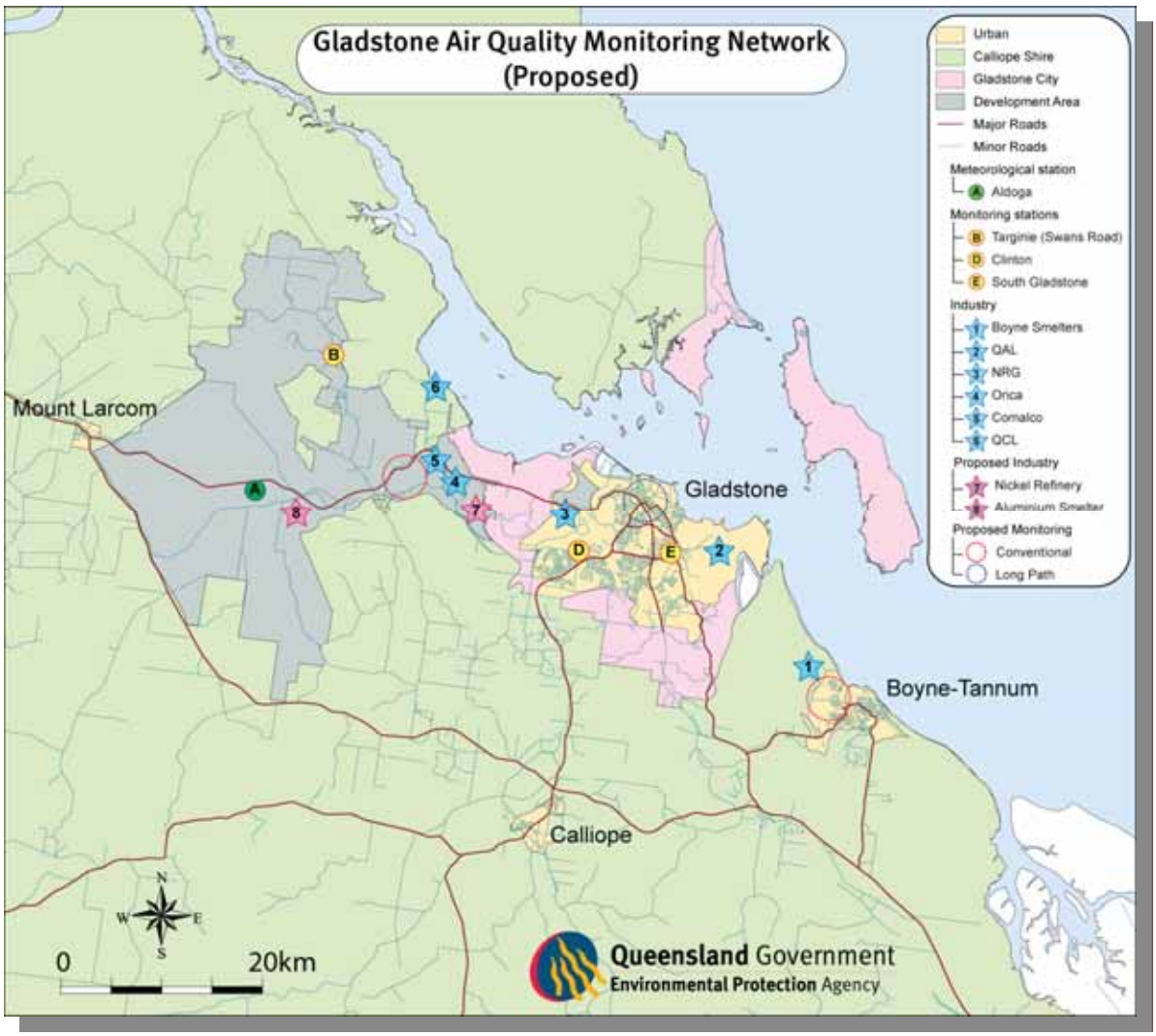
Clean and Healthy Air for Gladstone

Proposed Ambient air quality monitoring plan for Gladstone

January 2008

Air Sciences Branch
Environmental Sciences Division



Queensland Government
Environmental Protection Agency

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1 Summary

This document – the *Ambient air quality plan for Gladstone* – outlines the monitoring that will take place to assess the impact of air emissions on the ambient air quality in the Gladstone area for the Clean and Healthy Air for Gladstone Project.

The number and location of monitoring stations in the Gladstone region has been determined from a consideration of past monitoring data, an analysis of the prevailing winds and the modelling of industrial emissions in the region.

The monitoring network will comprise of six fixed stations and one mobile station:

- Targinie Swans Road (existing)
- North of Gladstone/Yarwun area (relocated Targinie – Stupkin Lane Monitoring station)
- Gladstone central - based on the Opsis UV DOAS system (new)
- Clinton (existing)
- South Gladstone (existing)
- Boyne/Tannum (new)
- Mobile Station (new)

The pollutants to be measured are based on the list of key pollutants identified for investigation from the hazard identification component of the project. The pollutants to be measured at each monitoring station are chosen based on which emissions are likely to impact on the monitoring station. As the South Gladstone station is designated as an Air NEPM performance monitoring station it will be measuring the widest range of air pollutants.

The levels of pollutants that can be measured continuously by instruments will be able to be accessed via the EPA's web site, with data being updated every three hours.

Details of the different categories of pollutants to be measured at the monitoring stations for assessment purposes are listed in the summary table below.

Table 1 Summary of the air quality monitoring to be carried out in Gladstone for the Clean and Healthy Air for Gladstone Project

Monitoring Station	Criteria Gases	Particulate Matter	Metals	VOCs	Carbonyls	PAHs	Acid/ Caustic Aerosols	Fluorides	Cyanides	Dioxins/ Furans/ PCBs
Targinie Swans Road	X	X	X	X	X	X				X
North Gladstone/ Yarwun area	X	X	X	X	X	X			X	X
Central Gladstone[a]	X[b]			X[c]						
Clinton	X	X	X	X	X	X	X	X	X	X
South Gladstone	X	X	X	X	X	X	X	X		X
Boyne/Tannum	X	X	X	X	X	X		X		X
Mobile[d]	X	X								

Note: Criteria gases – sulphur dioxide and nitrogen dioxide

Particulate matter – PM_{10}, $PM_{2.5}$, TSP and visibility reducing particles

[a] Opsis long path system system only

[b] Includes the measurement of ozone

[c] benzene, toluene, xylene and formaldehyde only

[d] mobile station to measure criteria gases and particulate matter, selection of other pollutants is dependent on the location

2 Introduction

The Clean and Healthy Air for Gladstone Project is a Queensland Government initiative, established to gain a better understanding of air pollution in the Gladstone area, and to identify any potentially associated risks to public health.

The two year project is being conducted by the Environmental Protection Agency (EPA) and Queensland Health (QH), working in consultation with the community and industry.

The project will follow accepted environmental health risk assessment principles and guidelines, and include key components as follows:

- hazard identification and dose response assessment;
- exposure assessment and risk characterisation;
- community health assessment;
- chief executive's report and system enhancements.

To undertake the exposure assessment and risk characterisation component of the project, a comprehensive dataset on the levels of air pollutants to which the community is exposed to is required. The hazard identification and dose response assessment component of the project has developed a preliminary list of key pollutants (Appendix 3) to be considered for exposure assessment.

This document outlines how the EPA plans to monitor for the preliminary list of key pollutants. The monitoring plan identifies:

- the number and location of the monitoring stations to provide adequate spatial coverage for exposure assessment;
- proximity to emission sources, identification of pollutants to be monitored
- instrumentation, sampling and analysis methodology;
- compliance with siting guidelines, instrument standards and data handling procedures;
- quality assurance.

3 Air quality monitoring network

3.1 Historical network

Monitoring began in the Gladstone region at the Barney Point station in 1979 to measure pollutant concentrations caused by the significant industrialisation of the region. Appendix 1 shows the extent of the monitoring activities at stations in the region. The monitoring network was expanded during 2001 – 2003 to seven stations to provide additional air quality

information needed to validate modelling tools being developed for the region. There were seven stations in the region, with the addition of stations at Targinie (Swans Rd), South Gladstone, Clinton, Targinie (Stupkin Lane), Mt Miller and Ticor Hill as part of the Gladstone Airshed Study.

Relevant supporting air quality data in past annual summary and trend reports is available from the EPA's website:
http://www.epa.qld.gov.au/environmental_management/air/air_quality_monitoring/air_quality_reports/.
These reports contain detailed monitoring data from the monitoring network which show comparisons to the various air quality standards as well as established trends over time.

3.2 Current network

The current monitoring network consists of four stations as shown in figure 1 and described in Table 2.

The technology used in these stations allows air quality to be measured continuously using 'state of the art' instruments. Data logging devices at the stations log the measurements automatically from the instruments every 10 seconds and process the data to half hour averaged pollutant concentrations. The data from the logging devices is automatically retrieved by the EPA's monitoring computer system.

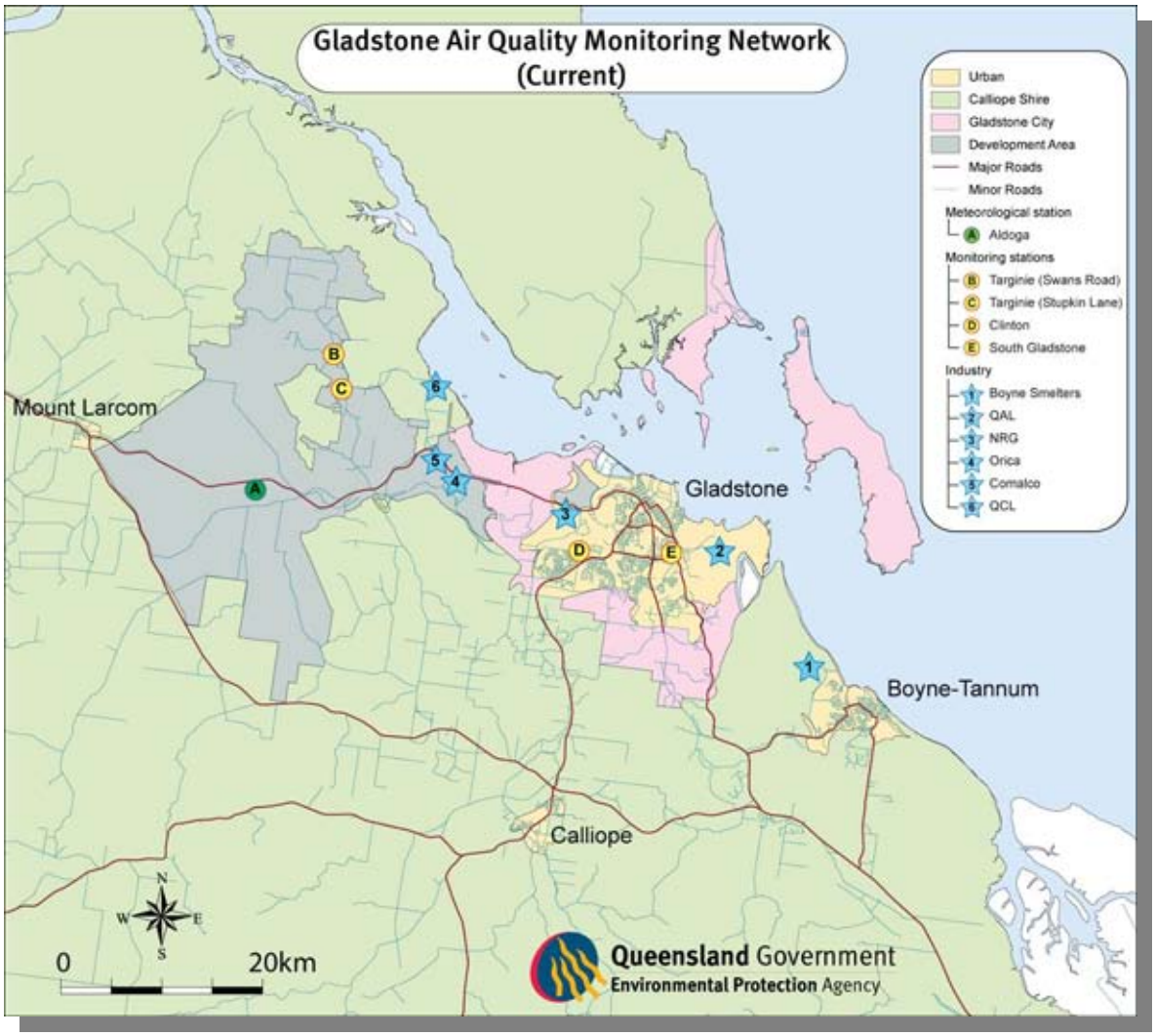
Monitoring provides a large amount of data, which are analysed, interpreted and reported by the EPA. The EPA reports annual summary and trend reports as well as monthly bulletins for the region. These reports are aimed at providing reliable and scientifically accurate information on air quality.

The air pollution levels measured at these monitoring stations can also be accessed via the EPA's web site, with data being updated every three hours.

Table 2 Description of current monitoring sites

Site	Location	Area classification	Coordinate reference	Pollutants monitored	Non-compliance with AS/NZS 3580.1.1 siting criteria
Clinton	Gladstone Airport, Aerodrome Road	Residential	Lat: -23.8695 Long: 151.2217	Nitrogen oxides Sulfur dioxide PM_{10}	Nil
South Gladstone	South Gladstone Primary School, Ann Street	Residential	Lat: -23.8620 Long: 151.2691	Nitrogen oxides Sulfur dioxide PM_{10} Visibility-reducing particles	Trees within 20m north-west of site
Targinie	Stupkin Lane	Rural	Lat: -23.7916 Long: 151.1077	Nitrogen oxides Sulfur dioxide PM_{10} Visibility-reducing particles	Trees within 20m
Targinie	Swans Road	Rural	Lat: -23.7758 Long: 151.1063	Nitrogen oxides Sulfur dioxide	Nil

Figure 1 Current Monitoring Network



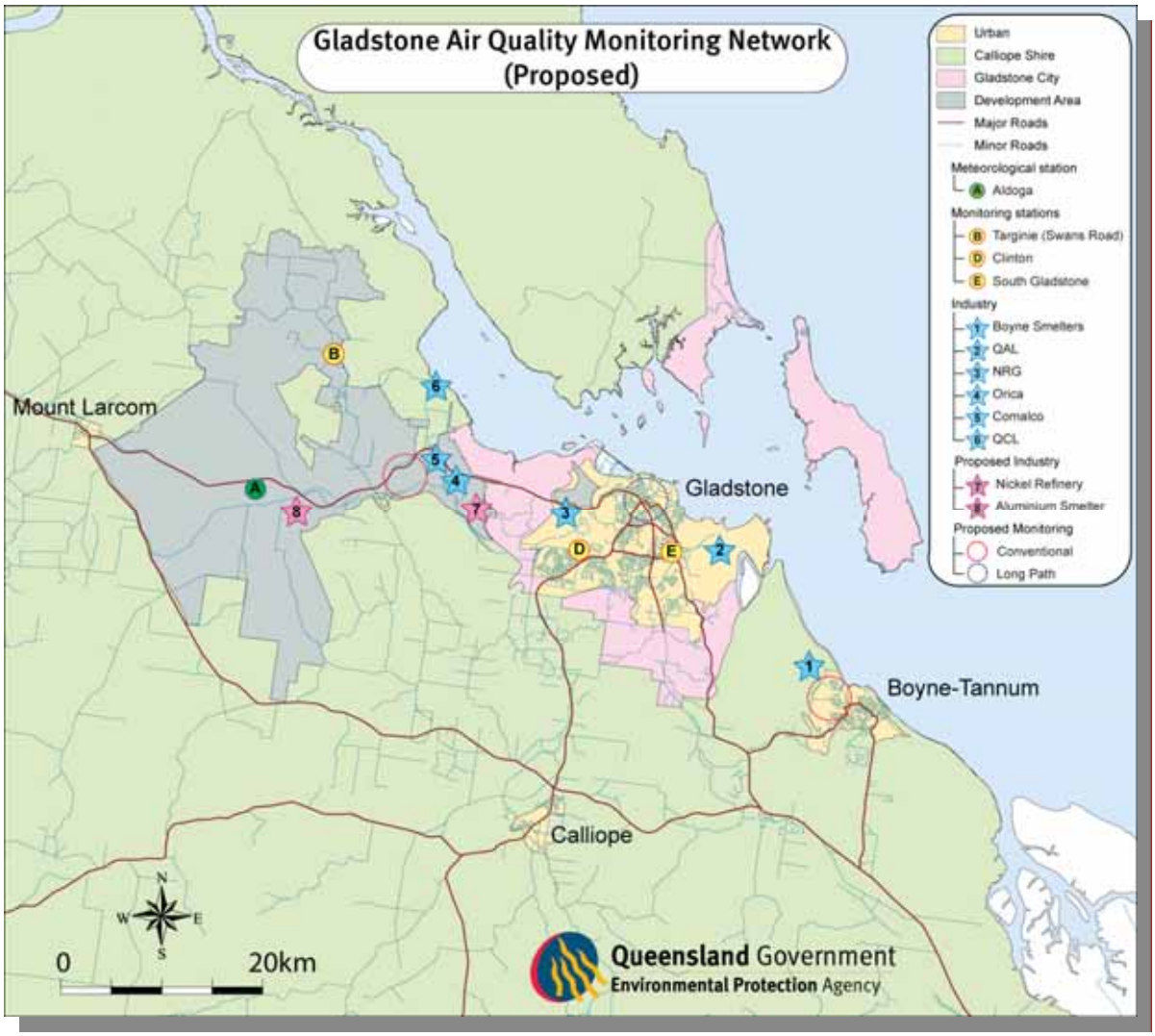
3.3 Proposed Network

The number and location of monitoring stations proposed for the Gladstone region has been determined from a consideration of the historic monitoring data, an analysis of the prevailing winds and the modelling of industrial emissions in the region (see Appendix 4 and 5).

Winds in the region are mainly onshore. On summer mornings, easterly and east-southeasterly winds are prominent. South-easterlies become more frequent during April mornings, and south-westerly winds are also present. This movement to southerly winds is marked during May mornings as a subtropical high pressure belt moves northwards and active fronts from further south penetrate the area. In the cooler months from May to August, morning winds become lighter and stay south-east to south-westerly. Changes become noticeable in September when the morning winds move more easterly and the high pressure belt moves to its furthest position north. From October to November, the morning winds move to the north-east and north-west, to be replaced by east/south-easterlies as the high pressure belt moves south again.

Afternoon wind directions vary little during the year, but they are generally lighter from May to August. North-east to easterly winds dominate throughout the year, particularly in afternoons from December and January. South-westerly winds usually occur during the cooler months of the year. A summary of annual wind data is given in Appendix 2.

Figure 2 Proposed Monitoring Network



To adequately cover the region, six fixed stations and one mobile station have been proposed and consist of :

- Targinie Swans Road (existing) – rural/industrial site

  The existing industries are approximately placed on a southeast line. This station is well placed to measure the accumulative emissions from all the industries when the wind is from the southeast (31% of the winds are from the ESE – SE – SSE).

- North of Gladstone/Yarwun area (relocated Targinie – Stupkin Lane Monitoring station) – rural/industrial site.

  This station was originally sited to measure the impact of the shale oil plant which ceased operation in 2004 and was within 2km of the Swans Road station. It is proposed to relocate this site closer to northern part of Gladstone to measure the impacts of Comalco and Orica and of the proposed nickel refinery.

- Gladstone central - based on the Opsis UV DOAS system (new)

  This instrument to be used at this site measures the air quality over a path length up to 1km, two paths will be used at this site. It also has the ability to measure some of the volatile organics continuously, providing half hourly averages.

- Clinton (existing) - residential site

Station is well placed to monitor the impact of the power station on the residential community as demonstrated from the modelling predictions and historic monitoring data.

- South Gladstone (existing) – residential site

  Station is well placed to monitor the impact of the QAL alumina refinery on the residential community as demonstrated from the modelling predictions and historic monitoring data.

- Boyne/Tannum (new) – residential site

  Station to be placed so as to represent the upper impact of emissions on the Boyne/Tannum residential community. Modelling indicates the northern part of the residential area would be the most suitable.

- Mobile Station (new)

This station is to be used to fill in the gaps not covered by the fixed monitoring network. It is envisage that the locations would be chosen based on the knowledge of the expected prevailing winds for the individual months of the year. The station could be located for periods between one to three months. The pollutants to be measured would depend on the proximity to the various sources of emissions.

4 Monitoring methods

The Gladstone air quality monitoring network will use a variety of monitoring instruments, sampling devices and analysis methods. These will be operated in accordance with the relevant Australian or International Standard or Equivalent Method.

The pollutants to be measured are based on the list of key pollutants identified for investigation from the hazard identification component of the project. The pollutants to be measured at each monitoring station are chosen based on which emissions are likely to impact on the monitoring station.

The various monitoring methods to be employed for the different pollutant categories in the Gladstone network are listed below.

4.1 Criteria Gaseous Pollutants

- **nitrogen dioxide -** gas phase chemiluminesence in accordance with AS3580.5.1-1993 Ambient Air - Determination of Oxides of Nitrogen - Chemiluminescence Method

  - differential optical absorption spectroscopy (DOAS) in accordance to the USEPA Equivalent Method

- **sulphur dioxide -** ultra-violet fluorescence in accordance with AS3580.4.1-1990 Ambient Air - Determination of Sulfur Dioxide –Direct Reading Instrument Method

  - differential optical absorption spectroscopy (DOAS) in accordance to the USEPA Equivalent Method

- **ozone** **-** differential optical absorption spectroscopy (DOAS) in accordance to the USEPA Equivalent Method

Nitrogen dioxide and sulphur dioxide will be measured at all stations, ozone will only be measured at the central Gladstone site by the Opsis UV DOAS system.

The instrument techniques used for the criteria gaseous pollutants allow for continuous measurements, with data logging devices at the stations logging the measurements automatically from the instruments every 10 seconds and process the data to half hour averaged pollutant concentrations. The data from the logging devices will be automatically retrieved by the EPA's monitoring computer system with access to the data on the EPA's website..

4.2 Particulate matter

- **visibility reducing –** particle scattering in accordance with AS3580.12.1-2001 Ambient Air – Particulate matter - Determination of light scattering – Integrated nephelometer method

- **total suspended -** AS2724.3-1984 Ambient Air – Particulate matter Determination of total suspended particulates (TSP) – High volume sampler gravimetric method

- **$PM_{10}/PM_{2.5}$ -** dual flow Tapered Element Oscillating Microbalance (TEOM) with Filter Dynamics Measurement System (FDMS) will measure $PM_{2.5}$, PM_{course} and PM_{10} and accounts for volatiles and semivolatiles

PM_{10}, $PM_{2.5}$, TSP and visibility reducing particles will be measured at all stations except for the central Gladstone station.

The instrument techniques used for PM_{10}, $PM_{2.5}$ and visibility reducing particles allow for continuous measurements, with data logging devices at the stations logging the measurements automatically from the instruments every 10 seconds and process the data to half hour averaged pollutant concentrations. The data from the logging devices will be automatically retrieved by the EPA's monitoring computer system with access to the data on the EPA's website.

Total suspended particulate matter will be sampled by high volume samplers and measured gravimetrically. A 24-hour sample will be collected once in every six days.

4.3 Metals

The TSP samples collected on the High Volume Samplers will be analysed by Queensland Health Forensic and Scientific Services for metals in accordance to the USEPA Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air – Method IO-3.1: Selection, Preparation and Extraction of Filter Material and Method IO-3.4: Determination of Metals in Ambient Particulate Matter Using Inductively Coupled Plasma (ICP) Spectroscopy. Metals to be determined include:

Antimony	Arsenic	Boron	Barium	Beryllium	Calcium
Cobalt	Chromium	Copper	Iron	Mercury	Manganese
Molybdenum	Nickel	Lead	Selenium	Strontium	Vanadium
Zinc					

4.4 Volatile Organic Compounds (VOCs)

VOCs will be collected in specially prepared canisters and analysed by Queensland Health Forensic and Scientific Services in accordance with the United States Environmental Protection Agency Compendium Method TO-15. Determination Of Volatile Organic

Compounds In Air Using Specially-Prepared Canisters And Analysed By Gas Chromatography/Mass Spectrometry (GC/MS) – Jan 1999. VOCs to be determined include:

Dichlorodifluoromethane	1,2-Dichloro-1,1,2,2-tetrafluoroethane	Vinyl Chloride
1,3 Butadiene	Bromomethane	Chloroethane
Trichlorofluoromethane	1,1-Dichloroethylene	Carbon disulfide
Dichloromethane	1,1,2-Trichloro-1,2,2-trifluoroethane	Carbonyl sulfide
trans-1,2-dichloroethene	1,1-Dichloroethane	
Methyl tert butyl ether	Methyl ethyl ketone	
cis-1,2-Dichloroethene	Hexane	Chloroform
Ethyl acetate	Tetrahydrofuran	
1,2-Dichloroethane	1,1,1-Trichloroethane	Benzene
Carbon Tetrachloride	1,2-Dichloropropane	Trichloroethene
Bromodichloromethane	Heptane	
cis-1,3-Dichloropropene	Methyl isobutyl ketone	
trans-1,3-Dichloropropene	1,1,2-Trichloroethane	Toluene
Methyl butyl ketone	Dibromochloromethane	
1,2-Dibromoethane	Tetrachloroethene	Chlorobenzene
Ethylbenzene	m- & p-Xylene	Bromoform
Styrene	1,1,2,2-Tetrachloroethane	4-ethyltoluene
o-Xylene	1,3,5-Trimethylbenzene	
1,2,4-Trimethylbenzene	1,3-Dichlorobenzene	
1,4-Dichlorobenzene	1,2-Dichlorobenzene	
1,2,4-Trichlorobenzene	Hexachloro-1,3-butadiene	

A 24-hour sample will be collected once in every six days at all sites except for the Gladstone Central site. The Opsis DOAS system at the Gladstone Central site will measure benzene, toluene and xylene and formaldehyde continuously. The data will be processed into half hour averaged pollutant concentrations and will be automatically retrieved by the EPA's monitoring computer system with access to the data on the EPA's website.

4.5 Carbonyl Compounds

Carbonyl compounds will be collected on an adsorbant cartridge and analysed by Queensland Health Forensic and Scientific Services in accordance with the United States Environmental Protection Agency Compendium Method TO-11A. Determination of Formaldehyde in Ambient Air Using Adsorbant Cartridge Followed by High Performance Liquid Chromatography (HPLC) [Active Sampling Methodology] –Jan 1999. VOCs to be determined include:

Formaldehyde	Acetaldehyde	Acetone	Propionaldehyde
Crotonaldehyde	Methacrolein	Acrolein	2-Butanone
Butyraldehyde	Benzaldehyde	Valeraldehyde	p-Tolualdehyde
Hexaldehyde			

A 24-hour sample will be collected once in every six days at all sites except for the Gladstone Central site. The Opsis DOAS system at the Gladstone Central site will measure

formaldehyde continuously. The data will be processed into half hour averaged pollutant concentrations and will be automatically retrieved by the EPA's monitoring computer system with access to the data on the EPA's website.

4.6 Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs will be collected on a combination of quartz filter and sorbent cartridge and analysed by Queensland Health Forensic and Scientific Services in accordance with the United States Environmental Protection Agency Compendium Method TO-13A. Determination of Polycyclic Aromatic Hydrocarbons (PAHs) Using Gas Chromatography/Mass Spectrometry (GC/MS) – Jan 1999. PAHs to be determined include:

Acenaphthene	Coronene	Dibenz(a,h)anthracene
Acenaphthylene	Fluoranthene	Fluorene
Anthracene	Benzo(b)fluoranthene	Benz(a)anthracene
Indeno(1,2,3-cd)pyrene	Benzo(a)pyrene	Naphthalene
Benzo(e)pyrene	Benzo(g,h,i)perylene	Phenanthrene
Benzo(k)fluoranthene Pyrene		Chrysene
Perylene		

A 24-hour sample will be collected once in every six days at all sites except for the Gladstone Central site.

4.7 Acidic/Caustic Aerosols

CSIRO Marine and Atmospheric Research has been approached to assist in the measurement of acid and caustic aerosols and will carry out the analysis.

Caustic aerosols will be measured at the south Gladstone station by the collection of PM_{10} aerosol samples and the analysis of total mass, pH and concentration of soluble ions (sodium, ammonium, magnesium, potassium, calcium, chloride, sulphate, nitrate, organic acids) to determine the alkalinity of the aerosol.

Acidic aerosols will be measured at the Clinton station by collection of a 6-day integrated sample of gas using passive samplers.

4.8 Fluorides

Fluorides will be collected by a manual double filter paper sampling and analysed by Queensland Health Forensic Services in accordance with the AS3580.13.2-1991 Methods for sampling and analysis of ambient air – Determination of fluorides – Gaseous and acid-soluble particulate fluorides - Manual double filter paper sampling.

A 24-hour sample will be collected once in every six days. Fluoride will be measured at three sites

4.9 Polychlorinated biphenyls (PCBs)/Dioxins/Furans

Trace semivolatile organic chemicals (SOC) such as polychlorinated dibenzodioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs) typically occur in ambient air at concentrations in the femtogram/m^3 (PCDDs, PCDFs and dioxin like PCBs), pictogram/m3 (PCBs). Analysis of these pollutants are very expensive and quantification in the atmosphere poses some special challenges on all aspects of sampling matrix preparation, sampling technology, storage, shipping and chemical analysis. EnTox will be engaged to carry out the sampling and with accredited laboratories for the analysis (ie NMI or ERGO for dioxin-like chemicals and dioxin-like PCBs and QHSS for indicator PCBs).

Protocols for a Gladstone sampling program is expected to be adopted from the United States Environmental Protection Agency (USEPA) 1997. Compendium Method TO9a:

Determination of polychlorinated, polybrominated and brominated/chlorinated dibenzo-p-dioxins and dibenzofurans in ambient air. In: Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. EPA/625/R-96/010b.

By definition SOCs occur in ambient air occur both in the vapour and the particle phase and hence sampling requires collection of both these phases. This is typically achieved using so called filter-sorbent type samplers where the particles are collected on a clean filter surface (typically glass fibre filter) and the vapour phase compounds are sorbed on a sorbent phase that is aligned behind the filter and usually consists of a combination of a styrene divenylbenzene polymer such as XAD2 and polyurethane foam that partially serves to hold the XAD-2 in place (sandwich configuration)

Proposed Sampling Strategy is to collect a monthly sample at each monitoring station during the winter months when dispersion is poor. A sampler that operates at low - medium sampling rates ranging from about 2-10 m^3/hr would provide a monthly sample from the order of several thousand cubic meters of air.