

Vibration associated with construction of new sewer infrastructure

When amey Black & Veatch builds new infrastructure for Scottish Water, the installation of pipes and chambers in the ground along with the use of heavy machinery can generate vibrations which, depending on the ground conditions may be transmitted through to nearby structures.

All construction work generates some vibration. To ensure we minimise disturbance to residents and keep the risk of cosmetic damage (cracking of finishings and plastered joints), we use the British Standard Code of Practice for noise (BS 5228-1:2009+A1:2014) and vibration (BS 5228-2:2009+A1:2014). We have vibration monitors in place to monitor the levels during the construction work.

How is vibration felt and measured?

The human body is highly sensitive to vibration and will feel movement at much lower levels than will typically cause structural damage. Vibration is generally measured in terms of peak particle velocity in units of millimetres per second (mm/s) corresponding to:



	<i>Vibration Level</i>
Human perception	0.3 mm/s
Moderate discomfort for extended periods	2-3 mm/s
Disturbance to people	5 mm/s
Small risk (<5%) of cosmetic cracks forming	12 mm/s
Small risk (<5%) of structural damage	>50 mm/s
Damage to foundations, retaining structures and in-ground services	>100 mm/s

A context of vibration levels that are typically generated

To provide a context the levels of vibration typically caused by the following domestic activities are listed below, (as detected at about 5 metres distance).

	<i>Vibration Level</i>
Slamming of a door within five metres	1-3 mm/s
Person jumping on timber floor	2-5 mm/s
Removal/ delivery truck in driveway	2-3 mm/s
Moving Heavy furniture	3-8 mm/s
Washing Machine out of balance	10-12 mm/s

Vibration reduces rapidly with increased distance from the source. For example, a medium-heavy excavator operating immediately adjacent to a house may generate vibration that causes some disturbance but not damage whereas at more than 10 metres the vibrations will be much more tolerable.

What levels of vibrations are expected for this project?

The above list of domestic activities is compared below with vibrations generated by typical construction equipment operating in the ground at a distance of about 10 metres from a property. Vibrations at the property itself will be less due to the rapid decay vibrations through the ground.

The vibration levels are dependent on the size of machinery, methods of construction used and the ground conditions encountered. In locations where there is high sensitivity to vibration, small plant may be operated to minimise discomfort to residents but this may result in the programme taking a longer time to complete and greater inconvenience.

	<i>Vibration Level</i>
Diggers, loaders, trucks etc.	1-3 mm/s
Sheet pile driving (soft to hard ground)	4-8 mm/s
Vibrating rollers and compactors	4-10 mm/s

Noise associated with construction of new sewer infrastructure

The installation of new pipes and chambers in the ground along with the use of heavy machinery can generate not only vibration but noise.

Understanding Noise

Sound sources (noise) Examples with distance	Subjective description
Jet aircraft (at 50m away)	Intolerable
Rock Concert	Intolerable
Chainsaw (at 1m away)	Intolerable
Accelerating Motorcycle (at 5m away)	Intolerable
Disco (1m from speaker)	Very Noisy
Pneumatic Hammer (at 5m away)	Very Noisy
Diesel truck (at 10m away)	Very Noisy
Loud Factory	Noisy
Busy road (5 m)	Noisy
Vacuum cleaner (at 1m away)	Noisy
Conversational speech (at 1m away)	Noisy
Average home	Noisy
Quiet library	Quiet
Theatre	Quiet
Quiet bedroom at night	Quiet
Background in TV studio	Very Quiet
Rustling leaves in the distance	Very Quiet
Hearing threshold	Very Quiet

The strength of sound, or sound pressure level, is measured in decibels (dB(A)). Variations of the dB(A) measurement are used to analyse noise and set prescribed levels for noise from commercial sites.

*Note: the "A" weighting is used to represent how humans hear sound.

Generally speaking:

- A 10 dB(A) increase in sound level is perceived as about twice as loud.
- A 10 dB(A) reduction in sound level is perceived as about half as loud.
- A 3 - 4 dB(A) change in sound level is usually just noticeable.

Factors other than sound level are important. Even at low volume, a sound may be annoying due to the characteristic of the noise such as pitch, duration, impulsiveness or how frequently it occurs.

Source: Bies D.A and Hansen C.H, Engineering Noise Control: Theory and Practice.

How do we monitor noise?

To ensure we minimise disturbance to residents, we use the British Standard Code of Practice for noise (BS 5228-1:2009+A1:2014) and vibration (BS 5228-2:2009+A1:2014). We have noise monitors in place to monitor the levels during the construction work.

Noise expected from the phases of work:

Piling sheet piles into the ground



The sheets are driven into the ground to secure the pit for excavation and prevent ground movement. **Very Noisy.**



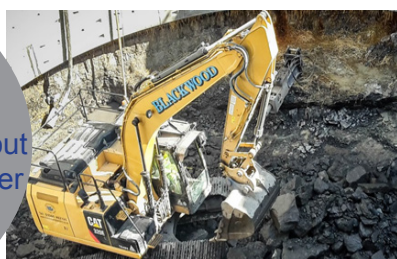
Excavating out the soft ground

We excavate down through the made ground and clay which is softer. **Noisy.**



Breaking / Pecking out the hard layer

The mud-stone rock layer is harder and will require to be broken out which generates louder noise. **Very Noisy.**



How do we help reduce the noise impact?

- We use a non-metallic dolly (part between the hammer and the driving helmet) to help prevent direct metal-to-metal contact.
- We will carry the louder work between 9am to 5pm (Monday to Friday) to minimise the number of people it will affect.
- The duration of piling work is carried out in short durations so it will not be a constant noise. This phase of work is relatively short in relation to the length of construction work as a whole.