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)
Validate	 Screen checked data to ensure consistent with expected conditions, other monitoring stations and over a longer timeframe (section 9)
Archive	 Copy validated data to read only archive (annual) (section 10)
Archive	

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.

			-				
A 9 - C - 1					Proc	essing Databas	e
File Home							
🖹 🔏 Cut	A Remove Sort	New Spelling	the Replace				E ⊳¶r ∽
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Paste	Advanced -	All - X Delete - More -	Find 🔓 Select 🔻	BIUA	- ** - 🖄 - 🗎		· .
Clipboard	Sort & Filter	Records	Find		Text Formatting		Est.
Startup							
·	Environmental M	Iontoring Data Proce	essing Registe	er_	EXIT		
	Recording Authority	GW-Western		•	Version 2010/10		
Batches awaiting Processing or Updating	Water Level Sites			▼ Data Processi	ng Site Information	Hilltop Comments	
Batches awaiting Processing or Updating	Rainfall Sites			Data Processi	ng Site	Hilltop Comments	Rainfall Deviation Plot
Batches awaiting Processing or Updating	Ground w ater Sites			▼ Data Processi	ng Site Information	Hilltop Comments	WELLS
Batches awaiting Processing or Updating	Manual Runs	[▼ Data Processi	ng		
Batches awaiting Processing or Updating	Air Quality/Met Sites etc	Upper Hutt at Savage Pa Data Source		Data Processi	Site Information	Hilltop Comments	
Batches awaiting Processing or Updating	Water Quality/Temperatur	re Sites Data Sourc	e	Data Processi	ng	Hilltop Comments	
	Soil Quality Sites				Site Information		Soil Profile
	Water Quality Runs	[▼ Data Processi	ng		
Gaugings awaiting Processing or Updating	Gaugings Datab	ase	Station Surv	veys	Ma	nagement/Rep	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

Copy	Y Ascending Y Selection + X↓ Descending Advanced + Priter Ascender Sort T Toggle Filter	Refresh All v V Delete v More v Records	♣ Replace ➡ Go To ▼ Find ↓ Select ▼ Find	▼ ▼ 臣 臣 録 諱 州 ▼ B I 型 A ▼ 渺 ▼ 逸 ▼ 夢 吾 吾 ⊞ ▼ 豐 ▼ Text Formatting 5
rtup 😑 🖊	Air Quality/Met Data Processing			
Upper	r Hutt at Savage Park AQ			Add New EXIT I View and Print Hilltop Report Comments
Data Sc	ource Carbon Monoxide			
62	Batch start date 15/10/2013 Batch start time 12:10		Batch end date Batch end time	
cessing Inforr	mation			
	Processed by Darren Li	Batch reprocessed?		Checked by Remove Auto
,	Processed date 24/02/2014	Reprocessed date		
-		Reprocessed date Reprocessed reason		Archived by Archived date Copy Data to C Copy Data to Archived date

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	
	Source Site Upper Hutt at Savage Park AQ Data Source PM10 (FH62) Series Data 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
Carbor Add C C0 8 F Edit n) C C0 8 F Edit n) C C0 8 F View m3) C Nitrogen O List C Nitrogen O Copy PM10 Transform Percentage Solar Radie Max Wind v Rename Sol Wind Spee Details Wind Spee Details Ming Transport AQ Met Station at Belmont Beginnal Park	Start of Data All Data Finish of Data From Graph Only Copy New Data Archive File sets the time range Archive File Destination Site Upper Hutt at Savage Park AQ Data Source PM10 (FH62) Filename H:\Check\AQ Update.hts Open file when copy completes S	Help
	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.

Transform	
Source Site Birch Lane AQ	
Measurement Nitrogen Oxide [Nitrogen Oxide]	Go
_ 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 Repack Interval 0	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.





ŝite	From	To	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 Al
🗌 🗠 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 Ga
🗌 🗠 Wairarapa College AQ	9-Sep-2003 12:20:00	9-Sep-2003 17:00:00	4.67 Hours		<u></u>
🗌 🗠 Wairarapa College AQ	23-Sep-2003 11:10:00	23-Sep-2003 13:20:00	2.17 Hours		
🗌 🗠 Wairarapa College AQ	24-Sep-2003 00:00:00	25-Sep-2003 13:50:00	1.58 Days		View Gaps
🗌 🗠 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		Cancer
🗠 Wairarapa College AQ	25-Nov-2003 12:40:00	25-Nov-2003 13:10:00	30.00 Minutes	•	
					<u>H</u> elp
Select gaps less than or equal to					
·····		<u>S</u> elect			
From 1	Го				

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 - [Hi\Check\AQ Update.hts]						
ile Edit View Data Configure Project	Scan Window Help					
9 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1						
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					
Carbon Monoxide	Gap from 10-Jan-2005 11:20:00 to 10-Jan-2005 13:50:00 of 2.50 Hours Gap from 26-Jan-2005 12:00:00 to 26-Jan-2005 14:30:00 of 2.50 Hours					
Carbon Monoxide	Gap from 14-Mar-2005 12:00:00 to 14-Mar-2005 14:30:00 of 4.33 Hours Gap from 14-Mar-2005 11:00:00 to 14-Mar-2005 15:20:00 of 4.33 Hours					
Calibrated Carbon Mono	Gap from 20-Apr-2005 12:20:00 to 20-Apr-2005 15:20:00 of 2.67 Hours					
CO 8 Hr Moving Mean (p	Gap from 28-Apr-2005 16:10:00 to 29-Apr-2005 12:00:00 of 19.83 Hours					
CO 1 Hr Fixed Mean (mg	Gap from 4-May-2005 17:00:00 to 4-May-2005 20:00:00 of 3.00 Hours					
CO 8 Hr Moving Mean (r	Gap from 16-Jun-2005 11:30:00 to 16-Jun-2005 14:30:00 of 3.00 Hours					
Nitric Oxide	Gap from 4-Jul-2005 13:20:00 to 4-Jul-2005 15:20:00 of 2.00 Hours					
Nitrogen Dioxide	Gap from 11-Aug-2005 11:50:00 to 11-Aug-2005 15:40:00 of 3.83 Hours					
E Mitrogen Oxides	Gap from 5-Sep-2005 11:10:00 to 5-Sep-2005 15:30:00 of 4.33 Hours					
E-M PM10 (TEOM)	Gap from 6-Sep-2005 13:30:00 to 6-Sep-2005 15:30:00 of 2.00 Hours					
PM10 (TEOM)	Gap from 8-Oct-2005 02:50:00 to 14-Oct-2005 11:50:00 of 6.38 Days					
PM10 (TEOM) 24 hr Aver	Gap from 15-Nov-2005 11:30:00 to 15-Nov-2005 14:40:00 of 3.17 Hours					
	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 Gap from 9-Feb-2006 12:20:00 to 9-Feb-2006 14:40:00 of 2.33 Hours					
Met Station at Shandon Golf Clul	Gap from 7-Har-2006 12:20:00 to 7-Har-2006 10:50:00 of 2.50 Hours					
🗄 🧰 Upper Hutt AQ	Gap from 22-Mar-2006 00:00:00 to 27-Mar-2006 10:00:00 of 5.46 Days					
😑 🎦 Upper Hutt at Savage Park AQ	Gap from 5-Apr-2006 09:50:00 to 5-Apr-2006 12:30:00 of 2.67 Hours					
Carbon Monoxide	Gap from 2-Haw-2006 11:00:00 to 2-Haw-2006 13:10:00 of 2.17 Hours					
- Carbon Monoxide	Gap from 29-Hay-2006 11:10:00 to 29-Hay-2006 13:00:00 of 1.83 Hours					
- Calibrated Carbon Mono	Gap from 26-Jun-2006 12:00:00 to 26-Jun-2006 14:00:00 of 2.00 Hours					
🗠 CO 8 Hr Moving Mean (p	Cap from 25-Jul-2006 13:00:00 to 25-Jul-2006 16:00:00 of 3.00 Hours					
	Gap from 28-Jul-2006 11:50:00 to 3-Aug-2006 13:40:00 of 6.08 Days					
	Gap from 24-Aug-2006 12:50:00 to 24-Aug-2006 14:40:00 of 1.83 Hours					
Nitric Oxide	Gap from 20-Sep-2006 14:30:00 to 20-Sep-2006 16:50:00 of 2.33 Hours					
Nitrogen Dioxide	Gap from 17-Oct-2006 13:00:00 to 27-Nov-2006 14:50:00 of 1.35 Months					
E 🗠 Nitrogen Oxides	Gap from 13-Dec-2006 14:10:00 to 18-Jan-2007 12:10:00 of 1.18 Months Gap from 1-Mar-2007 09:10:00 to 1-Mar-2007 11:50:00 of 2.67 Hours					
PM10 (FH62)	Gap from 4-Hav-2007 10:30:00 to 4-Mav-2007 11:50:00 of 5.00 Hours Gap from 4-Mav-2007 10:30:00 to 4-Mav-2007 15:30:00 of 5.00 Hours					
- PM 10 (FH62)	Gap from 12-Jun-2007 11:40:00 to 12-Jun-2007 13:50:00 of 2.17 Hours					
PM10 (FH62) 24 hr Aver	Gap from 26-Jun-2007 10:40:00 to 26-Jun-2007 15:00:00 of 4.33 Hours					
- C 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					
Wainuiomata Bowling Club AQ	Gap from 24-Jul-2007 12:40:00 to 24-Jul-2007 13:00:00 of 20.00 Minutes					
H- Tawa	Gap from 24-Jul-2007 14:10:00 to 24-Jul-2007 14:30:00 of 20.00 Minutes					
🗄 🎦 Wairarapa - Wgtn	Gap from 24-Jul-2007 14:40:00 to 24-Jul-2007 15:10:00 of 30.00 Minutes					
B Wararapa - Wgth	Gap from 24-Jul-2007 15:20:00 to 24-Jul-2007 15:50:00 of 30.00 Minutes					
Barometric Pressure	Gap from 24-Jul-2007 22:50:00 to 24-Jul-2007 23:00:00 of 10.00 Minutes					
Relative Humidity	Gap from 27-Jul-2007 23:40:00 to 28-Jul-2007 00:10:00 of 30.00 Minutes					
	Gap from 28-Jul-2007 07:20:00 to 28-Jul-2007 07:30:00 of 10.00 Minutes					
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 10 × (21 × 1 -					-		Processir	ng Database	
File Home								,	
Paste	Remove Sort Selection ~	ter Refresh	New Spelling	Find Go To ▼	B I	U A - By		E 菲菲 MT▼ [] [] [] [] [] [] [] [] [] [] [] [] [] [] [
Clipboard	Sort & Filter	All -	Records	Find		Те	ext Formatting	5	
-= Startup							,		
	Environmenta		i <mark>ng Data Proc</mark> Western	essing Regis			VIT		
- Re	ecording Authority	Jen 1	nostem		•				
Batches awaiting Processing or Updating	'ater Level Sites		[•	Data Processing	Site Information C	Hilltop Comments	
Batches awaiting Processing or Updating	ainfall Sites		[•	Data Processing	Site Information C	Hilltop Comments Deviation Plot	
Batches awaiting Processing or Updating	round wa ter Sites		[•	Data Processing	Site Information	Hilltop Comments WELLS	
Batches awaiting Processing or Updating	anual Runs		[Data Processing			
Batches awaiting Processing or Updating	r Quality/Met Sites et	С	Upper Hutt at Savage Pa Data Sourc	ark AQ e Carbon Monoxide	•	Data Processing	Site Information	Hilltop Comments	
A. ⊮) - (≅ - - -							Dr	ocessing Database	_
File Home							FI	ocessing Database	
Paste	Iter A Remove Sort	Selection * Advanced * Toggle Filter	All + A Delete +	Spelling Hore - Find	ab _{ac} Replac → Go To ↓ Select	- D Z T	_	 ↓ 目 目 律 律 ◆ - 目 書 書 田 	E >11 -
Clipboard	Sort & Filter		Records		Find		Text Fo	ormatting	14
	at Savage Park A	Q	Carbor	Monoxide	EX	π ↓	Copy Comments	Add new standard comment	
30/09	Samp Data	ling is averaged	M300E SN 579 and logged every 10 min st DS-4483 and analyser GPRS	utes. is connected via an iQu	est multiplex	Df.			
19/10	0/05 12:30:00 Delet	ed data of 4.83 h	ours from 19/10/2005 12	23000 to 19/10/2005 17	2000 due to	instrument calib	oration.		
			for period 19/10/05 123						
16/11	1/05 11:20:00 Delet	ed data of 3.67 h	nours from 16/11/2005 1	12000 to 16/11/2005 15	0000 due to	instrument calib	ration.		

To add a comment select from the following menu, depending on whether the missing or deleted data are restricted to the same day or multiple days.

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Alternatatively you can copy across gaps from Hilltop Manager.

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	Gap from 7-Jun-2012 11:20:00 to 7-Jun-2012 13:50:00 of 2.50 Hours
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	Gap from 24-Nov-2012 11:10:00 to 24-Nov-2012 19:10:00 of 8.00 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.

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300	303.1	305.5	305.9	5.53	2.7
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100	97.9	101.8	98.5	1.84	0.7
0	-1.5	0.0	-1.8	0.00	-0.3
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			203.000	3.69	
	198,900	203.7			
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200				1.84 0.00	

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.

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

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	Batches awaiting Processing or Updating	Manual Runs		•	Data Processing
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Corn	er V AQ				Add New EXIT	View and Print Hilltop Report Comments
Data S	ource PM10 (FH62)			_		
31 Processing Info	Batch start time	09/2013 00:00	Batch e Batch e		22/01/2014 (Final cal end dat 00:00 (Final cal end time	
	Processed by Darren Li	Batch reprocessed?	Г		Checked by	•
	Processed date 22/01/2				Checked date	Remove Auto Cals
	_	Reprocessed reason	,	-	Archived by	
Processir	ing justifiably delayed 🗖	·	1		Archived date	Copy Data to Check
Reason for	r delayed processing	— Սр	idate delayed 🗖 Rea	on for delayed	,	Copy Data to Archiv
F	Processing comment					

	Date	Time			
Batch Start 1	6/09/2013	00:00:00			
Batch End 2	2/01/2014	00:00:00			
Processing comment					
Hilltop comment add	le d?	No			
Processing delayed?	No	Reason for de lav	ed processing		
Processed by:		Darren Li	Date processed:	22/01/2014	
Update de layed?	No	Reason for delay	ed Update		
Checked by:			Date checked:		
Archived by:			Date checked:		
Hilltop Comments					
18/09/2013 14:10:00		data for 2.5 hours on lacement.	18/09/2013 from 14100	0 to 164000 due t	PM10 head
22/10/2013 10:08:00		ad replaced.			
18/11/2013 09:00:00			from 18/11/2013 09000 2 # E0989 replaced #64		0000 due to
10/12/2013 11:20:00		data for 2 hours on 1 ervices and calibration	0/12/2013 from 112000	to 132000 due to i	n strument three
8/01/2014 09:20:00	PM10 he	ad replaced.			
Hilltop Gaps					
18/09/2013 14:10	:00 18/09/	2013 16:40:00	2.5 hours		
18/11/2013 09:00	:00 20/11/	2013 17:00:00	2.33 days		
		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 Monto	ring Data Processing Regi	<u>ster</u>	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	•	Proposing Information Comments			
Batches awaiting Processing or Updating	Water Quality/Temperature Sites	Data Source	•	Processing			
	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 Hiltop Site Information Miscelaneous Site Lists Site Equivalent Calculations Website Data Processing Reporting V6 Script Shortcuts 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									
Choose 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
Blitch Lane AQ	Air Temperature (1.5m)	1/01/2013	1/01/2012
Blitch Lane AQ	Air Temperature (10m)	1/01/2013	1/01/2012
Blitch 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
Blich Lane AQ	Nitric Oxide	11/01/2012 15:00:00	1/01/2012
Blich Lane AQ	Ntrogen Dioxide	11/01/2012 15:00:00	1/01/2012
Blich Lane AQ	Ntrogen Oxides	11/01/2012 15:00:00	1/01/2012
Blitch Lane AQ	PM10 (FH62)	22/01/2014 12:00:00	1/01/2012
Birch Lane AQ	PM10 (TEOM)	13/12/2011 09:10:00	11/11/2011 13:20:00
Birch Lane AQ	Relative Humidity	1/01/2013	1/01/2012
Birch Lane AQ	SD Wind Direction (10m)	1/01/2012	1/01/2012
Blitch Lane AQ	SD Wind Speed (10m)	1/01/2012	1/01/2012
Blich Lane AQ	So a 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