

East End Mine Action Group (Inc)
(EEMAG INC)
East End, Mt Larcom. Q. 4695

**ADDITIONAL INFORMATION TO OUR PREVIOUS
SUBMISSION (DATED 14 DECEMBER 2010)
TO SENATE INQUIRY INTO
THE MANAGEMENT OF THE MURRAY-DARLING BASIN**

6 January 2011

The Committee Secretary
Senate Standing Committee on Rural Affairs and Transport
PO Box 6100
Parliament House
CANBERRA ACT 2600

Dear Sir / Madam,

Thank you for accepting this additional information to our previous submission (dated 14 December 2010) to the Senate Inquiry into the Management of the Murray-Darling Basin (MDB). We are lodging this under item (e) "*mining and gas extraction on the aquifer*".

- As Secretary of EEMAG, I respectfully request to be informed of and have the right of reply to any comments that may seek to discredit / undermine our claims; that are not published on the Senate Inquiry Website.

It must be mentioned that EEMAG Inc has NOT at any time sought for the East End mine to be closed down. We are seeking proper administrative justice for landholders affected by mine dewatering, and for mine dewatering to be required to be managed in proper compliance with environmental standards (including the principles and objectives of Water Reform/NWI – and where applicable the Water Act 2007). Although the Mt Larcom districts are not in the Murray Darling Basin, regulation of mine dewatering in Queensland in the MDB is all governed under the same culture and thus EEMAG's case is relevant to the MDBP enquiry.

Included below (beginning Page 2) are extracts from the Executive Summary of the Federally funded Mt Larcom Community Restoration Project Report (October 2003) (Consultant team leader Professor Brian Roberts) that gives a professional evaluation of EEMAG's situation. Quotes from Pages 48/49 of the CRP Report (beginning on Page 3) refer to evidence presented to 1995 Senate Select Committee and the CJC, with the comment there is evidence that the problem of 'capture' by mining companies has not been overcome. A CD of the 4

Volume CRP Report and hard copy of the Table of Contents will be posted to the Senate Inquiry, together with copies of FOI documents etc quoted from in our Submission of 14 December 2010 to substantiate our statements/claims.

A letter dated 28 November 2003 from the Project Leader for the Mt Larcom CRP Report, to respondents of the CRP Report states in part, quote: 'When compared to most reports, the present team's report may appear to use extravagant or emotive language, and may be more openly critical of government and industry than what has become the norm for consultants' reports.

It is important that all stakeholders appreciate that the present team is neither anti-development nor politically motivated. What makes this team different is that for a number of reasons each of its members have been willing to state honest opinions unimpeded by potential repercussions from influential respondents.' End of quote (My bold)(A computer copy of the letter attached.)

Pre-mining, the rural districts in the East End / Bracewell areas were recognised as zones with significant sub-artesian supplies that supported small scale irrigation. District records show that in 1980/81 there were 20^{1/2} small scale irrigators and that perennial creeks still flowed except in times of extreme drought when they fell back into permanent holes, but that in 2001 only 6^{1/2} irrigators remained (and that there was a loss of approx 30 km of perennial flows). This information is detailed in Attachment 17 Volume of Attachments for the Mt Larcom CRP Report.

Farmland in East End/Bracewell areas of Mt Larcom was broadly brushed by CSIRO in approx 1968 as Good Quality Agricultural Land. State Legislation was enacted to protect GQAL in 1992 but the required classification for East End/Bracewell areas was never done, presumably because the limestone resource was prioritised for mining. GQAL Map included in the Mt Larcom Community Restoration Project Report (2003) in the Volume of Attachments, as Item 3 in Attachment 16.

Please Note: I have attached a computer copy of the text of the Groundwater Resources Segment of the Mt Larcom CRP Report (which does not include the Maps and diagrams) as an important overview of the dispute on the technical assessments, reviewed by DI (Dingle) Smith, Emeritus Faculty, Australian National University, formerly Senior Fellow, Centre of Resource and Environmental Studies ANU)

MT LARCOM COMMUNITY RESTORATION PROJECT REPORT (2003)

Extracts from the Executive Summary

(A computer copy of the Executive Summary & Recommendations and list of consultants is attached.)

1. Funded by a \$100K grant from the Commonwealth Regional Solutions Programme, the Mt. Larcom Community Restoration Project sought to identify those factors contributing to Mt Larcom's economic decline and diminishing quality of life, and to recommend corrective actions.
2. The project team included regional development specialists from Cairns, Brisbane, Canberra, Adelaide, Mackay and Gladstone, all of whom offered their services at half their normal rates. Local landholders supplied accommodation and transport and organised local meeting schedules in and around Gladstone.

10. Groundwater depletion and its relation to pumpout procedures at the East End limestone mine was a major sphere of project investigation. The leading Australian limestone expert, who developed the groundwater segment of the study, concludes that modelling of the local karst aquifer is not an appropriate methodology. In summary he attributes most of the water depletion to the operation of the QCL mine rather than to drought, gravitational drainage or landholder consumption. The mine pump-out figures were considered to be so poorly recorded as to be of little practical use, while the meter attached to the mine pit sump was not adequately maintained so as to provide a meaningful back-up alternative. An associated report analyses creek flow upstream of the mine in comparison with rainfall/runoff over time and identifies declining rainfall trends, but finds additionally that creek flow progressively and disproportionately declined due to mining and identifies a date when these effects markedly increased. Recommendations are made to clarify this causation and remediation.

12. In recent years the consultative approach has been incorporated into planning procedures. There is evidence that on several occasions the consultation process has been abused and has degenerated into an inequitable manipulative farce.

13. Statewide there are several examples of the State abandoning the concept of co-existence by allowing political decisions to over-ride environmental considerations. The buyouts of Targinnie and lease renewals at Mt Larcom without first addressing residual impacts are considered prime examples. Once departures from decisions based upon science and sound environmental principles occur, planning and approval processes become a travesty and are liable to political and commercial manipulation. Such conduct may help explain the high level of community distrust and general loss of confidence in the administrative and political system. A summary of individual issues for corrective action is set out in the Recommendations section.

14. When political decisions pre-empt research findings, scientists and technical experts within Government Agencies operate in a highly stressful and compromised climate. Case studies at Mt Larcom and Targinnie show such circumstances are not conducive to good science and undermine the objective implementation of environmental legislation. As a result, regulatory compliance fails.

EXTRACT FROM PAGE 48 AND 49 MT LARCOM CRP REPORT (2003)

2.3.2 Background to Lack of Trust between Government, Mining Companies and the People

The Mt Larcom study must be viewed against a background of favourable treatment of mining companies by the Queensland government, at the expense of landholders and the community in general. Driven by income from royalties and rail freight, government has consistently made it easy for companies to get on with mining, while pacifying the community with Acts and Regulations designed to protect the environment and the livelihood of affected landholders. **While the evidence of shonky dealing during the 1990's may be regarded as outdated and no longer relevant to today's 'enlightened' policies, there is evidence that the problem of 'capture' of departmental officers by mining companies, through compliant senior bureaucrats, has not been overcome.** (My bold)

It is informative to compare the most recent (2002) environmental conditions (and the local community's queries on them) to the proven accusations made of the government/company relations during the 1990's. Attachment 18 shows the current lease renewal conditions and EEMAG's queries on QCL's renewal. If this documentation is compared with documents and press articles published between 1991 and 1997, the lack of trust on the part of landholders

can be appreciated. The difference between policy intention and implementation reality brought matters to a head in the Criminal Justice Commission and the Senate. These matters would not have been exposed had it not been for a whistle-blower and a sympathetic press. To quote the editor Courier Mail (10/10/97) 'For too long Queensland Mining ministers have been no more than cheersquad leaders for the industry instead of public guardians. It is time for that role to be reversed.' This editorial co-incided with an expose by the same newspaper headed 'Open Cut' in which one mine was used as a case study of what was said to be happening across the state. In that investigation by Wayne Sanderson (C.M. 4/10/97) the central question was 'Why are mining ventures that threaten Queensland's farmland, water resources and environment being approved?' Appendix 12 gives in chronological order Mining Environmental Officer Leggate's statements of administrative failure (1991), the Senate Select Committee extracts of Leggate's allegations, Sanderson's expose on the Charters Towers gold mine, and his editor's call for an end to obfuscation by government.

The earlier allegations against departments responsible for legal compliance with mining conditions remain much the same today: (My bold)

1. Turning a blind eye to breaches.
2. Accepting flawed arguments
3. Avoiding exposure and accountability
4. Compliant new appointments
5. Accepting false claims on environmental success
6. Facilitating new developments and renewals
7. Not evaluating costs and benefits of mining
8. Reacting to political pressure for development
9. Making public interest secondary to company interest
10. Absence of checks and balances in implementing the law
11. Reform being token and ineffective

These accusations were originally made by informed and dedicated mines department officers more than a decade ago. The extent to which these failures still occur in State Departments which have carriage of mining and environmental legislation, are a reflection of the moral dimension of the conflict between government, the mining company and landholders at Mt. Larcom. End of quotes.

Note: EEMAG has lodged submissions providing copious evidence on the use of inaccurate science in regulation of mine dewatering that flows into Calliope River Water Resources Plan, the lack of any process to ensure the best available science really IS used, and the lack of any appeal on the merits to properly protect the rights and water access of landholders under COAG Agreements on Water Reform/National Water Initiative to;

- Productivity Commission, Native Vegetation Inquiry (2003, 2004)
- Productivity Commission, Review of National Competition Policy Reforms (2004)
National Water Commission, Queensland Government's progress with implementation of the COAG water reforms (2005).
- National Water Commission, Fax 23.12.2005 Request to for NWC to recommend that final tranche payment to Queensland for Water Reform be withheld until dispute over science resolved
- National Water Commission, First Biennial Assessment of NWI 2007
- National Water Commission, Biennial Assessment of the National Water Initiative 2009
- National Water Commission, Biennial Assessment of NWI 2011 (2 Submissions)

- National Human Rights Consultation Secretariat (12.6.2009) Landholders' Human Rights not protected by way mining is regulated in Queensland nor under COAG Agreements on Water Reform / National Competition Policy and the National Water Initiative.

Attached is a list of FOI and other documents which will be sent by post to the Senate Standing Committee on Rural Affairs and Transport, to substantiate our quotes and claims in our previous submission dated 14 December 2010, together with those referred to in this submission. Any other documents that may be required are available on request.

Yours faithfully,

Heather Lucke,
Secretary
East End Mine Action Group Inc
Mt Larcom Qld 4695

LIST OF ATTACHMENTS POSTED TO SENATE STANDING COMMITTEE ON RURAL AFFAIRS AND TRANSPORT.

1. CD of Mt Larcom Community Restoration Project Report (4 Volumes) (October 2003).
2. List of consultants
3. Table of Contents
4. Copy of Appendix 12 – Extracts from Leggate on Mine Compliance

DOCUMENTS RELATING TO SUBMISSION DATED 14 DECEMBER 2010

5. Extracts from "Industry/Community Relationships in Critical Industrial Developments" (Hoppe 2005)
6. FOI of Fax from QCL to Co-ordinator General's Office 14 June 1995 re QCL Expansion Critical Issues "Guaranteeing the status quo remains with regard to environmental licences on current operations"
7. FOI of DME letter to QCL dated 8 August 1885, Re EMOS and Plan of Operations for expanded mining activities and lease renewal Refer Page 2, Para 3
8. FOI of fax from Department of Minerals and Energy to Office of Co-ordinator General dated 28/09/95 re QCL Expansion Project, Refer P 3, EMOS and Environmental Approvals using the IAS segment on groundwater impacts
9. Front Cover, first Page of QCL's 1996 Gladstone Expansion IAS, Pages 43 and Page 46, refer Page 46 Current Situation After 15 Years of Mining "Pumping from the mine has created a steep drawdown cone extending approximately 500 metres from the pit boundaries"
10. FOI of Ministerial Correspondence from DNR dated 20.12.88, quote "Data on hand indicates that water levels may have fallen by up to 2.5 metres at distances of 2 km from the mine due to mine dewatering."
11. Figure 9 (12 Feb 1997) DNR Resource Sciences Centre depicting "Mine Impacted Area 1991" showing an off-lease mine impacted zone of approx 20 sq km by 1991 with variable loss in levels of up to 6.5 metres.

12. Map of Mine Pit Zone of Influence dated 22/2/2000 by QCL's modelling consultant, showing a mine –impacted zone of 33 sq km (approx 30 sq km off lease impacted)
13. FOI of Memorandum dated 22 October 2001 "Status of Environmental Authorities at East End , refer P1, 1. First Application Item 2. Quote "EIS conducted in 1996 when cement plant upgraded. Information still valid." – (I.e in 2001 EPA used the 1996 Hydrology Report from QCL Gladstone Expansion IAS that evaluated a mine-induced drawdown cone extending approx 500 metres from pit boundaries instead of subsequent reports in 1998, 2000.)
14. Cement Australia's Environmental Authority No M2017 (for East End Mine) Quote "This environmental authority is granted under the Environmental Protection Act 1994 and includes conditions to minimise environmental harm caused or likely to be caused, by the authorised mining activities". From our interpretation the conditions the environmental authority contains relate to water monitoring, their discharge license on volumes, conductivity and total dissolved solids etc, but regarding the zone of mine-induced water depletion P7 has only Residual Void Outcomes (Residual Void is the end of life of the mine). The EA has NO conditions to minimize / repair off-lease water depletion caused or likely to be caused by mine dewatering and does NOT define what impacts on the water table are acceptable. (We interpret that Calliope River Water Resources Plan is coordinated with the Environmental Authority under "standard criteria" under the EP Act 1994 and have lodged numerous submissions that the science for the WRP is inaccurate.)
15. Letter from Solicitor (with reference to Barrister's opinion) dated 10 November 2004 quote "There is no basis either under the Mining Lease, stature or common law by which you can obtain a merits review of the decision of the Chief Executive. The only way in which you could do that is as part of an action against the mining company and the Queensland Government for negligence and/or nuisance. As we have previously discussed, this would be an extremely large case which would require a large amount of expert evidence and it would not only be very expensive for you to prove your claim but would open you to potentially huge claims for costs in the event you were not successful..... In these circumstances, there is no way forward for such an application for a merits review."
16. Letter from Solicitor dated 25 November 2004 that taking a case against Cement Australia to the Land & Resources Tribunal (LRT) does not amount to "an independent review" of DNR&M findings, since to take an action in the LRT under Sec 363 (2)(h) of the *Mineral Resources Act 1989* we would have to sue the Company and prove the liability and quantum of our claim against the Company and this is entirely different to merely seeking a meritorious review of the decision of the Chief Executive under Special Condition 4 attached to the mining leases.

"This is a huge undertaking and given the fact that it would be an action against a corporate giant such as Cement Australia with huge resources to defend such an action, you as a landowner would be at a distinct disadvantage. In fact, I consider that the costs of proving the claim and quantifying your loss would be extremely high, particularly when you consider the potential for matters to be taken on appeal and with the potential for costs orders to be made against you. The reality of these circumstances mean that it is virtually impossible for you to consider commencing such an action unless you are prepared to commit huge resources to proving your claim and defending any judgement which may be made in your favour against any appeals. I consider that there is a potential for costs, including any costs orders made against you, in such proceedings to be as high as \$450,000.00 to \$550,000.00."

EXECUTIVE SUMMARY AND RECOMMENDATIONS

1. Funded by a \$100K grant from the Commonwealth Regional Solutions Programme, the Mt. Larcom Community Restoration Project sought to identify those factors contributing to Mt Larcom's economic decline and diminishing quality of life, and to recommend corrective actions.
2. The project team included regional development specialists from Cairns, Brisbane, Canberra, Adelaide, Mackay and Gladstone, all of whom offered their services at half their normal rates. Local landholders supplied accommodation and transport and organised local meeting schedules in and around Gladstone.
3. The duration of the project was 18 months and financial control and local arrangements were the responsibility of the East End Mine Action Group Inc (EEMAG) – President P Brady. Financial records were formally audited and progress reports submitted at six monthly intervals.
4. The first stage of the project consisted of inspection and familiarisation of the study area, interviews with key figures, literature review and summation of existing reports. This was followed by the public election of a Community Advisory Group (CAG) to act as a steering committee to the consultants. Through public meetings, teleconferences and newsletters the CAG and consultants adopted a consultative approach to community involvement in the project.
5. When the consultants began to evaluate Mt Larcom's prospects of rejuvenation it soon became apparent that Mt Larcom and district could not be considered in isolation. Existing industrial and mining impacts, potentially escalating impacts and the prioritising of the industrial model, in conjunction with planning constraints, were seen to be controlling Mt Larcom's destiny.
6. Mount Larcom township was found to suffer similar decline to other small rural settlements but also reflected both negative and positive impacts of proximity to industrial development.
7. Industrialisation has been allowed to subvert the interests of the Yarwun / Targinnie and Mt Larcom. In contrast to strong residential and commercial development at Boyne Island, Tannum Sands and Calliope, industrialization has not carried these communities forward with them and planning has caused them to both stagnate and regress.
8. The adjacent communities appear to have little conceptual understanding of the Gladstone State Development Area (SDA or Aldoga Industrial Estate), its statutory framework, or that it is the first and to date apparently the only such precinct in Australia. As lay people there is little or no comprehension that Aldoga's broad public interest may override the private right.
8. Alternatives for arresting the socio-economic decline of Mt Larcom town and district centred on creating new wealth streams from supply of rurally-based services and products to the Gladstone population. Exploiting the burgeoning urban labour market within commuting distance offers a major injection of cash into the Mt. Larcom economy.
9. Limited water supplies, both surface and underground, were identified as a major constraint to intensification of agriculture in the district. Recommendations for augmentation of supplies are made.

10. Groundwater depletion and its relation to pumpout procedures at the East End limestone mine was a major sphere of project investigation. The leading Australian limestone expert, who developed the groundwater segment of the study, concludes that modelling of the local karst aquifer is not an appropriate methodology. In summary he attributes most of the water depletion to the operation of the QCL mine rather than to drought, gravitational drainage or landholder consumption. The mine pump-out figures were considered to be so poorly recorded as to be of little practical use, while the meter attached to the mine pit sump was not adequately maintained so as to provide a meaningful back-up alternative. An associated report analyses creek flow upstream of the mine in comparison with rainfall/runoff over time and identifies declining rainfall trends, but finds additionally that creek flow progressively and disproportionately declined due to mining and identifies a date when these effects markedly increased. Recommendations are made to clarify this causation and remediation.

11. A significant element of the project concerned the evaluation of planning and consultation procedures used by various organisations in the district – notably the Shire, EPA, NR&M, State Development, Gladstone Economic Industry Development Board [GEIDB] and the Gladstone Area Water Board. The performance of two industrial companies, Queensland Cement Limited (QCL, East End mine) and Southern Pacific Petroleum (Shale Oil) were closely examined. Documents show State Development and the GEIDB provide high level Federal briefings on SDA matters to a range of senior political figures. On a State level, the briefings include the Hon Premier, Minister for State Development and Director-General of State Development. Under the circumstances, the Federal Government's informed role and the Commonwealth's various incentives to industry, suggest that any criticism of the planning and approval processes connected with what is considered to be a severely flawed industrial model must, by definition, also include the Commonwealth. Several processes were deemed inadequate, biased or ineffective in achieving sound planning outcomes. A range of recommendations on correcting perceived weaknesses are made.

12. In recent years the consultative approach has been incorporated into planning procedures. There is evidence that on several occasions the consultation process has been abused and has degenerated into an inequitable manipulative farce.

13. Statewide there are several examples of the State abandoning the concept of co-existence by allowing political decisions to over-ride environmental considerations. The buyouts of Targinnie and lease renewals at Mt Larcom without first addressing residual impacts are considered prime examples. Once departures from decisions based upon science and sound environmental principles occur, planning and approval processes become a travesty and are liable to political and commercial manipulation. Such conduct may help explain the high level of community distrust and general loss of confidence in the administrative and political system. A summary of individual issues for corrective action is set out in the Recommendations section.

14. When political decisions pre-empt research findings, scientists and technical experts within Government Agencies operate in a highly stressful and compromised climate. Case studies at Mt Larcom and Targinnie show such circumstances are not conducive to good science and undermine the objective implementation of environmental legislation. As a result, regulatory compliance fails.

15. The Mt Larcom community is entitled to a declaration as to whether it is to receive official endorsement and promotion of prospects, or whether through censure and imposition of planning constraints it is to be denied progress as a result of management by stealth.

16. If nothing is done and the Mt Larcom community is to prosper, it may have to do so in spite of the stance of Government at various levels. Due to its location and down-wind proximity to the SDA, population increases of Mt Larcom appear inconsistent with the planning regimes of civic planners.

RECOMMENDATIONS

1. Sustainable Mt. Larcom Community.

Issue: Failure to meet the requirements for economic, social and human capitals. Lack of motivation to engage in capacity building and take full advantage of local markets for jobs, services and products. Insufficient initiative in identifying and exploiting new income streams.

Action:

- i) Use present report to appreciate realities of capitals, capacity and motivation to develop new opportunities.
- ii) Recognise and exploit the range of potential income streams in Mt. Larcom's semi-urban location.
- iii) Arrange community forums to examine an integrated approach to community sustainability, accepting that the structure and function of the future community cannot be the same as the past if it is to succeed.
- iv) Enlist the staff of CQU specialising in Sustainable Regional Development to facilitate evaluation and adoption of income-generating rural options proposed in the present report.

2. Agricultural Land Use Change

Issue: Absence of sufficient economically-sized rural properties to support viable farm families. Shortage of sufficient water to intensify cropping. Depressed prices for most traditional farm products. Ageing population with insufficient attractions for the next generation to return. Insufficient initiatives to exploit alternative income streams from rural land adjacent to a growing population centre.

Action:

- i) Recognise the impossibility of economic survival on small blocks producing traditional crops.
- ii) Organise well costed comparisons of new uses for rural land as proposed in the present study.
- iii) Promote the lifestyle advantages of enterprises which are potentially in demand from nearby city wage-earners and tourists. Engage young local entrepreneurs in these service ventures as a means of improving community structure.
- iv) Provide a mechanism for aged landholders who have become trapped by the diminished land values to sell and leave with dignity.

3. Water Supplies – Surface and Storage

Issue: Very limited irrigation water. Inability to compete with Industry on water price. Priority of Awoonga Dam water to Industry. Lack of local irrigation storages. High cost of Fitzroy pipeline water. Depletion of groundwater.

Action:

- i) Revisit socio-economic evaluation of damsites and pipelines, recognising highest bidders as inappropriate criterion in regional planning. Re-evaluate sites and supplies proposed in the present report using consultants independent of Shire Council, Gladstone Economic and Industry Development Board, Department of Natural Resources and Mining, Environmental Protection Agency, and beyond consulting firms currently engaged in the Gladstone region by these organisations.

4. Local Government Planning – Values, Priorities, Processes

Issue: Widely-held perception that Calliope Shire has given insufficient initiatives to maintain and enhance the Mt. Larcom community. Perceived failure of the Shire to anticipate and remedy the effect of industrial development on quality of life, land values and security of assets. Failure of the Shire to seek means of improving reasonably-priced water supplies for the Mt. Larcom area. Failure of the Shire to adequately support the community in developing improved procedures to rectify loss of groundwater. Failure of the Shire to anticipate the emerging accommodation needs of Industry and to promote and facilitate Mt Larcom’s accommodation prospects. Failure of the Shire to inform Mt. Larcom Chamber of Commerce that development application approvals would be negatively affected by State Development’s advice to the Shire to be ‘very cautious’ about development subject to Industrial Impact.

Action:

- i) Arrange a Community/Shire forum at which local development aspirations are consolidated with a view to agreed positive action from the Shire.
- ii) Election of Community Working Groups responsible for each of the development issues, each chaired by a Council member appropriate to Council’s sub-committees.
- iii) Select an honorary consultant to prepare a document on expanding the Shire Council’s narrow view of its socio-economic responsibilities beyond its legal obligations under the Local Government Act. This document to encourage cultural change within the Shire Council by drawing on case studies of Triple Bottom Line approaches in Shire Futures Strategies elsewhere. If such progressive change cannot be achieved under current leadership, electoral challenges should be encouraged through community action. The Shire Crier newsletter should be used to engage this important debate.

5. Department of State Development and Gladstone Economic and Industry Development Board

Issue: The representation, balance, values and interdependence of the Board requires evaluation by an independent outsider. Failure of the duo to emphasise the environmental and social impacts of new industries to their proponents requires early remediation. Attempts by the Board to bypass the EPA as the controlling body in Industrial development applications is causing serious impediments to environmental quality control. The ‘capture’ of civil servants within State Agencies by politicians through pressure from the captains of Industry can lead to corrupted process in approval of applications. Party politics and factional competition is excluding important community influence on decision making. The composition and accountability of the Board is considered partially responsible for Gladstone being recognised as a leading example of inadequate environmental impact procedures. See James and Bates (1992) who reported Queensland as worst of the States in not allowing the consultation process to influence the scope of EIS, changes to draft proposals and monitoring of on-going management.

Action:

- i) Reinstate the EPA to its proper authoritative role in development approval, monitoring and compliance.
- ii) Re-structure the Board to appropriately represent non-industrial interests as befits a modern democracy.
- iii) Ensure that full disclosure of interests, liaisons and dependencies of Board members is transparently evaluated before appointment.
- iv) Ensure that promotions to intending industrialists emphasise environmental standards required.
- v) Give the EPA the responsibility of guaranteeing that environmental standards must become central to Board planning.
- vi) Expand the Board to include appropriate Social Impact representatives to ensure that quality of life issues, health and welfare are given greater recognition than appears to have occurred in the recent past, eg. Accommodation.
- vii) Gain admissions from the Board that its previous planning procedures on shale oil, water supply and ‘good neighbour’ policy in the Industrial Area have largely failed, and insist that the Board identify the causes of these failures and propose positive corrective action.

6. Lessons from Yarwun/Targinnie

Issue: The adverse effects of the Shale Oil development have become the best example of planning failure in Australia’s recent industrial history. If this social tragedy is not to be repeated, serious attempts to analyse shortcomings in the process of development approval must be documented. Insistence by the company that they meet world’s best practice while approximately 140 nearby landholders have lost the value of their property is untenable. The delay and non-release of a government funded and controlled health study is unacceptable. In addition the release of polluted runoff water from this ‘zero runoff site’ is illegal.

Action:

- i) Request the EPA to critically evaluate the sequential development of Stuart Shale Oil to date, and to identify how each identified weakness in the process must be corrected for future staged developments.
- ii) Ensure that further approvals for Stuart (SPP) meet triple bottom line requirements irrespective of pressures relating to return on investment, production costs or product yield.
- iii) Appoint an honorary independent consultant to analyse the failure of community engagement and environmental compliance processes at SPP’s operation. This report must identify the successes and failures of each organisation involved at each stage of the development processes. This report must be compared to EPA’s report in i) above to eliminate interpretive anomalies.
- iv) Undertake a socio-economic analysis of the sequential situations of landholders in the SPP impact zone, documenting community requests, company responses, departmental input, health and property sales. Special attention must be given to demands for compensation and reactions to such demands. Class action negotiations to be included.

7. EPA Responses and Effectiveness

Issue: There is a well developed perception in segments of the local community that the EPA has:

- i) Insufficient resources to meet its EIS and compliance obligations.
- ii) Been instructed to test only for certain pollutants, notably NOX, SOX and particulates.
- iii) Omitted to report on serious air pollutants such as Dioxin and PCB's
- iv) Been sidelined either to a reference agency or bypassed entirely in important stages of the formal EIS process.
- v) Undertaken compliance action only in the event of complaints being received from alleged affected parties.
- vi) Entrusted its mining compliance operations to ex-Mines Department staff with a poor performance record.
- vii) Allowed political overriding of its best endeavours to insist on adequate environmental safeguards.
- viii) Failed to ensure that EMOS requirements and commitments have been met before supporting renewal of mining leases under more relaxed conditions.

Action:

- i) A study be made of the adequacy of EPA resources to prosecute environmental transgressors based on sufficient monitoring and analysis of pollution occurrences.
- ii) An investigation be made into the reasons why several dangerous pollutants are not monitored in EPA's air quality protocols.
- iii) The role and authority of EPA in the EIS, monitoring and compliance activities related to air and water impacts of development, be checked and evaluated at each stage of the application/approval/renewal process in the Gladstone area.
- iv) A report be commissioned to validate the contribution of the EPA to solution of conflict resolution on groundwater loss near East End mine.
- v) An examination of the role and authority of EPA in the renewal of mining leases at East End mine in 2002/3

8. Mining Lease Renewal Process and role by EPA and DNR&M.

Issue: There is evidence that the renewal of the East End Mining Leases on the 20 March 2003 was:

- i) Approved despite vigorous community opposition and claims of perpetual non-compliance due to residual impacts.
- ii) Approved several years after the previous lease had lapsed but unlicensed mining was allowed to continue for that out-of-lease period.
- iii) Re-worded to remove groundwater replenishment as a condition of renewal, as in the original lease conditions.
- iv) Was made retrospective to 1 August 1997 with the unacceptable deletion of the term "to affect injuriously" from the 2003 Special Conditions.
- v) Renewed on the false premise that mining affected groundwater only in the immediate vicinity of the mine.

Action:

- i) Unless parties to the QCL dispute can arrive at some alternative compromise and district settlement, an independent dye-tracer study be undertaken to determine the extent of mining's impact on groundwater in the northern section of the East End aquifer and the Bracewell and Cedar Vale areas. Once in-principle agreement has

been reached, all dye injection, sampling and analysis be done by jointly appointed, independent specialists requiring no input from landholders, the mine or State Government except permission to enter. This study must be continued until the extent of the groundwater area affected by the mine is agreed on.

- ii) A probity audit be conducted of the extent and timing of all correspondence relating to the East End Mining Lease renewal, including the role of the Ombudsman, to validate the legality of the renewal process.
- iii) An authoritative evaluation be made of the chronological development of conflict between the mining company (as assisted by state agencies) and the community, as represented by EEMAG Inc. The evaluation must test the veracity of alleged deliberate inaccuracies and omissions as listed in the present report, and investigate the acceptability of the responses and inputs from the state agencies involved.
- iv) Through restoration of a properly constituted Community Liaison Group, recommence negotiations between the mine, affected community and state agencies, to expedite the return of mine pump-out water to the local groundwater through injection at sites most likely to benefit the watertable. Reasons why this cannot be done under the EPA Act 1994 must be overridden in favour of agreed compromises.

10. Community Engagement: Equity and Ethics

Issue: There are perceptions that there is evidence of illegal activity and unethical behaviour on the part of industry and state agencies. A distinction needs to be made between companies and agencies involved in legal environmental negotiations and approval processes and those that engage in unethical conduct and deal in manipulative procedures. This warrants investigation.

Action:

- i) A report is required to define what constitutes legitimate and legal planning, consultative and impact *assessment* practices and to separate the legal from the moral obligations in this environmental conflict study so as to;
 - (i) highlight weaknesses in current processes and,
 - (ii) to use this information to improve future regional conflict resolution in Queensland.

Both the East End mine and Stuart Oil should be used as case studies of process failure.

10. Marine Monitoring

Issue: Past and current extent and frequency of inshore marine monitoring is inadequate for early identification and compliance monitoring of pollution from coastal industries including agriculture.

Action:

- i) Investigate and report on spatial and temporal marine sampling protocol for adequacy in meeting GBRMPA targets for reef health, fisheries and seagrass beds.
- ii) A separate study is recommended on the effect of landbased pollution on the crab population of the State's most significant crab fishery at Gladstone.

11. Freshwater Quality Monitoring

Issue: A number of industries including intensive animal production, affect water quality. The Reef Action Plan requires all waters entering the Barrier Reef Lagoon to meet national water quality standards.

Action:

- i) Investigation of the quality of surface and groundwater in all major waterways in the Gladstone area should be undertaken as a matter of urgency. The study should include diffuse and point sources in rural and urban settings. Analyses should include at least nutrients (P&N) and sediment (TSS).
- ii) Instigation of a study on biological indicators of surface water quality, including an in-depth study of local frog populations as the most sensitive indicator of the ecosystem health at the air/water interface. This study should include testing of rainwater storage for human consumption and should build on the modest initiative reported in the present report.

12. Blighted Land Values / Public Interest –v- Private Right

Issue: Depressed land values as a result of proximity to industry, and lack of recourse to compensation

Action:

- i) Examine the process by which industry/state compensates landholders, and consider the benefits of a National or Statewide Insurance Fund (as proposed in this study) or other equitable future policy directions.

Team Leader

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October 2003

MT LARCOM COMMUNITY RESTORATION PROJECT

Regional Solutions Grant
Commonwealth Department of Transport & Regional Services

Project Leader:
Professor Brian Roberts

To: Respondents to the Mt Larcom Community Restoration Project Report:

If positive outcomes are to be achieved from the above report, it is important that stakeholders responding to the report understand the context of the recommendations.

While it is understandable that organisations may respond defensively to the more critical recommendations, the object of the report is to improve the lot of local landholders and to review policy and procedures relating to impact studies.

When compared to most reports, the present team's report may appear to use extravagant or emotive language, and may be more openly critical of government and industry than what has become the norm for consultants' reports.

It is important that all stakeholders appreciate that the present team is neither anti-development nor politically motivated. What makes this team different is that for a number of reasons each of its members have been willing to state honest opinions unimpeded by potential repercussions from influential respondents.

A videotape of extracts from the formal presentation of the report in Gladstone on 31 October gives an insight into content and spirit of the recommendations and reflects the community participants' sincere desire to take the issues raised to the next phase. This videotape is available on request.

It would be helpful if responses to the CRP Report could be provided to the Regional Solutions grantee, EEMAG Inc, before Christmas.

Yours sincerely,

Independent Project Leader
28 November 2003

Price estimates indicate that such water may be delivered for approximately \$1 per kilolitre, which is about double the current price for domestic water in Gladstone.

Neighbouring Miriam Vale Shire has estimated that a desalination plant producing one megalitre for day would produce water at between \$1.27 and \$1.39 per kilolitre. Currently that Shire provides water to Agnes Waters at approximately 75c per kilolitre.

2.2 GROUNDWATER RESOURCES

2.2.1 INTRODUCTION

The question as to whether pumping from the Queensland Cement Ltd quarry has led to depletion of groundwater limestone aquifers in the Bracewell area of Mt Larcom has become lengthy and contentious.

This account reviews much of the now voluminous literature on this matter and concludes that there is a large body of evidence to support the view of deleterious effects on the groundwater of the East End, Bracewell and Cedar Vale areas.

Attention is drawn to the shortcomings in the Golder & Associates Reports prepared for the Environmental Protection Agency of the Queensland Government and especially to the lack of recognition that limestone aquifers have both slow and fast flow components. The former is amenable to the standard methods used for computer modelling of groundwater and the latter is not.

The account is organised into six Sections. These are:

1. Introduction
2. Limestone Hydrology
3. Water Use and Budgeting
4. Drought
5. Modelling
6. The Future

A bibliography to a selection of the major reports related to groundwater in the region is given. References to limestone hydrology and the like from the wider literature are not included.

The impression of the writer is that the local residents, many of whom are members of the East End Mine Action Group (EEMAG) fall into the category of Aussie battlers wrestling with a large industrial concern and government agencies all of whom have available large financial and human resources. It is akin to the situation presented in the Australian film – *The Castle*. The hope of this review is that more attention will be given to the shortcomings that are apparent in the publications and reports from QCL and the various government bodies involved.

2.2.2 LIMESTONE HYDROLOGY

2.2.2.1 General Background

The East End Mine and the surrounding area are dominantly composed of limestones. A feature of limestone terrain is that much of the water flow is subterranean with connections between surface streams and groundwater. In such areas water supply is dominated, and often dependent upon, the use of groundwater usually obtained from bores. This is the case for the farming community in the Mt Larcom region, which for many years relied upon bore water for pasture irrigation and for other rural activities. Groundwater of this kind can be regarded as a form of natural storage, akin to storage in dams in non-limestone regions. Indeed, it has the advantage over dam storage because losses due to evaporation in the summer months are negligible. As with surface storage it is necessary to manage the resource in a sustainable manner so that the groundwater is not 'mined', ie, the reserves over-exploited so that the storage is depleted or becomes unusable.

All limestone areas are dominated by underground water flow but the presence of fissures of all kinds, enlarged by natural solution of the limestone over long periods of geological time, results in patterns of underground water movement that differ from those in other rock types. The solution action of water in some forms of limestone can lead to the development of 'karstic' features. The term 'karst' comes from a region in northern Yugoslavia where these distinctive features were first described over a century ago. These features include a paucity of surface flow, streams that flow intermittently and which have enlarged fissures present in the stream beds, the presence of sink holes down which flood water flow and, at the extreme, the formation of caves. Caves are evidence of conduit flow in earlier phases of the development of karst features, under present conditions these conduits are often left 'high and dry'. However, conduit flow continues but at depth with the conduits now full of water. It is stressed that conduit flow can occur in solutionally enlarged fissure of very much smaller dimensions than 'caves' which are generally defined as sufficiently large to allow entry by humans!

The limestone terrain in the Mt Larcom area, and especially in the disputed Bracewell area, exhibits such karstic features in the surface terrain. These include stream flow sinking into fissures in limestone stream beds, the presence of sink holes that are only activated in times of flood rains and evidence of (now dry) caves that indicate flow in major fissures in earlier times, ie. before deeper conduits were solutionally enlarged.

2.2.2.2 Implications for groundwater

The development of karstic features indicates that the form and patterns of sub-surface flow are complex. Some water flows rapidly, especially after heavy rain, along solutionally enlarged fissures that can be regarded as similar to flow in pipes. Other water moves very slowly essentially as intergranular flow. The latter style of groundwater movement is regarded as the normal type of groundwater flow in non-limestone aquifer, such as sandstones.

A simple example of conduit flow is that in limestone areas, and the Bracewell area is no exception, boreholes for water sunk a few metres part can result in very different yields, some of no value as a source of water while others can have high water yields.

The difference in flow rates between the conduits and the slower inter-granular movement can vary by factors of thousands. In large conduits water flow is often measured in kilometres per day, intergranular flow at less than millimetres per day.

Often the pattern of underground water movement in karst areas does not match that of surface water catchments. It is difficult to define the underground catchments but frequently they differ quite markedly from those defined by surface streams.

A further feature of underground flow in karst limestones is that the conduit flows, which can carry a large proportion of the groundwater flow, can occur at considerable depths. In many places throughout the world, large freshwater springs emerge on the sea floor often at some distance from the coast and at depths well below sea level. The problem is that it is difficult to locate such underground flow lines. A well-known UK example is the very large fresh water springs that were encountered in the construction of the railway tunnel beneath the Severn Estuary. These are some 40m below sea level. Initially they flooded the tunnel and very large amounts of water have been pumped daily from the tunnel over a period exceeding a hundred years. Similar occurrences are known in Australia. For example, the very large submarine freshwater springs off the coast in southeastern Australia that are fed from limestones in the Mt Gambier region. Recently it has been suggested that similar submarine limestone springs exist off parts of the Queensland coast.

It is widely recognised in groundwater studies that underground flow in limestones, especially those having karstic features, is very different to that found in non-limestone aquifers. This has major implications for all forms of groundwater modelling which basically rely on what is termed Darcian flow. Such models normally assume that groundwater movement is isotropic over relatively large areas. While these assumptions remain as the basis for groundwater modelling and development they are of limited value in limestone aquifers, especially those with karst features.

A letter from the Minster (to DI Smith dated 25 Nov. 2002) states ‘...modelling is being done or a regional scale and is not meant to be utilised at a small scale’. This adds weight to the contention stressed through this report that possible conduit flow, such as postulated in the vicinity of Weir 2 or elsewhere would not be apparent from the Kalf modelling undertaken for QCL.

2.2.2.3 The Mt Larcom Area

The basic bedrock geology has been described in many of the reports and is illustrated in the Golder Associates report of April 2002. Their key map (Figure 3, marked as checked by John Waterhouse) however contains a major drafting error in that the key to the two major geological units is reversed.

The latest accounts classify the bedrock geology into the Erebus Beds and the Mt Alma Formation. Golder Associates describe the Erebus Beds as ‘limestone continuous’ and the latter as ‘limestone discontinuous’. The mine is located in the Erebus Beds and provides by far the best exposures in the region with most of the quarry faces composed of massive limestones. The occurrence of the limestone is the reason for the mine.

Dr. James (1997) reports on an inspection of the mine: ‘...that karst activity, in the form of open channels and pipes, can be observed to quite deep levels within the open pit; within 5-10m of the base of the pit and well above the pristine water table’ (p.3)

The disputed Bracewell area is mainly located in the Mt Alma Formation (ie. the ‘limestone discontinuous’ unit) of Golder Associates.

It is necessary to stress that in situ rock outcrops within the area are limited and that this restricts detailed mapping of the underlying geology. Maps by Golder Associates show major areas of outcrop many of which are located on low ridges. If indirect methods of geological mapping are used, it is clear that, in the Bracewell area, there are large areas of terra rosa soils. Such soils are uniquely found developed on limestone rock.

The division into Erebus Beds and the Mt Alma Formation is a key element in the dispute. Golder Associates stress that there is poor continuity of groundwater flow between the rocks that form these two formations. The critical disputed link is in the vicinity of Weir 2.

For Golder Associates at Weir 2 there is a 'rock barrier' composed of low permeability rocks of volcanic origin, ie with very different flow characteristics to the limestones. This, they argue, isolates the limestone aquifer upstream of Weir 2 from that downstream of the weir and thereby any effects of mine de-watering cannot be transmitted to upstream locations.

Other consultants, namely Dr. James (1997) and Prof. Volker (1998), take a differing stance and argue that there is (or could be) a groundwater link in the vicinity of Weir 2 that permits the effects of the mine de-watering to impact on the Bracewell aquifer.

It is possible to approach the problem in several ways, the major of which are:

- a detailed consideration of the geology and water movement in the area immediately adjacent to Weir 2;
- comparisons of changes in groundwater water level upstream of Weir 2 with other localities in the area that are agreed by all to be unaffected by mine-de-watering.
- water tracing in the vicinity of Weir 2 to clarify the possible fast flow connections from the disputed Bracewell area to the mine.

2.2.2.4 Weir 2.

When it became clear that the area immediately adjacent to Weir 2 was of critical concern QCL undertook a seismic survey prior to drilling additional bore holes, subsequently used for pump tests.

Following this work EEMAG, undertook excavations in the same area in order to gain a better understanding of the local situation, these were supervised by Dr. James.

There had been dispute over the interpretation of the findings. The excavations show that there is relatively rapid flow especially in a calcrete layer. 'Calcrete', as with limestone, is a calcium carbonate deposit susceptible to solution and which can exhibit the same flow characteristics as limestone bedrock. Accounts of these excavations, together with detailed borehole and weir discharge observations, are presented in a report by EEMAG and by Dr James, see James (1998).

It is pertinent to note the comments of Prof. Volker (1998) on these investigations.

'James reported on the results of the excavation near Weir 2 ... he claims that laterally extensive layer of relatively high hydraulic conductivity occurs across the flat lands of the valley constriction near Weir 2. This is dismissed by DNR [Feb 1998]. It would appear that there was confusion in the part of DNR about the validity of the calculation of hydraulic conductivity from the pit test inflow and the implications for downstream flow'.

It's also pertinent to note that solutionally-enlarged limestone fissures are well-exposed in the stream bed several hundred metres upstream of Weir 2, these would accommodate quite large stream flows. Downstream of Weir 2 there is on occasion recharge into Machine Creek. This could also be interpreted as indicating a hydrological connection in the limestone across the 'barrier'.

Volker (2000) gives an excellent summary of the situation at Weir 2 and its significance for the area under dispute. This is reproduced below.

‘If there is a relatively high permeability layer though the valley near Weir 2 and if it is was confined under pre-mining conditions, then a lowering of the water level at the downstream due to mining will increase the flow through it from Bracewell to the East End aquifers. The magnitude of the consequent influences on Bracewell groundwater levels would depend on a number of factors, most of which are open to considerable uncertainty. Kalf claims that the modelling results show no measurable influence of pit drawn down in the Bracewell aquifer. Of course that conclusion is directly dependent on the assumptions made in the development of the model and on the calibration process.’

Volker comments in an earlier review of the problem ‘...that the results from the pits excavated at Weir 2 early in 1998 seem to have been treated in a rather cavalier fashion in DNR (1998) without obvious justification’. He points out ‘...that information obtained from an excavated pit should not be under-estimated since it samples a greater area in plan than does a bore’

The ‘interim conclusion’ to Volker’s study of Aug. 1998 is:

‘On the basis of the available evidence, it cannot be concluded that there is no effect of mine dewatering on the Bracewell aquifer, for the following reasons.

1. Some connectivity between the aquifers in the vicinity of Weir 2 appears likely as indicated by the permeable material exposed by the excavation in early 1998.
2. In such a complicated aquifer system there is a distinct possibility of channels of relatively more permeable material linking the aquifers and acting as confined flow conduits.

The evidence on amounts and timing of drawdown in the Bracewell aquifer, in spite of the prolonged drought, are consistent with the possibility of mine dewatering effects reaching the Bracewell [area]’

His summary (1998) concludes:

‘The evidence on amounts and timing of drawdown in the Bracewell aquifer, in spite of the prolonged drought, are consistent with the possibility of mine dewatering effects reaching the Bracewell’.

To these earlier accounts can be added the findings of the analysis of rainfall and surface runoff at Weir 2. This is discussed below, see Section 4.2 and based on a consultant report by Spate (2002). The basic finding is that the runoff events in response to similar rainfalls have shown major decreases since the 1980s. This indicates that progressively more flow is carried by groundwater connections below the area of the Weir 2. Such declining water levels progressively lessen the stream surface flow. Put another way in pre-mine conditions water discharged from the area as both surface and groundwater flows. The major and progressively increased reductions in surface flow are because virtually all of the discharge from the Bracewell catchment is now carried by groundwater connections that link the groundwater flows above and below Weir 2. This supports the view that there is no effective barrier and that there is a continuity of flow.

2.2.2.5 Regional falls in groundwater levels

The report by Dr James (1997) analyses the borehole monitoring records to compare changes in groundwater level. This map is reproduced here as **Figure 1**. The comparisons are between the map of 1979 groundwater levels (accepted by all parties and included in earlier reports) and the observations from monitored boreholes for the period 1995-96. (See Figure 3.)

Such comparisons would be widely regarded by hydrogeologists as the accepted way to interpret patterns of change due to the mine de-watering. As far as I can see, this approach of a map of change in groundwater levels over the whole region has not been attempted in the reports by Golder and Associates although similar methods are reported DNR (1998).

Golder Associates, (April, 2002, Table 2) acknowledge the use of

‘...hydrogeological interpretations, based on ‘...groundwater contours, interpreted geology and applying experienced-based judgements to accepted hydrogeological principles.’ as ‘an application of well-established principles’.

These re-echo the comments of Golder Associates of May, 2001 (p.9). A simplistic approach is to contour the data without regard to topography and geology ‘...it is acknowledged that this approach might give the appropriate interpretation in the event (believed not to be correct) that East End Aquifer is directly connected with other limestone bodies through all ridges’.

The method used by Dr. James (1997) does not contour the 1995/6 water level data but shows where major falls in level have occurred. These are reproduced here as **Figure 1**. *The boreholes marked in green are those where there was little or no drop in level; those in red represent boreholes at which a major drop in level has been recorded.*

Key points to note are that the areas of little change (in green) are around the periphery of the disputed area and indicates that the effects of drought were relatively minor. To quote James ‘...the effects of the drought had been nullified by the past seasons’. James also adds a note to say the same pattern applied if 1997 observations were used.

The areas of major decline (in red) are those associated with the area of the mine (these approximate to the area of depletion depicted in the modelling results by Kalf) and the Bracewell area. Golder Associates do not accept the latter as having been effected by the mine de-watering. The Golder Associates map (Figure 11, April 2002) only shows depleted areas adjacent to the mine, these cease a short distance downstream from Weir 2.

It is also worthy of note that the groundwater levels in the Bracewell areas exhibit a ‘flat’ water level. Such a pattern is indicative of the fast underground flow rates commonly encountered in karstic limestones.

James also provides a number of cross sections that show the changes in water level from 1979 to 1995/96. One of these, Section 1 in James, is reproduced here as a part of **Figure 2**.

Section 1 on Figure 2 shows that from the vicinity of the mine and across the Bracewell area the decline in water levels is considerable, approximating to 5-7 metres.

Sections across other parts of the area, see **Section 2 on Figure 2**, show very little change in water level, this is especially the case for bore holes either located on volcanic rock or more distant from the mine.

Section 3, also shown as part of Figure 2, runs the length of Machine Creek and passes close to the contentious Weir 2.

The various accounts also consider minor changes in underground water catchment divides but such detail is not given here. The substance of the argument is best illustrated in the maps and cross sections.

James (1998) conclusion is:

‘... that in the Bracewell Lease No.1 aquifer [in this account referred as the ‘disputed’ area or ‘the Bracewell area’] depletion of the order of 5-7m is on record. This is now proposed as an indirect result of mine pumping, with seepage losses occurring probably through the topographical restriction near the Machine Creek bridge [close to Weir 2]’.

The areal analysis of the borehole records undertaken by James accords with normal practice in analysing water level changes. It is assisted by the availability of a large number of borehole records. This is important as local anomalies can occur in the pattern due to perched water tables and the possible effect of nearby pumped boreholes. There is however, very little doubt regarding the overall pattern which is fully consistent with depletion by mine de-watering. The pattern also shows that for those areas agreed as not effected by mine de-watering (Bracewell apart) that changes in water level have been minor.

The DNR report (1998) has maps, see especially Figure 8 reproduced here as **Figure 3**, that also show changes in level. These show differences between full supply level (generally taken as 1978/79) and those observed in December 1998. The overall pattern is similar to that presented by James and described above. That is there are two areas of major drawdown, one close to the mine and the other in the Bracewell area. Both the mine and Bracewell areas are labelled as ‘areas of high usage’. This is a rather strange term to use, the implications that the Bracewell area is a result of pumping for irrigation although elsewhere this current review (Section .3.2) shows that this has declined by two thirds in volume terms over the last twenty years. ‘Substantial reductions’ are now accepted by Golder Associates, see Addendum May 2001.

The DNR report (p.24) dismisses the effect of mine de-watering as responsible for the Bracewell depletion. The reasoning is:

‘If the argument is that the area of highest water level decline are largely caused by the mine then these areas ought be continuous and the amount of decline should decrease with distance from the mine. This is not the case, therefore factors other the mine must be responsible for this pattern’.

This again concerns the links in the area of Weir 2. As the critical link is narrow, see the descriptions in the Weir 2 studies undertaken by EEMAG and James, it would not show up in the map produced by the DNR. The spacing of boreholes is much too coarse. Despite this even on the DNR map there is a ‘trough’ that gives some credence to a link between the two areas of major draw down. This is indicated by the addition of a 5m contour for deletion on **Figure 3**. It is possible that the links underlying Weir 2 could be a relatively narrow limestone bedrock conduit that would not be apparent on maps of this kind.

Monitoring since the James report has continued and it is recommended that this study of the decline or otherwise of the boreholes is again plotted in map form as a major guide to the argument regarding the extent of mine de-watering.

James (1998) also comments on the extrapolation of the records into the future. He considers likely that in the Bracewell area levels will decline still further perhaps to an overall depletion of 17m.

EEMAG however, in privately conducted research over the last five years identifies losses at around 10 m in the Lower Bracewell limestone aquifer. In consideration of new record lows, EEMAG suggests that conduit flow from Bracewell to East End appears to ease (or cease) at around 66 AHD and the Lower Bracewell limestone aquifer is not worsening or declining further below about 59.5 m AHD. EEMAG warns this finding cannot be regarded as a permanent feature as further conduit intersection at the East End mine could change that.

EEMAG also makes a distinction between the Lower Bracewell limestone aquifer and “a substantial alluvium aquifer around and above Weir 2 associated with Machine Creek.” In contrast with the Lower Bracewell limestone aquifer, EEMAG’s data indicates periodic segregation between the limestone and alluvium with the alluvium falling to new record lows with each successive dry.

2.2.2.6 Flood of early 2003

The 30-day period, 3 Feb. to 2 March 2003, was one of exceptionally heavy rainfall in the Mt Larcom area. During this period 584mm were recorded at the Lucke gauge in Bracewell, 650mm at the Brady gauge at Cedar Value, 625mm at the Peters’ gauge in Hut Creek and 520 at Padget’s at East End. These totals are close to the annual rainfall received for several years during the 1990s and represent a major recharge event.

The automatic rainfall collection for the QCL mine site for the 30 day period was recorded at 920mm, very much higher than for the other gauges in the area. It has since been agreed the automatic measuring system malfunctioned.

Such an event undoubtedly represents one of the major recharge events in the area for some years. It is therefore instructive to consider the results to date of such a high rainfall event.

The rains resulted in surface flooding and the formation of the Bracewell Lake. This is a temporary natural storage that forms a shallow lake after major rainfall events. On this occasion it is estimated to have achieved about 80% capacity. When full surface storage is estimated to be about 30 megalitres.

A feature of the Bracewell Lake is that it discharges down well-defined sink holes. This is clear evidence of the presence in the Bracewell area of well-defined subterranean conduit flow.

The rate of draining of the Bracewell Lake via the sink holes in 2003 was shorter than was observed for similar events over the last 30 years or more.

It would be expected that such a major recharge event would have resulted in rises in the boreholes throughout the area including those in the local limestone aquifer. Detailed records of the borehole levels associated with this event have been undertaken by EEMAG and are still continuing. These records are available to interested parties.

The official March 2003 quarterly data indicates that several limestone boreholes at East End and a couple in Bracewell actually declined in level. Certainly at this period, use for irrigation or other abstraction purposes would be effectively zero.

The most significant feature from these records is that the increases in borehole levels in the local limestones up-gradient from Weir 2 represent less than a 50% recovery. For the first time in more than a decade infiltration from limestone to Machine Creek between Webbs' and the bridge at Bracewell Road is causing a persistent flow at the bridge. This stream flow has been measured at about half of the 18mm flow currently discharging over Weir 2. On the other hand, the once perennial Tea Tree limestone springs, located close to Weir 2, have not discharged in response to the heavy rains of early 2003. These springs were perennial up to 1984, they then became sporadic although re-generated during a prolonged aquifer recovery period in 1989-1991. They have not flowed since about late 1992 or early 1993.

All the indications are that much of the potential recharge has discharged via subterranean conduits fed by the sink holes. Further, that such discharge was at levels well below the elevation of Weir 2. This accords with the views expressed by Volker and James (Section 2.5 above) that the dewatering associated with the mine extends into the Bracewell area.

Ideally, confirmation of this deep and rapid flow from the Bracewell limestones to the severely depleted East End aquifer and the mine may be able to be obtained by analysing the records of water discharged into the mine. However, the arrangements for assessing the mine discharge were incapable of measuring such high flows. This further highlights the shortcomings of the mine pump records, further discussed in Section 3.2.

2.2.3 WATER USE AND WATER BUDGETTING

2.2.3.1 Pump- out

An unusual and commendable aspect of the assessment of the potential impact of the mine on local groundwater was the installation of a monitoring network. The main components of this are observations of water levels in boreholes and the installation and monitoring of several stream gauges. The records from some of the boreholes and for Weir 2 are available although it is pertinent to note that the latter were not converted to flow readings until the 1990s. Although many of the early weir records are acknowledged to be of a poor quality they do permit analysis of changes of run off over the life of the mine.

The most significant data required to assess the de-watering effects of the mine is undoubtedly the measurement of the mine pump-out. It is unclear if this was an initial requirement of the monitoring network.

Pumping from the mine commenced in late 1979 and a letter from the Minister for Lands, Forestry and Water Resources (dated 13 May 1980) states that 'the installation of a meter to record de-watering of the mine is being considered'.

The measurement of de-watering would best be undertaken by a meter on the pipe that links the quarry sump to the settling ponds. This has only very recently been installed. The method used from 1980 is to measure the flow at Weir 6 which is at the outlet from the settling ponds. While this gives an indication of the pump out, the quantities recorded at the Weir 6 will have been reduced by evaporation from the settling ponds.

The problem is that the discharge data for Weir 6 are not available until November 1983, over four years after the mine pumping commenced. Further the records for Weir 6 prior to 1996 only contain very short runs of data. For the period early Dec. 1987 until 1 October 1990 the only records are for a 10-week period in late 1989. There are no records from July 1994 until February 1996.

For the first 17 years of operation (to 1996) of the mine pump out data is only available in a discontinuous way for 7½ years.

The lack of any consistent run of data for the mine pump out until February 1996 means that any systematic analysis of the effects of the mine on the local water budget is impossible, for instance, comparable analysis of changes in run-off undertaken for Weir 2 and reported to EEMAG.

The Golder Associate report (April 2002) spends many pages discussing water use in the region of the mine but limits its comments on the mine pump out to:

‘...QCL mine pumping data has not been collated into a single data set. However, inspection of the data in various reports shows that the current dry season pumping rate of about 1,700 kl/day is a reasonable estimate. It is accepted that higher rates were pumped in earlier times of mine development causing the draw down in the East End aquifer’ (Golder 2002, p.36).

It is interesting to note that a year earlier the Golder Associates report of May 2001 (p.18) commented:

‘Mine abstraction (surface water plus groundwater) are monitored but the data have not been interpreted to provide a clear interpretation showing the amount of groundwater pumped. A mine water balance approach would be useful to provide a transparent process by which a justified estimate of the amount of groundwater pumped by the mine could be provided to the stakeholders’

That such a statement could be made by the EPA consultants and then not acted upon in the ‘consolidated review’ of April 2002 requires some kind of explanation.

The only comment that I can find to early pump-out volumes from the mine is contained in a letter from the Minister (N.Hewitt), dated 1980, that gives a figure of 60 litres/sec. (5184 kl/day) for the early period of pumping.

The Golder Associates report concludes (April 2002, p.36) by commenting:

‘If EEMAG does not have and still requires this information [pump out data] then either QCL or the appropriate Queensland government department are the appropriate sources’

In response to requests from me for further information, QCL directed me to Kershaw and Co. and a phone conversation with David Kershaw (June 2002) indicated that if the early data were ever collected they are now lost.

This must have been known by Golder Associates and the lack of any analysis of mine pump data, the critical component of any attempt to obtain a water balance for the area surrounding the mine, suggests that they do not have the data either.

The Department of Natural Resources (DNR 1998, p.38) comments that ‘discharge data are available at the mine site so that there is some knowledge of the aquifer discharge at the mine, even though there are gaps in the records’.

As the records available only appear to start in a systematic way from 1996, the above statement is hardly a sound account of the mine use data.

That such comments can be made twenty years after mine pumping had commenced requires some explanation by QCL. This confirms the view of this account that for a groundwater model not to take into account the mine pump out volumes is a major omission and does not represent best practice. The lack of useable mine pump out data prior to 1996 is very serious omission. Why this was not corrected much earlier also remains a mystery.

The lack of a useable run of mine pump data indicates a major flaw in the administration of the monitoring program and also renders any attempt to obtain a water balance presented in the various reports by Golder Associates to be so incomplete as to be of no practical value.

Even to a non-technical reader of the voluminous reports on the mine it is apparent that the amount pumped out of the quarry is the single most significant feature to be addressed in discussing the impact of the mine of local surface and groundwater.

2.2.3.2 Irrigation use

A major reason for the decline in water levels in the disputed Bracewell area, both groundwater and for surface streams, stressed in all Golder Associate Reports is the use by irrigators. These were accompanied by comments that there was a lack of data on such use. This is not surprising as it is not a requirement in Queensland for records to be of extraction in unlicensed irrigation areas. One would have expected QCL or EPA to undertake the appropriate studies to gather information on irrigation use. This is especially the case because irrigation is a major plank in their argument for the decline in water levels in the Bracewell area.

The local community view was that, for a variety of reasons, irrigation use had declined substantially since the mine commenced operations in the late 1970s. Among the reasons is that groundwater and surface water discharges had declined since the mine commenced pumping. In order to quantify this perception, Peter Brady (of EEMAG) undertook a survey of local irrigators about the year 2000.

Brady reported the number of irrigators using groundwater bores in 1980, close to the time that pumping from the mine commenced, as 20½ (the '½'s indicate minor use). The corresponding number for 2002, from the survey, was 6½. The survey also provided estimates of the decreases in the area irrigated and in the volumes pumped for irrigation.

Both the estimates for area irrigated and volumes pumped for irrigation in the year 2000 were approximately one-third of the pre-mine figures.

Brady also points out errors in the irrigation rate used in earlier water budgeting studies by Kalf.

This matter was addressed by Golder Associates in their addendum of May 2001 which briefly reviews Brady's initial data and comments:

'it is certainly accepted that there has been a substantial reduction [in irrigation use] over the last 20 years' [writer's underlining] (p.9, addendum May 2001).

The discussion of Brady's data does not mention that the irrigation volumes and area in 2000 was a third of that in 1980. It is also clear that no attempt has been made to incorporate the revised, and much reduced irrigation, information into the groundwater modelling. Brady's data were again updated in December 2001 in the EEMAG publication *Hydrology, Hydrogeology and Trilogy* (2001) a copy of which was made available to Golder Associates.

It is disappointing to see the response of Golder Associates to this survey undertaken by Brady. Golder Associates (p. 18, April, 2002) ignores the Brady's survey of irrigation use and again comments that;

‘...the lack of such information [irrigation use] has limited the effectiveness of model calibration in several areas and makes more difficult the task of separating out mine impacts from those attributable to drought’

Having agreed that ‘there is a substantial reduction in irrigation use’ in the May 2001 Addendum report this is discounted in the report of April 2002 which goes on to discuss the importance of plant transpiration from vegetation along Scrub Creek. Presumably this information had previously been incorporated into water balance studies and the model? If not, it is further evidence of the very shoddy approach to providing an acceptable water balance model. It appears that having received information regarding irrigation use that this has been casually discarded.

It is worthy of comment that QCL has spent vast sums in gathering groundwater information but has made no effort whatsoever to survey past irrigation use. Once this was gathered by EEMAG (by Brady) it is then largely ignored. It is notable that the Golder Associate reports to the EPA devote only minimal space and effort to aspects that involve economic, social or environmental aspects.

It is surely time that the modelling undertaken for QCL was adjusted to take account of ‘these substantial reductions’ in irrigation.

As a related point, water was formerly also abstracted from surface streams, especially for occasional irrigation for pasture at times of drought. As shown in the discussion of the analysis of stream flows for Machine Creek at Weir 2 what were formerly near perennial streams are now dry for most of the year and unavailable for this form of irrigation certainly at times of low rainfall when they would have previously been used. The changes to surface stream flow are discussed elsewhere in this review, see Section 4.2

2.2.3.3 Water budgeting – Summary

The water balance studies by QCL and Golder & Associates fall far short of what could be considered as best practise.

- They have failed at any stage to analyse the mine pump out data;
- The absence of the systematically collected mine pump out data prior to early 1996 displays either a major disregard for the key element in the monitoring program or extremely poor administration in that the records have been ‘lost’.
- Although agreeing (in May 2001 but not in April 2002) that irrigation use has declined substantially they have failed to use this in modelling studies.

The lack of the mine pump-out data prohibits any sensible analysis of changes in rainfall runoff relationships of the kind undertaken for Weir 2.

2.2.4 DROUGHT

2.2.4.1 Introduction

The decline in groundwater levels in the disputed Bracewell area since about 1991 is attributed by Golder Associates to the cumulative effects of persistent drought and non-sustainable irrigation use. We have demonstrated above, acknowledged by Golder Associates,

that the irrigation use has substantially declined (likely in terms of volume by two-thirds) since 1980.

This is no doubt however, that the whole of the region has been subject to several severe droughts in the period since the mine commenced pumping out groundwater although there was a recovery period in Bracewell in 1989-91. Irrigation apart, the other plank in the Golder Associates accounts is that the changes to groundwater flow in the Bracewell area result from drought conditions.

Before considering the case for groundwater it is necessary to comment on changes to surface stream flow upstream of Weir 2. It is acknowledged that throughout the area there are linkages between surface stream flow and groundwater, this is commonly the case in areas of limestone terrain.

2.2.4.2 Surface stream flow

The Golder and Associate reports are dominantly concerned with hydrogeological aspects of the problem, ie groundwater. The comments regarding changes to surface flow are given less weight.

For example, Golder Associates (May 2001 An Addendum) present little discussion on the reductions over time to stream flow. The main section to consider these is on pages 6/7. This reports the views of long term residents on changes in stream flow in the Bracewell area.

In earlier times the major streams in the Bracewell area, including Machine Creek, were virtually perennial and even in the driest periods associated with severe drought, pools remained which gave shelter to fish and were also used as a local source for irrigation water for pasture. It is likely that these were replenished from groundwater. The same applies to small perennial springs in the area that have now ceased to flow. Details of these are given in various reviews produced by EEMAG, see EEMAG (2002).

Not only have the streams lost much flow but it is likely that the reduced flow has caused major changes to the fresh water aquatic biota. For example, in places the stream banks contain many freshwater mollusc shells, these are no longer found in a living state due to the major changes in stream flow. The streams are now also devoid of fish. Nowhere in any Golder Associates reports is any comment made on such changes to the aquatic environment and biota.

The decreases in stream flow noted above first become apparent to the local residents in the late 1980s.

2.2.4.3 An analysis of stream flow at Weir 2

In order to more fully describe the problem of the reduction in flow at Weir 2, on Machine Creek, the Centre of Resource and Environmental Studies at the Australian National University undertook an analysis of the rainfall and Weir 2 runoff records for the period November 1978 to February 1997.

This used the daily rainfall from the Lucke gauge and the Weir 2 discharge data supplied by QCL. The latter are known to be of poor quality (see comments in DNR 1998).

A simple plot of the rainfall and runoff observations for the whole period is given in **Figure 4**. Simple inspection of **Figure 4** confirms the local perception that flows have declined dramatically over the runoff record.

Using a series of sophisticated techniques (fully described in the full CRES Report, see Spate, 2002) the rainfall and runoff at Weir 2 was compared for various flow events associated with periods of relatively heavy rainfall. The total record was divided into three parts. The periods are late 1978 to early 1985, from 1985 to 1990 and post-1990. The earliest of these is for the period when the effects of mine pump out are thought to be minimal, the second period is when (in the opinion of local residents) the effects became apparent in the Bracewell area and the final period into the 1990's.

Figure 5 analyses the rainfall and stream flow for the three periods to show the stream flow response to equivalent rainfall events. It is clear that the flow over time at Weir 2 for similar rainfall events is progressively and massively decreased. This provides an analytical basis that confirms the perception of the local community. Figure 6 provides an easily assimilated visual interpretation.

However the Golder & Associates maintain that decrease in stream flow is due to prolonged periods of drought. The correspondence in time with the effects of mine pumping (albeit at an unknown rate until about 1996) is regarded by them as coincidental. The contrary view is that the mine pumping has lowered water levels in the Bracewell area and this lowering has caused much of the previous surface flow to take underground flow paths.

The fact that earlier severe droughts did not cause the streams to lose all of their flow is dismissed as 'the current situation is more extreme and some groundwater levels appear to have dropped below the thresholds at which surface flows are sustained.' This is likely true but the question is why have they dropped to such thresholds in response to post-1990 drought conditions when they did not in response to rainfall deficits associated with earlier severe droughts?

The Golder Associates Report of May 2001 An Addendum (p. 7-8) lists some answers to this problem. Leaving aside mine de-watering, they list:

- (a) 'clearance of forest and scrub vegetation since the pre-war years, resulting in more rapid runoff (and less vegetation to intercept light rain, which can have prevented recharge under some conditions then).
- (b) loss of soil structure in grazed areas reducing infiltration and causing more rapid runoff
- (c) the local effects of irrigation'

The first of these explanations (a) is completely at variance with the views held by the majority of surface water hydrologists in Australia and elsewhere. The accepted view is that clearing of trees and shrubs enhances groundwater recharge.

Effects on more rapid runoff of surface water are of secondary importance. To illustrate this in a simple way, the clearing of forest and scrub vegetation is regarded as the major reason for the spread of dryland salinity. Trees and shrubs have deeper roots than grass or pasture and therefore, higher rates of plant transpiration. Once such forests or shrubs are cleared the soil water rises – carrying with it salt to the surface or near surface. To give another example from a limestone area in South Australia, the widespread planting of conifers as a replacement for grasslands has decreased recharge to soil and groundwater. Thus the clearing of forests and shrubs causes more water to pass through the soils to recharge groundwater. Golder Associates, for some reason consider the opposite to be the case!

The comment, point (a) in brackets, regarding changes due to interception are clearly wrong. There is less interception when trees and shrubs are cleared and therefore, more rain falls

directly onto the soils and ground vegetation to increase infiltration and thereby groundwater recharge.

Loss of soil structure can cause more runoff especially under heavy rainfall conditions. Thus for heavy rainfall some of the flow into the creeks, including Machine Creek, will be from direct surface runoff. However, the analysis of the discharge at Weir 2 shows the opposite to be the case, ie. for comparable rainfall events there is decreasing runoff with time.

As regards point (c), this is addressed in Section 3.2 of this report. This clearly shows that irrigation has markedly declined over the last twenty years and this is accepted as the case in Golder Associates (May 2001).

These comments from Golder and Associates on surface water hydrology and the effects on recharge are clearly wrong as any text book on hydrology in Australia will confirm.

On this basis, it begins to look more likely that the reason for the Bracewell decline in groundwater levels since about 1991 is due to mine de-watering.

2.2.5 MODELLING

The report *Groundwater flow modelling – a summary* (undated but thought to be September 1999) by Kalf and Associates updates earlier accounts of the groundwater model used in the Mt Larcom region.

This report states (on p.13):

‘The previous model has also indicated that on a regional basis the fractured rock mass behaves as an equivalent porous medium. The same assumption is used in the new model’.

This limitation is a problem encountered with all comparable models. Models of this kind are routinely used but have major limitations when applied to karstic limestone aquifers. For such aquifers it cannot be assumed that that ‘the fractured rock mass behaves as equivalent porous medium’. Kalf (p.10) acknowledges that the limestone in the area is karstic although adds the caveat that ‘the limestone is not strongly karstic’. What this means is unclear.

To a degree the problem is apparent in the widely different flow characteristics encountered in boreholes only a few metres apart. More significantly, conduit flow in isolated limestone solution ‘pipes’ of unknown size and location are not conducive to such modelling. It is accepted in the karst literature that conduit flow is often ‘turbulent’ in contrast to other rock types where underground flow is ‘laminar’. Turbulent flow is not conducive to the methods and assumptions that underpin groundwater models.

Although there are a large number of observation boreholes in the region covered by the model, there are insufficient to recognise conduit flow of the kind described here. This is especially the case when the problem relates to possible underground links that occur in a very small area such as in the vicinity of Weir 2.

Earlier in this account attention was drawn to examples where considerable volumes of underground flow are known at considerable depths and only become apparent because they discharge fresh water at depths well below sea level. There is no easy way to establish the existence of such deep conduit flow. It is quite possible that such flows occur well below the floor of the East End Mine. Thus even if water budgeting studies had been undertaken, and it appears they have not, they could still be inadequate if they relied entirely upon pump out data.

Others have drawn attention to other possible shortcomings with the model and how it has been employed.

The DNR *Position paper – East End Mine and Environs* (1998) in general accepts the model output but also describes a number of limitations. These include:

- Comments on recharge assumptions (p.27) ‘This is a standard approach in many models and is quite appropriate in many situations and as a first pass estimate of recharge.’ Then on p.29, ‘...A significant problem with the current model is the method of estimating recharge, there is a need to account for antecedent conditions’
- ‘Seed values for aquifer parameters were not plentiful for this model. This particularly applies to values of storativity. Limited values of hydraulic conductivity are available for pumping tests’ (p.27).
- ‘Although a model is very capable of producing estimates of system response over large areas with many complex interactions it is not a tool to predict the future (p.30)’.

Prof. Volker (2000) provides more critical comment on the Kalf modelling. These include ‘..it is not clear there has been a meaningful attempt to ensure there are no anomalies between results generated by the model and information such as is available from local residents’ (p.2).

Prof. Volker also draws attention to assumptions regarding the values used for recharge. These comments include ‘...the basic message is that effects of drought on water levels are subject to a great deal of uncertainty and it would be prudent to include consideration of all relevant information’ (p,1).

Dr. James (1997) also provides comments on the Kalf modelling. These confirm the comments above that ‘the model performs well when conditions are reasonably isotropic, as in sands or in artesian basin conditions’ (p.9). He also questions that the model ‘...simulated changes in the nature of the limestone by varying horizontal permeabilities in different areas. This is no doubt a valid approach in modelling although no justification of the physical base for this is offered’.

However the major limitation is that the model does not appear to have included data on mine pump-out or recognised the major decreases in irrigation use since 1980. Indeed, it does not appear to have seriously addressed any such form of post-mine water budgeting, a lack that has been consistently made by all reviewers such as the Golder Associates reports.

2.2.6 THE FUTURE

2.2.6.1 Introduction

Depletion of groundwater and reductions in surface flows in the disputed Bracewell area due to the effects of the mine are not accepted by QCL or the regulatory agencies. It is the contention of this report however, that there have been major falls in the groundwater levels and in surface water flows, especially for Machine Creek in the Bracewell area, that are dominantly due to the mine.

These changes have already had deleterious economic and social effects on the landholders and adverse effects on the biota of the surface streams. Given the dispute over many of the basic facts it is difficult to provide an account of possible future effects. The only estimates of likely future falls in the groundwater level in the disputed area is given by Dr James (1997) and more recently by EEMAG.

James suggests (on p.10) that the depletion in the most affected Bracewell area could amount to 17 metres in the next 10 years. In the period prior to 1997 he considers the drop attributable to mine de-watering to have been in the range of 5-7 metres. In addition the area of depletion would become much more extensive. Such extrapolation is problematic and could be modified if the linkage between the Bracewell and East End zones of depletion changes due to further falls in level. There will also be perturbations in the level that reflect short-term changes either due to drought or to periods of heavy rainfall causing temporary rises in groundwater levels. However, the overall decline in the water table experienced in the Bracewell area will continue.

The voluminous accounts of the possible effects of mine de-watering contain little mention of the effect on surface stream flow. It is apparent that there have been progressive and continuing declines in flow in Machine Creek. This has changed from effectively a perennial stream to one that only has surface flow following periods of relatively heavy rain. This reduction in flow has been accompanied by major changes in the aquatic biota. It would be

useful to obtain the opinion of the DNR as to whether, if such flows reductions are due to mine activity, they contravene any existing environmental legislation. The discussion to date has focussed exclusively on the economic and social effects of mine de-watering with little mention of environmental effects.

The future of the Bracewell area can be considered under three headings. These are:

- effects on the landholders and environment;
- the legal implications;
- remedial measures.

2.2.6.2 Effects on landholders and the environment

The thrust of this account is that groundwater levels and surface water flows in the Bracewell area have already been adversely affected by the mine de-watering. This has depleted the yield that can be obtained from boreholes and from pumping in times of drought from the previously perennial streams. These effects have been a major factor in causing the reduction in the pumping for irrigation predominantly for irrigating pasture. This has resulted in declining land values for the properties.

These changes are continuing and the groundwater levels and surface stream flows will continue to be adversely affected. Such changes will continue into the future and the area affected will continue to increase. This has and will continue to adversely effect the livelihoods of those resident in the area.

2.2.6.3 Legal implications.

It has been accepted from the granting of the initial lease that ‘...QCL undertakes to provide an equivalent replacement of water supply where a landholder is injuriously affected by mining’. For example, see the Environmental Management Overview Strategy (EMOS) dated July 1996.

The problem is the divergence of opinion on whether the Bracewell area has been adversely affected by mine de-watering.

It is noted that the discussion on ‘injuriously affected’ is always within the context of groundwater, as outlined above the effects on surface stream flows are not specifically addressed. It is the contention in this review that the effects on surface streams also cause economic and social hardship as well as detrimental environmental effects, eg. to aquatic biota.

2.2.6.4 Remediation

Four remediation techniques are available to make good the effects of mine de-watering. These are:

- cartage of water;
- the construction or deepening of boreholes;
- artificial recharge of aquifers;
- Grouting of limestone aquifers.

Cartage of water can only be effective when the quantities of water are small, ie for domestic supply, watering stock or for the most minor industrial uses. It is not viable as a replacement for lost supply for irrigation purposes.

Construction or deepening of boreholes is the preferred QCL remedy. There is doubt as to whether this would be a successful long-term remediation measure in the depleted Bracewell area. As Dr. James comments (1997, p.10), there is evidence that ‘...karst activity appears to diminish with depth’ and ‘...bores will have a lower probability of encountering good supplies’. If borehole remediation was proposed in the Bracewell area it would need to be preceded by extensive additional hydrogeological investigations.

Artificial recharge is a technique that brings in water from outside the depleted area to recharge the aquifers. In the Bracewell area this could be from the mine pump out, by diverting surface streams not affected by mine activity or from reservoirs in the region. It is important that the quality of the recharge water is not inferior to the supply which it is replacing.

Such waters are recharged into the aquifer either from unlined recharge ponds (these need not be large in surface area) or by borehole injection.

Recharge techniques are well understood although not widely used in Australia. There are however, problems in applying this technique to areas of karst limestone. There is always the possibility that the recharged water can flow away from the area in fast flow conduits. There are instances where water from mine de-watering is pumped into a nearby stream or down injection bores only to re-appear in a short time back in the mine!

Nevertheless artificial recharge remains a possible remediation measure, but with the acceptance that there is a lesser chance of success in a limestone aquifer than in other commonly occurring rock types.

Grouting is essentially undertaken by pumping cement into injection boreholes so as to block the fissures and conduits usually, but not exclusively, in limestone bedrock. Typically it is used to ‘waterproof’ major dams that have experienced leakage by flow under or around a dam sited on limestones. Dr. James (1997) gives an outline of how grouting could perhaps be used to form a barrier in the vicinity of Weir 2. Grouting of limestone aquifers is an expensive measure and there are many examples where it has not been a fully satisfactory solution to seal aquifer links.

2.2.6.5 QCL Experience

QCL has used water cartage, and borehole deepening and construction in areas close to the East End Mine where there is no dispute as to effects of mine de-watering. It also planned and partly implemented an artificial recharge scheme in the same area. This was to employ borehole injection techniques and it is understood that this was abandoned in part due to the concerns of the potential users as to the quality of the recharge waters, mainly related to increased salinity values.

2.2.6.6 Summary

It is the contention of this review that, commencing in the late 1980s, the disputed Bracewell area has experienced serious depletion of groundwater and surface supplies. The timing corresponds to the introduction of mine pumping. Further expansion of the mine will undoubtedly exacerbate these effects with further and progressive depletion in areas affected to date and the extension of the effects to contiguous landowners.

Such depletion has had major adverse impacts on the livelihoods of those resident in the area especially upon any form of agricultural activity that is dependant on local water supply, notably the raising of cattle. For many the depletion of water has changed the form of agriculture and contributed to the perception of a ‘blighted community’. Not only has the way

of life changed but the effects on water supply, vital to agriculture, have caused declines in the value of property. Even if QCL accepted that mine de-watering was responsible for such rural decline it is unlikely that remediation of the water depletion would return the community its pre-1990 way of life.

In the Terms of Reference negotiated for the Golder Report it was agreed the precautionary principle would apply. There is little evidence that the EPA or DNR&M have adhered, or required Golder Associates' findings to comply with Ecological Sustainable Development or the guiding principle of their Code of Practice, namely "... where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation." This especially applies to the changes in surface and groundwater resources that have occurred in the Bracewell area since the commencement of mining operations over twenty years ago.

List of Figures

Figure 1: James 1997 CLG Report and Smith 2003;

Figure 2: CLG Report 1997;

Figure 3: DNR, Bracewell-East End Area Estimated Water Level Differences Full Supply

Level – Dec 1996 with added 5m contour line.

Figure 4: Smith/Spate Rainfall and Streamflow Data (for Machine Creek)

Figure 5: Smith/Spate Even Count Partition Flow Super-events (for Machine Creek)

Figure 6: Smith/ Spate Easily assimilated rainfall and reduction to streamflow for Machine Creek.