SALT BUYERS AND SELLERS MEET

Organised by: Indian Salt Manufacturers Association and Alkali Manufacturers Association of India

Location: Gandhidham, Gujarat. May 16/17 2008.

Optimisation of Production and Quality of Solar Salt from New and Existing Solar Saltfields using Brine Mass Balance Computer Modelling.

Roland Mottershead: CGV Pty. Ltd. Perth, Western Australia.

Kevin Wellisch: K F Wellisch & Associates Pty. Ltd. Perth, Western Australia.

In Association with: Salt Partners Ltd. Zurich, Switzerland.

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- Authors: Roly Mottershead

  Kevin Wellisch

EXPERIENCE SINCE 1960s’

DESIGN, CONSTRUCTION, OPERATION AND MARKETING OF SOLAR SALTFIELDS

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INDIAN SALTFIELD – MANUAL HARVESTING

Roly Mottershead assisting with Indian salt harvest

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1967 – 1972 Design, Construct, Operation, thru to First Ship

Dampier Saltfield Western Australia – Capacity > 3MTPA

- Development of new computer-based brine mass balance models.
- Optimise design , decreased capital and operating costs for new solar saltfields
- Improved productivity and quality at existing solar saltfields.

- Association with Salt Partners Ltd.
- One-stop option for clients.
- Optimises layouts
- Reduces capital and operating costs
- Secures operational control through brine chemistry and biology
- Optimises quality though effective washing technology

SOLAR VERSUS ROCK SALT

Free solar energy versus expensive thermal energy

No new significant areas available for large solar saltfields, excluding India

China forced to use vacuum salt from rock salt. Up to 10MTPA new vacuum salt volume in China in 2007.

- CHLORALKALI PLANTS
- DEMANDING HIGH QUALITY AND CONSISTENT QUALITY SALT
- AUSTRALIAN AND MEXICAN SOLAR SALT QUALITY STANDARD IN JAPAN, KOREA, TAIWAN AND INDONESIA
- LOWER QUALITY CHINESE AND INDIAN SALT NOT AN ECONOMIC OPTION

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TARGET SOLAR SALT QUALITY

Planned Specification of Project Product SPT			
Component	**Range**		**Average**
	% w/w basis		
	High	Low	
Sodium Chloride	97.794%	97.286%	97.540%
Moisture	2.526%	2.000%	2.284%
Calcium	0.026%	0.042%	0.034%
Magnesium	0.042%	0.026%	0.018%
Sulphate	0.125%	0.083%	0.104%
Potassium	0.020%	0.010%	0.013%
Insolubles	0.009%	0.005%	0.007%

- Brine mass balance models – methodology
- Step 1 – Site investigation
- Evaluate area available and estimate production target.

- Brine mass balance models – methodology
- Step 2 – Estimate losses from harvesting to shipment

Example of NaCl losses from harvest thru shipping – for one million tonnes per annum

NaCl passing through each activity accounting for losses.		
Activity	**Factor to account for losses**	**NaCl passing through**
	%	**tonnes**
As shipped		975,400
As crystallized		1,091,812
After harvesting	1.0%	1,080,894
After wet salt haul	0.5%	1,075,490
After washing	7.0%	1,000,206
After stockpiling	1.0%	990,204
After recovery and barging	1.0%	980,302
After transfer to ship	0.5%	975,400
Product shipped	1,000,000	SPT
NaCl content	97.54%	

- Brine mass balance models – methodology
- Step 3 – Estimate average long-term monthly and annual freshwater evaporation rates and rainfall.

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Typical Evaporation and Rainfall for Western Australia and Gujarat Areas

Typical Average Monthly Evaporation and Rainfall Rates in India and Australia						
	India			Australia		
Month	Evaporation	Rainfall	Net Evaporation	Evaporation	Rainfall	Net Evaporation
	mm	mm	mm	mm	mm	mm
January	154.57	0.11	154.46	368.90	36.20	332.70
February	150.80	0.00	150.80	301.00	56.10	244.90
March	185.40	0.00	185.40	299.15	55.25	243.90
April	190.54	0.00	190.54	232.50	13.10	219.40
May	225.17	0.00	225.17	172.05	51.55	120.50
June	202.65	95.76	106.89	124.50	47.75	76.75
July	148.27	162.56	-14.29	137.95	21.30	116.65
August	127.97	316.31	-188.34	173.60	12.50	161.10
September	155.69	141.24	14.45	237.00	1.80	235.20
October	164.76	0.00	164.76	310.00	1.40	308.60
November	161.48	0.00	161.48	337.50	2.30	335.20
December	156.99	0.00	156.99	370.45	4.15	366.30
Total	2,024.29	715.98	1,308.31	3,064.60	303.40	2,761.20

- Brine mass balance models – methodology
- Step 4 – Determine seawater density
- Range of densities may occur during annual cycle.


25.04.2006

- Brine mass balance models – methodology
- Step 5 – Determine density of maiden brine feed to crystalliser ponds.
- Usually around 1.216 SG (25.8 ºBé)

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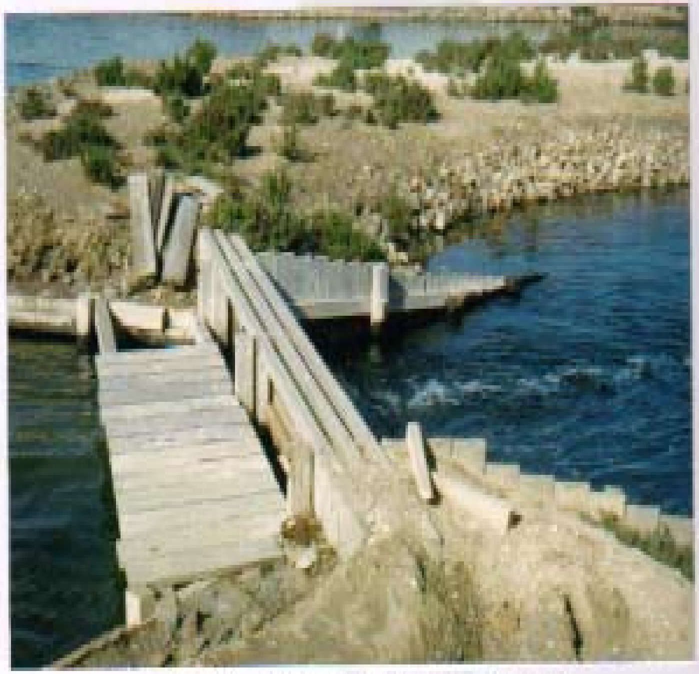
Typical brine transfer weir



ADELAIDE – DRY CREEK – BRINE TRANSFER WIER

- Brine mass balance models – methodology
- Step 6 – Establish density of bitterns discharge density
- Usually 1.25 SG (29 ºBé)
- Further recovery now practiced whilst maintaining quality

- Brine mass balance models – methodology
- Step 7 – Establish formulae for tracking major ions as brine concentrates
- Calcium, chlorine, magnesium and sulphate.
- Using Baseggio data.

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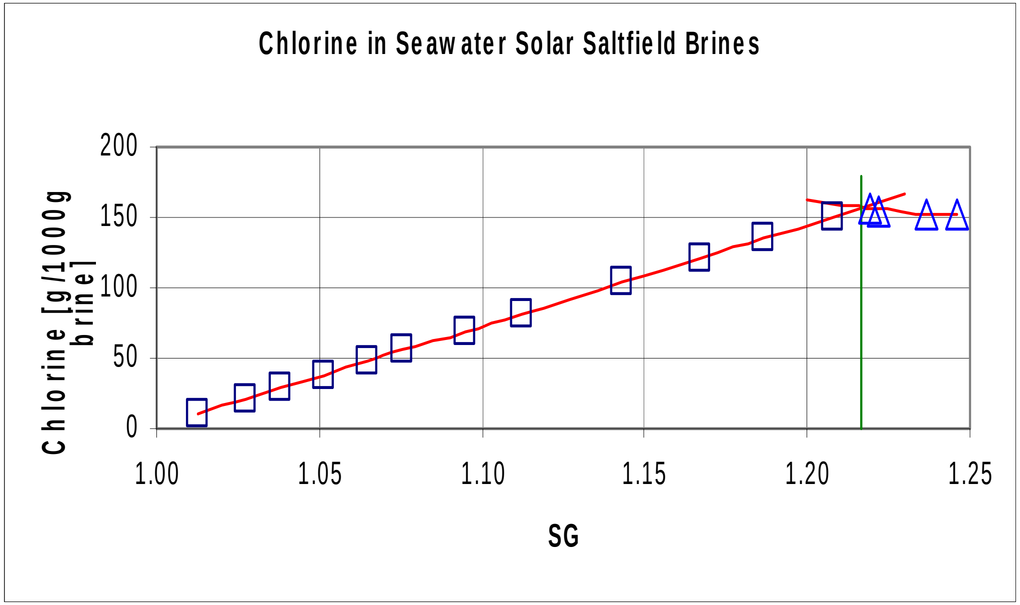

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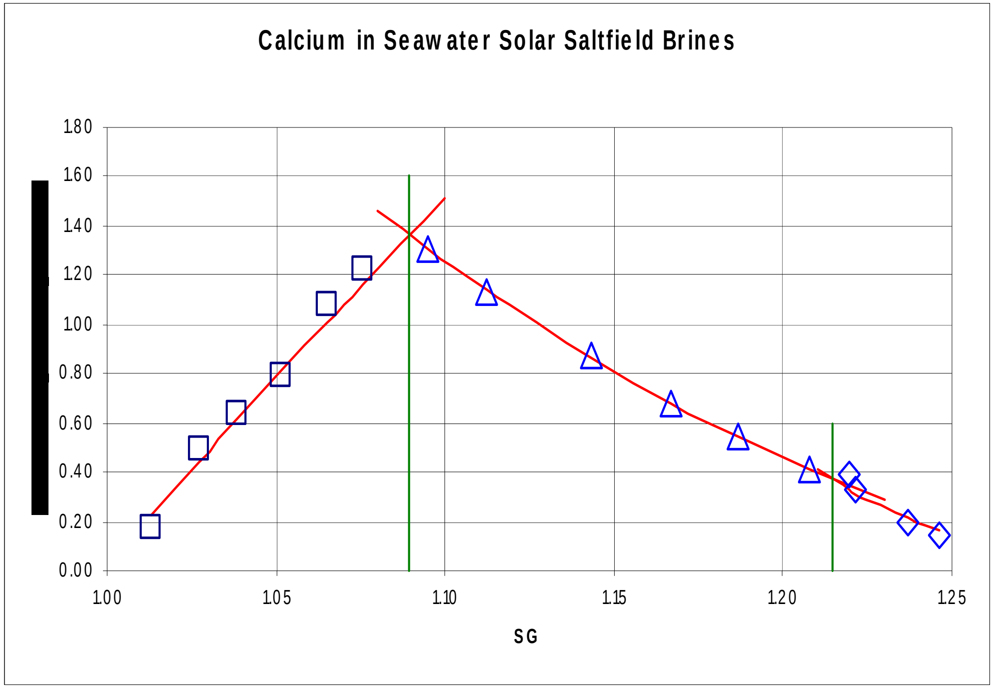

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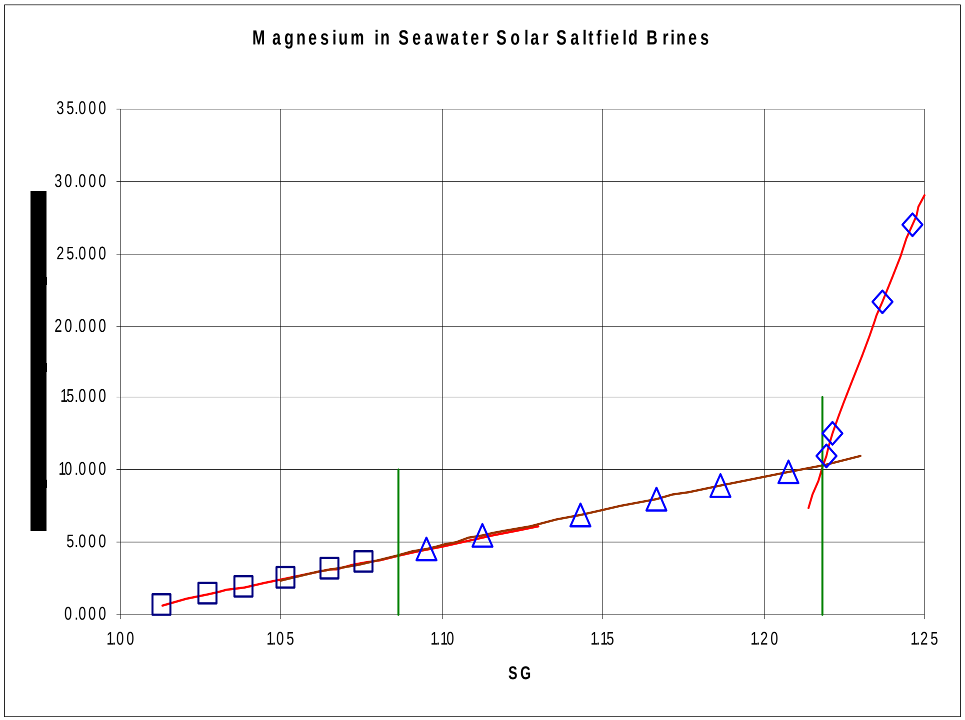

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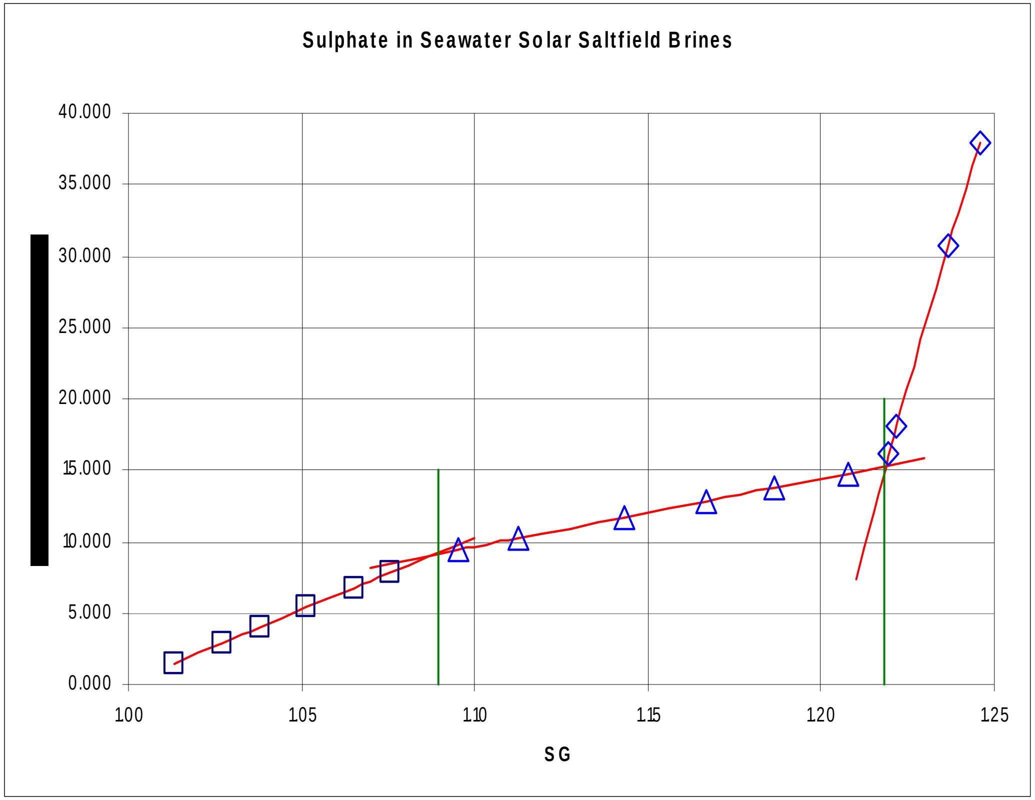

- Brine mass balance models – methodology
- Step 8 – Establish brine evaporation ratios over brine density range.
- Know-how by authors gained from data at operating saltfields

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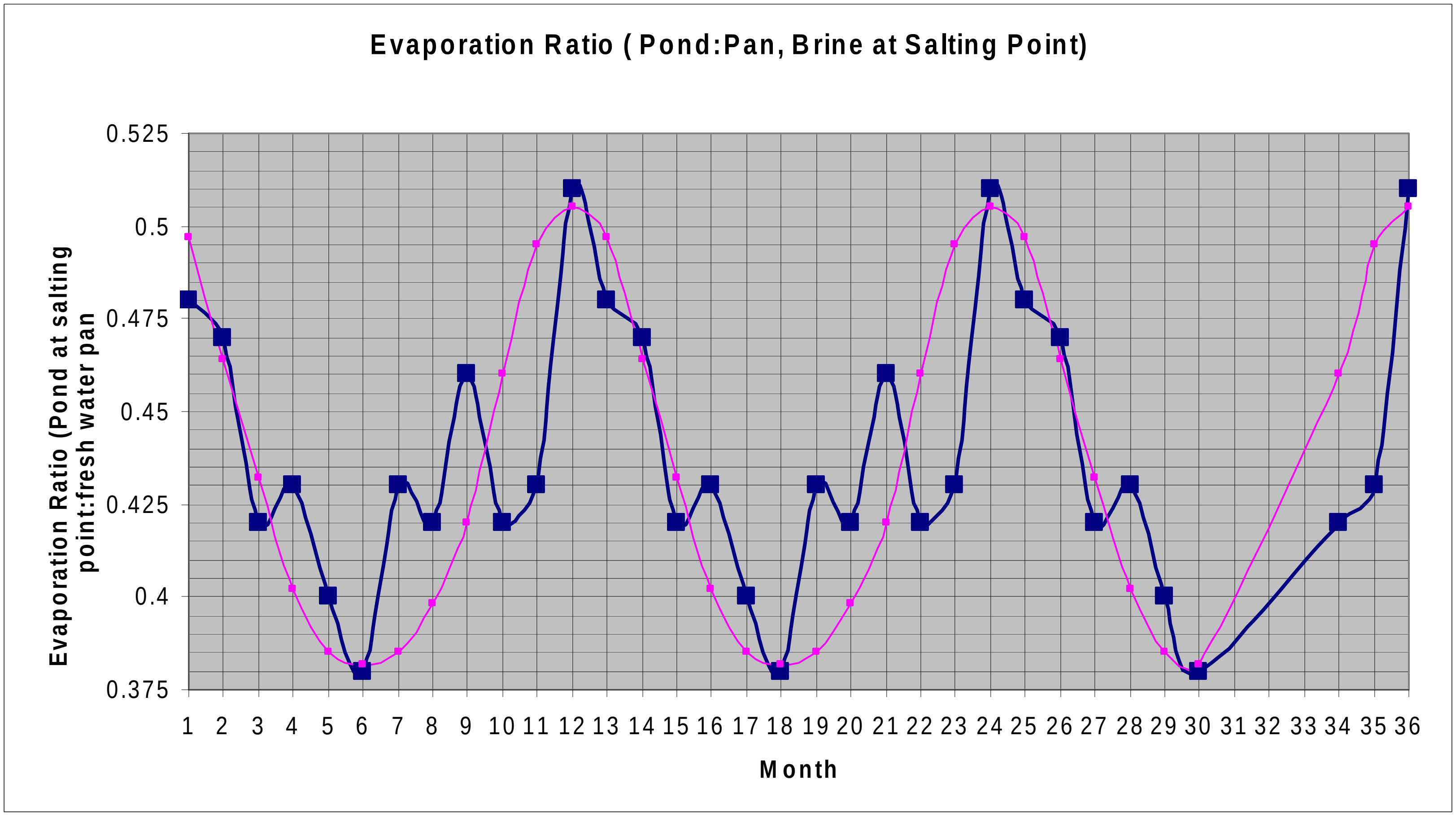


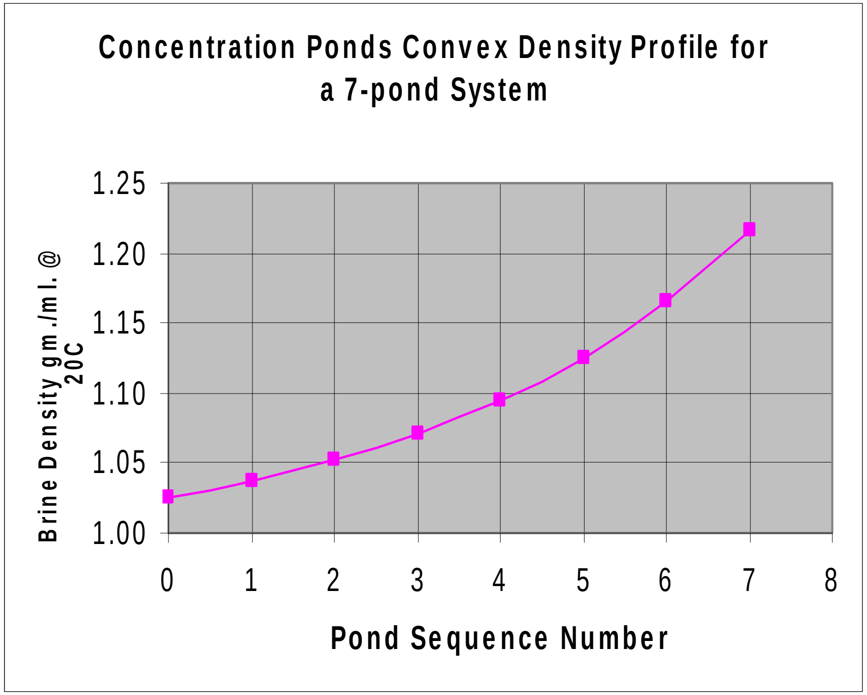
- Brine mass balance models – methodology
- Step 9 – Estimate any possible run-off into concentration pond system during rainfall events

- Brine mass balance models – methodology
- Step 10 – Fix number of concentration ponds
- Usually between 7 and 10. Economics and topography may influence final number.
- Chemical and biological control maintained

- Brine mass balance models – methodology
- Step 11 – Establish pond layout option for crystallisers
- Series preferred but topography may favour batch system.
- Usually now 2 ponds per series.

- Brine mass balance models – methodology
- Step 12 – Estimate vertical and horizontal seepage losses.
- Avoid poor vertical seepage loss areas or repair during construction
- Avoid horizontal losses through disciplined use of levee construction materials

- Brine mass balance models – methodology
- Step 13 – Select brine density profile for concentration and crystalliser ponds.
- This minimises area and maximises production


Concentration Ponds Convex Density Profile for a 7-pond System
Brine Density gm./ml. @ 20C
1.25
1.20
1.15
1.10
1.05
1.00
0
1
2
3
4
5
6
7
8
Pond Sequence Number

- Brine mass balance models – methodology
- Step 14 – Estimate the annual volume of seawater pumping
- This permits the model to be run to establish approximate pond areas required
- Use Baseggio data for volume.

- Brine mass balance models – methodology
- Step 15 – Run model and adjust seawater volume to suit required production.

- Brine mass balance models – methodology
- Step 16 – Adjust pond areas to suit topography, seepage areas, etc.

- Brine mass balance models – methodology
- Step 17 – Freeze pond areas and recalculate annual mass balance.

- Brine mass balance models – methodology
- Step 18 – Expand the mass balance model to provide monthly balances and brine flows.
- This requires estimate of monthly changes in brine evaporation rates at varying densities. Internal know-how.

- Conclusion
- Brine mass balance modelling as described has the following advantages:
- Optimal use of area
- Optimal design of pond system
- Reduced capital costs

- Operational control efficiencies
- High productivity
- Flexibility to adjust to changes in variables
- Continuity of high quality
- Reduced operating costs
- Options for further recovery of salt from brine and losses during handling

- Thank you and Mr Mottershead regrets his inability to present this paper personally.