Air quality data processing and archiving



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1. Purpose and scope

The purpose of this procedure is to ensure that air quality data obtained from the GW monitoring network represents, as far as possible, actual ambient contaminant concentrations at the monitoring site. This procedure supports the air quality monitoring objective to ensure that air quality data used for state of the environment and NES-AQ reporting are robust and scientifically defensible.

This procedure documents the data handling, validation and ratification processes necessary to produce a 'quality-assured' dataset that is ready for further analysis and reporting.

This procedure describes:

- Data storage procedures, including archiving
- Data adjustment and editing procedures, including corrections for calibrations
- Documentation of data adjustments and excluded or missing record
- Data quality acceptance criteria

2. Responsibilities

The Environmental Monitoring Officers - air quality (EMOs) and Environmental Scientist - air quality (AQ scientist) are responsible for data processing and validation. The AQ scientist is responsible for data ratification and the Senior Analyst, Science, Strategy and Information is responsible for data archiving.

3. Frequency

Air quality data are validated or processed within three weeks of a final calibration. Processed data are ratified annually with data for the previous calendar year being ratified by 30 June.

4. References

Good practice guide for air quality monitoring and data management. Ministry for the Environment, 2009. [http://www.mfe.govt.nz/publications/air/good-practice-guide-air-quality-2009/index.html]

5. Resources and definitions

5.1 Equipment required

- A computer connected to Hilltop database
- Site logs containing written records of all station visits and actions taken
- Record of daily data site checks
- E-logs (excel spreadsheets) containing the results of audit and final calibrations and a record of instrument maintenance carried out

5.2 Definitions and work flow

5.2.1 Definitions

Data processing is the series of steps and accompanying documentation necessary to convert raw data to the final data set.

Data editing is the process of examining data for spurious measurements that do not represent actual ambient concentrations and applying calibration curves to adjust the data to compensate for instrument drift over time.

Data checking involves QA of edited data and is carried out by someone other than the data editor

Data validation is the process of screening checked data to ensure that it is consistent over the monitoring network and over a longer time frame.

Data archiving is the process of uploading validated data to permanent read-only electronic storage.

Edit	• Copy raw telemetry data batch to intermediate file and edit and adjust (eg, applying calibration or instrument offsets) to remove non-representative measurements (section 7)
Check	 Check that data batches have been accurately edited and commented appropriately (section 8)
Validato	 Screen checked data to ensure consistent with expected conditions, other monitoring stations and over a longer timeframe (section 9)
validate	
	• Copy validated data to read only archive (annual) (section
Archive	10)

5.2.2 Work flow:

6. Data transfer, storage, handling and archiving

6.1 Data transfer

Station air quality analysers are connected by digital interface via multiplexors to dataloggers (IQuest DS-4483) that store air quality data collected at 10 second intervals as 10 minute or 5 minute averages at NZST. Information from the datalogger is called in by the HydroTel application every hour between 6 am and 6 pm by GPRS (General Packet Radio Service) using the Vodafone mobile network.

The service HydroHill runs on two GW telemetry servers 'Zeus' (Wellington) and 'Thor' (Wairarapa). Every five minutes HydroHill interrogates the HydroTel SQL database and checks for new data which is then copied into the relevant telemetry.hts file on the GW servers.

6.2 Data storage and archiving

The two GW telemetry servers are each divided into three data storage areas:

- 'raw' area is the repository for permanent storage of raw data. Data from the western area of the region is stored on H:\Raw\telemetry.hts.
- 'check' area is the shared area for data that has been edited and is ready for ratification. The common file used is H:\Check\AQ Update.
- 'archive' area contains the final permanent dataset which has read only access. H:\archive\telemetry.hts



Figure 6.1: Example of site tree showing current air quality stations in yellow

Daily backups of all files are made by ITSS, which in turn are backed up every seven days

The 'data source' refers to the actual measurements recorded by the instrument's datalogger for a particular contaminant, eg Carbon Monoxide. Calibrated data refers to a data source that has been transformed using calibration ratings entered into Hilltop Ratings programme, eg, Calibrated Carbon Monoxide. Data sources are converted into different units (eg, ppm to ug/m³) or averaging periods (eg, 10 minute averages to 24-hour averages) and the resulting outputs are stored as a 'virtual measurement', eg, CO 8 Hr Moving Mean (ppm). Calibrated data and virtual measurements are not a time series as such and are calculated on the fly every time the user wishes to view at the data. Data comments are only associated with the data source, and will not appear alongside the calibrated data or any virtual measurements.



Figure 6.2: Example of site tree showing data source and virtual measurements

When the sites were first set up, the data loggers could only log a maximum number of 32767, 32767, 327.67, 32.767 or 3.2767 depending on the maximum value expected and the resolution required. Carbon monoxide is logged to 2 decimal places as the maximum sample is not expected to exceed 327.67. NOx is logged to 1 decimal place as the as the maximum sample is not expected to exceed 3276.7 but will exceed 327.67. At most sites the data logger programme has now been updated to allow a 'floating, decimal point.

6.3 Data handling

Raw data may be examined and manipulated using specific Hilltop software applications. Hilltop Manager is used to view, edit and copy data to other areas. Hilltop Hydro provides specialised tables and graphing facilities needed to analyse air quality data.

6.4 Site metadata

Site metadata are stored on the processing database and in an excel spreadsheet WGN_DOCS-#1294147-GWRC AQ Site Metadata

7. Procedures – data editing

7.1 Select a period of data to edit

Air quality and meteorological data are processed or validated in batches. For carbon monoxide and nitrogen oxides a batch is the period starting and ending with a final calibration. This period may range from weeks to months, depending on an instrument's performance. PM_{10} data is processed between monthly maintenance or for the same time period as the data from a co-located gas analyser. Meteorological data is processed for the period between annual instrument replacements or services at any other time.

Details of who processed the data, checked it, the date the data were processed or checked, whether the data were processed within target time frames and the archive date are recorded in Data Processing Database (a SQL application).

To select a batch of data to process - open the Processing Database and use the drop down menu to select the site and parameter and click Data Processing to open the batch records for that site and data source as shown in Figure 7.1.

DATE ON and DATE OFF are the start and end dates for the period of data being processed.

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•	Environmental N	Iontoring Data Proce	essing Registe	er_	EXIT		
	Recording Authority	GW-Western		•	 Version 2010/10)	
Batches awaiting Processing or Updating	Water Level Sites			▼ Da Proce	ta Site ssing Information	Hilltop Comments	
Batches awaiting Processing or Updating	Rainfall Sites			▼ Da Proce	ta Site Information	Hilltop Comments	Rainfall Deviation Plot
Batches awaiting Processing or Updating	Ground w ater Sites			▼ Da Proce	ta Site Information	Hilltop Comments	WELLS
Batches awaiting Processing or Updating	Manual Runs	[Da Proce	ta ssing		
Batches awaiting Processing or Updating	Air Quality/Met Sites etc	Upper Hutt at Savage Pa Data Source	rk AQ P Carbon Monoxide	Da Proce	ta Site ssing Information	Hilltop Comments]
Batches awaiting Processing or Updating	Water Quality/Temperatur	re Sites Data Sourc	e	Da Proce	ta ssing	Hilltop Comments	
	Soil Quality Sites			•	Site Information		Soil Profile
_	Water Quality Runs			▼ Da Proce	ta ssing		
Gaugings awaiting Processing or Updating	Gaugings Databa	ase	Station Surv	veys	м	anagement/Re	porting/Other

Figure 7.1: First screen of the data processing register

Figure 7.2: Example of the batch processing record accessed by clicking the Data Processing tab highlighted in yellow in Figure 7.1

¥) - (≌ - -		-	_	100,000,000	Processing	Database	and the second second
File Home K Cut Clipboard S Startup S /	Filter	ing V Selection - ding Advanced - sort V Toggle Filter & Filter	Refresh All × Records	An arrow and a second seco		≡ 號 健 健	и • Щ • с
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Processing Inform	Batch start dat Batch start tim mation	e 15/10/2013 e 12:10		Batch end date Batch end time	22/01/2014 (Final cal end da 12:40 (Final cal end tim	e)	
	Processed by	Darren Li 👤	Batch reprocessed?		Checked by	•	
	Processed date	24/02/2014	Reprocessed date		Checked date		Remove Auto Cals
Processin	ıg justifiably delayed 🛛		Reprocessed reason		Archived by		Copy Data to Check
Reason for	delayed processing		Update del	layed 🗖 Reason for dela	yed update	.	Copy Data to Archive
Ρ	Processing comment	lo rating applied to the pe	riod 18/09/2013 to 22/01/2014 due to 2	Zero air generagtor issue.			

7.2 Copy raw data to editing file

Data in the raw telemetry file remains un-calibrated and unedited and is retained as a permanent record. Data must be copied from the raw telemetry file (source) to a data editing file (destination) before editing and in order for calibration ratings to be applied to gas data. To copy data, right click on the data source and enter the destination file name in the Copy Data Source dialogue box.

Manager - [H:\Raw\telemetry.hts]		
File Edit View Data Configure Project Scan W	Copy Data Source	
File Info 29808 4400 4404 490081 Ar Quality and Met Birch Lane AQ Wolkage Air Temperature (1.5m) Air Temperature (1.5m) Carbon Monoxide	Source Site Upper Hutt at Savage Park AQ Data Source PM10 (FH62) Image Check Data All Rating Sets Quality Data Check Data Quality WQ Sample Time Range From 27-Jun-2013 00:00 To 30-Apr-2014 00:00	Go Cancel
Cost Cost Cost Cost Cost Cost Nitrogen O List Copy Prenentage Solar Radie Matwind v Rename Solar Radie Matwind v Rename Sol vind Sp Sol vind Sp Sol vind Sp Cost Delete Matwind v Rename Sol vind Sp Delete Matwind v Rename Sol vind Sp Details Weind Spee Melling Transport AQ Met Station at Belmont Regional Park	Start of Data All Data Finish of Data From Graph Only Copy New Data Archive File sets the time range Archive File Image: Composition site Image: Composition site Destination Site Image: Composition site Image: Composition site Data Source PM10 (FH62) Image: Composition site Image: Composition site Filename H: Check VAQ Update.hts Image: Composition site Image: Composition site Image: Open file when copy completes Site Image: Composition site Image: Composition site	
	Quality Merge Rule Gap Rules Change Quality Statch by batch Copy gaps New Quality Merge Elements Don't copy gaps Progress Gap at Start	

Figure 7.3: Copy data dialogue box

After copying you may need to refresh by clicking on F5.

7.3 Identifying invalid data

Spurious or invalid data is data that does not reflect actual ambient concentrations. Invalid data can result from instrument malfunction, maintenance, calibrations, power outages etc. Invalid data is best identified by viewing the graphed data and looking for anomalies, such as positive or negative spikes, periods of flatline data or baseline drift and so on. All such periods should be cross-checked against the site log and instrument maintenance records to ascertain if there is a probable cause for the unusual data. Keep in mind that unusual data can also be 'real' due to the presence of a local emissions source, eg a vehicle idling outside the monitoring station or nearby construction works – painting etc.

Check for the following periods of invalid data:

Carbon monoxide and nitrogen oxides

- Spikes during audit and final calibrations
- Six daily automatic zero checks between midnight and 1 am (NOx)
- Daily zero checks/adjustments between midnight and 1 am (CO)
- Periods during maintenance
- Periods where logger has been reprogrammed or replaced
- Periods of power failure
- Data points where NO is greater than NOx (overplot NO and NOx). Bear in mind that when background levels are low the measurement errors associated with NO and NOx values may overlap resulting in negative values or NO being higher than NOx.

PM₁₀

- Periods during maintenance (annual calibration, PM₁₀ head cleaning)
- Periods where logger has been reprogrammed or replaced
- Periods of power failure
- Following automatic filter change at midnight
- Extreme or unusual negative or positive spikes

Meteorological data

- Periods during maintenance or instrument replacement
- Periods where logger has been reprogrammed or replaced
- Periods of power failure
- Extended periods of high wind speed or unchanging wind direction

7.4 Data editing

Data editing involves deleting invalid data and inserting or removing gaps in the data.

7.4.1 Deleting and inserting or closing gaps using Hilltop Manager

To delete data in Hilltop Manager, select a period of data and use the data/edit command to bring up the editing screen as shown in Figure 7.5.



Figure 7.5: Data edit screen in Hilltop Manager

To delete a data point (eg, a 10 minute average as shown above) hold down the Ctrl and Delete keys together.



Figure 7.6: Deleting a data point in Hilltop Manager edit mode

Once the required period of data is deleted, insert a gap by holding down the Ctrl and Insert keys at the same time. As a general rule a gap must be inserted when more than 15 minutes worth of data is removed and a comment inserted. This is to ensure that when the data is averaged we know where there are periods of less than 75% hourly data capture. However, the gaps are closed for the daily carbon monoxide zero checks.

7.4.2 Automatic Excel scripts to remove data from Hilltop

An Excel macro is available for deleting regularly occurring events, such as the six daily NOx auto calibrations and the daily CO audit calibrations. Such operations should

be carried out in the personal edit areas first – as this command cannot be undone. The Excel macros are contained in the following spreadsheets:

J:\AIR QUALITY\AQ Calibration Templates\Data Deletion Script for NOx.xls

J:\AIR QUALITY\AQ Calibration Templates\Data Deletion Script for CO (New).xls

Check these with Darren





7.4.3 Removing spikes using Hilltop Manager

Spikes can be removed using the Transform command in Hilltop. Ticking the 'Remove Spikes' feature removes all values outside a lower and upper limit (or keeps all the values between the lower and upper limit). For example, a lower limit of -70 and an upper limit of 100 means all values below -70 and above 100 are deleted. A gap will be inserted if the 'Gap at Spike' check box is ticked. See Figure 7.8.

Iransform	
Site Pirch I and AO	
Measurement Nitrogen Ovide [Nitrogen Ovide]	60
industrient findgen exide [findgen exide]	
_ Iime Range	
From 3/8/07 02:30:00 To 1-Oct-2007 09:10	D:00 Cancel
Start of Data All Data Einish of Da	ata
Destination	Help
Site Birch Lane AQ	
DataSource Nitrogen Oxide	<u>1</u>
Filename H:\Check\AQ Update.hts	•
Open file when transform completes	s
Options	Spikes
Mul 1 Div 1 Add 0	Remove Spikes
Apply Mul. Div and Add to all items	Limits -20
Keep all times	🔽 Gap at Spike
C Compress Range 0	Quality Filter
C Benack Internal D	Filter by Quality
	Limits
	Gap when rejecting data
Progress	

Figure 7.8: Data transform to remove spikes using Hilltop Manager

7.4.4 Closing gaps using Hilltop Manager

If you wish to remove all gaps of a specified duration between two dates, this can be achieved using the 'Gap' function in Hilltop Manager as shown in Figure 7.9. Type the gap length (eg 10 minutes) in the 'Select gaps less than or equal to' box. This will then check all the gaps of this length. Scroll through the list to check and if OK click the 'Remove gaps' tab to close or remove these gaps.





G	Gaps in Wairarapa College AQ [Nitric Oxide]						
1	Site	From	То	Duration 🔺			
	🗆 🗠 Wairarapa College AQ	2-Dec-2002 12:00:00	2-Dec-2002 16:00:00	4.00 Hours 📃	Select All		
	🗆 🗠 Wairarapa College AQ	3-Dec-2002 08:00:00	3-Dec-2002 08:50:00	50.00 Minutes			
	🗆 🗠 Wairarapa College AQ	13-Feb-2003 09:40:00	13-Feb-2003 16:20:00	6.67 Hours			
	🗆 🗠 Wairarapa College AQ	1-Apr-2003 14:10:00	1-Apr-2003 18:20:00	4.17 Hours	Deselect All		
	🗆 🗠 Wairarapa College AQ	8-May-2003 13:30:00	8-May-2003 16:40:00	3.17 Hours			
	🗆 🗠 Wairarapa College AQ	5-Jul-2003 11:30:00	5-Jul-2003 16:30:00	5.00 Hours			
	🗆 🗠 Wairarapa College AQ	8-Sep-2003 12:50:00	8-Sep-2003 13:10:00	20.00 Minutes	Remove Gaps		
	🗆 🗠 Wairarapa College AQ	9-Sep-2003 12:20:00	9-Sep-2003 17:00:00	4.67 Hours			
I	🗆 🗠 Wairarapa College AQ	23-Sep-2003 11:10:00	23-Sep-2003 13:20:00	2.17 Hours			
I	🗆 🗠 Wairarapa College AQ	24-Sep-2003 00:00:00	25-Sep-2003 13:50:00	1.58 Days	View Gaps		
I	🗆 🗠 Wairarapa College AQ	27-Sep-2003 14:20:00	30-Sep-2003 17:10:00	3.12 Days			
	🗆 🗠 Wairarapa College AQ	9-0 ct-2003 10:40:00	9-0 ct-2003 14:10:00	3.50 Hours			
	🗆 🗠 Wairarapa College AQ	10-Nov-2003 13:40:00	10-Nov-2003 15:40:00	2.00 Hours	Cancel		
	🗆 🗠 Wairarapa College AQ	11-Nov-2003 10:20:00	11-Nov-2003 14:30:00	4.17 Hours			
	🗆 🗠 Wairarapa College AQ	25-Nov-2003 12:40:00	25-Nov-2003 13:10:00	30.00 Minutes 🛛 🖵			
	Select gaps less than or equal to		ı		Help		
	From To		<u>S</u> elect				

Figure 7.10: Gap dialogue box in Hilltop Manager

To select a particular gap to be closed, place cursor on icon to the right of check box and left click with mouse.

Manager - [H:\Check\AQ Update.hts]					
🎦 File Edit View Data Configure Project	Scan Window Help				
28 B35 🛯 🕄 🔍	- 222				
File Info	Carbon Monoxide at site Birch Lane AQ				
🗄 🎦 Air Quality and Met					
🗄 🎦 Hutt Valley	Data starts at 2-Nov-2004 00:00:00				
😑 🧰 Birch Lane AQ	Gap from 2-Nov-2004 09:30:00 to 2-Nov-2004 12:00:00 of 2.50 Hours				
E Carbon Monoxide	Gap from 10-Jan-2005 11:20:00 to 10-Jan-2005 13:50:00 of 2.50 Hours				
Carbon Monoxide	Gap from 26-Jan-2005 12:00:00 to 26-Jan-2005 14:30:00 of 2.50 Hours				
Calibrated Carbon Mono	Gap from 14-mar-2005 11:00:00 to 14-mar-2005 15:20:00 of 4.33 Hours				
CO 8 Hr Moving Mean (n	Gap from 20-Apr-2008 12:20:00 to 20-Apr-2008 18:00:00 of 2.67 Hours				
CO 1 Hr Elved Mean (ma	Cap from 2-Apr-2008 12:00:00 to 25-Apr-2008 20:00:00 of 13:08 Hours				
CO 111 House Mars /s	Gap from 16-Jun-2005 11:30:00 to 16-Jun-2005 14:30:00 of 3:00 Hours				
CO o hr moving mean (in	Gan from 4-Jul-2005 13:20:00 to 4-Jul-2005 15:20:00 of 2:00 Hours				
Nitric Uxide	Gan from 11-Aug-2005 11:50:00 to 11-Aug-2005 15:40:00 of 3 83 Hours				
Ntrogen Dioxide	Gap from 5-Sep-2005 11:10:00 to 5-Sep-2005 15:30:00 of 4.33 Hours				
Nitrogen Oxides	Gap from 6-Sep-2005 13:30:00 to 6-Sep-2005 15:30:00 of 2.00 Hours				
E- PM10 (TEOM)	Gap from 8-Oct-2005 02:50:00 to 14-Oct-2005 11:50:00 of 6.38 Days				
	Gap from 15-Nov-2005 11:30:00 to 15-Nov-2005 14:40:00 of 3.17 Hours				
PM10 (TEOM) 24 hr Avei	Gap from 13-Dec-2005 08:10:00 to 13-Dec-2005 10:40:00 of 2.50 Hours				
🕀 🧰 Meling Transport AQ	Gap from 18-Jan-2006 08:30:00 to 18-Jan-2006 12:10:00 of 3.67 Hours				
🕀 🧰 Met Station at Shandon Golf Clul	Gap from 9-Feb-2006 12:20:00 to 9-Feb-2006 14:40:00 of 2.33 Hours				
😟 🛅 Upper Hutt AQ	Gap from 7-Har-2006 08:20:00 to 7-Mar-2006 10:50:00 of 2.50 Hours				
😑 🧰 Upper Hutt at Savage Park AQ	Gap from 22-Har-2006 00:00:00 to 27-Mar-2006 11:00:00 of 5.46 Days				
Carbon Monoxide	Gap from 5-Apr-2006 09:50:00 to 5-Apr-2006 12:30:00 of 2.67 Hours				
Carbon Monoxide	Gap from 2-may-2006 11:00:00 to 2-may-2006 13:00:00 of 2.17 Hours				
- Calibrated Carbon Mono	Can from 25-hay-2006 12:000 to 25-hay-2006 14:00:00 + 2:00 Hayes				
CO 8 Hr Moving Mean (n	Cap from 25-001-2006 12:00:00 to 25-001-2006 16:00:00 of 2:00 Hours				
CO 1 Hr Elved Mean (mo	Gap from 28-Jul-2006 11:50:00 to 3-bue-2006 13:40:00 of 5.08 bars				
CO 8 Hr Moving Mean (r	Gap from 24-Aug-2006 12:50:00 to 24-Aug-2006 14:40:00 of 1.83 Hours				
Nitric Ovida	Gap from 20-Sep-2006 14:30:00 to 20-Sep-2006 16:50:00 of 2.33 Hours				
The second secon	Gap from 17-Oct-2006 13:00:00 to 27-Nov-2006 14:50:00 of 1.35 Months				
The second secon	Gap from 13-Dec-2006 14:10:00 to 18-Jan-2007 12:10:00 of 1.18 Months				
The price (Truce)	Gap from 1-Har-2007 09:10:00 to 1-Mar-2007 11:50:00 of 2.67 Hours				
	Gap from 4-May-2007 10:30:00 to 4-May-2007 15:30:00 of 5.00 Hours				
PMIU (FH62)	Gap from 12-Jun-2007 11:40:00 to 12-Jun-2007 13:50:00 of 2.17 Hours				
	Gap from 26-Jun-2007 10:40:00 to 26-Jun-2007 15:00:00 of 4.33 Hours				
Solar Radiation	Gap from 29-Jun-2007 08:30:00 to 29-Jun-2007 08:40:00 of 10.00 Minutes				
SD Wind Direction (10m)	Gap from 3-Jul-2007 13:30:00 to 3-Jul-2007 14:30:00 of 1 Hour				
⊞ I Wainuiomata Bowling Club AQ	Gap from 24-001-2007 12:40:00 co 24-001-2007 13:00:00 of 20:00 Minutes				
🗄 🎦 Tawa	Gap from 24-001-2007 14:10:00 to 24-001-2007 14:30:00 of 20:00 Hindles				
😑 🎦 Wairarapa - Wgtn	San from 24-041-2007 15:20 to 24-041-2007 15:50:00 of 30 00 Minutes				
🖹 💼 Wairarapa College AQ	Gap from 24-Jul-2007 22:50:00 to 24-Jul-2007 23:00:00 of 10.00 Minutes				
Barometric Pressure	Gap from 27-Jul-2007 23:40:00 to 28-Jul-2007 00:10:00 of 30.00 Minutes				
📕 🕹 Relative Humidity	Gap from 28-Jul-2007 07:20:00 to 28-Jul-2007 07:30:00 of 10.00 Minutes				
	I .				
Ready					
🏄 Start 🚳 🏉 💿 🖉 🗷 💽 💓 🗂	😰 🕝 😋 💿 🛛 🔯 Inbox - Micros 🛛 🖳 WGN_DOCS-# 🛛 📻 Manager - [H 💆 Document2 🚺 Hydro				

Figure 7.13: List of gaps for the data source displayed by Hilltop Manager

7.5 Data annotation (comments)

All periods of missing record or deleted data must be accompanied by a data comment specifying the date/time of the missing record and the reason, if known. Data should also be commented to reflect any factors which may influence the data, for instance the switch to a new instrument or a change in instrument setting, such as sample inlet temperature for the PM_{10} analysers.



Figure 7.11 Read-only data comments associated with the data source can be viewed directly from Hilltop

Data comments are stored in a SQL database that can be viewed/edited and entered using the Data Processing Database. Open the database and use the drop down menu to select the desired site and parameter and click Hilltop Comments.

A 19 - C1			And Address of the owner of	Proces	sing Database
File Home					5
A Cut A Cut A Cut A Cut A Remove Sort ✓ Selection → ▼ Tog: → Advanced →	gle Filter	Spelling And	Go To To To To Select To B	• • E <u>U</u> A • ഈ • <u>3</u> • ≡	[] [] [] [] [] [] [] [] [] [] [] [] [] [
Clipboard Sort & Filter	Record	ds Fir	nd	Text Formatting	G.
• Environme	ental Montoring D	ata Processing	Register	EXIT	
Recording Autho	ority GW-Weste	rn	•	Version 2010/10	
Batches awaiting Processing or Updating	, 		×	Data Processing Information	Hilltop Comments
Batches awaiting Processing or Updating			•	Data Site Processing Information	Hilltop Comments Deviation Plot
Batches awaiting Processing or Updating			•	Data Site Processing Information	Hilkop Comments
Batches awaiting Processing or Updating			×	Data Processing	
Batches awaiting Processing or Updating	es etc Upper H	utt at Savage Park AQ Data Source Carbon M	tonoxide	Data Processing Information	Hilitop Comments
		_			Processing Database
Eile Hame					Processing Database
Pase Corp Pase Corp Filter Ascending Corp Filter Ascending Corp Filter Ascending Corp	V Selection *		ind ac Replace ac Replace ac Replace ac Replace	B <u>I</u> UA-W	 ・ 三 三 詳 詳 HT × ▲ × 目目 書 書 Ⅲ × Ⅲ ×
Clipboard Sort & F	ilter	Records	Find	Text	Formatting Gr
Startup B dbo_comments_AQual_	ALL				
Upper Hutt at Savage Par	'k AQ	Carbon Monoxide	EXI	T 🔸 Copy Commen	s Add new standard comment
30/09/05 12:10:00	Analyser installed is an M300E S Sampling is averaged and logge Data logger is an iQuest DS-448 Site is telemetered by SPBS	GN 579 3d every 10 minutes. 33 and analyser is connected	via an iQuest multiplexo	и.	
19/10/05 12:30:00	Deleted data of 4.83 hours from	19/10/2005 123000 to 19/1	0/2005 172000 due to	instrument calibration.	
19/10/05 12:30:00	Data manually ramped for period	19/10/05 123000 to 16/11/	/05 113000 due to unre	alistic calibration correction.	
16/11/05 11:20:00	Deleted data of 3.67 hours from	16/11/2005 112000 to 16/1	1/2005 150000 due to	instrument calibration.	

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Alternatatively you can copy across gaps from Hilltop Manager.

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	Upper Hutt at Savage Park AQ	PM10 (FH62)	5-Jul-2011 14:00:00	5-Jul-2011 14:20:00	20.00 Minutes		Bemove Gaps
	Upper Hutt at Savage Park AQ	PM10 (FH62)	11-Aug-2011 13:50:00	11-Aug-2011 16:30:00	2.67 Hours		
L	Upper Hutt at Savage Park AQ	PM10 (FH62)	14-Sep-2011 14:40:00	14-Sep-2011 15:00:00	20.00 Minutes		
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🕀 🗠 Nitrogen Oxides	Gap from 25-Jun-2012 12:00:00 to 25-Jun-2012 15:40:00 of 3.6/ Hours
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7.6 Apply calibration ratings to gas data

7.6.1 Background

Gas analysers are calibrated on a regular basis to correct for instrument response drift over a known period of time. The audit calibration involves using a reference gas to determine analyser response at a range of concentrations (eg dual point or multipoint) for the purpose of establishing the degree of instrument drift. The final calibration involves adjusting the instrument response against a range of known reference gas concentrations. Typically audit calibrations are carried out monthly to determine the degree of instrument drift. Final calibrations are carried out three-monthly or sooner if an audit calibration shows that the instrument drift is outside acceptable limits or following maintenance procedures likely to affect the instrument response.

The results of these calibrations are recorded in an e-log and are subsequently imported into the H:\Check\AQ Update.hts file where they are applied to the source data to create a calibrated data source.

7.6.2 Importing calibration ratings to Hilltop using e-logs

E-logs are Excel spreadsheets copied from the field laptops and saved on the J Drive. The e-log contains the results of audit and final caliabrations and records instrument checks and maintenance procedures carried out. The e-logs are filed electronically by site, instrument and date. For example: J:\AIR QUALITY\AQ Sites\Karori\e Logs\2009\Karori AQ Feb CO 2009.xls



Figure 7.14: Example of a calibration record in an e-log

Calibration 'ratings' are imported to Hilltop ratings programme where they are used to 'transform' the data measurement source to a 'rated' virtual data source, ie the data is adjusted to compensate for instrument drift.

An analyser response 'curve' is constructed using the x,y pairs. x = UNRATED (instrument response) and y = RATED (known concentration of reference gas). Two curves are constructed (quadratic spline for multipoint and linear interpolation for dual point) – an audit curve and a final curve.

The air quality data are adjusted using the difference between the two curves (final and audit). Typically instrument drift increases with time so the data is adjusted gradually between the final and audit calibrations, ie the final calibration curve is not fully applied until one minute before the final calibration was carried out. When an audit calibration is carried out for the purposes of checking the instrument response and no adjustment to the instrument is made – the audit calibration is not imported to Hilltop.

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Figure 7.15: Example of a list of ratings listed in Hilltop Hydro using Rating table function

To import a calibration rating, open the relevant e-log and check the Hilltop destination File name is correct, eg H:\Check\AQ Update.hts. To import the audit and/or final rating to Hilltop, click the 'Save' button. The calibration results will be automatically inserted into the specified file name in the correct order and time. Where a dual point calibration has been completed, results for the zero and span cells should be filled in – the other cells should be left blank.

7.6.3 Check that ratings have been imported to Hilltop correctly

Print out and check the rating pairs in Hilltop Hilder.

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Figure 7.16: Dialogue box for viewing calibration ratings that have been imported into Hilltop

The audit calibration rating start time (S. Time) should be one minute after the start time of the previous final calibration. The audit calibration rating effective time (E. Time) should be one minute before the start time of the final calibration.



The ratings for the final calibration have the same start and effective time which is the time the final calibration process starts. This has the effect of gradually smoothing the ratings from the previous final calibration to the latest audit calibration.

7.6.4 Nitrogen oxides data

NOx analysers sample air to determine the concentrations of NO and NOx separately. Only the NO and NOx channels are calibrated with a reference gas. An example of the audit calibration results recorded in an E-log is shown below. NO₂ is calculated by the analyser by subtracting sampled NO from sampled NOx. The NO₂ data source is not calibrated. The NO, NOx and NO₂ data sources are edited and commented. Comments and editing for each of these data sources should match exactly.

Audit Calibration Rating Table									
NO input by	NO output by	NOx input by	NOx output by	NO ²	NO ² Output				
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300	303.1	305.5	305.9	5.53	2.7				
200	201.0	203.7	202.0	3.69	1.1				
100	97.9	101.8	98.5	1.84	0.7				
0	-1.5	0.0	-1.8	0.00	-0.3				
NO input by	Rating Table NO output by	NOx input by	NOx output by	NO ²	NO ² Output				
Final Calibration	Rating Table								
NO input by	NO output by	NOx input by	NOx output by	NO ²	NO ² Output				
Calibrator	M200a	Calibrator	M200a	Input	Final Cal				
400	400.000	407.4	407.500	7.38	7.400				
300	300.800	305.5	306.300	5.53	5.500				
200	198.900	203.7	203.000	3.69	4.000				
100	98.800	101.8	100.100	1.84	1.300				
0	0.000	0.0	-0.100	0.00	-0.100				
File name: h:\Check\AQ Update.hts Site name: Corner V AQ Date: 27-Jul-2007 Start Time of Final Cal: 16:03									

Figure 7.17: Example of NOx calibration results in e-log

7.6.5 Graph calibrated and un-calibrated data

To determine whether the calibration ratings have improved the data's baseline, overplot the uncalibrated data with the calibrated data in Hilltop Manager using the same or on a separate axis, if this is easier to view.



Figure 7.18: Overplot of calibrated and uncalibrated data using Hilltop Manager

Changes to the baseline that happen gradually are addressed by applying the calibration curves in Hilltop to adjust the data. However, where there is a sudden change in baseline (unrelated to a final calibration) applying the calibration ratings may result in data that is not representative of ambient conditions. Any periods of raw data between calibrations that show a sudden change in baseline should be brought to the attention of the air quality scientist, so this can be addressed during the data ratification process.

7.6.6 Editing ratings in Hilltop ratings programme

Ratings can be deleted or changed using the Hilltop ratings programme



Figure 7.19: Hilltop Ratings screen

Sometimes applying a rating does not improve or appear to correct the instrument drift. This problem is often due to the instrument drift not being constant and/or differenes in the purity of the zero air and/or measurement error associated with the calibration process. During the data ratification process decisions may be made not to apply a calibration rating or to change the date the rating becomes effective, especially where there has been a sudden change in baseline. All adjustments to data made in this way must be documented with reasons in the processing database. Note due to the way the software operates it is not possible to have a period of data to which no calibration applies – the rating continues until a new rating is entered.

7.6.7 Identify invalid calibrations

Where an instrument has shown excessive zero or span drift, ie, outside of the tolerances in Table 7.1 below, the data should either be invalidated back to the last instrument adjustment or the previous calibration applied, in consultation with the AQ scientist.

Table 7.1: Tolerances for analyser span and zero drift for periods between final calibrations	Table 7.1:	Tolerances for	r analyser span	and zero drift	for periods be	tween final calibrations
-----------------------------------------------------------------------------------------------	------------	----------------	-----------------	----------------	----------------	--------------------------

Contaminant	Zero drift (absolute)	Span drift %
Carbon monoxide	+/- 1.5 ppm	+/- 15%
Nitric oxide (NO)	+/- 15 ppb	+/- 15%

Nitrogen oxides (NOx)	+/- 15 ppb	+/- 15%

Quality control charts for each analyser at each site are recorded on the instrument check sheet spreadsheet stored on J:\AIR QUALITY\AQ Sites. The QC charts monitor instrument drift at zero and span between audit and final calibrations.





Figure 7.20: QC charts showing zero and span drift relative to acceptance limits

The results of all multipoint calibrations are plotted on a chart in the instrument e-log to establish their linearity by least squares regression. The slope should be 1+/- 0.10, the intercept 0 +/- 1 and $R^2 > 0.995$. Where these acceptance criteria are not met the data should either be invalidated back to the last instrument adjustment or the previous calibration in consultation with the AQ scientist.

8. **Procedure – checking edited data**

All data that has been editted and is ready for checking should be placed in the in-tray on the AQ scientist's or team leader's desk.

The QA process involves:

• Checking that the calibration ratings have been loaded correctly from the e log templates and invalidate any calibrations where net zero or span drift exceeds the tolerances specified in Table 7.1.

- Checking that all calibration data has been removed and that a data comment has been entered.
- Perusing site logs and check that data comments have been entered where necessary.
- Checking that the data looks normal especially during periods where there have been site visits.
- Checking for correct relationship between NO, NOx and NO₂ (NO values should not exceed NOx or NO₂)
- Check that gaps in Hilltop match Hilltop comments

-8	Startup					
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		Recording Authority GW	∕-Western	•	Version 2010/10	
	Batches awaiting Processing or Updating	Water Level Sites	[]	T	Data Site Information C	Hilltop omments
-	Batches awaiting Processing or Updating	Rainfall Sites		•	Data Site Processing Information C	Hilltop omments Deviation Plot
-	Batches awaiting Processing or Updating	Groundwater Sites	[•	Data Site Processing Information C	Hilltop omments WELLS
	Batches awaiting Processing or Updating	Manual Runs		•	Data Processing	
	Batches awaiting Processing or Updating	Air Quality/Met Sites etc	Comer V AQ Data Source PM10 (FH62)	•	Processing Information C	Hilltop omments
	Batches awaiting Processing or Updating	Water Quality/Temperature Sites	S Data Source	•	Data Processing C	Hilltop omments

¹ 7 · (¹ · -					Processing I	Database
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Data S	ource PM10 (FH62)			_		
31 Processing Info	Batch start date 16/ Batch start time	09/2013 00:00	Batch e Batch e	nd date nd time	22/01/2014 (Final cal end dat 00:00 (Final cal end time	e) 3)
	Processed by Darren Li	Batch reprocessed?	Г		Checked by	.
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Processir	ing justifiably delayed 🔲		1		Archived date	Copy Data to Check
Reason for	r delayed processing	— Սр	idate delayed 🗖 Rea	on for delayed	d update	Copy Data to Archiv
F	Processing comment					

Comer V AQ				PM10 (FH62)	Batch No	31
Batch Start	Date 16/09/2013	<i>Time</i> 00:00:00				
Batch End	22/01/2014	00:00:00				
Processing comme	nt					
Hilltop comment a	dde d?	No				
Processing delayed	i? No	Reason for de laye	d processing			
Processed by:		Darren Li	Date processed:	22/01/2014		
Update de layed?	No	Reason for delaye	d Update			
Checked by:			Date checked:			
Archived by:			Date checked:			
Hilltop Comments						
18/09/2013 14:10:0	0 Deleted o clean/rep	lata for 2.5 hours on lacement.	18/09/2013 from 14100	0 to 164000 due t	o PM10 head	
22/10/2013 10:08:0	0 PM10 he	ad replaced.				
18/11/2013 09:00:0	0 Missing r instrumer	ecord for 2.33 days fr nt COM failure. FH62	rom 18/11/2013 090000 #E0989 replaced #644) to 20/11/2013 17 4 on 20/11/2013.	0000 due to	
10/12/2013 11:20:0	0 Deleted o mothly se	data for 2 hours on 10 ervices and calibration	0/12/2013 from 112000	to 132000 due to i	in strument three	
8/01/2014 09:20:00	PM10 he	ad replaced.				
Hilltop Gaps						
18/09/2013 14:1	0:00 18/09/	2013 16:40:00	2.5 hours			
18/11/2013 09:0	0:00 20/11/	2013 17:00:00	2.33 days			
10/12/2013 11:2	0:00 10/12/	2013 13:20:00	2 hours			

Once the data has been checked the Data Processing Database is updated. A processing comment may be added by the air quality scientist or team leader where data reprocessing is required. The data batch will be returned to the EMO for reprocessing if needed.

Once the processed data has been checked and re-processed if needed, hard copies of the batch record printout, E-log, calibrations ratings pairs are filed on the relevant site folder kept in the office.

9. **Procedure - data validation**

The data ratification process involves examining a longer period of data (typically a year's worth of data) and making any adjustments to the data to ensure it is representative of ambient conditions and is consistent across the monitoring network.

The following aspects are examined:

• Baseline shift over time

- Possible causes for any data outliers (eg, local effects such as construction activities, instrument problems or excessive temperature changes inside the monitoring station)
- Consistency with expected seasonal or diurnal patterns
- Consistency with other pollutants measured at the same site
- Consistency with the pollutants measured at other comparable sites in the region

10. Procedure – archiving validated data

The team leader is responsible for transferring validated data to the archive. Archiving data uses the transform function in Hilltop to transform calibrated data sources back to a normal data source (eg, from calibrated carbon monoxide to carbon monoxide). Nitrogen dioxide and PM_{10} data are simply copied into the archive as calibration ratings are not used.

Once the data has been archived the Data Processing Database is updated with the data archived date and the name of the team leader.

Environmental Montoring Data Processing Register EXIT								
	Recording Authority GW	-Western	ľ	Version 2010/10				
Batches awaiting Processing or Updating	Water Level Sites	[•	Data Site Hiltop Information Comments				
Batches awaiting Processing or Updating	Rainfall Sites	[-	Data Site Hiltop Rainfall Information Comments Deviation Plot				
Batches awaiting Processing or Updating	Groundwater Sites	[•	Data Site Hiltop WELLS				
Batches awaiting Processing or Updating	Manual Runs	[•	Data Processing				
Batches awaiting Processing or Updating	Air Quality/Met Sites etc	Birch Lane AQ Data Source Air Temperature (1	•	Data Site Hiltop Processing Information Comments				
Batches awaiting Processing or Updating	Water Quality/Temperature Sites	Data Source	•	Data Hiltop Processing Comments				
	Soil Quality Sites		V	Site Soil Profile				
	Water Quality Runs	[Data Processing				
Gaugings awaiting Processing or Updating	Gaugings Database	Station	Surveys	Management/Reporting/Other				
Startup Fm_Management Management and Reporting Hitop Site Information Miscellaneous Site Lists Site Equivalent Calculations Website Data Processing Reporting VB Script Shortuuts Release Notes								
Hilltop Site Information (all sites in Hilltop Site table)								
Hiltop Site Name Add / Edit Site Details View All Hiltop Comments for Site								

Report showing status of data archiving

Management and Reporting								
Hiltop Site Information Miscellaneous Site Lists Site Equivalent Calculations Website Data Processing Reporting VB Script Shortcuts Release Notes								
Data Processing / Missing Record Statistics								
Lhoose a date range, then a data type, then choose a report type								
Reporting Period: Start date: End date:								
 Surface water (river level and rainfall) 								
C Automatic groundwater								
C Manual groundwater								
C Gaugings								
C Water quality								
C Air Quality								
C Meteorological								
C Combined (surface water, groundwater and gaugings)								
C RSoE Sampling								
C Other Sampling (Riparian, Lake Onoke, Lake Wairarapa etc)								
Generate processing stats report performance Generate missing performance								
Other Reports								
Check for Missed Graph of Average Processing Times Air Quality Processing Status								
Startup Frm_Management Frm_AirQualityProcessingStatus								
Air Quality Processing Status								
Produce report of latest data in both AQ Update and Archive Files								
Get Report								

Site Na me	Measurement	Last Date in AQ Update	Last Date in Archive
Blich Lane AQ	Air Temperature (1.5m)	1/01/2013	1/01/2012
Blich Lane AQ	Air Temperature (10m)	1/01/2013	1/01/2012
Blich Lane AQ	Carbon Monoxide	19/03/2012 23:50:00	1/01/2012
Blitch Lane AQ	Max Wind Gust (10m)	1/01/2014	1/01/2012
Blitch Lane AQ	Min Wind Speed (10m)	1/01/2014	1/01/2012
Blitch Lane AQ	Ntric Oxide	11/01/2012 15:00:00	1/01/2012
Blich Lane AQ	Ntrogen Dioxide	11/01/2012 15:00:00	1/01/2012
Blitch Lane AQ	Ntrogen Oxides	11/01/2012 15:00:00	1/01/2012
Blitch Laine AQ	PM10 (FH62)	22/01/2014 12:00:00	1/01/2012
Blitch Laine AQ	PM10 (TEOM)	13/12/2011 09:10:00	11/11/2011 13:20:00
Blitch Laine AQ	Relative Humidity	1/01/2013	1/01/2012
Blitch Laine AQ	SD Wind Direction (10m)	1/01/2012	1/01/2012
Blitch Laine AQ	SD Wind Speed (10m)	1/01/2012	1/01/2012
Blitch Lane AQ	So b r Radiation	1/01/2014	1/01/2012

Air Quality Processing Status

11. Data reporting

11.1 PM₁₀

For comparison with the NES, the averaging period is 24 hours, calculated at midnight for the preceeding 24 hour period (the 24-hour average for 1 July 07 is calculated from data collected from 1/7/07 00:00 to 1/7/07 23:50). Only 24-hour periods with at least 75% data capture (ie 6 hours can be missing) are used. Missing data are left as a gap, ie no interpolation is carried out in accordance with MfE best practice. However, attention should be paid to where the gap is occurring during the 24-hour period to ensure that daily average calculated is generally representative. For example, a gap in the middle of a pollution episode would not be representative.

11.2 Calculating annual statistics using Excel

To calculate the annual statistics 2006 for PM₁₀:

Run PDay for PM_{10} at site from 1/1/06 to 1/1/07 with a gap tolerance of 6 hours. This ensures that 24-hour periods with less than 75% data capture are excluded from the dataset.



Run List data for PM_{10} 24-hour average at site from 1/1/06 to 1/1/07



Copy clipboard results to Excel spreadsheet.

In Excel:

- remove gaps, and deleted the first 24-hour average listed for 1/1/06 00:00 as this value actually applies to the previous 24-hour period (31/12/05).
- Shift the dates column down one cell so the dates and averages match those produced by the PDay table.
- Remove all periods where the gap tolerance not met by comparing to the PDay table
- Use Functions in Excel to run the desired statistics, eg MIN, MAX, MEDIAN, PERCENTILE etc
- Use Excel to round final 24-hour averages to 0 decimal place.

11.3 Calculating annual statistics using R

Alternatively save the Excel file as a csv file and read into R for further analysis.

11.4 Virtual measurements

The following virtual measurements are available and can be used for data reporting:

- Carbon monoxide 8-hour moving mean as ppm or mg/m3. Calculated on the hour for the previous 8 hour period.
- Carbon monoxide 1 hour fixed mean (mg/m3)
- PM₁₀ 24-hour average (midnight to midnight) ug/m3
- PM₁₀ 1-hour average ug/m3
- Wind speed calm days. Calculates the percentage of time during a 24-hour period that 10 minute averages were less than 1 m/s

- NO calibrated 1-hour average ppb or ug/m3
- NOx calibrated 1-hour average ppb or ug/m3
- NO₂ 1-hour average ppb or ug/m3

11.5 Reporting units

In accordance with MfE 2009 air quality statistics are reported to the following significant digits:

CO x.x mg/m3 NO₂ x.x ug/m3 PM₁₀ x ug/m3

11.6 Annual data capture rates

Percentage annual valid data for reporting purposes is calculated as the number of averaging periods less the number valid averaging periods achieved. For example, in calculating NO₂ averages there are 8760 hours per year – however, only 8000 of these might contain at least 75% valid data. Therefore the percentage valid data is 8000/8760 = 91.32%

The data capture rate allows for planned maintenance and calibrations not to count as 'missing record'. Using the example above, if there were 200 hours of planned maintenance and calibrations then:

Data capture rate = 8000/8760-200 = 93.45%

Unplanned data loss = 6.55%

11.7 Non-compliance with MfE good practice guide

It is recommended by MfE that labelling of the midnight hour should be 24:00 instead of 00:00. Unfortunately the Hilltop software does not allow this. Air quality data is logged as 10 minute averages as follows:

24/5/09 23:50

25/5/09 00:00