



Submitted to
Commonwealth Department of the
Environment and Heritage

SCHOOL OF ENTERPRISE
442 AUBURN ROAD
HAWTHORN VICTORIA 3322
AUSTRALIA
www.soe.unimelb.edu.au
TEL: 61 3 9810 3298
FAX: 61 3 9810 3149

Random Audit of Historical
Water Quality Monitoring Data
and Associated
Operational/Landscape and
Climate Data

UMEE LTD
ABN 53 081 182 685
ACN 081 182 685

First Report – 5 January 2007

Prepared by
Professor Ian Rae

Contact Details

For Contractual and Administrative details:

Ms. Sue Fitzpatrick
Project Manager
School of Enterprise
442 Auburn Road
Hawthorn VIC 3122

Phone: +61 3 9810 3116
Fax: +61 3 9810 3149
Email: s.fitzpatrick@soe.unimelb.edu.au

For Technical Details:

Professor Ian Rae

Phone: +61 3 93973794
Fax: +61 3 93973794
Email: iandrae@bigpond.com

Executive Summary

An audit of selected water monitoring data and associated operational and landscape details held by Forestry Tasmania and relating to pesticide spraying in forestry plantations was undertaken on 3 and 4 January 2007.

The data were examined for completeness and compliance with the sampling protocol established by Forestry Tasmania. The only major discrepancy between practice and the protocol was the time between spraying and first sampling, which always exceeded – often by a considerable margin – the recommended time of 30-120 minutes. The discrepancy is not expected to have had a significant effect on the relevance of the sampling data, and it is recommended that the protocol be reassessed to see if more reasonable expectations could be met.

All of the compiled data were subject to careful examination, and three cases are presented in some detail to show the way the data were assessed.

Finally, the complete data set was examined and recommendations made that data from 15 spray events involving 40 pesticide sprays, resulting in approximately 80 analytical results would be suitable for use in the PIRI modeling programme.

1. Introduction

The first stage of the audit was conducted on 3 and 4 January 2007 at the offices of the Forestry Tasmania in Hobart. Mr Peter Volker and Ms Erin Trainer provided relevant data and advice about the procedures used in Forestry Tasmania.

Considerable work had been done to collect information about spraying events and selected data for post-2000 years have been compiled in a Microsoft Access database. Before this date there are more gaps in data collections because protocols were not as well established. Also, while in recent years there has been emphasis on compilation of data by electronic means, it has not been possible to go back and enter historic paper-based information into the data base.

A number of paper files were inspected. They contained information on (i) spray plan (ii) contractor's report (iii) analytical data showing sample collection dates and the identity of the sampler, and separate information was available as to who had been trained in sample collection.

In making a proposal to undertake this work, I had outlined a methodology for selecting data for close scrutiny, and listed what I felt were the most important of the eleven criteria that needed to be met for samples. In the event, the available data set was smaller than I had expected and I was able to examine all of the data for the spray events that were listed in the Access database. Experience with the data also enabled me to refine my approach to the application of the criteria. Some specific comments are included in the next section.

2. Application of criteria

2.1 Pre-spray samples

Pre-spray samples were collected and analysed for all spray events. There are very few positive results for these, but an example was reported of a positive result for a pesticide other than that to be sprayed, the source of the contaminant being not identified.

2.2 Blanks

Data sheets show that blanks were used in all cases and did not reveal anything untoward.

2.3 Post-spray samples

In most cases, the post-spray sample was collected days after the spray event, but the protocol requires collection within 30-120 minutes. Late collection was such a common occurrence that it seems to me that protocol is unrealistic in its recommended timing. There could be logistic difficulties that make an elapsed time of the order of days, rather than minutes, more realistic. A sample taken within 30-120 minutes of spraying could reveal pesticide that was translocated to the water body more-or-less immediately,

especially from the water itself of the close riparian area. A sample taken after a few days would reveal on-going translocation of pesticide and would still be a meaningful result. It is recommended that the protocol be re-assessed with these points in mind, taking special account of possible logistic difficulties.

2.4 Post-rain samples

Under the protocol, samples are taken before spraying, after spraying and then after a 'significant' rain event, although this latter term is not well defined. Experience shows that it takes almost a month after sampling for the result to be known at a regional office of Forestry Tasmania. The post-spray sampling is automatically followed up with the post-rain event sampling. If positive results are found, sampling is continued – but at approximately monthly intervals because of the analytical turn-around time – until none of the target pesticide is detected. Although speeding up laboratory and administrative turn around time would facilitate this investigative process, a monthly sampling frequency does not seem inappropriate.

2.5 Wind speed

The protocol calls for wind speed to be less than 12 km/hour on the day of the spraying, but wind speed was not always reported by the contractor. Estimates were obtained from data collected by the nearest weather station, but variability of terrain meant that valid interpolation or extrapolation was seldom possible. Only a few cases of nominally excessive wind speed were encountered and since the sample analyses did not reveal elevated levels of pesticide it was concluded that there had been no significant spray drift. Droplet sizes used in forestry applications are typically 900-1000 μm , which is considerably above the range regarded in the PIRI model as likely to produce as significant drift (droplet size $<300 \mu\text{m}$) so this criterion was assigned minor relevance in judging the usefulness of analytical chemical data.

2.6 Landscape data

Landscape data are available for all coupes, and files contained detailed maps. Data were also available indicating the sampling points, with information about their suitability. The slope of the coupe was also recorded in the data set.

Buffers – roads and streams – were observed in almost all cases. One example of minor incursion into the buffer was noted but analytical results for samples were not elevated. Buffer areas can be seen in maps included in the paper files and in GIS records on electronic file.

The testing protocol requires that sampling not be performed on Class 1 streams because dilution in such major streams (minimum width 40 metres) would make it unlikely that a true indication of migration from the sprayed coupe would be reflected in the analytical data. Only one example was encountered and it is recommended that resulting data not be used in PIRI modeling.

Soil organic carbon content was judged from standard tables of organic carbon content of different soils, using the following protocol. A figure for the top 10-15 cm of soil was computed from the tabulated numbers for 1-10 cm ($\frac{2}{3}$ contribution) and 10-30 cm ($\frac{1}{3}$ contribution), less 25% to account for the difference between forested and plantation soil. Many pesticides bind to soil organic carbon and so the level of this component gives some indication of likely binding, and slow run-off, of pesticide that reaches the soil.

2.7 Training

In almost all cases, the person collecting the sample had been trained, according to records maintained by Human Resources. The data collection form only asked for the name of the person submitting the data, and I had to assume that this also the sample collector. While this is likely, it could not be guaranteed in all cases. In cases where no sample was collected, the reason might be that no trained person was available. The unavailability of a trained person could be caused by staff vacancy, illness or priority being given to another task. Reasons for a non-trained person collecting the sample might include the perceived need to have a sample if the result was predicted to be a significant one (in case of a spill or overspray, for example) but no such cases were encountered in this survey. After considering the cases, and noting no aberrant data, I decided to recommend that the resulting analytical data be used in PIRI modeling since any impact of incorrect sampling was likely to be small.

2.8 Laboratory analyses

Analyses are performed by the Analytical Services Tasmania, a laboratory of the Department of Primary Industries and Water. Samples are delivered to the laboratory within four days, during which degradation of analytes is expected to be minimal.

Samples being tested for Glyphosate are filtered on arrival. I had a query about this practice, since Glyphosate is known to bind to soil particles, from which it can be released under some circumstances, but I was unable to explore the issue because staff of the analytical laboratory were on vacation at the time of the audit. All other samples they are refrigerated then put through a C-18 filter, which is rinsed with a solvent to pick up any residual chemical on sediments.

Results are made available to Forestry Tasmania after approximately 10 days.

The detection limits are: Haloxypop-methyl, 0.05 µg/L; Metsulfuron – methyl, Sulfmeturon – methyl, Clopyralid, Alpha-cypermethrin, and Terbacil, 0.1 µg/L; Glyphosate, 10 µg/L. The laboratory is NATA-accredited for most pesticides used in Tasmanian forests, but not for Chlorpyrifos and Terbacil.

3. Examples of data sets from Bass District

A number of data sets compiled following spray events were examined. Three examples have been selected for detailed discussion here.

3.1 Ben Nevis, Asset ID 30766

The following table shows relevant data for the coupe with Asset ID 30766 in the Ben Nevis block of the Bass District, which has the following properties: loam soil with 6.8% reduced organic carbon, slope 10°, a coupe with vegetative cover approximately 60 metres from sample point. Mixtures of pesticides were applied by broadcast aerial spraying on two occasions in late 2001 and early 2002.

Pesticide	Product	L/ha	Area ha	Fraction active units FAI g/L	Spray date	Sample date	Sample type – post ...	Result*
Glyphosate	Roundup Biactive	3	15	360	04.09.01	15.10.01	Spray	nd
Glyphosate	Roundup Biactive	3	15	360	04.09.01	19.10.01	Rain	nd
Glyphosate	Roundup Max	3	10	510	04.09.01	15.10.01	Spray	nd
Glyphosate	Roundup Max	3	10	510	04.09.01	19.10.01	Rain	nd
Metsulfuron-methyl	Brushoff	0.05	32	?	04.09.01	15.10.01	Spray	nd
Clopyralid	Lontrel	1	32	300	17.01.02	18.01.02	Spray	nd
Clopyralid	Lontrel	1	32	300	17.01.02	18.01.02	Spray	nd
Clopyralid	Lontrel	1	32	300	17.01.02	12.02.02	Rain	nd
Clopyralid	Lontrel	1	32	300	17.01.02	12.02.02	Rain	nd
Haloxypop-methyl	Verdict	0.25	32	520	17.01.02	18.01.02	Spray	nd
Haloxypop-methyl	Verdict	0.25	32	520	17.01.02	18.01.02	Spray	nd
Haloxypop-methyl	Verdict	0.25	32	520	17.01.02	12.02.02	Rain	nd
Haloxypop-methyl	Verdict	0.25	32	520	17.01.02	12.02.02	Rain	nd

* nd = non-detect. The concentration of pesticide was below the detection limit shown in Section 2.8 of this report.

In considering the tabulated data, I can make the following comments. Firstly, the herbicide Glyphosate, in two commercial preparations (360 and 510 g/L respectively), was applied to sections of the coupe in September 2001 at the rate of 3 L/ha. This means that, overall, $3 \times 15 \times 360 + 3 \times 10 \times 510$ g of Glyphosate was applied (31,500 g = 31.5 kg). The spray mixture also included the herbicide Metsulfuron-methyl. Then in mid-January of the following year, the whole coupe was sprayed with a mixture of the herbicides

Clopyralid and Haloxyfop-methyl (1x32x300 = 9600 g and 0.25x32x520 = 4160g of active substance respectively).

Post-spray samples were taken for Glyphosate and Metsulfuron-methyl analysis after a period of eleven days – well outside the guideline value of 30-120 hours. Post-rain samples were taken four days later. In none of these samples was any pesticide detected (detection limit: Metsulfuron – methyl, 0.1 µg/L; Glyphosate, 10 µg/L).

3.2 Payanna, Asset ID 21030

Another pattern is shown by the spraying of the coupe identified as Asset ID 21030, in the Payanna block of the Bass District. The soil was moderately erodable, bare, fine sandy clay loam with 1.7% reduced organic carbon, on a moderately steep slope. Herbicides were broadcast by aerial spraying.

Pesticide	Product	L/ha	Area ha	Fraction active units (FAI) g/kg	Spray date	Sample date	Sample type – post ...	Result
Metsulfuron-methyl	Brushoff	0.02	20	600	07.05.04	10.05.04	Spray	0.3
Metsulfuron-methyl	Brushoff	0.02	20	600	07.05.04	21.05.04	Rain	nd
Sulfometuron-methyl	Oust	0.07	20	750	07.05.04	10.05.05	Spray	0.3
Sulfometuron-methyl	Oust	0.07	20	750	07.05.04	21.05.04	Rain	nd

The two herbicides were applied on 7 May 2004, and post-spray sampling took place three days later, again, later than required by the Forestry Protocol. Both pesticides were detected at a level of 0.3 µg/L, some three times the detection limit. No pesticides were detected in samples taken eleven days later, following a rain event. The decrease in pesticide concentrations could be attributed to normal process such as degradation or water-aided translocation.

3.3 Jetsonville, Asset ID 21134

In this third example, some elevated levels of pesticide were encountered. This was in the coupe with Asset ID 21134, in the Jetsonville block of the Bass District. The soil was silty clay loam and sandy loam having plant cover and with reduced organic carbon content of 0.98%. It was of shallow slope and judged to be moderately erodable.

Pesticide	Product	L/ha or kg/ha	Area treated ha	Fraction active units (FAI)	Spray date	Sample date	Sample type	Result (µg/L)
Alpha-cypermethrin	Dominex	0.25	63	100 g/L	23.12.04	21.12.04	Post-spray	nd

Alpha-cypermethrin	Dominex	0.25	63	100 g/L	23.12.04	21.12.04	Post-spray	nd
Alpha-cypermethrin	Dominex	0.25	63	100 g/L	23.12.04	23.12.04	Post-rain	nd
Alpha-cypermethrin	Dominex	0.25	63	100 g/L	23.12.04	23.12.04	Post-rain	nd
Terbacil	Eucmix pre-plant	0.85	221.5	880 g/kg	20.07.01	06.09.01 (note 1)	Post-spray	nd
Terbacil	Eucmix pre-plant	0.85	221.5	880 g/kg	20.07.01	06.09.01 (note 1)	Post-spray	nd
Terbacil	Eucmix pre-plant	0.85	221.5	880 g/kg	20.07.01	06.09.01 (note 1)	Post-spray	0.9
Terbacil	Eucmix pre-plant	0.85	221.5	880 g/kg	20.07.01	19.10.01 (note 2)	Post-rain	38.6
Terbacil	Eucmix pre-plant	0.85	221.5	880 g/kg	20.07.01	19.10.01 (note 2)	Post-rain	nd
Terbacil	Eucmix pre-plant	0.85	221.5	880 g/kg	20.07.01	19.10.01 (note 2)	Post-rain	3.1
Terbacil	Eucmix pre-plant	0.85	221.5	880 g/kg	20.07.01	27.11.01 (note 3)	Follow-up	9.8
Terbacil	Eucmix pre-plant	0.85	221.5	880 g/kg	20.07.01	27.11.01 (note 3)	Follow-up	0.3
Terbacil	Eucmix pre-plant	0.85	221.5	880 g/kg	20.07.01	27.11.01 (note 3)	Follow-up	nd
Terbacil	Eucmix pre-plant	0.85	221.5	880 g/kg	20.07.01	27.11.01 (note 3)	Follow-up	nd
Terbacil	Eucmix pre-plant	0.85	221.5	880 g/kg	20.07.01	02.05.02 (note 4)	Follow-up	nd
Terbacil	Eucmix pre-plant	0.85	221.5	880 g/kg	20.07.01	02.05.02 (note 4)	Follow up	nd

The record of the most recent spraying, with the insecticide alpha-cypermethrin, is confused by multiple sprayings that seem to place the ‘post-spray’ sampling prior to the spraying operation. In the event, none of the pesticide was detected in the ‘post-spray’ or the post-rain samples. The earlier spraying on 20 July 2001 with the herbicide Terbacil, however, produced a suite of interesting results. Post-spray samples were not taken until some seven weeks later, when three samples were collected at 11.45 am, 12.45 pm and 1.15 pm respectively (see note 1 in the table). No pesticide was detected in either of the first two samples, but for the third a result of 0.9 µg/L was returned by the laboratory. The post-rain samples (see note 2) were collected a further six weeks later – thirteen weeks after spraying – and once again three samples were collected, at 8.50, 9.10 and 9.25 am. The first of these returned a very high result, 38.6 µg/L, which we would attribute to a ‘first flush’ event except for the fact that with a rainfall for the coupe area of 960 mm it is not credible that there should have been no rain over the preceding three month period. The second and third of this set of post-rain samples returned much lower results, nd and 3.1 µg/L respectively, and even the last of these must be considered a ‘high’ result three months after spraying. I would be tempted to dismiss these post-rain results as aberrations, but two of the four follow-up samples (note 3) collected five weeks later (18 weeks after spraying) showed detectable pesticide, at levels of 9.8 and 0.3 µg/L respectively. Finally, analysis of further follow-up samples (note 4) collected in May 2002, more than nine months after spraying, did not contain detectable levels of pesticide.

4. Recommendation of acceptable data

Following careful examination of the data compilation, I have identified fifteen spray events for which reliable data are available for use in the PIRI modeling exercise. Most spray events involved several pesticides, for each of which post-spray and post-rain samples were collected, giving approximately 80 valid and useful analytical results. Of course, many of these 'results' are non-detects (identified in the tabulated database as 'nd').

Complete analytical data for these spray events and pesticides are available from Forestry Tasmania in the database maintained by Ms Trainer, and so are not shown in detail here. Instead, the table below indicates the coupe where spraying took place, the dates of spraying and sampling, and the pesticides involved.

In the 'comment' column I have indicated my reasons for rejection of some samples

Asset ID	Location (district, block)	Pesticide	Spray date	Comment	Use in PIRI?
13055	Bass, Lisle	Metsulfuron-methyl	01.08.03	- Sampling not timely, no pre-spray sample - no info on sampler	No
13055		Glyphosate	01.08.03	Ditto.	No
13055		Sulfometuron-methyl	01.08.03	No post-spray sample	No
13218	Bass, Ben Nevis	Glyphosate	07.05.04	No post-spray sample	No
13218		Metsulfuron-methyl	07.05.04	No post-spray sample	No
13415	Murchison, Crayfish	Alpha-cypermethrin	15.12.05	No info on sampler, but result should be useful	Yes
13497	Murchison, Inglis	Haloxypop-methyl	20.09.05	No info on sampler (see above), possible high wind but note refers only to closest weather station, post-spray sample taken after 3 days	Yes
13497		Clopyralid	20.09.05	As above	Yes

13855	Mersey, Huntsman	Sulfometuron-methyl	01.05.03	Pre-spray sample was positive for another chemical (metsulfuron-methyl) and post-spray was 7 days after	No
14020	Mersey, Moina	Sulfometuron-methyl	24.04.03	Query about area sprayed and sampling site	No
14179	Derwent, Repulse	Glyphosate	12.08.03	OK	Yes
14179		Sulfometuron-methyl	12.08.03	OK	Yes
14191	Derwent, Florentine	Glyphosate	08.09.03	OK	Yes
14191		Sulfometuron-methyl	08.09.03	OK	Yes
14320	Huon, Lune	Glyphosate	27.08.02	OK but possible high wind at closest weather station	Yes
14320		Metsulfuron-methyl	27.08.02	As above	Yes
15456	Bass, Payanna	Glyphosate	28.04.04	No result for glyphosate (analysis not performed?)	No
15456		Metsulfuron-methyl	28.04.04	OK	Yes
15456		Sulfometuron-methyl	28.04.04	OK	Yes
15556	Bass, Ringarooma	Glyphosate	08.05.04	OK although some doubt that sampling point captures sufficient run-off	Yes
15556		Metsulfuron-methyl	08.05.04	As above	Yes
15556		Sulfometuron-methyl	08.05.04	As above	Yes
15956	Mersey, Castra	Metsulfuron-methyl	12.10.04	OK, although spraying may have extended over several days (12-20 th)	Yes

15956		Sulfometuron-methyl	12.10.04	OK, as above	Yes
15956		Glyphosate	12.10.04	OK, as above	Yes
16236	Murchison, DIP	Metsulfuron-methyl	12.10.03	High wind speed at closest weather station	Yes
16236		Sulfometuron-methyl	12.10.03	As above	Yes
16236		Glyphosate	12.10.03	As above	Yes
17881	Huon, Southport	Glyphosate	02.08.03	OK	Yes
17881		Metsulfuron-methyl	02.08.03	OK	Yes
18357	Huon, Hastings	Glyphosate	04.04.04,29.04.04, 02.08.03	OK	Yes
18357		Metsulfuron-methyl	04.04.04, 29.04.04, 02.08.03	OK – late sample	Yes
19891	Derwent, Styx	Glyphosate	10.06.04	OK	Yes
19891		Sulfometuron-methyl	10.06.04	OK	Yes
19898	Derwent, Tyenna	Glyphosate	08.11.03, 27.05.04	Roads sprayed	Yes
19898		Metsulfuron-methyl	08.11.03	Roads sprayed	Yes
19898		Sulfometuron-methyl	27.05.04	OK	Yes
19918	Derwent, Counsel	Metsulfuron-methyl	23.05.03	OK	Yes
19918		Sulfometuron-methyl	23.05.03	OK	Yes
19918		Glyphosate	23.05.03	OK	Yes
21030	Bass, Payanna	Glyphosate	07.05.04	OK	Yes
21030		Metsulfuron-methyl	07.05.04	OK – query about capture of run-off	Yes
21030		Sulfometuron-methyl	07.05.04	As above	Yes
21134	Bass, Jetsonville	Alpha-cypermethrin	23.12.04	Confusing data and run –off persistent over long period (see Section 3.3 of this report)	No
21350	Bass, Tomahawk	Glyphosate	07.05.04	OK	Yes

21350		Metsulfuron-methyl	07.05.04	OK	Yes
21350		Sulfometuron-methyl	07.05.04	OK	Yes
30202	Bass, Goulds Country	Glyphosate	30.07.02	Possible high wind	No
30202		Metsulfuron-methyl	30.07.02	Sample taken on class 1 stream	No
30202		Sulfometuron-methyl	30.07.02	As above	No