Best practice principles of mine site monitoring and analysis of water

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Introduction

Sources of contaminated water on mine sites

- Pit and underground dewatering
- Process water storage
- Seepage or overflow
- Pits

Specific composition and physico-chemcial characteristics determine quality of water

Monitoring waste water at mine sites
Physico-chemical monitoring

- Use of ICP-MS scans
- Identification of specific tracers
- Identify presence of toxic species

To establish water quality criteria for protection of aquatic ecosystems need to measure a wide range of parameters initially

Examples of ICP-MS application from Northern Territory mines

- Identification of rhenium as a specific conservative tracer in waste water at Ranger mine
- Presence of elevated cadmium and low arsenic levels in Main waste rock dump seepage as distinguished from tailings dam and other pond waters (lower cadmium) at Pine Creek gold mine

To establish toxicity of water it may be necessary to measure chemical forms, eg AsIII compared with As V

Monitoring waste water at mine sites
Biological monitoring

- Use of aquatic fauna assemblages
- Toxicity testing of effluent
- Bioaccumulation of contaminants

Such tests give a more realistic assessment of the effects of waste water on aquatic biota

Factors associated with best practice principles
Methods of water release

- Undertake stream gauging and measure flow
- Collect rainfall and evaporation data
- Make precise catchment delineation
- Understand other sources of water eg ground water
- Catchment runoff coefficients

Such data needed to quantify loads of constituents and apply water management procedures

Factors associated with best practice principles
Water discharge criteria (ANZECC 2000)

- Go through ANZECC process and determine environmental values
- Determine suitable sampling sites
- Acquire baseline data

Factors associated with best practice principles Following commencement of mining

- Characterise waste waters (ICP MS)
- Undertake detailed catchment modeling
- Undertake pre-release toxicity testing
- Undertake aquatic assemblages survey
- Undertake bioaccumulation studies with organisms

Case study of Gympie Eldorado Gold Mine Queensland

Outline

- 1999 Summer Excess Wastewater in Tailings dam needed disposal
- Lack of safety margin
- How to devise water release
  - No impact to aquatic ecosystem
  - No risk to man

Solution was to go beyond 1992 Guidelines

How this was done a working model

Mining Project

- Gympie Eldorado Gold Mine an underground mine and mill
- Nearby Gympie 21 000 people mixed economy, range of non-mining activities
- Mining encounters groundwater with 0.9ML pumped to Mary River
- INCO process destroys cyanide before pumping to storage

Excess Water Accumulation

- Gympie experienced wet weather for 2 years from August 1998
- Mid Feb 1999 equal-record flood added 259 ML to tailings dam (capacity 450 ML)
- Approach to Minister for Mines 7 April 1999 who requested scientific studies, close consultation with stakeholders and other groups to devise controlled discharge plan

Approach Taken

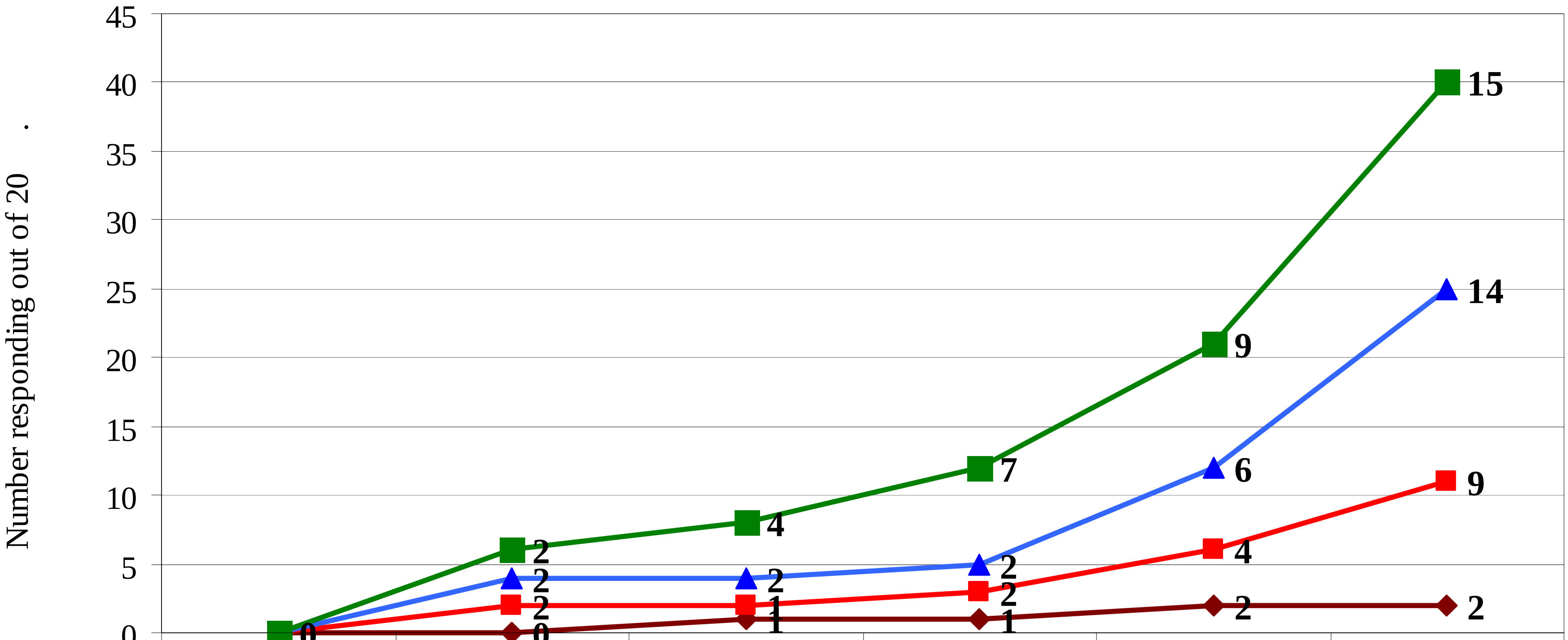
- Draft plan devised by authors
- Company sought to operate within the new ANZECC (2000) guidelines
- Arsenic, cyanide, mercury and other heavy metals well within ANZECC 1992 guidelines
- Consultation with community groups July-Sept 1999 gave feedback
- Final plan approved Sept 1999 for 350 ML over 9 month period commencing October 1999

Studies Prior to Release

- Comprehensive identification of contaminants
  - Antimony a limiting constituent
  - Nitrate may be limiting
  - Proposed a safe dilution of 1:20

Studies Prior to Release

- Pre release testing of waters
- Laboratory studies using 2 crustacean species
  - *Daphnia carinata*
  - *Paratya australiensis*
- Bioassay data supported a dilution of 1:20 causing no adverse effects



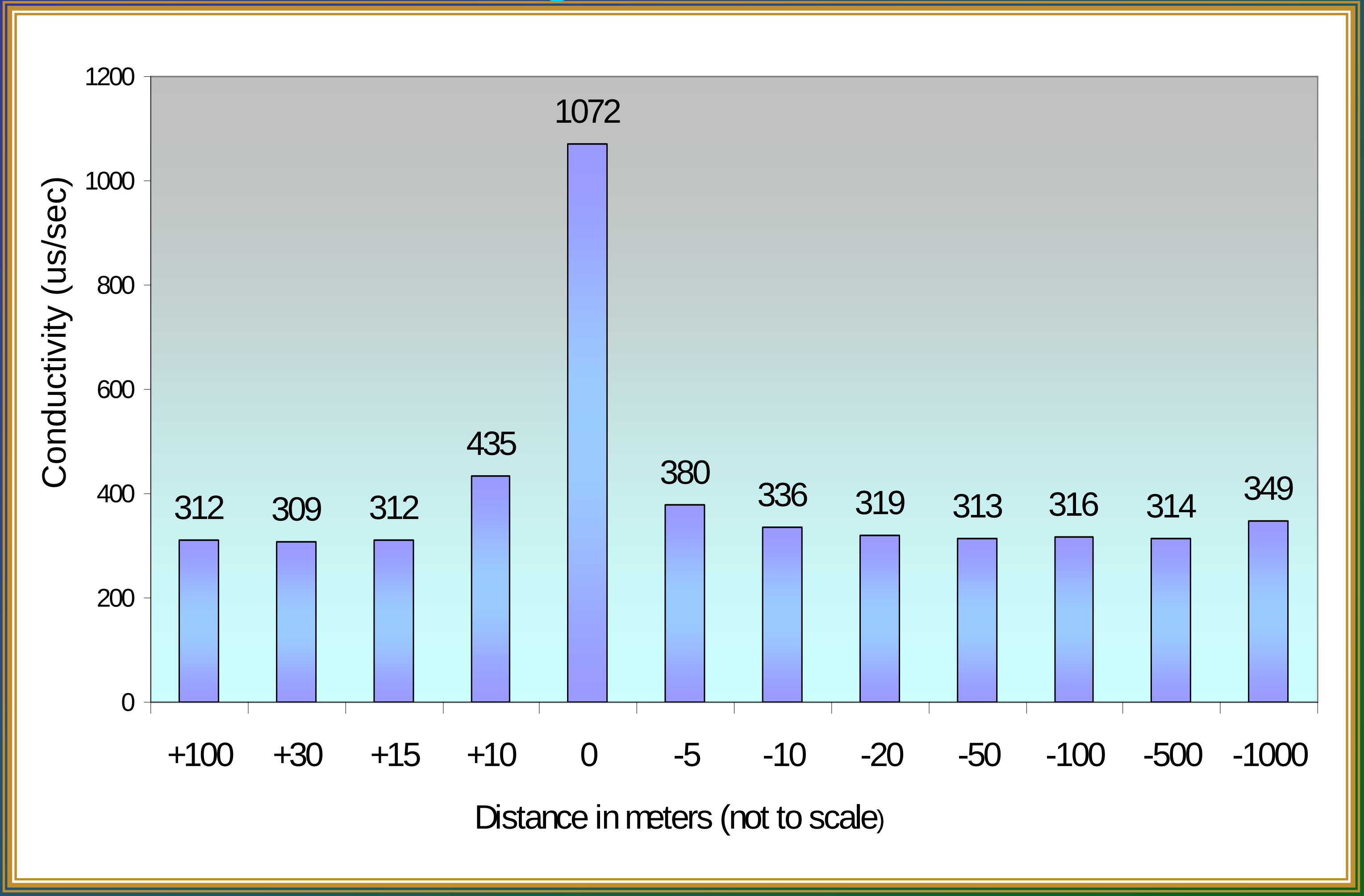
	river water	5% discharge	10% discharge	20% discharge	50% discharge	100% discharge
96hrs	0	2	4	7	9	15
72hrs	0	2	2	2	6	14
48hrs	0	2	1	2	4	9
24hrs	0	0	1	1	2	2

Percentage of discharge water diluted with river water

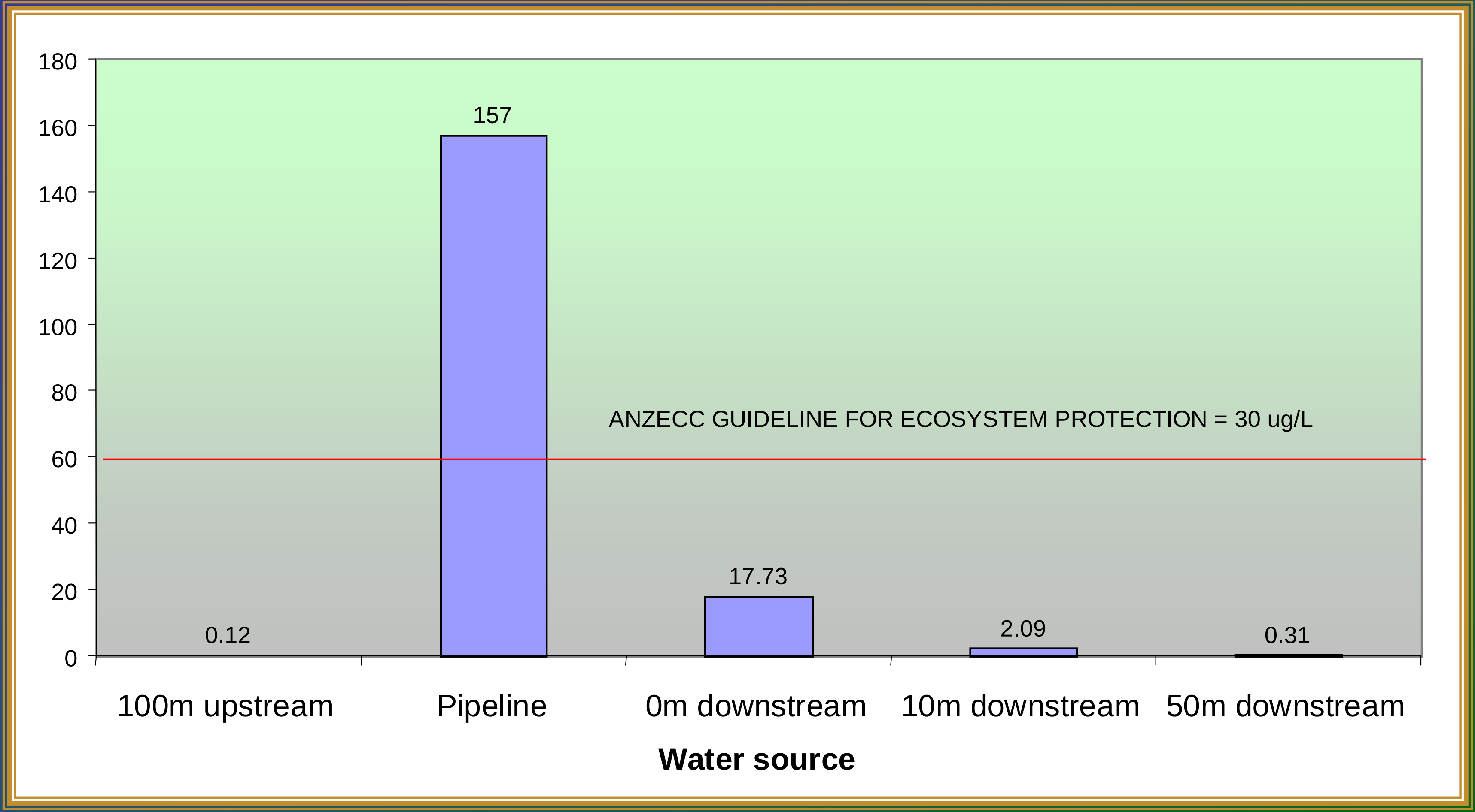
Studies undertaken during release Commencement of release

- Release water was pre-mixed tailings and mine dewatering 2:1
- Quality monitoring of results
- In stream validation 2 tests applied
  - Laboratory bioassay with *Paratya*
  - In situ bioassay
- Characteristics of discharge
  - Conductivity profile
  - Chemical analysis of test and discharge water

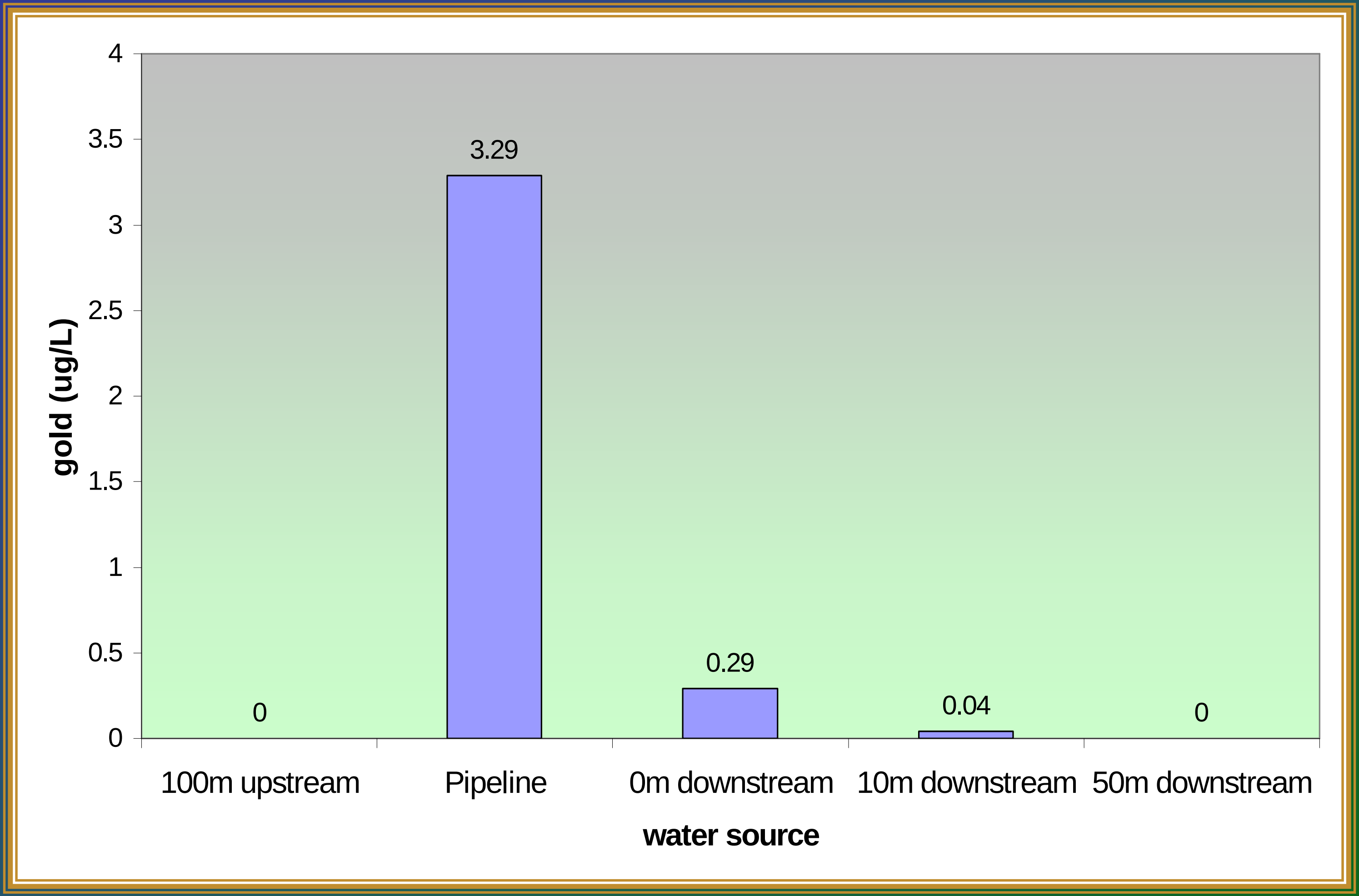
Conductivity measured upstream and downstream of discharge point. Positive values are upstream and negative values are downstream from discharge.



Concentration (μg/L) of antimony upstream, at the point of discharge and downstream.



Concentration of gold upstream, at the point of discharge and downstream



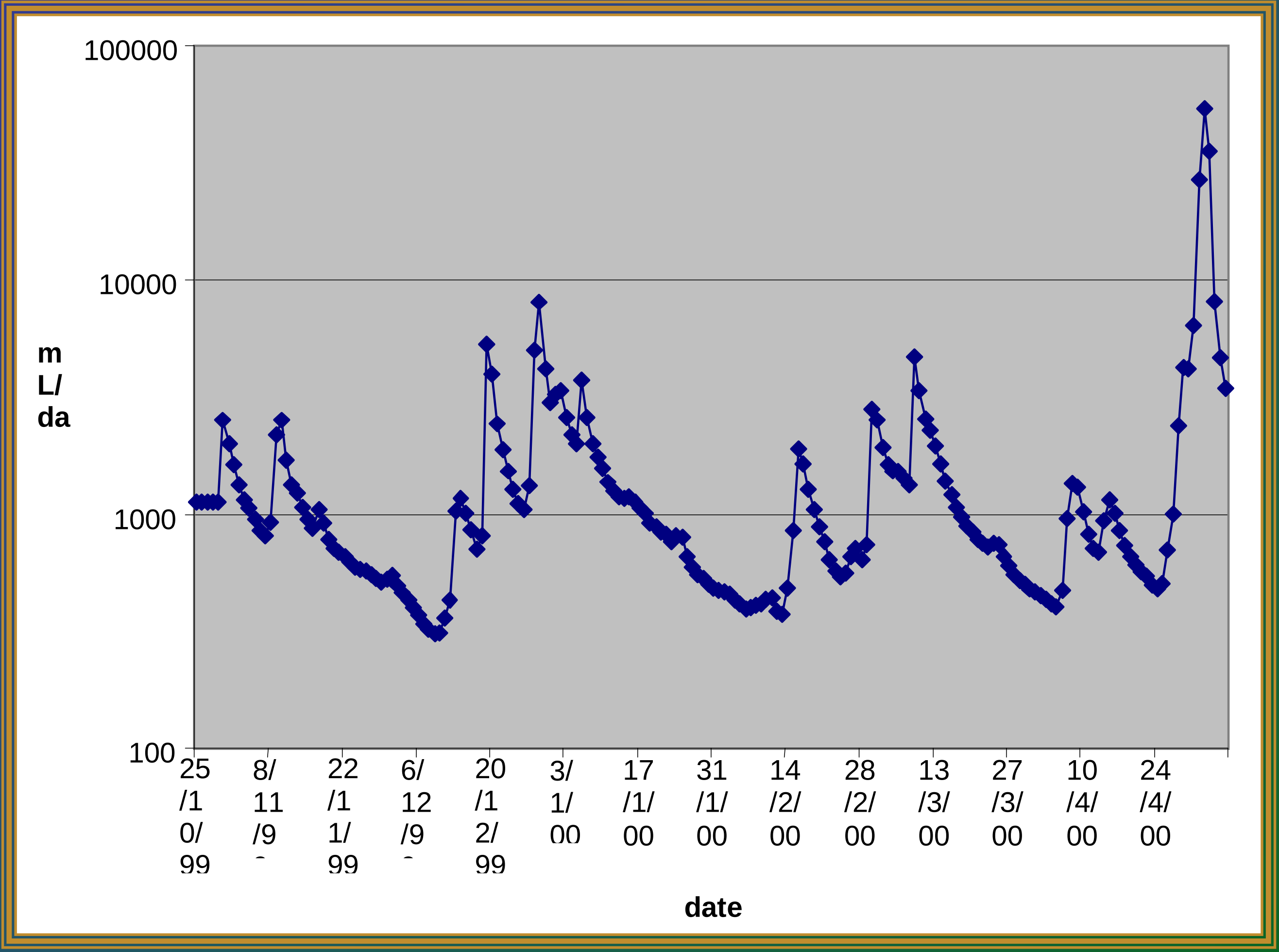
Confirmation of River Health

- Repeated in stream validation
  - Redesigned cages to retain shrimps for 96 hr
  - 5 different sampling points
- Laboratory confirmation of in stream data

Monitoring data during discharge October 1999 – May 2000

- Pump rates rainfall and river flows
- Monitoring data

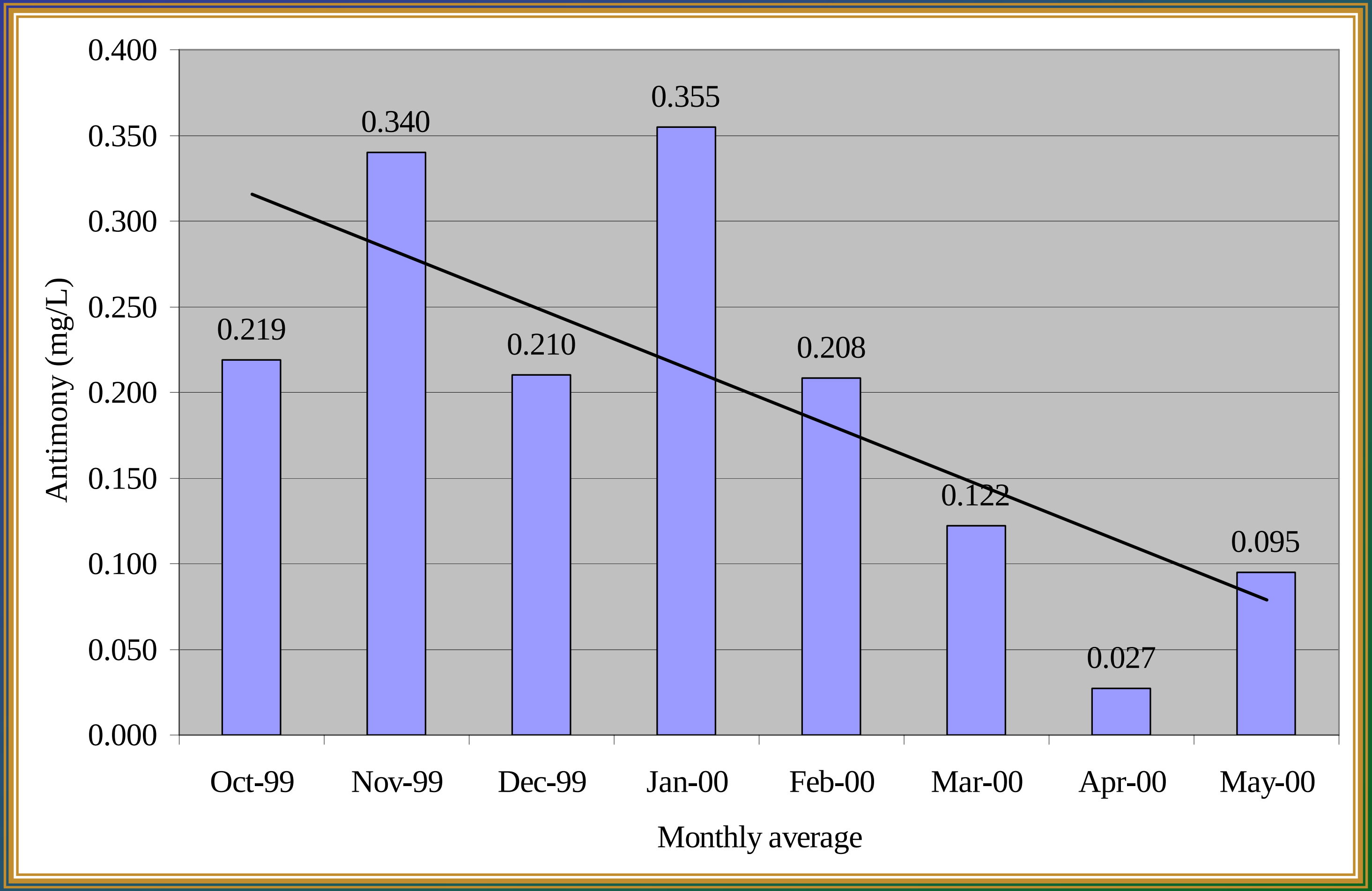
Mary River flow data 25 October 1999 to 7 May 2000



Summary of Studies

- General features of discharge
- Significance of controlling physico-chemical variables
- Significance of bioassay and in stream validation

Figure 6 Average monthly antimony levels in the surge tank including linear trend line.



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