75 year period the result will say >75 years. In cases where the option may be profitable in the future a number between 1-75 will appear indicating the year in which profitability is achieved. In terms of the applicability of the model data it is considered that if the breakeven point is less than about 20-30 years the venture should be given more thought, however, after this point long term running costs, bore replacement and many other costs may make the venture uneconomic.

The figures in the capital section are simply the nett present value figures of the area reclaimed multiplied by the land value.

4.7 Concluding and Printing the Analysis

After arriving at an answer the user can opt to quit from the system or continue to alter the assumptions, specific parts of the cashflow or try an alternative form of pumping system. To move from the evaluation section press “ALT M’ again and choose the required option.

To print the results of the analysis, select print and follow the commands which ask the user to determine what parts of the model are to be printed. To graph the discounted caahf low type backslash, graph, name, use to bring up Plot 1, which is a skeleton of the plot of the last modification to the cashflow.

5. CONCLUSIONS

PUMPS is an attempt by the author to give landholders and officers of the Department of Agriculture a framework on which to be able to assess the likelihood of groundwater pumping providing a management option for regional groundwater induced salinity problems.

The model is only to be used as a guide as it is not designed to be a comprehensive review of groundwater pumping related economics. Users of the model are actively encouraged to provide comments on its applicability and make modifications where appropriate.

The most beneficial use of the model will be to those users who have a sound knowledge of the assumptions on which it is based and who use the abililty of its structure to perform sensitivity analysis on the range of assumptions considered appropriate.

6. ACKNOWLEDGEMENTS

The author would specially like to thank Mr M.J. Lowe for his assistance in the construction of PUMPS. Mention should also be given to members of the Division of Agricultural Economics and Marketing, especially Mr Alan Peggs who reviewed the model. Mr H. Borg (W.A.W.A.) and officers of the Division of Resource Management also reviewed the final draft.

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APPENDIX 1. An example of the format of the spreadsheet

PUMPS

Version 1. 1988

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This model has been developed on spreadsheets to assist land managers and rural finance agencies derive the paremeters that influence the economic feasibility of establishing bore-pumping systems to reclaim salt affected land.

Data for the analyses comes from hydrogeological investigations by the Western Australian Department of Agriculture in the Eastern, Great Southern, and Northern Advisory districts. Other information has been obtained from hydrogeological consultants, the S.E.C. and pump manufacturers and distributors.

Aquifer yields range from <10-300 cubic metres per day from holes drilled into weathered Archaean, granitic or gneissic rocks to depths of 10-40 metres. Pump tests have been conducted on eight sites and are considered to be representative of conditions found in the wheatbelt.

A regional drilling programme identified the existence of extensive saprolite and sedimentary aquifer systems capable of manipulation by either conventional, solar or air-driven pumping methods.

The model results are to be used as a guide only. Assumptions used to define the model have been carefully compiled. However, no reclamation programme should be undertaken without preliminary site investigations by a professionally recognised and reputable consultant.

Three pumping systems have been reviewed:-

1. **CONVENTIONAL**:

   Standard borehole submersible pumps operated by mains power. (This section can also be used to assess conventional, shaft-driven and centrifugal systems.)

2. **SOLAR**:

   There are two options here - Standard and Advanced. The basic difference between the two is that the Advanced system provides power 24 hours per day though an energy storage system while the Standard option is restricted to pumping in daylight hours only. The cost of the Advanced system makes it well out of the reach of the ordinary land user at present.

3. **AIRWELL**:

   Airwell pumps are manufactured by A.K. Brown (Bruce Rock) and are compared as an alternative to the above. They are reviewed with permission of the manufacturer.

*** NOTES FOR ADVANCED SOLAR PUMPING SYSTEM**

If bore yields are to be maintained at a constant rate, an energy storage system is required. In addition to all of the costs incurred by the standard system there is the added costs for additional energy storage.

To calculate the cost of the storage system the equation used is:-

Pump capacity (W/hr) x energy constant per W = Cost
where the energy constant is $125**

(** provided by BP Solar Aust., Sydney)

eg: if the pump is rated at 1.1 kW/hr
then cost of the storage system alone is 1,100 x 125 = $137,000.

With existing technology and price structure this option is economically unsuitable for the average farmer.

CONVENTIONAL PUMPS (last update August 1988)

Groundwater extraction techniques differ depending on whether the Total Working Head (T.W.H.), which is approximately equivalent to the maximum drawdown, is less than or greater than 8-9 in. When the T.W.H. is greater than 8-9 m, submersible pumps are usually used, however, where the T.W.H. is less than 8-9 m, electric or diesel surface mounted pumps (on spear points or tube wells) can be used.

In the following analysis no value has been given to the discharged waters. In cases where the quality of the water is less than 2200 mS/rn it can be used to supplement existing stock supplies and its value can be included in the cashflow section.

PRESS “Return” TO CONTINUE

DATA USED TO RUN PUMPS

1. ASSUMPTIONS FOR . . . DRILLING COSTS

1. **Pump Bores**

Number of bores	2	(equals number of pumps required unless specified below)
Depth of bore	35	
Cost per metre ($)	$75	
THEREFORE drilling cost is:	$5,250	

2. **Observation Bores**

Number of bores	6
Depth of bore	5
Cost per metre (5)	$30
THEREFORE drill cost is:	$900

2. ASSUMPTIONS FOR . . . POWER COSTS

1. **Capital Costs**

Power lines	$9000	Distance (km)	**3.0**	Cost ($/km) $3000
Transformers	$1000	No. units	**1**	Cost ($/unit) $1000
Connection Charge	$200	Cost/unit	**$200**	
			$10,200	

2. **Energy Costs**

Pump capacity	**1.1**	kilowatt hour
Energy cost per unit	**15.5**	cents per kilowatt hour
THEREFORE power cost is:	0.17	per hour
No. of hours per day	**24**	hours pump running
No. days per annum	**365**	day pump running
THEREFORE running time is:		760 hours per annum per pump
Annual supply charge is:	**$73**	per transformer

THEREFORE annual cost of power for pumps (est.) is: $3,060

3. ASSUMPTIONS FOR . . . SITE COSTS AND DISPOSAL

1. **Site Costs**

Total of all miscellaneous costs (fencing etc): **$1,000**

2. **Disposal**

Method 1: Effluent to some “disposal site” eg. existing saltiake,

Distance to site	**3** km
Cost per kilometre	$**1,000**
THEREFORE total cost is:	$3,000

Method 2: Evaporation basin (total of all costs - not detailed here).

$**0**

THEREFORE estimated total site and disposal cost is: $4,000

4. ASSUMPTIONS FOR . . . CAPITAL COST OF PUMPS plus REPAIRS

1. **Capital Cost of Pumps**

No. of pumps	**2**	(as relevant from Section 1)
Cost of pumps	$1,000	
THEREFORE total capital cost is:	$2,000	

2. **Repairs**

Repairs	5% of capital cost
THEREFORE total repair cost is:	$100 per annum.

3. **Replacement**

Replacement after:	20 years

5. ASSUMPTIONS FOR . . . RATE OF RECLAMATION

Cells are formatted so enter percentage as 0.1 for 10%, 0.2 for 20%

YEAR	% RECLAIMED
3	**0%**
2	**10%**
3	**20%**
4	**40%**
5	**55%**
6	**80%**
7	**85%**
8	**90%**
9	**95%**
10	**100%**
11	**100%**
12	**100%**
13	**100%**
14	**100%**
15	**100%**

6. ASSUMPTIONS FOR . . . GENERAL

Consultant fees (including preliminary inspection, geophysical surveys interpretation and siteworks): $5,000

Rate of encroachment p.a. if no pump	0 ha per year
Limit to total area affected by encroachment	0 ha
Disposal of water requires	0 hectare evaporation basin

Annual running costs are incurred continuously.

Costs incurred at	100% of estimates

Soil conservation works written off over 1 year.

7. EVALUATION SECTION (1 Jan, 1980)

AREA RECLAIMED **20** NOTE: Press F9 to recalculate

REAL DISCOUNT RATE **5%**

NETT INCOME (S/ha) **$200**

MARGINAL TAX RATE **$0.20** cents per dollars

LAND VALUE **$300** assumes that salt affected land = $0/ha

Nett Present Value		**Capital**	**Total**
10 years	($54,933)	$6,000	($48,933)
15 years	($61,643)	$6,000	($55,643)
20 years	($66,618)	$6,000	($60,618)
25 years	($69,408)	$6,000	($63,408)
50 years	($72,298)	$6,000	($66,298)
75 years	($70,892)	$6,000	($64,892)

Year discounted cashflow breaks even >75 yrs.

NOTE: When Nett Present Value (NPV) = 0 scenario is: breakeven.

Example cashflow section for the first 5 of 75 years.

1. **COSTS** (Total $)

Year	**0**	**1**	**2**	**3**	**4**	**5**
Establishment	$27,350					
Annual running costs		$3,160	$3,160	$3,160	$3,160	$3,160
Replacement - pumps		$0	$0	$0	$0	$0
Replacement - compressor		$0	$0	$0	$0	$0
Replacement - solar panel		$0	$0	$0	$0	$0
Opp. cost of Evap. Basin		$0	$0	$0	50	$0
TOTAL	$27,350	$3,160	$3,160	$3,160	$3,160	$3,160

2. INCOME

Year	0	1	2	3	4	5
Proportion of Max. Prodn		0%	10%	20%	40%	55%
Projected returns per hectare		$200				
THEREFORE Income generated ($)		$0	$400	$800	$1600	$2200
ADJUST for reduced encroachment						
Area saved (ha)		0	0	0	0	0
Value of production ($)		0	0	0	0	0
TOTAL INCOME ($)		0	400	800	1600	2200

C/F SURPLUS/DEFICIT	($27,350)	($3,160)	($2,760)	($2,360)	($1,560)	($960)
CUMULATIVE C/F	($27,350)	($30,510)	($33,270)	($35,630)	($37,191)	($38,151)

3. Amendments

Year	0	1	2	3	4	5
ADJUST for i on debit balance						
Interest rate used = 15.00%		($4103)	($4577)	($4991)	($5345)	($5570)
ADJUST for taxation benefit						
Tax saved on established cost		$	$0	$0	$0	$0
Tax saved on running costs		$632	$632	$632	$632	$632
Tax saved on interest		%821	$915	$998	$1069	$1116
Tax saved replace cap. items			$0	$0	$0	$0
AMENDED CASHFLOW (5)	($27350)	($340)	($5789)	($45721)	($5204)	($4791)
CUMULATIVE CASHFLOW	($27350)	($27690)q	($33479)	($39200)	($44404)	($49195)
DISCOUNTED CASHFLOW		($26356)	($31357)	($36064)	($40141)	($43716)