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Classroom ventilation assessment toolkit

– new page for toolkit info

Along with testing, vaccination, good hygiene and physical distancing, good ventilation is important in minimising the risk of airborne transmission of the virus that causes COVID-19.

We are sending CO₂ monitors to state and state-integrated schools to support schools to understand and improve ventilation. You can measure CO₂ in any classroom for which you have concerns and use this guidance to support the identification of the right next steps.

Together, this information and your CO₂ monitor provide a toolkit to support you to understand and improve ventilation. We're continuing to add to the toolkit, so please stay up to date with this page.

If you have concerns about ventilation, don't wait to receive your CO₂ monitor. Please contact your property advisor as soon as possible.

*State-integrated schools should contact their diocese for support in the first instance. [Subject to Sarah's approval](#)

H2 - CO₂ in the classroom

Generally, a room with very good ventilation will have CO₂ values under 800 ppm for the majority of the day.

International standards indicate CO₂ levels fluctuating over the school day is normal. CO₂ levels in classrooms or other school buildings fluctuate over the day depending on how many people are using the room, what activities they are doing and the time of year.

The CO₂ levels generally build over the start of the day, drop at lunch time or breaks when students are out of the room, and build slightly again over the afternoon.

Short peaks in CO₂ readings and levels shouldn't be a cause for concern but should be a prompt to consider what steps could be taken in response. You'll find CO₂ levels decrease quickly when the class leaves the room and/or when windows or doors are fully opened.

If you've followed our guidance, ensured all windows and doors are fully opened as they were originally designed to do, and taken steps to reduce occupancy, activity or increase times when rooms are vacated and CO₂ levels continue to be high, please speak to your property advisor.

Sustained CO ₂ levels	What to do
Less than 800 ppm	Your space is very well ventilated – continue with your current approach.
800-1250 ppm	Open windows and doors as wide as practical, and for as long as practical each school day.

	<p>Ensure all exterior windows and doors are open, and any that aren't open can open as originally intended.</p> <p>This may require some maintenance or minor property improvements.</p> <p>Consider briefly vacating the room, changing activity or lowering the occupancy at times through the day to support the refreshment of air in the space.</p>
1251-2000 ppm	<p>Short peaks above 1250ppm throughout the day are common.</p> <p>If there are consistent sustained elevations in CO₂ levels over 1250ppm over the school day consider:</p> <ul style="list-style-type: none"> • briefly vacating the room at regular intervals (e.g. 5 minutes per hour) with all windows and doors fully open, to let the air in the room be refreshed • lower the occupancy or the level of vigorous activity performed in the room <p>If following these steps doesn't reduce CO₂ levels, please speak to your property advisor.</p>
Over 2000 ppm	<p>Peaks of high CO₂ can also occur. If you have followed the above advice and continue to have sustained CO₂ levels over 2000ppm, please contact your property advisor.</p>

Your property advisor has access to more tools to help identify what approaches might improve the ventilation in the space.

H2 - How to set up and use your CO₂ monitor

Using your portable CO₂ monitoring device

1. Follow the manufacturer's instructions in the box to get your device started.
2. Go to the classroom or other indoor space, and place the device at around student head height, away from doors, windows and sunlight, and at least 1m away from the closest people.
3. Take a number of measurements of CO₂ levels in PPM over the day to estimate average PPM levels. Take note of how ppm levels change based on who is in the room, doing what, with windows and doors open or closed.

Tip: The Aranet app allows you to track data over time and download this information for up to seven days.

How do I set it up?

1. To activate the device, fit the two supplied AA batteries. There is no on/off switch or other controls on the device that need to be set.
2. Prior to first use, then weekly, sit the device outside for 15-30 minutes to let it calibrate to the outdoor fresh air CO₂ levels (approx. 420ppm).

Pairing the device to your smart device (optional)

1. You can download the Aranet app from Google Play or the Apple App Store to connect your device to your smartphone via Bluetooth, and follow the instructions.
2. Using the app allows you to connect to your device to view (and download) CO₂ data and will help you understand how CO₂ levels in your space change throughout the day.

Note: The processing power of your device may affect app performance.

Positioning the device in the room

- The device is best placed in a discrete area where it will not be disturbed, will not be in direct sunlight, near open doors or windows or close to people in the room. These factors can each affect the temperature and CO₂ levels the device records.
- Place the device at around student head height ([sitting or standing is fine – just not near the roof ceiling or floor](#)), away from doors and windows, and at least 1m away from the closest people.
- It's OK for the device to be placed against a wall or on a desk.
- It's also fine to move the device to different locations if you are concerned about areas within the room, though generally readings are consistent throughout a space.

Tips and tricks

- If students breathe directly onto the device, the ppm will numbers increase. If this happens the device should reset itself within five minutes. If not, move the device outdoors for 10-15 minutes to allow it to re-calibrate.

Collapsible section – Frequently asked questions about CO₂ monitors

How do I get a CO₂ monitor? Please refer to the [recent School Bulletin](#) for information on how to confirm your delivery address.

What is the CO₂ monitor I will receive? You will receive a portable Aranet CO₂ monitors. They use high quality sensors to measure real-time CO₂, temperature and humidity levels. You can find out more about them here: <https://aranet.com/product/aranet4-sensor/>

How many will I receive? You will receive one portable CO₂ monitor to allow you to help you understand and troubleshoot ventilation performance. It is not intended to be a permanent fixture in any one space.

Why do the 'good' CO₂ readings in schools differ to 'good' the instructions in the pack? The instructions in your Aranet CO₂ monitor box include generic guidance for all users. Our guidance on CO₂ levels have been developed specifically for New Zealand schools.

I need support setting my CO₂ monitor up – how can I access support? If you've followed the above instructions and need more support, please contact your property advisor or ventilation.mailbox@education.govt.nz.

How does the CO₂ monitor work? The Aranet portable CO₂ monitoring device uses high quality sensors to measure real-time CO₂, temperature and humidity levels.

It stores up to seven days' data and you can download the Aranet app to track and download data, and customise settings.

The two supplied AA batteries will generally last around 12 months.

You can download the user guide here: <https://aranet.com/product/aranet4-sensor/>

[I have an internal environment monitoring device measuring CO₂ in my classroom – do I need to do anything differently? If you already have an internal environment monitor or other CO₂ monitor installed, please follow the set up advice you received at installation for that device.](#)

Ministry of Education: “Term 2” Ventilation Online Guidance

Final Draft

Dated 28 April 2022

IN CONFIDENCE – NOT FOR DISTRIBUTION – SUBJECT TO INTERNAL APPROVALS

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Legend:

CYAN = Headings
YELLOW = Note to add links

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L1 page: Ventilation in schools

H1: Ventilation in schools

Making sure indoor spaces are well ventilated and have lots of fresh air is recommended for schools at all levels of the COVID-19 Protection Framework, along with the appropriate use of face coverings, physical distancing, good hygiene and other health measures. Good ventilation works alongside these measures to help slow the spread of the virus that causes COVID-19.

The best way to maximise ventilation is to open all windows and doors as much as possible, and whenever it is practical to do so. The exception to this is spaces that are fitted with ducted air conditioning systems (excluding heat pumps), which do not rely on opening windows to bring in fresh air.

Follow our guidance to fine-tune your school’s ventilation strategies to maintain comfortable indoor temperatures while achieving good ventilation.

[Add link to layered diagram on the resources page]

Subheading: Ventilation help in winter

Air flow behaves differently at different temperatures – for example, the bigger the temperature difference between outside and inside, the more efficiently fresh outside air is drawn in through open windows. This means ventilation can work better during cold weather, so you can still achieve good ventilation with windows just partially open.

There are several ways to do this depending on your school’s design, how each space is being used and the outdoor conditions. **Read our tips** on how you can do this, with posters and a pre-winter checklist available on our **resources** page.

Support is available to schools who are concerned about maintaining good ventilation. This includes:

- specific ventilation advice from our [COVID-19 ventilation team](#)
- the free supply of a limited number of portable air cleaners and CO₂ monitors, being distributed to all schools in Term 2

- the supply of additional portable air cleaners where this is found to be the correct interim or supplementary solution
- the ability to purchase suitable portable air cleaners and CO₂ monitors from the Ministry's nominated suppliers at discounted pricing
- funding of urgent property improvements over \$5,000 that are required to achieve good ventilation
- we are also looking at potential operational funding options to assist with additional heating costs during winter.

For ventilation advice and to access this support, please contact your Property Advisor or our COVID-19 ventilation team on ventilation.mailbox@education.govt.nz.

TILE 1 link to separate page: *Ventilation guidance*

TILE 2 link to separate page: *Assessing ventilation*

TILE 3 link to separate page: *Ventilation resources*

L2 page: Ventilation guidance

H1: Ventilation guidance

A space's ventilation will be influenced by how it was designed, how it is currently being used, and the outdoor conditions. Good ventilation will provide fresh, clean air while maintaining comfortable temperature and humidity levels for the people in the space.

Good ventilation helps reduce COVID-19 airborne transmission by quickly and consistently removing the old air and replacing it with fresh, clean air.

Indicators that a space may not be well-ventilated include a feeling of stuffiness, lingering smells and **elevated CO₂ levels** created by the people in the room. When this is occurring, schools should also consider increasing the use of other measures such as face coverings and physical distancing.

You can quickly improve the air quality in any space by:

- limiting more vigorous activities, or moving them outdoors or to a better ventilated space
- limiting the number of people, especially in smaller, confined spaces
- fully opening all windows and doors to flush the air in the room, and where it's an option to do so, briefly vacating the room at the same time.

<Quick links/jump links/contents/on this page>

- **Guidance for all naturally ventilated spaces**
- **Guidance for naturally ventilated spaces on cold, wet or windy days**
- **Guidance for ducted, mechanically ventilated spaces**
- **Guidance for using heat pumps and other heating systems**
- **Other supplementary solutions**

H2: Guidance for all naturally ventilated spaces

Most New Zealand schools and classrooms are naturally ventilated using windows that can be opened. Make the most of this by:

- Opening all windows and doors as much as possible, and whenever it is practical to do so. Do not wait for a space to get stuffy before opening windows and doors.
- Opening all windows before the school day starts and having them open whenever the room is vacated during the day.
- Opening windows and doors on the opposite sides of a room where possible to enable the cross flow of air, including any that connect to internal corridors or other circulation spaces.
- Taking regular short breaks (5-10 minutes each hour) where everyone exits the space with the windows and doors fully opened, to flush the space with fresh air.

Regularly check for any property issues that may need to be resolved, such as:

- ensuring any window that was originally designed to open, can still open
- unsticking windows which may have been fixed or painted shut
- replacing missing or broken window winders, hinges, catches or closers
- correcting any previous alterations which may be impeding good ventilation

Please contact your Ministry property advisor if you require additional ventilation support to address any property concerns.

H2: Guidance for naturally ventilated spaces on cold, wet or windy days

Bad weather can make it impractical to fully open windows and doors, but on cold days good ventilation can still be achieved with windows partially opened.

This is because air flow behaves differently at different temperatures – for example, the bigger the temperature difference between outside and inside, the more efficiently fresh outside air is drawn in through open windows.

As a rule of thumb:

- it's possible to achieve good ventilation when partially opening all windows by 5cm
- fully opening all windows and doors for 3-5 minutes every hour can fully refresh and replace all the air in a classroom

On colder days, in addition to our general ventilation guidance, try to:

- Pre-heat spaces before the start of the school day. Having it warm inside improves the draw of fresh air through partially opened windows.

- Increase indoor heating during the day, if you need to, to offset the impact of having the windows partially open when it's cold outside.
- Where high level windows are fitted, open these first and wider than low level windows to reduce cold draughts in the room.
- Open lots of windows a little, rather than a few windows a lot. Close the door before you begin closing windows, reduce or close any windows directly facing the worst weather conditions (e.g. wind, rain or snow).
- On a wet day, try to keep wet clothes out of the classroom as bringing them in will make the classroom more difficult to heat.
- Consider adjusting the classroom layout to move students away from open windows, and other areas that may have cooler air or draughts.
- Consider relaxing uniform rules/dress codes and allowing warmer clothes to be worn, for people who are more sensitive to colder air and draughts.
- Continue to use refresh breaks, where all windows and doors are fully opened and preferably everyone exits the room for a few minutes each hour.
- Fine-tune your approach through the day as the weather changes. Fully opening windows still achieves the best ventilation, so increase your window openings if it warms up outside later in the day or whenever this can be done while maintaining a comfortable indoor temperature.

Continue **using your portable CO₂ monitors** to check if your ventilation is working effectively, in addition to the appropriate use of face coverings, physical distancing, good hygiene and other health measures.

H2: Guidance for ducted, mechanically ventilated spaces

Some schools are fitted with ducted mechanical ventilation systems that automatically source fresh air from the outside while also managing the temperature of the room. These are often referred to as HVAC or air conditioning systems. This doesn't include heat pumps, because they don't supply fresh air.

One way to identify if your space has a ducted mechanical ventilation system is to look for vents in the ceiling that bring in fresh air or extract old air.

Where ducted mechanical ventilation systems are fitted, the above advice for naturally ventilated spaces doesn't apply unless the system has specifically been designed to work in conjunction with windows and doors being open. If not, windows and doors should remain closed to allow the system to work as designed.

A well-configured ducted mechanical ventilation system will provide good ventilation while managing indoor temperatures. Make the most of this by:

- Ensuring the system is regularly checked, cleaned and maintained by an appropriately skilled technician.
- Having the system configured to come on at least two hours before and after the school day.
- Increasing the amount of fresh air brought in by the system and minimising the amount of old air it filters and recirculates.

- Continuing to **use your portable CO₂ monitors** to check if the system is working effectively.

Configuration and maintenance of ducted ventilation systems should only be done by appropriately skilled technicians. Technical guidance on this topic is available on our **resources** page.

H2: Guidance for using heat pumps and other heating systems

You can continue to use heat pumps to heat or cool spaces, even when windows and doors are open.

Heat pumps and most other heating systems only heat or cool recirculated air within the space. **They do not bring in fresh air, so to achieve good ventilation they must be used alongside a means of providing fresh air.**

When using heat pumps and other heating systems:

- pre-heat the space to a comfortable temperature before the school day to improve the draw of fresh air through partially opened windows
- increase indoor heating or cooling during the day, if you need to, to offset the impact of having the windows open
- resetting the temperature of the room to a comfortable level after it has been vacated and aired out, by briefly closing all windows and doors and running the system on its highest setting before re-occupying the room and re-opening windows.

Ahead of the colder months, your heat pump or heating system should be checked and serviced to make sure it is running at its best.

Using a heat pump with windows open will be less efficient and may incur some additional power costs.

H2: Other supplementary solutions

H3: Portable air cleaners (purifiers)

Air cleaners are a supplementary solution that can reduce COVID-19 airborne transmission by filtering and recirculating the air within a space. **They do not replace good ventilation practices in any circumstances, and do not reduce CO₂ levels or supply fresh air.**

Air cleaners can offer a modest improvement to air quality and can help compensate when air flow is very low, and in spaces that are challenging to ventilate well. Their effectiveness is dependent on being correctly sized for the room, running on a high fan speed, and having a quality HEPA filter.

All state and state-integrated schools have been offered air cleaners that meet these requirements to use at their discretion in spaces that may have a higher risk of airborne transmission such as some staff rooms, music rooms, high-use meeting and break-out rooms. Units are being distributed starting from March 2022.

If after following our guidance and working through ventilation concerns with your Ministry Property Advisor it is determined that an increased use of air cleaners is the appropriate temporary or supplementary solution, additional air cleaners can be made available.

As the Ministry will supply air cleaners to schools where they are required, there should be no need for schools to purchase their own, however some schools may elect to do so at their own cost.

In May 2022 we will advise arrangements for schools and other education sector entities to purchase air cleaners direct from the Ministry's selected supplier, at a discounted price.

If purchasing brands outside of these arrangements, our panel of experts recommend air cleaners that use H13-14 HEPA filters, have a Clean Air Delivery Rate (CADR) greater than 400 m³/hour, operate at less than 60dB and do not use emerging technologies that emit any substances into the air (for example ionisers, plasma discharge, ozone generators, photocatalytic oxidation or hydrogen peroxide).

H3: Ceiling fans

You can use ceiling fans to help circulate warm or cool air around the room. Though they can improve ventilation when windows are fully open, they are unlikely to improve ventilation while windows are partially opened.

H3: Extract and supply fans

Well-designed and positioned extract and supply fans that bring in fresh air or push out the existing air can boost natural ventilation in conjunction with, or as an alternative to opening windows and doors. If you are considering fitting extract or supply fans, please discuss with your Ministry Property Advisor first to ensure that they will improve existing ventilation.

H3: Portable fans

We recommend limiting use of portable fans as it can be difficult to determine whether they are assisting or interfering with air flow. Portable fans are also noisy and can be a safety hazard depending on how they are positioned in the room.

Most non-industrial portable fans do not produce sufficient air movement to offer a notable improvement to ventilation.

L2 page: Assessing ventilation

There are several ways to quickly assess whether a space is well ventilated. Your senses can give a good immediate indication – for example if a room feels stuffy or has lingering smells, it may not be well ventilated. You'll be able to verify this using your CO₂ monitor.

If you can't resolve ventilation issues using our guidance, or you are concerned about ventilation in your school you can contact your Ministry Property Advisor or the Ministry's ventilation team on ventilation.mailbox@education.govt.nz.

H1: Carbon dioxide (CO₂) monitoring

Measuring CO₂ levels indicates how well-ventilated a space is when it is occupied. Elevated CO₂ levels means fresh air isn't flowing into a space quickly enough to meet the needs of the space's occupants. If sustained at elevated levels this can cause drowsiness and concentration issues for the people in the space.

Also, if the air in a space is not replaced quickly enough, pollutants and airborne particles including viruses stay in the air for longer. That means if anyone in the room is infectious with COVID-19, the risk of airborne transmission of the virus is increased.

To help schools assess CO₂ levels, we have distributed portable CO₂ monitors to all state and state-integrated schools, with more being distributed in May 2022. Some spaces already have fitted CO₂ monitoring devices (via Internal Environment Monitors).

With winter approaching it is important to have a regular routine in place of checking CO₂ levels to gauge how well the supply of fresh air is being balanced with maintaining comfortable indoor temperatures. This is in addition to the appropriate use of face coverings, physical distancing, good hygiene and other health measures.

H2: How to set up your CO₂ monitor

1. Follow the manufacturer's instructions in the box. To activate the device, fit the two supplied AA batteries. There is no on/off switch or other controls on the device that need to be set.
2. Prior to first use, sit the device outside for 15-30 minutes to let it calibrate to the outdoor fresh air CO₂ levels (approx. 420ppm).
3. Download the Aranet smartphone app from Google Play or the Apple App Store. The app allows you to connect to the device via Bluetooth to track readings over time and download the readings for up to seven days, in CSV format. Doing this will avoid you having to manually record the readings.
4. With the app there is the option to change the measurement interval to our recommended setting of every 2 minutes, and to adjust the warning levels to match our advice presented below.

H2: Using your CO₂ monitor to perform spot checks

Spot checks provide an immediate indication of current CO₂ levels. If the levels are high, follow our guidance to try to lower them and also consider if you should monitor the space's CO₂ levels over a longer duration.

1. Take the device to each space and place it somewhere about student head height, away from doors and windows, out of direct sunlight, and at least 1m away from the closest people. Note breathing directly into or over the device will cause it to report high CO₂ levels.
2. Leave the device in the room for at least 5 minutes before checking the CO₂ levels reported on its screen. If temperature readings are also required, extend this to 30 minutes to allow the device to report this accurately.
3. Repeat this process in a selection of spaces, or all spaces on a regular basis (e.g. fortnightly). Look for patterns and relationships between CO₂ levels, who is in the room, doing what, and with windows and doors open or closed.

H2: Using your CO₂ monitor to gather a full day's readings

If you have a concern with how the space's ventilation is changing through the day, you can leave the device in the room for a longer period for it to automatically gather its readings.

1. Take the device into the space and place it somewhere about student head height, away from doors and windows, out of direct sunlight, at least 1m away from the closest people and in a place where it will not be disturbed or moved.

2. At the end of the day, use the app to view and download the CO₂ readings. If downloading the data, ensure you only review the data linked to that space on that day. Take note of how CO₂ levels change based on who is in the room, doing what, with windows and doors open or closed at different times through the day.
3. When discussing your concerns with your Ministry Property Advisor or the Ministry's ventilation team on ventilation.mailbox@education.govt.nz, provide a copy of the downloaded data.

H2: Interpreting CO₂ levels

It's normal for CO₂ levels to fluctuate over the school day. This will happen depending on how many people are using the room, what activities they are doing, how the space's ventilation is performing and the outdoor conditions.

CO₂ levels generally build from the start of the day, drop at lunch time or during breaks, and build again during the afternoon. CO₂ levels decrease quickly when the space is vacated and/or when windows or doors are fully opened.

Short peaks in CO₂ levels shouldn't be a cause for concern but should be a prompt to consider what steps could be taken in response. If you have consistent and sustained elevated CO₂ levels not addressed by following our guidance, please speak to your property advisor.

SUSTAINED CO ₂ LEVELS	WHAT TO DO
Less than 800 ppm	Your space is very well ventilated – continue with your current approach.
800-1250 ppm	<p>Open all windows and doors as much as possible, and whenever it is practical to do so each school day while maintaining comfortable indoor temperatures..</p> <p>Ensure all exterior windows are functional and can be opened as originally intended. This may require some maintenance or minor property improvements.</p> <p>Consider briefly vacating the room, changing activity, or lowering the occupancy at times through the day to purge and refresh the air in the space.</p>
1251-2000 ppm	<p>Short peaks above 1250ppm throughout the day are common. If there are consistent and sustained elevations in CO₂ levels over 1250ppm over the school day, consider:</p> <ul style="list-style-type: none"> • briefly vacating the room at regular intervals (e.g. 5 minutes each hour) with all windows and doors fully open, to purge and refresh the air in the space • lower the occupancy or the level of vigorous activity performed in the room • increase the use of other measures such as face coverings and physical distancing. <p>If the elevated CO₂ levels continue, please speak to your property advisor.</p>

SUSTAINED CO ₂ LEVELS	WHAT TO DO
Over 2000 ppm	Peaks of high CO ₂ levels can also occur. If you have followed the above advice and continue to have sustained CO ₂ levels over 2000ppm, please contact your property advisor.

H2: Purchasing additional CO₂ monitors

The portable CO₂ monitor the Ministry has selected is the **Aranet4 Home** device. We have distributed Aranet4 Home portable CO₂ monitors to all state and state-integrated schools, with more being distributed in May 2022.

If you would like to purchase additional devices, they can be sourced direct from our supplier Butler TechSense Ltd via the web site: <https://co2sensor.co.nz/>. A voucher code is available for schools and other education sector entities to order the devices at a discounted price. This will be published in the Education Bulletin early in term 2. Schools can also contact ventilation.mailbox@education.govt.nz to get a voucher code.

If purchasing another CO₂ monitor brand, we recommend ensuring the device has a nondispersive infrared (NDIR) CO₂ sensor.

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L3 page: Ventilation resources

H1: Downloadable resources – winter advice

- A4 Poster: Promoting air flow in schools
- A4 Poster: Maintaining good ventilation in winter (new)
- Checklist: Pre-winter ventilation checks (new)

H1: Downloadable resources – other

- Diagram: The Ministry's Ventilation Strategy (layered approach)
- A4 Poster: How different ventilation methods compare (new)
- A4 Poster: How to use a Samsung portable air cleaner
- A4 Poster: Where to position your portable air cleaner
- Technical Advice: Ducted mechanical ventilation systems

H1: Research and studies

H2: Classroom ventilation study (January 2022)

The results from our study with NIWA to understand more about classroom ventilation further verified our COVID-19 classroom ventilation strategy.

The study involved looking at ventilation levels in typical classrooms being used as they normally are during the day. This was done by monitoring the amount of CO₂, which indicates how much fresh air flow there is, in 18 different classrooms across three schools.

The study verified that good ventilation can be achieved in most naturally ventilated classrooms by opening windows and doors. The study highlighted the added benefits of opening windows and doors on different sides of the room, of introducing short breaks to periodically purge the room of stale air, and of supplementary assisted natural ventilation systems (e.g. extract/exhaust fans).

It also identified other areas for further research, including classroom ventilation in cold weather, and the effective use of portable air cleaners and other supplementary measures.

- Paper: NIWA rapid study

H2: The Effectiveness of Natural Ventilation: A Case Study of a Typical New Zealand Classroom with Simulated Occupation

As a follow-on to the NIWA classroom ventilation study, this study assessed how the ventilation was impacted by different opening areas, by differing indoor versus outdoor temperatures, and by supplementary measures such as portable air cleaners and fans. It will be published in May 2022.

H2: The Impact of Natural Ventilation During Winter on Thermal Comfort in Classrooms - A Systematic Literature Review

The aim of this study was to review the available literature on the impact of natural ventilation during winter on thermal comfort. It will be published in May 2022.

H2: Methods of Assisting Natural Ventilation in Classrooms – A Systematic Literature Review

The aim of this study was to review the available literature that compares and assesses the use of different ways of improving natural ventilation in classrooms. It will be published in May 2022.

H1: Other online resources

[Ministry of Education property advisors — education.govt.nz](https://www.education.govt.nz/property-advisors/)

[Te Mahau – Advice for schools and kura](https://www.te-mahau.govt.nz/)

[Unite against COVID-19 — covid19.govt.nz](https://www.covid19.govt.nz/)

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Ventilation in schools <https://temahau.govt.nz/ventilation>

In New Zealand, we have great outdoor air quality. The Ministry's approach to indoor air quality and ventilation is centred around this and encourages behaviours that promote good ventilation.

Our advice to schools continues to be maximise ventilation capabilities as much as possible while maintaining comfortable indoor temperatures to help to reduce the risk of transmission of airborne illnesses, such as COVID-19.

The importance of ventilation

All New Zealand schools are designed to be well-ventilated, either naturally or mechanically. When airborne illnesses are prevalent, maintaining good indoor air quality reduces the risk of airborne transmission by regularly refreshing the air in a space.

The COVID-19 pandemic will continue to require a health and safety response from schools to minimise the risk of transmission. As part of this, we're continuing to support schools to maintain good ventilation in their spaces year-round.

The best way to achieve good ventilation is to open windows and doors, either fully or partially, whenever you can. The exception to this is spaces that are fitted with ducted air conditioning systems (excluding heat pumps), which do not rely on opening windows to bring in fresh air.

Our guidance is provided to help schools understand ventilation requirements and to assess and mitigate any risks caused by poor ventilation.

Schools are encouraged to [follow our guidance](#) and fine-tune their ventilation strategies year-round, depending on the season and outdoor conditions.

[Ventilation guidance](#)

[Using good ventilation helps to improve indoor air quality and reduce the transmission](#) of airborne illnesses

[Assessing ventilation](#)

[There are several ways to determine if a space is well ventilated](#)

[Ventilation resources](#)

[Downloadable posters, guides and other resources](#)

[Device support](#)

[Portable CO2 monitor and air cleaner information](#)

Advice and guidance for colder weather

When it is colder outside, good ventilation practices need to be balanced with keeping rooms at a comfortable temperature.

Airflow works better when it's colder outside, and it is possible to maintain good ventilation with windows only partially open. Our advice to schools is to open windows for as long as practically possible, and to balance this with ensuring that the temperature remains comfortable inside. Windows that are ajar or partially open still promote good ventilation – every little bit helps.

There are three key actions to improve natural ventilation during colder weather:

- **Heat:** Heat the room before the start of the school day, which will allow people to open windows earlier in the day. Keep heating on throughout the day to stay warm, with windows partially opened whenever possible.
- **Open:** Open windows by at least a crack or as much as you can while staying warm. Opening lots of windows a little can be more effective in colder weather. If the weather is bad outside, close what you need to stay comfortable.
- **Reboot:** Take refresh breaks to clear the air at different times during the day by fully opening all the windows and doors, preferably while having everyone exit the room. Aim to do this at least four times each day.

[More resources](#) are available that provide additional advice on how to balance good ventilation with thermal comfort [\[add link\]](#).

Support for schools

Support is available to schools who are concerned about maintaining good ventilation. This includes:

- Guidance and resources available for download or print [\[add link to resources page\]](#)
- Funding of urgent property improvements over \$5,000 that are required to achieve good ventilation.
- Providing additional portable CO2 monitors and air cleaners at no cost to schools, to support them with good ventilation.
- The ability to purchase suitable portable air cleaners and CO2 monitors from the Ministry's nominated suppliers at discounted pricing.

For ventilation advice and to access this support, please contact your Property Advisor or our team on ventilation.mailbox@education.govt.nz.

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Ventilation Guidance <https://temahau.govt.nz/covid-19/advice-schools-and-kura/ventilation-schools/ventilation-guidance>

Our advice to schools continues to be maximise ventilation capabilities as much as possible while maintaining comfortable indoor temperatures to help to reduce the risk of transmission of airborne illnesses, such as COVID-19.

Ventilation overview

Good ventilation will remove the old air and replace it with fresh, clean air while maintaining comfortable temperature and humidity levels for the people in the space. This helps to reduce the transmission of airborne illnesses such as COVID-19.

Indicators that a space may not be well-ventilated include a feeling of stuffiness, lingering smells and [elevated CO₂ levels](#). Sustained and elevated levels of CO₂ indicate an increased risk of airborne transmissions of illnesses, including COVID-19.

Guidance for naturally ventilated spaces

Most New Zealand schools and classrooms are designed to be naturally well-ventilated by using windows that can be opened. Make the most of this by:

- Opening all windows and doors, partially or fully as conditions allow, whenever you can. Do not wait for a space to get stuffy before opening windows and doors.
- Opening all windows, partially or fully as conditions allow, before the school day starts and whenever the room is vacated during the day.
- Opening windows and doors on the opposite sides of a room where possible to enable the cross flow of air, including any that connect to internal corridors or other circulation spaces.
- Taking regular refresh breaks for 5-10 minutes, preferably where everyone leaves the room and windows and doors are fully opened, to flush the space with fresh air.

Regularly check for any property issues that may need to be resolved, such as:

- Ensuring any window or door that was originally designed to open, can still open.
- Unsticking windows which may have been fixed or painted shut.
- Replacing missing or broken window winders, hinges, catches or closers.
- Correcting any previous alterations which may be impeding good ventilation.

Ministry funding is available for urgent ventilation-related property improvements that exceed \$5,000. Please contact your Ministry property advisor if you require support to address any property issues or to access this funding.

Guidance for naturally ventilated spaces on cold, wet or windy days

Bad weather can make it impractical to fully open windows and doors, but on cold days good ventilation can still be achieved with windows partially opened.

This is because air flow behaves differently at different temperatures. The bigger the temperature difference between outside and inside, the more efficiently fresh outside air is drawn in through open windows.

On colder days, take these additional steps to help ventilate your space while balancing comfortable indoor temperatures:

- **Heat:** Heat the room before the start of the school day, which will allow people to open windows earlier in the day. Keep heating on throughout the day to stay warm, with windows partially opened whenever possible.
- **Open:** Open windows by at least a crack or as much as you can while staying warm. Opening lots of windows a little can be more effective in colder weather. If the weather is bad outside, close what you need to stay comfortable.
- **Reboot:** Take refresh breaks to clear the air at different times during the day by fully opening all the windows and doors, preferably while having everyone exit the room. Aim to do this at least four times each day.

Fine-tune your approach through the day as the weather changes. Fully opening windows still achieves the best ventilation, so increase your window openings if it warms up outside later in the day or whenever this can be done while maintaining a comfortable indoor temperature. You can use CO₂ monitors to check that these strategies are working, and identify whether adjustments need to be made.

In addition to the tips above schools can also adopt other, more specific ventilation strategies:

- Open high-level windows first and wider than low level windows to reduce cold draughts in the room.
- Open lots of windows a little, rather than a few windows a lot. Close the doors before you begin closing windows and reduce or close any windows directly facing the worst weather conditions (e.g. wind, rain or snow).
- On a wet day, try to keep wet clothes out of the classroom as bringing them in will make the classroom more difficult to heat.
- Adjust the classroom layout to move students away from open windows, and other areas that may have cooler air or draughts.
- Relax uniform rules/dress codes and allowing warmer clothes to be worn on the coldest days.

Guidance for spaces with ducted mechanical ventilation systems

Some schools are fitted with ducted mechanical ventilation systems that automatically source fresh air from the outside while also managing the temperature of the room. These are often referred to as HVAC or air conditioning systems. This doesn't include heat pumps [Link to heat pump advice] because they don't supply fresh air.

One way to identify if your space has a ducted mechanical ventilation system is to look for vents in the ceiling that bring in fresh air or extract old air.

Where ducted mechanical ventilation systems are fitted, the above advice for naturally ventilated spaces doesn't apply unless the system has specifically been designed to work in conjunction with windows and doors being open. If not, windows and doors should remain closed to allow the system to work as designed.

A well-configured ducted mechanical ventilation system will provide good ventilation while managing indoor temperatures. Ensure these systems are:

- Regularly checked, cleaned and maintained by an appropriately skilled technician.
- Configured to operate from at least two hours before and after the school day.

- Configured to increase the amount of fresh air brought in by the system and minimising the amount of old air it filters and recirculates, where this can be done while maintaining comfortable indoor temperatures.

You can use CO₂ monitors to assess whether the system is working effectively.

Configuration and maintenance of ducted ventilation systems should only be done by appropriately skilled technicians. Technical guidance on this topic is available on our [resources](#) page.

Guidance for using heat pumps and other heating systems

You can continue to use heat pumps to heat or cool spaces, even when windows and doors are open. Please note that using a heat pump with windows open will be less efficient and may incur some additional power costs.

Heat pumps and many other heating systems only heat or cool recirculated air within the space. They do not bring in fresh air, so to achieve good ventilation they are to be used alongside a means of providing fresh air.

When using heat pumps and other heating systems, consider:

- Pre-heating the space to a comfortable temperature before the school day to improve the draw of fresh air through partially opened windows.
- Increasing indoor heating or cooling during the day, if you need to, to offset the impact of having the windows open.
- Resetting the temperature of the room to a comfortable level after it has been vacated and aired out, by briefly closing all windows and doors and running the system on its highest setting before re-occupying the room and re-opening windows.

Your heat pump or heating system should be regularly checked and serviced to make sure it is running at its best.

Other supplementary solutions

Portable air cleaners (purifiers)

Air cleaners are a supplementary solution that can improve indoor air quality and reduce the airborne transmission of illnesses such as COVID-19 by filtering and recirculating the air within a space. They do not replace good ventilation practices in any circumstances as they do not supply fresh air or reduce CO₂ levels.

Air cleaners can offer a modest improvement to air quality and can help compensate when air flow is low and the air is stagnant in spaces that are challenging to ventilate well, and when it is impractical to sufficiently open windows. Their effectiveness is dependent on the air cleaner being correctly sized for the room, running on a high fan speed, and having a quality HEPA filter.

In 2022 we have made more than 13,000 air cleaners available to state and state-integrated schools to use at their discretion in spaces that may have a higher risk of COVID-19 airborne transmission. This may include staff rooms, music rooms, high-use meeting and break-out rooms. They can also be used in classrooms and other spaces when adverse weather conditions make it less practical to open the windows.

Schools, early childhood services and other education providers are able to purchase air cleaners at a discounted rate directly from our preferred suppliers. More detail is provided on the Device Support page [\[insert link\]](#).

Ceiling fans

Fixed ceiling fans help to circulate warm or cool air around the room. They can improve ventilation when windows are fully open, however are unlikely to result in an improvement when windows are only partially opened.

Extract and supply fans

Fitting well-designed and positioned extract and supply fans that bring in fresh air or push out the old air can boost natural ventilation in conjunction with, or as an alternative to fully opening windows and doors. If you are considering fitting extract or supply fans, please discuss with your Ministry Property Advisor first to ensure that they will successfully supplement the existing natural ventilation.

Portable fans

Most non-industrial portable fans do not produce sufficient air movement to offer a notable improvement to ventilation.

We recommend limiting use of portable fans as it can be difficult to determine whether they are assisting or interfering with air flow. Portable fans are also noisy and can be a safety hazard depending on how they are positioned in the room.

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Assessing ventilation <https://temahau.govt.nz/covid-19/advice-schools-and-kura/ventilation-schools/assessing-ventilation>

There are several ways to quickly assess whether a space is well ventilated.

Assessing ventilation

Your senses can give a good immediate indication of whether a space has good airflow – for example if a room feels stuffy or has lingering smells, it may not be well ventilated. You'll be able to verify this using a CO₂ monitor.

If you can't resolve ventilation issues using our guidance, or you are concerned about ventilation in your school you can contact your Ministry Property Advisor or the team on ventilation.mailbox@education.govt.nz.

Carbon Dioxide (CO₂) monitoring

Monitoring CO₂ levels is one way to quickly assess whether a space is well ventilated when it is occupied. Elevated CO₂ levels for a sustained period of time (e.g. over the course of an hour) indicate that fresh air isn't flowing into a space quickly enough to meet the needs of the space's occupants. This means that airborne particles and pollutants including illnesses such as COVID-19 stay in the air for longer, so if anyone in the room has an airborne illness, the risk of transmission is increased.

To help schools assess CO₂ levels, in 2022 we have distributed more than 12,000 portable CO₂ monitors to all state and state-integrated schools. A number of spaces also have internal environment monitoring devices fitted that include CO₂ monitoring.

To learn more about setting up your portable CO₂ monitor, please refer to the Aranet4 Setup and User guide [[insert downloadable](#)].

Using your portable CO₂ monitor to perform spot checks

Spot checks provide an immediate indication of current CO₂ levels. If the levels are high, follow our guidance to try to lower them and also consider if you should monitor the space's CO₂ levels over a longer duration.

Spot checks only provide a snapshot of the current CO₂ level and may not represent peak or sustained levels. Short peaks of elevated CO₂ levels are common in all indoor spaces and are not a cause for concern.

1. Take the CO₂ monitor to each space and place it somewhere around student head height, away from doors and windows, out of direct sunlight, and at least 1m away from the closest people. Note breathing directly into or over the device will cause it to report high CO₂ levels.
2. Leave the device in the room for at least 5 minutes before checking the CO₂ levels reported on its screen. If temperature readings are also required, extend this to 30 minutes to allow the device to report this accurately.
3. Repeat this process in a selection of spaces, or all spaces on a regular basis (e.g. fortnightly). Look for patterns and relationships between CO₂ levels, who is in the room, doing what, and with windows and doors open or closed.

Using your portable CO₂ monitor to gather a full day's readings

If you have a concern with how the space's ventilation is changing through the day, you can leave the CO₂ monitor in the room for a longer period for it to automatically collect its readings.

1. Take the CO₂ monitor into the space and place it somewhere around student head height, away from doors and windows, out of direct sunlight, at least 1m away from the closest people and in a place where it will not be disturbed or moved.
2. At the end of the day, use the smartphone app to view and download the CO₂ readings. When downloading and assessing the data, ensure you only review the data linked to that space on that day. Take note of how CO₂ levels change based on who is in the room, doing what, with windows and doors open or closed at different times through the day.
3. When discussing any concerns with your Property Advisor, provide a copy of the downloaded data.

Sustained CO ₂ levels	Actions to consider
Under 800	Your space is well ventilated, continue with current approach.
800-1250	Open windows more if this can be done while maintaining comfortable indoor temperatures. Consider lowering the level of activity, briefly vacating the room and/or purging and refreshing the air in the space (a “reboot”).
1250-2000	<p>Take further action to introduce more fresh air, for example:</p> <ul style="list-style-type: none"> • Open all windows and doors as much as possible, and whenever it is practical to do so while maintaining comfortable indoor temperatures. • Reboot the room by fully opening all windows and doors for a few minutes, preferably while vacating the room, to purge and refresh the air in the space. • Reduce the level of vigorous activity performed in the room or lower the total occupancy. <p>To reduce the risk of transmission of airborne illnesses such as COVID-19, also consider increasing other health measures such as face coverings and physical distancing.</p>
Over 2000	<p>If you have followed the above advice and still have sustained CO₂ levels over 2000ppm, contact your Property Advisor.</p> <p>In addition, instigate at least four refresh breaks through the school day where you reboot the room with all windows and doors open for a few minutes, and preferably with the room unoccupied.</p>

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Ventilation resources <https://temahau.govt.nz/covid-19/advice-schools-and-kura/ventilation-schools/ventilation-resources>

The Ministry has developed a series of downloadable resources to support schools with good ventilation.

Ventilation in a space

[A4 Poster: How different ventilation methods compare](#)

[A4 Poster: Promoting good air flow in schools](#)

A4 Poster: Tips for good ventilation in winter

[Technical Advice: Ducted mechanical ventilation systems](#)

[Property ventilation checklist](#)

Portable air cleaners

A4 Poster: Help Slow COVID-19 by correctly using air cleaners

[A4 Poster: Where and when to use air cleaners](#)

[A4 Poster: How to use a Samsung portable air cleaner](#)

[A4 Poster: Where to position your portable air cleaner in a room](#)

[Setup and User Guide: Samsung Portable Air Cleaners](#)

CO₂ monitoring

A4 Poster: Help Slow COVID-19 by monitoring CO₂ levels

[Setup and User Guide: Aranet4 Portable CO₂ Monitors](#)

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COVID-19 Ventilation research and studies

Many international studies and research from various authorities have informed the Ministry's COVID-19 ventilation response. Local studies were also undertaken to investigate the appropriate strategy for the context of New Zealand classrooms.

The Ministry set up the Ventilation Technical Advisory Group (VTAG), with members that have significant ventilation expertise to support and perform the studies below.

Classroom ventilation study

Our study with NIWA helped us understand more about classroom ventilation and helped verify our COVID-19 classroom ventilation strategy.

The study involved looking at ventilation levels in typical classrooms being used as they normally are during the day. This was done by monitoring the amount of CO₂, which indicates how much fresh air flow there is, in 18 different classrooms across three schools.

The study verified that good ventilation can be achieved in most naturally ventilated classrooms by opening windows and doors. The study highlighted the added benefits of opening windows and doors on different sides of the room, of introducing short breaks to periodically purge the room of stale air, and of supplementary assisted natural ventilation systems (e.g. extract/exhaust fans).

It also identified other areas for further research, including classroom ventilation in cold weather, and the effective use of portable air cleaners and other supplementary measures.

[NIWA rapid study](#)

[Download the results from our study with NIWA](#)

The Effectiveness of Natural Ventilation: A Case Study of a Typical New Zealand Classroom with Simulated Occupation

As a follow-on to the NIWA classroom ventilation study, this study assessed how the ventilation was impacted by different opening areas, by differing indoor versus outdoor temperatures, and by supplementary measures such as portable air cleaners and fans.

[Natural Ventilation](#)

[The Effectiveness of Natural Ventilation](#)

The Impact of Natural Ventilation During Winter on Thermal Comfort in Classrooms – A Systematic Literature Review

The aim of this study was to review the available literature on the impact of natural ventilation during winter on thermal comfort.

[Ventilation in Winter](#)

[Impact of Natural Ventilation in Winter on Thermal Comfort](#)

The Performance of Portable HEPA Air Cleaners in Naturally Ventilated Classrooms

This report summarises the current (at time of writing) research on the performance of portable air cleaners used in naturally ventilated classrooms for the purpose of COVID-19 mitigation.

[HEPA Air Cleaners](#)

[HEPA Air Cleaners in Naturally Ventilated Classrooms](#)

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Device support <https://temahau.govt.nz/covid-19/advice-schools-and-kura/ventilation-schools/device-support>

In 2022 we have distributed more than 12,000 portable CO₂ monitors and 13,000 portable air cleaners to all state and state-integrated schools to support them with good ventilation, as part of our rapid response to COVID-19. These devices were provided at no cost to the schools.

All schools that have requested and received devices need to ensure these are reflected on their fixed asset register. Schools are responsible for any ongoing maintenance and consumables. Warranty information for these devices is provided below.

Schools that would like to receive additional CO₂ monitors or air cleaners are able to request these directly from the Ministry, by filling out the request forms at the bottom of this page.

Schools, early childhood services and other education providers are able to purchase additional CO₂ monitors and air cleaners, with more detail provided below.

Aranet4 Portable CO₂ Monitors

Request additional devices

For a limited time, schools can request additional Aranet4 CO₂ monitors, to be provided at no cost, by completing the form below [add downloadable link].

Purchasing

Schools, early childhood services and other education providers can purchase these devices at a discounted price directly from the Ministry's supplier, Butler Techsense Ltd via the web site: <https://co2sensor.co.nz/>, and by using the voucher code '3DUCATION' at checkout.

If purchasing other CO₂ monitor brands or products, we recommend ensuring the device has a nondispersive infrared (NDIR) CO₂ sensor.

Warranty and device support

Aranet4 CO₂ monitors come with a 24-month warranty, including coverage of goods damaged in transit.

Schools can report any damage or faults with Aranet4 CO₂ monitors directly to the supplier, Butler Techsense Ltd. The supplier will send a new monitor to the school, along with a pre-paid courier bag to return the damaged/faulty product.

Process for reporting damaged or faulty devices:

1. Email support@butlertechsense.co.nz, including the following information:
 - School name
 - School address and postcode
 - Contact name
 - Contact phone number
 - Contact email address
 - Serial number of the Aranet4 CO₂ monitor
2. If possible, return the Aranet4 CO₂ monitor in its original box with the batteries supplied.

Portable Air Cleaners

Request additional devices

For a limited time, schools can request additional air cleaners, to be provided at no cost, by completing the form below [add downloadable link thing].

Schools, early childhood services and other education providers can purchase air cleaners at a discounted price, directly from the Ministry's two suppliers: Samsung NZ and Rentokil.

If purchasing other air cleaner brands and products, our panel of experts recommend air cleaners that use H13-14 HEPA filters, have a Clean Air Delivery Rate (CADR) greater than 400 m³/hour, operate at less than 60dB and do not use emerging technologies that emit any substances into the air (for example ionisers, plasma discharge, ozone generators, photocatalytic oxidation or hydrogen peroxide).

Samsung AX60 (Medium) and AX90 (Large) air cleaners

Purchasing and consumables

Samsung air cleaners can be purchased at a discounted price directly from Samsung NZ, via the website: <https://www.samsung.com/nz/air-care/air-purifier/> and using the voucher code '3DUCATION' at checkout.

Replacement filter consumables can be purchased from the same web site: <https://www.samsung.com/nz/home-appliance-accessories/all-home-appliance-accessories/>, also using voucher code '3DUCATION' at checkout.

Warranty and device support

(Unchanged)

Rentokil InspireAir-72 air cleaner

Purchasing and consumables

This air cleaner can be purchased at a discounted price directly from Rentokil. More information about these units can be found online at <https://web.rentokil-initial.com.au/inspireair72-education-nz>.

These can be purchased by calling 0800 RIPRODUCTS or emailing ri-products-nz@rentokil-initial.com and quoting the voucher code 'MOEInspire'.

Warranty and device support

Rentokil portable air cleaners come with a 24-month warranty, including coverage if damaged in transit.

Schools can report any damages or faults directly to Rentokil, either by calling 0800 RIPRODUCTS or emailing re-products-nz@rentokil-initial.com.