Monitoring ar

1. BACKGROUND

This paper highlights the processes employed by C
monitoring and control of manganese at the Cohu

Manganese has been an on-going issue at the Cohu
was detected in the reticulation network and a sig
ceived for black water.

The descriptions of complaints resulting from man
black to brown coloured water, and also included
The Australian Drinking Water Guidelines (ADWG)
unless the concentration exceeds 0.5 mg/L, but c
concentrations as low as 0.03 mg/L.

nd Control of Manga

y Campaspe Asset Management Services (CAMS) for the
huna Water Treatment Plant (WTP).

huna WTP for several years. In late 2007 manganese
significant number of customer complaints were re-

anganese in the supplied water varied from dirty to
d incidents of stained washing and black sediments.
G) indicate manganese is not a health consideration
customer complaints can be received at manganese

F
c
i
n
i

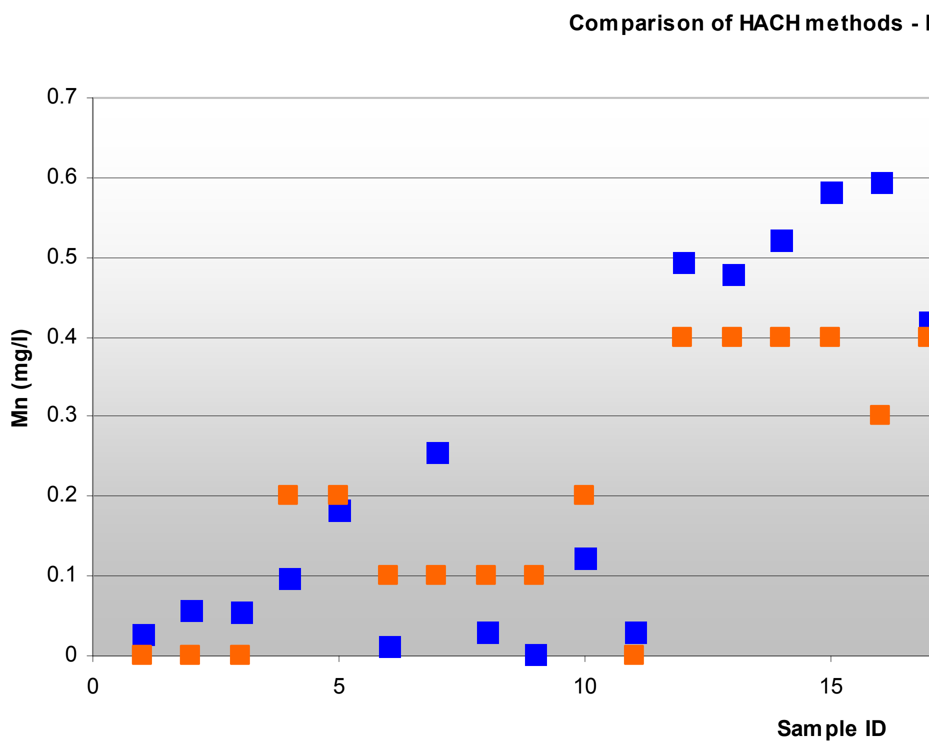
S
n
v
H
t

anese in a Variable

4. MONITORING MEASUR

Regular manganese testing was instigated on the raw wate
ducted using high range (HR) manganese testing kits (Hach
ing kits required a license application to be submitted to th
reagents contained cyanide, a listed carcinogen. The proc
initially delayed our ability to accurately measure mangane

Several lessons about manganese testing were learnt along
necessary so only the soluble component is measured. Raw
with a duplicate sample sent to Echuca for LR testing (as th
HR and LR tests are only comparable when the manganese
tives where observed. A comparison of the accuracy of the



Water Source

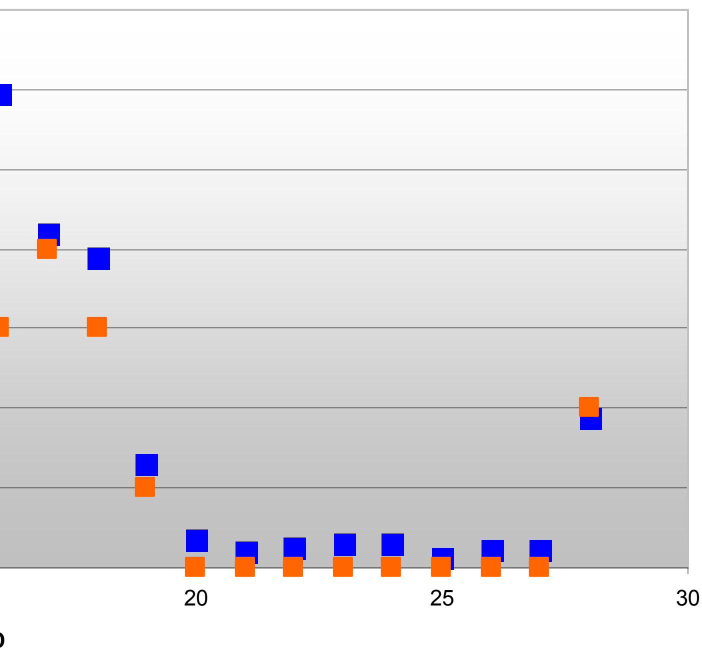
RES

Paper Prepared by: Len Monti
Campaspe Asset Management Services (CAMS)

ter and elevated storage. This testing was initially con-
ch DR890). The use of low range manganese (LR) test-
the Department of Human Services (DHS) as one of the
ocess to obtain the license took around 8 weeks, which
nese concentrations.

ng the way: filtering of water samples at 0.45 um is
aw water samples are tested on site using the HR test,
the cyanide license was allocated to Echuca WTP). The
e levels are above 0.3 mg/L, as on occasions false posi-
ne test kits is shown in the chart below.

ds - HR vs LR



Photos 1 & 2— Black water sa

2. EARLY OBSERVATI

Initially it was thought that internal rust particles
base of the tower and made its way into the retic
colored water in the tower, then in internal hoses
was scoured to remove rust material, but colour p
e.g wash down hoses.

Upon discovery of dirty water in the clear water s
ganese was external to the plant. The colour wou
posed to an oxidant (i.e. chlorine). After 7 days,
classic manganese appearance.

3. CONTROL MEASUR

Various control measures were considered after ex
web searches. Three chemicals and one mechani
nese to assist its removal during coagulation and f
dium hypochlorite and aeration.

The benefits and risks of each chemical or process

Oxidation Method	Benefits	

samples from the Cohuna network

IONS

es from the elevated storage had accumulated in the iculation network. This firstly exhibited as dirty/ es and finally in the clear water storage. The tower r persisted to develop in stagnant water in the plant,

r storage, it became apparent that the source of man- ould develop over 3 or 4 days after the water was ex- s, sediment would appear and was black in nature;

RES

extensive research with other water corporations and nical process were identified as able to oxidise manga- d filtration: potassium permanganate, chlorine gas, so-

ess is shown in the table below.

Risks	Suitable for Cohuna WTP?
High capital cost	No

Sample ID

LR Mn HR Mn

Figure 1— Comparison of

5. CONTROLLING MANGA

Hypo rates were determine from jar testing, and a normal
ple was greater than 0.3 mg/L manganese, hypo dosing was
10 mg/L, with some success.

The jar testing also trialed caustic pre-dose to bring the pH
oxidization. This was not implemented even though the ja
one significant manganese peak this past summer.

There was some formation of THMs during this process, but
ter Guidelines limits of 0.25 mg/L. The maximum valve ob
below 0.1 mg/L.

Raw Mn	0.037	mg/l				
Number	Pre-dose - NaOH	Hypo	Alum	Poly - Lt20	Floc time	Floc size
	mg/l	mg/l	mg/l	mg/l	min	
1	0	0	30	0.1	<1	Good - Sma
2	8	0	30	0.1	<1	Good
3	0	7	30	0.1	<1	Good
4	8	7	30	0.1	<1	Good - Heav lowest in be
5	0	10	30	0.1	<1	Good
6	8	10	30	0.1	<1	Good

Mn

of HR and LR methods

ANESE

al dose rate was set at 6 mg/L. When the raw water sam-
vas increased to 8 mg/L. The highest dose rate used was

pH up 6.8-7.0 in the clarifier outlet to aid in manganese
jar tests showed promising results as the there was only

ut they remained the below the Australian Drinking Wa-
observed has been 0.13 mg/l, with the majority of results

size	Settle Time min	Turb	pH	Mn mg/l	Chlorine residual mg/l @ 30 mins
mallest	1	0.53	6.16	0.034	
od	1	0.72	6.66	0.021	
od	1	0.56	6.19	0.025	
eaviest beaker	1	0.75	6.74	0.020	
od	1	0.59	6.24	0.021	
od	1	0.76	6.71	0.049	

Aeration	Simple control measure No chemical storage, handling or addition Good control for reservoirs	Sl Ineffec
Chlorine (gas)	Strong oxidant Moderate reaction time Familiar dosing equipment	Chlorine work Pre-chlor to react produce Appro
Potassium permanganate	Fast reaction time, < 30 secs Can treat taste and odour problems Does not produce trihalomethanes (THM) Strong oxidant Low dose rates	Over d Overdos Better f
Sodium Hypochlorite (Hypo)	Effective and simple to control Easy to measure effectiveness by chlorine residual Ease of handling Cost effective for small systems	pH d Modera Possible

Table 1 — Comparison

High capital cost High running costs Slow reaction time, > 1hr pH dependant fective in oxidising organically bound manganese	**No** Plant source under suction 30 secs residence time between channel and clarifier inlet Shallow body of moving water in channel
ne addition needs to be at head orks or just before filtration lorination has a higher potential act with organic compounds and ce trihalomethanes (THM) which are carcinogenic ropriate safety equipment required	**No** Moderate to control Easy monitor residuals in clarifier Safer to handle Extra storage of chlorine gas required
Easily overdosed r dosing can lead to pink water dosing can contribute additional manganese r for consistent manganese concentrations	**No** Control is difficult when manganese concentrations vary over short periods of time
H dependant, best above 8.0 erate reaction time, >20 mins ble THM formation with organic compounds	**Yes** Easy to control Easy to monitor residual in clarifier Safer to handle Storage of chlorine gas not required

on of control measures

7	8	10	30	0.1	<1	Good
8	8	20	30	0.1	<1	Good
9	8	4	30	0.1	<1	Good

Table 2– Examples of J

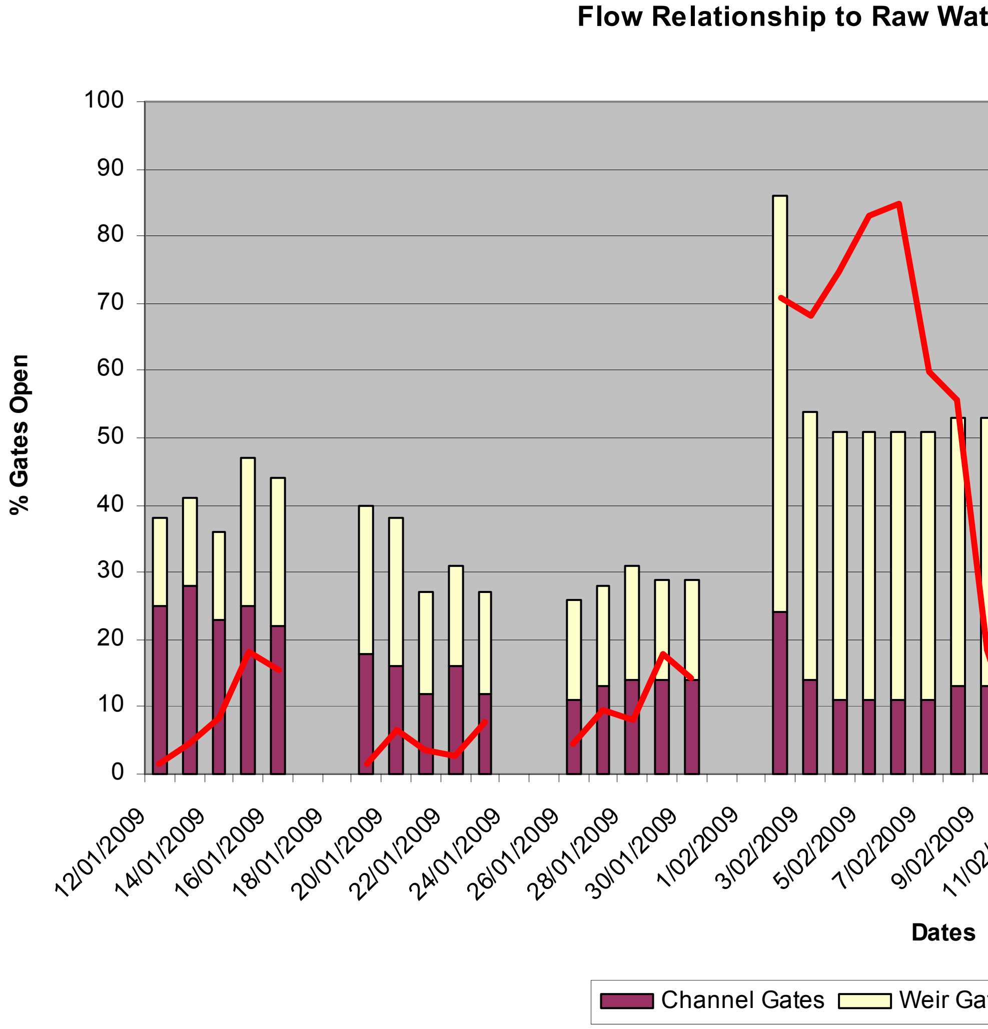
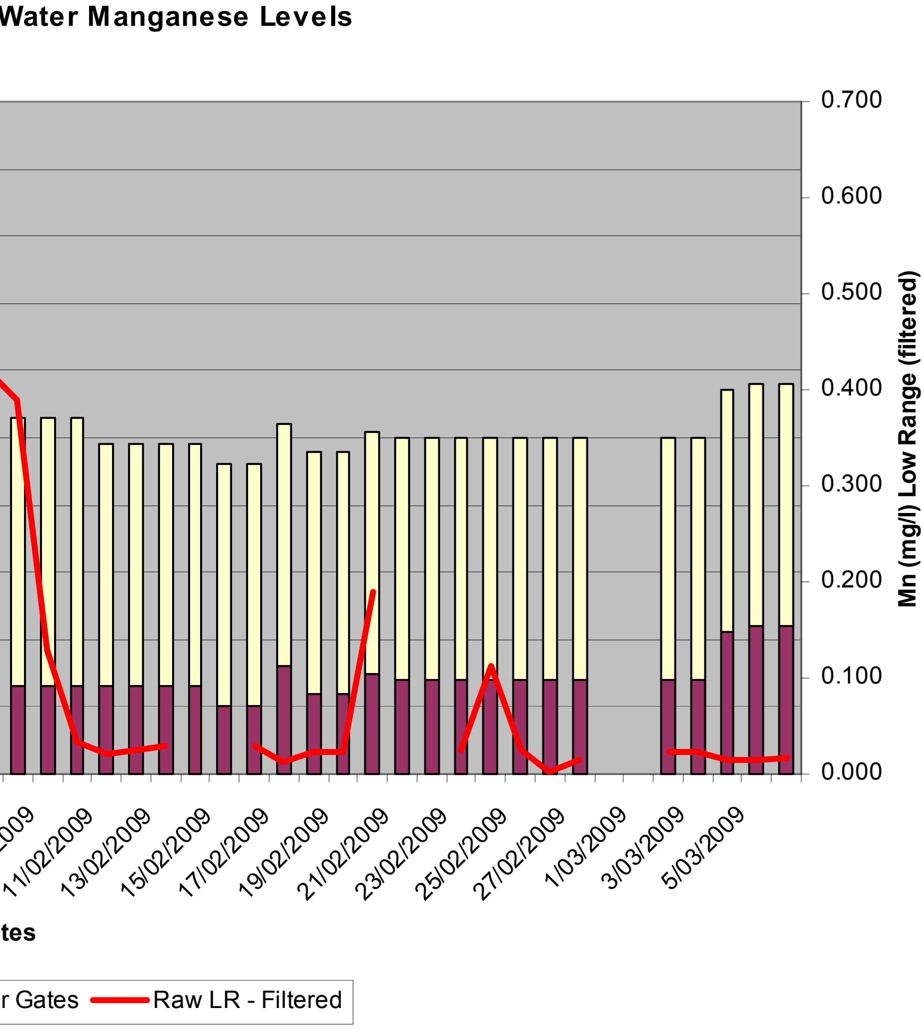


Figure 2 – Impact of flow

The manganese events were sporadic, and it soon became a
short (i.e. one day), with the longest event lasting for 7 da
be occurring. As the channel operates as a weir pool, we lo
downstream of the WTP. We started collecting records of s
to an increase in manganese levels. This gave us our first c
something we could proactively control to reduce the mang
from Goulburn-Murray Water and were able to correlate all

od	1	1.04	6.46	0.009	1.76
od	1	1.34	6.81	0.011	4.36
od	1	0.87	6.63	0.017	0.27

f Jar Test Results



w on manganese levels

e apparent that the spikes in the raw water source were days. This lead to an investigation as to why this might e looked at the control of the irrigation gates 0.5 km f stream flow and were able to correlate a change in flow t conclusive evidence of the source of the manganese and nganese levels. We obtained some historical flow data all the spikes we had observed to confirm our suspicions.

Table 1 — Comparison

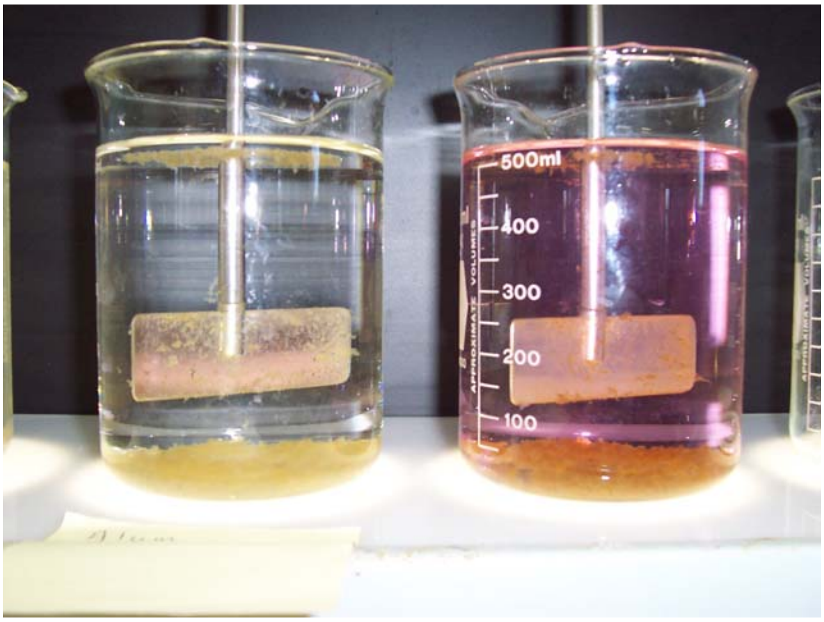


Photo 3 & 4 — Examples of how just 2 mg/

A temporary sodium hypochlorite dosing system w
setup up stream of alum addition and as close as p
maximize reaction time, as there is less than 30 se
clarifier.

Dosing has continued over the past two years, exp
mer when a blue green algae outbreak occurred o
(PAC) was dosed instead.

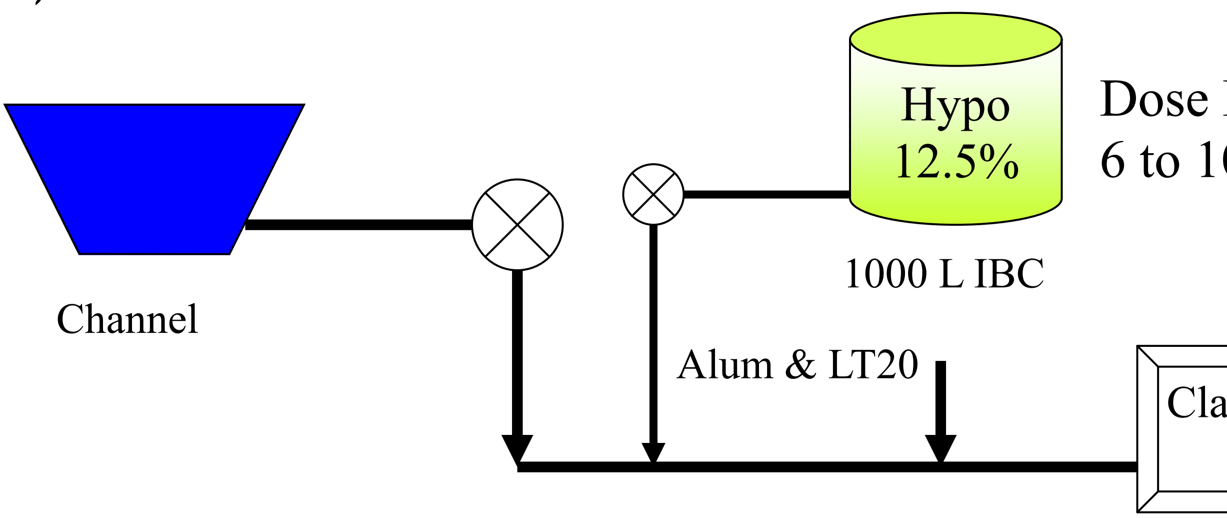


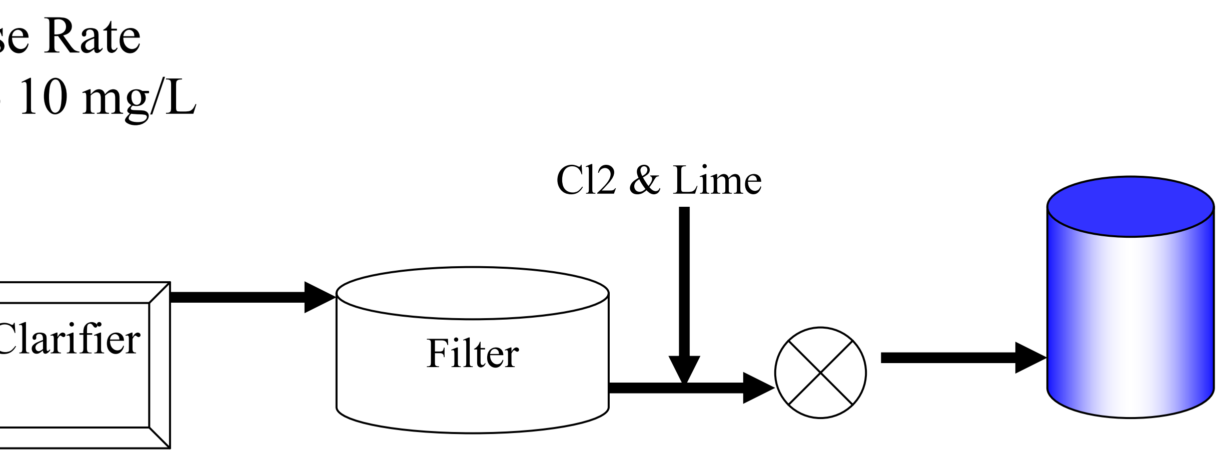
Diagram 1— Cohuna W

on of control measures

g/l of potassium permanganate can colour water

was implemented as the control measure. Dosing was
s practical to the discharge of the raw water pump to
seconds residence time between the plant inlet and

xpect for a period of nine weeks over the past sum-
on the Murray River and powder activated carbon



a WTP Process Diagram

from Goulburn-Murray Water and were able to correlate all
Our conclusions were that the spikes in manganese were a
nel supplying raw water to the WTP.

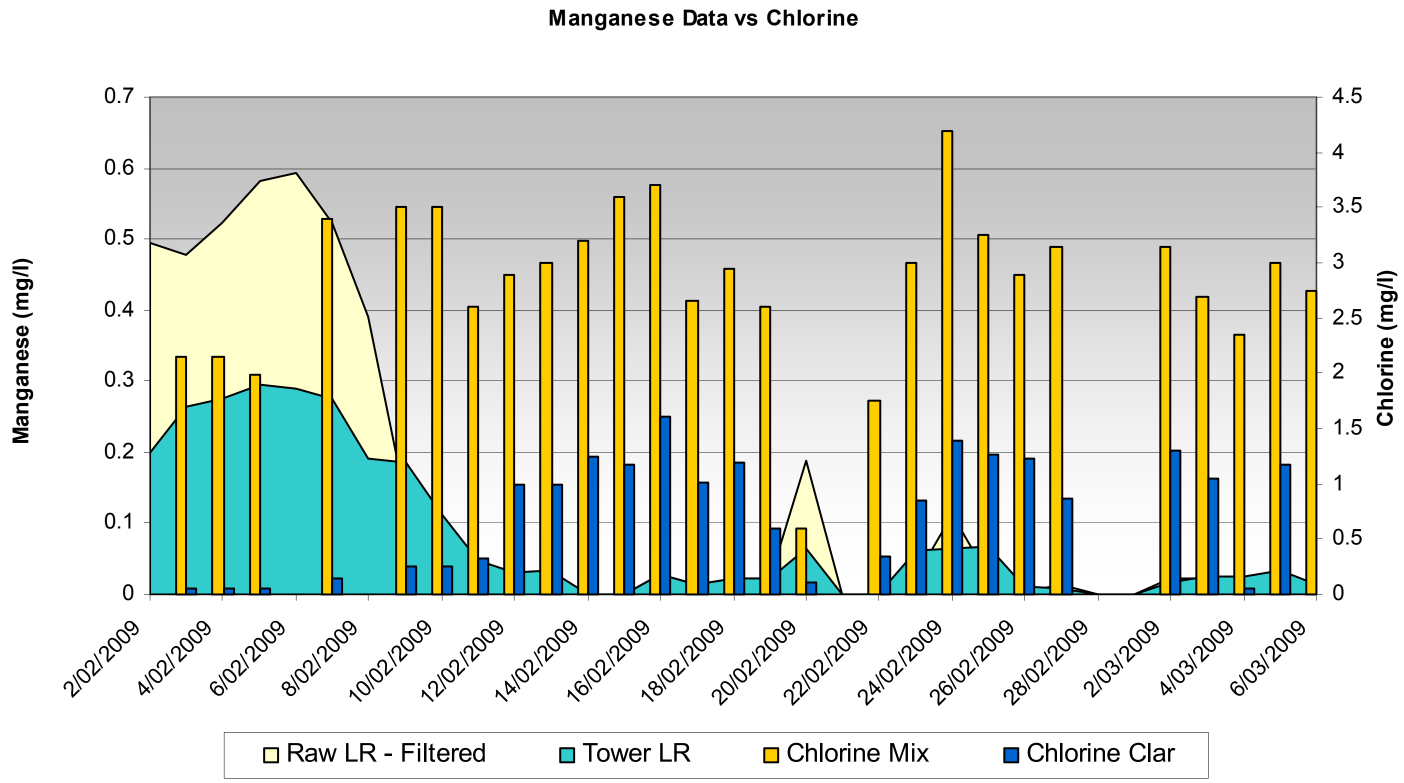


Figure 3 — Results of last event ~ February 2009 F

6. CONCLUSION

It is expected that manganese will remain a issue for Cohu
ety of management tools to control manganese residuals ha

— Daily monitoring of manganese in the raw water using th

— Continuous dosing of hypo at the clarifier inlet and main

— Regular (fortnightly) program of flushing and air scouring

— Regular desludging program for the clarifier, distribution

Several longer term options are being assessed as part of th
(GAC) and aeration, pre-dosing of caustic, a permanent hyp
arm, and filter media replacement.

all the spikes we had observed to confirm our suspicions. a direct consequence of low flows in the irrigation chan-

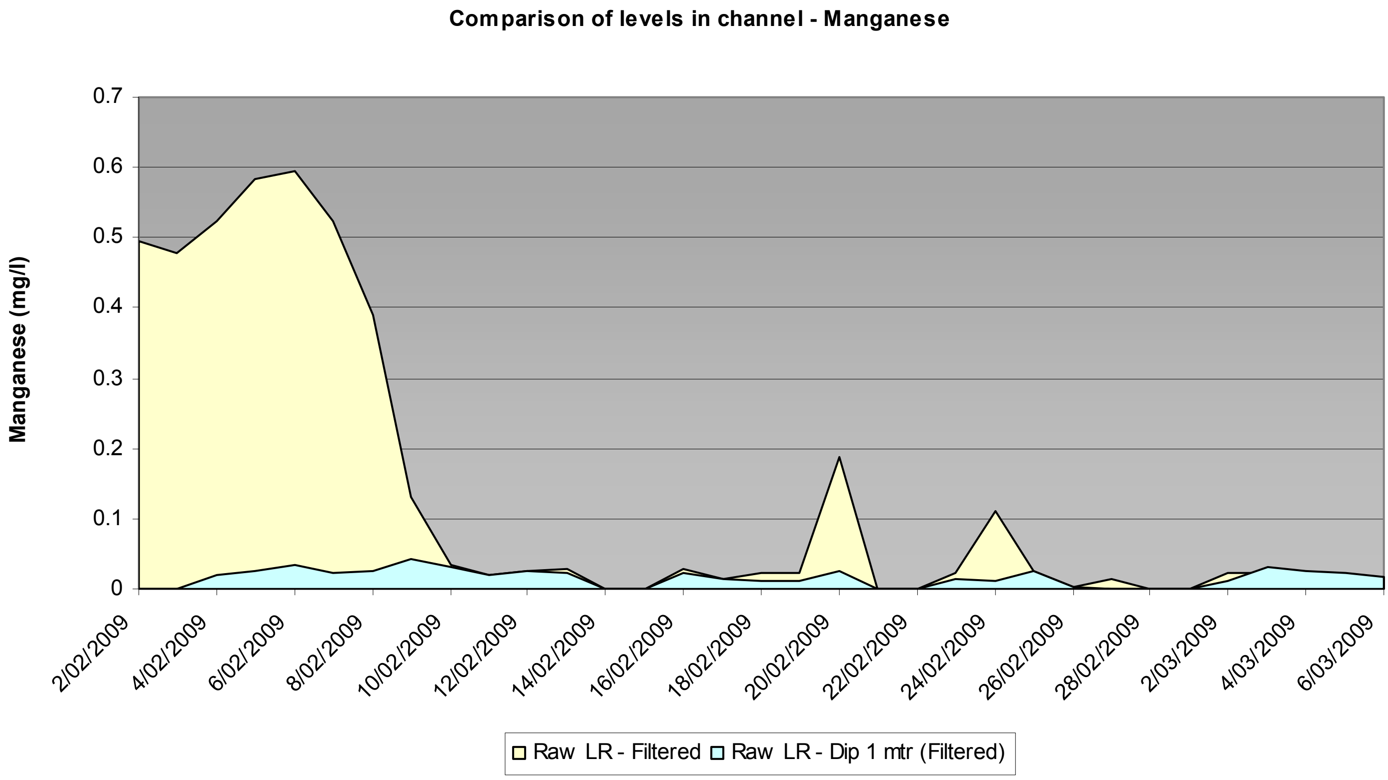


Figure 4 — Manganese at different levels in raw water

una WTP for a number years. After various trials, a vari- have been implemented:

the LR test method

aintaining a residual at the clarifier outlet

ing the distribution network

on channel and clear water storage.

the capital program, such as granular activated carbon ypo dosing installation, installation of a multilevel intake