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FINDING THE SOURCE OF HYDROCARBONS IN DRINKING WATER – A CUSTOMER COMPLAINT



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ABSTRACT

In October of 2013, Goulburn Valley Water (GVW) received a call from a customer complaining that the water had a horrible chemical like taste to it and was undrinkable. Analysis of a drinking water sample taken from the customer's tap confirmed the presence of high levels of the aromatic hydrocarbons toluene and xylene. Prior to this event GVW had never experienced an issue similar and an extensive investigation was undertaken. As a result the following notice was sent to the customer -

Officers have completed our investigation and the source of the contamination into the potable water service is occurring within the property. Please note that the results indicate that levels of some chemicals in the water sampled at your business are above the Australian Drinking Water Guideline Health Limits. As such, you are advised that this water is not suitable for consumption.

This paper documents the steps taken to locate the source of the contamination.

1.0 INTRODUCTION

Goulburn Valley Water (GVW) is committed to providing safe and reliable drinking water of a high quality which consistently meets the Victorian Safe Drinking Water Act. GVW recognises that water quality complaints provide a means for improving customer service and is committed to ensuring that all complaints are dealt with in an efficient, effective and timely manner. If the water quality is found to be noncompliant, GVW implements actions to rectify water quality as soon as possible.

2.0 DISCUSSION

2.1 Initial Complaint

GVW's Customer Service Centre received a call in October of 2013 from a business in Shepparton complaining that the water had a bad chemical taste to it and they were unable to drink it. The initial sample obtained from the customers sink had a 'solvent' odour and the immediate response was to give the customer an alternative water source for drinking (bottled water), undertake sampling for hydrocarbon analysis and advise the customer not to drink the tap water until further notice.

On investigation, it was noted that the property adjoining the business where the complaint originated was an Automotive & Industrial Paint Shop. The initial thoughts were that the source of the contamination could be from a cross connection between the premises. Both properties were sampled for hydrocarbon analysis on the initial day of the complaint (Wednesday, 23rd October) and urgent turnaround requested from the laboratory.

The customer's sample results from the first round of testing were received on Friday 25th October at 7:30pm, and are listed in Table 1. As suspected, the sample contained high levels of several solvents including toluene and xylene and other monocyclic aromatic hydrocarbons (MAH's) which were above the ADWG health guidelines.

This seemed to indicate that the customer may have some type of a cross connection with

the adjoining business selling solvents and paints. It was suspected that the contamination was limited to one property as the contamination was only present in one of the samples and taking into consideration the highly odorous nature of the water contamination, because there were no widespread complaints from residential areas to the south of the property

Table 1: *Analytical Report, Results of First Round of Sampling*

Parameter	Units	LOR	Sample Matrix	Water	Water
			Sample Date	23/10/13 13:00	23/10/13 13:10
			Sample Name	SH035412-1	SH035412-2
VOCs in Water Method: AN433/AN434					
Monocyclic Aromatic Hydrocarbons					
Benzene	µg/L	0.5		<0.5	<0.5
Toluene	µg/L	0.5		1100	<0.5
Ethylbenzene	µg/L	0.5		250	<0.5
m/p-xylene	µg/L	1		1000	<1
Styrene (Vinyl benzene)	µg/L	0.5		5.8	<0.5
o-xylene	µg/L	0.5		290	<0.5
Isopropylbenzene (Cumene)	µg/L	0.5		6.3	<0.5
n-propylbenzene	µg/L	0.5		15	<0.5

2.2 Pre-Site Background Check

A property history check revealed that three lots had been created from the original property (Figure 1, #12) and that the owner was a plumber. Assuming the possibility that the plumber could have done something creative with the plumbing, the theory that the source of contamination may be a cross-connection was further supported.

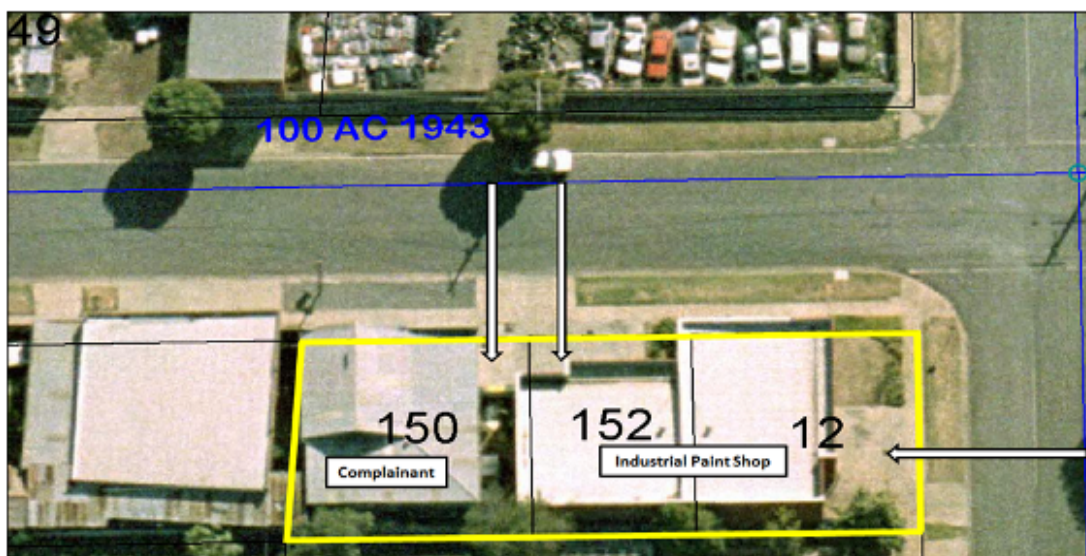


Figure 1: *GIS with Aerial Photo Overlay Indicating Original Lot and Service Locations*

An additional Trade Waste Customer background check was made confirming the Paint Shop was *not* a trade waste customer and so officers' undertaking the investigation needed to be considerate to both customers regards on-site inspection and right of entry.

The possible sources of the contamination considered prior to attending site to investigate

the cause included -

1. Cross connection to Retail Paint Shop
2. Rain water tank & pump
3. Burst Water Main
4. Water meter replacement – service in pit, potential for contaminated water
5. Syphoning from toilet cistern
6. Hot Water System
7. Inadequate backflow prevention & syphoning and from Retail Paint Shop
8. Water leak and saturated ground
9. Illegal connection/Meter tampering
10. Other connection to property to the south or west
11. GIS shows old scrap/car yard to north, possible recent works
12. Internal plumbing

The property history check listed the meters as located in GATIC pits and fitted with remote frequency output (not operational) and that there was very low water use with some quarterlies previously being estimated because of lack of access.

2.3 On Site Investigation

The site inspection was undertaken on Monday 28th October and it was again noted that the internal tap had a very strong solvent odour. All three water services were inspected and the following observations were made:

- Property #12 does not supply the other properties via a ring service.
- No evidence of tampering, no evidence of illegal connection.
- Audio testing for Meter noise/ illegal bypass or leak – none found.
- Property #150 is on a separate service line to the neighbouring Paint Shop at property #152 & Service pipes located with pipe locator indicating separation.
- Property #150 has no water when the meter stop tap is isolated and 152 was the same.
- None of the properties have a rain water tank or pump.
- The meters had not been tampered with and check valves are correctly in place. Each service has two check valves in the meter, a jumper valve in the RA meter stop and potentially an additional jumper valve in the service ferrule.
- Entire Paint Shop premises inspected with no area off limits. No signs of spills, spraying, industrial use of paints or large scale batching at the paint store. Paint storage inspected and there were no vats or buckets with hoses in them or evidence that there may be syphoning occurring.
- Property #150 does not have a hot water service.

Confirmed with Operations, GIS, Maintenance system and site inspection that there have been no mains bursts on the water main in question and none in the surrounding area recently. Consumption checked and found to be consistent with previous reads. No internal leaks

This left only four plausible options for the source of contamination –

1. Syphoning from toilet cistern - Unlikely but yet to be checked
2. Another cross-connection from a property to the south or west - Unlikely given that the customer has no water when the stop tap is turned off. Property to the south is a Food Store/Warehouse Distribution. Property to the west is residential
3. GIS shows old scrap car yard to north, possible recent works - Unlikely given the

highly odorous contaminate; as this would have instigated widespread complaints, this is also supported by the external Laboratory analysis of the water from the neighbouring Paint Shop. Additionally the customer with the contaminated water stated that the issue arose before the site was cleared for the construction of the new building

4. Unknown issue with internal plumbing - Old repair on internal water pipe evidenced by the installation of an isolation valve within the property.

The site investigation was thorough and ruled out a cross connection to the Paint Shop but was ultimately inconclusive. Because of this a new sample point was installed immediately prior to customers water meter and further sampling undertaken from the customers sink (same location as original sampling) and the new sample point at water meter. Following this, the service was flushed as hard as possible through the customers sink and the above samples repeated. After flushing the service, the water was sampled for "Taste & Odour". Operators' comments noted a sour-plastic like taste but no odour. The laboratory was also requested to undertake further testing of the original sample to provide a hydrocarbon fingerprint of the contamination.

2.4 Results of additional Sampling and further Investigation

On Thursday 31st October the hydrocarbon fingerprint results for the original sample were received. No exact petroleum identification could be determined by matching the sample's hydrocarbon fingerprint with reference chromatograms. However the laboratory stated that the distribution could be expected for water that has been in contact with light petroleum distillates such as mineral turpentine or petrol/gasoline, where water soluble components (aromatic hydrocarbons) have partitioned into the water phase.

On Friday 1st November, GVW received the results for the additional sampling which are listed in Table 2. The results confirmed that the contaminate was still present within the property but not present at the new sample point installed at the water meter. This confirmed that the issue is isolated to the single customer and does not originate from GVW's drinking water supply. Although GVW was no longer obligated to resolve the issue, the investigation to find and isolate the source of the contamination continued, as the levels of contamination were considered a health risk to the customer.

Table 2: *Analytical Report, Results of Second Round of Sampling*

VOCs in Water Method: AN433/AN434 Monocyclic Aromatic Hydrocarbons			Prior to Flushing		After Flushing	
			Meter	Customers Sink	Meter	Customers Sink
Benzene	µg/L	0.5	<0.5	<2.0†	<0.5	<2.0†
Toluene	µg/L	0.5	<0.5	1100	<0.5	86
Ethylbenzene	µg/L	0.5	<0.5	290	<0.5	22
m/p-xylene	µg/L	1	<1	1300	<1	94
o-xylene	µg/L	0.5	<0.5	360	<0.5	26
Styrene (Vinyl benzene)	µg/L	0.5	<0.5	6.0	<0.5	<2.0†
Isopropylbenzene (Cumene)	µg/L	0.5	<0.5	7.1	<0.5	<2.0†
n-propylbenzene	µg/L	0.5	<0.5	15	<0.5	<2.0†
1,3,5-trimethylbenzene	µg/L	0.5	<0.5	31	<0.5	2.7
tert-butylbenzene	µg/L	0.5	<0.5	<2.0†	<0.5	<2.0†
1,2,4-trimethylbenzene	µg/L	0.5	<0.5	120	<0.5	9.8
sec-butylbenzene	µg/L	0.5	<0.5	<2.0†	<0.5	<2.0†
p-isopropyltoluene	µg/L	0.5	<0.5	<2.0†	<0.5	<2.0†
n-butylbenzene	µg/L	0.5	<0.5	<2.0†	<0.5	<2.0†

The site was attended once again and this time the toilet cistern was dye marked with Fluorescein confirming no siphoning. It was found that the customers sink still had a strong solvent smell and it was during this inspection that a small amount of oil was noticed between the buildings which was in line with the internal plumbing and almost directly above the old repair identified by the tenant.

2.5 The Eureka Moment!

After returning to the office, the words “toluene leaching residential fittings” were entered into an internet search engine. The very first result returned was a US EPA paper on *Permeation and Leaching*, which included case studies of petroleum products permeating plastic piping and this led us to revisit the suspected contaminated area and take soil samples. Surface trash was removed and first soil sample taken from top 25mm of ground, comprising of crushed rock and debris. The pipe trench was then exposed to the same depth as the internal water pipe and a second soil sample taken from sidewall of the trench comprising of primarily clay. Area did not have an odour until the surface was disturbed. It was then noted that the soil was EXTREMELY odorous – with a strong smell of solvents. Despite warning the laboratory, the content was even higher than they were anticipating and they had to analyse again at an even higher dilution range to obtain reportable values, see Table 3 below.

Table 3: *Analytical Report, Results of Soil Sampling*

VOC's in Soil Monocyclic Aromatic Hydrocarbons	Method: AN433/AN434	Sample Matrix	Soil		
		Sample Date	1/11/13 13:00	1/11/13 13:20	
		Units	LOR		
Benzene		mg/kg	0.1	<0.5†	<0.5†
Toluene		mg/kg	0.1	51	19
Ethylbenzene		mg/kg	0.1	30	9.6
m/p-xylene		mg/kg	0.2	180	38
Styrene (Vinyl benzene)		mg/kg	0.1	<0.5†	<0.5†
o-xylene		mg/kg	0.1	150	19
Isopropylbenzene (Cumene)		mg/kg	0.1	7.1	0.9
n-propylbenzene		mg/kg	0.1	9.3	1.8
1,3,5-trimethylbenzene		mg/kg	0.1	64	5.7
tert-butylbenzene		mg/kg	0.1	<0.5†	<0.5†
1,2,4-trimethylbenzene		mg/kg	0.1	140	17
sec-butylbenzene		mg/kg	0.1	<0.5†	<0.5†
p-isopropyltoluene		mg/kg	0.1	4.0	<0.5†
n-butylbenzene		mg/kg	0.1	<0.5†	<0.5†

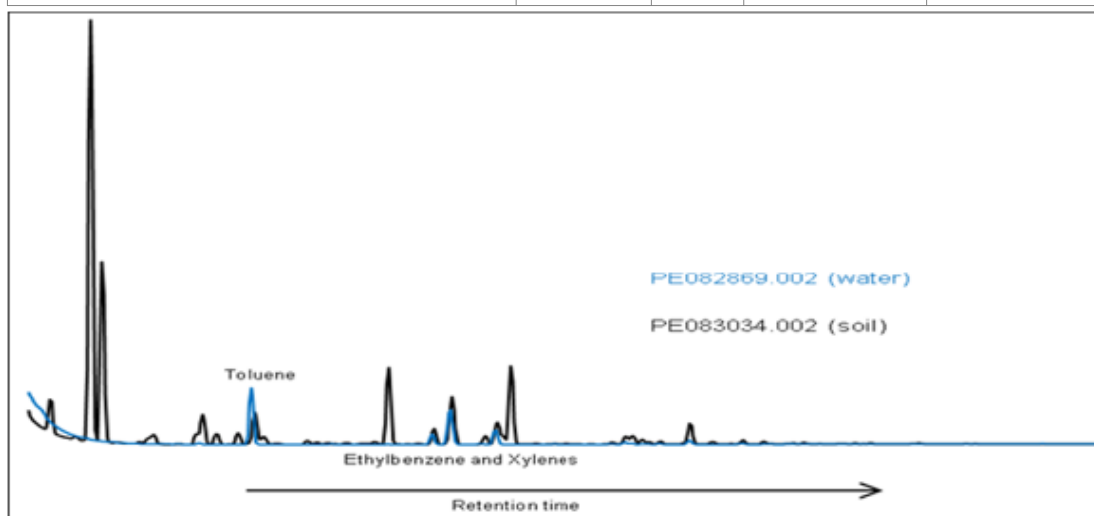


Figure 2: *GC-FID chromatogram comparison for Water and Soil samples*

The chromatogram comparison, Figure 2, between the water and soil samples had close matches for Toluene, Ethyl benzene and Xylene, confirming the contaminated soil was the source of the drinking water contamination. A hydrocarbon fingerprint of the samples was unable to identify a unique match, rather it appeared to be cocktail of contaminants; *similar to mineral turpentine, degreaser, high octane petrol, WD40, light distillates & possibly two stroke engine oil* which indicate that the area could have been a dumping ground for petroleum products for quite some time.

3.0 CONCLUSION

The issuing of the formal letter advising both the owner and the tenant that the water contamination originated within the property and that the water was not suitable for consumption eventually led to the owner relocating the internal pipework to by-pass the contaminated soil. After the owner relocated the pipe, the area of contamination was excavated to identify the pipe material and it was found to be *Rural Grade Poly Pipe*. This is significant as it confirms the contamination is via permeation of plastic piping.



Figure 4: *Original Repair - Rural Grade Poly Pipe*

The type of contamination and location adjacent to an Industrial Paint Shop initially led the investigation in the wrong direction of a cross-connection. If GVW had experienced this type of issue previously the immediate response would have been to look for soil contamination. Any future incidences of BTEX contamination would in the first instance lead to a search in the vicinity for contaminated soil.

4.0 ACKNOWLEDGEMENTS

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5.0 REFERENCES

US EPA Office of Water: Washington D.C. (2002), Distribution System Issue Paper, *Permeation and Leaching*, Prepared by: AWWA with assistance from Economic and Engineering Services, Inc <http://water.epa.gov/lawsregs/rulesregs/sdwa/tcr/upload/permeationandleaching.pdf>