

Historical use of mercury in legacy goldmines in Queensland

- Gavin Miller



Scottish Gympie Gold Mine circa 1900

FATE OF NATURAL AND ANTHROPOGENIC MERCURY AND THE MARY RIVER, SE QLD: A CHRONICAL OF LEGACY GOLD MINING, SUGAR CANE CROPPING AND HG-ORE DEPOSITS

Gympie, renowned for a gold discovery in 1867 in the nascent state of Queensland lies on the Mary River. An ensuing gold-rush transformed Gympie into a major gold producer with some 116t of gold won from >40 large mines in the historic period to 1925. Mercury amalgamation in at least 10 batteries was responsible for most gold recovery. Tailings were discharged either directly or to creeks draining to the Mary. At Cinnabar on a tributary of the Mary ore deposits discovered in 1872 were worked for Hg periodically through to the end of World War II. Additionally, Hg-based fungicides have until recently been utilized by the sugar cane industry on land in the lower reaches of the Mary. The fate of these Hg sources in a river that discharges into Korrawinga (Great Sandy Strait) which borders K'gari - a combined Ramsar/World Heritage site, is unknown.



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A MINERAL of a perfectly singular kind," wrote Englishman John Hill of mercury in the 18th century. "It penetrates the Substance of all Metals, and dissolves, and makes them brittle." Today many of us have come to share the old scientist's wonder at mercury's perfect singularity—but our wonder is mixed with fear of the element as a pollutant, and with confusion about the extent of the danger it poses.

The confusion is understandable. For years most of us thought of mercury, if at all, as that silvery liquid in thermometers. Then, suddenly, we became aware of mercury's double nature. It can be a deadly enemy, striking down even the unborn. Yet it plays a vital role in our daily lives.

We learned of a New Mexico family poisoned after eating meat from a hog fed with mercury-treated seed, of rivers and lakes closed to fishing because of mercury contamination, of canned tuna being removed from supermarket shelves, and of giant industries shaken by charges of pollution. Then came scientific reports that challenged some of the government's protective measures.

Earlier this year grim reports from Iraq reminded us again of mercury's perils: When a large shipment of mercury-treated grain seed was distributed, villagers used it to make bread and to feed animals. Some 450 people died and thousands more were afflicted.

Looking into the mercury question, I traveled across the United States and around the world: to Spain, where men have mined the element since before the time of Christ; to Japan, where a score of teen-agers still suffer the agonies of mercury poison ingested while in their mothers' wombs; to Sweden, where scientists and government officials, acting to save vanishing bird populations, pioneered mercury-control studies.

The answers I received sometimes differed, but on one thing all were agreed: "The great mercury scare" provides a textbook example of the kind of problem we will meet again and again in our chemical-filled age. The lessons we draw from it can serve us in confronting similar challenges to come.

The story of mercury, also called quicksilver, begins some 4½ billion years ago, when the earth was formed. It is an element, a metal, like copper and iron. It is about 1.2 times heavier than lead. But unlike any of these, it has a melting point of -38° F. (iron, by comparison, melts at +2,795° F.), so that we usually see mercury as a liquid. During the passage of eons, it worked its way throughout the earth's surface—appearing in rocks, soil, water, air, and living organisms.

At some prehistoric time a man was attracted by a red rock. He picked it up, mixed bits of it with water, and found that it could be used to draw on the walls of caves. The rock was cinnabar, the sulphide ore of mercury. Archeologists have found it used as a pigment

Quicksilver and Slow Death

By JOHN J. PUTMAN

NATIONAL GEOGRAPHIC STAFF

Photographs by

ROBERT W. MADDEN

Fluid as water, brilliant as silver, heavier than lead, mercury spills through a mine worker's fingers. A unique element—the only metal that is liquid at room temperature—mercury has fascinated mankind for centuries. Ancients used its compounds for medicines and pigments. Today thousands of products—from thermometers and light switches to pesticides—depend on its unusual properties. But recent tragedies, caused by rising levels in the environment, have shown that mercury can be a deadly servant.

the separation of lithium 6, an isotope involved in the fusion reaction in hydrogen bombs.

When American astronauts left for the moon, they carried long-life mercury batteries to power emergency lights. The same batteries power military radios, the sensors dropped along enemy supply trails in Viet Nam, and the cardiac pacemakers that have been sewn into hundreds of thousands of patients to keep their hearts beating steadily.

From Japan Comes a Dire Warning

It was in 1953 that man received his first notice that mercury's marvels came with a price tag higher than occasional occupational illnesses. That year in villages around Minamata, a small city on Japan's island of Kyushu, fishermen and their families began to fall victim to a mysterious and catastrophic disease. When I journeyed there, I found some of the villagers still paying that price.

Shinobu Sakamoto, 15 years old, lives in the village of Yudo. When she appeared in the doorway of the room where her mother and I sat talking over cups of green tea, I was struck by her loveliness: almond eyes, a bright smile, and a willowy body. She tossed down her book bag and spoke to us. The words came out not in the rapid flow of her mother's speech, but slowly, as if with pain, and cruelly distorted.

Mrs. Sakamoto answered with a smile and the girl walked—with a tottering, jerky gait—into the next room. I heard a television set snap on. Now and then, as Mrs. Sakamoto and I talked, we would hear the girl's gentle laughter from the other room.

Shinobu is one of 202 people who were poisoned by contaminated fish from Minamata Bay. Fifty-two died, including Shinobu's older sister. Most of the victims had eaten the fish, a three-times-a-day staple in such humble seaside villages.

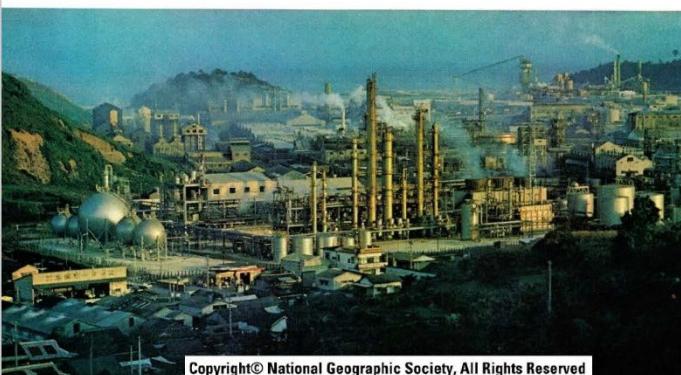
Shinobu had been poisoned while still in her mother's womb. Mrs. Sakamoto herself had experienced no symptoms. But the poison in her bloodstream had worked its way past the placental barrier to wreak its destruction on the unborn Shinobu.

"We did not know anything was wrong with her until, at about 3, we noticed she had difficulty walking and holding up her head; she fell down often.

"We took her to the hospital. By then the cause of the poisoning was known. I was told there was no cure. We could only try to train



CRIPPLED BY POLLUTION, Shinobu Sakamoto struggles to fasten her sweater buttons. She was inadvertently poisoned by waste from a chemicals plant at Minamata, Japan (right). In the 1950's the factory discharged lethal methyl mercury into Minamata Bay. Transferred through the food chain, the mercury became concentrated in fish, from which it passed to the population.



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Minamata

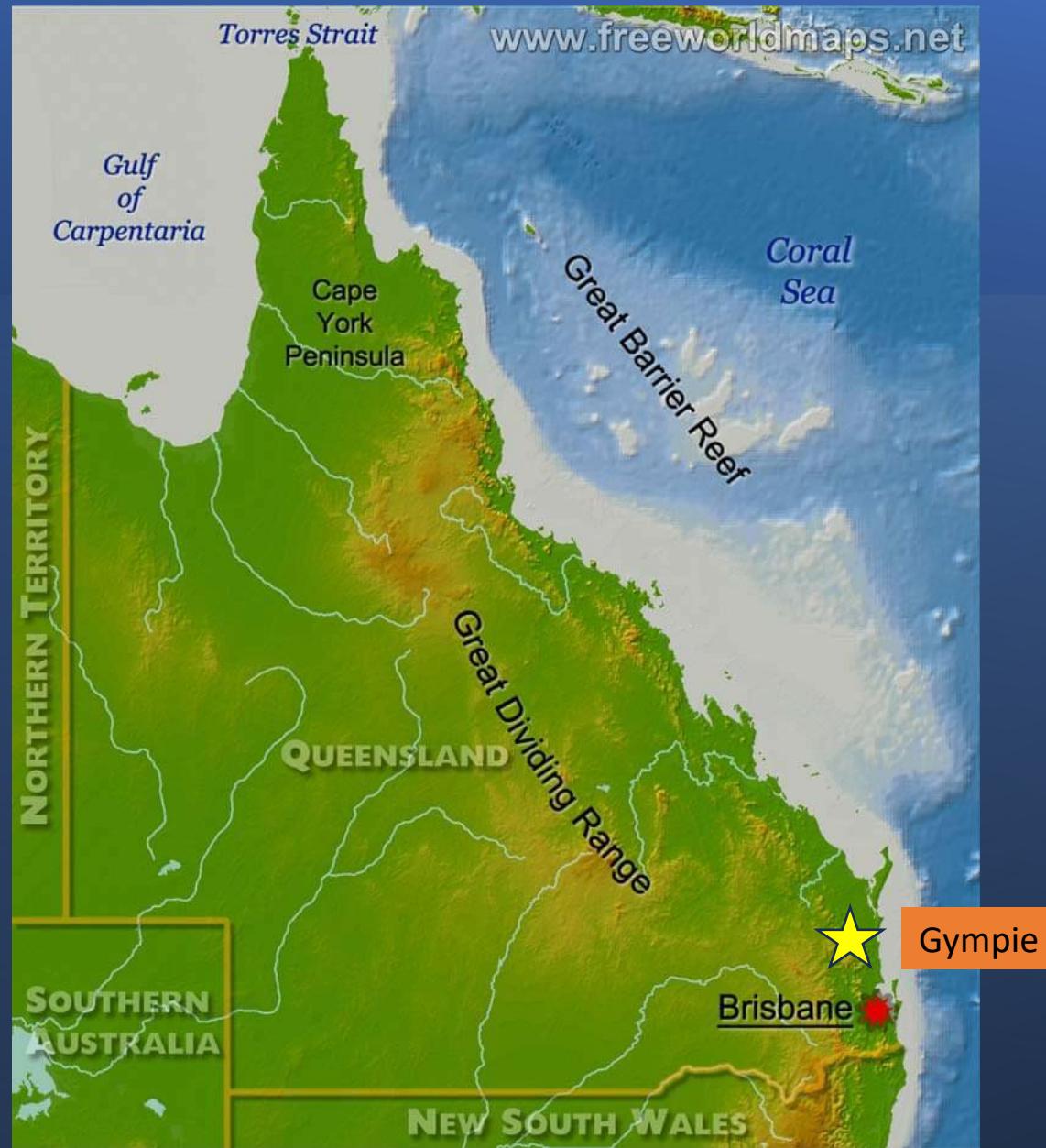


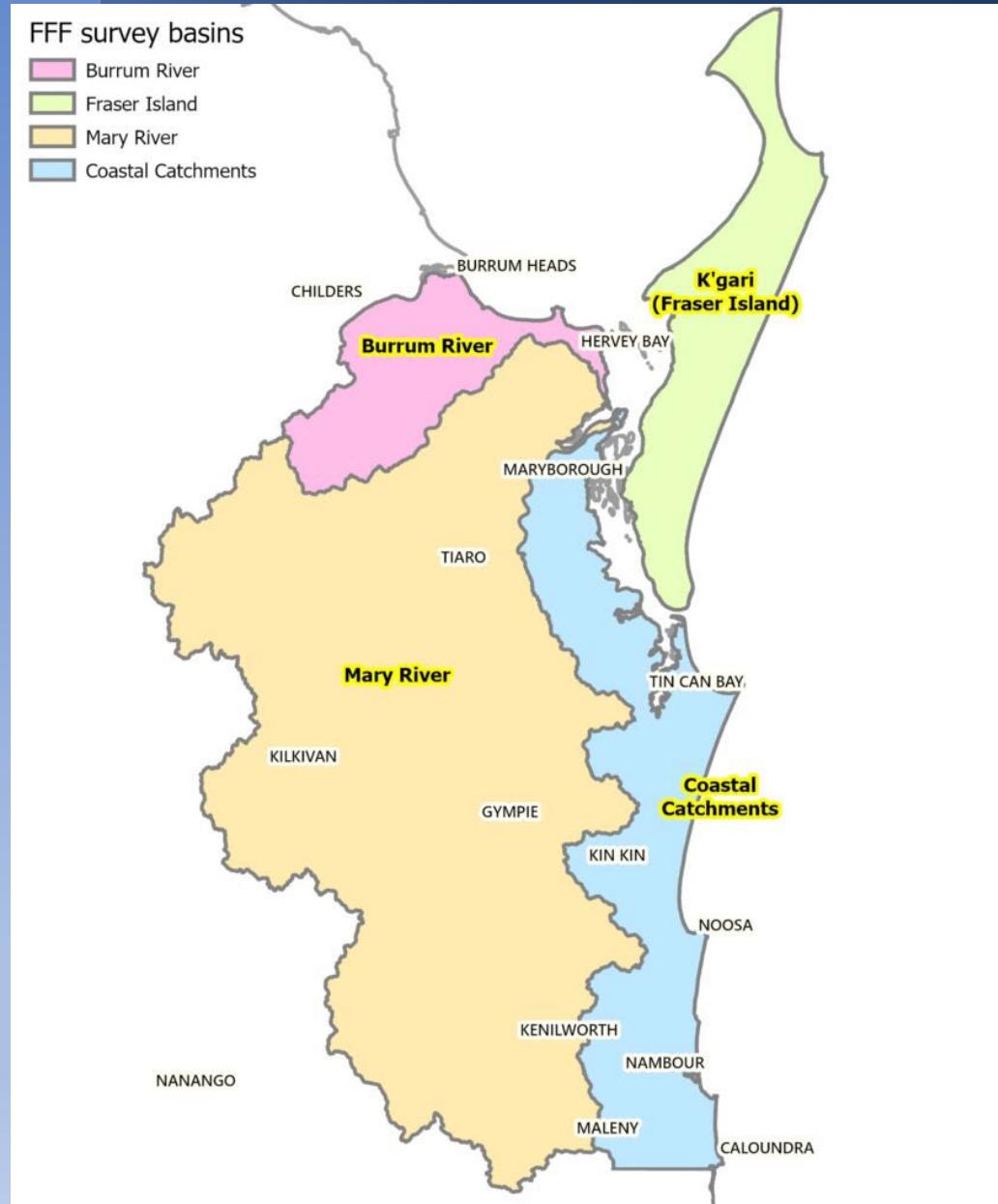
Minamata



Minamata









‘..for every kgm of gold recovered ... loss of 1kgm of mercury to the environment’

THE GOLD RECOVERY PROCESS

The gold—mercury amalgam from the stamper battery amalgamating trays was collected in enamel lined cast iron buckets and the contents pressed to extract surplus mercury which was returned to the storage flask for re-use. When sufficient solid amalgam was obtained, it was put into a retort which was then sealed and placed in the furnace. At a temperature of 250°C mercury sublimes (turns to vapour) and is condensed in the usually water jacketed tube for reuse in the stamper battery. It is worth noting that for every kgm of gold recovered there was a loss of 1kgm of mercury into the environment.

The gold cake was removed from the retort and placed in a graphite crucible with chemicals such as borax to purify the gold which was then heated to over 1064°C to melt the gold to enable it to be poured into moulds



Gympie Gold Mining and Historical Museum



Pure appl. geophys. 160 (2003) 145–156

Environmental Emission of Mercury During Gold Mining by Amalgamation Process and its Impact on Soils of Gympie, Australia

HARKIRAT S. DHINDSA,^{1,3} ANDREW R. BATTLE, 1
and SVENNING PRYTZ, 2

- *Abstract* — The aims of this study were to estimate the total amount of mercury released to the environment during 60 years of gold mining (1867–1926) at Gympie, Queensland, Australia and to measure the mercury levels in soil samples surrounding the mining activity. We estimated that 1902 tonnes of mercury was released to the environment and about 1236 tonnes of which was released to the air.

Note: 1902 tonnes Hg gross overestimation; > factor of ten

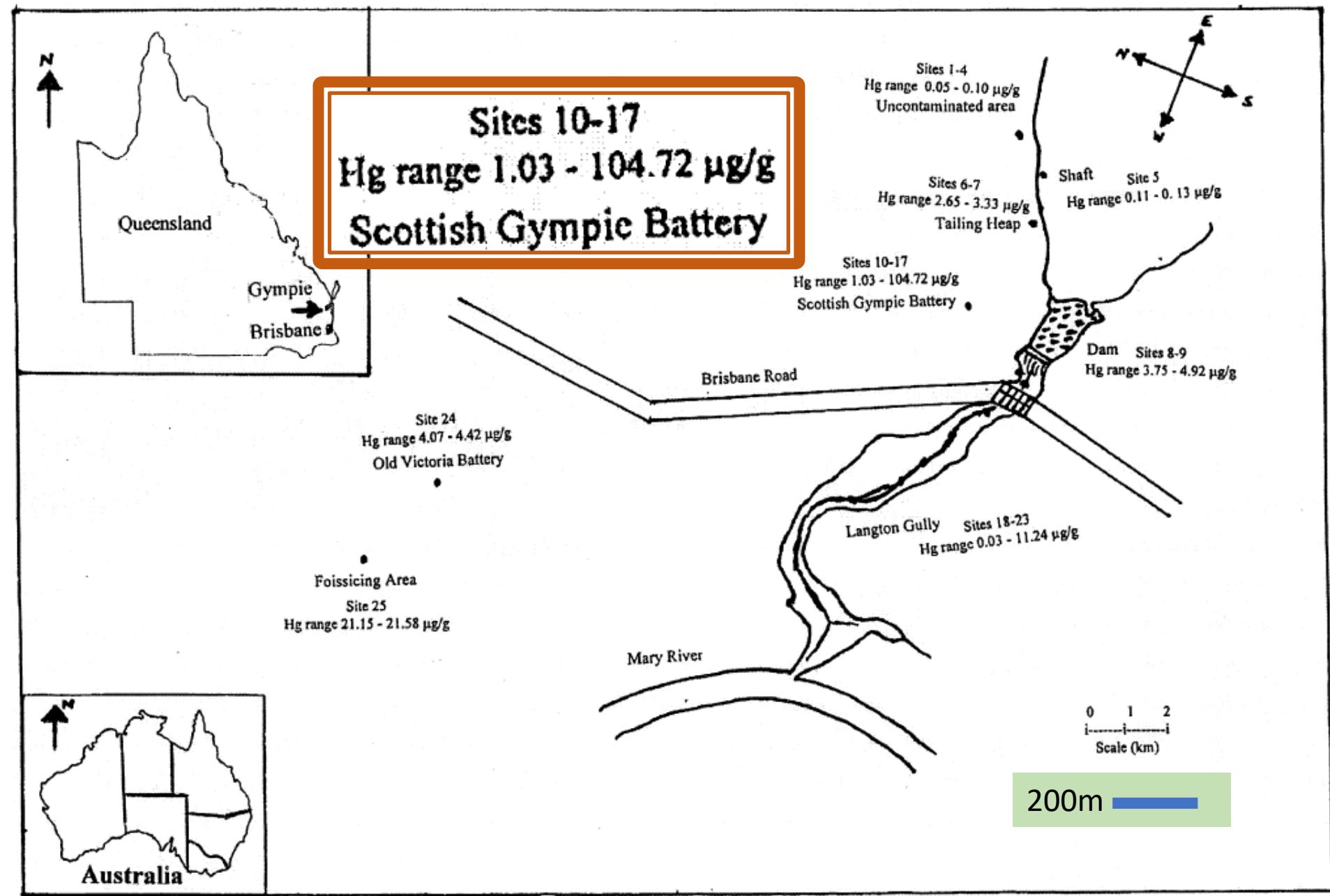
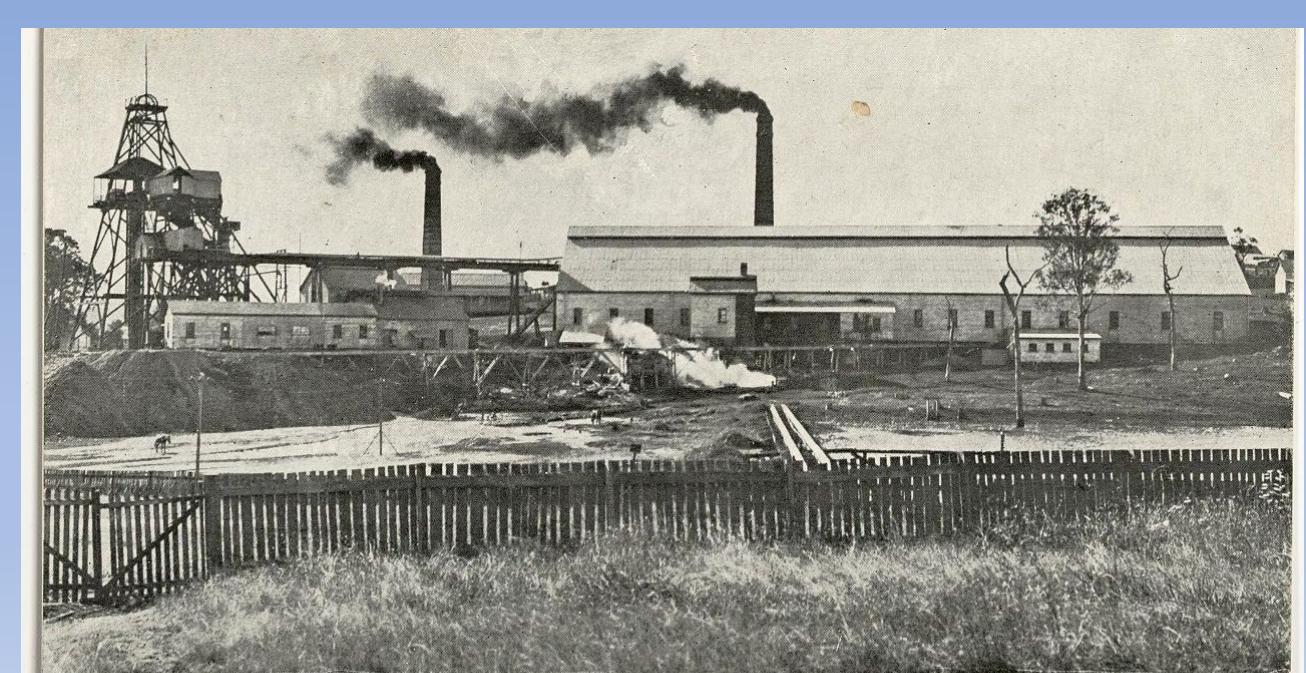
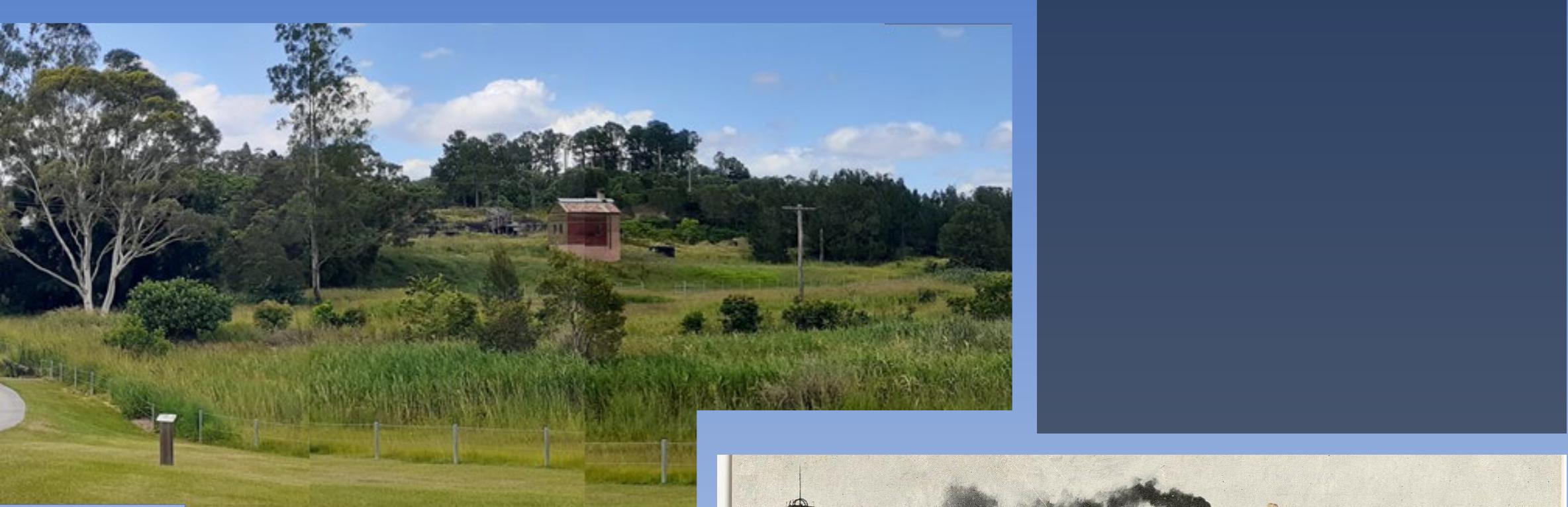


Figure 1
 Study and sampling areas.



THE SCOTTISH GYMPIE GOLD MINES, LTD.

[LEONARD BIRT, PHOTO.

Retort House

29 March 2023

NW corner



Retort House

SW corner

The presence of Hg 'contaminated above BG'

The presence of Hg over the site at levels contaminated above background indicate this contaminant introduced during processing of gold ore is widely distributed. The range found was 0.1- 18.8 ppm, arithmetic average 7 ppm.

9. Surface Water

Water from the lagoon was tested.

10. Groundwater

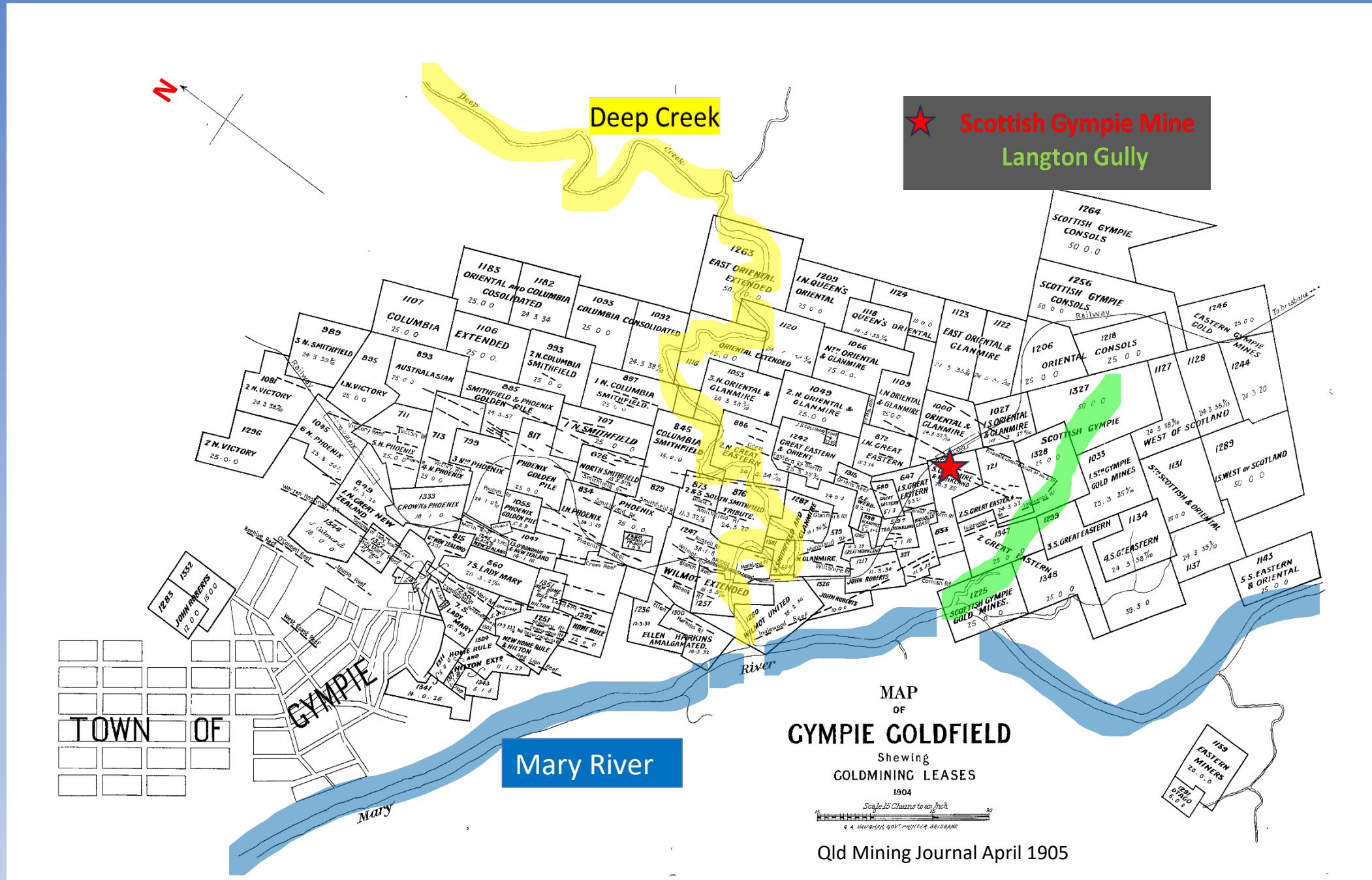
Groundwater testing was not conducted as contaminants are bound to soil and would not be expected to leach into groundwater.

11. Conclusions

Based on these investigations and risk assessment (Appendix 3) for a land use of low visitation, this site is considered suitable for development as a tourist area with appropriate design and management.

Groundwater testing not conducted as contaminants are bound to soil & would not leach into groundwater







<https://www.qld.gov.au/environment/land/management/abandoned-mines/remediation-projects/gympie#gallery-199535-2>

Urban development in Gympie has occurred over historic mining, and as a result subsidence events can pose a threat to buildings

THE GYMPIE GOLD STORY: EXPLORING AND REOPENING A HISTORIC GOLDFIELD IN TODAY'S BUSINESS REALITY.

Ron Cunneen¹ & Ian Levy²

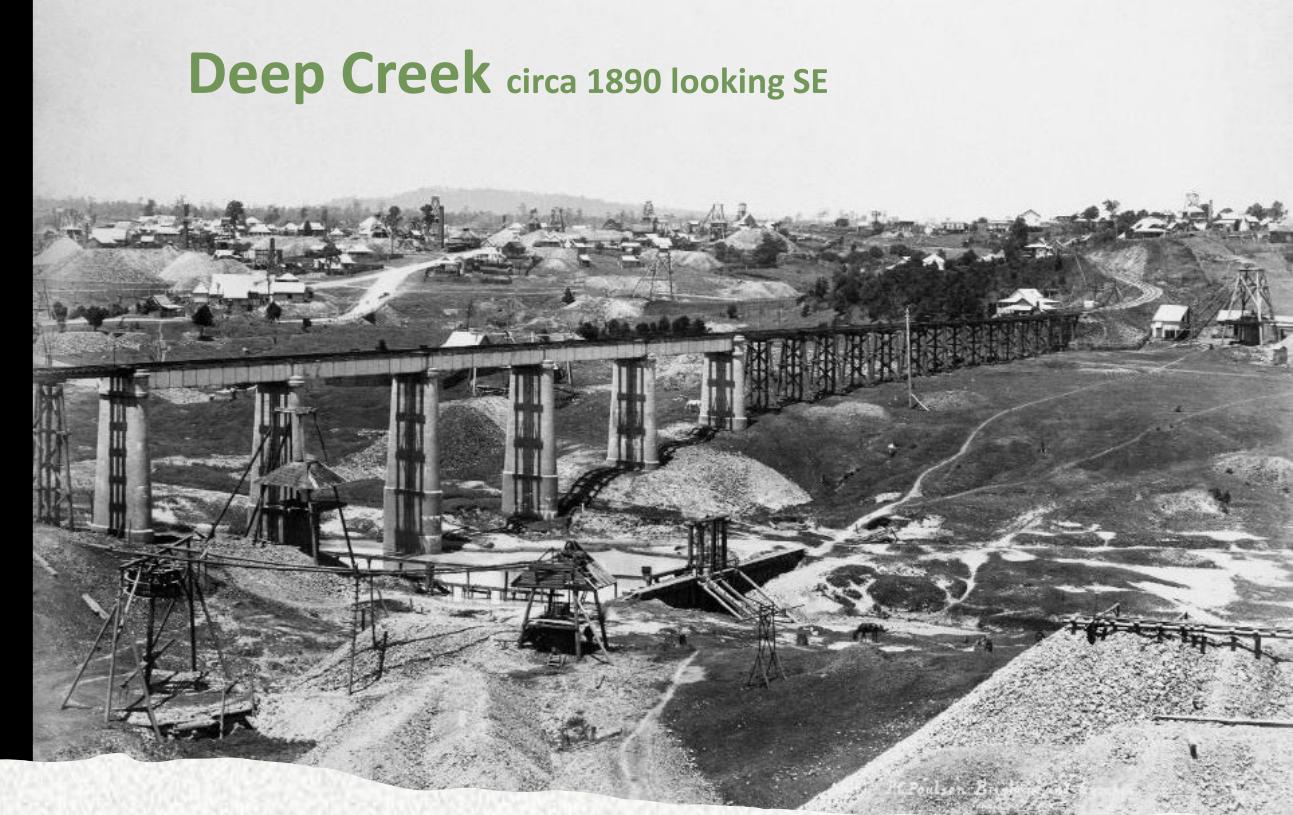
ABSTRACT

Fresh rock chip geochemistry has proven more useful in exploration than secondary geochemical halos in soil and stream sediments because the goldfield is heavily contaminated by 4.5 million tonnes of old tailings and millions of tonnes of mullock that had been distributed widely during and since historic mining.

^{1,2} Exploration geologists, Gympie Gold Limited.



Deep Creek circa 1890 looking SE



Deep Ck / Mary R; Normanby Bridge, Rail Bridge circa 1920





Hg metal present Deep Creek & Mary River (anecdotal evidence)

Photo: Courier Mail 21 Feb '14.

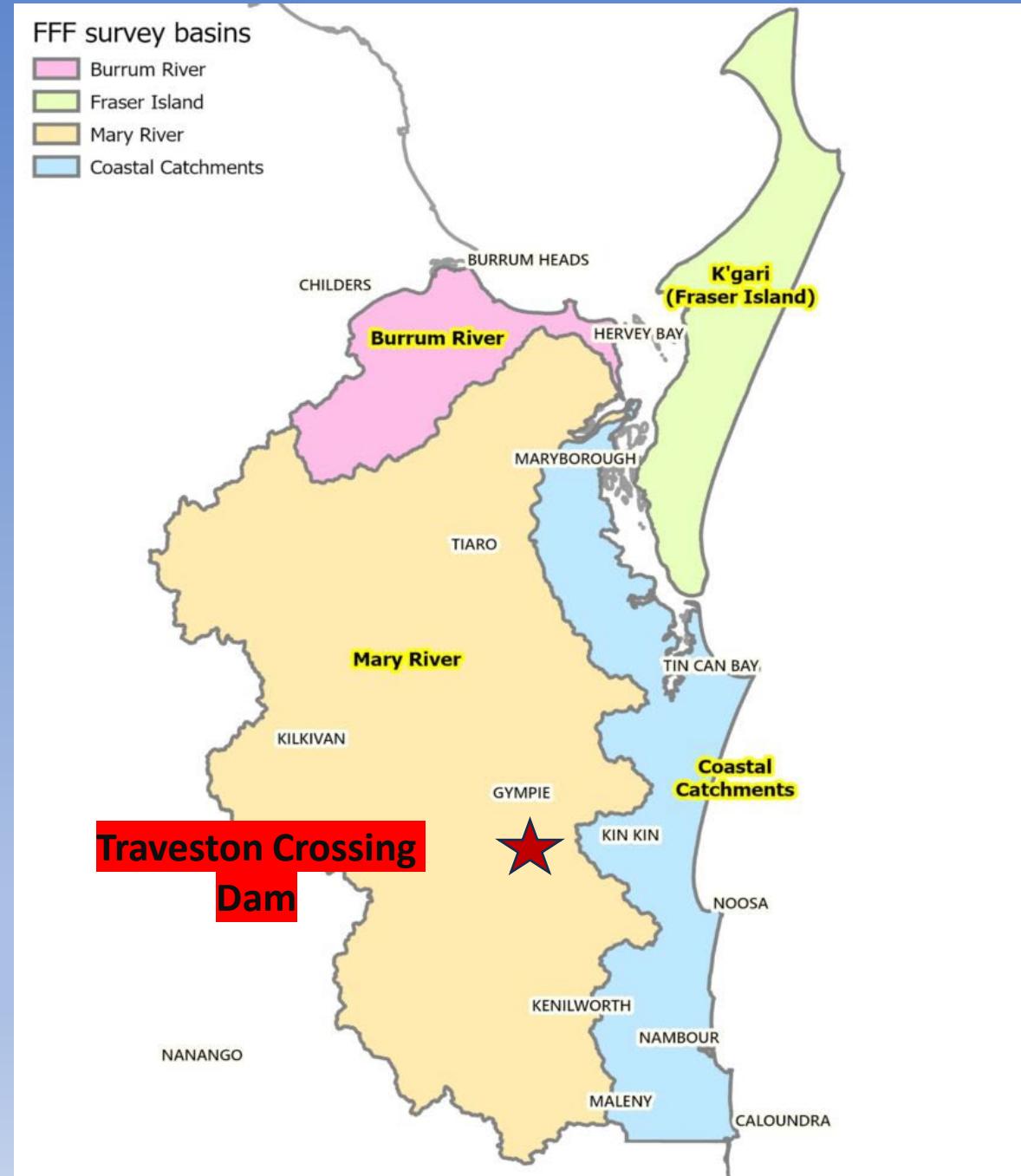
Tailings in Mary River, Langton Gully



This photograph shows battery tailings diverted into the Mary River from mines such as the Scottish and the 2 South Great Eastern.
Source: The Gympie Times, 1902.

Caption of original article: 'View Showing the Silted Up Condition of the Mary River; immediately below the Gympie Waterworks through the constant discharge of tailings and sludge direct into the river bed' (original: The Gympie Times December, 1902)

Photo from Ferguson 2009

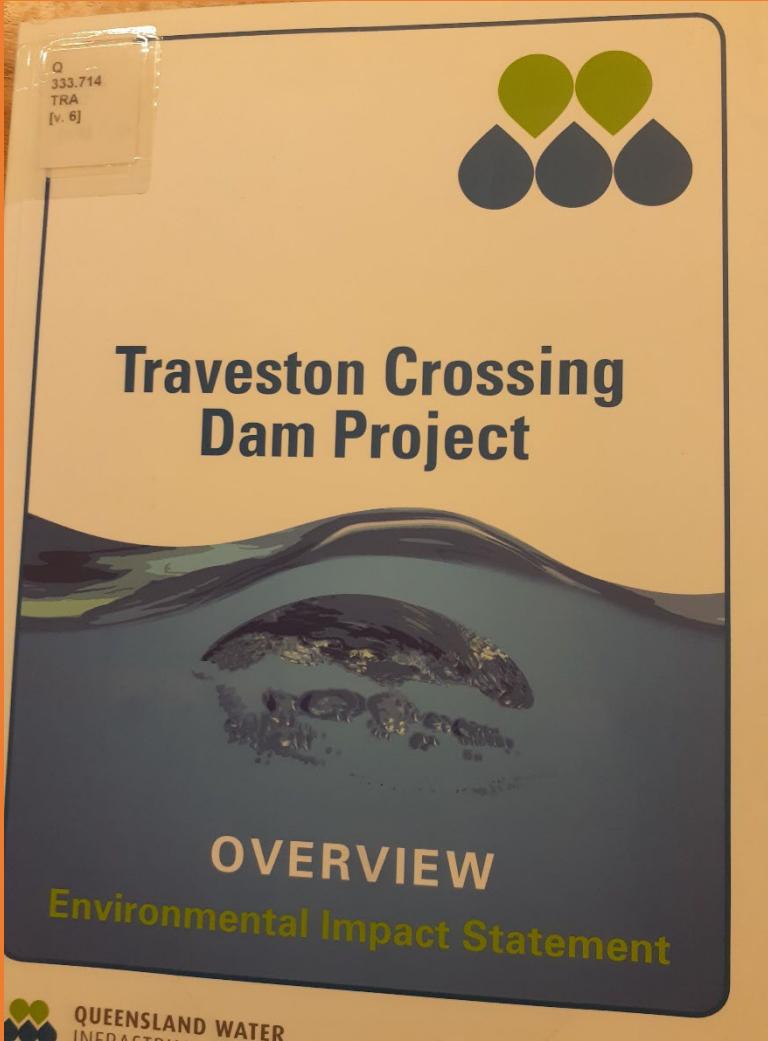


Traveston Crossing Dam – proposed location

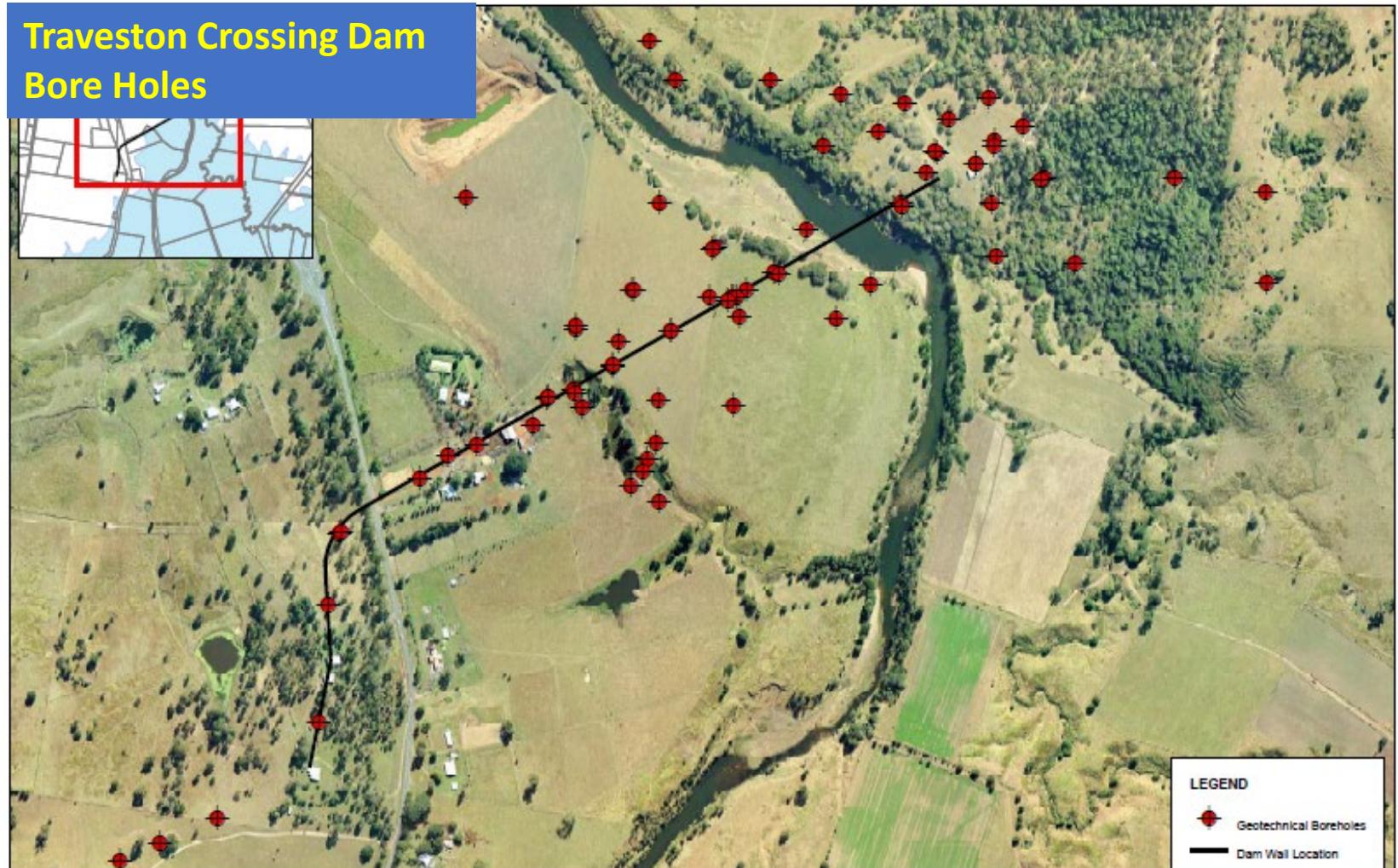


Mary River downstream





Traveston Crossing Dam Bore Holes



NOTES:
1. Digital Cadastral Database (DCDB) current at May 2007
2. Projection - MGA Zone 56 (GDA94)
3. Level Datum - Australian Height Datum (AHD)
4. Full Supply Level (FSL) EL 71.0m



0 37.5 75 150 225 300
Metres

QUEENSLAND WATER
INFRASTRUCTURE PTY LTD
SKM

FIGURE 6-48
TRAVESTON CROSSING DAM EIS
LOCATION OF GEOTECHNICAL HOLES
INCLUDED FOR PACKER TESTING
(BUNWATER, 2007A)

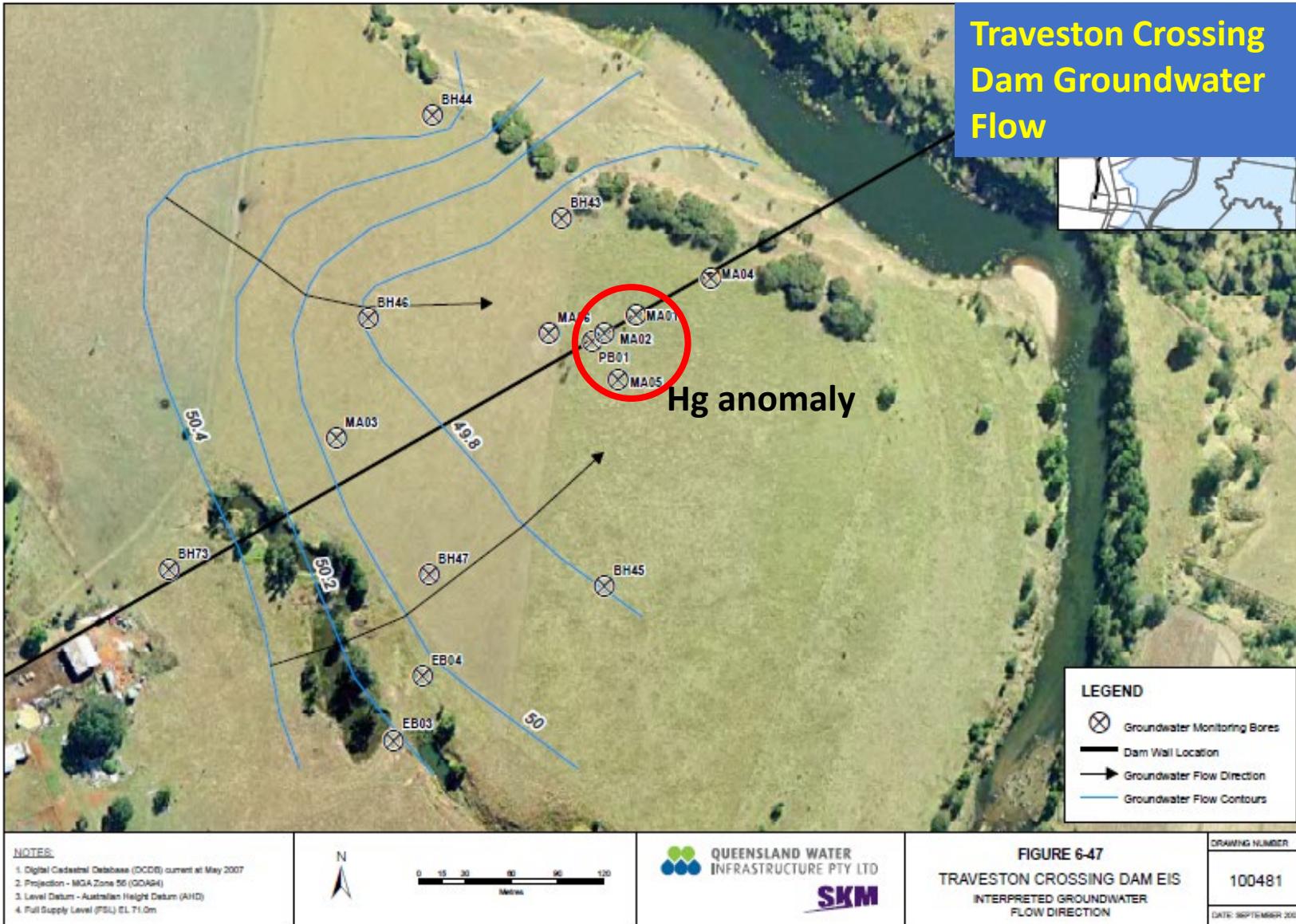
DRAWING NUMBER
100482
DATE: SEPTEMBER 2007

FIGURE 6-48 © Queensland Water Infrastructure Pty Ltd. Unauthorised reproduction of this figure is illegal.

Traveston Crossing Dam Groundwater Flow



FIGURE 6-47 Interpreted Groundwater Flow Direction, Traveston Crossing Dam EIS, Queensland, Australia. The figure shows the location of the Traveston Crossing Dam and the direction of groundwater flow relative to the dam wall.



P5006/6213

According to Golder Associates May 2007 Report 6:

No elevated concentrations of metals or pesticides/herbicides were found. Results of pesticides and herbicides were below detection levels;

P5007/6213 ALS laboratory results appear in Attachments B (P5083/6213) and C (P5094/6213).

ALS Dissolved Mercury by FIMS EG035F results mg/L:

BH46 20 Nov 2006 = 0.0006

BH44 20 Nov 2006 = 0.0007

BH4A 20 Nov 2006 = 0.0007

BH43 20 Nov 2006 = 0.0003

MA04 20 Nov 2006 = <0.0001

MA01 20 Nov 2006 = 0.0021

PB01 20 Nov 2006 = 0.0001

MA05 20 Nov 2006 = 0.0012

BH45 20 Nov 2006 = 0.0009

PB01 14 Dec 2006

***Dissolved mercury = 0.0002**

Total mercury = 0.0011

PB01 17 Dec 2006

*Dissolved Mercury = 0.0006

Total Mercury = 0.0008

*EG035T Total Mercury by FIMS

FIMS = Flow injection mercury system (FIMS)

LOR = Limit of Reporting = 0.0001mg/L, for both dissolved and total mercury by FIMS

Using the guidelines of Health 1996 NHMRC 1996, p28 – Inorganic chemicals - mercury 0.001 mg/l MA01, MA05 and PB01 mercury above Health-related guideline values.

NHMRC 2011 (2022 update)

filterable metals (soluble or dissolved, macromolecular and colloidal metals) – those constituents of an unacidified sample that pass a 0.45µm membrane filter

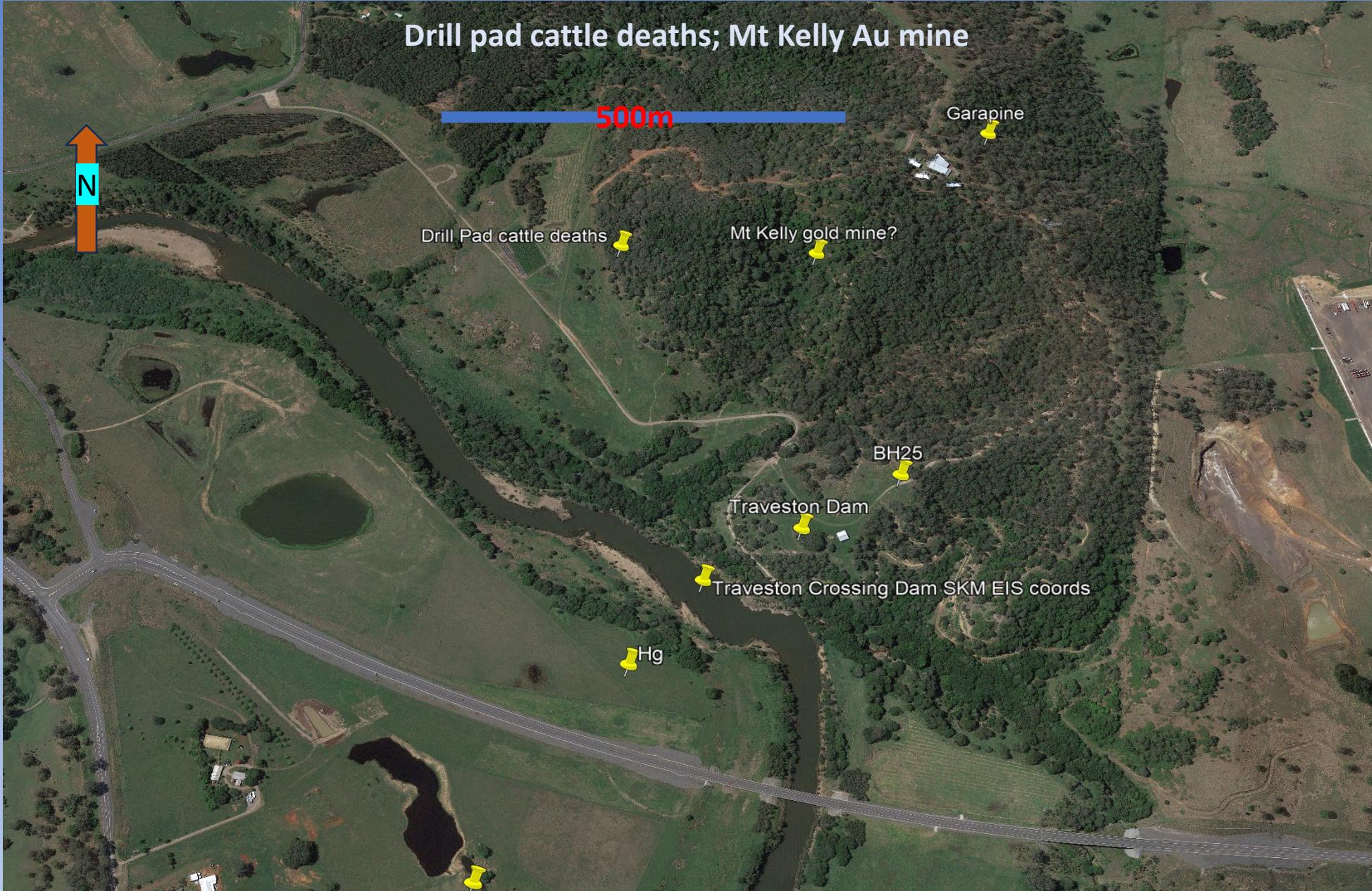
Cattle Deaths Traveston Crossing Dam

TRAVESTON CROSSING DAM

OVERVIEW
CATTLE DEATHS DOWNSTREAM OF DAM SITE IN
JUNE/JULY 2006

As at 27 April 2007

Drill pad cattle deaths; Mt Kelly Au mine



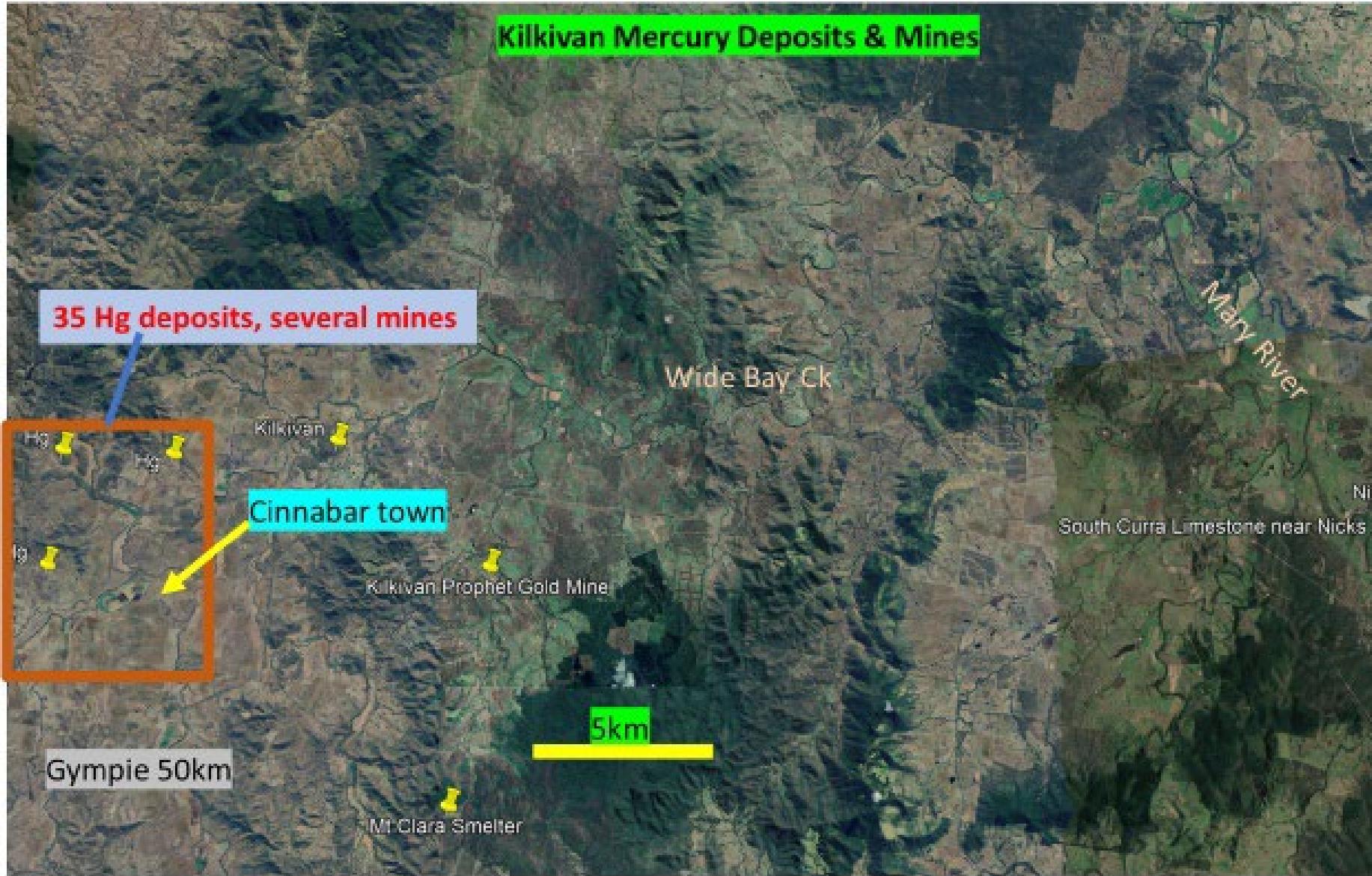
Excerpts from Attachment 3 2007 Senate Inquiry

P2; 18/23 Letter Golder Associates to QWI 23 March 2007

Soil sampling was conducted at 10 locations to identify any mineral accumulations due to past mining activities. Three soil samples were collected from the drilling pad area, two soil samples from the gully to the south of the drilling pad, two soil samples from the gully to the north of the drilling pad, one sample from a test pit part way up the hill and two samples from the top of the

hill, nearest the reported location of the Mount Kelly gold mine. Mercury and Arsenic are two elements which tend to be a focus of environmental investigations particularly in areas which are known for gold mining activity. The results of the initial chemical analysis of the 10 soil samples indicated that these elements would not present environmental and/or human health risks as their concentrations were below EPA's Environmental Investigation Levels (Mercury of 1 mg/kg, Arsenic of 20 mg/kg) and were also below Health Based Investigation Levels (Mercury of 15 mg/kg, Arsenic of 100 mg/kg). However, Golder Associates undertook tests with water to assess the reactivity of the soil samples.

We found that concentrations of Mercury in the leachate of the 10 soil samples were elevated when compared with the Australian Drinking Water Guidelines, indicating that there are potential environmental and human health risks with respect to Mercury. We think that this potential environmental concern may be better quantified through further investigations.



KILKIVAN MERCURY MINING.

By A. K. DENMEAD, M.Sc., Geologist.

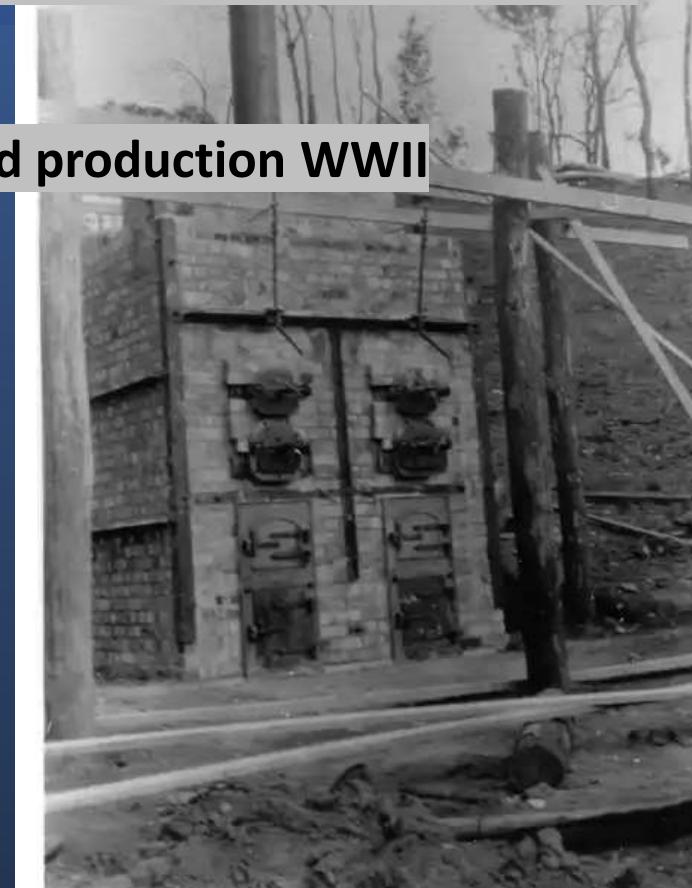
This intermittently productive mercury field was a prolific producer in the early days of Gympie when amalgamation was an essential feature of gold recovery; and after a long period of quiescence production was renewed on a small scale during the last war.

This Department encouraged individual efforts to increase production; and after the outbreak of war and the cutting off of European supplies, an intensive geological survey of the area was made, but without revelation of much promise of appreciable reserves.

It is now suggested that mercury metallisation is essentially superficial—and the ores mined are supposedly secondary enrichments—due to the precipitative action of the abundant lode lime upon mercury sulphide in solution. The richer ores have to be gouged out and the formations as a whole are far below normal workable grades; and little hope is offered of appreciable future production.—L.C.B.

'Prolific producer in the early days of Gympie'

Renewed production WWII



Mary River Maryborough Q



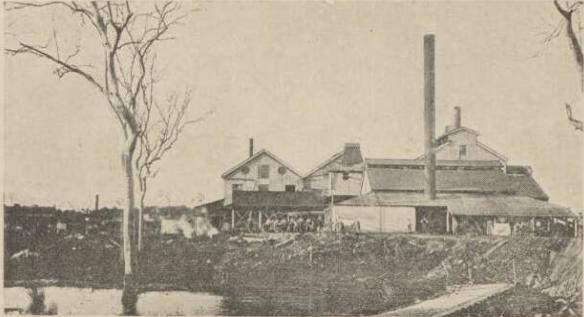
Sand & gravel extraction, Mary River Maryborough



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W. H. CLARK, Local Secretary.
T. J. DYASON, Manager.





Mary River Heads,
Great Sandy Straits



Great Sandy Straits

<https://finia.org.au/>



ELSEVIER

elevated concentrations of one or more of arsenic, chromium, iron, mercury, manganese, nickel and/or lead (*Cairns to Hervey Bay*).

The generally higher concentrations of metals present in dugong stranded in the vicinity of Hervey Bay may have, in part, been sourced from the urban environment of Moreton Bay (Brisbane, southern Queensland; as animals have been observed to migrate between the two regions to feed.

Marine Pollution Bulletin 51 (2005) 361–369

MARINE
POLLUTION
BULLETIN

www.elsevier.com/locate/marpolbul

Organochlorine and heavy metal concentrations in blubber and liver tissue collected from Queensland (Australia) dugong (*Dugong dugon*)

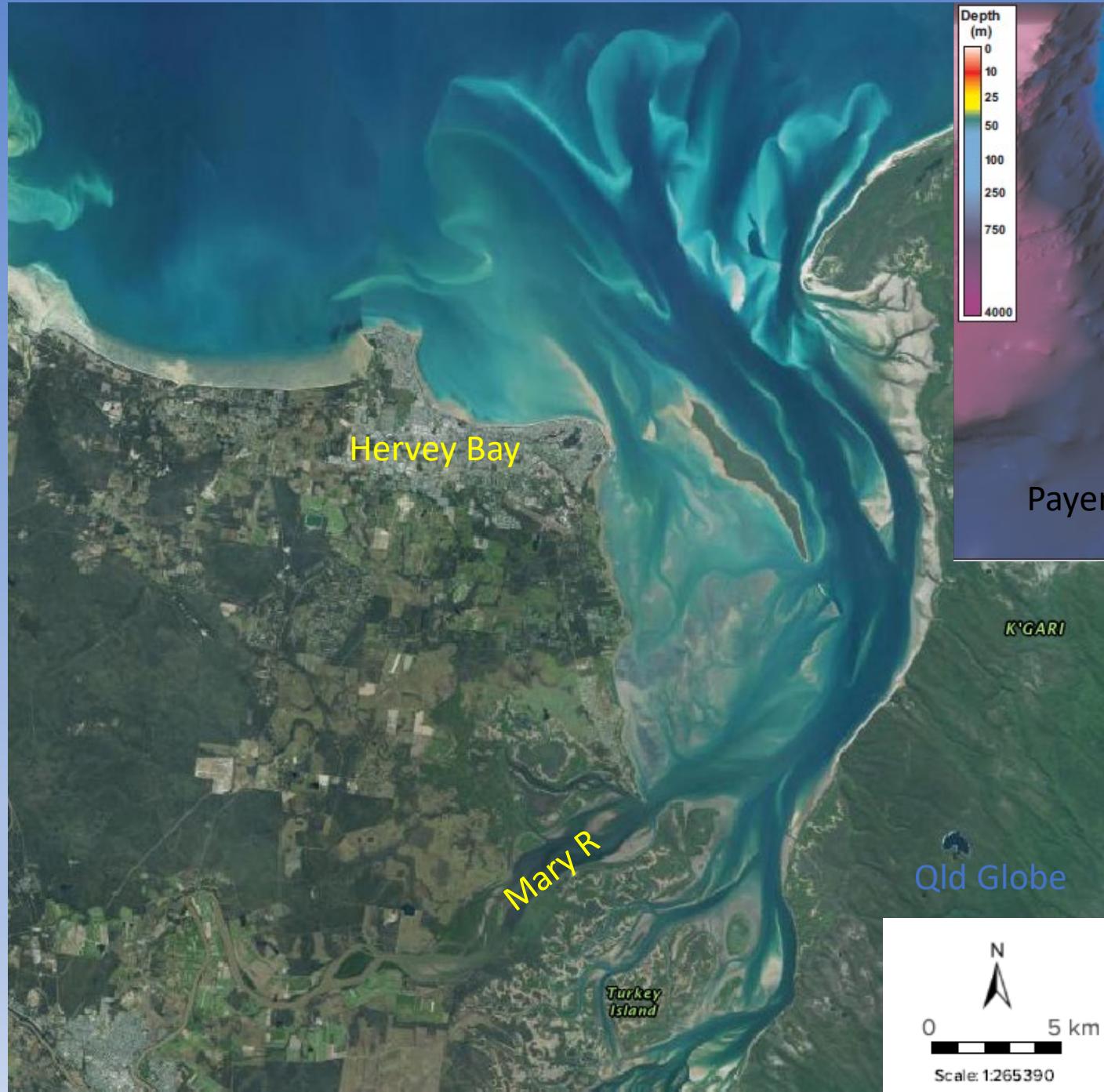
David Haynes ^{a,*}, Steve Carter ^b, Caroline Gaus ^c, Jochen Müller ^c, William Dennison ^{d,1}

^a Great Barrier Reef Marine Park Authority, P.O. Box 1379, Townsville 4810, Australia

^b Queensland Health and Scientific Services, P.O. Box 594, Archerfield 4108, Australia

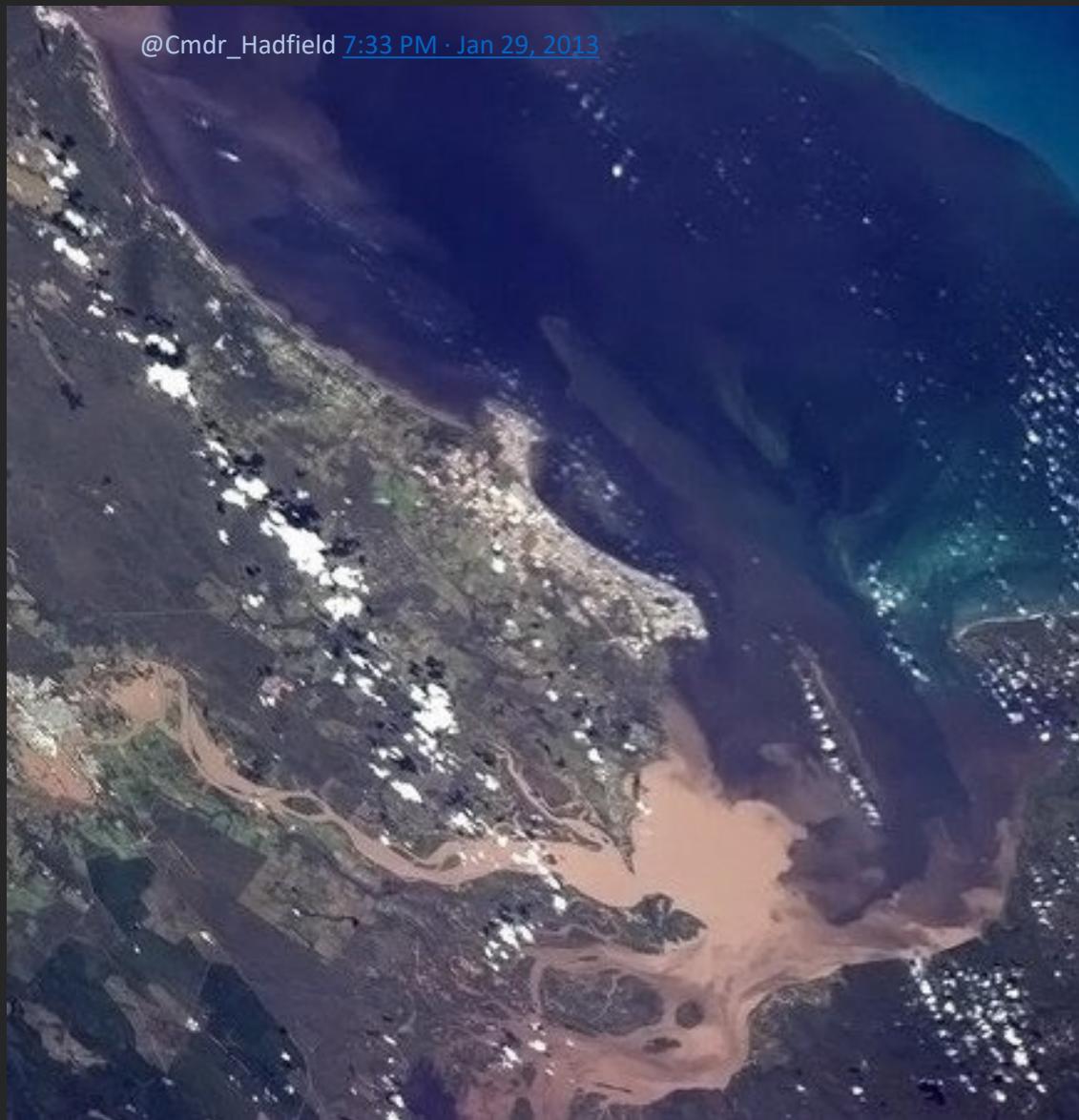
^c National Research Centre for Environmental Toxicology, The University of Queensland, 39 Kessels Rd, Coopers Plains 4121, Australia

^d Marine Botany, The University of Queensland, St. Lucia 4072, Australia



Payenberg, T. et al, 2008

@Cmdr_Hadfield 7:33 PM · Jan 29, 2013



<https://www.space.com/19212-astronaut-hadfield-celebrity-canada.html>

The impacts of flooding on the high-latitude, terrigenousclastic influenced coral reefs of Hervey Bay, Queensland, Australia

I. R. Butler · B. Sommer · M. Zann ·
J.-x. Zhao · J. M. Pandolfi

Marine Pollution Bulletin 96 (2015) 356–367



Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul



Department
of Science, Information Technology, Innovation and Arts (DSITIA)

The cumulative impacts of repeated heavy rainfall, flooding and altered water quality on the high-latitude coral reefs of Hervey Bay, Queensland, Australia



I.R. Butler ^{a,*}, B. Sommer ^a, M. Zann ^b, J.-X. Zhao ^c, J.M. Pandolfi ^a

^a Australian Research Council Centre of Excellence for Coral Reef Studies and School of Biological Sciences, The University of Queensland, Brisbane, Queensland 4072, Australia

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^c Radiogenic Isotope Laboratory, School of Earth Sciences, The University of Queensland, Brisbane, Queensland 4072, Australia



Green turtle – Big Tuan 24 Apr '22



THE CONVERSATION

Academic rigour, journalistic flair



University of Sunshine Coast/AAP

Dugongs and turtles are starving to death in Queensland seas – and La Niña's floods are to blame

Published: September 19, 2022 3.18pm AEST

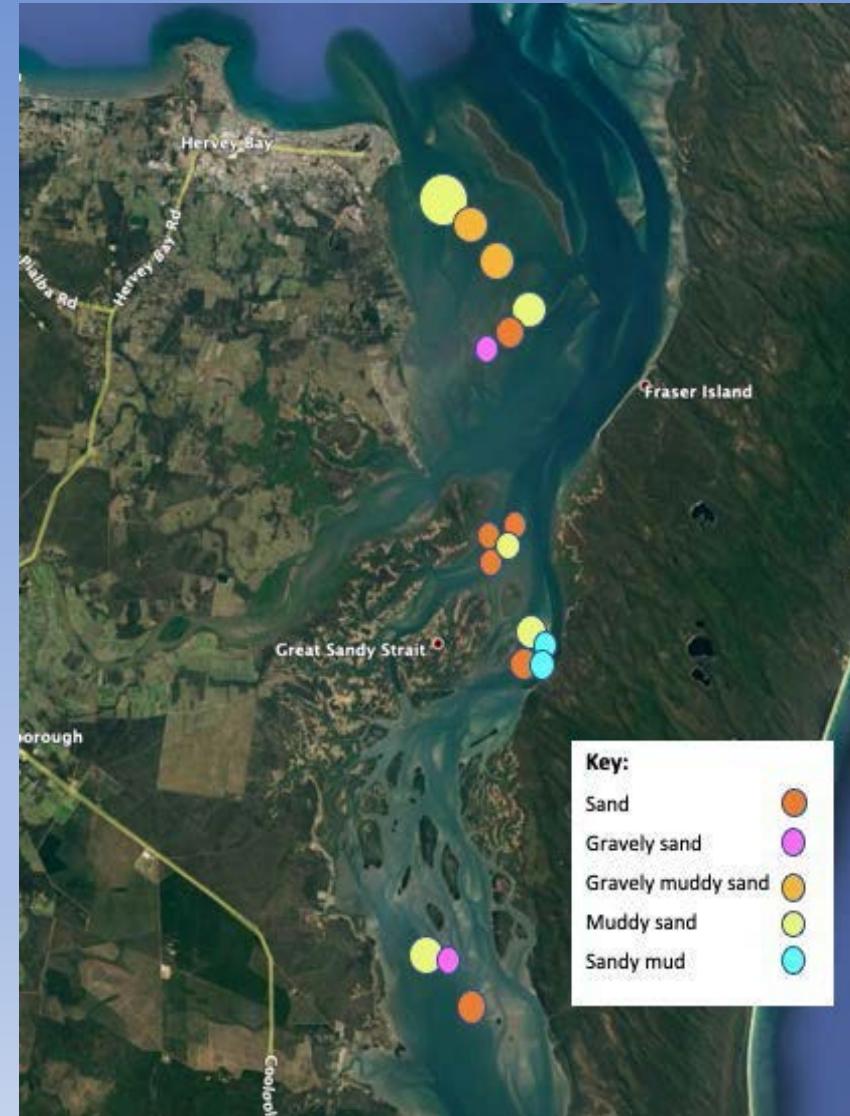
2021



Final Report to the Great Sandy Strait Research Consortium.

Hydrodynamics & Materials Transport in the Mary River & Great Sandy Strait An Initial Assessment
Assoc. Prof. Ron Johnstone
Dr Daniel Harris
Dr Sarah McSweeney

In this light, and in order to understand historical conditions and potential periods of pollution, a more substantive study is required where deeper sediment cores are collected and analysed for nutrients and heavy metals as performed on surface sediments in this study.



**Burdekin River Catchment & Inner
Continental Shelf Sedimentary Geology &
Geochemistry**

**Platform for study of Mary River, Great Sandy Straits,
& Hervey Bay**

An Episode of Mercury Contamination of Bowling Green Bay 1870-1900

G. J. Brunskill, J. Pfitzner, I. Zagorskis, G. S. Walker and Peter Isdale

Australian Institute of Marine Science, PMB 3, Townsville MC Qld 4810

A 3.8 metre long sediment core from Bowling Green Bay was radiochemically dated using ^{210}b and ^{137}Cs tracers. Bulk sediment accumulation rate was very high ($-17 \text{ kg mm}^2 \text{ yr}^{-1}$), and the sediment mixed layer thickness was approximately 50 cm. The time history of variation in the ratio Al/Ca in the sediment core suggests that there has been an increase in proportion of terrestrial riverborne sediment to this site in the last century. Increases in Pb and Cu concentrations in surface sediments are probably due to increases in the proportion of river sediment, and not due to local pollution. A large input of excess mercury (Hg in excess of 2 nMoles/g dry weight of sediment, background Hg being 60-100 pMoles/g) was found at 2.5-3.0 metre sediment depth in the core, and this was dated to the period 1870-1900. In this period, Hg concentrations in surface sediment may have exceeded US EPA sediment quality guidelines for this element. During this time, quicksilver mercury was used in Charters Towers' stamping mills to extract gold from crushed rock in the catchment of the Burdekin River, which flows into Upstart Bay and the Great Barrier Reef lagoon. Also during this time (1870-1900), rainfall and Burdekin River flood-event frequency were much higher than in the period 1900-1996, as revealed by coral core fluorescence profiles. Frequent flood events in the catchment were probably important to ensure the rapid delivery of contaminant Hg to the Great Barrier Reef lagoon. Present day Hg concentrations in surface sediments of Bowling Green Bay are still about three times higher than pre-1850 background Hg concentrations. Sediment delivery from the Burdekin River is cascaded from Upstart Bay to Bowling Green Bay, where most river mud is trapped. Only a small proportion of Burdekin River mud reaches Cleveland and Halifax Bay.

(Conference: Sources, Fates and Consequences of Pollutants in the Great Barrier Reef and Torres Strait. 1999.)

Detection of anthropogenic and natural mercury in sediments from the Great Barrier Reef lagoon

G Stewart Walker and Gregg J Brunskill

I CRC Reef Research Centre, James Cook University Qld 4811

2 Australian Institute of Marine Science, PMB No. 3, Townsville Qld 4810

ABSTRACT

A research program is investigating the analysis of sediment and coral cores as a means of detecting changes in past and present land use. Cores of sediment of up to 4 metres in length have been analysed from sites expected to be influenced by flow from the Burdekin, Herbert and Tully Rivers in north Queensland. The recent development of a new sensitive analytical method has allowed the detection of mercury in sediment cores. Background levels of mercury, and spatial and temporal excursions from those levels have been detected. Cores from Hinchinbrook Island, Bowling Green Bay and Upstart Bay have been found to have different profiles of mercury concentration.

CONCLUSIONS

Mercury exists in sediment from the study area. Levels of mercury are generally low and typical of an unpolluted site except for a large and sharp mercury spike in core 1260 from Bowling Green Bay and a gradual rise in mercury in the most recent sediment of core 1250 from Upstart Bay and core 638 from Missionary Bay. Further studies should address the distribution of mercury in this region. More information from analyses of other elements will aid the interpretation of the mercury results. Speciation to identify what form (or forms) the mercury exists in will be a priority.

Walker, G.S., Brunskill, G.J., 1996. Detection of anthropogenic and natural mercury in sediments from the Great Barrier Reef lagoon. In: Larcombe, P., Woolfe, K., Purdon, R. (Eds.), Great Barrier Reef: Terrigenous Sediment Flux and Human Impacts. second edition. CRC Reef Research Centre, Townsville. V2; 30 – 33.



Complex sediment deposition history on a wide continental shelf: Implications for the calculation of accumulation rates on the Great Barrier Reef



Stephen E. Lewis ^{a,*}, Jon Olley ^b, Takahisa Furuichi ^c, Ashneel Sharma ^c, Joanne Burton ^c

4.4. Mercury concentrations

In the USB2CO core (Fig.2), mercury was detected from 165 cm depth (OSL age 49±5 yrs) to the bottom of the core (OSL age 90±10 yrs at 242cm) with concentrations ranging from 0.36 to 2.96 mg kg⁻¹. Mercury was detected in the BGB-5OT core from 98cm (OSL age 90±10 yrs at 97cm) to 165 cm (OSL age 210 ± 20 yrs at 198cm) depth (Fig.3) and concentrations ranged from 0.16 to 0.46 mg kg⁻¹ in this section of the core. A marked increase in mercury concentrations coinciding with its use in goldmining in the Burdekin catchment between 1870 and 1890 was previously reported for a sediment core taken from close vicinity to BGB-5OT (Walker and Brunskill, 1996). Mercury was consistently below the practical quantitation limit throughout the BGB-2CO core.

Defining the Mercury (Hg) Transport Story: Impacts of Legacy Gold Mining in the Burdekin River Catchment, Queensland Australia

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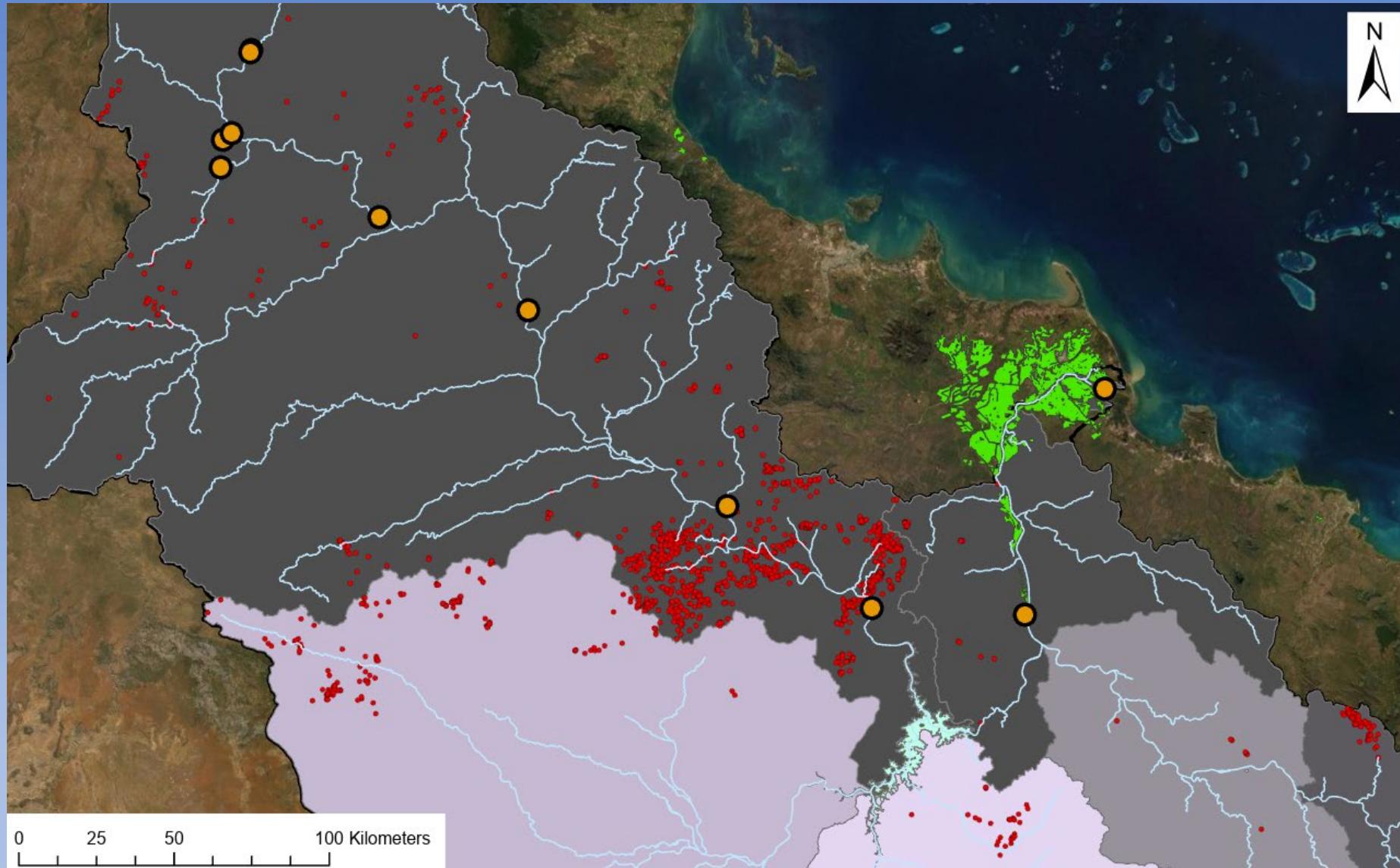


Figure 1: 2019 sample collection locations in the upper and lower Burdekin catchment (yellow points). The figure demonstrates major tributaries of the Burdekin River system, legacy gold mine sites (red) and sugar cane (120 km²) (green area). Note that organo-mercury fungicides such as Shirtan were applied to sugarcane roots to prevent root rot until its removal in 2020. The use of these fungicides allow sugar cane areas to act as an additional point source of Hg release into the Burdekin.

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Tasmania, as a British colony, faced political, economic and social pressures that had no consideration for environmental systems. This pressure for resource extraction and local calls for development combined to turn the Mount Lyell Mining and Railway Company into the largest copper producer in both the Southern Hemisphere and the British Commonwealth. The impact of these pressures caused environmental damages that will take centuries to return to a state similar to pre-colonial. Currently, no government body, company or individual can be held directly responsible for the environmental damage, as the first environmental regulations were in place after 1970, and mining companies still remained exempt. The historical mining events and environmental impact assessment detailed here may be used to identify the impact of historical flaws in environmental protection measures. It is important for Australia to address the damage caused by legacy sites such as Mount Lyell, as well as ensuring that current environmental regulations are sufficient to protect ecosystems of current and future generations.

Colonialism and the environment: The pollution legacy of the Southern Hemisphere's largest copper mine in the 20th century

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