OBJECTION RESPONSE PREPARED BY TONY SEVELKA, AACI, P.APP, MAI, AI-GRS, SREA, FRICS (JULY 20, 2022, REVISED AUGUST 12, 2022)

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- Blasting Vibrations, Airblast, Complaints & Lawsuits
- By-Law 2003-95 Pits and Quarries Regulating Setbacks under the Municipal.Act
- Flyrock Health & Safety Concerns
- Flyrock Power Point Presentation
- Flyrock Presentaton
- Flyrock-and-Other-Impacts-Supplement…
- House+Quarry+Application+Township of Lake of Bays 2005.pdf Interpretation…
- July 28, 1994 News Article (Ramara Quarry flyrock incidents)
- OPPI-Fly-Rock-Advisory-August-2021 (revised)
- Preventing Consequences of Flyrock Revised
- Revised FlyRock Advisory DM

INTRODUCTION

The research and attached supporting documentation presented in this objection response to Nelson Aggregate Co.'s application seeking municipal and provincial approvals to expand the existing Nelson Quarry in the City of Burlington has been independently prepared without compensation by Tony Sevelka as a concerned citizen over the health, safety and welfare of the public and environment.

Based on the research conducted, it is recommended that the City of Burlington, the Niagara Escarpment and the Ministry of Natural Resources and Forestry (MNRF) not support or approve Nelson Aggregate Co.'s application to extend (expand) the existing quarry, as the self-serving proponent-driven studies fail to address and protect the environment and the communities surrounding the quarry from the anticipated adverse effects and deleterious impacts of a blasting quarry operation - a human-made hazard.

Not only should the Nelson Aggregate Co. application to extend (expand) the existing Nelson Quarry be denied, the City of Burlington should force Nelson Aggregate Co. to permanently cease all blasting operations within 500-metres inside the boundaries of the existing quarry operation by passing a by-law to that effect, to protect the health and safety of onsite employees and offsite inhabitants in the surrounding communities (i.e. Settlement Areas and Rural Clusters) from this human-made hazard.

Blasting is an abnormally dangerous activity held to the rule of strict liability, which stems from common law dating back to an 1868 case in England. [1]

> In Rylands v. Fletcher, an English case from 1868, the opinion read that "[a] person who for his own purposes brings on his lands and collects and keeps there anything likely to do mischief if it escapes, must keep it in at his peril." American courts often cite this case as providing the origin of the rule on abnormally dangerous activities. In US jurisdictions, courts have never required that the activity take place on the defendant's land. However, they retained the requirement of "unnatural use" in the form of "not of common usage", meaning an activity that is unreasonable or inappropriate in light of the circumstances. See Restatement (Third) of Torts § 20, cmt.(d) (2009).

[1] https://www.law.cornell.edu/wex/abnormally_dangerous_activity.

- The community character and development are vital and of utmost importance for deciding what proposed land uses fit within that harmony and character. It is also a matter of protecting the *Settlement Areas* and *Rural Clusters* in proximity to the existing Nelson Quarry from the known and anticipated *adverse effects*, including property-value impacts. Elected officials of the City of Burlington have a legal duty to protect the community and its inhabitants in the short- and long-term by ensuring that non-compatible land uses such as the Nelson Quarry not be permitted.

- Inserting industrial activities that are *human-made hazards* in rural residential areas, characterized primarily by residential, agricultural and recreational (tourist) uses, brings about resident and visitor complaints related to noise, traffic congestion, accidents and violations, vibrations, fugitive dust, toxic fumes, flyrock, impacted domestic wells, and the like, drawing away limited code enforcement measures to address concerns that the City of Burlington will have very little authority to order correction. These concerns cost money and will have to be borne by all citizens of the City of Burlington for possibly 100 years or more (the potential life of an expanded blasting quarry). Property tax revenue will also be lost, not only from the hundreds of acres consumed and destroyed by the Nelson Quarry operation, but from the reduced value of the properties (residential and non-residential) impacted by the Nelson Quarry.

- The City of Burlington's sustainable future lies in its protection of its natural environment (i.e., Niagara Escarpment – Mount Nemo) and related opportunities to aid orderly residential development that will help grow the tax base and provide for a great place (i.e., *Healthy Community*) to live and raise a family.

> **Healthy Communities** – Communities: (1) that foster among their residents a state of physical, mental, social and economic well–being; (2) where residents take part in, and have a sense of control over, decisions that affect them; (3) that are physically designed to minimize the stress of daily living and meet the life-long needs of their residents; and (4) where employment, social, health, educational, and recreational and cultural opportunities are accessible to all segments of the community. (Burlington Official Plan, Chapter 13 – Definitions, April 2018)

- The Nelson Quarry extension (expansion) would irreversibly mar the existing pattern of residential growth, destabilize the community, and

impact the way residents expect to quietly enjoy their homes, indoor and outdoor amenity spaces, and disrupt plans for future work/live opportunities (or necessities) brought about by the Covid-19 pandemic. It would impact hundreds of families that have built their lives and invested their savings in an area that is zoned to benefit their desired lifestyle, and rob them of the hard-earned equity in their homes.

As stated by one court,

> The power to define the community character is a unique prerogative of a municipality acting in its governmental capacity. All of the other incidents of local government, including its electoral and legislative processes, management policies, and fiscal decisions, are ultimately aimed at determining and maintaining the community that its residents desire. It is the right to continue to exercise that authority which the Villages assert here, in the face of the potential threat posed by the Town's action with respect to the property along the Villages' borders.[2]

BRIEF OVERVIEW OF ACADEMIC AND PROFESSIONAL QUALIFICATIONS (TONY SEVELKA)

- Tony Sevelka holds a Bachelor of General Studies (BGS) degree with a major in Real Estate Studies.
- He is a professionally-designated real estate appraiser with approximately 50 years' experience, and addressing land use planning controls at the municipal and provincial levels forms a significant part of each appraisal assignment.
- He has completed more than 400 hours of legal courses, and is proficient at conducting legal research.
- He has authored approximately 20 valuation-related papers, which have been published in *The Appraisal Journal* or *Canadian Property Valuation Magazine.*
- He has dedicated almost three years since October 2019 researching and writing about blasting quarry operations and their ***adverse effects*** (e.g., nuisance, trespass, negligence, strict liability, property value impacts).
- He has become an expert in research related to flyrock incidents, and in 2021 completed the most comprehensive study ever undertaken on flyrock incidents, summarizing the distances that flyrock was launched in 92 "known" incidents, where the travel distance was disclosed.

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[2] *Chestnut v. Ramapo*, 45 A.D.3d 74 (N.Y. App. Div. 2007), https://casetext.com/case/chestnut-v-ramapo.

Flyrock is the dirty little secret of the aggregate industry and the explosives engineers acting on its behalf, and they have done a remarkably effective job of concealing it from the public![3]

> Whether a witness has the requisite skill to qualify him as an expert is chiefly a question of fact, the determination of which is within the exclusive province of the trial judge. To be an expert the witness need not be a specialist or have a license from an examining board or have had experience with the exact type of subject matter under investigation, nor need he be engaged in any particular profession or other calling. It is enough that, through study or experience, or both he has acquired such skill that he is better qualified than the jury to form an opinion on the particular subject.[Stanbury, North Caroline Evidence, § 133, p. 314. See Hopkins v. Comer, 240 N.C. 143, 81 S.E. 2d 368]

Shown as follows is a list of research papers on the topic of Blasting Quarry Operations authored by Tony Sevelka and which form part of the response to the June 29, 2022 "Notice of Objector Response" prepared by Quinn Moyer, Nelson Aggregate Co.:

- *Preventing the Potentially Deadly Consequences of Flyrock: Mandatory Minimum Setbacks Required (Revised 31-Oct-21)*
- *Blasting Quarry Operations: Damage From Airblast (Noise & Concussion) (7-Sep-21)*
- *Flyrock: An Inevitable By-product of Quarry Blasting Operations (10-Jun-21) (Power Point Presentation Gravel Watch June 27, 2021)*
- *Blasting Quarry Applications: Flyrock Health and Safety Concerns, Quality of Life and Property-value Diminution, Reciprocal Setback Requirements, and Blasting Impact (Non)Assessments (6-Mar-21)*
- *Adverse Effects: Thirteen Homeowners Near a Blasting Quarry Bought Out By Quarry Owner (26-Jan-21)*[4]
- *Flyrock: The Ultimate Adverse Effect From Quarry Blasting Operations & The Need for Adequate Setbacks (30-Dec-20)*[5]
- *Blasting Quarry Complaints, Flyrock Incidents & The Need for Adequate Setbacks (8-Dec-20)*
- *The Impact of Blasting Quarries & The Need for Adequate Setbacks (17-Nov-20)*[6]
- *Supplement to April 24, 2020 Flyrock and Other Impacts From Blasting Quarry Operations (10-Aug-2020)*
- *Flyrock and Other Impacts From Quarry Blasting Operations, Revised April 24, 2020*[7]

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[3] Tony Sevelka, "Flyrock: The Ultimate Adverse Effect From Quarry Blasting Operations & The Need For Adequate Setbacks," December 30, 2020, https://www.pitsense.ca/whats_new_2.html.

[4] https://files.secure.website/wscfus/6880241/28362475/adverse-effects-13-homeowners-bought-out-by-quarry-owner-jan-21.pdf.

[5] https://www.pitsense.ca/whats_new_2?r=20210008221719.

[6] https://intval.com/articles/Blasting-Quarries-and-Adequate-Setbacks.pdf.

ENGINEERS AND PLANNERS STATUTORY DUTY TO PROTECT THE HEALTH AND SAFETY OF THE PUBLIC

Engineers (as members of the Professional Engineers of Ontario) and Planners (as members of the Ontario Professional Planners Institute) have a statutory duty to protect the health and safety of the public, and, with respect to the dangers to the public associated with a blasting quarry operation, the proponent-driven studies prepared on behalf of Nelson Aggregate Co. have failed to do so.

- **Negligence** and **professional misconduct** under the *Professional Engineers Act, R.S.O. 1990, c. P.28* are defined as follows:

> "negligence" means an act or an omission in the carrying out of the work of a practitioner that constitutes a failure to maintain the standards that a reasonable and prudent practitioner would maintain in the circumstances. R.R.O. 1990, Reg. 941, s. 72 (1); O. Reg. 657/100, s. 1 (1).
>
> "professional misconduct" means,
>
> a) negligence,
> b) failure to make reasonable provision for the safeguarding of life, health or property of a person who may be affected by the work for which the practitioner is responsible.

- Pursuant to the Ontario Professional Planners Institute Act, 1994, one of the objects of the Ontario Professional Planners Institute is to

> 3. (1) (a) to promote, maintain and regulate high standards of professional planning practice and ethical behaviour;…
>
> (c) regulating and governing the conduct of members of the Institute in the practice of their profession, by prescribing rules of professional conduct and standards of practice and by providing for suspensions, expulsions or other penalties for professional misconduct, incapacity or incompetence.

The reference to the International Society of Explosives Engineers (ISEE) as a "Professional Affiliation" claimed by each engineer responsible for the preparation of the April, 23, 2020 Blast Impact Analysis is misleading as according to a past president (Jack Eloranta) of ISEE:

> **Judgement of 'Competence' is not the provenance of this 'so-called professional society.'** (March 23, 2020, email from Jack Eloranta)
>
> ***For $95 (and "two box tops") annually you too can become a member of ISEE!***

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[7] https://intval.com/articles/Flyrock-and-Other-Impacts-from-Quarry-Blasting-Operations.pdf.

A member of the Ontario Professional Planners Institute as a **Professional** must comply with the following:[8]

- A planner must strive to provide full, clear and accurate information on planning issues to clients, citizens and governmental decision makers.
- A planner must systematically and critically analyze ethical issues in the practice of planning.
- A planner must act in accordance with the highest standards of professional integrity.
- Maintain a high quality of service and a reputation for honesty and fairness.
- Carry out tasks with honesty, provide accurate captions and never intentionally distort the truth.
- Express an opinion only when it is based on practical experience, education, judgment and honest conviction.
- Perform services only in areas of competence obtained through experience and/or formal education.
- Critically examine and keep current with emerging knowledge and fully use evaluation and research evidence in professional practice.
- Conduct yourself honourably, responsibly, ethically, and lawfully so as to enhance the honour, reputation and usefulness of the planning profession.
- Advise clients or employers when you believe a project does not meet basic planning principles or guidelines.
- All professional planners must promote professional excellence within the profession. In summary, all professional planners must be aware of their professional responsibilities. The code of practice is intended to require a standard of excellence and practice to maintain the privilege of Members being exclusively referred to as a Registered Professional Planner in Ontario.

As ruled by the Ontario Municipal Board (OMB), all relevant policies of the Provincial Policy Statement (PPS), and not just those that favour aggregate extraction, must be considered, something which Nelson Aggregate Co.'s Planning Justification Report failed to take into account in assessing the merits of the proponent's application to extend (expand) the existing Nelson Quarry:

As reported by the Ontario Municipal Board (OMB) in *Kevin Matthews/Robin Latimer v. Gorham (Township)*, (2019),[9]

> The *PPS* mandates that all relevant policies must be considered by the planning authority.[10] The Ontario Municipal Board found in Ontario (Ministry of Natural Resources),…that Part lll of the ***PPS*** **makes it "abundantly clear" that a planning**

[8] https://ontarioplanners.ca/OPPIAssets/Documents/OPPI/OPPI-Standards-of-Practice.pdf.

[9] *Kevin Matthews et al v. Lempiala Sand & Gravel Limited*, File no. PL180754, https://www.cela.ca/sites/cela.ca/files/TLCA%20Case%20Synopsis.pdf.

[10] *PPS*, Part lll, policy 4.4.

> **authority must consider all relevant interests, and that all policies must be considered and weighed when land use decisions are to be made.[11] [para. 30]**
>
> **The phrase "as is realistically possible" in section 2.5.2.1 of the PPS means that a proposal for aggregate must address competing interests:**
>
> > **The "as is realistically possible" approach means addressing competing interests of many stakeholders, one of which is the aggregate industry. With respect, it would be an oversimplification of the policy and an error of interpretation in my estimation to suggest that "as is realistically possible" only includes the physical existence of the aggregate resource.[12] [para. 36]**
>
> **Ontario's *Planning Act,* and the *PPS* and the Official Plan applicable in the unorganized township of Gorham, stress balance and compatibility between land uses. Contrary to that mandatory direction, the LRPB [Lempiala Sand & Gravel Limited] focused solely on the provisions of the planning documents which support aggregate extraction [section 2.5] and did not consider the provisions which support recreational and residential land use, and environmental protection [para. 3]. [emphasis added]**

Section 1.2.6 of the 2020 Provincial Policy Statement (*PPS*)[13] sets out the provincial expectation when planning for major facilities such as a quarry in proximity to sensitive or incompatible land uses:

> ***Major facilities* and *sensitive land uses* shall be planned and developed to avoid, or if avoidance is not possible, minimize any potential *adverse effects* from odour, noise and other contaminants [e.g., flyrock], minimize risk to public health and safety, and to ensure the long-term economic viability of *major facilities* in accordance with provincial guidelines, standards and procedures.** [emphasis added]

With all due respect, the Nelson Aggregate Co. response to my two objection letters (December 1 & 8, 2020) is sorely lacking in substance and offers (unsupported) speculative statements by both the explosives engineer and the planner, and in a classic example of "by-passing" Nelson Aggregate's response fails to specifically address each ***Adverse Effect***, as defined in both the Environmental Protection Act and the Provincial Policy Statement, that the communities surrounding the proposed blasting quarry expansion would have to endure for possibly 100 years or more:

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[11] *Ontario (Ministry of natural Resources), Re,* 2012 CarswellOnt 10693, at para 25 [*Ontario (MNR)*], in TLCA Book of Authorities, Tab 2, applying Part lll of *PPS,* 2005.

[12] *2220243 ONT Inc, Re*, [2015] OMBD No 418, at para 41, in TLCA Book of Authorities, Tab 4.

[13] https://files.ontario.ca/mmah-provincial-policy-statement-2020-accessible-final-en-2020-02-14.pdf.

Adverse effects: as defined in the *Environmental Protection Act*, means one or more of: [underscoring added]

a) impairment of the quality of the natural environment for any use that can be made of it;
b) injury or damage to property or plant or animal life;
c) harm or material discomfort to any person;
d) an adverse effect on the health of any person;
e) impairment of the safety of any person;
f) rendering any property or plant or animal life unfit for human use;
g) loss of enjoyment of normal use of property; and
h) interference with normal conduct of business. [PPS p. 39]

Adverse effects, as defined in the Environmental Protection Act/Provincial Policy Statement, and their impact on the environment and the community, are conspicuously absent from the April 2020 Planning Justification Report prepared by MHBC on behalf on behalf of Nelson Aggregate Co.[14]

Also, the MHBC Planning Justification Report failed to consider and address factors such as those cited in the *Vulcan Materials* case, land use planning issues that are common to every rezoning application.

The North Carolina Court of Appeal in *Vulcan Materials Co. v. Guilford County, Board of Cty Com'Rs*, (1994),[15] upheld the Board's decision to deny Vulcan Materials' application to permit quarrying on a 235-acre parcel, listing some of the factors that must be satisfied in order for a permit to be issued:

(1) "the use as proposed, or the use as proposed subject to such additional conditions as the owner may propose or the Planning Board may impose, is consistent with the purposes of the District and compatible with surrounding uses;"

(2) "the use will not materially endanger the public health or safety if located where proposed and developed according to the plan submitted;"

(3) "the use will not substantially injure the value of adjoining or abutting property,[16] or that the use is a public necessity;" and

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[14] Planning Justification Report, April 2020,https://www.burlington.ca/en/services-for-you/resources/Planning_and_Development/Current_Development_Projects/ward_3/Nelson-Quarry-Extension/12.-Planning-Justification-Report.pdf.

[15] *Vulcan Materials Co. v Guilford County. Board. Of Cty. Com'Rs,* 444 S.E.2d 639 (1994) 115 N.C. App. 319, https://scholar.google.ca/scholar_case?case=7278696103547714002&q=%E2%80%9Cquarry%E2%80%9D+and+%E2%80%9Cconcussion%E2%80%9D&hl=en&scisbd=2&as_sdt=2006.

[16] "**One area resident testified that when she put her home, which is located directly across from the [proposed quarry] site, up for sale and disclosed that a quarry was proposed for the site, no one even looked at the house**." [emphasis added]

> (4) "the location and character of the use, if developed according to the plan submitted, will be in harmony with the area in which [it] is to be located and in general conformity with the plan of development of the Jurisdiction and its environs." Guilford County Development Ordinance § 3-13.4 (1992).
>
> **Because all four of these findings are required for the issuance of the special use permit, if there is not competent, material, and substantial evidence to support any one of these findings, we must affirm the Board's denial of the special use permit**. *Ghidorzi Constr., Inc. v. Town of Chapel Hill,* 80 N.C.App. 438, 441, 342 S.E.2d 545, 547, *disc. rev. denied,* 317 N.C. 703, 347 S.E.2d 41 (1986).

All *adverse effects*, which are essentially torts of nuisance and trespass, are to remain within the boundaries of the existing quarry operation and proposed extension (expansion) under the ownership of Nelson Aggregate Co, and the numbered companies under its control.

Why do the Aggregate Industry and their explosives engineers and planners conceal flyrock from the public? Because,

- flyrock is the ultimate *adverse effect*
- flyrock is uncontrollable and can never be eliminated
- flyrock has the potential to injure or kill humans, pets, livestock and wildlife
- flyrock has the potential to damage tree stands and other crops
- flyrock has the potential to damage personal and real property
- concealing the dangers of flyrock from the public serves the financial interests of the Aggregate Industry

The designated onsite *blast zone* or *blast area* must be confined within the boundary of a quarry operation, and all of the adverse effects associated with blasting must remain on site:

> “designated blast area” includes the danger area, which is the zone in which there exists a possibility of hazard to a person or property from flyrock, fume, air blast or ground vibrations, and is the area where the blaster has made arrangements to evacuate all persons whose safety might be threatened by the blasting operation. (Province of Newfoundland and Labrador, Department of Natural Resources, https://www.gov.nl.ca/iet/files/Quarry-Permit-Standard-Terms-Conditions.pdf)

- The onsite blast zone must be large enough to cover all of the potential deleterious adverse effects associated with quarry blasting.

- The onsite blast zone must not extend beyond the property boundaries of the quarry onto neighbouring public and privately owned third-party property.

Similarly, approval of Copcan Contracting Ltd.'s[17] aggregate permit required the applicant to confine the anticipated *adverse effects* of blasting quarry operations onsite:

> **All blasts shall be designed such that the blast hazard zone lies entirely within the quarry property**, and that peak particle velocities and noise levels do not exceed 19 mm/sec, as measured at a position along the mine property boundary, directly in line between the active pit and the nearest adjacent residence. [emphasis added]
>
> **Noise from quarry operations shall not exceed 3 minute Leq of 55 dBA as measured along the quarry side** of Jameson Road. [emphasis added]

According to T.M. International, LLC, the use of explosives to blast rock has many hazards, one of which is flyrock:[18]

> There are many hazards inherent in the use of explosives, not the least of which is flyrock. In fact, flyrock may be the greatest threat related to working with explosives, and it's something that those involved in the blasting situation may not realize. They may be primarily concerned about staying out of the blast radius [blast zone] and thereby avoiding being damaged by concussive force or ground vibrations, not realizing that flyrock may create a much greater danger.
>
> Flyrock is created when the force of an explosion projects rock fragments in varying directions that exceed the desired or expected distances from the blast face. Since the trajectory, size and speed of flyrock are difficult or impossible to anticipate, flyrock can create a tremendous danger for workers on…site.
>
> Flyrock is an integral part of blasting. However, uncontrolled or unexpected flyrock that is projected past a defined safety [blast] zone is not acceptable:
>
> **It is well known that rock and/or debris can be thrown over a kilometer [1,000 metres] from the blast site, and in a recent case rocks travelled approximately 1.3 kilometres [1,300 metres]** (Explosives information bulletin no. 69 I 27 February 2009 I Version 1)[19] [emphasis added]
>
> …[I]njuries due to flyrock and lack of blast area security accounted for 61% of all blasting injuries in surface US coal, metal, and non-metal mines during the period 1978-2003.

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[17] *Anning v. British Columbia (Minister of Energy and Mines)*, 2002 BCSC 896 (CanLII), <https://canlii.ca/t/5jrd>, retrieved on 2021-12-09.

[18] https://www.tmi2001.com/blog/preventing-controlling-flyrock/.

[19] https://www.rshq.qld.gov.au/safety-notices/explosives/flyrock-incidents2.

Adding the injuries due to premature blast and misfires, it exceeds 82% for the same period [Bajpayee, Verakis & Lobb] [p. 1][20]

"**For the past two decades, most explosives-related injuries and fatalities in surface mines occurred when workers were struck by rock, either because they were too close to the blast or rock was thrown much farther than expected**." (Verakis & Lobb, 2003) [p. 8] [emphasis added]

- The proponent-driven MHBC Planning Justification Report ignores the "legal" rights of adjacent and abutting third-party property owners, and is devoid of any (independent) third-party proximity studies that measure the deleterious impacts experienced by residents residing in communities surrounding existing blasting quarry operations.

- The MHBC Planning Justification Report fails to mention that Nelson Aggregate Co. has no legal right to conduct any testing (e.g. wells, noise, structures, etc.) or to place any testing equipment on private third-party property, as these actions constitute trespass.

- Residents in proximity to the proposed Nelson Quarry expansion are entitled to the uninterrupted *use* and *enjoyment* of their properties, and are under no legal obligation to provide Nelson Aggregate with the "free" use of their properties. These adjacent third-party property owners are entitled to the same quality and standard of life as every other citizen of the City of Burlington.

- Neighbouring wells that run dry due to Nelson Aggregate Co.'s quarry blasting operations would require on-site giant plastic tanks like the one pictured for reservoirs to be filled on a regular basis. Besides the inconvenient eyesore of the plastic tank, which <u>does not</u> provide potable water, homeowners would have to purchase bottled drinking water, and endure construction activity when a new well is being

[20] Dozolme, Ph. and Bernard, T. " Ultimate Technological Combination in Electronic Blasting, A Conclusive Contribution to Blasters' Health & Safety, *BME Delta Caps*, © 2006 International Society of Explosives Engineers, https://miningandblasting.files.wordpress.com/2009/09/ultimate-technological-combination-in-electronic-blasting.pdf.

> installed. This is what a resident had to endure at the Acton Quarry. There is also no guarantee that Nelson Aggregate Co. would accept financial responsibility for the damage, which means that a costly and time-consuming lawsuit against Nelson Aggregate Co. is the only remedy available to a victimized property homeowner.

A property without a stable source of potable water is not mortgageable, insurable, nor saleable without a deep discount, and, depending on the number of wells that have gone dry from the blasting quarry operation, the community may become stigmatized. The effected homeowners are effectively stripped of the hard-earned equity in their homes, which many people rely on to support themselves during their retirement years.

According to *PME,*[21] water quality has a significant impact on real estate prices.

> Numerous studies have shown that water quality has a direct impact on real estate prices. One study by the Florida Realtors Association found that a single county saw an accumulative property value increase of around $541 million due to improved water quality in the region. Furthermore, these studies find that one of the key factors in determining water quality and real estate valuation is water clarity. As water clarity decreases, the desire to use the water decreases, which reduces the desirability and value of the surrounding real estate. While there are many reasons why water clarity can change, it is often the result of an algal bloom, due to over-accumulation of nutrients in the water. This process, which is scientifically known as eutrophication, can lead to great economic losses for people and cities alike.
>
> The health of local waterbodies is extremely important for the overall economy of any given state. According to the Maine Department for Environmental Protection (Maine DEP), almost 60% of municipal revenues in the state of Maine are generated from taxes on property. In the city of Belgrade, for example, 60% of property taxes come from lakefront homes and studies suggest that if water clarity were to decline by one meter of visibility, the city would lose $10.5 million (or 5%) in property value. These values do not take into consideration the recreational values of clean water. According to Maine's DEP, residents spend a grand total of more than $153 million every year on recreational activities and 59% of that is spent in neighborhoods that are near lakes or other waterbodies. This supports an economic turnaround of jobs for as many as 3,000 people, generating a revenue of $30 million in income for the state's residents.

[21] Evan Harris, https://www.pme.com/uncategorized/water-quality-property-value.

As ruled in *Rockford Blacktop Construction Company v. County of Boone*, (1994),[22] the diminution in property values is a proper factor to consider when assessing land use compatibility of an application for a blasting quarry permit, citing *Lambrecht v. County of Will* (1991), 217 Ill.App.3d 591, 594, 160 Ill.Dec. 464, 577 N.E.2d 789. [emphasis added]

> ...[T]he diminution of property values within a neighborhood is a proper factor for the trial court to consider. (See La Grange State Bank, 75 Ill.2d at 309, 26 Ill.Dec. at 676, 388 N.E.2d at 391; Amalgamated Trust & Savings Bank v. County of Cook (1980), 82 Ill.App.3d 370, 382, 37 Ill.Dec. 717, 725, 402 N.E.2d 719, 727 ("[t]he rights of adjacent and abutting property owners are to be considered").) Moreover, regardless of the merits of the distinction drawn by Gorte between people who build their homes near existing quarries and those who buy their homes and "then have a quarry put in [their] back yard", there is nothing in the record to suggest that the trial court based its decision on, or was even influenced by, a similar concern. (Lambrecht v. County of Will)
>
> Given the evidence of the incompatibility of a quarry operation with surrounding land uses, the potential effect on the groundwater supply, the effects of blasting on nearby property, we agree with the trial court that plaintiffs have not proved by clear and convincing evidence that denial of the special use permit was arbitrary, unreasonable, and without a substantial relationship to the public health, safety, or general welfare. Cf. Meyer Material Co. v. County of Will (1977), 51 Ill.App.3d 821, 9 Ill.Dec. 638, 366 N.E.2d 1149.

QUARRY APPLICATION DENIED FOR ITS POTENTIAL ADVERSE EFFECTS ON THE HEALTH, SAFETY AND WELFARE OF THOSE WHO LIVE, WORK AND PLAY IN THE COMMUNITY (LAY WITNESS TESTIMONY PREVAILS)

In *Kramer Mining & Materials, Inc. v. Polk County Land Information Committee*, (2013),[23]the Wisconsin Court of Appeals upheld the County's decision to deny the quarry operator's application to permit a quarry in an area zoned for agriculture. The five reasons for rejecting the quarry application, which the appeal court found to be supported by sufficient evidence, accepting "lay" testimony over that of the proponent's experts, are:

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[22] *Rockford Blacktop Construction Company v. County of Boone*, 635 N.E.2d 1077, 263 Ill. App.3d 274, 200 Ill.Dec. 738, https://scholar.google.ca/scholar_case?case=28909198889248858 2&q=quarry+blasting+lambrecht&hl=en&as_sdt=2006.

[23] https://scholar.google.ca/scholar_case?case=15339741773914762388&q=%E2%80%9Cquarry%E2%80%9D+and+%E2%80%9Cproperty+value%E2%80%9D&hl=en&as_sdt=2006

- First, it credited evidence that there would be "increased traffic in the area disrupting the flow of emergency services."
- Second, it concluded the quarry would cause noise issues attributable to blasting, operation of the crusher and other heavy equipment, and increased traffic.
- Third, the Committee expressed skepticism that proposed noise reduction efforts would sufficiently reduce harmful effects of cumulative noise.
- Fourth, it credited the report and testimony of Dr. Daryoush Allaei, an expert in noise vibration and shock controls, concluding that vibrations could cause structural damage within the area.
- Finally, the Committee concluded that water quality could be negatively impacted for residents.

It was the Committee's conclusion that "operating the proposed [q]uarry at the proposed site would have a negative impact on the health, safety and welfare of those who live, work and play in Polk County." [emphasis added]

The appeal court found no merit in the proponent's argument that the refusal to issue a quarry permit, based essentially on the lay testimony of 24 witnesses, should be dismissed for not being founded on personal experience or academic or technical training.

10…Kraemer discounts entirely lay testimony presented at the public hearings. Kraemer complains that these lay witnesses (twenty-four, by Kraemer's count) "offered no personal experience or academic or technical training to support their `beliefs' [about the deleterious effects of the quarry]." It further argues their testimony does not comply with case law construing WIS. STAT. § 907.01, which establishes certain criteria for the admission of non-expert opinions or inferences.

11. However, **Kraemer cites no legal authority whatsoever that would have required the Committee to conduct its hearing in accordance with the rules of evidence**. Indeed, Kraemer concedes that was not mandatory. This is a proper concession. Wisconsin courts have repeatedly observed that the rules of evidence do not apply in these types of informal proceedings. See State ex rel. Ortega v. McCaughtry, 221 Wis. 2d 376, 389 n.4, 585 N.W.2d 640 (Ct. App. 1998) (prison adjustment committee not bound by rules of evidence); State ex rel. Kaczkowski v. Board of Fire & Police Comm'rs of City of Milwaukee, 33 Wis. 2d 488, 504a, 148 N.W.2d 44 (1967) (record of board inquiry revealed that rules of evidence were "scrupulously observed, a standard not required in most board hearings"). [emphasis added]

FLYROCK IS A COMMON OCCURRENCE OF BLASTING QUARRY OPERATIONS

The following statements contained in the April 20, 2020 Blast Impact Analysis Report prepared by Explotech[24] is not entirely accurate, and, to assert that "flyrock" is a "rare" event is **not** supported by the independent research that I have conducted. An onsite exclusion zone (setback) to protect quarry employees from injury or death and equipment from damage or destruction from flyrock, an inevitable by-product of quarry blasting, is essential, but the Blast Impact Analysis makes no provision or recommendation for a permanent onsite setback.

> **FLYROCK**
>
> Flyrock is the term used to define rocks which are propelled from the blast area by the force of the explosion. This action is a predictable and necessary component of a blast and requires that every blast have an exclusion zone established within which no persons or property which may be harmed are permitted.
>
> Government regulations strictly prohibit the ejection of flyrock off of a quarry property. The regulations regarding flyrock are enforced by the Ministries of Natural Resources and Forestry, Environment, Conservation and Parks and Labour. In the event of an incident where flyrock does leave a site, the punitive measures include suspension / revocation of licences and fines to both the blaster and quarry owner / operator. Fortunately, flyrock incidents are extremely rare due to the possible serious consequences of such an event. It is in the best interest of all, stakeholders and non-stakeholders, to ensure that dangerous flyrock does not occur. Through proper blast planning and design, it is possible to control and mitigate the possibility for flyrock [Explotech, Blast Impact Analysis, April 2020, p. 21].

The depraved indifference shown by Ontario explosives engineers in the preparation of proponent-driven Blast Impact Assessments (BIAs) to the significant dangers of *flyrock* is exemplified in the testimony of the explosives engineer at a 2020 LPAT hearing involving an application for a quarry in the Township of Tyendinaga:[25]

> Mr. Cyr attempts to explain away the absence of any meaningful analysis of flyrock in the BIA on the grounds that this falls outside the scope of an BIA that is aimed primarily at the MECP's Noise Guidelines. He further suggests that the issue of flyrock is best left to provincial ministries which have the authority to "aggressively prosecute" flyrock incidents after-the-fact [p. 13]. [underscoring added]

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[24] Blast Impact Analysis, Nelson Aggregate – Burlington Quarry Extension, Explotech, April 23, 2020, https://www.burlington.ca/en/services-for-you/resources/Planning_and_Development/Current_Development_Projects/ward_3/Nelson-Quarry-Extension/revised-documents-November-3-2020/Blast-Impact-Analysis-revised-April-23-2020.pdf.

[25] *Bates v Ontario (Natural Resources & Forestry)*, 2020 CanLII 1409 (ON LPAT), <https://canlii.ca/t/j4jw8>, retrieved on 2021-03-17

The Aggregate Resources Act, R.S.O. 1990, c. A.8, as amended,[26] defines "quarry" as follows:

> "quarry" means land or land under water from which consolidated aggregate is being or has been excavated, and that has not been rehabilitated, but does not mean land or land under water excavated for a building or structure on the excavation site or in relation to which an order has been made under subsection (3).

Until the proclamation of Regulation 466/20 of the Aggregate Resources Act in September 2020,[27] the only statute in Ontario to specifically prohibit the discharge of *flyrock* into the environment was section 14 of the Environmental Protection Act (EPA), which came about as a consequence of the 2013 Supreme Court of Canada ruling in *Castonguay*[28] that flyrock is a contaminant and that "***the flyrock could easily have seriously injured or killed someone [para. 39]***."

Canadian Environmental Law Association (CELA) was granted Intervener status in the *Castonguay* case, and in its Factum[29] CELA provided the following legal analysis of *flyrock* in the context of section 14 of the EPA, concluding that several of the applicable ***adverse effects*** are derived from common law tort liability theories;

> Fly rock, being a "solid…resulting directly or indirectly from human activities" can be a "contaminant", can be discharged" by "addition" or "deposit", can interfere with "air" or "land", and have an "adverse effect", such as "damage to property", or "impairment of the safety of any person". On the facts of this case, the Appellant's blasting activity and resulting fly rock debris damage met each of the definitions in section 1(1) and had serval adverse effects to which the EPA is applicable is derived from common law tort liability theories [para. 18].

The Environmental Protection Act (EPA), R.S.O. 1990, c. E. 19, as amended,[30] defines "natural environment as follows:

> "natural environment' means the air, land and water, or any combination or part thereof, of the Province of Ontario.

Despite being the ultimate *adverse effect* of quarry blasting operations, and despite the 2013 Supreme Court of Canada ruling in *Castonguay*, and even though *flyrock* is a greater hazard than "ground vibrations" or "airblast," the

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[26] https://www.ontario.ca/laws/statute/90a08#BK0.
[27] http://www.ecolog.com/daily_images/1004618147-1004619030.pdf.
[28] *Castonguay Blasting Ltd. v. Ontario (Environment)*, 2013 SCC 52, [2013] 3 S.C.R. 323, https://scc-csc.lexum.com/scc-csc/scc-csc/en/item/13289/index.do.
[29] https://cela.ca/wp-content/uploads/2019/07/C53611_FOI.pdf.
[30] https://www.ontario.ca/laws/statute/90e19#BK24.

Ministry of Natural Resources and Forestry (MNRF), the Ontario aggregate industry and the explosives engineers retained on their behalf have not implemented any precautionary safety measures to protect the public from the potential dangers of *flyrock*.

A literature review relevant to *flyrock* conducted by van der Walt and Spiteri (2020)[31] uncovered an initial study by Lundborg et al (1975), followed by 16 studies from 2010 starting with Monjezi et al. (2010) and ending with Dehghani and Shafaghi (2017) and Hasanipanah et al (2017). Six of those studies had "no discussion of testing methodology," and the studies implied one of the three following principles:

- *Flyrock* research based on Artificial Intelligence (AI) principles (53%)
- *Flyrock* research based on rock engineering principles (18%)
- *Flyrock* research based on empirical and statistical analysis (29%)

Van der Walt and Spiteri concluded that the effect of blast parameters on *flyrock* is still not fully known or understood, and that the findings, in part, are counterintuitive.

> Based on figure 9, the powder factor and stemming length seem to be the key parameters relating to flyrock, which is what one would expect. However, the burden is not highlighted as a critical parameter, which is contradictory to the face burst mechanism of flyrock. The summary of the fundamental causative parameters and the disregarding of the importance of burden also support the argument that the effect of blast parameters on flyrock is not fully known or understood [p. 712].
>
> Since the actual impact of blast design parameters on the risk of flyrock is debatable, based on the variable assumptions made in these publications, it can be concluded that flyrock is still not well understood. The biggest gap in knowledge seem to be the uncertainties concerning which blast and environmental parameter contribute to flyrock, and to what degree [p. 714].

Flyrock is a common occurrence, and not a "rare" event, as stated in the proponent-driven Blast Impact Analysis prepared by Explotech on behalf of Nelson Aggregate Co.

- According to the 2014 issue of the *Journal of Rock Mechanics and Geotechnical Engineering*, *flyrock* is an inevitable consequence of blasting rock, and can never be entirely eliminated:

[31] van der Walt, J. and Spiteri, W. 2020 "A critical analysis of recent research into the prediction of flyrock and related issues resulting from surface blasting activities," *Journal of the Southern African Institute of Mining and Metallurgy*, vol. 120, no. 12, pp. 701-714. https://www.saimm.co.za/Journal/v120n12p701.pdf.

> Due to the explosive force, rock fragments are propelled and thrust high into the air and beyond the safety limit of blast area, thus termed as "flyrock". This is mainly due to the flaws presented in the blast design and also due to the misinterpretation of rock mass behavior. The phenomena of flyrock are always uncontrolled and can never be brought down to zero [p. 26].[32]

- Reports of *flyrock* are a common occurrence, according to the District Manager of Mining Safety and Health, Warrendale, Pa.,[33] and under-reporting is responsible for five to ten times the actual number of *flyrock* incidents (Davies 1995).

- During 2019, the Tennessee State Fire Marshal's Office received 302 blasting complaints, of which 14 were for *flyrock*, accounting for 5% of the blasting complaints. [34]

- According to *Raina et al* (2013), one of the major reasons *flyrock* incidents go unreported is to avoid legal responsibility.

- Mining and quarrying are high-risk activities. Misfires and *flyrock* are common hazards associated with shot firing [blasting] activities, which are routinely undertaken in these industries. (WorkSafe Victoria safety alert published September 7, 2020)[35]

- Blasting is not a singular event, and the environment and other sensitive receptors (e.g., inhabited structures, houses, travelled highways) would be subjected to potential damage, injury or death from *flyrock* during the entire life of a quarry every time blasting occurs.

- Personally, I have documented approximately 180 "known" *flyrock* incidents.

- Canada does not track the number of *flyrock* incidents that have led to death or injury caused by blasting at surface mining operations. However, according to the National Institute for Occupational Safety and Health (NIOSH), *flyrock* at surface mining operations in the United

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[32] https://intval.com/articles/Flyrock-and-Other-Impacts-from-Quarry-Blasting-Operations.pdf.

[33] Petrie, District Manager of Mining Safety and Health and Health Administration, Warrendale, Pa,

[34] 2019 Annual Report on Blasting Fines in Tennessee, https://www.tn.gov/content/dam/tn/commerce/documents/fire_prevention/posts/2019-BLASTING-COMMISSIONERS-REPORT.pdf.

[35] https://www.aggregateresearch.com/news/state-investigates-quarry-blast/.

States has killed or injured 311 people from 1978 to 2004.[36] NIOSH defines flyrock as,

> "**any debris that lands outside the designated blasting area. It can vary in mass from marble-sized to car-sized and can be incredibly dangerous and potentially fatal**." [emphasis added]

The under-reporting of *flyrock* incidents was discussed by participants during an interactive forum at the 2011 annual general meeting of the Western Canada Chapter of the International Society of Explosives Engineers in Vernon, BC: [37]

> Flyrock incidents in Ontario are probably just not being recorded. The fine is for flyrock leaving a property onto another property. Often that is not seen and the evidence would be swept off the street. I would strongly suspect that several flyrock incidents in Ontario are not recorded…. (A. Grogan, pers. comm., October 16th 2011).

At the July 15, 2020 meeting of the Earth Removal Advisory Committee (ERAC) of The Town of Swampscott,[38] the topic of non-reporting of *flyrock* incidents at a local quarry was referenced as a consequence of a detail officer's truck being struck by *flyrock* while inside.

> Item #6 had a discussion of what was meant on parking requirements, the members questioned what it was referring to from the lawyers KP. James mentioned a situation where a detail officer was parked inside for a blast and fly rock damaged his truck. He states that fly rock that doesn't leave the quarry isn't reportable. [underscoring added]

According to Little (2007), [39]

- Only extreme flyrock events are recorded, due to either being noticed by the public or resulting from damage [p. 36].
- Factors of safety of 2.0 for equipment and 4.0 for personnel and non-personnel are applied to the calculated throw distance of flyrock at proposed blasting quarries [p. 39].

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[36] Josh Cabel, "*NIOSH Offers Tips for Flyrock Safety*," EHSToday, January 25, 2007, https://www.ehstoday.com/construction/article/21911356/niosh-offers-tips-for-flyrock-safety.

[37] Loeb, Jeffrey Thomas, "Regulatory mitigation of the adverse environmental effects of urban blasting," Thesis, 2012, University of British Columbia. https://open.library.ubc.ca/cIRcle/collections/ubctheses/24/items/1.0050876#downloadfiles.

[38] https://www.swampscottma.gov/sites/g/files/vyhlif1296/f/minutes/erac_minutes_7-15-20.pdf.

[39] T.N. Little, "Flyrock Risk," EXPLO Conference, Wollongong, NSW, 3-4 September 2007.

According to a former resident of Floral Park, *flyrock* was a common occurrence at the Fowler Quarry in the Township of Ramara, and was the reason that he sold his house and relocated his family:[40]

> …[A] former resident of Floral Park presented a brick to Council to compare the weight of the rock that flew onto their property in the past. The family became used to the blasts from the quarry and had resided on the property since 1992. The reason the family left Floral Park was because of the situation with the flying rock that landed on their lawn. There was always issues with flying rock and Fowler had to clear Rama Road after most blasts due to rocks on the road. This is a residential area and most residents now reside in the area year round [p. 17].

A failure to report or under-report *flyrock* incidents is a major safety concern of the European Federation of Explosives Engineers (EFEE), as expressed in its December 2016 letter.[41]

> The work of the EFEE's Environment Committee has shown in the last few months that it is still very difficult to obtain feedback about [flyrock] incidents or accidents occurring during blasting operations.
>
> Although everyone agrees that this feedback is fundamental for preventing probable future incidents and therefore for risk management, the incidents and their causes are still badly indexed. However, civil society, elected officials and especially residents, increasingly demand that these [flyrock] incidents be accounted for by public authorities, companies, and sometimes request information via the press or television.

According to Eloranta,[42] past president of the International Society of Explosives Engineers (ISEE) and responsible for revising the ISEE Handbook chapter on open pit and quarry operations, *flyrock* from any blast is "unacceptable," and

> Speaking generally…flyrock doesn't automatically suggest an excessive amount of explosives had been used. "Explosives doesn't equal flyrock."
>
> A fault in the rock, if unknown to the explosives engineer, can provide a path for that explosive energy that can mess up an otherwise well-designed blast,
>
> The same amount of energy in there can just launch those materials [flyrock].
>
> It's not accurate to suggest that the presence of faults and seams in a section of rock is unknowable…Enough geologic testing could identify those problem areas. But there's an economic issue with that solution. The cost of the testing would exceed the value of the product.

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[40] https://ramara.civicweb.net/document/19997#page12.

[41] EFEE Newsletter, December 2016, https://efee.eu/wp-content/uploads/2016/12/2016-12-EFEE-Newsletter-3.pdf.

[42] https://www.mankatofreepress.com/news/local_news/expert-flyrock-from-any-blast-unacceptable/article_8ad31cf8-b5cf-11e7-bf58-c3cdd328cf7f.html.

> **Anyone involved in blasting is obligated to place safety above all other considerations…Even if blasts that launch life-threatening rocks into populated areas are rare, even if no one is injured, accepting that as inevitable is unethical**. [emphasis added]

According to Lundborg, people should never be exposed to flyrock. Similarly, national laws in Chile relating to workplace safety require that workers never be exposed to flyrock. This requires that the probability of flyrock be zero for personnel (and non-personnel) located outside the Personnel Clearance Distance (blast area) for all blasts.[43] Likewise, Kentucky's Energy and Environment, Department for Natural Resources, has expressed a zero tolerance for flyrock incidents:[44]

> The Department for Natural Resources believes that one flyrock event is too many, and to that end, has prepared this RAM [Reclamation Advisory Memorandum] to further define steps this Department will require of the coal industry in eliminating flyrock events.
>
> 'Flyrock' is defined as 'blasted material cast into the air, or traveling along the ground, that is cast from the blasting site more than half the distance to the nearest dwelling, public building, school, church, commercial, community or institutional building; or any occupied structure; or that is cast beyond the permit boundary.'
>
> Flyrock events historically have not been limited to blasting operations within the distances which require the submission and approval of an 'anticipated blast design'…prior to blasting. Rather, flyrock events occurred and impacted dwellings, vehicles, persons, animal life, and other physical structures thousands of feet from the blast site resulting in death and the destruction of property.

- The uncontrollable nature and frequency of *flyrock* is discussed in *Lee Lime Corp. v. Massachusetts Turnpike Authority*, (1958):[61]

> There was evidence that two to four primary blasts occur annually to loosen limestone from the face of the quarry and that fragments displaced amount to 40,000 tons; these primary blastings result in the dislodging of pieces of stone of various sizes "from dust to rocks half the height of the court room and almost as square." These fragments are then reduced in size by secondary blasting so as to permit them to pass through the crusher. These secondary blasts are an indispensable part of the quarry operations and a quarry could not be conducted nor could a lime plant be conducted without them. **These secondary blasts number 15,000 to 20,000 a year and five per cent will throw stones for a distance of about 800 to 850 feet [244 to 259 metres] and are likely to reach**

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[43] *"Flyrock – A Basis For Determining Personnel Clearance Distance And Quantifying Risk of Damage to Equipment,"* scribd.com.

[44] "Reclamation Advisory Memorandum," https://eec.ky.gov/Natural-Resources/Mining/Mine-Permits/RAMS/RAM140.pdf. "During calendar year 2007, the Commonwealth of Kentucky had a [known] total of thirteen (13) flyrock events on surface coal mining sites, include one (1) that resulted in a fatality. To date [July 18] there have been nine (9) [known] flyrock events, including one (1) that resulted in a minor injury that very easily could have resulted in a fatality."

> **the new highway. There was also evidence that "the fly rock" is uncontrollable and results in making unavailable a large area of the petitioner's land by its inability to conduct blasting operations within 800 feet [244 metres] of the new turnpike [p. 435].** [emphasis added]

- In *M & N Materials, Inc. v. Town of Gurley, Alabama, et al.*, (2015),[45] in connection with a proposed blasting quarry operation, Jim Ludwiczak, a geologist and explosives expert, testified that "within a reasonable degree of blasting and geologic certainty" flyrock is *likely to occur* and will be *difficult to control*." Ludwiczak also stated that he had "seen flyrock occur in hundreds of other cases where conditions were similar to those encountered on Gurley Mountain."

> **I have seen flyrock occur in hundreds of other cases where conditions were similar to those encountered on Gurley Mountain. Some of these flyrock occurrences had some of the best blast designs I have ever seen, but flyrock still occurred. In some of [those] cases, flyrock traveled as far as 3,000 feet [914 metres], and frequently traveled 2,000 feet [610 metres].**

- In *Attorney-General. v. P.Y.A. Quarries Ltd.* [1958] EWCA, Civ 1[46] on April 25, 1956, Justice Oliver granted an injunction restraining the defendants from carrying on the business of quarrying in such a manner as to cause stones or splinters (i.e., *flyrock* debris) to be projected off-site or to occasion a nuisance to Her Majesty's subjects (citizens) by fugitive dust or ground vibrations. The injunction against *flyrock* is held to strict liability under the rule in Rylands v. Fletcher. "So far as the flying stones were concerned,…[the Justice] said that there was really no defense at all; that the case was 'absolutely proved at the time the Writ was issued." Only the injunction regarding fugitive dust and ground vibrations was appealed, which was denied by the appellate court.

> On a number of occasions damage by flying stones has been done to houses in the vicinity of the quarry and recently a pane of a kitchen window was blown in by blast, littering a breakfast table with jagged pieces of glass, the wife in the home narrowly escaping injury. We sincerely believe that your authority cannot fail to realise the seriousness of the position and the earnestness of our protest against…2. The flying pieces of rock on occasions following blasting operations landing some distance from the quarry constitute a very serious menace to life inside and outside the home and to users of the public highway.

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[45] *M & N Materials, Inc., v. Town of Gurley, Alabama*, 2015, United States District Court. https://lanierford.com/images/NewsPDFs/federal-court-decision-gurley-alabama-quarry-case.pdf

[46] *Attorney-General v. P.Y.A. Quarries* [1958], EWCA, Civ 1, https://www.bailii.org/ew/cases/EWCA/Civ/1958/1.html.

The complaints against *P.Y.A. Quarries* blasting quarry operation were from 30 local residents living within 35 yards (27 metres) to 360 yards (329 metres) of the quarry.

> **Policy considerations support…imposition of strict liability for blasting even though no physical invasion of the premises has taken place. Neither an industry nor the State should be allowed to use its property in an abnormally dangerous way that injures the property of its neighbors with impunity, because to do so is effectively an appropriation of the neighbor's property for the industry or State's use. The blaster, and not the wholly innocent party, should assume the costs of its blasting**. See Atlas Chem. Indus., 514 S.W.2d at 316 (characterizing the damage inflicted on other people's property as inverse condemnation); Branch, 657 P.2d at 275. [emphasis added]

- In *Rivers Dev. Conditional Use Appeal*, 2007,[47] Rivers' application for a 93-acre quarry and crushed rock processing facility in the Town of Moretown, Vermont, was denied, in part, because Rivers' blasting expert could not guarantee that flyrock would not leave the boundaries of the proposed quarry site, potentially launching flyrock as far as 1,500 feet (457 metres) and suggesting that the neighbours take cover in their homes after being warned before each scheduled blast at the quarry.

> Rivers' [blasting] expert could not assure that no blast at the Rivers quarry would result in rock being thrown beyond the Rivers boundary limits. He speculated that rock could be thrown, unintentionally, as far as 1,500 feet [457 metres] from the quarry floor. Because some homes are located within this distance, he recommended that area residents be notified prior to a blast and that they stay in their homes during a blast [p. 45]..

At the environmental hearing, Rivers' blasting expert Tim Rath, when asked specifically about the danger from flyrock, said that,

> **"You can never say never." No matter how careful a blaster is there is no certainty a blast will not cause flyrock. There are over 20 homes within 3,000 feet [914 metres] of the proposed quarry with the closest property lines just over 200 feet [61 metres] away.**[48] [emphasis added]

VIOLATIONS OF IMPROPER STORAGE AND HANDLING OF EXPLOSIVES

In 2014, the Ministry of Labour (MOL) and Workplace Safety North held an internal joint Webinar[49] in response to the alarming number of contraventions of the explosives storage and handling requirements, and explained why the MOL was "doing an explosives blitz."

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[47] 68-3-07 Vtec (justia.com).
[48] http://www.killthealbionquarry.org/DEATH-FROM-THE-SKY-FLYROCK.html.
[49] https://www.workplacesafetynorth.ca/sites/default/files/uploads/MOL-Blitz-Explosives-2014_0.pdf.

- Between April 1, 2011 and March 31, 2014, the Ministry of Labour issued 256 orders related to contraventions of the explosives storage and handling requirements set out in Regulation 854 (Mines and Mining Plants) under the Occupational Health and Safety Act (OHSA).
- The potential for serious or fatal injury, as well as significant property damage, is always present where explosives are used.
- Are written procedures established for blasting which include: flyrock, misfires, secondary blasting, wind direction [and a number of other issues Slide 31].

QUARRY BLAST INITIALLY MISTAKEN FOR EARTHQUAKE

A blast at the Miller Paving quarry in North Bay on May 16, 2018 was of such a magnitude that Natural Resources Canada mistook the quarry blast for an earthquake, with the impact of the blast felt as far away as South River, a distance of 37 miles (60 kilometres).

It seems the experts were baffled by that earthquake/dynamite blast today, but a seismologist with Natural Resources Canada thinks he has the answer. Stephan Halchuk told CKAT this afternoon that the shallow shake was confusing.

"Our instruments recorded shaking this morning in the very near vicinity of North Bay at 9:05 this morning. What our instruments record is the vibrations as they travel through the Earth's surface. Normally we're able to determine the difference between an earthquake, which typically occurs 10 to 20 kilometres below the surface of the earth, and blasts from construction quarries that happen at the surface." But Halchuk says today's event was very shallow.

"So it's hard for us to determine if it's a shallow earthquake or some surface man-made activity. We initially reported this as an earthquake because we can't tell where all the blasts are across the country. There are literally hundreds of blasting sites every day. But since talking with reporters and the local fire chief we've confirmed that there was blasting going on at the exact time, 9:05 this morning by a local company [Miller Paving]."

"This morning a blast shook all parts of the City and was felt as far as Astorville," said Fire Chief Jason Whiteley. "City Departments and the customer service centre were inundated with inquiries. Fire crews confirmed that Miller Paving at their Birch's Road quarry executed a controlled blast to produce aggregate for their upcoming highway project. City of North Bay Departments were unaware that the blasting was to take place today, therefore we could not make the public aware." BayToday phones were flooded with calls from people wondering what had happened. Many thought it was a gas explosion, others a plane or train crash. [update BayToday]

Shortly after 9 am the North Bay Police Service received several calls from concerned citizens regarding possible blasting in the area. Some of the complainants were from different areas both inside and outside the city as far away as South River. Residents reported that their entire house shook, their floors had swayed for a few seconds and their windows rattled and

> **blinds were banging against the windows. Another resident said he will be looking for cracks in his drywall because the intensity was so intense.**[50]

BLASTING SUPERVISOR FIRED RATHER THAN PUT PEOPLE AND PROPERTY AT RISK

"On April 15, 2003, in an article headlined 'Miner who resigned settles suit' which appeared in the Lexington Herald Leader, Roger Alford of the Associated Press reported":

> An Eastern Kentucky coal miner who resigned rather than detonate blasts that could have bombarded homes with rocks will receive $142,500 from his former employer.
>
> Oat Marshall, who is being heralded as a hero by some coalfield residents, claimed in a lawsuit that he refused to buckle under pressure to violate state blasting requirements…
>
> [Marshall] had said he feared setting off the blasts might have injured people or damaged property in the Letcher County community of Deane…
>
> Marshall, a blasting supervisor, resigned in August 2001 and filed a lawsuit in November 2001 against El Dorado Chemical Co. and Consol of Kentucky, claiming that by pressuring him to violate state requirements the companies had essentially forced him from his job. El Dorado was a blasting contractor for Consol.
>
> The lawsuit was scheduled for trial today [April 15, 2003] in U.S. District Court in Pikeville.
>
> "My client walked away from a good-paying job based on the fact that they had asked him to do something illegal," said Prestonsburg lawyer Ned Pillersdorf [p.9].[51]
>
> Pillersdorf acknowledged…that the settlement had been reached. He also acknowledged the amount of the settlement….
>
> Carla Anderson, of Letcher County, said Marshall should be praised.
>
> "It's a good thing, what he did," said Anderson, who says her home has been damaged by blasting in the McRoberts area….

GOOD PLANNING ENSURES LAND USE COMPATIBILITY & ENVIRONMENTAL SUSTAINABILITY, PUBLIC HEALTH, SAFETY & WELFARE AND PREVENTS DAMAGE TO PROPERTY

Good planning involves the application of land use principles that benefit all land uses on both a micro- and macro-level, and that avoid land use conflicts, while protecting the environment and ensuring the health, safety and welfare of the community.

> When land use are in harmony with each other, all land uses benefit from proximity to each other. Compatible land uses benefit all land users involved. Incompatible land uses

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[50] Jennifer Hamilton-McCharles, That was a blast, not a quake in North Bay, *Sudbury Star*, May 16, 2018.

[51] Vivian Stockman, "*The Social and Cultural Effects of Mountaintop Removal*," Ohio Valley Environmental Coalition.

result when no land use benefits from close proximity to another or when one benefits and the other(s) do not. Further, 'in harmony' needs to be evaluated at different scales. Two or more land uses can be compatible with each other at the neighborhood scale, but yet be inappropriate when viewed at a larger town-wide scale, or vice versa.

Conflicting land uses cause economic, physical and social drains on the community.[52]. This occurs because conflicts create barriers to new investment and discourage existing land owners from investing fully in their properties. This is often seen when agricultural lands are at risk for non-farm conversion. A sense of impermanence has been found to account for disinvestment as well as an erosion of confidence and long-run planning at the individual landowner level. It can result in landowners ceasing investment in their current land use because they ultimately feel the land use will be changed or not be sustainable.[53] (Resolution of the Town Board of the Town of Nassau Decision on the Troy Sand & Gravel Special Use Permit Application, September 1, 2015)

Compatibility – Land uses and development that are planned and designed to be compatible with their surroundings will prevent or minimize conflicts with their surroundings will prevent or minimize conflicts and avoid dangers to public health, safety and the environment. When land uses are not compatible, they can result in negative impacts on people/investments and the environment, such as:

- Nuisances, including noise, dust; odours;
- Financial expenditures by both private operators and the public to deal with legal issues and complaints;
- Danger to human health and safety and damage to property and investments from hazards, such as flooding, and the resulting public expenditures for evacuation and compensation; and
- Unexpected costs to mitigate conflict [p.28].[54]

In order to achieve compatibility, land use conflicts should be avoided. The encroachment of sensitive land uses (such as residential, educational and health facilities and day care centre) and major facilities (including industries, transportation corridors, airports, intermodal facilities, sewage treatment facilities, operating and former waste sites, and resource extraction activities) on one another is discouraged. Whenever a change in land use is proposed, consideration shall be given to the effect of the proposed use on existing land uses. [See p.66, Township of Dorian, Ontario, 2020 Official Plan]

Operating quarries, accompanied by blasting below the water table, are noted for negative externalities that impact the environment, the well-being and safety of the public, and nearby property values. The costs of potential adverse impacts must not be externalized and passed along to residents of the City of Burlington and innocent third-party property-owners, while profits earned at the expense of innocent third-parties remain the exclusive domain of the quarry owner (i.e., Nelson Aggregate Co.).

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[52] JunJie Wu. 2008. Land Use Changes: Economic, Social and Environmental Impacts. Choices 4th Quarter, 2008 (23) (4). A publication of the Agriculture and Applied Economics Association.

[53] Van Kooten, C.C. 1993. Land Resource Economics and Sustainable Development Economic Policies and the Common Good. UBC Press, Vancouver, British Columbia, Canada.

[54] http://www.gov.pe.ca/photos/original/ReportEng.pdf.

WHAT CAUSES LAND USE INCOMPATIBILITY?

All of the *adverse effects* listed in the Environmental Protection Act/Provincial Policy Statement speak to the issue of land use incompatibility, which are expanded upon by a paper prepared by Kisker (2019) for People United for Responsible Government.

> Every land use, whether it is agricultural, residential, commercial, or industrial has impacts. Our investigation found that the approach taken by many jurisdictions is to consider the relative intensity of various types of impacts when considering whether nearby land uses will be compatible. Although the list of impacts considered varies somewhat among jurisdictions, the following are the most-often listed relative impacts:[55]
>
> **1. Scale**—How much area is used? How many and how high are the buildings? Are buildings closely spaced (massing) or separated by open space?
>
> **2. Emissions**—Noise, dust, odor, vibration, lighting, heat, electrical interference, [contaminants, e.g., flyrock,] etc. If there is a significant difference in intensity or amount among the uses, incompatibility is certain.
>
> **3. Traffic**—One impact that's common to many uses is type and amount of traffic and the resulting congestion. However, there is a wide range, from hundreds of trucks per day to only a few cars per day. A large disparity implies incompatibility.
>
> **4. Population on site**—Commercial and industrial uses usually have more people [and equipment] present, than low density residential, for example, while high density residential populace may approach that of commercial.
>
> **5. Hours of operation**—Low intensity uses such a residential generally have much more restricted activities than higher intensity uses such as industrial.
>
> **6. Visual impact**—This may include not only the appearance of any structures (e.g. upscale residences vs. Quonset hut type industrial buildings [or pit or quarry]), but also the effect of outdoor storage as well as the expected maintenance level (fully landscaped vs. unmaintained, unirrigated space, trash accumulation, etc.)
>
> **Generally, if one or more large disparities in impacts between two land uses is present, it is likely that these land uses are incompatible**. It is occasionally possible to reduce a disparity in impacts through mitigation to make the two land uses compatible. If more limited disparities in impacts exist, then a "feathering" effect may be achieved by allowing a gradual increase/decrease in relative impacts. For example, rural, low density home sites may be next to developed single family, one-story homes, which may be next to higher-density dwellings, which may be next to multi-story housing complexes, which may be next to high-rise housing complexes. Typically, this feathering is accomplished through zoning these transitional regions to accommodate the evolution of land uses in the area. By resisting attempts to mix uses, jurisdictions can most effectively provide predictability to property owners.

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[55] Dave Kister, "Prepared for People United for Responsible Government, *Twin Peaks Partners, LLC,* May 9, 2019, https://weldpeopleunited.com/wp-content/uploads/2019/07/Land-Use-Compatibility-white-paper.pdf.

Conversely, **compatibility,** the antithesis of incompatibility**,** is defined in the 2021 Florida Statutes Community Planning Act as follows:

> **Compatibility** "means a condition in which land uses or conditions can coexist in relative proximity to each other in a stable fashion over time such that no use or condition is unduly negatively impacted directly or indirectly by another use or condition."[56]

According to the Ministry of the Environment, Conservation and Parks (MOECP)' D series Land Use Compatibility (Updated July 13, 2021), **Irreconcilable Incompatibilities** (a contradiction in terms) of land uses that cannot be reduced to a "trivial" level shall not be permitted:

> **Irreconcilable Incompatibilities (3.4)** When impacts from discharges and other compatibility problems cannot be reasonably mitigated or prevented to the level of a trivial impact (defined in Procedure D-1-3, "Land use Compatibility: Definitions") new development, whether it be a *facility* or a *sensitive land use*, shall not be permitted. [underscoring added]
>
> **Trivial Impact.** Present or predictable contaminant discharges which are or are likely to be so minor that there would not be an 'adverse effect'. In determining whether an impact will be "trivial", the timing and magnitude of contaminant discharges should be related to the 'sensitive land uses' normal use period(s).

It takes nothing more than common sense to conclude that a quarry, accompanied by blasting below the water table, which is one of the most noxious, toxic, hazardous and destructive uses of land, is incompatible with virtually all uses of land, especially all forms of residential, commercial and service commercial, including home businesses/occupations, and agricultural uses involving crops and livestock, and all areas of active human and non-human activity.

- No well-informed or well-advised person chooses to live or conduct business next to a blasting quarry operation, and allow themselves, their relatives, their friends, their employees or their customers to be exposed to the dangers of *flyrock*. *Flyrock* (debris and fugitive dust) launched off-site onto private third-party property or public property is *trespass* and *nuisance* and may warrant criminal prosecution of the offending blasting quarry operator.

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[56] The 2021 Florida Statutes, http://www.leg.state.fl.us/statutes/index.cfm?App_mode=Display_Statute&URL=0100-0199/0163/Sections/0163.3164.html.

BLASTING IS AN ULTRAHAZARDOUS ACTIVITY HELD TO STRICT LIABILITY

In *V & G Inc. v. Piedmont Drilling & Blasting*,[57] the plaintiff successfully argued, and the defendant conceded, that blasting is subject to strict liability as no amount of due care can predict with certainty the consequences of the use of explosives. As noted by the appeals court, the courts have consistently held that blasting with explosives is an ultrahazardous activity for which strict liability is imposed:

> Plaintiff correctly asserts that blasting with explosives is deemed an "ultra hazardous" activity, for which strict liability is imposed. Guilford Realty & Insurance Co. v. Blythe Brothers Co., 260 N.C. 69, 131 S.E.2d 900 (1963). In Blythe, plaintiffs sought compensation for damages caused by defendant's use of explosives to blast a tunnel for a sewer line. The Court held:
>
> > **Blasting is considered intrinsically dangerous; it is an ultrahazardous activity ... since it requires the use of high explosives and since it is impossible to predict with certainty the extent or severity of its consequences.... "Blasting operations are dangerous and must pay their own way.... The principle of strict or absolute liability for extrahazardous activity thus is the only sound rationalization."** [emphasis added]
>
> 19 Id. at 74, 131 S.E.2d at 904 (quoting Wallace v. A.H. Guion & Company (S.C.), 237 S.C. 349, 354, 117 S.E.2d 359, 361 (1960)) (citations omitted). North Carolina cases decided after Blythe have uniformly held that blasting is an ultra hazardous activity for which the actor is strictly liable. See, e.g., Kinsey v. Spann, 139 N.C.App. 370, 374, 533 S.E.2d 487, 491 (2000), in which this Court reiterated that:
>
> > **Ultrahazardous activities are those that are so dangerous that even the exercise of reasonable care cannot eliminate the risk of serious harm. In such cases, the employer is strictly liable for any harm that proximately results. In other words, he is liable even if due care was exercised in the performance of the activity. In North Carolina, only blasting operations are considered ultrahazardous. (citing Woodson v. Rowland, 329 N.C. 330, 350-51, 407 S.E.2d 222, 234 (1991)) (internal quotation marks omitted).** [emphasis added]

As of 2017, there are 42 states that recognize strict liability for blasting.[58]

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[57] *V & G, Inc. v. Piedmont Drilling & Blasting*, 644 S.E.2d 16 (2007), https://scholar.google.com/scholar_case?case=4971878775139737741&q=ultrahazardous&hl=en&scisbd=2&as_sdt=2006.

[58] Randy Gardner, "Blasting Law and Case Studies," Power Point Presentation," Vibra-Tech, 2017, https://www.vtca.org/wp-content/uploads/2017/04/Presentation_sc17_gardner.pdf.

ADVERSE EFFECTS FROM BLASTING QUARRY OPERATIONS GENERATE COUNTLESS PUBLIC COMPLAINTS AND LAWSUITS

Land uses and developments that are planned and designed to avoid incompatibility with their surroundings, now and in the future, prevent or minimize conflicts and avoid dangers to public health, safety and welfare, and the environment.

Aggregate extraction is a destructive, noxious and hazardous use of land that is notorious for generating public complaints and lawsuits, with the frequency of complaints and lawsuits increasing with the scale of operations. As the scale of aggregate operations become increasingly larger, there are corresponding increases in the short- and long-term *adverse effects*, the duration (and number) of public complaints, and number of lawsuits. A general list of major concerns and complaints expressed by residents adversely impacted by blasting quarry operations compiled by the San Diego Union-Tribune (Oct 18, 2009)[59] is reproduced below:

- They [quarry operators] destroy communities;
- They cause nervous, health, and sleep disorders in their communities;
- People move away. Good luck selling your seriously depreciated house, though—to whom?... [unsuspecting home buyers are often unaware or uninformed about the adverse effects of residing near a blasting quarry operation, and overpay];
- They [quarry operators] are fined constantly by authorities. Sort of like a parking ticket. It's just a minor cost of business;
- They poison groundwater supplies with the deadly benzene runoff from the ammonium nitrate explosives;
- They damage houses with the blasts: e.g., cracked plaster, structures shifting off foundations. (…[N]ote that in the Massachusetts Web site…, the insurance companies won't cover the tens of thousands of dollars' damage from nearby mining companies.); [and]
- **Huge pieces of "flyrock" (isn't that a quaint new term!?) land as far away as three miles [4.83 kilometres] from the mine blasting, terrorizing residents and damaging houses (amazingly only one killed so far). Check the Nashville, Tenn., Web site for flyrock details of several nearby interstate highways closed down after huge boulders land on the road. The death was in West Virginia, of a little boy killed in his bed by flyrock smashing through his bedroom window**. [emphasis added]

[59] Biddle Jr, Nicholas. "Forum: National anti-quarry 'tea party' blasting across Web," https://www.sandiegouniontribune.com/sdut-forum-national-anti-quarry-tea-party-blasting-2009oct18-story.html.

Addressing each adverse effect listed in the Environmental Protection Act/Provincial Policy Statement is a mandatory requirement (i.e., not optional) of every application for a licence to permit aggregate extraction, which Nelson Aggregate's so-called experts have failed to do in their proponent-driven studies.

According to Canadian Environmental Law Association (CELA), the Ministry of the Environment, Conservation and Parks' (MECP) prioritization of risk leaves many complainants without a voice and no effective remedy short of taking costly legal action against the owner of a *major facility* that causes *adverse effects*.[60]

> CELA is strongly of the view that a risk-based approach to responding to concerns about land use compatibility issues fails to address the living reality of many Ontarians. Nuisance impacts, such as those related to dust, noise and odour, are a major concern for individuals living in low-income, disadvantaged and vulnerable communities. **CELA regularly receives inquiries from the public related to noise pollution from major facilities or agricultural equipment (i.e. bird bangers) located near their homes, dust from neighbouring pits and quarries, and odours from nearby slaughterhouses or factories. For these individuals, MECP's current approach to compliance means that they are often referred out to their local municipalities, which do not have the bylaws in place to properly address their concerns**. [emphasis added]
>
> **Ongoing use of a risk-based approach to compliance will mean that the public has to turn to courts and tribunals, such as the Small Claims Court and the Normal Farm Practices Protection Board, to deal with nuisance impacts that are properly within the jurisdiction of MECP and could be avoided with a more robust land use compatibility assessment**. [emphasis added]

Every one of the listed *adverse effects* is also an actionable offence either in "nuisance" or "trespass," (and possibly negligence) and compliance with statutory regulations (limits) is not a defence.

- In the September 2000 Plaintiffs' Trial Memorandum (Docket No.S0562-97RcC), Jayne Nicklaw et al. (Plaintiffs)[61] claimed against Camara et al., (Defendants) for depositing state waste and slag, and building roads, on

[60] CELA's June 29, 2021 letter to MECP regarding Ontario's Land Use Compatibility Guideline, https://cela.ca/wp-content/uploads/2021/06/CELA_Submission_Land_Use_Compatibility_Guideline.pdf.

[61] Several Plaintiffs have successfully had their property tax assessments reduced on the basis that the quarrying activities have diminished their property values.

their property.[62] Prosser, Law of Torts '87, (5th ed. 1984), is cited as authority on the tort of nuisance.

> The different ways and combinations of ways in which the interest in the use or enjoyment of land may be invaded are infinitely variable. A private nuisance may consist of an interference with the physical condition of the land itself, as by vibrations or blasting which damages a house, the destruction of crops, flooding, raising the water table, or the pollution of a stream or of an underground water supply. It may consist of a disturbance of the comfort or convenience of the occupant, as by unpleasant odors, smoke or dust or gas, loud noises, excessive light or high temperatures, or even repeated telephone calls; or of his health, as by a pond full of malarial mosquitoes. Likewise, it may disturb merely his peace of mind, as in the case of a bawdy house, the depressing effect of an undertaking establishment, or the unfounded fear of contagion from a tuberculosis hospital. A threat of future injury may be a present menace and interference with enjoyment, as in the case of stored explosives, inflammable buildings or materials, or a vicious dog; and even though no use is being made of the plaintiff's land at the time, the depreciation in the use value of the property because of such conditions or activities is sufficient present damage upon which an action may be based. Many nuisances involve an assortment of interferences: a factory may cause vibration, smoke and dust, loud noises, pollution of a stream, and a fire hazard. So long as the interference is substantial and unreasonable, and such as would be offensive or inconvenient to the normal person, virtually any disturbance of the enjoyment of the property may amount to a nuisance. Prosser, supra, ' 87, at 619-620 (citations & footnotes omitted).[emphasis added]
>
> It is apparent from what has been said hereafter that the conduct may often result in substantial interference, as when a cement factory locates next to a small farmer, without such conduct being unreasonable, and even when defendant is exercising utmost care while utilizing all the technical know-how available. It has often been observed that liability, if imposed in such a case, is liability without fault. But this is a mistake. The harm is intentional. Private property cannot be physically harmed or its value impaired in this way, however socially desirable the conduct, without payment being made for the harm done, if the interference that is the consequence of the activity is substantial and considered to be unreasonable. This, of course, does not mean that the activity will be enjoined. When the defendant engages in an activity with knowledge that this activity is interfering with the plaintiff in the use and enjoyment of his property, and the interference is substantial and unreasonable in extent, the defendant is liable, and the monetary recovery is simply a cost of engaging in the kind of activity in which the defendant is engaged. Id. at 625 (citations and footnotes omitted).

- In 2017, *Miller*[63], for a second time, was found liable for damages in nuisance for interference caused to the *use* and *enjoyment* of each

[62] Plaintiffs' Trial Memorandum (Docket No.S0562-97RcC), September 2020, Microsoft Word - 183771-Trial memorandum.doc (vermont.gov).

[63] *Battiston v Smiths Construction Company*, 2017 CanLII 77336 (ON SCSM), <http://canlii.ca/t/hnsh8>, retrieved on 2019-10-07.

plaintiff's property, located nearby in a designated Settlement Area. The court heard from 21 witnesses over the course of twelve days of trial before issuing its ruling in favour of the residents. The interference caused by the operation of the asphalt plant arose from "*odour, noise* and *dust*" that significantly impacted all fourteen residents' ability to enjoy the "full" use of their properties. The court found that the interference was "substantial," meaning it was "non-trivial." Each resident testified that they would not have chosen to reside proximate to the quarry had they known how the operations of the temporary asphalt plant would affect them.

> **I base my conclusion that the interference was "substantial" based upon how the effects of the plant's operation impacted the plaintiffs. While the defendant produced records to support the fact that the noise / odour issues were not constant and that their complaints as chronicled in a diary would suggest occasions when odours or noise were not experienced daily, the bottom line is that it impacted the plaintiffs' ability to regularly enjoy their properties. They were no longer willing to continue with their gardens and outdoor activities due to concern of possible negative health effects and the unpleasantness of being outside when the odours and /or noise were present. The plaintiffs spoke of no longer planning social events (barbecues) because it was impossible to predict whether the plant would be operating. This hindered or ended planned activities. In every instance, the plaintiffs testified, had they known the negative impact the operation of the temporary asphalt plant would have on them, that they would not have chosen to purchase their home [para. 19].** [emphasis added]

As to whether the interference was reasonable, the court rejected *Miller's* defense of compliance with *noise* and *odour* emissions limits, finding that compliance with statutory limits does not make the interference complained of reasonable, commenting, in pertinent part, as follows:

> **Various factors such as the severity of the interference, the character of the neighbourhood, the sensitivity of the plaintiffs, the frequency and duration of the interference, and the utility of the conduct may be considered in making this determination, depending on the particular circumstances of the case. There is no finite list. The focus, generally but not absolutely, is on whether the interference suffered by the plaintiffs is unreasonable, and not on whether the nature of defendant's conduct is unreasonable [para. 22]**
>
> **[T]he defendant relied upon the third party investigations by both the Ministry of Natural Resources and the Ministry of Environment, which, for the most part, confirmed that there were emissions but which found that the noise and odour emissions from the plant were within acceptable statutorily mandated limits [para. 31].** [emphasis added]

All fourteen residential neighbours were awarded damages. While recognizing that providing asphalt under a government contract has public utility, *Miller* is a "for profit" operation. No evidence was presented to suggest that alternative locations for the portable asphalt plant were not feasible, even if less convenient. (para. 28) As observed by the court in the prior 2009 decision.

> **[The area] is zoned rural and if anything it would be much more residential than commercial, as there is only a roof truss business, a quarry and farming property in the area as opposed to approximately 150 residential houses….**
>
> **The plaintiffs were aware that there was a quarry when they purchased their properties but they did not know that this asphalt plant was going to operate in it.…The noise and odour that they experienced when the plant started was severe. Overnight, the enjoyment of their land and residences was substantially interfered with.…**
>
> **A private, for-profit company should be required to pay the full cost of its operations without forcing the plaintiffs to effectively subsidize its business through the free use of their properties [para. 28].** [emphasis added]

The area surrounding Nelson Aggregate's proposed quarry expansion in the City of Burlington is incompatible with the character of the surrounding area, which is predominantly rural residential. There are 156 occupied dwellings within 1,000 metres of the proposed blasting quarry operation, an ***Area of Influence*** (AOI) which is inadequate to capture the full list of ***Adverse Effects*** identified in the Environmental Protection Act/Provincial Policy Statement. **For this reason alone, Nelson Aggregate's application to permit expansion of the existing quarry should be denied**.

- *Miller Paving Ltd.*[64] was denied leave to appeal an October 27, 2015 OMB decision involving a proposed quarry expansion, as no "question of law" was raised. In upholding the OMB decision imposing a 300 metre setback within the quarry property from the *property line* of adjacent residences, the Superior Court of Justice (Divisional Court), stated, in pertinent part,

> **Section 4.1.1 [PPS] is for potential influence areas within which adverse effects may be experienced for industrial uses setting the distance for**

[64] *Miller Paving Limited v. The Corporation of the Township of McNab/Braeside et al*, 2016 ONSC 6570.

> **Class III at 1000 m. Section 4.3 recommended minimum separation distances for Class III at 300 m [para. 24].**
>
> **Miller has put forth the position based on the facts of the case and the decision of the OMB. In reviewing the decision, I do not agree that there is a question of law. The OMB was cognizant of the provincial interest as well as the expert opinions and the arguments of the property owners. The Province provided no evidence at the hearing. The Provincial Guidelines were just that guidelines. The OMB considered the evidence and concluded as set out in the Official Plan, namely section 11(2) (3) concerning limiting the disturbance to the subject site. Miller has not provided any authority to support its argument that there is a question of law. The decision of the OMB was one based on the evidence provided at the hearing and at best, is a question of mixed law and fact [para. 32].**[emphasis added]
>
> **There is nothing that has been presented by Miller that puts into substantial doubt the decision of the OMB on this issue. On reviewing the decision, there is ample evidence that the OMB used to support its decision. The OMB did not solely rely on the Guideline D-6. There is nothing directed to this Court that the using of Guideline D-6 would bring the correctness of the OMB decision into serious doubt [para. 39].** [emphasis added]

There have been three "known" flyrock incidents at the Miller Braeside Quarry: one in 2005, one in 2007; and again in 2021. The "mega" quarry blast in 2005 launched flyrock that struck the roof of the Battiston residence 400 metres from the quarry site, and caused damage to a truck, house foundation and more.[65] Obviously, the 300-metre setback imposed by the municipality on the Miller Braeside Quarry is inadequate.(During the investigation of 2021 flyrock incident, Miller was found to be in violation of the conditions of its Site Plan imposed as a result of earlier litigation.)

- In the recent Ontario Land Tribunal (OLT) hearing involving an application to expand an existing blasting quarry in Ramara Township, the planner representing the quarry owner, which is the same planner representing Nelson Aggregate Co., misled the OLT by stating that a permanent setback requirement has never been imposed by a municipality on an aggregate operation in Ontario. That statement is false, but, in any event, a municipality has the authority under both the Planning Act and the Municipal Act to impose setbacks and separate incompatible uses to protect the environment, health, safety and

[65] Derek Dunn, "Inspection reveals violations at site of Arnprior blasting," *Arnprior Chronicle-Guide*, Jan 7, 2022, https://www.thestar.com/local-arnprior/news/2022/01/07/inspection-reveals-violations-at-site-of-arnprior-blasting.html.

welfare of its citizens, and to preserve property values (e.g. homeowner equity).

Contrary to the view expressed by the planner at the OLT, it is within the jurisdiction of a municipality to enhance minimum setbacks beyond those mandated for pits and quarries under the Aggregate Resources Act (ARA), as ruled by the Ontario Court of Appeal in *Township of Uxbridge v. Timber Brothers Sand & Gravel Ltd.*, (1975),[66]

> **The provincial legislation [ARA] does no more than set minimum set-back requirements or standards and in no way attempts to restrict the right of a municipality to enhance these standards. This the municipality may do provided it acts within its delegated legislative powers and does not enact provisions in by-laws which are inconsistent with statutory provisions**. [emphasis added]

This same planner also failed to mention two "known" flyrock incidents at the Ramara Quarry, one of which occurred on July 26, 1994 launching flyrock approximately 1,200 feet (366 metres) (see attached July 28, 1994 news article), and the other sometime earlier (as admitted by the quarry operator), and the planner did not take into account the concerns expressed in the "flyrock" advisory issued by the Ontario Professional Planners Institute (see attached OPPI Flyrock Advisory – revised August 2021). The OPPI advisory states, in part,

> The PPS also requires that development, and activities being considered near existing aggregate operations and aggregate deposits, consider and address"*…issues of public health, safety and environmental impact*." In undertaking development, municipal planners are required to consider public health and safety for new developments in relation to existing mineral aggregate operations and resources areas. Municipal planners need to ensure that new development near existing operations, or known resources, do not create or exacerbate public health and safety issues.

- As pointed out by the Ministry of the Environment, in response to the House Quarry application (2005), the D-6 Land Use Guidelines requires that separation distances be applied reciprocally in addressing land use incompatibility:

> It is noteworthy that these distances apply regardless of whether it is a new sensitive land use proposed in the vicinity of an existing Class III Industrial Use

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66 *Township of Uxbridge v. Timber Brothers Sand & Gravel Ltd.*, 1975 CanLII 507 (ON CA), <https://canlii.ca/t/g1cpz>, retrieved on 2021-04-30. Leave to appeal to the Supreme Court of Canada denied.

> such as a quarry, or whether it is a new quarry proposed in the vicinity of existing sensitive land uses. As a matter of good planning, the primary consideration should be to minimize conflicts between incompatible land uses, regardless of which…exists and which is proposed.[67] (see attached House Quarry Application Township of Lake of Bays, 2005)

- In *Capital Paving Inc. v. Wellington (County),* [2010] O.M.B.D. No. 9, the OMB addressed the application of what became para. 1.2 of the 2014 Provincial Policy Statement (PPS) on the buffering (separation) of resource extraction activities and *sensitive land uses* from each other and coordination of land uses to prevent ***adverse effects***. The OMB stated that:

> **While residential sensitive uses would be restricted in locating near to existing or expanding aggregate operations and in the area of known deposits, the PPS also provides protection in buffering or separation when the residential use is in place first … It is fair to say that the PPS speaks to the incompatibility of sensitive residential use with earlier aggregate operations and the reverse is also true that a proposed pit may be incompatible with the prior residential use [para. 16].** [emphasis and underscoring added]

- City of Timmins Zoning By-law 2011-7100[68] also applies setbacks reciprocally when dealing with ***sensitive land use***, as it relates to Pits and Quarries.

> **3. Pits and Quarries**
>
> a. The **influence area** between any pit and any ***sensitive land use*** shall be 1,000 m [3,280 ft.] measured as the shortest horizontal distance from the zone boundary of the RD -MX Zone or the maximum approved limit of the excavation, whichever is the lesser, and the closest property line of the ***sensitive land use*** unless technical studies and or the use of mitigative measures can demonstrate that the minimum separation distance can be reduced to 300 m [984 ft.] without any ***adverse effects*** The separation distance shall apply on a reciprocal basis with respect to establishing a new ***pit***. This provision shall not apply to infill on any existing lot of record approved or zoned for a sensitive land use as of the effective date of this by- law. [underscoring added]
>
> **b**. The minimum separation distance between any quarry and any ***sensitive land use*** shall be 500 m [1,640 ft.] measured as the shortest horizontal distance from the zone boundary of the RD -MX Zone or the maximum approved limit of the excavation, whichever is the lesser, and the closest property line of the ***sensitive land use***. The separation distance shall apply on a reciprocal basis with respect

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[67] House Quarry Application, Township of Lake of Bays File: Z39/05, https://static1.squarespace.com/static/5c59cf4c7a1fbd06dcdc52b6/t/5c6dff67f4e1fc98466d9c20/1550712680419/House+Quarry+Application+.pdf.

[68] **Section 4: General Provisions**, https://timmins.civicweb.net/filepro/documents/238?preview=13810.

> to establishing a new ***quarry***. This provision shall not apply to infill on any existing lot of record approved or zoned for a ***sensitive use*** as of the effective date of this by- law. [underscoring added]

- According to the Quarry Code of Practice, 3rd Edition, May 2017, Environment Protection Authority of Tasmania,[69] suggested setbacks are reciprocal:

> Where possible, quarries should be located to minimize visual dust, and noise impacts on adjacent sensitive uses, in order to reduce the potential for environmental nuisance. New quarries should not be located close to existing residences or other sensitive receptors. Similarly, proposals to locate new residences adjacent to existing quarries should be discouraged, if possible, to reduce the potential environmental nuisance.
>
> It is suggested that planning authorities and operators seek to maintain the following separation distances, measured from the planned maximum extent of quarry operations to any sensitive use. [underscoring added]
>
> 1. where regular blasting takes place 1,000 metres [p. 10]

- In 2015, John Georgakopoulos of Willms & Shier, prepared a presentation on **Legal Aspects of Nuisance** at a **Land Use Compatibility Workshop** (May 14, 2015) for the Ontario Professional Planners Institute,[70] which describes public and private nuisances as follows:

> **Public nuisance**
> - unreasonable interference with public's right to use and enjoy public aspects of air, land and water
> - anyone who creates a public nuisance may be held responsible
> - compliance [with regulatory requirements] is not a defence
>
> **Private Nuisance**
> - unreasonable interference with use and enjoyment of land by occupier
> - balance competing interest of parties
> - occurs where individual or corporation creates authorized, permitted or permitted others to cause interference
> - both corporation and individuals having control
> - compliance [with regulatory requirements] is not a defence

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[69] https://epa.tas.gov.au/Documents/Quarry%20Code%20of%20Practice%20May%202017%20-%20web.pdf

[70] John Georgakopoulos, "Legal Aspects of Nuisance," https://static1.squarespace.com/static/50ba2be5e4b012760add2bd3/t/55675763e4b05a70c05368f5/1432835939040/J.+Georgakopoulos+-+Legal+Aspects+of+Nuisance+%28AWMA+OPPI+Land+Use+Compatibility+Workshop+-+May+14%2C+2015%29_850410+%281%29.pdf

Examples of cases where *adverse effects* have met the test to sustain an action in Public or Private Nuisance:

- ***Four Vaughan companies, Directors and Officers*** (2012 and 2013) – four waste companies operated a waste disposal site, and in 2011 were convicted of permitting the discharge of smoke and odour causing *adverse effects.* (Private Nuisance – Odour) (Directors and Officers sentenced to 11 days in jail)
- ***Universal Resource Recovery Inc.*** **(2013)** – composting facility discharged odours that caused *adverse effects*, and the facility was shut down in May 2011 for causing loss of enjoyment to neighbours, impairing quality of natural environment, causing material discomfort to a person.(Private Nuisance – Odour)
- ***Bobcaygeon Company*** **(2012)** – dairy processing facility expanded its operations without ministry approval, and discharged noise that caused *adverse effects* to neighbouring property owners. (Public Nuisance – Noise)
- ***R v 1404749 Ontario Ltd.*** **(2012)** – large plume from industrial fire at site in Toronto, with plume drifted off-site over roadways and railways used by GO Transit and smoke caused disruptions in road and GO train traffic leading to evacuations in the area. (Public Nuisance – Dust and Odour)
- ***TMS Lighting Ltd. v KJS Transport Inc.*** **(ONCA 2014)** – dust from KJS Transport property caused substantial and unreasonable interference with use and enjoyment of TMS lands (retail lighting manufacturer). Four factors considered to establish nuisance:
    1. severity of interferences
    2. character of neighbourhood
    3. utility of defendant's conduct
    4. sensitivity of plaintiff

    (Private Nuisance – Airborne [fugitive] dust)
- ***1191802 Ontario Ltd. O/A Jim Weir Custom Crushing*** **(2012)** – rock crushing process generated noise and residents awakened by loud noise, of construction equipment from nearby quarry. Residents complained of

  - loss of enjoyment of property
  - personal stress
  - possible reduction in property values

  (Private Nuisance – Noise and Vibration)

- ***Austin Powder Ltd.*** **(2014)** – quarry blasting services at limestone quarry near Arnprior. Flyrock discharged beyond 200 metre control area, later determined should have been 500 metre control area. Flyrock struck worker at neighbouring business in arm, and scalehouse 230 metres away and two vehicles 300 metres away struck and damaged by flyrock. (Public Nuisance – Dust and Flyrock)

- The City of Burlington new (updated) Official Plan (November 2020) describes *Sensitive Land Uses* as follows:

> **Sensitive Land Uses** – Buildings, *amenity areas*, or outdoor spaces where routine or normal activities occurring at reasonably expected times would experience one or more *adverse effects* from contaminant discharges [e.g., flyrock], fumes, sound waves or radiation generated by a nearby major facility [e.g., quarry, accompanied by blasting below the water table]. *Sensitive land uses may* be a part of the natural or built environment. Examples *may* include, but are not limited to: residences, day care centres, and educational and health facilities. (Chapter 13, Page 13-29,

The proposed expansion of the existing Nelson Quarry by Nelson Aggregate Co., which is to involve blasting below the water table, is a *major industrial facility* (Class III, consistent with MOECP definition).

> **Class III Industrial Facility.** A place of business for large scale manufacturing or processing, characterized by: large physical size, outside storage of raw and finished products, large production volumes and continuous movement of products and employees during daily shift operations. It has frequent outputs of major annoyance and there is a high probability of fugitive emissions.

The surrounding land uses, including *Settlement Areas, rural clusters, golf course, Niagara Escarpment* (recreation)*,* and *agricultural and agricultural-related uses* (crops, livestock, equine, dog kennels, etc.), including the abutting public highways, are all *sensitive land uses,* many round the clock, seven days a week, and it is not possible to mitigate the *adverse effects* (and deleterious impacts) of a blasting quarry operation to a "trivial" level.

> On June 4, 1993, the company [Sugar Ridge Coal Co.] detonated a blast in an area less than 300 feet [91.44 metres] from northbound interstate traffic…**The blast created a large amount of flyrock, some of which struck a car**

> **traveling north on Interstate 75. A 16-year old boy, a passenger in a car driven by his parents, was killed as a result of the flyrock impact.**
>
> **The U.S. Department of Justice prosecuted three individuals—the certified blaster, the day shift superintendent, and the mine manager for violations of 30 U.S.C. § 1268(e) and (f). The certified blaster and the superintendent pled guilty to a misdemeanor count of a willful and knowing violation of a permit. The mine manager was acquitted after a trial. The certified blaster was given a ten-month sentence and the superintendent was given an eight-month sentence. The company went out of business within four months of this blasting incident** [p. 1].[71] [emphasis added]

A January 31, 2003 memorandum from the Directorate General of Mines Safety (DGMS) to "All Owners, Agents & Managers of mines"[72] detailed an incident of *flyrock*, which travelled in the opposite direction of the planned blast, striking and killing an employee at a distance of 412 metres from the blast:

> **The projectiles [flyrock] ejected due to blasting travelled for a distance of about 412m in the reverse direction away from the free face and hit a mechanical supervisor. The enquiry further revealed that the deceased had taken proper shelter in a blasting shelter but had come out of the shelter immediately on hearing to the sound of blast and was subsequently hit by the projectiles**.

A blasting quarry operation is also a "***human-made hazard***," from which *sensitive land uses* must be protected, and which generates environmental land use compatibility concerns such as *noise*, *vibration*, *odour*, *fugitive dust*, *contaminants* (i.e., flyrock), *toxic fumes,* and air pollution. (See Section 4.6 Land Use Compatibility, Burlington Official Plan, November 2020).

The domino effect of continually expanding a pit or quarry footprint from one property to the next (effectively eliminating setbacks between properties) has the intended consequence of indefinitely postponing rehabilitation (something that is not even remotely possible with aggregate extraction below the water table), perpetuating adverse effects, and leaving behind a permanently scarred landscape never to be returned to any productive economic land use.

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[71] C. W. Shea and D. Clark, "Avoiding Tragedy: Lessons To Be Learned From A Flyrock Fatality," https://www.osmre.gov/resources/blasting/docs/Flyrock/1993SugarRidgeFatality.pdf.

[72] No. DGMS (SOMA)(Tech)Cir. No. 2 of 2003, https://elibrarywcl.files.wordpress.com/2015/02/dgms-cir_02_03-blasting-projectiles.pdf.

- Blasting at *City Sand's* quarry on the outskirts of the City of St. John's, Newfoundland, led to a flyrock incident in 1988, which resulted in a temporary prohibition from blasting in certain parts of the 48-acre quarry, now in the Town of Paradise. A subsequent blast at the same quarry on July 3, 1998 resulted in flyrock that damaged two homes in the nearby Jane Heights subdivision (Elizabeth Park), and led to a permanent revision of the quarry's blasting plan to reduce the potential for flyrock.

> From 1983, the Department of Mines and Energy [Newfoundland & Labrador] required a buffer zone of 300 meters between quarrying and a residential development. That requirement was a condition of the quarry leases issued to City Sand [and Gravel].…[T]he requirement of a 300 meter buffer zone was not a problem for City Sand in 1983 but became an issue in respect of residential development [of an infill 17-lot subdivision in Jane Heights approximately 225 metres from the quarrying activity] authorized [in 1985] for a nearby area, part of which was within 300 meters of the quarry's operations [para. 6].[73] [emphasis added]
>
> Complaints respecting the effects of quarry blasting were received by Metro Board and provincial regulatory authorities from residents in Jane Heights in June 1986 and May 1988.…The 1988 incident resulted in a temporary prohibition from blasting in certain parts of the quarry site. There were no further problems reported with further quarry blasting until July 3, 1998, when fly-rock caused damage to the garage of one resident of Jane Heights and to the roof of another [para 20].[74] [emphasis added]
>
> **In 1988, fly-rock from the blasting landed in the [300-metre] buffer zone. Blasting operations were subsequently prohibited in certain areas of the quarry….[On] July [3,] 1998, two Jane Heights residences were damaged as a result of fly-rock. City Sand was then required to revise its blasting plan to minimize the potential for fly-rock.** City Sand commenced an action in early 1998, claiming that the Respondent should be held liable in tort for damages to City Sand as a result of the significant costs incurred from the revised blasting plan. The Supreme Court of Newfoundland and Labrador, Trial Division, dismissed City Sand's action for damages, finding that no duty of care was owed by the Respondent to City Sand. The decision was unanimously upheld on appeal.[75] (Leave to appeal to the Supreme Court of Canada was denied.) [emphasis added]

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[73] *City Sand and Gravel Limited and O.D. Holdings Limited v. Her Majesty the Queen in Right of Newfoundland, as represented by The Honourable Minister of Municipal and Provincial Affairs*, 2008 CanLII 1399 (SCC), <http://canlii.ca/t/1vgkt>, retrieved on 2020-07-10.

[74] *City Sand and Gravel Limited v. Newfoundland (Municipal and Provincial Affairs)*, 2007 NLCA 51 (CanLII), <http://canlii.ca/t/1sfnv>, retrieved on 2020-07-11.

[75] Supreme Court of Canada Summary 32302 *City Sand and Gravel Limited, et al. v. Her Majesty the Queen in Right of Newfoundland, as represented by The Honourable Minister of Municipal and Provincial Affairs* (Newfoundland & Labrador) (Civil) (By Leave), file:///C:/Users/Windows%207%20PC/Documents/Supreme%20Court%20of%20Canada%20-

> **The Buffers between the quarrying operations and the residential use or future urban development are intended to separate the two conflicting uses and to reduce the adverse effects of the quarrying operations on the other uses** [par 17]. [emphasis added]
>
> **The buffer zone, by definition, is a neutral area designed to separate, in this instance, two inconsistent and adjoining uses. From an occupational health and safety perspective, it is a safety mechanism in the sense that should fly-rock or debris be ejected from the quarry site, as a result of blasting or other techniques, the likelihood of injury or damage to others is minimized. No evidence was placed before me to suggest the buffer zone is an area of usage to the plaintiff [City Sand and Gravel], that is granting the plaintiff [City Sand and Gravel] permission, in its operations, to eject rock or debris into this area and outside the boundaries of its leasehold realty property** [para. 29]. [emphasis added]
>
> **City Sand understood from discussions with the Department of Mines and Energy, which issued the quarry leases, that there was a [300-metre] buffer zone around the quarry site. However, the quarry leases did not confer upon City Sand rights over property outside the quarry site [p.38].** [emphasis added]
>
> **A municipal authority reviewing a proposed residential development may owe a duty of care to future residents in respect of known hazards. Though City Sand emphasized that point, it did not acknowledge directly that its blasting, which entailed the inherent risk of fly-rock, exposed it also to liability in tort to those same residents. As City Sand had no right to eject fly-rock outside the quarry site, the respondent argued that Metro Board owed no duty of care to City Sand.** The trial judge agreed – Trial Decision para. 56. I see no fundamental flaw in that position. **City Sand carried on a legitimate but inherently dangerous operation. It constituted a danger to persons and property outside the quarry site.** Prior to the development of Jane Heights, neither the owner of the land comprising that development, nor Metro Board, found it necessary to take legal action in respect of fly-rock landing outside the quarry site. **City Sand could not however compel Metro Board to restrict development of adjacent land so that a public danger would not be created [para. 54].**[76] [emphasis added]

While *City Sand* was permitted to continue to carry out blasting operations based on a 300-metre setback, which reduced the amount of onsite land available for extraction, there had been a growing awareness that a 300-metre buffer (setback) for the operation of a blasting quarry was insufficient to protect the health and safety of the public against "flyrock. "The concept of a buffer or buffer zone was in its early developmental stage when the problem of "flyrock" arose in 1988

%20SCC%20Case%20Information%20-%20Summary%20-%2032302%20City%20Sand%20and%20Gravel%20Flyrock.htm.

[76] *City Sand and Gravel Limited v. Newfoundland (Municipal and Provincial Affairs)*, 2007 NLCA 51 (CanLII).

between the City Sand quarry and the residents of the adjoining Jane Heights subdivision (para.64).[77]

In 1996, in response to a growing awareness of "flyrock" as a public health and safety concern, the Department of Municipal and Provincial Affairs in its conditions for approval of a blasting quarry operation required that a **1,000-metre buffer zone be maintained from a *cottage* or *residence***.[78]

The effects of flyrock do not decrease with distance: a 200-gram projectile can be just as fatal at 20 metres as at 1,000 metres.

The effect of flyrock does not change markedly according to the distance; it is only the probability that changes. Indeed, the probability of impact decreases with distance…[79]

In November 2018, *City Sand* announced that it would be closing the Paradise quarry, as, according to Larry O'Keefe, the quarry co-owner, "we've reached the back boundary of our property, which has a watershed behind us, so therefore we're not allowed [to] continue going back into the ground, [a]nd with the construction of the [Outer] Ring Road 20-odd years ago [opened as a highway in 1998], it would make it unfeasible to construct our second lift of material."

> "The government had purchased land to the west of us, and [it] thought we would then be able to extract the rock from that piece of property."
>
> However, O'Keefe said, in the 1990s the zoning of the property changed from mineral workings to open space buffer—blocking City Sand and Gravel from using the land….
>
> Mayor of Paradise, Dan Bobbett, said the town's hands are tied by a municipal plan developed with an independent commissioner.
>
> **"It looked at all the growth in the Town of Paradise and looked at buffer zones, and in this particular one, we can't do it because the commission basically said that you must obey these buffers, "Bobbett said.** [emphasis added]
>
> **Residential homes are in close proximity to the blasting operation, he added.** [emphasis added]

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[77] *City Sand and Gravel Limited v. Newfoundland (Municipal and Provincial Affairs)*, 2007 NLCA 51 (CanLII).
[78] *City Sand and Gravel Ltd. et al. v. Newfoundland (Minister of Municipal and Provincial Affairs),* 2005 NLTD 67 (CanLII), <http://canlii.ca/t/fwvrv>, retrieved on 2020-07-22, para. 20.
[79] EFEE NEWSLETTER September 2019, p. 32.

> "**In this case, the buffer zones are in place for the safety of our residents and we have to maintain those safety zones**…."[80] [emphasis added]

At trial,[81] the Town Planner Stephen Jewczyk, with the benefit of hindsight, recognized the potential danger of flyrock as a health and safety issue on the inhabitants in the residential subdivision near the blasting quarry, with the court finding as follows:

> On the issue of foreseeability, I am satisfied, based on Stephen Jewczyk's comments on discovery, as well as the ongoing evolution and growth of both the residential area and quarry operations, and the change in the size of the recommended buffer zones [increased to 1,000 metres] which took place between 1983 and 1996, that none of the parties foresaw any danger might be created [flyrock from quarry blasting].[para. 58]

THE ROLE OF PLANNING AND ZONING: PRESERVATION OF PROPERTY VALUES AND SEPARATION OF INCOMPATIBLE LAND USES

It was through the land use theories advanced by Olmsted (1870) and Howard (1902) that zoning and city planning could produce wealth, health, and prosperity.

> Property owners and land developers realized Olmsted's predictions in their broader sense and urged city politicians to protect and enhance the value of their assets by separating uses, and regulating the density, shape, and size of buildings in order to secure higher land values and to preserve the local tax base.
>
> Areas with good access to public amenities not only gain better land value,[82] but also attract a larger portion of new development.[83] Others have established that high environmental standards and good access to facilities and services have a direct, positive impact on quality of life.

The Land Use Law Centre at Pace University describes the land use powers that have been delegated to local governments.[84]

> Perhaps the most significant land use power that the state legislature has delegated to local governments is the authority to adopt zoning laws. These laws divide land within the municipality into zones, or districts, and prescribe the land uses and the intensity of development allowed within each district. This delegated authority is found in the

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[80] Ariana Kelland, CBC News, November 8, 2018, https://www.cbc.ca/news/canada/newfoundland-labrador/city-sand-gravel-closing-paradise-1.4896754.

[81] City Sand and Gravel Ltd. et al. v. Newfoundland (Minister of Municipal and Provincial Affairs), 2005 NLTD 67 (CanLII), <https://canlii.ca/t/fwvrv>, retrieved on 2022-07-10

[82] Eugene F Brigham, "The Determinants of Residential Land Values" (1965) 41 Land Economics 325.

[83] *E.g.* Amy Armstrong et al., *State of New York City's Housing and Neighborhoods* (New York: Furman Center, NYU, 2009) 15.

[84] Land Use Law Center, Pace University School of Law, n. d., https://law.pace.edu/sites/default/files/LULC/LandUsePrimer.pdf.

provisions of the Town, Village and General City Law known as zoning and planning enabling acts.

The enabling statutes require land use regulations to be "in accordance with a comprehensive plan" or "in accordance with a well considered plan." Planning "is the essence of zoning" says the judiciary in New York State. Comprehensive planning is society's insurance that the public welfare is served by land use regulation.

According to *Canadian Law of Planning and Zoning* (Carswell, 1973) [85]

The principal purpose of zoning regulations, as with restrictive covenants, is to preserve property values by prohibiting uses which are believed to be deleterious to neighbourhoods mainly residential in character. People living in an area of single family homes naturally want the same type of homes in the district, that is, a use that is compatible. They want to preserve the amenities of their locality. Thus from the standpoint of the rate payers it is the status quo that is sought to be maintained and build up residential areas which are figuratively rimmed with "keep out" signs. **Industry, always an unwelcome intruder in a residential community, also favours a zoning wall that bars residential and other incompatible encroachments**. [emphasis added]

The notional route is segregation of people and the uses they make of their land. Density and development standards control the costs of the dwelling placed on the land and a latter determines the economic (and usually the social) position of those who live in them. Ghettos are created for the rich as well as the poor by walls of exclusionary restrictions. Land values are thus preserved by keeping out undesirable uses and consequently undesirable people. **The preservation of property investment is the prime motive underlying many bylaws although they do not always clearly articulate this policy**. [emphasis added]

And, as noted in *Saint-Romuald (City) v. Olivier,* 2001,[86] private law and municipal land use controls protect adjoining owners in the enjoyment of their indoor and outdoor amenity space[87] and promote separation of incompatible land uses to avoid *adverse effects*.

9. Private law has long protected adjoining owners in the enjoyment of the amenities of their land. Article 947 of the Civil Code of Québec, S.Q. 1991, c. 64, protects that enjoyment, as does the tort of nuisance at common law. Thus neighbours obtained an injunction in nuisance against a tobacco factory that emitted "noxious odours" in Appleby v. Erie Tobacco Co. (1910), 22 O.L.R. 533 (Div. Ct.), and on the same basis successfully opposed the establishment of a dog hospital in a residential area in Macievich v. Anderson, 1952 CanLII 206 (MB CA), [1952] 4 D.L.R. 507 (Man. C.A.). The doctrine of Rylands v. Fletcher (1868), L.R. 3 H.L. 330, imposes virtually absolute liability on owners

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[85] *Service Corporation International (Canada) Inc. v. Burnaby (City of)*, 1999 CanLII 7012 (BC SC), <https://canlii.ca/t/1d45r>, retrieved on 2021-12-09.

[86] *Saint-Romuald (City) v. Olivier*, 2001 SCC 57 (CanLII), [2001] 2 SCR 898, <https://canlii.ca/t/51z2>, retrieved on 2021-12-09.

[87] The City of Toronto defines "amenity space" as indoor or outdoor space on a lot that is communal and available for use by the occupants of a building on the lot for recreational or social activities. (Zoning By-law 569-2013, as amended, Chapter 800.50 (15).

> who bring on their land "anything likely to do mischief if it escapes" and causes damage to a neighbour, unless the escape was due to the neighbour's default (pp. 339-40). These private law remedies were designed, in a general sense, to protect neighbourhood amenities.
>
> 14 An Act Respecting Land Use Planning and Development, R.S.Q., c. A-19.1, authorizes Quebec municipalities to regulate the use of land by dividing their territories into zones to which are allocated various groups and classes of uses. This is to be done: [TRANSLATION] "based on common characteristics of land occupation relating to volume, nuisance, compatibility, use and aesthetics" (s. 16 of the new zoning by-law). The impact of a particular land use on neighbouring lands is clearly a key concern, which is shared by common law jurisdictions. The loss of amenities by noise and air pollution, increased traffic, increased demands on municipal services, or other disruptions, may conveniently be referred to as "neighbourhood effects". The minimization of such adverse effects on surrounding owners or the community as a whole is one of the principal objectives of zoning controls.

Conversely, poor planning policies can negatively impact some residents' quality of life, use and enjoyment of their properties, and the value of their properties in a manner that is inequitable with the community at large.

> A planning practice may be considered as creating inequality, or unfair treatment, if those targeted by harmful regulation, such as eminent domain or the location of unattractive [or undesirable] uses [e.g., blasting quarry operation], "are systematically different from [the community as a whole]…

A fundamental problem with planning decision-making is the focus on the *mere process* rather than on the substantive content of planning within an ethical framework built on fairness and long-term sustainability.

> Sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (World Commission on Environment and Development, 1987, p. 43)
>
> "Cumulative Effects" is defined as "the combined effects of past, present and reasonable foreseeable land-use activities, over time, on the environment." (Land-use Framework Glossary for all regional plans, Alberta Land Use Secrertariat)

Similarly, Chapter 4 of the City of Burlington Official Plan (November 2020) commits the City to protecting the environment and ensuring *healthy* and *sustainable communities*:

> **Environment and Sustainability** reflects the City's intention to continue to be a prosperous, liveable and *healthy community* through the process of *sustainable development.* This includes policies to protect and enhance the Natural Heritage System, *urban forest*, and *watersheds*, to achieve *sustainable* design and environmental *compatibility* and address the *impacts of a changing climate*, contamination and other environmental matters.

Accordingly, it is of critical importance to ensure that a quarry, accompanied by blasting below the water table, not be permitted to locate in proximity to existing and planned future incompatible or *sensitive land uses* as it is not uncommon for a quarry, once established, to remain in operation for 100 years or more, and expose five generations to the anticipated and unanticipated operational *adverse impacts*, individually and collectively.

Governmental agencies characterize aggregate extraction as a "temporary" or "interim" use, and mandate "rehabilitation" for an after-use. Unfortunately, a quarry that blasts below the water table has no reasonable prospect of reclamation or rehabilitation to an economic use, as post-extraction results in a dangerous and lifeless crater filled with rain water, and a scarred and interrupted landscape. Fragmentation of the land base also precludes application of an integrated, comprehensive and sustainable approach to land use planning.

It is apparent from the following statement in the April, 2020 Planning Justification Report prepared on behalf of Nelson Aggregate Co., that the planner lacks an awareness or understanding as to the purpose of planning, which is intended to *preserve property values* and to *separate incompatible land uses*, and to eliminate or mitigate *adverse effects* (Environmental Protection Act/Provincial Policy Statement) to a "trivial" level.

The planner's statement is also offensive, as it suggests that since residents are enduring (and have been for decades) the deleterious impacts of Nelson Aggregate's existing blasting quarry operation, that that is justification for the proposed quarry expansion, which will cause more *adverse effects* and impact more than the 156 occupied dwellings within 1,000 metres of the proposed quarry expansion. At 2.52 persons per household (2016 Burlington Population Density), the number of people to be *adversely* impacted in the 156 occupied dwellings is 393 people (156 × 2.52), and, of course, this doesn't take into account visitors (e.g., friends, relatives, workers), and people working, driving, cycling and playing in the communities in proximity to the proposed quarry expansion. Blasting quarries also terrify and harm pets/livestock and wildlife, another health and safety issue ignored by the proponent's planner.

> Property values are not a planning consideration when evaluating the appropriateness of new or expanded mineral aggregate operations in the rural area and operations are typically located in close proximity to surrounding residents from close to market locations. From a planning perspective, residents are to be protected by appropriately designing the site to minimize impacts on surrounding land uses. In addition, mineral

> aggregate extraction is already established use in the area [p. 36, Planning Justification Report].

At the Public Hearing of July 13, 2015[88] regarding an application by Troy Sand & Gravel for a permit to allow a blasting quarry with a life expectancy of 150 years in the Town of Nassau, New York, Veterinarian Dr. Lisa Dietrich testified as follows:

> …[T]hat domestic animals are clinically affected by dust, allergens and other irritants that may result from blasting at the quarry, and suffer stress from anxiety related to equipment and blasting noise.

On the basis of the Veterinarian's testimony, the Town of Nassau also concluded that these same irritants could have broader implications:

> We think that those same things could also cause safety concerns for the handlers of animals. It is reasonably foreseeable that there could be impacts on domestic animals which could result in added expenses for the household, lower the animal's quality of life, and as related to agriculture, reduce farming and agri-tourism opportunities [p. 34].

The Town of Nassau rejected the notion that private third-party land could be used to further mitigate *fugitive dust* impacts from the proposed blasting quarry operation:

> **The Town considers use of private land to further mitigate fugitive dust impacts as unacceptable**. As per this criteria, new land uses in Nassau are expected to perform to a level where no emissions of dust or other materials that could cause damage to the health of persons, animals, plant life or other forms of property are allowed. The anticipation that land beyond the quarry property would allow dust to settle indicates that this criteria cannot be met (1,000+/- acres of land with no information). The public record establishes ongoing concerns about fugitive dust and its implications on private property. [emphasis added]

In *McLean Lake Residents' Association v. City of Whitehorse and Yukon Government Department of Energy, Mines and Resources*, [2007],[89] involving an application to rezone 14 hectares (34.6 acres) to permit a quarry with a life expectancy of 50 years, the Supreme Court of the Yukon Territory rejected the argument that property values are outside the scope of the *Environmental Assessment Act*:

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[88] Resolution of the Town Board of the Town of Nassau Decision on the troy Sand & Gravel Special Use Permit Application.

[89] *McLean Lake Residents' Association v. City of Whitehorse*, [2007], https://www.yukoncourts.ca/sites/default/files/documents/en/mclean_lake_v_city_of_whitehorse_and_ytg_2007yksc44.pdf.

> "**I do not necessarily agree with the statement in the Screening Report that property values are outside the scope of the Environmental Protection Act. Surely, the definition of "environmental effect" is broad enough to include property values. Obviously, if there is a significant negative impact on the property values, that would be a significant finding to be taken into consideration** [para. 43]. [emphasis added]

The Yukon Supreme Court also took exception to the notion of aggregate quarries in the Industrial Service areas being perceived as "interim uses" pursuant to Section 8.6(3) of the City of Whitehorse Official Community Plan.

> Policy 8.6(3) states that the aggregate quarries in the Industrial Service areas along McLean Lake Road may continue but they are over time to be redeveloped to other industrial uses, thereby being "perceived" as "interim uses." **If the proposed quarry development is captured by this policy it is clearly not in conformance as it has a 50-year life expectancy which is anything but an "interim use**." [emphasis added]

As noted by the Yukon Court, the *Environment Act* represents a strong commitment by the Yukon Government to protect the environment:

> ***Right of Action***
> 8(1) Every adult or corporate person resident in the Yukon who has reasonable grounds to believe that
>
> (a) a person has impaired or is likely to impair the natural environment; or
>
> (b) the Government of the Yukon has failed to meet its responsibilities as trustee of the public trust to protect the natural environment from actual or likely impairment may commence an action in the Supreme Court.

ADVERSE EFFECTS EXPERIENCED BY RESIDENTS NEAR "PITS" AND "QUARRIES"

Study One

As referenced in the July 2014 Department of State Development *Resource Area Management and Planning Final Report*,[90] the *Urban Growth Management for Metropolitan Adelaide* report discusses the findings of complaint data received by quarry operators, the EPA, PIRSA (Department of Primary Industries and Regions), and the City of Tea Tree Gully with regards to excavation activity within and adjacent metropolitan Adelaide, and indicates average distances of around 500 to 700 metres (1,640' to 2,297') "capture" the majority of complaints for hard rock quarries.

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[90] Department of State Development *Resource Area Management and Planning Final Report*, July 2014, https://energymining.sa.gov.au/__data/assets/pdf_file/0020/240662/2014-07-22_DSD_Resource_Area_Management_and_Planning.pdf.

- The majority of complaints received were in relation to blasting activities, with the average distance for these complaints occurring at 489m from the mine/quarry. [2.3.2, p. 20]
- Dust was also a common complaint, the average complaint distance relating to dust from hard rock quarries occurred at a distance of 690m [2,264']...indicating that blasting activity is likely to cause dust to travel further distances. [p. 20]
- The average distance for noise complaints for hard rock quarrying was 675m [2,215']…[p. 20]
- The highest frequency of complaints for hard rock quarries occur between 500m and 550m [1,640' and 1,804']…[p. 20]

The findings of the Adelaide study show that while 60% of blasting complaints were received at a distance of 500 metres or less, noise complaints from blasting quarries occurred at an average distance of 675 metres. This suggests that a separation distance of no less than 675 metres (2,215') is needed from a blasting quarry operation to reduce complaints from nearby residents. (p. 20).

Study Two

Pursuant to Interim Control By-Law No. 05-15 passed by the Township of Zorra, which placed a one-year freeze on new aggregate extraction operations, Oxford County, in 2015, undertook a survey of County residents with the intent to develop recommendations for appropriate amendments to the County Official Plan and the Township of Zorra Zoning By-law with respect to aggregate extraction operations.[91] A total of 67 survey responses were received from residents with 83.6% residing in either the Township of Zorra or the Town of Ingersoll. Most of the residents indicated that they were usually at home during the day. The findings from the residents surveyed are summarized as follows:

- 60% of respondents who described themselves as living within 1,000 metres of a pit or quarry indicated that they moved to their current location before operations began.
- 64% of respondents stated that there were no benefits to living within 1,000 metres of an existing or rehabilitated aggregate operation.
- 52.2% of respondents, in response to an open-ended question, attributed pit/quarry operations to negative impacts, including property values, road safety, road infrastructure, property damage,

[91] Aggregate Policy Review Study, Resident and Operator Survey Results, *Oxford County*, 2015,

health impacts and other (dust, noise, landfill, trespass, visual, non-adherence to haul route, agricultural productivity).

- Residents consistently attributed pit/quarry operations to negative impacts on the ability to enjoy personal outdoor amenity space (i.e. backyard/nature) and driving (due to road safety and infrastructure damage attributed to pit/quarry trucks).
- Resident respondents identified most frequently being 'very concerned' with the potential impact pit/quarry operations have on ground water quality.

The Oxford resident survey does not distinguish between the 77 licenced pits and 2 licenced quarries, the latter of which has the potential for significantly more *adverse effects* on the environment and the surrounding communities. There are only two blasting quarry operations within Oxford County (LaFarge and Carmeuse), one of which is in a remote location. Therefore, the resident survey essentially captures complaints related only to the operation of *pits*, and given the greater number of *adverse effects* associated with a *blasting quarry operation*, a minimum separation distance of 1,000 metres is considered appropriate as a means of separating incompatible land uses and reducing the number of resident complaints and potential lawsuits.

Study Three

A questionnaire sent by Adelola and Nenuwa (2017) to 150 residents residing in proximity to three different quarries in Nigeria resulted in 127 responses regarding the adverse impacts from quarry blasting. **The respondents most severely impacted by the blasting quarries reside within two kilometres (2,000 metres) of each of the three quarries**, and the responses to the questionnaire were analyzed using percentage distribution with respect to complaints of shock wave (ground vibrations), dust, noise, blown roof, wall crack, window shatter and landslide:

- The Ikere community is the most affected by shock wave [ground vibrations] as 73.7% agreed that it is common, at Ikole community, 31.3% complained of shock wave while at Igbemo, 46.3% confirmed the incidence of shock wave. According to…these group of people, shock wave is usually felt by the human body whenever there is blasting at the quarry. The shock waves [ground vibrations] travel through the earth and cause the ground to vibrate which constitutes nuisance to the environment and sometimes leads to restiveness of the human body. The situation is similar to the circular ripples produced on the surface of a pool of calm water when it is struck by a rock. The aged members of the communities are more adversely affected by the shock wave.

- At Ikere-Ekiti, 44.7% of the respondents said dust is one of the effects of ground vibration, at Ikole-Ekiti 52.1% agreed to this fact, while 41.5% said the dust problem is more severe when the level of ground vibration is high. Dust problem is experienced more during the dry season than rainy season, high temperatures aid vibration and consequently loose soil particles will be suspended in the air. Most of the people affected by dust are those who reside very close to the quarry site.
- Noise effect is highest at Ikole-Ekiti as 52.1% agreed that ground vibration is accompanied by noise, 18.4% said noise is one of the effects of ground vibration at Ikere-Ekiti, while 26.8% of the residents at Igbemo-Ekiti complained about the problem of noise. Some waves usually escape in the form of noise, although this phenomenon is not significant in two of the study areas (Ekere-Ekiti and Igbemo-Ekiti).
- The incidence of blown roof in the study areas is 21.1% complained about at Ikere-Ekitit, 31.3% at Ikole-Ekiti and 12.2% at Igbemo-Ekiti. Majority of those who complained about blown roof are artisans who owned small sheds or shops and elderly respondents who live in very old houses, some of the houses, shops and sheds in these communities are old and the roofing materials are very weak. These roofs are more weakened by shock waves received from ground vibration and they are usually blown off by winds or rainstorms.
- The case of wall crack was observed at Ikere-Ekiti by 31.6% of the respondents; at Ikole-Ekiti by 41.7% of the respondents and 26.8% of the respondents at Igbemo-Ekiti said wall crack is a ground vibration problem. Although vibration damage usually first appears as extensions of old cracks, the plaster which is the weakest material in the building is the first material to form new cracks.
- Window shatter was observed by 36.8% of the respondents at Ikere-Ekiti, 10.4% of respondents at Ikole-Ekiti agreed that window shatter is caused by ground vibration while 17.1% of respondents at Igbemo-Ekiti confirmed the statement. Ground vibration during blasting releases shock waves which cause sudden expansion and contraction of window panes, this leads to shattering of the windows. This occurrence is common when there are old cracks on such window panes.
- Although landslide is not commonly experienced in the study areas, few respondents still believed ground vibration during blasting is responsible for earth movement which have led to some cases of rack falls, deep failure of slopes and shallow debris flows and bench collapse in and around the quarry areas. 7.9% of respondents at Ikere-Ekiti agreed to this fact. 18.8% at Ikole-Ekiti agreed while just 2.4% of the respondents from Igbemo-Ekiti believed landslide is one of the effects of ground vibration during blasting. Landslides occur when the slope changes from a stable to an unstable condition. A change in the stability of a slope can be caused by ground vibration during blasting.

Study Four

A peer-reviewed study published in August 2020,[92] conducted a proximity analysis to isolate the effects of exposure to quarrying operations, based on

[92] Maysaa Nemer, Rita Giacaman and Abdullatif Husseini, "Lung Function and Respiratory Health of Populations Living Close to Quarry Sites in Palestine: A Cross-Sectional Study," *International Journal of*

two population groups: the *exposed* group living within 500 metres of a quarry site, and a *control* group living more than 500 metres from a quarry site, and the results are alarming.

- People who live in close proximity to the quarry sites reported exposure to dust at home (98%), land destruction (85%), plant leaves covered with dust (97%), and an inability to grow crops (92%).
- The exposed group reported significantly higher eye and nasal allergy (22% vs. 3%), eye soreness (18% vs. 1%), and dryness (17% vs. 3%), chest tightness (9% vs. 1%), and chronic cough (11% vs. 0%) compared to the control group.
- Lung function parameters were significantly lower among the exposed group compared to the control group; mean forced vital capacity (FVC) was 3.35 L vs. 3.71 L ($p = 0.001$), mean forced expiratory volume in the first second (FEV_1) was 2.78 L vs. 3.17 L ($p = 0.001$). Higher levels of airway restriction were found among the exposed group. Among the exposed group, lung function parameters worsened with the increasing closeness of home to the quarry site [p 1].
- Only one [other] study from Nigeria has investigated lung function among a mixed group of workers and residents who live near quarry sites compared to a control group, which found lower lung function parameters among the workers and nearby residents compared to the control group [p. 2].[93]
- In Palestine, there was only one study that investigated the overall environmental impacts of stone quarry work in Jammain village located in the north of the West Bank, This study found high concentrations of dust particles in the surrounding area of quarry sites, and a high prevalence of reported symptoms among the nearby population, including cough, dyspnea, nasal inflammation, as well as hearing impairment. Asthma was also reported among 30% of the respondents. Approximately 75% of the declared sample reported that they suffered from noise pollution as a result of quarry activities [p. 2].[94]
- Although previous research, in Palestine and worldwide, showed that populations living near quarry sites are exposed to dust and suffer from adverse health effects, no previous research has measured the lung function of such populations in comparison with those who live far away from quarry sites [p. 2].

Study Five

Explosives generate fumes and carbon monoxide (CO) during detonation. Gases are produced as a normal by-product of blasting operations regardless of the types of explosive materials employed. Normally, in open pit blasting or outdoor construction blasting, any gases generated are readily diluted by the

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Environmental Research and Public Health, 2020: 1-13, file:///C:/Users/Windows%207%20PC/Downloads/ijerph-17-06068%20(3).pdf.

[93] Urom, S., Antai, A., and Osim, E. "Symptoms and Lung Function Values in Nigerian Men and Women Exposed to Dust Generated From Crushing of Granite Rocks in Calabar, Nigeria," *Niger. J. Physical Sci.*, 2004, 19, 41-47.

[94] Sayara, T. "Environmental Impact Assessment of Quarries and Stone Cutting Industries in Palestine: Case Study of Jammain," *J. Environ. Prot. Sustain. Dev.*, 2016, 2, 32-38.

atmosphere and the prevailing winds or air currents. However, according to a case study prepared jointly by the Pennsylvania Office of Surface Mining Reclamation and Enforcement and by the Pennsylvania Department of Environmental Protection,[95] blasting at an open pit mine led to carbon monoxide poisoning of a family in a residence distant 430 feet (131.1 metres) to 500 feet (152.4 metres) from the point of the mine blasting.

> **The distance to the home from the blasts on March 31, 2000, when the first CO incident occurred was about 500 feet [152 metres] and about 430 feet [131 metres]away for the second event. The house is founded in close proximity to the coalbed and the same stratigraphic unit being blasted. As the blasting pumped gas into the aquifer, the 36- inch diameter 28-foot deep well acted as a sump to collect the CO. Other than the highwall, this may have been the only other exit point available to the fumes since perched aquifer would be flanked on all sides by a less permeable surficial soils.**
>
> **In April of 2000, two adults and their newborn infant, were poisoned by carbon monoxide in their home and received medical treatment at a Pennsylvania hospital. Carboxyhemoglobin levels were; child - 31%, father - 28%, and mother - 17%. Initially the furnace was blamed but after further review, blasting at a nearby coal mine was determined to be the source. All other sources of carbon monoxide were ruled out. The blasting was about 400 feet [131 metres] from the house. The conditions that led to the migration of gas include: the blasts were highly confined, the geologic structure contained fractures that served as conduits for the carbon monoxide to reach a hand-dug well outside the house, and the well was atmospherically connected to the basement floor drains.**
>
> [The r]esidence…is about 430 feet from the nearest blast and topographically sits at an elevation of 1370'. A hand-dug 36-inch diameter, cobble lined, well that is about 28 feet deep serves as the primary source of water. The well is located on the east side of the house nearest the mine (Figure 2).
>
> On Monday, April 11, 2000, the family…[is] contacted the Pennsylvania Department of Environmental Protection (DEP) with a complaint of muddy water from blasting. During the initial site visit, the DEP inspector discovered that the family had suffered carbon monoxide poisoning on April 1, 2000. **The family's carboxyhemoblogin levels from that exposure were reported by the Presbyterian Hospital in Pittsburgh to be: wife - 17%; husband - 28%; and infant (11 days old) - 31%**.
>
> April 2, 2000 - the contractor who had installed a new furnace in September 1998, was called to check the furnace for fumes. **They found 650 ppm [parts per million] in the basement, 450 ppm on the first floor, and 400 ppm on the second floor**. The contractor informed the family that the carbon monoxide buildup in their home was a result of an inadequate furnace draft. They reworked the furnace flu and installed a power vent to ensure adequate draw. Furthermore, one of the basement windows was removed to provide fresh air to the basement. At this time the gas hot water heater was

[95] "Carbon Monoxide Poisoning at a Surface Coal Mine…A Case Study," https://www.osmre.gov/resources/blasting/docs/OSMREReports/ISEE2001CO3.pdf.

also replaced with an electric heater. As a future safeguard, the residents purchased two carbon monoxide detectors; one for the basement and one for the bedroom.

April 17, 2000 - two blasts are detonated. The first blast, at 11:51, located approximately 430 feet [131 metres] from the home was followed by another blast at 14:02, approximately 475 feet [145 metres] away from the home.

April 20, 2000, one blast was detonated at 13:45. About an hour later, the carbon monoxide detectors in the home sounded an alarm and reported carbon monoxide levels of 73 ppm in the basement and 46 ppm in the upstairs of the home. The family left the house.

The local volunteer fire department was alerted of this incident. They arrived at 16:00 and found 72 ppm at the furnace. After venting the house, they restarted the furnace and got readings of 144 ppm at the furnace. Unaware of any other source of carbon monoxide in the area, they focused on the furnace because their training had taught them that the furnace is the most likely source of carbon monoxide in homes. As a precautionary action, the DEP inspector, requested that State Industries voluntarily cease blasting until an investigation could be conducted.

On April 21, 2000 - the DEP Emergency Response Team (ER) was called in to assist. ER personnel sampled the air quality inside the house and from a 36" diameter, cobble lined, well. **The investigators found that the highest concentrations were inside the home at the floor drains, the highest being 200 ppm. The well had 160 ppm**….

ER vented the well with a high volume fan. They observed a negative air pressure in the basement floor drains. They concluded that the air coming out of the well was supplied from the basement and that the furnace could draw air from the well. Their investigation led them to believe that blasting was the source of the carbon monoxide….[emphasis and underscoring added]

Study Six

In one of the most disturbing examples of a community decimated by the operations of a surface coal mine, complaints from homeowners about *blasting*, *dust* and *flyrock* became of such concern, the mine owner (Arch Coal) hired land agents and embarked on a plan to buy out nearby residents in the Town of Blair, West Virginia.[96]

- Between 1990 and 1993, four families who lived in the Blair area sued Dal-Tex, the then owner of the mine, for blasting damage, loss of well water, and dust and noise nuisances. Three of the cases settled out-of-court, with the terms of the settlement never disclosed, and in the fourth case a local judge dismissed the allegations against Dal-Tex.

[96] Ken Ward Jr. "Buying Blair: Arch Coal found way to move residents away, *Charleston Gazette-Mail*, Updated Oct 25, 2017. https://www.wvgazettemail.com/news/special_reports/buying-blair-arch-coal-found-way-to-move-residents-away/article_c9999d45-538b-56cb-9300-aa5894c048cf.html

- According to the 1997 article "Shear Madness," (U.S. News & World Report), subsidiaries of Arch Coal purchased more than half of the 231 homes in Blair. "Vacated and stripped, at least two dozen have been burned down by arsonists," Subsequently, the elementary school and the town's only grocery stores closed.

Blair residents who wanted the company to buy their property had to sign agreements that they would never again protest a strip mine, and were required to promise not to live or own property in a 25-square-mile area around Arch Coal's mining operations.

One of the families (the Moores), who had lived in Blair for six years, became tired of the blasts that shook their home and rattled windows, and the dust that aggravated their son's asthma, but the Moores refused to sell their property to the companies affiliated with Arch Coal.

In 1997, the Moores commenced an action against the companies alleging that the companies "conspired with each other to operate and implement what they have identified as a 'target property acquisition' program which was intended to force and coerce [the Moores] and other families residing near the Dal-Tex complex to move forever' from their homes in the Blair area." Arch Coal settled the case and paid the Moores $225,000, of which $35,000 was paid for their three-quarter-acre lot and the mobile home that sat on it.[97]

Study Seven

Residents near the Malartic open pit mine in Quebec filed a $70 million class action suit for the impacts on 700 houses and 1,400 people located closest to the blasting quarry operation. The suit, launched on August 1, 2016, aimed to compensate damages related to *dust*, *noise* and *daily blasts*.[98]

> The company itself admitted the impacts of its mine on local community members and has agreed, on September 1st 2016, to offer $50 million relocation and compensation package for the 3500 residents of Malartic, some of whom live up to about 2-2.5km [1.24-.55 miles] away from the mine site at the city limits….
>
> The Canadian Malartic gold mine is currently the largest urban mine in operation in Canada. Despite having spent millions to date in mitigation measures and using best available practices, the mine is incapable of meeting regulated levels and has incurred some 4000 environmental infractions since construction started in 2009 [and mining

[97] Ken Ward Jr. "Buying Blair: Arch Coal found way to move residents away," *Charleston Gazette-Mail*, Updated Oct 25, 2017.

[98] "Miningwatch Predicts $100 Million in Compensation," posted by Ajax Mine on October 25th, 2016. http://www.kapa-kamloops.ca/stop-ajax/blog/miningwatch-predicts-100-million-in-compensation.html

started in 2011]. The mine is now seeking an expansion permit which would increase the length of the open pit from 2.5kn to 3.5 km [1.55 to 2.17 miles], and nearly double the total volume of rocks extracted.

Community members also launched an injunction asking the court to order the company to respect laws and regulations at all time from now on.

Court documents offer insight into the establishment and operation of the Malartic open pit, and its *adverse effects* on the community, which preceded the Class Action Lawsuit.[99]

Mining started in 2011 and is scheduled to end in 2028. Its activities are a source of various troubles and inconveniences for its neighbors [para. 4]..

Conscious of these repercussions, the Respondent invited members of the community to participate in a working group (Working Group). Its mandate is to "develop a document with the local community to equip itself with a framework and guidelines in order to cancel, mitigate and/or compensate for the impacts generated by the operations of the mine." The Working Group is made up of twelve members, i.e. three representatives of the Respondent, three representatives of the City of Malartic, three representatives of the Monitoring Committee and three representatives of the Citizens Committee of the southern zone of the Malartic railway (Citizens Committee). The latter, however, withdrew after a few working meetings and are today at the origin of collective action [para. 5].

The Working Group finalized the Guide to cohabitation aimed at mitigating and compensating for impacts and the acquisition of properties in Malartic (Guide) following a period of 15 months of analysis, writing and phased consultation between May 2015 and August 2016, before the application for authorization to exercise collective action from 1st August 2016. The Guide entered into force on 1st September 2016, before the decision of authorization "bring the class action, dated May 5, 2017 [para. 6] [footnote omitted]

The Guide includes a program to compensate residents and owners of Malartic for past and future inconveniences suffered as a result of mine activities….It offers compensation for material impacts, inconvenience and inconvenience caused by dust, vibrations from blasting, noise, air quality, loss of enjoyment, stress and fatigue. The targeted territory is divided into three zones, circumscribed according to "the impacts measured on noise, dust and blasting" [para. 7].

The Guide proposes indemnities payable by periods, at the end of these periods. The first two periods ranging from 1st July 2013 to 30 June 2016 and 1st July 2016 to 31 December 2016. Subsequent annual periods from 1st January to 31 December each year. The compensation amounts are adjusted on 1st July of each year from 2017, according to the consumer price index for Quebec established by Statistics Canada [para. 8]. [footnote omitted]

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[99] *Trottier v. Canadian Malartic Mine,* 2018 QCCA 1075 (CanLII), < https://canlii.ca/t/hsqwn >, consulted on 2021-05-02. Also see *Lemire v. Canadian Malartic,* 2019 QCCS 849 (CanLII), < https://canlii.ca/t/hz4rq >, consulted on 2021-05-02.

> For the first two periods expiring on December 31, 2016, a very large majority of residents and owners of the Town of Malartic, that is to say 83% of the members of the group targeted by the collective action, took advantage of the Guide. They asked for compensation and they received the compensation payable. The Guide foresees an application until 2028, which corresponds to the end of the planned activities of the mine [para. 9].
>
> In the authorization judgment of May 5, 2017, the judge assigned the appellant the status of representative for the exercise of the class action and he defined the group as follows:
>
> > All persons who, since 1st August 2013, are owners, tenants or residents, or are owners, tenants or residents of buildings in the center districts, East and Laval of the town of Malartic, bounded by the…railway to the north, by chemin du Lac Mourier to the west, by the mine to the sough and by avenue Champlain to the west, in addition to the residents of chemin des Merles in Rivier-Heva, including the owners of the buildings included in this area, even if they do not live there, as well as tenants of commercial buildings [para. 10] [footnote omitted]

An October 15, 2019 news release[100] reported that Canadian Malartic Mine Corporation reached an out-of-court settlement with the defined group in the Class Action lawsuit, which the court confirmed on December 13, 2019:

> "This agreement includes additional compensations for the residents located closest to the mine site, within 800m (2,625') of the pit edge," stated Ugo Lapointe of Coalition Quebec Meilleure Mine and MiningWatch Canada….
>
> Although out-of-court settlements are almost always the results of compromises between divergent interests, the groups recognize the following benefits to the affected citizens:
>
> - ending years of litigation and avoiding a four-month long, costly hearing…[scheduled for] 2020;
> - retroactive compensation for the years 2013 to 2018;
> - additional compensation of up to $1.7 million for house retrofitting and renovation for all the property owners;
> - no legal fees or costs for the citizens.

Blasting quarries are notorious for their known and documented ***adverse effects***, and the only means of protecting the public is to impose a minimum mandatory and permanent onsite setback of at least 500 metres combined with a mandatory minimum separation distance of 1,000 metres between the lot boundaries of the quarry and sensitive receptors (i.e., code for human targets), settlement areas and rural clusters. Nelson Aggregate's application to expand the existing blasting quarry fails to meet these important minimum setback and separation distance requirements essential for the safety and

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100 "Largest Gold Mine in Canada Settles with Affected Citizens Out of Court," *MiningWatch*, October 15, 2019.

well-being of the public and for the use and enjoyment of private third-party property and public property.

- Post-Covid, between 40% and 60% of all workers have expressed a desire to work either full- or part-time from home, which means that people residing near Nelson Aggregate's existing and proposed blasting quarry expansion will be exposed to ***adverse effects*** for generations on their quality of life, their indoor and outdoor amenity space, their work space and their property values, which other communities (residents) in other parts of the City of Burlington do not have to endure. **Post-Covid, living/working from home 24/7 will become the new "normal**." More home occupations can be expected to be established in the City of Burlington, including the communities in proximity to the Nelson Quarry.

> A Statistics Canada paper estimated that in January 2021, 32% of Canadian employees aged 15 to 69 worked mostly from home, compared with 4% in 2016 (Mehdi and Morissette 2021)
>
> **Prior to the COVID-19 pandemic, there was already a growing trend towards working from home.** Town staff routinely received requests for new home-based business uses that the current by-law does not permit. BWG residents clearly wanted to use their homes as affordable business incubators (for things like swimming lessons, catering, e-commerce, medical offices, contracting and more), and needed more flexibility in how they used their properties (including things like conducting business on-site and using accessory buildings for storage). In response, staff initiated the process of amending the Zoning By-law at the end of 2018.
>
> **Since the pandemic hit, there has been a global acceleration towards working from home, e-commerce and associated permissions.** This change is likely here to stay and to grow in coming years.[101]

- In *Battiston v. Smiths Construction Company*, 2017,[102] residents residing near *Miller Breaside Quarry* were exposed to *Odour, Noise* and *Dust*, which the appeal court concluded interfered with the residents' use and enjoyment of their properties, and that the interference was "non-trivial."

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[101] https://www.townofbwg.com/HBB.

[102] *Battiston v Smiths Construction Company*, 2017 CanLII 77336 (ON SCSM), <https://canlii.ca/t/hnsh8>, retrieved on 2022-07-11.

> A nuisance consists of an interference with a person's use or enjoyment of land that is both substantial and unreasonable (Antrim Truck Centre Ltd. v. Ontario Transportation, 2013 SCC 13 at page 13) [para. 8].
>
> Only if the interference is substantial does the second part of the test warrant consideration [para. 8].
>
> The plaintiffs' evidence was clear that the odour, noise and dust significantly impacted their ability to enjoy the use of their residential properties [para. 13].
>
> I base my conclusion that the interference was "substantial" based upon how the effects of the plant's operation impacted the plaintiffs. While the defendant produced records to support the fact that the noise / odour issues were not constant and that their complaints as chronicled in a diary would suggest occasions when odours or noise were not experienced daily, the bottom line is that it impacted the plaintiffs' ability to regularly enjoy their properties. They were no longer willing to continue with their gardens and outdoor activities due to concern of possible negative health effects and the unpleasantness of being outside when the odours and /or noise were present. The plaintiffs spoke of no longer planning social events (barbecues) because it was impossible to predict whether the plant would be operating. This hindered or ended planned activities. **In every instance, the plaintiffs testified, had they known the negative impact the operation of the temporary asphalt plant would have on them, that they would not have chosen to purchase their home** [para. 19].

MNRF, City of Burlington and Niagara Escarpment Commission should be concerned (as should Nelson Aggregate Co.) about the significant cumulative *adverse effects* that Blasting Quarry Operations have on the health, safety and welfare of people who live, work and play in our communities, the environment and long-term land use planning objectives. *Adverse effects* from Blasting Quarry Operations can last 100 years (five generations) or more, as an aggregate licence has no expiry date.

Nowhere in the Ontario Aggregate Resources Act (ARA) is there any reference or requirement for an onsite Safety Blast Area or Zone to protect quarry employees and prevent Flyrock from being launched offsite. Flyrock, an undefined term in the ARA, is not to leave the boundaries of the site, but how that is to be accomplished remains a mystery, as there is no way to prevent Flyrock, an uncontrollable consequence and by-product of blasting rock. The aggregate industry has no legal right to externalize any adverse effects beyond the boundaries of a blasting quarry operation onto public or private third-party property (homes, farms, businesses, parkland, roads, etc.).

CHARACTERISTICS OF FLYROCK AND TRAVEL DISTANCES

In quarry blasting, only 20 to 30 percent of the energy produced is utilized to fragment and move rock mass. The remaining energy is wasted to create unwanted environmental impacts. Often, the factors that cause excessive airblast and ground vibrations have the potential to cause flyrock as well.

Characteristics of Flyrock

Flyrock involves the uncontrolled propelling of rock fragment produced by blasting. Institute of Makers of Explosives (IME) has defined flyrock to distinguish it from blast area accident. It is defined as the rock propelled beyond the blast area by the force of an explosion.[103] **These rocks can travel distances of more than 600 m at speeds of up to 650 km/h**.[104] [emphasis added]

Flyrock comes in different sizes and shapes, ranging in mass from few ounces to several tons. Persson et al. [1994] referenced flyrock weighing approximately three tons thrown to a distance of 980 ft. [299 m].

Flyrock can be cast thousands of feet from a blast. The most dangerous source is ejection from a crack or weak zone in the highwall face where gases violently vent. This action is akin to a rifle where the expanding gases eject a projectile. Frequently the ejection of stemming out of the top of a blast hole is called rifling.[105]

Flyrock is unpredictable and dangerous. Flyrock can travel in any direction or multiple directions from a blast.[106]

A rock that lands harmlessly in a field may not appear to be a large issue. However, mowing and tilling become hazardous when rock is struck by farm equipment. Rock through timber stands mar trees and potentially impact the market value.[107]

In areas of steep slopes, a rock set in motion by the explosive energy may roll hundreds of feet. In this instance the rock rolled through a trailer down slope from the mine. Children were playing in the front yard at the time. Fortunately no one was injured.[108]

Blasting can launch flyrock in any direction at great speed and for a considerable distance, as reported on New England Laborers' Health and Safety Fund's website:

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[103] IME, "*Glossary of commercial explosives industry term"* (Washington, D.C.: Safety Publication No. 12, p. 16, 2007).

[104] H.C. Verakis, Flyrock: a continuing blast safety threat: *Proc. 37th Annual Conf. on Explosives and Blasting Technique*, International Society of Explosives Engineers, San Diego, 2011, 731-739.

[105] "Controlling the Adverse Effects of Blasting." https://www.osmre.gov/resources/blasting/docs/WYBlasterCertModules/8AdverseEffectsBlasting.pdf. (This blaster-training module was put together, under contract, with Federal funds provided by the Office of Technology Transfer, Western Regional Office, Office of Surface Mining, U.S. Department of the Interior, located in Denver, Colorado.) Much of the information in the module is derived from the Surface Mining Control and Reclamation Act of 1977 (SMCRA). The performance standards apply to all surface coal mines. Similar standards have been adopted on some State and local levels and applied to non-coal blasting operations such as quarrying and construction.

[106] http://www.killthealbionquarry.org/flyrock_danger.pdf.

[107] "Controlling the Adverse Effects of Blasting."

[108] "Controlling the Adverse Effects of Blasting."

> **Blasting can be much more dangerous than you think. Even if you are thousands of feet away from the blast, you can still be hit by debris from the blast**. This debris is called Flyrock. Flyrock can travel at high speeds and very far from the blast area. It can easily pierce a windshield or even the metal of a truck. [emphasis added]
>
> **A worker thought he was safely seated in the cab of his truck about 2000 feet [610 metres] from the blast, when all of a sudden he saw flying rocks propelling toward him. Luckily, he was able to duck below the dashboard and was not injured. A rock, the size of a football entered the front of the windshield, traveled where his head would have been and exited the back. Other rocks in the cloud dented the truck. If any of the flying rocks would have hit the driver, he could have been killed. The furthest rocks from the blast flew about 6000 feet [1,829 metres]**.[emphasis added]

A study of blasting *flyrock* risk undertaken by Zhou, et al. (2009)[109] found that wind conditions can have a profound impact on the travel distance of *flyrock*:

> **…[W]ind can assist in the producing of flyrock. When the wind direction is in accord with the designed throwing distance, the flyrock can travel distance two times [more] than normal** [p.1185]. [emphasis added]

Flyrock is an ever present danger wherever rock blasting occurs, and, therefore, the prevention (or avoidance) of flyrock must be dealt with proactively and explicitly before approving an application for a blasting quarry operation.

> **Accidental flyrock in blasting operations has a major impact on the external environment…due to the hazards involved and is more significant than vibrations or airblast….[E]ven if it is normal practice in these zones to take into account the impact of possible vibrations and even the effects of airblast when modeling the project, flyrock risks are not dealt with in initial studies, other than by way of integrating general safety distances. These risks are only sometimes taken into account much later in the operation and most often following an accident or significant flyrock being recorded externally [off-site]** [p. 549] [110] [emphasis added]

FACTORS THAT CAUSE FLYROCK

Often the factors that cause excessive airblast (concussion) and ground vibrations have the potential to cause flyrock as well. For this reason, it is crucial that explosives engineers and planners understand and incorporate

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[109] Zhou, Z., Li, X., Liu, X., & Wan, G., "Safety Evaluation of Blasting Flyrock Risk with FTA Method," *School of Resources and Safety Engineering, Central South University,* Changsha 410083, Hu'nan, China. https://miningandblasting.files.wordpress.com/2009/09/safety-evaluation-of-blasting-flyrock-risk-with-fta-method.pdf.

[110] A. Blanchier, "Quantification of the levels of risk of flyrock," Rock Fragmentation by Blasting: The 10th International Symposium on Rock Fragmentation by Blasting, 2012 (Fragblast 10); Leiden: 549-553.

safety provisions (i.e., adequate setback and separation distances) for the factors that can create flyrock. Some of the common causes of flyrock are:[111]

1) Overloaded blastholes with excessive amounts of explosives
2) Heavily confined charges or the lack of relief (e.g. Lift blasts)
3) Explosives loaded into incompetent materials (egg. mud seams, fractures, and/or voids)
4) Insufficient front-row burden, causing front-face blowouts
5) Burdens and spacings too close together (resulting in high powder factors)
6) Inadequate/insufficient stemming material
7) Inadequate delay between holes in the same row or between rows; detonators firing out of sequence
8) Deviation of blast hole detonation from the intended sequence
9) Changing geology or rock type
10) Spacing and burden exceeds borehole depth
11) Angled boreholes
12) Secondary blasting
13) Human error, improperly loaded blasts

FLYROCK STUDIES

The proponent-driven April 2020 Blast Impact Analysis prepared by Explotech on behalf of Nelson Aggregate Co. is devoid of any meaningful analysis of the study of flyrock and its potential for *adverse effects*, and no such study has ever been undertaken by the Ministry of Natural Resources and Forestry (MNRN).

According to GEO REPORT No. 260, Halcrow China Limited, 2002,[112] separation distance (setbacks) is the only totally effective safety measure against *flyrock*:

> The only totally effective safety measure [against flyrock] is a minimum clearance distance, acting as a safety zone. In order to determine the required minimum clearance distance, it is necessary to ascertain the 'flying distance', (the distance to which flyrock may be thrown). **The available [flyrock] data is of two types: reported instances and experimental/theoretical estimation**. [emphasis added]
>
> - **Recorded instances**. The data on recorded flyrock projection is based on published HSE and Mines & Quarries Division of GEO data. Both indicate significant numbers of rocks passing beyond 200 m. Very few (4 out of 80, or 5%) travelled beyond 300 m. Only one exceeded 450 m, and this travelled to 800 m. **It should be noted that**

[111] Controlling the Adverse Effects of Blasting – Module 8, Slide 60, https://miningquiz.com/pdf/Blasting/Module_8.pdf.

[112] This report was prepared by Halcrow China Limited in August 2002 under Consultancy Agreement No. GEO 10/98 for the sole and specific use of the Government of the Hong Kong Special Administrative Region, https://www.cedd.gov.hk/filemanager/eng/content_475/er260links.pdf.

these numbers are the minimum number that occurred, being those that were reported. Numerous incidents at shorter ranges (up to 500 m) may not have travelled outside the quarry boundary or may not have caused injury and therefore were not treated as reportable incidents. In the UK, under-reporting by factors of 5 to 10 are considered possible below 500 m (Davis, 1995).

- [In the United Kingdom, over a five-year period, 85 flyrock incidents had been reported and documented: 25 incidents (29%) were between 200 and 300 metres; 15 incidents (17%) were between 300 and 500 metres; 5 incidents (6%) were between 500 and 700 metres; and only one incident (1%) exceeded 700 metres. Overall, 95% of the analyzed flyrock incidents occurred within 600 metres. p. 26[113]]

- **Experimental data**. Research on flyrock was undertaken by the Swedish Detonic Research Foundation (Lundborg et al., 1975). It was summarized in more accessible form by Hoek & Bray (1981) in their textbook "Rock Slope Engineering". It has been established that maximum 'flying distance' is about 540 m for a 200 m diameter (about 15 kg) block. For fragments of 75 to 100 mm size (about 2.5 kg) the maximum range is 410 to 470 m.

From the foregoing, it is apparent that the only absolute guarantee for safety from flyrock is a large minimum clearance distance, the size of which depends on the blasthole diameter in use. The Safety Zone would need to extend 400 to 600 m from the blast. [emphasis added] [pp. 182-83]

- In the United Kingdom, over a five-year period, where incidents of flyrock had been reported and documented, cumulatively 100% of the flyrock incidents occurred within 800 metres of the blast site, as summarized on the chart prepared by *Hill.*[114]

Distance from blast (m)	Number of incidents	Percent of total	Cumulative %
100	17	20	20
200	22	26	46
300	25	29	75
400	7	8	84
500	8	9	93
600	2	2	95
700	3	4	99
800	1	1	100
total	**85**	**100%**	

[113] https://intval.com/articles/Flyrock-and-Other-Impacts-from-Quarry-Blasting-Operations.pdf.

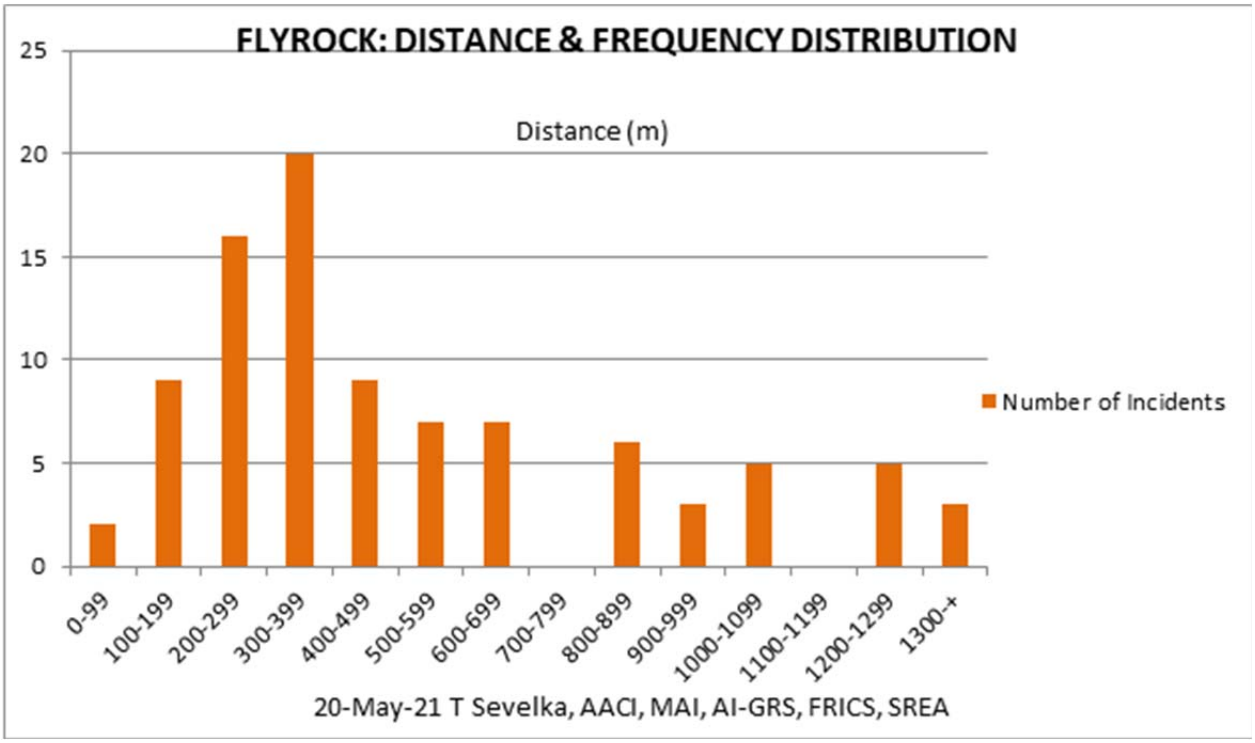
[114] William Hill, "Dangers Proposed To Highway 7 By Hidden Quarry Flyrock," p.7, William Hill Mining Consultants Ltd, 2013, http://sg.crcrockwood.org/wp-content/uploads/2017/01/HQ-Flyrock-Dangers-ref.-Highway-7.pdf.

As reported in an August 5, 2013 news release issued by the publication "Quarry,"[115] in response to a 2011 flyrock incident at Brayford Quarry, the UK *Health and Safety Executive* (HSE) said that,

> **With 3,250 injuries, including 27 fatalities, since 2000, quarrying in the UK remained one of the most dangerous industries to work in.**

A more recent study of discovered *flyrock* incidents undertaken by Sevelka (2021), where the *flyrock* distances are known, resulted in an analysis of 92 *flyrock* incidents. The results of the *flyrock* study, the most comprehensive and largest known of its kind, are as follows:

ANALYSIS OF FLYROCK TRAVEL DISTANCES



An analysis of 92 *flyrock* incidents, where the distance from the blast is known, indicate that 91% (84) of the *flyrock* incidents occurred within 1,099 metres, and 97% occurred within 1,299 metres.

The number of *flyrock* incidents within each interval, starting at between 300 and 399 metres, and the average distance travelled within each interval are summarized as follows:

[115] https://www.quarrymagazine.com/Article/3260/Quarry-blast-goes-drastically-wrong.

- 20 (22%) of the flyrock incidents occurred between 300 and 399 metres (330 metres avg)
- 9 (10%) of the flyrock incidents occurred between 400 and 499 metres.(446 metres avg)
- 7 (8%) of the flyrock incidents occurred between 500 and 599 metres (515 metres avg)
- 7 (8%) of the flyrock incidents occurred between 600 and 699 metres (622 metres avg)
- 6 (7%) of the flyrock incidents occurred between 800 and 899 metres (802 metres avg)
- 5 (5%) of the flyrock incidents occurred between 1200 and 1299 metres (1225 metres avg)
- 3 (3%) of the flyrock incidents occurred over 1300 metres (2307 metres average)

At 80%, which accounts for the first 74 *flyrock* incidents in ascending order, *flyrock* reached a distance of 800 metres, and, at 90%, which accounts for the first 83 *flyrock* incidents in ascending order, *flyrock* reached a distance of 1,020 metres.

The following examples are cited from the 1991 issue of Pit & Quarry,[116] and the documented travel distances of *flyrock* at limestone blasting quarries are from 1,159 feet (353 metres) to 6,292 feet (1,918 metres).

FLYROCK DISTANCE

1,159 feet	(353 metres)
3,063 feet	(934 metres)
4,057 feet	(1,237 metres)
4,057 feet	(1,237 metres)
5,050 feet	(1,539 metres)
6,292 feet	(1,918 metres)

Blasting is an ultrahazardous or inherently dangerous activity, and flyrock is the ultimate adverse effect. As noted in in *Macdonald v. Construction LTEE et al.*, (1972),[1]

> **…[T[he use of explosives, on the balance of probabilities, does involve danger to another's property. I cannot see how anyone can possibly describe such an operation as not being, in the language of the cases on the subject, "extra hazardous" or "inherently dangerous."** [emphasis added] (Citing *J. P. Porter Co. Ltd. v. Bell*, [1955] 1 D.L.R. 62, 35 M.P.R. 13, and *Rylands v. Fletcher*, [1868] UKHL 1)

The United States District Court reached a similar conclusion in *Boyce v. United States, D.C.*,

> **Surely it is a matter of common knowledge, and we accord judicial notice to the fact, that blasting by use of dynamite or other explosives is a hazardous activity and as such likely to damage others.** See *Boyce v. United States*, D.C., 93 F.Supp.

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[116] ISMR Blasters Workshop, Jasper, Indiana, December 7, 2009, PowerPoint presentation, Slide 14, https://www.in.gov/dnr/reclamation/ISMR/2009/BLASTING/Clark/ISMR_Blasters_Workshop.ppt.

[1] *Macdonald v. Desourdy Construction LTEE et al.*, 1972 CanLII 1150 (NS SC), <https://canlii.ca/t/gwg69>, retrieved on 2021-08-17.

866, 868; 31 C.J.S. Evidence § 9, **page *226 824; and 29 Am.Jur.2d, Evidence, section 23, page 60.** [emphasis added]

Over various timeframes, the percentage of injuries attributed to ***reported*** flyrock incidents by the following authors ranges from 19.05% (Verakis and Lobb)[117] to 68.20% (Little),[118] as reported by Raina, et al. (2015. p. 661).[119]

Table 2. Accident statistics of reported flyrock cited by different authors

Reference	Period	Blasting injuries	Percentage of flyrock injuries in blasting related accidents
Mishra and Mallick[11]	1996–2011	30	24.19
Verakis[10]	2010–2011	18	38.00
Bajpayee *et al.*[9]	1978–1998	281	40.57
Verakis and Lobb[19]	1994–2005	168	19.05
Little[20]	1978–1998	412	68.20
Kecojevic and Radomsky[21]	1978–2001	195	27.69
Adhikari[22]	–	–	20.00

Research undertaken in 2021 by Dataphyte found that the incidence of flyrock is underreported globally:[120]

> Dataphyte reviewed that globally, the majority of flyrock incidents go unreported or unnoticed, and in most jurisdictions, **incidents of flyrock that do not leave the blast area or that do not cause injury or death within or outside the blast area are not officially reported**. [emphasis added]

- **According to *Davis* (1995), under-reporting of flyrock incidents is responsible for five to ten times the actual number of flyrock incidents**.[121]

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[117] Verakis, H. and Lobb, T., "*Flyrock revisited an ever present danger in mine blasting*," 2007; http://docs.isee.org/ISEE/Support/Proceed/ General/07GENV1/07v109g .pdf.

[118] Little, T. N., "*Flyrock risk*". In Proceedings of EXPLO Conference, Wollongong, NSW, 3–4 September 2007, pp. 35–43, https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-2570%2120191217T043417.551%20GMT.

[119] Avtar K. Raina, V.M.S.R. Murthy and Abhay Soni, "Flyrock in surface mine blasting: Understanding the basics to develop a predictive regime," *Current Science* (Vol. 108, No. 4, 25, February 2015): 660-665.

[120] Samad Uthman, Into the 'cracks' Land (1): RCC Blasts Rocks for Lagos-Ibadan Road Construction, But Ogunmakin Suffers the Injury, *Dataphyte*, Nov 12, 2021, https://www.dataphyte.com/latest-reports/climate/into-the-cracks-land-1-rcc-blasts-rocks-for-lagos-ibadan-road-construction-but-ogunmakin-suffers-the-injury/

[121] T.N. Little, "*Flyrock Risk*," EXPLO Conference, Wollongong, NSW, 3-4 September 2007, https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-2570%2120191217T043417.551%20GMT.

- **According to *Raina et al.* (2015), the amount of research conducted on flyrock is "abysmal,"[122] and the percentage of accidents occurring due to flyrock justifies its importance irrespective of the fact that the problem is seldom reported.** [123]
- Flyrock that lands harmlessly in a field may not appear to be a large issue. However, mowing and tilling become hazardous when rock is struck by farm equipment.
- Flyrock through timber stands mars trees and potentially impacts their market value.
- **Flyrock is the number two killer in mining operations.**

DEADLY CONSEQUENCES OF FLYROCK (SENSITIVE RECEPTORS, I.E., HUMAN TARGETS)

Listed as follows is a sample of *flyrock* incidents at different blasting quarries in various geographic locations, which have killed onsite quarry employees, offsite residents while in or outside their homes, off-site employees and customers in places of business, children in schools, pedestrians while walking near quarries, and occupants in vehicles on roads near quarries.

- **Flyrock 6:** On March 22, 2016, a blast at a quarry launched *flyrock* debris 366 metres that penetrated a pickup truck striking and killing 42-year old Tracy Hockemeier, a quarry employee positioned 366 metres from the blast and preventing others from entering the blast area.

- **Flyrock 12:** On July 19, 2013, a blast at a quarry showered *flyrock* debris as far as 1,000 metres that damaged 18 cars and 14 factories; injured 10 workers and residents in a housing estate; and struck and killed a factory worker in his 30s in a factory penetrated by numerous rocks at a distance of 500 metres.

- **Flyrock 34:** On June 4, 1993, a blast at a surface mine launched a large amount of *flyrock* debris approximately 91 metres that struck a car on Interstate 75, Tennessee, and 16-year old Brian Agujar, a passenger in the car driven by his parents, was killed as a result of the *flyrock* impact.

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[122] Raina, A. K., Soni, A. K. and Murthy, V. M. S. R., "*Spatial distribution of flyrock using EDA: An insight from concrete model tests. In Rock Fragmentation by Blasting* (eds Singh, P. K. and Sinha, A.)," Taylor and Francis, London, 2013, pp. 563–570.

[123] Davies, P. A., "*Risk based approach to setting of flyrock danger zones for blasting sites*," *Trans. Inst. Mines Met.*, May–August 1995, 96–100.

The blaster was sent to prison for five months. (Prior *flyrock* incident occurred in April 1992.)[124]

- **Flyrock 36:** On July 11, 1990, a blast at a quarry launched *flyrock* debris 283 metres that struck a resident who was mowing grass on his property, who later died on July 17, 1990 from head injuries.

- **Flyrock 38:** On April 5, 2017, a blast at a quarry launched *flyrock* debris 280 metres that struck and killed the blaster's helper.

- **Flyrock 40:** On December, 21, 1999, a blast at a quarry launched *flyrock* debris that struck 32-year old Lee Messner, a quarry equipment operator, at 244 metres, who subsequently died from his internal injuries, with *flyrock* debris also damaging a building at 457 metres from the blast. Messner left behind a wife and one child. (Prior *flyrock* incident occurred in 1996.)[125]

- **Flyrock 41:** On August 15, 2019, a blast at a quarry launched *flyrock* debris, some of which bore through the roof of a home and struck and killed 36-year old Shupikai Chitsana while in her kitchen, and her aunt was also struck by *flyrock*, but she survived. Shupikai leaves behind her five children and husband.

- **Flyrock 48:** On July 15, 2015, a blast at a quarry launched *flyrock* debris 200 metres that struck and killed a factory worker, and seriously injured two others. *Flyrock* debris also struck a building at 50 metres, and damaged and destroyed several vehicles 150 metres from the blast site.

- **Flyrock 68:** May 27, 2020, a blast at a quarry launched *flyrock* debris that struck and killed 10-year old M. Nanhini, and that struck and injured her brother Soundarrajan.

- **Flyrock 74:** On July 16, 2007, *flyrock* fragments from a quarry blast were launched 483 metres and struck and killed 40-year old Bobby Messer, a quarry mechanic, and damaged the mechanic's truck. Messer is survived by his wife and three children.

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[124] Courtney W. Shea and Dennis Clark, "Avoiding Tragedy: Lessons To Be Learned From A Flyrock Fatality," © 2020, *International Society of Explosives Engineers*, https://www.osmre.gov/resources/blasting/docs/Flyrock/1993SugarRidgeFatality.pdf.
[125] MSHA - Metal and Nonmetal Mine Fatal Accident Investigation Report: 12/21/1999.

- **Flyrock 86:** On December 4, 2013, a blast at a quarry launched *flyrock* debris, including a 96-pound boulder that struck and killed 63-year old Stephen Hetzler, an experienced blaster, standing 47 metres from the blast. Investigators determined the *flyrock* was travelling approximately 400 miles per hour (644 kilometres per hour).

- **Flyrock 94:** On December 13, 2017, a blast at a quarry showered *flyrock* debris over an area of 800 metres, striking and killing 71-year old Ronald Sutherland (an experienced blaster), injuring five people, wrecking 10 vehicles, significantly damaging 14 houses and causing minor damage to 20 other houses.

- **Flyrock 100:** One July 16, 1997, a blast at a quarry launched one employee, Skip Sibley, over a quarry ledge, leaving him seriously injured with face and chest burns, and another employee, Joel Kanute, had his body impaled by *flyrock* debris, killing him instantly. Both were experienced blasters.

- **Flyrock 103:** In 2015, a blast at a quarry launched *flyrock* debris that struck and killed a baby on her mother's back, and "the child was ripped in half" by the force of the impact from the flying rock. The baby's mother and a motor rider were also struck by *flyrock* and sustained injuries.[126]

- **Flyrock 104:** On April 12, 2007, a blast at a quarry launched *flyrock* debris 300 metres that struck and killed a 12-year old boy standing in his courtyard.

- **Flyrock 114:** On February 28, 2021, a blast at a quarry in Senemal village of Lakhanpur Block, launched *flyrock* debris that struck 36-year-old Harekrishna Bhoi, a supervisor at the quarry. Bhoi died after being struck on the head by *flyrock* debris. [127]

- **Flyrock 121:** On September 19, 2011, a blast at a quarry near Perne in India, launched *flyrock* debris that struck 18-year-old Balu Namdeo

[126] "Joma residents protest as CP's quarry operations kills baby," *3News*, August 15, 2015, Joma residents protest as CP's quarry operations kills baby | 3NEWS.
[127] "1 killed in Jharsuguda quarry blast," *the pioneer*, March 3, 2021, https://www.dailypioneer.com/2021/state-editions/1-killed-in-jharsuguda-quarry-blast.html.

Kolpe, a shepherd who was tending his sheep. Kolpe was struck in the head and "died on the spot."[128]

- **Flyrock 153:** On November 19, 2017, a blast at a quarry in Katombola, Southern Province, launched *flyrock* debris 50 metres that struck and killed an 11-year old boy on the spot (ripping his stomach, cutting his head and breaking his ribs) and seriously injured three other children, aged four and seven.[129]

- **Flyrock 154:** On May 29, 2021, a blast at a quarry in Chittoor, launched *flyrock* debris 500 metres that struck and killed 25-year-old Jakir, a daily wager who had just completed loading mangoes into a trailer at a mango orchard abutting the quarry.[130]

- **Flyrock 155:** Sometime in the early 1990s, a blast at a quarry in Coboconk, Ontario, launched *flyrock* debris that penetrated the roof of a man's home, striking and killing the homeowner. A Coroner's Inquest followed. (Source: Retired Legal Counsel. This is the same *flyrock* incident cryptically alluded to during the MOE investigation of the two *flyrock* incidents at the Pakenham Quarry in 2009.)

- **Flyrock 158:** On February 6, 2000, a blast at the Makkah Quarry, Saudi Arabia, launched *flyrock* debris that showered a nearby shopping district, killing an Egyptian passer-by and injuring five others.[131]

- **Flyrock 159:** On June 21, 2021, a blast at a quarry in Thrissur, India, launched *flyrock* debris that struck and killed Abdul Naushad, the brother of the quarry owner, injured five others, and damaged several houses.[132]

- **Flyrock 160:** On March 14, 2018, a blast at a quarry in Kiyuni Sub County launched *flyrock* debris that penetrated a public school at a distance beyond 250 metres, and struck Sylvia Gwoliranye, a 14-year-

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[128] "Stone from quarry blast kills 18-year old," *The Times of India*, Sept 21, 2011, https://timesofindia.indiatimes.com/city/pune/stone-from-quarry-blast-kills-18-year-old/articleshow/10058714.cms.

[129] Funga, Mukosha. "Quarry flying stone kills nearby juvenile," *News Diggers*, November 20, 2017, https://diggers.news/local/2017/11/20/quarry-flying-stone-kills-nearby-juvenile/.

[130] Pradesh, Andhra. "One killed in quarry blast in Chittoor," *The Hindu*, May 29, 2021, One killed in quarry blast in Chittoor - The Hindu.

[131] "One Killed, Five Injured in Makkah Quarry Blast," *Kuwait News Agency (KUNA)*, 06/02/2000, https://www.kuna.net.kw/ArticlePrintPage.aspx?id=1058118&language=en.

[132] "One killed, five injured in quarry blast in Thrissur," *Kaumudi Online*, 21 June, 2021, https://keralakaumudi.com/en/news/news.php?id=576544&u=.

old pupil at the school. Sylvia was struck in the head by the *flyrock* while seated in class, and eventually died after losing a lot of blood.[133]

- **Flyrock 161:** On September 4, 2020, a blast at a construction site at Gochas in the Hardap region launched *flyrock* debris that struck 50-year-old Anna Ida Jaars in the head, killing her while sitting outside a house, at a distance of 700 metres from the blast site.[134]
- **Flyrock 162:** On March 27, 2020, a blast at KTH Quarry in Kampong Speu Province launched a 5 kg rock that penetrated the roof of an onsite office, more than 70 metres from the blast site, and struck 20-year-old Chhoeun Sopheak, a company administrator, who succumbed to his injuries while being transported to a hospital.[135]
- **Flyrock 163:** On May 27, 2016, a blast at a stone quarry at Gaurhari village of Mahoba district, launched *flyrock* debris that showered and killed four quarry labourers, and critically injured one.[136]

Another flyrock incident had the potential to injure and kill a number of students travelling in a school bus passing a quarry, a parent's worst nightmare.

- **Flyrock 76:** A quarry blast sent an 80-pound boulder crashing into a school bus on the New York Thruway on its way to a Toronto music contest carrying 52 band and choral students and striking three students, two of which were injured and were taken to the hospital. A man driving eastbound on the same Thruway was also struck and injured by flyrock. The flyrock incident was ***Termed by many as the Blasting Industry's worst Nightmare!***[137]

In another flyrock incident, blasting launched flyrock debris in more than one direction, landing in an industrial park and on the runway of an airport, which had the potential to injure and kill a significant number of people.

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[133] "Stone from quarry hits, kills pupil inside class," *Daily Monitor*, March 15, 2018, https://www.monitor.co.ug/uganda/news/national/stone-from-quarry-hits-kills-pupil-inside-class-1745402.

[134] Cloete, Luqman. "Family wants redress after flying rock kills woman," *namibian*, Sept 9, 2020, https://www.namibian.com.na/204296/archive-read/Family-wants-redress-after-flying-rock-kills-woman.

[135] "Office Worker Killed After Quarry Blast," *Cambodia News English*, March 28, 2020, https://cne.wtf/2020/03/28/office-worker-killed-after-quarry-blast/.

[136] Xinhua. "Blast inside stone quarry kills 4 in India," *The Citizen*, May 27, 2016, https://www.citizen.co.za/news/news-world/1135041/blast-inside-stone-quarry-kills-4-in-india/.

[137] Lawrence J. Mirabelli, Blasting Safety, *Quarry Academy*,

- **Flyrock 24:** A quarry blast showered flyrock debris 3,000' (914 metres) on an industrial park doing damage to a building and 11 vehicles in the Technica USA parking lot, and flyrock debris was showered 4,000' (1,219 metres) in another direction landing on a runway of West Lebanon Airport (Flyrock 24 – June 11, 2007).

The government of Mumbai, India, explicitly acknowledges the dangers associated with a blasting quarry operation and the potentially deadly consequences of flyrock:

- ***As per Directorate General of Mines Safety circular no. DGMS (SOMA)/(Tech) Cir No. 2 of 2003 Dt. 31/01/20003 (Annexure II), on subject of Dangers due to blasting projectiles [flyrock debris], all places within a radius of 500 m from the place of firing [blasting] to be treated as danger zone and accordingly, all person in danger zone to take protection in substantially built shelter at the time of blasting.***

- ***The regulations for danger zone (500 m) prescribed by Directorate General of Mines Safety also have to be complied compulsorily and necessary measures should be taken to minimize the impact on the environment.***

According to a 1979 study prepared on behalf of the United States Department of the Interior Bureau of Mines,[138] flyrock is the greatest single hazard in blasting quarry operations, and the determination of "blasting area" is purely "qualitative." ("Flyrock incidents occur wherever there is hard rock mining," Eze & Usani, 2014[139])

> By far the greatest single hazard in surface mine blasting operations is flyrock. Flyrock accounts for approximately half of all blasting –related accidents in surface mines for somewhat more than one-third if fall of ground accidents are also include in blasting-related accidents. Clearly, improved blasting practices and more definitive blasting regulations are still needed to minimize the flyrock hazard.
>
> Section 57.2 of MESA's Metal and Nonmetal Health and Safety Regulations (CFR 30) defines blasting area as "the area near blasting operations in which concussion or flyring material can reasonably be expected to cause injury." **Note that this definition is entirely qualitative. It gives the blasting foreman no clue on how far to move**

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[138] "A Model for the Determination of Flyrock Range as a Function of Shot Conditions," https://files.dep.state.pa.us/Mining/BureauOfMiningPrograms/BMPPortalFiles/Blasting_Research_Papers/Flyrock/Flyrock%20Range%201979.pdf.

[139] C. L. Eze and U. U. Usani, "Hard Rock Quarry Seismicity and Face Bursting Flyrock Range Prediction in the Granite and Migmatites Rocks of North Central Nigeria," *Int. Journal of Engineering Research and Applications* (December 2014): 1-6. https://www.researchgate.net/profile/Eze_Chibuogwu/publication/274008421_Hard_Rock_Quarry_Seismicity_and_Face_Bursting_Flyrock_Range_Prediction_in_the_Granite_and_Migmatites_Rocks_of_North_Central_Nigeria/links/5525b22f0cf295bf160eae0e/Hard-Rock-Quarry-Seismicity-and-Face-Bursting-Flyrock-Range-Prediction-in-the-Granite-and-Migmatites-Rocks-of-North-Central-Nigeria.pdf?origin=publication_detail.

personnel and equipment from the blast. [emphasis added] Section 57.6-160 states: "Ample warning shall be given before blasts are fired. All persons shall be removed from the blasting area unless suitable shelters are provided to protect men endangered by concussion or flyrock from blasting." The second part of this regulation is difficult to enforce because a quantitative definition of blasting area is lacking. Clearly, Federal or State inspectors at present have no adequate means of checking compliance with 57.6-160 and similar state regulations.

HERE IS WHAT A FLYROCK INCIDENT SOUNDS AND LOOKS LIKE

Most people, including planners, appraisers, mortgage lenders and real estate brokers/salespersons have never heard of flyrock and have no understanding of the dangers flyrock from quarry blasting poses to anyone in proximity to a blasting quarry.

Having knowledge of a quarry does not constitute informed consent nor imbue a prospective purchaser with an understanding of the deleterious impacts of a blasting quarry on property values, quality of life, and health, safety and welfare. In fact, uninformed purchasers of property near a blasting quarry overpay, meaning that their purchase prices do not meet the definition of market value, as one of the conditions of market value requires that *both parties be well-informed or well-advised*.

Market Value is defined as,[140]

The most probable price as of a specified date, in cash, or in terms equivalent to cash, or in other precisely revealed terms, for which the **specified property rights** should sell after reasonable exposure in a competitive market under all conditions requisite to a fair sale, with the buyer and seller each acting prudently, knowledgeably, and for self-interest, and assuming that neither is under undue duress. [emphasis added]

Implicit in this definition is the consummation of a sale as of a specified date and the passing of title from seller to buyer under conditions whereby:

- Buyer and seller are typically motivated;
- **Both parties are well informed or well advised, and acting in what they consider their best interests**; [emphasis added]
- A reasonable time is allowed for exposure in the open market;
- Payment is made in terms of cash in [Canadian] dollars or in terms of financial arrangements comparable thereto; and
- The price represents the normal consideration for the property sold unaffected by special or creative financing or sales concessions granted by anyone associated with the sale.

- The majority of the people living in the community moved into the area with knowledge of the existing quarry (Slide 8, Planner Zeman's December 10, 2020 webinar advocating for Nelson Aggregate Co.'s

[140] *The Dictionary of Real Estate Appraisal, 7th Edition (2022*); The Appraisal Institute, p. 118.

proposed blasting quarry expansion.[141]) Zeman never interviewed any of the people who purchased properties in the communities surrounding the existing quarry or communities surrounding blasting quarry operations in other municipalities.

- No prospective purchaser with full knowledge of the deleterious effects of a quarry accompanied by blasting below the water table would ever have chosen to purchase a residential property in proximity to Nelson's existing quarry in the City of Burlington (or any other quarry).

- Neither Zeman's April 2020 proponent-driven Planning Justification Report nor his December 10, 2020 promotional webinar ever mention flyrock, even though flyrock is the ultimate *adverse effect* of a blasting quarry operation, as flyrock has the potential to injure and kill human and non-human life. Zeman knew or ought to have known about the dangers of flyrock, and, as a member of the Ontario Professional Planners Institute, he had a duty to protect the public interest, which he failed to do.

Here is a link to a YouTube video of a quarry blast gone horribly wrong, with flyrock debris scattered everywhere and how close 12 people came to death, which the quarry operator attempted to conceal:

https://www.youtube.com/watch?v=bUf9tZUMb0g

> "On 10 April 2018, twelve people were at risk of being struck by flyrock during an overburden blast conducted at Albury Quarry. Those at risk included members of the public, workers and a shotfirer [blaster] who were at the firing location at the time of blasting. The members of the public included the partner and three friends of the quarry manager and a visiting truck driver.
>
> At the time of the blast, four people were about 275 metres from the loaded shot that was to be fired (the blast area). The other people, including the shotfirer, were about 320 metres from the blast area. Multiple rocks were launched into the air by the blast. Most of those present were forced to take evasive action to avoid being struck. Three light vehicles and two excavators in the immediate vicinity of these people were struck by flyrock. A piece of rock measuring approximately 400 x 200 x 200 millimetres struck the shotfirer's [blaster's] utility, knocked the vehicle's raised bonnet off its mounts, smashed through the front windscreen and landed on the driver's seat.
>
> **After the incident, those present were asked to delete video footage of the blast**. The incident was not reported to the NSW Resources Regulator until 7 September 2018. The circumstances of the incident, including the number of people present and the

[141] https://www.halton.ca/getmedia/bbb0d95f-dfba-45a5-ac8e-34fdb263fefa/Nelson-Region-Public-Information-Session-December-10-2020.aspx.

> amount of flyrock produced, were not made known to the Regulator until video footage of the incident was received in November 2018." (See Investigation Report: https://www.resourcesregulator.nsw.gov.au/__data/assets/pdf_file/0003/1248519/Investigation-report-Dangerous-Shotfiring-Incident-Albury-Quarry-10-April-2018.pdf) [emphasis added]

FLYROCK IS AN UNAVOIDABLE BY-PRODUCT OF QUARRY BLASTING.

The only way to avoid injury or death to human and non-human life, harm to the environment, and damage to personal and real property from flyrock is to impose mandatory minimum setback requirements, which must be provided by the proponent and not innocent neighbouring third-party property owners, who are not under any legal obligation to subsidize a private for-profit quarry operation without compensation for the illegal use of private third-party property (i.e., a de facto expropriation).

Blasting is an ultrahazardous activity, and Flyrock is the most dangerous aspect of blasting quarry operations, and is considered the ultimate ***adverse effect***. Flyrock is also a contaminant under the Environmental Protection Act.

> **As noted, of the 163 discovered flyrock incidents, 26 incidents of flyrock ended in loss of life (29 people were killed), resulting in a "kill" rate of 16%. An additional 36 people were injured in the 26 flyrock incidents that resulted in loss of life**. (See Preventing Consequences of Flyrock, Oct. 31, 2021, p. 9)

Attached are two Power Point presentations on flyrock, the ultimate adverse effect of a blasting quarry. The Power Point presentations (Sevelka and Hill) were presented to members of Gravel Watch (June 27, 2021).

> **Flyrock meets the Ontario EPA definition of contaminant, and the *adverse effects* are not trivial. In *Castonguay Blasting Ltd. v. Ontario (Environment)*, 2013 SCC 52 (CanLII), [2013] 3 SCR 323**, <https://canlii.ca/t/g1038> **the Supreme Court held that "the flyrock could easily have seriously injured or killed someone."**

- **Why is there no definition of "flyrock" in the Aggregate Resources Act**? (**A problem that is undefined has no solution, and demonstrates a lack of credibility**.)
- **What studies, if any, has MNRF undertaken in connection with "flyrock"**? (**See Preventing Consequences of Flyrock, Oct 31, 2021, p. 4-5, which documents the "throw" distances of "flyrock" in three independent studies**.)
- **Why is it that a "blaster" at a quarry in Ontario does not require a licence**? (**Even a hair stylist requires a licence**.)

- **Why does MNRF permit an onsite (unlicenced) "blaster" to arbitrarily decide the setback (i.e., safety zone) before each blast, which effectively amounts to a floating setback that puts innocent third-parties (onsite and offsite) at risk of "flyrock?**

- Oversight of the aggregate industry, either by the Ministry of Natural Resources and Forestry (MNRF) or the Ministry of the Environment and Climate Change (MOECC), has been ineffective. For example, only in response to a reported flyrock incident at the Miller Braeside quarry (Arnprior, Ontario) by a local resident on September, 10, 2021,[142] was an onsite inspection of the quarry undertaken by the Ministry of Northern Development, Mines, Natural Resources and Forestry (MNDMNRF), which revealed that

> **Miller…had failed to comply with several orders placed on it five years ago – after losing a civil suit to residential neighbours. It failed to create a proper berm to reduce noise and dust; it had concrete blocks located in the wrong area: and it didn't have fuel tanks on a concrete pad. The latter – should a spill occur – is to prevent contamination of an aquifer that provides water to many homes**.[143] [emphasis added]

- **<u>What measures has MNRF undertaken or proposes to undertake to protect the public (innocent third-parties), including onsite employees, from flyrock, the ultimate *adverse effect* of a blasting quarry operation, without innocent third-parties (or their estate) being forced to seek legal recourse in the courts at considerable time and expense</u>?**

Since it is well documented that flyrock debris comes in all manner of size, shape and weight,[144] and can be launched in **<u>all</u>** directions[145] at great

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[142] <u>Two previous flyrock incidents are known to have occurred at the Miller Braeside quarry: one in 2005 and the other in 2007, with flyrock reaching a distance of over 400 metres from the blast site, and striking a house and vehicle The 300-metre setback imposed on the quarry site pursuant to Township of McNab/Braeside By-law 2015-03 proved inadequate</u>. See https://www.omb.gov.on.ca/e-decisions/pl130785-Oct-27-2015.pdf.

[143] Dunn, Derek. "Inspection reveals violations at site of Arnprior blasting," *InsideOttawaValley.com*, January 6, 2022, https://www.insideottawavalley.com/news-story/10546385-inspection-reveals-violations-at-site-of-arnprior-blasting/.

[144] "<u>Persson et al. [1994] referenced flyrock weighing approximately three tons [6,000 pounds] thrown a distance of 980 ft [299 metres]</u>," https://www.cdc.gov/niosh/mining/userfiles/works/pdfs/apfasbo.pdf. [emphasis added]

[145] A January 31, 2003 memorandum from the Directorate General of Mines Safety (DGMS) to "All Owners, Agents & Managers of mines" detailed an incident of *flyrock*, which travelled in the <u>opposite</u> direction of the planned blast, striking and killing an employee at a distance of 412 metres from the face of the quarry.

velocity,[146] [147] at a considerable distance from the blast site, the **useless** statement in the ARA that follows gives the aggregate industry free reign to engage in indiscriminate blasting, an ultrahazardous activity held to strict liability,[148] and to unleash untold carnage on the environment and vulnerable sensitive receptors (i.e., code for human targets and non-human life).

> **A licensee or permittee shall take all reasonable measures to prevent fly rock from leaving the site during blasting if a sensitive receptor [i.e., code for human target] is located within 500 metres of the boundary of the site (Ontario Regulation 244/97, Rule 28, subsection 0.13 (1).**

The only obvious and logical inference from this statement is that flyrock is a concern within 500 metres from the boundary of the quarry site, and that a permanent minimum onsite setback of 500 metres should be imposed on every blasting quarry operation, rather than a floating setback arbitrarily selected by an (unlicenced) blaster before every blast. No such setback is provided (recommended) in the proponent-driven studies prepared by the so-called experts on behalf of Nelson Aggregates.

> **An explosion at a gravel operation on Vancouver Island caused serious injuries to one employee and minor injuries to two others. The incident occurred at Mid-Island Aggregate…Three employees were injured when a dynamite blast went wrong and sent baseball-sized chunks of rock flying approximately 400 to 500 metres…."Within the quarry, we have employees doing various functions," added Thiessen. "When there is a blast, they all move into a safe area." Despite these precautions, a woman in her 50s had her arm severed below the elbow, after a rock hit her right arm, as she made an effort to shield herself from the debris. Two men were also hit, when they tried to take cover under an excavator. One man suffered head injuries and it is believed that he could have been killed if he wasn't wearing a hard hat. The third employee's injuries were more minor but all three were taken to Victoria General Hospital. It is understood that when the charge was**

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[146] "The effects of flyrock do not decrease with distance: a 200-gram projectile can be fatal at 20 m, as it can at 1,000 m," p.8, SAFEX NEWSLETTER no.61, Quarter 2 June 2017, https://www.ime.org/uploads/public/SAFEX%20Newsletters/SAFEX%20Newsletter-61.pdf. [underscoring added]

[147] Flyrock can reach speeds of 400 miles (644 kilometers) per hour, Flyrock Hazard Alert, *Virginia Department of Mines Minerals and Energy (DMME)*, https://www.energy.virginia.gov/mineral-mining/documents/SAFETY/ALERTS/blastingflyrock/FlyrockHazardAlert.pdf.

[148] "Courts have often identified blasting (the controlled use of explosives to break down or remove rocks) as the paradigm of an abnormally dangerous activity because of its inherent dangers, and they applied strict liability in cases where blasting resulted in physical harm. The victims of physical harm resulting from blasting were often totally innocent and uninvolved in the activity, while the persons conducting the blasting were doing so for their own financial benefit and were well-aware of the risks. Courts therefore took the position that defendants should be held strictly liable for any harm caused by projected debris [e.g., flyrock]. See Restatement (Third) of Torts § 20, cmt.(e) (2009)." https://www.law.cornell.edu/wex/abnormally_dangerous_activity.

> **set, the three workers were expecting the debris to fly high in the air and fall to earth, as they watched from a 'safe zone' about 200 metres away. However, when the explosion detonated, a shower of jagged rock came hurtling towards them. "The debris did not fly in an arcing pattern. The explosion was severe enough that it flew horizontally," said Peter Thiessen, the company's chief financial officer.[149]**
>
> **Tracy L. Hockemeier, Leadman, age 42, was fatally injured on March 22, 2016, when he was struck by fly rock during blasting operations in the Winterset section of Plant 862. Hockemeier was sitting in a pickup truck, approximately 1,200 feet {366 metres] from the blast sit, preventing others from entering the blast area. When the blast was initiated, fly rock was propelled upward, landing on and penetrating the roof of the truck and striking the victim.**
>
> **The accident occurred as a result of multiple factors, including geology of the blast area, the condition of and loading of blast holes, and failure to communicate between the mine operator and contractor blasters. The mine operator and contractors failed to ensure that the blast area was cleared, or adequate shelter taken, prior to initiating the shot. The victim was not task trained for evaluating blast area clearance or blasting procedures.[150]**

According to expert testimony presented during the Ministry of Environment's (MOE) investigation of two unreported flyrock incidents in July 2009 at Pakenham Quarry, near Arnprior, Ontario, where flyrock debris was launched over 300 metres striking two parked vehicles (on the edge of the quarry) and a worker at a neighbouring business,[151] and a 500-metre setback was recommended, the expert stated that,

> **Any experienced blaster would have had the same fly rock incident take place." "There is no technology to identify anomalies in rock such as mud seems or voids." "90% of all fly rock incidents are unexplainable." "[The expert] advised 'that the hazard zone [for Pakenham Quarry] be increased to 500 m when firing any future blasts…'**

SETBACKS, BUFFER ZONES AND SEPARATION DISTANCES PREVENT INCOMPATIBLE USES AND ADVERSE EFFECTS (NUISANCES AND TRESPASS)

Setbacks or buffer zones for blasting quarries vary from 500 metres to 1,000 metres in the following jurisdictions:

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[149] "Gravel quarry explosion injures three," *hazardex*, 28 September 2011, https://www.hazardexonthenet.net/article/45269/Gravel-quarry-explosion-injures-three.aspx.

[150] Final Report – Fatality #3 – March 22, 2016, https://www.msha.gov/data-reports/fatality-reports/2016/fatality-3-march-22-2016/final-report.

[151] *R. v. Austin Powder Ltd.*, ONCJ, 2014 (Charges under the Environmental Protection Act LSB File No. 11-8155).

Setback/Buffer Zone

- Nigeria (min. safe distance from residence) : 3,000 metres[152]
- Nigeria (discomfort or nuisance) : 1,000 metres[153]
- Algonquin Highlands, Ontario : 1,000 metres[154]
- St. John's, Newfoundland and Labrador : 1,000 metres[155]
- Nova Scotia, Canada : 800 metres[156]
- Palm Springs, California : 805 metres[157]
- New Brunswick : 600 metres[158]
- Quebec, Canada : 600 metres[159]
- India : 500 metres[160]

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[152] "A person shall not locate a quarry or engage in blasting within three kilometers (3km) [3,000 metres] of any existing residential, commercial or industrial area," https://standards.lawnigeria.com/2020/08/21/national-environmental-quarrying-and-blasting-operations-regulations-2013/

[153] "A person shall not blast in such a way that the impact of such blast will cause any form of discomfort or nuisance to the public and residents within 1,000 meters from the epicenter of the site or users of the roads thereof," https://standards.lawnigeria.com/2020/08/21/national-environmental-quarrying-and-blasting-operations-regulations-2013/.

[154] Algonquin Highlands Official Plan, By-law 2018-75, approved Nov 28, 2018, restricts blasting quarry operation to areas ***farther than 1,000 metres from a residential or sensitive land use; farther than 1,000 metres from a boundary of a Settlement Area; and farther than 1,000 metres from the Waterfront designation.***

[155] "The minimum Buffer adjacent to a Mineral Working shall be 1000 metres where blasting occurs," Development Regulations 6.23 (Mineral Working), https://stjohns.ca/sites/default/files/files/publication/Envision%20Development%20Regulations%20January%202022_0.pdf.

[156] "The NSE *Pit and Quarry Guidelines* (1999) stipulated setbacks to prevent structural and environmental damage as well as the requirements for pre-blast surveys, blast monitoring, and blast designs. The setback between blasting for a quarry and structures is 800 m. "http://www.scotianmaterials.info/quarry.html#:~:text=The%20setback%20between%20blasting%20for,800%20m%20of%20the%20Project..

[157] "Quarry operations shall not be closer than one-half (1/2) mile [805 metres] from any residential zone and not closer than 100 (100) feet [xxx metres] to any property line." Palm Springs, California Municipal Code, ZONING CODE, https://library.qcode.us/lib/palm_springs_ca/pub/municipal_code/item/zoning_code-chapter_93_00-93_23_03.

[158] "k) 600 metres from any drinking water supply well, unless the written permission of the owner(s) within the 600 metres is obtained and submitted to the Department for acceptance….", Department of Environment and Local Government, Rock Quarry Siting Standards, https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Air-Lair/RockQuarrySitingStandards.pdf.

[159] "11. The operating site of a new quarry must be located at a minimum distance of 600 m from any dwelling, unless the dwelling is owned or rented to the owner or operator of the quarry." 10. It is prohibited to establish a new…quarry, the operating site of which is located in a territory zoned by the municipal authorities for residential, commercial or mixed purposes (commercial residential0. It is also prohibited to establish a new quarry less than 600 m from such territory…", http://legisquebec.gouv.qc.ca/en/ShowDoc/cr/q-2,%20r.%207.

[160] "As per Directorate General of Mines Safety circular n. – DGMS (SOMA)/(Tech) Cir. No. 2 of 2003 Dt. 31/01/2003 (Annexure ll), on subject of **Dangers due to blasting projectiles**, all places within the radius of **500 m** from the place of firing to be treated as danger zone and accordingly, all person in danger zone to take protection in substantially built shelter at the time of blasting." "The regulations for danger zone (500 m) prescribed by Directorate of Mines…have to be complied with compulsorily and necessary measures should

- Malaysia : 500 metres[161]
- Victoria, Australia : 500 metres[162]

Even other land uses where potential *adverse effects* are substantially less severe and dangerous on *sensitive land uses* and *Settlement Areas* than those associated with a quarry, accompanied by blasting below the water table, require a significant separation (setback) distance ranging from **500 metres** (Cannabis Production) to **2,000 metres** (Cannabis Facility outdoor production) to avoid land use incompatibility. Even a ***human-made hazard*** such as a "fireworks" display, with its *adverse effects* and its potential to launch deadly "projectiles" requires a minimum safe distance of **300-metres** from all "**vulnerable occupancies**" in the Town of Caledon.

- In Ontario, pursuant to the Renewable Energy Approval Regulation O. Reg. 359/09,[163] the **minimum setback is 550 metres between wind turbines and noise receptors at buildings where permanent or seasonal residency is possible and likely to occur**. [emphasis added]

- A kennel and all associated structures (such as buildings, structures, fencing, and runs) must be setback a minimum of **600 m from any settlement area boundary** and 150 m from all property lines. (Huron-Kinross, Ontario, Zoning By-law 2018-98, Section 4.16 e)[164] [emphasis added]

- **No kennel shall be permitted closer than 600 m to a dwelling constructed prior to the kennel** on a lot other than the lot upon which the kennel is proposed. (Town of Lakeshore, Ontario, Zoning By-law 202-2012, Section 6.28, Adopted January 10, 2012, modified September 15, 2018)[165] [emphasis added]

- [Prince Edward County, Ontario,] made [changes] to the Cannabis Production and Processing by-law including…a **500 m setback** for

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be taken to minimize the impact on environment." https://mpcb.gov.in/sites/default/files/whats_new/2020-08/CircularSitingcriteriaforstonequarriesinthestateofMaharashtra03082020.pdf.

[161] Environmental Requirements: A guide to Investors 2010, Appendix G.

[162] Gill Higgins, "Fair Go: Dust particles from quarry causing adverse health effects for residents nearby," !news, June 22, 2020, https://www.tvnz.co.nz/one-news/new-zealand/fair-go-dust-particles-quarry-causing-adverse-health-effects-residents-nearby.

[163] https://www.ontario.ca/document/technical-guide-renewable-energy-approvals/required-setback-wind-turbines#section-2.

[164] https://www.brucecounty.on.ca/sites/default/files/file-upload/business/huron_kinloss_by-law_2019-98_final.pdf.

[165] https://www.lakeshore.ca/en/business-and-development/resources/Documents/Zoning-By-law/zoning-by-law-updated-sept-2018.pdf.

cannabis production without air treatment in rural and industrial zones from sensitive use zone boundaries and/or lot line.[166]

- [In the Town of Markham, Ontario,] [i]t is recommended that a medical marihuana production facility can only be located in a General Employment Zone and required to be **800 m from a sensitive use, or any Residential or Mixed Use Zone** and that the operation is located in a single-tenant building [recommendation 56].[167] [emphasis added]

- [In the Town of Melancthon, Ontario]…a Cannabis Facility shall be a permitted use in the [Agricultural] A1 Zone provided the lot on which the Cannabis Facility is constructed is utilized for outdoor cultivation of Cannabis and the following regulations shall apply; vii. **Minimum Separation from a settlement area boundary: 2,000 m** [By-law No. 47-2019, Section 3.24][168] [emphasis added]

- The Town of Caledon, effective April 26, 2022, passed a "Fireworks By-law" requiring a permit for firework displays with the permit imposing **minimum safe distances of 300 m from all vulnerable occupancies (schools, nursing and care facilities), industrial, fuel dispensing facilities containing livestock….**[169] [emphasis added]

  > On July 4, 2021 (Independence Day), Matiss Kivlenieks, the Columbus Blue Jackets goalie, was struck by a mortar-style firework while he was in a hot tub, causing damage to his heart and lungs, from which he died on route to the hospital.[170]

- A private for-profit company such as Nelson Aggregate Co., a blasting quarry operator, does not possess a legal right to externalize setback (blast safety zone) requirements and launch *adverse effects* offsite that compromise the *health, safety* and *welfare* of the surrounding communities and that diminish the utility and value of neighbouring

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[166] Smith, Amanda. "PEC eases production facility by-laws," *quintenews*, Aug 17, 2021, https://www.quintenews.com/2021/08/17/pec-eases-cannabis-production-facility-bylaws/.

[167] The Phase 2 Strategic Directions Report, June 2016, https://www.markham.ca/wps/wcm/connect/markham/abecc367-cb83-4eb5-b35e-ce498798cba8/New-Zoning-Bylaw-Phase-2-Recommendation-Report-Appendix-B-20160614.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_2QD4H901OGV160QC8BLCRJ1001-abecc367-cb83-4eb5-b35e-ce498798cba8-mrQgMnY.

[168] https://melancthontownship.ca/wp-content/uploads/2020/03/Cannabis-ZBA.pdf.

[169] https://www.caledon.ca/en/town-services/fireworks.aspx

[170] https://www.espn.com/nhl/story/_/id/31764017/columbus-blue-jackets-goalie-matiss-kivlenieks-24-dies-tragic-accident.

properties, the owners of which do not participate in the anticipated profits of the quarry operation or receive any financial compensation.

As aptly stated by a local resident in response to a proposed quarry expansion in the Township of McNab/Braeside seeking to externalize a setback requirement on adjoining privately-owned third-party property:[171]

> **"We expect to retain full use of our lands as purchased and insist that we remain safe from the adverse effects while situated anywhere on our own property. We therefore demand respect for our property boundaries."** (John Kerr)

If the province (MNRF) has no desire, or lacks the will to protect the public from the potentially deadly consequences of flyrock, a health and safety issue of a blasting quarry operation (a *human-made hazard*), then it is up to each municipality in Ontario, including the City of Burlington, to protect its citizens, quarry employees and the general public from flyrock by imposing a permanent minimum setback requirement on a quarry operation, either under an Official Plan, Zoning By-law or By-law pursuant to the Ontario Municipal Act.

A municipality can impose "Setback Limits" on a Pit or Quarry pursuant to the Municipal Act S.O, 2001, c. 25. Here is an extract from By-law No. 2003-95, "A By-law to Regulate the Operation of Pits and Quarries," passed by The Corporation of the United Townships of Dysart, Dudley, Harcourt, Guilford, Harburn, Bruton, Havelock, Eyre and Clyde.

> **Setback Limits**
>
> 16) In this By-law, "Excavation Setback Area" means the area within the setbacks for a pit or quarry established by the Municipality's Comprehensive Zoning By-law.
>
> 17) No person shall excavate aggregate within the "Extraction Setback Area" of a site.
>
> **This authority granted under the Municipal Act has been utilized by municipalities such as the Town of Erin, the Corporation of the United Townships of Dysart, Dudley, Harcourt, Guilford, Harburn, Bruton, Havelock, Eyre and Clyde (commonly referred to as the Municipality of Dysart et al.), the Township of Oro-Medonte, the Township of Strong, and the Town of Halton Hills to regulate matters involving hours of operation, areas of ingress and egress, operational standards such as set-backs, rehabilitation, and maintenance standards, as well as to require owners of pits and quarries to level and grade the floor and sides**.

[171] Dunn, Derek. "Township passes bylaw limiting quarry size," *InsideOttawaValley.com,* January 8, 2015, https://www.insideottawavalley.com/news-story/5249453-township-passes-bylaw-limiting-quarry-size/.

Here is the link to the By-law: https://www.dysartetal.ca/en/municipal-government/By-Law%20Enforcement/By-Law%202003-95%20Pits%20and%20Quarries.pdf. (pdf of the By-law is attached)

ARA LICENCING REQUIREMENTS DO NOT PRE-EMPT A MUNICIPALITY'S JURISDICTION OVER LAND USE CONTROLS

Licencing requirements pursuant to Section 12 of the Aggregate Resources Act (ARA) do not replace a municipality's jurisdiction over land use controls and land use compatibility (avoidance of *adverse effects*), as described in *Kevin Matthews/Robin Latimer v. Gorham (Township)*, (2020),[172]

> [84] Section 12 (1) of the ARA, which requires that a licence application provide information on "any planning and land use considerations," does not displace a municipality's role or jurisdiction in determining zoning issues, but instead actually highlights the municipality's role. This principle is laid out in *Carlyle Development v. Baldwin (Township)*, 2017 CarswellOnt 7658 ("*Carlyle*") at paragraph 35:
>
> Section 12(1) of the ARA sets out matters to be considered by the Minister in deciding whether to issue an aggregates licence, including the effect of the operation of a proposed quarry on nearby communities and planning and land-use considerations. Also, the Provincial Standards require that a licence application provide information on "any planning and land use considerations". The Board finds that these provisions do not displace a municipality's role or jurisdiction in determining zoning issues. They reinforce the point that MNRF considers a municipality's land-use planning decisions associated with proposed quarry sites when deciding whether or not to issue a licence, thus highlighting a municipality's role in this regard.
>
> [87] In Ottawa (City) v. Sample, 2001 CarswellOnt 4408 (SCJ), ("Sample"), the OMB considered the evidence that supported an environmental assessment, because it was presented in support of an Official Plan amendment. In paragraph 15 of Sample, the court stated: "It would be unprecedented to require the OMB to decline its independent jurisdiction to decide whether an undertaking is good land use planning or not, simply because an undertaking has received an approval from the Ministry of the Environment.
>
> [88] **Sample underscores the principle that the same evidence may be, and often is, considered by several authorities as they make related decisions on an application**. This is exactly the situation in this matter—LRPB was required to make a decision on the planning merits of the ZBL application. A future ARA licence application is a separate and distinct process with its own approval that is undertaken under a separate regime and jurisdiction, notwithstanding that some of the same information may inform both decisions. [emphasis added]

[172] *Kevin Matthews/Robin Latimer v Gorham (Township)*, 2020 CanLII 32070 (ON LPAT), <https://canlii.ca/t/j6xdm>, retrieved on 2021-12-09.

MUNICIPAL GOVERNMENT'S ROLE IN PROMOTING HEALTH & SUPPORTING HEALTHIER COMMUNITIES

All municipalities have a legal duty to provide for the health, safety and well-being of its citizens:[173]

> Promoting healthy communities is at the heart of what local government is about. It means creating places and spaces that cultivate belonging, inclusion, connectedness and engagement. It means creating a well-planned built environment that supports healthy behaviours and choices. It means a vibrant social environment in which people can live, work, learn and play. In short, it means striving to create the conditions in which all citizens, no matter where they are in life, can thrive, now and in the future.
>
> While there are many influences on our lives today, it is at the local level where policies and plans are made and can directly affect the health and well-being of our citizens. Local governments have a unique role to shape the local conditions that have an impact on the health of individuals and communities.
>
> Strong communities provide the essential social infrastructure necessary for individuals and families to attain well-being. Social well-being encompasses two components: basic needs such as nutrition, housing, sufficient income, and public health and safety; and opportunities for learning, faith, recreation, creativity and artistic expression, community identity, citizen engagement and co-operation….[174]

Nelson Aggregate Co.'s application to use (destroy) land to expand its existing blasting quarry operation in the City of Burlington represents a ***human-made hazard*** involving the potentially deadly use of "explosives," which compromise the health and safety of the surrounding environment and communities, and which undermine the policies inherent in a sustainable environment, now and in the future. (See Section 4.6 Land Use Compatibility, Burlington Official Plan, November 2020).

EMPIRICAL METHODS OF CALCULATING FLYROCK ARE INACCURATE

There are a number of recognized formulas used by explosives engineers in calculating the "throw" distance of flyrock, but none are particularly accurate.

- **There are several empirical methods for calculating *flyrock* (Lwin & Aung, 2019) but none are capable of accurate prediction** (Balakrishnan & Rai, 2021) due to the complexity of flyrock analysis. Flyrock is unpredictable, both in terms of distance and direction (Rathore & Jain, 2007). **The potentially deadly consequences of**

[173] How Do Local Governments Improve Health and Community Well-being?, A Resource Guide for Local Governments, Ministry of Health, Sept 2013, https://squamish.ca/assets/planH/d0e40f740e/planh-local-government-guide-web.pdf.
[174] Official Community Plan, District of Saanich.

flyrock do not decrease with distance, as a 200-gram projectile can be as fatal at 20 metres as it is at 1,000 metres (Sauvage, 2017).[175]

- **The testing methodologies used to measure the *actual* flyrock distance are not scientific and are highly dependent on the scrutiny of the researcher**. In order to present results that are objective and uncriticizable, an accurate, quantitative and objective method of measuring the travel distance of flyrock is required (van der Walt & Spiteri, 2020).

- In a case study of the July 15, 2015 flyrock incident at a construction site in Johor, Malaysia, that propelled flyrock up to a distance of 200 metres killing one worker and injuring two others, it was determined that the blast design was only 69% accurate in predicting flyrock distance.

> In this study five empirical models are used to compare the [flyrock] incidents. It was found that none of the existing formulas could accurately predict flyrock distance. Analysis shows that the gap between predicted and actual flyrock distance can be reduced by including blast design and geological conditions in forecasts. Analysis revealed only 69% of accuracy could be achieved if blast design is the only parameter to be considered in flyrock projection and the rest is influenced by the geological condition.[176]

NELSON AGGREGATE CO.'S ASSERTION THAT VIBRATIONS FROM REPEATED BLASTING CANNOT CAUSE PROPERTY DAMAGE NOT CREDIBLE

Nelson Aggregate Co.'s speculative claim that vibrations from blasting cannot cause damage is unsupported by the evidence. Here are a few of the many documented cases rebutting that presumption:

1. In *Ward v. HB Zachry Const. Co.* (Zachry), (1978),[177] the issue in dispute was a claim for damages to the homeowner's house caused by vibrations from blasting at the defendant's quarry, distant 4,250 feet (1,295 metres) from the homeowner's property.

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[175] Anne Charline Sauvage. "Flyrock: French Experience," *SAFEX Newsletter*, No. 61 June 2017. https://ap3e.pt/wp-content/uploads/2021/03/2017-2-Newsletter-61.pdf

[176] Edy Tonnizam Mohamad, Chang Shiang Yi, Bhatawdekar Murlidhar, Rosli Saad, "Abstract: Effect of Geological Structure on Flyrock Prediction in Construction Blasting," *Geotechnical and Geological Engineering*, Issue 4/2018.

[177] *Ward v. HB Zachry Const. Co.*, 570 F.2d 892 (1978), Court of Appeals, 10th Circuit, https://scholar.google.ca/scholar_case?case=17504658548879244532&q=damaged+quarry&hl=en&as_sdt=2006#[2]

The Court of Appeal (10th Circuit) upheld the trial court's damage award of $8,000 to the homeowner, attributed to the diminution in the value of the homeowner's property as a direct consequence of the *blasting* at the quarry.

The quarry owner attempted to discredit the testimony of the homeowner, shift responsibility for the homeowner's property damage to another company operating in the area, and argue the implausibility of causing damage to a residence at a distance of 4,250 feet (1,295 metres):

> Defendant…argues that the trial court erred in failing to direct a verdict for defendant upon the grounds that plaintiff failed to establish a causal connection between defendant's blasting and plaintiff's alleged damages. Defendant advances three principal arguments in favor of this contention: (1) plaintiff's house had cracks in it before defendant began blasting; (2) another company was blasting in the same area at the same time; and (3) defendant's expert testified that the blasting which was done could not have damaged a house so far away.

In response to the quarry owner's first two arguments, the appeal court commented as follows:

> We have little difficulty in concluding that there was sufficient evidence in plaintiff's favor that we may reject defendant's first two arguments. **Although plaintiff admitted that her house had some cracks before the blasting started, the evidence when viewed most favorably to plaintiff establishes that the condition of the house was worsened by defendant's blasting**. Similarly, although the presence of another company in the area did cause some confusion, there is sufficient evidence in the record to indicate that plaintiff was able to accurately trace the damaging blasts to defendant. [emphasis added]

The quarry owner's third argument that the homeowner's *lay* testimony could not overcome the testimony of an expert witness and that blasting at the quarry could not cause property damage at a distance of 4,250 feet (1,295 metres) was also rejected by the appeal court, commenting as follows:

> Defendant's third argument is that its expert witness testified that the blasting which was done could not have damaged a structure as far away as plaintiff's house and that plaintiff's lay testimony cannot overcome the testimony of an expert. We reject defendant's contention that this is a question which can be resolved only by expert testimony. **Despite the testimony of defendant's expert that the damage could not have occurred because of the blasting, the record contains plaintiff's testimony that it did**. We must view favorably plaintiff's testimony that she simultaneously heard the explosions, felt the vibrations, and saw and heard mortar falling from the walls and ceiling of her house. [emphasis added]

> **Plaintiff [Ward] testified that as defendant blasted, she heard the explosions and felt the resulting concussion and vibrations. Plaintiff testified that as defendant blasted she often directly viewed mortar falling out of cracks in the wall or ceiling, or heard the mortar fall in another room and would later discover bits of mortar on the floor.** [emphasis added]

On the issue of acceptance of lay testimony, the Court of Appeal cited the following case law:

> Testimony similar to that of plaintiff [Ward] in this case has been accepted in other cases as adequate evidence of causality. In Smith v. Clark, 315 P.2d 960 at 962 (Okl.1957) the testimony was that Mrs. Clark was at home at the time of the blast, that she felt the vibration and heard the crystal in the cabinets tinkle, and that she found cracks which had not been there before the blasting. In Smith v. Yoho, supra, 324 P.2d at 532, the plaintiff testified that she was in the damaged building at the time of the blast, that the building shook and the lights tingled, and that she observed mortar falling from cracks in the building. In the latter case, the Oklahoma Supreme Court rejected contentions similar to those proffered by defendant [Zachry] in this case:
>
> Defendant's contentions that no causal connection was established between the act of blasting and the damage to the property and that the verdict was clearly against the weight of the evidence, are both apparently based upon defendant's theory that plaintiff could only establish causal connection and the right to recover by the use of expert testimony. Defendant asserts that plaintiff had no expert testimony and that defendant did have such testimony, and therefore concludes that defendant is entitled to prevail as a matter of law. We do not agree. The evidence in the case at bar is substantially similar to the evidence approved as sufficient by this court in the case of *Smith v. Clark*, Okl., 315 P.2d 960. We are of the opinion and hold that the evidence in case at bar likewise reasonably supports the judgment and is sufficient to establish causal connection…..[178]

It was acknowledged that the house had some cracks before the blasting from the quarry, but "some uncertainty as to which cracks were caused by the blasting and which were caused by settlement and age need not prevent recovery." *Oklahoma Transportation Company v. Hays,* 405 P.2d 181,

> The record discloses that plaintiff's [Ward's] expert was qualified and that his opinion was based upon plaintiff's descriptions which the jury found reliable. The amount of the jury's verdict reflects that some credence was given either to defendant's [Zachry's] expert or to the points brought out on cross-examination by defense counsel. While the jury was engaged in resolving conflicting testimony as to the amount of damages, we do not believe that the jury was

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[178] *See also* *Superior Oil Co. v. King, supra,* 324 P.2d at 848; *Pate v. Western Geophysical Co. of America,* 91 So.2d 431 (La.App.1956) (evidence sustained finding of causality despite expert testimony as to scientific impossibility); and *Central Exploration Co. Inc. v. Gray,* 219 Miss. 757, 70 So.2d 33 (1954).

> involved in mere speculation. The evidence shows the extent of damages as a matter of just and reasonable inference.

In Oklahoma, the use of explosives imposes strict or absolute liability without regard to proof of negligence, as conceded by the quarry owner. [citations omitted] The appeal court rejected the defendant's argument that blasting could not cause damage more than 600 feet (183 metres) away

> …[However,] defendant [Zachry] argues that no Oklahoma case has applied strict liability in a factual situation in which the distance between the blasting site and the damaged property was over 600 feet [183 metres].[179] The other side of this coin, however, is that no Oklahoma case has held that strict liability was inapplicable to blasting more than 600 feet [183 metres] away from the damaged property.[180]

2. Recently, a Florida court awarded homeowners $62,022 for damages caused to their home by vibrations from quarry blasting. The property in question was built in 2000, just short of 1.5 miles from the White Rock blasting quarries.[181] In 2015, the homeowners saw the first signs of cracks, and over the years, they got worse. Some of the damage included floor tiles cracking, a crack in the stairs, exterior wall cracks and cracks in the popcorn ceiling. (**The court rejected the evidence of the defendant's two explosives engineers that the quarries were too far away to cause damage, and that the damage to the home was due to "settlement, wear and tear and deterioration, thermal expansion and contraction**."

3. Vibration damage from blasting quarry operations can occur at a great distance from the blast, even if blasting is conducted within regulatory limits. In *SDI Quarry v. Gateway Estates Park Condominium Association*, 249 So.3d 1287 (2018),[2] blasting 20 times a year eventually collapsed the shore of South Lake from five feet to a foot-and-a-half, at a distance no closer than 7,000 feet (2,134 metres) from the quarry operation:

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[179] Defendant's [Zachry's] assertion in this regard does not appear to be strictly correct, for in *Seismograph Service Corp. v. Buchanan, supra,* 316 P.2d at 186, the opinion noted that the blasting was done 600 feet from plaintiffs' house and noted that damage was also sustained by certain other structures which "were an even greater distance from the point of explosion than was their house."

[180] It seems apparent that a rule attempting to predicate the application of strict liability upon some arbitrary distance requirement such as 600 feet [183 metres] would be worthless if it did not take into account many other factors including especially the intensity of the charge which was detonated. [emphasis added]

[181] https://www.martindale.com/legal-news/article_morgan-morgan_2555063.htm

[2] *SDI Quarry v. Gateway Estates Park Condominium Association*, 249 So.3d 1287 (2018), https://scholar.google.com/scholar_case?case=5383564357932576454&q=SDI+Quarry+v+Gateway+Estates&hl=en&as_sdt=2006.

> **In 2011, about five or six years after Appellee began its blasting activities, the shore of the South Lake began to destabilize, and saturated soil at the edge of the lake began to slough and slump into the water. This opened up fissures in the slope, which undermined the upward bank. In time, holes appeared in the bank, and pieces of the once level surface fell off, resulting in a narrowing of the horizontal area from roughly five feet to about a foot and a half. Residents observed the ground falling into the water in close temporal proximity to the blasting**. [emphasis added]

4. In *Donnell v. Vigus Quarries*, (1975),[182] the homeowners (plaintiff) were awarded $27,000 for damages caused to their property by *concussion* and *vibration* from repeated blasting at a quarry 0.25 miles (402 metres) away. In 1966, the plaintiff commenced construction of a barn. At that time there was no blasting at the quarry adjoining their property. In 1967, the Donnells noticed some blasting at the quarry. Concerned over the effect blasting might have on a home that the Donnells were planning to construct, a representative of the quarry was contacted.

   The quarry representative assured the Donnells that there would be no blast damage to structures on their property, which was about 400 m from the quarry. Construction of the home was completed in 1969, and the Donnells moved in the same year. In addition to the barn and house, they built a workshop and a pavilion. In late 1969 or 1970 after experiencing vibrations from blasting, the Donnells observed that the front and rear porches had cracked. On further inspection of the home and other structures on the property, additional cracks were found in the house, barn, pavilion and workshop. Most of the cracks appeared in the fireplaces, the ceilings, basement and floors of the new buildings.

   > **During the period following plaintiffs' construction project (1970-1972) defendant, in the course of its operations, set off 441 blasts in delayed blasting. The largest charge employed was 1612 pounds [731 kilograms] of explosives, the smallest 300 pounds [136 kilograms].**

   Joseph Brooks, a consulting engineer with a Masters degree in civil engineering, was retained by the Donnells. He testified that the home was above average in construction, and that the other buildings on the property were of typical construction. The home is on a rise and the home and other structures are built on hard clay with no fill.

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[182] *Donnell v. Vigus Quarries, Inc.*, 526 S.W.2d 314 (1975). https://scholar.google.com/scholar_case?case=11912900217179761342&q=Donnell+v.+Vigus+Quarries+Inc&hl=en&as_sdt=2006.

Accordingly, drainage settlements and differential settlement were ruled out as causes of the cracking and damages to the structures. Brooks inspected the property in April 1972 and again in February 1973. In response to a hypothetical question, Brooks testified that the damage to the plaintiffs' property was caused by blasting operations. While acknowledging that blasting may be lawfully pursued, the court held that when explosives are intentionally detonated there is absolute liability for injuries and damages.

> **Preliminarily we note that blasting is a work which may be lawfully pursued. However, when one intentionally detonates explosives he is absolutely liable for injuries and damages which are the proximate result of such explosions. Summers v. Tavern Rock Sand Company, 315 S.W.2d 201 (Mo. 1958).**

The court was sensitive to the fact that "in cases such as this *vibrations* and *concussions* cannot be seen, and the case must, to a large extent be based on circumstantial evidence [citation omitted]." Damages to property in cases of explosion are measured as the difference in market value *before* and *after* the blasting operation or the cost of restoring the property, whichever is the lesser. A local real estate broker testified on behalf of the Donnells, without objection, that, prior to the blast damage, the value of the property was $90,000, and, because of the blasting, the value of the property had decreased by $35,000. The trial court awarded $27,000 in damages, which was upheld by the appeals court.

5. In *Laughon Johnson v. Burch*, (1981),[183] the plaintiffs sustained property damage from nearby blasting in connection with road work. Severe *vibration* and *concussion* from the blasting caused cracks to the exterior and interior of the plaintiffs' residences. At trial,

> **plaintiffs conceded they had no evidence that defendant was negligent in either case. The plaintiffs' evidence showed that cracks developed in the interior and exterior of their homes following severe vibration and concussion associated with the blasting.**

The trial court ruled in favour of the plaintiffs applying the rule of strict liability, finding as a fact that the *concussion* from the defendant's blasting operation proximately caused the damages. On appeal, the Supreme Court of Virginia upheld the lower court's ruling. The court concluded that "when property is damaged by vibration or concussion

[183] *Laughon Johnson v. Burch*, 278 S.E.2d 856 (1981). https://scholar.google.com/scholar_case?case=3814718433162417000&hl=en&as_sdt=2006.

from blasting operations, there will be liability upon the blaster irrespective of negligence, provided, of course, the damage claimed is a direct and proximate result of the explosion," quoting favourably from *Exner*:

> **"It is true that some courts have distinguished between liability for a common-law trespass, occasioned by blasting, which projects rocks or debris upon the property or the person of the plaintiff, and liability for so-called consequential damages arising from concussion, and have denied liability for the latter where the blasting itself was conducted at a lawful time and place and with due care. [Citations omitted.] Yet in every practical sense there can be no difference between a blasting which projects rocks in such a way as to injure persons or property and a blasting which, by creating a sudden vacuum, shatters buildings or knocks down people. In each case, a force is applied by means of an element likely to do serious damage if it explodes. The distinction is based on historical differences between the actions of trespass and case and, in our opinion, is without logical basis." 54 F.2d at 513-14.**

6. In *Clay v. Missouri Highway and Transportation Commission*, (1997), the Missouri Court of Appeals upheld an award of $22,340 against Max Rieke & Brothers, Inc., under strict liability for repeated blasting (an abnormally dangerous activity) of rock that damaged an aquifer of high quality water, and reduced the value of the homeowners' property 0.85 miles (1,368 metres) away.[184]

> Leslie R. Clay, Jr. and his wife Alma Clay are residents of Tiffany Springs, Missouri. Their residence in Tiffany Springs sits above an aquifer. This aquifer had supplied a well on their property with unusually high-quality drinking water since 1945.
>
> In November 1989, roadwork began on Highway 152 in the Tiffany Springs area. MHTC hired Rieke to cut the right of way for the new highway down to a grade specified by MHTC. Rieke used explosives to break up and remove rock from the roadway site. MHTC had anticipated that Rieke would use explosives to blast away rock, but had not specifically required the use of explosives in its contract.
>
> Rieke tried to blast in a controlled fashion. Specially-placed explosive charges cut the rock and left smooth walls of rock for the sides of the highway. At trial, some experts testified that this controlled blasting only caused shock waves to move about twenty feet into the rock. **The Clays alleged, however, that the blasting caused vibrations at their home some .85 miles [1,368 metres] away and that it affected the quality and quantity of the water coming from the aquifer. More specifically, they alleged that due to cracks in the aquifer caused by the blasting, sediment such as sand and oil contaminated the**

[184] *Clay v. Missouri Highway and Transp. Com'n*, 951 S.W.2d 617 (1997), https://scholar.google.ca/scholar_case?case=6636206402696025097&q=clay+v+missouri+highway+and+transp+com%27n&hl=en&as_sdt=2006.

> **aquifer and, ultimately, their well-water, that the water level of their well dropped, and that the water flow in their well was drastically reduced**. [emphasis added]
>
> After a civil jury trial, plaintiffs Leslie and Alma Clay were awarded…$22,340 from contractor Max Rieke & Brothers, Inc. (Rieke) under a theory of strict liability for blasting, for property damage caused by the blasting of rock during construction of a nearby road. The Clays alleged that the blasting damaged their property by damaging an aquifer that had been supplying unusually high quality water to their property.
>
> **We think that the trial court properly refused to require the Clays to prove that it was the vibrations or concussions from the blasting that directly caused their damage; they were required to submit only that it was the blasting that caused their damage**. We so rule because we conclude from a review of the history of the doctrine of strict liability for blasting that, while such a claim may be established by proof of vibration and concussion, see Wiley v. Pittsburg & Midway Coal. Mining Co., 729 S.W.2d 228, 232 (Mo. App.1987), it may also be established by other methods of proof. [emphasis added]
>
> **The potential that blasting might cause widespread damage to other people's property is precisely the reason that liability is imposed on users of explosives without regard to their negligence**. As a general rule, under a theory of strict liability for blasting defendants are liable for any damage caused by the blasting, irrespective of their negligence. Wiley., 729 S.W.2d at 232; Donnell v. Vigus Quarries, Inc., 526 S.W.2d 314, 316 (Mo.App.1975); Summers v. Tavern Rock Sand Co., 315 S.W.2d 201, 203 (Mo. 1958); Richards v. C.B. Contracting Co., 395 S.W.2d 737, 739-40 (Mo.App.1965). Plaintiffs must present evidence that the blasting was of sufficient capacity to have caused the damage. This evidence may be circumstantial. Wiley, 729 S.W.2d at 232; Donnell, 526 S.W.2d at 316. [emphasis added]

7. In *Carrascal v. Scottsdaye Ins. Co.,* (2021),[185] the United States District Court, SD Florida, refused to grant the insurer summary judgment in their effort to deny a claim for property damages caused by repeated blasting at a nearby quarry. The court accepted the testimony of the engineer acting on behalf of the homeowner:

> Plaintiffs' expert engineer, Gerald Zadikoff, P.E. with G.M. 1249* Selby, Inc., opines that Plaintiffs' damages were caused by the house shaking and vibrating, and not earth movement. **He asserts that the long duration of the shaking and the vibrations caused cyclic loading on the structure and fatigue of the building materials. The result of the vibrations, in his view, is the damage to the interior and exterior walls, windows, roof, the foundation/wall joints, walkway slab, etc**. [emphasis added]

[185] *Carrascal v. Scottsdale Ins. Co.,* 557 F. Supp. #d 1247 (2021)– District Court, SD Florida, https://scholar.google.ca/scholar_case?case=14212735262110159003&q=quarry+blasting+causes+damage&hl=en&scisbd=2&as_sdt=2006.

> At his deposition, Mr. Zadikoff opined that the cracks in the home were caused by small seismic waves over time. **He states "the wave is in the air, hits your ear drum. That vibration causes a vibration to your brain. It is the same thing in the house. There is a wave, the Rayleigh vibration, it hits the house. In the house translation, like the brain, [the house] is damaged**." [emphasis added]

The Florida District Court cited with approval the ruling in *Puente v. Tower Hill Signature Ins. Co.,* Case No. 18-22208-CA-22 (11th Jud. Cir. Mar. 14, 2019), upheld on appeal,[186] in drawing the distinction between an exclusionary and non-exclusionary clause in an insurance policy:

> My problem with your exclusion is it's not the movement of the soil that causes the harm. It's the wave that just happens to move the soil on its way, just like a bullet will happen to move your jacket on its way to your chest, but that *1251doesn't mean the movement of your jacket caused the damage to your shoulder. The bullet caused the damage.

8. A case study of the Metlaoui Mining Basin, Southwestern Tunisia, undertaken by Aloui et al. (2016),[187] concluded that both *ground vibration* and *airblast* can cause structural damage, and are a nuisance to the inhabitants as open pit mines (quarries) approach Settlement areas.

9. Comision Pastoral Paz y Ecologia and Unitarian Universalist Service Committee, Guatemala, in 2007, started monitoring, investigating and analyzing damage to several buildings in villages immediately surrounding the Marlin mine (owned by Goldcorp, Inc. headquartered in Vancouver, B.C.), and compared the condition of buildings in two similar control villages on the opposite side of the Tzala River valley and more than five kilometers (>3.11 miles) from the mine and outside the impact of the mining operation.[188] Buildings in the two villages near the mine have more cracks than the buildings in the two control villages, and the villages surrounding the Marlin mine are becoming destabilized by the surface mining operation.

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[186] *Puente v. Tower Hill Signature Ins. Co.,* 307 So. 3d 968 – Fla: Dist Court of Appeals, 3rd Dist. 2020, https://scholar.google.ca/scholar_case?case=7660767275719094182&q=Puente+v.+Tower&hl=en&as_sdt=2006

[187] Aloui M, Bleuzen Y, Essefi E, Abbes C (2016), "Ground Vibrations and Air Blast Effects Induced by Blasting in Open Pit Mines: Case of Metlaoui Mining Basin, Southwestern Tunisia," *J Geol Geophys* 5: 247. doi:10.4172/2381-8719.1000247 https://www.longdom.org/open-access/ground-vibrations-and-air-blast-effects-induced-by-blasting-in-open-pit-mines-case-of-metlaoui-mining-basin-southwestern-tunisia-2381-8719-1000247.pdf.

[188] https://www.giscorps.org/wp-content/uploads/2017/01/Report_and_Figures.pdf?189db0&189db0.

> **A total of 33 damaged buildings [1 to 4 kilometers from the mine and within 300 metres of the nearest road] were observed in the villages surrounding the Marlin mine**. Generally, the damage ranges in severity from buildings having one or more cracks with no displacement to buildings with cracks displaced far enough that light can be seen through one or more of the cracks. One building…is severely damaged. [emphasis added]
>
> Land instability, seismic activity, damage due to underlying soil types, and to faulty construction were eliminated as likely causes of the structural cracking. The type and pattern of most cracks were determined to be those caused by ground vibrations. Vibration monitoring results were not conclusive as to the damage being caused by ground vibrations, but no other possible causes are identified. **By a process of elimination, the most likely cause of the building damage is ground vibration. There are no sources of vibrations in the area except those resulting from mine blasting and heavy truck traffic; therefore it is very highly likely that the damage in local villages is caused by the mining activity and associated truck traffic**. [emphasis added]
>
> **Protests against the mine are becoming larger and more frequent. Conflicts between mine workers and other residents are on the rise. People are leaving the area in growing number, some saying that they can no longer live in this situation of conflict**. The engineering team also suffered from the unrest. One member of the team was attacked and injured by mine workers during the November 2008 field trip. [emphasis added]

10. In *R. v. Chenard*, Ontario Court of Justice, 2005,[189] ***vibration*** that escaped from a blast site was held to be a contaminant, pursuant to Section 1(1) of the EPA, which had the potential to cause an *adverse effect* (Section 14(1)). The appeal court found that the Justice of the Peace failed to consider the words "or was likely to cause an adverse effect" or to consider "the accumulative effect of all 32 blasts" [emphasis added] in determining whether the contaminant *vibration* from blasting rock was the cause of the *adverse effect*:

> "**Based on the evidence that was adduced during the course of the four day trial, it is evident to me that the Justice of the Peace did not consider the words "or was likely to cause an adverse effect" or to consider the accumulative effect of all 32 blasts, including those on 6th of September, 2001** [para.43]" [emphasis added]

11. Quesne (2001)[190], as cited by Svinkin (2004)[191] and Sayed-Ahmed and Naji (2006),[192] reported a case of ground and house exterior

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[189] *R. v. Chenard*, 2005 ONCJ 501 (CanLII), <https://canlii.ca/t/1mfqs>, retrieved on 2022-02-03

[190] Quesne, J.D. 2001. Blasting vibration from limestone quarries and their effect on concrete block and Stucco homes, Vibration Problem. Geo-Discussion Forum.

[191] Mark R. Svinkin. 2004. "Drawbacks of Blast Vibration Regulations," *VibraConsult*, https://vulcanhammernet.files.wordpress.com/2017/01/blst-crt.pdf. Retrieved on April 23, 2022.

[192] E.Y. Sayed-Ahmed and K.K. Naji. Residential Houses Cracking Dure to Nearby Subsurface Construction Blasting: Critical Review of Current Safe Limits, Civil Engineering Department, University of Qatar, Doha, Qatar,

walls vibrations measured at distances of approximately 1.6 to 6.4 km (1 to 4 miles) from a blast site. Peak particle velocities (PPVs) were below the 0.5 ips (12.7 mm/sec), and in accordance with R1 8507, which asserts no possibility of structural damage at this level. However, amplification factors of wall vibrations were found from 4x to 9x as high as vibration measured at the ground and resulted in numerous cracks in the different house structures.

> **According to Svinkin (2004), there are no unified or widely accepted criteria for the safe limits of ground vibrations. It is not the soil PPV that matter, but it is the structural response to the ground vibration. All blast vibration complaints are actually due to the structure vibration not the ground vibration (Sayed-Ahmed & Naji, 2006).** [emphasis added]

12. A blasting quarry operation in Brisbane has come under fire from local residents claiming that vibrations from blasting twice a month, each blast reportedly "lasting less than 0.6 of a second," is causing property damage, with some homes having more than 100 cracks. One resident had glass panels explode on the balcony after a blast. A structural engineer and statistician examined the blasting records of the quarry, and concluded that the manner in which vibrations from the blasting are being monitored are inappropriate and unreliable in measuring structural response.[193]

> In October 2018, residents submitted a major complaint to the department claiming vibration data had been misrepresented due to the location of sensors away from homes and the use of shock-absorbing material.
>
> "A measuring device on top of shock absorbing material won't give you an accurate reading of what is actually happening on the ground," civil and structural engineer Roy Saint said.
>
> "**What we noticed is some of the readings done were done with probes in soft material and it was felt the opportunity was taken by the operators of the quarry to blind the results**."
>
> **Applied statistician Clancy Birrell, who on a pro-bono basis investigated blasting data from January 2001 to March 2017, obtained through a right to information request, found differences in vibrations outside BCC monitoring locations versus inside homes.**
>
> **He found the amplification felt in homes was about 2.5 times higher than the BCC locations.**

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[193] Walker, Sabrina. "Mount Coot-tha residents fighting quarry over house and health concerns," *brisbane times*, June 30, 2019, https://www.brisbanetimes.com.au/national/queensland/mount-coot-tha-residents-fighting-quarry-over-house-and-health-concerns-20190614-p51xxl.html.

DAMAGE FROM LOW FREQUENCY BLASTING AND REPEATED BLASTING ALMOST AN ABSOLUTE CERTAINTY

In Miller Paving Ltd. v. McNab/Braeside (Township), (2015),[194] Dr. Kiger addressed the high probability of damage to neighbouring structures (homeowners' property) resulting from repeated blasting, even at low ground-vibration levels.

> [Quarry blasting is done by drilling blast holes behind the working face of the quarried material to blast it loose for harvesting. The hole size, spacing, and amount of explosive are designed by an experienced blaster. The explosive most often used is ANFO (Ammonium Nitrate and Fuel Oil). When the explosive is detonated a detonation wave moves through the explosive at a speed of about 18,000 feet per second changing the solid material to a gas at a very high rate. This detonation wave and rapidly expanding gas will create a cavity, crushing, cracking and moving the surrounding material. It will also introduce 2 types of waves into the earth around the explosion. First a surface, or Rayleigh wave, that will damp out and disappear in a relatively short distance. And second a body wave that will travel great distances in the bedrock (under any barrier). It is this body wave that will move through the bedrock and cause the earth above the bedrock to vibrate and shake homes, even at large distances from the explosions. **There is no way to mitigate or block the movement of these body waves.]** [evidence presented by Dr. Kiger in connection with an Application for Rezoning and Special Use Permit for a proposed Granite Quarry in Alvaton, Meriwether County, GA][195] [emphasis added]

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[194] *Miller Paving Ltd. v. McNab/Braeside (Township),* PL130785, OMB, October 27, 2015 http://www.omb.gov.on.ca/e-decisions/pl130785-Oct-27-2015.pdf.

[195] On October 23 2018, the Meriwether County Board of Commissioners (CBC) denied the request to rezone the property and grant a special use permit for a blasting quarry. The appeal of the CBC ruling to deny the rezoning was upheld by the Superior Court in *Luther H. Randall, lll, et al., v. Meriwether County, Georgia, et al.* File No. 18CV0270 [May 1, 2019]. In upholding the decision of the Board of Commissioners, the Superior Court made a number of observations, including the following: "**The proposed zoning for use as a granite**

In the…1980 report [prepared for the US Bureau of Mines] by Siskind et al,[196] the authors establish 0.5 in/sec (12.7 mm/s) as the "threshold" for damage to structures, and they define "threshold" as a 5% probability of cosmetic damage. The probability of damage to a home may be relatively small in any single blasting event. However, numerous opportunities for an unlikely occurrence (like damage to the home) will result in a very likely occurrence of damage. For example, if the probability of damage (P_d) in any single blasting event is 0.05, or 5 percent, then the probability of not being damaged (P_u) is 95 percent. One can use the probability law of independent events to calculate the probability of damage occurring at least once in 100 events….[F]or example see… "Introduction to Probability and Statistics" Third Edition, 1964, by Henry L Alder and Edward B Roessler; published by W.H. Freeman and Company. Thus, assuming the probability of damage is the same for each event, 0.05, then the probability of not being damaged at least once in 100 events is:

$$P_{u\text{-}100} = (0.95)^{100} = 0.006$$

And the probability of the structure being damaged in 100 explosions is 1 minus the probability that it is not damaged, thus:

$$P_{d\text{-}100} = 1 - 0.006 = 0.994$$

This implies that the probability of damage in 100 events is about 99 percent, meaning damage is almost certain if the homes are subjected to these blast induced ground vibrations numerous times. Thus, even though damage is unlikely to result from any single blasting event, some damage in the form of cracking of walls, ceiling, tile, concrete, nail popping, loosening of framing joints, etc. becomes very likely over time with numerous repetitions of blast-induced ground vibrations. And once damage occurs (like cracking, nails pops, or framing joints loosening) that damage will rapidly increase with repeated exposure to the vibrations, even at lower levels of vibrations.

In recognition of the fact that damage to residential homes can occur even at low ground-vibration levels, other countries have set much more stringent limits on allowable

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quarry [is] unsuitable in view of the many residences within .75 miles [1,207 metres] of the proposed quarry pits….The applicant failed to reliably demonstrate that the proposed zoning as a granite quarry will not adversely affect the existing use or usability of the adjacent and nearby residential property owners. Evidence from experts (real estate appraiser, geologists, noise control engineer, blasting expert) indicated that: (a) **the applicants did not reliably demonstrate that the proposed quarry will not decrease the value of adjacent residential properties;** (b) there is a potential for negative impacts to drinking water wells in the area of the property; (c) the application provided no details on how surface water will be reliably collected and properly concentrated to enter the quarry holes; (d) the applicant's noise study is not reliable and underestimates sound emission by more than 20 dB in several cases; (e) **blasting at the quarry has a high likelihood of damaging many of the more than 100 residential structures within one to two miles of the proposed granite pits over the life of the proposed operation and will significantly degrade the quality of life for those residents affected**; and, (f) the application has no information on how the quarry operation will be reclaimed when its reserves are exhausted….The proposed use will generate additional traffic, noise, blasting, dust, and other operational processes not consistent with the surrounding properties or the Low Density Residential Zoning [p. 9-11]." [emphasis added] https://flintriverkeeper.org/wp-content/uploads/2019/05/Randall_etal_v_Meriwether_County_etal_Final_Order.pdf.

[196] D.E. Siskind, M.S. Stagg, J.W. Kopp, and C.H. Dowding, "Report of Investigations 8507: Structure Response and Damage Produced by Ground Vibration From Surface Mine Blasting," (1980), prepared for US Bureau of Mines. Online at http://www.osmre.gov/resources/blasting/docs/USBM/RI8507BlastingVibration1989.pdf [RI 8507].

> peak ground vibrations….[R]egulatory agencies in Leicestershire County, UK have established the upper limit on allowable peak particle velocity as 0.24 in/sec (6.096 mm/sec); in Australia the common limit is 0.2 in/sec (5.08 mm/sec) and it is 0.001 in/sec (0.00254 mm/sec) for historical buildings and monuments for frequencies less than 15 Hz [hertz].

Janet Bradley, legal counsel for the Township of McNab-Braeside, argued that buffers (setbacks) are often the only effective means of eliminating *adverse effects* between incompatible land uses. Bradley prevailed in advancing the Township's position that the buffers must be provided within the boundary limits of the ownership or control of the landowner needing the buffers (i.e., *Miller Paving*, the quarry operator).

> Often distance is the only effective way to mitigate the [adverse] effects of industry on its neighbours….Bradley contended buffers should be on the properties of the parties needing it for their operations (not extending into people's back yards)…[p. 4].[197][

A private for-profit company such as a quarry operator does not possess a legal right to externalize buffer (setback) requirements to maximize its own profits, while diminishing the use, enjoyment and value of neighbouring properties, the owners of which do not participate in the anticipated profits from the quarry operation or receive any financial compensation.

In *Fontaina Scott v. Mountaineer Grading Co.*,[198] Dr. Kiger explained the *dimensional changes* homes undergo daily and seasonally, and how they can be magnified or exacerbated by subsequent blast induced vibrations.

> All homes undergo daily and seasonal changes due to things like humidity variations and changing temperatures, like the sun moving from one side of the home to the other (the warm side will expand relative to the cooler side); or seasonal variations of temperature and humidity. For example[,] most of us have experienced a 'sticking door' or a door that will not close (or easily open) during certain times of the year. These environmental effects will cause strains in the walls, ceilings, structural framing, tile covered surfaces,…etc. These strains are know[n] by engineers as prestrains, that is strains that exist before an[] event like a blast induced ground vibration. The prestrain condition may be such that a very small vibration will push the item, like a wall panel, a framing connection, or piece of tile, over its strain limit and result in a crack or loosening of a structural frame connection. Once a crack is initiated the crack will grow at a much lower level of vibrations than was required to initiate the crack. This is because of the stress concentration that exist at the crack tip; envision for example a small crack in an automobile windshield where even a small bump from ones hand can cause the crack to

[197] "Quarry expansion, but no asphalt plant in Braeside: Opponent," Arnprior Chronicle, March 25, 2015, https://issuu.com/arnpriorchronicleguide/docs/arnprior032615.

[198] *Fontaina Scott v. Mountainer Grading Co.*, Putnam Co. Civ. Act. No. 09-C-286.

grow. Thus, even low levels of repeated occurrences of blast induced ground vibrations can cause significant damage to a home over time. For example[,] the German vibration standard is 0.16 ips [inches per second] for buildings with visible damage and cracks in masonry. See for example Table 1 in "Vibration Criteria for Historic and Sensitive Buildings" by Konon and Schuring.[199]

The fact that these prestrain conditions can produce a condition in the home such that damage to a home will occur at even very low levels of vibrations is acknowledged in BOM [Bureau of Mines] RI 8507[200] in their Conclusion 7 of page 68; Conclusion 7 is pasted below. This conclusion agreed to by the 4 experts that authored RI 8507, clearly states that "…**there may be no absolute minimum vibration threshold**…"; that is, when inevitable prestrain conditions are present in a home, any blast induced ground vibrations might cause damage to the home.

> **7. All homes eventually crack because of a variety of environmental stresses, including humidity and temperature changes, settlement from consolidation and variations in ground moisture, wind, and even water absorption from tree roots. Consequently, there may be no absolute minimum vibration damage threshold when the vibration (from any cause, for instance slamming a door) could in some case precipitate a crack about to occur.**

In Bureau of Mines RI 8507 they suggest a maximum allowable ground vibration peak particle velocity of 0.5 inches per second (ips) [12.7 mm/sec] at which there is a 0.5 percent probability of damage. However, the standards in many countries are much lower….[R]egulatory agencies in Leicestershire County, UK have established the upper limit on allowable peak particle velocity (ppv) as 0.24 ips; [6.1 mm/sec] in Australia the common limit is 0.2 ips [5.08 mm/sec] and it is 0.001 [ips or 0.0254 mm/sec] for historical buildings and monuments for frequencies less than 15 Hz. Note that frequencies less than 15 Hz are very likely in blast induced ground vibrations of large distances from the blasts. The Australian standard for historical buildings of 0.2 mm/sec (0.001 ips) implies that if a building is really important the allowable vibrations to prevent damage is extremely low. Therefore, standards in reality represent an economic decision. Since at almost any vibration level some homes might be damaged, but for the mine to operate at an economic level, some probability of damage is tolerated. **The level of 0.5 ips [12.7 mm/sec] widely adopted in the US is far greater than the standards adopted in other countries**. [see Table 2, R. Pesch and A. Robertson, "Drilling and Blasting for Underground Space", Wollongong, NSW, 3-4, September 2007.] [bolding added]

The size of the blast induced ground vibration waves shaking the homes are large in comparison to the footprint dimensions of a typical home. The length of the ground vibration wave train is the duration of the blast induced vibration shaking at the homes, typically about 3 to 4 sec, times the speed of the ground wave, typically about 800 ft per sec [243.84 m/sec] . Thus, for a typical blasting event with multiple individual explosions the ground vibration wave train is about 3,000 ft [914.4 metres] long. These ground vibrations at long distances, i.e. more than 1,000 ft [304.8 metres], have a dominate frequency of the ground vibration equal to about 8 or 10 Hz (cycles per sec); for a frequency of 10Hz a single cycle of the ground shaking is 80 ft [24.384 metres] in length

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[199] Konon and Schuring, "Vibration Criteria for Historic and Sensitive Older Buildings" ASCE Preprint 83-501; American Society of Civil Engineers (ASCE), Houston, Texas, October 17-19, 1983.

[200] US Bureau of Mines RI 8507, *"Structural Response and Damage Produced by Ground Vibration From Surface Mine Blasting"*, 1980.

> (one cycle is up down and back up) so that the leading edge of the home is picked up then pulled down while the back of the home is being picked up; this up and down of the front and then back of the house occurs repeatedly for the full 3 to 4 second duration of the ground vibration; in this example that would be about 30 to 40 complete cycles (10 cycles per second for 3 or 4 seconds). When these repeated distortions of the house matches the natural frequency of the house, the motions will be amplified and damage to the house will be significantly increased.

In 2016, Dr. Kiger was contacted by a reporter in connection with an article about a family's 10-year exposure to the *adverse effects* endured as a consequence of blasting at a nearby surface coal mine in Appalachia, and the homeowners' failed attempts to hold the coal mine operator accountable for the damages to their home.[201] The coal mine operator contends that all blasts are conducted within regulatory limits and, therefore, the blasting cannot cause structural damage, despite the apparent damage to the homeowners' residence (persistent drywall cracks in nearly every room, windows and doors out of alignment, and slanting of the floor toward the centre of the home, where the dining room floor has settled lower than the hallway floor). According to Dr. Kiger, the regulatory blasting standards are based primarily on a 1989 study of new residential structures in Indiana, which are not representative of the older homes typical in Appalachia:

> "**These more fragile homes [in Appalachia] are much more susceptible to damage from blasting-induced ground vibrations," he wrote. "In many other countries, the experts established a much lower threshold for damage**."
>
> **In a 2010 report prepared for a court case involving blast complaints in Mingo County, W.Va., Kiger compared the blasting limits from the Indiana study to Australian standards for historical buildings, which designate a vibration level 500 times lower than the acceptable level for surface mine blasts in the United States**. "Therefore, standards really represent an economic decision," Kiger stated in the report.

BLASTING WITHIN REGULATORY LIMITS OFFERS NO ASSURANCE AGAINST PROPERTY DAMAGE

Residents' complaints of property damage attributed to blasting quarry operations are often summarily dismissed, despite evidence to the contrary, by operators of nearby surface mines (quarries) on the pretext that blasting is being conducted within regulatory limits.

> The mines usually abide by the regulatory limits of 1 inch/second ground movement and 133 dB air blast. Vibration is supposed to be minimized by separating the explosions of each delay by at least 8 ms. Mines usually use a "scaled-distance formula." This limits

[201] Molly Moore, "Blasted: Homeowners near mine seek recourse for property damage," *The Appalachian Voice*, February 18, 2016, https://appvoices.org/2016/02/18/blasting-homeowners-property-damage-coal/.

the amount of explosive per delay period. For example, the limit for a blast 2,600 feet [792 metres] from the closest protected structure is 2,234 pounds [1,013 kilograms] per delay period. The closer a mine gets to a house, the less explosive per delay is allowed. The formula does not have to be followed if a seismograph is at the closest house.

When a citizen files a complaint, the DEP [Department of Environmental Protection] inspector, in nearly every case, will write that blasting was within the regulations and go away, leaving angry citizens. They feel as if they are in the Twilight Zone. How can the inspector say blasting is being done properly when their house shakes? Some inspectors have even pinpointed types of blasts that cause problems under these limits, especially air blasts above 115 dB...Yet, DEP and OSM [Office of Surface Mining] refuse to look beyond these standards.

The regulations are based on research done 15-20 years ago by the Bureau of Mines. None was done in West Virginia, and research was with smaller blasts and partly on a new house built specifically to test blasting. Two recent bodies of research have been developed that refute the accepted limits.

Sam Kiger, Dean of Engineering at the University of Missouri, was the expert for the Bim blasting case, which was tried in court in Boone County in March 1999. Kiger is an international expert in protecting federal buildings from blasting damage. **After examining 6,000 blasting logs, he testified that there is about a 95 percent chance of damage at a vibration limit of .5 inches/second [12.7 mm/sec], if you count each of the holes shot (50 on average) as a separate vibration. In the Bim case, he also testified that low-frequency waves (2 Hz-11 Hz) generated by some blasts can be more damaging. The frequencies can match that of a house and amplify the shaking**.

Freda Harris, who had a blasting case with a mine in Indiana, gathered many documents during the case and subsequent FOIAs [Freedom of Information Act requests] of OSM. She wrote a manual for Citizens Coal Council. One of her most intriguing findings was that there can be "hot spots" in a community where the geography can make blasts worse. She emphasizes that damage and vibrations can feel worse if a house's natural frequency is approximately between 4 Hz and 12 Hz. The above-ground part of the house often vibrates more than the ground outside and the foundation. Yet, the DEP/OSM standard is based on ground vibration.

Most of the blasting studies of the Bureau of Mines were done by the David Siskind. The FOIAs provided much correspondence between Siskind and other experts, some of it quite critical. **A top official of Vibra-Tech, a leader in designing blasting technology, said: "Any criteria…which ignores the frequency of a structure and the frequency content of the ground motion is overly simplistic…Your criteria, as proposed, will neither protect the interest of the citizen and the homeowner, nor will it protect the blaster from alleged damage claims."**

After the Bureau of Mines was shut down by Congress [in March 1996], Siskind became a private consultant. He testified for the coal company that lost the Bim case. The majority of the blasting cases have overturned his studies, and thereby the limits used by DEP and OSM. As he wrote an OSM official on June 17, 1997: "The battles I am now seeing are not 0.5 in/sec [12.7 mm/sec] versus 1.0 in/sec [25.4 mm/sec]. Complainants are trying to dismiss all the science as biased,

> **wrong or nonapplicable. For the most part, they are succeeding in ways that pay off**."
>
> **Interestingly, the DEP "Surface Mine Blasting Study Guide" acknowledges that the response of the human body is greater at lower frequencies**: "This explains why people file complaints even when the blasting is conducted at safe (no damage) levels." The guide recommends seven ways to possibly reduce ground vibration, including: use less explosive per delay, increase the length of delay, detonate the blast away from houses, increase the scaled distance formula. Interestingly, many of the problem blasts violated one of those seven recommendations.
>
> The study guide also notes that blasting complaints will be likely when air blasts exceed 115 dB. It has nine recommendations on how to reduce air blasts, including using enough cover over the explosives in the holes, avoid cloudy days and temperature inversions and avoid open sides in the direction of homes. Again these were often disregarded during problem blasts [p. 15-17].[202]

QUARRY OPERATOR'S ADMISSION AGAINST SELF-INTEREST PREVENTS CLASS ACTION LAWSUIT

In *Freeman v. San Rafael Rock Quarry Inc.*,[203] pursuant to a June 2001 Marin County (California) Grand Jury report, which was critical of the county's handling of complaints about the quarry and recommended the district attorney institute a nuisance abatement action against the quarry, the homeowners were unsuccessful in their motion for a class action. The nuisances identified in the Grand Jury's report consisted of *dust, noise, blasting* and *truck traffic* attributed to a substantial unlawful expansion of the quarry in 1986 without permits.

While the defendant quarry was able to prevent a class action lawsuit commenced by 11,075 class members within five square miles of the quarry, in doing so the quarry owner's two experts candidly admitted that the impacts from blasting experienced by each homeowner would vary based on factors such as the distance from the quarry, rock and soil formation, the age and condition of each property, the quality of building materials and type of building construction, and even the design of the internal floorplan and nature and placement of furnishings.

> …[T]he Salter report found that "[t]he variation in noise is due to the wide range of distances between the noise sources and homes and shielding of the noise provided by

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[202] Vivian Stockman, "*The Social and Cultural Effects of Mountaintop Removal*," Ohio Valley Environmental Coalition, file:///C:/Users/Windows%207%20PC/Documents/comments-of-the-ohio-valley-environmental-coalition-ovec-po-box-6753-huntington-wv-on-the_compress.pdf.

[203] *Frieman v. San Rafael Rock Quarry, Inc.* 10 Cal.Pptr.3d 82 (2004) 116 Cal.App.4th 29, https://scholar.google.ca/scholar_case?case=7418002689018790095&q=san+rafael+rock+quarry+inc&hl=en&as_sdt=2006.

> natural terrain, intervening homes and vegetation. Because of these factors, in many locations, neighbors within a few hundred feet of each other have dramatically different exposure." The report notes that noise exposure also varies inside of individual homes due to the orientation of rooms, nature of furnishings, size and construction of windows and whether windows are open or closed.
>
> The…report, prepared by Blast Dynamics, Inc., analyzed how blasting at the Quarry affected neighboring residents. This report identified a number of variables in the way that different residents would experience vibration from blasting. **These variables include the presence of rock or soil formations that alter the frequency of blast waves, the natural or "resonant" frequencies in each structure that changes the response to vibration, distance from the blast site and differences in the duration of the blasts**. The report included a geologic map of the area showing a combination of soil, rock, sandstone, artificial fill, bay mud and marshland under the relevant area. **The report noted that soil typically filters out high frequency energy, while rock transmits it. Test blasts were detonated at the Quarry and instruments were placed at various locations to evaluate the differing effects. The results of the velocity measurements showed a decrease in impact with distance from the blast site, but the frequency measurements showed no consistent pattern. The report concluded that: "[t]he test data shows that it is unreasonable to expect that any two sites will experience the same blast related vibration**...." [emphasis added]

VIBRATIONS RULED A PUBLIC NUISANCE: EVERY STRUCTURE/ RESIDENCE IMPACTED DIFFERENTLY BY VIBRATIONS

In *Fraser (Re),* 2018 NSUARB 74,[204] the Board ruled that *vibrations* are a public nuisance, and caused damage to the Claimants' property:

> The Claimants testified the demolition of the two schools was not a problem. However, when the compacting occurred, mainly during the months of April, May and June 2013, the house shook, dishes rattled, and windows vibrated. The Claimants started to notice damage to their home including:
>
> 1. Cracks in the plaster walls and ceilings;
> 2. Separation and heaving of the floor boards;
> 3. Cracking in the fireplaces and chimneys;
> 4. Cracks in the foundation;
> 5. Leaks and moisture in various areas of the home;
> 6. Deformation of floors, door frames and windows; and
> 7. Deformation of siding on the exterior of the home [para. 25].
>
> The Claimants state the sun porch was tilted forward and came off its posts. They have also experienced problems on their lands with increased water, moss growth, and the lands heaving and sinking in areas [para. 26].

Murphy, an engineer, went on to explain the causation of some of the damage attributed to vibration and his reliance on the *Vibration Guidance Manual of* the California Department of Transportation (Caltrans):

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[204] *Fraser (Re)*, 2018 NSUARB 74 (CanLII), <https://canlii.ca/t/hrg94>, retrieved on 2021-05-09.

> **When analyzing distance from the source of the vibrations to a house, the composition of the soil and ground through which the waves must travel is significant to the readings that are achieved at various distances. In every single case, it may be different because of the different subterranean composition. Consequently, distances that have been created in a laboratory do not necessarily work in the real world unless one can exactly duplicate the subterranean composition and the specific house structure [para. 184]** [emphasis added]
>
> **…[Murphy].stated every experiment is specific to the facts of that soil composition and the specific house structure [para. 185]**. [emphasis added]
>
> **…[T]here's so many factors that go into vibration and the effects on a structure. It's impossible to duplicate those in a scientific setting, to duplicate them all [para. 185]**. [Board's emphasis]
>
> Caltran's noted vibrations can cause damage to structures….[para. 170] The damage they can cause is dependent upon the structure (J. Pistrol, F. Kopf et. al, Ambient Vibration of Oscillating and Vibrating Roller: **Apart from the Characteristics of the excitation (duration, frequency, magnitude, etc.) the immission on buildings highly depends on the type of structure, material properties, stiffening elements, inherent damping, natural frequencies and other building parameters [para. 171]**. [emphasis added]
>
> And now there's some jurisdictions that have determined that – with experience, that there has been – damage has occurred at the 5 millimetres per second, and so they're saying – they're picking that as a safe threshold and then – but basically what they're saying is you've got to do monitoring and you have to do pre-condition surveys. These are the ways that the municipality, the province, the state – you know, that's the way they're going to have to try to ensure that things are dealt [with] fairly. [Board's emphasis]

The Board rejected the expert testimony of Robert Cyr, an explosives engineer of Explotech, who appeared on behalf of Transportation and Infrastructure Renewal (TIR), and testified that "it was highly improbable that the construction vibrations would have initiated any structural damage to the Claimants' home…"

> Mr. Cyr opined it was highly improbable the compactor caused the damage to the Claimants' home based on his opinion that no damage can occur below the vibration amplitudes of the Z-Curve created by the USBM, an experiment he conducted in Ontario, studies of Dowding and environmental factors, and the Stantec monitoring results [para. 158].
>
> … While the nature of the transmitting medium (rock, earth, water, etc.) and presence of joint sets, fractures, faults and shear zones will all impact the rate of decay of the ground vibrations, the fact that intensities diminish with distance within consistent media is unavoidable [para. 168].

Cyr, however, did concede to the effects of water in the subsoil, and that he had no way of knowing the difference in the subsoils of the school site and the Claimants' home:

> It's possible that water infiltration into the subsoil could impact the effect of the waves on the claimants' property,
>
> **Mr. Cyr acknowledged… that his study was conducted in Ontario and that he has no way of knowing the difference in the soils between his test site and that which existed between the School Property and the Claimants' home**. [emphasis added]

ADVERSE EFFECTS CAUSED BY BLASTING QUARRY OPERATIONS RULED A PUBLIC NUISANCE

In *Attorney-General. v. P.Y.A. Quarries Ltd.* [1958] EWCA, Civ 1[205] on April 25, 1956, Justice Oliver granted an injunction restraining the defendants from carrying on the business of quarrying in such a manner as to cause stones or splinters (i.e., *flyrock* debris) to be projected off-site or to occasion a *nuisance* to Her Majesty's subjects by fugitive dust or ground vibrations. The injunction against *flyrock* is held to strict liability under the rule in Rylands v. Fletcher. "So far as the flying stones were concerned,…[the Justice] said that there was really no defense at all; that the case was 'absolutely proved at the time the Writ was issued." Only the injunction regarding fugitive dust and ground vibrations was appealed, which was denied by the appellate court.

> On a number of occasions damage by flying stones has been done to houses in the vicinity of the quarry and recently a pane of a kitchen window was blown in by blast, littering a breakfast table with jagged pieces of glass, the wife in the home narrowly escaping injury. We sincerely believe that your authority cannot fail to realise the seriousness of the position and the earnestness of our protest…2. The flying pieces of rock on occasions following blasting operations landing some distance from the quarry constitute a very serious menace to life inside and outside the home and to users of the public highway.

As for the *fugitive dust* and *ground vibrations*, they were ruled public nuisances. The action was brought by the Attorney-General against the Glamorgan County Council and the Pontardawe Rural District Council under three broad headings alleging the nuisances complained of existed since 1947. The appellate court dismissed the defendants' appeal. The case is summarized below:

> D[efendants] owned a mining [quarry operation] that caused noise and dust pollution to a section of the public, and tried to argue that since it only affected a section of [H]er [M]ajesty's subjects [twenty-eight houses, a farm and two highways], not [H]er subjects as a whole, it couldn't be a public nuisance. C[ourt of] A[ppeal] rejected this, saying any

[205] https://www.bailii.org/ew/cases/EWCA/Civ/1958/1.html.

nuisance which materially affected the reasonable comfort and convenience of life of a class of Her Majesty's subjects was a public nuisance. Whether the no. [of] citizens affected was enough to constitute a class depends on the facts of each case. An injunction was granted.

Denning LJ: To see if it is a public nuisance, we should look at the reason of the thing and to say that a nuisance is a public nuisance which is so widespread in its range or so indiscriminate in its effect that it would not be reasonable to expect one person to take proceedings on his own responsibility to put a stop to it, but that it should be taken on the responsibility of the community at large. E.g. blocking up a public footpath that is only used by a couple of people:[is] still a public nuisance since it is indiscriminate against those who may wish to walk along it. Another example is a landowner who "permits gypsies with filthy habits to encamp in a residential neighbourhood".

Romer LJ: It does not have to be shown that all members of the class have been affected: it is enough that a representative cross section of the class has been affected.[206]

RECOGNITION OF POTENTIAL PROPERTY VALUE IMPACTS FROM QUARRY OPERATIONS

Courts have recognized the traditional role and power of municipalities to protect its residents' economic interests, preserve the community's tax base, and protect the health, safety and welfare of the public.

- In *Red Wing Properties, Inc.*, Interim Decision of the Commissioner, January 20, 1989, in declining to consider property value and tax diminution in the context of a sand and gravel mine, the Commissioner stated that it is local government's prerogative to protect the community's property values through local zoning. Local zoning may restrict the activity that may cause a decline in property values. The MLRL [Mined Land Reclamation Act] amendments of 1991 explicitly retained local governments' authority to enact laws of general applicability – zoning – while restricting their power and reclamation standards. The role of local governments in protecting the property values and tax base of the community through zoning has been affirmed in subsequent commissioner's decisions, as well as by the courts (*See, Matter of Dailey*, Interim Decision of Commissioner, May 14, 1992; *Matter of Kearney Gravel*, Interim Decision of the Commissioner, September 28, 1992)[207]

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[206] *Case summary last updated at 19/01/2020 17:42 by the Oxbridge Notes in-house law team. https://www.oxbridgenotes.co.uk/law_cases/ag-v-pya-quarries.*

[207] Final Environmental Impact Statement, County Line Stone Co., Inc., Akron Quarry, Towns of Newstead and Pembroke Erie and Genesee Counties, New York DEC No: 9-1456-00004/00013, June 18, 2019, p. 4.

- In 2012, the proponent of a quarry application in the City of Westbrook (2012 Pop. 17,501), Maine, in a Consent Order[208] willingly agreed to purchase homeowners properties within a half-mile (805 metres) of the proposed quarry for their market value. The measure requires the quarry proponent to meet with the owners of the homes and discuss purchasing their homes for its fair market value as of the date of the Consent Order based on a written appraisal prepared by a Maine licensed appraiser and submitted by the property owner.[209]

  > …This measure requires Pike to meet with the owners of homes located within ½ mile [805 metres] of the quarry to discuss purchasing their homes for its fair market value as of the date of the Consent Order using a written appraisal prepared by a[] Maine licensed appraiser and submitted by the property owner. This is a very important measure that Pike willingly agreed to include in the CO that was requested by the residents to protect their property values in the event that the performance standards are not effective and residential property values are devalued in the quarry area. This allows the residents to recoup their investment in their homes prior to full commercial operation of the quarry and relocate to another location [p.9].

  On its face, and in the absence of appropriate separation distances and setbacks, the buyout by the quarry proponent of properties within a half-mile (805 metres) of the quarry at market value appears to be a practical solution for the preservation of homeowner equity, but the stipulated distance is unlikely to capture all of the impacted properties, and, depending on the number of properties involved, it could effectively destroy the community.[210]

- In 2019, residents of Kyaggundal Village, Nigeria, affected by flyrock debris from a nearby 15-acre quarry, and residing within a radius of 500 metres are being compensated by the quarry owner to temporarily relocate to safer places and return after 24 months.[211]

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[208] A Consent Order is generally a voluntary agreement worked out between two or more parties to a dispute. It generally has the same effect as a Court Order and can be enforced by the court if anyone does not comply with the order. See https://definitions.uslegal.com/c/consent-order/#:~:text=A%20consent%20order%20is%20governed,not%20comply%20with%20the%20orders..

[209] Westbrook Planning Board Minutes, September 25, 2012, https://www.westbrookmaine.com/ArchiveCenter/ViewFile/Item/239.

[210] Acquisition by the quarry owner of 13 residences, as far as approximately 1,509 metres from the excavated area of the blasting Acton Quarry operation, has effectively obliterated any sense of community life along Third Line, https://files.secure.website/wscfus/6880241/28362475/adverse-effects-13-homeowners-bought-out-by-quarry-owner-jan-21.pdf.

[211] "Residents reject cash to abandon stone quarry site," *Monitor*, September 4, 2019, https://www.monitor.co.ug/uganda/news/national/residents-reject-cash-to-abandon-stone-quarry-site-1846128?view=htmlamp.

> **A Chinese firm, Hunan Road and Bridge Construction Group Companies Ltd, which is managing the quarry, last week [August 2019] started compensating about 80 residents with plots of land and houses within 500 metres radius from the stone quarry to enable then to relocate to safer places and return after 24 months**. [emphasis added]

- In *Parker Mountain Aggregates Limited v. Nova Scotia (Ministry of Environment)*, 2010,[212] the court found that it was not just speculation that homeowners within 1,000 metres of a quarry would experience a decline in the value of their properties.

> "**Such a decline [in the value of their properties] will be the direct result of the development and operation of the quarry** [para. 16]."

In Nova Scotia, a blasting quarry is not permitted within 800 metres of a residential structure without written consent from **all** owners of structures within 800 metres from the point of blast. Four residents, including Angela Vroom, who resides 1,000 metres from the quarry, were granted status as respondents to an appeal brought by *Parker Mountain Aggregates Limited* (PMAL)[213] from a decision of the Nova Scotia Department of Environment (NSE) suspending the quarry's permit. Angela Vroom also owns a 25-acre property adjacent to the quarry, which she claims was adversely affected by the quarry:

> She…owns a 25 acre parcel adjacent to the quarry. She reported excessive noise, dust, dirt and traffic when the Appellant started operations in 2009. **She further reported that the 2009 blasting threw rocks [flyrock] on her property damaging trees** [para. 10]. [emphasis added]

All four respondents (homeowners) expressed the concern that approval of the quarry permit would negatively affect their property value.

- In Verbillion *et al. v. Enon Sand & Gravel, LLC*, 2021,[214] the Ohio Court of Appeals upheld the lower court's ruling in which the trial judge concluded that property owners whose properties bordered the proposed quarry expansion, exposed to truck traffic (100 trucks per

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[212] *Parker Mountain Aggregates Limited v. Nova Scotia (Minister of Environment)*, 2010 NSSC 277 (CanLII), <https://canlii.ca/t/2bjb4>, retrieved on 2022-01-20.

[213] Parker Mountain Aggregates Limited v. Nova Scotia (Minister of Environment), 2010 NSSC 277 (CanLII), <https://canlii.ca/t/2bjb4>, retrieved on 2022-01-20.

[214] *Verbillion, et al. v. Enon Sand & Gravel, LLC*, 2021-Ohio-3850, https://scholar.google.com/scholar_case?case=7412176152641197603&q=%22quarry%22+and+%22property+value%22&hl=en&scisbd=2&as_sdt=2006.

day), would be damaged in a manner not experienced by the general community; and that their wells would be adversely affected. It was also noted that,

> **[The trial judge] took 'judicial notice'[215] that adjoining property values would be diminished if blasting occurred** [para. 47]."

- In *Troy Sand & Gravel Co., Inc., et al. v. Fleming, et al.*, 2017,[216] the appellate division of the Supreme Court of New York upheld the ruling of the lower court that denied an application to permit a quarry on a 214-acre parcel, scheduled to remain operational for approximately 150 years, in the Town of Nassau. The quarry application was denied by the Town of Nassau for a host of reasons including concerns related to blasting (fugitive dust, vibration, noise, flyrock) and the impact of the proposed quarry on property values. The quarry application failed to meet a standard that "the nature and intensity of intended operations shall not discourage the appropriate development and use of adjacent land and buildings nor impair the value thereof" (Local Law No. 2 [1986] of the Town of Nassau. A comprehensive Value Impact Analysis prepared by Professor Hite on behalf of the Town of Nassau concluded, unequivocally, that the proposed quarry "would have a deleterious financial effect on existing homeowners in the surrounding area and could result in a significant decrease in neighboring property values."[217]

  > **Hite's study concludes that mine operations are a disamenity that would have a negative impact on property values ranging from a 7.5% to 36% discount. Related to these discounts, she concludes (page 12) that 'These discounts are statistically significant at the 99+% level; such a high degree of significance leads us to conclude that, without a doubt, the quarry that Troy Sand & Gravel Co., Inc., proposes to develop and operate in the Town of Nassau, Rensselaer County, New York, will have a deleterious financial effect on existing homeowners.'** (Sept 1, 2015, Decision of Town Board of the Town of Nassau, p. 72)

- The diminution in property values is always a major concern expressed by residents living near proposed pits and quarries, a sentiment conveyed by the Town of Caledon in a January 22, 2014 submission to

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[215] "Judicial notice" is a judge's recognition of a fact without requiring a party to prove it.

[216] *Troy Sand & Gravel Co., Inc., et al. v. Fleming, et al.* 156 A.D.3d 1295 (2017), 68 N.Y.S.3d 540, https://scholar.google.com/scholar_case?case=6635546804191739814&q=%E2%80%9Cquarry%E2%80%9D+and+%E2%80%9Cproperty+value%E2%80%9D&hl=en&scisbd=2&as_sdt=2006.

[217] See Resolution of the Town Board of the Town of Nassau Decision on the Troy Sand & Gravel Special Use Permit Application, Resolution No. 17, September 1, 2015.

the Standing Committee on General Government Report on the Review of the Aggregate Resources Act.

> **8. Reduction in value of neighbouring properties**
> An issue which is raised by the public at all municipal meetings for aggregate operations is the impact on the value and rnarketability of neighbouring properties. At one of Caledon's public meetings for an aggregate pit, a resident provided evidence confirming that the Province of Ontario's Municipal Property Assessment Corporation (MPAC) has recognized the impact on property value by providing a 10% reduction in assessment to a landowner due to proximity of the property to an aggregate pit. [emphasis added]

The loss in value (homeowner equity) of a house in proximity to a quarry, accompanied by blasting below the water table, is significantly greater than the 10% loss indicated for a house in proximity to an aggregate pit.

As noted in *Martin Marietta Mater. v. Bd of Zoning Adj.* (2007),[218] citing from the Cass County Comprehensive Plan, adjoining land use is one of the most important factors effecting the utility (use and enjoyment) and value of a given parcel, and that the best way to avoid externalizing *adverse effects* on a given parcel is too separate incompatible uses.

> One of the most basic factors affecting the use of a given parcel of land is the use of adjoining parcels. This is due to the fact that the use of land has an impact that goes beyond the boundary of the land being used. Economists refer to this impact as a `land use externality' because it is generally not included in the property owner's decision-making process since it is external to the efficiency and profitability of the property being used. **As an example of land use externalities, a house surrounded by sand and gravel pits is less enjoyable to live in and has less value for residential purposes than the same house surrounded by similar houses**. The noise, smoke and heavy truck traffic generated by the excavations are so incompatible with residential life that the value of the house declines. Yet the gravel pit owners have no economic incentive to lessen the impacts of their activities since the declining value of the house does not affect the profitability of their businesses. In effect, it is a cost imposed by the gravel pit owners on the owner of the house.... The best way to minimize these external costs is to separate incompatible land uses or buffer them from each other. [emphasis added]
>
> In general, a residential land use is the most sensitive to adjacent land uses. This is because the characteristics which most people value in a residential area — quiet, serenity, stability, to name a few — are the most difficult characteristics to find and maintain.

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[218] *Martin Marietta Materials, Inc., et al., and State of Missouri ex rel. v. Board of Zoning Adjustment of Cass County, Missouri and City of Peculiar, Missouri, et al.,* 246 S.W.3d 9 (2007), https://scholar.google.com/scholar_case?case=2443837302635348511&q=%22quarry+operation%22+and+%22property+value%22&hl=en&as_sdt=2006.

> **Finally, it is important not to think of land use externalities solely in terms of economic effects. Minimizing negative externalities and creating positive externalities can lead to a variety of benefits. Not only will property values be increased and stabilized, but social values can be reinforced, safety and *convenience can be improved, and psychological stress can be lessened*.** [emphasis added]

HOMEOWNERS UNABLE TO SELL HOMES AT FULL VALUE DUE TO BLASTING AT NEARBY QUARRY

Residents attribute house damage and loss in property value and the inability to sell their homes to the nearby McGee blasting quarry operation:[219]

Residents of the Grandview, a neighbourhood of 22 homes located roughly 750 feet (229 metres) to 1,700 feet (518 metres) from McGee's West River Road quarry operation, have complained blasting at the quarry has damaged their homes, reduced their property value and disrupted their lives. In July 2017, Cheri and Pietro Nicolosi, who live near the quarry, filed a lawsuit claiming that blasting at the quarry damaged their home, caused problems with their water and caused them emotional distress. The lawsuit names the City of Augusta, McGee Construction and Maine Drilling and Blasting, the firm which blasts rock for McGee, and seeks compensation for damages and to have McGee's permit to blast and extract rock at the quarry site revoked.[220]

> AUGUSTA — **Grandview neighborhood residents said blasting at a quarry operation [of McGee Construction] in a pit adjacent to their neighborhood has made it impossible to sell their homes at their full value and caused cracks in their homes' floors and walls, and it makes them anxious before and angry after blasts that can occur up to 10 times a year**. [emphasis added]
>
> **They asked the city, as they have before, to take action to protect their neighborhood. Councilors are considering a proposal to reduce the size of blasts in quarries in the city.** [emphasis added]
>
> Roland Maheux, who lives with his wife, Anna, on Edwards Street, about 760 feet from the blasting area of the McGee Construction-owned pit off West River Road, described a Sept. 29 blast as violent and said he literally could see the walls of his home moving and could feel shaking throughout the home. **He said his home has evidence of structural fatigue including cracks in walls and floors, and steps that are slowly creeping farther away from his home. He said he thinks at least some of that damage "is a**

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[219] Edwards, Keith. "Augusta quarry's neighbors attribute house damage to blasting," *Kennebec Journal*, November 17, 2016. https://www.centralmaine.com/2016/11/17/augusta-quarrys-neighbors-attribute-house-damage-to-blasting/.

[220] Keith Edwards, "Blasting at McGee site probably not damaging nearby neighborhood, consultant tells August board, *ASCE*, 2017-09-13, https://cqrcengage.com/asce/app/document/23793269;jsessionid=1rflrikl9uox31kihxpvi8mg7l.

result of the pounding my house has taken (from blasting in the quarry) over the last 14 years."

He said he gets anxious before every blast. And he said when a violent blast happens, he reacts so strongly to the potential damage to his home that he used to go outside after some of them and yell and scream.

Other neighborhood residents said they also think cracks and other damage to their homes has been caused by blasting at the pit.

Patrick Street resident Gary Leighton said he and his wife have tried twice over the last six years to sell their home but have been unable to do so. He said he thinks the blasting, as well as publicity and the resulting stigma attached to it, has hurt their ability to sell their home, even though it is beautiful home with a big yard and good neighbors. [emphasis added]

"Our hope is that a resolution can finally be reached so those of us who want to sell can do so, and those who want to remain can enjoy our neighborhood," Leighton said….

City officials are considering proposed changes to the city blasting ordinance that would reduce the standards for allowable blasts in quarries in Augusta to just 15 percent of the city's current standards, which are already tighter than state blasting standards. Blasting and construction company officials said last week that standard would be so low it wouldn't be economically feasible to continue blasting rock for construction projects.

Industry representatives said last week they would work with the city staff to come up with a potentially new standard as a compromise that would reduce the vibrations coming from blasts but still allow the companies to operate their quarries….

The proposal for tighter rules was made in response both to ongoing complaints from residents of the Grandview neighborhood and to a city official describing a blast he observed from inside a home as startling and alarming. The Grandview neighborhood is next to a McGee Construction-owned pit and quarry operation that blasts rock up to 10 times a year off West River Road. Nazar has attended roughly 40 blasts at quarry operations, mostly in the McGee pit, over the last 10 years. During a recent blast, Nazar was in the home of Maheux, and he said the blast was "startling" and felt much more significant than blasts of similar size he observed outside….

Disputes between the pit owner and neighbors about the effect of blasting there go back many years, and the city's current mining and blasting rules were formed after a lengthy process involving multiple interested parties.

Also, a May 13, 2015 blast at the McGee Quarry that caused damage to the homes of neighbouring residents prompted the city of Augusta, Maine, to file a lawsuit.[221] As expected, the quarry operator denied responsibility for the damage.

[221] Edwards, Keith., "Augusta quarry pit neighbors say blasting damaged Homes," *Kennebec Journal*, September 21, 2015, https://www.pressherald.com/2015/09/21/augusta-quarry-pit-neighbors-say-blasting-damaged-homes/.

> A resident who lives about two-tenths of a mile north of the pit's entrance on West River Road and roughly 2,000 feet [610 metres] away from the pit itself says she believes the concrete floors and walls of the basement in her 8-year-old home were cracked by the May 13 blast, which she said felt and sounded like a bigger blast than other blasts at the pit owned by Steve McGee Construction.
>
> Donna Bonenfant said gaps of roughly a quarter-inch opened up between several of the floor joists and the main support beam of the main floor of her home, visible from the basement, gaps which she said weren't there before the blast. What appear to be water stains are visible around some of the cracks in her basement walls.
>
> "I don't know what to do about these. What if it leaks?" Bonenfant said, pointing to one of several cracks spread across parts of the concrete basement floor of her home. "I know to expect some cracks, but this many? **A cement contractor looked at it and said there is no way all these cracks would come from just the house settling**." [emphasis added]
>
> Across the Kennebec River from the pit site, Riverside Drive resident John Liacos said he noticed hairline cracks in some of the ceramic floor tiles installed when his home's kitchen was redone in the spring of 2014, which he doesn't believe were there before the May blast. He said he's also discovered small cracks in the drywall of the kitchen ceiling.
>
> Liacos acknowledged he's not sure of the date when he first noticed the cracks, but said a contractor who looked at the cracks said they had to have been caused by "something serious," and Liacos suspects it was the blast.
>
> Bonenfant and Liacos both said they contacted the company that did the blasting, Maine Drilling and Blasting, to file claims for the damage. Both said their claims were rejected.
>
> "We got a letter saying, sorry, we're not responsible for it," Liacos said. "If nobody is willing to admit it, what are you going to do? I want to be treated fairly. I was hoping to get some sort of resolution from Maine Drilling and Blasting."

An August 22, 2017 report was prepared by Golder Associates,[222] in response to numerous complaints to the City of Augusta, Maine, over the past 15 years concerning blasting at the McGee quarry. Golder did not bother to review the submitted complaints, "but understands the file includes numerous complaints related to emotional distress and concerns about structural impacts to [22] homes" located roughly 750 to 1,700 feet (229 to 518 metres) north of the Quarry. In this respect, the Golder report made the following admissions:

> 10. It is possible that poor foundation support conditions for a home may present conditions more susceptible to structural damage from blasting vibrations than typically cited in the literature….

[222] Preliminary Findings, Review of Selected Blasting Records and Project Information, McGee Quarry, City of Augusta, Maine," Golder Associates, August 22, 2017, https://cms6.revize.com/revize/augustame/GolderReport_170822%20Augusta%20Prelim%20Findings.pdf.

11. It is possible that geological conditions and/or site-specific structure response from blasting vibrations could present conditions more susceptible to structural damage than typically cited in the literature….

13. All of the blast vibrations reviewed would be considered "strongly perceptible" to "disturbing" based on human perceptions of blasting… This conclusion is consistent with information presented by MD&B in their 11/10/16 presentation. Human beings can detect vibrations as low as about 0.02 in/s [0.508 mm/sec].

14. Human perception and quality of life criteria are a significant and increasing factor in the development of allowable vibration and airblast overpressure standards for blasting ordinances for quarries and construction. Criteria based on structural damage probability versus that for quality of life are a common controversial issue pitting annoyance and emotional effects of nearby residents against the financial interests of quarry operators and construction companies.

15. Review of allowable vibration criteria for other selected towns/cities in Maine, Maine DEP guidelines for quarries…, and European guidelines indicate Augusta's current criteria are similar to somewhat more restrictive than most, but there are exceptions. Of those reviewed, the City of Westbrook appeared to have the most restrictive vibration criteria for quarry blasting in Maine (0.5 in/s [12.7 mm/sec] maximum PPV for all cases except for a specific residence where 0.25 in/s [6.35 mm/sec] applied). **Review of selected international standards indicates Germany has one of the more restrictive European guidelines with residential vibration limits between 0.2 and 0.8 in/s [5.08 mm/sec and 20.32 mm/sec] depending on frequency – these criteria appear to be intended to eliminate the possibility of even minor structural damage and substantially limit human complaints**. [emphasis added]

PROPERTY VALUE IMPACTS OCCASIONED BY AGGREGATE EXTRACTION OPERATIONS

An internet search was undertaken for Proximity Studies related to the potential impact of blasting quarry operations on residential properties in proximity.

Study One

In a large scale peer-reviewed study of the impact of rock mines (quarries) on residential property prices, the first of its kind,[223] Malikov, et al (2018), documented 5,500 house sales that took place in Delaware County during the 2009-2011 period (roughly two years). Within the County are four surface rock (limestone) mines (quarries), three of which are no longer operational. The only operational quarry (state mine: Del-5), at 510 acres, also happens to be the largest and is subject to blasting, which creates a far greater nuisance (hazard) than other types of surface mines.

[223] Emil Malikov, Yiguo Sun and Diane Hite, "(Under)Mining Local Residential Property Values: A Semiparametric Spatial Quantile Autoregression," *Journal of Applied Econometrics* (June 22, 2018): 82-109. https://onlinelibrary.wiley.com/doi/epdf/10.1002/jae.2655.

> Given that the other mines in the county were no longer in operation by the period of our study and hence did not generate noise, dust and traffic, in our analysis we focus solely on the operational Del-5 mine, which is not only very large but is also located in an area of high urban development.

Standard software was used to calculate straight-line distances from each property (sale) to the mine centroid of Del-5. The study found statistically significant property-suppressing effects of being located near an operational rock mine (quarry), which gradually decline to near-zero at roughly a 10-mile distance.

- For residential property in the middle of the price distribution (r = 0.50), our estimates suggest that, between two identical houses, the one located a mile closer to a rock mine is predicted to be priced, on average, at about 3.1% discount.[224] The analogous average discounts for houses in the first and third quartiles of price distribution are around 2.3% and 3.4%, respectively. For an upscale property in the 0.95th quantile [$552,500 avg house price], it is at an astounding 5.1%. This is rather expected because of income sorting whereby higher-income households have higher ability to pay for better environmental quality: in this case, distance from a disamenity.

- Conversely, households with lower incomes and less expensive homes are perhaps more willing to substitute environmental quality for other, more necessary, house characteristics such as easier access to employment, including jobs in the environmental-externality-generating rock mining industry itself.[225]

- As a back-of-the-envelope welfare calculation using unconditional sample quantiles of house values corresponding to the fitted quantile functions,[226] the above discount estimates imply the average loss in property value associated with the house being located a mile closer to a rock mine ranging from $3,691 to $10,970 for houses within the interquartile range of price distribution. For more expensive neighborhoods in the 0.95th quantile, such losses can be, on average, as high as $28,410.

A July 9, 2018 Supplementary Appendix[227] of Professor Hite's study includes the following statement:

- Our estimates suggest that, all else equal, a house located a mile closer to a rock mine is priced, on average, at about 2.3–5.1% discount, with more expensive properties being subject to larger markdowns.

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[224] 5.28 thousand feet [one mile] times the mean estimate of 0.58% per 1,000 feet. The average discount estimates for other quantiles of house price are obtained similarly.

[225] Cohen and Coughlin (2008) discuss such positive employment accessibility effects associated with environmental disamenities which may counteract negative externality effects in the context of a noise-generating airport.

[226] And assuming a constant marginal willingness to pay.

[227] http://qed.econ.queensu.ca/jae/2019-v34.1/malikov-sun-hite/Malikov-Sun-Hite-Mining-Property-Values-Appendix.pdf.

Study Two

Professor Hite undertook a study in 2015 that analyzed the property value impacts of rock and gravel mines on house prices in Upstate New York. The study used a large data set of MLS realtor-negotiated house sales (18,941) covering the period of January 1, 2000 to May 7, 2015, with all sales adjusted to current 2015 dollars based on the House Price CPI, in areas surrounding three industrial stone quarries and one sand/gravel pit in Columbia, Saratoga and Rensselaer Counties. The sales surrounding the four mines are from Capital Region Multiple Listing Service (MLS) data, and, according to Hite, use of only Realtor mediated sales in Hedonic Price Models consistently demonstrate lower impacts of disamenities than do those that include all house sales (Jauregui and Hite, 2009);[228] "thus estimates of impacts in the current study should be considered underestimates of the true impacts of mines [by about 3.0%]."

Hite's study, which was relied upon by the Town of Nassau in its 2015 review of Troy Sand & Gravel Co., Inc.'s application to permit a blasting quarry with an expected life of 150 years on 89 acres of a 216-acre parcel, concluded that

> **Mine operations are a disamenity that would have a negative impact on property values ranging from a 7.5% to 36% discount. Related to these discounts, she concluded (page 12)[7] that 'These discounts are statistically significant at the 99+% level; such a high degree of significance leads us to conclude that, without a doubt, the quarry Troy Sand & Gravel Co., Inc., proposes to develop and operate in the Town of Nassau, Rensselaer County, New York, will have a deleterious financial effect on existing homeowners**.'
>
> …[T]here are 293 residential parcels within 1 mile [1,609 metres] of the [proposed] mine site, equating to about 750 people (293 residences at 2.6 people per household as per US Census Data). That equals about 15% of the Town [of Nassau] population. The Town does not consider this a remote location [p.35]…
>
> **To most people, it makes intuitive sense that an operation like a mine – which creates traffic, noise, and dust and that is highly unattractive – would result in nearby house prices being depressed. Statistically based studies have borne out this intuition, and the current study scientifically conservatively demonstrates these impacts….Dr. Hite's 1998 article in Land Economics[229] found that individuals who were aware of the existence of a disamenity (in this case, landfills), bid down the prices of houses within 3 miles [4.83 kilometres] by an average of 10.65% as compared to individuals who did not know about the**

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[228] Jauregui, Andres", and Diane Hite. 2009. "The Impact of Realtors on House Prices near Environmental Disamenities." *Housing Policy Debate* 20(2): 295-316.

[7] Diane Hite and Derrick Robinson, "The Impact of Hard Rock and Gravel Mines on House Prices in Upstate New York," June 23, 2015.

[229] Hite, Diane. 1998. "Information and Bargaining in Markets for Environmental Quality," *Land Economics* 74(3): 303-316, August 1998.

> **disamenity. The same group of people received further discounts as high as 20% based on how close the homes sought to be purchased were to the disamenity. In addition, because house prices are influenced by comparable sales, even individuals without knowledge of the disamenity received discounted house prices** [p.12][8] [emphasis added]

Because uninformed buyers overpay for property impacted by a quarry operation, an acknowledged disamenity, these transactions taint the data pool of comparable sales if they are relied upon by realtors setting asking prices or real estate appraisers estimating market value.

Study Three

Erickcek's study (2006)[230] of the economic impact of the proposed 853-acre Stoneco Gravel Mine (Pit), when in full operation, concluded that residential property values in Richland and Richland Township, Michigan, would be reduced by $31.5 million, adversely impacting the value of 1,400 homes, which represent over 60 percent of the Richland Residences, with residential properties declining 20% within a half-mile (805 metres) to 4.9% within 3 miles (4,828 metres):

- A residential property located a half mile (805 metres) from the gravel mine (pit) would experience an estimated 20 percent reduction in value; one mile [1,609 metres] from the mine, a 14.5% reductions; 2 miles [3,219 metres] from the mine, an 8.9% reduction; and 3 miles [4,828 metres] from the mine, a 4.9 percent reduction. These estimates are similar to estimates published in academic journals on the effects of landfills on nearby property values [p.5].

- The loss in property value results from the negative consequences of the mining operation and reflects the deterioration in the area's quality of life due solely to the operation of the gravel mine. In other words, the loss in house value is a way to quantify in dollars the deterioration in quality of life, as capitalized in the price of the house. It captures the price reduction the homeowner would have to offer to induce a new [informed] buyer to purchase the property. Even if homeowners do not move as a result of the gravel mine, they will lose homeowner equity as the potential sale price of their house is less. Therefore, regardless of whether or not a person actually sells their property, it measures the adverse effects in their quality of life in being subjected to the disamenities introduced into the area by the gravel mine [p.6].

The "hedonic pricing model" relied upon by Erickcek was developed by Professor Hite, Auburn University, based on detailed transactional data from

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[8] Diane Hite and Derrick Robinson, "The Impact of Hard Rock and Gravel Mines on House Prices in Upstate New York," June 23, 2015.

[230] Erickcek, George. "An Assessment of the Economic Impact of the Proposed Stoneco Gravel Mine Operation on Richland Township," *W.E. Upjohn Institute*, 2006, https://research.upjohn.org/cgi/viewcontent.cgi?referer=https://scholar.google.com/&httpsredir=1&article=1225&context=reports.

Delaware County, Ohio, for the initial purpose of studying land use planning issues (Erickcek, 2006):

> Hite examines the effects of distance from a 250-acre gravel mine [i.e., blasting limestone quarry] on the sale price of 2,552 residential properties from 1996 to 1998. Her model controls for a large set of other factors that determine a house's sale price, including number of rooms, number of bathrooms, square footage, lot size, age of home, sale date, and other factors specific to the locality, so that she can focus solely on the effect of proximity to the gravel mine on house values. She finds a large, statistically significant effect of distance from a gravel mine on home sale price: controlling for other determinants of residential value, proximity to a gravel mine reduces sale price. Specifically, Hite reports that the elasticity of house price with respect to distance from a gravel mine [i.e., blasting quarry] is .097, implying that a 10 percent increase in distance from the gravel mine is associated with slightly less than a 1 percent increase in home value, all else the same.[231] Conversely, the closer the house to the proximity to the mine, the greater the loss in house value.

According to Professor Hite, model results provided in elasticity form are particularly difficult for lay people to understand. As a result, Erickcek transformed the elasticity model into a graph that calculates property discounts associated with the estimated model demonstrating that the reduction in house values shown on the graphic (page 5) due to the mine (pit) ranged from 30% adjacent to the mine (pit), to about 5% at 3 miles (4,828 metres) from the mine (pit). While the Hite study relied upon by Erickcek pertains to a blasting quarry, Erickcek justified and explained his reliance on the Hite study to measure the impact of a proposed gravel pit, as if fully operational, on area property values in his December 20, 2006, addendum.

> Hedonic pricing models have been the standard research technique for evaluating property value impacts for decades.
>
> The Upjohn report based its estimates of property value impacts for Richland using model estimates from Professor Hite's research because her research was based on high quality data. In addition,…hers was the only study we knew of at the time that used hedonic pricing models to estimate residential property value impacts of mines. Since conducting the study, we have become aware of another study that uses hedonic pricing models, and we have conducted our own analysis based on data for an area gravel mine supplied in an industry consulting report [Sustaining A River: An Economic Impact Study

[231] This estimate is based on a constant elasticity model specification. At the Upjohn Institute's request Professor Hite tested the sensitivity of these findings to model specification, and in all specifications finds a large, statistically significant negative effect of proximity to gravel pit on house prices. The simulations for Richland Township reported below are based on the estimates from the constant elasticity specification and yield slightly lower estimated negative property value impacts than those based on models using other functional forms. We consider this number to be a conservative estimate.

of the Lower Great Miami River Segment Improvements, by Radha Ayalasomayajula, Fred Hitzhusen and Pierre Wilmer Jeanty].

- This study used a hedonic price model similar to that used in Professor Hite's study to estimate the impact of gravel mining operations near the Great Miami Rive in Butler and Hamilton counties, Ohio. The sample contained sales data on only 119 homes – far fewer than the 2,552 homes Professor Hite had in her sample.
- The model used in this study accounted for structural characteristics of the individual homes including number of baths, living area, age, number of bedrooms and whether they had a fireplace. In addition, it included the distance from a gravel mine and distance to the closest urban area.
- The study found that, on average, property values increased by $1,675 per every 1/10th mile the home was away from the mining operation. In other words, the value of a home one mile away from the gravel mine would be worth $16,725 more than the identical house located at the mouth of the mine. The study's analysis limited its impact to only a one-mile radius.[232]

Although Professor Hite's data set is ideal for studying these property value impacts, we were uncomfortable basing the Upjohn report on her initial analysis. Professor Hite agreed to do additional work for the Institute [without seeking compensation]….[T]his involved running checks on the data and variable construction, adding control variables, and testing the robustness of here results to model specification. The simulations presented in the Upjohn report were based entirely on new work performed by Hite for the Upjohn Institute and show somewhat lower property value impacts than in her initial report….Professor Hite's interest in this project is solely to produce high quality research that is publishable in a peer-reviewed, scholarly journal.[233]

As pointed out by Professor Hite, pits and quarries have a number of operational similarities: I would like to emphasize that the two types of gravel operations [pits and quarries] are very similar in that, like landfills, they both involve increased truck traffic, noise, and dust and the destruction of large tracts of land….[T]he main difference is that gravel produced at limestone quarries requires significantly more blasting. To the extent that blasting results in higher average noise or dust levels for area residents, these operations may have larger adverse effects on nearby property values. The adverse property effects from limestone quarries in my study are very large…and…it is improbable that all of these adverse property effects are the consequence of blasting.

Erickcek also took into account an assessor's testimony at an August 9, 2006 public hearing held in Howard Township in Cass County on Moose Lake

[232] The study's analysis was not as sophisticated as Hite's model in that it generated a strictly linear estimate of the negative impact of the mining operation on housing prices. Hite's model generates a more realistic "curved" estimate that declines first at an increasing rate and then at a decreasing rate.

[233] Professor Hite received no compensation for her work, despite the fact that is was fairly extensive.

Aggregate's Application for a Conditional Use Permit, confirming that the assessments on 13 residences near the Moose Lake Gravel Mine were reduced by 30% based on his expertise. The estimated 30% reduction in the assessments of these 13 properties is nearly identical to the estimates in the Upjohn Institute study.

> Later the township assessor revised the negative impact to only 10 percent; however, upon the protest of two of the homeowners of the impacted properties, the assessor increased the negative impact of the mining operation back up to 30 percent of the property's original SEV. The two owners had their properties independently appraised and the Township assessor agreed: "I believe that if I had the appraisals before…that I probably would have left everbody's at 70 percent, but I didn't have any knowledge of that." [footnote omitted]

In addition to the obvious adverse impacts (nuisances) of dust and noise generated by the operations of an active gravel pit, which decline with distance from the gravel pit, three other adverse or negative impacts that would not decline so quickly with distance are *traffic congestion and traffic accidents, town or community reputation and uncertainty about future development or land use plans,* all of which result in a negative impact on residential property values.

- **Road Congestion:** Still, township residents who do not live along potential truck routes or who reside far enough away from the mine to avoid its dust and noise, will face increased road congestion [and traffic accidents] due to the truck traffic generated by the mine. Gravel trucks can be slow-moving and difficult to pass. Also, due to the lack of sidewalks, the trucks will have to share the road with pedestrians and bicyclists. In addition, while the proposed truck route for the gravel mine stays clear of the Village of Richland, independent truck contractors would be allowed by state law to drive through the Village on M-43 and/or M-89. For some instances, this could prove to be the low-cost route for the independent haulers. If this occurs, it will have a negative impact on the Village's environment, which would be shared by most all of the township residents.

  Reputation of the area – Just as amenities such as a good school system can improve a town's reputation and improve property values, the introduction of a disamenity such as a gravel mine can harm the reputation of the area [community], in turn depressing property values.. As George Tolley of the University of Chicago writes "people living away from the area, who are not directly affected by the disamenities, view the area as undesirable."[234]

- **The operation could also alter future development plans for the township**. In real estate, uncertainty only decreases land values. Once the mining operation is in place, it can ease the allowance of other heavy industry uses to occur in the township. In short, the gravel mine could open the door to other heavy primary

[234] George S. Tolley, *Effects of the Proposed Indeck Facility on Property Values, Land Use and Tax Revenues.* May, 2000 page 6.

industries. This is the "blight-begets-blight" principle. In fact, one argument cited in defense of having trucks use 24th Street is that it was used before for heavy trucks going to a now closed landfill. In short, this will raise uncertainty about the allowance of other noisy, heavy industries into the region.

Study Four

Kolala, et al, (2020)[235] undertook a study employing the Hedonic pricing method (Rosen, 1974)[236] to quantify the impact on residential property values in proximity to the Fimiston super pit (quarry) in Western Australia, which measures 3.5 km in length, 1.5 km in width and 360 metres in depth. Kalgoorlie-Boulder has an estimated population of about 32,000, and the main economic actively is mining, followed by agriculture, manufacturing and processing activities. The most common complaints from residents residing in proximity to the super pit relate to blasting, noise and dust.

To estimate the "dis-amenity impact" of the open pit gold mine on residential property values in the community, sales data for 21,850 residential properties sold in Kalgoorlie-Boulder, between 1990 and 2018, were analyzed, and adjusted to 2012 values using the consumer price index (CPI).

- The average house sale price in the sample of 21,850 house sales was AU$250,000, in 2012 prices; has a 700 square metre (7,535 sf) lot, three bedrooms, and one bathroom; and is located 3 km (1.864 miles) from the super-pit, 2.5 km (1.553 miles) from the CBD, 1 km from the nearest school, and 0.5 km (0.311 miles) from the nearest park.

- The distance between the super pit and the first street with residential properties is less than 200 m (656'), and the maximum distance to the pit to residential homes is just under 7 km (4.35 miles).

- The data set contains information on the sale price, location, and sale date; as well as house features such as the number of bedrooms, bathrooms, lot size, type of roofing, wall construction material, and the year the property was built. The initial data contained over 30,000 sales records, but after data checking and restricting the observations to single-family houses and units within the Kalgoorlie-Boulder metropolitan area,…21,850 complete records [remained].

- The maximum distance from a residential home to the super pit is just under 7 km….Cadastral data were obtained from Landgate, the Western Australian Land Information Authority….[T]he distance of each house to relevant neighbourhood amenities, (schools, parks, sports facilities and central business district) and dis-

[235] Kolala, Chomba & Polyakov, Maksym & Fogarty, James, 2020, "Impacts of mining on property values in Kalgoorlie_Boulder, Western Australia," Resources Policy, Elsevier, vol. 68C.
[236] Rosen, S., 1974. Hedonic prices and implicit markets: product differentiation in pure competition. J. Polit. Econ. 82 (1), 34-55.

amenities (super-pit and the airport) using ArcMap 10.5. Model estimation was… performed [in] R (R Core Team 2019)).[237]

- The study found that residential properties within 2 km (1.243 miles) of the Fimiston super-pit trade at a 20% to 30% discount to similar residential properties located at least six to 7 km (4.35 miles) from the super pit. It was also concluded that the results of the study provide valuable information for planners seeking to set appropriate buffer zones (separation distances) around mining operations to avoid land use conflicts, while protecting residential property values.

Study Five

In *M & N Materials, Inc. v. Town of Gurley, Alabama, et al.*,[238] the United States District Court issued summary judgment in favour of the Town of Gurley, upholding the Town's April 13, 2004 decision to annex a quarry operator's 266 acres, and to prevent quarrying based on a number of potential adverse effects on the environment and the community related to *health, safety, morals* and *general welfare* of the Town's residents. On the issue of property value impacts, Key, a member of the Appraisal Institute, prepared a Proximity Study involving small samples of grouped sales.

- Key's Proximity Study grouped sales of modest detached single-family dwellings within 875 feet (267 metres) of the lot boundaries of a quarry that was operational when the sales occurred, compared to a group of sales located beyond 875 feet (267 metres) of the lot boundary of the operational quarry (i.e., the control group). Both groups of sales are from the same subdivision.

- The purchase price of each sale in both groups of sales were *time-adjusted* to the effective date of appraisal (November 23, 2004), and relied upon to isolate the impact, if any, the proposed quarry in the Town of Gurley would have on the value of nearby residences within 875 feet (267 metres) of the boundary limits of the proposed 266-acre quarry. Combined, the house sales in both groups ranged in price from $82,000 to $125,000.

- Based on the *distance* parameter of the Proximity Study, Key concluded that residences within 875 feet (267 metres) of the boundary limits of the proposed quarry would sustain an estimated 12.2% diminution (loss) in value, a rate that falls within the 10% to 15% discount suggested by two knowledgeable local realtors.

The risk factors associated with a quarry operation to which homeowners are exposed, as identified in Key's study, include the following:

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[237] R: Core Team, 2019. R: a language and environment for statistical computing. Foundation for Statistical Computing, Vienna, Austria. URL. https://www.R-project.org/.

[238] *M & N Materials, Inc. v. Town of Gurley, Alabama, et al*, United States District Court, Northern District of Alabama, Northeastern Division, November 13, 2105, https://lanierford.com/images/NewsPDFs/federal-court-decision-gurley-alabama-quarry-case.pdf.

- **Quiet Enjoyment** : Noise issues
- **Trespass** : Dust and airborne particles
- **Structural Damage** : Blasting
- **Ongoing Monitoring** : Determining change of structural damage
- **Market Resistance** : Proximity issues resulting in a diminution in value

Key's Proximity Study does not indicate the distance from the actual quarry activity (mining and blasting), a point that is more distant than the 875 feet (267 metres) measured from the boundary limits of the quarry. Likewise, the distance from the planned quarry activity (mining and blasting) to the boundary limits of the proposed quarry is not specified. Further, the Proximity Study does not disclose whether the purchasers in both groups of sales were aware of the potential hazards of flyrock, as identified by Ludwiczak, the blasting expert whose testimony in this case was also accepted by the court.

Purchasers relocating from major urban centres to a rural community like the Town of Gurley are unlikely to fully grasp the deleterious effects associated with residing in proximity to a blasting quarry operation, including the dangers of flyrock, which is the ultimate adverse effect due to its potential for injury or death of human and non-human life. If the purchasers in both groups of sales were not fully aware of, or well-advised as to the adverse effects of residing near a blasting quarry, the loss in property value would be expected to be higher. Buyers given the choice of selecting between two homes at the same price and similar in age, quality of construction, building materials, utility and lot size, would avoid choosing the one in proximity to a blasting quarry (or non-blasting quarry).

Study Six

In *Ronald Overton et al. v. M.S & R Equipment Company, Inc., et al*,[239] a case involving a number of homeowners claiming damages against an operational quarry, Key and Maloy[240] conducted an analysis that examined price change over the 2010-2014 period for house sales in two subdivisions located one mile west of an operational quarry (non-impacted by an operational quarry), compared to the cumulative price change for the same period of sales in two similar subdivisions located just north of an operational quarry (impacted by an operational quarry).

[239] *Ronald Overton et. al., v. M.S. & R. Equipment Company, Inc., et al.*
[240] Richard Maloy, MAI, SRA, JD, is a member of the Appraisal Institute.

In both instances, price change in the control subdivisions (not impacted by an operational quarry) out-performed the price change experienced in the two impacted subdivisions (near an operational quarry). The cumulative change in price for sales in the non-impacted subdivisions was 11.1% and 18.63%, compared to -5.41% and 4.05% for the sales in the impacted subdivisions (near an operational quarry), summarized as follows:

- Price Change in Non-impacted Subdivisions : 11.1% and 18.63%
- Price Change in Impacted Subdivisions : -5.41% and 4.05%

It is well known in real estate literature that environmental disamenities are likely to have financial impacts with larger effects in more expensive upscale neighbourhoods and more modest effects in less expensive neighbourhoods (e.g., Gayer; Reichert et al., 1992).

According to Toffey,[241] the initial introduction and addition of disamenities has a cumulative effect of stigmatizing and destabilizing a community, and causes house prices to decline:

> There is a dynamic consideration to adding an initial disamenity [e.g., quarry] to an area. A well-known tendency is that blight begets blight.
>
> If a disamenity [e.g., second quarry] is added that is of little or no benefit to a community, there is a tendency to take the attitude that the disamenity harm is already done and that adding other disamenities is simply putting like things together as is the blight-begets-blight tendency. The bar will be lowered on what is considered an acceptable disamenity for future additions. The area of the disamenity is cast into a continuing downward cycle of increasing disamenity in the future.
>
> As an area acquires more disamenities, the satisfactions of people living near the area are directly decreased for the reasons above. An additional effect is that the area gets a reputation of being undesirable. People living away from the area, who are not directly affected by the disamenities, view the area as undesirable. The satisfaction of people living near disamenities is further decreased because they acquire the reputation as living in an undesirable areas.
>
> …[P]eople have become increasingly concerned generally about environmental disamenities, which would make them less willing to pay as much for properties where there are disamenities.

[241] "Impact on Property Values and Tax Burden of the Proposed Dennison-Pratt Schist Quarry," https://halifaxvermont.com/wp-content/uploads/2013/11/Bartenhagen-N.-property-values-07-28-2015.pdf.

Study Seven

In *Warren Tp. v. Suffness, et al.,* 1988,[242] the appellate division of the Superior Court of New Jersey upheld the Tax Court's decision to apply its own judgment to valuation data submitted by experts in order to arrive at true (market) value for three contiguous properties, by deducting 25% from the land value estimate and 25% from the estimated cost of the improvements for the impacts of the nearby blasting quarry. In other words, the value of both the *lot* and *improvements* were equally impacted by the abutting blasting quarry.

> **With regard to the quarry operated on the October 1, 1980 valuation date, the Tax Court Judge found that the "dwelling house" on each lot had been affected by the noise and dust caused by the quarry operation, and cracks had occurred in each house as a result of quarry blasting operations.** The Tax Court Judge had the right to apply his own judgment in making an independent assessment of the true values. **His deduction [of 25%] from the value of each lot's improvements to account for the adverse effect of the lot's proximity to the quarry in the absence of expert evidence to support such a deduction is sustainable because it is so clearly logical and reasonable that the value of the improvement will be affected by the adverse quarry condition** [para. 415].[emphasis added]

COMMUNITY HEALTH, SAFETY AND WELFARE TAKES PRECEDENCE OVER QUARRY COMPANY'S DESIRE TO MAXIMIZE (RAPACIOUS) PROFITS

- In *Hoffman Mining Co. Inc. v. Zoning Hearing Bd.*, (2011),[243] Hoffman leased a 182.1-acre tract in Adams Township, Pennsylvania. On November 20, 2006, Hoffman submitted an application to the Zoning Board requesting a variance from Adams Township Zoning Ordinance to allow surface coal mining within 300'of residences. To conduct surface coal mining, the Zoning Ordinance requires a 1,000' (305 m) setback from residential structures. However, under the Surface Mining Conservation and Reclamation Act (SMCRA) only a 300' (91 m) setback is required.

  The SMCRA is concerned with the methods by which the mineral (coal) is derived from the surface of the ground at all stages, whereas, the Zoning Ordinance merely contains a required minimum distance from which surface mining may be conducted next to a residential structure.

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[242] *Warren Tp. v. Suffness*, 225 N.J. Super. 399 (1988) 542 A.2d 931, https://scholar.google.ca/scholar_case?case=10694856670601680060&q=%E2%80%9Cquarry+blasting%E2%80%9D&hl=en&scisbd=2&as_sdt=2006

[243] *Hoffman Mining Co. v. Zoning Hearing Bd. Of Adams Twp.* 32 A.3d 587 (Pa. 2011).

> **The challenged provision [setback] of the Zoning Ordinance is a quintessential land use control logically connected to land use planning and is therefore, not preempted by Section 17.1 of SMCRA.** [emphasis added]

Hoffman's request for a variance from the township's 1,000' (305 m) setback requirement was rejected by the Court as the setback requirement was not found to be unique to Hoffman's 182.1-acre parcel of leased land, nor was the property owner (Lessee) deprived of all economic use of the land.

The Court was unsympathetic to Hoffman's argument that the 1,000' (305 m) setback from Village residences imposed by the township would deprive Hoffman of its ability to mine 88% of 220,000 tons of mineable coal, reducing potential profits by some $6,000,000.

> Hoffman asserts that because of the unique physical circumstances and conditions of the Property, the 1,000 foot setback would deprive it of its ability to mine 220,000 tons of mineable coal or 88% of the reserves on the Property. Because the setback would have that effect, Hoffman argues that it has shown that the Zoning Ordinance has denied it of the use of its property entitling it to a variance [para. 612].
>
> Testimony before the Board established that approximately 220,000 tons of coal with a market value of $30 per ton would be lost if the 1,000 foot setback was applied, amounting to an economic detriment of at least $6,000,000 [para. 613].

The health, safety and welfare of the nearby Village residents was found to take priority over the mining company's desire to maximize profits by attempting to impose costly and adverse impacts on innocent third-party homeowners, and to disrupt the homeowners' quality of life.

- In *Miller & Son Paving, Inc. v. Wrightstown Township*,(1982),[244] *Miller* challenged the Township's 1971 Zoning Ordinance, which as a consequence of the following setback requirements imposed on quarries reduced potential profits:

> **Setback**. No extraction shall be conducted closer than two hundred (200) feet [61 metres] to the boundary of any district in which extraction is permitted nor closer than three hundred (300) feet [91 metres] from the center line of any street, nor closer than four hundred (400) feet [122 metres] to the point of intersection of center lines of two streets.

[244] *Miller & Son Paving, Inc. v. Wrightstown Township,* 499 Pa. 80 (1982), 451 A.2d 1002, https://scholar.google.ca/scholar_case?case=17369936114114070190&q=%E2%80%9Cquarry+setback%E2%80%9D&hl=en&as_sdt=2006.

Miller is the owner of a 47-acre tract, which has been used for quarrying since 1959, and operating within the previously established setback requirements of the Township, and at one point operating within 113' (34 m) of an adjoining property, in non-conformance with the setback requirements of the new Township Zoning Ordinance. The new Zoning Ordinance extending the setback requirements for quarries was adopted by the Township on December 31, 1971.

Miller's challenge to the validity of the setback requirements imposed on quarries under the new Township's Zoning Ordinance was rejected, with the Pennsylvania Supreme Court finding that,

> **If a municipality can create a use zone excluding surface mining altogether, then it must surely be able to impose the lesser burden of requiring setbacks for such use in zones in which it is permitted [para. 610]**. [emphasis added]

Miller's claim that the setbacks imposed by the Township's Zoning Ordinance had deprived access to 2,685,000 tons of mineable stone worth $7,000,000 was found to be without merit:

> Appellant…argues the local setback requirements are arbitrary, capricious and confiscatory because there are two million six hundred and eighty-five thousand tons of stone which could have otherwise been quarried to the setback restrictions established by the Surface Mining and Reclamation Act. It thus argues the application of the township's setback lines to the business of quarrying "takes" the quarry property within those more expansive lines and so cannot be justified under the police power.
>
> **The difficulty with this argument is it proves too much. Were we to accept it, neither zoning ordinances nor state statutes could provide setback lines for minerals suited to extraction solely by surface mining methods, since setbacks so applied would preclude extraction and thus constitute a taking of the mineral involving eminent domain, and hence not supported under the police power.**
>
> All zoning involves a "taking" in the sense that the owner is not completely free to use his property as he chooses, but such a taking does not entitle the owner to relief, unless the owner's rights have been unreasonably restricted. See Village of Euclid v. Ambler Realty Company, 272 U.S. 365, 47 S.Ct. 114, 71 L.Ed. 303 (1926); Marple Township Appeal, 430 Pa. 113, 243 A.2d 357 (1968). Reasonable restrictions are valid exercises of the police power and not unconstitutional takings under the power of eminent domain. Restrictions are not per se unreasonable simply because they limit the extraction of minerals. The fallacy of appellant's argument is clear. If a municipality can create a use zone excluding surface mining altogether, then it must surely be able to impose the lesser burden of requiring setbacks for such use in zones in which it is permitted.

> **The valid exercise of the zoning power is predicated upon its exercise for a legitimate public purpose. Accordingly, zoning ordinances must be enacted for the health, safety or general welfare of the community and their provisions, including setbacks, must advance those purposes.** [citations omitted]

The Pennsylvania Supreme Court also ruled that a property owner "does not have a vested right under the doctrine of natural expansion to extend a non-conforming setback beyond that which existed at the time the new [zoning] ordinance was passed."

ANTICIPATED LOSS IN PROPERTY VALUES (HOMEOWNER EQUITY)

In *Sand Springs Material LLC* (SSM)*v City of Sand Springs* (City), 2010,[245] the Court of Civil Appeals of Oklahoma upheld the City's decision to refuse to permit SSM to operate a blasting quarry on a number of grounds, including concerns expressed by 150 property owners that property values will be adversely affected, with the appeal court commenting as follows:

> [para. 15]…[E]vidence was presented that a potential buyer decided not to pursue the purchase for fear that the quarry would be approved and his property value would diminish. SSM argues that "One citizen's decision to no longer buy a home in this area is hardly evidence that property values will be adversely affected." Therefore, SSM concludes that the "fears" of 150 property owners that their property values would decline should be disregarded pursuant to Volunteers because there is no actual evidence property values will decline. In essence, SSM argues that until the quarry is in operation and is shown to adversely affect property values, the quarry must be approved. **Volunteers requires evidence supporting a landowner's "fears" that property values will decline. It does not require evidence that property values have actually declined before a proposed use can be denied.**
>
> [para. 16]…[I]t was the opinion of SSM's expert that blasting operations would not physically damage nearby residential structures, he also stated that there was "no doubt" that occupants would feel the vibrations caused by the proposed blasting. **A home owner is qualified to testify regarding the value of owner's property [citation omitted]. SSM cannot simply dismiss, as unsubstantiated fears, the evidence provided by 150 property owners**. [emphasis added]

Based on the research conducted, the anticipated loss in property value (homeowner equity) for the 156 houses[246] within 1,000 metres of the quarry expansion lands is expected to average **20%** to **30%**.

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[245] *Sand Springs Materials LLC v. City of Sand Springs,* 243 P.3d 768 (2010) 2010 OK CIV APP 128, https://scholar.google.com/scholar_case?case=5244406433361108630&q=ssm+llc+v+city+of+sand+springs&hl=en&as_sdt=2006.

[246] I have not personally inspected any of the 156 houses.

- The **average sale price of a detached dwelling** in the City of Burlington in **June 2022 was $1,639,545**, whereas the **median price was $1,347,500**, both based on 108 sales. (Source: Toronto Regional Real Estate Board © 2022)
- Applying **20%** and **30%** to the **median** figure of **$1,347,500** means that the **average loss in homeowner equity will be $269,500 ($1,347,500 × 0.20) to $404,250 ($1,347,500 × 0.30)**.
- The total property loss is **$42,042,000** ($1,347,500 × 0.20 × 156) **to $46,800,000** ($1,347,500 × 0.30 × 156) for all 156 detached dwellings within 1,000 metres.

BENEFITS OF MANDATORY FIXED MINIMUM SETBACKS AND SEPARATION DISTANCES APPLIED TO BLASTING QUARRY OPERATIONS

Appropriate mandatory fixed minimum setbacks (500 metres) and separation distances (1,000 metres) imposed on new and expanding blasting quarry applications, including Nelson Aggregate's application, should protect onsite personnel and equipment, and reduce or eliminate the potential for damage to offsite private third-party personal and real property from vibration and airblast and the potentially deadly consequences of flyrock, and reduce or eliminate *adverse effects*, which can include

- damage to personal and real property (onsite and offsite)
- soil erosion, subsidence and sinkholes (onsite and offsite)
- exposure to fugitive dust, toxic fumes and odours (onsite and offsite)
- damage to the quantity and quality of private third-party domestic wells
- compromising the health and safety of human and non-human life (onsite and offsite)
- compromising the quality of human and non-human life (onsite and offsite)
- damage to agricultural lands (e.g., specialty crops, organic farming, livestock)
- damage to the natural environment
- disruption of the use and enjoyment of public property (e.g., parks, campgrounds, trails, roads/highways)

- disruption of the use and enjoyment of private third-party real property (e.g., residences, farms, businesses)
- diminishing the value of private third-party real property (e.g., residences, farms, businesses)
- disrupting a growing 24-hour stay-at-home live and work economy occasioned by the coronavirus (COVID-19) (A January 2022 survey conducted by Pew Research Center of 5,889 workers surveyed, found that 61% of people working from home say they're not going into the workplace because they choose not to.[247])

There would also be an increase in the number of complaints and lawsuits (e.g., trespass, nuisance, negligence, emotional distress) from nearby homeowners and business owners as more people are forced or choose to work from home.

[247] Rachel Minkin, "COVID-19 Pandemic Continues To Reshape Work in America," *Pew Research Center*, February 16, 2022, https://www.pewresearch.org/social-trends/2022/02/16/covid-19-pandemic-continues-to-reshape-work-in-america/.

The Impact of Blasting Quarries & The Need For Adequate Setbacks (17-Nov-20)

(see https://intval.com/articles/Flyrock-and-Other-Impacts-from-Quarry-Blasting-Operations.pdf and https://intval.com/articles/Flyrock-and-Other-Impacts-Supplement-1.pdf)

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SECTION I

Municipalities Can Impose Setback Requirements, Restrict the Location of Pits and Quarries or Prohibit Pits and Blasting Quarries For Health and Safety Reasons

In *Uxbridge Township v. Timber Brothers*,[1] the court ruled that the *Ontario Planning Act* explicitly provided for the power for municipalities to make by-laws prohibiting pits and quarries in certain areas. Uxbridge Township had imposed a by-law providing land uses and residential setbacks for pits and quarries. A further by-law regulated the operation of pits and rehabilitation and safety requirements.[2]

> *The court interpreted this to allow only the prohibition of new pits, not the regulation of existing ones. The court considered that the Municipal Act in Ontario provided the power to regulate the "operation" of pits and quarries. The operator challenged an Uxbridge Township bylaw on (among other grounds) the basis that the province already regulated quarry rehabilitation and setbacks. The court found that the Municipality could provide additional setbacks:*
>
> > The provincial legislation does no more than set the minimum set-back requirements or standards and in no way attempts to restrict the right of a municipality to enhance these standards. This the municipality may do provided it acts within its delegated legislative powers and does not enact provisions in by-laws which are inconsistent with statutory provisions.
> >
> > The court held that municipal setbacks that were less than those provided for in provincial legislation were invalid.
>
> *The court allowed an injunction against the pit based on the other portions of the gravel regulation bylaw.*
>
> *This case was referenced by the Supreme Court of Canada in Spraytech[3] specifically for the proposition that municipalities may regulate the environment more than the province does.*
>
> *The SCC went on to hold that general welfare provisions in municipal statutes, including in Alberta [and Ontario], authorize environmental regulation within a municipality relating to pesticides, notwithstanding the existence of provincial laws relating to the same subject.*

Under the Ontario *Municipal Act*, the province can delegate to a municipality the right to legislate on a prescribed range of matters. They include the following:

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[1] [1975] O.R. (2d) 484 (Ont. C.A.) Leave to appeal to Supreme Court of Canada Dismissed. 1975 CanLII 507 (ON CA), <http://canlii.ca/t/g1cpz>, retrieved on 2020-11-05.

[2] Laura Bowman, Staff Counsel, Environmental Law Centre, "Gravel can be the pits!" Webinar – September 22, 2010, https://elc.ab.ca/media/7529/GravelPitsHandout.pdf.

[3] *114957 Canada Ltée (Spraytech, Société d'arrosage) v. Hudson (Town)*, 2001 SCC 40 (CanLII), [2001] 2 SCR 241, <http://canlii.ca/t/51zx>, retrieved on 2020-11-05

By-laws

(2) A single-tier municipality may pass by-laws respecting the following matters:

1. Governance structure of the municipality and its local boards.
2. Accountability and transparency of the municipality and its operations and of its local boards and their operations.
3. Financial management of the municipality and its local boards.
4. Public assets of the municipality acquired for the purpose of exercising its authority under this or any other Act.
5. Economic, social and environmental well-being of the municipality, including respecting climate change.
6. Health, safety and well-being of persons.
7. Services and things that the municipality is authorized to provide under subsection (1).
8. Protection of persons and property, including consumer protection.
9. Animals.
10. Structures, including fences and signs.
11. Business licensing. 2006, c. 32, Sched. A, s. 8; 2017, c. 10, Sched. 1, s. 1.

In addition to the delegation of the above-noted specific powers, Section 102 of the Ontario *Municipal Act* empowers municipalities with an "omnibus" *General Power*:

102. *Every council may pass such by-laws and make such regulations for the health, safety, morality and welfare of the inhabitants of the municipality in matters not specifically provided for by this Act and for governing the conduct of its members as may be deemed expedient and are not contrary to law. 1994, c. 23, s. 54*

A by-law comes into existence as follows:[4]

1. *The city council or municipal council makes a decision about a matter within its power, through a simple majority vote by council members. Matters are brought before council through reports and other communications from municipal officials and committees, and they are brought by individual council members. (The council can also delegate bylaw-making powers to others, such as community councils, agencies, and boards.)*
2. *Council's decision is confirmed by a bylaw enacted at the council meeting. Bylaws are numbered by the year and order of enactment….*
3. *Some decisions of council are then turned over to the city solicitor or municipal solicitor to be drafted into a specific bylaw, particularly if they are decisions that will be frequently referred to, require enforcement, or amend existing bylaws. These draft bylaws are also known as bills. A bill has to be taken back to council for enactment, again through a simple majority vote.*
4. *A bylaw is effective on the date it is enacted unless a different date is specified in the bylaw, in which case it is effective on that date.*

[4] Margaret Kerr, JoAnn Kurtz & Arlene Blatt, *Legal Research: Step by Step*, Fourth Edition (Toronto: Emond), 28.

Quarry Setback/Buffer Zone Requirements in Various Jurisdictions

Setbacks or buffer zones for blasting quarries vary from 500 metres to 800 metres in the following jurisdictions:

		Setback/Buffer Zone
- Nova Scotia, Canada	:	800 metres[5]
- New Brunswick	:	600 metres[6]
- Quebec, Canada	:	600 metres[7]
- India	:	500 metres[8]
- Malaysia	:	500 metres[9]
- Victoria, Australia	:	500 metres[10]

- According to the Mine Safety and Health Administration (MSHA), where flyrock incidents have been known to occur at operating surface mines, the "blast area should as a minimum be one-and-a-half times the furthest distance that any previous flyrock has traveled."[11] For example, a known flyrock incident occurring 400 metres from the blast area would require an expanded minimum setback or buffer of 600 metres (400 m × 1.5).
- On two occasions in July 2009, blasting at the Pakenham quarry near Arnprior launched flyrock beyond the 200-metre control area. In the first incident, a small rock struck a worker at a neighbouring business on the arm. In the second incident,

---

[5] "The NSE *Pit and QuarryGuidelines* (1999) stipulated setbacks to prevent structural and environmental damage as well as the requirements for pre-blast surveys, blast monitoring, and blast designs. The setback between blasting for a quarry and structures is 800 m. "http://www.scotianmaterials.info/quarry.html#:~:text=The%20setback%20between%20blasting%20for,800%20m%20of%20the%20Project..

[6] "k) 600 metres from any drinking water supply well, unless the written permission of the owner(s) within the 600 metres is obtained and submitted to the Department for acceptance….", Department of Environment and Local Government, Rock Quarry Siting Standards, https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Air-Lair/RockQuarrySitingStandards.pdf.

[7] "11. The operating site of a new quarry must be located at a minimum distance of 600 m from any dwelling, unless the dwelling is owned or rented to the owner or operator of the quarry." 10. It is prohibited to establish a new…quarry, the operating site of which is located in a territory zoned by the municipal authorities for residential, commercial or mixed purposes (commercial residential0. It is also prohibited to establish a new quarry less than 600 m from such territory…", http://legisquebec.gouv.qc.ca/en/ShowDoc/cr/q-2,%20r.%207.

[8] "As per Directorate General of Mines Safety circular n. – DGMS (SOMA)/(Tech) Cir. No. 2 of 2003 Dt. 31/01/2003 (Annexure ll), on subject of **Dangers due to blasting projectiles**, all places within the radius of **500 m** from the place of firing to be treated as danger zone and accordingly, all person in danger zone to take protection in substantially built shelter at the time of blasting." "The regulations for danger zone (500 m) prescribed by Directorate of Mines…have to be complied with compulsorily and necessary measures should be taken to minimize the impact on environment." https://mpcb.gov.in/sites/default/files/whats_new/2020-08/CircularSitingcriteriaforstonequarriesinthestateofMaharashtra03082020.pdf.

[9] Environmental Requirements: A guide to Investors 2010, Appendix G.

[10] Gill Higgins, "Fair Go: Dust particles from quarry causing adverse health effects for residents nearby," !news, June 22, 2020, https://www.tvnz.co.nz/one-news/new-zealand/fair-go-dust-particles-quarry-causing-adverse-health-effects-residents-nearby.

[11] David Sparkman, "It's Been a Busy 2018 for MSHA," ESHToday, Mar 26, 2018, https://www.ehstoday.com/safety/article/21919560/its-been-a-busy-2018-for-msha.

rocks were observed flying well beyond the control area. A scale house located 230 metres from the blast was struck by a number of rocks. Two vehicles held at a controlled stop along nearby Young Road on the edge of the quarry property located about 300 metres from the blast were also struck by rock resulting in extensive damage. An investigation of the two off-site flyrock incidents determined that the control zone (setback) should have been 500 metres.[12] (Flyrock 18)

- On two occasions blasting at the Miller Braeside quarry in the Township of McNab/Braeside propelled flyrock debris outside of the limits of the quarry, once in September 2005 and again in August 2007 (Flyrock 22). The 300-metre setback from the quarry boundary proved inadequate, putting neighbouring residents and property at considerable risk. Blasting at the quarry in September 2005 propelled flyrock debris into a nearby residential neighbourhood causing damage to residences, driveways and wells. "One neighbor, Mr. Battison, described flyrock that landed on his roof over 400 metres from the site."[13] Reportedly, some neighbours received compensation but only if they signed a confidentiality agreement, and to never come after Miller again for any damages. The August 2007 quarry blast hurled flyrock debris that damaged a home and structurally damaged the foundation of another home in another direction, with one of the property owners (James), claiming $250,000 in damages.
- City Sand quarry (St. John's, Newfoundland) carried out a legitimate but inherently dangerous operation, and it had no right to eject flyrock outside the quarry site, which constituted a danger to persons and property. The quarry site was subject to a 300-metre setback. On two separate occasions blasting by City Sand propelled flyrock beyond its property limits, and in one instance the flyrock damaged two houses in a residential subdivision. City Sand's quarry leases did not confer upon City Sand rights over property outside the quarry site (para. 38).[14] In 1996, in response to a growing awareness of the dangers of flyrock as a public health and safety issue, the Department of Municipal and Provincial Affairs in its conditions for approval of a blasting quarry required a 1,000-metre buffer zone be maintained from a *cottage* or *residence* (Flyrock 42).
- The State of Vermont Environmental Court upheld Moretown Village's decision not to issue a permit for the proposed Rivers Quarry, based in part on the "unduly harmful" impacts that quarry blasting and potential flyrock hazards would have on

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[12] Court Bulletin (Austin Powder Ltd. OCJ 2014), https://news.ontario.ca/en/court/29428/burlington-firm-fined-130000-for-arnprior-blasting-offences.

[13] *Miller Paving Ltd.*, PL130785, OMB, October 27, 2015 [para. 55].

[14] *City Sand and Gravel Limited v. Newfoundland (Municipal and Provincial Affairs)*, 2007 NLCA 51 (CanLII), <http://canlii.ca/t/1sfnv>, retrieved on 2020-11-10. Leave to Appeal to the Supreme Court of Canada denied. *City Sand and Gravel Limited and O.D. Holdings Limited v. Her Majesty the Queen in Right of Newfoundland, as represented by The Honourable Minister of Municipal and Provincial Affairs*, 2008 CanLII 1399 (SCC), <http://canlii.ca/t/1vgkt>, retrieved on 2020-11-10.

the quality of life of residents residing within 1,500 feet (457 metres) of the quarry:[15]

> *Rivers is recommending that neighbors within 1,500 feet [457 metres] of the quarry suspend their use and enjoyment of their outdoor property whenever a blast is to occur. A dozen times per year, for the next thirty-three years. All of Rivers' neighbors presently enjoy the scenic natural beauty of their property without interruption; some have done so for decades prior to the Rivers quarry being proposed for their neighborhood. The Rivers quarry will bring undue harmful impacts to its neighbors; it fails to conform to criterion 9(E)(i) [impact upon the environment or surrounding land uses].[p. 63]*

Flyrock can travel great distances, as shown by the following incidents reported in the January 1991 issue of Pit & Quarry (p. 44):

• Conklin quarry	(limestone)	:	3,063.6'	(933.8 m)
• Sibley quarry	(limestone)	:	1,159.2'	(353.3 m)
• Roberta quarry	(limestone)	:	4,057.2'	(1,236.6 m)
• Falling springs quarry	(limestone)	:	5,050.8'	(1,539.5 m)
• Okalona quarry	(limestone)	:	4,057.2'	(1,236.6 m)
• Oglesby quarry	(limestone)	:	6,292.8'	(1,918.0 m)
• Latah quarry	(trap rock)	:	828.0'	(252.4 m)
• Mine O	(taconite)	:	11,360.2'	(3,462.6 m)
• Barkely pit	(porphyry)	:	2,119.7'	(646.1 m)
• Mine A	(sandstone)	:	1,987.2'	(605.7 m)

Applying the precautionary principle to proposed blasting quarries, best planning practices warrant locating proposed quarries in locations that:

- do not conflict with existing or proposed incompatible land uses (e.g., residential, commercial, mixed residential-commercial, hotels/motels, schools, places of worship, golf courses, parks, scenic landscapes, historic landmarks, utility corridors, etc.);
- are sufficiently distanced from settlement areas (or proposed settlement areas) and areas of substantial human activity (e.g., heavily travelled roads, highways or trails, convention centres, etc.);
- do not cause social, environmental, human health or safety impacts;
- eliminate the potential for flyrock to damage personal or real property, or to injure or kill people; or
- do not reduce residential property values or homeowner equity, or do not cause residential property to become unmortgageable or unsaleable.

Incidences of Flyrock Unreported or Uninvestigated

Globally, the majority of flyrock incidents go unreported or unnoticed, and in most jurisdictions incidents of flyrock that do not leave the blast area or that do not cause injury or death within or outside the blast area are not officially reported.

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[15] *Rivers Dev. Conditional Use Appeal*, https://cases.justia.com/vermont/environmental-court/2010-03-25-Rivers%20Development%20LLC-1.pdf?ts=1396150941.

- *"Reports of flying rock incidents of stone quarries are a fairly common occurrence, according to Petrie"* (Jim Petrie, district manager of the Mining Safety and Health Administration in Warrendale, Pa) (Flyrock 62 – August 22, 2018)
- The accidents due to flyrock are rarely reported (Davies 1995) and is one of the major problems in prediction regime. However, the flyrock that cause no damage are frequent and could be documented for improving prediction models.[16]
- Davis (1995) considers under-reporting is responsible for five to ten times the actual number of [flyrock] incidents.[17]
- DNX Castonguay Inc. was fined $75,000 for failing to notify the Ministry of the Environment (MOE) of a May 12, 2010 flyrock incident from a quarry blast in Magnetawan that caused damage to the roof of a garage of an adjacent property.[18] (Flyrock 16)
- On May 28, 2014, a blast at a North Bay quarry launched outside the blasting area onto a neighbouring residential property. The quarry owner, Bruman Construction Inc., and the blaster, Consbec Inc. failed to report the flyrock incident to the Ministry of the Environment and Climate Change (MOECC), and each company was fined $75,000.[19] (Flyrock 10)
- On September 3, 2014, a blast at a quarry in Merrick Township propelled flyrock onto a neighbouring residential property, and the blasting company Rock Breakers (2007) was fined for failing to report the flyrock incident to the Ministry of the Environment. [20](Flyrock 11)
- An April 10, 2018 flyrock incident from a blast at a New South Wales quarry that struck three light vehicles in an exclusion zone remained unreported to the Regulator until September 7, 2018.[21] After the flyrock incident, those present were asked to delete footage of the blast.[22]
- Blasting at a quarry near Arnprior by Austin Powder Limited launched flyrock debris on both July 20 and July 23, 2009 (Flyrock 18), which travelled beyond the 200-metre blast area. In the first incident, a rock struck a worker's arm at a neighbouring business. In the second incident, rock struck a scale house at a

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[16] A. K. Raina, V.M.S.R. Murthy and A. K. Soni, "*Flyrock in bench blasting: a comprehensive review,"* Bulletin of Engineering Geology and the Environment, © Springer, February 2014, https://www.academia.edu/12477942/Flyrock_in_bench_blasting_a_comprehensive_review_A_Bull_Eng_Geol_Envir.

[17] T.N. Little, "*Flyrock Risk*," EXPLO Conference, Wollongong, NSW, 3-4 September 2007, https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-2570%2120191217T043417.551%20GMT.

[18] Court Bulletin, https://news.ontario.ca/en/court/28915/dnx-castonguay-inc-fined-75000-for-failing-to-report-discharge-of-fly-rock.

[19] https://www.siskinds.com/failure-notify-brings-150000-fine-despite-no-damage-property/.

[20] Court Bulletin, https://news.ontario.ca/en/court/35239/drilling-and-blasting-contractor-fined-60000-for-fly-rock-discharge-and-failing-to-report-incident.

[21] https://www.amsj.com.au/flyrock-incident-damages-vehicles-during-blast/.

[22] https://www.resourcesregulator.nsw.gov.au/__data/assets/pdf_file/0003/1248519/Investigation-report-Dangerous-Shotfiring-Incident-Albury-Quarry-10-April-2018.pdf.

distance of 230 metres, and two vehicles held at a control stop on Young Road near the edge of the quarry at a distance of 300 metres were also struck by rocks, causing extensive damage. Austin Powder Limited was fined $130,000 for failing to report the flyrock incidents forthwith to the Ministry of the Environment.[23]

- Blasting of the Niagara Escarpment on August 4, 2004 for the construction of the Red River Valley Expressway propelled flyrock debris the size of softballs 200 metres into a residential neighbourhood that damaged two residences and two vehicles. A prior blast on July 16, 2004 propelled debris that damaged one residence. The blasting company responsible for the flyrock did not report the incidents to the Ministry of the Environment.[24] (Flyrock 31)
- On May 17, 2017, a blast at a surface coal mine launched about a dozen lumps of flyrock, where workers were standing, and one 20 kg rock (44 pounds) penetrated the hood of a light vehicle at a distance of 246 metres, inside the 500-metre employee exclusion zone. One worker suggested to the other workers that they should report to the mine that damages to the light vehicle were caused by the car killing a kangaroo while being driven offsite.[25] (Flyrock 5)
- Flyrock is less likely to be noticed or reported in sparsely inhabited areas.

According to the Minister of the Environment, in their Factum[26] presented before the Supreme Court of Canada in *Castonguay Blasting Ltd. v. Ontario (Environment),* 2013 SCC 52,[27] blasting is as an inherently dangerous activity, which requires all incidents of flyrock to be reported:

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[23] Court Bulletin, https://news.ontario.ca/en/court/29428/burlington-firm-fined-130000-for-arnprior-blasting-offences.

[24] Catch Article: Red Hill blasting nets fine, February 5, 2008, http://www.hamiltoncatch.org/view_article.php?id=247&utm_source=CastonguayNewsletterNov&utm_medium=email&utm_campaign=Castonguay.

[25] Investigation Report, "Dangerous shot firing incident at the Moolarben Coal Mine on 17 May 2017, https://www.resourcesregulator.nsw.gov.au/__data/assets/pdf_file/0008/1086677/Investigation-Report-Moolarben-Shot-Firing-Incident.pdf.

[26] https://www.scc-csc.ca/WebDocuments-DocumentsWeb/34816/FM020_Respondent_Her-Majesty-the-Queen-in-Right-of-the-Province-of-Ontario-as-Represented-by-the-Minister-of-the-Environment.pdf.

[27] *Castonguay Blasting Ltd. v. Ontario (Environment)*, 2013 SCC 52 (CanLII), [2013] 3 SCR 323, <http://canlii.ca/t/g1038>, retrieved on 2020-11-14.

> *Blasting is an inherently dangerous activity with a clear connection to the objective of environmental protection. By its very nature, it destroys or alters the environment for various purposes such as quarrying or construction. The regulation of blasting and the need to report errant blasts is therefore consistent with the broader secondary purposes of the EPA, which include the protection of the environment, people and property from discharges into the natural environment that are likely to cause harm [para. 7]*

As reported by Ward,[28] the West Virginia Department of Environmental Protection (WVDEP) failed to investigate most of the citizen complaints of flyrock incidents reported to the agency during the period of January 2004 to December 2007. Only 4 of 36 flyrock incidents had been investigated:

> *…Detailed investigations by WVDEP are performed in few of the flyrock incidents the agency becomes aware of….OSM [Office of Surface Mining] found, OEB was involved in only 4 of 36 flyrock events during the period examined, from January 2004 to December 2007.*
>
> *OSM recommended that OEB 'should investigate every flyrock event in detail to determine or require the company to determine the most likely cause(s) in order to devise a site-specific remediation plan.*
>
> *WVDEP inspectors who cited companies for flyrock incidents* ***typically ordered the operators to clean up the off-permit [flyrock] material, instead of determining the cause and propsing [sic] corrective measures*** *to prevent repeat [flyrock] incidents.* ***During the period examined, the median penalty was [a nominal] $1,200.***

Flyrock Is Inevitable Wherever Rock Is Blasted

Many explosives experts and authors have commented on the inability to control the throw of flyrock, which is a natural phenomenon whenever explosives are used to blast rock.

- Flyrock can still be generated even in the best-designed blast (Slide 19, Power Point Presentation 2015).[29]
- Flyrock can never be completely eliminated (Surface mineral workings: control of blasting, 2000).[30]
- The detrimental effects of flyrock are unavoidable and cannot be completely eliminated… (Ghasemi et al, 2012)[31]
- Flyrock is a hazard that operators try to minimize but is always present (Ormerod, 2019).[32]
- Flyrock is an undesirable phenomenon in the blasting operation of open pit mines (Amini, et al, 2011).[33]
- Flyrock is a concern for both researchers and blasting engineers as it is a random phenomenon. However, it has received relatively little attention from researchers due to the

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[28] http://blogs.wvgazettemail.com/coaltattoo/2009/08/17/have-a-blast-osm-finds-wvdep-lax-in-policing-flyrock/.

[29] **current developments in quarry blasting - e-library WCL.**

[30] https://www.gov.scot/publications/blasting-surface-mineral/.

[31] http://tarjomefa.com/wp-content/uploads/2016/05/4695-English.pdf.

[32] https://envirosuite.com/news/kaboom-what-happens-around-a-blast-after-it-goes-off.

[33] file:///C:/Users/Windows%207%20PC/Downloads/Evaluationofflyrockphenomenonduetoblastingoperation%20(1).pdf.

complex nature of the interaction between blast design and rock parameters (Raina, et al., *2011)*[34]

- Danger and damage from flyrock in rock blasting has been a serious problem ever since blasting was introduced. Not only have men been killed and injured but also buildings, equipment and materials have been damaged (Lundborg et al. 1975).[35]
- The phenomena of flyrock are always uncontrolled and can never be brought down to zero (Singh, eta al, 2014).[36]
- Flyrock due to blasting in opencast mines is complex in nature as it is a random phenomenon.[37]
- "You can never say never." No matter how careful a blaster is there is no certainty a blast will not cause flyrock. (Tim Rath, Green Mountain Explosives, Testimony at Rivers Quarry Application Hearing)[38]
- Rivers' blasting expert cannot guarantee that flyrock will not leave the Rivers parcel, regardless of what precautions are taken to minimize the risk (Cross Exam of Rath 12/15/2008).[39]
- Every borehole is a separate detonation. This means that during every blast event (at the proposed Rivers' quarry) there would be 62 chances for flyrock from face burst, cratering, or stemming ejection. After every event, there will be an additional ten seconds or so when flyrock could rain down on neighboring homes, properties and Route 100B that could result in property damages, injury, or even death (Testimony of Art Hendrickson on 12/15/2008, para. 110).[40]
- Flyrock is a potential hazard anytime and anywhere there is blasting (MSHA, 2016).[41]
- Blasting is not an exact science (Scott Parker, expert blaster testifying on behalf of Director of Occupational Health and Safety, para. 23).[42] (Flyrock 20)
- Mining and quarrying are high-risk activities. Misfires and fly rock are common hazards associated with shot firing [blasting] activities, which are routinely undertaken in these industries. (WorkSafe Victoria safety alert published September 7, 2020)[43]

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[34] Raina, A.K., Chakraborty, A.K., Choudhury, P.B. *et al.* "Flyrock danger zone demarcation in opencast mines: a risk based approach," *Bull Eng Geol Environ* **70,** 163–172 (2011). https://doi.org/10.1007/s10064-010-0298-7.

[35] A. Aghajani-Bazzazi, M. Osanloo and Y. Azimi, "*Flyrock prediction by multiple regression analysis in Esfordi phosphate mine of Iran,"* © 2010 Taylor & Francis Group, London, file:///C:/Users/Windows%207%20PC/Downloads/074.pdf

[36] https://www.researchgate.net/profile/Avtar_Raina/publication/264560232_Prediction_of_blast-induced_flyrock_in_Indian_limestone_mines_using_neural_networks/links/5539cf9e0cf247b8588148a8/Prediction-of-blast-induced-flyrock-in-Indian-limestone-mines-using-neural-networks.pdf.

[37] R. Trevidi, T.N. Singh and A.K. Raina, *"Prediction of blast-induced flyrock in Indian limestone mines using neural networks,"* Journal of Rock Mechanics and Geotechnical Engineering 6 (2014) 447-454.

[38] http://www.killthealbionquarry.org/DEATH-FROM-THE-SKY-FLYROCK.html.

[39] http://www.killthealbionquarry.org/flyrock_danger.pdf.

[40] "Blasting and Flyrock," http://www.killthealbionquarry.org/flyrock_danger.pdf.

[41] https://www.msha.gov/news-media/announcements/2016/03/24/flyrock-dangers-best-practices.

[42] *Director of Occupational Health and Safety v. Government of Yukon, William R. Cratty and P.S. Sidhu Trucking Ltd.*, 2012 YKSC 47 (CanLII), <http://canlii.ca/t/fs6vt>, retrieved on 2020-11-16. "The whole purpose of the *OHS Act* is to promote safe practices in the workplace at all time. This includes safety for members of the public that are in proximity to the workplace [para. 46]."

[43] https://www.aggregateresearch.com/news/state-investigates-quarry-blast/.

- Flyrock meets the Ontario EPA definition of contaminant, and the adverse effects of "flyrock" are not trivial (Castonguay Blasting Ltd. v. Ontario (Environment), [2013] 3 SCR 323, 2013 SCC 52 (CanLII)).
- According to Section 21.66 (1) of the Occupational Health and Safety Act (OSH), B.C., a blaster must take precautions against *flyrock*, which is referenced as "flying" material.[44]
- In April 2015, WorkSafeB.C. suspended the blaster's permit after a flyrock incident rained rocks on a Colwood Neighbourhood, including a 17-pound rock that smashed through a couple's bedroom ceiling and broke their bed frame.[45] (The company doing the blasting for Colwood's Allandale Pit received three penalties from WorkSafeB.C. within three years for violations related to flyrock.)

According to Lundborg, people should never be exposed to flyrock. Similarly, national laws in Chile relating to workplace safety require that workers never be exposed to flyrock. This requires that the probability of flyrock be zero for personnel (and non-personnel) located outside the Personnel Clearance Distance (blast area) for all blasts.[46] Likewise, Kentucky's Energy and Environment, Department for Natural Resources, has expressed a zero tolerance for flyrock incidents:[47]

> *The Department for Natural Resources believes that one flyrock event is too many, and to that end, has prepared this RAM [Reclamation Advisory Memorandum] to further define steps this Department will require of the coal industry in eliminating flyrock events.*
>
> *'Flyrock' is defined as 'blasted material cast into the air, or traveling along the ground, that is cast from the blasting site more than half the distance to the nearest dwelling, public building, school, church, commercial, community or institutional building; or any occupied structure; or that is cast beyond the permit boundary.'*
>
> *Flyrock events historically have not been limited to blasting operations within the distances which require the submission and approval of an 'anticipated blast design'…prior to blasting. Rather, flyrock events occurred and impacted dwellings, vehicles, persons, animal life, and other physical structures thousands of feet from the blast site resulting in death and the destruction of property.*

In response to a spike in flyrock incidents, the Queensland Government issued a safety bulletin in February 2009,[48] which, in part, states:

> *In the past few months, there have been some very serious incidents reported from the coal mines of the Bowen Basin, North Queensland and from quarries around Brisbane. All of these could well*

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[44] https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-21-blasting-operations#SectionNumber:21.66.

[45] Kyle Esser, "Blaster has permit suspended after rain of rocks in Colwood," Times Colonist, April 16, 2015, https://www.timescolonist.com/news/local/blaster-has-permit-suspended-after-rain-of-rocks-in-colwood-1.1825157.

[46] *"Flyrock – A Basis For Determining Personnel Clearance Distance And Quantifying Risk of Damage to Equipment,"* scribd.com.

[47] "Reclamation Advisory Memorandum," https://eec.ky.gov/Natural-Resources/Mining/Mine-Permits/RAMS/RAM140.pdf. "During calendar year 2007, the Commonwealth of Kentucky had a [known] total of thirteen (13) flyrock events on surface coal mining sites, include one (1) that resulted in a fatality. To date [July 18] there have been nine (9) [known] flyrock events, including one (1) that resulted in a minor injury that very easily could have resulted in a fatality."

[48] "Flyrock Incidents," https://www.dnrme.qld.gov.au/business/mining/safety-and-health/alerts-and-bulletins/explosives/flyrock-incidents2.

have ended up with very serious or fatal results. Significant damage to property and structures has also been reported. The frequency of these incidents has reached a point where it is well beyond acceptable limits.

Flyrock is an integral part of blasting. However, uncontrolled or unexpected flyrock that is projected past a defined safety zone is not acceptable. It is well known that rock and/or debris can be thrown over a kilometre from the blast site, and in a recent case rocks travelled approx 1.3km [1,300 metres].

Why Is Flyrock So Dangerous?

Most people have never heard of *flyrock*, and yet it is the most dangerous aspect of blasting rock. Wherever there is blasting of rock, flyrock can occur, and, no matter how well a blast is executed, the consequences of flyrock are unpredictable. Flyrock can launch in any direction at great speed, and flyrock debris can shower a large area. Flyrock comes in all shapes, sizes and weights. Flyrock has the potential to damage the environment and personal and real property, and injure and kill people, livestock and wildlife. Flyrock is any material propelled from a rock blasting operation.

The following extracts address flyrock, and are from a 2019 Worker's Hazard Alert issued by the National Institute for Occupational Safety and Health (NIOSH):[49]

Why do you need to read this? Flyrock has killed and injured people. *Flying material, both within the blast area and outside it, is responsible for over half of all blasting –related injuries and fatalities. MSHA (Mine Safety and Health Administration) records from 1994-2001 show that in surface mining, 32 people were killed or badly hurt because the blast area was not cleared. Another 17 people were injured or killed by rocks that were thrown outside of the blast area. This total (49 people) is greater than the combined total of the other blast accident causes in mining (premature blast, transporting explosives, fumes, and misfires). Flyrock is a potential hazard anytime and anywhere there is blasting [p. 1].*

….Blasting is the best way to shatter rock. In a blast, a number of holes are drilled into the ground and loaded with explosives. The BLASTER-IN-CHARGE computes the ideal distance between these holes, the depth of the holes, and their slant or angle….

Flyrock can be as small as marbles or as large as a car. It is propelled with great force. Flyrock may come from high in the air, roll down a hillside, or come straight at you like a bullet. That is why the blaster places guards at entry roads around the area where rocks might fly—to keep people out and protect workers from death and injury. Yet people have still been killed inside [and outside] the blast area…[p. 7].

What is the danger from flyrock? *Flyrock can come at you from any direction. Flyrock can be thrown high like a fly ball, fly straight like a fastball, roll along the ground, or ricochet from any direction. Flyrock can be gravel, rocks, tree trunks, construction materials, mud—even water [p. 3]….*

What causes flyrock? *Sometimes problems occur during blasting. There may be a hidden crack below ground that the blaster fills with too much explosive. The blaster may think that he or she has to break a lot of tough granite, when really there is soft dirt from old diggings. The blast crew may have made a mistake and not loaded enough stemming. A mud seam below ground may not have been reported by the driller. These things seldom happen. But when they do, there is going to be flyrock—debris that travels beyond the guarded area…[p. 7].*

Flyrock is totally unexpected. *"I had shot a dozen of these. Each of them went 'poof.' The ground rose up and fell down. Just 'poof.' One of the regulars was standing by his door, just inside the blast*

[49] https://www.cfins.com/wp-content/uploads/2019/01/blasting-safety-worker-alert.pdf.

area. I told him he had to go inside. He said, 'don't worry, nothing will happen.' I said, 'I know that, but you will have to go inside anyhow.' He fussed and we discussed, but in the end he went inside. We shot it, and it blew all over the place. There had been a water line there beside the hole, must have been decades ago. So the earth was not the hard rock that we expected. And it blew. Rocks landed right beside the door where the man had been standing. Had he stayed there, he would have been hurt.' –J.E., a Kentucky blaster [p. 3].

Flyrock is fast. *On a Friday evening in 1994, two blast crew members were 236 feet away from the blast. The crew saw the flyrock coming toward them as soon as they set off the shot. They turned and ran to a pickup truck that was just 10 feet away. They did not make it. The survivor heard the flyrock hit the pickup truck and the ground. Then he saw his partner beside the pickup truck lying face down with blood coming out of his nose and ear. His hardhat was dented by the flyrock. He never regained consciousness [p. 3].*

Flyrock can travel beyond the blast area. *It can travel far and high. In July 2002 in West Virginia, rocks traveled one-half mile. One rock the size of a football smashed into the cab of a contractor's truck. It went through the front windshield, between a trucker and his supervisor and out the back. They were outside the blast area thought they were "safely" watching. They were lucky—they were not hurt [p. 5].*

Additional concerns around the use of explosives to blast rock and the undesirable and potentially dangerous generation of flyrock are as follows:

Despite the fact that flyrock uses only about one percent of the explosive energy caused by the blast, it is responsible for up to 40 percent of injuries, as opposed to, for example, ground vibration. One can easily understand this when we think of flyrock as small projectiles fired with great force by exploding gasses. Essentially, the effect of flyrock is similar to spraying an area with bullets from a machine gun.

Complicating matters is the fact that separating pieces of rock from a rock face is the goal of blasting, whether it is actually to get at the minerals within the rock face or to get at what is behind it. Thus, blasters have every intention of creating this [flyrock] debris. However, the goal is to do it with controlled throw – knowing exactly where the pieces are going to go and making sure not to be in range of them.

Unfortunately, predicting the trajectory and amount of flyrock has proven to be a very inexact science. While steps can be taken to minimize flyrock and one can generate some reasonable predictions about rock throw, there are too many random elements to predict the trajectory, range and size of all explosive debris accurately.

This creates a massive problem for project managers because it is so crucial that they get these calculations right. Underestimating flyrock predictions can put people's lives and the company's property in danger while overestimating can impede the progress of the project. Studies to try to more accurately predict the impact of flyrock in various blasting situations have proven costly and not yielded highly satisfactory results.

While it is not currently possible to prevent the creation of flyrock itself, almost all flyrock injuries and fatalities, as well as flyrock damage to property, is avoidable when taking the proper precautions. Too often, people on mining or construction sites fail to anticipate the problems flyrock will cause, or they think of it as 'a necessary evil' and hope for the best.

This kind of thinking can only lead to tragedy. Then there is the fact that some industries and situations that are not mining or construction related can also be prone to an unanticipated explosion, and the people in those situations often have no preparation or protection against flyrock whatsoever. Clearly, this is a problem people need to address.[50]

[50] "Preventing and Controlling Flyrock," https://www.tmi2001.com/blog/preventing-controlling-flyrock/.

DEP Chief Regulator Informs Explosives Engineers of Dangers of Flyrock

A letter from the PA Regulator (Chief, Explosives & Safety, Department of Environmental Protection (DEP), Bureau of Mining Programs), addressed to the Eastern Pennsylvania Chapter of the International Society of Explosives Engineers (ISEE), describes the dangers of flyrock and acknowledges that blasting is an ultrahazardous activity. **That is quite an admission**! **It does beg the question: why would the Regulator have to inform the ISEE about the dangers of flyrock and that blasting is an ultrahazardous activity? Is it possible that members of the ISEE do not understand the dangers inherent in blasting or do ISEE members simply choose to ignore or bypass the issue of flyrock when preparing Blasting Impact Analysis/Assessment reports on behalf of the aggregate industry**? The Regulator's letter was posted July 27, 2020, on the ISEE Chapter website:[51]

> *Flyrock is an inherent risk of blasting, but is preventable. It does not have to happen. When it does occur there is a lot of effort by the blasting contractor, the permittee and DEP to find out why it happened and how to prevent it from happening again. Current blast records and widespread videotaping of blasts are critical for these efforts to succeed. These days most flyrock incidents are not caused by basic blast design errors such as too little stemming, boreholes too large for hole depths or burdens and spacings being too large or small. Most of the flyrock incidents that have occurred recently have been due to precautions not being taken to address conditions in the rock being blasted.*
>
> *Quarry faces are often uneven which requires bore tracking and face profiling. Careful drilling with appropriate drilling equipment for the site conditions are a must as are detailed drill logs, so the blaster is aware of any changes in the rock. On construction blasting operations one of the biggest problems is inconsistent rock. Care must be taken to ensure that the blaster knows the extent and condition of the rock surrounding each and every borehole.*
>
> *Blasting is an ultrahazardous activity and is regulated as such. Flyrock is prohibited. Flyrock is a serious violation and appropriate enforcement action will be taken in each case. All blasting in PA must be authorized by DEP permits. The activities conducted on those permits should not be a danger to the public or their property.*
>
> *When designing blasts please be careful to include any measures that will prevent flyrock. We have been very fortunate to not have a flyrock fatality in PA since 1999. However, there have been several incidents in the past few years where there was potential for injury or worse. Added precautions will help to ensure flyrock incidents do not occur.*

Flyrock Statistics Cited by Different Sources

As acknowledged by *Raina et al.* in their February 2015 article,[52] "flyrock is one of the most contentious issues in bench blasting [and] has the propensity to cause fatality and severe injuries." Flyrock, arising from open-pit blasting, continues to elude explosives engineers, despite a reasonable understanding of throw [p. 660]. According to the article, the amount

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[51] https://www.easternpaisee.com/letter-from-the-chief-on-flyrock/.

[52] Raina, A. K., Murthy, V. M. S. R. and Soni, A. K., "*Flyrock in surface mine blasting: understanding the basics to develop predictive regime,*" Current Science, Vol. 108, No. 4, 25 February 2015, https://www.currentscience.ac.in/Volumes/108/04/0660.pdf.

of research conducted on flyrock is "abysmal,"[53] and the percentage of accidents occurring due to flyrock justifies its importance irrespective of the fact that the problem is seldom reported.[54] Over various timeframes, the percentage of injuries attributed to *reported* flyrock incidents by the following authors ranges from 19.05% (Verakis and Lobb)[55] to 68.20% (Little)[56]:

Table 2. Accident statistics of reported flyrock cited by different authors

Reference	Period	Blasting injuries	Percentage of flyrock injuries in blasting related accidents
Mishra and Mallick[11]	1996–2011	30	24.19
Verakis[10]	2010–2011	18	38.00
Bajpayee *et al.*[9]	1978–1998	281	40.57
Verakis and Lobb[19]	1994–2005	168	19.05
Little[20]	1978–1998	412	68.20
Kecojevic and Radomsky[21]	1978–2001	195	27.69
Adhikari[22]	–	–	20.00

- According to Dyno Nobel Americas, which participated in a 2008 "Blast Service Management" presentation, in one year they fire "approximately 100 blasts per day" and reports "approximately 150 [customer] flyrock incidents annually," while conceding that "many [flyrock] incidents aren't reported." In 2007, Dyno Nobel Americas had 32 flyrock incidents for 30,021 quarry blasts or 1.07 flyrock incidents per 1,000 blasts.[57]
- During 2019, the Tennessee State Fire Marshal's Office received 302 blasting complaints, of which 14 were for *flyrock*, accounting for 5% of the blasting complaints.[58]
- Canada does not track the number of flyrock incidents that have led to death or injury caused by blasting at surface mining operations. However, according to the National Institute for Occupational Safety and Health (NIOSH), flyrock at surface

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[53] Raina, A. K., Soni, A. K. and Murthy, V. M. S. R., "*Spatial distribution of flyrock using EDA: An insight from concrete model tests. In Rock Fragmentation by Blasting* (eds Singh, P. K. and Sinha, A.)," Taylor and Francis, London, 2013, pp. 563–570.

[54] Davies, P. A., "*Risk based approach to setting of flyrock danger zones for blasting sites*," *Trans. Inst. Mines Met.*, May–August 1995, 96–100.

[55] Verakis, H. and Lobb, T., "*Flyrock revisited an ever present danger in mine blasting*," 2007; http://docs.isee.org/ISEE/Support/Proceed/ General/07GENV1/07v109g .pdf.

[56] Little, T. N., "*Flyrock risk*". In Proceedings of EXPLO Conference, Wollongong, NSW, 3–4 September 2007, pp. 35–43, https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-2570%2120191217T043417.551%20GMT.

[57] "Blast Service Management, https://www.911metallurgist.com/blog/wp-content/uploads/2016/01/Blast-Service-Management.pdf.

[58] 2019 Annual Report on Blasting Fines in Tennessee, https://www.tn.gov/content/dam/tn/commerce/documents/fire_prevention/posts/2019-BLASTING-COMMISSIONERS-REPORT.pdf.

mining operations in the United States has killed or injured 311 people from 1978 to 2004.[59] NIOSH defines flyrock as,

> *"any debris that lands outside the designated blasting area. It can vary in mass from marble-sized to car-sized and can be incredibly dangerous and potentially fatal."*

Examples of Flyrock's Greatest Hits!

Some of the more disturbing and fatal flyrock incidents, compiled from a variety of sources, are listed as follows:

- A quarry blast launched an 82-pound boulder 402 metres that penetrated the roof of the porch of David Ross's residence and tore off the home's siding (Flyrock 58 – August 23, 2010).
- A large amount of flyrock travelled approximately 300 feet (91 metres) and struck a car on Interstate 75, and a 16-year old boy, a passenger in the car driven by his parents, was killed as a result of the flyrock impact (Flyrock 34 – June 4, 1993).[60].
- Flyrock fragments travelled approximately 483 metres striking and killing 40-year old Bobby Messer, a mechanic, and rocks hit and damaged the mechanic's truck (Flyrock 74 – July 16, 2007).
- Two employees were injured and a third employee had her arm severed below the elbow after being struck by baseball-sized rocks propelled 400 metres to 500 metres from the quarry blast (Flyrock 13 – September 26, 2011).
- A quarry blast launched flyrock debris into a residential neighbourhood that struck and damaged five properties (Flyrock 55 – November 27, 2019).
- A quarry blast launched flyrock debris more than 300 metres and caused widespread damage to the quarry plant, private cars and buildings within the complex, and three people were injured (Flyrock 49 – January 10, 2006).
- A quarry blast showered flyrock debris over an area of 650 metres that struck and damaged three residences, primary school, tavern, saw mill and fish pond (Flyrock 61 – May 5, 2007). **The forensic investigation of this catastrophic flyrock incident "led to the conclusion that it was necessary to set the safe distance for residents at [a] distance [greater] than 700 metres."** [emphasis added]
- A quarry blast launched boulder fragments that struck and killed 10-year old M. Nandhini, and that struck and injured her brother Soundarrajan (Flyrock 68 – May 27, 2020).
- A quarry blast hurled hundreds of rocks, some the size of car tires, which sprayed a shopping centre, office complex and service station, and injured three people, one of them critically (Flyrock 64 – February 4, 2009). Police closed off roads littered with large chunks of rocks, and paramedics and emergency workers raced to treat the injured.

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[59] Josh Cabel, "*NIOSH Offers Tips for Flyrock Safety*," EHSToday, January 25, 2007, https://www.ehstoday.com/construction/article/21911356/niosh-offers-tips-for-flyrock-safety.

[60] The United States District Court for the Eastern District of Tennessee sentenced the blaster to 10 months, five to be served in a penitentiary and five months to be served under home detention (with electronic monitoring) followed by a year of supervised probation." The day shift superintendent was given an eight-month sentence. The company went out of business within four months of the blasting incident.

- A quarry blast launched flyrock debris, some of which bore through the roof of a house and struck and killed 36-year old Shupikai Chitsana, and her aunt was also struck by flyrock, but she survived her injuries (Flyrock 41 – August 15, 2019). Shupikai leaves behind her five children and husband.
- A quarry blast showered flyrock debris as far as 1,000 metres that damaged 18 cars and 14 factories, and injured 10 factory workers and killed one factory worker in a factory penetrated by numerous rocks at a distance of 500 metres (Flyrock 12 – July 19, 2013). A team of 37 fire and rescue personnel carried out a search and rescue operation with the assistance of 16 policemen and TNB employees before declaring the area safe for the public.[61]
- A quarry blast showered flyrock debris that damaged 14 pieces of parked equipment and several vehicles, injuring one person, and a 309-pound boulder was launched 250 metres (Flyrock 46 – 2008).
- A quarry blast showered flyrock debris 3,000' (914 metres) on an industrial park doing damage to a building and 11 vehicles in the Technica USA parking lot, and flyrock debris was showered 4,000' (1,219 metres) in another direction landing on a runway of West Lebanon Airport (Flyrock 24 – June 11, 2007).
- A quarry blast launched 13 boulders across a four-lane highway into resident's yards of 5-acre estate lots, and a store. A car was damaged, and another 50-pound boulder was launched 1,760 ' (520 metres) (Flyrock 26 – April 25, 2006).[62]
- A quarry blast generated excessive airblast (145 decibels) and flyrock debris that damaged 23 homes. Three homes had structural damage from flyrock and two homes had glass broken from their windows (Flyrock 37 – November 3, 1989).

Examples of Known Repeat Flyrock Offenders

The following are examples of blasting operations where the incidence of flyrock has occurred on more than one occasion.

- Gateway Materials Quarry (2 known flyrock incidents – Flyrock 7 & 29)
- Alum Luck Mine (2 known flyrock incidents – Flyrock 17)
- Arnprior Quarry (2 known flyrock incidents – Flyrock 18)
- Hamilton Boulevard Extension (2 known flyrock incidents – Flyrock 20)[63]
- Percy Quarry (2 known flyrock incidents – Flyrock 21)
- Miller Braeside Quarry (2 known flyrock incidents – Flyrock 22)

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[61] Edy Tonnizam Mohamad, Danail Jabed and Hossein Motaghedi, "*The Effect of Geological Structure and Powder Factor in Flyrock Accident, Masai, Johor, Malaysia*," EJGE, Vol. 18 [2013], Bund. X: 5661-5672, http://www.ejge.com/2013/Ppr2013.485mar.pdf.

[62] "Denny Perry, president of Stuart M. Perry Quarry, said his family's business contracts Winchester Building Supply to do all their blasting. 'We got out of it because we felt it was safer and more economic,' he said. 'We didn't want to store explosives.'" https://www.aggregateresearch.com/news/state-investigates-quarry-blast/.

[63] November 1, 2007, a piece of flyrock flew 350 metres penetrating the roof of a residence and landing in the living room (para. 7) in the Lobird Trailer Court neighbourhood. On May 6, 2008 flyrock debris was launched onto the same neighbourhood penetrating the roof of one residence and landing in the living room, and showering flyrock debris struck roads, fences, sheds and residences (trailers) (para. 1). *Director of Occupational Health and Safety v. Government of Yukon, William R. Cratty and P.S. Sidhu Trucking Ltd.*, 2012 YKSC 47 (CanLII), <http://canlii.ca/t/fs6vt>, retrieved on 2020-11-16.

- Comsbec Red Hill Valley Parkway (2 known flyrock incidents – Flyrock 31)
- Surface Mine Campbell County (2 known flyrock incidents – Flyrock 34)[64]
- City Sand's Quarry (2 known flyrock incidents – Flyrock 42)
- Hobet Mine (2 known flyrock incidents – Flyrock 45)
- Netley Branch Mine (numerous flyrock incidents over 15 years – Flyrock 51)
- Imperial Quarry (2 known flyrock incidents – Flyrock 65)
- Morrisville Mine (2 known flyrock incidents – Flyrock 66)
- Manitou Sand and Gravel Pit (2 known flyrock incidents – Flyrock 75)
- Colwood's Allandale Pit (3 known flyrock incidents)[65]
- Trail Bay Estates (2 known flyrock incidents)[66]

Empirical Methods of Calculating Flyrock Phenomenon Not Accurate

There are several empirical methods for calculating *flyrock*, but none are capable of accurate prediction due to the complexity of flyrock analysis.

> *Only a fracture of the accessible explosive energy is practically employed in rock fragmentation, and the rest of the energy is wasted in the form of unwanted events such as fly rocks, back breaks, etc. [1, 2]. Although safety has favorably been enhanced in the mining blasting operation, but various accidents due to flyrock phenomenon have been reported by the Mine Safety and Health Administration (MSHA) [3–6]. According to Institute of Makers of Explosives (IME), flyrock is defined as the rock propelled beyond the blast area by the force of an explosion [7]. Many experimental and theoretical researches on flyrock phenomenon have demonstrated that insufficient delay timing between blast rows, stemming and burden, geological discontinuities, excessive charge, and deviation in drilling process is the main reasons of flyrock occurrence [8–11]. The researches by Ladegaard-Pedersen and Holmberg [12] revealed the relationships between powder factor, density of the explosive and flyrock. Lundborg [13] studied the blasting operations in granite and proposed a prediction model for flyrock in hard rock. Also Bajpayee et al. [14] and Raina et al. [15] have proposed empirical prediction models for flyrock. These models have focused on the prediction of the initial velocity and maximum distance of the fragmented rocks from the blasting face.*
>
> *Despite considerable efforts, [the] difficult nature of rock engineering problems has caused previously empirical methods to be not appropriate in predicting flyrock phenomenon. Most of these models have been developed based on blasthole diameter.*
>
> *Despite the considerable progress made over the last three decades, significant challenges for wholly omitting of unwanted flyrock phenomenon, injuries, and fatalities still exist.*[67]

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[64] https://www.osmre.gov/resources/blasting/docs/Flyrock/1993SugarRidgeFatality.pdf.

[65] Shalu Mehta, "Three penalties in three years for blasting firm working Allandale lands in Colwood," Jan. 9, 2020, https://www.saanichnews.com/news/three-penalties-in-three-years-for-blasting-firm-working-allandale-lands-in-colwood/.

[66] Christine Wood, "Residents raise concerns with blasting," CoastReporter, April 6, 2007, https://www.coastreporter.net/news/local-news/residents-raise-concerns-with-blasting-1.1179765.

[67] Hasel Amini, Raoof Gholami, Masoud Monjezi, Seyed Rahman Torabi and Jamal Zadhesh, "Evaluation of flyrock phenomenon due to blasting operation by support vector machine," *Neural Computing & Applications*, May 2011, file:///C:/Users/Windows%207%20PC/Documents/Evaluation%20of%20flyrock%20phenomenon%20due%20to%20blasting%20operation%202011%20Amini%20et%20al.pdf.

Blasting Standards Inadequate to Avoid Structural Damage to Nearby Residences and Blast Vibration Complaints

In case studies[68] of two residences near subsurface blasting excavations the houses experienced damage, and it was concluded that the damage was the result of the *structural* response to the ground vibrations:[69]

> *Subsurface construction blasting generates ground vibration which may have a damaging effect on residential buildings. Codes of practice define damage criteria to limit the effect of the vibrations resulting from the subsurface blasting on nearby structures. All these criteria are based on the soil Peak Particle Velocity (PPV) generated due to blasting on the ground surface close to the structure. The real culprit, however, is not the ground PPV but it is the structural response to the ground vibration….*
>
> *Blasting is generally adopted for rock excavation; the level of the resulting ground vibration and the structural response depends on the explosive type and weight, delay time, blasting technology, soil properties, distance between the structure and the blasting centre, susceptibility ratings of the adjacent and remote structures, and the age and type of the structure [ST-051-1]….*
>
> *When a charge is detonated in a solid medium (like rock), a family of waves is generated. These waves generate different particle movement and travel at different wave velocities. The resulting ground-borne vibrations may have an effect on residential buildings ranging from disturbing the occupants to causing severe threshold "cosmetic" or structural damage. Problems may occur as a result of large amplitude (low frequency) vibrations, repeated occurrence of smaller amplitude vibrations, or from differential settlement induced by soil particles rearrangement. Classifying ground vibrations types, monitoring their effects and establishing their severity were widely investigated (Dowding 1985; Franfield 1996; Dowding; 1996; Massarsch 1993; Wiss 1981; Skip 1984) [ST-051-1].*
>
> *Ground vibrations resulting from subsurface construction blasting are usually monitored to assess their impact on nearby structures. Currently, there are no unified or widely accepted criteria for the safe limits of ground vibrations (Svinkin 2004). Codes of practice adopt safe limit criteria which are mainly based on field observation (ISEE 1998). Most of these criteria correlate the structural damage with the soil Peak Particle Velocity (PPV) produced on the ground surface close to the structure. Some other criteria correlate the structural damage to the PPV together with the soil particles vibration's frequency. Most of the safe limit criteria limit the PPV of the ground vibration to 51 mm/s at the nearest "non-owned" structure to the blasting site. However, it is not the soil PPV that matter but it is the structural response to the ground vibration: all the blast-vibration complaints are actually due to the structure vibration not the ground vibration. Thus, the currently adopted criteria can not define reliable and acceptable safe limits for subsurface construction blasting. Three factors of ground vibration affect the structural response: ground vibration amplitude defined via the PPV, ground vibration duration (which is not the same as the blast duration), and ground vibration frequency. Usually seismographs report the PPV and the frequency and often ignore the duration. Reducing ground vibration duration would reduce the structure response but increase the perception of the occupants to the ground vibration {ST-051-1]….*
>
> *Currently, there is no universally accepted standard for safe limit of ground vibrations generated by blasting. However, the International Standards ISO 4866-1990 refers some major regulations of*

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[68] E. Y. Sayed-Ahmed and K. K. Naji, "Residential Houses Cracking Due to Nearby Subsurface Construction Blasting: Critical Review of Current Safe Limits," Civil Engineering Department, University of Qatar, Doha, Qatar, paper presented at 1st Int'l Structural Specialty Conference, Calgary, Alberta, Canada, May 23-26, 2006, https://www.researchgate.net/publication/280530625_Residential_Houses_Cracking_Due_to_Nearby_Subsurface_Construction_Blasting_Critical_Review_of_Current_Safe_Limits#:~:text=Subsurface%20construction%20blasting%20generates%20ground,damaging%20effect%20on%20residential%20buildings.&text=All%20these%20criteria%20are%20based,surface%20close%20to%20the%20structure.

[69] Ground vibrations can be caused by construction, equipment or blasting, etc.

ground vibrations for different types of buildings. It was continuously argued that the structural/threshold damage could be related to the PPV of the ground vibration (Duvall and Fogelgon 1962; Wiss 1968; ISEE 1998) [ST-051-2]….

The [German] DIN 4150 and the Swiss Standards criteria for safe limits against ground vibrations resulting from blasting are…plotted in Figure 2 and compared to the criterion of the US OSM. It is evident from Figure 2 that these two criteria are significantly conservative compared to both the American and British criteria. It was argued that the DIN 4150 criterion is not damage-based; it is intended to minimize the perceptions and complaints of housing residents who live adjacent to blasting sites [ST-051-04].…

Despite its wide applicability, the currently used safe-limit criteria for ground vibration which are all based on the PPV and frequency of the ground vibrations fail in many situations (ISEE 1998; Quesne 2001). For example, these criteria make no distinction for the type, age or stress history of the structure; all of which considerably affect the safe limits [ST-051-4].

A major drawback is also in the concept of the safe limit criteria itself. The currently adopted criteria were obtained by only correlating the structural damage to the intensity of the ground vibration. However, a safe limit criterion against ground-born vibrations due to blasting should be based on the structure vibration/response not the ground vibration. In other words, the 51 mm/s safe-level criterion should be applied to the PPV of the structural vibration due to blasting not to the soil vibration [ST-051-4].

The intensity of the vibration depends on the soil-structure interaction that determines the structure responses to the ground excitation. A ground vibration frequency which is 40% (or more) greater than the fundamental frequency of the structure introduces a structure PPV that is less than the PPV of the ground vibration. On the other hand, a ground vibration with a frequency below the fundamental frequency of the structure causes the structure to vibrate at least as much as the ground. If the ground vibration frequency is close to the structural natural frequency, a state of resonance may be generated and the PPV of the structure will increase considerably beyond the PPV of the ground vibration. This phenomenon is totally disregarded in all the currently adopted safe limit criteria against ground-born vibrations due to subsurface blasting [ST-051-4].

Low-rise buildings have a natural frequency in the order of 4~12 Hz (Medearis 1977; Siskind 1980; ISEE 1998). However, the structures and their parts (e.g. floor, walls, etc.) respond differently to ground vibration as they have different natural frequencies. For example, the natural frequencies are 12~20 Hz for interior walls' horizontal vibrations and 8~30 Hz for floors vertical vibrations. Mid-walls' vibrations cause residential buildings to "rattle" making vibration more noticeable and aggravate human response to annoyance from ground vibration. It is difficult, if not impossible, to follow a uniform vibration standard to reduce the human perception of vibration due to subsurface blasting (Baliktsis 2001) [ST-051-5].…

Data recorded for the two case studies of houses located nearby subsurface blasting were examined. It is evident form the readings of the seismographs (samples of them are summarized in Tables 2 and 3) that the PPVs recorded for all blasting events were well below 51 mm/s; the safe limit required by the MoI [Ministry of Interior] and defined in most of the currently available safe limit criteria [ST-051-8].

…[P]lotting the relations between the PPVs and the frequencies of the ground vibrations for these events (Figures 5 and 7) reveals that the ground vibrations satisfy the safe limit criteria set by the USBM, the OSM and the BS 7385. Some the events do not satisfy the Swiss Standards and most of them are unsafe compared to the DIN 4150 specifications. However, these two standards are human annoyance driven as opposed to structural damage driven criteria [ST-051-8].

Despite satisfying all these criteria, threshold cracks, and even structural cracks, appeared in these [two] houses after the excavation by blasting. Furthermore, the residents complained that the blasting effects were significantly pronounced [ST-051-8].

The authors of the two case studies recommend that the PPV for low level frequencies (4-30 Hz) be multiplied by 4 before comparing them to the current safe limits, with the value of the factor refined to include the ratio between the ground vibration frequency and the natural frequency of the nearby structure, while conceding this concept still needs to be explicitly experimentally verified.

In a subsequent paper published in 2013 by the same authors (Sayed-Ahmed and Naji),[70] they reiterate their findings of cracks and structural damage to two nearby houses caused by blasting, even though the blasting had been carried out within regulatory limits, and recommend application of a safety factor. The authors also allude to a 2005 study by Gad et al, which confirms their findings, and they too suggest application of a safety factor.

> *Rock excavation is commonly adopted by blasting which generates a family of waves that travel at different wave velocities. Approximately 15% of the total blast energy is utilized for actual breakage and mass displacement with the reminder spent on undesirable activities Niclson (2005). Among these are the ground-borne vibrations which may have an effect on residential buildings ranging from disturbing the occupants to causing severe threshold "cosmetic" or structural damage. Problems may occur as a result of large amplitude (low frequency) vibrations, repeated occurrence of smaller amplitude vibrations, or from differential settlement induced by soil particles rearrangement. Classifying ground vibrations types, monitoring their effects and establishing their severity were investigated (Dowding1985; Franfield 1996; Dowding 1996; Massarsch 1993; Wiss 1981; Skip 1984). The level of ground vibration resulting from subsurface blasting and the structural response depends on the explosive type and weight, delay time, blasting technology, soil properties, distance between the structure and the blasting centre, susceptibility ratings of the adjacent and remote structures, and the age and type of the structure [p. 93].*
>
> *This paper shows that it is not the soil PPV that matter but it is the structural response to the ground vibration: all the blast-vibration complaints are actually due to the structure vibration not the ground vibration. Thus, the currently adopted criteria cannot define reliable and acceptable safe limits for subsurface construction blasting [p. 94].*
>
> *It is evident that the currently adopted safe limit criteria ignore a very important factor which is the structural response to the ground vibration. It is argued that ground vibrations with low level frequencies affected the structural response of these two houses causing resonance and wall rattling. These, in turn, caused threshold, and even structural, cracks beside the severe disturbance to the residents [p. 97].*
>
> *So, as a modification, the PPVs of the low level frequency vibrations (4–30 Hz) should be magnified by a certain factor (estimated as 4.0 in the current investigation) before comparing them to the currently adopted safe limit criteria. This would simulate the resonance or wall rattling which may occur to the houses subjected to ground-born vibrations with low level frequencies. With this modification, Figures 5 and 7 reveal that some of the ground vibrations are significantly outside the safe limit defined by the safe limit criteria and would cause damage to the structures [p. 97].*

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[70] E. Y. Sayed-Ahmed and K. K. Naji, "Status quo and critical review of PPV safe limits for subsurface construction blasting close to low-rise buildings," Research and Applications in Structural Engineering, Mechanics and Computation – Zingone (Ed.) © 2013 Taylor & Francis Group, London ISBN 978-1-138-0061-2 https://scholar.google.com/scholar_lookup?title=Status%20Quo%20and%20critical%20review%20of%20PPV%20safe%20limits%20for%20subsurface%20construction%20blasting%20close%20to%20low-rise%20buildings&author=E.Y.%20Dayed-Ahmed&publication_year=2-4%20September%202013&pages=93-98.

Gad et al. (2005)[71] presented an investigation which agrees with the reached conclusion of this paper. They investigated the effects of blast vibrations on a single storey brick veneer house, which was monitored for over 1 year and was subjected to 43 blasts with ground PPV ranging from 1.5 to 222 mm/s. They recommended an amplification factor ranging between 2.0 and 4.0 for the ground PPV depending on the PPV value…[p. 97].

***Other** data collected by Niclson (2005) for residential houses located nearby subsurface blasting had PPVs ranged between 0.06 mm/s and 11.5 mm/s which were well below the 51 mm/s defined by common safe limit criteria. Despite this fact, many complaints of structural/threshold damages were reported which also confirm the conclusions reached in this work [p. 98].*

Quarry Blast Initially Mistaken for Earthquake

A blast at the Miller Paving quarry in North Bay on May 16, 2018, was of such a magnitude that Natural Resources Canada mistook the quarry blast for an earthquake.

It seems the experts were baffled by that earthquake/dynamite blast today, but a seismologist with Natural Resources Canada thinks he has the answer. Stephan Halchuk told CKAT this afternoon that the shallow shake was confusing.

"Our instruments recorded shaking this morning in the very near vicinity of North Bay at 9:05 this morning. What our instruments record is the vibrations as they travel through the Earth's surface. Normally we're able to determine the difference between an earthquake, which typically occurs 10 to 20 kilometres below the surface of the earth, and blasts from construction quarries that happen at the surface." But Halchuk says today's event was very shallow.

"So it's hard for us to determine if it's a shallow earthquake or some surface man-made activity. We initially reported this as an earthquake because we can't tell where all the blasts are across the country. There are literally hundreds of blasting sites every day. But since talking with reporters and the local fire chief we've confirmed that there was blasting going on at the exact time, 9:05 this morning by a local company [Miller Paving]."

"This morning a blast shook all parts of the City and was felt as far as Astorville," said Fire Chief Jason Whiteley. "City Departments and the customer service centre were inundated with inquiries. Fire crews confirmed that Miller Paving at their Birch's Road quarry executed a controlled blast to produce aggregate for their upcoming highway project. City of North Bay Departments were unaware that the blasting was to take place today, therefore we could not make the public aware." BayToday phones were flooded with calls from people wondering what had happened. Many thought it was a gas explosion, others a plane or train crash. [update BayToday]

Quarry Blast Vibrations Cause Property Damage and Impact Residents' Health

On March 25, 2015, a massive blast at Pitt River Quarry blew out home doors and some residents suffered ear ringing.[72]

Lafarge issued a letter of apology and explanation to neighbours of the Pitt River Quarry for a massive blast on Wednesday.

The blast blew open the doors of nearby homes and left some people with ears ringing – at least that was the talk at the rally against a second quarry on Sheridan Hill which took place later that night.

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[71] E. F. Gad, J. L. Wilson, A. J. Moore and A. B. Richards, "Effects of Mine Blasting on Residential Structures," *Journal of Performance of Constructed Facilities*, ASCE 19(3): 222-228.

[72] Neil Corbett, "Gravel quarry sorry for blast," Maple Ridge-Pitt Meadows News, Mar. 31, 2015, https://www.mapleridgenews.com/news/gravel-quarry-sorry-for-blast/.

The letter explained that unforeseen changes in the weather and air pressure resulted in a much louder blast than anticipated.

Cloud cover dropped after the blast was loaded, and the wind picked up. "We noticed these change in conditions. But since we had already started loading the blast, it is best practice [safety wise] to let the blast go instead of letting mixed explosives sit overnight," said the letter.

The company said the air pressure was outside acceptable tolerances for Lafarge, which it says are more stringent than B.C. Mines….

Blasting Within Regulatory Limits Offers No Assurance Against Property Damage

Residents' complaints of property damage attributed to blasting operations are often summarily dismissed, despite evidence to the contrary, by operators of nearby surface mines on the pretext that blasting is being conducted within regulatory limits.

The mines usually abide by the regulatory limits of 1 inch/second ground movement and 133 dB air blast. Vibration is supposed to be minimized by separating the explosions of each delay by at least 8 ms. Mines usually use a "scaled-distance formula." This limits the amount of explosive per delay period. For example, the limit for a blast 2,600 feet [792 metres] from the closest protected structure is 2,234 pounds per delay period. The closer a mine gets to a house, the less explosive per delay is allowed. The formula does not have to be followed if a seismograph is at the closest house.

When a citizen files a complaint, the DEP [Department of Environmental Protection] inspector, in nearly every case, will write that blasting was within the regulations and go away, leaving angry citizens. They feel as if they are in the Twilight Zone. How can the inspector say blasting is being done properly when their house shakes? Some inspectors have even pinpointed types of blasts that cause problems under these limits, especially air blasts above 115 dB (these are explained in the analysis of each mine below). Yet, DEP and OSM [Office of Surface Mining] refuse to look beyond these standards.

The regulations are based on research done 15-20 years ago by the Bureau of Mines. None was done in West Virginia, and research was with smaller blasts and partly on a new house built specifically to test blasting. Two recent bodies of research have been developed that refute the accepted limits. (I can supply copies to anyone who wishes).

Sam Kiger, Dean of Engineering at the University of Missouri, was the expert for the Bim blasting case, which was tried in court in Boone County in March 1999. Kiger is an international expert in protecting federal buildings from blasting damage. After examining 6,000 blasting logs, he testified that there is about a 95 percent chance of damage at a vibration limit of .5 inches/second, if you count each of the holes shot (50 on average) as a separate vibration. In the Bim case, he also testified that low-frequency waves (2 Hz-11 Hz) generated by some blasts can be more damaging. The frequencies can match that of a house and amplify the shaking.

Freda Harris, who had a blasting case with a mine in Indiana, gathered many documents during the case and subsequent FOIAs [Freedom of Information Act request] of OSM. She wrote a manual for Citizens Coal Council. One of her most intriguing findings was that there can be "hot spots" in a community where the geography can make blasts worse. She emphasizes that damage and vibrations can feel worse if a house's natural frequency is approximately between 4 Hz and 12 Hz. The above-ground part of the house often vibrates more than the ground outside and the foundation. Yet, the DEP/OSM standard is based on ground vibration.

Most of the blasting studies of the Bureau of Mines were done by the David Siskind. The FOIAs provided much correspondence between Siskind and other experts, some of it quite critical. A top official of Vibra-Tech, a leader in designing blasting technology, said: "Any criteria…which ignores the frequency of a structure and the frequency content of the ground motion is overly

simplistic…Your criteria, as proposed, will neither protect the interest of the citizen and the homeowner, nor will it protect the blaster from alleged damage claims."

After the Bureau of Mines was shut down by Congress [in March 1996], Siskind became a private consultant. He testified for the coal company that lost the Bim case. The majority of the blasting cases have overturned his studies, and thereby the limits used by DEP and OSM. As he wrote an OSM official on June 17, 1997: "The battles I am now seeing are not 0.5 in/sec versus 1.0 in/sec. Complainants are trying to dismiss all the science as biased, wrong or nonapplicable. For the most part, they are succeeding in ways that pay off."

Interestingly, the DEP "Surface Mine Blasting Study Guide" acknowledges that the response of the human body is greater at lower frequencies: "This explains why people file complaints even when the blasting is conducted at safe (no damage) levels." The guide recommends seven ways to possibly reduce ground vibration, including: use less explosive per delay, increase the length of delay, detonate the blast away from houses, increase the scaled distance formula. Interestingly, many of the problem blasts violated one of those seven recommendations.

The study guide also notes that blasting complaints will be likely when air blasts exceed 115 dB. It has nine recommendations on how to reduce air blasts, including using enough cover over the explosives in the holes, avoid cloudy days and temperature inversions and avoid open sides in the direction of homes. Again these were often disregarded during problem blasts [p. 15-17].[73]

Blasting Supervisor Fired Rather Than Put People and Property At Risk

"On April 15, 2003, in an article headlined 'Miner who resigned settles suit' which appeared in the Lexington Herald Leader, Roger Alford of the Associated Press reported":

An Eastern Kentucky coal miner who resigned rather than detonate blasts that could have bombarded homes with rocks will receive $142,500 from his former employer.

Oat Marshall, who is being heralded as a hero by some coalfield residents, claimed in a lawsuit that he refused to buckle under pressure to violate state blasting requirements…

[Marshall] had said he feared setting off the blasts might have injured people or damaged property in the Letcher County community of Deane…

Marshall, a blasting supervisor, resigned in August 2001 and filed a lawsuit in November 2001 against El Dorado Chemical Co. and Consol of Kentucky, claiming that by pressuring him to violate state requirements the companies had essentially forced him from his job. El Dorado was a blasting contractor for Consol.

The lawsuit was scheduled for trial today [April 15, 2003] in U.S. District Court in Pikeville.

"My client walked away from a good-paying job based on the fact that they had asked him to do something illegal," said Prestonsburg lawyer Ned Pillersdorf [p.9].[74]

Pillersdorf acknowledged…that the settlement had been reached. He also acknowledged the amount of the settlement….

Carla Anderson, of Letcher County, said Marshall should be praised.

"It's a good thing, what he did," said Anderson, who says her home has been damaged by blasting in the McRoberts area….

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[73] Vivian Stockman, "The Social and Cultural Effects of Mountaintop Removal," Ohio Valley Environmental Coalition, file:///C:/Users/Windows%207%20PC/Documents/comments-of-the-ohio-valley-environmental-coalition-ovec-po-box-6753-huntington-wv-on-the_compress.pdf.

[74] Vivian Stockman, "*The Social and Cultural Effects of Mountaintop Removal*," Ohio Valley Environmental Coalition.

Proposed Quarry A Potential Nuisance – Injunction Imposed Against Blasting

In *Tinicum Township v. Delaware Concrete, Inc.*,[75] the trial court issued a preliminary injunction against the quarry operator because, among other reasons, *blasting* would cause a nuisance to nearby residential properties. The trial court's ruling was upheld by the appeals court.

> *The Township's expert witness, Alperstein, testified that the cliffs above the nearby residential properties were very loose and friable, and that blasting would cause a high probability of rocks dislodging from the cliffs and endangering the lives and property of those below. DVC's expert witness, Chiappetta, stated that the chances of a vibration reaching the boulder above Levinson's house were minimal to non-existent, but he admitted that the boulder was so precariously positioned that a vibration could dislodge it, and he recommended Levinson and his family evacuate their home on days blasting was to occur. Moreover, Chiappetta stated that he never calculated the stress vibrations might place on the cliffs located behind other residences in between the Levinson house and the quarry. Because there are reasonable grounds in the record to support the trial court's grant of a preliminary injunction based on nuisance, we affirm.*

In reaching its decision to affirm the trial court's injunction against blasting based on *nuisance*, the appeals court relied on the ruling of the Supreme Court of Pennsylvania in *Machipongo Land and Coal Company, Incorporated, v. Department of Environmental Protection*, 799 A.2d 751 (Pa.2002),

> *holding that if mining causes or has a significant potential to cause a public nuisance, it can be prohibited regardless of whether the landowner complied with all applicable statutes and regulations. Machipongo, 799 A.2d at 755.*

Homeowners' Wells Near Dewatering Aggregate Pit Impacted

According to neighbouring residents, 16 wells have had water issues since Dufferin Aggregates recently restarted the dewatering process at its Teedon Pit in Tiny Township. [76]

> *Dufferin Aggregates has applied to expand the Teedon pit along Darby Road in Tiny Township and is requesting to take nearly seven million litres of water per day for aggregate washing purposes….*
>
> *Dufferin Aggregates, a division of CRH Canada, owns and operates a gravel pit off Darby Road in Tiny Township. With its current water permit set to expire in mid-April, the company has applied for a new 10-year permit to take water for aggregate washing purposes. It is seeking a licence to take 1.6 million litres per day from a well and 5.2 million litres per day from a washing pond 210 days a year….*
>
> *The fact this pit sits on French's Hill, the recharge area for the Alliston aquifer which is said to contain some of the purest water in the world, is the main source of contention.*
>
> *"The artesian springs of Springwater, Tiny and Tay Townships represent what is arguably the cleanest natural water on Earth," said Bill Shotyk, Bocock Chair for Agriculture and the Environment at the University of Alberta.*

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[75] *Tinicum Township v. Delaware Concrete, Inc. and Mario Diliberto*, 812 A.2d 758 (2002) https://scholar.google.com/scholar_case?case=15752167703902735334&q=golf+or+flyrock&hl=en&as_sdt=2006.

[76] Andrew Mendler, Midland Mirror, "Area residents protest proposed quarry expansion in Tiny Township," Mar 8, 2018, https://www.simcoe.com/community-story/8299946-area-residents-protest-proposed-quarry-expansion-in-tiny-township/.

Shotyk has been testing water from all over the world over the past 25 years and says water found locally is the cleanest water ever tested.

"I have no doubt about the unique quality and inherent value. If we have the best water in the world, why put this valuable asset at risk?" asks Shotyk. "Every effort should be made to protect these aquifers for future generations to enjoy, as they are enjoyed today."…

"This (aquifer) takes very dirty rainwater and cleans it to a supreme level, but there is no value put on that," said Ann Ritchie Nahuis, who noted 16 neighbouring wells have had water issues since Dufferin Aggregates recently restarted the dewatering process…

[Commencing at roughly the same time as the construction of the sump pond (January to May 2009) and aggregate washing operations at the Teedon Pit (which started in Spring 2009) were impacts on water quality in nearby local residents' domestic wells,…

Starting in 2009 the wells began producing turbid (ie. cloudy) water with elevated levels of very fine grained particles. Local residents and experts for the MOECC and the pit owners have simply referred to these very fine grained particles as "silt". To my knowledge there has been no testing to determine the actual particle sizes of the fine grained particles which are turning up in residents' wells, and this is one of many deficiencies in the responses to residents' complaints by the MOECC and the pit owners.

There have been complaints at one time or another since 2009 from a number of residents including the following: - Bonnie Pauze and Jake Pigeon (1189 Marshall Road); - Glenn and Janet Irvine (7062 Highway 93); - Peter and Jenny Anderson (6970 Highway 93); - Kim and Rob Tower (1190 Marshall Road); - David Barkey (30 Darby Road); - Rick Lang (20 Darby Road).

A common theme in many of the complaints including my clients' are episodes of cloudy "or silty" well water which in extreme cases clog filters and destroy equipment. Some complainants have also experienced prolonged periods of abnormally high groundwater levels which have caused local flooding problems and/or well issues.

The responses to these complaints have been very poor. The previous owners of the pit (Cedarhurst) did not appreciate complaints. Complaints were often not logged or responded to (in violation of Condition 5.1 of the PTTW), and when there was a complaint response the company and/or its agents could be aggressively hostile. A scientific approach was absent, and victim blaming was often resorted to.

The MOECC wasn't much better. What I would have expected from the MOECC is a proper, science based investigation of the complaints - unfortunately this has never happened. And rather than admitting to its failings in licensing an aggregate washing operation on top of a hill overlying a vulnerable and valuable aquifer without thinking through the potential consequences, the MOECC has resorted to downplaying and/or ignoring complaints and to criticizing residents for poor well construction/maintenance.

I can see no sign in the record of the MOECC and/or the (previous) site owners' complaint responses of an open mind or of a sincere effort to take the complaints at face value and to conduct a proper scientific investigation of whether there was some possible linkage between what was happening at the Teedon Pit and the complainants' observations of impacts on off-site groundwater resources.

My clients (Bonnie Pauze and Jake Pigeon) have lived at their present location on Marshall Road about 1.4 km downgradient from the Teedon Pit since 1993. They have 2 wells on their property (one for the house and one for the barn), which until 2009 consistently provided excellent quality water supplies. There were no exceptions, their wells simply delivered excellent quality water.

Since the construction of the wash pond (starting January 2009) and the beginning of aggregate washing at the Teedon Pit (in spring 2009), my clients have suffered very negative impacts to the quality of water from their 2 wells caused by periodic episodes of high levels of very fine particles (silt/clay) in their well water. Their February 2015 written complaint which was sent to the MOECC is provided in Appendix 2.

The episodes since 2009 have a seasonal aspect to them. In general, the winter months are good and the wells deliver clear water. Once the snow cover has melted the silt problems can arise. For example after having silt problems earlier in the fall of 2017, since freeze up there was no silt at all in their wells through the winter until an episode which began February 19, 2018 and lasted for about a month. Then it got colder and the wells became clear again and have been so up until the time of my writing this review.

The prior owners' consultant and the MOECC resorted to victim blaming, rejecting any responsibility and telling my clients that the age and/or poor construction of their wells was to blame for any silt problems. This is hard to accept. If there were a problem with the wells' construction, then it would be an ongoing problem. It would not be something that was episodic as has been experienced by my clients. The timing of the problems developing (both wells delivering excellent water until 2009, and then both wells having episodic silt issues since then) is also highly unlikely to have occurred by chance.

The silt episodes seem to be sometimes related to recent aggregate washing activities at the Teedon Pit, but there have been times when a silt episode develops even though no aggregate has been washed recently. My clients have numerous jars and sample bottles full of cloudy water, which they have shown the MOECC and the consultants for the previous owners. Testing by the prior owners' consultants confirmed elevated levels of turbidity and total suspended solids (TSS) in 2015 [p. 10]][77]

[There have been numerous violations in connection with the three PTTWs issued to allow aggregate washing operations at the site, as documented in Wilf Ruland's report, p. 13-18.]

Balancing Aggregate Extraction Against the Need to Avoid Unacceptable Impacts

In *Mansell Neil Mansell Concrete PL v. Marrochy Shire Council*,[78] the Planning & Environmental Court of Queensland upheld Council's decision to refuse to issue a quarry permit. The appeals court decision addressed the following issues:

…[B]alancing of need to protect and develop hard rock resource with the need to avoid unacceptable impacts on amenity of encroaching residential development, noise conditions proposed which involve untested technologies; dust, vibrations, flyrock; expectations; precautionary principle; role of Environmental Protection Agency; whether concurrence agency can change it's [sic] response after appeal instituted, issues of protection of environment and visual and character amenity, whether proposal conflicts with planning scheme; whether there are planning grounds; planning need.

The land the subject of the development application is described as Lot 2 on RP165748 and has an area of 18.29 hectares. It is rectangular in shape, except for an irregular southern boundary where it lies adjacent to a concave bend in Zgrajewski Road. Its long axis has a rough north-south alignment, the average side length being approximately 650m and width 300m. The total length of the frontage is 325.07 meters. The northern boundary of the property intersects the summit of the hill where the elevation is approximately 105m. South from this boundary the land drops steeply to the 25m contour over half the length of the block, giving an average slope of about 14º. Over the remaining southern half the land flattens out, reaching a lowest level of about 10m near its south-western corner. The hill is dissected by a number of small gullies fed by springs and flowing into a stream which flows from east to west across the flat southern portion of the property [para. 2]. [See p. 9 Map showing location of proposed quarry.]

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[77] Wilf Ruland, "Review of an Application for a Permit to Take Water for Aggregate Washing at the Teedon Pit near Waverly, Ontario," April 23, 2018, p. 9-10, http://aware-simcoe.ca/wp-content/uploads/2020/01/April-23-2013-Review-of-Teedon-Pit-PTTW-Application-Wilf-Ruland-P.-Geo..pdf.

[78] https://archive.sclqld.org.au/qjudgment/2007/QPEC07-086.pdf.

The site is located in an area characterised by either rural activities or native bushland. The rural activities can by divided into two categories:

- *Cultivated land either used for sugar cane production or banana growing. Sugar cane generally grown on the flatter floor plain type lands and bananas on the steeper hill slopes.*
- *Uncultivated but cleared land used either for cattle grazing or left vacant [para. 3].*
- *Approximately 600 meters to the south of the subject land (at its closest point) and approximately 650 meters from the extractive industry proposed on the subject land is a strip of rural residential allotments focused on Musgrave Drive, Leichardt Drive and Auburn Court [para. 4].*

The description given above of the Musgrave Drive and (part of) Leichardt Drive as a "strip of rural residential allotments" comes from Mr Ryter's report, but this description was not borne out on the inspection of these areas. The Coolum Heights Estate which is serviced by these streets presents as residential development of a very high value with substantial homes built on large allotments with extensive rural and mountain views. There are also residences due south (which is quite close to the Zgarjewski Road frontage), and to the east, including the residences of Kelly O'Shea and Alan Hubbard which are on acreage and share a boundary to the site [para. 7].

Planning Context From a planning perspective, the time for development of the subject land as a quarry has simply passed,

because of the gradual encroachment, particularly in the last 10 years, of residential development which everyone recognises as an incompatible use when associated with a hard rock quarry.

In a joint statement issued by all three town planning experts, the issue was put this way:

In some cases, protection of amenity and environment may result in an extractive resource being sterilised.

The key planning principle in this case is balancing the need to permit the extraction of a valuable hard rock resource, with protection of amenity of nearby residences and the environment. Where encroachment of potentially incompatible land uses has occurred for whatever reason, extra care needs to be taken to ensure the maintenance of amenity [para. 15]. [emphasis added]

The subject land had been acquired by the owner five years before the quarry application was submitted in 2002, and the owner conceded that,

The reason for delaying making the [quarry] application was largely commercial.

As noted by the appeals court, Mr. Schomburgk in his report (Ex17), after referring to the adverse impacts, summarized the position of the Council and the Objectors succinctly (at 5.5.7):

"In my opinion, those impacts (visual as well as noise, blasting and traffic) are likely to change the character and amenity in an unacceptable way. In this case, it will then be a matter for the Court to balance these impacts with the technical advice of other experts. In my opinion, however, the balance in this case favours refusal. Encroaching residential development has simply compromised the ability of this resource to be won without unacceptable impacts on the environment and the amenity of the locality as it is today."

Council's decision to refuse to approve the proponent's application for a quarry was upheld by the appeals court on the grounds that **the cumulative adverse impacts on the environment and on the amenity of nearby residents outweighed any potential commercial benefits from the proposed blasting quarry.**

Neighbours Attribute House Damages to Blasting at a Nearby Quarry[79]

Homeowners are demanding Hanson Heidelberg Cement Group pay for damages they say were caused by a recent blast….

More than a dozen people said the blast put cracks in their ceilings, walls and driveways. It also fractured their foundations.

It shook my house. It felt like an earthquake in my house," said Joseph George.

For decades the Hanson Heidelberg Cement Group has been conducting routine quarry blasts with little to no problems, but George said that changed Nov. 24.

"It shook like 5 or 6 seconds after the blast went off," said George.

"I have a crack going down the middle of my ceiling. I have sheet rock falling off. It's bad. They are tearing my house up."

But George and others worry most about the damage that can't be seen.

'We can see what is going on inside, but the foundation is the really important thing. Are we on rock or are we on sand or has the rock been turned to sand?" said Dean Livingston, a family member of a homeowner….

An employee of the Hanson Heidelberg Cement Group said a person would be sending a statement soon.

"They did not deny the blast at all," said Livingston.

Livingston said the blast caused cracks and doors not to close at his mother-in-law's house and nothing has been fitting like it used to.

"You straighten a mirror on the wall, and it goes back crooked," said Livingston.

Livingston said the company offered to have an inspector come look at the homes, but he said he'll be getting a second opinion.

"Can you permanently correct this? That's what we don't know," said Livingston.

Quarry Permit Denied in Part Due to Blasting and Flyrock

In rejecting Rivers' proposed quarry on a 93-acre parcel in the Town of Moretown and ruling in favour of the residents (objectors), that part of Vermont Environmental Court's January 2007 decision addressing *blasting* and *flyrock* is reproduced below: [80]

> ***Blasting* at the proposed quarry would have several materially adverse impacts upon the surrounding properties and uses, including substantial risks to the Neighbors' water supply from toxic chemical spills and altered groundwater flow patterns, air quality impacts from dust, and aesthetic impacts including noise over 70 dBA beyond the Rivers' property line. These risks and impacts are addressed more fully in other sections of this decision; here we focus only on the hazard that flyrock poses to neighboring properties and uses.** [emphasis added]

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[79] Liz Lohuis, "Upstate rock quarry blast blamed for damaging homes," December 11, 2015, https://www.wyff4.com/article/upstate-rock-quarry-blast-blamed-for-damaging-homes-1/7018879.

[80] http://www.killthealbionquarry.org/flyrock_danger.pdf.

Flyrock is rock propelled by an explosion outside of the defined blast area. Flyrock occurs for a number of reasons, including face busts, stemming ejections, and cratering, which in turn are often the result of undetected voids, mud seams, or other anomalies in the rock. Even a very small crack in the rock connecting to a bole [sic] hole can produce flyrock. Flyrock can travel at great velocities over great distances. For example, the flyrock accident described by Rivers' blasting expert in West Lebanon, New Hampshire, caused a head-sized fragment of rock to travel off of the quarry site at over 300 feet-per-second (204.5 mph) and land some 4,000 feet [1,219 metres] away, with other fragments breaking a window and a stone curb at the Technica USA parking lot, some 3,000 feet [914 metres] away from the blast. Mr. Hendrickson testified to five other recent examples of accidents resulting from quarry blasting in Vermont, some of which resulted in pieces of flyrock striking with enough force to become embedded in a metal post and a landscaping rock more than 700 feet [213 metres] away from the blast.

Flyrock is unpredictable and dangerous. Flyrock can travel in any direction or multiple directions from a blast. Rivers' blasting expert cannot guarantee that flyrock will not leave the Rivers parcel, no matter what precautionary measures are taken. Out of concern for the Neighbors' safety, Rivers' blasting expert recommends that anyone within 1,500 feet [457 metres] of a blast remain inside or under cover. It is unclear whether remaining inside would protect against a head-sized rock fragment traveling over two hundred miles per hour. Numerous Neighbors, including Parties Holden, Porter, Hendrickson, Byrne/Farley, McMullin and Sanders, are within this 1,500 [feet] danger zone, as shown on the uncontroverted map admitted as Neighbors' Exhibit N.14. The Holden residence, for example, is a mere 720 feet from the proposed quarry site.

The risk of flyrock is substantial and material, and cannot be eliminated from the proposed project. The risk of flyrock would be present every time there is a blast, i.e., ten or more times a year for 33 years. Errant flyrock could result in injury to or the death of nearby residents, injury to or death of horses at the Mad River Stables on the McMullin property, and damage to homes and property.

Because the risk of flyrock leaving the Rivers parcel cannot be eliminated by Rivers, the risk…[of] property damage, injury, or death will be borne by the Neighbors to the proposed quarry. We cannot condone that shifting of risk onto the long-time residents and farms that have existing in this portion of the Mad River Valley for many years prior to Rivers' pending applications.

Neighbors' Question #12 of their Statement of Questions in Docket No. 7-1-05 Vtec asks: "Whether, under MZR Section 3.5(C), the application and proposed quarry will not cause a hazard to public health or safety?" We must conclude that because Rivers cannot eliminate the risk of high-velocity rock fragments leaving its property whenever a blast is conducted, the proposed quarry will cause a hazard to the health and safety of nearby residents, recreational users of the area, and travelers on Route 100B, in violation of MZR § 3.5(C).

Neighbors' Question #12 of their Statement of Questions in Docket No. 7-1-05 Vtec asks: "Whether, under MZR Section 4.10(A), the land or structure(s) for the application and proposed quarry will be used or occupied in any manner so as to create dangerous, injurious or obnoxious conditions that adversely affect the reasonable use of adjoining or nearby properties?" We must conclude that Rivers proposes to use its land so as to create a dangerous condition that adversely affects the reasonable use of adjoining and nearby properties, in violation of MZR § 4.10(A).[81]

Neighbors' Question #13 of their Statement of Questions in Docket No. 7-1-05 Vtec asks, in part: "Whether under MZR Section 4.10(B)(1)-(5), the application and proposed quarry meets the following standards: […] (3) No fire, explosive or safety hazard shall be permitted which significantly endangers other property owners or which results in a significantly increased burden on municipal facilities." We must conclude that Rivers' proposed quarry creates an explosive and safety hazard which significantly endangers other property owners, in violation of MZR § 4.10(B)(3).

[81] MZR § 4.10(A) reads in its entirely: "No land or structure in any zoning district shall be used or occupied in a manner so as to create dangerous, injurious or noxious conditions that adversely affect the reasonable use of adjoining or nearby properties."

Neighbors' Question #14 of their Statement of Questions in Docket No. 7-1-05 Vtec asks, in part: "Whether, under MZR Section 5.2(C), the application and proposed quarry will adversely affect [the conditional use criteria, including the character of the area and the bylaws in effect]?" We must conclude[] that Rivers' proposed quarry would have a substantial and material adverse effect on the character of the area by introducing a dangerous industrial use into this bucolic neighborhood characterized by single family homes, horse farms, and quiet recreational pursuits. In addition, the proposed quarry would adversely affect the bylaws in effect, including MZR §§ 4.10(A) and 4.10(B)(3).

Neighbors' Question #8 of their Clarified Statement of Questions in Docket No. 68-3-07 Vtec asks: "Does the proposed quarry fail to comply with 10 V.S.A. § 6086(a)(8) because it will have an undue adverse effect on aesthetics, including the scenic or natural beauty of the area, due to noise, trucks, blasting, crushing, drilling, dust, and an industrial scar on the landscape, a scenic landscape that currently supports residential and recreational uses and several horse farms?" We must conclude that the blasting activity on Rivers' proposed quarry would have an undue adverse effect on aesthetics under Criterion 8, even without considering the other proposed quarry activities.

Neighbors' Question #9 of their Clarified Statement of Questions in Docket No. 68-3-07 Vtec asks: "Does the proposed quarry fail to comply with 10 V.S.S. § 6086(a)(9)€ because Rivers has failed to prove that the proposed quarry will not have an unduly harmful impact upon the surrounding environment or surrounding uses and development, and/or because Rivers will not leave the site in a condition suited for alternative use or development?" We must conclude that Rivers has failed to prove that its proposed blasting will not have an unduly harmful impact upon surrounding uses and development under Criterion 9(E).

In accordance with the forgoing, the Court must rule in favor of the Neighbors on Neighbors' Questions 12, 13, and 14 in Docket No. 7-1-05 Vtec and Neighbors Questions 8 and 9 in Docket No. 68-307 Vtec.

On appeal, Environmental Court Judge Durkin issued a 70-page decision upholding refusal of Rivers' quarry permit application, with part of the judge's ruling based on the dangers of blasting and flyrock, as reported by The Valley Reporter:[82]

…Environmental Court Judge Durkin made his decision on Rivers' proposed quarry based in part on Rivers' blasting expert's testimony. The judge wrote in his decision Fact 171, Page 45, "However, Rivers' expert could not assure that no blasts at the Rivers' quarry would result in rock being thrown beyond the Rivers' boundary limits. He speculated that rock could be thrown, unintentionally, as far as 1,500 feet [457 metres] from the quarry floor. Because some homes are located within this distance he recommended that area residents be notified prior to a blast and that they stay in their homes during a blast." In part of the conclusion on Page 62 the judge wrote, "To this area, the Rivers' quarry will bring activities and noises not yet experienced; they will be new intrusions into this neighborhood and district. While the prospect of fly rock trespassing upon neighboring properties will be rare, if occurring at all, Rivers could not provide assurances that fly rock will not descend upon neighboring properties and perhaps onto Route 100B. While Rivers' expert credibly asserts that this is unlikely to happen, he also recommended that those within 1,500 feet [457 metres] of the quarry site remain indoors during blast events. Thus, at least as frequently as a dozen times each operational season, the lives of neighboring property owners will be interrupted and they will be directed to remain indoors, lest they wish to risk limb, life, or property damage. Both the frequency of these intrusions into neighbors' lives and the disparity between such interruptions and the character of this area, leads us to conclude that the project will cause the unduly harmful impacts from which criterion 9(E)(i) seeks to protect."

[82] Hendrickson, "Quarry ruling did not create unattainable standard," *The Valley Reporter*, June 23, 2010, https://www.valleyreporter.com/index.php/news/my-view/4537.

The blasts at Rivers' proposed quarry would be very large. Judge Durkin wrote in his decision "a combined blast could expend as much as 7,848.4 pounds of explosives." (Almost four tons of explosives.)

…[Judge Durkin] concluded, based on the facts before him, that blasting dangers posed an unacceptable risk to the neighbors and traveling public on 100B. He also concluded that the noise coming from the quarry would exceed both Moretown zoning and Act 250 noise standards.

SECTION II – DOCUMENTED FLYROCK INCIDENTS

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Flyrock 49

On January 10, 2006, a quarry blast propelled flyrock more than 300 metres and caused widespread damage to buildings and cars, and injured three people. The quarry operator paid a nominal fine of €1,000. (The quarry blaster was fined a sum of €3,000.)

> *On the 6 November 2009 at Clonmel Circuit Court, Tipperary, Denis Tarrant & Sons Limited pleaded guilty to one charge. This case arose as a result of a flyrock incident on the 10 January 2006 at the quarry of Denis Tarrant & Sons Limited, Kilfeacle, Co. Tipperary.* ***The rock travelled*** *over 300m and caused widespread damage to quarry plant, private cars and buildings within the quarry complex. Three people were also injured.*[83]

Flyrock 50

On two occasions in 2013 flyrock was propelled onto a busy highway in Virginia where traffic had been stopped prior to initiating each blast.

> *On both occasions flyrock was thrown onto a busy highway where traffic had been stopped prior to initiating the blast. In May [2013], flyrock traveled approximately 400 feet [122 metres] striking one vehicle and damaging another when it ran over a football size rock that had landed in the highway. In August [2013], flyrock traveled approximately 1,200 feet [366 metres] and landed in the roadway; no vehicles were struck or damaged in this incident. Fortunately, no one was injured in either of these incidents.*[84]

Flyrock 51

On December 21, 2010, a blast at the Netley Branch Mine caused a showering of flyrock dover a distance of 1,200 feet (366 metres), impacting a county road, trees and nearby homes.[85]

> *[MSHA Inspector] Belcher testified that the 15 year history of the mine showed that the area was subject to flyrock events.…If there had been a history of flyrock events, the [ground control] plan must include greater blasting details.…In this case, due to the dangers associated with blasting, rocks were projected between 1,100-1,200 feet through the air and landed near people's homes.…One of the rocks fragmented and struck the window of a nearby home.…[p. 7].*
>
> *One home that was affected by the flyrock event…was previously affected by a flyrock event five years earlier.…Due to this history, and the proximity of the homes, Belcher believed that there should have been a "heightened awareness of the sensitivity of the area.". The Netley Branch Mine had a blast remediation plan prior to the flyrock event cited here. Such plans are put in place once a flyrock event occurs.…In the plan, it identifies what went wrong, what led to the occurrence of the flyrock event, and what measures will be put in place to prevent a similar occurrence [p. 7].*
>
> *…Belcher conducted interviews on December 22, 2010 with homeowners who lived near the mine site.…Belcher examined the distances between where the rocks landed and the homes...He found that there were four to five different rocks ranging in sizes from four-by-four finches to 12 by 12 inches. These rocks were scattered on nearby property and Belcher saw the marks on the paths of the rocks.…Belcher stated, there were five people in one home and three people in another and said, "fortunately no one was injured or killed, but there was people home at the time [p.8]."*
>
> *Photographs…showed a rock that broke through part of a window of the house closest to the blast site.…This house was approximately 1,000 feet from the blast.…The photos also showed splattering on the ground where rocks had landed.…The owner of the house told Belcher that the*

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[83] https://www.hsa.ie/eng/Topics/Inspections/Prosecutions/Prosecutions_2009/.

[84] https://www.dmme.virginia.gov/DMM/PDF/SAFETY/ALERTS/blastingflyrock/FlyrockHighway.pdf.

[85] *Revelation Energy, LLC. V. MSHA*, Docket No. KENT 2011-357-R, Order No. 8257014; 12/21/2010, https://fmshrc.gov/decisions/alj/KENT%202011-1106.pdf.

window had been broken by the flyrock in the photo….Belcher interviewed this homeowner, and the homeowner stated that the rock came from the mine on the morning of the blast….Belcher and the homeowner walked around the entire yard, and the owner pointed out the rocks that landed in his yard [p. 9].

According to the photographs, flyrocks landed on a county road, and on other property further from the blast site….The rock was large enough to kill a person if it struck him or her in the head….Other photos similarly showed rocks that had splattered on the side of homes, on trees, and on rooftops [p. 9].

After conducting an investigation as a result of the December 21, 2010 flyrock incident, Belcher discovered that three elements of the [ground control] plan were violated…..The first violation that Belcher discovered was that "sufficient burden was not maintained on the side of the shot toward the dwelling."….The burden was the amount of spoil that was either left in place from the previous shot or solid material that had not yet been shot….There was a calculation based on the diameter of the hole to determine how much burden is necessary to help prevent flyrock from traveling as far….Here, the burden and spacing in the ground control plan ranged from 14-17 feet, with a 14-foot minimum….The plan states that "any variance from this minimum requires identification."….No variance was ever requested….[p. 9].

The combination of the three violations…created a situation where the gravity was highly likely and the injury or illness that could be expected was fatal….Belcher testified that the combination of these three violations made the occurrence of a flyrock event more likely than if only one of these violations were present….Even flyrock that does not leave the mine property presents a hazard to miners on the property….Belcher testified that the injury to be expected from such an event would be fatal [p. 11].

The Operator…failed to follow their acknowledged ground control plan to prevent a flyrock event that occurred on December 21, 2010…. A blast remediation plan outlining specific blasting safety pre-caution measures had been previously incorporated into the ground control plan and acknowledged on April 26, 2010. A previous flyrock event…occurred at this same mine on November 19, 2008….The blast was detonated…causing 4 separate rocks measuring between 4 x 4 and 13 x 13 to be cast from the blast and land in the yards of two residences located on Big Blue Springs of Blackberry Creek. One of the smaller rocks…struck the window of a residence occupied by Gary Hatfield. This type of practice presents a high degree of risk of serious injury or death to residents living below the mine. The mine Operator has engaged in aggravated conduct constituting more than ordinary negligence by not following their acknowledged ground control plan…[p. 18].

At the June 5, 2014 hearing, the Commission had difficulty containing its displeasure over the respondent's position that flyrock impacting anyone other than a miner did not constitute a *Significant and Substantial* violation of the Federal Mine Safety and Health Act (Mine Act):

Respondent's argument that a violation may only be S&S [Significant and Substantial] if it can lead to a serious injury of a miner, is both bizarre and incorrect. While it is true that Congress passed the Mine Act to ensure the health and safety of miners, the Commission has never interpreted S&S in such a narrow fashion so as to limit it to the health and safety of miners. Both §104(d) and the seminal Commission cases that developed the criteria for S&S spoke only of the type of injury, not the status of the individual who suffered such injury. [citations omitted] One need not come up with an example that illustrates the absurdity of this position, because this case does so in spades. To say that a violation that placed persons who resided in the path of flyrocks at grave risk was not significant and substantial because they may not meet the statutory definition of miners is absurd. The Mine Act makes no such distinction when persons lives are at risk [p. 22].

Flyrock 52

On April 14, 2011, blasting at a quarry in the process of being redeveloped into a housing project, caused flyrock to be propelled for hundreds of yards causing serious damage to several houses.[86]

> *Rocks the size of rugby balls were hurtled hundreds of yards from a disused quarry, causing serious damage to several houses.*
>
> *One householder even found a boulder had crashed through her roof into her bathroom after the botched blast at Barrwood Quarry in Kilsyth, North Lanarkshire.*
>
> *Nobody was injured, but the four nearby Barrwood Cottages, along with other properties in Ladeside Drive, were hit by falling rocks….*
>
> *Betty Wilson, 65, who lives in one of the one-bedroom Barrwood Cottages, said: "All hell let loose." Debris was flung hundreds of yards from the blast site, through her roof and into her bathroom.*
>
> *She said she saw bricks soaring over her rooftop as the blast sent boulders flying up to 400 yards [366 meters] away. Mrs Wilson said yesterday: "I was in my bedroom when all hell broke loose.*
>
> *"I heard a crashing noise and glass smashing and a brick came through my roof into my bathroom. If I'd been there I would be dead."…*
>
> *"The worst hit were Barrwood Cottages, right on the edge of the site." Strathclyde Police secured the quarry and a health and safety investigation is due to begin today….*
>
> *"Debris from the controlled explosion exceeded the perimeter of the safety exclusion zone set by the specialist blasting contractors on site….*

Flyrock 53

On May 28, 2014, a blast at the North Bay quarry (1141 Carmichael Drive) operated by Bruman Construction caused flyrock to be projected outside of the blast area onto a neighbouring residential property and near where an employee of Bruman Construction was standing.[87]

> *Consbec Inc. and Bruman Construction Inc. pleaded guilty to one offence each and were fined $150,000 for failing to forthwith notify the ministry of a fly-rock discharge into the natural environment, contrary to the Environmental Protection Act….*
>
> *Fly-rock landed on the residential driveway about 25 feet from where the homeowner and an employee from Bruman Construction were standing. There was no property damage and no one was injured.*
>
> *Subsequently, the homeowner contacted the ministry to advise of the discharge of fly-rock from the quarry. However, at no time did either Consbec or Bruman Construction advise the ministry of this discharge.*
>
> *On November 20, 2015 Bruman Construction Inc. was convicted of one offence and fined $25,000 plus a victim fine surcharge of $6,250 and was given 6 months to pay the fine. On September 13, 2016, Consbec Inc. was also convicted of the same offence and fined $125,000 plus a victim fine surcharge of $31,250 and was given two years to pay the fine.*

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[86] Dean Herbert, "Quarry blast terror as rocks crash into homes," April 15, 2011, https://www.express.co.uk/news/uk/240842/Quarry-blast-terror-as-rocks-crash-into-homes.

[87] North Bay Nipissing News, "Major fines handed down for North Bay blasting incident," September 14, 2016, https://www.northbaynipissing.com/news-story/6857859-major-fines-handed-down-for-north-bay-blasting-incident/.

[Fly-rock is considered a contaminant under the Environmental Protection Act *("EPA"). Section 14 of the EPA prohibits the discharge of a contaminant into the natural environment. A contaminant is defined under the EPA as something resulting from human activities that causes or is likely to cause an adverse effect. Section 15 of the EPA requires all persons to notify the MOECC if they discharge a contaminant into the natural environment, out of the normal course of events, and the discharge causes or is likely to cause an[] adverse effect. What constitutes an adverse effect is broadly defined in the EPA.]*[88]

Flyrock 54

On November 30, 2018, blasting for road building in BC's interior coastal woodlands resulted in flyrock travelling 500 metres and penetrating the roof of an occupied cookhouse.[89]

An Interior Coastal Woodland's road building contractor had a very serious flyrock incident, with a 6-inch rock penetrating through a cookhouse roof.

The cookhouse was occupied at the time and the rock landed within 6 meters of workers. The blue arrow in the picture…points to hole in roof….

[WorkSafe required] [n]o blasting within 1 km [1,000 metres] of an occupied dwelling. If there is any question as to risk to people, property, aircraft and/or boats STOP and report to Supervisor.

Flyrock 55

On November 27, 2019, blasting at a nearby quarry sprayed flyrock into a Crab Orchard neighbourhood causing extensive damage to 5 residences.[90]

Cumberland County deputies responded to the Market Street area in Crab Orchard yesterday for residences sustaining damage reportedly from a blast from a nearby rock quarry. Officers spoke with Elite Blasting Services that told them there were voids and mud seams, which when the explosion took place, expelled rocks and mud from the blast area. Five homeowners on the 700 and 800 block of Market Street reported damage…:

- Home on 700 block of Market Street – damage to foundation and chimney.
- Home on 700 block of Market Street – damage in two areas of foundation and to a well on property.
- Home on 800 block of Market Street – damage to roof, camper and scattered rocks and mud throughout property.
- Home on 800 block of Market Street – damage to roof and scattered rocks and mud on property.
- Home on 800 block of Market Street – damage to roof of barn, gutters and structural damage *to* shed and barn. Scattered rocks and mud on property.

The homeowners told deputies this was not the first time something like this happened. There is a seismograph on one property installed to measure the blasts coming from the quarry because of past issues….

[In February 2008,…Crab Orchard residents – 26 whose homes have suffered damages ranging from broken septic lines to septic tanks being raised to hot water heaters being broken by blasts that citizens claim came from the reopening old county rock quarry….Property owners want to know who is going to pay for the damage to their property…."What am I supposed to do about my

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[88] Paula Lombardi, "Failure to Notify brings $150,000 Fine Despite no Damage to Property," September 28, 2016, https://www.siskinds.com/failure-notify-brings-150000-fine-despite-no-damage-property/.

[89] http://www.bcforestsafe.org/files/Safety%20Alert-Interfor-Blasting%20Close%20Call-Coastal%20Woodlands-Nov%2030-2018.pdf.

[90] Scott Humphrey, 1057 News.com, "Rock Quarry Blast Damages Five Homes In Crab Orchard," http://1057news.com/2019/11/27/11/52/46/rock-quarry-blast-damages-five-homes-in-crab-orchard/.

home?" one woman asked. "I am on $900 a month disability income. How can I afford [to] fix my house or afford a lawyer?"][91]

Flyrock 56

On September 7, 2020, WorkSafe Victoria described a blast at a quarry that damaged buildings on an adjoining property from flyrock that travelled several hundred metres.[92]

During the firing of a quarry production shot, fly rock ejected from the blast travelled several hundred metres and entered a neighbouring property. Several rock fragments struck and damaged buildings. These fragments narrowly missed employees who were actively working on the property at the time of the shot fire.

Mining and quarrying are high-risk activities. Misfires and fly rock are common hazards associated with shot firing activities, which are routinely undertaken in these industries.

Employers and other duty holders who fail to adequately identify and control the risks associated shot firing activities can create serious risks to the health and safety of both employees and people in the surrounding areas.

Flyrock 57

On April 14, 1995, an explosion at the Collinson Quarry shattered windows throughout the surrounding area, caused flyrock to penetrate a house and hit a parked vehicle, with minor injuries sustained.[93]

An explosion at a Knoxville Road stone quarry broke windows, sent a rock through a house, damaged a car and caused minor injuries here Friday, according to Milan police reports.

Police said they received a call at 1:08 p.m. from someone at Collinson Quarry that "an explosion went bad." The dynamite blast did extensive property damage, mostly shattering windows, throughout Milan, police said.

Residents of High Cliff Estates Mobile Home Park, which neighbors the quarry, said the blast shook their homes, knocked trailer skirts loose and, in at least two instances, sent flying rocks into their property.

Police, deluged with phone calls for much of the afternoon, received reports of minor injuries and some gas line leaks. John Bloome, Iowa-Illinois Gas & Electric Co. district supervisor, said that three hours after the incident, his crews had not found any gas line leaks, although the blast had apparently blown out some pilot lights.

Mobile home park residents near East 17th Avenue and 4th Street were apparently hardest hit by the explosion. Several residents said they felt the stronger-than-usual blast and saw a cloud of "smoke" rising over the quarry, which lies directly east of them.

"It was basically like an earthquake," said Doris Davis, park resident.

"You usually hear the booming and you can feel a little bit of a shake . . . but I never felt something like this before," added park resident Dolores Smith.

Ms. Smith's neighbor, Dolores Fouts, vouched that the blast was unusual -- a flying rock struck the car parked in her driveway, leaving a large dent and a pile of powder.

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[91] Michael R. Moser, Crossville Chronicle, "Crab orchard residents seek relief from blasting damage," Feb. 5, 2008, https://www.crossville-chronicle.com/news/local_news/crab-orchard-residents-seek-relief-from-blasting-damage/article_bff0ce16-f7b3-5af0-b1c7-dc7791969b34.html.

[92] https://www.worksafe.vic.gov.au/safety-alerts/rock-fragments-quarry-blast-impact-active-worksite-neighbouring-property.

[93] https://qconline.com/news/local/quarry-blast-rocks-milan-homes-shatters-windows/article_f36034c0-f1a4-5b8b-844a-e722e0873e04.html?utm_medium=social&utm_source=email&utm_campaign=user-share.

John Bloome's trailer also was struck. He said he could not find the rock that must have caused the fist-sized hole in his trailer, but the projectile knocked a wooden box across the bedroom and shattered a large mirror on the dresser, he said.

Exterior damage to the mobile homes occurred on the sides facing the quarry. Residents said pictures inside were knocked off walls and medicine cabinets were thrown open and emptied.

Scott Schitz, with the Illinois Department of Mines and Minerals, said Milan residents near the flying rocks were lucky. "It will kill people. The rocks fly at tremendous velocity," he said.

The state currently has no law to regulate quarry blasting, although a bill in the House would give the department that power, he said.

"These kinds of complaints are common," Mr. Schitz said.

Callers to The Dispatch and The Rock Island Argus newsroom said the quarry blasts were all too common in their neighborhood and were an accident waiting to happen.

A man answering the phones at the quarry this afternoon said the company blasts dynamite every day. He said he did not know about the property damage in Milan.

"This is a business," he told a reporter. "I've got trucks everywhere. I don't have time for this."

Flyrock 58

On August 23, 2010, a blast at a quarry in Buffalo Township launched an 82-pound boulder into a home nearly a quarter-mile (402 metres) away.[94]

A stone quarry in Buffalo Township was shut down on Monday after a blast sent an 82-pound chunk of stone into a home nearly a quarter-mile [402 metres] away.

The chunk crashed through the roof of a South Bridge Road home's porch. Another portion of stone landed in a yard between Interstate 70 and Route 40.

Authorities said the rock came from Stone Quarry along Route 221.

David Ross told Channel 11 News he was riding his stationary bike he heard two crashes. When he went outside, he saw the rock and the damage it did to his front porch.

"I heard the dynamite go off and then I heard, with a snap of the finger, I heard another crash and that's when I knew something happened," said Ross. "So I came walking out and saw all this debris on my porch."

Not only did the rock rip through the porch, but it tore off the home's siding, too.

"A couple weeks ago we sat out in the yard and waited for the dynamite to go off and feel the vibration in the ground. That's all it was, that's all it has ever been," said Ross.

Ross's neighbor heard the commotion, felt the ground shake and found a rock on her property as well.

"A couple seconds later, I just heard a noise," said Ruth Dewitt. "Sounded like, incoming something. I was looking up. I was trying to figure out where this was. I saw it about 15 to 20 feet above the ground."

The Department of Environmental Protection has halted blasting at the quarry and cited the company after the incident. An investigation is under way.

"They think they hit a pocket of methane gas and it gave it a higher boot," Ross said.

No injuries were reported.

Ross said the quarry company said they will pay for the repairs to his home.

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[94] https://www.wpxi.com/news/quarry-blast-sends-82-lb-rock-into-buffalo-twp-hom/289213871/.

Flyrock 59

On September 22, 2010, blasting at an undisclosed location caused flyrock to be propelled 550 metres, penetrating the roof of a Quality Control Lab, and nearly striking two workers.[95]

> *On September 22nd 2010, at 17hr 10minute an incident occurred at working place of Quality Control lab-Cement testing room near the dam site. The boulder formed at the blasting site of power intake of concrete face rock fill dam (CFRD) which was at a distance of 200m towards north from the face of dam. The size of the boulder was biotite-gniess rock type with dimensions of 3m, 1.5m and 1.6m in respect of length, breadth and height (Figure 3). For the secondary blasting, the boulder was drilled with two holes of 45mm diameter with a spacing of 0.6m and depth of 1.5m. The explosive cartridge of 40mm (390gm/cart.) and 300mm length were used with a detonating cord of 10g/m. After the charging of 1560gm explosive per single hole 0.3m was left for stemming. When the blasting occurred a huge sound was heard and two flyrocks ejected from the boulder which covered a distance of 550m from the blasting site to the Quality control laboratory (Figure 5). Two persons were working in that testing laboratory where the two flyrocks punctured in the iron sheet roof as well as the underneath card board. Fortunately the two fly rocks fell 3m apart from the working personnel in that quality control laboratory.*

Flyrock 60

On May 25, 2018, a local paper reported an explosion at a Rhode Island quarry that caused flyrock to damage nearby buildings and injure two people in a town-owned pickup truck parked on a nearby road.[96]

> *A planned explosion at a quarry in a Rhode Island town sent granite flying into a nearby truck, injuring two town employees.*
>
> *Authorities say one of the employees of Westerly's Public Works Department suffered head trauma and was kept at the hospital overnight after the blast Wednesday. The other employee was treated and released that day.*
>
> *Interim Town Manager Mark Rooney says the workers had stopped alongside a road near the blast site to make a phone call when they were hit by flying debris. He says there was some kind of safety failure, but investigators have yet to determine exactly what happened.*
>
> *A state police bomb squad is assisting in the investigation.*

Flyrock 61

On May 5, 2007, blasting at the Kamenica quarry in central Serbia resulted in a massive flyrock incident with flyrock fragments spread over an area of 650 metres.[97] The structural and environmental damage caused by the flyrock incident, (Figure 8 p. 1090), impacted (a) family house, (b) saw mill, (c) fragment crater, (d) family house, (e) family house, (f) tavern, (g) fish pond, and (h) primary school.

> *The inspection revealed that flyrock fragments had sizes varying from 3-50 cm and more in diameter and that, on average, there was one fragment per 16m^2 (Fig. 7).*

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[95] A. K. Mishra and M. Rout, ""Flyrocks – Detection and Mitigation at Construction Site in Blasting Operation," *World Environment*, 2011; 1(1): 1-5, http://article.sapub.org/10.5923.j.env.20110101.01.html.

[96] Associated Press, https://apnews.com/article/ed9fa4e1046340c9b6937676d6501ec9 and Westerly Sur, https://www.newportri.com/article/20180620/NEWS/180629992.

[97] Sasa Stojadinovic, Radoje Pantovic and Miodrag Zikic, "Prediction of flyrock trajectories for forensic applications using ballistic flight equations," *International Journal of Rock Mechanics & Mining Sciences* 48 (2011): 1086-1094, http://tarjomefa.com/wp-content/uploads/2016/05/4694-English.pdf.

The most severely damaged structure was a two storey family house with several flyrock fragments penetrating through the roof and walls (Fig. 8 position d and Fig. 9).

In the case of the 50 cm fragments, the fact was that fragments did not fall at distances of larger than 320 m. The majority of the 5 cm fragments fell at distances below 300 m but it was not possible to claim with certainty that this was their maximum throw.…It must be mentioned that estimation of the velocities for the fragments between 5 and 50 cm was not supported by any calculations. The reason for that was the fact that it was impossible to inspect the whole area affected by flyrock to determine the maximum throw for each fragment size…[p. 1091].

…[T]he maximum throw of flyrock fragments…was 650 m for the 20 and 25 cm fragments. This corresponds to the statements of some eye witnesses that flyrock fragments were falling into a nearby fish pond at the distance of more than 500 m [p.1093].

The forensic investigation of the flyrock incident **"led to the conclusion that it was necessary to set the safe distance for residents at distance [greater] than 700 m."**

Flyrock 62

On August 22, 2018, a blast at Camara's quarry in Castleton, Vermont showered a number of nearby homes with flyrock.[98]

Federal mining officials are investigating a loud blast at Camara's slate quarry that sent pieces of rock flying onto the front yards of homes on nearby Blissville Road. Some residents of Blissville Road felt the effects of the blast on Aug. 22, but no one was hurt, according to Bruce Sherwin, assistant Castleton police chief. Debris landed on lawns on Blissville Road, he said. Last week a single of piece slate, about 2 inches long, was still lying near the front door of Cecilia Rodriguez's home, where it landed after the blast. Rodriguez and other residents said they felt and heard the blast at a quarry off Rice Willis Road just before 1 p.m. on Aug. 22. Some fragments also apparently landed on the lawn of Jon Pintelo next door to Rodriguez. Both properties are on the western boundary of the quarry. Lawrence and Jane Nicklaw, who live on Blissville Road next to the quarry, said the blast was bigger than usual. "It felt like the whole house jumped," Lawrence Nicklaw said. "Everything was rattling, my wife was outside screaming. One of the slate fragments landed not far from where their son, Robert, had been picking cherry tomatoes in the backyard. A larger piece landed along the side of their home," Nicklaw said. "It hit the ground and shattered," he said. "Afterward, a blasting company employee rushed to a property next to the Nicklaw's, picked up fragments and threw them into the high grass," Nicklaw said. The Nicklaws heard the warning whistle before the blast, but expected only the normal explosion at the quarry. But this blast was big enough to increase the cracking in his Sheetrock ceiling, he said. Explosives are used to gain access to slate deposits. In this case, the blast was fired to remove cover material. "It was a bigger shot than normal," said David Camara Sr., one of the owners of Camara Slate Products Inc. "I know there was some fly rock." A federal inspector who investigated the incident found no damage to residents' homes, according to Jim Petrie, district manager for the Mining Safety and Health Administration in Warrendale, Pa. Petrie said he didn't know if proper blasting procedures were followed because he had not received the inspector's report.

Sometimes you can have a well-designed blast and due to weakness in the strata, fissures or voids it may send (fragments) off the quarry you don't expect to go. Reports of flying rock incidents at stone quarries are a fairly common occurrence, according to Petrie. There have been cases of debris causing injury, he said.

Dyno Nobel Inc. of Symsbury, Conn., was hired to set off the blast in order to remove earth and rock that was covering the usable slate, Camara said. A warning horn or whistle was apparently sounded before the blast, Camara said. Neighbor Fran Chester said she didn't hear any alarm, but the blast was loud enough to rumble through her house and frighten her. "I thought it was thunder

[98] Tom Mitchell, Rutland Herald, https://www.rutlandherald.com/news/quarry-blast-sends-slate-pieces-into-nearby-yards/article_258669ca-9aa6-566b-9ca3-e21dab8328d1.html.

or an earthquake," she said. "It would be nice if they notify us." Cecilia Rodriguez agreed. "What if a piece [of flyrock] lands on a kid's head?" she said. "They should be more careful.

Flyrock 63

On July 30, 2018, blasting for a road extension in Hendersonville sent rocks the size of softballs flying into a nearby residential pool and driveway.[99]

State and city officials say they are investigating a blasting incident that sent softball-sized stones into a residential pool and driveway in the Wynbrooke subdivision on Monday. No injuries were reported.

According to Hendersonville Fire Chief Scotty Bush, employees of Charles Deweese Construction, Inc., were cutting a road on the back side of Pilot Knob, connecting to Crooked Creek Lane when fly rock went into a home's pool. The home's owner also reported a cracked window caused by the vibration of the blast, Bush said….

"As part of this process, the blasting firm must now submit a Plan of Corrective Action to the Tennessee State Fire Marshal's Office," added Walters. The plan would include the reasons for the incident and the changes that will be made to ensure another fly rock incident doesn't occur, he said….

"More information must be gathered and a report about the incident must be completed," he said. "When that's finished, this matter will work its way through our complaint process where a recommendation by our legal team will be made about additional steps."

Bush said he plans to meet with Mayor Jamie Clary and the City Attorney John Bradley to see what the city's legal options are as well.

Flyrock 64

On February 4, 2009, a blast at the Lyttelton Dolomite Quarry in South Africa hurled rocks, some the size of car tires, which ripped through a shopping centre, office complex and service station, injuring three people, one of them critically. Hundreds of rocks were showered over a large debris field also impacting motorists and a cyclist.[100]

What was meant to have been a routine detonation at the open cast Lyttelton Dolomite Quarry in Botha Avenue on Wednesday left shoppers, motorists and business people running for cover as rocks, some as big as car tyres, rained down on the Doringkloof shopping centre, the Soetdoring business park, a nearby Engen petrol station and cars.

As police closed off roads littered with large chunks of rocks, paramedics and emergency workers raced to treat the injured.

Among the injured was a delivery man who was hit in the chest while cycling past the centre. The rock, which left him critically injured, is believed to have been the size of a soccer ball.

Among the injured was gardener David Malete, whose leg was broken when he was hit by a rock while watering the business park's garden.

For Martha Chauke, a passing car saved her life. The rock which hit her in the arm and back was deflected as the car drove past her.

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[99] Tena Lee, "Blasting Sends Rocks Flying," Hendersonville Standard, August 2, 2018, https://www.hendersonvillestandard.com/news/blasting-sends-rocks-flying/article_fe3f700c-96bf-11e8-af8c-8736054753e5.html.

[100] Graeme Hosken, "Quarry blast wreaks havoc," February 5, 2009, https://www.iol.co.za/news/south-africa/quarry-blast-wreaks-havoc-433434.

As people emerged from their shelter, word quickly spread of extensive damage to nearby buildings and cars. One of the severely damaged cars belonged to undercover police officers who were conducting investigations at the centre. The rock which struck it could be seen lying on the vehicle's floor after it had ripped a huge hole through the back door.

The rock had just missed Malouna Rademeyer's head as she stepped out of her car which she had just parked. "As I got out of my car I heard a 'whoosh' and then a massive bang. I dropped to the ground and began screaming," said Rademeyer. Hundreds of rocks landed around her.

Realising the danger she was in when a rock the size of a soccer ball hit another car, Rademeyer ran for cover. "I was petrified. I did not know what was happening. All I knew was that I had to get to safety," she said.

Rademeyer said some people slipped and fell as they tried to run for shelter.

Businessman Lieb Liebenberg was having a meeting with his daughter, Susan Dry, and a client when the blast occurred. "Everything shook. I thought something terrible had happened. I grabbed Susan and pushed her underneath the table," he said.

As he ran to the mall entrance to see what had happened he was greeted by a wall of dust, stones and rocks hurtling towards him. "I just turned and ran as fast as I could. I didn't have time to think. I did not know what had happened. All I knew was that we were in danger," he said, describing how people caught outside ran as fast as they could to safety.

He said it was absolute chaos.

"Nobody knew what had happened. People were crying and screaming. I saw a man lying on the ground covered in blood. It was a nightmare," he said.

Businessman Gerhardt Meyer, who was walking into Soetdoring business park, said the explosion sounded like a bomb blast. "Everything shook. The blast nearly threw me to the ground."

Running into the street he saw a motorist swerving across the road as his car was hit by rocks. "One of the rocks went straight through the windscreen. I thought the guy was dead, but it missed him by inches. He stopped and got out and ran. It went straight through the back of his car.

"It was a miracle he was not killed," he said.

For business colleagues - Elsa Heyneke, Martie Erasmus and Susan Malan - the sound and sight of rocks hurtling through the roof and windows of their office was terrifying.

Erasmus had just stood up to make coffee, when a rock crashed through the roof and landed in the chair where she was sitting minutes before. "It missed me by inches. I heard this massive bang and then there was dust, glass and pieces of roof falling around me.

"I just screamed," she said.

Tshwane Emergency Services spokesperson, Johan Pieterse, said three people were injured by flying debris from the blast.

"One of the injured was critically hurt when he was hit in the chest by a rock while riding a bicycle. Two pedestrians sustained minor injuries, including lacerations and broken bones," he said….

Police spokesperson, Captain Colette Weilbach, said an investigation was under way to determine what had gone wrong during the blast. "The case being investigated will fall under the Explosives Act," she said.

Quarry spokesperson, James Duncan, said the mine along with the Minerals and Energy Department would be conducting a joint investigation.

"At this stage it is not known what could have caused broken rock from the blast in the open pit to fly over the mine's protective wall," he said.

Duncan said mining activities had been suspended.

Flyrock 65

On June 29, 1999, a blast at the Imperial Quarry in Nazareth Township sent rocks over a 200-foot (61 metres) quarry wall and into a residential neighbourhood 1,500 feet (457 metres) away.[101]

> *…[T]here was a second mishap that sent rocks over a 200-foot [61 metres] quarry wall and 1,500 feet [457 metres] into the same neighborhood. No one was injured, but both incidents violated state mining regulations and alarmed residents.*
>
> *"This one surprised everyone. It was a serious blowout," said Gordon F. Revey, a blasting engineer Essroc hired to investigate the cause of both explosions. "It's just astounding to me, because no one did anything grossly wrong."…*
>
> *Essroc's manager of Pennsylvania operations, Mario Bracci, said his initial reaction after the June 29 incident was to terminate the contract with Essroc's blasting contractor, Mauer & Scott of Northampton.*
>
> *However, he said Revey's investigation showed Mauer & Scott, which has conducted more than 500 successful shots over the last five years for Essroc, followed standard blasting procedures….*

In March, 1999, there was a previous flyrock incident at the same quarry, which hurled boulders 700 feet (213 metres) onto two homes and two cars in the same neighbourhood.

Flyrock 66

In April, 2008, a blast at a Morrisville mine in Vermont hurled flyrock a distance of about 700 feet, with 25 rocks found scattered from Pine Crest Trailer Park to the Morrisville town garage.[102]

> *A negligent blast at a Morrisville mine hurled rocks almost 700 feet through the air, and could have caused serious injury or death.*
>
> *That is the finding of the U.S. Mine Safety and Health Administration, after investigating an incident in April on Cochran Road in Morrisville….*
>
> *In his report, federal inspector Zane Burke said 25 rocks from the mine blast were found scattered from Pine Crest Trailer Park to the Morrisville town garage; some had been flung almost 700 feet.*
>
> *The rocks "were measured to be 4 to 11 inches long," Burke said, and were found on the lawns of several mobile homes, in front of parked vehicles there, and even on top of the town garage roof, hundreds of feet away….*
>
> *Mitchell Green, vice president of Maine Drilling and Blasting, said in an interview that the errant blast was an "anomaly" and the result of "unforeseen" circumstances.*
>
> *"On the day of the incident, we had designed a blast that was very appropriate. We did not feel that mats were called for in this case," he said. "We had established that it was safe."*
>
> *Green said the blast was designed to shoot rock into a large open face in the quarry, but because of unseen vertical "seams," or cracks in the rock, the rocks didn't shoot forward into the rock face as expected, but up into the air.*

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[101] Tracy Jordan, "June 29 Mishap Caused When Explosives Were Set In a Joint Through The Limestone, Officials Say," The Morning Call, https://www.mcall.com/news/mc-xpm-1999-09-09-3260561-story.html.

[102] Jesse Roman, "Blast hurled rocks almost 700 feet," VTCNG, June 12, 2008, https://www.vtcng.com/stowereporter/archives/blast-hurled-rocks-almost-700-feet/article_9c3f1729-96a8-5398-95a5-c5ca9f1610a4.html.

Green said Maine Blasting employees were stationed at the entrance of the mine, on Cochran Road in front of the trailer park, and at the town highway garage, and traffic on the road had been stopped.

"The fact that our people were standing right in front of the park, securing the area, supports the conclusion that the design we put together was safe," Green said….

"We never mat it; we've never been required to mat it," he said. "If we were blasting right next to a car or house, you would, but we're 450 feet away from the nearest trailer. That's a long way."

Burke reported finding rocks as far away as the entrance to the town salt shed, 764 feet from the mine. He said that he found rocks on the front lawns of several mobile homes, and a rock that went 24 feet past one trailer and landed in its back yard.

Burke reported finding rocks as far away as the entrance to the town salt shed, 764 feet from the mine. He said that he found rocks on the front lawns of several mobile homes, and a rock that went 24 feet past one trailer and landed in its back yard….

Kay Shedd said she was sitting in her mobile home at Pine Crest Trailer Park in Morrisville that late April day when "an awful bang" shook her entire house.

Milliseconds later, she said, she heard another bang; a rock hit the side of her mobile home with such force that two pictures came crashing down off the wall.

"What if a car was driving by, or a kid was riding a bicycle or walking by? What then?" Shedd asked. "I don't think this is good, not at all. This is dangerous and it isn't anything we should have to live with."…

"I'm not so much worried about damage to the house as I am to humans. There are kids walking up and down the street. One of these times, if they keep it up, somebody is going to get hurt," McFarlane said in an interview after the blast.

He said the problems started last year when a stone "a little smaller than a grapefruit" flew over from a blast, and hit McFarlane's companion in the left side, sending her to the hospital,"…

Asked about blasting damage in the past, Percy said 'There was damage in the past to someone's car, but that's why (I have) insurance," Burke wrote.

Burke said Percy told him no damage was reported in the trailer park, but "I informed him (that) I searched the park and found damage to one trailer. He said, 'Ah (expletive),'" Burke wrote….

Flyrock 67

On October 1, 2020, blasting at a construction site in Franklin, Tennessee, launched large rocks into nearby homes and yards of Lockwood Glen Neighborhood.[103]

A *Franklin neighborhood is safe after large rocks falling from the sky, crashed through homes and into yards in the Lockwood Glen Neighborhood.*

"This is unbelievable. Like how does something like this happen?" thought homeowner Stanley Berry after seeing his guest bedroom with a massive hole in the roof and ceiling.

Berry says the blast happened just before noon Thursday as he was downstairs. He thought the sheetrock falling just from the seismic activity but then saw the large rock, split into three pieces across the room.

[103] Ryan Breslin, "Large Rocks From Franklin Construction Site crash Through Homes, 'It Absolutely Would Have Killed Someone,'" NEWS4Nashville, October 2, 2020, https://www.wsmv.com/news/large-rocks-from-franklin-construction-site-crash-through-homes-it-absolutely-would-have-killed-someone/article_03add48c-051a-11eb-88f6-fff8314e4b28.html?utm_medium=social&utm_source=email&utm_campaign=user-share.

"It was a sheer disbelief. It was a thought of how a company could be so negligent that they would put the residents of this community at risk," says Berry.

He describes his development as very active, with kids outside playing and people walking their dogs. So he knows everyone in the area is lucky the rocks fell in the spots they did. "It absolutely would have killed someone and you know the bigger piece of this too is not only the damage to these homes, because the homes can be fixed, [it's] that it seems like there's a disregard for the lives they put at risk."

Berry says after the rock hit the Lockwood Glen Neighborhood, "original conversations were that, you know, there was negligence in regard to where they placed the blast mat."

Then he reached out to the Department of Commerce and Insurance and the State Fire Marshal's office, who were able to confirm "they did not use blast mats on the shot."

"How do you not put a blast mat down when you detonate a charge? If they've had that kind of negligence, what reassurances can you give us that the other work that they've done back here is not going to end up leaving us impacted in the future?" says Berry.

Not only does he want to see more concern and remorse, he'd like to see a better answer for how his home will be fixed.

"They told me that they were going to make it whole, they said that they were going to come in and do the work, we're going to make sure that you are satisfied, and we're going to make sure like it never happened. And then conversations that I had with the same people this morning gave me the clear understanding that that is not what's going to happen." Berry continues,

"Their intent is to come in a repair the segments that were damaged right, which you would think is reasonable, however at the end of the day, if they only do that it's going to leave a clear mark that the damage occurred, devaluing my property, devaluing my home and not leaving me satisfied."

As someone that just moved into the home two weeks ago and is still unpacking, he wants the investment he just made with his family to be exactly what they bought.

"I would like…the house to be repaired as though this never happened. I don't want it to be a quick fix situation where they send in these restoration companies where they try to come by and say that they'll be here on Monday to make the repairs and left in the situation where I have a constant reminder when I look up in my roof what happened."

Flyrock 68

On May 27, 2020, a blast from a quarry near Senthamangalam, India, hurled portions of a boulder that struck and killed a 10-year old girl, and injured her brother.[104]

A 10-year old girl died after a portion of boulder from a stone quarry hit her on [the] head while the quarry operators were blasting a rock with dynamite sticks near Senthamangalam…

The Senthamangalam police identified the deceased as M. Nandhini, daughter of Murthy, 38, of Vaiyappamalai. She was a Class V student of a government school at Paramathi-Velur in Namakkal district.

Pointing out that the girl was staying in a hostel, a police officer said, the quarry operators blasted a rock using dynamite sticks. "Stone pieces flew in the air and hit Nandhini, who was playing outside the house, on her head. She succumbed to her head injuries on the spot. Her brother Soundarrajan was also hit by a stone, fracturing his hand," the officer said.

[104] "Girl dies as boulder from stone quarry hits her on head," TNN, May 29, 2020, https://timesofindia.indiatimes.com/city/salem/tn-hiv-positive-patients-in-namakkal-district-receive-groceries-for-free/articleshow/76046185.cms.

Flyrock 69

On November 17, 2011, blasting at a quarry in Tremont, launched flyrock that damaged three nearby homes.[105]

> *The regulation of blasting should be a top priority for the town, planning board members agreed Tuesday.*
>
> *The issue was put on the front burner by a Nov. 17 blasting mishap at a quarry on Clydesdale Lane owned by John Goodwin Jr. Construction. Rocks thrown by the explosion damaged three nearby homes.*
>
> *At a Nov. 21 meeting, selectmen directed town manager Millard Billings to discuss the possibility of an ordinance regulating the use of explosives. Mr. Billings got straight to the point when presenting the selectmen's directive to the planning board.*
>
> *"There was blasting and something went wrong," he said, while giving details on the damage.*
>
> *Mr. Billings provided planning board members with photos of the damage from rocks – some as large as 12 inches in diameter – thrown from the blast onto properties owned by Tim Rich and Jerry Harper. Mr. Rich was in his bedroom when a large rock crashed through the roof, Mr. Billings said. A third home also was damaged.*
>
> *"All the damage was property damage," Mr. Billings said. "Luckily, no one was killed."*

Flyrock 70

On February 8, 1999, blasting at a quarry in Kyusyu, Japan, caused rocks to fly nearly 300 metres, striking a company car, a factory employee and a roof of a house.[106]

> *…[u]sing DS detonators and #3 Kiri dynamite (31.5kg), some rocks flew nearly 300m away…This incident at the quarry brought about the following damages. (Fig. 5)*
>
> - *Human damage:*
>
> *A piece of rock cracked through the front glass of a car and then it hit and rebounded upon a driver's door and fell on the right thigh of an employee under operating the car. The degree of injury…was a thigh contusion…*
>
> - *Physical damage:*
>
> *The front glass and the inner globe of driver's door suffered the damage by a piece of rock. And another piece of rock damaged also to a roof on the factory building. An opening (nearly 4cm) with crazing arose on the slate roof.*

Note: The paper also describes two other flyrock incidents at two other nearby quarries.

Flyrock 71

On September 25, 2017, blasting in connection with the construction of Emera's Maritime Link project resulted in flying debris damaging homes in Cape Ray located between 250 and 300 metres away.[107]

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[105] Mark Good, "Blast damage sparks Regulation," The Ellsworth American, December 1, 2011, https://www.ellsworthamerican.com/maine-news/blast-damage-sparks-regulation/.

[106] K. Noguchi, "Fly-rock incidents by blasting at three quarries," *Sci. Tech. Energetic Materials,* Vol. 65, No. 6, 2004: 206-214, http://www.jes.or.jp/mag_eng/stem/Vol.65/documents/Vol.65,No.6,p.206-214.pdf.

[107] Chantelle MacIsaac, "Emera blasting damages homes in Cape Ray," Sept. 30, 2017, https://www.saltwire.com/news/local/emera-blasting-damages-homes-in-cape-ray-47877/?location=west-coast.

Jeff Myrick, the company's senior manager of communications and public affairs, said the blast, which is part of routine work on the road leading to the transmission compound station, saw debris damage homes located between 250-300 metres away….

Several homeowners in Cape Ray reported damage from a blast. No injuries were reported.

Flyrock 72

On March 19, 2013, blasting at the M & M Stone Harleyville Materials Quarry sent flyrock across Groff Mill Road.

Pieces of rock, some very large, were thrown across Groff Mill Road….The Department of Environmental Protection has ordered the company to develop a plan by March 29th that will ensure safety.[108]

"The investigation revealed that a rock(s) were ejected upwards and outwards from the body of the shot which traveled approx. 381 feet [116 metres] to the resting place," a Pennsylvania Department of Environmental Protection Explosives Inspection Report on the incident notes.

'At least one was the size of a basketball,' Mary West, assistant township manager, told the Lower Salford Township Board of Supervisors…Township police officers stopped traffic on the road during the blasting, although they had not received a request to do so, West said.

Blasting will not be allowed to resume until the quarry submits a corrective action plan 'stating how they will ensure that debris is not ejected into the air for future blasting,' and the DEP approves that plan, according to the DEP's Explosives Compliance Order….

The first notification to DEP was about the level of the blast, but claimed there had been no flyrock. A bit later, the blaster called again and reported that flyrock had left the permitted area,' Fries wrote in an email. The noise level from the blast was registered at 135 decibels, two more than the 133 allowed level, the DEP said….

A Lower Salford officer who lives near the quarry witnessed the blast, Fries said. There is also a video tape of the blast, she said….The DEP put the blast time at 2:51 p.m. Within minutes of that time, a school bus passes down Groff Mill Road, West said.

'We never, ever, ever got a call here that stone left the quarry in the past, but information on what the complaints were about or enforcement actions taken was not immediately available.'[109]

Flyrock 73

On April 10, 2009, flyrock was launched from a quarry blast, and struck and penetrated the roof of a residence at a distance of 600 to 700 yards, as reported in *Lakeview Rock Products v. Secretary of Labor Mine Safety and Health Administration* (MSHA),[110]

As noted at the hearing investigating the flyrock incident, in reference to the list of factors to be considered in defining the *blast area*, the judge made the following observations:

"[T]he area in which concussion (shock wave), flying material, or gases from an explosion may cause injury to persons. 30 C.F.R. § 56.2 Definitions. The definition continues with the following guidance: "In determining the blast area, the following factors shall be considered: (1) Geology or

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[108] "Quarry in Harleysville Ordered to Stop Blasting," WNPV, March 25, 2013.

[109] Bob Keeler, "Harleysville quarry ordered to stop blasting after stones thrown into road," The Reporter, Mar 24, 2013 Updated Nov 14, 2018, https://www.thereporteronline.com/news/harleysville-quarry-ordered-to-stop-blasting-after-stones-thrown-into-road/article_db72eb6a-741e-5383-bcca-cf0ed4e22f4a.html#:~:text=The%20M%20%26%20M%20Stone%2FHarleysville,the%20shot%20which%20traveled%20approx.

[110] file:///C:/Users/Windows%207%20PC/Documents/FMSHRC%20ALJ%20Decision.html.

material to be blasted. (2) Blast pattern. (3) Burden, depth, diameter, and angle of the holes. (4) Blasting experience of the mine. (5) Delay system, powder factor, and pounds per delay. (6) Type and amount of explosive material. (7) Type and amount of stemming. 30 C.F.R. § 56.2.

The definition of "blast area" can be sharpened to focus on the issue presented here: the flyrock. Using that approach, the applicable portion of that definition is "the area in which flying material from an explosion may cause injury to persons." While it is indisputable, under the plain text of the guidance, that the enumerated factors are to be considered, the list does not purport to exclude other relevant factors in determining the blast area. Thus the list, while helpful, does not represent an exclusive list of the factors that are to be considered when conducting the ultra-hazardous activity of blasting. Restated, one must not lose sight of the fact that the definition of "blast area" cannot be overtaken simply by a list of factors that are to be considered.

The circumstances surrounding the flyrock incident are described as follows:

…On April 10, 2009, at about 2:45 p.m., Lakeview "conducted a blast in an area high up on the east end of the mine's highwall." Sec. Br. at 3. That blast produced flyrock which penetrated the roof of a nearby residential home which was located off the mine site. The flyrock then proceeded to travel through the home's attic and ended up in the home's living room. That home, a new residence, some 600 to 700 yards away from the detonation site, was situated above the mine's highwall.

> A matter of good luck, although the homeowners' three children were home at the time of the blast event, as was their mother, no one was injured. To be precise, and as noted in the citation itself, the flyrock minimally penetrated the living room's ceiling, "coming to rest just beneath [the] gypsum wall board lining the inner ceiling of…the living room." The homeowner testified that some small particles reached the living room floor…The fact the flyrock pierced the roof is ample evidence of the seriousness of the event.

The Secretary contends that, to comply with the standard, there must be ample warning given to those within the "blast area."…She looks to the definition of that term, "blast area," which, as previously noted, is a defined term, and concisely expressed as "the area in which concussion (shock wave), flying material, or gases from an explosion may cause injury to persons." The Secretary emphasizes that in this instance there is no need to speculate whether the flyrock could have caused an injury, since the rock not only reached the residence but pierced the structure itself. As damage actually happened here, the facts go beyond the situation where such material may cause injury, progressing to the point where it did cause damage to a residential home, and therefore the Secretary contends that the home was indisputably within the blast area.…

In holding those conducting blasting accountable, courts frequently invoke the principle of res ipsa loquitur [the principle that the occurrence of an accident implies negligence]. These principles have been long standing. For example, in Rote v. Bellefonte Furnace Company, 37 Pa. C.C. 315, 1906 WL 2951 (Pa. Comm. Pl.) (1906), homeowners close to a quarry had their dwellings hit by rocks produced by blasting. The mine failed to give notice of its blasting to the homeowners. As with Lakeview, the mine contended that it had "conducted [itself] along the safest and most careful lines known to the business."…However, the Court observed that "[s]uch blasting without ample warning is always dangerous, and might be fatal," and it concluded that liability attached regardless of whether any negligence was involved.…Similarly, in Allegheny Coke Co. v. Massey, 174 S.W. 499, 163 Ky. 792, (March 26, 1915), the Pike County Circuit Court held that where blasting cast a rock upon one's dwelling, the mine contractor was liable, regardless of negligence. There, ample warning was given before the blast and the family ran into their home. Unfortunately a rock went through a window, blinding a child in one eye. The point is that, where the activity is blasting, liability was found to be absolute. The Court observed, "it makes no difference whether precautions are used or not to prevent the injury…the act itself is a nuisance."…

Thus, the cases involving blasting examine only whether harm resulted and hold those conducting that activity strictly liable. Accordingly, in cases such as Garland Coal & Mining Company v. Few, 267 F.2d 785 (10th Cir. 1959), an action by a landowner for damages from the adjacent mine's blasting activity was upheld on a strict liability basis and that strict liability extended to more than flyrock, as it included damages from concussion and vibration. This has been the longstanding

result in American jurisdictions where blasting operations produce harm; there is no duty to establish evidence of a breach of a standard of care to establish liability for harm from such activities. Smith v. Yoho, 324 P.2d 531, 533 (Okla. 1957), Ward v. H. B. Zachry Const. Co., 570 F.2d 892, 895-96 (10th Cir. 1978). Thus, ***it seems an anomaly that, in the context of the remedial statute that the Mine Act is, liability for harm associated with blasting activity would be more burdensome to establish than in a common law proceeding. Obviously, adopting such a view would require a revisiting of the Hobet standard. However, if a strict liability approach were to be applied in instances such as Hobet and Western Mobile, mine operators would likely react with a more stringent approach in terms of these blast warning standards and situations such as the significant injuries in those cases would likely be reduced. So too, homes, such as the residence in this case, would be less likely to be assaulted by flyrock from blasting****.* [emphasis added]

For its part, Lakeview contends that, at the time of the blast, it had no reasonable basis on which to extend the blast area to include the home, even though it acknowledges that the flyrock penetrated the structure's roof, proceeded through the attic and ended up in the family's living room. Lakeview relies upon the recounting of its blaster, who stated that the blast in issue was "nearly identical to prior blasts in the same area" and consequently it contends "that [the blaster, Robert Hylemon] acted reasonably and prudently with the 'blast at issue.'"…Accordingly, Lakeview asserts that, as the blast in question was only ten feet away from the previous blast and nearly identical to that earlier blast, it would be unreasonable to hold the mine liable under the cited standard and to expand the blast area simply because of the flyrock result here….Thus, ultimately, it is Contestant's position that the Citation should be vacated on the basis that the Secretary failed to meet her burden of proof….

In its Reply, the Secretary contends that Lakeview has missed the central point that its failure was not correctly determining the actual blast area….Thus, Lakeview's notifying those within the blast zone it identified means nothing if it incorrectly identified the zone itself. Instead, the Secretary contends that the appropriateness of a blast zone is a blast-by-blast test, employed by an experienced mine blaster. In responding to Lakeview's claim that the blast was "not unusual" from the other blasts it had detonated, the Secretary disputes that characterization, arguing that the location of the blast was certainly unusual due to its being located in the upper northeast corner of the highwall and so close to the recently built residences. The Secretary points out that even Lakeview's Hylemon acknowledged that proximity to residences is a factor a blaster must consider. Yet Hylemon, the one who needed to know such information, did not even know of the existence of the nearby housing. A prudent blaster, the Secretary submits, should have examined the top of the highwall and thereby become informed as to what was above the spot where the blast was detonated. Without taking that action, Lakeview cannot claim that it made a proper assessment of the location of the blast….

Lakeview Rock's blaster, was asked about his consideration of the nearby residences and he admitted that not only did he not consider the nearby homes, he did not even know of their presence, let alone their proximity. Thus, when the blaster was asked if he had calculated how nearby any residence was to where he was blasting and if he knew that a house had recently been built at that the location where the flyrock landed, he responded that he did not…. Nor did he go to the top of the pit where he was blasting and look around to see if anything new was up in that area….The blaster also acknowledged the authoritativeness of the reference book, "Explosives and Rock Blasting," though he was only "vaguely" familiar with it….Importantly, the blaster agreed that "proximity to residences" is something a blaster should consider when planning a blast…

It is worth remembering that this case is not in the realm of speculation. Thus, there is no argument disputing that the blast occurred, that flying material left the mine site, that it landed on the house with sufficient force to penetrate the residence's roof, not coming to rest until it reached the family's living room….The Secretary therefore contends, and the Court agrees, those undisputed facts demonstrate that the home was within the blast area.

… Hylemon not only failed to calculate and therefore consider the proximity of the residences to the blast site, he did not even know the homes were there. Had he examined the area above the top of

the highwall, as he should have, he would have discovered the home sites. Further, while Hylemon asserted, in effect, that this was a one of a kind event and therefore, implicitly, unpredictable, the Secretary, as previously noted, observes that even after the event, Hylemon had no idea that flyrock had hit a residence until mine management so informed him the following day. Therefore, his testimony that this event was unique is unsupported. Given these undisputed circumstances, the Court agrees that Lakeview's failures constituted at least moderate negligence…

Despite the quarry operator being found guilty of "moderate" negligence under the Mine Act, the flyrock incident had the potential of injuring or killing the occupants (including three children) of the residence, for which the quarry operator was fined a nominal sum of $1,000! The financial penalties for the same flyrock incident in a common law proceeding (not governed by a remedial statute) would have been substantially higher, as blasting is deemed an ultrahazardous activity held to a strict liability standard.

Flyrock 74

On July 16, 2007, flyrock debris from a blast at the Three Mile Mine in Pike County, Kentucky, struck and killed Bobby Messer, a mechanic standing 1,586 feet (483 metres) from the blast, and flyrock debris damaged his truck.[111]

…[O]n July 16, 2007, Bobby Messer, a 40-year old mechanic received fatal injuries when he was struck by fly rock from a production blast….The fly rock that struck the victim travelled approximately…[1,586] feet, into an area where miners parked their vehicles and mine equipment between shifts. The fly rock passed over a 50 foot embankment prior to reaching the accident site (Appendix II). Although several pieces of fly rock were found at the accident site, the size of the rock that struck the victim could not be determined….

Other pieces of fly rock, including one approximately 16 inches x 20 inches (see measured from an imprint in ground) hit within a few feet of where the men were standing. The rock appeared to have broken on impact with the ground, with smaller pieces bouncing in a fan like direction. Fly rock also struck the adjacent mechanic's truck resulting in several areas of damage….

The fly rock at this mine was a high angle, blow-out type of fly rock due to the terrain between the blast site and the impact area(s) and the impacted fly rocks continuing path after impacting the ground.

Flyrock 75

On November 5, 2001, a blast at the Manitou Sand and Gravel pit showered large rocks 4 inches to 20 inches ("a good 15 to 20 pounds") upon the residents in the neighbourhood south of the pit. A prior blast on September 17, 2001 also resulted in flyrock.[112]

On November 5, Dolomite, leasor of the Manitou Sand and Gravel pit, conducted a blast to open a new lift (or level) in the quarry floor. That blast, as well as earlier blast on September 17, resulted in flyrock. According to Shirley Zicafoose, "Large rocks were rained upon residents to the south of the pit. Rocks as large as 30 pounds were blasted out of the pit onto adjacent property." Upset by this occurrence, Zicafoose called the police, contacted Ogden Supervisor Gay Lenhard and wrote a letter to Suburban News.

The police report substantiated Zicafoose's concern and stated that the 'Rocks ranged in size from 4 inches in diameter to 20 inches in diameter (a good 15-20 pounds). It also stated that, "Any of the

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[111] MSHA Flyrock Investigation, https://arlweb.msha.gov/FATALS/2007/ftl07c09.pdf.

[112] "Flyrock from Ogden mining site causes neighborhood concerns," https://westsidenewsny.com/pastarchives/OldSite/westside/news/2001/1217/features/flyrock.html.

rocks certainly could have caused injury or death to anyone that could have been hit while in the yard. Structures and cars are also subject to damage."…

John L. Swierkos, Jr., geologist and environmental coordinator at Dolomite, responded to the DEC [NYS Department of Environmental Conservation] in a letter saying, "It's not our intention to have an incident such as this to ever occur. This was an initial development blast rather than a normal production blast." He said, "Upon inspection we did find flyrock. No matter what kind of blast we are doing, this is unacceptable."…

Flyrock 14 (updated)

On April 11, 2011, blasting at the Cookeville Limestone Quarry hurled debris and an 86-pound boulder that crashed through the roof of the Hudgens' residence at 1250 Skyline Drive, 407 feet (124 metres) away.[113]

…[On] April 11, 2011, a blast was needed at the top of a highwall to clear cap stone and create a ramp that would make the area accessible to heavier equipment….In creating the blast design, it is necessary for the blaster-in-charge to consider the minimum distance to any nearby structure that people inhabit, such as a home or a school, and makes [sic] adjustments in the amount of explosives to ensure that flyrock does not reach the structure….In the present case, the blaster-in-charge identified the home of Roy Douglas (Doug) Hudgens and Sarah Hudgens as the nearest inhabited structure. The Hudgens' home was 407 feet away from the blast site.….

On April 11, 2011, at 12:15 p.m., Mr. Hudgens arrived at his home for lunch….When Mr. Hudgens entered his home, he observed a cloud of dust in the air, appearing to originate from his bedroom….Once in his bedroom, Mr. Hudgens observed a large rock, later determined to weigh 86 pounds, and a hole in the ceiling, where the rock had entered through the roof….The rock crushed a chest of drawers on impact and caused extensive damage to the home, including knocking out a window, creating cracks on the inside and outside walls of the home, and strewing insulation, remnants of ceiling joists, and other debris across a 10 foot area of his bedroom….A rocking chair next to the drawers was covered in at least a foot of insulation pulled down from the ceiling by the rock....

The flyrock landed over 400 feet from the site of the blast….Previous blasts at the Cookeville Limestone Quarry caused dust to be carried up the hill to his home and neighbors' property, covering cars and porches, but, in those instances, the Hudgens' home was not physically damaged….Prior to April 11, Mr. Hudgens claimed that he experienced shockwaves and the smell of noxious fumes originating from the quarry at least once a month, though he agreed that he never had to be treated for dust or fume inhalation by a doctor….However, Mr. Hudgens testified that a neighbor, Asher Lefebvre, experienced breathing difficulty due in part to the effect of dust….Mr. Hudgens also testified that shockwaves from blasting caused damage to the doors, windows, and bricks of the Lefebvre home….

On April 11, 2011, Sarah Hudgens was at home, reading in her bedroom rocking chair, until some time after 11:00 a.m.….She left her home at 11:30 a.m. for a lunch date and did not return until approximately 1:00 p.m.….When she returned, she observed extensive damage to her home caused by the 86 pound rock that entered through the roof….She described damage to clothes and a bed, as well as the insulation covering much of her bedroom….She testified that she was provided with no warning on the day of the blast or any day prior….

On April 14, 2011, Blair traveled to the Cookeville Limestone Quarry to determine if a previous citation should be extended or terminated….Upon his arrival, Randy Livingston, the Cookeville Limestone Quarry manager, told Blair that "he would have to have an extension on the clearing [of] the top of the shot area because the first time they shot it they hit a house off property."…Livingston

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[113] *Secretary of Labor, Mine Safety and Health Administration (MSHA) v. Austin Powder Company*, Docket No. SE 2011-583-M, A.C. No. 40-0080-256299 E24, https://www.fmshrc.gov/decisions/alj/ALJ_12172013-SE%202011-583.pdf.

had not previously notified MSHA that the house had been damaged because there is no reporting requirement for flyrock if there is no injury.…Blair reviewed the drill records and the partial shot record that were provided by Austin Powder and examined the blast site….Blair observed mud in the woods near the blast site, which he attributed to the shot going in the wrong direction….Blair also reviewed a video of the blast in which he observed the material shooting straight up from somewhere near the center of the blast site….Blair found this to be an indication that either the drilled holes were overloaded or the stemming failed….

Blair assessed the type of injuries that could result from the violation as a person being fatally injured by flyrock….In Blair's opinion one person, Mrs. Hudgens, was affected, though he acknowledged he could have found that both Mr. and Mrs. Hudgens were affected….Blair indicated that although the citation was written as "low negligence," he would have written it for "high" or "reckless disregard" after learning more of the facts….Specifically, he would have issued the citation for a higher level of negligence if he had known the amount of dirt that was drilled through to sink the blast holes and the type of stemming that was used to fill the tops of the holes….Blair also testified that rock was protruding above the ground at the site, which signaled to Blair that the area was "backfilled" with rock and dirt….Blair believed the backfill mixed with the cap stone increased the potential fly material and should have resulted in the blast area being doubled or tripled in size to avoid injury….Blair also found that the violation was S&S [significant and substantial] because Blair believed that it was reasonably likely to cause an accident and the injuries were reasonably likely to be serious or fatal….

Blair testified that if he had been the blaster-in-charge, he would have doubled or tripled the blast area, which would have included the Hudgens' home, to prevent injury….He believed that the blast area should have been extended to at least 800 feet because of "the way they stem the hole[s], [and because of] the loading process of the holes"….He added that an area was cleared 500 feet in the direction of the mine property, but not the same distance in the direction of the Hudgens' home….He stated that the home was 407 feet from the blast site…..

Clark testified that in his opinion the Hudgens' home was in the blast area based on his application of the Section 56.6306(e) requirements to the Austin Powder records of the April 11, 2011, blast…."[B]last area" is defined in Section 56.2 as "the area in which concussion (shockwaves), flying material, or gases from an explosion may cause injury to persons." Under Section 56.2, a blast area is determined by considering these seven factors: 1) the geology or material to be blasted, 2) the blast pattern, 3) the burden, depth, diameter, and angle of the holes, 4) the blasting experience of the mine, 5) the delay system, powder factor, and pounds per delay, 6) the type and amount of explosive material, and 7) the type and amount of stemming. Clark's analysis of what constituted the blast area on April 11 focused on three of the seven factors….In his view, the geology to be blasted, the blasting experience of the mine, and the type and amount of stemming, were inadequately considered before the shot was fired….He did not believe that the other [four] section 56.2 factors were at issue….

In examining the first factor, geology to be blasted, Clark reviewed the records and described the pre-blast geology of the drill area as "rock with a lot of dirt."…In Clark's experience, since dirt is not a solid material, the blaster-in-charge must compensate by adding more stemming to the bore hole and by ensuring the explosives are not put into the dirt portion of the bore hole….Clark also testified that the amount of dirt in the drill area made the geology unpredictable which should have require[d] that the blast area be expanded further than 407 feet in the direction of the Hudgens' home….

Clark explained that the fourth factor, blasting experience of the mine, refers to the history a miner (blaster) has blasting in an area. If experienced blasters have a routine consisting of similar loads and conditions, the mine and the blaster would expect consistent results….If the conditions are dissimilar, like the mixed dirt and rock conditions on April 11, Clark expected that the blaster would require an extension of the blast area, as the blaster would find the blast less predictable….

Clark described the seventh factor, type and amount of stemming, as relating to the inert substance that is put in the blast hole on top of the explosives in order to hold the energy of the explosives within the rock….In his opinion, drill cuttings comprised of dirt and rock, as was used in the April 11

blast, are "not a good stemming material."…Clark testified that the stemming could have significance in how the blast area should have been determined….

Clark admitted that during his time as a blaster-in-charge, he had unintended incidents of flyrock, but the rocks did not leave the blast area….Rather, the flyrock landed in an area where he knew it had the potential to land. In his opinion, the blast area was anywhere the flyrock had the potential to land….

Clark also testified that the duties contained in both Sections 56.6306(e) and (f) are meant to apply to the protection of all persons in the blast area, not just to miners or to persons on mine property….Clark stated that when he was a blaster-in-charge, his practice was to notify the mine operator prior to the detonation so the operator could alert its employees to evacuate…, but Clark recognized that the blaster-in-charge is ultimately responsible for the safety of the blast….

John Capers is a corporate technical manager for Austin Powder Company….Capers was admitted to testify as an expert in the field of explosives….Capers explained Austin Powder's application of the seven Section 56.2 factors for determining a blast area….In addressing the geology of the area, Capers provided examples of geological formations, and explained that within a quarry, the geology is slightly different on each bench….He stressed that blasters are limited to what they can see visually in determining the stability of the geology of the blast area….

Capers testified that the blast report demonstrates that the blaster-in-charge knew the nearest protected structures, private residences including the Hudgens' home, were to the north and the blast was directed due south away from the structures….

Capers concluded the flyrock originated from a group of underground broken rocks located six to twelve inches away from the solid bore hole, but he could not determine if the fly rock came from the explosive area or the stemming area….Capers later contradicted his testimony and said "the rock did not come from the stemming area," in support of his statement that crushed stone stemming would not have prevented the flyrock…. Capers testified that after watching the video of the blast, he concluded the flyrock was caused by a hole located toward the rear of the shot….However, upon cross examination, Capers testified the flyrock incident was not a "blast back," when the rock goes in the opposite direction, because the flyrock "wasn't caused by material ejecting to the rear of the shot. The flyrock was from the evacuation of a hole almost in the center of the blast [and] went straight up."…

Frady [the blaster] acknowledged the chance that rock would not travel in the direction he intended, but he did not consider it a "reasonable" or "likely" possibility….Frady emphasized that the blast design was for "nothing to go back" and that there were no previous reports of flyrock in the wooded area around the quarry….When clearing the blast area, Frady stated that he only checks the direction that he designed the shot to shoot….Therefore he cleared the mine shop, which was located 400 to 500 feet to the south of the blast, in accordance with the blast design….

Frady testified that he ensured that the Cookeville Limestone Quarry workers left the quarry with their equipment at 11:30 a.m. on April 11, and that he shot the blast at 11:45 a.m.….When asked why he did not inform the homeowners of the blast, Frady said he did not know the local homeowners because he was "going to a different quarry every single day in a different county."…<u>Frady recorded the initial blast report immediately after the blast, but explained that he made changes to the original blast report sometime after 5:00 p.m. on the night of April 11, 2011….He made the changes to give more detailed information on the blast and to update the report to include the flyrock incident</u>….In Frady's opinion, the flyrock came from "sort of the middle of the shot in the back corner[,] [b]ut it almost look[ed] like it c[ame] just in the middle."…

Frank (Randy) Livingston is employed as the quarry manager and supply superintendent at Cookeville Limestone Quarry….Livingston testified that Austin Powder blasts at the quarry twice a month on average….Livingston indicated that the section of the quarry where the April 11 blast occurred had been blasted before on different levels, although he could not recall how many times….<u>Livingston acknowledged that "a fly rock of any size can go at any time off of any shot loaded by anybody</u>.

Austin Powder has a long history of violations consisting of "241 violations between January 4, 2007, and April 20, 2011," and for causing the flyrock incident, an 86-pound boulder crashing through the roof of a neighbouring home with the potential to injure or kill the residents, the blaster received a poultry fine of $4,689. The environmental court's overriding concern was not to protect nearby residents from the potentially deadly effects of flyrock, but rather to ensure that "the proposed penalty will not adversely affect the Austin Powder's ability to continue in business." This misguided concern despite the court acknowledging,

> *The…flyrock entered the Hudgens' home with sufficient force to break a hole in the roof and smash several pieces of furniture, interior walls, and windows. Indeed, the 87 pound rock landed within a few fee[t] of where Mrs. Hudgens had been sitting. If she had not left her bedroom shortly before the blast, it is reasonable to conclude she would have been seriously injured or killed [p. 21].*

As for the degree of negligence assigned to Austin Powder for this potentially catastrophic flyrock incident, the environmental court concluded only that "Austen [sic] Powder's negligence was 'moderate.'" Without any rational explanation, the flyrock incident was downplayed to ignore the potential of more than one person being fatality impacted. Further, no legal duty was imposed on the quarry operator to increase the blasting safety zone by a factor of two to three (800 feet to 1,200 feet), consistent with the inspector's finding, and to protect the entire Hudgens' family (and visiting relatives and guests) from future flyrock incidents.

> *…[T]here was a reasonable likelihood that the injury in question would be of a reasonably serious nature. I credit Inspector Blair's obvious observation that flyrock can crush a person and produce a fatality….The violation was S & S [significant and substantial]. The violation was very serious. I credit the inspector's testimony that fatal injuries could result from not warning and clearing persons in a blast area and thus allowing them to evacuate….Persons affected by the violation are subject to the hazards of flyrock. The inspector found that one person usually is affected, based on his opinion that "most of the time it's only one person that gets hit."…[Flyrock always has the potential to injure or kill more than one person] In this case, the person was Mrs. Hudgens…..*

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President, International Forensic & Litigation Appraisal Services Inc. and
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Blasting Quarry Complaints, Flyrock Incidents & The Need For Adequate Setbacks (8-Dec-20)

For previous research papers see:

https://intval.com/articles/Flyrock-and-Other-Impacts-from-Quarry-Blasting-Operations.pdf

https://intval.com/articles/Flyrock-and-Other-Impacts-Supplement-1.pdf

https://intval.com/blasting-quarries-adequate-setbacks/

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SECTION I

Flyrock Is Inevitable Wherever Rock Is Blasted

Many explosives experts and authors have commented on the inability to control the throw of flyrock, which is a natural phenomenon whenever explosives are used to blast rock.

- Flyrock can still be generated even in the best-designed blast (Slide 19, Power Point Presentation 2015).[1]
- Flyrock can never be completely eliminated (Surface mineral workings: control of blasting, 2000).[2]
- The detrimental effects of flyrock are unavoidable and cannot be completely eliminated… (Ghasemi et al, 2012)[3]
- Flyrock is a hazard that operators try to minimize but is always present (Ormerod, 2019).[4]
- Flyrock is an undesirable phenomenon in the blasting operation of open pit mines (Amini, et al, 2011).[5]
- Flyrock is a concern for both researchers and blasting engineers as it is a random phenomenon. However, it has received relatively little attention from researchers due to the complex nature of the interaction between blast design and rock parameters (Raina, et al., *2011)*[6]
- Danger and damage from flyrock in rock blasting has been a serious problem ever since blasting was introduced. Not only have men been killed and injured but also buildings, equipment and materials have been damaged (Lundborg et al. 1975).[7]
- The phenomena of flyrock are always uncontrolled and can never be brought down to zero (Singh, eta al, 2014).[8]
- Flyrock due to blasting in opencast mines is complex in nature as it is a random phenomenon.[9]

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[6] Raina, A.K., Chakraborty, A.K., Choudhury, P.B. *et al.* "Flyrock danger zone demarcation in opencast mines: a risk based approach," *Bull Eng Geol Environ* **70,** 163–172 (2011). https://doi.org/10.1007/s10064-010-0298-7.
[7] A. Aghajani-Bazzazi, M. Osanloo and Y. Azimi, "*Flyrock prediction by multiple regression analysis in Esfordi phosphate mine of Iran,"* © 2010 Taylor & Francis Group, London, file:///C:/Users/Windows%207%20PC/Downloads/074.pdf
[8] https://www.researchgate.net/profile/Avtar_Raina/publication/264560232_Prediction_of_blast-induced_flyrock_in_Indian_limestone_mines_using_neural_networks/links/5539cf9e0cf247b8588148a8/Prediction-of-blast-induced-flyrock-in-Indian-limestone-mines-using-neural-networks.pdf.
[9] R. Trevidi, T.N. Singh and A.K. Raina, *"Prediction of blast-induced flyrock in Indian limestone mines using neural networks,"* Journal of Rock Mechanics and Geotechnical Engineering 6 (2014) 447-454.

- "You can never say never." No matter how careful a blaster is there is no certainty a blast will not cause flyrock. (Tim Rath, Green Mountain Explosives, Testimony at Rivers Quarry Application Hearing)[10]
- Rivers' blasting expert cannot guarantee that flyrock will not leave the Rivers parcel, regardless of what precautions are taken to minimize the risk (Cross Exam of Rath 12/15/2008).[11]
- Every borehole is a separate detonation. This means that during every blast event (at the proposed Rivers' quarry) there would be 62 chances for flyrock from face burst, cratering, or stemming ejection. After every event, there will be an additional ten seconds or so when flyrock could rain down on neighboring homes, properties and Route 100B that could result in property damages, injury, or even death (Testimony of Art Hendrickson on 12/15/2008, para. 110).[12]
- Flyrock is a potential hazard anytime and anywhere there is blasting (MSHA, 2016).[13]
- Blasting is not an exact science (Scott Parker, expert blaster testifying on behalf of Director of Occupational Health and Safety, para. 23).[14] (Flyrock 20)
- Mining and quarrying are high-risk activities. Misfires and fly rock are common hazards associated with shot firing [blasting] activities, which are routinely undertaken in these industries. (WorkSafe Victoria safety alert published September 7, 2020)[15]
- Flyrock meets the Ontario EPA definition of contaminant, and the adverse effects of "flyrock" are not trivial (Castonguay Blasting Ltd. v. Ontario (Environment), [2013] 3 SCR 323, 2013 SCC 52 (CanLII)).
- According to Section 21.66 (1) of the Occupational Health and Safety Act (OSH), B.C., a blaster must take precautions against *flyrock*, which is referenced as "flying" material.[16]
- In April 2015, WorkSafeB.C. suspended the blaster's permit after a flyrock incident rained rocks on a Colwood Neighbourhood, including a 17-pound rock that smashed through a couple's bedroom ceiling and broke their bed frame.[17] (The company doing the blasting for Colwood's Allandale Pit received three penalties from WorkSafeB.C. within three years for violations related to flyrock.)

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[10] http://www.killthealbionquarry.org/DEATH-FROM-THE-SKY-FLYROCK.html.
[11] http://www.killthealbionquarry.org/flyrock_danger.pdf.
[12] "Blasting and Flyrock," http://www.killthealbionquarry.org/flyrock_danger.pdf.
[13] https://www.msha.gov/news-media/announcements/2016/03/24/flyrock-dangers-best-practices.
[14] *Director of Occupational Health and Safety v. Government of Yukon, William R. Cratty and P.S. Sidhu Trucking Ltd.*, 2012 YKSC 47 (CanLII), <http://canlii.ca/t/fs6vt>, retrieved on 2020-11-16. "The whole purpose of the *OHS Act* is to promote safe practices in the workplace at all time. This includes safety for members of the public that are in proximity to the workplace [para. 46]."
[15] https://www.aggregateresearch.com/news/state-investigates-quarry-blast/.
[16] https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation/ohs-regulation/part-21-blasting-operations#SectionNumber:21.66.
[17] Kyle Esser, "Blaster has permit suspended after rain of rocks in Colwood," Times Colonist, April 16, 2015, https://www.timescolonist.com/news/local/blaster-has-permit-suspended-after-rain-of-rocks-in-colwood-1.1825157.

- Flyrock incidents occur wherever there is hard rock mining, and involves the uncontrolled propelling of rock fragment produced by blasting.[18]

According to Lundborg, people should never be exposed to flyrock. Similarly, national laws in Chile relating to workplace safety require that workers never be exposed to flyrock. This requires that the probability of flyrock be zero for personnel (and non-personnel) located outside the Personnel Clearance Distance (blast area) for all blasts.[19] Likewise, Kentucky's Energy and Environment, Department for Natural Resources, has expressed a zero tolerance for flyrock incidents:[20]

> *The Department for Natural Resources believes that one flyrock event is too many, and to that end, has prepared this RAM [Reclamation Advisory Memorandum] to further define steps this Department will require of the coal industry in eliminating flyrock events.*
>
> *'Flyrock' is defined as 'blasted material cast into the air, or traveling along the ground, that is cast from the blasting site more than half the distance to the nearest dwelling, public building, school, church, commercial, community or institutional building; or any occupied structure; or that is cast beyond the permit boundary.'*
>
> *Flyrock events historically have not been limited to blasting operations within the distances which require the submission and approval of an 'anticipated blast design'…prior to blasting. Rather, flyrock events occurred and impacted dwellings, vehicles, persons, animal life, and other physical structures thousands of feet from the blast site resulting in death and the destruction of property.*

In response to a spike in flyrock incidents, the Queensland Government issued a safety bulletin in February 2009,[21] which, in part, states:

> *In the past few months, there have been some very serious incidents reported from the coal mines of the Bowen Basin, North Queensland and from quarries around Brisbane. All of these could well have ended up with very serious or fatal results. Significant damage to property and structures has also been reported. The frequency of these incidents has reached a point where it is well beyond acceptable limits.*
>
> *Flyrock is an integral part of blasting. However, uncontrolled or unexpected flyrock that is projected past a defined safety zone is not acceptable. It is well known that rock and/or debris can be thrown over a kilometre from the blast site, and in a recent case rocks travelled approx 1.3km [1,300 metres].*

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[18] C. L. Eze and U. U. Usani, "Hard Rock Quarry Seismicity and Face Bursting Flyrock Range Prediction in the Granite and Migmatites Rocks of North Central Nigeria," *C. L. Eze Int. Journal of Engineering Research and Applications*, Vol. 4, Issue 12 (Part 2), December 2014, pp. 01-06, http://www.ijera.com/papers/Vol4_issue12/Part%20-%202/A412020106.pdf.

[19] *"Flyrock – A Basis For Determining Personnel Clearance Distance And Quantifying Risk of Damage to Equipment,"* scribd.com.

[20] "Reclamation Advisory Memorandum," https://eec.ky.gov/Natural-Resources/Mining/Mine-Permits/RAMS/RAM140.pdf. "During calendar year 2007, the Commonwealth of Kentucky had a [known] total of thirteen (13) flyrock events on surface coal mining sites, include one (1) that resulted in a fatality. To date [July 18] there have been nine (9) [known] flyrock events, including one (1) that resulted in a minor injury that very easily could have resulted in a fatality."

[21] "Flyrock Incidents," https://www.dnrme.qld.gov.au/business/mining/safety-and-health/alerts-and-bulletins/explosives/flyrock-incidents2.

According to Eloranta, past president and former vice-president for technical matters for the International Society of Explosives Engineers (ISEE), ***"[a]ny amount of flyrock is unacceptable.***"[22]

> *…**[A]nyone involved in blasting is obligated to place safety above all other considerations, according to Eloranta. Even if blasts that launch life-threatening rocks into populated areas are rare, even if no one is injured, accepting that as inevitable is unethical.*** [emphasis added]

An explosives engineer that fails to address **flyrock** in a **blasting impact report** in a meaningful way points to **negligence** and **professional misconduct** under the *Professional Engineers Act, R.S.O. 1990, c. P.28*:

> *"negligence" means an act or an omission in the carrying out of the work of a practitioner that constitutes a failure to maintain the standards that a reasonable and prudent practitioner would maintain in the circumstances. R.R.O. 1990, Reg. 941, s. 72 (1); O. Reg. 657/100, s. 1 (1).*
>
> *"professional misconduct" means,*
>
> *a) negligence,*
> *b) failure to make reasonable provision for the safeguarding of life, health or property of a person who may be affected by the work for which the practitioner is responsible.*

Flyrock Statistics Cited by Different Sources

As acknowledged by *Raina et al.* in their February 2015 article,[23] "flyrock is one of the most contentious issues in bench blasting [and] has the propensity to cause fatality and severe injuries." Flyrock, arising from open-pit blasting, continues to elude explosives engineers, despite a reasonable understanding of throw [p. 660]. According to the article, the amount of research conducted on flyrock is "abysmal,"[24] and the percentage of accidents occurring due to flyrock justifies its importance irrespective of the fact that the problem is seldom reported.[25] Over various timeframes, the percentage of injuries attributed to *reported* flyrock incidents by the following authors ranges from 19.05% (Verakis and Lobb)[26] to 68.20% (Little)[27]:

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[22] Mark Fischenich, "Flyrock from any blast 'unacceptable,'" The Free Press, Oct 21, 2017, https://www.mankatofreepress.com/news/local_news/expert-flyrock-from-any-blast-unacceptable/article_8ad31cf8-b5cf-11e7-bf58-c3cdd328cf7f.html.

[23] Raina, A. K., Murthy, V. M. S. R. and Soni, A. K., "*Flyrock in surface mine blasting: understanding the basics to develop predictive regime,"* Current Science, Vol. 108, No. 4, 25 February 2015, https://www.currentscience.ac.in/Volumes/108/04/0660.pdf.

[24] Raina, A. K., Soni, A. K. and Murthy, V. M. S. R., "*Spatial distribution of flyrock using EDA: An insight from concrete model tests. In Rock Fragmentation by Blasting* (eds Singh, P. K. and Sinha, A.)," Taylor and Francis, London, 2013, pp. 563–570.

[25] Davies, P. A., "*Risk based approach to setting of flyrock danger zones for blasting sites*," *Trans. Inst. Mines Met.*, May–August 1995, 96–100.

[26] Verakis, H. and Lobb, T., "*Flyrock revisited an ever present danger in mine blasting*," 2007; http://docs.isee.org/ISEE/Support/Proceed/ General/07GENV1/07v109g .pdf.

[27] Little, T. N., "*Flyrock risk*". In Proceedings of EXPLO Conference, Wollongong, NSW, 3–4 September 2007, pp. 35–43, https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-2570%2120191217T043417.551%20GMT.

Table 2. Accident statistics of reported flyrock cited by different authors

Reference	Period	Blasting injuries	Percentage of flyrock injuries in blasting related accidents
Mishra and Mallick[11]	1996–2011	30	24.19
Verakis[10]	2010–2011	18	38.00
Bajpayee *et al.*[9]	1978–1998	281	40.57
Verakis and Lobb[19]	1994–2005	168	19.05
Little[20]	1978–1998	412	68.20
Kecojevic and Radomsky[21]	1978–2001	195	27.69
Adhikari[22]	–	–	20.00

- According to Dyno Nobel Americas, which participated in a 2008 "Blast Service Management" presentation, in one year they fire "approximately 100 blasts per day" and reports "approximately 150 [customer] flyrock incidents annually," while conceding that "many [flyrock] incidents aren't reported." In 2007, Dyno Nobel Americas had 32 flyrock incidents for 30,021 quarry blasts or 1.07 flyrock incidents per 1,000 blasts.[28]
- Davis (1995) considers under-reporting is responsible for five to ten times the actual number of [flyrock] incidents.[29]
- During 2019, the Tennessee State Fire Marshal's Office received 302 blasting complaints, of which 14 were for *flyrock*, accounting for 5% of the blasting complaints.[30]
- Canada does not track the number of flyrock incidents that have led to death or injury caused by blasting at surface mining operations. However, according to the National Institute for Occupational Safety and Health (NIOSH), flyrock at surface mining operations in the United States has killed or injured 311 people from 1978 to 2004.[31] NIOSH defines flyrock as,

> "***any debris that lands outside the designated blasting area. It can vary in mass from marble-sized to car-sized and can be incredibly dangerous and potentially fatal.***" [emphasis added]

Examples of Flyrock's Greatest Hits!

Some of the more disturbing and fatal flyrock incidents, compiled from a variety of sources, are listed as follows:

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[28] "Blast Service Management, https://www.911metallurgist.com/blog/wp-content/uploads/2016/01/Blast-Service-Management.pdf.

[29] T.N. Little, "*Flyrock Risk*," EXPLO Conference, Wollongong, NSW, 3-4 September 2007, https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-2570%2120191217T043417.551%20GMT.

[30] 2019 Annual Report on Blasting Fines in Tennessee, https://www.tn.gov/content/dam/tn/commerce/documents/fire_prevention/posts/2019-BLASTING-COMMISSIONERS-REPORT.pdf.

[31] Josh Cabel, "*NIOSH Offers Tips for Flyrock Safety*," EHSToday, January 25, 2007, https://www.ehstoday.com/construction/article/21911356/niosh-offers-tips-for-flyrock-safety.

- A quarry blast launched an 82-pound boulder 402 metres that penetrated the roof of the porch of David Ross's residence and tore off the home's siding (Flyrock 58 – August 23, 2010).
- A large amount of flyrock travelled approximately 300 feet (91 metres) and struck a car on Interstate 75, and a 16-year old boy, a passenger in the car driven by his parents, was killed as a result of the flyrock impact (Flyrock 34 – June 4, 1993).[32].
- Flyrock fragments travelled approximately 483 metres striking and killing 40-year old Bobby Messer, a mechanic, and rocks hit and damaged the mechanic's truck (Flyrock 74 – July 16, 2007).
- Two employees were injured and a third employee had her arm severed below the elbow after being struck by baseball-sized rocks propelled 400 metres to 500 metres from the quarry blast (Flyrock 13 – September 26, 2011).
- A quarry blast launched flyrock debris into a residential neighbourhood that struck and damaged five properties (Flyrock 55 – November 27, 2019).
- A quarry blast launched flyrock debris more than 300 metres and caused widespread damage to the quarry plant, private cars and buildings within the complex, and three people were injured (Flyrock 49 – January 10, 2006).
- A quarry blast showered flyrock debris over an area of 650 metres that struck and damaged three residences, primary school, tavern, saw mill and fish pond (Flyrock 61 – May 5, 2007). **The forensic investigation of this catastrophic flyrock incident "led to the conclusion that it was necessary to set the safe distance for residents at [a] distance [greater] than 700 metres."** [emphasis added]
- A quarry blast launched boulder fragments that struck and killed 10-year old M. Nandhini, and that struck and injured her brother Soundarrajan (Flyrock 68 – May 27, 2020).
- A quarry blast hurled hundreds of rocks, some the size of car tires, which sprayed a shopping centre, office complex and service station, and injured three people, one of them critically (Flyrock 64 – February 4, 2009). Police closed off roads littered with large chunks of rocks, and paramedics and emergency workers raced to treat the injured.
- A quarry blast launched flyrock debris, some of which bore through the roof of a house and struck and killed 36-year old Shupikai Chitsana, and her aunt was also struck by flyrock, but she survived her injuries (Flyrock 41 – August 15, 2019). Shupikai leaves behind her five children and husband.
- A quarry blast showered flyrock debris as far as 1,000 metres that damaged 18 cars and 14 factories, and injured 10 factory workers and killed one factory worker in a

[32] The United States District Court for the Eastern District of Tennessee sentenced the blaster to 10 months, five to be served in a penitentiary and five months to be served under home detention (with electronic monitoring) followed by a year of supervised probation." The day shift superintendent was given an eight-month sentence. The company went out of business within four months of the blasting incident.

factory penetrated by numerous rocks at a distance of 500 metres (Flyrock 12 – July 19, 2013). A team of 37 fire and rescue personnel carried out a search and rescue operation with the assistance of 16 policemen and TNB employees before declaring the area safe for the public.[33]

- A quarry blast showered flyrock debris that damaged 14 pieces of parked equipment and several vehicles, injuring one person, and a 309-pound boulder was launched 250 metres (Flyrock 46 – 2008).
- A quarry blast showered flyrock debris 3,000' (914 metres) on an industrial park doing damage to a building and 11 vehicles in the Technica USA parking lot, and flyrock debris was showered 4,000' (1,219 metres) in another direction landing on a runway of West Lebanon Airport (Flyrock 24 – June 11, 2007).
- A quarry blast launched 13 boulders across a four-lane highway into resident's yards of 5-acre estate lots, and a store. A car was damaged, and another 50-pound boulder was launched 1,760 ' (520 metres) (Flyrock 26 – April 25, 2006).[34]
- A quarry blast generated excessive airblast (145 decibels) and flyrock debris that damaged 23 homes. Three homes had structural damage from flyrock and two homes had glass broken from their windows (Flyrock 37 – November 3, 1989).
- A quarry blast sent an 80-pound boulder crashing into a school bus on the New York Thruway carrying 52 students and striking and injuring three students. A man driving eastbound on the same Thruway was also struck and injured by flyrock. The flyrock incident was ***Termed by many as the Blasting Industry's worst Nightmare!*** (Flyrock 76)
- A quarry blast launched flyrock debris, including a 96-pound boulder that struck and killed Stephen Hetzler, an experienced blaster, standing 153' (47 metres) from the blast (Flyrock 86 – December 4, 2013).
- A quarry blast propelled flyrock debris that struck teenager Ismail Kayima, causing a badly broken leg that had to be amputated (Flyrock 88 – July 11, 2008).
- A blast from a quarry near Burlington International Airport sent flyrock debris in the wrong direction, hurling rocks, some the size of microwave ovens hundreds of yards away that damaged at least five planes, seven buildings and a dozen cars. Some stones left craters in the asphalt and ripped small branches from trees. (Flyrock 19 – September 24, 2008)[35]

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[33] Edy Tonnizam Mohamad, Danail Jabed and Hossein Motaghedi, "*The Effect of Geological Structure and Powder Factor in Flyrock Accident, Masai, Johor, Malaysia*," EJGE, Vol. 18 [2013], Bund. X: 5661-5672, http://www.ejge.com/2013/Ppr2013.485mar.pdf.

[34] "Denny Perry, president of Stuart M. Perry Quarry, said his family's business contracts Winchester Building Supply to do all their blasting. 'We got out of it because we felt it was safer and more economic,' he said. 'We didn't want to store explosives.'" https://www.aggregateresearch.com/news/state-investigates-quarry-blast/.

[35] "Quarry blast goes horribly wrong," Sept. 25, 2008, https://www.aggregateresearch.com/news/quarry-blast-goes-horribly-wrong-in-vermont/.

Examples of Known Repeat Flyrock Offenders

The following are examples of blasting operations where the incidence of flyrock has occurred on more than one occasion.

- Gateway Materials Quarry (2 known flyrock incidents – Flyrock 7 & 29)
- Alum Luck Mine (2 known flyrock incidents – Flyrock 17)
- Arnprior Quarry (2 known flyrock incidents – Flyrock 18)
- Hamilton Boulevard Extension (2 known flyrock incidents – Flyrock 20)[36]
- Percy Quarry (2 known flyrock incidents – Flyrock 21)
- Miller Braeside Quarry (2 known flyrock incidents – Flyrock 22)
- Comsbec Red Hill Valley Parkway (2 known flyrock incidents – Flyrock 31)
- Surface Mine Campbell County (2 known flyrock incidents – Flyrock 34)[37]
- City Sand's Quarry (2 known flyrock incidents – Flyrock 42)
- Hobet Mine (2 known flyrock incidents – Flyrock 45)
- Netley Branch Mine (numerous flyrock incidents over 15 years – Flyrock 51)
- Imperial Quarry (2 known flyrock incidents – Flyrock 65)
- Morrisville Mine (2 known flyrock incidents – Flyrock 66)
- Manitou Sand and Gravel Pit (2 known flyrock incidents – Flyrock 75)
- Colwood's Allandale Pit (3 known flyrock incidents)[38]
- Trail Bay Estates (2 known flyrock incidents)[39]
- Compass Quarries, Paradise, Lancaster County (2 known flyrock incidents – Flyrock 83)
- New Greenpark, Rawang (more than 2 known flyrock incidents – Flyrock 84)

Quarry Operator Must Compensate All Residents Within 500 Metres to Relocate and Avoid Potential Dangers of Flyrock

The residents of Kyaggundal Village, who are affected by flyrock debris from a nearby 15-acre quarry, have rejected compensation from the quarry operator as being inadequate to relocate from their damaged houses.[40]

> *Residents of Kyaggunda Village in Bukulula Sub-county, Kalungu District, who are affected by flying stones from a nearby quarry, have rejected compensation for their damaged houses, saying the money is too little to facilitate their relocation.*

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[36] November 1, 2007, a piece of flyrock flew 350 metres penetrating the roof of a residence and landing in the living room (para. 7) in the Lobird Trailer Court neighbourhood. On May 6, 2008 flyrock debris was launched onto the same neighbourhood penetrating the roof of one residence and landing in the living room, and showering flyrock debris struck roads, fences, sheds and residences (trailers) (para. 1). *Director of Occupational Health and Safety v. Government of Yukon, William R. Cratty and P.S. Sidhu Trucking Ltd.*, 2012 YKSC 47 (CanLII), <http://canlii.ca/t/fs6vt>, retrieved on 2020-11-16.

[37] https://www.osmre.gov/resources/blasting/docs/Flyrock/1993SugarRidgeFatality.pdf.

[38] Shalu Mehta, "Three penalties in three years for blasting firm working Allandale lands in Colwood," Jan. 9, 2020, https://www.saanichnews.com/news/three-penalties-in-three-years-for-blasting-firm-working-allandale-lands-in-colwood/.

[39] Christine Wood, "Residents raise concerns with blasting," CoastReporter, April 6, 2007, https://www.coastreporter.net/news/local-news/residents-raise-concerns-with-blasting-1.1179765.

[40] "Residents reject cash to abandon stone quarry site," Daily Monitor, September 4, 2019, https://www.monitor.co.ug/uganda/news/national/residents-reject-cash-to-abandon-stone-quarry-site-1846128.

> ***A Chinese** **firm, Hunan Road and Bridge Construction Group Companies Ltd, which is managing the quarry, last week started compensating about 80 residents with plots of land and houses within 500 metres radius from the stone quarry to enable them to relocate to safer places and return after 24 months**…. [emphasis added]*
>
> *The crushed stones are being used to tarmac the Nyendo-Bukakkata road….*
>
> *Some residents near the quarry, including Mr Herman Kafeero and Mr Andrew Kavuma, claimed they were not considered for compensation yet their farmland and houses are located within a radius of 500 metres of the quarry….*
>
> ***Mr David Dratre, the Hunan Road and Bridge Construction Company Ltd spokesperson, said the compensation was based on a report by the government chief valuer and advised those who are not satisfied with the amounts given to them to put their complaints in writing**….[emphasis added]*

Majority of Complaints Over Blasting Quarries Within 500 to 700 Metres

As referenced in the July 2014 Department of State Development *Resource Area management and Planning Final Report*,[41] the *Urban Growth Management for Metropolitan Adelaide* report discusses the findings of complaint data received by quarry operators, the EPA, PIRSA (Department of Primary Industries and Regions), and the City of Tea Tree Gully with regards to excavation activity within and adjacent metropolitan Adelaide, and indicates average distances of around 500 to 700 metres "capture" the majority of complaints for hard rock quarries.

> *The majority of complaints received were in relation to blasting activities, with the average distance for these complaints occurring at 489m from the mine/quarry. [2.3.2, p. 20]*
>
> *Dust was also a common complaint, the average complaint distance relating to dust from hard rock quarries occurred at a distance of 690m...indicating that blasting activity is likely to cause dust to travel further distances.* [p. 20]
>
> *The average distance for noise complaints for hard rock quarrying was 675m…[p. 20]*
>
> *The highest frequency of complaints for hard rock quarries occur between 500m and 550m…*[p. 20]
>
> *The findings in this report show that while 60% of blasting complaints were received at a distance of 500m or less, the majority occurred at around the 500m. This would suggest that for blasting operations, a separation of at least 500m would be needed.* [p. 20]

[41] Department of State Development *Resource Area Management and Planning Final Report,* July 2014, https://energymining.sa.gov.au/__data/assets/pdf_file/0020/240662/2014-07-22_DSD_Resource_Area_Management_and_Planning.pdf.

SECTION II

Flyrock 76

In an online Power Point presentation "Blasting Safety" by Mirabelli of Quarry Academy,[42] there is reference to a quarry blast that sent an 80-pound boulder crashing into a school bus on the New York Thruway carrying 52 students and striking and injuring three students. A man driving eastbound on the same Thruway was also struck and injured by flyrock. The flyrock incident was ***Termed by many as the Blasting Industry's worst Nightmare!***

> *A quarry blast sent an 80-bound rock crashing into a chartered bus carrying 52 band and choral students from a Connecticut high school. Three (3) people were injured in the accident, which occurred on the New York Thruway, about 25 miles west of Albany. Two (2) girls on the bus, which was headed westbound to a Toronto music contest, were injured….A Utica man driving on the eastbound side of the Thruway also sustained minor injuries from flying rock.* [Slide 7]

Flyrock 77

A January 11, 2001 incident report of the Queensland Government[43] documents an explosion at a blasting quarry that caused flyrock, which struck an employee at a distance of 75 metres, resulting in the employee losing his right eye, and having his cheek bone shattered and jaw broken. Other pieces of flyrock were scattered up to 150 metres from the area of the blast.

> *A shotfirer [blaster] was struck on the right side of his face by flyrock after a toe was blasted at a quarry. He was videoing the shot 75m from the blast area whilst sheltering behind a steel hopper with another person. The flyrock travelled towards these persons. The shot was fired by another person from a different location.*
>
> *The shotfirer lost his right eye, his cheek bone was shattered, which required reconstructive surgery and his jaw was broken.*
>
> *The flyrock involved and its trajectory were not identified however the video record shows flyrock ricocheting upwards and to the side of the camera. Other pieces of flyrock were found scattered up to 150m from the blast area.*

Flyrock 78

On January 10, 2006, a blast at a Tipperary quarry launched flyrock over 300 metres causing widespread damage to quarry plant, private cars and buildings, and injuring three people.

> *On the 6 November 2009 at Clonmel Circuit Court, Tipperary, Dennis Tarrant & Sons Limited [William Tarrant, Irish Industrial Explosives Limited and Mr. Manus Carroll [each] pleaded guilty to one charge [and paid nominal fines.]. This case arose as a result of a flyrock incident on the 10 January 2006 at the quarry of Denis Tarrant & Sons Limited, Kilfeacle, Co. Tipperary. The rock*

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[42] Lawrence J. Mirabelli, Senior Technical Consultant, Quarry Academy (DYNO and SANDVIK), https://www.911metallurgist.com/blog/wp-content/uploads/2016/01/Blasting-Safety.pdf.

[43] Queensland Government, Department of Natural Resources, Mines and Energy, Serious injury flyrock accident, Significant incident report n. 27, 11 January 2001, Version 1," https://www.dnrme.qld.gov.au/business/mining/safety-and-health/alerts-and-bulletins/mines-safety/serious-injury-flyrock-accident?SQ_DESIGN_NAME=print_preview.

travelled over 300m and caused widespread damage to quarry plant, private cars and buildings within the quarry complex. Three people were also injured.[44]

Flyrock 79

In May 2017, the Planning & Environment Resources Regulator, NSW Government[45] reported a blast at a surface mine that propelled flyrock a distance of 245 metres striking a ute (utility vehicle), with six people standing alongside the ute within the 500 metre exclusion zone.

Flyrock hit and damaged a ute when the rock was ejected during blasting operations at a mine. There were six people standing alongside the ute at the time…. The operator reported that the people and ute were positioned inside the blast exclusion zone, 245m from the blast. ***The blast exclusion zone required a distance of 500m.*** [emphasis added]

Flyrock 80

In 1991, a blast at a Killanully quarry launched an 8-pound rock 802 feet (244 metres), within 20 paces of a house in Ballygarvan Village.[46]

Flyrock 81

In 2011, a blast at an Opencast Coal Quarry in West Glamorgan launched flyrock beyond the site's 150-metre danger zone.[47]

A blast took place at an Opencast Coal Quarry in West Glamorgan, South Wales, causing flyrock to project outside the site's 150 metre danger zone. The weather conditions were dry, sunny and freezing and that day was regarded as the coldest day during two weeks of freezing conditions.

The incident was reported to the Health and Safety Executive although it was not reportable under RIDDOR, as the flyrock did not project beyond the site boundary*.* [emphasis added]

Flyrock 82

In 2011, a blast at a quarry projected flyrock debris up to 450 metres from the blast area that damaged a building.[48]

Employees and infrastructure were put at risk when a face-burst projected flyrock material up to 450m from the blast area. .Flyrock in storage shed (approx. 250m) This incident became even more serious when it was discovered that not all personnel had been removed from the exclusion zone.

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[44] Health and Safety Authority, Prosecutions 209, https://www.hsa.ie/eng/Topics/Inspections/Prosecutions/Prosecutions_2009/.

[45] Weekly incident summary, May 24, 2017, https://www.resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0008/717434/weekly-incident-summary-week-ending-24-may-2017.pdf.

[46] "Residents oppose quarry expansion," The Irish Times, July 12, 2004, https://www.irishtimes.com/news/residents-oppose-quarry-extension-1.1148702.

[47] The Global Mineral Products Health & Safety Hub, Incident alert, 01/03/2011, https://www.safequarry.com/IncidentReports/IncidentView.aspx?kincident=283.

[48] NSW Government, Industry & Investment, Safety Alert, "People put at risk inside blast exclusion zone," June 2011, https://resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0007/397294/SA11-06-People-put-at-risk-inside-blast-exclusion-zone.pdf.

Flyrock 83

On December 21, 1999, blasting at a quarry in Paradise, Lancaster County, launched flyrock debris that struck and killed Lee Messner, a loader operator, while sitting in his truck approximately 800 feet (244 metres) from the blast. Other flyrock debris damaged a building approximately 1,500 feet (457 metres) from the blast.[49]

> *On December 21, 1999, Lee E. Messner, loader operator, age 32, was fatally injured when he was struck by flyrock while sitting in a pickup truck. Messner and Arthur Miller, production foreman, were in the truck guarding the access roadway leading to the quarry and primary plant during blasting operations.*
>
> *The accident occurred because the company and the contractor failed to ensure that persons had cleared the blast area or were in a blasting shelter or protected location. The contract blaster had not verified their location prior to initiating the shot, had not informed them of any potential for flyrock, and had only instructed them to clear the primary crusher area….*
>
> *The accident occurred on a roadway adjacent to the surge pile located in the primary plant area. The roadway was approximately 40-50 feet wide, and intersected the haul road from the pit to the primary crusher dump. The accident site was approximately 180 feet away from the west quarry wall, and approximately 800 feet from the blast holes located on the third production bench, one level above the quarry floor….*
>
> *At least one of the blastholes 'blew-out' causing a massive amount of flyrock. Flyrock peppered the west highwall. Flyrock damaged a building approximately 1,500 feet west of this blast.*
>
> ***Flyrock had struck buildings at the secondary crushing plant approximately 3 years ago [1996] from a prior shot in another area of the quarry**. A seismograph was in place approximately 950 feet from the blast at Hess Mills, Vintage Road….*[emphasis added]
>
> ***The blaster was aware that there were blast holes which could create flyrock. Failure to clear the blast area or ensure that all personnel were in a blasting shelter or other protected location prior to initiating the blast showed a serious lack of reasonable care which constitutes more than ordinary negligence and is an unwarrantable failure to comply with a mandatory standard.*** [emphasis added]

Flyrock 84

On July 26, 2007, a blast at a quarry in New Greenpark, Rawang launched flyrock debris into a nearby residential subdivision that penetrated the roof of the home of Harkit Kaur and landed in her living room, and that struck one other house.[50]

> *Housewife Harjit Kaur had the shock of her life when a rock, the size of a football, landed in her living room recently.*
>
> *That was not all. The granite rock punched a hole through the roof, carpet and floor tiles of her house on Jalan NGP 2/5 in New Greenpark, Rawang in the 3.20pm incident on July 26, [2007].*
>
> *If it had happened a week earlier, it could have killed her maid and her 80-year-old mother Gurdev Kaur, said a shaken Harjit.*
>
> *"My mother would usually lie down on the couch here while the maid would sit on the floor in the hall to watch television. It so happened that my mother went to hospital that day and the maid was outside the house.*

---

[49] United States Department of Labor and Mine Safety and Health Administration, Report of Investigation, April 17, 2000, https://arlweb.msha.gov/FATALS/1999/FTL99M53.HTM.

[50] "Flying rocks from quarry blasting," The Star, 10 August 2007, https://www.thestar.com.my/news/community/2007/08/10/flying-rocks-from-quarry-blasting.

"If the maid had been sitting in her usual spot, she would definitely have been hit by the rock. We hope such incidents will stop because flying rocks raining down on houses and people could cause fatal injuries," she said….

According [to] Rawang B New Greenpark RT chairman Zahir Abdullah, residents in the area had to cope with vibration and a few had their roofs damaged.

"It has been going on for years. Some houses have been hit by flying rocks from the quarry while others have cracks on their walls."

"There should not be a quarry so close to a residential area at all. Why is this blasting still going on? There are many places out of town where quarrying could take place," he said. [emphasis added]

Selayang Municipal Council (MPS) deputy president Jamri Basni and MPS councillor M.B Raja, who were visiting the area, saw a rock hitting another house located about 30m from Harjit's place.

Raja noted that the grill at the back door of the house had been hit by the rock debris.

"The rock debris caused the side of the grill to break."…

Flyrock 85

On April 14, 2011, a residential subdivision in the village of Kilsyth was showered with flyrock debris from a blast at a nearby quarry, and five homes on Ladeside Drive were damaged, some of them severely.[51]

The [flyrock] incident involved a controlled blast at a site operated by Dawn Homes, off Kilsyth's Stirling Road [which exceeded the perimeter of the safety exclusion zone set by specialist blasting contractors on site].

A number of homes have been damaged - some of them severely - after an explosion at a nearby building site in Kilsyth, North Lanarkshire. [emphasis added]

Jean Fleming, who lives on Stirling Road, said rocks were blasted out of the quarry and flung over the rooftops. She said: "There was the most massive explosion. The noise was horrific. Absolutely deafening.

"The rocks went right over the house - you could see them being blasted across the roof.

"Everyone is shocked and very traumatised."

Mrs Fleming said her house had a smashed window, broken roof tiles and a broken circuit board.

Her neighbour, Betty Wilson, saw her roof broken and a rock fall into her shower. Mrs Wilson added: "If I had been in the shower I would be dead. A brick came through the roof."…

Yvonne Ross, who lives in nearby Ladeside Drive, saw the damage to houses on her estate after she arrived home with her children

She told BBC Scotland: "The police and fire brigade were here when I got back. The street was cordoned off and they were checking everyone's house.

"Rocks from the explosion went through the roofs of houses. In one case a boulder went right through into the lounge.

"One of bricks has broken our front step but the damage is quite minor. It must have travelled quite a distance to reach my door."

---

[51] "Kilsyth explosion in building site badly damages homes," BBC, April 14, 2011, https://www.bbc.com/news/uk-scotland-glasgow-west-13082821.

Mrs Ross said debris from the explosion went right through a brick wall in one garden and "right through a conservatory and bathroom wall" in another home.

She added: "No-one has been injured which is quite surprising really. It's a total miracle."

Strathclyde Police said it was believed a total of five homes in Ladeside Drive, opposite the quarry, had been damaged by debris…."

A spokesman for Strathclyde Fire and Rescue said: "Fire crews were immediately tasked with searching the dwellings for any casualties, evacuating the immediate area of non-emergency services personnel and instigating a 300m [984ft] hazard zone in liaison with the police.

"It was subsequently confirmed that, thankfully, no members of the public had suffered any injuries….

Flyrock 86

On December 4, 2013, a blast at Kansas Falls Quarry launched flyrock debris that struck and killed Stephen W. Hetzler, the blaster, who was standing 153 feet (47 metres) from the lead holes of the blast. The largest rock that struck Hetzler weighed approximately 96 pounds.[52]

Stephen W. Hetzler, Lead Man, age 63, was killed on December 4, 2013. He initiated a blast and was struck by flyrock. Hetzler was standing 153 feet away from the lead holes of the blast. The largest rock that struck Hetzler weighed approximately 96 pounds.

Several pieces of flyrock traveled toward Hetzler's location. A rock 19 inches long by 14½ inches wide by 7½ inches thick struck Hetzler in the upper torso knocking him to the ground.

The blast consisted of 66 holes, 3½-inches in diameter to a full depth of 8 feet, laid out in 6 rows on a 9-foot by 9-foot burden and spacing. The bench height was 8 feet with no drill log. One lead-in line was observed during the investigation. The amount of explosive product, ANFO, loaded in the 66 holes was 716 pounds. The holes were stemmed with 5 feet of drill cutting

***The investigators reviewed the basic blast design and determined the flyrock that resulted in this accident was a blow-out type of flyrock due to the straight path that directly impacted the victim. Investigators determined the flyrock was travelling approximately 400 miles per hour**.* [emphasis added]

***Steve Hetzler (victim) had approximately 16 years of mining experience and worked at this mine for 11 years, 48 weeks, and 4 days. A representative of MSHA's Educational Field Services staff conducted an in-depth review of the mine operator's training records. The training records for Hetzler were reviewed. All of his required MSHA Part 46 training, including annual refresher training and task training, was found to be up-to-date and in compliance with MSHA requirements**.* [emphasis added]

***The accident occurred because management failed to establish safe work procedures for persons to follow during blasting activities at the mine. The victim was using his work cellular phone to video record the blast. Hetzler was positioned too close to the blast and was not provided a blasting shelter to protect him from flyrock**.* [emphasis added]

***Corrective Action: Management developed and implemented a Blasting SOP [Blasting Standard Operating Procedures], addressing the positioning of miners during blasting procedures. Miners will be located at least 1,000 feet [305 metres] from the blast area. The blaster will always be located inside a blasting shelter.** The SOP also addresses*

[52] United States Department of Labor, Mine Safety and Health Administration, Metal and Nonmetal Mine Safety and Health, Fatal Explosives and Breaking Agents Accident December 4, 2013, MAI-2013-19, https://www.msha.gov/sites/default/files/Data_Reports/Fatals/Metal/2013/ftl13m19.pdf.

communications of the blaster with the other miners to clear the blast area before the blast is initiated. All persons involved in blasting were trained regarding the SOP. [emphasis added]

Flyrock 87

On April 25, 2005, a blast conducted by Maine Drilling and Blasting at a quarry in Raymond, HN, launched flyrock debris that resulted in damage to buildings and vehicles over 1,000 feet (305 metres) away.[53]

Flyrock 88

On July 11, 2008, flying debris from a blast at a Uganda quarry struck teenager Ismail Kayima while riding in a lorry (truck) and had to have a badly broken leg amputated.[54]

A teenager has had to have a badly broken leg amputated after being struck by a flying rock while riding in a lorry, while residential areas have been affected by flying explosion debris. A school roof and a health centre were damaged adjacent to the Cementers quarry.

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President, International Forensic & Litigation Appraisal Services Inc. and
International Valuation Consultants Inc.
Email : info@intval.com Web site : www.intval.com

[53] Arthur Hendrickson, "Danger from Flyrock," The Valley Reporter, October 16, 2008, https://www.valleyreporter.com/index.php/news/my-view/4368. -

[54] "Mine, Quarry, Pit and Tunnel Accidents From www.safetynews.co.uk," Courtesy of Burgess and Associates-Hot Zone USA, www.hzburgess.com, August 2013. http://sota-training.com/pdfs/mines-quarry-pit-tunnels-2007-2013.pdf.

Blasting Quarry Operations: Damage from Airblast (Noise & Concussion) and Vibrations, and Complaints and Lawsuits (7-Sep-21)

> ***Rock quarrying and stone crushing is now a global phenomenon and has been the cause of concern everywhere in the world, including the advanced countries (Lameed and Ayodele, 2010). Quarrying negatively affects the environment in a variety of ways from exploration and blasting, transport and disposal of waste rocks. The major environmental effects are destruction of vegetation, disruption of animal habitats, diversion and blockage of natural drainage systems, soil erosion and river siltation, noise,…vibration [and flyrock debris] and dust pollution (Maponga and Munyanduri, 2001) [p. 316].***[1] [emphasis added]

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[1] Marzouk, S.H. and Mohamed, Abuo El-Ela A., "Influences of limestone stone quarries on groundwater quality," *Int. J. Hum. Capital Urban Manage.*, 3(4): 315-324, Autumn 2018, http://www.ijhcum.net/article_34117_cb311e43b286d3457041ebfec70faa52.pdf.

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Introduction

According to a 2012 Power Point presentation prepared by Morin of Explotech,[2]

- *The derivatives of blasting which cause the greatest amount of concern to property owners adjacent to blast sites are flyrock, ground vibrations and overpressure (air blast). [Slide 90]. [underscoring added]*

Airblast and Ground Vibrations are defined as follows:

> ***Airblast*** *– Air over Pressure (air blast) is often used to describe the air waves, which are generated by blasting activities. Air waves are compressed waves that travel through the air. Under certain weather conditions and poor blast design, air blast can travel considerable distances. Audible air blast is called noise, while air blasts at frequencies below 20 Hz and inaudible to the human ear are called concussions. Over pressure is usually expressed in pounds per square inch (PSI) or in decibels. (dB) (Bollinger, 1971, Siskind et al., 1980, Konya and Walter, 1985, ABC, 1987) [p. 103].*[3]
>
> ***Ground Vibrations*** *– Is a technical term that is used to describe mostly man-made vibrations of the ground, in contrast to natural vibrations of the Earth studied by seismology. For example, vibrations caused by explosions, construction works, railway and road transport, etc. – all belong to ground vibrations. [Wikipedia, https://en.wikipedia.org/wiki/Ground_vibrations]*

This research paper deals primarily with ground vibrations and airblast from blasting quarry operations, briefly touching on flyrock, and the complaints and lawsuits brought against companies engaged in rock blasting. Noise and vibration, along with flyrock, are *contaminants* under the *Ontario* Environmental Protection Act (EPA), and have the potential to

- adversely or permanently impact the environment
- compromise the health or safety of human and non-human life
- negatively impact the quality of human and non-human life
- damage personal and real property
- damage or preclude crop production (e.g., organic, specialty farming, etc.)
- disrupt business operations and recreational activities
- cause nuisance or trespass

According to A. G. Taylor of the Ministry of the Environment, the acoustic wave (concussion) generated by quarry blasting can be of greater significance than ground

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[2] https://www.slideserve.com/ami/city-of-ottawa-explosives-information-session-2012-explotech-engineering,

[3] Mohamed, Adel M. E.," Quarry blasts assessment and their environmental impacts on the nearby oil pipelines, southeast of Helwan City, Egypt," *NRIAG Journal of Astronomy and Geophysics*, Volume, Issue 1, June 2013: 102-115, https://reader.elsevier.com/reader/sd/pii/S2090997713000308?token=F95F3CA4B70080D9A6CCA1A5C6E7355F0501C222785348C0711CD4F4EC3F93ACB38A575A96DA1F9D6924309479117970&originRegion=us-east-1&originCreation=20210728140702.

vibration induced by the same blast, and that sonic boom research can be applied to quarry blasts:[4]

> *Quarry blasts were monitored during 1973--1974 at several locations in Southern Ontario to determine if the acoustic wave (concussion) was likely to be of significance from the points of view of structural damage and human annoyance. The monitoring instrumentation used included sonic boom microphone-- carrier system and FM tape recorder.* ***The characteristics of the blast wave, overpressure, spectrum, and duration were analyzed using a storage oscilloscope and real-time analyzer and were compared with the characteristics of sonic booms. The two phenomena were shown to be similar in spectral content to most energy in the infrasonic region; the overpressure at several thousand feet from a blast can be similar to that of a sonic boom, whereas the duration of the pressure perturbation is several times longer for a blast than for a sonic boom. It is concluded that damage and annoyance criteria developed from sonic boom research may reasonably be applied to quarry blasts. It was also found that in many instances the acoustic wave can be of greater significance than ground vibration induced by the same blast****.* [emphasis added]

Rock extraction typically involves the use of explosives, and requires preparation of a proponent-driven Blast Design Report (Blast Impact Assessment), which theoretically only measures overpressure sound (airblast) and ground vibrations, both of which are contaminants. The theoretical predictions of ground vibration and airblast must be measured along the perimeter of the proponent's site to ensure that the contaminants do not escape and cause, or are likely to cause, external *adverse effects*. Subsurface conditions of the lands where blasting is to occur are unknowable, as are the subsoil conditions of neighbouring private third-party properties over which the quarry proponent has no legal right of trespass.

> ***Blasts are made with the same mixture of ammonium nitrate and fertilizer and fuel oil used in the bomb that killed 168 people [including 19 children, and more than 500 people were injured] in Oklahoma City [in 1995]…., but the mining explosions are 10 to 100 times stronger," Loeb wrote in August 1997. (U.S. News and World Report)***
>
> ***Blast detonations associated with the larger mines have increased from approximately 100,000 pounds [45,359 kilograms] to over 1 million pounds [453,592 kilograms] of explosives. (Ken Ward Jr., August 3, 2003)***

According to the judge's ruling in *Macdonald v. Construction LTEE et al.*,[5]

> *…**[T[he use of explosives, on the balance of probabilities, does involve danger to another's property. I cannot see how anyone can possibly describe such an operation as not being, in the language of the cases on the subject, "extra hazardous" or "inherently dangerous."*** [emphasis added] (Citing J. P. Porter Co. Ltd. v. Bell, [1955] 1 D.L.R. 62, 35 M.P.R. 13, and Rylands v. Fletcher)

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[4] Taylor, A.G., "Quarry blast acoustic wave (concussion) – response of structures and human annoyance," *Ontario Ministry of the Environment*, Toronto, *JASA*, https://asa.scitation.org/doi/pdf/10.1121/1.1995087.

[5] *Macdonald v. Desourdy Construction LTEE et al.*, 1972 CanLII 1150 (NS SC), <https://canlii.ca/t/gwg69>, retrieved on 2021-08-17.

Vibration and Airblast (Noise) Are Contaminants Under the Environmental Protection Act of Ontario

In *R. v. Chenard*,[6] the accused was charged with discharging a contaminant, namely *vibration*, from blasting explosives into the environment in contravention of Section 14(1) of the Environmental Protection Act of Ontario (EPA), R.S.O. 1990, c.E.-19. The vibrations damaged and disrupted the use and enjoyment of the Webster's' property.

> ***[3]*** *Section 14(1) of the Environmental Protection Act sets out:*
>
> > *Despite any other provision of this Act or the regulations, no person shall discharge a contaminant or cause or permit the discharge of a contaminant into the natural environment that causes or is likely to cause an adverse effect.*
>
> ***[4]*** *"Adverse effect" is defined in the Act and means one or more of:*
>
> *(a) impairment of the quality of the natural environment for any use that can be made of it,*
> *(b) injury or damage to property or to plant or animal life,*
> *(c) harm or material discomfort to any person,*
> *(d) an adverse effect on the health of any person,*
> *(e) impairment of the safety of any person,*
> *(f) rendering any property or plant or animal life unfit for human use,*
> *(g) loss of enjoyment of normal use of property, and*
> *(h) interference with the normal conduct of business; ("conséquence préjudiciable)". [underscoring added]*
>
> ***[6]*** *"Contaminant" is defined in section 1 of the Environmental Protection Act as follows:*
>
> > *"contaminant" means any solid, liquid, gas, odour, heat, sound, vibration, radiation or combination of any of them resulting directly or indirectly from human activities that may cause an adverse effect".*

Chenard, a *blaster* by trade, was retained by Mr. Tulloch to excavate a trench to accommodate the installation of water and sewer lines to service a new residence on the lakefront. The Websters own the adjacent property, whose home is 30 years old, and situated approximately 114 feet (35 metres) from the blast area.

> *[10] Prior to any blasting taking place, a pre-blast survey was made at the Webster residence by a contractor who identified certain damage accepted by Mr. Webster as being caused by his own personal renovations. The damage was documented.*
>
> *[11] Mr. Chenard began a series of 30 blasts through bedrock on July 17, 2001 with the last blast planned for July 25, 2001.*
>
> *[12] Because of the fact that the first 30 blasts were insufficient to accommodate the proper flow for the sewer and water line, it was necessary to perform two more blasts on September 6, 2001 [bringing the total blasts to 32].*
>
> *[13] While there was a pre-blast inspection of the Webster residence before the start of the first series of blasts, there was no pre-blast assessment prior to the commencement of the September 6 blasting.*
>
> *[15] On the 8th of September, 2001, Mr. and Mrs. Webster discovered a leak in the basement bathroom ceiling. A pipe had bust in the ceiling, water was pouring in, and it became necessary to*

[6] *R. v. Chenard*, 2005 ONCJ 501 (CanLII), <https://canlii.ca/t/1mfqs>, retrieved on 2021-08-24.

> *retain the services of a local plumber on an emergency basis. Eventually the ceiling tile and the entire bathroom area had to be refinished.*

Following a four-day trial, the Justice of the Peace accepted the evidence of the homeowners, which is summarized as follows:

> *First of all, there was a vibration. Ms. Webster's evidence about the jolt she felt was credible and it was uncontradicted. She was at the best position to feel the jolt. She was standing on a floor beneath the surface of the ground, and the foundation of their home rested on the same bedrock as that being blasted. She was within 114 feet [34.7 metres] of the blasting. Also, the evidence of the boat rocking and all of the pictures being askew in the home support the finding that there was a vibration.*
>
> *The second, that the vibration was discharged into the natural environment, was also proven. Mr. Chenard put explosives into some of the holes, although not all. The Court is satisfied that Mr. Chenard discharged the contaminant, that being the vibration, into the natural environment.*
>
> *Number three, that there was an adverse effect. The Court is satisfied that there was an adverse effect. There were numerous damages to the Webster home. Two days after the blast of September 6 the Websters found a major repair that they had to do in their basement bathroom.*

While the homeowners' evidence was accepted by the Justice of the Peace, she had concluded that the discharge of the *vibration* contaminant occasioned by the blast on September 6, 2001 had not been proven as the cause of the *adverse effect* (i.e., damage to, and disruption of use and enjoyment of the Websters' residence).

> ***Finally, and this is the element that was not proven, the discharge of the contaminant on September 6 caused the adverse effect****. There was little evidence to support a finding that the Websters' loss of enjoyment of normal use of their property was directly attributable to the blast that was the substance of the charge. Witnesses describe the September 6th blast as the largest blast. However, they also admitted that their comparison took into account the fly rock that they saw, the blasting mats lifting off the blast area, and the sound of the explosion. The only witness who felt the actual vibration was Mr. Webster.* [emphasis added]

The Crown appealed against the ruling of the Justice of the Peace, and, while the appeal court accepted the findings of the Justice of the Peace, the appeal court concluded that the trial court failed to consider the secondary aspect: "or was likely to cause an adverse effect." In defining the term "likely," the appeal court relied on the following:

> ***[40]*** *The word "likely" carries with it a tremendous amount of responsibility to the trier of fact and to any appellate review. In Black's Law Dictionary (Fourth Edition) it equates to "probable" and "in all probability". In the Oxford Illustrated Dictionary "likely" is referred to as "probable" and "such as may well happen".*
>
> ***[41]*** *In the case of R. v. Walter Wood (28 April 1987), Provincial Offences Court, [unreported], a decision by Justice of the Peace W. G. Jacklin, he refers to R. v. Carbone, 1973, 20 Criminal Reports, New Series, 313, relating to substantial likelihood.*
>
> *The learned Judge in dealing with substantial likelihood:*
>
> > Does not mean proof beyond a reasonable doubt, but is 'more akin to the balance of probabilities in that the evidence should substantially weigh in favor of the likelihood of a repetition of the offence.
>
> *Here, we're dealing with likely. I am of the opinion that in fact likely is something less than substantial likelihood. It has been found that substantial likelihood is akin to the balance of*

probabilities and in the matter of Labatt Breweries of Canada Limited, it connotes a probability.

[42] *Also,*

Dealing with the issue under Regina v. Toronto Refiners and Smelters, the Ontario High Court of Justice, the Divisional Court, Volume 20, Ontario Reports, 2nd Series, at page 772. At page 774:

> The questions stated should be determinative of the issue before the Court. It is argued by the respondent that the words "causes or is likely to cause harm or material discomfort to any person" are descriptive of the contaminant. In our view, in order to succeed, it must be shown that the contaminant did in fact cause or was likely to cause, in the circumstances that existed, harm or material discomfort to a person.

In reversing the judgment of the lower court, the appeal court found that the Justice of the Peace had failed to consider the words "or was likely to cause an adverse effect" or to consider "the accumulative effect of **all** 32 blasts": [emphasis added]

[43] *Based on the evidence that was adduced during the course of the four day trial, it is evident to me that the Justice of the Peace did not consider the words "or was likely to cause to an adverse effect" or to consider the accumulative effect of all 32 blasts, including those on 6th of September, 2001.*

The City of Burlington has a Noise and Nuisance by-law (No. 19-2003),[7] which, in part, states,

No noise or vibrations shall be made, caused or created so as to be heard or felt or otherwise perceived outside the property and which are, in the view of all the circumstances including the nature of the neighbourhood and the use to which adjoining properties are put and the time of day during which such noise or vibrations are made, caused or created excessive or which are, or may cause a nuisance to the public generally or to others residing or carrying on a manufacture, trade or business in the vicinity.

Domestic animals are clinically affected by rock-blasting, as testified to by Dr. Lisa Dietrich (Public hearing July 13, 2015) in the application for a permit by Tory Sand & Gravel submitted to the Town of Nassau.

…Testimony from Veterinarian Dr. Lisa Dietrich…indicates that domestic animals are clinically affected by dust, allergens and other irritants that may result from blasting at the quarry, and suffer stress from anxiety related to equipment and blasting noise. We think that those same things could also cause safety concerns for the handlers of the animals. It is reasonably foreseeable that there could be impacts on domestic animals which could result in added expenses for the household, lower the animal's quality of life, and as related to agriculture, reduce farming and agri-tourism opportunities.

The research conducted makes it abundantly clear that quarry blasting conducted within regulatory limits does not eliminate property damage from ground vibrations or airblast, and has a negative impact on health and quality of life of residents in nearby communities. The standard response from quarry operators to complaints from residents of communities impacted by blasting is "that the quarry is operating within regulatory limits"

[7] file:///C:/Users/Windows%207%20PC/Downloads/19-2003%20(5).pdf.

and, thereby, avoid acknowledging and accepting legal responsibility for payment of damages.

> *Various sources of vibrations are involved in construction and mining projects such as blasting, heavy equipment, pile driving and dynamic compaction. Elastic vibrations that are generated by these sources may harmfully affect the nearby residential areas. Their effects include annoyance of people and cosmetic and structural damage to the buildings [p. 1].*[8]

Majority of Complaints Over Blasting Quarries Within 500 to 700 Metres

As referenced in the July 2014 Department of State Development *Resource Area management and Planning Final Report*,[9] the *Urban Growth Management for Metropolitan Adelaide* (Australia) report discusses the findings of complaint data received by quarry operators, the EPA, PIRSA (Department of Primary Industries and Regions), and the City of Tea Tree Gully with regards to excavation activity within and adjacent metropolitan Adelaide, and indicates average distances of around 500 to 700 metres "capture" the majority of complaints for hard rock quarries.

> *The majority of complaints received were in relation to blasting activities, with the average distance for these complaints occurring at 489m from the mine/quarry. [2.3.2, p. 20]*
>
> *Dust was also a common complaint, the average complaint distance relating to dust from hard rock quarries occurred at a distance of 690m...indicating that blasting activity is likely to cause dust to travel further distances.* [p. 20]
>
> *The average distance for noise complaints for hard rock quarrying was 675m…[p. 20]*
>
> *The highest frequency of complaints for hard rock quarries occur between 500m and 550m…*[p. 20]
>
> *The findings in this report show that while 60% of blasting complaints were received at a distance of 500m or less, the majority occurred at around the 500m. This would suggest that for blasting operations, a separation [or setback] of at least 500m would be needed.* [p. 20]

No Safe Level of Vibration For Threshold Damage to Nearby Structures or Dwellings Caused by Blasting

The susceptibility of a structure or dwelling to damage from blasting depends on vibration levels, excitation frequencies [frequency at which body is made vibrate in forced vibration], and related site and structure factors (Singh and Roy 2010), and there is no absolute minimum vibration damage threshold whereby blasting or environmental or occupant-related vibration could precipitate a crack.[10]

> *…**The threshold level of cracking is highly dependent on the level of residual stresses present that may reduce the apparent PCV level causing damage. It is widely accepted among blast researchers that the lengthening of old cracks and formation of superficial "hair-sized new cracks constitutes a threshold damage level (Rainer 1982; Northwood et al.***

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[8] "A Case Study of Blast Vibration Modelling in The Hanason Servtex Quarry, Garden Ridge City, Texas," A Thesis by Mohamed Mahmoud Ahmed Radwan, Texas A&M University, December 2016, file:///C:/Users/Windows%207%20PC/Downloads/RADWAN-THESIS-2016%20(6).pdf.

[9] Department of State Development *Resource Area Management and Planning Final Report*, July 2014, https://energymining.sa.gov.au/__data/assets/pdf_file/0020/240662/2014-07-22_DSD_Resource_Area_Management_and_Planning.pdf.

[10] Heath, D. J., Gad, E. F. and Wilson, J. L. "Vibration and Environmental Loads Acting on Residential Structures: State-of-the-Art Review," © 2015, *American Society of Civil Engineers*.

> ***1963; Singh and Roy 2010; Siskind et al. 1980; Stagg et al. 1984; Dowding 1996). Few publications present observations of damage and corresponding ground motion measurements****. Dowding (1996) notes the only definitive method of correlating the incidence of cracking with blast vibrations is to conduct a pre- and postvibration crack survey, which will also reduce complaints and lawsuits.* ***The identification of an appropriate limit unlikely to cause any damage is made all the more difficult by the presence of residual stresses, particularly older structures, resulting from settlement, poor maintenance, weather cycles, and prior repair and renovation (Konon and Schuring 1983). For this reason, Siskind et al. (1980) note there may be no absolute minimum vibration damage threshold whereby blasting or environmental or occupant –related vibration could precipitate a crack****.* [emphasis added]

Vibrations Ruled a Public Nuisance

In *Fraser (Re)*, 2018 NSUARB 74,[11] in which the Board ruled that *vibrations* are a public nuisance, Murphy went on to explain the causation of some of the damage attributed to vibration and his reliance on the *Vibration Guidance Manual of the California Department of Transportation (Caltrans)*:

> ***When analyzing distance from the source of the vibrations to a house, the composition of the soil and ground through which the waves must travel is significant to the readings that are achieved at various distances. In every single case, it may be different because of the different subterranean composition. Consequently, distances that have been created in a laboratory do not necessarily work in the real world unless one can exactly duplicate the subterranean composition and the specific house structure [para. 184]*** [emphasis added]
>
> ***…[Murphy].stated every experiment is specific to the facts of that soil composition and the specific house structure [para. 185]****.* [emphasis added]
>
> ***…[T]here's so many factors that go into vibration and the effects on a structure. It's impossible to duplicate those in a scientific setting, to duplicate them all [para. 185]****.* [Board's emphasis]
>
> *Caltran's noted vibrations can cause damage to structures….[para. 170] The damage they can cause is dependent upon the structure (J. Pistrol, F. Kopf et. al, Ambient Vibration of Oscillating and Vibrating Roller:* ***Apart from the Characteristics of the excitation (duration, frequency, magnitude, etc.) the immission on buildings highly depends on the type of structure, material properties, stiffening elements, inherent damping, natural frequencies and other building parameters [para. 171]****.* [emphasis added]
>
> *And now there's some jurisdictions that have determined that – with experience, that there has been – damage has occurred at the 5 millimetres per second, and so they're saying – they're picking that as a safe threshold and then – but basically what they're saying is you've got to do monitoring and you have to do pre-condition surveys. These are the ways that the municipality, the province, the state – you know, that's the way they're going to have to try to ensure that things are dealt [with] fairly.* [Board's emphasis]

Strict Liability Extends to Ground Vibrations and Concussions (Airblast) From Blasting

In *Enos Coal Mine v. Schuchart et al.*,[12] the Indiana Supreme Court ruled there is no logical reason not to extend strict liability for property damage from *vibrations* simply because there is no physical trespass as in falling debris (flyrock) from an explosion on nearby land.

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[11] *Fraser (Re)*, 2018 NSUARB 74 (CanLII), <https://canlii.ca/t/hrg94>, retrieved on 2021-05-09.

[12] *Enos Coal Mining Company v. Schuchart et al.*, 243 Ind. 692 (1963) 188 N.E.2d 406, https://scholar.google.com/scholar_case?case=5259210695212382453&q=%22a+little+damage+is+reasonable%22&hl=en&as_sdt=2006.

The court ruled that the common law principle of liability in trespass applies equally where damage is caused only by *vibration*, commenting by way of analogy, as follows:

> *In these days of nuclear explosions, the breaking of sound barriers by airplanes and missiles, violent explosions from artillery and gunnery practice (to mention but a few of the advances of science), nearby buildings and property can be shattered or destroyed as effectively as by an earth quake without any physical invasion of the property.*
>
> *The United States Supreme Court has recognized these modern problems in holding that property owners are entitled to compensation for deterioration in property values caused by noise and vibration of jet planes in the use of air space near an airport. Griggs v. Allegheny County (1962), 369 U.S. 84, 82 S.Ct. 531, 7 L.Ed.2d 585.*

In *Spano v. Perini Corp.*,[13] the Court of Appeals of New York declared that "one who engages in blasting must assume responsibility and he is liable without fault for any injury he causes to neighboring property." The Spano Court overturned the use of negligence for nontrespassory blasting damages for the following reasons:

1) *Existing and out-of-state court decisions use strict tort liability for construction blasting;*
2) *Individual property rights are a concern;*
3) *Strict tort liability is used for accidental explosions;*
4) *It is difficult to prove negligence in blasting cases;*
5) *Blasting involves a substantial risk of harm; and*
6) *It is problematic to determine which party should bear liability for blasting damages [p. 209].*[14].

In *Wiley v. Pittsburg & Midway Coal Min. Co.*,[15] the Missouri Court of Appeals acknowledged that damage to property by *concussion* or *vibration* from blasting must be demonstrated by circumstantial evidence because

> ***the concussions or vibrations that travel through the air or the earth cannot be seen***. Donnell v. Vigus Quarries, Inc., 526 S.W.2d 314, 316 (Mo.App.1975); Poston v. Clarkson Construction Co., 401 S.W.2d 522, 525 (Mo.App.1966). [emphasis added]
>
> *From cases such as Summers v. Tavern Rock Sand Co., 315 S.W.2d 201 (Mo.1958), it appears that a submissible case for damages caused by blasting may be made on testimony that vibrations were felt coincidentally with the detonation of the explosive and that physical evidence of structural damage was observed thereafter. Thus, in the present case, plaintiffs' testimony of the vibrations sensed, corroborated by the calendar diaries, and the perceived cracks in walls and floors was enough at least to survive a motion at the close of plaintiffs' evidence.*

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[13] *Spano v. Perini Corp.*, 25 N.Y.2d 11 (1969), https://scholar.google.ca/scholar_case?case=17690906301222304702&q=spano+v+perini+corp&hl=en&as_sdt=2006.

[14] file:///C:/Users/Windows%207%20PC/Downloads/Is_Construction_Blasting_Still_Abnormally_Dangerou%20(2).pdf.

[15] *Wiley v. Pittsburg & Midway Coal Min. Co.*, 729 S.W.2d 228 (1987), https://scholar.google.ca/scholar_case?case=16844615106345768138&hl=en&as_sdt=2005&sciodt=2006.

In *Associated Contr. Stone v. Pewee Val. San. & Hosp.*,[16] the Kentucky appellate court upheld the lower court's injunction preventing a proposed quarry from being established a short distance southeast of the City of Pewee Valley, in a rustic neighborhood with no industry and no public water supply. The suit to prevent operation of a blasting quarry was brought by over 50 parties, with proof clustered along three salient issues:

1) *Lowering of the "water table" likely to result from drainage of underground waters, by force of gravitation, to and out of the face of the quarry when the rock formations are cut open;*
2) *Damage to the natural water supply through disturbance, by the use of explosives at the quarry, of underground barriers that now serve to impound the water; and*
3) *Disruption of the peace and quiet by vibrations from blasting.*

Apart, however, from the water phase of the case, there is other and more positive proof that the operation of the quarry will materially affect the peace and quiet of the neighbors in the enjoyment of their homes. It so happens that before the institution of this proceeding the defendants set off at the quarry site a 2,000-lb.[907 kilograms] test charge of dynamite, a quantity they admit to have been substantially smaller than they expect to use routinely. This blast was heard and the tremor felt by several of the plaintiffs in their homes nearby. One said that his television set, the chimney, and "every window in the house" shook. Another said the noise caused his wife to jump up and scream and the concussion "actually blew the curtains out." Some of the plaintiffs live directly across the road from the quarry property. ***If their homes were shaken by the test shot, it is certain that they would be repeatedly shaken by the larger shots expected to be used in the regular course of business. We think this is an interference they should not be forced to suffer****.* [emphasis added]

The appeal court concluded that the rule of nonliability for damage by *concussion* or *vibration* is inconsistent with the principles set forth in Louisville Refining Company v. Mudd, Ky. 1960, 339 S.W.2d 181, for the determination of what is a nuisance. The appeal court held that the lower court's finding that "a nuisance necessarily would result was not clearly erroneous."

…[B]y their own stipulations and admissions during the course of trial the defendants left no room to suppose that they could or would conduct their operations in any manner or on any scale that would not involve a shaking of the environs occupied by the plaintiffs. Their case was honest and forthright. They made no pretense that this particular result would not be a necessary incident of their business as they intended to operate it.

As noted in the Northern Kentucky Law Review (Vol. 8/323), in reference to an Ohio case involving blasting,

If the means employed [blasting] will, in the very nature of things, injure and destroy his neighbor's property, notwithstanding the highest possible care is used in handling of the destructive agency, the result to the adjoining property is just as disastrous as if negligence had intervened. If one may knowingly destroy his neighbor's property in the improvement of his own, it is little consolation to the neighbor to know that his property was destroyed with due care and in a scientific manner *[p. 334].* [emphasis added]

[16] *Associated Contr. Stone v. Pewee Val. San. & Hosp.*, 376 SW 2d 316 (1963), https://scholar.google.ca/scholar_case?case=5042499607404372 94&q=%22quarry%22+and+%22concussion%22&hl=en&as_sdt=2006.

In *J. P. Porter Co. v. Bell et al.*,[17] the Nova Scotia Court of Appeal upheld the trial court's ruling that Porter was responsible for structural damage from ground vibrations to three dwellings distant 1,430 feet (436 metres), 2,250 feet (686 metres) and 2,275 feet (693 metres) from where Porter conducted 198 blasts during the period of August 15, 1951 to April 3, 1952. Porter was found strictly liable for the damages caused to the Plaintiffs' houses under the rule of *Rylands v. Fletcher*.

> *From August 15, 1951, to April 3, 1952, inclusive, the defendant engaged in blasting and dredging operations at the Seaward Defence Site; but its blasting operations ceased on February 2, 1952. From this site the houses of the plaintiffs Bell, Overstone and MacDonald were situated westwardly about 1,430, 2,250, 2,275 ft, [693 metres] respectively.*
>
> *According to the trial Judge "the rock being blasted and removed was of sedimentary origin and was stratified formation and that same formation extended westerly from the point of blasting to and beyond the location of the plaintiffs' houses and dipped about 10 degrees toward the west. This stratified rock was broken or cracked approximately at right angles to the dip at various intervals."*
>
> ***There is no doubt that the detonation of the dynamite during the period in question in 198 blasts, comprising a total of 38,343 pounds of explosive, did cause vibrations in the submarine rock which extended to the adjoining land-rock formation and caused the houses to vibrate**. ["The individual blasts involved the detonation of dynamite in amounts ranging from 15 to 720 lbs. [327 kilograms in drill-holes ranging in number from 1 to 12."]* [emphasis added]
>
> *The first essential question, whether the blasts and the resultant vibrations caused the damage complained of, was answered by the trial Judge, after an exhaustive examination of direct and opinion evidence, as follows: "**I accordingly find that each of the plaintiffs' houses was substantially damaged by their vibratory motion which was in turn caused by the rock vibrations originating at the defendant's blasting operations and transmitted through rock from the point of origin to the rock beneath the houses on which they stood**." In evaluating the weight of this evidence he was quite justified in preferring the former.* [emphasis added]
>
> ***In my opinion there was ample evidence to support this conclusion on the issue of causation in fact**. The trial Judge was faced with evidence which on this issue consisted "of what a large number of credible witnesses actually saw, felt and heard" supported by competent opinion evidence on the one hand; and of competent opinion evidence to the contrary effect on the other hand.* [emphasis added]

Quarry Blasting Operations Ruled a Public Nuisance

In *Attorney-General. v. P.Y.A. Quarries Ltd.* [1958] EWCA, Civ 1[18] *flyrock, fugitive dust* and *ground vibrations* involving 28 houses, a farm and two highways, were ruled public nuisances by the appellate court, noting that the trial judge devoted a day to observe the blasting quarry operation for himself.

> *…[T]he judge devoted a day to a view of the premises, and blasting operations were carried out in his presence. In the course of his Judgment the learned Judge arrived (in brief) at the following findings. So far as the flying stones were concerned, he said that there was really no defence at all; that the case was "absolutely proved at the time the Writ was issued"; and that, notwithstanding the installation of the wagon drill, he was quite satisfied that the nuisance had not been wholly abated and that he should grant an injunction. As to vibration, he came to the conclusion "that for some reason - I cannot tell what it is - there is on occasion such vibration as to frighten people, to shake*

[17] *J. P. Porter Co. Ltd. v. Bell et al*., 1954 CanLII 303 (NS CA), <https://canlii.ca/t/gwcvk>, retrieved on 2021-08-21.

[18] https://www.bailii.org/ew/cases/EWCA/Civ/1958/1.html.

their houses and to make them thoroughly uncomfortable, and that such vibration as that, when it is caused, is a nuisance and must cease." With regard to dust, the Judge said that it would not be right to base an injunction on the explosions, having regard to their comparative rarity since the end of 1953, but that excessive dust emanated from the secondary crusher when the door leading into it was left open, as was frequently the case. Finally he said:

> "I have no doubt that there is dust nuisance from this place - of course, only in dry weather. I have no doubt that they have not done anything to cope with it and I am going to order them to do so by injunction."

The quarry owner failed in its effort to convince the trial judge that an inadequate number of people were impacted by the blasting quarry operations to qualify as a public nuisance.

D[efendants] owned a mining [quarry operation] that caused noise and dust pollution to a section of the public, and tried to argue that since it only affected a section of her majesty's subjects [twenty-eight houses, a farm and two highways], not her subjects as a whole, it couldn't be a public nuisance. C[ourt of] A[ppeal] rejected this, saying any nuisance which materially affected the reasonable comfort and convenience of life of a class of Her Majesty's subjects was a public nuisance. Whether the no. [of] citizens affected was enough to constitute a class depends on the facts of each case. An injunction was granted.

Denning LJ: To see if it is a public nuisance, we should look at the reason of the thing and to say that a nuisance is a public nuisance which is so widespread in its range or so indiscriminate in its effect that it would not be reasonable to expect one person to take proceedings on his own responsibility to put a stop to it, but that it should be taken on the responsibility of the community at large. E.g. blocking up a public footpath that is only used by a couple of people:[is] still a public nuisance since it is indiscriminate against those who may wish to walk along it. Another example is a landowner who "permits gypsies with filthy habits to encamp in a residential neighbourhood".

Romer LJ: It does not have to be shown that all members of the class have been affected: it is enough that a representative cross section of the class has been affected.[19]

Quarry Owner's Experts Testify That Every Property Owner Near a Quarry Is Uniquely Impacted By Blasting

In *Freeman v. San Rafael Rock Quarry Inc.*,[20] pursuant to a June 2001 Marin County (California) Grand Jury report, which was critical of the county's handling of complaints about the quarry and recommended the district attorney institute a nuisance abatement action against the quarry, the homeowners were unsuccessful in their motion for a class action. The nuisances identified in the Grand Jury's report consisted of *dust, noise, blasting* and *truck traffic* attributed to a substantial unlawful expansion of the quarry in 1986 without permits. The appellate court upheld the trial court's refusal to certify the class action for the group of homeowners residing within five square miles of the quarry, which sought non-economic and economic damages based upon allegations of "public nuisance for annoyance, inconvenience, and discomfort."

In denying the motion for class certification, the trial court stated "common questions of law or fact do not predominate," and that "special injury" involves another element where

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[19] *Case summary last updated at 19/01/2020 17:42 by the Oxbridge Notes* in-house law team. https://www.oxbridgenotes.co.uk/law_cases/ag-v-pya-quarries.

[20] *Frieman v. San Rafael Rock Quarry, Inc.* 10 Cal.Pptr.3d 82 (2004) 116 Cal.App.4th 29, https://scholar.google.ca/scholar_case?case=7418002689018790095&q=san+rafael+rock+quarry+inc&hl=en&as_sdt=2006.

proof would vary significantly between the estimated 11,075 class members. The trial court's ruling was supported by two reports prepared on behalf of the quarry owner, both of which acknowledge that the noise and vibration experienced by each class member would vary considerably depending on a number of environmental and property-specific factors:

> *…[T]he Salter report found that "[t]he variation in noise is due to the wide range of distances between the noise sources and homes and shielding of the noise provided by natural terrain, intervening homes and vegetation. Because of these factors, in many locations, neighbors within a few hundred feet of each other have dramatically different exposure." The report notes that noise exposure also varies inside of individual homes due to the orientation of rooms, nature of furnishings, size and construction of windows and whether windows are open or closed.*
>
> *The…report, prepared by Blast Dynamics, Inc., analyzed how blasting at the Quarry affected neighboring residents. This report identified a number of variables in the way that different residents would experience vibration from blasting. These variables include the presence of rock or soil formations that alter the frequency of blast waves, the natural or "resonant" frequencies in each structure that changes the response to vibration, distance from the blast site and differences in the duration of the blasts. The report included a geologic map of the area showing a combination of soil, rock, sandstone, artificial fill, bay mud and marshland under the relevant area. The report noted that soil typically filters out high frequency energy, while rock transmits it. Test blasts were detonated at the Quarry and instruments were placed at various locations to evaluate the differing effects. The results of the velocity measurements showed a decrease in impact with distance from the blast site, but the frequency measurements showed no consistent pattern.* ***The report concluded that: "[t]he test data shows that it is unreasonable to expect that any two sites will experience the same blast related vibration****…."* [emphasis added]

According to Gui, et al.,[21] rock blasting can induce many adverse effects on the surrounding environment, including structural damage, business disruption and emotional traumatization of humans (pets, livestock and wildlife):

> *Explosion induces ground and structure vibration [1, 2] and annoying noise. When the explosive is detonated, an extremely high pressure pulse from the chemical reaction induced energy is generated which is transmitted into rock mass adjacent to the blast hole, producing a dilatational wave that propagates away from the charge. Stress wave due to blasts may cause damage to the surrounding rock and, furthermore, when the wave reaches a free face or open fissure (non-transmission), it will be reflected and converted into tensile wave, which may produce tensile cracking and spalling if the tensile strength of the rock is exceeded by the tensile wave [3, 4]. Also due to the fact that some rock blasting projects are close to the inhabitant area, the surrounding buildings may be damaged due to blasting induced ground vibration if large strength wave propagates in the soil foundation and shock wave propagating through the air [5]. Disruption of some business activities, possible structural damage and emotional-traumatized residents are the problems that need to be addressed.*

[21] https://eprints.ncl.ac.uk/file_store/production/243779/F23A01B2-D058-4FFB-99CD-EA91F34E1A51.pdf.

Noise From Quarry Operations Causes Negligent Infliction of Emotional Distress

In *Town of Stonington et al. v. Galilean Gospel Temple et al.*,[22] the Supreme Judicial Court of Maine affirmed the trial court's award of $5,000 to the Eatons for *Negligent Infliction of Emotional Distress* (NIED) caused by the operation of the quarry.

> *[15]…[T]he Eatons state that the defendants' operation of the quarry "generated noise, dust and interfered with Plaintiffs' possession and use of their property and residence," and that the defendants' "cutting and burning ... deprived Plaintiffs of the safe and quite enjoyment of their home." By echoing language that describes the essence of a private nuisance complaint, the Eatons' complaint provided Cormier and the Temple fair notice of a claim that the operation of the quarry resulted in a nuisance.*
>
> *[12] Competent evidence supports the court's finding that the Eatons suffered from serious emotional distress. Mr. Eaton testified that he suffered from throbbing headaches and depression. Mrs. Eaton testified that the noise has caused her neck muscles to tighten. As a result, she was given muscle relaxants and a collar. Given this testimony, the court did not err in finding that the Eatons suffered serious emotional distress. See Gammon, 534 A.2d at 1283 (holding that the evidence supported plaintiff's NIED claim where plaintiff had nightmares, his personality was affected and his relationship with his family deteriorated).*

In *Manford F. Eaton et al. v. Francis A. Cormier et al.*,[23] the trial court found Cormier and Galilean Gospel Temple jointly and severally responsible for a private nuisance and awarded $20,000 in damages to Manford and Helen Eaton. The award was affirmed by the Supreme Judicial Court of Maine.

> *[2] This is the second time this case is before us. See generally Town of Stonington v. Galilean Gospel Temple, 1999 ME 2, 722 A.2d 1269. We previously determined that the Eatons had properly pled a cause of action for nuisance against Cormier and the Temple and remanded for a trial on the issue, as well as for a determination of whether Cormier and the Temple should be held jointly and severally liable should a nuisance be found. See id. at ¶¶ 13-16,* 722 A.2d at 1272-74.
>
> *[3] Following our remand, the court conducted a hearing in which it took notice of evidence introduced in the prior proceeding and heard additional evidence regarding conditions on the Eatons' property since the prior proceeding. It also heard testimony from officials of the Town of Stonington regarding their monitoring of the noise levels generated by the quarry and testimony from Cormier's son who acts as foreman at the quarry. The court then issued its decision in which it found that the quarrying activities constituted a private nuisance…*
>
> *[7]…[A]s we noted in our last opinion in this case, a landowner is liable for a nuisance created by the activity of a third party on the land if (1) the possessor knows or has reason to know that the activity is being carried on and that it is causing or will involve an unreasonable risk of causing the nuisance, and (2) the possessor consents to the activity or fails to exercise reasonable care to prevent the nuisance. Galilean Gospel Temple, 1999 ME 2, ¶ 21, 722 A.2d at 1273 (citing RESTATEMENT (SECOND) OF TORTS § 838 (1979)); see also State v. Charpentier, 126 N.H. 56, 489 A.2d 594, 599 (1985) ("liability for common law nuisance may be established if the landowner knew or had reason to know that a public nuisance existed") (citing RESTATEMENT (SECOND)*

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[22] *Town of Stonington et al. v. Galilean Gospel Temple et al.*, 722 A.2d 1269 (1999) 1999 ME 2, https://scholar.google.com/scholar_case?case=11545182235842632857&q=%E2%80%9Cquarry%E2%80%9D+and+%E2%80%9Cvibrations%E2%80%9D&hl=en&as_sdt=2006#[2].

[23] *Manford F. Eaton et al. v. Francis A. Cormier et al.*, 748 A.2d 1006 (2000) 2000 ME 65, https://scholar.google.com/scholar_case?case=4841522329640716275&q=%E2%80%9Cquarry%E2%80%9D+and+%E2%80%9Cvibrations%E2%80%9D&hl=en&as_sdt=2006.

OF TORTS §§ 838 & 839 (1979)); Benton v. Montague, 253 N.C. 695, 117 S.E.2d 771, 776 (1961) ("the owner of land is not liable for injury caused by the acts of a licensee unless such acts constitute a nuisance which the owner knowingly suffers to remain") (emphasis added).

Probability of Damage From Blasting Operations

According to Sam Kiger, former Dean of Engineering at the University of Missouri, vibration damage from blasting is almost an absolute certainty:[24]

> *Sam Kiger…was the expert for the Bim blasting case, which was tried in court in Boone County in March 1999. Kiger is an international expert in protecting federal buildings from blasting damage. After examining 6,000 blasting logs, he testified that there is about a 95 percent chance of damage at a vibration limit of .5 inches/second, if you count each of the holes shot (50 on average) as a separate vibration. In the Bim case, he also testified that low-frequency waves (2 Hz-11 Hz) generated by some blasts can be more damaging. The frequencies can match that of a house and amplify the shaking [p. 16]..*

Freda Harris reached a similar conclusion finding that geological "hot spots" in a community can make vibrations from blasting worse:

> *Freda Harris, who had a blasting case with a mine in Indiana, gathered many documents during the case and subsequent FOIAs of OSM [Office of Surface Mining]. She wrote a manual for Citizens Coal Council. One of her most intriguing findings was that there can be "hot spots" in a community where the geography can make blasts worse. She emphasizes that damage and vibrations can feel worse if a house's natural frequency is approximately between 4 Hz and 12 Hz. The above-ground part of the house often vibrates more than the ground outside and the foundation. Yet, the DEP [Department of Environmental Protection]/OSM standard is based on ground vibration [p. 16].*

An often quoted blasting study conducted by Siskind,[25] arguing that a vibration limit at 0.5 in/sec constitutes a safe blasting limit, has been criticized by other experts and successfully challenged in the courts:

> *Most of the blasting studies of the Bureau of Mines were done by the David Siskind. The FOIAs provided much correspondence between Siskind and other experts, some of it quite critical.* ***A top official of Vibra-Tech, a leader in designing blasting technology, said: "Any criteria…which ignores the frequency of a structure and the frequency content of the ground motion is overly simplistic…Your criteria, as proposed, will neither protect the interest of the citizen and the homeowner, nor will it protect the blaster from alleged damage claims*** *[p. 16]."*[26]
>
> *After the Bureau of Mines was shut down by Congress, Siskind became a private consultant. He testified for the coal company that lost the Bim case. The majority of the blasting cases have overturned his studies, and thereby the limits used by DEP and OSM. As he wrote an OSM official on June 17, 1997: "The battles I am now seeing are not 0.5 in/sec versus 1.0 in/sec. Complainants are trying to dismiss all the science as biased, wrong or nonapplicable. For the most part, they are succeeding in ways that pay off [p. 16].*

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[24] file:///C:/Users/Windows%207%20PC/Downloads/comments-of-the-ohio-valley-environmental-coalition-ovec-po-box-6753-huntington-wv-on-the%20(1).pdf.

[25] "Investigation of Damage to Structures in the McCutchanville-Daylight Area of Southwestern Indiana, *Office of Surface Mining Reclamation and Enforcement Technical Report/1994*, Volume 2 of 3, https://www.osmre.gov/resources/blasting/docs/OSMREReports/McCutchanville-DaylightIN/M-DPart1CompositeReport.pdf.

[26] file:///C:/Users/Windows%207%20PC/Downloads/comments-of-the-ohio-valley-environmental-coalition-ovec-po-box-6753-huntington-wv-on-the%20(1).pdf.

> *Evans [, an engineer for an explosives firm in southwestern Virginia,] said they concentrate much more on the effects of the low frequencies than on per particle velocity [PPV]. The per-particle reading almost never goes higher than .3 inches, well below the regulatory limit of 1 inch per second. However, just as Sam Kiger and Freda Harris determined, the low frequencies are bothersome [p. 18].*
>
> ***Interestingly, the DEP "Surface Mine Blasting Study Guide" acknowledges that the response of the human body is greater at lower frequencies**: "This explains why people file complaints even **when the blasting is conducted at safe (no damage) levels [p. 17]."***
>
> ***The amplitude of the structure response to ground vibrations and resultant strains within building components are also dependent on the efficiency of energy transfer from the foundation to the framework and wall components. The efficiency of energy transfer increases significantly when the natural frequency of the ground vibrations matches the natural frequency of the structure** [p. 103].*[27] [emphasis added]

And, according to Sayed-Ahmed and Naji,[28] ground vibrations can have a damaging effect on residential buildings, as occurred in the two case studies undertaken:

> *Subsurface construction blasting generates ground vibration which may have a damaging effect on residential buildings. Codes of practice define damage criteria to limit the effect of the vibrations resulting from the subsurface blasting on nearby structures. All these criteria are based on the soil Peak Particle Velocity (PPV) generated due to blasting on the ground surface close to the structure. **The real culprit, however, is not the ground PPV but it is the structural response to the ground vibration**. In this paper, the currently adopted safe limit criteria of ground vibrations generated by subsurface construction blasting are presented. Two case studies have been performed on two residential houses located nearby an excavation-by-blasting construction site [ST-051-1]…*
>
> *When a charge is detonated in a solid medium (like rock), a family of waves is generated. These waves generate different particle movement and travel at different wave velocities. The resulting ground-borne vibrations may have an effect on residential buildings ranging from disturbing the occupants to causing severe threshold "cosmetic" or structural damage. Problems may occur as a result of large amplitude (low frequency) vibrations, repeated occurrence of smaller amplitude vibrations, or from differential settlement induced by soil particles rearrangement [ST-051-1].*
>
> *Two case studies have been performed and discussed for two residential houses (one and two storeys) located adjacent to an excavation where blasting was to be used for excavating the rock. Analysis of the accumulated data recorded during blasting is presented and compared to the currently adopted ground vibration safe limit criteria. The PPV and the vibration frequency due to excavation by blasting measured close to these houses satisfied the existing safe limits criteria for subsurface blasting ground vibration. Despite this fact, both houses suffered threshold cracks and one of them even had structural cracks [ST-051-2]…*

In a study of damaged residences beyond 300 metres from a Ugandan quarry undertaken by Yomekpe-Agbeno and Affam (2008),[29] the authors conclude that *frequencies* and

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[27] https://www.osmre.gov/resources/blasting/docs/OSMREReports/McCutchanville-DaylightIN/M-DPart1CompositeReport.pdf.

[28] "Residential Houses Cracking Due to Nearby Construction Blasting: Critical Review of Current Safe Limits," 1st International Structural Specialty Conference, Calgary, Alberta, May 2006, file:///C:/Users/Windows%207%20PC/Downloads/CSCE06ST-051%20(1).pdf.

[29] Yomekpe-Agbeno, S. K. and Affam, M. (2008) "Establishing Ground Vibration Threshold Level for Open Pit Mining Environment – A Case Study," *Ghana Mining Journal*, pp. 19-24, file:///C:/Users/Windows%207%20PC/Downloads/42804-Article%20Text-37701-1-10-20090519%20(2).pdf.

weather conditions are important considerations when assessing damage potential of a particular blast, as are other factors related to type and quality of construction of structures and residences, and distance from the blast site.

Since 2003, when blasting activities started at the Plant North Pit quarry, residents living close to the pit have complained of cracks and general deterioration of their buildings, damages to electrical and electronic appliances and general nuisance by way of fright and noise, In October 2005, the Environmental Protection Agency ordered the temporary suspension of blasting operations at the Plant North Pit quarry.

> *Damage caused to the building structures…cannot be attributed to a single cause alone. There are several causative agents such as; poor building materials quality, poor, foundation problems, differential settlement, ground vibration, ageing and building maintenance culture.* ***The ground vibrations from the extensive open pit blasting activities can however, worsen the already precarious conditions of the buildings or they can act as catalysts to worsen the already deplorable state of the structures*** *[p. 19].* [emphasis added]
>
> *A total of 542 blasts were recorded and out of this only 20 blasts (representing about 6% of total blasts) had ground vibration levels above 1.5 mm/s while 9 blasts had blast values in excess of 120 dB(L) which is the recommended Environmental Protection Agency (EPA) of Ghana levels. The records also show that attention was not paid to Frequencies (at vibration levels were recorded) and weather conditions at the times of the monitoring exercises. Frequencies and weather conditions are important parameters when assessing the damage potential of a particular blast in terms of ground vibration and air blast.* ***According to Konya and Walters (1990), frequency is an important factor in assessing the damage potential of vibrations as structural resonance lies in the low frequency range typically of 5 to 20 Hz and blast vibration in this frequency range can cause a resonance response in structures which produces increased displacement and strain, giving serious problems in the structures. Also air blast levels rise with increased overcast skies with a corresponding increased damage potential*** *[p. 22].* [emphasis added]

Considering the substandard quality of the buildings in the Prestea township, the authors of the study conclude that the German Standard of 8 mm/s Peak Particle Velocity (PPV) is too high, and recommend that the maximum ground vibration not exceed 2 mm/s:

> ***Even though this level [2 mm/s] can increase drilling and blasting costs considerably, it is considered a better option than expensive lawsuits in the likely event of any further damages that may be caused to building structures in the township*** *[p. 19].* [emphasis added]

Repeated Blasting Damages Property From Vibrations Especially At Low Frequencies

Repeated blasting causes damage to structures, especially at low frequencies below 20 Hz (or 20 cycles per second). Amplification factors of four (4) are reported in BOM RI 8507.[30] Dr. Sam Kiger, a now-retired Civil and Environmental Engineering professor at the University of Missouri, presented, in part, the following in connection with expert evidence in *Fontaina Scott v. Mountaineer Grading Co. – Putman Co. Civ. Act. No. 09-C-286.*[31]

> *At relatively low dominate frequencies, that is below about 20 Hz (or 20 cycles per second), blast induced ground vibrations are amplified by structures….Amplification factors of 4 are reported in BOM RI 8507. Michael J. Mann of the Ohio Department of Natural Resources Division of Mines & Reclamation investigated the response of structures at larger distances from surface mining operations where lower ground vibration frequencies are much more likely to dominate.[32] The data published by Mann…indicate measured structural amplifications as high as 10….This is the most damaging type of ground vibrations because [of] amplification induced in…homes at these low frequencies.*
>
> *Blast induced ground vibrations can be amplified by local soil and other geological conditions. For example in BOM 656[33] they report that the thickness of overburden, i.e. the thickness of the soil layer over bedrock, has a direct effect on amplitude and frequency of ground vibrations from blasting. They go on to indicate that the effect is to increase amplitude and lower frequencies. Note that both increased amplitude and lower frequencies will result in increased damage to structures. The Soil layer frequency, f, can be estimated from the textbook by Woods[34] as f = V / 4H, Hz; where V is the seismic velocity in the soil layer, H is the soil layer thickness, and the units of the frequency, Hz, is cycles per second. Whenever vibration frequencies generated by blasting operations match the soil layer frequencies, amplification will occur. The thickness of soil layers often vary significantly between hilly terrain and low lying valley terrain. Thus, unexpected local amplifications of the blast induced ground vibrations can occur resulting in peak ground motions being larger at relatively far away locations than they are at locations relatively close to the blasting.*
>
> *All homes undergo daily and seasonal dimensional changes due to things like humidity variations and changing temperatures, like the sun moving from one side of the home to the other (the warm side will expand relative to the cooler side); or seasonal variations of temperature and humidity. For example most of us have experienced a "sticking door" or a door that will not close (or easily open) during certain times of the year. These environmental effects will cause strains in the walls, ceilings, structural framing, tile covered surfaces, and etc. These strains are known by engineers as prestrains, that is strains that exist before an event like a blast induced ground vibration. The prestrain condition may be such that a very small vibration will push the item, like a wall panel, a framing connection, or piece of tile, over its strain limit and result in a crack or loosening of a structural frame connection. Once a crack is initiated the crack will grow at a much lower level of vibrations than was required to initiate the crack. This is because of the stress concentration that exist at the crack tip; envision for example a small crack in an automobile windshield where even a small bump from ones hand can cause the crack to grow. Thus, even low levels of repeated*

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[30] US Bureau of Mines RI 8507, *"Structural Response and Damage Produced by Ground Vibration From Surface Mine Blasting,"* 1980,

[31] "Scott owns property in Fraziers Bottom and says the defendant company's blasting operations on the new U.S. 35 in 2008 affected her and her property. She lists property damage, nuisance, trespass, negligence and/or gross negligences and strict liability in her complaint. She seeks compensatory and punitive damages, attorney fees, costs and other relief." https://putnam112.rssing.com/chan-8516446/all_p14.html.

[32] Michael J. Mann, Ohio Department of Natural resources, Division of Mines & Reclamation, New Philadelphia, Ohio, USA, "RESPONSE OF MANUFACTURED HOUSES TO BLAST VIBRATIONS," Copyright © 2003 International Society of Explosives Engineers, 2000 BAI.

[33] Bureau of Mines Bulletin 656, "*Blasting Vibrations and Their Effects on Structures*," 1971.

[34] Woods and Hall, "*Vibrations of Soils and Foundations*," Prentice-Hall, 1970.

occurrences of blast induced ground vibrations can cause significant damage to a home over time. For example the German vibration standard is 0.16 ips [4.06 mm/s] for buildings with visible damage and cracks in masonry. See for example Table 1 in "Vibration Criteria for Historic and Sensitive Buildings" by Konon and Schuring..[35]

The fact that these prestrain conditions can produce a condition in the home such that damage to a home will occur at even very low levels of vibrations is acknowledged in BOM RI 8507[36] *in their Conclusion 7 on page 68…This conclusion, agreed to by the 4 experts that authored RI 8507, clearly states that "…**there may be no absolute minimum vibration damage threshold…"; that is, when inevitable pre strain conditions are present in a home, any blast induced ground vibrations might cause damage to the home**.* [emphasis added]

In Bureau of Mines RI 8507 they suggest a maximum allowable ground vibration peak particle velocity [PPV] of 0.5 inches per second (ips) [12.7 mm/s] at which there is a 0.5 percent probability of damage. However, the standards in many countries are much lower; for example…regulatory agencies in Leicestershire County, UK have established the upper limit on allowable peak particle velocity (ppv) as 0.24 ips [6.1 mm/s]; [I]n Australia the common limit is 0.2 ips [5.1 mm/s] and it is 0.001 ips [0.025 mm/s] for historical buildings and monuments for frequencies less than 15 Hz. Note that frequencies less than 15 Hz are very likely in blast induced ground vibrations at large distances from the blasts. The Australian standard for historical buildings of 0.2 mm/sec (0.001 ips) implies that if a building is really important the allowable vibrations to prevent damage is extremely low.[37] *Therefore, standards in reality represent an economic decision. **Since at almost any vibration level some homes might be damaged, but for the mine to operate at an economic level, some probability of damage is tolerated. The level of 0.5 ips [12.7 mm/s] widely adopted in the US is far greater than the standards adopted in other countries**.* [emphasis added]

*The size of the blast induced ground vibration waves shaking the homes are large in comparison to the footprint dimensions of a typical home. The length of the ground vibration wave train is the duration of the blast induced ground vibration shaking at the homes, typically about 3 to 4 sec, times the speed of the ground wave, typically about 800 ft per sec [244 m per sec]. Thus, for a typical blasting event with multiple individual explosions the ground vibration wave train is about 3,000 ft [914 metres] long. These ground vibrations at long distances, i.e. more than 1,000 ft [305 metres], have a dominate frequency of the ground vibration equal to about 8 or 10 Hz (cycles per sec); for a frequency of 10 Hz a single cycle of the ground shaking is 80 ft [24 metres] in length (one cycle is up down and back up) so that the leading edge of the home is picked up then pulled down while the back of the home is being picked up; this up and down of the front and then back of the house occurs repeatedly for the full 3 to 4 second duration of the ground vibration; in this example that would be about 30 to 40 complete cycles (10 cycles per second for 3 or 4 seconds). **When these repeated distortions of the house matches the natural frequency of the house, the motions will be amplified and damage to the house will be significantly increased**.* [emphasis added]

It is recognized that the probability of damage to a home is relatively small in any single blast. However, numerous opportunities for an unlikely occurrence, like damage to the home, will result in a very likely occurrence of damage. For example, if the probability of damage to the home, Pd, in any single blasting event is 0.05, or 5 percent; then the probability of not being damaged, Pu, is 95 percent. One can use the probability Law of Independent Events to calculate the probability of damage occurring at least once in 100 events. Thus, assuming the probability of damage is the

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[35] Konon and Schuring, "Vibration Criteria for Historic and Sensitive Older Buildings," ASCE Preprint 83-501; American Society of Civil Engineers (ASCE), Houston, Texas, October 17-19, 1983.

[36] US Bureau of Mines RI 8507, "*Structural Response and Damage Produced by Ground Vibration From Surface Mine Blasting*," 1980.

[37] See Table 2, R Pesch and A Robertson, "Drilling and Blasting for Underground Space," Wollongong, NSW, 3-4, September 2007, https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.500.4403&rep=rep1&type=pdf.

same for each event, 0.05, then the probability of ***not*** *being damaged at least once in 100 events (explosions) is:*

Pu-100 = (0.95)100 = 0.006

and the probability of the home ***being*** *damaged in 100 explosions is 1 minus the probability that it is not damaged, thus:*

Pd-100 = 1 - 0.006 = 0.994

This implies that the probability of damage in 100 events is about 99 percent and that implies damage to the home would be almost certain. Therefore, even though damage is unlikely for any single blasting event, some damage in the form of cracking of walls, ceiling, tile, concrete,...etc becomes very likely with numerous repetitions of blast induced ground vibrations. And once damage occurs (like cracking, nails pops, or framing joints loosening) that damage will increase at even lower levels of vibrations with repeated exposure to the vibrations. [emphasis added]

According to Jordan,[38] ground vibration levels, measured as peak particle velocity (PPV), are governed by Australian Standard AS 2187.2 (Storage and use of explosives), but no consideration is given to the frequency or frequencies in blast vibrations and their relationship with the natural frequencies of a structure or building, and the potential for damage.

Except in an informative appendix (i.e. not forming part of the standard) to the latest edition of AS 2187.2, no consideration is given in the criteria to the frequency or frequencies in the blast vibrations and their relationship with the natural frequencies of the building or structure. [emphasis added]

*Resonance effects in structures are well known and form the basis for response spectrum analysis in earthquake engineering. Whilst the behaviour of whole structures is the main concern in earthquake actions analysis, the behaviour of individual elements of buildings and structures can be considered and this is applicable in determining whether, for example, a wall or ceiling panel, or even a pane of glass, may be vulnerable to damage at quite low vibration levels****….[R]esonance effects measured by the author have seen PPVs amplified by factors of more than 60× [in a single charge trial blast]***. [emphasis added]

…***PPV levels commonly applied, whilst designed to prevent damage, did not give any indications of a structure's likelihood of damage: in most cases no damage could be found at PPVs many times those prescribed, whereas at other times damage seemed to be occurring with vibrations of low PPV***. [emphasis added]

Jordan also describes unexplainable damage to historical structures even when blasting is measured at lower PPVs of 5 mm/s or even 2 mm/s.

In recent times there has been damage noted in some of the buildings being monitored which cannot be explained simply on the basis of the peak particle velocity [PPV] in the ground wave. ***In particular, cosmetic cracking has been noted in some large ceilings when the recorded resultant PPV was close to the allowed maximum, which in itself has been set very conservatively***. [emphasis added]

Elastic modelling of the ceilings and derivation of the vertical frequencies in the ground wave suggested that resonance was involved, with both ground wave frequencies and ceiling vibration

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[38] Jordan, Bill. "Mine blasting vibration and its effects on buildings and structures – implementing a frequency-based approach," *Bill Jordan & Associates Pty Ltd, Newcastle NSW,* Email: bill@bjaeng.com.au, https://aees.org.au/wp-content/uploads/2013/11/29-JORDAN-Bill-MineBlastingVibration.pdf.

modes being in the 12 Hz to 16 Hz range. In general, frequencies much above 30 Hz are usually attenuated at the typical distances between workings and sensitive buildings.

It is interesting to note that individual wall panels tend to have resonant frequencies above 30 Hz, even in very large houses. Whole building vibration could be being experienced at much lower frequencies, but the difficulties of modelling such structures elastically does not give confidence in obtaining a sensible result. Even constructing a very detailed finite element model of such a building would be both costly and of doubtful accuracy.

Insurance Company Denies Homeowner Claim for Property Damage Caused by Vibrations from Off-site Quarry Blasting

In *Hernandez v. Citizens Prop.*,[39] the Florida appellate court held that insurance coverage is excluded for cracks in walls and floors that occurred due to vibrations from off-site quarry blasting operations by a policy's earth-movement/settlement exclusion.

The insured filed a claim for cracks in the walls and flooring of his house. ***The insured's engineer concluded that the damage was the result of soil underneath the house shifting from vibrations caused by blasting explosions at a nearby rock quarry****. The insurer denied coverage, asserting an earth-movement/settlement exclusion of the policy. The insured filed suit and argued that the exclusion did not apply. The insured noted that the policy lists nine causes of loss that are considered "earth movement," and that the alleged cause of loss, blasting, is not included. The insurer moved for summary judgment, which the trial court granted, finding that the policy did not cover indirect damage to property as a result of earth movement that may have been triggered by off-site explosions. The appellate court affirmed. The earth-movement exclusion of the policy excluded coverage for damage caused by earth movement "unless direct loss by explosion ensues." The appellate court found that the earth movement at the property did not cause an explosion, but rather that the earth movement was caused by explosion.* [emphasis added]

The appellate court noted that the exclusion contains anti-concurrent causation language that "loss caused directly or indirectly" by certain causes is excluded "regardless of any other cause or event contributing concurrently" to the loss. ***It held that the policy's terms excluding "earth sinking, rising, or shifting," "settling, cracking, or expansion of the foundation," "whether caused by natural or manmade activities," unambiguously precluded coverage under the policy****.*[40] [emphasis added]

Homeowners' Awards For Vibration Damage Caused By Blasting Restricted To Five-Year Limitation Period

In *Harrod Concrete and Stone Co. v. Melton III*,[41] eight homeowners and one tenant (Appellants) had their respective damage awards set aside by the appellate court of Kentucky and remanded to the lower court for further proceedings, consistent with a five-year limitation period successfully argued by Harrod (the quarry owner), restricting the computation of proven damages subsequent to August 1996. The failure to timely file the claims for damages from vibrations reduced the amount of damages to which each

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[39] *Hernandez v. Citizens Prop.*, 308 So. 3d 102 – Fla. Dist. Court of Appeals, 3rd Dist. 2020, https://www.lexology.com/library/detail.aspx?g=7a837bcd-6ebb-46b3-97d3-42fac4688214.

[40] Lenzen, Derek R., "Florida Appellate Court Holds Earth-Movement Exclusion Excludes Coverage for Cracking Damage Caused by Off-Site Blasting Vibrations," *Phelps Dunbar LLP*, August 25, 2020, https://www.lexology.com/library/detail.aspx?g=7a837bcd-6ebb-46b3-97d3-42fac4688214.

[41] *Harrod Concrete and Stone Co. v. Melton III*, Ky: Court of Appeals 2007, https://scholar.google.ca/scholar_case?case=7521342049644934355&q=harrod+concrete+and+stone+co+v+melton+iii&hl=en&as_sdt=2006.

homeowner (and one tenant) should have been entitled, had the claims been filed in the early 1980s rather than in August 2001.

> *The homes allegedly all had varying degrees of damage, including cracks in the interior and exterior walls and slabs, cracks in chimneys and joints, bowed walls, cracked drywall, nail pops, and fogged and/or cracked windows. All of the homes are located in Franklin County, Kentucky over an area of roughly two square miles.*
>
> *…[The damage here was known and present as far back as the early 1980's for some of the Appellees. We agree with Harrod that "[c]racks are not latent or inherently undetectable. Neither are nail pops, drywall cracks or cracked and fogged windows. These conditions are patently obvious." Certainly, all the Appellees had knowledge of the blasting vibrations occurring as a result of Harrod's limestone operation from the first day of moving into their respective homes. Additionally, Harrod introduced evidence at trial showing that many Appellees knew or should have known of the damages and the possible cause before August 1996.[6] For example, the Dunns and Devers filed insurance claims for blast damage and received payments before 1996. Moreover, the Olivers filed insurance claims before 1996, which were denied; however, they had been advised in June 1996 by an engineering firm that they had blast damage.*
>
> *Nor are we persuaded that Appellees were unable to determine the cause of the damage because they allegedly complained to state mining officials and to Harrod directly about the alleged blast damage and were told that the blasting was not causing their property damage.* ***The Appellees [homeowners and one tenant] are not relieved of their responsibility to exercise reasonable diligence to discover the cause of their damages merely because Harrod may have denied responsibility****. Thus, the trial court erred and its instructions to the jury should have limited the award, if any, to only those damages proven to have occurred subsequent to August 1996. Accordingly, we reverse and remand.* [emphasis added]

The property damage attributed to vibrations from quarry blasting was supported by the evidence of the Appellees' expert, Dr. Deatherage, whose qualifications were unsuccessfully challenged by Harrod.

> *Dr. Deatherage testified that he is a professor of civil engineering with a Ph.D. in civil engineering. Moreover, he has numerous peer reviewed publications which he has authored. Dr. Deatherage's education, training, and experience were sufficient to qualify him as an expert. To the extent that Harrod argues Dr. Deatherage's opinions fall outside the scope of scientific, technical or other specialized knowledge pursuant to Daubert, we disagree.*
>
> *The principles established in Daubert and its progeny concerning the admissibility of expert testimony "apply not only to expert testimony based on scientific knowledge, but are equally applicable to expert testimony based on technical or other specialized knowledge."*
>
> *…[I]n forming his opinions, Dr. Deatherage visually inspected the homes and interviewed the occupants. Dr. Deatherage also reviewed countless photographs of the alleged damage, reviewed the opinions of Harrod's experts, as well as reviewed technical publications regarding blast vibrations.*

Lafarge Fined For Mining (Blasting) and Removing Aggregate From Unlicensed Area

Lafarge pleaded guilty to conducting illegal blasting quarry operations in an unlicensed area and removing limestone adjacent to its quarry in Dawson Township, Manitoulin Island.

> *The company was fined $45,000 and was ordered to rehabilitate the vertical rock faces located on unlicensed private land and Crown land. As part of the agreement, Lafarge will pay an additional*

$45,900 in outstanding royalties to the Ontario Aggregate Resources Corporation for materials excavated from the Crown land.

The court heard that Lafarge alerted an aggregates officer that the company had removed aggregates from outside its licence. A subsequent investigation confirmed that Lafarge had extracted nearly 148,000 cubic metres of limestone outside its licence area, as well as 119,000 cubic metres from adjoining Crown land. Although the Crown land is part of an aggregate permit that the company holds, the company did not have the required approval to excavate the area at that time. [42]

Coloured Aggregates Fined For Illegally Moving Blasted Rock and For Upgrading A Road Outside Its Permitted Area

Coloured Aggregates was convicted of contravening its River Valley quarry site plan by moving aggregate outside of its permitted quarry and for upgrading a road outside of its permitted area.[43]

An Aurora-based aggregate company has been fined by the Ministry of Natural Resources and Forestry for illegally moving material outside of its permitted North Bay site….

On Sept. 16, [2019] the company was convicted of contravening its site plan contrary to the Aggregate Resources Act. The company was fined $35,000 and given 30 days to pay….

The…[Ontario Court of Justice in Sturgeon Falls] heard that between June 1 and July 31, 2017, the company extracted rock within its permitted area, then hauled it outside of the permitted area and stockpiled it there.

It also upgraded an old logging road to create a new access point to the quarry. This upgraded road was partially within the permitted area and partially outside the permitted area.

Both these actions were in contravention of its approved site plan.

This marks the second time in two months Coloured Aggregates has been corrected by the province.

In August, the company was issued four requirements from the Ministry of Labour following the death of a worker in the employ of Consbec Inc., a Sudbury-based drilling and blasting company that Coloured Aggregates had contracted for work at the River Valley quarry.

The employee was critically injured while drilling and later died of their injuries.

Property Damage Complaints Persist Over Quarry Blasting Operations

As reported in the 2017 issue of Quarry,[44] the number of complaints from communities in proximity to blasting quarries in Victoria, Australia, has been on the rise. As is typical, quarry operators/blasters always respond by denying responsibility for any property damage occasioned by blasting operations.

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[42] Adams, Kate. "Lafarge Canada Inc. fined for removing aggregate from unlicensed area," *BayToday.ca*, June 25, 2010.

[43] "Aggregate company fined for illegally moving rock," *Northern Ontario Business*, Oct 31, 2019, https://www.northernontariobusiness.com/industry-news/design-build/aggregate-company-fined-for-illegally-moving-rock-1778370.

[44] "Managing safer blasting under community scrutiny," *Quarry,* May 2, 2017, https://www.quarrymagazine.com/2017/02/05/managing-safer-blasting-under-community-scrutiny/.

Flyrock, lack of blast area security, premature blasts and misfires are the four major areas of injuries and fatalities from blasting in open cut mines and quarries….

More recently, quarries and mines close to houses, along with regulators, have been responding to complaints from the community that blasting is causing damage to their homes. Approvals of residential developments near existing quarries are contributing to the increased number of complaints.

The common response from our industry, that the ground vibrations and air blast levels measured at their property are within the limits specified in approvals, will not alleviate the concerns of householders that cracks in plaster or brickwork are attributed to blasting. [emphasis added]

On-going Complaints Over Vulcan's Blasting Quarry Operations in Lorton, Virginia

Residents within a mile or two [3.22 kilometres] of the Vulcan quarry in Lorton, Virginia, have been complaining for years about the adverse impacts caused by blasting quarry operations.[45] From the edge of the quarry, there is a separation of 320 feet (97.5 metres) to the closest homes in Occoquan Overlook and 180 feet (54.9 metres) in SouthPointe.

For years, residents within a mile or two of the Vulcan quarry in Lorton have heard the twice-weekly thuds of explosions, watched vases bounce across tables and pictures rattle on walls….[emphasis added]

Those who live near the quarry, located on Ox Road just south of the new Fairfax Water treatment plant, have two major complaints they want Vulcan to address: the amount of traffic created by trucks loaded with tons of stone leaving the quarry daily, and the impact the blasting has on their lives, through the noise and tremors caused by the explosions….[emphasis added]

Although the quarry has been in business since the 1950s, the area surrounding it has undergone drastic changes in the past few years since the prison closed, said Mike Grogan, another Southpointe resident. ***As the population has increased, homes have been built closer to the quarry, and the people who live there weren't prepared for the blasts.*** [emphasis added]

Many of the residents who live near the quarry thought they were the only ones feeling the aftershocks of the blasts in their homes, Grogan said, and didn't report their concerns or complaints to anyone. It was only at the November [2006] meeting of the South County Federation that Supervisor Gerry Hyland (D-Mount Vernon) became aware of the situation, he said. [emphasis added]

The Fairfax County requirements demand a 0.4 [inch/sec] [10.16 mm/sec] peak particle velocity [PPV] and a 130 air over pressure [airblast] decibel reading…. Vulcan detonates between 20,000 pounds and 25,000 pounds of explosives twice a week at the quarry….The operating hours for the quarry are 7 a.m. until 6 p.m. during the week…[46]

While Vulcan has never been found to be operating in excess of Fairfax County requirements, McKernan [Deputy Chief of the Fire Prevention Division] said he believes the blasting industry needs stricter regulations….[emphasis added]

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[45] "Shockwaves of Dissent from Quarry Neighbors," *The Connection Newspapers*, December 7, 2006, http://m.connectionnewspapers.com/news/2006/dec/07/shockwaves-of-dissent-from-quarry-neighbors/.

[46] "Vulcan's Uncertain Future In Lorton, Vulcan Quarry's special-use permit may not be renewed based on neighbor's complaints of structural damage," *The Connection to your community*, April 4, 2007, http://www.connectionnewspapers.com/news/2007/apr/04/vulcans-uncertain-future-in-lorton/.

McKeeman said there's a long list of books that state the damages found in these neighboring homes are common and can be found in neighborhoods that are nowhere near quarries. [emphasis added]

On-going Complaints Over Vulcan's Blasting Quarry Operations Near Hendersonville

Residents as far away as one mile have been complaining for years about the damage to their homes, which they attribute to the Rogers Group Inc. blasting quarry operations. By 2018, more than 330 residents joined a Facebook Group (Saundersville Area Blasting Concerns).

Some neighbors in Hendersonville say far too often the earth is moving beneath them and loud blasting at a nearby quarry is making them lose control of their homes. Now, the city is coming forward with something that might help.

There's a crack in a window on Saundersville Road. The homeowner believes it's not because of anything in her neighborhood, but rather the rock quarry nearby.

"I'm hearing from some of the neighbors about the impact on their homes," said Hendersonville Mayor Jamie Clary. "They're seeing that pictures are being moved, glasses are being rattled. They're worried it's having an impact on their foundations or walls or other parts of their homes." [emphasis added]

[Mayor] Clary said he lives in the area hit by blasting.

Another neighbor told News4 he feels helpless investing in a house when he has no control over damage to it. He said he would never have built in the neighborhood if he knew the problem was this bad. [emphasis added]

A lot of the worries were voiced in the Facebook group, Saundersville Area Blasting Concerns, now with more than 330 members.[47] [emphasis added]

Wyncrest resident Tasha Buttrey had just moved in three weeks prior when she first felt the ground shake in 2018. She says it wasn't long before she learned from neighbors that a quarry owned by Rogers Group was nearby.

"The house shook and knocked a mirror off the wall," she said. "We heard a pop and we watched it crack the dry wall around the door frame." [emphasis added]

Buttrey says she didn't bother filing a formal complaint with the state fire marshal's office who regulates the blasting, or Rogers Group.

"Proving the damage is directly due to blasting, is nearly impossible," she said. To make matters worse, when one files a complaint with the fire marshal's office, the state office obtains its readings from Rogers Group itself, Buttrey noted. The readings rarely if ever show the quarry is in violation of state standards. [emphasis added]

"The community is left with very little recourse," she added. "Everybody feels pretty hopeless about it."

For their part, Rogers Group and the third-party company it hires to monitor its blasting, has consistently said it is well within the state guidelines.

"We are always way under the state requirements," Rogers Group Area Vice President Bryan Ledford told the Hendersonville Standard in March of 2018. While the state requirements are one to two inches per second peak particle velocity, Rogers Group targets .5 inches [per second], he said. "just to make sure we stay below the legal limits."

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47 https://www.wsmv.com/news/neighbors-claim-rock-quarry-blasting-creates-problems-for-nearby-homes/article_cba4c58e-5ae3-51a0-a272-8431dff528c8.html.

State Rep. Terri Lynn Weaver (R-Lancaster) says she would like to see the state limits lowered to meet federal standards, and has introduced legislation that revises portions of the state's Blasting Standards Act of 1975.[48]

On-going Litany of Complaints Over Quarry Blasting From Residents As Far Away As Two Miles From the Quarry

Some forty residents within two miles (3.22 kilometres] have filed a litany of complaints against Arkhola Sand and Gravel Co.'s Roberts Quarry, a blasting quarry southwest of Tahlequah.[49]

There was a rapid series of muffled detonations, and 8,000 tons of limestone slowly peeled away for the 40-foot thick formation.

Over ***a ridge, roughly 4,800 feet [1,463 metres] west of the explosion, Elsie Torix noted the blast on her calendar****.* [emphasis added]

*"****I felt everything start to shak[e]," she recounted later that afternoon. "It was just like an earthquake. It*** *was a small one, compared to what they usually put off."* [emphasis added]

Superintendent Darwin Tackett said Friday's [March 15, 1985] "shot" was typical of a normal working day at Arkhola Sand and Gravel Co.'s Roberts Quarry…

Friday's blast couldn't possibly have damaged Elsie and Louie Torix's mobile home, Arkhola officials said. Neither could any of the other shots that since 1978 have opened up the limestone quarry, Tackett said.

But the Torixes and 39 other property owners in around the Zeb community cite a litany of grievances against the quarry. Residents blame the blasting for drying wells, dirtying well water, cracking brick veneer, breaking windows and wrecking mobile homes*.* [emphasis added]

Confronted with claims of structural damage in homes one and two miles from the quarry*, Arkhola officials point to their cinder-block control block building at the very edge of the quarry.* [emphasis added]

If the blasting damaged buildings, they say, it would certainly have damaged the control house by now….

1n a 1980 jury trial, the Torixes won a $31,000 judgment against Arkhola. They said Arkhola's blasting ruined their well and destroyed their mobile home*.* [emphasis added]

At the 1980 trial, expert witnesses for Arkhola testified that the blasting could not possibly have affected the well and trailer.

The Torixes' first trailer sat atop a ridge overlooking the quarry.

The Torixes said when the blasting ruined that trailer, they mortgaged a new mobile home and set it up below the ridge, away from the blasting. Still, they claim, the trailer is beginning to show the same structural stresses that eventually destroyed the other trailer*.* [emphasis added]

When the Torixes sued Arkhola in 1980, the firm offered to buy them out for $500 an acre. The Torixes spurned the offer. The farm is worth twice that, they said*.* [emphasis added]

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[48] https://www.hendersonvillestandard.com/news/blasting-complaints-about-local-quarry-prompts-bill-to-revise-state/article_f59581dc-5f34-11ea-9a0e-6fc489384d49.html.

[49] Palmer, Griff. "Quarry Blasts Rattle Residents, Stir Up Lawsuit," *The Oklahoman*, March 17, 1985, https://www.oklahoman.com/article/2101866/quarry-blasts-rattle-residents-stir-up-lawsuit.

The Torixes said they took a live-and-let-live attitude when they first learned Arkhola had leased 900 acres from a nearby landowner. But the Torixes' benevolence quickly faded.

*"**The first shot they put off out there, those damned dishes fell out of the cabinet**," Louie Torix said….*[emphasis added]

Complaints of Property Damage From Quarry Blasting Vibrations Ignored by Council and Considered a "Civil Matter"[50]

Residents in the communities surrounding Roadstone's Belgard quarry complaining of damages to their houses from blasting operations were advised by South Dublin County Council that their only remedy was to pursue costly and time-consuming civil actions against the owner of the quarry.

SOUTH Dublin County Council has advised that alleged damage to residential properties from the operation of commercial activities "are a civil matter", when asked about alleged damage to houses near Roadstone's Belgard quarry.

*As previously reported in The Echo, **a resident near the quarry claimed that the routine blasting that is carried out has worsened in recent months, causing the windows and mirrors in his house to shake**.* [emphasis added]

When the story went online, a number of commenters claimed that reverberations from the quarry blasts, which occur on Friday afternoons, could be felt further afield in Hazelgrove, Citywest, Kingswood, Brookview, Fettercairn and Ard Mor. [emphasis added]

The issue was raised at Monday's monthly meeting of the Tallaght Area Committee, when Fianna Fáil councillor Charlie O'Connor asked the council's CEO if he was "dealing with complaints from local residents claiming alleged damage to their homes from constant blasting at the Roadstone Quarry." [emphasis added]

The council advised that, "damage to residential properties from the operation of commercial activities are a civil matter."….[emphasis added]

…Brownsbarn resident Michael Fogarty claims that the blasting at the site started occurring twice a week for several months last year, and the level of disruption to nearby residents has increased.[51] [emphasis added]

Mr Fogarty, who has lived in the area for 14 years, told The Echo: "When we first moved here there was always an explosion on a Friday – you got used to it.

"But a few months ago, they started doing them on Tuesdays as well.

"Having explosions once a week was horrible, but twice a week is a disaster.

"I was at home on a Tuesday before Christmas and the mirror fell off the fireplace, the windows shook and my four-year-old started bawling crying. The houses were shaking. [emphasis added]

"Some of the explosions aren't bad, but some of them are really, really bad.

[50] O'Flaherty, Aideen. "Alleged damage to property from blasting is a 'civil' matter,'" *Echo.ie*, March 29, 2021.
[51] https://www.echo.ie/residents-claim-explosions-at-belgard-quarry-have-worsened/.

Developer Refuses to Exercise Option to Purchase Land Next to Blasting Quarry Due to Dangers of Flyrock and Vibration Damage to Foundations of Homes Expressed by the Quarry Owners

Braddock Park Homes, Inc. had entered into an agreement to purchase 45 acres, which included a five-and-a-half acre portion referred to as the Enoe Mountain Village (EMV property) located adjacent to a blasting quarry, conditional on Town approval for a 118-unit subdivision of townhouses.

The Town of Hillsborough approved rezoning of the entire 45 acres, including the 5.5-acre EMV property adjacent to the blasting quarry, to permit the proposed development. After owners of the quarry raised objections to the rezoning expressing health and safety concerns over the prospect of a residential subdivision next to a blasting quarry, the developer chose not to exercise the purchase option on the 5.5-acre EMV property.

> *In the fall of 2013, the Town began a series of hearings to allow the public to express their views about the rezoning petition….[R]epresentatives attended the public hearings and opposed the rezoning of the EMV Property….[R]epresentatives told the Town that (1)…[Resco Products, Inc. and Piedmont Minerals] operate an active mine adjacent to the EMV Property; (2) they regularly engage in explosive blasting at the mine; and (3) they conduct the explosive blasting operations roughly 300 feet [91.44 metres] from the EMV Property [para. 3].*[52]

The quarry operators expressed the following specific concerns over the prospect of residential development of the adjoining EMV lands:

> ***During a public hearing on the rezoning, representatives of the quarry owners argued that their future neighbors 'could be endangered by fly rock, excessive air blasts, and excessive ground vibrations from the blasting operations,' according to the court record.***[53] [emphasis added]

Quarry Application Denied Over Anticipated Vibration and Property Value Impacts

In *Sand Springs Materials LLC v. The City of Sand Springs*,[54] the Oklahoma Court of Appeal upheld the judgment of the district court to deny Sand Springs Material's (SSM) a permit to operate a quarry on 1,000 acres. The denial of the permit was, in part, based on anticipated vibration impacts and diminution in property value of a 150 property owners.

> *[15]…SSM's reliance on In re Volunteers of America, Inc., 1988 OK 8, 749 P.2d 549, is misplaced.[4] That case holds that denial of a special exception to a city ordinance cannot be "based on fears `which may or may not have a basis in fact.'" Id. at ¶ 12, 749 P.2d at 552. "[A]ctual*

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[52] *Cheryl Lloyd Humphrey Land Investment Company, LLC v. Resco Products, Inc, and PiedMont Minerals Company, Inc.,* 2021 NCSC 56, https://scholar.google.com/scholar_case?case=10039052016572520713&q=%E2%80%9Cfly+rock%E2%80%9D&hl=en&scisbd=2&as_sdt=2006.

[53] Kokai, Mitch. "Chief justice highlights right of petition in N.C. Supreme Court Ruling," *Carolina Journal*, 14 June 2021, https://www.richmondobserver.com/national-news/item/12494-chief-justice-highlights-right-of-petition-in-n-c-supreme-court-ruling.html.

[54] *Sand Springs Materials LLC v. The City of Sand Springs*, 243 P.3d 768 (2010) 2010 OK CIV APP 128, https://scholar.google.com/scholar_case?case=5244406433361108630&q=%E2%80%9Cquarry%E2%80%9D+and+%E2%80%9Cvibrations%E2%80%9D&hl=en&as_sdt=2006#[4].

> *evidence must be presented to show that the [special use] will be `injurious to the neighborhood or otherwise detrimental to the public welfare.'" Id. Here, actual evidence was presented. For example, evidence was presented that a potential buyer decided not to pursue the purchase for fear that the quarry would be approved and his property value would diminish.* ***SSM argues that: "One citizen's decision to no longer buy a home in this area is hardly evidence that property values will be adversely affected." Therefore, SSM concludes that the "fears" of 150 property owners that their property values would decline should be disregarded pursuant to Volunteers because there is no actual evidence property values will decline. In essence, SSM argues that until the quarry is in operation and is shown to adversely affect property values, the quarry must be approved. Volunteers requires evidence supporting a landowner's "fears" that property values will decline. It does not require evidence that property values have actually declined before a proposed use can be denied****.* [emphasis added]
>
> *[16]* ***Finally, although it was the opinion of SSM's expert that blasting operations would not physically damage nearby residential structures, he also stated that there was "no doubt" that occupants would feel the vibrations caused by the proposed blasting. A home owner is qualified to testify regarding the value of the owner's property****. H.D. Youngman Contractor v. Girdner, 1953 OK 277, ¶ 0, 262 P.2d 693, 694 (Syllabus 3).* ***SSM cannot simply dismiss, as unsubstantiated fears, the evidence provided by 150 property owners****.* [emphasis added]

Concern was also expressed by the Environmental Protection Agency over a landfill, designated a supersite, located approximately 2,000 feet (610 metres) away from the proposed quarry.

> *[T]he EPA "remained concerned" that blasting operations at the quarry would compromise efforts to secure the existing hazardous contamination at the landfill and create subsurface fissures that could promote downward offsite migration of landfill contaminates [para. 13].*

Diminution in Property Value and Loss of Property Use Occasioned by Blasting

In *Clay v. Missouri Highway Transp. Com'n* (MHTC) et al. (Rieke),[55] the Missouri Court of Appeal awarded the Clays $19,640 as the diminution in property value caused by blasting of rock either against MHTC or Rieke, the contractor, and $2,700 for the loss of use against Rieke only.

The Clays' residence sits above an aquifer, and the aquifer had supplied a well on their property with unusually high-quality drinking water since 1945. In November 1989, MHTC retained Rieke to cut a roadway for a new highway. Rieke used explosives to break up and remove rock from the roadway site, and caused damage to the Clays' property, which is 0.85 miles (1,368 metres) from the blasting site.

> *Rieke tried to blast in a controlled fashion. Specially-placed explosive charges cut the rock and left smooth walls of rock for the sides of the highway. At trial, some experts testified that this controlled blasting only caused shock waves to move about twenty feet [6.1 metres] into the rock. The Clays alleged, however, that the blasting caused vibrations at their home some .85 miles [1,368 metres] away and that it affected the quality and quantity of the water coming from the aquifer. More specifically, they alleged that due to cracks in the aquifer caused by the blasting, sediment such as sand and oil contaminated the aquifer and, ultimately, their well-water, that the water level of their well dropped, and that the water flow in their well was drastically reduced.*

[55] *Clay v. Missouri Highway and Transp. Com'n*, 951 S.W.2d 617 (1987), Mo: Court of Appeals, Western District, https://scholar.google.com/scholar_case?case=6636206402696025097&q=Clay+v.+Missouri&hl=en&as_sdt=2006.

…[T]here was evidence to support the submission that vibrations or concussions resulting from the explosion entered the plaintiffs' property, for there was testimony that the Clays and their neighbors felt and heard the blasting. They also testified that they began to have problems with their water supply after the blasting. Thus, they do claim a trespass, and they do claim their damage resulted from the blast. What they do not claim, however, is that the vibrations or concussions which they felt directly caused their damage. Rather, they claim that the same blasting that caused the vibrations also, but separately, split and cracked rock outside their property, and that as a result, it caused a lowering of the water level in the entire aquifer, including that on their property, and polluted the aquifer that supplied their well.

The Clays were not required to prove that the vibrations and/or concussions were the direct cause of the damage to their property, but only that blasting caused the damage.

…[T]he trial court properly refused to require the Clays to prove that it was the vibrations or concussions from the blasting that directly caused their damage; they were required to submit only that it was the blasting that caused their damage. We so rule because we conclude from a review of the history of the doctrine of strict liability for blasting that, while such a claim may be established by proof of vibration and concussion, see Wiley v. Pittsburg & Midway Coal. Mining Co., 729 S.W.2d 228, 232 (Mo.App.1987), it may also be established by other methods of proof.

As a matter of public policy, innocent parties whose properties have been damaged should not bear the costs of blasting by either the state or an industry.

Policy considerations support such imposition of strict liability for blasting even though no physical invasion of the premises has taken place. Neither an industry nor the State should be allowed to use its property in an abnormally dangerous way that injures the property of its neighbors with impunity, because to do so is effectively an appropriation of the neighbor's property for the industry or State's use. The blaster, and not the wholly innocent party, should assume the costs of its blasting. See Atlas Chem. Indus., 514 S.W.2d at 316 (characterizing the damage inflicted on other people's property as inverse condemnation); Branch, 657 P.2d at 275.

…[T]hese principles have application here, where the Clays similarly claim that the blasting caused physical damage to their property by damaging the rock formations underlying nearby property, thereby causing injury to the aquifer or to other subterranean aspects of the property in question. They presented expert testimony by Dr. Paul Hilpman, a Professor Emeritus of Geology at the University of Missouri and the Director of the Center for Underground Studies, to support this theory. He testified that the blasting damaged geological structures that resulted in the contamination of the Clays' well. Dr. Hilpman testified that the blasting fractured rock and sandstone layers in the aquifer and that these fractures in turn caused the water table to drop and allowed oil to migrate up into the water-producing area of the rock strata. This resulted in a lower water level in the Clays' well and in pollution of their well water. This type of damage is equally serious and equally likely to affect the value of property as is damage caused by vibrations or concussions on the property. We find the Clays' proof of damage was sufficient to support their strict liability for blasting and inverse condemnation claims.

Dr. Hilpman testified that some of the rock had to be blasted and that the blasting would cause more subterranean fracturing than simple cutting. He also testified that the oil showed up in the Clays' well because it was able to migrate up into the water zone through fractures in a limestone layer that were caused by blasting.

Denial of Quarry Permit Supported By Material, Competent and Substantial Evidence as to Land Use Incompatibility

In *Vulcan Materials Co. v Guilford County. Board. Of Cty. Com'Rs*,[56] the Board denied Vulcan's application for a quarry comprising approximately 235 acres, with an initial 10-acre quarry pit 300 feet deep, and eventual expansion to 17 to 20 acres. Vulcan's appeal resulted in the reversal of the Board's decision by the Superior Court, which then led to a further appeal by the Board to the North Carolina Appeals Court, which restored the Board's decision to deny the quarry permit.

Those opposed to the issuance of the quarry permit offered competent and material evidence as follows in summary form:

- there are 119 homes within 3,000 feet [914 metres], and 450 homes within one mile [1,609 metres], of the quarry site; [underscoring added]
- Mt. Hope Church Road, a two lane paved road, is traveled twice a day by ten school buses;
- the area immediately surrounding the quarry site is residential and agricultural, although a commercial business, Replacements Ltd., has a 100,000 square foot facility some 11,000 feet [2.08 mites] from the proposed quarry site;
- area residents obtain their water from wells which are generally 80 [feet] [24.4 metres] to 140 feet [42.7 metres] deep;
- the proposed quarry site is located in part of a watershed for a planned drinking water source;
- one area resident testified that when she put her home, which is located directly across from the site, up for sale and disclosed that a quarry was proposed for the site, no one even looked at the house; [underscoring added]
- the Guilford County Comprehensive Plan adopted in 1986 reserves the area of the site for residential use;
- neighbors of a Vulcan quarry in Elkin, North Carolina, stated through affidavits that they have suffered broken windows, cracked walls, dried up wells, dust, noise and falling rocks as a result of the operation of that quarry; [underscoring added]
- Vulcan was fined $10,000 by the United States Department of Labor for an incident in which a man was killed by flying debris [flyrock] from a quarry blast while mowing his lawn some 900 feet [274 metres] from a Vulcan quarry in Weston, Illinois; [underscoring added]
- there are several quarries already operating in Guilford County; and, according to the National Environmental Journal, Vulcan is the seventh worst emitter of toxic chemicals in the United States, based on air, water, land, underground, public sewage, and off-site releases. [underscoring added]

The Carolina appeal court rejected Vulcan's argument that because "quarrying" is a permitted use within the context of the zoning ordinance, it necessarily is in "harmony with the area." As concluded by the Carolina appeal court, the proposed quarry is not in harmony with the character of the area.

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[56] *Vulcan Materials Co. v Guilford County. Board. Of Cty. Com'Rs,* 444 S.E.2d 639 (1994) 115 N.C. App. 319, https://scholar.google.ca/scholar_case?case=7278696103547714002&q=%E2%80%9Cquarry%E2%80%9D+and+%E2%80%9Cconcussion%E2%80%9D&hl=en&scisbd=2&as_sdt=2006.

…[C]ompetent, material, and substantial evidence reveals that the use contemplated is not in fact in "harmony with the area in which it is to be located" the Board may so find. See 3 Robert M. Anderson, American Law of Zoning § 21.13, at 682 (3d ed. 1986); 3 Rathkopf § 41.13, at 41-83; see Triple E. Assocs. v. Town of Matthews, 105 N.C.App. 354, 358, 413 S.E.2d 305, 307-08, disc. rev. denied 332 N.C. 150, 419 S.E.2d 578 (1992); Piney Mountain Neighborhood Assoc., Inc. v. Town of Chapel Hill, 63 N.C.App. 244, 251, 304 S.E.2d 251, 255 (1983); People's Counsel for Baltimore County v. Mangione, 85 Md.App. 738, 584 A.2d 1318, 1322-23 (1991).

On-going Complaints and Environmental Concerns Over Votorantim Cimentos St. Marys Bowmanville Blasting Quarry Operations

A sampling of homeowner complaints and environmental damage attributed to Votorantim Cimentos, the owners of the Bowmanville blasting quarry are summarized as follows:

- "Many complaints are related to blasting and come from outside the immediate surrounding area." (Sept 11, 2018 Community Relations Committee Minutes). [underscoring added]
- Received eight complaints (vibration, noise and dust) in third-quarter of 2017 (to October 4). (Oct 3, 2017 Community Relations Committee Minutes)
- Received four complains (noise, flooding and odour) in the second quarter 2017, and St. Marys refused to discuss shoreline erosion with community members on advice of legal counsel due to legal proceedings, an issue that had been raised at previous community meetings. "**Community believes that St. Marys should not be able to decline a new member to the committee, and that discussion should be allowed to continue even if the member chosen was involved in legal action against St. Marys**." "Complaints reported to MNRF/MOECC etc can't be reviewed with the complainant unless he/she authorizes the MNRF/MOECC." (June 6, 2017 Community Relations Committee Minutes) [emphasis added]
- Received 26 complaints (blasting, plume, noise and dust) in 2016 (Nov 29, 2016 Community Relations Committee Minutes)
- "St. Marys Cement reported exceedances in air emissions on five occasions in 2015.[57] "According to St. Marys "it is not abnormal to have exceedances." "St. Marys' operations released 4,096 tonnes of sulphur dioxide between January 1 and December 31, 2015," whereas, "[t]he Ministry of Environment and Climate Change allows for 3,511 tonnes."[58]
- "Clarington council…heard there were 13 community complaints in 2015."
- In 2014, St. Marys' Bowmanville operation was the 10th largest emitter with 7,135 tonnes (combined emissions for a group of contaminants known as "criteria air contaminants" that cause air-quality-related issues such as smog and acid rain). These contaminants include sulphur oxides, nitrogen oxides, volatile organic compounds, carbon monoxide and ammonia.[59]

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[57] Swinson, Stefanie. "St. Marys Cement reports several exceedances in air emissions in 2015," *toronto.com*, Jun 15, 2016, https://www.toronto.com/news-story/6722518-st-marys-cement-reports-several-exceedances-in-air-emissions-in-2015/.

[58] https://www.toronto.com/news-story/6722518-st-marys-cement-reports-several-exceedances-in-air-emissions-in-2015/.

[59] Ministry of the Environment and Climate Change, Chapter 3, Section 3.05, p. 337, https://www.auditor.on.ca/en/content/annualreports/arreports/en16/v1_305en16.pdf.

- Received "a large number of complaints about blasting during the 2010 winter [Christmas] holidays."[60]

Conclusions

Blasting quarry operations cause untold adverse effects, and the only effective remedies are minimum setbacks and separation distances, or an outright ban of blasting quarries.

- Blasting rock is an ultrahazardous activity, and has the potential to injure or kill onsite workers and people offsite.
- Blasting within regulatory limits does not prevent property damage, even at great distances.
- Vibrations and airblast from blasting rock can cause damage at great distances from the blast site.
- Blasting can traumatize people (especially children, the elderly and disabled), including those suffering from Post-traumatic Stress Disorder (PTSD), and pets and wildlife.
- Commercial and homeowner insurance policies do not cover property damage caused by blasting.
- Citizen complaints and private law suits are common occurrences in response to the adverse effects occasioned by blasting rock, as provincial oversight is often ineffective or non-existent.
- Owners whose property is damaged or depreciated by airblast and ground vibrations from blasting operations are forced to initiate time-consuming and costly civil litigation.
- Blasting that injures or relies on the use of the property of its neighbours, directly or indirectly, with immunity, is effectively an appropriation (de facto taking) of the neighbours' property without compensation.
- Current residents and future generations lose control over what happens once a blasting quarry operation is established, and are forced to endure the adverse effects of quarry operations for the rest of their lives, as quarry operations can last for 100 years or more (five generations); in Ontario, a permit or licence to extract aggregate typically has no expiry date.
- Blasting quarry operations depreciate the value of nearby non-residential and residential property, and erode investor and homeowner equity.
- Non-residential and residential properties near blasting quarries are more difficult to sell, and mortgage financing on good terms and conditions is not readily available.

[60] Hatherly, Tara. "St. Marys Cement to stop blasting during winter holidays this year," *DurhamRegion.com*, August 3, 2011, https://www.durhamregion.com/news-story/3452188-st-marys-cement-to-stop-blasting-during-winter-holidays-this-year/.

BLAST VIBRATION DAMAGE CASES

Blast Vibration Damage 1

In *Alonso v. Hills et al.*,[61] as a consequence of recurrent quarry blasting operations, the California appeal court upheld the trial court's damages award of $2,650, consisting of $1,650 for damage to and depreciation of the property, and $1,000 for the plaintiff's distress in body and discomfort, annoyance, fright and shock.

According to the homeowner, the residence is located in Rockaway Beach, a community of 300 homes and 200 yards (183 metres) distant from the quarry. The evidence that there were 85 homes and the distance was 300 yards (274 metres) from the quarry had no bearing on the outcome of the case.

Blasting conducted at the quarry on November 2, 1946, February 3, 1947, and on many occasions before and after caused violent concussions in the nature of earthquake thereby injuring plaintiff's real property and building, and disturbed the enjoyment of the dwelling by plaintiff and his family, shocked plaintiff's nerves and injured his health, and caused his children great fear.

The February 3, 1947 quarry blast launched a 3-pound rock (flyrock) that destroyed a bench on the property near which one of the plaintiff's daughters was standing, causing the plaintiff to lose sleep and fear for his security and that of his family.

> *[2] The recurrent blasting in the operation of defendant's quarry, causing cumulative injury to plaintiff's property and interference with its enjoyment and requiring injunctive relief could conceivably be considered as one line of conduct in the character of a nuisance giving rise to one cause of action, without necessity of separate statement of separate blastings.*

On the issue of the relevance of expert evidence argued by the quarry owner, the appeal court ruled that expert testimony was not entitled to preference over testimony as to facts, and that inferential evidence can overcome direct evidence:

> *…[R]regular scientific expert testimony is not entitled to preference over testimony as to facts; the relative weight must be decided by the trier of facts. (Rolland v. Porterfield, 183 Cal. 466,469 [191 P. 913].)*
>
> *[8] The finding that on November 2, 1946 [before the blast], plaintiff's property was of the reasonable value of $5,000 finds competent support in plaintiff's testimony that he figures the valuation of his house at that time in the neighborhood of $5,500. (Isenberg v. Sherman, 212 Cal. 454, 483 [298 P. 1004, 299 P. 528], 10 Cal.Jur. 1023.) Appellant's attack on plaintiff's evidence on the ground of contradictions in his statements as to his cost price go to the weight of this evidence only, of which the trier of facts is the sole judge.*
>
> *[9] It is true that there was no direct evidence as to structural weakening. However, plaintiff testified that after the November 2 blast there were cracks all through the exterior of the house, the stucco outside was buckled, the window sills and frames all knocked out of proportion, the plumbing leaking, barbecue pit and terrace ruined. From such evidence of visible injury an inference can be*

[61] *Alonso v. Hills*, 95 Cal.App.2d 778 (1950) 214 P.2d 50, https://scholar.google.ca/scholar_case?case=4442811314394772785&q=Alonso+v.+Hills&hl=en&as_sdt=2006.

drawn that also the general structural strength of the building must have suffered. Whether the inference should be drawn in this case was again for the trier of facts. (Blank v. Coffin, 20 Cal. 2d 457, 461 [126 P.2d 868]; 10 Cal.Jur. 738,739.) Such inferential evidence can also overcome direct evidence to the contrary. "[I]t is elementary that direct evidence may be disbelieved and contrary circumstantial evidence relied upon to support a verdict or finding." (Gray v. Southern Pacific Co., 23 Cal. 2d 632,641 [145 P.2d 561].)

Blast Vibration Damage 2

In *Davis v. L & W Construction Company*,[62] air concussions and ground vibrations from blasting at a quarry about six-eighths of a mile (1,207 metres) away damaged the Davis residence. Their two-storey residence, measuring 32' × 32', is a stucco covered and hollow tile structure, with basement, and was in "good solid condition prior to the blasting" by the quarry operator. When quarrying operations were in progress, which had worsened by 1966, the Davis' house shock, a window broke, and structural cracks began to appear.

An experienced building contractor testified on behalf of the homeowners, stating that one time while in the home the building was in good condition, and that during a second visit he found cracks, "both diagonal and vertical." He concluded,

> ***[V]irtical or horizontal cracks cannot result from settling and are usually caused by jar, shaking or possibly wind***. [emphasis added]

Neighbours Albert Poli and John Head also testified as to the damages each sustained to their home as a consequence of the blasting quarry operations.

- *Albert Poli stated he lives about three-fourths mile [1,207 metres] west of the quarry, in a 24' × 48' frame house with cement block basement. The structure had never settled, but the foundation is shaken and cracking all over.*
- *John Head testified he resides approximately 70 rods [352 metres] southeast of plaintiffs [Davises], or about one and a fourth miles [2,012 metres] from the quarry. He had seen cracking and hairline cracks in the Davis home. His more remote residence trembled whenever there was blasting at defendant's quarry, and every room reveals damage to plaster and paper.*

The appellate court ruled in favour of the Davises and awarded damages, measured as the loss in market value, based on a before- and after-blasting analysis, while holding the quarry operator "liable without fault" for engaging in a notoriously hazardous activity.

> ***Surely it is a matter of common knowledge, and we accord judicial notice to the fact, that blasting by use of dynamite or other explosives is a hazardous activity and as such likely to damage others.*** *See Boyce v. United States, D.C., 93 F.Supp. 866, 868; 31 C.J.S. Evidence § 9, page *226 824; and 29 Am.Jur.2d, Evidence, section 23, page 60. [emphasis added]*
>
> *Since 1916 we have consistently adhered to that concept sometimes previously referred to as strict liability, but in cases of the nature here involved, now more appropriately termed "liability without fault". See Lubin v. City of Iowa City, 257 Iowa 383, 131 N.W.2d 765; Monroe v. Razor Construction Co., 252 Iowa 1249, 110 N.W.2d 250; Pumphrey v. J. A. Jones Construction Co., 250 Iowa 559, 94*

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[62] *Davis v. L & W Construction Company,* 176 NW 2d 223(1970) Iowa Supreme Court, https://scholar.google.com/scholar_case?case=13093628744042978336&q=quarry+blasting+concussion&hl=en&as_sdt=2006&as_vis=1.

N.W.2d 737; and Watson v. Mississippi River Power Co., 174 Iowa 23, 156 N.W. 188. Also Annos. 20 A.L.R.2d 1372, 1375.

*…**[I]f one engages in an activity on his own land of such hazardous nature as to involve risk of harm to the person, land or chattels of neighboring parties, he is liable for the consequences proximately resulting therefrom without regard to degree of care, scientific manner in which done, purpose or motive.** Watson v. Mississippi River Power Co., supra, at 174 Iowa 29-31, 156 N.W. 188; Davis v. Georgia-Pacific Corporation, Or., 445 P.2d 481; Harper and James on the Law of Torts, section 14.6, page 815; and Restatement, Torts, section 520.* [emphasis added]

And, as stated in Monroe v. Razor Construction Co., supra, loc. cit., 252 Iowa 1252, 110 N.W.2d 252: "Under this rule, negligence of the defendant need not be shown as an essential element of plaintiffs' recovery." See also Cronk v. Iowa Power & Light Co., 258 Iowa 603, 613, 138 N.W.2d 843.

***Consequently the user of explosives acts at his own peril and is liable if damage proximately results to another, either from the direct impact of debris thrown by the blasting, or from consequential concussions or vibrations**. In addition to authorities cited, supra, see Exner v. Sherman Power Const. Co., (2 Cir.) 54 F.2d 510, 512-513; Garden of the Gods Village v. Hellman, 133 Colo. 286, 294 P.2d 597, 600-601; Morse v. Hendry Corporation, Fla.App., 200 So.2d 816, 817; Berg v. Reaction Motors Div., 37 N.J. 396, 181 A.2d 487, 492-494; Davis v. Georgia-Pacific Corporation, supra, loc. cit., 445 P.2d 483; Bedell v. Goulter, 199 Or. 344, 261 P.2d 842, 845-846; and Annos. 20 A.L.R.2d 1372, 1377.* [emphasis added]

Blast Vibration Damage 3

From January 2007 through January 30, 2009, 104 complaints were filed against White Rock Mining in connection with noise and property damage from ground vibration caused by blasting quarry operations in South Florida, for which the quarry owner denied responsibility.[63]

In every case, the fire marshal visited the homes, took pictures of the damages, and interviewed the homeowners. Some described the noise as "very loud and frightening," and others said the house shook like an earthquake, with vibrations causing pictures to fall off the wall and dishes in the cabinets shaking.

The fire marshal inspector then verified the blasting schedules at the different blasting sites and found they had not exceeded the requirements established by Florida law.

In every case the result was "no violation…."

That White Rock is responsible for the blasting damage is further emphasized by the fact that when the blasting stopped, so did the claims for property damage.

Blast Vibration Damage 4

On June 25, 2007, the Town of Niagara, New York, served LaFarge with an injunction ordering it to "cease and desist operations" detrimental to residents of the nearby Tuscarora Village mobile home community.[64]

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[63] Quarry blasting will cause severe damage - Shelby County Reporter | Shelby County Reporter, February 10, 2010.

[64] Forgione, Rick. "Town of Niagara: Town halts quarry blasts," *Niagara Gazette*, Jun 25, 2007, https://www.niagara-gazette.com/news/local_news/town-of-niagara-town-halts-quarry-blasts/article_c2fa654c-44f7-5e67-86a6-674269df72e4.html.

The order claims the quarry has violated town law by creating dust and other safety hazards harmful to nearby residents. In addition, the noise and vibrations from the blasting have hurt residents' quality of life and damaged portions of their homes, the order said. [emphasis added]

A resident of Tuscarora Village suffered a concussion and a lower back sprain Friday after falling in the shower while the quarry was blasting. She was treated at Mount St. Mary's Hospital and is now recovering at home.

[Town Supervisor] Richards was on site during that blast and immediately contacted Town Attorney Michael Risman to research possible action against LaFarge to halt future blastings.

"It crossed the line at that point," Richards said.

Tuscarora Village residents realized something was different at the quarry almost immediately Monday when everything was silent as they walked outside, said Sharon Ruth, who is among the residents who have opposed the blastings.

"We're glad that steps are being taken, but they're only temporary steps," she said, adding that residents still ask for what they've wanted all along. "We don't want to get hurt, we don't want to get sick and we don't want our houses caving in."

Bill Poole, general manager of the quarry, could not be reached for comment Monday afternoon [June 25, 2007]. He said Friday the quarry has taken steps to reduce the level of blasting, despite being within legal limits according to federal regulations.

Blast Vibration Damage 5

On November 18, 2013, a blast at Lafarge's Spyhill quarry in Calgary sent shockwaves that shook the homes of countless residents in the nearby communities.[65]

The Calgary Fire department says routine blasting at a gravel pit was the cause of a loud explosion that was felt by many in nearby communities on Monday afternoon.

Emergency operators were flooded with calls from people in the northwest reporting a loud boom and smoke in the sky at about 1:40 p.m.

As it turns out, Lafarge was conducting routine, permitted, blasting at its quarry on 85 Street N.W.

A spokesperson for Lafarge says the cold and dry conditions caused the noise and dust from the blast at its Spyhill site to carry further than normal.

Blast Vibration Damage 6

On November 5, 2013, a blast at a McCook quarry sent tremors that shook the western suburbs of the Village of La Grange, Illinois, which the quarry operator dismissed as a "routine blasting operation." Blasting at the quarry has been a rocky road for thousands of residents for more than a decade in dealing with the fallout from quarry blasting.

According to the Village of La Grange, the company denies its blast was out of the ordinary and behind the tremor that shook the western suburbs just after 12:35 p.m.

"Hanson Material Service quarry has stated that they were preforming routine blasting operations at 12:35 p.m. today and that the blast was consistent with their typical operations. The quarry reports that the recorded seismic readings related to the blast were below regulatory limits," according to a message posted on the village website.

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[65] Schmidt, Colleen. "Blast rocks northwest neighbourhoods," *CTVNEWS*, November 18, 2013, https://calgary.ctvnews.ca/blast-rocks-northwest-neighbourhoods-1.1549013.

"Further, the quarry states that approximately seven seconds after the blast, a separate seismic event was recorded. Hanson is in the process of reviewing the seismic readings in order to better understand what may have occurred, but at this time they are denying any correlation between their blast and the seismic event."

The U.S. Geological Survey (USGS) says the magnitude of Monday afternoon's blast in the western suburbs registered at 3.2, down from an initial estimate of 3.7 earlier in the day.

Patch readers have shared comments about the blast, which caused "pictures to jump off walls," and entire houses to shake, according to commenters.

Here's what people had to say on the La Grange Patch Facebook page:

- ***Dawn** said she felt it downtown, near the train station. "We thought a truck hit the building in the alley, because that is a common occurrence."*
- ***Liliana** said, "My mom heard it and felt it at 50th and Ashland. She says she wouldn't be surprised if there are cracks in the walls of her house. Direct quote: 'It felt like the house shook right off of its foundation."*
- ***Monique** said, "We're real close to the quarry and felt a normal blast followed by the house levitating about 5 seconds later."*
- ***Jamie** said, "(It) Totally shook my house. Heard the blast. Felt the shake."*
- ***Sean** said, "Felt and heard it on Stone. Shook all the glassware in the cabinets."*
- ***Karen** said, "No way[,] it was the quarry... Oak Brook, downers Grove, Hinsdale all reporting it too."*
- ***Catrina** said, "Not understanding how they can deny that the blast wasn't out of the ordinary!?! The apparently "ordinary blast" was heard before the tremor that shook our home and literary made me jump just from the sound. Now I'm not used to earthquakes, but do they normally make an explosion noise first?"*
- ***Claudia** said, "The entire 300 block Leitch ave shook."*
- ***Karen** said, "Foundation shook, felt like a truck hit the house, LaGrange Country Club area!"*
- ***Tom** said, "Felt on Hillgrove"*
- ***Christine** said, "We felt it in La Grange, whole house shook for several seconds. 0-100 blk N Spring"*
- ***Bill** said, "Felt strong in LGP (wife) and Wheaton (me) for a sec."*
- ***Becky** said, "All the neighbors in 100 block S Catherine."*
- ***Melissa** Felt it in Brookfield."*

For thousands of residents in and around southwest suburban McCook, it has been a rocky road for more than a decade in dealing with the fallout from quarry blasting.[66]

Although some quarry operations have been there for a century-- using explosives to dislodge limestone-- the testy battle between community groups, companies and public officials is more recent and ongoing….

The I-Team obtained photos from one Countryside resident who says Monday's blast cracked walls and she thought her house was going to collapse. She and other residents who live around here say the concussion on Monday was the worst in years, although the ground shakes on a regular, sometimes daily, basis.

There was such damage to Joliet Road along the Vulcan Quarry in McCook that in 1998 state officials closed the roadway after determining it was unsafe for public use.

Three years ago --- without admitting any wrongdoing — Vulcan paid a $40 million settlement to the Illinois Department of Transportation. A repair project is now in its infancy-- with Joliet Road remaining closed-- and affecting motorists and rail traffic every day. [underscoring added]

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[66] "Recent quarry blast not the first to shake McCook," *abc30*, November 5, 2013, https://abc30.com/archive/9315049/.

Blast Vibration Damage 7

On April 25, 2017, a blast at the 54-acre Jefferson Quarry in Mankato, Minnesota, struck with such force that it was initially thought to be an earthquake. The quarry owner refused to accept financial responsibility for the widespread damage caused to the homes of 128 nearby residents,[67] despite evidence of flyrock debris. The quarry blast was amplified by atmospheric conditions to create the equivalent of a magnitude 2.8 earthquake, and was heard miles away.[68]

> ***A blast at a locally owned quarry here two months ago struck with surprising power. An earsplitting boom was followed by a violent trembling that shook homes and garages to their foundations, toppled lamps off tables and knocked one man over as he tended his backyard garden***. [emphasis added]
>
> *In the investigations that followed, a government scientist said the ground shook because of an explosion at the Jefferson Quarry. But the mining company said its own research found that an earthquake had struck the city seven seconds after it set off charges.*
>
> *The resulting standoff has left homeowners wondering who will pay for all the cracked plaster and other damage, and whether it will be months or even years before legal action can resolve who's at fault.*
>
> *"Nobody wants to take responsibility for anything," said Ann Helgeson, who bought her house adjacent to the quarry just weeks before the ground shook. She was home with her young son that day when the house started to shake from the cellar up.*
>
> *Now, the freshly painted walls are cracked and portions of the once-flat floor dip. Gaps can be seen where the living-room ceiling meets the wall. "We've got cracks upstairs everywhere," said her 6-year-old son, Gage.*
>
> *Helgeson's insurance company inspected the damage in early May and left her thinking that it would be covered. It wasn't until a letter arrived in the mail last week that she learned the company had determined the cracks were caused by natural settling and therefore were not insured. What's more, the company wrote, they were dropping her completely after noticing that a portion of her home's exterior had asbestos shingles, which they don't cover.*
>
> ***Left without other options, Helgeson said she's hoping someone from the city will step in to help her and some of the other 128 homeowners who reported damage***. [emphasis added]
>
> *"I myself have been saying the city should start a class-action lawsuit against [quarry owner Jordan Sands]. We need somebody impartial to come in," she said.*

Blast Vibration Damage 8

On May 13, 2015, a quarry blast, which prompted the city of Augusta, Maine, to file a lawsuit, caused damage to the homes of neighbouring residents.[69] As expected, the quarry operator denied responsibility for the damage.

> *Some residents near a quarry operation in a pit off West River Road that has been controversial with its neighbors say a May blast that prompted the city to file a lawsuit also caused cracks in the floors of their homes.*

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[67] McKinney, Matt., "Was Mankato boom a mine blast or an earthquake?", *Star Tribune*, July 2, 2017.
[68] https://www.duluthnewstribune.com/news/4256859-mankato-quarry-blast-rocks-city-feels-earthquake.
[69] Edwards, Keith., "Augusta quarry pit neighbors say blasting damaged Homes," *Kennebec Journal*, September 21, 2015, https://www.pressherald.com/2015/09/21/augusta-quarry-pit-neighbors-say-blasting-damaged-homes/.

A resident who lives about two-tenths of a mile north of the pit's entrance on West River Road and roughly 2,000 feet [610 metres] away from the pit itself says she believes the concrete floors and walls of the basement in her 8-year-old home were cracked by the May 13 blast, which she said felt and sounded like a bigger blast than other blasts at the pit owned by Steve McGee Construction.

Donna Bonenfant said gaps of roughly a quarter-inch opened up between several of the floor joists and the main support beam of the main floor of her home, visible from the basement, gaps which she said weren't there before the blast. What appear to be water stains are visible around some of the cracks in her basement walls.

"I don't know what to do about these. What if it leaks?" Bonenfant said, pointing to one of several cracks spread across parts of the concrete basement floor of her home. "I know to expect some cracks, but this many? ***A cement contractor looked at it and said there is no way all these cracks would come from just the house settling****."* [emphasis added]

Across the Kennebec River from the pit site, Riverside Drive resident John Liacos said he noticed hairline cracks in some of the ceramic floor tiles installed when his home's kitchen was redone in the spring of 2014, which he doesn't believe were there before the May blast. He said he's also discovered small cracks in the drywall of the kitchen ceiling.

Liacos acknowledged he's not sure of the date when he first noticed the cracks, but said a contractor who looked at the cracks said they had to have been caused by "something serious," and Liacos suspects it was the blast.

Bonenfant and Liacos both said they contacted the company that did the blasting, Maine Drilling and Blasting, to file claims for the damage. Both said their claims were rejected.

"We got a letter saying, sorry, we're not responsible for it," Liacos said. "If nobody is willing to admit it, what are you going to do? I want to be treated fairly. I was hoping to get some sort of resolution from Maine Drilling and Blasting."

Blast Vibration Damage 9

In *School District No. 162 et al. v. Grosshans & Petersen, Inc.*, the trial court found the quarry operator responsible for damages to the plaintiffs' properties caused by ground vibrations stemming from quarry blasting, a ruling upheld by the Supreme Court of Nebraska. The blasting activities which led to the vibration damage are described as follows:

Beginning about December 23, 1955, and at various times until April 27, 1956, defendant used dynamite to blast rock in the 603 quarry. The blasting was so done as to break the rock into pieces sufficiently small to go through a crusher so that the rock could be used in highway construction. Defendant often prepared as many as 48 holes for one explosion. These were drilled to depths of as much as 20 feet. Dynamite was placed in these holes to within 30 to 36 inches of the top. Dirt was then tamped in the holes to lessen any upward push of the explosion. The dynamite was so wired that it exploded in "delays" of 25/1000 of a second, and there were from two to four delays in each explosion. Beginning December 23, 1955, and ending April 27, 1956, defendant exploded dynamite 2 days in December, 9 days in January, 10 days in February, 21 days in March, and 11 days in April. On several days there were two and sometimes three and four explosions a day.

The age and condition of the schoolhouse prior to the quarry blasting operations, and the damage to the schoolhouse from the ground vibrations are described as follows:

The school building was built about 1920. It was of brick construction on a concrete foundation. There was no steel reinforcement. Sometime prior to 1954 a settlement crack appeared in the east wall. That was repaired in 1954. There is also evidence of some replastering that was done prior to that time. The building was inspected, repaired, and repainted in 1954.

During the months of the blasting large cracks appeared in the walls of the schoolhouse where the brick separated, and cracks appeared in the plaster on walls and ceiling and in the concrete tunnel in the basement. Bricks pulled away from joists at the top of the walls. The extent of these cracks need not be recited as the extent of the damage to the building is not an issue here. It is sufficient to point out that they appeared to a large extent in that part of the building that received the first impact of vibrations from the quarry.

The quarry is located about one-half mile (805 metres) from the schoolhouse and lay witnesses within a 2½ mile (4.02 kilometre)radius of the schoolhouse and other witnesses closer to the schoolhouse testified as to the damage caused by ground vibrations emanating from blasting operations at the quarry.

Plaintiffs offered evidence of lay witnesses living within a radius of 2½ miles of the schoolhouse, and other witnesses who were close to or in the schoolhouse when blasts occurred. These witnesses described the effects of explosion blasts at the quarry which they observed as "the house shook"; "vibration" was felt when a car was driven near the quarry; "barn vibrated"; the "house commenced to quiver and the windows rattled"; "dishes rattled in the cupboard"; an elevator building "shook," windows rattled, and "the bars on my scale * * * rattled"; "could feel the ground shake"; cans on the shelves of a store "shook" and the floor "shook"; china in a cabinet "shook"; large rocks were blown out and upon land of one of the witnesses; the blast "shook the earth"; a furnace rattled; in the school building the blast "shook us"; light fixtures swayed; and there was rattling of the windows and vibration in the schoolhouse. [emphasis added]

The above paragraph is not an all-inclusive statement of the evidence of what lay witness after witness testified as to what they saw and observed.

The testimony of the quarry operator's expert witness that "there is no direct evidence that explosions in the quarry caused the damage to the school building" was rejected in favour of the plaintiffs' expert, whose credentials and testimony were accepted by the trial court:

Plaintiffs' expert witness was examined and cross-examined extensively and often as to his qualifications. He was a graduate of the College of Engineering of the University of Nebraska; he worked for several years as a structural engineer designing power plant buildings; he worked with a consulting engineering firm doing structural design and cost estimates on schools, churches, dwelling houses, warehouses, and factory buildings; his work involved the structural soundness of masonry walls; in training and practice he had made a study of the various causes of structural failures in buildings in order to avoid their recurrence in buildings designed; he had had formal training in the effect of vibration on structures and in dealing with the loads which come or fall on structures caused by vibration; he had studied writings devoted solely to the subject 604 *of ground vibrations; in his practical experience he had noted the effect of forces upon buildings; he had read technical articles and books upon building failures; he had knowledge of the nature of the ground between the quarry and the schoolhouse; he had examined the exposed soil profile at the quarry and made a soil boring at the schoolhouse; and he explained the types of vibrations which occur in the soil when an explosion occurs.* ***He testified that in his opinion the damage was caused by a horizontal movement of the bearing walls; as to the effect of a repetition of vibrations, which singly might not cause a failure but if repeated eventually could do so; and that the appearance of the damage may be delayed***. [emphasis added]

The witness was permitted to testify as to the age, in his opinion, of the cracks in various parts of the building. His testimony in this regard was largely corroborative of the custodian's evidence. He gave as his reason the difference of color of the surface in contrast with the surface of the cracked area, the absence of dust or debris, etc. The witness was also permitted to testify that in his opinion the damage to plaintiffs' building (other than the settlement cracks which appeared earlier and

which no one claims were caused by defendant) was caused by a horizontal force which was vibration in the ground.

On cross-examination the witness testified that wind was not the cause of the failure and that the only other possible source of failure was a ground movement exerting force upon the building. He distinguished a settlement crack from the cracks here involved. He testified that the ground vibrations were the only possible cause of the cracks and other conditions that appeared in the building during and after the blasting operations of the defendant. [emphasis added]

In fixing the quantum of damages, items requiring repair which existed prior to the quarry operator's blasting operations were excluded from the trial court's award.

Plaintiffs' expert witness on damages excluded any items requiring repair which existed prior to the defendant's blasting operations. He fixed the fair and reasonable cost for the repairs, including architect's fee, at $53,900. Defendant's expert witness made like exclusions and fixed the reasonable cost of repairs at $23,100. Defendant here states that there is no evidence that repairs to preexisting damage were required in order to effect repairs to the damage claimed to have resulted from the blasting. The jury fixed the damages at $25,750.

Blast Vibration Damage 10

Residents in an upscale suburb of Masvingo, Zimbabwe, had their homes damaged by blasting at the nearby Chifen Quarry, which became operational in 2019.[70]

Scores of houses in Zimre Park, an upmarket suburb in Masvingo have allegedly been damaged by quarry blasts taking place on the outskirts of the city, a charged meeting of residents heard yesterday.

Zimre Park Residents Association is now demanding compensation from Chifen Engineering and Hardware for houses whose window panes were shattered, buildings walls and pillars that developed cracks and ceilings that collapsed as a result of the mining process.

The residents also want Chifen to immediately stop blasting at the mine until its operations are rectified and considered safe.

The worst blast took place on August 29, 2020 and lawyers representing residents and Chifen have exchanged letters on the issue.

One of the residents who declined to be named said that his child survived death when a ceiling that fell during the blast missed his head by a whisker. [emphasis added]

The meeting of stakeholders held at Chifen Quarry mining site along Harare Masvingo Highway yesterday [March 9, 2021] sought to resolve the issue. Residents complained that in addition to the damages, their houses shook heavily each time there is a blast at the quarry which is 3km from the suburb.

The meeting also attended by The Mirror brought together representatives of the association including the chairperson Farai Makunike, officials from the Ministry of Mines, a representative of Ward councillor Against Chiteme, Masvingo City Council officials and officials from the Environmental Management Authority.

Chifen was represented by the mine manager Ephraim Mutemachani, ***What irked residents is that Chifen management allegedly accepts responsibility for the damages during face to face meetings but refuses the same once the matter is reduced to writing.*** [emphasis added]

[70] Mandigora, Mike., "Quarry mine blasts damage Masvingo houses," *The Mirror*, March 10, 2021, https://masvingomirror.com/quarry-mine-blasts-damage-masvingo-houses/.

Chifen lawyers Mutendi, Mudisi and Shumba Legal Practitioners refused responsibility for the damages in a letter written to residents.

However, residents said the same company had already repaired councillor Against Chiteme's house in the same area that was damaged by the blasts.

The letter from the lawyers said that the damage to the houses could have been caused by vibrations from vehicles using Harare Masvingo Highway, swelling and shrinkage of building material or chemical changes in mortar, bricks and plaster.

Chifen however, said that they were bringing in blasting experts to look into the matter and ensure that their work will be safe….

"We are also doing an assessment on the damages and will only act when the results are out," said Mutemachani. [emphasis added]

Blast Vibration Damage 11

Despite evidence of extensive property damage from ground vibrations (clearly visible in the CBS 42 video) to homes in Alabama within a half-mile (805 metres), the nearby quarry owner, Vulcan, denies responsibility for the damage.

If you've ever experienced an earthquake, it's probably something you'll never forget. For neighbors in Tarrant who live within a half-mile of Vulcan Materials, that's how they described what it feels like when the company blasts every week.

…The company uses explosives at its quarry to make gravel, sending off shots about once or twice a week, sometimes more.

"If you're in the homes it feels like dynamite has went off at your house," Tarrant resident Emma Walters said.

The foundation of Walters' home is crumbling. She told CBS 42 she fears that it will cave in one day. Cracks along the front of her house send water flooding into her basement when it rains, and the inside is marked with splits along the walls.

"I know ***they have a right to make a living, but they don't have a right to destroy my home. My home is all I've got," she said. "My husband and I worked for years for that****."*…[emphasis added]

Despite falling within the proper legal limits, resident[s] are now giving their complaints to city officials. During the Tarrant City Council meeting last week, several residents shared stories of startling sounds, trembling homes and damages they believe were all the result of blasting.

*"****You all come to our neighborhoods, and you tear up and you tear up and you tear up, under the auspices of the guise of the government," said Tarrant Mayor Pro Tem Tracie Threadford. She explained blasting is even impacting her own home.*** [emphasis added]

Randy Jones, area operations manager at Vulcan Materials, was at the meeting, where he told neighbors while the blasts may cause loud sounds and homes to rattle, the vibrations are monitored and are not strong enough to cause damage.

Residents did not react well to that statement. Many were visibly upset, and soon after shared their stories. One woman even handed out photos showing her ceiling caved in, claiming it was from a blast. She said she now wants to sue….

Since that public hearing, Fleming reported several residents called with complaints, and Vulcan Materials had seismographs installed near their homes to monitor vibrations for future blasts. He added that has been their protocol all along, but there was an influx in phone calls since the

hearing. Several seismographs are already installed throughout nearby neighborhoods and monitored for every blast….[71]

We first told you about neighbors concerned about blasting damage in Tarrant last week.

Since then, ***CBS 42 has heard from more residents claiming the blasts from Vulcan Materials are causing their foundations to crumble and causing cracks all throughout their homes****.* [emphasis added]

Cynthia Hurd Threatt says the blasts caused her ceiling to cave-in twice.

*"****I heard this thud by the time I got to my bedroom and I came back and looked and my whole living room ceiling was raining sheetrock****," she told CBS 42.* [emphasis added]

The Alabama State Fire Marshall, who regulates blasting in the state, says he is aware of the growing concerns for residents living near Vulcan Materials. He says he spoke with the Tarrant Fire Department and as of now, they will handle the reports about damages locally.

An official with Vulcan Materials says, since a City of Tarrant public hearing last month about the blasting, they have received more phone calls from those living nearby and additional calls after CBS 42's Your Voice Your Station report.[72]

Blast Vibration Damage 12

A group of more than 200 homeowners filed a class action lawsuit against Rinker Materials and six other companies over the effects of blasting limestone in Northwest Miami-Dade County.[73]

The group is seeking $22 million in damages, claiming the blasting has badly damaged houses, cracking walls, foundations and swimming pools*.* [emphasis added]

*"****We have a right to live in our homes and enjoy peace and quiet without having them violently shaken. We want this to stop and to also get some compensation for our damages,****" said Michael Pizzi, president of Citizens Against Blasting and a Miami Lakes community council member.* [emphasis added]

David M. Wells, an attorney for Rinker Materials, said the Ocala-based company has been blasting in West Dade for 30 years and complies with Miami-Dade law. "We are completely confident that we have not caused any homeowners damages," he said. "We look forward to reading the lawsuit and hopefully sitting down with residents to do some talking."

He said there has always been blasting in the area and the problem is that more homes are being built closer to the blasting site.

The other companies named in the suit are Vecellio Realty Inc., WRQ Property Associates, Tarmac Florida Inc., Sunshine Rock Inc., Sawgrass Rock Quarry Inc. and Pelmad Corp. All are Florida-based and run operations in Northwest Dade.

Although two of the firms are not blasting companies, Gonzalo Dorta, an attorney for Citizens Against Blasting, said they are also liable.

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[71] Vincente, Chloe. "Can Blasting in Tarrant damage your home? Residents say yes, company says no," *CBS42*, April 30, 2021," https://www.cbs42.com/your-voice-your-station/can-blasting-in-tarrant-damage-your-home-residents-say-yes-company-says-no/.

[72] Vincente, Chloe. "More neighbors report blasting damage following CBS 42 investigation," *CBS42*, May 7, 2021, https://www.cbs42.com/your-voice-your-station/more-neighbors-report-blasting-damage-following-cbs-42-investigation/.

[73] Yee, Ivette M., "200 Residents File Suit Over Blasting," *MiamiHerald.com*, 200 Residents File Suit Over Blasting. | Dorta Law.

"Those companies either subcontracted the blasting companies or own the land and pulled the permits to blast," said Dorta. He noted that ***under Florida case law the companies are responsible for any negligence resulting from ultra-hazardous activities, including explosions***. [emphasis added]

Residents of the affected areas, which include Country Club of Miami, Palm Springs North, Miami Lakes and Hialeah Gardens, said blasting has continued unabated for the past two years. They said they have called county officials on numerous occasions to take action – all to no avail.

*"****There was this one humongous blast recently, three to four times stronger than all the others. It felt like the earth moved," said Nanette Maccari, who lives in Country Club of Miami. "I could hear my house creaking. My bookshelves came crashing down and the chairs in my house were wobbling from side to side. I felt dizzy and I burst into tears****."* [emphasis added]

Maccari showed a notebook in which, she said, she has logged the time, day and damage of each blast for the past year.

Some homeowners claim they've lost personal items as well.

"See here, this is a picture of my daughter when she was 6 years old. It was shattered because of a blast," said Yolanda Arroyo, a resident of Palm Springs North.

Pizzi said builders and real estate companies failed to notify some homeowners about the blasting. A Miami-Dade ordinance requires that prospective buyers be told if blasting is occurring within a two- mile radius of the home they contemplate buying. [emphasis added]

Blast Vibration Damage 13

On December 7, 2018 Goldston, North Carolina residents near the 220-acre Daurity Springs Quarry expressed their concerns after being subjected to the consequences of a quarry blast.[74] Goldston is a small town of 500 acres and one mile in diameter.

There was a terrible explosion that rattled and shook my house, sending me out the back porch, thinking Goldston was experiencing an earthquake. Once outside, I could see a cloud of dust just behind the tree line. (Marian Norton, Goldston Resident)

Goldston resident and Army veteran James Womack…spoke of the effect the blasting had on him.

"Later [last week], there was a single blast and I hit the deck," Womack said. "I was in artillery, when you hear the blasts, you hit the deck, and I got out of the army 50 years ago."

Residents repeated concerns about the possible damage to their homes and foundations as a result of the blasting.

The Daurity Spring Quarry is right behind Goldson resident Primrose Sutton's home.

"My whole house shakes," Sutton said. "My question is if I have house damage, who is going to be responsible to pay for that?"

Other residents voiced concerns about the quality of their well water due to the blasting and subsequent excavation at the quarry.

"I'm sure my water will be affected by this," Goldston resident Kenneth McIntosh said. "How am I protected with the well water that I have?"

Concerns were also raised about the stability of the town's water and sewer infrastructure which was installed less than five years ago because of the blasting….

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[74] Mann, Casey. "Goldston neighbors speak out against quarry's nuisance," *Chatham News+Record*, January 3, 2019, https://www.chathamnewsrecord.com/stories/goldston-neighbors-speak-out-against-quarrys-nuisance,1299.

Goldston area property tax values spiked unrealistically with the last county re-evaluation. Our home is currently valued at over four times what we paid for it. Realistically, we probably won't get a return on our investment. Another older home on South Main Street recently sold for less than half of its appraised value (and that was before blasting began)[75]….[emphasis added]

We're going to have to adjust to a lifestyle of no peace and quiet, devalued properties, and dangers involved with nearby blasting of heavy truck traffic, increased noise, jarring blasts, dust and flying rock. My porch is no longer a haven, nor my yard a safe playground for the grandchildren. [emphasis added]

Blast Vibration Damage14

On December 5, 2019, vibrations from a blast at a quarry in Raleigh County, West Virginia, shook homes and caused damage to property in nearby neighbourhoods.[76]

A series of explosions that have rocked Maxwell Hill residents for two years are the result of blasting at a rock quarry on Sand Branch Road, Raleigh County Emergency Operations Center officials said Thursday [December 5, 2019].

Maxwell Hill resident Jim O'Dell, 79, said that he and his neighbor, Mary Peters, heard the blast at 4:07 p.m. on Thursday. ***He said that, for the past two years, he has heard loud blasts that tend to start at 4 p.m***. [emphasis added]

The blast on Thursday was bigger and shook his house.[emphasis added]

"I always thought, 'That's manmade,' " he said. "But today, it almost shook the roof off of my house.

"I've been living here for 47 years, and that's the heaviest blast I've ever felt."

Several more residents called The Register-Herald to report the blasts. One caller was from the Bluefield area of Mercer County….[emphasis added]

Officials reported that the EOC does not receive prior notification from Appalachian Aggregates on days that the blasts are planned.

They do receive calls from citizens, they reported….

Another EOC official reported that several citizens had called EOC Thursday to report the blasts, which is not uncommon when the company is blasting. [emphasis added]

O'Dell said Thursday evening that the Thursday blast was not considerate of area residents or property owners.

"Why are they shaking everybody's houses around here?" *O'Dell asked. "That's too big of a blast.* [emphasis added]

"It's bad enough to crack a concrete floor."

O'Dell suggested that The Register-Herald call Del. Mick Bates (D-Raleigh). Bates owns Bodyworks, a health club in Maxwell Hill.

"He doesn't want his chandeliers shook out of the ceiling," O'Dell added.

Bates said he also heard the blast.

"That was a pretty loud bang," Bates said. "I was doing other things.

"I didn't feel anything here, but the percussion was pretty intense.

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[75] https://www.chathamcountync.gov/home/showpublisheddocument/42504/636809132850100000.

[76] Farrish, Jessica. "Quarry blasts cracks neighbors' ceilings," *The Register-Herald*, Dec 5, 2019, https://www.register-herald.com/news/quarry-blast-cracks-neighbors-ceilings/article_4eecbd93-1963-588e-a213-dfb7bf6c9a6b.html.

"I didn't have any issues with power or equipment," he added.

O'Dell's wife said the couple's ceiling ***was cracked after the explosion***. [emphasis added]

Blast Vibration Damage 15

In November 2016, vibrations from a blast at the Sarawak quarry, Kemble, Ontario, then owned by Harold Sutherland, caused damage to the neighbouring Wilcox's home, for which they were inadequately compensated, and that terrified the family.[77]

We live at…Grey Road 1, Kemble….directly south of the proposed Sarawak Quarry Expansion. E lines of our property butt against this proposed expansion site.

We built our home in 2006. The quarry we were told at the time was 'dead' by our real estate agent, and as such we purchased the land and built our dream home. Over the years we have built a couple of structures on our property…We recently completed renovations to the inside of our home, upgrading our kitchen….and created a walk-out basement only a few years ago…. and spent several thousand dollars on concrete driveways and sidewalks….[emphasis added]

The expansion of this quarry means that trying to sell our property will become impossible because nobody will want to buy our house with quarry equipment stored in plain site [sic] of the house, as we currently have to view daily. Nobody will want to pay what our house is worth to look at this eyesore daily. Nobody will want to buy our house for fear the property (open field) to our north will become littered with more machinery, equipment, piles of things, trailers, rubble, rock, gravel, etc. And nobody will want to buy our house because of the constant noise experienced when these pieces of equipment and machinery come to and from this space. [emphasis added]

A blast occurred at the existing quarry in November 2016…That blast scared the living daylights out of my husband who was in the upstairs of our big garage when it went off, causing the drywall in the upstairs loft he was in to crack along most every seam. At the time this occurred, the Ministry, Township and County were all contacted by us, and we got the same story from everyone – that the blast was in acceptable limits. [emphasis added]

We call bull on that – because acceptable limits do not cause my husband to flee from his place out of fear, and it certainly would NOT cause damage to our property Harold Sutherland sent an inspector to view the damage, and we were paid by them $500 to fix the damage. Our quote was more than twice this amount. So not only did this blast cause damage, it also caused us financial setback, distress, worry and fear it will keep happening, only for use to be told 'it['s all acceptable'. [emphasis added]

Blast Vibration Damage 16

In a 2003 lawsuit against Vulcan Materials, 57 residents sought to be compensated for damages to their homes from vibrations caused by blasting at the 137-acre Bellwood Quarry in northwest Atlanta.[78]

Neighbors say blasting by quarry damages homes. Lawsuit by 57 residents calls for home repairs, end of detonations…

Mary Hollifield says she had to nail this painting to the wall to keep it from falling from the detonations at the nearby county-owned quarry. Officials of Vulcan Materials, which rents the quarry, deny their work causes damage.

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[77] https://pub-georgianbluffs.escribemeetings.com/filestream.ashx?DocumentId=1422.

[78] "Neighbors say blasting by Vulcan damages homes," *Aggregate Rsesearch.com*, May 9, 2003, https://www.aggregateresearch.com/news/neighbors-say-blasting-by-vulcan-damages-homes/.

Kitchen cabinets are coming loose from the walls, linoleum floors are sinking and ceilings are cracking. All this and more from dynamite blasts at the Bellwood Quarry in northwest Atlanta, say residents of the neighborhood next door. "I thought it was some kind of earthquake," said Anne Johnson, a 63-year-old part-time school crossing guard who lives in the adjacent Grove Park area. "I just want to be comfortable. That's all." Johnson and her husband, a retired cabdriver of 30 years, are still paying off their home on Francis Place that they bought for $8,500 in 1969….

The homeowners want Vulcan to stop blasting at Bellwood and to pay for damages to their homes….

The residents' lawsuit comes a month after state Insurance Commissioner John Oxendine said his office would examine the 1978 state code that governs commercial blasting to determine if it is too weak. The state decided to look into regulations after complaints from people who live near Hartsfield International Airport, where blasting has taken place to build a fifth runway. Residents there also want the blasting stopped….Residents are mostly low-income and predominantly black. Many residents are retired. "it's been traumatic," said Mary Hollifield, president of the Grove Park Neighborhood association and a retired teacher whose kitchen floor is sinking. "I like it here. I don't want to go anywhere else."…

The previous quarry renter, C.W. Matthews Contracting Co.…sold that company's quarry rights to Vulcan in 1997. Before the sale, Matthews set aside $150,000 for a "residential neighborhood claim fund." The fund was "established for the payment of damages to any residence located adjacent" to the quarry. Residents found out about the money last year, when they sought help form Fulton County Commissioner Emma Darnell, who represents the area. The Grove Park Residents' lawyer, Cooper Knowles, said Darnell told the residents that a board would have to be appointed to decide if money was due….[emphasis added]

Neighborhood residents say the blasts are occurring less frequently – weekly rather than daily as was the case when Matthews mined the quarry. ***Still, residents say in their lawsuit, the blasting violently shakes homes, causing structural damage including, but not limited to, cracks and holes in walls, ceilings, beams and foundations, broken water and sewage pipes, and broken windows.,,,*** [emphasis added]

Residents of Grove Park said they didn't begin to realize that the blasting was so destructive until many of them grew older and retired, meaning they were home more during the day when blasting occurred. What they discovered are walls that rumble and pictures falling off the walls, they say*. "I wish they'd stop," said Dorothy Mayes, 72. "I'm too old. I don't want to sell.* [emphasis added]

Note: On June 30, [2006,] the city [Atlanta] bought Vulcan's interest in its long-term lease for $25 million and Fulton County's underlying fee interest for $15.2 million. The quarry occupies 137 acres….[and] will be converted into a new 300-acre park and greenspace…[79]

Blast Vibration Damage 17

In *Whitney v. Ralph Meyers Contracting Corporation*, 118 S.E.2d 622 (1961),[80] ground vibrations from blasting rock in connection with the construction of Highway 64, near Huntington, West Virginia, caused damage to the Whitneys' home, located 1,800 feet (549 metres) from the blasting operation. The Whitneys' house had been moved to its new location about January 15, 1959, and after reoccupying the house, "cracks began to appear in the basement walls and continued to increase in number and size until April 10, 1959, when the basement walls, or, at least, the larger part thereof, collapsed, permitting the

[79] https://www.atlantaga.gov/home/showpublisheddocument?id=1677.
[80] https://scholar.google.com/scholar_case?case=6394650802472535198&q=%E2%80%9Cquarry%E2%80%9D+and+%E2%80%9Cvibrations%E2%80%9D&hl=en&as_sdt=2006.

house to fall." [underscoring added] The appeal court of West Virginia upheld the damages awarded to the Whitneys by the trial court.

> *In the instant case, the facts detailed are sufficient to permit a jury to infer that the damages were the direct result of the blasting done by the defendant, by the vibrations through the earth occasioned by such blasting. Plaintiffs were not required to show that the damages to the basement walls were the result of any particular or isolated explosion, but only to establish facts that would fairly raise an inference as to the cause thereof.* ***That repeated vibrations of the earth, at or in the vicinity of plaintiffs' property, occasioned*** *625* ***by the blasting operations, occurred during times material, appears to be clearly established by the proof and, we believe, the evidence sufficiently establishes that the damage to the basement walls did not occur because of normal pressures or circumstances****. In Scranton v. L. G. De Felice & Son, Inc., 137 Conn. 580, 79 A.2d 600, 601, a case decided on facts very similar to the instant case, involving the question here being considered, the Court said: "* * * The finding that the blast in question was followed immediately by a marked and noticeable shaking of the plaintiff's buildings and that cracks then appeared in the exterior and interior plaster is ample under the circumstances to justify the conclusion that the cracks resulted from the blast."* [emphasis added]
>
> ***Several witnesses testified to the nature and severity of the vibrations resulting from the blasting operations of defendant, which reached plaintiffs' property and its vicinity, and of complaints made to defendant relating thereto****. No witness saw any crack or break in the basement walls appear simultaneous with experiencing any vibration.* [emphasis added]

Blast Vibration Damage 18

In *Aikman v. George Mills & Co. Ltd. et al.*,[81] the trial judge held that ground vibrations from blasting to deepen the Livingstone Channel in the Detroit River caused damage to the Aikman Residence in Amherstburg, Ontario, a ruling which was upheld on appeal. The Aikmans' residence, newly constructed in 1931, is located about 3,500 feet from the closest point at which work was commenced by George Mills & Co.in 1932. Both George Mills & Co. and the blaster (Arundel Corporation) were found strictly liable for the damage done by the escaping vibrations, pursuant to the principle of *Ryland v. Fletcher* (1868), L. R. 3 H.L. 330, and held jointly and severely responsible for the full amount of the damages awarded by the court to Aikman.

> *The first of the work in the channel with which we are concerned in this case was done by the defendants George Mills & Company on section B. The method followed on this section was spoken of as the "dry" method. Coffer-dams were built…around the part of the channel that was to be deepened, the area was dewatered, and the rock was blasted away to the required depth. The first blasting was done on December 17, 1932, and there was blasting on many later days in December; but the charges of explosion used were relatively small, and it was not until January 11, 1933, that any charge was used that, on the evidence, can reasonably be found to have been heavy enough to cause damage to the plaintiff's house. On January 11 there were two blasts in each of which more than 2,000 lbs [907 kilograms]. of dynamite were used; and from that time until August 2, blasts of that magnitude were of very frequent occurrence…. The heaviest seems to have been on July 18, when 5751 lbs [2,609 kilograms] were used. After August 2 there were only (relatively) light blasts on any part of the work until the Arundel Corporation began work in section C. on September 27. From that time until the end of October there was blasting in section C. almost daily, on some days several blasts, until the latter part of October; but the work on this section was done under water, the drills being operated from scows, and the area blasted, and consequently the quantity of dynamite used, in any one blast being less than in the "dry" work done in section B. On*

[81] *Aikman v. George Mills & Co. Ltd. et al*., 1934 CanLII 99 (ON SC), <https://canlii.ca/t/g1g6g>, retrieved on 2021-08-24.

> *only three occasions was as much as 2,000 pounds [907 kilograms] of dynamite exploded at one time; but explosions of 1,500 or 1,600 pounds [726 kilograms] weight were frequent.*

Mr. Aikman described the extent of the damage to his home as follows:

> *…[I]n the summer he found some 200 cracks, of which seventeen were in the foundation where he had found two on his first examination and one was in the stone work; that in November there were twenty cracks in the stonework, and that all cracks had opened considerably; that he glued strips of paper across some of the cracks and a fortnight later found some six or eight of these strips broken. He says that on one occasion a crack appeared at the moment of a blast and that on another occasion some article was jolted from a shelf in the kitchen. Both he and the plaintiff swear to the trembling of the house at the time of blasts, and the plaintiff speaks of windows and dishes rattling.*

While the Aikmans' evidence of damage lacked some specificity, other homeowners in the area were able to corroborate the timing of various blasts and the impact to their homes.

> *Neither the plaintiff nor Mr. Aikman gives any very precise evidence as to the time of the appearance of the several signs of damage; but a witness, Mrs. Teeter, who lives in the neighbourhood and who, apparently, has in contemplation a claim for damage done to her house, had kept some notes and was able to tell of the rattling of the crystals of a lamp, almost at the moment of the explosion of a heavy charge of dynamite by George Mills & Company on April 20, and of the appearance of a crack in one of the walls of her house at the time of the firing of a much lighter blast (2,027 lbs.) [919 kilograms] on February 20; and Mrs. Wilson, who is not a claimant but is tenant of an old and solidly constructed building tells of much damage caused and of vibration at the time of blasts sufficient to shake articles from a table and a picture from its place; and other witnesses give evidence upon which it is perfectly certain that houses in Amherstburg were shaken by the blasts and were to a greater or less extent damaged.*

As to the cumulative effect of repeated blasting on the Aikmans' residence, the court had this to say:

> *The fact is, however, that what the plaintiff sues for is not the damage done to a wall by a certain blast, to a chimney by another, to the foundations by a third, and so on, but for the damage done to the house as a whole by the whole series of blasts, and that a finding that any part, or any definable part, of that damage was caused by the blasting done by the Arundel Corporation in section C. (where no very heavy charges were used;…) would be speculative in the extreme. Indeed, it is probably correct to describe the plaintiff's house in its present condition as a house the fabric of which has suffered from the cumulative effect of a series of shocks, rather than as a house in which there are many defects each of which is attributable to a shock.*

The judge was unimpressed by the evidence presented by the defendant's expert:

> ***The impression created by the evidence was that such investigation as there was superficial, and that there was too much reliance upon theoretical opinion****.* [emphasis added]

And, while it was possible that shrinkage could cause damage to the residence, the judge favoured the expert opinion of Mr. Allan, testifying on behalf of the homeowner, who found no indication of shrinkage.

> *…I have come to the conclusion that it is safe to adopt the opinion expressed by Mr. Allan when called in reply and cross- examined, to the effect that while it cannot be said that there was no shrinkage of timber, or no cracks caused by shrinkage, it can be said that more than half of the cracks are attributable to something other than shrinkage. Mr. Allan would not swear positively that*

it was impossible that 90 per cent. of the cracking had been caused by shrinkage; but he said that he could find no evidence of shrinkage, and, as has been stated, that he believed that the greater part of the cracking seen must be attributed to another cause. It cannot be found that there had been any settlement (or unusual settlement) of the house; and, as I have said, my conclusion is that the opinion that at least the greater part of the damage was caused by the blasting is well supported by the evidence.

Blast Vibration Damage 19

In *Phillips v. California Standard Company*,[82] damages were awarded to the farmer whose well water quantity and quality was damaged by vibrations 770 feet (235 metres) from the nearest hole where blasting had taken place. The well had been drilled in 1940 to a depth of 270 feet (82.3 metres), and produced "clear, odourless, drinkable water, pumping approximately 300 gallons (1,136 litres) per hour," and was in good condition prior to the blasting undertaken by the defendant on October 25, 1956.

There was evidence that on October 25, 1956, the plaintiff's mother-in-law was in the kitchen of the plaintiff's home having breakfast at about…8:00 a.m. when she heard a terrific explosion which jarred the house and dishes, and that her daughter felt there had been an earthquake. There were admittedly several explosions. At all events, at approximately 5:30 to 5:45 p.m. on October 25, 1956, the plaintiff visited the well. He heard a gurgling sound which he said sounded like air in the well, drew off some two pails of water which was highly discoloured and highly odiferous, smelling highly of sulphur and, as said by some of the witnesses, like a smell of rotten eggs. The odour and sedimentary pollution rendered it totally unfit for human or animal use.

The evidence is overwhelming and overpowering linking the plaintiff's loss with defendant's explosions, the vibrations of which would extend a mile deep and horizontally for some 2,400 feet [732 metres]. The strata injury from the shot or shots need not necessarily have occurred in the immediate vicinity of the well in question and may have occurred some distance from the same, but the shots undoubtedly did cause strata damage which affected the well's production. Obviously there was a strata injury beneath the plaintiff's farm, probably caused by the intensity of the seismic explosions and it is noteworthy that the quantity and quality deterioration in the plaintiff's well water commenced only after the explosions set off by the defendant. The production from the plaintiff's well was reduced almost to zero.

Blast Vibration Damage 20

Vibrations from blasts at a granite quarry is impacting Sungai Ara, Malaysia, a community of 8,000 people, and have caused roof tiles, walls and floors to crack, and in August 2021 flyrock debris hit the roof of a neighbouring house.[83]

GEORGE TOWN: A granite quarry has been causing sleepless nights for some 8,000 residents at a suburb in Sungai Ara, with explosions and tremors shaking their homes since early this year.

The residents, who moved in five years ago, were told that the quarry has been dormant and would soon make way for a bungalow project.

However, since February [2021], the digging and detonation work from the quarry site has caused roof tiles, walls and floors to crack*….*[emphasis added]

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[82] *Phillips v. California Standard Company*, 1960 CanLII 525 (AB QB), <https://canlii.ca/t/gcwlh>, retrieved on 2021-08-24.

[83] Namblar, Predeep. "Residents blast quarry activities in their backyard," *Free Malaysia Today*, August 24, 2021, https://www.freemalaysiatoday.com/category/nation/2021/08/24/residents-blast-quarry-activities-in-their-backyard/?__cf_chl_jschl_tk__=pmd_BDucwK0Lp2V__tFF1z_nxHqI6db8nyZDFF4FMyd8ziM-1630458943-0-gqNtZGzNAnujcnBszQiR.

Besides structural damage, there is dust and noise pollution. Lorries carrying materials to and from the quarry have also suffered mishaps – flipping over a hill and another crashing into a traffic light, residents told FMT. [emphasis added]

One resident, Askin Meera, 55, said the tremors from the quarry have become more frequent and more intense since February, after a rather quiet last five years.

He said the residents' associations of Setia Pearl Island, Setia Pulau Mutiara 3 and Stramax Residence had written to the chief minister for help last month after a two-year discussion with local representatives, a Penang official and the quarry operator fell through.

Askin said that under present environment department guidelines, a minimum 500m buffer was required between a quarry and any residential area. Their homes are less than 150m from the quarry. [emphasis added]

He said there were three landslips at the same hill site about four weeks ago near Persiaran Nuri.

"My house is less than 100m away from the quarry fencing. Last week, flying rocks from the quarry hit the roof of a neighbour's house.

"We didn't know a quarry existed there when we bought this place as it was dormant. We saw a signboard showing that the site would be developed for bungalows," he told FMT.

At a meeting, a Penang exco had told the residents that the quarry had been in existence since the 1990s and they were told to "live with them"….[emphasis added]

THE CORPORATION OF THE UNITED TOWNSHIPS OF DYSART, DUDLEY, HARCOURT, GUILFORD, HARBURN, BRUTON, HAVELOCK, EYRE AND CLYDE

BY-LAW NO. 2003 - 95

A BY-LAW TO REGULATE THE OPERATION OF PITS AND QUARRIES

WHEREAS Section 124(1) of the Municipal Act S.O. 2001, c. 25 authorizes the Municipality to pass by-laws for regulating the operation of pits and quarries within the Municipality.

AND WHEREAS the Council of the Corporation of the United Townships of Dysart et al deems it advisable to regulate the operation of pits and quarries within the Municipality.

NOW THEREFORE the Council of the Corporation of the United Townships of Dysart et al enacts as follows:

Definitions

In this by-law the following definitions shall apply:

1) "Aggregate" means gravel, sand, clay, earth, shale, stone, limestone, dolostone, sandstone, marble, granite, rock other than metallic ores.

2) "Holiday" means a holiday as defined in the Interpretation Act of Ontario.

3) "Operate" means, when used in relation to a pit or quarry, all activities associated with a pit or quarry that are carried out on land from which aggregate is being excavated.

4) "Person" means an individual, a partnership, a corporation, a municipality, a public road authority or other group or body.

5) "Pit" means land or land under water from which unconsolidated aggregate is being or has been excavated and that has not been rehabilitated, but does not mean land or land under water excavated for a building or other work on the excavation site.

6) "Planting Strip" means an area which shall be used for no purpose other than the planting of trees or a continuous un-pierced hedgerow of evergreens or shrubs, not less than 1.5 metres high, immediately adjacent to the lot line or portion thereof along which such planting strip is required herein.

7) "Quarry" means land or land under water from which consolidated aggregate is being or has been excavated and that has not been rehabilitated, but does not mean land or land under water excavated for a building or other work on the excavation site.

8) "Rehabilitate" means to treat land from which aggregate has been excavated so that the use or condition of the land:

   a) is restored to its former use or condition; or

   b) is changed to another use or condition that is or will be compatible with the use of the adjacent land.

9) "Site" means the lands used for the operation of a pit or quarry.

10) "Municipality" means the Corporation of the United Townships of Dysart, Dudley, Harcourt, Guilford, Harburn, Bruton, Havelock, Eyre and Clyde.

Application

11) No person shall operate a pit or quarry on land except in compliance with the provisions of this by-law, any other applicable by-law of the Municipality and all Provincial and Federal legislation.

12) Nothing in this By-law is intended to make lawful any operation of a pit or quarry, which would otherwise be unlawful under a zoning by-law, other Municipal by-law or Provincial or Federal legislation or regulation.

13) This By-law shall not apply to the excavation of aggregate by an individual or group of individuals for use by the individual or group of individuals but not for resale for commercial purposes.

Hours of Operation

14) Unless otherwise agreed to in the Operators Agreement referred to herein, no person shall permit the operation of any machinery or equipment in connection with a pit or quarry, other than water pumping equipment:

   a) on a holiday or on a Sunday; and/or

   b) on any Saturday during the months of July and August, except where deemed by Council to be an emergency situation.

15) Unless otherwise agreed to in the Operators Agreement referred to herein, no person shall permit:

a) the hauling or trucking of aggregate from a pit or quarry on any other day except between the hours of 6:00 am. and 6:00 pm; and/or

b) the crushing of aggregate in a pit or quarry on any other day except between the hours of 7:00 am. and 7:00 pm., Monday to Friday inclusive, during the months of January to June inclusive and September to December inclusive.

Setback Limits

16) In this By-law, "Excavation Setback Area" means the area within the setbacks for a pit or quarry established by the Municipality's Comprehensive Zoning By-law.

17) No person shall excavate aggregate within the "Excavation Setback Area" of a site.

Screening:

18) The person operating a pit or quarry shall before commencing operation, plant and thereafter maintain a planting strip along the boundary of the site to obstruct the view of the pit or quarry in compliance with the Municipality's Comprehensive Zoning By-law. For operations commencing after the date of passing of this by-law the planting strip, ingress and egress shall be shown on the site plan, approved in accordance with Section 25 of this By-law.

Maintenance Standards

19) The person operating the pit or quarry shall ensure that:

a) any building or structure or processing plant on the site is maintained in a good state of repair and the site is kept in an orderly and safe condition;

b) each entrance to and exit from the site is located in accordance with an approved entrance permit;

c) all internal combustion engines located and operated within the site are properly fitted with sound muffling equipment equal to the manufacture's specifications or better, and all equipment is operated to avoid any nuisance due to noise;

d) all entrances to public roads are treated with appropriate dust control measures, as often as is necessary and whenever requested by the Municipality; and

e) all scrap on the site is collected in an area on the site but outside the "Excavation Setback Area". All scrap is to be removed from the site to an approved disposal area approved for that purpose by Provincial and Municipal agencies. For the purpose of this paragraph, "scrap" means all waste material, refuse, debris, including scrap lumber and metal, discarded machinery, equipment, and motor vehicles.

Rehabilitation:

20) The person operating a pit or quarry shall rehabilitate the site in accordance with the provisions of this by-law.

21) The person operating a pit or quarry shall ensure that:

a) all topsoil or subsoil stripped in the operation of the site is used in the rehabilitation of the site;

b) adequate vegetation is planted and maintained to control erosion of any topsoil replaced on the site;

c) when the site is finally rehabilitated, the excavation face:

i) of any pit has a slope that is at least 3 horizontal metres for every vertical metre; and

ii) of any quarry has a slope that is at least 2 horizontal metres for every vertical metre;

22) The person operating a pit or quarry shall, as part of the rehabilitation, remove from the pit or quarry and the land surrounding the pit or quarry, or from that portion of the pit or quarry not being used, all structures and equipment used in the operation of the pit or quarry save and except fences.

23) The person operating a pit or quarry shall rehabilitate the pit or quarry in accordance with any plans filed with the Municipality, which plans form part of an Operator's Agreement as set out below. Such plans may require progressive rehabilitation.

Operator's Agreement

24) Prior to amending the Municipality's Comprehensive Zoning By-law to permit the establishment of a pit or quarry, or an extension to an existing pit or quarry, the person proposing to operate a pit or quarry shall make application for and shall enter into an Operator's Agreement with the Municipality.

25) Every application shall be accompanied by a site plan signed by the applicant which must show:

a) a general description of the proposed site, including lot and concession lines, if any;

b) the shape, dimensions and area of the of the proposed site;

c) the use of the land and the location and use of the buildings and structures within 150 metres of the proposed site of a pit, or within 500 metres of the proposed site of a quarry;

d) the location, dimensions and use of the buildings and other structures existing or proposed to be erected on the proposed site;

e) the location of the "Excavation Setback Area";

f) the location and type of existing and proposed fences;

g) the location of the proposed planting strip;

h) every existing and proposed entrance to and exit from the proposed site;

i) any surface water excluding spring run-off, but including all streams and creeks, on and surrounding the proposed site and proposed water diversion, storage and drainage facilities on the site and points of discharge to surface water;

j) subject to available information, the location of existing water wells on and within 300 metres of the proposed site;

k) if it is intended to excavate below the water table;

l) the direction of excavation of the pit or quarry;

m) the progressive rehabilitation and final rehabilitation plans; and

n) any other necessary information respecting the proposed site.

26) An Operator's Agreement shall contain:

a) a statement that the person operating the pit or quarry will comply with the provisions of this By-law;

b) a statement that the person operating the pit or quarry shall operate and rehabilitate the pit or quarry in accordance with the approved site plan, this By-law and the Operator's Agreement;

c) a statement that the person operating the pit or quarry shall be responsible for all reasonable costs incurred by the Municipality, with respect to the application, the re-zoning, the preparation of the Operator's Agreement, including any survey, engineering, planning or legal costs; and

d) the consent of the registered owner of the site to the registration of the Operator's Agreement on title to the lands to which it applies.

27) An Operator's Agreement may contain:

a) additional site specific regulations with respect to the proposed pit or quarry;

b) additional operation or rehabilitation requirements;

c) requirements relating to haul routes;

d) requirements relating to the provision of municipal road improvements and sign postings;

e) the requirement to post security to ensure compliance with the Operator's Agreement and the rehabilitation of the pit or quarry; and

f) such other matters as the Council of the Municipality deems appropriate.

General

28) This By-law in no way relieves any person from complying with any other by-law of the Municipality, including any zoning by-law and shall not in any way restrict or limit the Council of the Municipality in exercising its discretion respecting an application to amend the Municipality's Comprehensive Zoning By-law to permit a pit or quarry or the extension of a pit or quarry.

29) If any provision of this by-law is for any reason held to be invalid by a court of competent jurisdiction it is hereby declared to be the intention of the Council of the Municipality that all remaining provisions shall continue to be in full force and effect.

Penalty

30) Any person who contravenes or fails to comply with any provision of this By-law shall be guilty of an offence and upon conviction shall be liable to the fines and penalties prescribed by the Provincial Offences Act.

31) Where this by-law requires any matter or thing to be done and there is default of its being done by the person directed or required to do it, such matter or thing may be done by the Municipality at the person's expense and the Municipality may recover the expense incurred in doing it by action or in a like manner as municipal taxes.

READ a first, second and third time, signed and the Corporate Seal attached hereto this 8th day of September, 2003.

_____

Murray Fearrey - Reeve

_____

CAO/Clerk Tammy McKelvey

Prepared by Tony Sevelka (March 21, 2021)

Blasting Quarry Applications: Flyrock Health and Safety Concerns, Quality of Life and Property-value Diminution, Reciprocal Setback Requirements, and Blasting Impact (Non)Assessments

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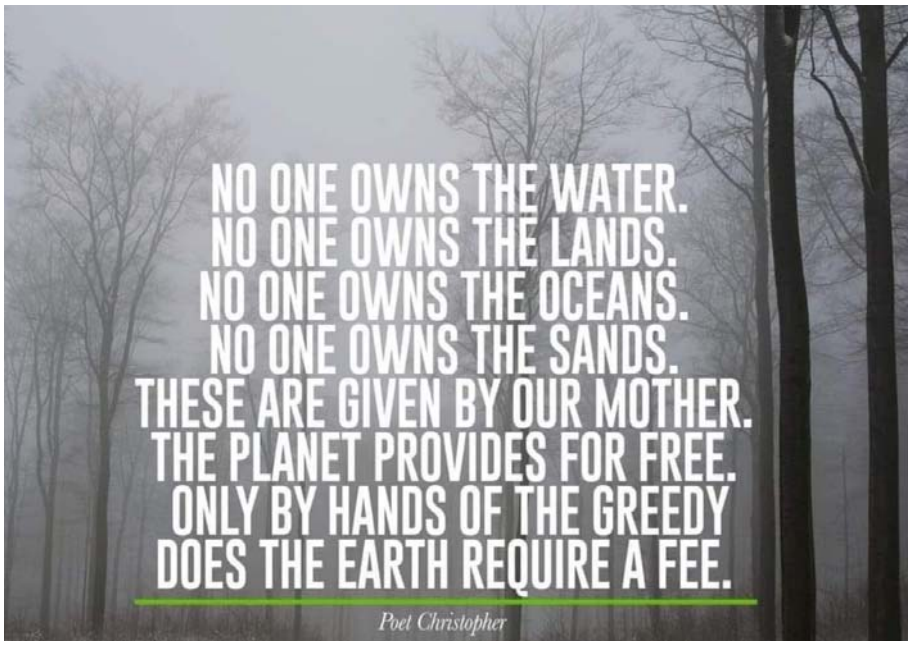

Introduction

Blasting quarry operations are a significant source of adverse effects and complaints, and have the potential to cause temporary or permanent damage to the environment, and cause temporary or permanent injury and death of humans, animals and wildlife. The primary focus of this paper is applications for quarry blasting and *flyrock*, which is the ultimate adverse effect caused by blasting quarry operations, and proponent-driven Blasting Impact Assessments, which are sorely lacking in protecting the public interest.

The depraved indifference shown by Ontario explosives engineers in the preparation of proponent-driven Blast Impact Assessments (BIA) to the significant dangers of *flyrock* is exemplified in the testimony of the explosives engineer at a 2020 LPAT hearing involving an application for a quarry in the Township of Tyendinaga:[1]

> *Mr. Cyr attempts to explain away the absence of any meaningful analysis of flyrock in the BIA on the grounds that this falls outside the scope of an BIA that is aimed primarily at the MECP's Noise Guidelines. He further suggests that the issue of flyrock is best left to provincial ministries which have the authority to "aggressively prosecute" flyrock incidents after-the-fact [p. 13].* [underscoring added]

The Aggregate Resources Act, R.S.O. 1990, c. A.8, as amended,[2] defines "quarry" as follows:

> *"quarry" means land or land under water from which consolidated aggregate is being or has been excavated, and that has not been rehabilitated, but does not mean land or land under water excavated for a building or structure on the excavation site or in relation to which an order has been made under subsection (3).*

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[1] *Bates v Ontario (Natural Resources & Forestry)*, 2020 CanLII 1409 (ON LPAT), <https://canlii.ca/t/j4jw8>, retrieved on 2021-03-17

[2] https://www.ontario.ca/laws/statute/90a08#BK0.

Until the proclamation of Regulation 466/20 of the Aggregate Resources Act in September 2020,[3] the only statute in Ontario to specifically prohibit the discharge of *flyrock* into the environment was section 14 of the Environmental Protection Act (EPA), which came about as a consequence of the 2013 Supreme Court of Canada ruling in *Castonguay*[4] that flyrock is a contaminant and that "***the flyrock could easily have seriously injured or killed someone [para. 39]***."

Canadian Environmental Law Association (CELA) was granted Intervener status in the *Castonguay* case, and in its Factum[5] CELA provided the following legal analysis of *flyrock* in the context of section 14 of the EPA, concluding that several of the applicable adverse effects are derived from common law tort liability theories;

> *Fly rock, being a "solid…resulting directly or indirectly from human activities" can be a "contaminant", can be discharged" by "addition" or "deposit", can interfere with "air" or "land", and have an "adverse effect", such as "damage to property", or "impairment of the safety of any person". On the facts of this case, the Appellant's blasting activity and resulting fly rock debris damage met each of the definitions in section 1(1) and had serval adverse effects to which the EPA is applicable is derived from common law tort liability theories [para. 18].*

The Environmental Protection Act (EPA), R.S.O. 1990, c. E. 19, as amended,[6] defines "natural environment as follows:

> *"natural environment' means the air, land and water, or any combination or part thereof, of the Province of Ontario.*

Despite being the ultimate adverse effect of quarry blasting operations and despite the 2013 Supreme Court ruling in *Castonguay*, and even though *flyrock* is a greater hazard than "ground vibrations" or "airblast," the Ministry of Natural Resources and Forestry (MNRF), the Ontario aggregate industry and the explosives engineers retained on their behalf have not implemented any precautionary safety measures to protect the public from the potential dangers of *flyrock*.

Flyrock Is Any Material Propelled From A Rock Blasting Operation

- *Flyrock is debris ejected from the blast site that is traveling through the air or along the ground…. [It is] the single most dangerous adverse effect that can cause property damage and personal injury or death [to humans, pets and livestock][7] [Slide 4]*
- *Flyrock may be rock or soil. Any size material is capable of damaging property or injuring [or killing] people. [Slide 57]*
- *Flyrock damage is quite obvious when a structure is hit. Holes and marks are very visible. [Slide 59]*

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[3] http://www.ecolog.com/daily_images/1004618147-1004619030.pdf.
[4] *Castonguay Blasting Ltd. v. Ontario (Environment)*, 2013 SCC 52, [2013] 3 S.C.R. 323, https://scc-csc.lexum.com/scc-csc/scc-csc/en/item/13289/index.do.
[5] https://cela.ca/wp-content/uploads/2019/07/C53611_FOI.pdf.
[6] https://www.ontario.ca/laws/statute/90e19#BK24.
[7] Controlling the Adverse Effects of Blasting, blaster-training module put together by the Office of Technology Transfer, Western Regional Office, Office of Surface mining, U.S. Department of the Interior, Denver Colorado.

- *A rock that lands harmlessly in a field may not appear to be a large issue. However, mowing and tilling become hazardous when rock is struck by farm equipment. Rock through timber stands mar trees and potentially impact the market value. [Slide 59]*
- *Flyrock can be cast thousands of feet from a blast. [Slide 58]*

Flyrock is an ever present danger wherever rock blasting occurs, and, therefore, the prevention (or avoidance) of *flyrock* must be dealt with proactively and explicitly before approving an application to permit a blasting quarry operation.

> *Accidental flyrock in blasting operations has a major impact on the external environment…due to the hazards involved and is more significant than vibrations or airblast….[E]ven if it is normal practice in these zones to take into account the impact of possible vibrations and even the effects of airblast when modeling the project, flyrock risks are not dealt with in initial studies, other than by way of integrating general safety distances. These risks are only sometimes taken into account much later in the operation and most often, following an accident or significant flyrock being recorded externally [off-site] [p. 549].*[8] [emphasis added]

Flyrock Incidents Underreported and Lack of Public Awareness of Flyrock

Reports of *flyrock* are a very common occurrence,[9] and under-reporting is responsible for five to ten times the actual number of *flyrock* incidents (Davies 1995). According to *Raina et al* (2013), one of the major reasons *flyrock* incidents go unreported is to avoid legal responsibility. Also, *flyrock* that lands in an uninhabited area unnoticed goes unreported.

A Tasmanian family, Peter Guichelaar and his wife Sharon, own a 377-hectare (932-acre) farm next to "The Gums" quarry, and they were still finding *flyrock* on their farm 13 years after blasting at the quarry had stopped.[10]

> *The last blasting over 13 years ago generated so much flying rock that we are still collecting them. If a blast occurs during the growing crop, the whole crop is lost forever, since we cannot mow the paddock anymore due to severe damage to our mower. We recently had to replace a mower at a cost of $25,000 because of damage done by rocks that are still close [to] the border next to the quarry from the previous blast 13 years ago [p. 32].*

Suspicions and root causes behind *flyrock* and the under-reporting of *flyrock* incidents were discussed by participants during an interactive forum at the 2011 annual general meeting of the Western Canada Chapter of the International Society of Explosives Engineers in Vernon, BC: [11]

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[8] A. Blanchier, "Quantification of the levels of risk of flyrock," Rock Fragmentation by Blasting: The 10th International Symposium on Rock Fragmentation by Blasting, 2012 (Fragblast 10); Leiden: 549-553.

[9] Petrie, District Manager of Mining Safety and Health and Health Administration, Warrendale, Pa,

[10] Objections to the Development Plan for "The Gums" Quarry, Annexure 4-A1 – October 2017, https://www.flinders.tas.gov.au/client-assets/images/Council/Downloads/Agendas/2017.10/Annex%204B.%20A1.%20Representations.pdf.

[11] Loeb, Jeffrey Thomas, "Regulatory mitigation of the adverse environmental effects of urban blasting," Thesis, 2012, University of British Columbia. https://open.library.ubc.ca/cIRcle/collections/ubctheses/24/items/1.0050876#downloadfiles.

> *Flyrock incidents in Ontario are probably just not being recorded. The fine is for flyrock leaving a property onto another property. Often that is not seen and the evidence would be swept off the street. I would strongly suspect that several flyrock incidents in Ontario are not recorded. I think in BC the flyrock incidents are recorded because there's an incident* (A. Grogan, pers. comm., October 16th 2011).
>
> *I think that a lot of the flyrock incidents that occur are due to faulty blast designs to start with, the blaster's blast design should control flyrock and the blasting mats should be a secondary measure. Where blasters get in trouble, are when blasters have faulty blast designs and try to use the blasting mats to control the flyrock and as soon as the mats open up, you've got a flyrock incident. A lot of it relates back to a blaster not being trained on how to do a proper blast design in the first place* (R. Elliott, pers. comm., October 16th 2011).
>
> *Some contractors, they will factor into their price, the cost of paying out damage claims. Their insurers never hear about it. The insurance company never has to pay a dime* (A. Grogan, pers. comm., October 16th 2011).
>
> *I don't think imposing higher fines is the answer. You have to look at what is the cause of the problem and go after the cause. They will just include that in their price to do the job* (R. Elliott, pers. comm., October 16th 2011).
>
> *Many times there is a flyrock incident, the blaster gets fined the company fires the blaster and hires a new one. The blaster always fronts the penalties and the blasting companies don't care* (A. Grogan, pers. comm., October 16th 2011).
>
> *I think that anybody who is involved in the blasting process should be held accountable. Some companies have flyrock incidents. In one instant, I have watched that rotating door where they fired the blaster and get another one.* (J. Launay, pers. comm., October 16, 2011)

Blasters, consultants and inspectors complain that *flyrock* is treated with indifference and not taken seriously by blasting companies, according to Loeb (2012): [12]

> *It is the general consensus among blasters, consultants and inspectors alike, that blasting companies are not taking the necessary precautions to prevent flyrock, and are pushing the blasters to conduct their work too cheaply. This in turn causes larger holes, wider spacing on blast hole patterns, and less regard for safety from flyrock. Due to the manner in which the regulations are written, the blaster is essentially a scapegoat, and the company simply hires a new blaster and continues business as usual [p. 48].*

The growing trend of outsourcing the blasting function at quarries also has led to an increase in *flyrock* incidents, as noted in the 2012-2013 Annual Performance Report of the Queensland Commissioner for Mine Safety and Health:[13]

> *With an increasing trend for surface metalliferous mines and quarries to outsource their drill and blast activities to contractors in the form of 'rock on ground contracts', there is a tendency for site management to disconnect themselves from the day to day involvement and oversight of these activities and their associated hazards, especially the generation of flyrock. This is removing the opportunity for the next generation of mine/quarry manager/supervisors from gaining the hands on experience and understanding they would have received in the past [p. 25].*

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[12] Loeb, Jeffrey Thomas, "Regulatory mitigation of the adverse environmental effects of urban blasting," Thesis, 2012, University of British Columbia. https://open.library.ubc.ca/cIRcle/collections/ubctheses/24/items/1.0050876#downloadfiles.

[13] file:///C:/Users/Windows%207%20PC/Downloads/201213commissionersreportminesafetyandhealth.pdf.

At the July 15, 2020 meeting of the Earth Removal Advisory Committee (ERAC) of The Town of Swampscott,[14] the topic of non-reporting of *flyrock* incidents at a local quarry was referenced as a consequence of a detail officer's truck being struck by *flyrock* while inside.

> *Item #6 had a discussion of what was meant on parking requirements, the members questioned what it was referring to from the lawyers KP. James mentioned a situation where a detail officer was parked inside for a blast and fly rock damaged his truck. He states that fly rock that doesn't leave the quarry isn't reportable. Tonia suggested that we ask KP what she had in mind with this item.* [underscoring added]

The Magazine of Mining Health and Safety (MESA) [15] reported that of 34 quarry accidents 28 or 82% were attributed to *flyrock*:

> *Of 34 accidents that occurred during scheduled blasting, 28 involved death, injury or property damage as a result of flyrock striking persons, equipment, buildings or other property the MESA reports showed. Where flyrock was the agent, "being too close" to the blast was the reason most frequently listed in the accident reports on death and injuries of miners. In one case, however, a 37-year-old miner with 12 years of mining experience was 1,600 feet [488 metres] from the blast when he was struck and killed by a flying rock fragment attributed to undetected fissures in the rock being blasted. Flyrock which travelled 1,200 feet [366 metres] through the air left another miner an invalid for life. In still other instances, flyrock broke the leg of a miner who was 2,500 feet [762 metres] from the explosion and damaged nine houses located from 1,650 [feet] [503 metres] to 2,000 feet [610 metres] from the center of the blast [p. 5].*

According to Little (2007), [16]

- *Only extreme flyrock events are recorded, due to either being noticed by the public or resulting from damage [p. 36].*
- *Factors of safety of 2.0 for equipment and 4.0 for personnel and non-personnel are applied to the calculated throw distance of flyrock at proposed blasting quarries [p. 39].*

A failure to report or under-report *flyrock* incidents is a major safety concern of the European Federation of Explosives Engineers (EFEE), as expressed in its December 2016 letter.[17]

> *The work of the EFEE's Environment Committee has shown in the last few months that it is still very difficult to obtain feedback about [flyrock] incidents or accidents occurring during blasting operations.*
>
> *Although everyone agrees that this feedback is fundamental for preventing probable future incidents and therefore for risk management, the incidents and their causes are still badly indexed. However, civil society, elected officials and especially residents, increasingly demand that these [flyrock] incidents be accounted for by public authorities, companies, and sometimes request information via the press or television.*

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[14] https://www.swampscottma.gov/sites/g/files/vyhlif1296/f/minutes/erac_minutes_7-15-20.pdf.
[15] MESA, Magazine of Mining Health and Safety, United States Department of the Interior, December/January Volume 2, No. 6, https://play.google.com/books/reader?id=SwNl7rxA5ugC&hl=en&pg=GBS.PA1.
[16] T.N. Little, "Flyrock Risk," EXPLO Conference, Wollongong, NSW, 3-4 September 2007.
[17] EFEE Newsletter, December 2016, https://efee.eu/wp-content/uploads/2016/12/2016-12-EFEE-Newsletter-3.pdf.

- Most people residing or working near a blasting quarry operation have no awareness or understanding of the risks that *flyrock* poses, unless they have been the unfortunate victims of a *flyrock* incident. Others contemplating the purchase of a home or business near a proposed or existing blasting quarry operation are equally unaware of the dangers of blasting rock and the potential for *flyrock*.
- The lack of awareness of *flyrock* extends to professionals such as planners, real estate agents and real estate appraisers. Planners fail to take into account appropriate setbacks when dealing with applications for blasting quarries, putting the public at risk of injury or death. Real estate agents over-price property or fail to inform prospective purchasers of the dangers of purchasing property near existing or proposed blasting quarries. Appraisers overstate the value of real estate near existing or proposed blasting quarries, causing purchasers to overpay for properties, and potentially putting mortgage lenders' loans at risk.
- Municipal and provincial approval authorities and affected residents are precluded from making fully-informed decisions as to the appropriateness of an application for a proposed blasting quarry, as the Blasting Impact Assessments prepared on behalf of proponents do not provide any analysis of *flyrock* and the need for appropriate setbacks from sensitive receptors (e.g., human targets), and fail to properly describe and analyze sensitive receptors.

Flyrock incidents are seldom, if ever, publicized by the Ontario Ministry of Natural Resources and Forestry (MNRF), which is responsible for the licensing and oversight of the aggregate industry. Media coverage of a *flyrock* incident only occurs when there is property damage or when people are injured or killed. Otherwise, most incidents of *flyrock* go unreported, and often go unnoticed if *flyrock* debris lands off-site in an open and uninhabited area.

According to a former resident of Floral Park, *flyrock* was a common occurrence at the Fowler Quarry in the Township of Ramara, and was the reason that he sold his home and relocated his family:[18]

> *…[A] former resident of Floral Park presented a brick to Council to compare the weight of the rock that flew onto their property in the past. The family became use to the blasts from the quarry and had resided on the property since 1992. The reason the family left Floral Park was because of the situation with the flying rock that landed on their lawn. There was always issues with flying rock and Fowler had to clear Rama Road after most blasts due to rocks on the road. This is a residential area and most residents now reside in the area year round [p. 17].*

Populated settlement areas, venues of significant human activity (e.g. golf courses, parks, conference centres, sporting and entertainment arenas), free-roaming livestock farms and managed tree farms, and heavily-travelled roads (e.g., highways) near blasting quarries are more prone to incidents of *flyrock* that have the potential to cause property damage, injury or death.

[18] https://ramara.civicweb.net/document/19997#page12.

An examination of 12 Blasting Impact Assessments prepared on behalf of proponents seeking permits for new or proposed blasting quarry operations are devoid of any concern for human or animal life (pets and livestock), ignoring entirely any acknowledgement or meaningful analysis of *flyrock*, and simply referencing undefined "sensitive receptors" that may be impacted by "vibration" and "overpressure" from blasting.

Since Blasting Impact Assessments do not indicate how the reported distances from the proposed quarry boundary or the proposed extraction limit to each "sensitive receptor" have been measured, the reliability of the distances are in doubt. For example, if a sensitive receptor is a residential property, the separation distance should be calculated to the lot limit (to account for outdoor amenity space) rather than to the exterior wall of the house. As well, vacant building lots with "as-of-right" zoning to permit development are not mentioned, even though they will be impacted when they are developed if the quarry application is approved.

Law Suits Over Adverse Effects Caused By Blasting Quarry Operations

A quarry blasting operation is incompatible with virtually every conceivable use of land, and no well-informed or well-advised person would choose to live or conduct business next to a blasting quarry operation, and be exposed to the dangers of *flyrock*. *Flyrock* (debris and fugitive dust) launched off-site onto private third-party property is a *trespass* and *nuisance* and may warrant criminal prosecution.

- In *Attorney-General. v. P.Y.A. Quarries Ltd.* [1958] EWCA, Civ 1[19] on April 25, 1956, Justice Oliver granted an injunction restraining the defendants from carrying on the business of quarrying in such a manner as to cause stones or splinters (i.e., *flyrock* debris) to be projected off-site or to occasion a nuisance to Her Majesty's subjects by fugitive dust or ground vibrations. The injunction against *flyrock* is held to strict liability under the rule in Rylands v. Fletcher. "So far as the flying stones were concerned,…[the Justice] said that there was really no defense at all; that the case was 'absolutely proved at the time the Writ was issued." Only the injunction regarding fugitive dust and ground vibrations was appealed, which was denied by the appellate court.

  > *On a number of occasions damage by flying stones has been done to houses in the vicinity of the quarry and recently a pane of a kitchen window was blown in by blast, littering a breakfast table with jagged pieces of glass, the wife in the home narrowly escaping injury. We sincerely believe that your authority cannot fail to realise the seriousness of the position and the earnestness of our protest…2. The flying pieces of rock on occasions following blasting operations landing some distance from the quarry constitute a very serious menace to life inside and outside the home and to users of the public highway.*

  As for the fugitive dust and ground vibrations, they were ruled public nuisances. The action was brought by the Attorney-General against the Glamorgan County Council and the Pontardawe Rural District Council under three broad headings

[19] https://www.bailii.org/ew/cases/EWCA/Civ/1958/1.html.

alleging the nuisances complained of existed since 1947. The appellate court dismissed the defendants' appeal. The case is summarized below:

> *D[efendants] owned a mining [quarry operation] that caused noise and dust pollution to a section of the public, and tried to argue that since it only affected a section of her majesty's subjects [twenty-eight houses, a farm and two highways], not her subjects as a whole, it couldn't be a public nuisance. C[ourt of] A[ppeal] rejected this, saying any nuisance which materially affected the reasonable comfort and convenience of life of a class of Her Majesty's subjects was a public nuisance. Whether the no. [of] citizens affected was enough to constitute a class depends on the facts of each case. An injunction was granted.*
>
> *Denning LJ: To see if it is a public nuisance, we should look at the reason of the thing and to say that a nuisance is a public nuisance which is so widespread in its range or so indiscriminate in its effect that it would not be reasonable to expect one person to take proceedings on his own responsibility to put a stop to it, but that it should be taken on the responsibility of the community at large. E.g. blocking up a public footpath that is only used by a couple of people:[is] still a public nuisance since it is indiscriminate against those who may wish to walk along it. Another example is a landowner who "permits gypsies with filthy habits to encamp in a residential neighbourhood".*
>
> *Romer LJ: It does not have to be shown that all members of the class have been affected: it is enough that a representative cross section of the class has been affected.*[20]

- In *Ryan v. Victoria (City),* 1999 CanLII 706 (SCC), [1999] 1 S.C.R. 201, at para. 52-53, the Supreme Court of Canada explained public nuisance, noting that it was "a poorly understood area of the law":[21]

> *52…."A public nuisance has been defined as any activity which unreasonably interferes with the public's interest in questions of health, safety, morality, comfort or convenience": see Klar, supra, at p. 525. Essentially, "[t]he conduct complained of must amount to ... an attack upon the rights of the public generally to live their lives unaffected by inconvenience, discomfort and other forms of interference": See G.H.L. Fridman, The Law of Torts in Canada, Vol. I (1989), at p. 168. An individual may bring a private action in public nuisance by pleading and proving special damage. See, e.g., Chessie v. J.D. Irving Ltd. (1982), 1982 CanLII 2918 (NB CA), 22 C.C.L.T. 89 (N.B. C.A.). Such actions commonly involve allegations of unreasonable interference with a public right of way, such as a street or highway. ...*
>
> *53. Whether or not a particular activity constitutes a public nuisance is a question of fact. Many factors may be considered, including the inconvenience caused by the activity, the difficulty involved in lessening or avoiding the risk, the utility of the activity, the general practice of others, and the character of the neighbourhood. See Chessie, supra, at p. 94.*

- A teenager in a car on an interstate highway was struck and killed after *flyrock* launched from a blast at a nearby mine penetrated the vehicle driven by the parents. This led to both civil and criminal prosecutions, and the quarry went out of business.

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[20] *Case summary last updated at 19/01/2020 17:42 by the Oxbridge Notes in-house law team. https://www.oxbridgenotes.co.uk/law_cases/ag-v-pya-quarries.*

[21] Quoting from *George v Newfoundland and Labrador*, 2016 NLCA 24 (CanLII), <https://canlii.ca/t/grtl5>, retrieved on 2021-02-28.

> *On June 4, 1993, the company [Sugar Ridge Coal Co.] detonated a blast in an area less than 300 feet [91.44 metres] from northbound interstate traffic…The blast created a large amount of flyrock, some of which struck a car traveling north on Interstate 75. A 16-year old boy, a passenger in a car driven by his parents, was killed as a result of the flyrock impact.*
>
> *The U.S. Department of Justice prosecuted three individuals—the certified blaster, the day shift superintendent, and the mine manager for violations of 30 U.S.C. § 1268(e) and (f). The certified blaster and the superintendent pled guilty to a misdemeanor count of a willful and knowing violation of a permit. The mine manager was acquitted after a trial. The certified blaster was given a ten-month sentence and the superintendent was given an eight-month sentence. The company went out of business within four months of this blasting incident [p. 1].*[22]

In *Vulcan Materials Company v. City of Tehuacana,*[23] Vulcan appealed a 2002 Summary Judgment upholding a 1998 Ordinance[24] forbidding quarrying or blasting operations within the city limits of the City of Tehuacana, adopted to avoid a public nuisance, and protect the health, safety and quality of residential life, and protect against the potential for "injury or death from overfly of rock (*flyrock*)…"

> *WHEREAS, the City of Tehuacana is predominantly a residential city, with little or no industry inside city limits; and*
>
> *WHEREAS, a rock quarry operating near the city limits has indicated its intention to begin quarrying and blasting operations within the city limits of the City of Tehuacana; and*
>
> *WHEREAS, the quarrying and blasting operations would constitute a public nuisance and result in excessive noise and vibration to city residents; and*
>
> *WHEREAS, the quarrying and blasting operations could constitute a physical danger to residents of the city due to the possibility of overfly of rock or other materials from blasting onto residents of the city or property of residents of the city; and*
>
> *WHEREAS, the blasting and quarrying operations would have a detrimental effect on the quality of residential life in the city due to vibration, excessive noise from blasting, excessive noise from the operation of heavy equipment, the potential for injury or death from overfly of rock, (flyrock), air blast damage, ground motion damage, and excessive dust from operations. [underscoring added]*

Before passing the contested ordinance in 1998, the City of Tehuacana held public hearings.

> *Numerous citizens complained about Vulcan's operations outside the City as well as the two blasts conducted inside the City limits. Specifically, the citizens complained that Vulcan's activities caused shaking of houses, lifting furniture off the floor, rattling windows, shaking and jostling people in their homes, noise, dust, smoke, property damage, fear, interference with enjoyment of property and life, interference with the use of public roads and streets, and exposure to fly and throw rock. The City, and the district court, cite one flyrock incident in particular that had occurred when SCS was conducting quarrying activities on the tracts outside of the City in which a 500-pound boulder was*

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[22] C. W. Shea and D. Clark, "Avoiding Tragedy: Lessons To Be Learned From A Flyrock Fatality," https://www.osmre.gov/resources/blasting/docs/Flyrock/1993SugarRidgeFatality.pdf.

[23] *Vulcan Materials Co. v. City of Tehuacana*, 369 F. 3d 882, Court of Appeals, 5th Circuit 2004. https://scholar.google.com/scholar_case?case=13980108463387688348&q=vulcan+materials+co+v+city+of+tehuacana&hl=en&as_sdt=2006.

[24] https://static.secure.website/wscfus/10353646/25987757/4-blasting.pdf.

> *propelled into a Tehuacana resident's yard. Residents also complained that the mining activities caused springs and wells in the area to dry up [para.885]*[25]*.* [underscoring added]

Vulcan's leased lands are partly in Tehuacana, a city with a population of about 300 residents, and, because the ordinance precluded Vulcan from establishing a blasting quarry operation, Vulcan claimed that the ordinance constituted a taking for which they were entitled to compensation. The trial court's 2002 Summary Judgment in favour of the City of Tehuacana was overturned by the appellate court and the case was remanded for a jury trial to determine whether the ordinance precluding quarrying and blasting constituted a taking of Vulcan's leasehold interest (i.e., expropriation).

The appeals court did, however, caution against finding that a taking had occurred, where the claimant's activities "are tantamount to public nuisances."

> *First, although Mayhew does not cite the specific "nuisance exception" discussed in Lucas, it is evident in the court's own application of Lucas that the Mayhew court found the reasoning of Lucas to be uniformly persuasive…..[para. 893].*
>
> *Second, we are persuaded that the "nuisance exception" is simply a sound rule. All property in Texas is held subject to the valid exercise of the police power and the City is not required to compensate Vulcan if its exercise of police power is reasonable. City of College Station v. Turtle Rock Corp., 680 S.W.2d 802, 804 (Tex.1984). "Although it is fundamental that the government cannot destroy the property of private citizens at will and without justification, the government is given, through its police powers, the ability to abate public nuisances." LJD Properties, Inc. v. City of Greenville, 753 S.W.2d 204, 207 (Tex.App. — Dallas 1988).*
>
> *Third, courts should be cautious in finding a taking where the claimant's activities "are tantamount to public nuisances. "Keystone, 480 U.S. at 491, 107 S.Ct. 1232. This approach is consistent with the concept of reciprocity of advantage as described by Justice Stevens in Keystone [para. 894]:*
>
> > Under our system of government, one of the State's primary ways of preserving the public weal is restricting the uses individuals can make of their property. While each of us is burdened somewhat by such restrictions, we, in turn, benefit greatly from the restrictions that are placed on others. These restrictions are properly treated as part of the burden of common citizenship. Long ago it was recognized that all property in this country is held under the implied obligation that the owner's use of it shall not be injurious to the community, and the Takings Clause did not transform that principle to one that requires compensation whenever the State asserts its power to enforce it. *Id.*at 491-92, 107 S.Ct. 1232 (citations and quotations omitted) [para. 894]..

According to a representative of the City of Tehuacana, on remand of the case for a jury trial in c.2007, the court ruled in the City's favour, upholding the ordinance as a valid exercise of the police power.

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[25] *Vulcan Materials Co. v. City of Tehuacana*, 369 F. 3d 882, Court of Appeals, 5th Circuit 2004.

Flyrock - A Health and Safety Concern

According to Raina, et. al., (2011),[26] several attempts to predict and define *flyrock* made worldwide could not address the problem since the phenomenon of *flyrock* is not a regular feature or desired outcome of blasting.

- If *flyrock* is uncontrolled the rocks, which can travel significant distances, pose a risk to persons involved with blasting as well as anyone else in the area of the blast. There is also the potential for damage to nearby property or equipment. [Nova Scotia, Health and Safety, May 5, 2006][27]

  > *Between 2003 and 2005, there were at least five serious incidents or near misses involving flyrock. All of these incidents had the potential for very serious or fatal results. In some cases there was significant damage to property and structures. [The setback between blasting for a quarry and a structure is 800 metres.][28]*

- Blasting is a serious and potentially dangerous practice on a mine site due to the use of explosives, and it is difficult to determine the specific trajectory of fly rock during a blast. [Mine Safety and Health Administration (MSHA), Feb. 5, 2018][29]

  > *Despite being positioned a safe distance from the blast area, the shot detonated early without warning, and several miners were impacted by debris [flyrock]. While there were no fatalities, the miners suffered injuries of varying severity. [MSHA recommends that Blast Area should as a minimum be one and a half times the furthest distance that any previous fly rock has travelled.][30]*

- The BCRSC [British Columbia Forest Safety Council] was created in September 2004 as a not-for-profit society dedicated to the health and safety of forest workers.

  > *An Interior Coastal Woodland's road building contractor had a very serious fly rock incident with a 6-inch rock penetrating through a cookhouse roof. The cookhouse was occupied at the time and the rock landed within 6 meters of workers. Road crew blasting took place approximately 500 m horizontal distance and 400 m vertical distance upslope /above the cookhouse. [Blasting Close Call, Safety Alert: 2018-03 – Coastal Woodlands. No blasting within 1 (one) kilometre of an occupied dwelling.][31]*

- Worksafe [Victoria] is issuing a reminder to businesses in the mining and quarries sector about the importance of managing the risks associated with fly rock

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[26] Raina, A. K., Chakraboty, Choudhury, P. B. and Ramulu, M. (2008) "*Application of Factor of Safety Concept for Evaluation of Flyrock risk in some Limestone Mines*," http://cimfr.csircentral.net/435/.

[27] https://novascotia.ca/lae/healthandsafety/flyrock.asp.

[28] Nova Scotia Environment and Labour, Pit and Quarry Guidelines, Effective May 4, 1999, p. 4, https://novascotia.ca/nse/dept/docs.policy/Guidelines-Pit-and-Quarry.pdf.

[29] "MSHA Issues Warning On Blast Safety Following Fly Rock Injuries," February 5, 2018, https://www.natlawreview.com/article/msha-issues-warning-blast-safety-following-fly-rock-injuries.

[30] http://rockproducts.com/2018/01/18/msha-issues-serious-accident-alert-for-fly-rock/.

[31] https://www.bcforestsafe.org/files/Safety%20Alert-Interfor-Blasting%20Close%20Call-Coastal%20Woodlands-Nov%2030-2018.pdf.

generated when undertaking shot firing activities. [Safety alert published Sep. 7, 2020][32]

> *During the firing of a quarry production shot, fly rock ejected from the blast travelled several hundred metres and entered a neighbouring property. Several rock fragments struck and damaged buildings. These fragments narrowly missed employees who were actively working on the property at the time of the shot fire.* [see Figure 1 for image of flyrock damage]
>
> *Mining and quarrying are high-risk activities. Misfires and fly rock are common hazards associated with shot firing [blasting] activities, which are routinely undertaken in these industries.* [underscoring added]

- Explosives Inspectorate Resources Safety & Health Queensland [Explosives safety alert no. 61, August 13, 2012][33]

> *A crib hut, located at a blast distance of approximately 1230 metres, was damaged when a flyrock incident occurred at a coal mine in Central Queensland.(The image below, shows the damage.) The blast-exclusion zone was set at 1000 metres. Blast guards and other people were just outside the exclusion zone. The flyrock was linked to a face defect that was not noticed before firing the overburden blast that ejected rock from a face burst. (See image below.)*
>
> …Mr. Slater lost his life and Mr. McGuiness was exposed to serious risk due to the exposure to fly rock from unconfined blasting and the deliberate detonation of an unknown quantity of deteriorated explosive. Fly rock distribution was in excess of an estimated 300 metres and the accident site was 42 metres from the point of detonation [p. 168].[34]

- Worker's Hazard Alert *DANGER: Blast Area Flyrock Awareness National Institute for Occupational Safety and Health*[35]

> *In July 2002 in West Virginia, rocks traveled one-half mile [805 metres]. One rock the size of a football smashed into the cab of a contractor's truck. It went through the front windshield, between a trucker and his supervisor and out the back. They were outside the blast area and thought they were "safely" watching. They were lucky – they were not hurt [p. 5].*

- The Directorate General of Mines Safety (India) issued a bulletin on January 31, 2003, to all owners, agents and managers of mines warning of the "dangers due to blasting projectiles [flyrock]," and directed that the "danger Zone" for surface mines be increased from 300 metres to 500 metres.[36]

> *Accidents due to projectiles ejecting from blasting had been a major source of accident in both below ground and opencast workings….There had been, however, a number of instances where flying fragments due to blasting had ejected not only within but also beyond the [300m] danger Zone, resulting into serious and even fatal accidents.*

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[32] https://www.worksafe.vic.gov.au/safety-alerts/rock-fragments-quarry-blast-impact-active-worksite-neighbouring-property.
[33] https://www.rshq.qld.gov.au/safety-notices/explosives/flyrock-damage-outside-the-blast-exclusion-zone.
[34] Mining warden inquiries 1972-2001, file:///C:/Users/Windows%207%20PC/Downloads/mining-warden-inquiries-reports.pdf.
[35] https://www.cfins.com/wp-content/uploads/2019/01/blasting-safety-worker-alert.pdf.
[36] https://elibrarywcl.files.wordpress.com/2015/02/dgms-cir_02_03-blasting-projectiles.pdf.

> *The projectiles [flyrock] ejected due to blasting travelled for a distance of about 412m in the reverse direction away from the free face and hit a mechanical supervisor. The enquiry further revealed that the deceased had taken proper shelter in a blasting shelter but had come out of the shelter immediately on hearing to the sound of blast and was subsequently hit by the projectiles.*
>
> *The matter is brought to your attention so that the following corrective measures are taken in case similar conditions exists in any mine under your control.*
>
> *(1) In the interest of safety to treat all the places within a radius of 500m of the place of firing as the danger zone, all persons who are required to remain within the danger zone at the time of blasting should take protection in substantially built shelter.*

- Blast impacts can directly or indirectly affect the health and safety of surrounding communities. Fumes and dust can directly affect health (see Section 3.3.1), and *flyrock* can directly compromise safety. In contrast, other impacts, such as vibration, may be more likely to exacerbate stress reactions in nearby residents, which may be an indirect pathway to ill-health. Vibration may cause residents to feel anxiety about potential damages to their homes, property, commercial interests and ecological sites of significance (see Section 3.3.6). [Australia, Community Health and Safety Handbook, Sept. 2016].[37] [underscoring added]

- The Director of Health and Safety rejected the argument that the defendants owed "no duty whatsoever to the general public" under the Occupational Health and Safety Act [para. 16] involving an incident of *flyrock* that showered the Lobird Trailer Court with rock "varying from small pebble-sized pieces to missiles weighing 22 kg." "One demolished a shed; another crashed through the roof of a trailer and landed in the occupant's living room. One tenant, who was outside, was forced to run for cover. Remarkably, no one was injured or killed [para. 4]."[38] (Parker, a blasting expert and consultant, "testified that blasting is 'not an exact science' and there can be problems, including *flyrock* that cannot be foreseen or prevented. Even the most skilled and careful blaster cannot create a perfect blast every time [para. 32]").

> *In the late afternoon of May 6, 2008, as part of a Yukon government project to extend Hamilton Boulevard, a professional blaster working for Sidhu Trucking set off a large explosion near the Lobird Trailer Court. That sent blast rock flying more than 200 metres to homes in the neighbourhood, striking five homes and some other property.*[39]
>
> *An investigation of the May 6th flyrock incident recommended a danger radius of 228 metres around the blast site, and that only those persons incidental and necessary to*

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[37] "Community Health And Safety Handbook, *Leading Practice Sustainable Development Program for the Mining Industry*," Australian Government, September 2016, https://www.industry.gov.au/sites/default/files/2019-04/lpsdp-community-health-and-safety-handbook-english.pdf.

[38] *Director of Occupational Health and Safety v. Government of Yukon, William R. Cratty and Pl S. Sidhu Trucking Ltd.*, 2010 YKTC 42, https://www.yukoncourts.ca/sites/default/files/documents/fr/dir_ohs_v_ytg_2010_yktc_42.pdf. Convictions upheld on appeal, https://www.yukoncourts.ca/sites/default/files/documents/en/2012_yksc_47_doh_v_yg.pdf.

[39] "Yukon contractor, inspectors guilty in road blast," CBC, May 11, 2010, https://www.cbc.ca/news/canada/north/yukon-contractor-inspectors-guilty-in-road-blast-1.878173.

blasting operations should be within 365 metres of the blasting site.[40] *"Flying rock was not directed at the Lobird Subdivision, but was vented in that direction because of the malfunction, stressed the report."*

- According to the Mine Health and Safety Council of South Africa, *flyrock* is the ultimate adverse effect that can cause serious injury and death.

  Human response to flyrock is generally extreme. Apart from any consideration of damage, it is the only blasting-related hazard that can cause serious injury and death. It is the ultimate adverse effect of blasting and must be avoided at all costs.[41] *[Milestone 5, p. 31] [emphasis added]*

- A September 28, 2006 Memorandum[42] was issued by the Commonwealth of Virginia, Department of Mines, Minerals and Energy to "All Licensed Mine Operators and Blasting Contractors," informing of the "imminent danger" of the occurrence of *flyrock*.

  The occurrence of flyrock can be considered an 'imminent danger'…'Imminent Danger' means the existence of any condition or practice in a mine which could reasonably be expected to cause death or serious injury before such condition or practice can be abated. [emphasis added]

- According to *SouthShore Forest Consultants*,[43] *flyrock*, ground vibrations and airblast from blasting has adverse effects on tree roots and hydrology:

  Tree Roots & Hydrology Blasting operations cause several adverse environmental effects: ground vibrations, airblast, flyrock, generation of fines, fumes and dust. Essentially, the energy released by the explosives is useful for fragmentation, displacement and movement of broken rock whereas wasteful part of energy causes many adverse impacts such as ground vibrations, airblast, flyrock, dust and fumes. Ground vibrations cause the ground to vibrate in transverse, longitudinal and the vertical directions.

  Research indicates there is a high potential for tree root damage as blast distances decrease. Heat and gas produced from the blasting can also alter the directional flow of water. Small fibrous feeder tree roots could be significantly impacted when positioned within 100m of blasting activity. The effect of ground vibrations and noise on human beings is well documented but they sometimes also cause damage to the property.

  Trees similar to structures have foundations (structural roots), stem walls and foliage which could be impacted by flyrock and gravitational air pressure.

  Any change to the groundwater flow would most certainly impact tree and plant health. All scientific information relating to open pit rock blasting indicates that impacts increase significantly with lessened distances to permanent structures in the environment. Rock fly, vibration, heat and subterranean gas will negatively affect free roots.

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[40] Tristin Hopper, "Blasting renewed, investigation ongoing," Yukon News, Jun 17, 2008, https://www.yukon-news.com/news/blasting-renewed-investigation-ongoing/.

[41] Mine Health and Safety Council, South Africa, https://mhsc.org.za/sites/default/files/public/research_documents/SIM140901%20Final%20Report.pdf.

[42] https://www.dmme.virginia.gov/DMM/PDF/SAFETY/ALERTS/blastingflyrock/FlyrockMemo.pdf.

[43] Michael Butcher, Morley Island – Visitor Centre Rock Blasting & Tree Root Impacts, May 18, 2019. http://www.islandstrust.bc.ca/media/347830/np-bov-20191_agd_pkg.pdf.

According to Eloranta,[44] past president of the International Society of Explosives Engineers (ISEE) and responsible for revising the ISEE Handbook chapter on open pit and quarry operations, *flyrock* from any blast is "unacceptable," and

> *Speaking generally…flyrock doesn't automatically suggest an excessive amount of explosives had been used. "Explosives doesn't equal flyrock."*
>
> *A fault in the rock, if unknown to the explosives engineer, can provide a path for that explosive energy that can mess up an otherwise well-designed blast,*
>
> *The same amount of energy in there can just launch those materials [flyrock].*
>
> *It's not accurate to suggest that the presence of faults and seams in a section of rock is unknowable…Enough geologic testing could identify those problem areas. But there's an economic issue with that solution. The cost of the testing would exceed the value of the product.*
>
> ***Anyone involved in blasting is obligated to place safety above all other considerations…Even if blasts that launch life-threatening rocks into populated areas are rare, even if no one is injured, accepting that as inevitable is unethical***. [emphasis added]

Violations of Improper Storage and Handling of Explosives

In 2014, the Ministry of Labour (MOL) and Workplace Safety North held an internal joint Webinar[45] in response to the alarming number of contraventions of the explosives storage and handling requirements, and explained why the MOL was "doing an explosives blitz."

- *Between April 1, 2011 and March 31, 2014, the Ministry of Labour issued 256 orders related to contraventions of the explosives storage and handling requirements set out in Regulation 854 (Mines and Mining Plants) under the Occupational Health and Safety Act (OHSA).*
- *The potential for serious or fatal injury, as well as significant property damage, is always present where explosives are used.*
- *Are written procedures established for blasting which include: flyrock, misfires, secondary blasting, wind direction [and a number of other issues Slide 31].*

Blasting Traumatizes Pets and Leads to Unhealthy Behaviour

According to a July 3, 2019 Forbes article, dogs can become traumatized and experience unhealthy behaviour when exposed to fireworks, thunderstorms and other sudden, loud noises (i.e., blasting).[46]

> *Fireworks may be fun for people, but they sure can wreak havoc in a household with pets. Dogs are particularly prone to having panic attacks or anxieties triggered by loud noises. Some breeds, such as herding dogs, are more likely to have noise phobias, suggesting that genetics plays a role in the predisposition for developing them. But dogs with a noise phobia may not only fear fireworks; they may also react fearfully to other sudden loud noises, such as thunderstorms, vacuums, sirens, shouting, construction noises or gunshots.*
>
> *Dogs demonstrate their fears in a variety of ways, such as running or pacing around the house, trembling, barking, whining, soiling the premises, digging at the door or destroying their human's*

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[44] https://www.mankatofreepress.com/news/local_news/expert-flyrock-from-any-blast-unacceptable/article_8ad31cf8-b5cf-11e7-bf58-c3cdd328cf7f.html.

[45] https://www.workplacesafetynorth.ca/sites/default/files/uploads/MOL-Blitz-Explosives-2014_0.pdf.

[46] "Use Science To Help Your Dog Survive Fireworks (And Thunderstorms)," https://www.forbes.com/sites/grrlscientist/2019/07/03/use-science-to-help-your-dog-survive-fireworks-and-thunderstorms/?sh=146f578496d1.

> *things. In extreme cases, dogs have even jumped out of windows or have choked to death when tied up outdoors. Other dogs may instead show more subtle signs of their distress, such as licking their lips or drooling. Some dogs even become catatonic.*
>
> *As many as 40% of dogs experience noise anxieties (ref), and July 5 is the busiest day of the year at local animal shelters for dealing with runaway dogs.*

Avalanche blasting in Fernie, BC, had similar adverse effects on local dogs.[47]

> *In Fernie, a large number of local dogs live in fear of the unexplainable explosions at the ski hill. Thirty percent of all dogs are naturally fearful of sudden loud noise—thunder, fireworks and gunshots.*
>
> *Dogs who become more afraid with each blasting session develop all kinds of strange behaviours, everything from hiding, shaking, panting, diarrhea. They may even take to running scared. Travelling blindly, faster and farther with each blast until they find a good hiding place. Fernie dogs have been known to run so far away they get lost, taking days or weeks to find. Running away becomes easier when the snow pack builds bringing fence tops down where they scramble over and take off.*

Every time blasting occurs at a nearby quarry,[48] one of the neighbour's dog is given a tranquilizer to deal with the trauma.

> *She has to give her dog a tranquilizer when blasting occurs.*

Provincial Policy Statement - Adverse Effects of Quarry Blasting Operations

Section 1.2.6 of the 2020 Ontario Provincial Policy Statement (*PPS*)[49] sets out the provincial expectation when planning for major facilities such as a quarry in proximity to sensitive or incompatible land uses. The *PPS* (6.0 Definitions) takes its definition for "adverse effects" from the Ontario *Environmental Protection Act* (*EPA*), which means one or more of:[50]

a) impairment of the quality of the natural environment for any use that can be made of it;
b) injury or damage to property or plant or animal life;
c) harm or material discomfort to any person;
d) an adverse effect on the health of any person;
e) impairment of the safety of any person;
f) rendering any property or plant or animal life unfit for human use;
g) loss of enjoyment of normal use of property; and
h) interference with normal conduct of business.

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[47] Cathy Smith-Clark, "Boom Boom Bow WoW," FernieFix, Feb 6, 2014, https://www.ferniefix.com/article/community/boom-boom-bow-wow.

[48] Joe Nixon, U.Nazareth Quarry Blast Damages Roofs, Autos* Incident at Essroc Cement Corp. Operation Sends Mud, Rocks Flying," *The Morning Call*, Mar 9, 2021, https://www.mcall.com/news/mc-xpm-1998-03-26-3180302-story.html.

[49] https://files.ontario.ca/mmah-provincial-policy-statement-2020-accessible-final-en-2020-02-14.pdf.

[50] https://www.ontario.ca/laws/statute/90e19#BK16.

The *PPS* policies flow from the provincial interests articulated in s.1.1.1 of the *Act*, including,

> *c) avoiding development and land use patterns which may cause environmental or public health and safety concerns;*
> *d) avoiding development and land use patterns that would prevent the efficient expansion of settlement areas;*
> *h) promoting development and land use patterns that conserve biodiversity;*
> *i) preparing for the regional and local impacts of a changing climate.*

In carrying out the objectives of the *PPS*, the *official plan* is the most relevant document:

> *4.6 The official plan is the most important vehicle for implementation of this Provincial Policy Statement. Comprehensive, integrated and long-term planning is best achieved through official plans.*
>
> *Official plans shall identify provincial interests, and set out appropriate land use designations and policies. To determine the significance of some natural heritage features and other resources, evaluation may be required.*

Precautionary Approach and Zero Tolerance of Flyrock

According to *Blancier*,[51] the risk and adverse effects of *flyrock* associated with quarry blasting is seldom or properly addressed as part of the investigations and studies undertaken in support of an application for a licence to permit quarry operations, even though *flyrock* is considered a greater hazard than vibrations or airblast:

> ***Accidental flyrock in blasting operations has a major impact on the external environment…due to the hazards involved and is more significant than vibrations or airblast….[E]ven if it is normal practice in these zones to take into account the impact of possible vibrations and even the effects of airblast when modeling the project, flyrock risks are not dealt with in initial studies, other than by way of integrating general safety distances. These risks are only sometimes taken into account much later in the operation and most often, following an accident or significant flyrock being recorded externally [off-site] [p. 549]***. [emphasis added]

And, as documented by Kentucky's Department for Natural Resources, which has expressed a zero tolerance for *flyrock* incidents, historically *flyrock* has <u>not</u> been confined to the distances which required submission and approval of an "anticipated blast design."

> ***Flyrock events historically have not been limited to blasting operations within the distances which require the submission and approval of an 'anticipated blast design'…prior to blasting. Rather, flyrock events occurred and impacted dwellings, vehicles, persons, animal life, and other physical structures thousands of feet from the blast site resulting in death and destruction of property***.[52] [emphasis added]

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[51] A. Blanchier, "Quantification of the levels of risk of flyrock," Rock Fragmentation by Blasting: The 10th International Symposium on Rock Fragmentation by Blasting, 2012 (Fragblast 10); Leiden: 549-553.

[52] "Reclamation Advisory Memorandum," https://eec.ky.gov/Natural-Resources/Mining/Mine-Permits/RAMS/RAM140.pdf. "During calendar year 2007, the Commonwealth of Kentucky had a [known] total of thirteen (13) flyrock events on surface coal mining sites, including one (1) that resulted in a fatality. To date [July 18, 2008] there have been nine (9) [known] flyrock events, including one (1) that resulted in a minor injury that very easily could have resulted in a fatality."

According to *Flintstone Mining Services,*[53] "there is no acceptable level of *flyrock* incidents," and *flyrock* distances are unpredictable:

> *Flyrock is notoriously inconsistent and a prediction of 200m does not mean that flyrock will travel 200m from every blast.*
>
> *It only takes one [blast] hole to create enough wild flyrock to create a possibly tragic situation, and at the same time risk the loss of the quarry licence, the shortfirer's [blaster's] licence and the company's insurance policy.*

Causes of Flyrock

The phenomena of *flyrock* are always uncontrolled and can never be brought down to zero.[54] The causes of *flyrock* have been identified by numerous explosives engineers, as reported by Trivedi et al (2014).[55]

> *Inadequate burden, inadequate stemming length, faulty drilling, back breaks, loose rock on top of the bench due to poor previous blast, very high explosive concentration, inappropriate delay timing, and their sequence, and inaccuracy of delays are the prominent blast design parameters responsible for flyrock problems (Workman and Calder, 1994, Siskind and Kopp, 1995, Adhikari, 1999, Rehak et al., 2001). Unfavorable geological conditions, such as open joints, weak seams, and cavities, have been identified as the major causes of flyrock hazards in opencast mines (Persson et al., 1984, Fletcher and D'Andrea, 1986, Bhandari, 1997, Shea and Clark, 1998) [p. 447].*

Some of the common causes of *flyrock* are listed in the Blaster-Training Module:[56]

1. Overloaded blastholes with excessive amounts of explosives
2. Heavily confined charges or the lack of relief (i.e. lift blasts)
3. Explosives loaded into incompetent materials (i.e. mud seams, fractures, and/or voids)
4. Insufficient front-row burden, causing front-face blowouts
5. Burdens and spacings too close together (resulting in high powder factors)
6. Inadequate/insufficient stemming material
7. Inadequate delay between holes in the same row and between rows; detonators firing out of sequence
8. Deviation of blast hole detonation from the intended sequence
9. Changing geology or rock type
10. Spacing and burden exceeds borehole depth
11. Angled boreholes
12. Secondary blasting
13. Human error, improperly loaded blasts

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[53] "Flyrock prediction From Mystery to science," published in *Quarry*, 2014, https://www.quarrymagazine.com/2014/10/02/flyrock-prediction-from-mystery-to-science/

[54] R. Trivedi, T.N. Singh and A.K. Raina, "Prediction of blast-induced flyrock in Indian limestone mines using neural networks," *Journal of Rock Mechanics and Geotechnical Engineering*, 6 (2014), 447. file:///C:/Users/Windows%207%20PC/Downloads/1-s2.0-S1674775514000651-main.pdf.

[55] R. Trivedi, T.N. Singh and A.K. Raina, "Prediction of Rock Mechanics and Geotechnical Engineering," *Journal of Rock Mechanics and Geotechnical Engineering*, Volume t, Issue 5, October 2014, Pages 447-454. https://www.sciencedirect.com/science/article/pii/S1674775514000651#bib4.

[56] Controlling the Adverse Effects of Blasting, https://www.osmre.gov/resources/blasting/docs/WYBlasterCertModules/8AdverseEffectsBlasting.pdf.

Flyrock Uncontrollable and Prediction of Flyrock Throw Unreliable

According to Raina et al.,[57] one of the problems with *flyrock* prediction is its random nature, and calculations of throw are based on gross generalizations.

> *One of the downers in flyrock prediction is its random nature, as one cannot generate a flyrock and need to rely on chance. Modelling of random flyrock with regular variables poses a challenge to the researchers. There have been attempts to predict the flyrock using throw or heave prediction routines but these suffer from the perils of gross generalizations. Since flyrock is a potential threat to property and life, one cannot risk under-prediction [p. 661]*
>
> *A survey of the literature also points to a departure in identified causative variables and those used for prediction (Table 3). One of the important observations from Table 3 is that despite the fact that improper burden, geology and associated anomalies are identified as major causes of flyrock, these do not find place in predictive models as parameters [p. 661].*

A January 31, 2003 memorandum from the Directorate General of Mines Safety (DGMS) to "All Owners, Agents & Managers of mines"[58] detailed an incident of *flyrock*, which travelled in the opposite direction of the planned blast, striking and killing an employee:

> *The projectiles [flyrock] ejected due to blasting travelled for a distance of about 412m in the reverse direction away from the free face and hit a mechanical supervisor. The enquiry further revealed that the deceased had taken proper shelter in a blasting shelter but had come out of the shelter immediately on hearing to the sound of blast and was subsequently hit by the projectiles.*

A study of blasting *flyrock* risk undertaken by Zhou, et al. (2009)[59] found that wind conditions can have a profound impact on the travel distance of *flyrock*:

> *…[W]ind can assist in the producing of flyrock. When the wind direction is in accord with the designed throwing distance, the flyrock can travel distance two times [more] than normal p. 1185].*

A literature review relevant to *flyrock* conducted by van der Walt and Spiteri (2020)[60] uncovered an initial study by Lundborg et al (1975), followed by 16 studies from 2010 starting with Monjezi et al. (2010) and ending with Dehghani and Shafaghi (2017) and Hasanipanah et al (2017). Six of those studies had "no discussion of testing methodology," and the studies implied one of the three following principles:

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[57] Avtar K. Raina, V. M. S. R. Murthy and Abhay K. Soni, "Flyrock in surface mine blasting: understanding the basics to develop a predictive regime," *Current Science,* Vol. 108, No. 4, 25 February 2015: 660-665. https://www.jstor.org/stable/24216626?read-now=1&seq=6#page_scan_tab_contents.

[58] No. DGMS (SOMA)(Tech)Cir. No. 2 of 2003, https://elibrarywcl.files.wordpress.com/2015/02/dgms-cir_02_03-blasting-projectiles.pdf.

[59] Zhou, Z., Li, X., Liu, X., & Wan, G., "Safety Evaluation of Blasting Flyrock Risk with FTA Method," *School of Resources and Safety Engineering, Central South University,* Changsha 410083, Hu'nan, China. https://miningandblasting.files.wordpress.com/2009/09/safety-evaluation-of-blasting-flyrock-risk-with-fta-method.pdf.

[60] van der Walt, J. and Spiteri, W. 2020 "A critical analysis of recent research into the prediction of flyrock and related issues resulting from surface blasting activities," *Journal of the Southern African Institute of Mining and Melallurgy*, vol. 120, no. 12, pp. 701-714. https://www.saimm.co.za/Journal/v120n12p701.pdf.

- *Flyrock* research based on Artificial Intelligence (AI) principles (53%)
- *Flyrock* research based on rock engineering principles (18%)
- *Flyrock* research based on empirical and statistical analysis (29%)

Van der Walt and Spiteri concluded that the effect of blast parameters on *flyrock* is still not fully known or understood, and that the findings, in part, are counterintuitive.

> *Based on figure 9, the powder factor and stemming length seem to be the key parameters relating to flyrock, which is what one would expect. However, the burden is not highlighted as a critical parameter, which is contradictory to the face burst mechanism of flyrock. The summary of the fundamental causative parameters and the disregarding of the importance of burden also support the argument that the effect of blast parameters on flyrock is not fully known or understood [p. 712].*
>
> *Since the actual impact of blast design parameters on the risk of flyrock is debatable, based on the variable assumptions made in these publications, it can be concluded that flyrock is still not well understood. The biggest gap in knowledge seem to be the uncertainties concerning which blast and environmental parameter contribute to flyrock, and to what degree [p. 714].*

The uncontrollable nature of *flyrock* is discussed in *Lee Lime Corp. v. Massachusetts Turnpike Authority*:[61]

> *There was evidence that two to four primary blasts occur annually to loosen limestone from the face of the quarry and that fragments displaced amount to 40,000 tons; these primary blastings result in the dislodging of pieces of stone of various sizes "from dust to rocks half the height of the court room and almost as square." These fragments are then reduced in size by secondary blasting so as to permit them to pass through the crusher. These secondary blasts are an indispensable part of the quarry operations and a quarry could not be conducted nor could a lime plant be conducted without them.* ***These secondary blasts number 15,000 to 20,000 a year and five per cent will throw stones for a distance of about 800 to 850 feet [259 metres] and are likely to reach the new highway. There was also evidence that "the fly rock" is uncontrollable and results in making unavailable a large area of the petitioner's land by its inability to conduct blasting operations within 800 feet of the new turnpike [p. 435].*** [emphasis added]

As reported by the Federal Mine Safety and Health Review Commission,[62] a *flyrock* incident left Burton Lay paralyzed from the chest down after being struck by *flyrock* at a distance of 1,115 feet (340 metres) from the blast. *Flyrock* incidents at the surface mine were common, occurring in 90% of the blasts, and reaching distances of 1,400 or 1,500 feet (457 metres). James Ludwiczak, a blasting and mining consultant, testified that he would have expected the December 19, 1983 blast to have propelled *flyrock* a distance of about 300 feet (91.44 metres), but could only speculate as to the actual *flyrock* distance of 1,115 feet (340 metres), exceeding the calculated *flyrock* throw by a factor of 3.72.

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[61] *Lee Lime Corp. v. Massachusetts Turnpike Authority*, 337 Mass. 433 (1958) 149 NE 2d 905, https://scholar.google.com/scholar_case?case=8453729559483718978&q=Flyrock&hl=en&scisbd=2&as_sdt=2006.

[62] *Hobet Mining & Construction v. Sol (MSHA) & Sol (MSHA) v. Hobet Mining & Construction*, FMSH Review Commission, https://www.fmshrc.gov/decisions/alj/85111807.PDF. See also *Dept. of Energy v. Hobet Min. & Const.,* 358 SE 2d 823 (1987) W. Va., https://scholar.google.com/scholar_case?case=17148911866299365 66&q=Hobet&hl=en&as_sdt=2006.

Flyrock, meaning rock being propelled through the air outside of the immediate blast site, was common when bottom shots were blasted. ***In the two months prior to December 19, 1983, flyrock occurred in about 90 percent of the shots. On many occasions, it travelled in excess of 1000 feet [305 metres] from the site of the blast. Most of these instances involved shots of 150 holes or more. On a few occasions flyrock was propelled beyond the blasting crew into the woods, approximately 1400 or 1500 feet [457 metres] from the pit****. These incidents also involved shots of 150 holes or more. [emphasis added]*

Mr. Ludwiczak…felt the stemming in the holes on December 19, 1983 was adequate and the burden in the 3 ½ foot holes was not too great. Based on the information given him, he stated that he would expect flyrock to be propelled about 300 feet [91.44 metres] from the December 19 shot. He was not able to account for the flyrock actually travelling 1115 feet [340 metres], but "guessed" that it may have resulted from a wet hole or a crack in the strata or an upheaval of the rock*.* [emphasis added]

Analysis of Flyrock Travel Distances

The following examples are cited from the 1991 issue of Pit & Quarry,[63] and the documented travel distances of *flyrock* at limestone blasting quarries are from 1,159 feet (353 metres) to 6,292 feet (1,918 metres).

FLYROCK DISTANCE

1,159 feet	(353 metres)
3,063 feet	(934 metres)
4,057 feet	(1,237 metres)
4,057 feet	(1,237 metres)
5,050 feet	(1,539 metres)
6,292 feet	(1,918 metres)

A number of sources (media announcements, governmental incident reports, studies, articles, journals, presentations) all identified by way of internet searches, resulted in a comprehensive data set on the distances that *flyrock* debris has been hurled as a consequence of blasting operations.

Distance From Blast (m)	Number of Incidents	Percentage of Total	Cumulative Percent
0-99	2	2%	2%
100-199	9	10%	12%
200-299	16	17%	29%
300-399	20	22%	51%
400-499	9	10%	61%
500-599	7	8%	68%
600-699	7	8%	76%
700-799	0	0%	76%
800-899	6	7%	83%
900-999	3	3%	86%
1000-1099	5	5%	91%
1100-1199	0	0%	91%
1200-1299	5	5%	97%
1300-+	3	3%	100%

[63] ISMR Blasters Workshop, Jasper, Indiana, December 7, 2009, PowerPoint presentation, Slide 14, https://www.in.gov/dnr/reclamation/ISMR/2009/BLASTING/Clark/ISMR_Blasters_Workshop.ppt.

An analysis of 92 *flyrock* incidents, where the distance from the blast is known, indicate that 91% (84) of the *flyrock* incidents occurred within 1,099 metres, and 97% occurred within 1,299 metres.

- 20 (22%) of the flyrock incidents occurred between 300 and 399 metres (330 metres avg)
- 9 (10%) of the flyrock incidents occurred between 400 and 499 metres.(446 metres avg)
- 7 (8%) of the flyrock incidents occurred between 500 and 599 metres (515 metres avg)
- 7 (8%) of the flyrock incidents occurred between 600 and 699 metres (622 metres avg)
- 6 (7%) of the flyrock incidents occurred between 800 and 899 metres (802 metres avg)
- 5 (5%) of the flyrock incidents occurred between 1,200 and 1,299 metres (1,225 metres avg)
- 3 (3%) of the flyrock incidents occurred over 1,300 metres (2,307 metres average)

Further, at 80%, which accounts for the first 74 *flyrock* incidents in ascending order, *flyrock* reached a distance of 800 metres, and, at 90%, which accounts for the first 83 *flyrock* incidents in ascending order, *flyrock* reached a distance of 1,020 metres.

A January 25, 2021 email from a professional engineer stated he "investigated one case of a *flyrock* for over 1km away from a quarry while employed by MECP (MOE back in 1996)." He also disclosed "a recent case of a very large garage overhead door that was damaged by the pressure wave only!"

- *Flyrock* can be stones, rocks, mud, or even water. *Flyrock* has been known to land a half-mile [805 metres] farther than planned. (PowerPoint presentation Slide 50)[64] [underscoring added]
- *Flyrock* is a potential hazard anytime, and anywhere there is blasting. (PowerPoint presentation, Slide 56)
- Dr. Lusk is critical of explosives engineers, stating that "Licensed Blasters must follow the nonsense [Blast Plan] that engineers have planned for them." (Kentucky Professional Engineers in Mining Seminar, *Flyrock*, August 17, 2012, PowerPoint presentation, Slide 5)[65] [underscoring added]

Adverse Effects Including Flyrock Incidents Increase Exponentially As Setbacks Reduced and Vice Versa

As indicated below, the first and second editions of the *Best Practices Guide* for blasting rock in an urban area have been prepared by the Western Canada Chapter of the International Society of Explosives Engineers [ISEE} to protect the *health* and *safety* of the public, and *flyrock* is recognized as a *risk* factor *adverse effect*.

There are a couple of important distinctions between the 2016 first edition and the 2019 second edition of the blasting guide. The name of the blasting guide has been changed from *Best Practices Guide for Urban Blasting Operations* (2016) to *Best Practices Guide for Close Proximity Blasting Operations* (2019), and a reduction in the distance of 500 metres from the rock blasting to any building/structure indicates that *risk* (adverse effects) increases

[64] "Blasting & Flyrock Awareness, Recognizing the Hazards," https://miningquiz.com/powerpoints/blasting.htm.
[65] https://pem.engr.uky.edu/sites/pem/files/Flyrock-Braden-Lusk.pdf.

proportionately (2016), whereas in the 2019 edition, *risk* (adverse effects) is indicated to increase **exponentially**.

According to *Best Practices Guide for Close Proximity Blasting Operations* (2nd Edition, June 18, 2019),[66]

> *The purpose of the Best Practices Guide for Close Proximity Blasting Operations is to:*
>
> 1. *Provide guidelines to protect the safety and health of the public, workers and Close Proximity structures within the area of influence to mitigate the following environmental effects of Close Proximity drilling and blasting operations:*
>
> *a) Noise/Nuisance,*
> *b) Dust,*
> *c) Blast Vibration,*
> *d) Air Overpressure,*
> *e) **Flyrock**, [emphasis added]*
> *f) Surface Water Contamination. [p.4]*
>
> *A close proximity blasting operation is defined within this document as any drilling & blasting operation for rock excavation within 500m (1,600') of any building and/or utility (Close Proximity Structure). [p. 4]*
>
> *It is generally accepted that the prevalence of risk [adverse effects, including flyrock] involved in blasting activities increases **exponentially** with a reduction in distance to Close Proximity structures [p. 9]. [emphasis added]*
>
> *It is suggested that blasting mats be utilized for flyrock protection when blasting within 300m (1,000') of any inhabited structure [p. 18]. [Mats are not practical in the multiple sequenced explosions used in quarries.]*

According to *Best Practices Guide for Close Proximity Blasting Operations* (2nd Edition, June 18, 2019),[67]

> *The purpose of the Best Practices Guide for Close Proximity Blasting Operations is to:*
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>
> *a) Noise/Nuisance,*
> *b) Dust,*
> *c) Blast Vibration,*
> *d) Air Overpressure,*
> *e) **Flyrock**, [emphasis added]*
> *f) Surface Water Contamination. [p.3]*
>
> *An urban blasting operation is defined as any drilling & blasting operation for rock excavation undertaken within 500m (1,600') of any building, structure, and/or utility (urban structure). [p. 8]*

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[66] Best Practices Guide for Urban Blasting Operations, 1st Edition,2016, published by Western Canada Chapter of the International Society of Explosives Engineers. https://www.chbaco.com/wp-content/uploads/2018/08/best_practices_guide_for_urban_blasting_operations_1st_edition_draft.pdf.

[67] Best Practices Guide for Close Proximity Blasting Operations, 22d Edition, 2019, published by International Society of Explosives Engineers Western Canada Chapter. https://iseewest.starchapter.com/images/downloads/best_practices_guide_for_close_proximity_blasting_operations__2nd_edition.pdf.

> *It is generally accepted that the prevalence of risk [adverse effects, including flyrock] involved in blasting activities increases **proportionately** to the reduction in distance to urban structures [p. 8]. [emphasis added]*
>
> *It is suggested that blasting mats be utilized for flyrock protection when blasting within 300m (1,000') of any inhabited structure [p. 18]. [Mats are not practical in the multiple sequenced explosions used in quarries.]*

No Automatic Right of Rezoning to Permit a Blasting Quarry If Land Uses Are Incompatible and Profitability Is Not a Relevant Factor

In *Cottonwood Farms v. Board of County Commissioners*,[68] the Colorado Court of Appeal upheld the district court's ruling to deny a rezoning request to permit a blasting quarry on a 323-acre tract, and ruled that application of the Preservation of Commercial Mining Deposits Act to the property as zoned did not constitute an unconstitutional taking, The appellate court rejected the plaintiff's assertion "that aggregate mining was the only reasonable use of the property," and "that the zoning regulations impermissibly excluded mining as a use by right, in violation of the applicants' due process rights."

> *It is well-established that extant zoning ordinances do not constitute unconstitutional confiscations of property merely because they restrict the ability of landowners to realize greater profit from the use of their property. E.g., Sellon v. City of Manitou Springs, 745 P.2d 229 (1987); Landmark Land Co. v. City County of Denver, 728 P.2d 1281 (Colo. 1986), appeal dismissed sub nom. Harsh Inv. Corp. v. City County of Denver, 107 S. Ct. 3222 (1987); Baum v. City County of Denver, 147 Colo. 104, 363 P.2d 688 (1961). In these circumstances, the zoning authority has not "taken" the property, but has merely created an obstacle to the possibility of obtaining windfall profits. See County of Ada v. Henry, 105 Idaho 263, 668 P.2d 994 (1983). Moreover, the fact that the plaintiff may have paid more than the land was worth under existing zoning in the hope of securing a zoning change is generally not a factor to be considered in the plaintiff's favor in analyzing a taking claim. E.g., Westbrook v. Board of Adjustment, 245 Ga. 15, 262 S.E.2d 785 (1980); Mintz v. Village of Pepper Pike, 57 Ohio App.2d 185, 386 N.E.2d 849 (1978) (noting that the plaintiffs' claim of financial loss was more accurately described as denial of a windfall). See generally 1 A. Rathkopf D. Rathkopf, The Law of Zoning and Planning § 6.07 (1988).*
>
> *…[T]he combination of the extant zoning classification and the Preservation Act does not prohibit the economic activity of aggregate mining. The applicants do not allege any changed circumstances or any new zoning action taken by the Board that allegedly reduced the value of their property. See, e.g., Roosevelt v. City of Englewood, 176 Colo. 576, 492 P.2d 65 (1971); Majestic Heights Co. v. Board of County Comm'rs, 173 Colo. 178, 476 P.2d 745 (1970). In such circumstance, the combination of the zoning regulations and the Act has not effected a taking of the property by denying all reasonable use thereof. The Board's refusal to in effect enhance the value of the property cannot be equated to conduct that reduced the value thereof.*

There is no automatic right of rezoning agricultural land to permit a quarry, and entitle a landowner to rapacious profits from extracting aggregate at the expense of innocent third-party owners of neighbouring properties and the environment.

The *Board of County Commissioners*, following extensive hearings, concluded that the proposed blasting quarry operation did not conform to the Jefferson County Comprehensive Plan, and that a blasting quarry is incompatible with the existing

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[68] *Cottonwood Farms v. Board of County Commissioners*, 725 P.2d 57 (Colo.App. 1986), https://casetext.com/case/cottonwood-farms-v-board.

surrounding uses, which would result in a number of adverse impacts on the community, including a substantial reduction in the market value of neighbouring properties.

> *The Board concluded that the proposed quarry operation would not be compatible with existing uses in the surrounding area and, in particular, would not conform to Jefferson County Comprehensive Plan provisions respecting visual, air quality, noise pollution, water quality, blasting safety and economic impact standards.*

Land Use Planning Policies – Avoiding Costly Quarry Battles

Rural and semi-rural communities in Ontario are concerned about blasting quarries, and the *adverse effects* or *impacts* on the *environment* and the *citizens*, which can only be avoided by separating incompatible land uses and imposing adequate setbacks on applications for new quarries or expansion of existing quarries. By-laws and Official Plan policies[69] that restrict blasting quarries to farther than 800 metres from "sensitive receptors" and 1,000 metres from Settlement Areas (e.g., human targets exposed to flyrock), would

- provide clear direction as to where new or expanded blasting quarries could possibly locate within a municipality, while still protecting the *environment* and protecting and maintaining the *health, safety and welfare of its citizens and the general public* during the entire period a blasting quarry is expected to remain operational;
- save the municipality (i.e., taxpayers) and ratepayer groups from expending substantial resources (time and money) on fighting blasting quarry applications in inappropriate locations within a municipality;
- virtually eliminate future citizen complaints and lawsuits that operational blasting quarries inevitably generate (i.e., flyrock, noise, fumes, odour, dust, ground vibration, subsidence, sinkholes, airblast, soil contamination, personal or real property damage, [70] injury or death of humans, pets or wildlife, well-water quality or quantity, etc.); and

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[69] 4.3.8 Mineral Aggregate Resources (Township of Algonquin Highlands Official Plan 2019 https://www.algonquinhighlands.ca/deptdocs/Official%20Plan%20OFFICE%20CONSOLIDATION%2001-Jan-2019.PDF.)

[70] In *McLaughlin v. River Road Co-op Ltd. et al.*, 1988 CanLll 7958 (NB QB), gas that leaked from the defendant's gas bar contaminated the plaintiff's well and left the plaintiff without potable water. The problem of unpotable water could not be readily resolved. As noted by the court, "[t]he evidence is uncontradicted that the home has a market value of $50,000.00 without the water problem but with the water problem a 'best scenario of $25,000.00 and worst scenario of $7,000.00." The court awarded the plaintiffs $15,000 in general damages and $2,500 for on-going costs taking into account (a) the digging up of the…back lawn in the spring of 1985; (b) the hardship imposed…in carrying water from neighbors and springs involving distances of up to nine miles; (c) the anxiety caused by the lack of predictability of fresh water flowing through the stripper system; (d) the inconvenience in having water tested on an ongoing basis; (e) the effort required…to maintain the stripper, specifically the addition of the salt and the cleaning of the filter systems; (g) the loss of space in the basement; and (h) the diminution of value of the McLaughlin home for an approximate seven year period." <https://canlii.ca/t/gbhr9>, retrieved on 2021-02-25.

- preserve a municipality's tax base by avoiding the deleterious effects that blasting quarries have on the value of nearby residential properties (e.g., Settlement Areas),[71] and ensure that homeowner equity is not eroded or that a community is not stigmatized,[72] so as to render homes unmarketable[73] or unmortgageable.[74]

Preventing exposure to the hazardous impacts of blasting quarries is the priority and responsibility of government, and this must be made clear in land use documents (zoning by-laws and Official Plans), and by-laws passed under the health, safety and nuisance provisions of the Ontario Municipal Act.[75]

Property Value Protection Plan

Properties near quarries sustain damage and a loss in property value, and this has been recently acknowledged by Lafarge Corporation, who in May 2018 agreed to enter into a mitigation/Host Community Agreement and a Property Value Protection Plan with the Town of Lockport as a condition of rezoning of 200 acres to permit expansion of their existing blasting quarry operation.

> *The two major concerns expressed [by residents] were property values and potential damage caused by the mining [quarry] operation. Therefore,…Lafarge Corporation adopted a Property Value Protection Plan. In short…this document would ensure that if a resident in this area [within 1,000 feet or 305 metres of the quarry] would sell their home and cannot get the full appraised value of their home, Lafarge will make up the difference in the sale price based on a home that is not near the quarry. The second protection states that Lafarge would reimburse or pay for repairs that are caused by their mining operation and will be backed by a $500,000 bond. They also will enter into an agreement with the Town called the Host Community Agreement, which states that a percentage of the income stream from Lafarge's production operation will be paid to the Town. These agreements are required to be in place for the duration of their operation, possibly a forty-year period. The agreements end when the quarry is fully rehabilitated to the satisfaction of the Town of Lockport and the NYS Department of Environmental Conservation.*

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[71] In a large scale peer reviewed study of the impact of blasting rock quarries on residential property values, the first of its kind, Malikov, et al. (2018) documented a sample of 5,500 house sales that took place in Delaware County during 2009-2011 (roughly two years), and conclude that the impact on the value of houses within one mile of a blasting quarry is 23% (low-priced houses) to 51% (high-priced houses $552,500 avg at 95%th quantile), Emil Malikov, Yiguo Sun and Diane Hite, "Under)Mining Local Residential Property Values: A Semiparametric Spatial Quantile Autoregression," *Journal of Applied Economics* (June 22, 2018): 82-109.

[72] According to Toffey, the initial introduction and addition of disamenities has a cumulative effect of stigmatizing and destabilizing a community, and causes house prices to decline. Extracts taken from Untiled Document, https://halifaxvermont.com/wp-content/uploads/2013/11/Bartenhagen-N.-property-values-07-28-2015.pdf.

[73] Lafarge Corporation reached an agreement in May 2018 with the Town of Lockport, New York, in connection with rezoning of 200 acres to permit a quarry, conditional "on the entry into a mitigation/host community agreement with a property value protection plan."

[74] "The public record contains an abundance of information from landowners who feel they will have difficulty in selling their properties if the mine [blasting] quarry is in operation, and that it will deprive them of the ability to sell or develop additional residences on land already owned," Within a half-mile (805 metres) are 105 residential parcels and within one mile (1,609 metres) are 291 residential parcels. September 1, 2015, hearing of the Town of Nassau, which denied Troy Sand & Gravel a permit to operate a blasting quarry.

[75] https://www.ontario.ca/laws/statute/01m25#BK146.

> LaFarge officials say they are open to expanding a property value protection zone around its planned quarry expansion south of Hinman Road, following outcry from residents at a public meeting Wednesday.
>
> Several residents urged the Lockport Town Board to reject a mining permit allowing LaFarge to expand over 200 acres south of the current quarry, raising concerns about noise and home values.
>
> In an effort to assuage those concerns, LaFarge is offering a property value protection plan for all homeowners within 1,000 feet of the mining site. The plan requires the company to pay the difference between market value and the actual amounts those homeowners receive when selling their properties. The permit also requires pre-blast surveys, by a third-party firm, for all residential and commercial structures within 1,000 feet of the mine (save for structures owned or leased by LaFarge).
>
> Some speakers whose homes sit just outside the zone said they, too, are likely to see their home values drop once the quarry expands.
>
> "When I retire in seven years, I'll be lucky to give up my home. If they don't think it'll hurt property values, they should have no problem including us in the property protection plan," said Bob Ensminger, referencing claims from LaFarge representatives that many properties near active quarries increase or remain the same in value.
>
> The town board passed the mining permit unanimously, but several members said they are confident LaFarge would be open to expanding the 1,000-foot zone for the property value protection and pre-blast surveys.
>
> "We did hear the concerns of the community last night. We will be addressing the 1,000-foot limit around the quarry for the property value protection plan," said Project Manager Perry Galdenzi. "We're going to sit down with Supervisor (Mark) Crocker and his staff, and…see if we can possibly include more people in that."
>
> Galdenzi added the LaFarge felt the 1,000-foot limit was fair and included those most impacted by the expansion of the mine onto over 200 acres south of Hinman Road.
>
> "We just felt 1,000 feet from the mine was a fair distance, and that it included the vast majority of people affected by the mine," Galdenzi said. "anybody beyond 1,000 is not going [to] be affected. It's one of those thing[s] where if you pick 1,000-feet, the person who is 1,001 feet is going to complain."…[76]
>
> Lafarge has agreed to include about 30 more homes in a protection zone around its new stone quarry on Hinman Road…Supervisor Mark C. Crocker said Friday that the town and Lafarge have agreed to expand the zone in which the company will compensate homeowners for losses caused by blasting [Thomas J. Prohaska, August 3, 2020, Buffalo News][77]
>
> "The protection zone, originally 1,000-foot radius around the quarry, now covers all homes on Hinman and Murphy roads, and on the east side of Campbell Boulevard between Hinman and Murphy [Aggregate Research.com, July 18, 2018]."[78]

In the two years following expansion of the quarry, there has been one claim for structural damage caused by blasting at the quarry, for which Lafarge had to compensate the property owner.

Lafarge never informed the Town's residents about *flyrock*, and the dangers it poses, raising the question of whether the Town would have approved expansion of the blasting quarry operation, moving closer to the inhabited residences in the community.

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[76] Tim Fenster, LaFarge considers expanding mine protection zone, May 11, 2018, https://www.lockportjournal.com/news/local_news/lafarge-considers-expanding-mine-protection-zone/article_4280d838-e0f1-54a2-ab4a-9a66c3a44a7a.html.

[77] https://buffalonews.com/search/?sd=desc&l=25&s=start_time&f=html&t=article%2Cvideo%2Cyoutube%2Ccollection&app=editorial&nsa=eedition&q=Lafarge.

[78] https://www.aggregateresearch.com/news/lafarge-na-widen-protection-zone-homes-around-lockport-quarry/.

As for the Property Value Protection Plan and $500,000 repair fund, they will not resolve past adverse effects sustained by the community or likely future adverse effects from blasting, which may still destabilize and stigmatize the community. Blasting in the new quarry will continue for approximately 40 years. Some of the concerns expressed by local residents are summarized below:

- There have been drainage issues for at least forty-five years that have not been addressed satisfactorily by Lafarge. He feels they are not staying within the regulated amounts of water discharge.
- The consulting geologist explained how the water will be pumped from the new quarry back into the existing quarry and out to the canal. Ms. Tudor-Schultz stated the entire plain floods.
- Town Supervisor Crocker inquired if the flooding areas are on the west, southwest side near the eighteen acres of wetlands in the area. Mr. Ensminger stated he is approximately 400 feet from the wetlands, and when he reports the flooding issues, Lafarge does clear up the flooding for a short period of time, but then it resumes. He stated when Lafarge is not pumping out water, the area near him dries up.
- The current berms and fencing are not being maintained.

In 2011, Lafarge signed a Consent Decree, which involved 21 facilities throughout the United States, including the Lockport quarry, for violations of the EPA Clean Water Act, involving unpermitted discharges of stormwater.[79]

Low Frequency Blasting and Repeated Blasting Can Cause Structural Damage

According to the Surface Mining Control and Reclamation Act (SMCRA) and F-SMRCA, low frequency blasting is problematic, and can cause structural damage.

> *109. On one occasion, the United States District Court, Southern District of Indiana, has seen fit to reduce blasting limits in a surface coal mine blasting case. While this case originated out of a complaint for nuisance, in Massa v. Peabody, IP 88-63-C, decided August 4, 1989, Judge Tinder found that blasting with frequencies in the 4-12 Hz range was a problem and ordered a .50 ips peak particle velocity limitation for any blast in the frequency range regardless of its distance from the blast.*[80]
>
> *113. As with all other structures, homes have one or more natural (or harmonic or resonant) frequency. The mathematical effect of a natural frequency is that induced vibrations which are the same frequency as a natural frequency will cause vibrations to increase with time rather than decrease with time. As a practical matter, this means the midwall response of a home subjected to vibrations from a blast (or any other source) could be a displacement of up to four times the displacement at the foundation. It can also cause "racking" or shaking of the structure. See Exhibit 197*
>
> *114. When such a phenomena occurs, it clearly places considerable stress on the mortar between bricks, plaster walls and corners of a structure.*

[79] https://www.epa.gov/enforcement/lafarge-north-america-inc-clean-water-act-settlement.
[80] https://www.in.gov/nrc/decision/89-106r.v5.html.

> *115. Exhibit 197, OSM report RI 8507, indicates natural frequency of wood frame structures is in the 5-10 Hz range for racking. Natural frequencies of one story homes can be as high as 18 Hz, but of course the initial displacement at 18 Hz is only 1/2 of the displacement of a 9 Hz frequency for the same peak particle velocity. This study concludes that frequencies below 10 Hz are the most serious ones.*
>
> *116. The DNR (and NRC) has a duty to approve blasting plans which will not cause damage to off site property.*

A case study of the Metlaoui Mining Basin, Southwestern Tunisia, undertaken by Aloui et. al. (2016)[81] concluded that both *ground vibration* and *airblast* can cause structural damage, and are a nuisance to the inhabitants as open pit mines (quarries) approach Settlement areas.

> *…[O]nly 20-30% of the used energy [in blasting] is served for rocks fragmenting and displacing, while the rest is wasted in the form of ground vibration, air blast, noise and fly-rocks [1]. Both ground vibration and air blast are matter[s] of great concern as they would result in damage to the existing surface structures and nuisances to the inhabitants in the vicinity of mines, which are exceedingly approaching near populated areas. In order to analyze the vibration-related problems, the combined effect of several factors such as site characteristics, propagation of surface, the body waves in the ground, and response of structures should be taken into consideration p. 1].*
>
> *The measured event frequencies of blast induced ground vibrations represent high-potential damage risk due to resonance effects. However, the frequency interval of 1-5 Hz that has higher damage risk constitutes the majority of all shots. These low frequencies are very critical to residential structures because they are in the range of their natural frequencies. The measured values frequency are near the natural frequency of residential structures (<20 Hz) [and] is the most dangerous because it causes amplification of ground vibration [p. 7].*
>
> *Air blast represents an undesirable and unavoidable output of blasting technique. The air blast damage and annoyance may be influenced by numerous factors such as blast design, weather, field characteristics, and human response. Air blast disturbances propagate as compression wave in air. Under specific weather conditions and poor blast designs, air blast can travel for long distances [11] [p. 2].*
>
> *All frequencies of induced air blast monitoring recorded were less than 20 Hz (Table 3), which increases risk of damage. In fact, air blast is considered as an ever annoying phenomenon in Metlaoui Mine and mostly propagates in low frequencies (<20 Hz), and causes perceptible rattling of windows easily in the building [p. 7].*

According to Loeb,[82] *ground vibration* from blasting is unavoidable, and can cause damage to neighbouring structures, including residences.

> *Ground vibrations are an unavoidable environmental effect of urban blasting. Neighbouring structures, including residential homes can sustain damage during blasting due to [1]*

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[81] Aloui M, Bleuzen Y, Essefi E, Abbes C (2016), "Ground Vibrations and Air Blast Effects Induced by Blasting in Open Pit Mines: Case of Metlaoui Mining Basin, Southwestern Tunisia," *J Geol Geophys* 5: 247. doi:10.4172/2381-8719.1000247 https://www.longdom.org/open-access/ground-vibrations-and-air-blast-effects-induced-by-blasting-in-open-pit-mines-case-of-metlaoui-mining-basin-southwestern-tunisia-2381-8719-1000247.pdf.

[82] Jeff Loeb and Dwayne D. Tannant, "Urban Construction Blasting in Canada – Complaints and Associated Municipal Bylaws," *Civil Engineering Architecture*, 2(1): 1-10, 2014, https://www.hrpub.org/download/20131215/CEA1-14801317.pdf.

- *permanent ground deformation due to heave or gas pressures,*
- *vibratory settlement of a building foundation, and*
- *direct vibratory cracking in a building due to ground vibrations*

Whether damage to nearby home[s] occurs because of blasting depends on the magnitude of the induced vibrations and the quality and type of home construction [p. 1].

In *Koeman v. Pacific Blasting & Demolition Ltd.*,[83] *drilling* and *repeated blasting* between 1999 and 2001 at an adjacent real estate development was found by the Court to be the cause of damage to the Koeman's home, in which they had lived for 24 years.

[4] The plaintiff complains of drilling and repeated blasts of explosives (168 blasts) [sic should read 188] with cumulative effect which he lists as

The noise and dust, vibrations and shocks have been severe.

The complete house shakes and vibrated during many blasts.

The engineer from Metro Blasting said that the shaking of the drilling is even worse than the blasting for damage

Consistently my wife has a headache because of noise. And me too.

Her nervous system is also affected by the blasts.

Pictures just about daily have to be straightened out.

Stuff falls of [f] the selves

Dirt and dust is everywhere

If I am on the phone in my study I sometimes have to hang up because the noise makes it impossible to hear the other party.

Even in the middle of a beautiful day all doors and window[s] have to be kept closed.

On weekdays it is impossible to sit outside on many of my patios or decks.

In my wine cellar 35 bottles of wine that were sitting against the concrete wall popped

of which, <u>except for the last item, these are substantially matters of nuisance</u>. [underscoring added]

In ruling in favour of the homeowners, the Court concluded,

[21] This Court is satisfied that there is damage to be found in the claimant's home much as he described and some of which can probably be attributed to repetitive blasting. This Court is satisfied that there was repetitive blasting in the vicinity of his house.

[22] This Court concludes that in all probability no individual blast had sufficient concussive force, either by air pressure or ground wave, to cause damage. However, there are numerous blasts set off over time, each with measurable force, most of which could probably be detected at the claimant's residence.

[23] The total effect could have resulted in cracks to the house, mostly in a high wall which was without much in the way of lateral support.

[24] The loss of bottles of wine poses an interesting question that is, how did the bulk of the stock of wine remain unaffected while only 35 bottles in a very localized area pop? 35 Bottles from a fairly large stock of wine were lost during the time period in question. They were first described as broken, then as having their corks pop out. This point raises some question of the reliability of the evidence as it relates to the wine. Nevertheless, it is not in dispute that the wine was lost. It does

[83] *Koeman v. Pacific Blasting & Demolition Ltd.*, 2003 BCPC 147 (CanLII), <https://canlii.ca/t/5b7k>, retrieved on 2021-03-15.

not seem contrary to probability that repeated vibration of stacked bottles of wine would be vulnerable to damage. And in this, that is accepted.

Trespass of Land - Flyrock and Vibration

The Factum of the Interveners[84] in the *Castonguay* case before the Supreme Court of Canada, which involved a *flyrock* incident, describe *trespass* as follows:

Trespass is the intentional physical invasion of property by people or objects, however minute the invasion, without the consent of the owner of occupant. Liability in trespass does not depend on proof of damages. To deposit a foreign substance such as water on the property of another and, in so doing, disturb that person's possession of property, however slight the disturbance, constitutes trespass, regardless of whether the substance is toxic or non-toxic. [citations omitted]

In *Enos Coal Mine v. Schuchart et al.*,[85] the Indiana Supreme Court ruled there is no logical reason not to extend strict liability for property damage from *vibrations* simply because there is no physical trespass as in falling debris [flyrock] from an explosion on nearby land. The court ruled that the common law principle of liability in trespass applies equally where damage is caused only by *vibration*, commenting by way of analogy, as follows:

In these days of nuclear explosions, the breaking of sound barriers by airplanes and missiles, violent explosions from artillery and gunnery practice (to mention but a few of the advances of science), nearby buildings and property can be shattered or destroyed as effectively as by an earth quake without any physical invasion of the property.

The United States Supreme Court has recognized these modern problems in holding that property owners are entitled to compensation for deterioration in property values caused by noise and vibration of jet planes in the use of air space near an airport. Griggs v. Allegheny County (1962), 369 U.S. 84, 82 S.Ct. 531, 7 L.Ed.2d 585.

Nuisance and The Rule In Rylands v. Fletcher (Strict Liability)[86]

According to Grant,[87] the tort of nuisance is similar to the tort of trespass, to the extent that it is for the protection of a property owner's "use and enjoyment" of land, and can apply to all-manner of activities conducted by a nearby quarry blasting operation that have the potential for adverse effects.

Nuisance focuses on the effect of certain activities on neighbouring property holders, the nature of the interest invaded, and the extent of the invasion, rather than on the tortfeasor (as in negligence). The essence of the tort of private nuisance is that the tortfeasor has unreasonably and substantially interfered with another's reasonable use and enjoyment of his or her land. Interference can be separated into two categories: material physical damage, and interference with enjoyment of land.

It is not necessarily a defense to nuisance to show that all possible care has been taken in carrying on the activity which caused the invasion.

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[84] https://cela.ca/wp-content/uploads/2019/07/Castonguay-SCC-Factum.pdf.

[85] *Enos Coal Mining Company v. Schuchart et al.*, 243 Ind. 692 (1963) 188 N.E.2d 406, https://scholar.google.com/scholar_case?case=5259210695212382453&q=%22a+little+damage+is+reasonable%22&hl=en&as_sdt=2006.

[86] *Rylands v. Fletcher*, (1868), LR 3 HL 330.

[87] Adam Grant, "*Making Use of Unusual Torts in Subrogation*," July 2017, https://mccagueborlack.com/emails/articles/unusual-torts.html?utm_source=Mondaq&utm_medium=syndication&utm_campaign=LinkedIn-integration.

> *In determining whether there has been an unreasonable interference with the use and enjoyment of the plaintiff's land, the court balances the gravity of the harm caused against the utility of the defendant's conduct in all the circumstances. The court also measures the harm in the context of factors like the character of the locale, and whether or not the plaintiff has an abnormal sensitivity.*[88]
>
> *The Rylands v. Fletcher rule is one of the situations at common law where there can be tort liability for unintended and non-negligent harm. The rule states that "a person who for his own purposes brings on his lands and collects and keeps there anything likely to do mischief if it escapes, must keep it in at his peril, and if he does not do so, is prima facie answerable for all the damage which is the natural consequence of its escape."*

The three things necessary to succeed in an action under the rule in Rylands v. Fletcher (strict liability) are:

1. *The defendant brought something capable of causing harm onto his or her land.*
2. *The defendant made use of the thing for his or her own profit or benefit.*
3. *The use of the thing, in addition to being dangerous, was unusual or non-natural [p. 339].*[89]

Aggregate Resources Act Acknowledges Flyrock

As proclaimed in Vol. 153-37, of *The Ontario Gazette*,[90] September 12, 2020, Ontario Regulation 466/20, made under the Aggregate Resources Act (ARA), pursuant to Subsection 0.13 (1) of the Regulation, as made by subsection (1), has been amended, in part, to address *flyrock*.

> 28. ***A licensee or permittee shall take all reasonable measures to prevent fly rock from leaving the site during blasting if a sensitive receptor is located within 500 metres of the boundary of the site****. [emphasis added]*

The Ontario ARA does not define or explain *flyrock*, an omission which can only be construed as deliberately concealing from the public the ultimate adverse effect of blasting, and reinforcing the industry-wide practice of the Aggregate industry and the explosives engineers acting on its behalf to deny or ignore the existence of *flyrock* as evidenced by the numerous Blast Impact Assessments examined.

> ***Flyrock is the dirty little secret of the aggregate industry and the explosives engineers acting on its behalf, and they have done a remarkable job of concealing it from the public [p. 3].***[91]

Blasting is an ultrahazardous activity, and is subject to strict liability No amount of regulatory oversight or care in preparing for a quarry blast can prevent *flyrock*. *Flyrock* does not respect property boundaries, and the aggregate industry's explosives engineers cannot 'will' *flyrock* from occurring. When *flyrock* is launched off-site onto private third-party property, the owner/operator/blaster of the quarry is legally liable, even if there is no harm.

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[88] *Antrim Truck Centre Ltd. v. Ontario (Transportation)*, 2013 SC 13, and Allen M. Linden & Bruce Feldthusen, *Canadian Tort Law*, 10th ed (Toronto: LexisNexis Canada, 2015) at 609-621.
[89] C. A. MacLean, L. M. Olivo and J. Fitzgerald, Contract and Tort Law, Second Edition, Emond, Toronto, Canada.
[90] http://www.ecolog.com/daily_images/1004618147-1004619030.pdf.
[91] Tony Sevelka, "Flyrock: The Ultimate Adverse Effect From Quarry Blasting Operations & The Need For Adequate Setbacks," December 30, 2020.

Incompatible Land Uses and Sensitive Receptors Impacted by Flyrock

While the *Aggregate Resources Act* (ARA) does not explicitly call for a minimum setback requirement, it is unlawful for a blasting quarry to launch *flyrock* (fugitive debris and dust) off-site, and no governmental agency can be complicit in an unlawful act of *trespass, nuisance* or the rule of *Rylands v. Fletcher*, and certainly not without compensating innocent private third-party property owners.

Accordingly, to give effect to ARA's admonition to prevent *flyrock* from leaving the site, an inevitable consequence of blasting rock, it is appropriate to measure back 500 metres from each sensitive receptor toward the perimeter of the proposed quarry. This approach is consistent with the reciprocal nature of setbacks dealing with incompatible land uses, as spelled out in the MOE D Series guidelines.

> ***Land Use Compatibility*** *A recognized factor and principle of good land use planning, whereby land uses which are known or expected to cause environmental problems for one another, when in proximity, are deemed incompatible and are protected from one another by separation and/or other means. [D-1-3 Land Use Compatibility: Definitions]*[92]

An application for a quarry blasting below the water table, one of the most obnoxious, destructive and hazardous uses of land, is a **Class lll Industrial Facility.**

> ***Class lll Industrial Facility*** *A place of business for large scale manufacturing or processing characterized by: large physical size, outside storage of raw and finished products, large production volumes and continuous movement of products and employees during daily shift operations. It has frequent outputs of point source and fugitive emissions of significant impact and there is high probability of fugitive emissions. See Guideline D-6, "Compatibility Between Industrial Facilities and Sensitive Land Uses" for classification criteria and examples to categorize a specific industry.*

Human targets are vulnerable 24 hours per day to the potential adverse effects, including *flyrock*, of a blasting quarry operation, and are euphemistically alluded to as "sensitive receptors" in MOE's definition of **Sensitive Land Use**.

> ***Sensitive Land Use*** *A building, 'amenity area' or outdoor space where routine or normal activities occurring at reasonably expected times would experience I [one] or more 'adverse effect(s)' from contaminant discharges generated by a nearby 'facility' [e.g., a proposed quarry blasting below the water table]. The 'sensitive land use' may be a part of the natural or built environment. Depending upon the particular 'facility' involved, a sensitive land use and associated activities may include one or a combination of: [underscoring added]*
>
> *i. residences or facilities where people sleep (e.g. single and multi-unit dwellings, nursing homes, hospitals, trailer parks, camping grounds, etc.). These uses are considered to be sensitive 24 hours/day.*
> *ii. a permanent structure for non-facility related use, particularly of an institutional nature (e.g. schools, churches, community centres, day care centres).*
> *iii. certain outdoor recreational uses deemed by a municipality or other level of government to be sensitive (e.g., trailer park, picnic area, etc.)*
> *iv. certain agricultural operations (e.g., cattle raising, mink farming, cash crops and orchards).*
> *v. bird/wildlife habitats or sanctuaries.*

[92] https://www.ontario.ca/page/d-1-3-land-use-compatibility-definitions.

An inexhaustive list of <u>other</u> existing or permitted uses of land under a zoning by-law (ordinance) or Official Plan (Master Plan) that qualify as sensitive receptors to be avoided for the anticipated life of a new blasting quarry operation or expansion (extension) of an existing aggregate operation proposing to blast include:

- golf course
- ski club
- cemetery
- conference centre
- historic stone wall
- public water tank
- pumping station
- pub/restaurant, fast food establishment
- motel/hotel/bed and breakfast facility
- public water supply (e.g., aquifers, water bottling operations)
- highways (heavily-travelled roads)
- trailways
- waterfalls/dams
- communication tower
- fishing club
- dog kennel
- historic structure
- historic barn
- managed tree farm
- private well (e.g., domestic wells)
- snow storage facility
- service station (underground gas tanks, propane tanks)
- organized sport or entertainment venue
- utilities (e.g., gas lines, optic fiber cable, power lines above or below grade)
- railway corridors
- streams/rivers/wetlands/lakes
- karst topography

Application of Aggregate Resources Act and Planning Act

As noted by the Ontario Municipal Board (OMB) in reviewing an application for expansion of an existing blasting quarry operation,[93] jurisdictional issues involve both the Aggregate Resources Act (ARA) and the Planning Act:

> *This Board must make findings not only under the ARA, but also under the Planning Act. In the words of counsel for the Township, "the Aggregate Resources Act and the Planning Act are two completely different beasts [para. 138]."*

The Aggregate Resources Act offers no guidance as to how *flyrock* should be addressed so as to ensure the health and safety of the public, and simply calls for a "Blast Design Report." All assessments in technical reports must contain the following information:[94]

- Methodology, the approach or the series of steps taken to make determinations
- Data that supports the conclusions in the report
- Mitigative measures to address potential impacts
- Proposed contingency and mitigative measures that will be implemented if unforeseen impacts occur

Unless otherwise specified, all technical report(s) must be prepared by a person with appropriate training and/or experience.

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[93] *Miller Paving Ltd. v McNab / Braeside (Township)*, 2015 CanLII 70369 (ON LPAT), <https://canlii.ca/t/glwwn>, retrieved on 2021-02-23

[94] https://files.ontario.ca/mnrf-aggregates-combined-standards-en-2020-08-27.pdf.

Each report must state the qualifications and experience of the individual(s) that have prepared the report(s) [p. 27]

> ***2.7 Blast design report***
> *Applications for a Class A licence or for an aggregate permit, for a quarry that would authorize the extraction or removal of more than 20,000 tonnes of aggregate per year must complete the following;*
>
> *A blast design report is required if a sensitive receptor is within 500 metres of the limit of exaction to demonstrate that provincial guidelines for blast overpressure and ground* vibration can be satisfied.

The issue of *flyrock* cannot be adequately addressed in a Blast Design Report (Blasting Impact Assessment) relying solely on the provincial guidelines for *blast overpressure* and *ground vibration*, nor without resorting to sound Planning and land use principles. As the potential dangers of *flyrock* are not directly addressed in a Blasting Impact Assessment, and appropriate setbacks are the only effective remedy, a statistical analysis of *flyrock* incidents and distances is of utmost importance.

> ***1.5 Planning and land use considerations***
> *1.51 A statement must be prepared which details any applicable planning and land use considerations that are relevant on or adjacent to where the proposed site will be located, such as provincial or Crown land plans/policies and municipal planning documents.*
>
> *1.52 Despite section 1.5.1, any provision of a zoning by-law that restricts depth of aggregate extraction is inoperative as per s.12.1(1.1) of the Act [p. 25]*

Changes in the wording between the 2014 Provincial Policy Statement and the 2020 Provincial Policy Statement hold Planners to a stricter professional standard as it relates to assessing mitigation measures of adverse effects:

> *The 2014 edition states that planners should ensure adverse effects are mitigated but the 2020 edition states that planners shall ensure such effects are mitigated.*[95]

A Blasting Impact Assessment that fails to provide a detailed analysis of the frequency and distance of *flyrock* incidents, and the location and description of <u>all</u> sensitive receptors (e.g., human targets) likely to be struck within the known travel distances of *flyrock* is of no Planning assistance in determining appropriate setbacks. *Flyrock*, an uncontrollable by-product of blasting rock, is <u>never</u> permitted to leave the boundaries of a site slated for use as a quarry.

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[95] James Morgan, "Dust and sound discussed during past week at Colacem LPAT hearing," *TheReview*, November 24, 2020. https://thereview.ca/2020/11/24/dust-and-sound-discussed-during-past-week-at-colacem-lpat-hearing/.

Ministry of Environment "D series Guidelines" and Reciprocal Setbacks

A review of House Quarry Application, Township of Lake of Bays File: Z39/05,[96] included an analysis of the Ministry of Environment Guidelines when considering a change in land use and the compatibility between industrial (e.g., quarry) and sensitive land uses (e.g., homes and farms), and the reciprocal nature of setback requirements:

> *The Ministry of the Environment has two guidelines that are to be used by approval authorities (such as municipalities) when considering changes in land use, and particularly when determining the compatibility between different land uses - more specifically, between industrial and sensitive land uses such as residential. They are as follows: • D-1 Land Use Compatibility • D-6 Compatibility between Industrial Facilities and Sensitive Land Uses.*
>
> *By letter dated October 9, 2003 Mr. Frank Wilson, Director, Northern Region of the Ministry of the Environment (MOE), wrote the following to members of the Peninsula Lake Association:*[underscoring added]
>
> > "Since 1996, local planning authorities, such as municipalities or planning boards, have been delegated increased decision-making authority under the Planning Act. To assist these planning authorities in exercising their new decision-making responsibilities, provincial ministries have been transferring relevant data and information for their use, including the D Series Guidelines.
> >
> > With respect to your question regarding rezoning applications to permit the development of new quarry operations, the MOE Procedure D-1-2 "Land Use Compatibility: Specific Applications" recommends that for new pits and quarry operations, the influence area is to be determined by appropriate studies (e.g., noise, dust, vibration, hydrogeological) carried out in support of the land use approvals. Under Municipal Plan Review, the approval authority is responsible for requesting these studies and determining the zone of influence. In organized areas, the approval authority rests with the municipality or planning board. In unorganized areas, the Ministry of Municipal Affairs and Housing in partnership with the MOE and the Ministry of Natural Resources is the approval authority."
>
> *Ministry of Environment Land Use Guideline D-6 advises the Township to determine the minimum separation distance and potential area of influence for a Class III industrial use (such as a quarry) in the vicinity of sensitive land uses (such as homes and farms). It establishes the following parameters:*
>
> - *300 metres minimum separation distance to avoid incompatible uses; and*
> - *1,000 metres potential area of influence for any adverse effects "to be identified, mitigation proposed and an assessment made on the acceptability of the proposal" (MOE, D-6, Appendix C).*
>
> *It is noteworthy that these distances apply regardless of whether it is a new sensitive land use proposed in the vicinity of an existing Class III Industrial Use such as a quarry, or whether it is a new quarry proposed in the vicinity of existing sensitive land uses. As a matter of good planning, the primary consideration should be to minimize conflicts between incompatible land uses, regardless of which is exists and which is proposed. [underscoring added]*
>
> *The Ministry of the Environment also requires that the developer enter into a binding legal agreement for any mitigation prior to the approval of the use (Ministry of the Environment Guidelines D-1-1, D-6).*

[96] House Quarry Application, Township of Bays File: Z39/05 https://static1.squarespace.com/static/5c59cf4c7a1fbd06dcdc52b6/t/5c6dff67f4e1fc98466d9c20/1550712680419/House+Quarry+Application+.pdf.

As a result of the interpretation of the MOE D-6 Guidelines provided by the Ministry of Environment, the Planner that reviewed the House Quarry Application (Class lll Industrial Use) made the following observations and recommendation:

> *I would note that Section E.38 of the Lake of Bays Official Plan specifies that a 300 metre setback from a pit or a 500 metre setback from a quarry use is required, subject to studies, when considering new sensitive land uses. If a sensitive use is proposed to be located within the stated setbacks, then an "impact assessment" should be prepared to evaluate the presence and impact of any adverse effects. It appears that the intent of this policy is to be consistent with the Ministry of the Environment D-6 Guidelines. However, because Policy E.38 applies only where new sensitive land uses are proposed near an existing quarry, and not in the opposite scenario, in my opinion the policy is in fact inconsistent with the MOE Guidelines to that extent, and the Township's Official Plan policy should be amended accordingly as soon as possible.* [underscoring added]

In *Miller Paving Ltd. v. McNab/Braeside (Township)*,[97] involving an application to extend a blasting quarry operation, the OMB also acknowledged the reciprocal nature of setbacks, commenting as follows:

> *Ministry rules on separation distances, between quarries and residences, specify that quarries cannot come closer than a given distance from residences – but inversely, residences similarly cannot come closer to quarries. Other governing documents say likewise [para. 68].*

Buffers and setbacks are essential to ensure that all adverse effects from a proposed blasting quarry are capable of being reduced to a trivial level, but the cumulative or repeat impacts of some adverse effects to which the environment and third-party property-owners would be subjected during the life of a blasting quarry cannot be ignored as potential sources of nuisance and trespass.

The distinction between a buffer and a separation distance (i.e., setback) is described by the MOE as follows, and the applicability and application of both depends entirely on the combination of incompatible land uses, and the nature of the adverse effects:

> ***Buffer*** *A method of control used to prevent or minimize the adverse effects of incompatible land uses and may be in the form of:*
>
> 1. *a land area or intervening space sufficient to provide the necessary distance separation; or*
> 2. *a natural or man-made feature such as a berm, wall, barrier, topography, trench, fence or other structure or technical control (e.g., solid brick walls, triple-glazed windows to lessen the effect of noise, an active or passive gas venting system); or*
> 3. *a land use different from the 2 [two] conflicting ones but compatible with each; or*
> 4. *any combination of the above, interposed between conflicting land uses.*
>
> ***Buffer Area*** *The air, land and/or water between a 'facility' and nearby 'sensitive land use', where land use controls are used to prevent or minimize 'adverse effects', it can be of variable size, shape and composition to produce the desired results and apply to all or part of an 'influence area'. A 'buffer area', depending upon the circumstances, may be on or off site, or both.*
>
> ***Separation Distance*** *The linear measurement between a 'facility' property/properties and a 'sensitive land use/uses'. The distance should be adequate to minimize or prevent the 'adverse effects' of one land use upon the other, so that at most there would only be a 'trivial impact.'*

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[97] *Miller Paving Ltd. v McNab / Braeside (Township)*, 2015 CanLII 70369 (ON LPAT), <https://canlii.ca/t/glwwn>, retrieved on 2021-02-23.

According to the Quarry Code of Practice, 3rd Edition, May 2017, Environment Protection Authority of Tasmania,[98] suggested setbacks are reciprocal:

> *Where possible, quarries should be located to minimize visual dust, and noise impacts on adjacent sensitive uses, in order to reduce the potential for environmental nuisance. New quarries should not be located close to existing residences or other sensitive receptors. Similarly, proposals to locate new residences adjacent to existing quarries should be discouraged, if possible, to reduce the potential environmental nuisance.*
>
> *It is suggested that planning authorities and operators seek to maintain the following separation distances, measured from the planned maximum extent of quarry operations to any sensitive use. [underscoring added]*
>
> 1. where regular blasting takes place 1,000 metres [p. 10]

For the protection of property and health and safety reasons, and to avoid trespassing on private third-party property, *flyrock* is not permitted off-site. Containment of *flyrock* on-site can only be achieved through the use of mandatory setbacks imposed as a precautionary measure. Blasting is not a singular event, and the environment and other sensitive receptors (e.g., inhabited structures and houses) would be subjected to potential damage, injury and death from *flyrock* during the entire life of a quarry, every time blasting occurs.

Shortcomings of Proponent-Driven Blasting Impact Assessments

In the preparation of a Blasting Impact Assessment, it is inconceivable for an explosives engineer to engage in willful blindness[99] by failing to acknowledge and conduct an analysis of *flyrock*, the ultimate *adverse effect* of blasting, which has the potential to injure and kill humans and animals.

- At an LPAT hearing an explosives engineer, with respect to preparation of a proponent-driven Blast Impact Assessment for a proposed quarry, testified that he did not include a safety factor in the calculation of maximum *flyrock* throw, and, in what can only be construed as irresponsible, abdicated any responsibility for the health and safety of the public by declaring that "it would be irresponsible for him or anyone else at this point in the licencing [pre-approval] phase to establish setback distances."
- A 2009 proponent-driven Blasting Assessment Impact prepared by Explotech[100] in support of an application to expand an existing quarry, asserted that the quarry could be "excavated to less than 200 metre separation [p. 4]," while failing to disclose previous *flyrock* incidents in September 2005 and August 2007, one of which travelled a distance of over 400 metres (with both incidents causing damage

---

98 https://epa.tas.gov.au/Documents/Quarry%20Code%20of%20Practice%20May%202017%20-%20web.pdf

99 "Willful blindness" defined as "closing the conscious (but not always the unconscious) mind to the likely harmful consequences of one's actions." Contract and Tort Law for Paralegals, Second Edition, 2018, p. 208.

100 Blasting Impact Assessment Miller Braeside Quarry Extension, http://www.mcnabbraeside.com/userfiles/file/municipal-information/information/3_6%20Blasting%20Impact%20Analysis%20May%2026%2009.pdf.

to residences, driveways and wells, and showering the area with debris), and even though the quarry is subject to a minimum setback of 300 metres under the zoning by-law, the setback requirement also proved inadequate to prevent *flyrock* from travelling beyond the boundaries of the quarry.

- At a 2020 LPAT hearing, the explosives engineer responsible for preparation of a 2009 proponent-driven Explotech Blasting Impact Assessment[101] in support of an application for a blasting quarry conceded that blasting requires "a conservative approach, i.e., caution," and that *flyrock* or vibration, depending on the circumstances, are the most damaging, with "flyrock being the direct impact on something." Presumably, the "something" is "human targets." However, the explosives engineer acknowledged that nowhere in the Blasting Impact Assessment is there any analysis of *flyrock.* As *Flyrock* is known to launch in every direction, and is an uncontrollable and unavoidable by-product of blasting, the following statement *couched* in obfuscatory language offers no protection to "structures (i.e., code for human targets in occupied dwellings)" from the potentially deadly consequences of *flyrock*.

  > *Orientation of the mineral extraction operation [i.e., blasting] will be designed and maintained so that the direction of the overpressure propagation and flyrock from the face will be away from structures as much as possible. To this end, extraction [blasting] has assumed a retreat towards the East and North [p. 13].*

- At a 2014 trial[102] regarding an unreported *flyrock* incident on July 23, 2009 at the Pakenham Quarry in Arnprior[103] where "some rock rifled to the North and North East of the opening face" and "[t]he scale house approximately 230m North was struck [penetrated] by fly rock [debris] as were some vehicles [extensively damaged] on Young Road some 300 plus meters from the blast."

  > *Luckily, [five people] the drivers and the passengers were not seriously hurt despite a rock entering the driver's open window and smashing through the rear passenger window of the first vehicle.*

  The camera recording the blast was also destroyed by the *flyrock* debris, and, conveniently, the memory card has no actual footage of the blast. According to the evidence of Explotech's explosives engineer,

  > *Flyrock can come from the top of the blast and typically occurs when the explosive product is loaded too close to the top of the hole (i.e., insufficient collar). Flyrock from the top of the blast typically exhibits a high looping trajectory. Flyrock from the face occurs because the designed burden has been compromised either by joints or fractures in the rock or an unforeseen reduction in the burden due to over break from the preceding blast. The trajectory of flyrock from the face is normally a flatter trajectory.*

---

[101] Blasting Impact Assessment, Demill Melrose Quarry Application, Explotech, December 2009.

[102] *R. v. Austin Powder Ltd.*, ONCJ, 2014 (Charges under the *Environmental Protection Act* LSB File No. 11-8155)

[103] The long delay in this case between the date of the charge and the plea was due to the parties waiting for the outcome of decision in the case of *Castonguay Blasting Ltd. v. Ontario (Environment)*, 2013 SCC 52, which had a direct bearing on the legal issues in this case.

And, Explotech concluded by stating that "we do not believe this [flyrock] incident was foreseeable, and "strongly recommend that the hazard zone be increased to 500m when firing any future blasts in this quarry." [underscoring added]

A prior *flyrock* incident at the Pakenham Quarry, three days earlier on July 20, 2009, had also gone unreported to the Ministry of Environment (MOE), after an unnamed individual at a neighbouring business was struck in the arm by *flyrock*.

Austin Powder, the contractor responsible for blasting at the Pakenham Quarry, stated that "90% of fly rock incidents are 'unexplainable.'" [underscoring added] He also conceded that Austin Powder has experienced *flyrock* incidents elsewhere, and that "everyone in rock [blasting] has them." [underscoring added]

The person actually responsible for executing the July 23, 2009 quarry blast that struck the scale house had not expected the *flyrock* to travel in the direction that it did:

> *…[T]his is where the incident happened,…right back here somewhere. That's my guess, I mean, like as I said I didn't see it but I'm assuming that, like the scale house was right about here, the way I shot this technically, it just goes this way, it doesn't go that ways, well apparently it did.*

- A proponent-driven "draft" Blast Impact Assessment prepared by Explotech[104] is illustrative of the misguided loyalty of explosives engineers to their clients with the sole objective of obtaining municipal and provincial approvals to permit a blasting quarry, expressing concern not for the health and safety of the residents in the surrounding communities in the event of a *flyrock* incident, but only for how a *flyrock* incident would affect the financial interests of the quarry operator.[105]

  > *In the event of an incident where flyrock does leave a site, the punitive measures include suspension/revocation of licences and fines to both the blaster and quarry operator [p. 25].*

  The public has a right to be protected from *flyrock* by proactive measures (i.e., imposing mandatory minimum setbacks) taken to prevent *flyrock* before it happens, not after the fact. After-the-fact measures are of no comfort to the residents in the nearby communities, especially if they are the ones harmed or fatally wounded by the *flyrock* or have had their residences or property damaged.

Flyrock meets the Ontario EPA definition of contaminant, and the adverse effects of *flyrock* are not trivial.[106] In *Castonguay Blasting Ltd. v. Ontario (Environment)*, [2013] 3 SCR 323, 2013 SCC 52 (CanLII), the Supreme Court held that "the flyrock could easily have seriously

---

[104] "Draft" Blast Impact Analysis, Reid Road Reservoir Quarry, December 2019, https://www.milton.ca/en/business-and-development/resources/Reid-Road-Quarry/M7700C-James-Dick-BIA-Reid-Road-Reservoir-Quarry-December-3-2019---DRAFT....pdf.

[105] Ontario Engineers are governed by Professional Engineers Act, R.R.O. 1990, Reg. 941. Section 72. (2) defines "professional misconduct," in relevant part as (a) negligence, and (b) failure to make reasonable provision for the safeguarding of life, health or property of a person who may be affected by the work for which the practitioner is responsible." https://www.ontario.ca/laws/regulation/900941#BK88.

[106] The EPA "Land Use Compatibility Definitions" defines "**Trivial Impact**" as "present or predictable contaminant discharges which are or are likely so minor that there would not be an 'adverse effect.'" Wherever and whenever rock blasting occurs (i.e.., proposed blasting quarry), *flyrock* is inevitable.

injured or killed someone." Castonguay was charged in two separate *flyrock* incidents, the facts of which are summarized in Canadian Environmental Regulation & Compliance News.[107]

> *Ontario's Ministry of the Environment issued, January 10, 2014, a court bulletin announcing the DNX Castonguay Inc. has been fined $175,000 [plus victim fine surcharges of $34,750] for the discharge of fly rock beyond the limits of a work site in two incidents causing adverse effects and for failing to report one of the incidents to the ministry, contrary to Ontario's Environmental Protection Act.*
>
> *In 2008 Castonguay Blasting Ltd., a federal corporation with head offices in Sudbury, ON, was hired as part of a partnership with Castonguay G.P., to blast rock during the development of a large retail store….*
>
> *The intent during a blast is to have loosened rock and rock debris fall in a controlled manner in a designated blast area. When rocks and debris are discharged outside of the controlled blast area into the wider environment, the rocks and debris are referred to as "fly-rock".*
>
> *In September 2008, fly rock was discharged beyond the limits of the work site during rock blasting.*
>
> *As a result fly-rock hit a nearby movie theatre causing damage to the roof, side of building, windows, and a glass door. Fly-rock also landed in the theatre's parking lot. At the time, the theatre was not open to the public.*
>
> *A maintenance worker was on the roof of the theatre during the blast but was not injured. The incident was not reported to the ministry for almost seven hours.*
>
> *In October 2008, the company initiated a boulder "re-blast" at the same work site to reduce the size of previously blasted oversized rocks. The blast resulted in smaller particles of fly-rock being discharged outside the blast site, causing damage to a number of vehicles parked in the lot of a nearby retail store.*

To ignore conducting an assessment of the potential dangers of *flyrock* even if the omission is allowed under the Ontario ARA does not extinguish the underlying obligation of *reasonableness* on the part of an explosives engineer in the preparation of a Blasting Impact Assessment, nor can an explosives engineer (or quarry operator/owner) avoid civil liability (or possibly criminal liability) for a *flyrock* incident that causes injury or death, pursuant to the legal principles articulated in *Ryan v. Victoria (City)*, 1999 CanLII 706 (SCC), [1999] 1 SCR 201, <https://canlii.ca/t/1fqpf>, retrieved on 2021-01-29.

> *Conduct is negligent if it creates an objectively unreasonable risk of harm. To avoid liability, a person must exercise the standard of care that would be expected of an ordinary, reasonable and prudent person in the same circumstances. Legislative standards are relevant to the common law standard of care, but the two are not necessarily co-extensive. The fact that a statute prescribes or prohibits certain activities may constitute evidence of reasonable conduct in a given situation, but it does not extinguish the underlying obligation of reasonableness. By the same token, mere compliance with a statute does not, in and of itself, preclude a finding of civil liability. Statutory standards can, however, be highly relevant to the assessment of reasonable conduct in a particular case, and in fact may render reasonable an act or omission which would otherwise appear to be negligent.*
>
> *The "special rule" which existed at common law with respect to railways can no longer be justified in principle and should be set aside. Under this rule, a railway, as long as it complied with the requirements imposed upon it by applicable statutes, regulations and administrative orders, was under no further obligation -- absent extraordinary circumstances -- to act in an objectively*

[107] https://www.blaney.com/sites/default/files/CERCN_Feb2014.pdf.

> *reasonable manner. Its effect was to excuse railway companies in most cases from the ordinary obligation of prudence. The courts in applying this rule implicitly recognized that statutory compliance cannot replace the common law standard of care, and can be accepted as a substitute for that standard only in certain circumstances.*
>
> *With the abolishment of the special rule, the correct principles can be stated more clearly. Compliance with a statutory standard of care does not abrogate or supersede the obligation to comply with the common law standard of care. The requirements are concurrent, and each carries its own penalty for breach. However, in appropriate circumstances, compliance with statutory standards may entirely satisfy the common law standard of care and thus absolve a defendant of liability in negligence.*
>
> *The weight to be accorded to statutory compliance in the overall assessment of reasonableness depends on the nature of the statute and the circumstances of the case. It should be determined whether the legislative standards are necessarily applicable to the facts of the case. Statutory compliance will have more relevance in "ordinary" cases -- cases clearly within the intended scope of the statute -- than in cases involving special or unusual circumstances. It should also be determined whether the legislative standards are specific or general, and whether they allow for discretion in the manner of performance. A party acting under statutory authority must still take such precautions as are reasonable within the range of that authority to minimize the risks which may result from its actions.*

Further, according to Davis, *flyrock* incidents are grossly under-reported to avoid the obvious legal consequences.

> ***Davis (1995) considers under-reporting is responsible for five to ten times the actual number of [flyrock] incidents [p. 36].***[108] [emphasis added]
>
> ***One of the major constraints in the prediction of flyrock is non-reporting of such incidents (Davis 1995) for obvious legal reasons [p. 900].***[109] [emphasis added]

Litigation in 2000 brought against numerous slate quarries, including U.S. Slate, in Vermont, revealed that U.S. Slate never kept any records of its blasting and mining operations.

> *"…U.S. Slate has never kept any records of its blasting and mining operations, even during the approximate two year period it was expressly required to do so under the terms of its Act 250 permit. Notwithstanding the commencement of this lawsuit, U.S. Slate has steadfastly refused to keep any records of the date, size, or location of its blasts, nor of the types or amounts of explosives used in such blasts." Plaintiffs' Trial Memo, 2000*[110]

The percentage of accidents occurring due to *flyrock* justifies its importance irrespective of the fact that the problem is seldom reported.[111]

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[108] T.N. Little, "*Flyrock Risk*," EXPLO Conference, Wollongong, NSW, 3-4 September 2007, https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-2570%2120191217T043417.551%20GMT.

[109] http://www.ejge.com/2013/Ppr2013.079alr.pdf.

[110] Comments to House Natural Resources, Fish & Wildlife Committee, January 27, 2020, https://legislature.vermont.gov/Documents/2020/WorkGroups/House%20Natural/Act%20250/Public%20Commentary/W~Annette%20Smith~VCE%20Slate%20Quarry%20Regulation%20Comments~1-28-2020.pdf.

[111] Davies, P. Al, "Risk based approach to setting of flyrock danger zones for blasting sites," *Trans. Inst. Mines Met.*, May-August 1995, 96-100.

The 12 Blasting Impact Assessments examined focus entirely on (undefined) "sensitive receptors" and show a complete disregard for property damage, quality of life and the health and safety of human and animal life. Other shortfalls typically identified in Blasting Impact Assessments are listed as follows:

- Potential *Nuisances* occasioned by blasting operations never mentioned[112]
- "Adverse effects" not defined, inadequately addressed or overlooked
- *Flyrock* (the ultimate adverse effect) not defined, inadequately addressed or overlooked
- Calculations of rock throw (distance) made without provision for a safety factor (e.g., for weather conditions, for uncontrollable factors and for unforeseen factors such as human error)
- Reciprocal setback measurements from lot limits of sensitive receptors (e.g. homes, farms, parks, heavily-travelled roads, school bus routes) closest to a proposed quarry not provided
- Character of the area not described or inadequately addressed (some land uses are more sensitive than others, but virtually none are compatible with a proposed blasting quarry and its adverse effects)
- Population statistics (permanent, seasonal & transient) for an appropriately defined zone of influence not provided
- Description of "sensitive receptors" not provided
- Activities associated with each "sensitive receptor" not disclosed
- Age and construction of each "sensitive receptor (i.e., structure)" not provided (every structure has a different level of tolerance to ground vibrations and airblast from blasting)
- Number of occupants and pets (if applicable) and use of "sensitive receptor (e.g. residential or business) that will be adversely impacted by blasting not addressed
- Expected life of proposed quarry operation (i.e., all phases) not disclosed
- Estimated frequency and number of blasts during the expected life of the quarry operation not disclosed

The superficial nature of the Blast Impact Assessments examined precludes meaningful analysis of potential health and safety risks, quality of life issues and potential nuisances that residents (and passers-by, visitors, workers, business employees and patrons) will experience as a result of quarry blasting operations. A Blast Impact Assessment that fails to include a meaningful analysis of *flyrock* is, at best, misleading, and, at worst, points to incompetence or negligence.

[112] Only one Blasting Impact Assessment examined mentioned "nuisances."

Conclusion

The Blasting Impact Assessments examined reflect both intentional and unintentional omissions as to the factors that cause short- and long-term adverse effects, some of which are irreversible or catastrophic. Blasting Impact Assessments are proponent-driven, with the overriding and sole objective to gain municipal and provincial approvals to operate a blasting quarry, without regard for the health, safety and welfare of the residents in the community. *Flyrock* (debris and fugitive dust), the ultimate adverse effect on the environment, and the health and safety of humans and animals is simply ignored even though it is universally recognized as an uncontrollable phenomenon with the potential for serious consequences.

The only practical remedy for the avoidance of *flyrock* (debris and fugitive dust) and to ensure that it remains onsite, is by imposing a setback of sufficient distance.

- A mandatory minimum setback of 800 metres imposed on the lands of the proponent would significantly eliminate the potential for impacting private third-party land, and minimize complaints and claims of trespass, nuisance and the *rule* of Rylands v. Fletcher (strict liability) for property damages, injury or death.

The time to address *flyrock* and its potential adverse effects on the health and safety of residents, including quality of life and property-value diminution, in the surrounding community is before a *flyrock* incident occurs.

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President, International Forensic & Litigation Appraisal Services Inc. and
International Valuation Consultants Inc.
Email : info@intval.com Web site : www.intval.com

FLYROCK AND SETBACKS

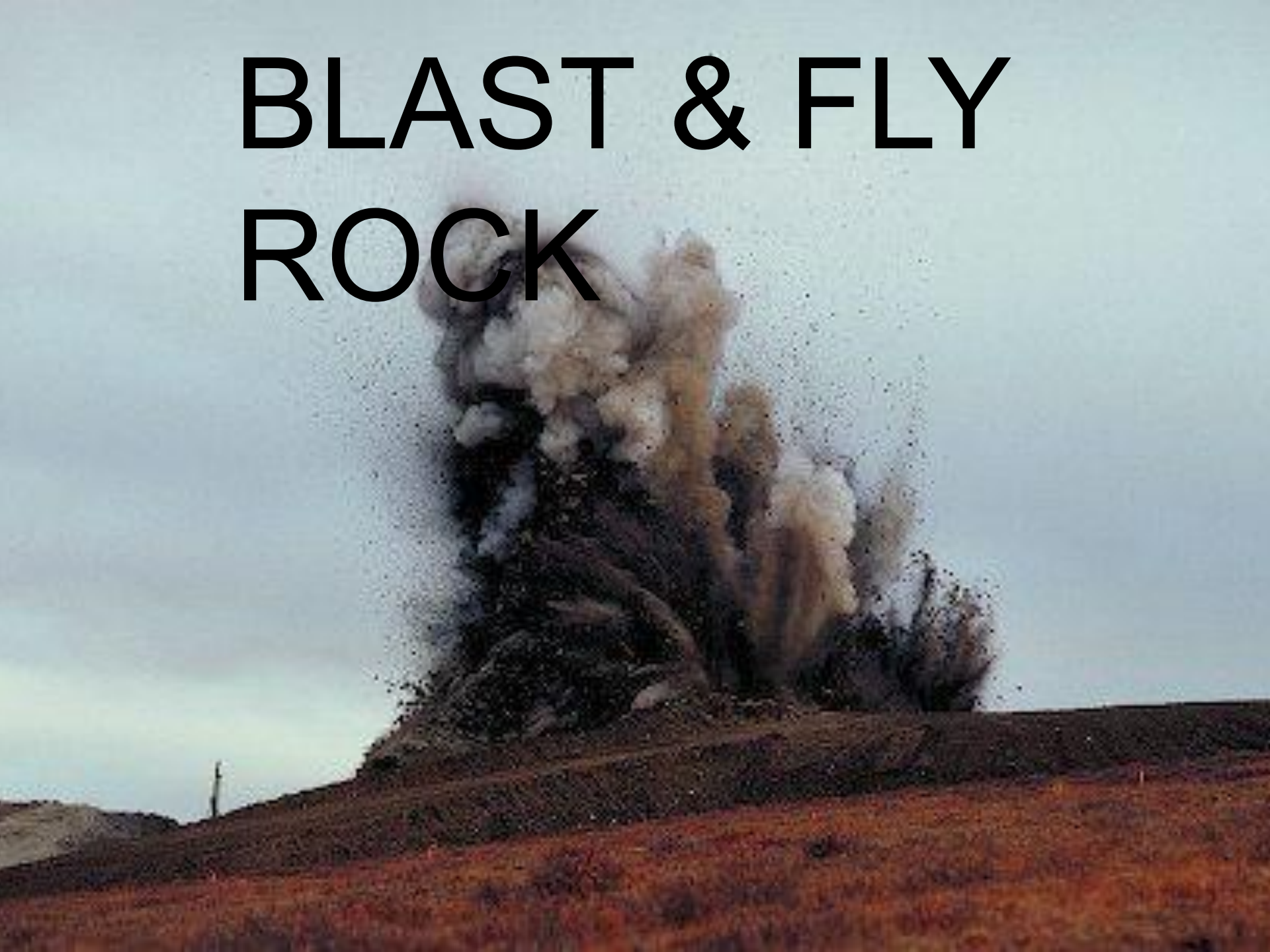
By

WILLIAM HILL P.Eng

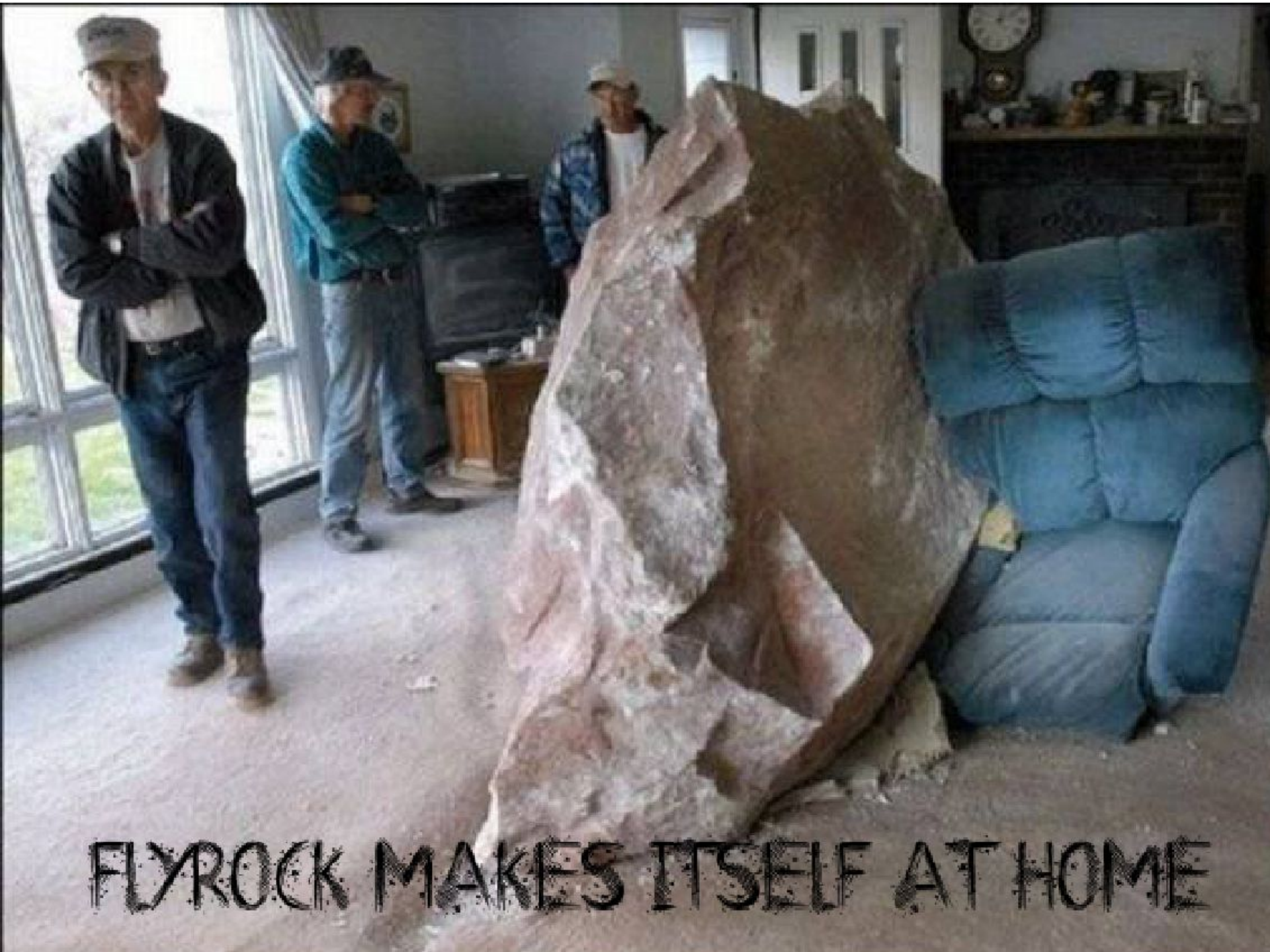
BLASTING PROBLEMS

- 1. NOISE
- 2. VIBRATION
- 3. **FLYROCK**

BLAST & FLY ROCK



FLY ROCK CAN
BE BIG

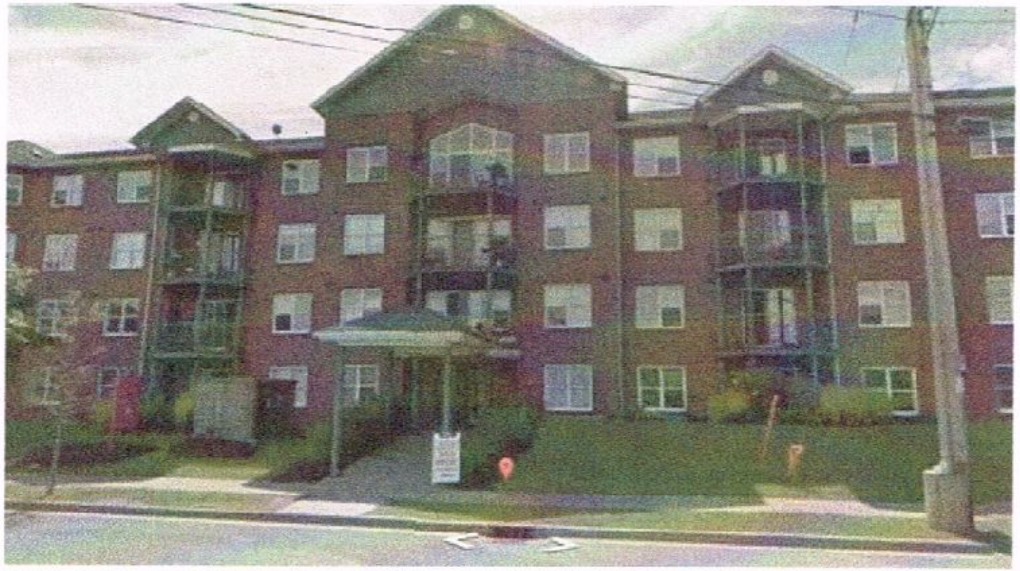

FLYROCK MAKES ITSELF AT HOME

FLY ROCK CAN
TRAVEL
A LONG

Quarry boulder crashes through apartment rooftop

AMANDA PANACCI STAFF REPORTER

Published September 22, 2016 - 3:53pm
Last Updated September 22, 2016 - 8:50pm



Parkland Arms apartment was struck by a basketball-sized rock on Monday, causing property damage but no injuries.

The province is investigating after a "basketball-sized" boulder from a nearby quarry crashed through the roof of a Halifax apartment building Monday afternoon.

RECENT DISASTER - JULY 19, 2013

NEW STRAITS TIMES

19 July 2013 last updated at 10:50 pm

UPDATE: Explosion at rock quarry kills one, 11 injured

FLY ROCK CAN
BE FATAL

Damage at 350m

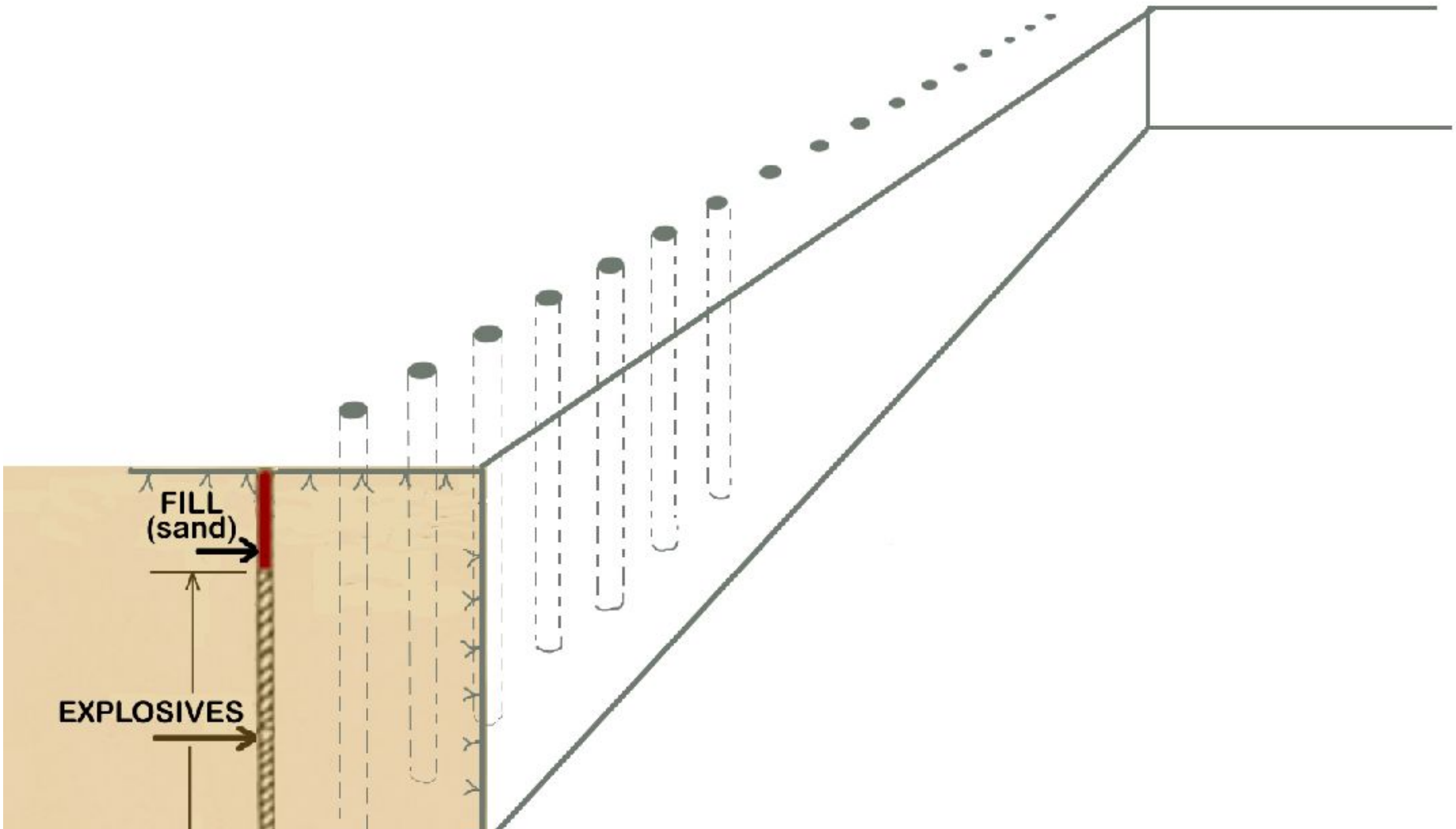
Dyno Nobel Liability Reduction

- **Eight years ago!**
- **Dyno Nobel Americas fires approximately 100 blasts per day**
  - ✓ **Approximately 150 flyrock incidents annually**
    - Many aren't reported
    - These numbers don't represent customer flyrock incidents
  - ✓ **Loss to the bottom line approximately $4 million dollars per year**
  - ✓ **Loss of sales**
  - ✓ **Loss of insurance to do business**
  - ✓ **Interruption of normal business flow**

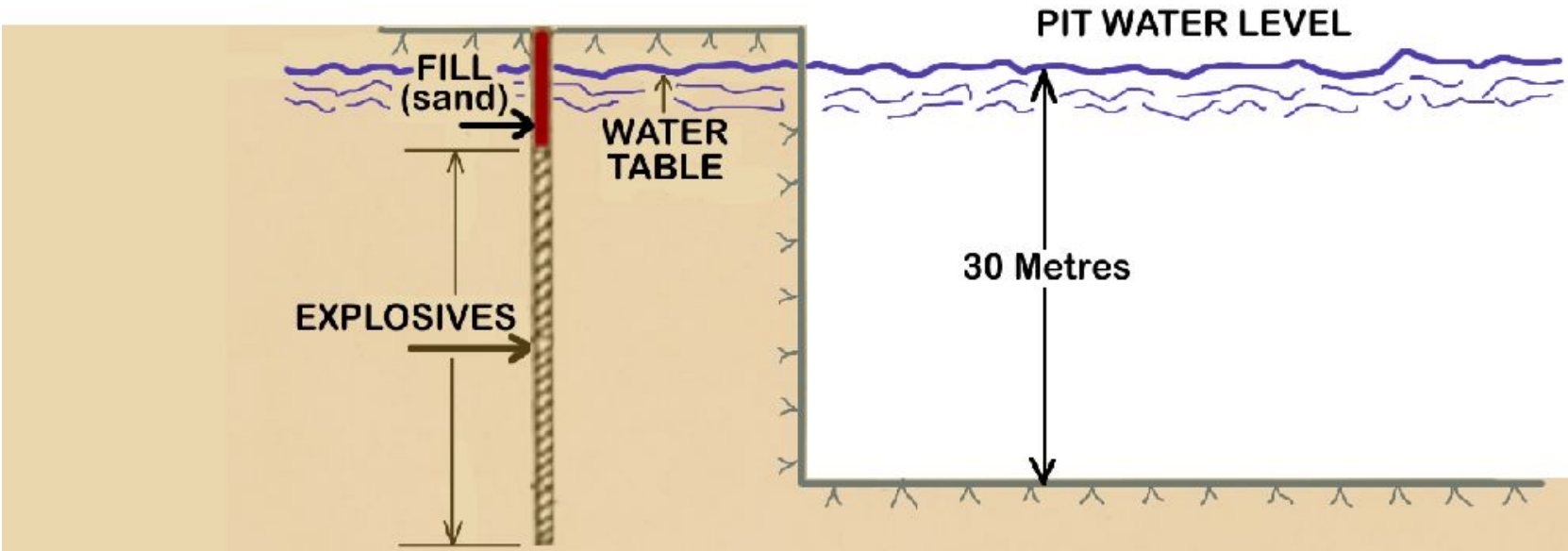
Information from Summa Insurance
Ralph Gremmel

QUARRY ACADEMY

BLASTING IN A MINE

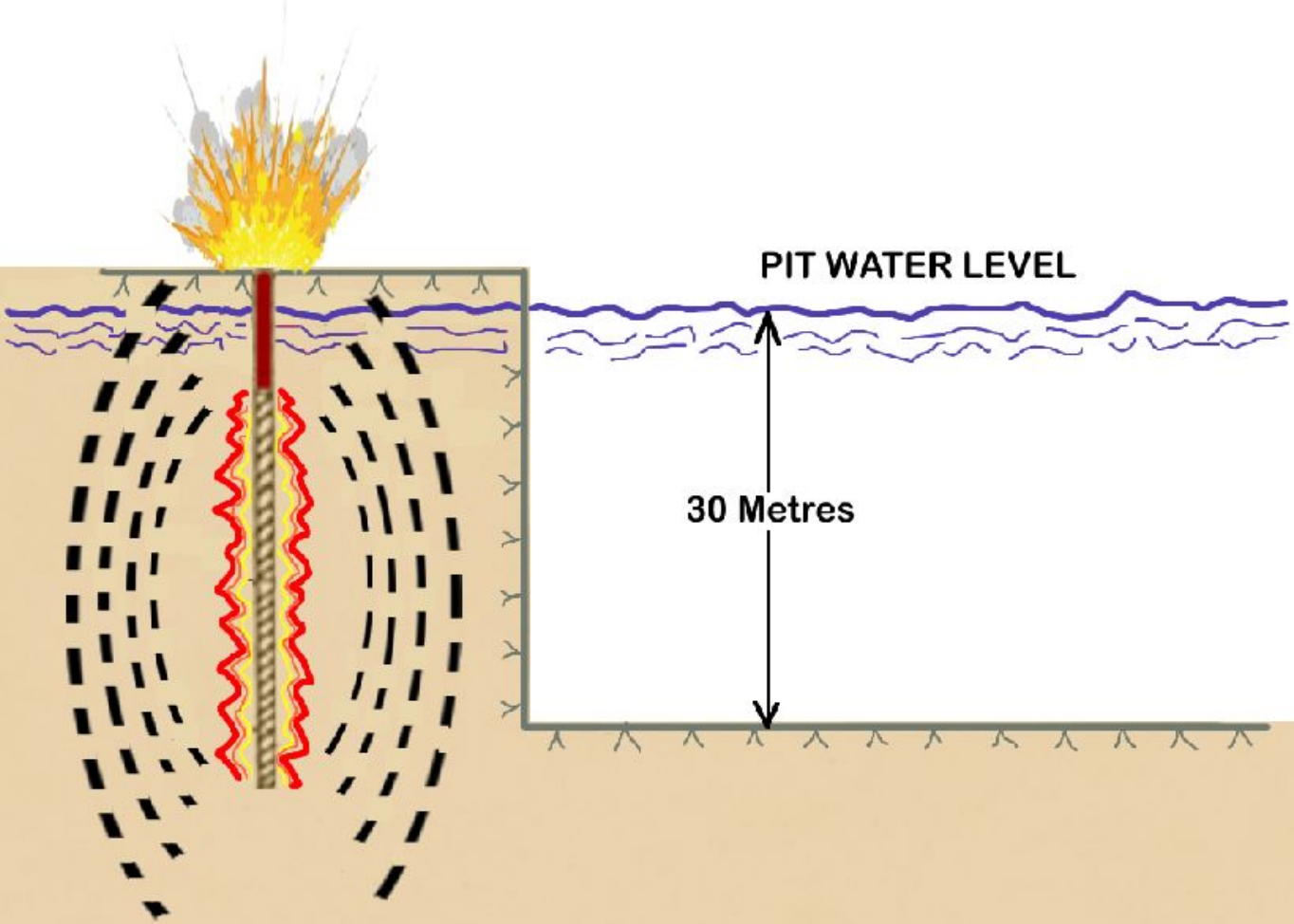


CROSS SECTION OF A DRILL HOLE

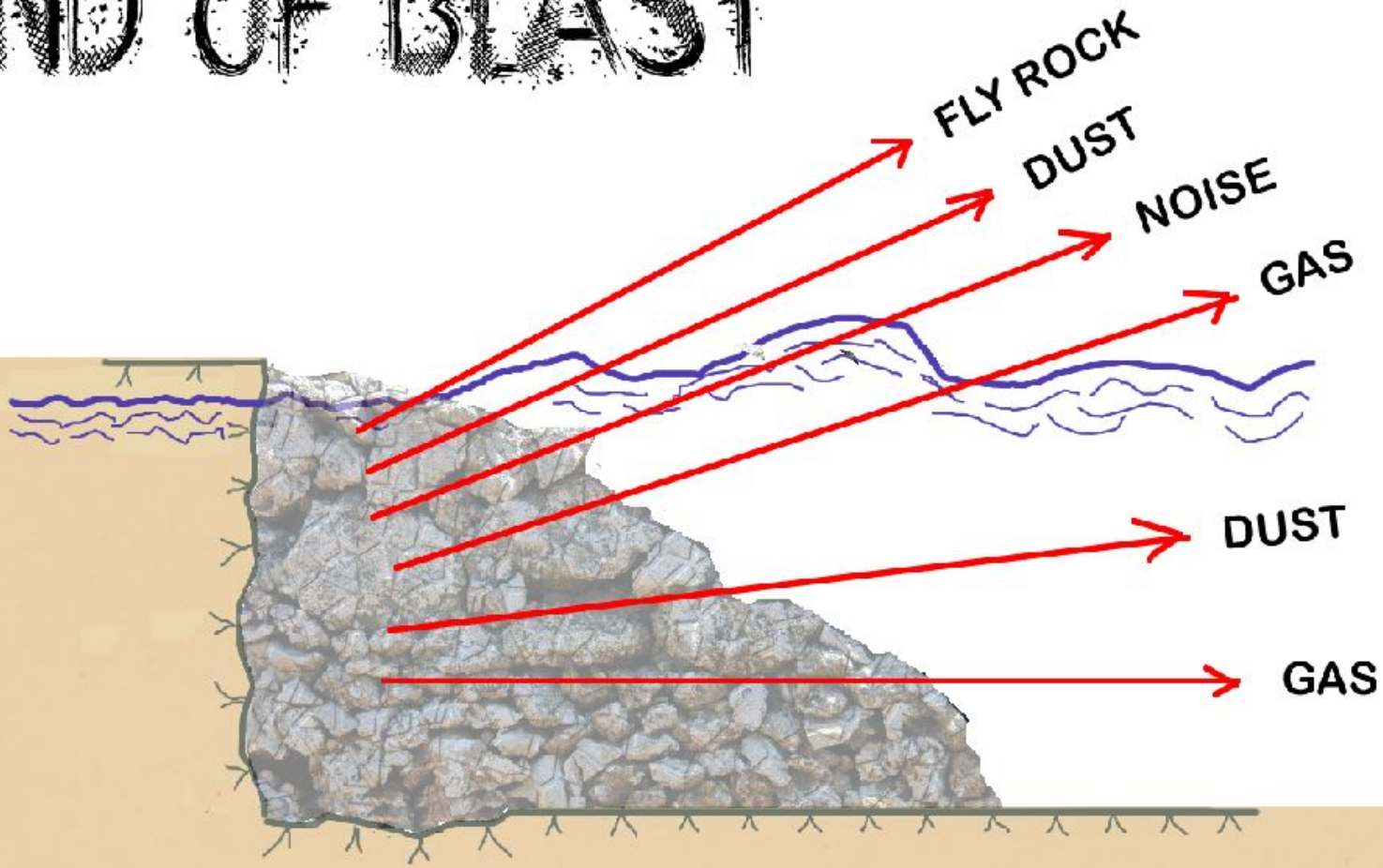


BLAST INITIATION

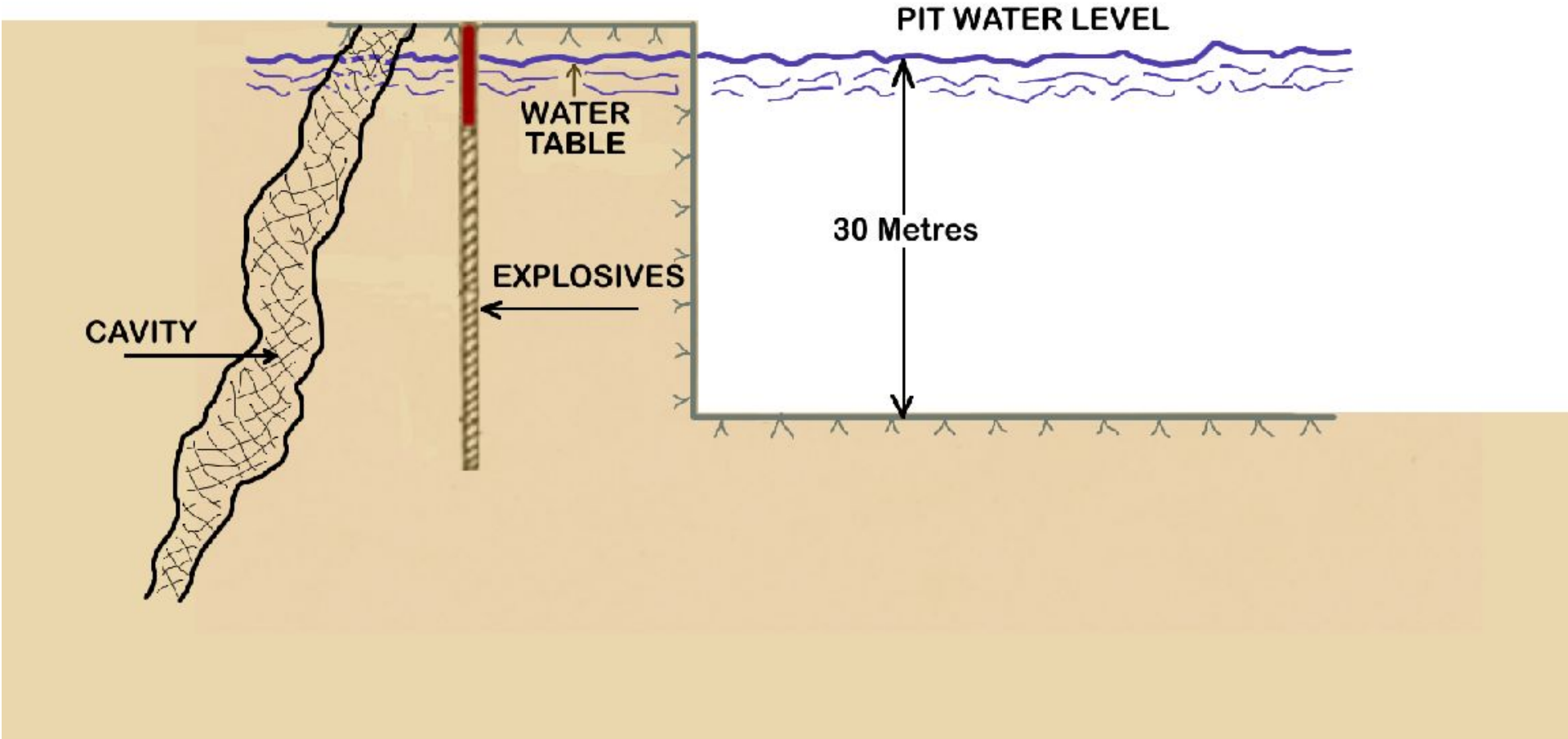
SHOCKWAVES TRAVEL 360 DEGREES



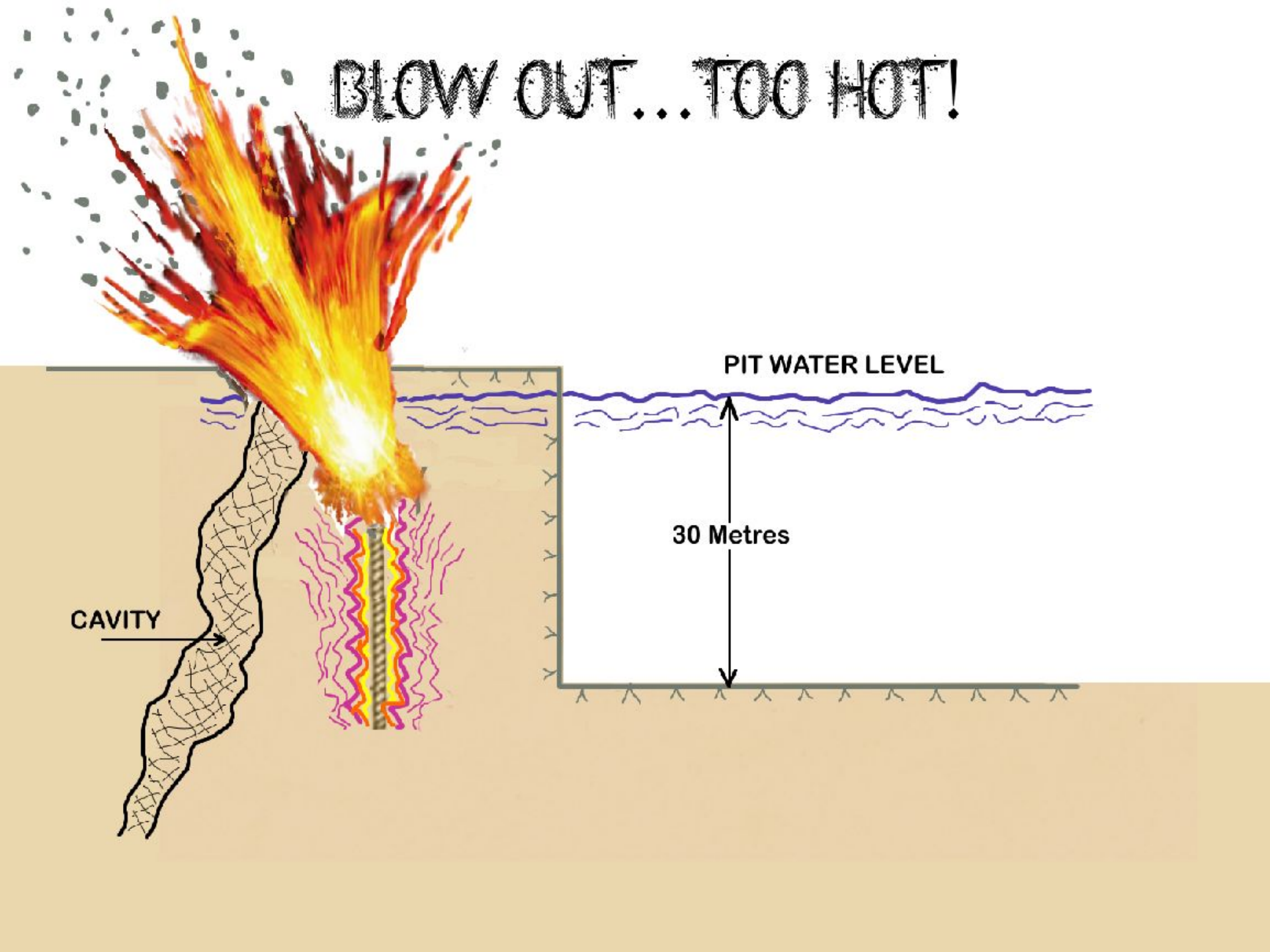
END OF BLAST



DRILL HOLE AND SOLUTION CAVITY



BLOW OUT…TOO HOT!



Ken Taylor of Austin Powder

- KT said that in consideration of the blasting experience - no difference would have resulted -that any experienced blaster woud have had the same fly rock incident take place
- There is no technology available to identify anomalies in rock such as mud seams or voids

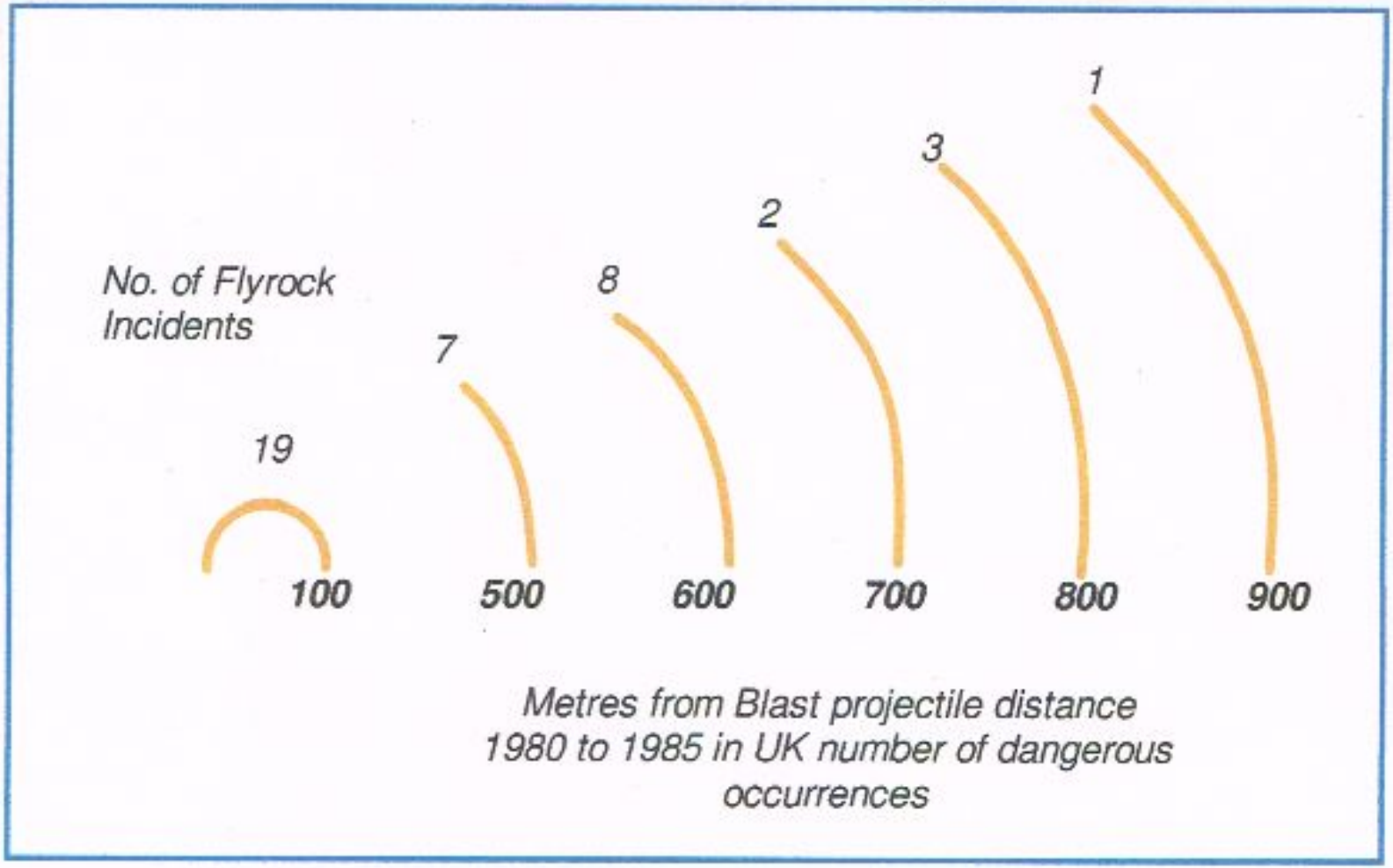
Mr. TAYLOR: Stated that there has never been a fly rock incident at this particular quarry prior to this one.

Mr. TAYLOR: Added that 90 % of fly rock incidents are "unexplainable"

HOW FAR?

- US BUREAU OF MINES RESEARCH
- NOISE – VIBRATION – FLYROCK
- SINCE 1970
- TERROCK CONSULTING ENGINEERS
- RICHARDS AND MOORE (AUSTRALIA)
- BETTER MODEL FOR FLYROCK
- SINCE LATE 1990S

Flyrock - occurrences



RPQ
richard@rpq.eu.com

We have applied the formulae as developed for the United States Bureau of Mines to predict expected range of fly rock for the products and patterns used on this blast. The validity of these equations for application in Eastern Ontario Quarries was confirmed by the Ontario Ministry of Labour in the early 1990's following a fatality resulting from fly rock at an Ontario limestone quarry.

EXPLOTECH

Recommendations

- Based on our site visits and a review of this incident, it appears that blast procedures were properly followed and that while not probable, the potential exists for a recurrence.

We strongly recommend that the hazard zone be increased to 500m when firing any future blasts in this quarry.

Yours truly,

René A. Morin, P. Eng.

LICENCED PROFESSIONAL ENGINEER
RENE MORIN
PROVINCE OF ONTARIO

- KT explained the mixture of mud and rock in the debris field confirmed for him that a mud seam caused the fly rock event
- KT GPS'd all positions from where photos taken and placed them on Google Earth - depicted in slide show - showing where vehciles were hit, where the guard zones were placed, where the people were located on the crew
- KT did a second Google earth showing a new guard zone, double in size, to a 2,000 ft distance - based upon a fly rock computer modelling "predictor" that calculates the safe distance - was not used prior to the 23'rd blast and the predictor does not take into account things like mud seams

FLYROCK: AN INEVITABLE BY-PRODUCT OF QUARRY BLASTING OPERATIONS

Prepared: June 10, 2021
Prepared by: Tony Sevelka,
AACI, P App, FRICS, MAI, AI-GRS

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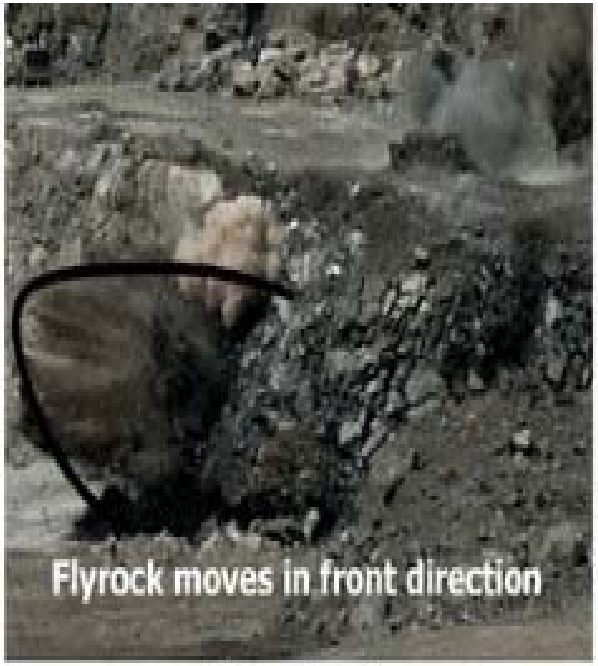
Cratering



Face burst

Rifling

Flyrock is the dirty little secret of the Aggregate Industry and the explosives engineers acting on their behalf, and they have done a remarkable job of concealing the dangers of flyrock from the public!

There are many undesirable environmental and health and safety risks associated with blasting quarry operations, but the focus of this presentation is generally on flyrock.

What is a Quarry?

"quarry" means land or land under water from which consolidated aggregate is being or has been excavated, and that has not been rehabilitated, but does not mean land or land under water excavated for a building or structure on the excavation site or in relation to which an order has been made under subsection (3) **(Aggregate Resources Act)**

https://www.ontario.ca/laws/statute/90a08

What is Flyrock?

- **Flyrock means any material propelled by a blast that would be actually or potentially hazardous to persons or property**

  https://www.lawinsider.com/dictionary/flyrock

- **Flyrock is debris ejected from the blast site that is traveling through the air or along the ground. Flyrock may be rock or soil. Flyrock is considered a *contaminant* under the Environmental Protection Act (EPA), which results from human activities (i.e., quarry blasting) that causes or is likely to cause an *adverse effect*.**

Note: There is no definition of "flyrock" in the Ontario Aggregate Resources Act.

What does the Ontario Aggregate Resources Act Say About Flyrock?

- ***A licensee or permittee shall take all reasonable measures to prevent fly rock from leaving the site during blasting if a sensitive receptor is located within 500 metres of the boundary of the site***. (O. Reg. 466/20, s. 2 (2), effective January 1, 2022

  https://www.ontario.ca/laws/regulation/970244

- **This ARA regulation implies that it is permissible for a licensed blasting quarry operation to launch flyrock off site as long as there are no sensitive receptors within 500 metres. (The term "sensitive receptor" is often code for "human targets.")**
- **The flaw in this ARA regulation is self-evident, and inconsistent with the EPA regulation that flyrock launched off site is not permissible.**
- **Launching flyrock off site onto privately owned third-party property constitutes unlawful "trespass."**

What does the Ontario Aggregate Resources Act Say About Flyrock?

Note: In the Aggregate Resources Act "sensitive receptor" means (a) a school or child care centre, or (b) any residence or facility at which at least one person sleeps, including a long-term care home, hospital, trailer park or campground. O. Re. 466/20, s. 1.

In the Provincial Policy Statement (PPS) 2020 "sensitive land uses: means buildings, amenity areas, or outdoor spaces where routine or normal activities occurring at reasonably expected times would experience one or more *adverse effects* from contaminant discharges generated by a nearby *major facility. Sensitive land uses* may be a part of the natural environment or built environment. Examples may include, <u>but are not limited to</u>: residences, day care centres, and educational and health facilities. [underscoring added]

What does the ARA say about blasting?

(5) A licence, aggregate permit or wayside permit that authorizes blasting at the site is subject to the following conditions:

1. No blasting shall occur on a holiday, or between 6 p.m. and 8 a.m., unless the permittee holds an aggregate permit and there is no sensitive receptor located within 2,000 metres of the area in which the blasting takes place.

This ARA regulation implies that it is permissible for a licensed quarry operation to blast anytime during the day between 8:00 am and 6:00 pm, excluding holidays, provided there are no sensitive receptors within 2,000 metres.

Why does the Aggregate Industry and their explosives engineers conceal flyrock from the public?

- **Because flyrock is uncontrollable and can never be eliminated**
- **Because flyrock is the ultimate *adverse effect***
- **Because flyrock has the potential to damage personal and real property**
- **Because flyrock has the potential to damage tree stands and other crops**
- **Because flyrock has the potential to injure or kill humans, pets, livestock and wildlife**
- **Because concealing the dangers of flyrock from the public serves the financial interests of the Aggregate Industry.**

Note: Flyrock meets the Ontario EPA definition of contaminant, and the *adverse effects* are not trivial. In *Castonguay Blasting Ltd. v. Ontario (Environment)*, 2013 SCC 52 (CanLII), [2013] 3 SCR 323, <https://canlii.ca/t/g1038> the Supreme Court held that "the flyrock could easily have seriously injured or killed someone."

What are *adverse effects*?

The PPS takes its definition of *adverse effects* directly from the *Environmental Protection Act*, and means one or more of:

a) impairment of the quality of the natural environment for any use that can be made of it;

b) injury or damage to property or plant or animal life;

c) harm or material discomfort to any person;

d) an adverse effect on the health of any person;

e) impairment of the safety of any person;

f) rendering any property or plant or animal unfit for human use;

g) loss of enjoyment of normal use of property; and

h) interference with normal conduct of business.

What are the causes of flyrock?

- Overloaded blastholes with excessive amounts of explosives
- Heavily confined charges or the lack of relief (i.e. lift blasts)
- Explosives loaded into incompetent materials (i.e. mud seams, fractures, and/or voids)
- Insufficient front-row burden, causing front-face blowouts
- Burdens and spacings too close together (resulting in high powder factors)
- Inadequate/insufficient stemming material
- Inadequate delay between holes in the same row and between rows; detonators firing out of sequence
- Deviation of blast hole detonation from the intended sequence
- Changing geology or rock type
- Spacing and burden exceeds borehole depth
- Angled boreholes
- Secondary blasting
- Human error (incompetence or negligence)
- Blaster under the influence of drugs or alcohol

Why is Flyrock so Dangerous?

- **Flyrock can come at you from any direction. Flyrock can be thrown high like a fly ball, fly straight like a fastball, roll along the ground, or ricochet from any direction. Flyrock can be gravel, rocks, tree trunks, construction materials, mud—even water.** (p. 3 Worker's Hazard Alert, https://www.cfins.com/wp-content/uploads/2019/01/blasting-safety-worker-alert.pdf)
- **Flyrock can be as small as marbles or as large as a car.** (p. 3, Worker's Hazard Alert)
- **Each pound of explosives has the force of 76 million horse power. An 8½-pound piece of flyrock travelled 1,200 feet (366 metres) from the blast and with enough force to dent the roof of a truck. The dented roof killed the worker.** (ISEE Blaster's Handbook)

Why is Flyrock so Dangerous?

- **Flyrock debris can travel 6,000 feet (1,829 metres) or more, reach speeds of 400 miles per hour (644 kilometres per hour), and can penetrate buildings, smash vehicles, and cause great bodily harm or death.** (Pits & Quarries, 1991 and Flyrock Hazard Alert, https://www.dmme.virginia.gov/dmm/PDF/SAFETY/ALERTS/blastingflyrock/FlyrockHazardAlert.pdf)
- **Any size material is capable of damaging property or injuring or killing people, pets, livestock and wildlife.**
- **Blasting in a karst landscape makes the risk of flyrock an "extreme problem." (Ludwiczak, Blasting Consultant)**
- **Wind can increase the distance that flyrock can be launched by as much as a factor of two (Zhou, et al).**

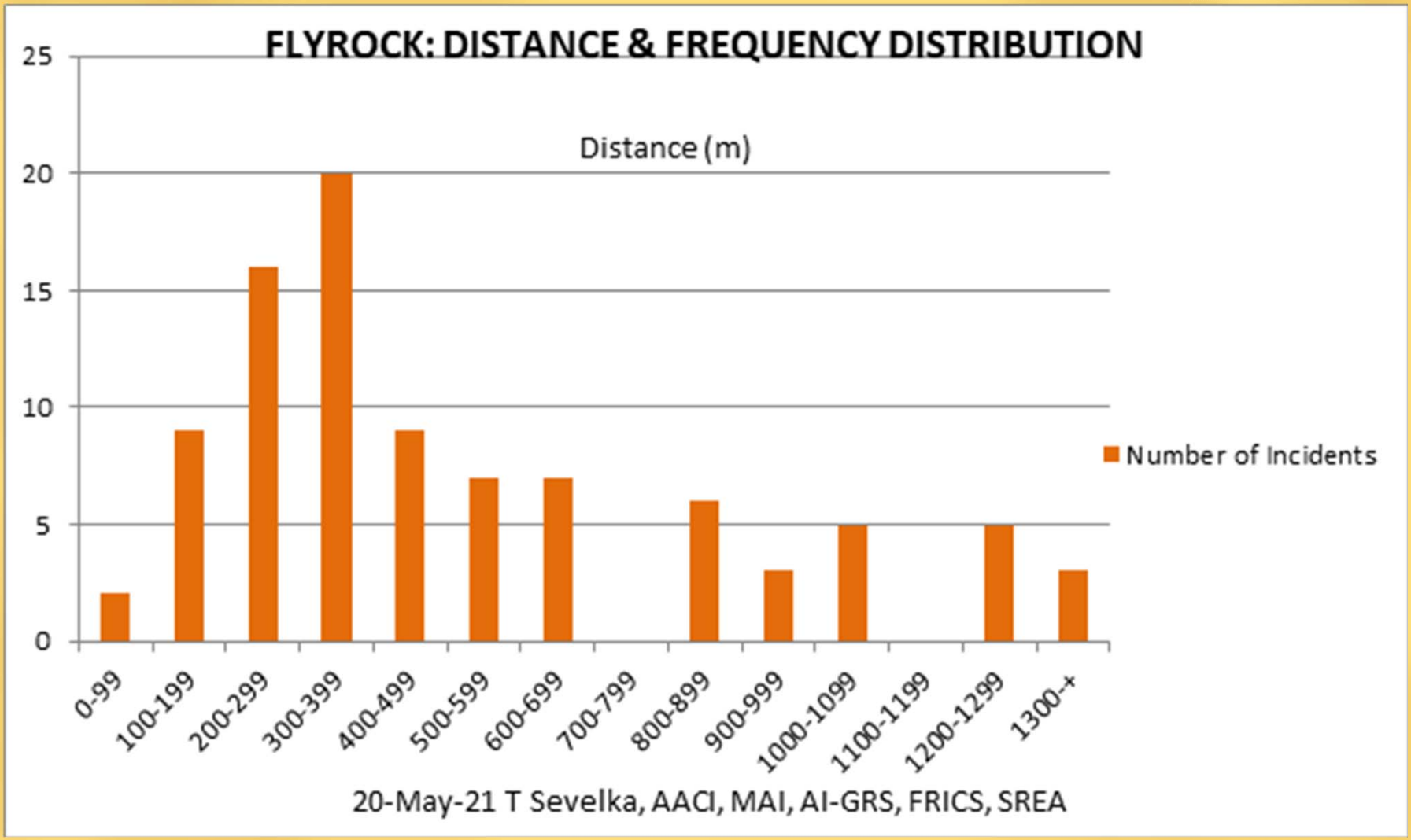
How Prevalent is Flyrock?

- **Flyrock is a common occurrence (District Manager, Mining Safety and Health, Warrendale, Pa.)**
- **Flyrock occurs 5% of the time (Regional Operations Manager, Consbec Inc., Nova Scotia, para. 11, Parker Mountain Aggregates, 2007 CanLII 91661 (NS OHSAP)**
- **5% of 15,000 to 20,000 yearly secondary quarry blasts will throw flyrock 800 feet (244 metres) to 850 feet (259 metres) (para. 435, Lee Lime Corp. v. Massachusetts Turnpike Authority, 149 NE 2d 905 – Mass: Supreme Court)**
- **Under reporting is responsible for five to 10 times the actual number of flyrock incidents (Davies 1995)**

How Prevalent is Flyrock?

- **Flyrock goes unreported by Blasting Quarry operators so as to avoid legal consequences (Raina et al. 2013)**
- **Flyrock that lands outside of the boundaries of a quarry in an uninhabited area unnoticed goes unreported.**
- **Most incidents of flyrock are only reported when uncovered by the public or when flyrock causes damage, injury or death.**

Analysis of Flyrock Travel Distances



An analysis of 92 *flyrock* incidents, where the distance from the blast is known, indicate that 91% (84) of the *flyrock* incidents occurred within 1,099 metres, and 97% occurred within 1,299 metres.

The number of *flyrock* incidents within each interval, starting at between 300 and 399 metres, and the average distance travelled within each interval are summarized as follows:

- 20 (22%) of the flyrock incidents occurred between 300 and 399 metres (330 metres avg)
- 9 (10%) of the flyrock incidents occurred between 400 and 499 metres.(446 metres avg)
- 7 (8%) of the flyrock incidents occurred between 500 and 599 metres (515 metres avg)
- 7 (8%) of the flyrock incidents occurred between 600 and 699 metres (622 metres avg)
- 6 (7%) of the flyrock incidents occurred between 800 and 899 metres (802 metres avg)
- 5 (5%) of the flyrock incidents occurred between 1200 and 1299 metres (1225 metres avg)
- 3 (3%) of the flyrock incidents occurred over 1300 metres (2307 metres average)

Further, at 80%, which accounts for the first 74 *flyrock* incidents in ascending order, *flyrock* reached a distance of 800 metres, and, at 90%, which accounts for the first 83 *flyrock* incidents in ascending order, *flyrock* reached a distance of 1,020 metres.

Examples of Flyrock Incidents

- **Flyrock 78:** On January 10, 2006, a blast at a quarry in Ireland launched flyrock debris over 300 metres causing widespread damage to a quarry plant, private cars and buildings, and injuring three people.
- **Flyrock 94:** On December 12, 2017, a blast at a quarry in Belize showered flyrock debris over an area of approximately 800 metres, that killed Ronald Sutherland, injured five people, wrecked vehicles and left many houses badly damaged.
- **Flyrock 98:** A blast at a quarry in Ghana resulted in flyrock damaging the roofs of many homes in a nearby residential community, and in 2015, 300 residents sued two quarry companies for causing damage to their homes and properties.

Examples of Flyrock Incidents

- **Flyrock 137:** On May 7, 2016, a blast at a quarry in Africa launched flyrock debris that struck community members' homes and caused their homes to crack.
- **Flyrock 138:** On February 13, 2018, a blast at a construction site off Murfreesboro Road in Franklin, Tennessee, launched flyrock debris that "totaled" more than 50 cars at the neighbouring Ford Lincoln dealership
- **Flyrock 140:** On June 3, 2013, an explosion at a quarry in Quebec damaged 20 homes in the nearby community of Saint-Joseph-de-Coleraine.

Blast Design Report
(Blast Impact Assessment)

An application for a permit for a blasting quarry requires preparation of a number of technical reports, one of which is the Blast Design Report.

- **A blast design report is required if a sensitive receptor is within 500 metres of the limit of excavation to demonstrate that provincial guidelines for blast overpressure and ground vibration can be satisfied.**
- **An application for a quarry proposing to blast requires details about frequency and timing of blasts (more blast means greater potential for flyrock)**

Blast Design Report
(Blast Impact Assessment)

- **An application for a quarry proposing to blast requires identification of the number of sensitive receptors located within 500 metres of the boundary of the site and the distance from the boundary to each sensitive receptor (more receptors means more property damage and more human targets that are likely to be injured or killed in the event of a flyrock incident)**

A Proponent-Driven Blast Design Report

- Does not include an assessment of the potential for flyrock, the ultimate *adverse effect* on the communities in proximity to the proposed blasting quarry operation
- Does not include an assessment of the health risks from exposure to toxic fumes in communities in proximity to a blasting quarry operation.
- Does not include an assessment of complaints generated from residents residing in communities in proximity to a blasting quarry operation.
- Does not identity the number and age of residents in the communities in proximity to the proposed blasting quarry operation that will be exposed to the *adverse effects*
- Does not identity the number of patrons/visitors of businesses and tourist attractions in proximity to the proposed blasting quarry operation that will be exposed to the *adverse effects*.

A Proponent-Driven Blast Design Report

- Does not list the date and type of construction of each building or structure (i.e., sensitive receptor) in the communities in proximity to the proposed blasting quarry operation, each of which has a different tolerance to ground vibrations and overpressure from blasting.
- Does not identify as “sensitive receptors” unimproved “legal lots of record,” under separate and distinct ownership which possess “as-of-right” development potential.
- Does not take into account any *adverse effects* enhanced by wind conditions with respect to overpressure from blasting quarry operations.
- Does not include an estimate of the expected life of the proposed blasting quarry operation (i.e., all phases).

A Proponent-Driven Blast Design Report

The superficial nature of proponent-driven Blast Design Reports (Blast Impact Assessments) precludes meaningful analysis of potential health and safety risks, quality of life issues and potential nuisances that residents (and passers-by, visitors, workers, business employees and patrons) will experience as a result of a proposed blasting quarry operation.

Who is responsible for protecting the environment and the public from the dangers of flyrock?

The depraved indifference shown by Ontario explosives engineers in the preparation of proponent-driven Blast Impact Assessments (BIA) to the significant dangers of *flyrock* is exemplified in the testimony of the explosives engineer at a 2020 LPAT hearing involving an application for a quarry in the Township of Tyendinaga:

> *Mr. Cyr attempts to explain away the absence of any meaningful analysis of flyrock in the BIA on the grounds that this falls outside the scope of an BIA that is aimed primarily at the MECP's Noise Guidelines. He further suggests that the issue of flyrock is best left to provincial ministries which have the authority to "aggressively prosecute" flyrock incidents <u>after-the-fact</u> [p. 13].* [underscoring added]

The same explosives engineer absolved himself of any obligation to "make reasonable provision for the safeguarding of life, health or property of a person affected by the work for which the practitioner is responsible" (Professional Misconduct Section 72. (2) Regulation O. Reg. 941) in preparing a Blasting Impact Report for the proposed Childs Pit and Quarry Expansion.

> *While not specifically required as part of the scope of the Blast Impact Analysis under the Aggregate Resources Act, this report touches on the topics of the flyrock and general water wells for general information purposes only.* (p. 3, Blast Impact Analysis, Explotech, May 27, 2020)

Flyrock, as the ultimate *adverse effect*, is the most dangerous aspect of a blasting quarry operation, and, therefore, an analysis of flyrock must form part of the Blast Design Report (Blast Impact Assessment) together with ground vibration and overpressure (airblast) (Moore and Richards, 2005)

Flyrock Can Never Be Mitigated

Flyrock is a lethal product of ***unforeseen circumstances*** *which can never be mitigated. The likelihood of flyrock occurring from a delayed or accidental premature planned, or post blast inspection, a misfire or explosives accident,* ***can never be predicted****. No amount of planning will mitigate this risk.* [Section 2.1, Submission to the Senate Rural and Regional Affairs & Transport Legislation Committee Inquiry into Australia's General Aviation Industry, © *Fight Path Forum*, November 2020]

Protection From Flyrock

Setbacks are the only effective means of protecting third-party-owned property against flyrock, and protecting humans, pets, livestock and wildlife from injury or death.

- a minimum setback requirement of 800 metres imposed on the proponent of a proposed blasting quarry application would eliminate most of the risk associated with flyrock

Some jurisdictions have imposed mandatory setbacks on proposed blasting quarry operations:

- 800 metres setback between blasting and structures (Nova Scotia)
- >1,000 metres from a boundary of a Settlement Area (Algonquin Highlands)
- 500 metres minimum separation distance from sensitive land use (Timmins)
- 600 metres minimum from residential, commercial and mixed-use (Quebec)
- 600 metres from any drinking water supply well (New Brunswick)

Protection From Flyrock

Draft Ministry of the Environment, Conservation and Environment (MOECP) Land Use Compatibility Guideline (March 2021)

https://prod-environmental-registry.s3.amazonaws.com/2021-03/Proposed%20Land%20Use%20Compatibility%20Guideline.pdf

- The primary purpose of the Guideline is to support the implementation of the Provincial Policy Statement, 2020 (PPS) issued under Section 3 of the *Planning Act*, including policies 1.2.6.1 and 1.2.6.2 (Land Use Compatibility).

Protection From Flyrock

A new or expanding aggregate quarry operation, blasting and dewatering below the water table, is the most obnoxious, toxic and environmentally destructive land activity, with no prospect of rehabilitation, and qualifies as a *Class3 major facility.*

- A *Compatibility Study* is required when a new or expanding major facility is proposed to locate where there are existing or planned sensitive uses within the AOI (Area of Influence), including MSD (Minimum Separation Distance).
- A *Class 3 Major Facility* is subject to the following provisions
  - 1,000 meter Area of Influence (AOI) from existing or permitted land uses, and
  - 500 metre Minimum Separation Distance (MSD)

Protection From Flyrock

3. <u>MINIMIZE</u> and <u>MITIGATE</u> Impacts [p. 5]

- **If the separation distance is not possible, the compatibility study must identify mitigation measures to ensure no adverse effects will remain post-mitigation.**
- **<u>Even with proposed mitigation, the separation distance should be maximized to minimize impacts, and should not be less than the MSD</u>.** [underscoring added]
- **Once implemented, monitor and maintain required mitigation measures over time to avoid future compatibility issues.**

***Where avoidance and minimization/mitigation of impacts is not possible,* <u>do not permit</u> the proposed incompatible land use.**

Note: Other planning issues that have not been addressed in this Guideline (e.g. issues related to species at risk, agricultural concerns, impacts to water, cultural heritage and archaeology) must be considered through other assessments and processes required under applicable legislation and policies.

Protective Blasting Shelter v Vulnerable Sensitive Receptor (i.e., Human Target)

5/8” thick steel construction

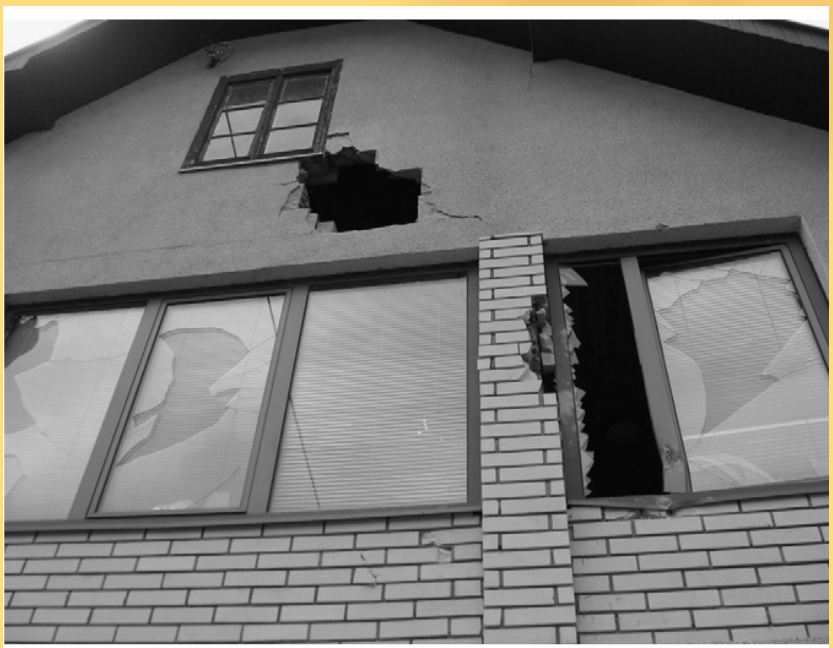


Fig. 9. The damage to structure (50 cm flyrock fragment at 320 m distance).

Wood-frame construction

Blasting Is An Ultrahazardous Activity Held To Strict Liability

- There is no duty to establish evidence of a breach of a standard of care to prove liability for damage, injury or death caused by blasting.
- In *Garland Coal & Mining Company v. Few*, 267 F.2d 785 (10th Cir. 1959) https://casetext.com/case/garland-coal-mining-company-v-few, blasting operations on adjoining land were upheld on a strict liability basis, and extend to more than flyrock, as it includes damages from concussion (airblast) and vibration.

Flyrock Canadian Cases

- ***Castonguay Blasting Ltd. v. Ontario (Environment)***, 2013 SCC 52 (CanLII), [2013] 3 SCR 323, <https://canlii.ca/t/g1038>
- ***Director of Occupational Health and Safety v. Government of Yukon, William R. Cratty and P.S. Sidhu Trucking Ltd.***, 2012 YKSC 47 (CanLII), <https://canlii.ca/t/fs6vt>
- ***City Sand and Gravel Limited v. Newfoundland (Municipal and Provincial Affairs)***, 2007 NLCA 51 (CanLII), <https://canlii.ca/t/1sfnv>, (Leave to Appeal to Supreme Court of Canada denied)
- ***Miller Paving Ltd. v McNab / Braeside (Township)***, 2015 CanLII 70369 (ON LPAT), <https://canlii.ca/t/glwwn>, (para. 55)
- ***James v. Miller Group Inc.***, 2013 ONSC 3266 (CanLII), https://canlii.ca/t/g2f5j
- ***James v Miller Group Inc.***, 2015 ONSC 3138 (CanLII), <https://canlii.ca/t/gj16p>

- ***Dexter Construction Company Limited (Re)*, 2020 NSLB 41 (CanLII), <https://canlii.ca/t/j7xz3>**
- ***Parker Mountain Aggregates Limited*, 2007 CanLII 91661 (NS OHSAP), <https://canlii.ca/t/j7q8f>**
- ***R. v. Chenard*, 2005 ONCJ 501 (CanLII), <https://canlii.ca/t/1mfqs>**
- ***Ontario (Ministry of Labour and Ministry of the Environment) v. Sunrise Propane Energy Group Inc. et al.*, 2013 ONCJ 358 (CanLII), <https://canlii.ca/t/fzhvs>**
- ***MacMillan Bloedel (Alberni) Ltd. et al. v. British Columbia Hydro & Power Authority et al.*, 1972 CanLII 1042 (BC CA), https://canlii.ca/t/gwgbw**
- ***Roy Judge Co. Ltd. v. Norris et al.*, 1973 CanLII 1236 (NS CA), https://canlii.ca/t/gwgdr**
- ***WCAT-2009-01297 (Re)*, 2009 CanLII 36791 (BC WCAT), https://canlii.ca/t/24kng**
- ***R. v. Austin Powder Ltd.*, ONCJ, 2014 (Charges under the *Environmental Protection Act* LSB File No. 11-8155) (Pakenham Quarry, Arnprior – 2009 unreported flyrock incident damaged a scale house and vehicles)**

Flyrock American Cases

- ***Dept. of Energy v. Hobet Min. & Const.*, 358 S.E.2d 823 (1987),** https://scholar.google.com/scholar_case?case=17148911866299365 66&q=flyrock&hl=en&as_sdt=2006
- ***Ramsburg v. Target Stores, Inc.*, 982 F. Supp. 1194 (1987)** https://scholar.google.com/scholar_case?case=3137640203151959616&q=flyrock&hl=en&as_sdt=2006
- ***Fantasy Valley Resort, Inc. v. Gaylord Fuel Corp.*, 92 Md. App. 267 (1992) 607 A. 2d 584,** https://scholar.google.com/scholar_case?case=8781503776859543886&q=flyrock&hl=en&as_sdt=2006
- ***Fagundes v. Ammons Development Group, Inc.*, 820 S.E.2d 350 (2018), NC App.,** https://scholar.google.com/scholar_case?case=15107525352572638587&q=flyrock&hl=en&as_sdt=2006

Flyrock American Cases

- ***Matter of Mastro v. Hudacs*, 224 A.D.2d 621 (1996) 638 N.Y.S.2d 681, https://scholar.google.com/scholar_case?case=8561234087670744605&q=flyrock&hl=en&as_sdt=2006**
- ***Amerikohl Mining, Inc. v. Fayette County Zoning Board*, PA Commonwealth Court 2012, https://scholar.google.com/scholar_case?case=4967608865363526286&q=flyrock&hl=en&as_sdt=2006**

August 10, 2020 Supplement to April 24, 2020 Flyrock and Other Impacts from Quarry Blasting Operations

(see https://intval.com/articles/Flyrock-and-Other-Impacts-from-Quarry-Blasting-Operations.pdf.)

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SECTION I

The Incidence and Dangers of Flyrock Occasioned by Blasting

According to a January 2020 article appearing in the Journal of Mining and Environment (JME),[1]

> ***[I]n China, flyrock is the reason of about 27% of surface mine disaster events*** *[p. 1]*[2] [emphasis added]
>
> *…Flyrock…is one of the most hazardous phenomena in the drilling and blasting operation of surface mines. This phenomenon is defined as driving rock fragments beyond a desired area, which can result in human injuries, fatalities, and structure damages [p. 1].*[3]
>
> *There can be many reasons for the flyrock phenomenon occurring ranging from deviations in the blast pattern design or their implementation, explosive use, and known or unknown ground conditions [p. 1].*

According to a 2003 paper prepared on behalf of the International Society of Explosives (ISEE),[4] flyrock accounted for 21.5% of all blasting injuries in surface mining in the United States from 1994 to 2001. According to records of Mine Safety and Health Administration (MSHA),[5]

> ***1 out of 10 accidents happened because of flyrock that landed outside the blast area. Accidents happened not just to blasters but also to people guarding the blast area, contractors sitting in their trucks, miners waiting to go back to work, neighbors working in their own yards, and even to people driving on the highway.*** [emphasis added]
>
> *If you are a mile away or even only 500 yards away, you may be able to see flyrock coming but* ***it is too fast to avoid****. And if one piece of rock flies, there will likely be others with it.*

A case study of a flyrock incident presented in an April 2020 article of J. Inst. Eng. India Ser. D[6] addresses the comparative dangers of flyrock occasioned by blasting and identifies some of the underlying causes of flyrock:

> *In blasting operations, flyrock (uncontrolled flying fragment) is one of the main causes of accident. The other blasting impacts to the surroundings such as ground vibration, noise (air overpressure/air-blast), fumes and dust can hardly cause direct injury and fatality to human, although they may cause structural damage and nuisance to the nearby residential houses and habitats.*

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[1] Norouzi Masir et al., *Journal of Mining & Environment, Published online*, retrieved 2-May-20 http://jme.shahroodut.ac.ir/article_1666_85bf4cbae3cc897226cce579c31233b3.pdf.

[2] Fan L., Shen, w. and Li, Y. "The causes of flyrock and safety precautions in demolition blasting," *Engineering Blasting of China*" 8 (1): 35-38.

[3] Monjezi, M., Bahrami, A., Varjani, A.Y. and Sayadi, A.K. (2011). "Prediction and controlling of fly rock in blasting operations using artificial neural network." *Arab J Geosci"* 4; 421-425.

[4] H. Verakis and T. Lobb, "An Analysis of Blasting Accidents in Mining Operations," *International Society of Explosives Engineers*, 2003.

[5] "Toolbox Safety Talks: Blast Safety, http://www.cfins.com/wp-content/uploads/2019/01/blasting-safety-toolbox-complete.pdf.

[6] C. Sawmliana, Panchanan Hembram, R.K. Singh, S. Banerjee, P.K. Singh and P. Pal Roy, "An Investigation to Assess the Cause of Accident due to Flyrock in an Opencast Mine: A Case Study," *J. Inst. Eng. India Ser. D,* retrieved 12-May-2020 https://doi.org/10.1007/s40033-020-00215-4.

> ***The accident due to flyrock remains one of the major contributors of fatal and serious accidents in opencast mines. The 'Danger Zone' as given in Coal Mine Regulations [1] has already been increased from 300 to 500 m in the new Coal Mines Regulation [2] [Reg. 196 (2) (b)] to avert flyrock-related accidents in opencast coal mines.*** [emphasis added]
>
> *There are many reasons for flyrock causes and associated accidents during blasting in opencast mines. Overcharging of holes with explosive, less stemming length, improper stemming, less burden, undercut, overcut/break-back/end-back due to previous blasting, presence of loose material in the strata, cavities, improper initiation sequence among others are the common causes of flyrock in bench blasting. The reasons for accident due to flyrock also include failure to evacuate the area, failure to take shelter, failure to communicate, taking unsafe shelter, etc.*

According to Dr. Kiger, a now-retired Civil and Environmental Engineering professor at the University of Missouri, [7] flyrock is a significant concern to both quarry workers and nearby residents, as identified in his response to a proposed rezoning to permit a quarry:[8]

> *"Flyrock" is rock that is ejected from the blast site in a controlled explosion in mining operations. The term refers to rock that flies beyond the blast site, potentially causing injuries to people and damage to property. This is considered a significant issue in mining. Indeed,* ***between 1994 and 2005, 32 miners were injured by flyrock.[9] Flyrock can vary in mass from marble-sized to car-sized.*** [emphasis added]
>
> *At quarry blasting operations flyrock is a constant hazard not only to the workers at the quarry, but also to nearby homes and residents. Flyrock can be produced when the holes filled with explosive intersects a naturally occurring fracture or soft loose material in the rock being quarried. This fault in the rock provides a path for the shock wave generated by the detonation wave in the explosive to escape and propel a part of the surface rock into the air. The shock wave is moving at a very high speed so it can propel the flyrock great distances. Note that a shock wave is defined as a disturbance in the atmosphere moving at a speed greater than the speed of sound (1,100 feet per second at sea level).*
>
> *The shock wave will be very disturbing to anyone within one to two miles of the blast (there are more than 100 homes within 0.75 miles of the proposed quarry pits in Alvaton). The escaped shock wave might even crack windows in this area. The shock wave is very similar to the sonic boom generated by a jet airplane when it "breaks the sound barrier." I have reviewed the reports by two geologists provide[d] by the clients which state that preliminary geologic mapping suggests that there are pervasive schist interlayers within the granite body with pervasive intergranular fractures. As stated above, such fracturing increases the likelihood for blasting to produce flyrock at the proposed quarry.*
>
> *Another way these unwanted events of flyrock and/or blast shock waves often occur is when the drill hole encounters a void, or open crack at the depth of the explosive. The explosive material is*

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[7] Dr. Kiger is a nationally and internationally recognized expert in explosion effects and blast resistant structural design. He has authored or co-authored over 100 technical papers and reports, and is the principal author of the US Army Technical Manual "Fundamentals of Protective Construction", TM5-855. He previously chaired the American Society of Civil Engineers (ASCE) Technical Committee on Shock and Vibratory Effects; is a Past President of the WV Section of ASCE, and is a member of the National Research Council's Committee for Oversight and Assessment of Blast Effects and Related Research. In 1985, Dr. Kiger was recognized as the US Army Corps of Engineers Researcher of the year for his work in explosion resistant structural analysis and design; and in 2008, he was awarded a Lifetime Achievement Award in Shock and Vibration "for outstanding contributions and leadership in the community."

[8] Rezoning denied and upheld on appeal. https://flintriverkeeper.org/wp-content/uploads/2019/05/Randall_etal_v_Meriwether_County_etal_Final_Order.pdf.

[9] The National Institute for Occupational Safety and Health, *Mining Topic: Blasting and Explosives* (last accessed October 17, 2018), *available at* www.cdc.gov/niosh/topics/explosives.html.

most often in the form of slurry[10] *and is pumped into the blast hole. If there is a void or open crack too much explosive can collect and the resulting blast will blow out producing a shock wave into the atmosphere and, potentially, flyrock.*[11]

Predicted Versus Actual Flyrock Distance

In a case study of the July 15, 2015 flyrock incident at a construction site in Johor, Malaysia that propelled flyrock up to a distance of 200 metres killing one worker and injuring two others, it was determined that blast design was only 69% accurate in predicting flyrock distance.

In this study five empirical models are used to compare the incidents. It was found that none of the existing formulas could accurately predict flyrock distance. Analysis shows that the gap between predicted and actual flyrock distance can be reduced by including blast design and geological conditions in forecasts. Analysis revealed only 69% of accuracy could be achieved if blast design is the only parameter to be considered in flyrock projection and the rest is influenced by the geological condition.[12]

Repeated Quarry Blasting

In Miller Paving Ltd. v. McNab/Braeside (Township),[13] Dr. Kiger addressed the high probability of damage to neighbouring structures (homeowners' property) resulting from repeated blasting, even at low ground-vibration levels.

[10] "Slurry" is defined as "an explosive material containing substantial portion of a liquid, oxidizers, and fuel, plus a thickener, [p. 12]" according to Geotechnical Engineering Manual Gem-22, Revision #4, August 2015, https://www.dot.ny.gov/divisions/engineering/technical-services/technical-services-repository/GEM-22b.pdf.

[11] Dr. Sam Kiger, P.E., Professor Emeritus, Civil & Environmental Engineering, University of Missouri, "Proposed Granite Quarry in Alvaton, Meriwether County, GA," October 20, 2018.

[12] Edy Tonnizam Mohamad, Chang Shiang Yi, Bhatawdekar Murlidhar, Rosli Saad, "Abstact: Effect of Geological Sturcture on Flyrock Prediction in Construction Blasting," *Geotechnical and Geological Engineering*, Issue 4/2018.

[13] *Miller Paving Ltd. v. McNab/Braeside (Township),* PL130785, OMB, October 27, 2015 http://www.omb.gov.on.ca/e-decisions/pl130785-Oct-27-2015.pdf.

[Quarry blasting is done by drilling blast holes behind the working face of the quarried material to blast it loose for harvesting. The hole size, spacing, and amount of explosive are designed by an experienced blaster. The explosive most often used is ANFO (Ammonium Nitrate and Fuel Oil). When the explosive is detonated a detonation wave moves through the explosive at a speed of about 18,000 feet per second changing the solid material to a gas at a very high rate. This detonation wave and rapidly expanding gas will create a cavity, crushing, cracking and moving the surrounding material. It will also introduce 2 types of waves into the earth around the explosion. First a surface, or Rayleigh wave, that will damp out and disappear in a relatively short distance. And second a body wave that will travel great distances in the bedrock (under any barrier). It is this body wave that will move through the bedrock and cause the earth above the bedrock to vibrate and shake homes, even at large distances from the explosions. ***There is no way to mitigate or block the movement of these body waves.]*** *[evidence presented by Dr. Kiger in connection with an Application for Rezoning and Special Use Permit for a proposed Granite Quarry in Alvaton, Meriwether County, GA]*[14] [emphasis added]

In the…1980 report [prepared for the US Bureau of Mines] by Siskind et al,[15] *the authors establish 0.5 in/sec (12.7 mm/s) as the "threshold" for damage to structures, and they define "threshold" as a 5% probability of cosmetic damage. The probability of damage to a home may be relatively small in any single blasting event. However, numerous opportunities for an unlikely occurrence (like damage to the home) will result in a very likely occurrence of damage. For example, if the probability of damage (P_d) in any single blasting event is 0.05, or 5 percent, then the probability of not being damaged (P_u) is 95 percent. One can use the probability law of independent events to calculate the probability of damage occurring at least once in 100 events….[F]or example see… "Introduction to Probability and Statistics" Third Edition, 1964, by Henry L Alder and Edward B Roessler; published by W.H. Freeman and Company. Thus, assuming the probability of damage is the same for each event, 0.05, then the probability of not being damaged at least once in 100 events is:*

$$P_{u\text{-}100} = (0.95)^{100} = 0.006$$

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[14] On October 23 2018, the Meriwether County Board of Commissioners (CBC) denied the request to rezone the property and grant a special use permit for a blasting quarry. The appeal of the CBC ruling to deny the rezoning was upheld by the Superior Court in *Luther H. Randall, lll, et al., v. Meriwether County, Georgia, et al.* File No. 18CV0270 [May 1, 2019]. In upholding the decision of the Board of Commissioners, the Superior Court made a number of observations, including the following: "The proposed zoning for use as a granite quarry [is] unsuitable in view of the many residences within .75 miles [1,207 metres] of the proposed quarry pits….The applicant failed to reliably demonstrate that the proposed zoning as a granite quarry will not adversely affect the existing use or usability of the adjacent and nearby residential property owners. Evidence from experts (real estate appraiser, geologists, noise control engineer, blasting expert) indicated that: (a) the applicants did not reliably demonstrate that the proposed quarry will not decrease the value of adjacent residential properties; (b) there is a potential for negative impacts to drinking water wells in the area of the property; (c) the application provided no details on how surface water will be reliably collected and properly concentrated to enter the quarry holes; (d) the applicant's noise study is not reliable and underestimates sound emission by more than 20 dB in several cases; (e) blasting at the quarry has a high likelihood of damaging many of the more than 100 residential structures within one to two miles of the proposed granite pits over the life of the proposed operation and will significantly degrade the quality of life for those residents affected; and, (f) the application has no information on how the quarry operation will be reclaimed when its reserves are exhausted….The proposed use will generate additional traffic, noise, blasting, dust, and other operational processes not consistent with the surrounding properties or the Low Density Residential Zoning [p. 9-11]." https://flintriverkeeper.org/wp-content/uploads/2019/05/Randall_etal_v_Meriwether_County_etal_Final_Order.pdf.

[15] D.E. Siskind, M.S. Stagg, J.W. Kopp, and C.H. Dowding, "Report of Investigations 8507: Structure Response and Damage Produced by Ground Vibration From Surface Mine Blasting," (1980), prepared for US Bureau of Mines. Online at http://www.osmre.gov/resources/blasting/docs/USBM/RI8507BlastingVibration1989.pdf [RI 8507].

> *And the probability of the structure being damaged in 100 explosions is 1 minus the probability that it is not damaged, thus:*
>
> $$P_{d\text{-}100} = 1 - 0.006 = 0.994$$
>
> *This implies that the probability of damage in 100 events is about 99 percent, meaning damage is almost certain if the homes are subjected to these blast induced ground vibrations numerous times. Thus, even though damage is unlikely to result from any single blasting event, some damage in the form of cracking of walls, ceiling, tile, concrete, nail popping, loosening of framing joints, etc. becomes very likely over time with numerous repetitions of blast-induced ground vibrations. And once damage occurs (like cracking, nails pops, or framing joints loosening) that damage will rapidly increase with repeated exposure to the vibrations, even at lower levels of vibrations.*
>
> *In recognition of the fact that damage to residential homes can occur even at low ground-vibration levels, other countries have set much more stringent limits on allowable peak ground vibrations….[R]egulatory agencies in Leicestershire County, UK have established the upper limit on allowable peak particle velocity as 0.24 in/sec (6.096 mm/sec); in Australia the common limit is 0.2 in/sec (5.08 mm/sec) and it is 0.001 in/sec (0.00254 mm/sec) for historical buildings and monuments for frequencies less than 15 Hz [hertz].*

Janet Bradley, legal counsel for the Township of McNab-Braeside, argued that buffers (setbacks) are often the only effective means of eliminating adverse effects between incompatible land uses. Bradley prevailed in advancing the Township's position that the buffers be provided within the boundary limits of the ownership or control of the landowner needing the buffers (i.e., *Miller Paving*, the quarry operator).

> *Often distance is the only effective way to mitigate the [adverse] effects of industry on its neighbours….Bradley contended buffers should be on the properties of the parties needing it for their operations (not extending into people's back yards)…*[p. 4].[16]

A private for-profit company such as a quarry operator does not possess a legal right to externalize buffer (setback) requirements that diminish the utility and value of neighbouring properties, the owners of which do not participate in the anticipated profits from the quarry operation or receive any financial compensation.

In *Fontaina Scott v. Mountaineer Grading Co.,*[17] Dr. Kiger explained the *dimensional changes* homes undergo daily and seasonally, and how they can be magnified or exacerbated by subsequent blast induced vibrations.

> *All homes undergo daily and seasonal changes due to things like humidity variations and changing temperatures, like the sun moving from one side of the home to the other (the warm side will expand relative to the cooler side); or seasonal variations of temperature and humidity. For example[,] most of us have experienced a 'sticking door' or a door that will not close (or easily open) during certain times of the year. These environmental effects will cause strains in the walls, ceilings, structural framing, tile covered surfaces,…etc. These strains are know[n] by engineers as prestrains, that is strains that exist before an[] event like a blast induced ground vibration. The prestrain condition may be such that a very small vibration will push the item, like a wall panel, a framing connection, or piece of tile, over its strain limit and result in a crack or loosening of a structural frame connection. Once a crack is initiated the crack will grow at a much lower level of vibrations than was required to initiate the crack. This is because of the stress concentration that exist at the crack tip; envision for example a small crack in an automobile windshield where even a*

[16] "Quarry expansion, but no asphalt plant in Braeside: Opponent," Arnprior Chronicle, March 25, 2015, https://issuu.com/arnpriorchronicleguide/docs/arnprior032615.

[17] *Fontaina Scott v. Mountainer Grading Co.*, Putnam Co. Civ. Act. No. 09-C-286.

small bump from ones hand can cause the crack to grow. Thus, even low levels of repeated occurrences of blast induced ground vibrations can cause significant damage to a home over time. For example[,] the German vibration standard is 0.16 ips [inches per second] for buildings with visible damage and cracks in masonry. See for example Table 1 in "Vibration Criteria for Historic and Sensitive Buildings" by Konon and Schuring.[18]

The fact that these prestrain conditions can produce a condition in the home such that damage to a home will occur at even very low levels of vibrations is acknowledged in BOM [Bureau of Mines] RI 8507[19] *in their Conclusion 7 of page 68; Conclusion 7 is pasted below. This conclusion agreed to by the 4 experts that authored RI 8507, clearly states that "…**there may be no absolute minimum vibration threshold**…"; that is, when inevitable prestrain conditions are present in a home, any blast induced ground vibrations might cause damage to the home.*

> **7. All homes eventually crack because of a variety of environmental stresses, including humidity and temperature changes, settlement from consolidation and variations in ground moisture, wind, and even water absorption from tree roots. Consequently, there may be no absolute minimum vibration damage threshold when the vibration (from any cause, for instance slamming a door) could in some case precipitate a crack about to occur.**

In Bureau of Mines RI 8507 they suggest a maximum allowable ground vibration peak particle velocity of 0.5 inches per second (ips) at which there is a 0.5 percent probability of damage. However, the standards in many countries are much lower….[R]egulatory agencies in Leicestershire County, UK have established the upper limit on allowable peak particle velocity (ppv) as 0.24 ips; in Australia the common limit is 0.2 ips and it is 0.001 for historical buildings and monuments for frequencies less than 15 Hz. Note that frequencies less than 15 Hz are very likely in blast induced ground vibrations of large distances from the blasts. The Australian standard for historical buildings of 0.2 mm/sec (0.001 ips) implies that if a building is really important the allowable vibrations to prevent damage is extremely low. Therefore, standards in reality represent an economic decision. Since at almost any vibration level some homes might be damaged, but for the mine to operate at an economic level, some probability of damage is tolerated. The level of 0.5 ips widely adopted in the US is far greater than the standards adopted in other countries. [see Table 2, R. Pesch and A. Robertson, "Drilling and Blasting for Underground Space", Wollongong, NSW, 3-4, September 2007.]

The size of the blast induced ground vibration waves shaking the homes are large in comparison to the footprint dimensions of a typical home. The length of the ground vibration wave train is the duration of the blast induced vibration shaking at the homes, typically about 3 to 4 sec, times the speed of the ground wave, typically about 800 ft per sec. Thus, for a typical blasting event with multiple individual explosions the ground vibration wave train is about 3,000 ft long. These ground vibrations at long distances, i.e. more than 1,000 ft, have a dominate frequency of the ground vibration equal to about 8 or 10 Hz (cycles per sec); for a frequency of 10Hz a single cycle of the ground shaking is 80 ft in length (one cycle is up down and back up) so that the leading edge of the home is picked up then pulled down while the back of the home is being picked up; this up and down of the front and then back of the house occurs repeatedly for the full 3 to 4 second duration of the ground vibration; in this example that would be about 30 to 40 complete cycles (10 cycles per second for 3 or 4 seconds). When these repeated distortions of the house matches the natural frequency of the house, the motions will be amplified and damage to the house will be significantly increased.

In 2016, Dr. Kiger was contacted by a reporter in connection with an article about a family's 10-year exposure to the adverse effects endured as a consequence of blasting at a nearby surface coal mine in Appalachia, and the homeowners' failed attempts to hold the coal mine

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[18] Konon and Schuring, "Vibration Criteria for Historic and Sensitive Older Buildings" ASCE Preprint 83-501; American Society of Civil Engineers (ASCE), Houston, Texas, October 17-19, 1983.

[19] US Bureau of Mines RI 8507, *"Structural Response and Damage Produced by GroundVibration From Surface Mine Blasting"*, 1980.

operator accountable for the damages to their home.[20] The coal mine operator contends that all blasts are conducted within regulatory limits and, therefore, the blasting cannot cause structural damage, despite the apparent damage to the homeowners' residence (persistent drywall cracks in nearly every room, windows and doors out of alignment, and slanting of the floor toward the centre of the home, where the dining room floor has settled lower than the hallway floor). According to Dr. Kiger, the regulatory blasting standards are based primarily on a 1989 study of new residential structures in Indiana, which are not representative of the older homes typical in Appalachia:

> *"These more fragile homes [in Appalachia] are much more susceptible to damage from blasting-induced ground vibrations," he wrote. "In many other countries, the experts established a much lower threshold for damage."*
>
> *In a 2010 report prepared for a court case involving blast complaints in Mingo County, W.Va., Kiger compared the blasting limits from the Indiana study to Australian standards for historical buildings, which designate a vibration level 500 times lower than the acceptable level for surface mine blasts in the United States. "Therefore, standards really represent an economic decision," Kiger stated in the report.*

Homeowners Awarded Damages Caused by Vibrations and Shockwaves from Blasting

In *Cann v. Carl B. Potter Ltd.*,[21] blasting in bedrock to a depth of 50 to 60 feet in 1975 for the construction of a public highway and installation of sanitary and storm sewers, and water lines caused damage to a dwelling about 600 feet (183 metres) to 700 feet (213 metres) away. "[A]s a result of escaping *vibrations* and *shock waves*, the plaintiffs' property was damaged and the plaintiffs suffered injury, loss and damage." The dwelling, built on bedrock with a thin cover of soil, was constructed in 1959, with a rear addition constructed in 1962. Before the property was purchased in 1972, the homeowners conducted a thorough inspection of the dwelling looking for defects*, noting only a hairline crack of two to three inches on a living room plaster wall.*

No pre-blast report was ever made of the Cann residence by the blasting company. At first the Canns felt light tremors, but as the blasting got closer to the dwelling the tremors became more pronounced. According to the Canns, after the blasting in 1975 "the house was shaken up and…cracks in the plaster [appeared] at various places in the house." The Canns kept records of the time when the sound of blasting was heard and the noticeable effects to the dwelling. The effects on the dwelling were documented by Mr. Cann, and confirmed by a neighbour:

> *[P]laster dust fell from the plastered walls and pictures moved on the walls and fell from the walls. He gave these records to one, Kaiser, who was an adjuster acting for his insurance company, and these records were never returned….After he found that the first record had been lost, he kept later records…A neighbour…kept records of blasting times and dates and of the severity of tremors felt by her.*
>
> *Mr. Cann produced Exhibit 2, indicating the location of the various cracks in the plastered walls of the house and…where there were cracks in the foundation wall and in the fireplace and in the*

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[20] Molly Moore, "Blasted: Homeowners near mine seek recourse for property damage," *The Appalachian Voice*, February 18, 2016, https://appvoices.org/2016/02/18/blasting-homeowners-property-damage-coal/.
[21] *Cann v. Carl B. Potter Ltd.*, 1980 CarswellNS 292, 42 N.S.R. (2d) 682, 77 A.P.R. 682.

> *chimney, and the concrete base of the chimney. He found water was entering the basement from the outside.*

In his evidence on behalf of the homeowners,

> *Dr. Potyondy [professional engineer] particularly stressed the relative displacement of the two sections of the cracked foundation wall. This indicated to him that the wall was subject to a lateral force and that blasting nearby probably caused this movement. He also expressed the opinion that the damage to the chimney and fireplace was consistent with damage caused by blasting nearby.*

The homeowners' other expert, Mr. Yurkew, also a professional engineer, in his April 9, 1976 report,

> *[described] the cracks which he saw throughout the house and the way in which the mantelpiece had pulled away from the south wall of the house…[and] the cracks in the brickwork of the fireplace chimney. He…concluded that any movements which were evident at the time of his inspection must…be the result of extraneous forces.*

Mr. Yurkew prepared a second report on March 10, 1980, pursuant to a follow-up visit and inspection of the house. After being assured in March 1980 that the house was built on bedrock, while maintaining the opinion that the damage observed was caused by lateral force from blasting, Mr. Yurkew abandoned,

> *the theory put forward in his report of April 9, 1976, with regard to densification of the soil and settlement of the foundations…[para. 29].*

Mr. Jacques' company was retained to conduct a pre-blast survey, and it was determined that the pre-blast survey should stop at 500 feet, which excluded the Cann house some 600 feet distant, putting budgeting constraints (economic considerations) of a private company before the safety and well-being of the public.

> *Mr. Jacques' firm was retained by the Public Service Commission, and the City of Halifax, had regard to the possible areas in which houses could be damaged by blasting operations and gave consideration to matters of cost. I take this to mean that there were some budget constraints which determined that the pre-blast survey should stop at the 500 ft. distance and that, if one had regard only to the possibility of damage from blasting, one would extend the area beyond the 500 ft. and would probably include the Cann house at a distance of 600 ft [para. 34].*

Rejecting the evidence presented on behalf of the defendant and ruling in favour of the homeowners, the trial court judge said:

> *It has been established to my satisfaction, by a preponderance of evidence, that the damage complained of by the plaintiffs occurred during the period when the defendant company was carrying on its blasting operations in the vicinity of the Cann house and ceased when those blasting operations ceased. In view of that finding, I cannot accept the opinion of the witness, J.W. Cowie, that the damage was caused by humidity changes and thermal changes in the house. If his opinion were correct, one would expect not only that some of the damage complained of would have occurred long before October, 1975, as he said it did, but also that such changes would continue to occur after April, 1976, and there is no evidence that this, in fact, happened [para. 51].*

The trial court also found the defendant liable without negligence having to be proved, stating,

> *the defendant company is liable to the plaintiffs without the necessity of proving negligence on the part of the defendant company. The defendant company was in occupation of the construction site at Kearney Lake Road and Dunbrack Street and conducted blasting operations thereon by the use of explosives, causing vibrations to escape from the site, which vibrations caused the damage complained of by the plaintiffs at their residence [para. 57].*

The homeowners were entitled to recover damages basing their cause of action on nuisance or on *Rylands v. Fletcher* (1868), L.R. 3 H.L.333 (para. 59). The trial court's ruling was upheld by the Nova Scotia Court of Appeal.[22]

Homeowner Awarded Damages Caused By Blasting Operations

In *Jones v. Consolidation Coal Co.,*[23] the appeals court upheld the trial court's judgment awarding the homeowners $14,850 in property damages incurred as a result of the defendant's blasting at a distance of 2,000 feet (610 metres) from the home.

> *At trial, plaintiffs, Ronald and Shirley Jones, testified that they bought their home, outbuildings, and 20 acres near Sparta, Illinois, from Shirley's mother over 20 years ago. They paid $17,000 for the two-story house, a barn, two machine sheds, two small sheds, and the acreage. Plaintiffs remodeled and added to the house after they purchased it.*
>
> *They experienced no damage to their home prior to 1978. In the early summer and fall of 1978, defendant conducted blasting operations at its Burning Star No. 3 Mine, approximately one-fourth mile from plaintiffs' residence. Plaintiffs testified that they felt strong vibrations from the periodic blasting at the mine. They began to notice damage to their residence and outbuildings after the blasting. The damage included: cracking plaster and fireplace, separation of paneling and a kitchen counter top from the wall, sagging kitchen floor, and water damage. In addition, they noticed cracking in the concrete floors of their garage and barn. Plaintiffs contacted defendant and their insurance agent about the damage. They asked Roy McKinley, a local contractor, to give them an estimate of the cost of repair. Plaintiffs effected some repairs to their residence prior to trial.*
>
> *Clarence Clasen, plaintiffs' insurance agent, testified that he had been in plaintiffs' residence several times between 1971 and 1978. Prior to 1978, he did not notice significant cracking or water damage. He visited the Jones residence during or shortly after 1978 and observed cracking at various locations throughout the home and separation of the kitchen cabinet from the wall. He also noticed cracking of the masonry in a milkhouse attached to plaintiffs' barn.*
>
> *Plaintiffs' neighbor, Larry Phelps, testified that he had been to plaintiffs' residence prior to and after the damage to the residence. He observed no damage prior to 1978; however, after 1978 he noticed cracking plaster and separation of the kitchen cabinet from the wall.*
>
> *Clarence Welty testified that he lived approximately 2 1/2 miles east of plaintiffs' house. During the summer of 1978, he felt vibrations from the blasts at defendant's mine and noticed cracks forming in his house.*
>
> *Roy McKinley, a retired carpenter, testified that he had bid hundreds of repair jobs during the period of time that he worked as an independent contractor. In November of 1978, he gave plaintiffs an itemized estimate…of the cost of repair work for their residence. The written estimate of $16,350 was later admitted as evidence and included $4,500 for tearing up the cracked concrete floor in plaintiffs' garage and replacing it with a new floor. McKinley acknowledged that the cost of replacing the floor was "expensive" and that he had, in the past, used caulk to fill cracks in "outside concrete." He stated that a car could probably be parked on the concrete, but driving a car in and out of a*

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[22] *Cann v. Carl B. Potter Ltd.*, 1980 CarswellNS 291, 42 N.S.R. (2d) 681, 77 A.P.R. 681.

[23] *Jones v. Consolidation Coal Co.*, 174 Ill. App.3d 38 (1988) 528 N.E.2d 33, https://scholar.google.com/scholar_case?case=4697769657346115593&q=%22ground+vibration%22&hl=en&scisbd=2&as_sdt=2006.

garage with a cracked floor would eventually result in more extensive cracking. McKinley stated that the concrete would eventually "break up" and it would have to be replaced.

The three issues (unsuccessfully) argued by the defendant on appeal were

1) That the court erred in awarding damages based on the cost of repair where repairs were made and on no evidence of actual cost of repair was introduced
2) That the cost of removing and replacing the plaintiff's cracked concrete garage floor entails an unreasonable destruction of the structure and results in cost to defendant disproportionate to the benefit to the plaintiffs
3) That the judgment was against the manifest weight of the evidence

In respect of issue 1) the appeals court dismissed the defendant's argument in part because there was no proof of the existence of a repair bill. As for issue 2), it was argued by the defendant based on the testimony of their appraiser, Thomas Rheinecker. Rheinecker testified,

that the plaintiff's outbuildings were worth nothing, hence the decrease in value was less than the cost of repair….Rheinecker…[also testified] that effecting the repairs sought would only increase the value of the property $3,000 to $4,000.

The court rejected the appraiser's testimony as to the value of the outbuildings characterizing the testimony "as inherently improbable and unworthy of belief." The court also was not convinced that "an injured homeowner should be relegated to a diminution in value standard where structures are damaged," while citing the following in support of its position:

In Myers v. Arnold (1980), 83 Ill. App.3d 1, 403 N.E.2d 316, the court noted that the diminution in value rule may be inadequate and unfair in some instances. The court stated:

> "Allowing a plaintiff to recover the lesser of the cost of repair or the diminution in market value may be appropriate where the interest which has been harmed is purely financial, as where the land was purchased as a business investment with an eye towards speculation or where it is held solely for production of income. However, the same measure of damages may be painfully inadequate when the land is held for a personal use such as a family residence and the harm may be corrected with a reasonable expenditure even though the expenditure exceeds the amount the land has diminished in value. In the latter case**, the full repair cost will come much closer to restoring what was actually lost and will not require the injured party to correct the harm with funds from his own pocket**." Myers, 83 Ill. App.3d at 7, 403 N.E.2d at 321. [emphasis added]

The Restatement (Second) of Torts would go even further. The comments to section 929 indicate that

> "if a building such as a homestead is used for a purpose personal to the owner, the damages ordinarily include an amount for repairs, even though this might be greater than the entire value of the building. So, when a garden has been maintained in a city in connection with a dwelling house, the owner is entitled to recover the expense of putting the garden in its original condition even though the market value of the premises has not been decreased by the defendant's invasion." (Restatement (Second) of Torts § 929, comment b (1979).)

On issue 3) the defendant's ground vibration and structural response expert referenced "peak particle velocity" (PPV) as a standard formula that measures the intensity of vibration and movement, and concluded that the damage sustained by the homeowners was not the result of the defendant's blasting operation:

> *Clark cited studies for the proposition that, as PPV approaches two inches per second [ips], there is a 6% probability of failure in dry wall and plaster. According to defendant's records, PPV never rose above 1.1 [inches per second] during the relevant time frame. At the time, government regulations required restriction of PPV readings to under 2.0 [ips]. The regulation has since been changed to 1.0 [ips]. Clark inspected the damage to plaintiffs' property and concluded that it could not have been caused by blasting. In his opinion, the damages were caused by construction defects, natural causes, and aging.*

Raymond Taucher, an administrative assistant for the defendant in 1978, testified that he had inspected the reported homeowners' damage after the 1978 blast,

> *but did not believe it was the result of blasting. Taucher testified that the closest point, the defendant' mining operation was 2,000 feet [610 metres] from the plaintiffs' residence.*

The appeals court was not persuaded by Clark's expert testimony or the argument that mere "temporal proximity" is insufficient to establish a cause and effect relationship.

> *…[T]he testimony of an expert must be judged by the same rules of weight and credibility applicable to other witnesses. (Presswood v. Morris (1979), 70 Ill. App.3d 513, 388 N.E.2d 844.)… [N]o particular significance [is attached] to the fact that defendant produced an expert witness while plaintiffs presented only lay witnesses. As for defendant's claim that mere "temporal proximity" of blasting and damage is insufficient to establish a cause and effect relationship, we find this argument to be without merit given the evidence presented in this case.*
>
> *In Arras v. Columbia Quarry Co. (1977), 52 Ill. App.3d 560, 367 N.E.2d 580, this court held evidence similar to that in the case at bar relevant and admissible to establish a cause and effect relationship. In Arras, plaintiffs' neighbor, Anna Dugar, testified that the water in her well disappeared after the explosion in defendant's quarry, just as water in plaintiffs' well had disappeared. This court held that the alleged effect of the same blast on other wells in the vicinity would be admissible. The only relevancy the Dugan testimony had was to prove that defendant's blasting damaged plaintiffs' well. As in Arras, Clarence Welty testified that he experienced cracking in his home during the period of blasting, just as cracks had formed in plaintiffs' home. We hold that the lay testimony presented by the plaintiffs was sufficient to establish a causal connection between the blasting and the damage to plaintiffs' residence. This court cannot substitute its opinion for the finding of the trier of fact unless its holding is against the manifest weight of the evidence. (Scheduling Corp. of America v. Massello (1987), 151 Ill. App.3d 565, 503 N.E.2d 806.) We cannot say that an opposite conclusion is clearly evident in the case at bar.*

Homeowners Allowed to Pursue Claim Against Blasting Quarry for Trespass and Mental Anguish

In *Dockins v. Drummond Co., Inc.*,[24] the homeowners claimed that Drummond, the quarry operator, engaged in repeated blasting within 1,500 feet (457 metres) that damaged their home and caused them to suffer mental anguish. Summary judgment of the trial court in favour of the quarry operator on the claims of "wantonness," as related to trespass, and mental anguish were reversed on appeal.

> *The Dockinses presented evidence that Drummond had blasted within 1,500 feet of their home. The Dockinses testified that they repeatedly contacted Drummond (12 to 14 times) to complain about the blasting and the damage to their home. The Dockinses also presented evidence that Drummond had received from the Surface Mining Commission two notifications of violations for*

[24] *Dockins v. Drummond Co., Inc.*, 706 So. 2d 1235 (Ala. Civ. App. 1997), https://scholar.google.ca/scholar_case?case=17391733386660306567&q=Dockins+v+Drummond&hl=en&as_sdt=2006.

"exceeding air blast limits" during the blasting at issue. "Wantonness in the context of a claim for trespass is an invasion of the plaintiff's property with knowledge of the violation of the plaintiff's rights in his or her property." [citations omitted]

Therefore, we conclude that the Dockinses presented substantial evidence in support of their claim that Drummond had wantonly continued its blasting operations. The summary judgment is reversed insofar as it relates to the wantonness claim.

The Dockinses next argue that the trial court improperly entered summary judgment on their claim for damages for mental anguish. Drummond argues that mental anguish damages are not recoverable in an action alleging damage resulting from blasting, absent a physical injury. The Dockinses concede that they were not physically injured by the blasting; however, they argue that a physical injury is not required in order to recover mental anguish damages in a blasting case.

Our supreme court has held that damages for mental anguish are allowed in an action alleging "culpable tortious conduct," regardless of the absence of a physical injury. Taylor v. Baptist Medical Center, Inc., 400 So.2d 369, 374 (Ala.1981)….Our supreme court has further held that, "[i]n order to recover damages for mental distress where the tort results in mere injury to property, the trespass to property must be committed under circumstances of insult or contumely." Harris v. Birmingham Hide & Tallow Co., 589 So.2d 150, 151 (Ala.1991). The Dockinses allege that Drummond continued its blasting with knowledge that it was causing damage to the Dockinses' property. Therefore, we conclude that the Dockinses are entitled to submit to the jury their claim for mental anguish damages, if they present substantial evidence that they suffered mental anguish caused by the blasting.

Homeowners Unable to Sell Homes at Full Value Due to Blasting at Nearby Quarry[25]

Residents of the Grandview, a neighborhood of 22 homes located roughly 750 feet (229 metres) to 1,700 feet (518 metres) from McGee's West River Road quarry operation, have complained blasting at the quarry has damaged their homes, reduced their property value and disrupted their lives. In July 2017, Cheri and Pietro Nicolosi, who live near the quarry, filed a law suit claiming that blasting at the quarry damaged their home, caused problems with their water and caused them emotional distress. The law suit names the City of Augusta, McGee Construction and Maine Drilling and Blasting, the firm which blasts rock for McGee, and seeks compensation for damages and to have McGee's permit to blast and extract rock at the quarry site revoked.[26]

Grandview neighborhood residents said blasting at a quarry operation [of McGee Construction on West River Road] in a pit adjacent to their neighborhood has made it impossible to sell their homes at their full value and caused cracks in their homes' floors and walls, and it makes them anxious before and angry after blasts that can occur up to 10 times a year. [emphasis added]

They asked the city, as they have before, to take action to protect their neighborhood. Councilors are considering a proposal to reduce the size of blasts in quarries in the city. [emphasis added]

Roland Maheux, who lives with his wife, Anna, on Edwards Street, about 760 feet [232 metres] from the blasting area of the McGee Construction-owned pit off West River Road, described a Sept. 29 blast as violent and said he literally could see the walls of his home moving and could feel shaking throughout the home. He said his home has evidence of

[25] Keith Edwards, "Augusta quarry's neighbors attribute house damage to blasting," November 17, 2016, https://webcache.googleusercontent.com/search?q=cache:afY3Ta1nC4EJ:https://www.centralmaine.com/2016/11/17/augusta-quarrys-neighbors-attribute-house-damage-to-blasting/+&cd=1&hl=en&ct=clnk&gl=ca.
[26] https://cqrcengage.com/asce/app/document/23793269;jsessionid=1rflrikl9uox31kihxpvi8mg7l.

structural fatigue including cracks in walls and floors, and steps that are slowly creeping farther away from his home. He said he thinks at least some of that damage "is a result of the pounding my house has taken (from blasting in the quarry) over the last 14 years." [Over 14 years there have been 140 blasts at the McGee Construction quarry] [emphasis added]

He said he gets anxious before every blast. And he said when a violent blast happens, he reacts so strongly to the potential damage to his home that he used to go outside after some of them and yell and scream. [emphasis added]

Other neighborhood residents said they also think cracks and other damage to their homes has been caused by blasting at the pit. [emphasis added]

Patrick Street resident Gary Leighton said he and his wife have tried twice over the last six years to sell their home but have been unable to do so. He said he thinks the blasting, as well as publicity and the resulting stigma attached to it, has hurt their ability to sell their home, even though it is beautiful home with a big yard and good neighbors. [emphasis added]

"Our hope is that a resolution can finally be reached so those of us who want to sell can do so, and those who want to remain can enjoy our neighborhood," Leighton said. [emphasis added]

Last week councilors heard a presentation from the technical supervisor for Gardiner-based Maine Drilling and Blasting, the firm contracted to blast rock in a quarry owned by McGee Construction off West River Road in Augusta. He spoke about blasting and when it does and does not present a potential danger to property.

City officials are considering proposed changes to the city blasting ordinance that would reduce the standards for allowable blasts in quarries in Augusta to just 15 percent of the city's current standards, which are already tighter than state blasting standards. Blasting and construction company officials said last week that standard would be so low it wouldn't be economically feasible to continue blasting rock for construction projects. [emphasis added]

Industry representatives said last week they would work with the city staff to come up with a potentially new standard as a compromise that would reduce the vibrations coming from blasts but still allow the companies to operate their quarries.

Matt Nazar, development director for the city, said that has not yet happened….

…Lou Craig, a Grandview resident, said he believes blasting at the McGee pit has damaged his home, including causing a massive horizontal break he said will cost him thousands of dollars to fix.

He said he's filed a claim with Maine Drilling and Blasting over the damage….

City Manager William Bridgeo said the city is working with an independent expert to have the presentation made by Smith, and other information presented to the city, analyzed. He said councilors would discuss those findings at a future meeting, likely Dec. 8….

The proposal for tighter rules was made in response both to ongoing complaints from residents of the Grandview neighborhood and to a city official describing a blast he observed from inside a home as startling and alarming. The Grandview neighborhood is next to a McGee Construction-owned pit and quarry operation that blasts rock up to 10 times a year off West River Road. Nazar has attended roughly 40 blasts at quarry operations, mostly in the McGee pit, over the last 10 years. During a recent blast, Nazar was in the home of Maheux, and he said the blast was "startling" and felt much more significant than blasts of similar size he observed outside. [emphasis added]

Smith said that blast was not damaging to buildings despite what Nazar felt. He said it is a natural human reaction to be surprised by blasts. Nazar said that blast and the other blasts he's observed at the West River Road pit this year were well below allowable standards for ground vibration contained in the city's blasting ordinance. He said data indicated the blast was only 20 percent to

25 percent of the maximum allowable blast. So if the city wants to address neighbors' concerns by reducing the blasts' impact, the city's allowable standards would have to be lowered dramatically.

Disputes between the pit owner and neighbors about the effect of blasting there go back many years, and the city's current mining and blasting rules were formed after a lengthy process involving multiple interested parties.

Homeowners Near Quarry Forced to Sell Their Homes at a Loss

The noise, dust and dirt from a nearby quarry in Estey's Bridge, New Brunswick, have forced homeowners to resell their homes for less than they paid, as reported in a May 28, 2019, CBC news release.[27] The Royal Road quarry operated by Mira Construction Limited opened in December 2014. About 40 homes are affected by the Mira Quarry, and about 100 trucks are in the area each day. "There's so much dust, dirt and noise that you cannot be outside", and "you've…lost total enjoyment of your property."[28]

PA's Rick DeSaulniers threatens to oppose budget if nothing is done about truck traffic at Estey's Bridge.

The uncertainty and instability of a minority government is working out just fine for a group of rural residents near Fredericton who are upset about noise and dust from a quarry close to their homes.

They say the pivotal role of their MLA, Rick DeSaulniers of the People's Alliance, has finally got them some attention from the provincial government after almost five years.

"This is the first time that an MLA has really gone to bat for us," says Gerry McQuinn, an Estey's Bridge resident who says his property is plagued by noise and dust from the quarry just across the Nashwaaksis Stream.

"We needed somebody to step up and be forceful for the government to look at it," McQuinn said as the rumble of trucks echoed across his backyard. "So I guess it worked."

Last month, DeSaulniers threatened to vote against the Progressive Conservative government's budget estimates for the Department of Environment and Local Government.

That got him a meeting with Premier Blaine Higgs and, according to the department, stepped-up monitoring of the quarry owned by Mira Construction Ltd.

"I have a significant amount of clout," said DeSaulniers. "I took a calculated risk. … Obviously, the position I'm in there has caused the government to pay attention."

Judith Seymour, the chair of the Estey's Bridge local service district, says she's not optimistic the situation will get better, but at least the first-term Alliance MLA has the government's attention.

"Rick's got us a meeting with the minister and a meeting with the premier, which is something the local service district couldn't get in five years. We couldn't even get an answer to a letter."

The quarry was approved without an environmental impact assessment by the Progressive Conservative government of David Alward just before the 2014 election. [emphasis added]

It's across from the stream behind McQuinn's property. Trucks driving in and out of the quarry cross a small bridge built over the stream, leading to dirt and debris falling through the open bed into the waterway. [emphasis added]

McQuinn and other residents have catalogued at-risk species, including salmon parr, wood turtles and butternut trees. He said the trucks also make noise from early in the morning until the evening, and dust regularly settles on his property. [emphasis added]

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[27] Jacques Poitras, "Quarry opponents finally get government's ear when MLA flexes 3rd-party muscle," https://www.cbc.ca/news/canada/new-brunswick/minority-government-quarry-dust-rural-new-brunswick-1.5152489.

[28] https://www.cbc.ca/news/canada/new-brunswick/esteys-bridge-quarry-1.4381771.

People in the area who have sold their homes have been forced to accept resale prices lower than what they originally paid, he said. [emphasis added]

"It's very taxing on us. It's very demoralizing that somebody won't help us out."

The previous Liberal government turned down another company's proposal for a second quarry in the area in 2017, but Environment Minister Jeff Carr said in the legislature last month it's impossible to undo Mira's approval.

"Will we ever be able to eliminate the situation? I don't see it happening, to be honest."

No one from Mira Construction responded to a CBC News request for an interview….

"I care a great deal about what's going on with these people, their health, their well-being, the frustration and the stress," he said. "Five, six years of this is too much. It's gone on too long. These folks need to get some kind of justice."…. [emphasis added]

After trying to get a meeting with Higgs on the issue, since Christmas, DeSaulniers warned Carr in an April 17 committee session that "if we don't get some action … then I may very well vote against this budget for this department."

Carr responded that his department would "ratchet up and turn the screw on the approval to operate" and if the company didn't follow the conditions of that approval, "we will shut them down." He also asked for the research that local residents had done. [emphasis added]

Defeating departmental estimates would not have triggered an election but would have bogged down the legislative process and embarrassed the Tories.

"It was a calculated risk I took and it worked," DeSaulniers said, adding that "within minutes," someone from Higgs's office contacted the Alliance. "Our chief of staff said we set a record" for a response, he added.

Higgs and Carr met with DeSaulniers and local residents. Environment Department spokesperson Erika Jutras said it has adopted several new measures, including having the department:

- *Visit the site "several times per week" and respond to resident complaints.*
- *Work with Public Health to evaluate potential health impacts in the area.*
- *Order Mira Construction to conduct a noise study and develop a "prevention and control plan."*

Jutras said the province will also continue to test water in the Nashwaaksis Stream and require the company to do its own testing. It also told the Department of Public Safety about complaints about speeding trucks and rocks falling off trucks….

So far there's been no actual reduction in the noise and dust levels, though, and McQuinn doesn't have a lot of faith things will change. Shutting down the quarry would probably lead Mira to sue the province, he said.

The new steps are "more or less window dressing for us, thinking that they're going to cure all our problems, which they cannot."

The quarry's approval to operate from the department is up for renewal later this year, but Seymour is not optimistic that stricter conditions will be added….

DeSaulniers said that in the end, the only option may be for the province to buy out the affected properties — something he said he'll use his clout to push for. [emphasis added]

Neighbouring Homeowner Reluctantly Settles Lawsuit Against Blasting Quarry for Damages to House

A family residing near a quarry was forced to settle a claim for damages to their property, reportedly for an amount less than the cost to repair, as the family could not afford to fight the lawsuit in Federal Court. The homeowners had purchased the property in 2009, with

the realtor assuring them that the quarry, dormant at the time of the purchase, would not restart operations.[29]

> *After a long year of mediation, negotiations and $20,000 in lawyer fees, Poultney residents Kristin and Jeff Silverman have settled their lawsuit with Hilltop Slate, Jeffrey M. Dunster and K-D Stone Inc., and said they're moving their young family out of Vermont.*
>
> *"By moving in with my parents, in Hampton, we will be homeless, and kids can decide where to go to school," Kristin Silverman said. "If you don't have the money to go to court, you're dead in the water."*
>
> *When the Silvermans bought their home at 1276 York St. Extension in Poultney nine years ago [February 17, 2009, for $142,000], their real estate agent told them it was unlikely anyone would resume mining the old quarry abutting their property, which hadn't been used since the 1950s, Silverman said….*
>
> ***But last year [2017], Hilltop Slate decided to mine the quarry, and the Silvermans say the result was a ruined foundation spitting rock and mortar onto their basement floor as it began to crumble and buckle beneath the home, among other issues….***[emphasis added]
>
> *After enduring damage to their home that they said was a result of the blasting and mining just 100 feet from their home, the Silvermans filed a three-count lawsuit in January requesting $150,000 for claims of negligence, $150,000 for being a nuisance and a sum equal to three times the value of their home due to gross negligence, according to the lawsuit filed by Burlington lawyer A.J. LaRosa.*
>
> ***According to court documents, the town of Poultney also issued a cease-and-desist letter to the quarry on the grounds that their blasting endangered the highway.*** [emphasis added]
>
> *The lawsuit states Hilltop had mineral rights to the quarry and had active operations there between June 2017 and January 2018, and had transferred the right to operate the quarry to Dunster and/or K-D Stone Inc.*
>
> *The Silvermans went into mediation Oct. 12 with the hope that Hilltop would do what many quarries do when there's at risk of damaging neighboring property with quarrying activities — buy them out, Silverman said. Silverman could not disclose the amount of the settlement due to confidentiality. Hilltop Slate and K-D Stone Inc. didn't respond to calls seeking comment.*
>
> *Silverman said the quarrying company wasn't interested in buying their property, and taking the case to federal court would require $60,000 more in legal fees, something the Silvermans couldn't afford….*
>
> *Silverman said the settlement wouldn't be enough to cover the damage to their home, and they couldn't see the point in paying to repair the damage anyway, given the fact that Hilltop would resume work in the quarry.*
>
> *"You're powerless," Silverman said. "Quarries have endless resources and attorneys. Normal people like us don't."*
>
> *Now, Silverman said they're working with PNC Holding LLC, who will send out an assessor to evaluate the property for which they still owe $120,000, and they'll probably be forced into foreclosure or a short sale of the home.*
>
> *"I blame Vermont for it," Silverman said. "It's the Act 250 exemption. The government doesn't care."*
>
> *According to Act 250, Criterion 10, for a quarry to apply for a permit to operate, the quarry must adhere to the town plan and zoning laws, unless the quarry was registered by Jan. 1, 1997, in which case the quarry would be exempt from all Act 250 requirements. The requirements include*

[29] Kate Barcellos, "Poultney family settles quarry lawsuit," October 26, 2018, https://www.rutlandherald.com/news/local/poultney-family-settles-quarry-lawsuit/article_659e9166-4eba-5077-988a-1ae32f8a6fb8.html

> *town zoning setback requirements from adjacent properties which, for Poultney at the time, was "200-foot setback of all pits, dumps and buildings to any residential building or property line."*
>
> *"We're trying to protect residents who have a quarry operating (near them) so they can enjoy their property line," Rep. Patty McCoy, R-Poultney, said at a Poultney planning commission meeting earlier that year. "There has to be a way that we protect pre-existing homes."*
>
> ***Silverman said throughout the legal battle, she was contacted many times by other homeowners who have experienced damage to their homes as a result of quarrying and advised anyone interested in buying a home in Vermont do their due diligence, especially if there is a quarry property nearby, regardless of whether their real estate agent tells them it's non-operational.*** [emphasis added]
>
> *"It's crazy to me that this many people are affected, and nobody can help," Silverman said. "There's this big push to move to Vermont, but do they know what they're getting into?"*

A letter by Kristin Silverman[30] posted online sometime after the settlement provides additional details as to the adverse impacts endured while residing near an operational blasting quarry:

> *My family lived on the property happily until almost 9 years later. One early morning I was sitting in my kitchen when I smelled the overwhelming smell of diesel and heard machinery. When I went out to explore, I found an excavator operated by Hilltop Slate, working under 60 feet from my backyard. When I went to the Tarans about this they too were surprised.*
>
> *You see what my husband and I were blind to was a thing called, "Mineral Rights". Although the Tarans owned the property, everything you could see, Hilltop (Daniel Boone) owned the mineral rights, everything under the ground.*
>
> *They worked all hours of the day. If the light was there so were they. Weekends. Sometimes as early as 5:30 in the am….*
>
> *We went to the Town of Poultney hoping they could help/protect us in some way. They repeatedly told us it was a civil matter.*
>
> *We went to the EPA, MSHA, even Bill Burke in Rutland at the Act 250 office. Everyone was sympathetic but no one could help.*
>
> *We even met with a group of local quarry owners. Although they agreed Daniel Boone and Hilltop were not operating in a way that these owners manage their quarries, they admitted there was largely nothing that could be done except sue Hilltop. These same quarry owners said that if we were their neighbor they would have bought us out and have been done with it.*
>
> ***At first Hilltop was an annoyance (noise, diesel fumes, fast cars, litter on our property, etc). Eventually they began blasting. At times this was under 90 feet from our well head. The sludge pumped through our well repeatedly clogged the filters and at one point was so bad we lost water for a number of days and were forced to move in with my parents for a time. My children had to give up their beloved chickens because we could no longer provide** *water* ***for them on a constant basis.*** *My mother did our laundry.* [emphasis added]
>
> *There was no warning that came with the blasting. One day there was a loud noise. That was how it started. Never a horn or signal, neighborly knock for a "heads-up". Nothing. Sometimes when I was in the yard you could hear someone from near the pit yell, "Clear" just as an explosion was detonated.* ***Blasting wasn't occasional. It happened sometimes daily for a period. Sometimes on weekends.*** [emphasis added]

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[30] https://legislature.vermont.gov/Documents/2020/WorkGroups/House%20Natural/Bills/19-0040/Written%20Testimony/Slate%20Quarries/W~Kristin%20Silverman~19-0040,%20Statement%20re-%20Slate%20Quarries~4-22-2019.pdf.

> ***Some of these blasts sent "fly rock" (rock from the blast) the size of my husband[']s foot into the road and onto our property. Someone from the quarry would drive up the road after the blast pushing the "fly rock" back towards the pit. Our well was damaged and our foundation buckled in towards our fuel tanks. Our 165 foot deep well was damaged (although Shawn Camara claimed my well was not deep enough and that blasting "hydrates" wells) according to an engineer that we hired. Our foundation that had stood strong for nearly 200 years was now in danger of knocking over the fuel tanks.*** [emphasis added]
>
> ***Fearing for our safety and our home, we did seek litigation against Hilltop Slate. Because of the monetary amount of the law suit, it was going to be handled in Federal Court. When we finally got to mediation with Hilltop and our lawyers, we realized we were "out of our league". I am a teacher. My husband is a factory worker at Hubbardton Forge. We had already spent tens of thousands in lawyers, engineers, tests, etc. Coming up with upward of $50,000 was not a possibility.*** [emphasis added]
>
> ***We settled. Not for enough to fix the house. We paid back most of the money we borrowed from friends and relatives. We fixed the problem with the fuel tanks. We put the house on the market for what we owe. We are looking into the foreclosure process because the damage and location of our property to the quarry have made the property worthless.*** [emphasis added]
>
> ***This process has taken 2 years. We stand to lose everything we worked and saved for.*** [emphasis added]

Flyrock Continues to be the Most Dangerous Aspect of Rock Blasting Operations

As noted in *Mwafulirwa's* July 2014 Dissertation, there is a need for research work on flyrock as it remains the most dangerous aspect of blasting operations.[31]

> *As a general recommendation, research work in reducing fly-rocks from rock blasting operations should continue because even today, the danger associated with fly-rocks is very high and fly-rocks still remain as the most dangerous aspect of rock blasting in the mining and construction industry [p. 175].*

Raina et al.[32] expressed similar concerns over the dangers of flyrock and the need for additional research of flyrock.

> *Flyrock can result in injuries or even fatalities as well as damage to properties and/or equipment, here referred to as "object(s) of concern". Flyrock is a concern for both researchers and blasting engineers as it is a random phenomenon. However, it has received relatively little attention from*

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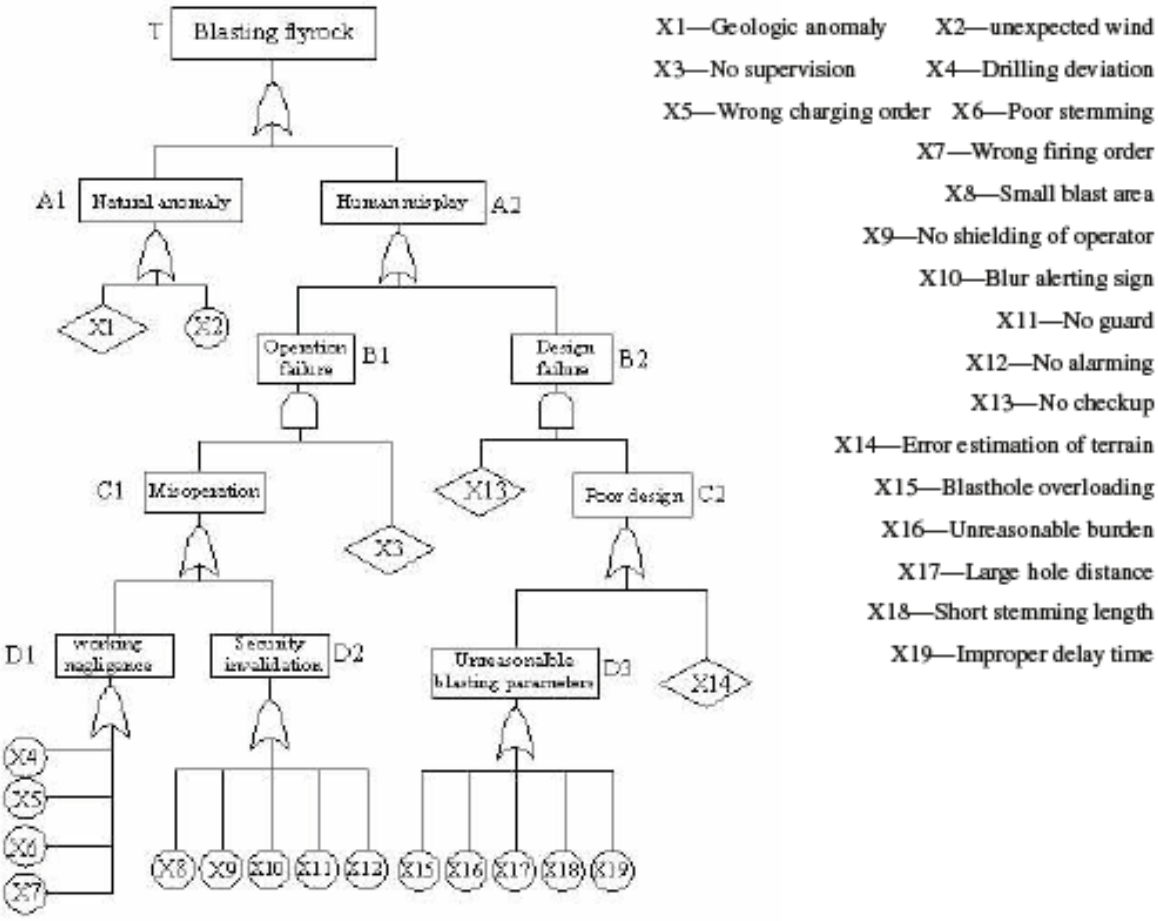
[31] Khwima Yauma Mwafulirwa, "Methodology for Characterizing the Efficacy of Blasting in Open-Pit Mines; Video and Image Analysis," July 2014 Dissertation, *University of Porto – Faculty of Engineering, Portugal,* file:///C:/Users/Windows%207%20PC/Downloads/Methodology_for_Characterizing_the_Efficacy_of_Blasting_in_O.pdf.

[32] A. K. Raina, A. K. Chakraborty, P. B. Choudhury and A. Sinha, "Flyrock danger zone demarcation in opencast mines," *Bulletin of Engineering Geology and the Environment* (2011) 70: 163-172, https://d1wqtxts1xzle7.cloudfront.net/50489185/s10064-010-0298-720161122-8304-1q8k9eq.pdf?1479861280=&response-content-disposition=inline%3B+filename%3DFlyrock_danger_zone_demarcation_in_openc.pdf&Expires=1597071244&Signature=bNTVEvpN5wN-k3I2StbIu2ITcGoNGXf2M09B8G4H05IirzNsPWJoR-7KrGhD-2U1Ywi6hqGlDv~~FzPsgz0vvyEAmd392Nex3d6e9bM0LptgiLkhonnL4zIrhCyTZka16waFg80kPxgT15yVAxAYSX5laqPdNsbtQYpNzq5ZWpfNS-ppKRUyuyMSoFVUVxeN0PxuF475iZwlo9XBO56fk1oGIaQJcN~FrtbYVBlLCglaOBAnhWnzzPyeBaxu5NJl33f8Gk9Nkgd~XoweUpmU5sfkt5UGGtsxX7zRGvhCicjkH2SOjYxljX-6ek1xZ4hRiydlwpWNfz2fpcEruKpwtA__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA.

researchers due to the complex nature of the interaction between the blast design and rock parameters. To date, most research has focused on the prediction of the maximum throw of flyrock and the initial velocity of the rock fragment projected from the blast face. Such workers as (Bajpayee et al. 2004; Raina et al. 2006; Bhowmik et al. 2004) detailed the major reasons for and control of flyrock with an exhaustive literature survey [p. 163-164].

Fault-Tree Risk Analysis of Flyrock Accidents in Blasting Operations

The events or risk factors in blasting operations that contribute to flyrock accidents are depicted in the following fault-tree prepared by Zhou et al:[33]



The fault-tree labels flyrock as T (the top event), and the underlying events or risk factors potentially responsible for flyrock accidents are labelled A, B, C and D. The occurrence of flyrock is complicated by the inherent variability of blasting operations. Each underlying event in the fault tree describes some failure involving some controllable or uncontrollable aspect of the blasting operation. Flyrock accidents can be caused by a singular event (risk factor) or a combination of events (risk factors). The numerous controllable and

[33] Zilong Zhou, Xibing Li, Xiling Liu and Guoxiang Wan, "Safety Evaluation of Blasting Flyrock Risk with FTA Method," *School of Resources and Safety Engineering, Central South University*, Changsha 410083, Hu'nan, China, https://miningandblasting.files.wordpress.com/2009/09/safety-evaluation-of-blasting-flyrock-risk-with-fta-method.pdf.

uncontrollable risk factors involved in blasting operations that cause flyrock accidents are summarized as follows:

2.1 Poor Design of Blasting Parameters *The efficiency of blasting is determined by the precise blasting to the design contour. Inaccuracies in the design of blasting patterns can cause large deviations from expectation and result in flyrock occurrence. They include:*

a) Blasthole Overloading *The consumption of explosives, i.e. the quantity of explosives consumed in kg/m^3 of rock mass is governed by a host of factors, such as physicomechanical properties of rock, cross sections of workings, proper charging of blast hole, etc. Any of the factors can lead to the excessive charging. When the blasthole overloading occurs, it generates tremendous amount of energy to form flyrock.*

b) Unreasonable Burden *Due to irregularity of bench slopes, the design of reasonable burden is always challenging. Too short a burden distance wastes energy and always causes the release of energy at the weakest side only. While too great a burden distance creates oversize boulders and results in the vertical shooting of boulders.*

c) Too Short Stemming *Stemming provides confinement and prevents the escape of high-pressure gases from the blasting hole. In general, the stemming length should be not less than 25 times the blast hole diameter. When the designed length of the stemming is too short, the high-pressure gases would shoot out the stemming and solid substance around the hole top directly.*

d) ***Improper Delay Time*** *Short delay blasting is one of the popular methods in practice, which can produce less seismic impact of blasting, less noise, less shock wave, and less flyrock. The determination of proper delay time is the key of success. However, when the delay time is too long, the unloading effect disappears and lots of fly-rocks appear.*

2.2 Operation Negligence *All the construction and operations are done by people, and then the misplay is unavoidable. The operation negligence usually is the main reason of blasting accidents including flyrock events. It has many kinds of manifestation, such as:*

a) Inaccurate Drilling *For the invisibility characteristic of soil and rock material, the accurate positioning of the drilling angle is impossible in practice. Different operators may drill holes with completely different angles and length even at the same position, then the drilling deviation changes the designed blasting patterns insensibly.*

b) Poor Stemming Quality *Stemming material quality is another factor lead to the occurrence of flyrock. When poor quality stemming with lower cost is used, there is fissure left between stemming and hole wall. Then there is not enough power to hold back the escape of high-pressure gases from releasing.*

c) Wrong Firing Sequence *Firing pattern must be performed so that each hole or group of holes, gets as favorable confinement and throw conditions as possible. When the firing sequence is deliberately reversed, the flyrock accident is on the way.*

2.3 Blast Area Security *The blast area should be determined by considering geology, blasting patterns, blasting experience of operator, delay systems, type and amount of explosive material, and type and amount of stemming. A lot of empirical formulas have been suggested to determine the blast area. However, the exact determination of the blast area is never an easy thing. Even carrying out the most exact calculation of the blast area, an unintentional invader can make all the effort nothing and become the victims. Besides the unwitting invaders, the informed people sometimes are curious to the detonation phenomenon and may approach the site nearly. So the blast area must be all-clear before blasting and all the access roads leading to the blasting site be guarded while blasting.*

2.4 Unknowable Natural Conditions *A common problem in geotechnical projects is the lack of knowledge and accurate technology to identify and recognize the specific anomaly or weakness in the rock structure, which can lead to the subsequent flyrock problem. The rock structure and rock properties may vary considerably from location to location even within the same blast area. The*

> *discontinuity of joints and fissures can cause very high explosive concentration in the hole. The wind also can assist in the producing of flyrock. When the wind direction is in accord with the designed throwing direction, the flyrock can travel distance two times than normal*

Tragically, the risks of flyrock are too often taken into account long after a blasting operation has been established, and is most often the result of a catastrophic flyrock event resulting in personal property damage, real property damage, personal injury or death, or a combination thereof.[34] "***Flyrock is an accident that needs to be considered before it happens [p. 13]***."[35] [emphasis added]

Incidents of Flyrock Go Unreported to Avoid Disclosure of Legal Responsibility

According to *Raina et al*,[36] one of the major reasons flyrock incidents go unreported is to avoid disclosure legal responsibility:

> *…[Flyrock] is known to have resulted in accidents ranging from serious injuries, fatalities, and damage to property – belonging and not belonging to the owner of the mine (Jenkins and Floyd, 2000; Rehak, et al., 2001; Bajpayee et al. 2002; Fletcher and D'Andrea, 1987; Verkis, 2011). Flyrock incidents still continue to happen (McKenzie, 2009; Amini et al. 2011; Stojadinovic, et al., 2011; Rezaei, et al., 2011; Kricak, et al. 2012).*
>
> *One of the major constraints in the prediction of flyrock is non-reporting of such incidents (Davies 1995) for obvious legal reasons [p. 900].*.

Incidents of Flyrock Uninvestigated and Lack of Regulatory Oversight

According, to an August 17, 2009 newspaper article,[37] only 4 of 36 flyrock incidents were investigated by the Office of Surface Mining [OSM] Charleston Field Office during January 2004 to December 2007:

> *…a…[March 2009] report from the guys at the OSM Charleston Field Office outlines significant problems in the way the West Virginia Department of Environmental Protection [WVDEP] is regulating blasting. The 18-page report focuses on citizen complaints about "flyrock" — rocks and boulders from blasts that literally fly off mine sites into nearby communities….*
>
> *—**Detailed investigations by WVDEP are performed in few of the flyrock incidents** the agency becomes aware of. OSM praised the WVDEP Office of Explosives and Blasting for its investigation reports. But, OSM found, OEB was involved in only 4 of 36 flyrock events during the period examined, from January 2004 to December 2007.*
>
> *When WVDEP's Division of Mining and Reclamation performed its own investigations (rather than referring the matters to OEB), "the actions were inconsistent because of inspector's varying degrees of expertise or guidance on procedure."*

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[34] Blanchier, A., "Quantification of the Levels of Risk of Flyrock," *Proceedings of the Thirty-Ninth Conference on Explosives and Blasting Technique* (pp. 17-20), St. Louis, MO: ISEE.

[35] Jackson, Brett Christopher, "Total Cost Optimization For Contour Blasting In The Appalachia Region," (2015). *Theses and Dissertations-Mining Engineering.* 20. https://uknowledge.uky.edu/mng_etds/20.

[36] Avtar Krishen Raina, V.M.S.R. Murthy and Abhay Kumar Soni, "Relevance of Shape of Fragments on Flyrock Travel Distance: An Insight from Concrete Model Experiments Using ANN," *EJGE*, Vol. 18 [2013], Bund. E, 899-907, http://www.ejge.com/2013/Ppr2013.079alr.pdf.

[37] Ken Ward Jr., "OSM finds WVDEP lax in policing flyrock," *Clarkson Gazette-Mail*, http://blogs.wvgazettemail.com/coaltattoo/2009/08/17/have-a-blast-osm-finds-wvdep-lax-in-policing-flyrock/.

OSM recommended that OEB "should investigate every flyrock event in detail to determine or require the company to determine the most likely cause(s) in order to devise a site-specific remediation plan."

— WVDEP inspectors who cited companies for flyrock incidents ***typically ordered mine operators to clean up the off-permit material, instead of determining the cause and proposing corrective measures*** *to prevent repeat incidents.*

— OSM said that monetary fines for flyrock violations were "too low for the seriousness of the violations." ***During the period examined, the median penalty was $1,200.***

— Staffing issues "are a possible impediment" to strong flyrock enforcement. At the time of the OSM review, there were six blasting inspectors for the entire state. ***OEB was authorized to have 17 positions, but at the time of the report had five vacancies****….*

— WVDEP does not track performance of the mine operator and contract employees it certifies to perform blasting at strip mines. ***Because of this, OSM was unable to identify the blasters or companies responsible for some flyrock problems.*** *OSM said, "Having the ability to identify habitual offenders for enforcement purposes is critical to initiating suspension or revocation proceedings."*

*Finally, OSM cautioned WVDEP that "****blasting is the single most frequently occurring event at mines that has the potential to cause injury, death or property damage****."*

OSM continued:

> **Due to the significant danger of flyrock, it is recommended that in all cases, OEB institute the cessation of blasting activity in the area where flyrock originates and adjacent areas until an investigation is completed and prescribed changes are implemented by the company to ensure there is a reasonable expectation that flyrock will not occur again from the same cause.**

WVDEP's response to that recommendation?

> OEB does not feel it is necessary to issue an [imminent harm cessation order] or cease blasting on all flyrock cases. It is the inspector's call as to whether or not the individual incident warrants an IHCO. However, OEB will take multiple incidents into consideration in determining if blasting should cease.

Blasting Operations Are Dangerous and Must Pay Their Own Way - No Amount of Damage to Neighbouring Properties is "Reasonable"

As concluded by the Indiana Supreme Court in *Enos Coal Mine v. Schuchart et al.*,[38] there is no logical reason not to extend strict liability for property damage from vibrations simply because there is no physical trespass as in falling debris from an explosion on nearby land. The appeals court ruled that the common law principle of liability in trespass applies equally where damage is caused only by vibration, commenting, in part, by way of analogy, as follows:

> *In these days of nuclear explosions, the breaking of sound barriers by airplanes and missiles, violent explosions from artillery and gunnery practice (to mention but a few of the advances of science), nearby buildings and property can be shattered or destroyed as effectively as by an earth quake without any physical invasion of the property.*
>
> *The United States Supreme Court has recognized these modern problems in holding that property owners are entitled to compensation for deterioration in property values caused by noise and vibration of jet planes in the use of air space near an airport. Griggs v. Allegheny County (1962), 369 U.S. 84, 82 S.Ct. 531, 7 L.Ed.2d 585.*

[38] *Enos Coal Mining Company v. Schuchart et al.*, 243 Ind. 692 (1963) 188 N.E.2d 406, https://scholar.google.com/scholar_case?case=5259210695212382453&q=%22a+little+damage+is+reasonable%22&hl=en&as_sdt=2006.

> *It is argued that the owner of property may make the fullest use of his property so long as he does not trespass upon other property or damage it by his negligent acts. On the other hand, there is also the principle that one may not use his property so as to injure the property of another. This conflict in the general principles of law is the result of the historical difference between an action in trespass and an action on the case. An examination of this historical development affords no logical reason for the original difference.*

The court cited *Wendt* v. *Yant Construction Co.* (1933), 125 Neb. 277, 249 N.W. 599, as being in accord with the general principle that if damage is inflicted there ordinarily is liability for one's acts without regard to fault regardless of whether the damage is caused from blasting that projects rocks or by concussion:

> *"The weight of authority sustains the position that there is no distinction in liability for damage to property from blasting which projects rocks or by concussion."*

The court also argued that while certain business operations are "necessary" for the promotion of industrial development, if they have adverse impacts on neighbouring properties the homeowners are entitled to be compensated by the business owners. Adverse impacts (minor or extensive) caused without the consent of the neighbouring homeowners are compensable regardless of whether the business operation is legally permissible and operating in compliance with regulatory limits.

> *It is also urged that in business and industry certain operations are "necessary" for the encouragement of industrial development and that even though such business activities cause some injury to neighboring properties, a "reasonable use" is permissible. From our viewpoint, this is to say that "a little damage" is "reasonable" and legal, but too much damage is "unreasonable" and wrong. What is or is not "reasonable" is an uncertain yardstick. Although it is a standard of conduct in some cases because of the lack of a better one, it is to be avoided, so far as possible, because of its vagueness and lack of certainty.*
>
> *A business should bear its own costs, burdens, and expenses of operation, and these should be distributed by means of the price of the resulting product and not shifted, particularly, to small neighboring property owners for them to bear alone. We can understand no sensible or reasonable principle of law for shifting such expense or loss to persons who are not involved in such business ventures for profit. Industrial development is to be encouraged, not at the expense of private individuals without their consent, but by the price of the resulting product in the industry itself. If there is a public interest in such development, the only equitable and just way to distribute such expense or cost would be through the equitable use of public funds.*
>
> *"Blasting operations are dangerous and must pay their own way." 2 Harper and James, Torts § 14.6, p. 814 (1956).*
>
> *"The individual citizen may be deprived of his home or other property by the proper exercise of the power of eminent domain; but it ought not to be said that it can be lawfully destroyed without compensation in the interest of a mere business enterprise, simply because such enterprise is of great magnitude and general public interest." Watson v. Mississippi R.P. Co. (1916), 174 Iowa 23, 34, 156 N.W. 188.*

Miramar Quarries a Source of Frustration for 6,300 Residents Impacted by Blasting

Residents of the City of Miramar have long been plagued by the adverse impacts of blasting, with over 6,300 residents signing a petition to have the quarry blasting stopped.

> *The Miramar City Commission has asked Gov. Ron DeSantis to order a temporary stop to rock mine blasting during the state of emergency called for the COVID-19 pandemic.*

The commission acted following a flood of complaints from homeowners who claimed the blasting caused cracks in their pools, patios, walls, floors and ceilings and even the foundations of their homes — as well as fraying their nerves. A recent petition issued to stop the blasting has the backing of more than 6,300 signers from Miramar, Pembroke Pines, Doral and other nearby communities in Miami-Dade and Broward. [emphasis added]

Complaints began to mount about the same time that DeSantis signed the COVID-19 state of emergency order on April 1[, 2020] that ordered nonessential businesses to close, according to Miramar Mayor Wayne Messam. Laid-off workers were home to hear the daytime blasts. [emphasis added]

The resolution's author, Commissioner Yvette Colbourne, told commissioners during the April 15 meeting that she sent the resolution to other affected cities to join the appeal to the governor.

Residents' beef is with White Rock Quarries in northwest Miami-Dade County. The company's Hialeah plant has been operating since the 1980s, long before suburban sprawl surrounded the facility….

Blasting has been an issue since the mid-1990s when new communities sprang up near the plant including Sunset Lakes, Sunset Falls, Riviera Isles, Huntington, Nautica and County Club Ranches. Homeowners complained that the blasting was hurting their properties. [emphasis added]

The Florida Fire Marshal's Office oversees quarry operations, monitoring blasting activities and restricting blasting to weekday daylight hours. Seismologists also measure the explosions to make sure they remain within permit limits.

Broward County prohibits blasting, but Miami-Dade County allows it. Miramar now also outlaws blasting within city limits, though allowed it when the far western communities were being developed.

While there's been a lot of talk over the years, blasting continues and most likely will continue until the quarry's permits are not renewed or canceled. Permits are active for one year and must be renewed pending inspection by the Fire Marshal.

Given the experiences of homeowners, Mayor Messam questioned whether state rules on blasting are adequate to prevent damage. He said the limits were developed elsewhere in the nation, not Florida where just inches under sandy soil lays a porous plateau of limestone. [emphasis added]

"While we did a study and found that they are working with required limits, at the end of the day, if residents experience damage, they should be paid," he said. [emphasis added]

An attempt to compensate homeowners was established in 2003 by then-Gov. Jeb Bush, who signed into law a measure to provide communities with state mediation to hear damage complaints, Messam said. "However, the state assigned the Department of Administrative Hearings (DOAH) to hear and rule on the complaints… If the DOAH sides with the quarry, the complainant must pay all [litigation] costs, including those of the quarry."

Messam said that in mid-March [2020] he noticed a spike in complaints on neighborhood websites, like Next Door. Some examples:

- *Will Pen, of Silver Isles, wrote: "FYI I have lived in Silver Isles for 18 years. I have filed lawsuits since these blasts have caused the interior pipes of my pool to crack and thus cause major leaks. Cracks on exterior walls that have being certified as caused by this…. nothing, nada…."*
- *Henry Abdelnour, Silver Isles: "I've been living in Miramar for 15 years now. Those blasts were happening way before I moved in. They occur every day on workdays between 11 a.m. and 2 p.m. You just need to get used to them because there is nothing you can do. Sometimes they stop for a little while but not right now. Unfortunately, your complaints won't go anywhere."*

- *Debra Briggs, Silver Lakes: "This has been going since we moved here in 1996. I had to put laminate on my floors because my beautiful expensive tile had cracks throughout my home. I am pissed beyond belief and they do nothing!!"*
- *Sean Emmett, Sunset Lakes: "We feel it in our home and in my office, which is on the fourth floor of one of the buildings in Flagler Station adjacent to the Turnpike just south of NW 106th St. Some of the blasts are so bad that the office building sways from side to side for up to 10 seconds and our desks and computer monitors shake…Our local government officials granted the developers permission to build our homes knowing this could become an issue. Unfortunately, we are up against the might of the quarry operators who have support in Tallahassee and deep pockets to pay lawyers to defend them…"*

If the proposed moratorium on blasting takes place, Messam wants to work out some solution to the noise and damages.

"The issue ultimately comes down to the Legislature to put regulations and laws in place,'' Messam said. "And the more scientific than political we are, the more effectively we can all work. The current statutes make it very difficult."[39]

Formation of Sinkholes

According to the US Geological Survey, the formation of sinkholes can have catastrophic consequences.

It is a frightening thought to imagine the ground below your feet or house suddenly collapsing and forming a big hole in the ground. Sinkholes rarely happen, but when they strike, tragedy can occur. Sinkholes happen when the ground below the land surface cannot support the land surface.

A sinkhole is an area of ground that has no natural external surface drainage--when it rains, all of the water stays inside the sinkhole and typically drains into the subsurface. Sinkholes can vary from a few feet to hundreds of acres and from less than 1 to more than 100 feet deep. Some are shaped like shallow bowls or saucers whereas others have vertical walls; some hold water and form natural ponds….Typically, sinkholes form so slowly that little change is seen in one's lifetime, but they can form suddenly when a collapse occurs. Such a collapse can have a dramatic effect if it occurs in an urban setting.

Sinkholes form in what geologists call "karst terrain." Karst terrain is a region where the bedrock can be dissolved by ground water.

Sinkholes are common where the rock below the land surface is limestone, carbonate rock, salt beds, or rocks that can naturally be dissolved by groundwater circulating through them. As the rock dissolves, spaces and caverns develop underground. ***Sinkholes are dramatic because the land usually stays intact for a while until the underground spaces just get too big. If there is not enough support for the land above the spaces, then a sudden collapse of the land surface can occur. These collapses can be small…or they can be huge and can occur where a house or road is on top****.* [emphasis added]

New ***sinkholes have been correlated to land-use practices, especially from groundwater pumping and from construction and development practices****. Sinkholes can also form when natural water-drainage patterns are changed and new water-diversion systems are developed.* ***Some sinkholes form when the land surface is changed, such as when industrial and runoff-storage ponds are created. The substantial weight of the new material can trigger an underground collapse of supporting material, thus causing a sinkhole****.* [emphasis added]

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[39] Ann Henson Feltgen, "Miramar asks governor for temporary halt to blasting during COVID-19 pandemic," April 24, 2020, https://www.floridabulldog.org/2020/04/miramar-asks-governor-temporary-halt-blasting-amid-covid-19/.

> *The overburden sediments that cover buried cavities in the aquifer systems are delicately balanced by groundwater fluid pressure. The water below ground is actually helping to keep the surface soil in place. Groundwater pumping for urban water supply and for irrigation can produce new sinkholes in sinkhole-prone areas. If pumping results in a lowering of groundwater levels, then underground structural failure, and thus, sinkholes, can occur.*
>
> ***The sudden and sometimes catastrophic subsidence [is] associated with localized collapse of subsurface cavities (sinkholes)... This type of subsidence is commonly triggered by ground-water-level declines caused by pumping and by enhanced percolation of ground water.*** *Collapse features tend to be associated with specific rock types, such as evaporites (salt, gypsum, and anhydrite) and carbonates (limestone and dolomite). These rocks are susceptible to dissolution in water and the formation of cavities Salt and gypsum are much more soluble than limestone, the rock type most often associated with catastrophic sinkhole formation. Evaporite rocks underlie about 35 to 40 percent of the United States, though in many areas they are buried at great depths. Natural solution-related subsidence has occurred in each of the major salt basins in the United States.* ***The high solubilities of salt and gypsum permit cavities to form in days to years, whereas cavity formation in carbonate bedrock is a very slow process that generally occurs over centuries to millennia. Human activities can expedite cavity formation in these susceptible materials and trigger their collapse, as well as the collapse of pre-existing subsurface cavities****.*[40] [emphasis added]
>
> ***In 1994, a New Windsor Maryland man [Robert W. Knight] was killed when his van fell in a [sink]hole that opened on Rt. 31. The site was near a limestone rock quarry [Redland Genstar Inc., operator of Medford quarry].***[41]

As reported in the Baltimore Sun on December 1, 1998,[42] the widow of Robert W. Knight reached an out-of-court settlement with the quarry operator.

> *Redland Genstar Inc. has settled a multimillion-dollar lawsuit by the widow of a Westminster city employee killed in 1994 after his van plunged into a sinkhole on the road to New Windsor.*
>
> *Jury selection was to begin yesterday for an estimated three-week trial, but instead the attorneys met privately with Carroll County Circuit Judge Raymond E. Beck Sr.*
>
> *Robert W. Knight was driving to New Windsor about 2 a.m. March 31, 1994, to get food during his shift at Westminster Wastewater Treatment Plant. A sinkhole 45 feet wide and 18 feet deep had opened on Route 31, a state road northeast of Medford Road.*
>
> *Emergency crews worked more than two hours to free him from the van, and Knight was flown to Maryland Shock Trauma Center in Baltimore, where he died five hours after the accident.*
>
> *Nancy Lee Knight filed a $13 million lawsuit in 1996 against Genstar, operator of the nearby Medford quarry, and the state of Maryland, alleging negligence and wrongful death….*
>
> *Knight settled her claim against the state of Maryland Nov. 17 for $50,000, and the state was dismissed as a defendant. The amount was the maximum that could be recovered under the 1984 Maryland Tort Claims Act and the much older doctrine of sovereign immunity, according to court papers and the assistant attorney general handling the case….*
>
> *In her claims against the state, Knight had said state officials in the Department of the Environment and the State Highway Administration were negligent in regulating the Medford quarry and in maintaining Route 31.*

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40 https://www.usgs.gov/media/images/karst-landscapes-are-more-prone-have-land-subsidence-and-sinkholes.

41 https://www.wusa9.com/article/news/local/maryland/new-sinkholes-in-frederick-put-focus-on-hazardous-geology-in-region/65-557172801.

42 Sheridan Lyons, The Baltimore Sun, "Settlement reached in sinkhole death Worker's van plunged into Route 31 opening," December 1, 1998, https://www.baltimoresun.com/news/bs-xpm-1998-12-01-1998335117-story.html.

Sinkholes occur naturally in some limestone and marble formations, where water dissolves the rock and creates cavities that then collapse.

Because quarries dig below the water table and must pump out water, the lawsuit alleged that this process had weakened the rock under the road and caused the ground to collapse in front of Knight's van. [emphasis added]

The Knight lawsuit had been looked at as a possible test of the "sphere of influence" of quarry operations. A state law passed in 1991 holds mining companies liable for property damage caused by such activity within a specific area but does not presume that they are at fault. [emphasis added]

Genstar had previously denied that the area where the sinkhole occurred is within its sphere of influence. [emphasis added]

Sinkholes and Water Problems

Alabama A&M & Auburn Universities maintain a public website devoted to addressing issues concerning *Karst Conditions (Sinkholes) and Water Problems*:[43]

Can pumping of ground water cause land subsidence?

Definitely. *As water is pumped from underground formations in major aquifers where the water is not replaced on a regular basis, the load bearing strength is weakened and over time the overburden materials can cause relatively large land areas to subside or settle under the force of gravity. This can ruin building foundations, rupture buried gas and water lines and cause other problems. Land subsidence has occurred in a number of areas across Texas due to excessive pumping of ground water, including the Houston-Galveston area during recent years.*

Does open-pit quarrying in karst areas increase the likelihood of sinkhole formation?

Yes. *Open-pit quarrying in some types of bedrock may not increase the formation of sinkholes, but the likelihood that open-pit quarrying in karst bedrock will increase the formation of sinkholes is near 100 percent. As a quarry is dug deeper below ground level or expanded in size, a greater volume of water must be pumped continuously to prevent pond formation in the bottom of the pit. Increased quarrying and pumping causes a cone of depression to expand throughout any surrounding surface aquifer system linked to the pit. Over time, underground fractures may begin to form, causing water to be emptied even from voids and caverns below the surface water aquifers. Not only will shallow wells surrounding the quarry begin to dry up, but surface streams fed from ground water may also dry up during low rainfall periods. And worst of all, accelerated sinkhole formation is likely as soil overburden and fractured materials begin to collapse into underground voids that were once full of water. If blasting is used in a quarry, the vibration and shock waves can accelerate the formation of bedrock fractures, which may lead to soil piping and the eventual collapse of the above materials into underground caverns. Any quarrying activity that intersects with or changes underground water levels or flow patterns can lead to sinkhole problems and even to nearby flooding if surface to ground water flow patterns are temporarily or permanently interrupted.*

Am I more likely to get a sinkhole on my property because a neighbor of mine recently got a sinkhole on his property, and if so, how can I locate where a sinkhole is most likely to occur?

Not necessarily. *Karst terrain, where sinkholes most commonly occur, generally has an underlying limestone type bedrock that is honeycombed with cavities and crevices of varying size. There may be several cavities or none in the bedrock under your property. If there is a sinkhole very near your property, there is more reason for concern because sinkholes sometimes occur in sets. Periodic surface inspection of your property for any sinking or soft areas might be prudent. But, the only way to be certain there are no cavities or voids under your property that could at some time result in the development of a sinkhole, is to get a geological bedrock density inspection. This means contacting a company with certified geologists who can use one of several types of instruments to survey and*

[43] https://ssl.acesag.auburn.edu/natural-resources/water-resources/faq/subject.php?code=116.

map the location of any voids in the geology below your property. One such company is GeoModel, Inc. The URL for their web site is http://www.geomodel.com and their email address is geomodel@geomodel.com.

Can a sinkhole under the foundation of a home be repaired so there is no risk for future damage?

***Not really**, because few things in life are 100 percent risk free. Since sinkholes are natural systems, as are floods, tornadoes, and hurricanes, there can be no guarantee that a repaired sinkhole will not cause future problems. However, engineering companies have used techniques varying from simple injection of grout into sinkholes to more advanced systems of engineered reinforced plugs, pins, and porous concrete that have been very successful.*

Can altering surface drainage and flow around or into sinkholes affect groundwater supplies in karst terrain?

***Yes.** Man-made changes to drainage on the surface or to sinkholes may easily alter the rate at which the underlying aquifer receives its normal recharge. Vegetation slows runoff from storms and allows water to percolate into the soil. However, runoff from impermeable materials (e.g. cement drains, asphalt roads or parking lots, and roofs of structures) may rapidly be funneled through specific sinkholes into an aquifer. Artificially filled sinkholes may become blocked inputs. Increasing the rate of runoff and/or blocking sinkhole inputs may result in temporary flooding, unless runoff is diverted away from its natural sink point (thereby altering the recharge to yet another sink point). This may drastically affect the amount of groundwater available for use in the immediate vicinity.*

Can collapses and formation of sinkholes in karst landscapes be avoided?

***No, not completely.** Dissolution of water soluble carbonate rocks (limestone, dolomite and marble) below the land surface will lead to formation of below ground caverns. These openings or fractures that form in the bedrock will allow water to penetrate until connecting channels often form underground. After some time (a few years to thousands of years), mechanical failure of the overburden will occur and soil material will collapse to form sinkholes. Greater rainfall and storm water flow through cracks will accelerate the process, as will other events such as mining operations, increased ground water pumping and more frequent and heavier traffic loads on the overburden.*

Can excessive pumping of underground water cause a sinkhole to form?

***Yes.** Many sinkholes have formed due to de-watering of underground voids. The soil arch over a void is often partially supported by the buoyancy of the water table. When the water is removed and the soil material above the void becomes wet from heavy rainfall, it may collapse. A number of adjacent voids may coalesce to form a large void. Patterns of pumping from high yield wells over extended periods of time can result in large and rapid drawdown of the water table and the emptying of voids and also the creation of solution voids due to ground water flow patterns. Water table drawdowns can cause voids to develop along solution channels, eventually leading to sinkhole formation at a distance from the well itself.*

Can locations for potential sinkholes be accurately predicted in karst areas?

***No, not completely.** Most sinkholes form where there are open voids below the ground surface due to solution of water soluble minerals (carbonates) in karst areas. After a time mechanical failure will cause rocks and overburden, including soil, to eventually collapse to form sinkholes in many unexpected locations across karst landscapes. Large voids and deep caves can be detected throughout karst terrain with the proper geophysical instruments, but shallow and smaller voids are more difficult to detect, even with test drilling. Soil piping may go unnoticed for years and then cause sudden catastrophic collapse into large underground voids. Actions that cause the emptying of underground voids and caves of water can cause the land surface above to collapse without warning.*

Can pumping of ground water cause land subsidence?

> ***Definitely.*** *As water is pumped from underground formations in major aquifers where the water is not replaced on a regular basis, the load bearing strength is weakened and over time the overburden materials can cause relatively large land areas to subside or settle under the force of gravity. This can ruin building foundations, rupture buried gas and water lines and cause other problems. Land subsidence has occurred in a number of areas across Texas due to excessive pumping of ground water, including the Houston-Galveston area during recent years.*

Does open-pit quarrying in karst areas increase the likelihood of sinkhole formation?

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How can overdrafting of groundwater cause problems?

> *Special problems may result from the excessive use of groundwater. Overdrafting occurs when people draw water out of an aquifer faster than nature can replenish it. The most obvious problem created is a shortage of water. Overdrafting, however, can also create significant geotechnical problems. Although not an issue, at many locations around the world, overdrafting has caused land subsidence and formation of sinkholes. This can produce severe engineering difficulties. Parts of Mexico City, for instance, have subsided as much as 10 meters in the past 70 years, resulting in a host of problems in its water supply and sewer system. Land subsidence may also occur when the water table is lowered by drainage. In the early 1970s, for example, an entire residential subdivision in Ottawa Canada subsided when a collector sewer was constructed nearby. The subsidence seriously damaged the residents' property.* [See *Pugliese et al. v. National Capital Commission et al.; Beaver Underground Structures Ltd. et al.; Third Parties Dunn et al. v. Regional Municipality of Ottawa-Carlton et al.*, 17 O.R. (2d) 129, Ontario CA, August 1977; Supreme Court of Canada upheld the ruling of the Ontario Court of Appeal.]

In *Pugliese et al. v. National Capital Commission et al.,* the homeowners claimed their properties sustained damages totaling approximately $2 million:

> ***The one hundred and seventy-one plaintiffs in the Pugliese action, who are the owners of one hundred and one residential properties in the Township of Nepean in the Regional Municipality of Ottawa-Carleton, and the four plaintiffs in the Dunn action, who are the owners of two residential properties in the same part of the municipality, claim that the ground water table below their properties was substantially lowered by the construction of a collector sewer on lands of the National Capital Commission located nearby, and that their homes and lands were seriously damaged by the resulting subsidence. There is also a claim that properties involved both in the Pugliese action and in the Dunn action were damaged as a result of drilling and blasting operations.*** [emphasis added]
>
> *As a result of the dewatering the ground water table was lowered in the lands adjacent to and in the general vicinity of the LCS [Lynwood Collector Sewer]. At the location of the LCS it was lowered to at least the invert elevation of the LCS. The lowering of the ground water table caused the*

> *underlying clay strata to consolidate and the underlying loose sand and silt strata to compress. This resulted in a differential settlement over the base of the foundations of the plaintiffs' homes. The damages suffered by the plaintiffs included severe cracking and faulting to the floors, foundations, walls, ceilings and fireplaces of their residential structures, including depressed exterior foundation walls, sloping floors to depressed walls, brick or stone veneer cracked or pulled away from walls and severe distortions of door and window frames. Subsidence of the plaintiffs' lands also occurred with cracking to the curbs, laneways, sidewalks and landings. Damages amounting in the aggregate to approximately two million dollars are claimed, based on nuisance, negligence or breach of statutory duty.*
>
> *The depth of the limestone bedrock was erratic and varied from a near ground surface elevation to a depth much in excess of fifty feet. The ground water table before construction was commenced for the LCS was generally at a depth of approximately four to fourteen feet below the ground surface. The LCS was to be constructed by a tunnelling operation, and the invert of the LCS was to be installed approximately forty feet below the ground surface. Beaver and Cosentino had the option of controlling the ground water conditions either by the use of compressed air during tunnelling operations, or by dewatering in advance of tunnelling operations. Commencing in the summer of 1974 and continuing until the winter of 1975-76, they adopted a dewatering system of pumping from deep drainage wells. The total quantity of water pumped by Beaver and Cosentino greatly exceeded the daily maximum which was permitted under the "Permits to Take Water" issued by the Ministry of the Environment under The Ontario Water Resources Act, R.S.O. 1970,*

With the concurrence of all parties, the Ontario Court of Appeal agreed to determine the matter on a stated question of law related to the homeowners' claims (other than those related to blasting operations) as if it were an appeal from a determination under Rule 124 (Ontario Rules of Practice). The Court of Appeal concluded as follows:

> 1. *An owner of land does not have an absolute right to the support of water beneath his land not flowing in a defined channel, but he does have a right not to be subjected to interference with the support of such water, amounting to negligence or nuisance.*
> 2. *Such an owner does have a right of action*
>
> *(a) in negligence for damages resulting from the abstraction of such water, or*
>
> *(b) in nuisance for damages for unreasonable user of the lands in the abstraction of such water.*
> 3. *Such an owner does not have a right of action under The Ontario Water Resources Act for damages for subsidence arising from the pumping of water in excess of the amounts set out in permits issued under that Act.*

The Supreme Court of Canada[44] upheld the Ontario Court of Appeal ruling, varying the judgment, in part, to read as follows:

> *In an action by an owner of land in negligence or nuisance from the pumping of ground water not flowing in a defined channel for any damage resulting from the abstraction of such water, no right of another owner to pump such water avails as a defence in respect of any pumping exceeding the quantity authorized under The Ontario Water Resources Act".*

In reference to the fine for pumping water in excess of that permitted under *The Ontario Water Resources Act,* the Supreme Court of Canada stated,

> *…I do not view the enactment for the protection of the land owners from damage by excessive pumping as creating a duty but as a limitation of whatever right existed of doing it with impunity.*

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[44] *N.C.C. et al. v. Pugliese et al.*, 1979 CanLII 32 (SCC), [1979] 2 SCR 104, <http://canlii.ca/t/1tx79>, retrieved on 2020-07-12.

How adequate is the enforcement by penalty when this is $200 a day and the damage is probably in excess of $2,000,000[?]

The Supreme Court of Canada found that the pumping violation in that Act was considered a *nuisance* when causing damage to other properties, as well as a *negligent act*. The homeowners were entitled to sue the defendants in *nuisance* and in *negligence.*

How does groundwater move though karst terrain (sinkhole areas)?

Unlike in other types of terrain, groundwater in karst regions is channelized within the natural underground system of interconnected pipes or tunnels that collectively transmit water from input (recharge) points to output (discharge) points. Recharge in karst terrain occurs in two ways. First, rainwater may percolate through the soil and into fractures in the soluble rock over large areas of the countryside. This is known as diffuse recharge. Secondly, surface flow may enter caves or sinkholes directly. This is called discrete recharge. Both mechanisms occur simultaneously in most karst regions. Discharge from the ground to the surface occurs in several different ways. Karstic groundwater is released from natural springs as cave streams exit from openings or as seeps as water emerges from the ground over wide areas. Spring flow may range from a few to thousands of gallons per minute. A significant quantity of water may also be withdrawn from wells drilled to obtain water for domestic, commercial, agricultural, or other industrial uses. The natural subsurface flow in karst terrain can be very complex. It is often difficult to ascertain exactly where water entering a karstic aquifer flows and where it eventually emerges on the surface. In practice, paths of travel are determined by introducing tracers, such as dyes, into input points and observing where they resurface.

How should I manage a sinkhole on my personal property?

That depends on the age of the sinkhole and the role it plays in local water flow patterns. New relatively small sinkholes that form due to mining operations lowering the water table can be filled with local soil material. It is not a good recommendation though to fill old sinkholes with impervious material, especially if such sinkholes are established components of the local drainage system. Filling such sinkholes can lead to flooding problems and formation of additional, and sometimes, much larger sinkholes. It is a good idea however, to maintain overall stability of a sinkhole on your property. A good conservation practice is to establish a natural vegetated buffer zone around such sinkholes to maintain the quantity and quality of recharge water entering the aquifer there. Thought should be given to the size of the drainage area and proximity to sources of contamination when assessing vulnerability of the sinkhole and the size of buffer needed.

If I get a sinkhole on my property will it keep getting bigger and bigger over time?

Usually no. *The size of most sinkholes stabilize after a period of time. When an underground cavity enlarges to the point that its ceiling can no longer support the weight of overlying sediments, the earth suddenly collapses into the cavity. A circular hole typically forms and grows over a period of time that typically will last from a few minutes to a few hours. Slumping of the sediments along the sides of the sinkhole may take several days to completely stop. Unless stabilized with vegetation or rocks, water erosion of the edge of a sinkhole may continue for years in a climate that gets regular rainfall. If a sinkhole becomes an active conduit for surface water flow directly to subsurface water channels, it is not likely to stabilize and will likely continue to grow in size over time.*

Is ground water more susceptible to pollution in areas with sinkholes?

Yes. *Pollution of groundwater resources is always a problem in karst terrain with sinkholes. Sinkholes are natural funnels that can convey toxic substances directly into the below ground plumbing system. Sinkholes have long been used as dumps for waste materials. The dumping of solid wastes, such as dead animals, garbage, and refuse into sinkholes is a major hazard to groundwater resources. Liquid wastes dumped into sinkholes can enter a groundwater system undiluted through the underground drainage routes or conduits. Sinkhole dumping is just one way of contaminating karstic groundwater. Many karstic aquifers are now contaminated by fertilizers and*

pesticides applied to fields overlying carbonate rock, leakage from municipal landfills sited in these areas, leaky septic systems and sewage lines, seepage from accidental chemical spills, and other contaminated effluent along transportation and urban corridors. An excellent practice to follow is to never put anything in a sinkhole that you would not want in your drinking water. Be cautious in using potential pollutants in karstic terrain because the overburden above many of these aquifers may not have the capacity to filter contaminated water before it reaches the groundwater and the cavernous system of the aquifer has little capacity to filter contaminated groundwater before it reaches discharge sites. Most states now have special codes prohibiting the dumping of any kind of wastes into or adjacent to sinkholes.

Sinkholes Swallow Property and Trees

According to a May 15, 2014 article,[45] sinkholes continue to swallow property and trees in Opelika, Alabama.

Sinkholes are swallowing property in Opelika. One homeowner says he's lucky he took a break from cutting the grass when he did, otherwise he may have sunk 20 feet into the ground along with a large tree in his front yard.

Heavy rain is doing more than just flooding streets and overflowing creeks in Opelika, it's causing tall trees to be sucked into the ground. Jerome Hamby was cutting the grass Wednesday afternoon when the ground gave away right in the place where he was about to resume work after a short break.

"I praise the lord that I came to take a break, because if I was out there - I was just cutting around that - you know what I mean? If I was out there cutting, I would probably be in that hole with the tree."

Sinkholes are becoming a recurring problem for this part of Opelika near Lee Road 704. Hamby says a road in his neighborhood was forced to close because of the ground caving in. He says the problem is partly due to drilling at a nearby rock quarry. [emphasis added]

"Well, they say they're going to shut this thing down in August, and they tell me then that it should do away with the sink holes in this community."

This is the second time a large sink hole has done damage to his property in recent years. He wants to move, but the offers he's getting on his house are less than he paid for it. [emphasis added]

"It's a shame, I'm going on 76, you work all your life to have a home and then you deal with this. And believe me, it puts a lot of stress on you. A lot of stress. Until then, he'll have to hire professionals to help him pull a tree out from deep in the ground that once stood high above his property. [emphasis added]

On May 16, 2014, a follow-up article elaborated on the problem of sinkholes in Opelika, and in Alabama.[46]

Despite popular belief, sinkholes are not unusual in Alabama and they can come in all sizes.

"There are major land areas in Alabama that have the same issues because they contact the underground geology that's water soluble and when some of that gets dissolved it leave[s] large holes of water.

Sinkholes are very common," explains Dr. James. Hairston,- AU Professor Emeritus/ Retired and ACES Water Program Coordinator.

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[45] WTVM, "Homeowner narrowly escapes sinkhole that swallows tree," May 15, 2014, updated July 25, 2014, https://www.wtvm.com/story/25523713/opelika-sinkhole-swallows-trees-whole/?autostart=true.

[46] WTVM, "Experts say sinkholes are not uncommon in Alabama," May 16, 2014, updated July 27, 2014, https://www.wtvm.com/story/25532311/experts-say-sinkholes-are-not-uncommon-in-alabama/.

Sinkholes are frequently associated with urban development in karst landscapes.

Mining or quarrying and high water withdrawal can lead to some types of sinkholes and is what Hairston believes happened yesterday in Opelika. [emphasis added]

A quarry is in operation just down the street from Hamby's property.

"They call it a cone of depression. The deeper the sinkhole gets, you have a cone forming away from the line quarry where the water starts dropping," says Hairton. [emphasis added]

In 2007, Lee County sued and reached a settlement with the then owners of the rock quarry, where the quarry will pay for and repair any sinkhole related damages in a given area on public and private property.

"They say they're going to shut this thing down in August and they tell me then that it should do away with the sinkholes in this community," says Hamby.

"You have that [sinkhole] potential anywhere close to a quarry," explains Hairton. [emphasis added]

The closing of the quarry and the factors leading up to the closing of the quarry were reported by the Opelika Observer on September 9, 2014.[47]

The limestone quarry that has made its home in Lee County for over a century will soon close its doors. As previously reported by the "Observer," the quarry on Alabama Highway 166 in Opelika will be closed by the end of the year.

MidSouth Aggregates, Inc., and its holding company, Oldcastle Materials, Inc., made the decision to close the quarry that has been in operation since as early as the mid-1800s for various reasons. Community rumors spoke of an imbalance of revenue and cost of production, and others blamed the numerous sinkholes around Lee County and the cost of repairing them for the closing.

In 2007 the city of Opelika and Lee County brought a lawsuit against the owner of the quarry, MidSouth Aggregates, as well as its holding company, Oldcastle Materials, Inc. The case was eventually settled outside of court. According to the Lee County Commission, there were eight items in the settlement. The quarry agreed to the following:

- *pay for and repair sinkhole-related damages, present and future. They will repair damage on public and private property, with a financial cap of $1.6 million;*
- *make significant road repairs, at its expense (Lee Road 148 had been closed because of sinkholes);*
- *conduct initial sinkhole susceptibility testing and weekly inspections, at its expense;*
- *provide defense and indemnification of Lee County, at its expense;*
- *agree to the continuing jurisdiction of the Lee County Circuit Court;*
- *stay in strict compliance with operating restrictions and its Alabama Department of Environmental Management discharge permit limits;*
- *provide a $5 million performance bond, which will remain in effect for seven years after closure if the quarry closes; and*
- *repay Lee County $2 million for legal fees.*

Tom Aley, president of Ozark Underground Laboratory in Missouri, was heavily involved in the litigation process of the 2007 lawsuit. His company was hired to evaluate the validity of the claims brought against the quarry and Oldcastle Materials, Inc.

Aley worked extensively in Opelika, accessing [sic] the formation of sinkholes and the drying up of the Spring Villa area surrounding the quarry.

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[47] Rebecca Martin, Opelika Observer, "Quarry closure examined," September 9, 2014, https://opelikaobserver.com/quarry-closure-examined/.

> *"In my opinion, once the quarry has ceased its operations, the spring that has been dry for so many years will flow again," Aley said. "The timeline of course depends a great deal on the amount of rainfall Opelika gets, but I look for the flow to resume within a couple of years."*
>
> *Justin Hardee, Lee County engineer, said MidSouth Aggregates and Oldcastle Materials have dutifully upheld their settlement responsibilities. The highway department reported a sinkhole under the asphalt of Lee County Road 148 in April of this year, and Hardee said the quarry took care of the problem in accordance with the settlement agreement.*
>
> *"The closing of the quarry is a bittersweet thing for the highway department," Hardee said. "It employed county residents and also provided our department with a great deal of the materials we use in road construction and repair. We are, however, looking forward to the safety concerns the sinkholes caused not being an issue."*
>
> *The quarry will officially close later this fall.*

In the 2007 law suit, the city of Opelika brought an action against Hanson Aggregates Southeast Inc. and Oldcastle Materials Inc., "alleging that violations at their facilities were damaging the health and properties of their neighbors," as reported by Lawyers and Settlements.com.[48] The location of the sinkholes caused by the quarry and the settlement reached are described as follows:

> *The civil suit against Oldcastle Materials and former quarry operator Hanson Aggregates Southeast alleged that deep drilling from the quarry, located between Alabama Highway 166, just south of Opelika, is responsible for numerous sinkholes and an overwhelming loss of spring water in the surrounding area.*
>
> *As part of a settlement reached, though pending approval from the Opelika Utilities Board and the Lee County Circuit Court where Judge Jacob Walker III presides, the quarry companies will pat [sic] the city…$1.1 million. Under the deal, Oldcastle will install, at its own expense, an 8-inch waterline from the fire hydrant near Brown Tool & Mold Company to the westerly most entrance of Spring Villa Park. The length of said waterline is approximately 5,000 feet, and it will serve Spring Villa Park. Further, Oldcastle will repair, at its own expense, all existing and future sinkholes and sinkhole-related damages to properties, easements and rights-of-way owned by the city and the Opelika Utilities Board. If the bridge crossing Little Uchee Creek suffers sinkhole-related damages, Oldcastle will repair the bridge at its own expense; and will indemnify the city and the utilities board from future claims and liability arising from sinkhole-related damages. [**OPELIKE AUBURN NEWS: QUARRY SINKHOLES**]*

Quarry Dewatering Causes Sinkholes on Neighbouring School Campus

In *Solebury School v. Commonwealth of Pennsylvania DEP and New Hope Crushed Stone & Lime Co.* (NHCS),[49] the DEP ruled in favour of the Solebury School, finding that the sinkholes were caused by dewatering at NHCS' quarry. The case summary that follows has been prepared by *Miano* and *Keays*:[50]

> *This case study involves a private boarding school [on 90 acres] located in a rural area and a [215.75-acre] limestone quarry [with extraction confined to 141 acres] located directly next to the school. The school and the quarry are located in karst terrain.*

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[48] Quarry Sinkholes, October 17, 2007, https://www.lawyersandsettlements.com/settlements/09711/quarry-sinkholes.html.

[49] *Solebury School v. Commonwealth of Pennsylvania Dep't of Envtl. Prot. and New Hope Crushed Stone & Lime Co.*, No. 2011-136-L, 2014 WL 4087592, (Environmental Hearing Board July 31, 2014), https://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=1053&context=sinkhole_2018.

[50] Steven T. Miano and Peter V. Keays, "When Sinkholes Become Legal Problems," 15th Sinkhole Conference, https://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=1053&context=sinkhole_2018.

Mining has been occurring on the quarry property [NHCS] since the 19th Century, but it wasn't until the 1960s that mining began at depth, which required the dewatering of the quarry pit. The state regulatory agency issued the quarry its first mining permit in the mid-1970s. Although the permit approves mining to a depth of -200' MSL [mean sea level], the agency has required the quarry to apply for separate "depth corrections" in order to mine progressively closer to that depth. In July 2011, the agency issued the quarry a depth correction allowing it to mine to a depth of -170' MSL; the previous depth correction, issued in 2007, allowed the quarry to mine to -120' MSL. Following the issuance of the most recent depth correction, the quarry was pumping 2-4 million gallons of water per day from the quarry pit.

In 1989, collapse sinkholes began to open on the school's campus. The sinkholes ranged from several feet across to nearly a quarter an acre, most exceeding 20 feet across. ***Between 1989 and 2014 at least 29 sinkholes opened on the school's campus, and at least 10 sinkholes opened on neighboring properties, the largest of which was 150 feet long, 75 feet wide, and 15-20 feet deep. Over the course of this time period, wells on the school's campus began to go dry. Deeper wells were drilled, only to dry up a few years later. In addition, the creek that historically ran across the campus and the quarry property ran dry; what little flow remained was sporadic and was drained by a swallet that formed on the quarry's property, not far from the school's property line.*** [emphasis added]

The sinkholes presented an enormous danger to the safety of the students, faculty, staff, and visitors, and posed a potentially existential problem for the school*. Around the time that the quarry applied for its most recent depth correction in 2008, the school retained two experts—a licensed professional engineer and a Ph.D. in geology—to investigate the potential cause or causes of the sinkholes, and to make recommendations as to how future sinkholes might be prevented. Based on the investigation of these experts, which revealed that the dewatering of the quarry pit was causing the sinkholes and that deepening the quarry pit would promote continued sinkholes on the campus, the school opposed issuance of the depth correction. The agency limited its review to the marginal impact of adding 50 feet to the quarry, as opposed to the continuing impact of the ongoing dewatering of the quarry (an approach that was later held to be improper and unlawful). After concluding that the school failed to show that the depth correction would exacerbate the sinkhole problem, the agency issued the depth correction in 2011. The school appealed the depth correction to a state administrative court.* [emphasis added]

Not surprisingly, the issue of causation was at the heart of the school's appeal, which was ultimately resolved in the school's favor after a two-week trial, most of which was focused on conflicting expert testimony. The court ultimately concluded that—because the quarry's dewatering had substantially lowered the groundwater under the school, which, given the underlying karst features, resulted in the sinkholes—the quarry's dewatering of the quarry pit is the "overriding cause" of the sinkholes.[51] *At trial, the quarry and the agency's experts offered several alternate theories of sinkhole causation, including flooding caused by heavy precipitation and the school's development activities on its campus, which the court rejected.* ***The court found that continued dewatering will further depress groundwater levels below the school, and—crediting the opinions of the school's expert witnesses—found that "dewatering of the quarry is directly resulting and will continue to result in the hazardous formation of collapse sinkholes****."*[52] [emphasis added]

The court anchored its legal conclusions on various provisions of the state's noncoal surface mining act and related regulations. Citing the stated purpose of the act, which includes "preventing and eliminating hazards to health and safety,"[53] the court pointed to the requirement that no permit may be issued unless the applicant affirmatively demonstrates, among other things, "that it will ensure the protection of the quality and quantity of surface water and groundwater, both within the permit area and adjacent areas,

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[51] Environmental Hearing Board July 31, 2014).
[52] *Solebury School v. DEP* at *16.
[53] *Solebury School v. DEP* at *21 (quoting 52 P.S. § 3302).

> ***as well as the rights of present users of surface water and groundwater**."*[54] *Citing a number of statutory and regulatory provisions, the court affirmed that the agency not only has the authority to deny the depth correction "if continued mining is causing unavoidable and serious harm to health and safety," but also the "duty to ensure that mining can be performed without undue risk to health, safety, and welfare."*[55] *The court ruled that by issuing the depth correction the agency acted unlawfully and unreasonably by enabling a serious hazard to continue unabated. The court also rejected the standard for reviewing the quarry's application, stating that "the question is not whether the limited subject of the revision can be safely accomplished," but rather "whether the project as a whole, as revised, can be safely accomplished."*[56] *Invoking a statutory provision that declares "any condition that creates a risk of…subsidence, cave-in, or other unsafe, dangerous or hazardous condition"*[57] *to be a public nuisance, the court ruled that the quarry is creating a public nuisance. The court also invoked the agency's statutory duty to abate and remove public nuisances.*[58] [emphasis added]
>
> ***In the wake of the court's decision, the agency required the quarry to begin reclamation and to submit a reclamation plan and timeline that was driven by the time needed to restore the groundwater and abate the nuisance, rather than the time needed to extract the remaining mineable reserves**. The quarry's failure to comply resulted in the issuance of an order that imposed various requirements and restrictions upon the quarry, most notably, a daily pumping limit of 500,000 gallons. That order was recently upheld by the court.*[59] [emphasis added]
>
> *This case exemplifies the critical role that expert witnesses can play in sinkhole litigation. As the court wrote: "the School assembled a top-notch team of experts for evaluating the karst geology of the [basin] and the hydrogeologic connection between the quarry's dewatering and the sinkhole development on the School's campus, the key issues in the case."*[60] ***This case also illustrates that statutes and regulations and the permitting process can be powerful tools that a party can use to combat sinkholes, even in cases where the government agency entrusted with enforcing those laws fails to do so.*** [emphasis added]

Quarry Dewatering Causes Neighbouring Homes to Sink

In *Henderson v. Wade Sand & Gravel Co., Inc.*,[61] the Alabama appeals court overturned the trial court's ruling, which had rejected the homeowners' claims against the quarry for damages to their houses caused by dewatering at the quarry a half-mile (805 metres) away.

> *The plaintiffs' houses were constructed roughly fifty years ago, and are located in a residential neighborhood.* ***In 1977, the land on which their houses are situated began to sink, large sinkholes appeared, and their houses began to break up. Investigation disclosed that the sinking of their property was due to the activities of defendant, Wade Sand and Gravel Company, which operated a quarry one-half mile north of plaintiffs' homes. In the course of its operations, the quarry, which began operating in 1957, periodically pumps water from the bottom of its pits, and empties it into a nearby creek. This resulted in ground water being leeched from under plaintiffs' land, leaving large underground cavities. Heavy rains then caused water to flow through the empty cavities at an accelerated rate, destroying the***

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[54] *Solebury School v. DEP* at *21 (citing 25 Pa. Code § 77.457(a))
[55] *Solebury School v. DEP* at *22.
[56] *Solebury School v. DEP* at *24.
[57] 52 P.S. § 3311(b).
[58] See 52 P.S. § 3311(b): 71 P.S. § 510-17(3).
[59] *New Hope Crushed Stone and Lime Company v. DEP,* 1373 C.D., 2017 (Pa. Commw. Ct. 2018), https://www.courtlistener.com/opinion/4517931/new-hope-crushed-stone-and-lime-company-v-dep/.
[60] *Solebury School v. DEP* at *28.
[61] *Henderson v. Wade Sand & Gravel Co., Inc.,* 388 So. 2d 900 (1980) Ala. Supreme Court, https://scholar.google.com/scholar_case?case=6837030642937266250&q=henderson+v+wade+sand+%26+gravel+co+inc&hl=en&as_sdt=2006.

> ***structure of the land beneath plaintiffs' homes, and carrying away much subsoil and surface soil.*** [emphasis added]

At trial, the court denied the homeowners' request to present a study undertaken by the U.S. Geological Survey, which predicted the type of damage sustained.

> *In 1969, the U.S. Geological Survey began a study of the sinkhole problem in the Roberts Field area, which includes plaintiffs' homes and the quarry. The defendant [Wade Sand and Gravel Co.] cooperated in the study and was allegedly familiar with the contents of the report subsequently published. Plaintiffs contend that the study predicted that damage of the type complained of would occur if defendant continued to pump water from its pits.*

The appeals court rejected the lower court's application of the "reasonable use" rule in a landowner's right to take water for a legitimate purpose (e.g., quarrying) with impunity, while causing neighbouring houses to become unsupported and to collapse.

> *We agree with the reasoning of this case, and conclude that the reasonable use rule was inappropriately applied in Sloss I & II. While the Sloss rule may have been acceptable, even beneficial, in an earlier era of lower population density and more primitive technology, it could produce disastrous results today. Carried to its logical extension, it would allow a quarry owner to willfully sink the City of Birmingham with impunity, provided that it was done in furtherance of a legitimate enterprise and that due care was exercised in the pumping.* ***A rule which provides no check on a landowner's ability to utilize his land to the detriment of society cannot be tolerated.*** *The appellee admits that "at some point a balance must be struck between annoyance and inconvenience to plaintiff and the right of defendant to do business," although they omit to specify when the point is reached. Accordingly,* ***we hold that where a plaintiff's use of groundwater, whether it be for consumption or, as here, for support, is interfered with by defendant's diversion of that water, incidental to some use of his own land, the rules of liability developed by the law of nuisance will apply***. [emphasis added]

A defendant is subject to liability under the law of nuisance for interference of a plaintiff's use of water, "either for (1) an intentional invasion when his conduct was unreasonable under the circumstances of the particular case, or (2) an unintentional invasion when his conduct was negligent, reckless or ultrahazardous." [underscoring added] *Henderson, supra,* at 903; *Labruzzo v. Atlantic Dredging one a lacy are if & Constr. Co.*, 54 So.2d 673, 675, 29 A.L.R.2d 1346, at 1351 (Fla.1951).

The case was remanded for further consideration by the trial court consistent with the opinion of the appeals court.

Homeowners File Law Suits Over Sinkholes That Rendered Subdivision Homes Unfit for Occupancy and Worthless

According to a February 15, 2019 press release,[62] 14 luxury homes in a rural subdivision have been rendered unfit for occupancy after numerous sinkholes opened throughout the subdivision.

> *Residents of an upscale neighbourhood on British Columbia's Sunshine Coast will officially be barred from returning to their dream homes today.*

[62] "Fourteen 'dream' homes ordered evacuated as sinkholes open in Sechelt,"

> *Sinkholes throughout the subdivision have prompted the District of Sechelt to issue evacuation orders covering 14 properties.*
>
> ***The homes, with views overlooking Sechelt Inlet, are similar to others in a nearby subdivision valued at over $1 million, although the BC Assessment Authority values most of the buildings in the Seawatch subdivision at zero.*** [emphasis added] [6657 Gale Ave N Sechelt assessed in 2020 for $2 and 6636 Gale Ave N Sechelt assessed in 2020 for $1][63]
>
> *An engineering report issued to the district says future sinkholes or landslides within the subdivision could damage infrastructure or buildings, and injury or death are possible consequences.*
>
> *The district has informed residents by email that fences around the subdivision will be locked Friday afternoon and only RCMP and firefighters will be permitted inside after that.*
>
> ***A statement issued by the district says Concordia Seawatch Ltd. designed, built and sold the subdivision, despite engineering reports as early as 2006 describing the development of sinkholes.*** *(CKAY, The Canadian Press)* [emphasis added]

As reported in a follow-up article,[64] a dozen homeowners have launched a lawsuit against the District of Sechelt, the Province of B.C. and the developer.

> *In eight lawsuits filed last week, the Goys and other homeowners allege the geotechnical hazards underneath the subdivision were no mystery to the district when the development was approved in 2006. Court documents claim the district was negligent in approving their homes, and continually negligent by ignoring problems as they cropped up during construction.*
>
> *Four lawsuits from other homeowners with similar claims have been filed in past months. No statements of defence have been filed.*
>
> *Six months in, warning signs still stand around the deserted neighbourhood. Concrete medians block roads in and out of the area and two-metre-high construction fences circle empty houses. Goy said there's been reports of vandalism.*
>
> *For the first five weeks after leaving home, the Goys house-sat, lucky to have friends who were on vacation. The couple has been renting in Sechelt since, and are still making payments — and paying taxes — on the house they can't live in.*
>
> *"[The houses] have been rendered useless and worthless by a series of mistakes made with many different levels of governments over the years," Rod said.*
>
> *All of the homeowners' lawsuits also name the province of B.C. and developer [Concordia Seawatch] as defendants, alongside the district. Residents say the province has extended the state of emergency keeping them from their homes on a weekly basis since February and claim the order extensions are an "abuse of power."*
>
> ***Various real estate agents are also named in several of the lawsuits.*** [emphasis added]
>
> *The neighbours have leaned on each other for comfort and communication, texting each other for updates. Rod said residents are not personally notified every time the order is extended — they have to drive to the neighbourhood to check if a new notice has been physically posted on-site, or search online once a week.*

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[63] Karin Larsen, "$1 and $2 property assessments confirm worst fears for residents of sinkhole-plagued neighbourhood," CBC News, January 3, 2020, https://www.cbc.ca/news/canada/british-columbia/1-and-2-property-assessments-confirm-worst-fears-for-residents-of-sinkhole-plagued-b-c-neighbourhood-1.5414366.

[64] Rhianna Schmunk, "12 homeowners in sinkhole-ridden B.C. neighbourhood sue over 'worthless' dream homes," Aug 22, 2019, https://www.cbc.ca/news/canada/british-columbia/sechelt-sinkholes-homeowners-lawsuits-bc-1.5255774.

They all know it could take years for their legal cases to wind through court, but Goy said the residents didn't know how else to move forward.

"I don't think anybody was looking to be adversarial in our neighborhood ...We were just looking for help."

Subsequently, the defendants filed responses, with the province stating that "it didn't cause or contribute to any loss or damage included in the Goy's claim, and extended the state of local emergency at the request of the district, and based on a geotechnical report highlighting the danger." As for the developer, "Concordia Seawatch, claims a geotechnical report it relied on from 2006 said the properties were expected to be safe, and that the district had other information it ought to have shared."[65]

A review of the documents, filed with the law suits, by a CBC journalist[66] reveals the following chronology of events involving development of the subdivision:

1992 *- The earliest report on the city's website from Terra Engineering found "the property as a whole to be well suited to the type of residential development proposed" and that "if care is undertaken to prevent post-development storm water runoff from reaching unprotected slopes, the long term erosion potential of the surface is minimal." The final page reads: "There is no particular natural hazards of this site," but the report also recommends more testing.*

1993 *– Under a section titled "Geological Hazards," a Golder Associates report found "various types of existing and potential natural hazard which can affect development" and goes on to say "the assigning of probability levels to specific hazard events, or a series of events, can only be achieved by carrying out more detailed geotechnical and hydrological studies to determine appropriate hazard probability/magnitude relationships."*

1998 *– A development application was made, but the city notes it was "left uncompleted" in that year.*

2004 *– Geotactics Engineering prepared a report for the developer after one day on site and "an earlier report by Geotek Designs for part of the site was made available as background information." The report concluded that "the probability of occurrence of geotechnical hazards is estimated to be less than 10 percent in 50 years," but it also noted "several test pits should be excavated around the property to verify the subsurface conditions here" and that "each of the lots in Phase 1 should have an individual geotechnical assessment prior to final design and construction."*

2005 *–Sechelt district staff reported that in February, test pits were excavated to verify conditions at the "Shores" development. The report recommended council issue a development permit provided there are protections for banks and the shoreline, as well as "Registration of a Covenant on each of the lots in Phase 1 stating that a geotechnical assessment is required prior to the issuing of a Building Permit establishing building setbacks, storm runoff disposal and foundation construction specifications."*

2006 *– Geotactics Engineering wrote a follow-up report dated April 2006, mentioning the formation of four sink holes in the proposed subdivision area, "one of which was 10 feet in diameter and about eight feet deep." The report reads "On further investigation, the occurrence of sink holes in this area was found to be more common than previously believed" in other parts of Sechelt. Nonetheless, the*

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[65] Rafferty Baker, "Province, district deny responsibility after 12 homeowners sue over sinkhole-riddled development," November 7, 2019, https://www.cbc.ca/news/canada/british-columbia/sechelt-sinkhole-defendant-claims-1.5351050#:~:text=British%20Columbia-,Province%2C%20district%20deny%20responsibility%20after%2012%20homeowners%20sue%20over%20sinkhole,with%20denials%20and%20finger%2Dpointing.

[66] Penny Daflos, https://bc.ctvnews.ca/fair-warning-or-obstruction-duelling-claims-and-a-document-trail-in-sechelt-1.4299923.

report concluded with the identical line from 2004: ***"The probability of occurrence of geotechnical hazards is estimated to be less than 10 per cent in 50 years." A supplementary addition the following month claims "until a soil collapse occurs, the presence of a (potential) sink hole is generally undetectable. The occurrence is random." The city imposes as "restrictive covenant against title" to the area, which includes the Geotactics report.*** [emphasis added]

2007 *– Construction begins.*

2008 *– Thurber Engineering assessed the construction of retaining walls and slopes, but addressed the sink hole issue, noting the addition of rounded gravel to the existing sand could be an issue: "If water ingress occurs into the sand due to, for example, excessive lawn watering or broken water service, then any seepage through the sand that exits where there is rounded gravel backfill could cause internal erosion and piping with resultant formation of a sinkhole at the crest of the slope."*

2012*– The first sinkhole to affect a home at The Shore manifests. Thurber Engineering found a spring developed in May of that year, with a sinkhole collapsing without warning June 1 and "Additionally, there have been several instances of slope instability during and after construction." But their conclusion was that "Given the low potential for internal erosion of the soils present at the site, we believe the most likely cause of the sinkholes is collapse of piping cavities."*

The city tried to address the issue by filling the hole with gravel while hiring consultants to assess the area with ground penetrating radar, land surveying equipment and aerial mapping. Thurber mentions several reports they reviewed but were not made public, including a 1997 report by Geotek Designs they quote as saying: "'There are no indications of any threat of landslide.' Geotek also states that 'the land can safely be used for the use intended.'"

2013 *– The District of Sechelt announces it has accepted a settlement offer of $75,000 from Concordia Seawatch toward the community's costs to investigate the sinkhole issue after council had approved "remedial action requirements."*

2015 *– Another sinkhole forms, which renders a home uninhabitable; a lawsuit would follow. Thurber Engineering warns "identified voids and loose zones could develop into sinkholes in the future if measures ear [are] not taken to address the processes which contribute to sinkhole development."* ***Urban Systems provides three solutions for dealing with the ongoing issue, the most comprehensive coming in at just shy of $10 million. Urban Systems suggests a fourth option: "the closure of the subdivision, either partially or fully, and abandonment of infrastructure."***

The District of Sechelt meets with Seawatch residents and tells them it won't pay for a multi-million dollar solution, which doesn't come with a guarantee of success and would require a 8.5 per cent property tax increase on all Sechelt residents to finance. [emphasis added]

Dec. 25, 2018 *– Another sinkhole opens, 25 metres deep and four metres wide. Thurber Engineering suggests closing Seawatch Lane to vehicle traffic pending geotechnical assessment with warnings of the sinkhole hazard in the area.* ***Most chillingly, Thurber warns "Future sinkholes could damage existing infrastructure such as underground utilities, roads or sidewalks, or private property including buildings and retaining walls. Injury or even death is a possible consequence****."* [emphasis added]

February 2019 *– The Seawatch subdivision is put on evacuation alert and begin packing their things.*

Feb. 15, 2019 – The District of Sechelt declares a local state of emergency and the evacuation order is executed at 1 p.m. *The same day, Ron Davis emails this statement to CTV News: "The developer of the Seawatch housing development, Concordia Seawatch Ltd., has great concern and compassion for the homeowners and families that are now being required to leave their homes. As the developer and others are currently involved in civil litigation relating to the Seawatch Development, we are not providing further comment at this time."* [emphasis added]

2020 *– A trial claiming damages against the District of Sechelt and Concordia is slated to begin, stemming from a 2015 sinkhole.*

Class Action Law Suit Against Quarry Operator For Past and Future Damages Settled

In 2003, a Circuit Court Judge of Munks Corner ruled that the settlement of a class-action lawsuit against Martin Marietta, operator of Berkeley Quarry, was fair.[67]

> *Nearly two dozen Cross and Eutawville area residents began picketing Martin Marietta Materials' Berkeley Quarry last week, vowing to continue the protest until they get answers from company officials about payment for property damages they attribute to the blasting of limestone rock at the quarry….*
>
> *In 2003, Circuit Court Judge Markley Dennis of Moncks Corner ruled that a class-action lawsuit brought against Martin Marietta by hundreds of area residents was fair. In the settlement, Martin Marietta agreed to pay $1 million to be distributed among property owners with eligible claims, also known as "past claims" as defined in the 24-page settlement.*
>
> ***The settlement came after years of residents complaining about cracked driveways and foundations, discolored or "rusty" water, sinkholes and other property damages that could be attributed to the blasting of limestone rock at the Martin Marietta quarry in Cross, an active quarry for at least three decades.*** [emphasis added]
>
> *Protesters say the $1 million settlement has been allocated but not fairly.*
>
> *"Some of the people who got money shouldn't have gotten money because they live out of state … and they just got property (land, not structures)," Wallace said.*
>
> ***Attorney Dawes Cooke of Charleston, the 2003 court-approved settlement administrator, told The Times and Democrat Thursday that "any property owner (within a five-mile radius of Martin Marietta) was entitled to make a claim … "However, he said very little money has been awarded to landowners. He said he received a total of 675 "past claims," but some of the claims were rejected.*** [emphasis added]
>
> ***Cooke said the $1 million settlement fund was depleted last year [2008].*** [emphasis added]
>
> ***As part of the settlement terms, Martin Marietta agreed to annually replenish the Future Claims Fund with a maximum of $100,000, "contingent upon the company having sufficient funds generated from five cents per ton of annual sales" at the local quarry, he said.*** [emphasis added]
>
> ***From 2003 until April 2009, Cooke said he collected the "future claims" filed by Cross area residents, but protesters say they haven't been duly compensated for those "future claims" (meaning new damages allegedly caused by Martin Marietta's quarry work since the 2003 settlement).*** [emphasis added]
>
> *Martin Marietta is now handling the "future claims," says Paul Dominick, a Charleston attorney serving as legal counsel to the company.*
>
> *In a prepared statement, Dominick said, "Future Claims must not be repetitive of prior claims, must be accompanied by supporting documentation and must be to compensate for damages caused by the Martin Marietta operations.*
>
> *Dominick wrote that since taking over the claims process, "Martin Marietta has been working with class members to gather the appropriate documentation to support their Future Claims. All Future Claims will be reviewed by Martin Marietta within 60 days from Aug. 26."*
>
> *He noted in the statement that since the settlement was reached in 2003, "Martin Marietta has gone beyond the requirements of the settlement agreement and spent a significant amount of time and*

[67] Maratha Rose Brown, "'We need our money,' say picketing residents near MMM quarry," September 14, 2009, https://thetandd.com/news/we-need-our-money-say-picketing-residents-near-mmm-quarry/article_1075045c-1b39-54a2-9f0e-ac9b6c44c93f.html.

money in the Cross community drilling private wells and filling small holes on residents' properties without regard to whether the Martin Marietta operations impacted the properties."

The attorney said Martin Marietta "will continue to work with the class members and their counsel in the administration of the Future Claims fund."

Protester Carolyn Davis of 1467 County Line Rd. maintains that Martin Marietta has not kept its promise to the community.

Davis said her roof leaks, her yard contains numerous sinkholes and she's been forced to purchase bottled water for 33 years because of the "rusty water" produced by her inadequate well. She said Martin Marietta previously dug a new well for her but "it didn't work." [emphasis added]

"When the people blast at the quarry, pictures fall off the wall" of her home, Davis said. [emphasis added]

"I haven't received any money from them. My septic tank has sinked in, and I don't have good water yet," she added. [emphasis added]

Davis noted that prior to the development of the rock quarry, she didn't have any problems with her well and she wasn't faced with constant home repairs. [emphasis added]

J.W. Garrett, who lives about a mile from the Martin Marietta site, said when the quarry began operating about 35 years ago, "it didn't take them long to do the damage." The blasts at the quarry "feel like earthquakes," he said, adding that "a lot of people's wells went dry" when the quarry work began…. [emphasis added]

"We're certainly appreciative and realize the value of industries in Orangeburg County and what they contribute to our county in jobs and resources," [Orangeburg County Council Chairman] Wright told The Times and Democrat. "But citizens have their rights also in the democracy we live in to voice their opinions if they felt they were not treated fairly."

Sinkholes Linked to Quarry Operations

This is a cautionary tale of a Stockertown quarry that has been identified as a major contributor to a rash of sinkholes responsible for disrupting traffic and damaging private property in Northampton County for years.[68]

For the first time, a state official…publicly blamed a Stockertown quarry for contributing to a rash of sinkholes that has disrupted traffic and damaged property in parts of Northampton County for four years.

But Gary Hoffman, deputy secretary of operations for the state Department, stopped short of blaming Hercules Cement Co. for a sinkhole that damaged a northbound Route 33 Bridge in January [2004] and led to its $3.5 million replacement as well as the state's decision to replace the southbound bridge.

Hoffman said it was PennDOT's fault the northbound bridge over the Bushkill Creek failed because the state did not take into account the geology when the space was built in the 1970s.

"We know that the quarry is unquestionably a contributor," Hoffman told residents and government officials at Memorial Library of Nazareth and Vicinity. "But to say it is 50 percent, 60% percent of the problem or 90 percent of the problem, I think none of us can say that." [emphasis added]

Hercules officials did not attend the meeting, which elected officials called to brief residents on an 8-month-old joint state and federal probe into the sinkholes and a new plan to slow sinkhole development in and around the Bushkill.

[68] https://ei.lehigh.edu/envirosci/enviroissue/sinkholes/newspapers17.html.

The sinkhole plan, which residents oppose and is being reviewed by the state Department of Environmental Protection and U.S. Army Corps of Engineers, calls for Hercules and PennDot to jointly line 850 feet of the creek, up to the state-owned land around the Route 33 bridges, with a synthetic material.

The state hopes the plastic membrane, which Hercules has a separate permit to use at two other stream locations further north, will stop creek water from draining into the ground and causing sinkholes. The lining would then reduce the amount of creek water flowing underground through sinkholes and into the quarry.

Hoffman said he knows the lining won't solve the overall sinkhole problem, but it's the best short-term solution to protect the bridges. He added the lining would help protect the creek if the Corps receives federal approval and local or state assistance to line more of the stream bed.

However, he said, if the joint plan is approved, PennDot would not begin its share of the work if studies show the lining would have a detrimental effect on residents downstream of Route 33.

Studies have shown that quarries can cause sinkholes when they pump groundwater out of their pits. The pumping creates a massive underground funnel called the "cone of depression" or "zone of influence." Groundwater is sucked up through the cone, which then buckles the surface above until a hole opens. [emphasis added]

Based on Hercules' own groundwater studies, which DEP uses as its official records, the quarry's cone is believed to cover 2.2 square miles, stopping on the east side of the northbound Route 33 bridge. The studies estimate Hercules' cone will grow an additional 1.3 miles when the quarry, now 300 to 330 feet deep, uses DEP's March 2003 approval to mine deeper. [emphasis added]

Although state officials previously acknowledged the size of Hercules' cone, no one said Hercules has contributed to the sinkholes, which began opening in 2000 when a Palmer Township family was forced from their home and the small Stockertown-Tamamy bridge was swallowed. [emphasis added]

DEP mining inspector Mike Menghini said…that although the state granted Hercules' a "conditional approval" to mine an additional 150 feet, the agency is now having second thoughts. [emphasis added]

We are not comfortable with them going deeper. We want them to go laterally," Menghini said. We could stop [the permit] if it shows an effect they cannot remediate, but then they can appeal that."

[Accelerated sinkhole formation in the study area by the infiltration of surface water through the beds and banks causes piping of soils and subsequent sinkhole formation at the ground surface near the stream. In order to prevent this infiltration, restoration activities that consider sealing the stream bottom or otherwise preventing the infiltrating water from piping or overburden soils are required. Bushkill Creek was historically stocked with brown trout but stocking no longer occurs due to the overall stream degradation due to human impacts. The significance of this project is that the restoration could improve the habitat conditions suitable for stocking to resume in this portion of the watershed. Fisheries officials indicate that future trout stocking plans could include Bushkill Creek if the habitat is restored.][69]

A review of potential groundwater impacts conducted by Terran Corporation[70] on behalf of Mad River Township Trustees and Village of Enon in connection with a proposed quarry application raised numerous concerns, some of which relate to *groundwater extractions* and *blasting*:

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[69] "Congressional Fact Sheet," https://ei.lehigh.edu/envirosci/enviroissue/sinkholes/factsheet.html.

[70] Terran Corporation, May 15, 2017, https://citizensagainstmining.org/wp-content/uploads/2017/03/Erdos-Ltr-Quarry-Model-Review-5-15-17-1.pdf.

Blasting and groundwater extractions, in all cases, serve to reactivate and enhance karst, leading to sinkhole development (Lolcama et al., 2002). Quarry blasting may result in the destruction or disruption of groundwater flow paths, changes in the pattern of groundwater movement and changes in the quantity of water flowing through the karst system (Ekmekci, 1993). There are documented occurrences of increases in turbidity of groundwater to wells and springs at limestone quarries that utilize blasting (Green et al., 2005). Any groundwater monitoring program designed for determining potential adverse effects of the proposed quarry operations in the carbonate aquifers beneath Mad River Township must pay special attention to the disturbs of blasting. How this will be assessed is completely missing in the current groundwater monitoring outline provided in the EAI report.

Should quarry operations create any adverse effects to existing groundwater wells, the stated remedial action options offered by Enon Sand & Gravel would include lowering of pumps, deepening of existing wells, or installation of replacement wells. These remedial actions might be plausible for some wells distant from the quarry whose water levels have not been lowered near the top of the Elkhorn shale. These remedial measures would not be successful for wells close to the quarry where essentially the entire thickness of the carbonate aquifer has been drained. There are no aquifers in the Elkhorn shale to deepen or replace the affected homeowner well. The proposed remedial measures would not be successful for well owners if the lower portion of the carbonate aquifer has minimal saturated porosity or lacks permeability. Also, these remedial measures would not address the taking of groundwater from owners whose groundwater levels have been lowered sufficiently to dry up springs on their property.

Missing from consideration in remedial measures of this permit application are remedies for property owners subjected to adverse water quality effects of the mining operations. Increased turbidity from blasting, bacterial or nitrate contamination resulting from accelerated induced recharge from lowered groundwater levels are two probable scenarios that need to be addressed.

Sinkhole in Quarry Zone of Dewatering Influence (ZOI) Leads to Condemned Dwelling, and Quarry Liability for Damages – Mass Sell-off of Homes Follows

As reported in the February 8, 2020 issue of The Frederick News-Post,[71] a sinkhole caused a house to collapse, prompting officials to condemn it, and led to a mass sell-off of homes in the city of Frederick.

Jennifer Nelson was planning a funeral for a neighbor in September 2018 when she learned some concerning news.

A sinkhole had opened under her neighbor's house at 25 Hamilton Ave. in Frederick. Her home — the one she grew up in and purchased from her mother — at 27 Hamilton Ave. wasn't as damaged, but it raised concerns about whether her property was also at risk.

"On Sept. 11, 2018, our lives went from the normal hectic … to being flipped upside down in a matter of minutes," Nelson told the House's Environment and Transportation Committee at a bill hearing this week. "A large sinkhole had opened up under my next door neighbor's home … swallowing most of the house and the contents inside."

Nelson had cared for her elderly neighbor, helping him through hospice care before he died in August 2018. Because of her care, he gave her that house.

But roughly two weeks later, it was mostly destroyed by a sinkhole, which may have happened because of its position near a quarry, and the house sitting on karst terrain, a mixture of limestone and similar materials.

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[71] Steve Bohnel, "Del. Krimm introduces bill in response to sinkhole issue in Frederick," https://www.fredericknewspost.com/news/politics_and_government/levels_of_government/state/del-krimm-introduces-bill-in-response-to-sinkhole-issue-in-frederick/article_ca8fdcbb-32da-5203-86f8-97143697fe92.html.

***To combat issues like that, Del. Carol Krimm (D-Frederick) introduced a bill (House Bill 178) that would** require real estate agents or homeowners to disclose that a property is prone to sinkholes opening up under their homes.* [emphasis added]

More specifically, the bill notes that these properties are in "zones of dewatering influence" (ZOI), which means they have been marked by the state's Department of the Environment as prone to sinkholes. [emphasis added]

***Krimm** noted in written testimony that since the ZOI was designated, 114 of 135 properties in Frederick have transferred ownership at least once.* [emphasis added]

"Disclosure of this potential danger is necessary for informed decision making by a potential property purchaser, whether residential or non-residential," Krimm wrote. "Sinkholes are a reality in Frederick, and in other communities with ZOI designations. There must be a duty to inform of the potential of such an occurrence for the safety of our residents, our business owners, and their patrons." [emphasis added]

Tracy Coleman, deputy director of public works for the city of Frederick, told committee members that in cases of sinkholes opening up under homes — and lying in ZOIs — the Department of the Environment visits the site and determines if there is "proximate cause" involved with a nearby quarry. [emphasis added]

Coleman said in Nelson and her neighbor's case, MDE determined the quarry was responsible for the sinkhole. Representatives from that quarry have appealed the decision, and it's still in litigation, she said. [emphasis added]

Nelson, whose family has been relocated three times since the incident, declined to talk about the bill or case after the hearing, citing the litigation.

Bill Castelli, a senior vice president and lobbyist with Maryland Realtors, was in favor of the bill. But there are challenges to implementing it, he said, because the maps of ZOI from the MDE are not easy to find online. [emphasis added]

The disclosure should be akin to a "buyer notice" when someone sells their property, Castelli said. [emphasis added]

"We think it should be a simple disclosure that would catch the attention of the buyer and direct them to MDE to investigate it further, and then it would allow them to discover whether the property is in [the zone], or whether the property is out," Castelli said. [emphasis added]

Jennifer Minnick, director of housing for Habitat of Humanity for Frederick County, said in written testimony that Habitat bought a property at 23 Hamilton Ave. without knowing whether it was in a zone of dewatering influence. [emphasis added]

Habitat helped Keysha Saxon, a single mother with three children, buy the house, noting it is handicap-accessible for her son, who uses a wheelchair.

"Where would Keysha and her family go if a sinkhole was discovered or in the process of forming? We cannot re-house them without having the funds to do so," Minnick wrote.

She said after the hearing that it's important for potential homeowners to know whether the risk of sinkholes exists, so they can look into buying insurance. [emphasis added]

Legislation Holding Quarry Operators Responsible for Well and Sinkhole Damages Within "Zone of Influence" Not Applied Retroactively[72]

> ***Medford Quarry's Wakefield Valley neighbors were told yesterday [April 9, 1996] that they may not look to the quarry owners to repair sinkhole damage or replace wells that went dry in the past five years -- a period when the mining industry fought a law that made it responsible for that kind of damage.*** [emphasis added]
>
> *Assistant Attorney General M. Rosewin Sweeney advised the Maryland Department of the Environment that quarry owners will become responsible for well and sinkhole damage caused by their operations only after the MDE adopts a "zone of influence [ZOI]" map outlining each quarry's area of responsibility.*
>
> *C. Edmon Larrimore, head of the minerals, oil and gas division of the MDE's Water Management Administration, relayed the legal opinion to New Windsor-area residents at a hearing yesterday on the zone of influence [ZOI] proposed for Redland Genstar Inc.'s Medford quarry.*
>
> *The Maryland Aggregates Association challenged the law soon after the 1991 General Assembly passed it and obtained an injunction that prevented state agencies from enforcing the law while it was under court challenge. The case ended in 1995 when the Supreme Court refused to hear a mining company's appeal.*
>
> *The mining companies "bought four years of exemption by challenging the law," said New Windsor resident David T. Duree, chairman of the county Planning Commission.*
>
> *The zone of influence [ZOI] outlined last night by MDE geologist Janine S. Mauersberg extends roughly from the branch of Turkeyfoot Run near Nicodemus Road on the south to 250 feet north of Little Pipe Creek on the north. On the east and west sides, it lies 300 feet beyond the edges of the limestone formation. Ms. Mauersberg called the line "conservative" because it extends beyond the water-bearing limestone into metabasalt, a harder, less porous rock.*
>
> *The audience at the hearing ranged from residents who wanted their properties included in the zone to a developer [Powers Homes] who wanted his land removed.*
>
> *Nicodemus Road resident Winston Griffin found the zone-of-influence line drawn through the center of his property, leaving it half in, half out.*
>
> *"One of the headaches is that if you're on that line, the quarry is going to disavow any responsibility," he said. Mr. Griffin said he hasn't had problems with loss of well water but would like his entire property included in the zone.*
>
> *Jeff Powers, president of Powers Homes, told the MDE officials that he would like his land excluded [from the ZOI]. "This is extremely detrimental to my development of the property," he said, adding that he believes the mining companies gain a limit on their liability through the law's application only to wells and sinkholes.*
>
> ***By holding quarries responsible unless they could prove damage did not result from their operations, the bill, sponsored by Richard N. Dixon, reversed a 1968 law that had made it difficult for nearby property owners to recover damages from mining companies.*** [emphasis added]

[72] Donna R. Engle, The Baltimore Sun, "Quarry not held liable for damage Mining companies not responsible for drywells sinkholes," April 10, 1996, https://www.baltimoresun.com/news/bs-xpm-1996-04-10-1996101102-story.html.

Ontario Karst Terrains

In 2013, at the request of MNR planning staff in the ministry's Southern Region, Ontario Geological Survey, provided a summary of some key geological investigation methods for addressing karst hazards in selected jurisdictions of Ontario.[73]

> *One of the key objectives of this article is to address concerns of provincial staff involved in municipal land-use planning, specifically in eastern Ontario. The main purpose of this document is to provide a more comprehensive summary of the kinds of geoscience field work and data sets that could be integrated into field-based studies in order to address gaps in the current guidelines framework (e.g., Natural Hazards Technical Guidance documents for use with the current Ontario Provincial Policy Statement).*
>
> ***The mandate of the Ontario Geological Survey is to provide citizens and institutions of Ontario with accurate and objective earth science knowledge about Ontario, in order to sustain and support quality of life, economic prosperity, environmental quality, and public health and safety.*** *The OGS does not comment on best practices or recommended approaches for reviewing and approving changes to land-use or development applications in karst terrains.* [emphasis added]
>
> *Because karst is where you find it, concerns regarding structural collapse, and regulations and guidelines related to sinkhole hazards and subterranean caves are best addressed at the local or site specific level. Karst features presented in the OGS karst map (Brunton and Dodge 2008) and accompanying reports divided karst features into 3 main types:*
>
> *known karst,*
> *inferred karst, and*
> *potential karst.*
>
> *Some of the main challenges concerning the production of comprehensive provincial policy statements and guidelines for conducting various forms of construction development and/or farming practices in karst terrains of Ontario include the fact that 1) the bedrock geology and nature of Quaternary sediments covering the Paleozoic bedrock vary across southern Ontario and 2) a number of the ministries involved in Provincial Policy Statement–decision making and in creating best practices documents have few or no Qualified Persons.*
>
> *Because karst terrain development is tied to the interaction of aggressive waters and favourable rock types, it is essential that groundwater conditions and karst features are properly documented at both a local and regional scale. Solutionally aggressive waters associated with karstification are undersaturated in mineral phases of particular rock types (e.g., limestone, dolostone, gypsum) and enriched in carbon dioxide gas (slightly acidic), so dissolution of that material (rock) may arise until saturation in those mineral phases is achieved. Cave and spring precipitates (e.g., stalactites, stalagmites, tufa) result from supersaturation of groundwaters and resultant deposition of carbonate. Therefore, karstification involves both dissolution and precipitation geochemical processes associated with water–rock interactions. The presence of biological and/or organic compounds in soils and rock (e.g., bacterial activity and hydrogen sulphide and presence of organic compounds, such as oil, gas, and bitumen) also may increase carbonate solubilities and enhance karst terrain development.*
>
> ***Stage 1: Ministry Pilot Studies for Locally Based Karst Terrain Mapping***
>
> *Stage 1 involves the compilation and use of available maps, satellite imagery, air photos and reports within a given study area to identify and delineate the location, distribution, physical characteristics of karst features and available data concerning surface water hydrology (drainage patterns on a seasonal basis) and groundwater quality. The Ontario Geological Survey has a*

[73] F.R. Brunton, "Karst and Hazard Lands Mitigation: Some Guidelines for Geological and Geotechnical Investigations in Ontario Karst Terrains," *Earth Resources and Geoscience Mapping Section, Ontario Geological Survey*, December 2013, file:///C:/Users/Windows%207%20PC/Downloads/FRB-2013-KarstHazard-Mitigation%20(1).pdf.

number of ArcGIS®-based data sets that could be integrated for a given development application or an application for a change in land-use planning. Data layers that should be included in such studies are the following: Karst, Bedrock topography, Physiography, Quaternary and Bedrock Geology, as well as hydrology and subsurface groundwater data. The complexity and associated costs of the initial desktop study of a geotechnical or engineering site investigation, only one component of which would be an examination of karst hazard concerns, would be dependent upon the nature of the development being proposed (i.e., ranging from a few thousand dollars for a single dwelling home with a septic system, to millions of dollars that would be required for the development of a nuclear facility).

Stage 2: Ministry Pilot Studies for Karst Terrain Mapping and Hazard Land Mitigation

Specific or Comprehensive Planning: *address karst hazards directly by 1) field-based mapping of hazards (e.g., irregular surface drainage patterns and disappearing streams, presence of sinkholes, caves, solution-enhanced joints); 2) identifying compatible land-use activities; 3) establishing construction standards for development; 4) developing policies for addressing current inappropriate land uses; and 5) producing karst feature buffers that are specific to a given region and local set of land-use policies. This would involve restricting development around karst features through establishment of a fixed radius of no development or no storage of farm-related materials such as fertilizers or manure piles.*

Structural Concerns: *limit development that would require extensive blasting of carbonate or mixed carbonate–gypsum–evaporite bedrock, and/or intensive construction that would create excessive weight (large subdivisions, industrial parks) and/or alter drainage that could compromise underlying caves or buried sinkholes.*

Surface Water and Groundwater Contamination Concerns: *prevention of the construction of industrial point sources (e.g., chemical plants, dry cleaning facilities), waste lagoons, underground storage tanks, landfills and/or related changes in designation of land uses for either rural subdivision development (intensive septic system installations) or animal and crop agricultural uses. Land uses that drastically alter the position of local water tables and/or modify local drainage patterns, in association with inadequate storm-water management, may accelerate sinkhole subsidence and increase sinkhole and cave flooding in an unpredictable manner.*

Geotechnical Studies: *provide specific information relative to karst features through the identification and characterization of surface and deeper soils (overburden characterization – Quaternary geology studies), bedrock geology and an evaluation of local to regional hydrologic and hydrogeologic studies.*

NEGATIVE ASPECTS OF LIVING IN KARST TERRAINS

- *rapid drainage of rain and surficial waters may result in low water in wells during summer and reduced water supplies in late summer;*
- *rapid drainage or infiltration of waters into overburden and bedrock systems can transport waste contaminants from various sources (e.g., human, farm animal, nutrients, industrial) to groundwater drinking supplies;*
- *structural concerns, land subsidence and ground movements, resulting in property damage and possible threats to life—these are often induced by changes in land-use planning and redirection of surface waters and groundwater supplies.*

Quarrying in Karst

According to *Urich*,[74] quarrying in a karst terrain has a number of adverse land use impacts, including the following:

> ***2.7.1 Quarrying***
> *In aesthetic terms, limestone quarrying is the most 'obvious and, in both process and landform terms, the most dramatic anthropogenic impact on karst terrain' (Gunn & Bailey 1991, 1993). The quarrying of limestone has both geomorphological and ecological impacts. The work of Gunn & Bailey (1991, 1993), Gunn & Hobbs (1999) and Hess & Slattery (1999) detailed these impacts in a British context. However, many of their findings are applicable to quarrying in any environment.*
>
> *In essence, quarrying represents an intensification of the erosion process. In the case of Britain, the volume of material excavated would have taken up to 10 000 years to erode naturally. It is the rate of change that has dramatic and equally rapid impacts on hydrology and karst ecology. One of the more common impacts of quarrying is the drawdown of water in the subcutaneous zone surrounding the quarry. In some cases, this has led to doline formation. In other cases, the entire subcutaneous zone may be removed by quarrying activities and in such cases the impacts on local water resources and karst processes can be profound. When groundwater pumping is required to maintain a quarrying operation, the impacts typically affect a greater area than when pumping is not required. Groundwater drawdown can influence groundwater discharge from springs in the region of the quarrying operation, in terms of both quantity (seasonality) and quality of debouched water.*
>
> *The stripping of forest cover and soil for quarry development destroys the karst ecology of the area earmarked for quarry development. Deposition of the spoils from these activities can also influence karst processes. The size and depth of the quarry has implications for the subsequent recolonisation of the environment by surrounding vegetation. With an increase in depth, it is correspondingly likelier that a different limestone composition will be exposed. Upon abandonment, the soil formed from this parent material could be significantly different from the surrounding environment, obviating the development of a complementary plant assemblage (Ruthrof 1997).*
>
> *Gunn & Bailey (1991) assert that the size of a quarry is of less impact than its situation. They describe three possible locations for quarry development: on flat ground, along or into the side of a valley, or into a hill. Quarries developed in flat areas have less impact and this is restricted to the destruction of local karst features. Valleyside and hillside quarries are, however, favoured for their economy; it is easier and cheaper to work material laterally rather than vertically. Generally, hillside quarries have a greater geomorphological impact than valleyside operations. Cases of complete hill removal through quarrying have been documented (Stanton 1990; Urich et al. 2001).*

[74] Peter B. Urich, "Land use in karst terrain: review of impacts of primary activities on temperate karst ecosystems," *Department of Conservation, Wellington New Zealand,* June 2002, https://www.doc.govt.nz/documents/science-and-technical/Sfc198.pdf.

SECTION II – DOCUMENTED FLYROCK INCIDENTS

Flyrock 38

On April 5, 2017, at an opencast coal mine in Ramgarh District of Jharkhand State, a blaster's helper was killed after being struck by flyrock at a distance of 280 metres from the blast site.

> *The maximum possible travel distance of flying fragments based on different flyrock prediction models was 227 m. In the synonymous blast, only vertical throws of the flying fragments up to 70 m (approximate) height were observed. It was difficult to find out the exact cause of [the] flyrock incident. However, based on the detailed investigation, it was concluded that the possible cause of flying fragments travelling up to a distance of 280 m could be due to the presence of a weak zone in the rock strata.*[75]

Flyrock 39

On February 7, 2012, blasting at Moons Hill Quarry, Stoke St Michael, in the UK sent flyrock outside a danger zone toward employees and across a public road.

> ***A Somerset company has been fined after a quarry blast sent rocks of up to 15 kilos flying outside a danger zone toward employees and across a public road. Falling rocks narrowly avoided hitting workers as they landed well outside the designated blast zone at Moons Hill Quarry…on February 7, 2012****.* [emphasis added]
>
> ***Rocks also fell onto a public highway, exposing road users to unacceptable danger.*** [emphasis added]
>
> *Frome-based WCD Sleeman and Sons Ltd, who organised the blast, were prosecuted on February 27 after an investigation by the Health and Safety Executive (HSE) identified serious control failings.*
>
> ***Bristol Crown*** ***Court heard that workers acting as sentries outside the danger area were aware of rocks flying above their heads and landing all around them immediately after the blast. Rocks also landed in the processing plant area of the quarry, which is on the other side of a public road.*** [emphasis added]
>
> *HSE inspectors discovered that the blast had not been properly planned, that too much explosive was used in an area where the ground was already broken and measures put in place to reduce risks were inadequate.*
>
> *Sleeman was fined £30,000 and ordered to pay £20,000 in costs after pleading guilty to breaching Section 3(1) of the Health and Safety at Work Act 1974.* ***The court heard the firm was prosecuted after a similar offence in Devon when it was fined £20,000 with £17,000 costs in 2013****.* [emphasis added]
>
> ***HSE inspector Catharine Pickett described the incident as "very serious" and put the public and employees at risk of death or injury. "Blasting operations at quarries are potentially very dangerous.*** *The risks must be rigorously controlled by good engineering practice and in accordance with legal requirements.* [emphasis added]
>
> ***"Quarrying remains one of the most dangerous industries to work in with 3,250 injuries, including 27 fatalities, reported to HSE since 2000."*** [emphasis added]

http://www.hazardexonthenet.net/article/91111/UK-company-in-court-again-after-dangerous-quarry-blast.aspx

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[75] C. Sawmliana, Panchanan Hembram, R.K. Singh, S. Banerjee, P.K. Singh and P. Pal Roy, "An Investigation to Assess the Cause of Accident due to Flyrock in an Opencast Coal Mine: A Case Study," *J. Inst. Eng. India Ser. D* (January-June 2020) 101(1):15-26.

Flyrock 40

In Pennsylvania in 1999, an equipment operator had stopped work clearing the crusher area near the blast site. He and his superintendent were parked in the usual spot, 800 ft [244 metres] away guarding the road. They were watching the blast. A baseball-sized piece of flyrock went through the windshield.

The victim died after surgery. He was only 32 years old. The supervisor was unharmed. Rocks flew 1,500 ft [457 metres] on that day.[76] [emphasis added]

Flyrock 41

[On August 15, 2019,] a Pangoula Farm woman on the outskirts of Harare died when a huge stone from a Lafarge quarry blast bore through the roof and struck her on the head. Shupikai Chitsana (36) who was in the kitchen died on the spot while her aunt was injured after a fly rock from Lafarge Cement quarry mine ripped through the roof and hit her in the head. [emphasis added]

*…**[T]he deceased is survived by her spouse and five children.*** [emphasis added]

After losing their mother due to irresponsible mining activities, the bereaved family was told by the government not to speak to anyone about the incident….

Lafarge Cement Corporate Affairs Manager Tawanda Njerere confirmed the incident and said investigations by the police and the Ministry of Mines and Mining Development are underway….[77]

Flyrock 42

Blasting at *City Sand's* quarry on the outskirts of the City of St. John's, Newfoundland, led to a flyrock incident in 1988, which resulted in a temporary prohibition from blasting in certain parts of the 48-acre quarry on the outskirts of the City of St. John's, now in the Town of Paradise. A subsequent blast at the same quarry on July 3, 1998 resulted in flyrock that damaged two homes in the nearby Jane Heights subdivision (Elizabeth Park), and led to a permanent revision of the quarry's blasting plan to reduce the potential for flyrock.

From 1983, the Department of Mines and Energy [Newfoundland & Labrador] required a buffer zone of 300 meters between quarrying and a residential development. That requirement was a condition of the quarry leases issued to City Sand [and Gravel]….[T]he requirement of a 300 meter buffer zone was not a problem for City Sand in 1983 but became an issue in respect of residential development [of an infill 17-lot subdivision in Jane Heights approximately 225 metres from the quarrying activity] authorized [in 1985] for a nearby area, part of which was within 300 meters of the quarry's operations [para. 6].[78] [emphasis added]

Complaints respecting the effects of quarry blasting were received by Metro Board and provincial regulatory authorities from residents in Jane Heights in June 1986 and May 1988….The 1988 incident resulted in a temporary prohibition from blasting in certain parts of the quarry site. There were no further problems reported with further quarry blasting until July 3, 1998, when fly-rock caused damage to the garage of one resident of Jane Heights and to the roof of another [para 20].[79] [emphasis added]

In 1988, fly-rock from the blasting landed in the [300-metre] buffer zone. Blasting operations were subsequently prohibited in certain areas of the quarry….[On] July [3,] 1998, two Jane Heights residences were damaged as a result of fly-rock. City Sand was then required to

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[76] https://www.usgs.gov/special-topic/water-science-school/science/sinkholes.

[77] https://miningzimbabwe.com/woman-killed-in-lafarge-compound-after-cement-mine-blast/.

[78] *City Sand and Gravel Limited and O.D. Holdings Limited v. Her Majesty the Queen in Right of Newfoundland, as represented by The Honourable Minister of Municipal and Provincial Affairs*, 2008 CanLII 1399 (SCC), <http://canlii.ca/t/1vgkt>, retrieved on 2020-07-10.

[79] *City Sand and Gravel Limited v. Newfoundland (Municipal and Provincial Affairs)*, 2007 NLCA 51 (CanLII), <http://canlii.ca/t/1sfnv>, retrieved on 2020-07-11.

revise its blasting plan to minimize the potential for fly-rock. *City Sand commenced an action in early 1998, claiming that the Respondent should be held liable in tort for damages to City Sand as a result of the significant costs incurred from the revised blasting plan. The Supreme Court of Newfoundland and Labrador, Trial Division, dismissed City Sand's action for damages, finding that no duty of care was owed by the Respondent to City Sand. The decision was unanimously upheld on appeal.*[80] [Leave to appeal to the Supreme Court of Canada was denied.] [emphasis added]

The Buffers between the quarrying operations and the residential use or future urban development are intended to separate the two conflicting uses and to reduce the adverse effects of the quarrying operations on the other uses [par 17]. [emphasis added]

The buffer zone, by definition, is a neutral area designed to separate, in this instance, two inconsistent and adjoining uses. From an occupational health and safety perspective, it is a safety mechanism in the sense that should fly-rock or debris be ejected from the quarry site, as a result of blasting or other techniques, the likelihood of injury or damage to others is minimized. No evidence was placed before me to suggest the buffer zone is an area of usage to the plaintiff [City Sand and Gravel], that is granting the plaintiff [City Sand and Gravel] permission, in its operations, to eject rock or debris into this area and outside the boundaries of its leasehold realty property [para. 29]. [emphasis added]

City Sand understood from discussions with the Department of Mines and Energy, which issued the quarry leases, that there was a [300-metre] buffer zone around the quarry site. However, the quarry leases did not confer upon City Sand rights over property outside the quarry site [p.38]. [emphasis added]

A municipal authority reviewing a proposed residential development may owe a duty of care to future residents in respect of known hazards. Though City Sand emphasized that point, it did not acknowledge directly that its blasting, which entailed the inherent risk of fly-rock, exposed it also to liability in tort to those same residents. As City Sand had no right to eject fly-rock outside the quarry site, the respondent argued that Metro Board owed no duty of care to City Sand. *The trial judge agreed – Trial Decision para. 56. I see no fundamental flaw in that position.* ***City Sand carried on a legitimate but inherently dangerous operation. It constituted a danger to persons and property outside the quarry site.*** *Prior to the development of Jane Heights, neither the owner of the land comprising that development, nor Metro Board, found it necessary to take legal action in respect of fly-rock landing outside the quarry site.* ***City Sand could not however compel Metro Board to restrict development of adjacent land so that a public danger would not be created [para. 54].***[81] [emphasis added]

In my view, Metro Board in this case made a conscious policy decision to authorize the Jane Heights development. When, in June 1984, the development was found to be contrary to the Regional and Municipal Plans, Metro Board sought and obtained the approval of the Department and Minister to amend those plans via the Development Scheme. When the Development Scheme was adopted, Metro Board promptly amended its regulations in order to implement the Development Scheme and approved the development of Jane Heights. Throughout that process the decisions were taken at the highest level of Metro Board. The approval of the development was not "merely the product of an administrative direction, expert or professional opinion, technical standards or general standards of reasonableness"... The decision to allow additional residential development to the east of the proposed Outer Ring Road had financial, social and economic ramifications. Though not referenced in the Metro Board minutes, it is reasonable to infer that the

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[80] Supreme Court of Canada Summary 32302 *City Sand and Gravel Limited, et al. v. Her Majesty the Queen in Right of Newfoundland, as represented by The Honourable Minister of Municipal and Provincial Affairs* (Newfoundland & Labrador) (Civil) (By Leave), file:///C:/Users/Windows%207%20PC/Documents/Supreme%20Court%20of%20Canada%20-%20SCC%20Case%20Information%20-%20Summary%20-%2032302%20City%20Sand%20and%20Gravel%20Flyrock.htm.

[81] *City Sand and Gravel Limited v. Newfoundland (Municipal and Provincial Affairs)*, 2007 NLCA 51 (CanLII), <http://canlii.ca/t/1sfnv>, retrieved on 2020-07-11.

members of Metro Board were guided by such considerations. There was no evidence of improper factors entering into the deliberations of Metro Board [para. 51].[82]

Buffer Zone Requirements for a Blasting Quarry Operation Increased

While *City Sand* was permitted to continue to carry out blasting operations based on a 300-metre buffer, which reduced the amount of onsite land available for extraction, there had been a growing awareness that a 300-metre buffer for the operation of a blasting quarry was insufficient to protect the health and safety of the public against "flyrock." The concept of a buffer or buffer zone was in its early developmental stage when the problem of "flyrock" arose in 1988 between the City Sand quarry and the residents of the adjoining Jane Heights subdivision. (para. 64).[83]

In 1996, in response to a growing awareness of "flyrock" as a public health and safety concern, the Department of Municipal and Provincial Affairs in its conditions for approval of a blasting quarry operation required that a 1,000-metre buffer zone be maintained from a *cottage* or *residence*.[84]

In November 2018, *City Sand* announced that it would be closing the Paradise quarry, as, according to Larry O'Keefe, the quarry co-owner, "we've reached the back boundary of our property, which has a watershed behind us, so therefore we're not allowed [to] continue going back into the ground, [a]nd with the construction of the [Outer] Ring Road 20-odd years ago [opened as a highway in 1998], it would make it unfeasible to construct our second lift of material."

"The government had purchased land to the west of us, and [it] thought we would then be able to extract the rock from that piece of property."

However, O'Keefe said, in the 1990s the zoning of the property changed from mineral workings to open space buffer — blocking City Sand and Gravel from using the land….

Mayor of Paradise, Dan Bobbett, said the town's hands are tied by a municipal plan developed with an independent commissioner.

"It looked at all the growth in the Town of Paradise and looked at buffer zones, and in this particular one, we can't do it because the commission basically said that you must obey these buffers," Bobbett said. [emphasis added]

Residential homes are in close proximity to the blasting operation, he added. [emphasis added]

*"**In this case, the buffer zones are in place for the safety of our residents and we have to maintain those safety zones**…."*[85] [emphasis added]

Flyrock 43

On November 17, 2011, a blast at a quarry in Tremont, Maine, showered a nearby neighbourhood with flyrock that penetrated two (or possibly three) occupied homes, a workshop, a garage and a lobster boat, and caused extensive damage.

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[82] *City Sand and Gravel Limited v. Newfoundland (Municipal and Provincial Affairs)*, 2007 NLCA 51 (CanLII).
[83] *City Sand and Gravel Limited v. Newfoundland (Municipal and Provincial Affairs)*, 2007 NLCA 51 (CanLII).
[84] *City Sand and Gravel Ltd. et al. v. Newfoundland (Minister of Municipal and Provincial Affairs),* 2005 NLTD 67 (CanLII), <http://canlii.ca/t/fwvrv>, retrieved on 2020-07-22, para. 20.
[85] Ariana Kelland, CBC News, November 8, 2018, https://www.cbc.ca/news/canada/newfoundland-labrador/city-sand-gravel-closing-paradise-1.4896754.

Bruce Rich was in his living room last week watching a movie, about meteors when rocks started falling from the sky around his house. [emphasis added]

But it wasn't rocks from space that pelted his home on Nov. 17, causing substantial damage. It was rocks from a quarry a few hundred yards east of his house, where a contractor had detonated explosives to blast away rock from a ledge. [emphasis added]

Rich, a lobster fishermen, said Friday that a large rock "as big as a TV tray" came through his bedroom wall, smashed through his bedroom door and came to rest in another bedroom. Debris from the blast also flew through a wall of his adjacent workshop, smashed five of his lobster traps and put rips and dents in his roof, which he said will have to be reshingled. [emphasis added]

On Friday, a shard of rock the size of a man's hand still protruded from an interior wall next to Rich's bedroom door…. [emphasis added]

He estimated that "thousands" of rocks of varying sizes sailed over the trees between his house and the quarry and landed on his Spruce Lane property. [emphasis added]

"It was raining rocks outside the window," Rich said. "The big one didn't hit where I was sitting or I would have been killed. I'm very upset." [emphasis added]

Danielle Neal, who with Jerry Harper lives next door to Rich, said Friday afternoon that rocks from the blast struck the house they live in. Rocks punctured the roofs of their house and garage, the body of an older truck inside the garage, and bent the frame of an all-terrain vehicle in their yard, demolishing it, she said. A large rock also smashed through the side of Harper's lobster boat, which is sitting on blocks outside their house. [emphasis added]

"It's fortunate no one got killed," Neal said. "I think there should be more regulation over [blasting]." [emphasis added]

Neal said she and Harper have consulted with an attorney to explore their options, but that they "don't know how far it's going to go." [emphasis added]

The contractor who set the blast said Wednesday that he has apologized to Rich, Neal and another nearby homeowner whose house also was hit, though to a lesser extent, by the flying debris. *Drilling and Blasting of Exeter was blasting ledge at the quarry, which is owned by local contractor John Goodwin Jr.* [emphasis added]

David Eastman of Northern Drilling and Blasting said Wednesday that his firm has been blasting in that same quarry on and off for a decade and has never had a problem before.

He said that on Nov. 17, he used 6,500 pounds of an "emulsion type" of explosive in the blast. He has licenses from the State Fire Marshal's Office and the federal Bureau of Alcohol, Tobacco and Firearms to transport and store the explosives, he said….

Eastman said he made sure Rich's house was sealed up right away and, on Monday, sent a carpenter to Rich's house to begin repairing the damage. Rich, however, sent the carpenter away before he could get to work, he said….

Rich said Friday that the carpenter showed up Monday before anyone from his insurance company had seen the damage. He said that he expects the same carpenter to come back next week to do an estimate, but that he expected to solicit estimates from other carpenters, too.

Rich said he has consulted with an attorney, but he has not decided what he will do. He has not ruled out filing a law suit against the contractor, he said. [emphasis added]

"I don't know yet," Rich said. "I can't sleep. My blood pressure is up and everything. I don't feel safe here no more." [emphasis added]

Inquiries made this week to state agencies about the incident suggest that Eastman's company might not face any regulatory penalties for damaging the homes…. [emphasis added]

Millard Billings, Tremont's town manager, said Friday that Tremont does not have any sort of blasting ordinance, but it might by next summer.

He said he has been asked by the town's Board of Selectmen to approach the planning board so a blasting ordinance can be drafted and submitted to voters for possible adoption at the annual town meeting in May. He said he plans to raise the issue with the planning board when it meets this coming Tuesday.

What kind of requirements the town might impose on blasting, Billings said, has not been determined. Town officials likely will consider requiring blasting contractors to be insured, to be properly licensed by the appropriate state and federal agencies, and perhaps to follow other precautions such as using protective blast mats.

"It depends how in depth they want to get into," Billings said.[86]

Flyrock 44

As reported in a regulatory update of the Division of Mineral Mining (DMM), Virginia,[87]

In October 2008, a volleyball size rock was thrown 1,700 feet [518 metres] hitting a MCC building located 100 feet from the jaw crusher operator's booth. The crusher was manned and operating at the time.

Flyrock 45

As reported in *Dept. of Energy v. Hobet Mine & Const.*, 358 S.E. 2d 823 (1987),[88] Burton N. Lay, an employee, was paralyzed after being struck by flyrock at a distance of 1,115 feet (340 metres), for which the operator of the mine was fined a nominal sum of $1,000, a fine that was overturned on appeal. In a previous incident, flyrock had travelled in excess of 1,500 feet (457 metres).

This case arises from an accident at Hobet Mining Company's strip mine located in Boone County. Hobet was in the process of removing material known as innerburden to reach a coal seam at Hobet Mine No. 21. The ordinary procedure for removing innerburden is to drill holes into the strata, pack the holes with explosive charges, detonate the charges, remove the shattered material and repeat the process. ***After one such charge was detonated, Burton N. Lay was struck in the back by a piece of fly rock that had traveled 1,115 feet. His resulting injuries required extensive medical treatment and he is now permanently paralyzed from the mid-back down.*** [emphasis added]

The West Virginia Department of Mines investigated the accident. Their findings determined that the procedures used in setting and detonating the blast that injured Mr. Lay at Hobet No. 21 was the standard procedure at Hobet, and that Hobet had experienced fly rock traveling in excess of 1500 feet before. *Nonetheless, Hobet continued to allow employees to place themselves in unsheltered positions at various distances from explosive charges while they were detonated. Based on these facts, the Department issued a notice of violation to Hobet for failing to maintain a safe blasting area as defined in West Virginia Administrative Rules and Regulations, Series III, § 3.32.* [emphasis added]

Following a full evidentiary hearing before the Department of Mines Hearing Examiner, Hobet was assessed a fine of $1000.00 for not maintaining a safe blast area. Hobet appealed to the Kanawha County Circuit Court. The circuit court, by final order on 10 May 1985, reversed the hearing

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[86] Bill Trotter, "MDI homes pelted with rocks from errant quarry blast," November 25, 2011, https://bangordailynews.com/2011/11/25/news/mdi-home-pelted-with-rocks-from-errant-blasting/.

[87] "Blasting Regulation Changes and Flyrock," Division of Mineral Mining, Created 2009, https://www.dmme.virginia.gov/DMM/PDF/TRAINING/REFRESHER/lawchanges/ARBlastingRegChanges2009.pdf.

[88] https://scholar.google.com/scholar_case?case=17148911866299365666&q=fly+rock&hl=en&as_sdt=2006

examiner's decision. The circuit court applied a higher standard of proof than that applied by the department and held that there must be a knowing violation.

Flyrock 46

A 2008 YouTube video posted online by WorkSafeBC describes a flyrock incident in Barnaby, which caused injury to a worker and damaged vehicles and equipment. One flyrock weighed 140 kilograms (309 pounds) and was propelled 250 metres.[89]

At this site a blaster initiated a 100-hole open face blast. Flyrock flew up to 250 metres. 14 pieces of parked equipment and several vehicles were damaged. The force of the blast was so powerful that this 140 kilogram rock flew 250 metres all the way to the entrance of the construction site. A blaster must ensure that the danger area is clear of workers and is kept clear during the blasting operation but at this site five workers were put at risk by being allowed to stay within the danger area of the blast. One worker was struck by a small piece of flyrock and another worker suffered abrasions as he ducked for cover…..

Flyrock 47

A 2012 article *Environmental and Safety Accidents Related to Blasting Operation* authored by *Kricak et al.*,[90] includes an overview of the incidence of flyrock in various jurisdictions, and presents a case study of a flyrock incident in an unnamed andesite quarry in an unidentified location. The flyrocks, consisting of 3 rocks up to 50 centimetres (1.64 feet) in diameter, were propelled a distance of about 300 metres and caused extensive external and internal damage to a neighbouring home.

A field-scale investigation related to flyrock accident was conducted in an andesite quarry where rocks up to 50 cm in diameter were propelled almost 300 m from the center of blasting field causing extensive damages to the surrounding objects. The study revealed that accident occurred due to the existence of andesite alteration in one section of the blast field. The existence of this alteration caused a sliding of rock masses along the subsistent joint planes and thereby reduced burden for the second row of blastholes. Alterations involved small area of andesite masses that were not detected by previous geological exploration or visually observed prior to initiation of blastholes [p. 360]. [See Figures 1, 2 and 3 at page 361 for photos of property damage and flyrocks that caused the damage.]

Flyrock 48

On July 15, 2015, blasting at a construction site in Johor, Malaysia, propelled flyrock a distance up to 200 metres from the blasting face, killing a nearby factory worker and injuring two other workers, and damaging several vehicles.

…[O]n the day the blasting, an unprecedented catastrophe occurred in which a part of the rock mass approximately 2,000 m^3 from blasted granite flew away for a distance up to 200 m from the blasting face. From site survey, it was found that the size of the fly rock varied from 5 cm^3 to 0.3 m^3. Figure 1 shows the location of the areas involved. As a result of the explosion, unexpected fly rock covered surrounding area of the location. This unexpected accident killed a worker and injured two others. Workers involved were about 150 m to the west of the blasting location. Several vehicles

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[89] "It Was Raining Rocks." https://www.worksafebc.com/en/resources/health-safety/slide-shows/accident-snapshot-fly-rock-from-blasting?lang=en.

[90] Lazar Kricak, Vladislav Kecojevic, Milanka Negovanovic, Ivan Jankovic and Dario Zekovic, *American Journal of Environmental Science*, 2012, 8 (4), 360-365, file:///C:/Users/Windows%207%20PC/Downloads/ajessp.2012.360.365%20(2).pdf.

were also destroyed and damaged. Some small fragments flew to a factory in southwest (about 50 m away). Figures 2 to 4 show the effect of the blasting [p. 16].[91]

…[I]t…[was] concluded that in present case study geological structure of rock-discontinuity of rock in west contributed to fly rock and blasting practice of blast design, communication, security arrangement, evacuation of persons from blasting zone, resulted into fly rock accident [p. 20].

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President, International Forensic & Litigation Appraisal Services Inc. and
International Valuation Consultants Inc.

Email : info@intval.com Web site : www.intval.com

[91] Edy Tonnizam Mohamad, Bhatawdekar Murlidhar, Danial Jahed Armaghani, Rosli Saad and Chang Shiang Yi, " Effect of Geological Structure and Blasting Practice in Fly Rock Accident at Johor, Malaysia," *Jurnal Teknologi, (Sciences & Engineering)*, 78: 8-6 (2016) 15-21, file:///C:/Users/Windows%207%20PC/Documents/Effect%20of%20Geological%20Structure%20and%20Blasting%20March%202016%20Mohamad%20et%20al.%20a522b38e6c1a32fe5710c323e99ee69e459f.pdf.

House Quarry Application

Township of Lake of Bays File: Z39/05

I act as independent planning consultant to the Peninsula Lake Association. As you know, the Association is one of a number of parties to the hearing before the Ontario Municipal Board concerning the proposed zoning by-law amendment and site plan respecting the House Quarry application. The portion of the hearing relating to the zoning appeal by Mr. House was dismissed by the OMB for jurisdictional reasons relating to the Township's previous comprehensive zoning by-law, which was repealed in its entirety prior to the OMB hearing. The balance of the hearing was adjourned by the OMB to provide an opportunity for Mr. House to make an application for an amendment to the Township of Lake of Bays Comprehensive Zoning Bylaw 04-181. My understanding is that if this new application is refused by Township Council like the previous one was, it will likely be appealed by Mr. House to the OMB, where it would be consolidated with the pending site plan appeal and the two matters would proceed together upon the resumption of the OMB hearing.

On November 4, 2003 I addressed Township Council during its consideration of Mr. House's previous zoning amendment application. That application was refused by Council at that time. Since then, there has been no substantive change in the proposed application which would cause me to revise my planning opinion. In my professional planning opinion, the House Quarry application does not conform to the governing policies of the Lake of Bays Official Plan, does not represent good planning for the site and the surrounding communities, and should be refused once again.

The current zoning amendment application proposes the establishment of three zones on the subject property. These can be characterized as follows:

• A stone quarry extraction area is located at the south end of the property on a treed slope facing Peninsula Lake. This slope is clearly visible from a large portion of the lake. Likewise, the area from which was cleared on the property back in 2001-2002, as part of the quarry operations which took place prior to the Township obtaining an injunction to stop the quarrying, is also visible from the lake;

• The bulk of the property is proposed to be re-zoned from Rural to Restricted Rural, with an accessory driveway / haul route for the proposed quarry;

• Two small portions of the property are proposed to be re-zoned to Environmental Protection to recognize unevaluated wetlands; and

• The rock splitting and processing area and landscaping business fronting onto Highway #60 are proposed to be zoned for Restricted Rural (with an exemption to permit rock processing and wholesaling of rock products).

The subject property is designated Rural and is located in the vicinity of numerous established rural residences and cottages on Peninsula Lake, as well as rural residences fronting along Highway #60 adjacent to the property. Immediately to the west of the property is a 192 acre historic farm which is home to horses, cattle, sheep, hens and turkeys. There are other quarry uses in the area, none of which are of recent vintage, and none of which have any noticeable impacts on their neighbours due to their location further away from the residential area and topography. It is acknowledged by all concerned that the proposed House quarry seeks to become the first new quarry operation to be permitted by the Township in this area in many decades.

Proposed setback dimensions are not shown on the zoning by-law schedules provided by the applicant. From my knowledge of the site plan application, it would appear that the setbacks to neighbouring rural residential properties range as low as 30 metres (100 feet). Approximate distances from the rock processing area to the neighbouring residential property are in the order of 70 metres (229 feet).

As you are aware, the Provincial Aggregate Resources Act does not apply within the Township of Lake of Bays. Accordingly, controls over the establishment, use and monitoring of quarries are the responsibility of the Township, to be regulated through zoning and site plan controls as well as the Township's Pits and Quarries By-law. As part of the review process for any proposed new quarry within the Township, an assessment must be made respecting the extent to which the application conforms or does not conform to the Official Plans of the Township and of the District of Muskoka.

In my professional opinion, the House Quarry application does not conform to either Official Plan, for the reasons that follow.

District of Muskoka Official Plan

The District Official Plan contains clear policies to guide applicants and landowners to achieve compatibility between existing and new uses in the District of Muskoka. Key features of the rural and waterfront areas of the community are to be preserved.

The District Official Plan anticipates that aggregate uses may be located in the Rural area of the District, provided that they "should not conflict with the tourism base of Muskoka" (Policy E-3). Moreover, Policy E-12 states in part as follows:

"stone quarrying shall not be permitted to occur where it would require the elimination of significant landscape features. Significant landscape features include any combination of topography and vegetation, which create scenic vistas vital to the tourism industry and will be defined through local policy."

Policy E-16 of the District Official Plan sets out the requirements for a proposed new pit or quarry operation. The matters to be considered include: the appropriateness of the location; quality and quantity of the resources; location and size of stockpiles; and impacts on surrounding land uses, especially residential. These study requirements must be met to the satisfaction of the local municipality, with input from the District. To my knowledge, the submissions by the applicant to date have failed to satisfactorily address any of these matters and, in particular, the potential impacts on surrounding land uses, especially residential.

District Official Plan Policy F4 (in particular 4c) addresses the need to preserve scenic views, and Policy 4e) specifically addresses the waterfront landscape. To date, no information has been provided by the applicant to demonstrate conformity with these specific policies.

Lake of Bays Official Plan

The Township's Official Plan contains numerous policies addressing proposed new quarry operations. For example, it stipulates that "resource industrial will only be permitted in a manner which will be environmentally sound and prevent land use conflicts" (Section F.20). The "matters to be addressed to the satisfaction of the Township" for a proposed new pit or quarry are found in Section F.28.

Section I of the Township's Official Plan expressly notes that resource related industries require a rural and remote location (Sections I.3 and I.12). In my professional opinion, given its proximity to existing established residential and farm uses, the site of the House Quarry application can in no way be characterized as "remote".

Sections D.2, D.128 and E.24 of the Township Official Plan set out overarching responsibilities for new development to prove their compatibility with existing land uses – especially established residential uses. While recognizing the need for industrial and aggregate uses in the Township, the Official Plan stipulates that the conservation of the natural environment will take precedence over development when the two are in conflict and where mitigation measures are unable to protect environmentally sensitive or significant features and functions. Moreover, noxious uses shall not be permitted without mitigation.

In addition to compatibility issues, the Township Official Plan contains clear policy direction emphasizing the need to preserve vistas and panoramas (Section D-9). Section D-10 further states that visual, vegetative impact should be minimal and that ridgelines and skylines should be protected.

Sections E.27 and E28 of the Township Official Plan address compatibility of new uses. E.27 states that:

"new development or use of land will be compatible with:

a) the type and character of the area in which the use is being proposed, and

b) other legal conforming land uses in the vicinity so as to ensure protection of public investment and the continued operation and expansion of such uses, where feasible and appropriate".

This policy contemplates the impact which an incompatible use can have on the ability of existing lands uses to continue to operate and to expand. This policy speaks to the concerns addressed by the Ministry of the Environment Land Use Compatibility Guidelines.

In summary, to date I have seen little from the applicant which demonstrates compliance with these and other applicable policies enshrined in the Township Official Plan.

Ministry of Environment Guidelines

The Ministry of the Environment has two guidelines that are to be used by approval authorities (such as municipalities) when considering changes in land use, and particularly when determining the compatibility between different land uses - more specifically, between industrial and sensitive land uses such as residential. They are as follows: • D-1 Land Use Compatibility • D-6 Compatibility between Industrial Facilities and Sensitive Land Uses

By letter dated October 9, 2003 Mr. Frank Wilson, Director, Northern Region of the Ministry of the Environment (MOE), wrote the following to members of the Peninsula Lake Association:

"Since 1996, local planning authorities, such as municipalities or planning boards, have been delegated increased decision-making authority under the Planning Act. To assist these planning authorities in exercising their new decision-making responsibilities, provincial ministries have been transferring relevant data and information for their use, including the D Series Guidelines.

With respect to your question regarding rezoning applications to permit the development of new quarry operations, the MOE Procedure D-1-2 "Land Use Compatibility: Specific Applications" recommends that for new pits and quarry operations, the influence area is to be determined by appropriate studies (e.g., noise, dust, vibration, hydrogeological) carried out in support of the land use approvals. Under Municipal Plan Review, the approval authority is responsible for requesting these studies and determining the zone of influence. In organized areas, the approval authority rests with the municipality or planning board. In unorganized areas, the Ministry of Municipal Affairs and Housing in partnership with the MOE and the Ministry of Natural Resources is the approval authority."

Ministry of Environment Land Use Guideline D-6 advises the Township to determine the minimum separation distance and potential area of influence for a Class III industrial use (such as a quarry) in the vicinity of sensitive land uses (such as homes and farms). It establishes the following parameters:

• 300 metres minimum separation distance to avoid incompatible uses; and,

• 1,000 metres potential area of influence for any adverse effects "to be identified, mitigation proposed and an assessment made on the acceptability of the proposal" (MOE, D-6, Appendix C).

It is noteworthy that these distances apply regardless of whether it is a new sensitive land use proposed in the vicinity of an existing Class III Industrial Use such as a quarry, or whether it is a new quarry proposed in the vicinity of existing sensitive land uses. As a matter of good planning, the primary consideration should be to minimize conflicts between incompatible land uses, regardless of which is exists and which is proposed.

The Ministry of the Environment also requires that the developer enter into a binding legal agreement for any mitigation prior to the approval of the use (Ministry of the Environment Guidelines D-1-1, D-6).

I would note that Section E.38 of the Lake of Bays Official Plan specifies that a 300 metre setback from a pit or a 500 metre setback from a quarry use is required, subject to studies, when considering new sensitive land uses. If a sensitive use is proposed to be located within the stated setbacks, then an "impact assessment" should be prepared to evaluate the presence and impact of any adverse effects. It appears that the intent of this policy is to be consistent with the Ministry of the Environment D-6 Guidelines. However, because Policy E.38 applies only where new sensitive land uses are proposed near an existing quarry, and not in the opposite scenario, in my opinion the policy is in fact inconsistent with the MOE Guidelines to that extent, and the Township's Official Plan policy should be amended accordingly as soon as possible.

Noise Impacts

Section E.32 of the Township Official Plan states that an acoustical study may be required to determine if provincial guidelines can be achieved for developments within 50 metres of a provincial highway or for stationary noise generators such as aggregate operations. The Lake of Bays Pits and Quarries By-law further states that noise "shall be controlled in accordance with applicable federal, provincial and local legislation" (Section 4.4).

The Environmental Protection Act defines "contaminant" as "any solid, liquid, gas, odour, heat, sound, vibration, radiation or combination of any of them resulting directly or indirectly from human activities that may cause an adverse effect". The Act stipulates that "no person shall discharge into the natural environment any contaminant, and no person responsible for a source of contaminant shall permit the discharge into the natural environment of any contaminant from the source of contaminant, in an amount, concentration or level in excess of that prescribed by the regulations."

The Ministry of the Environment Guideline entitled *LU-131 Noise Assessment Criteria in Land Use Planning*, which supports the D-1 Land Use Compatibility series of guidelines for planning sensitive of land uses near aggregate facilities, introduces three classes of sensitive land use. These are 1-urban, 2-mixture and 3-rural. The Ministry of the Environment Guideline entitled, *NPC-205 Sound Level Limits for Stationary Sources in Class 1 & 2 Areas, NPC-232 Sound Level Limits for Stationary Sources in Class 3 Areas and NPC-233 Information to be Submitted for Approval of Stationary Source of Sound are designed for use with the Guide for Applying for Approval (Air); Noise and Vibration.*

Adverse effects as defined in the Environmental Protection Act, means one or more of:

- impairment of the quality of the natural environment for any use that can be made of it;

- injury or damage to property or plant and animal life;

- harm or material discomfort to any person;

- an adverse effect on the health of any person;

- impairment of the safety of any person;

- rendering any property or plant or animal life unfit for use by humans;

- loss of enjoyment of normal use of property; and,

- interference with normal conduct of business.

The Environmental Protection Act states that Certificates of Approval are required for the following:

- Portable crusher (per O. Reg. 524/98, 13[iv]);

- Emissions from the extraction area (per clause 9 (1) (a) which states that without a Certificate of Approval, no person may, "construct, alter, extend or replace any plant, structure, equipment, apparatus, mechanism or thing that may discharge or from which may be discharged a contaminant into any part of the natural environment other than water";

- Any discharge of a contaminant to the environment that might cause an adverse effect. (Sub-section 14(1) states that "despite any other provision of this Act or the regulations, no person shall discharge a contaminant or cause or permit the discharge of a contaminant into the natural environment that causes or is likely to cause an adverse effect").

The Ministry of Environment Guidelines NPC-232 and NPC-205, Sound Level Limits for Stationary Sources (for both Rural and Urban areas) note that stationary sources of noise "encompass all the activities taking place within the property boundary of the facility".

In my opinion, the "processing operations" of this quarry must include the extraction area and its related truck haul route as well as the proposed stone cutting and stockpiling activities in the proposed Rural (Ru2-Eaa zone). Any consideration of setbacks should be based on the all parts of the property used for extractive or industrial purposes and these should be in accordance with the minimum standards established by the Ministry of Environment for such purposes.

In summary, to date insufficient information has been provided by the applicant to demonstrate how the proposed quarry operation addresses any of these Ministry of Environment Guidelines.

Traffic

There are significant limitations on access to the subject property as noted by the applicant's own traffic information. The Skelton Brumwell & Associates Inc. report dated April 1, 2003 (pages 12-13) noted that the access to the subject property is deficient in regards to both minimum decision sight distances at 100 km/hour and the minimum sight distance for a left or right turning vehicle at 80 km/hour on Highway #60.

The report noted that the actual minimum decision sight distance at 100 km/hour is 300 metres while the desired minimum decision sight distance at 100 km/hour is 400 metres. Thus, the available sight decision distance is "below this limit". The report noted that the desired minimum sight distance for a left or right turning vehicle to attain operating speed before being overtaken at 80 km/hour is 270 metres. However, the available or *actual* minimum sight distance is "below this requirement". Nevertheless, the report concluded that since the "turning volume is so small relative to the background volume, the entrance location and sight distances are acceptable."

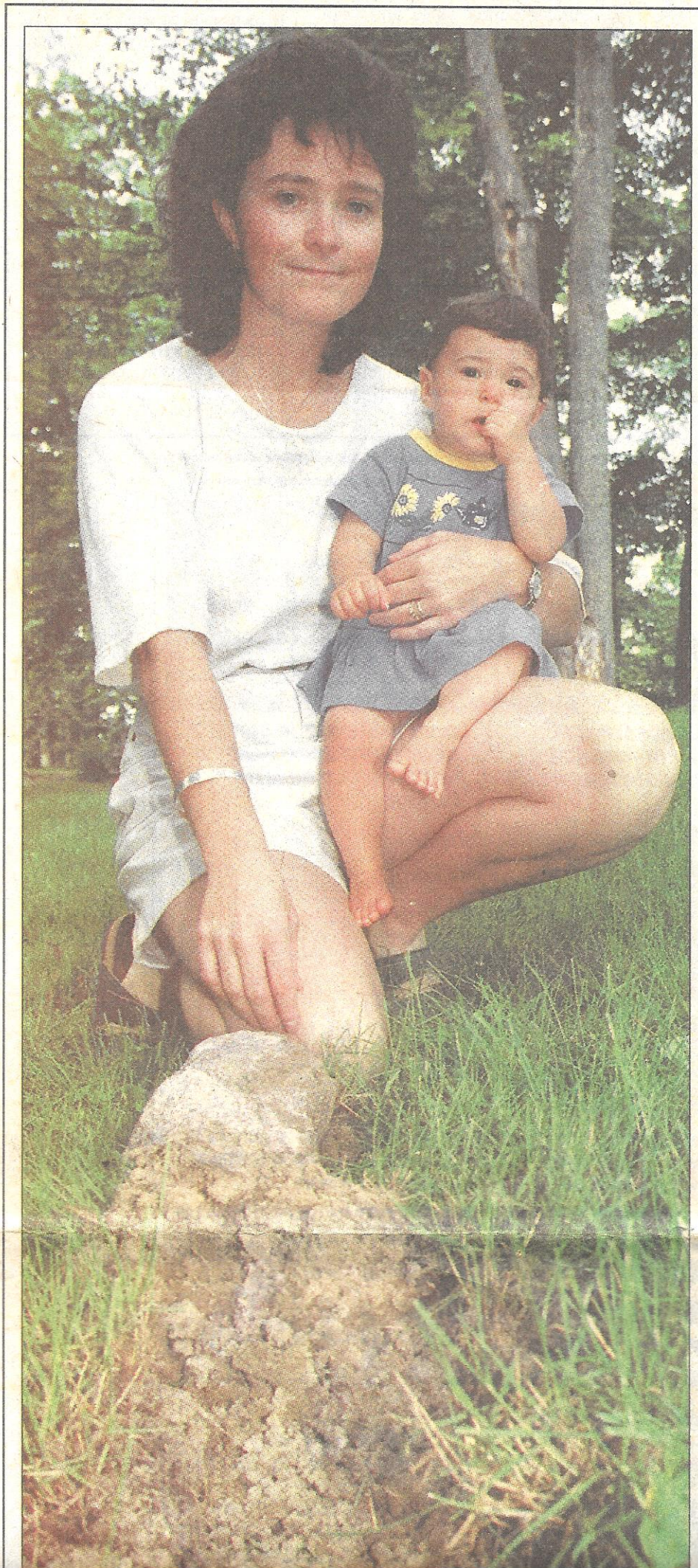
In my opinion, without the "necessary physical improvements" to the access having been completed, it cannot be assumed that there will be minimal adverse impacts to traffic flows, road safety and sight distances as a result of quarrying and related operations at this site. The impact of the quarry and its associated operations must be assessed in light of the District of Muskoka policies for entrances on Highway #60 and the Ministry of Transportation requirements. Accordingly, in my opinion, the appropriate improvements to the site access based on a detailed transportation study with measurement of the impacts of the traffic on Highway #60 from the proposed operations must be completed and evaluated prior to any consideration of a change to the land use for the subject lands.

Conclusions

For all of these reasons, it is my professional opinion that the proposal for the proposed House quarry zoning by-law amendment and the related site plan application continues not to represent good planning for the site and the surrounding community. The introduction of this proposed industrial land use would be incompatible with existing, established neighbouring land uses. Moreover, it has not been satisfactorily demonstrated by the applicant that the proposed quarrying, rock processing and wholesaling operations would result in minimal adverse impacts on the surrounding community.

Respectfully submitted,

Janet E. Amos, MCIP, RPP



P & T photo/**John Size**

Kirsty Spencer and her 10-month-old daughter survey a hole in their front lawn caused by an 8.5-pound chunk of granite. Kirsty believes the rock came from a nearby granite quarry after a blast.

Huge granite chunk slams family's lawn

By John Size
The Packet & Times

FLORAL PARK - The sky is indeed falling.

That storybook warning became a fact for Shane and Kirsty Spencer, who live on Glenn Ellen Drive in Floral Park near Washago.

An 8.5-pound chunk of granite hit the Spencer's front yard like a meteorite, tearing a two-foot hole in the lawn, about 2 p.m. Tuesday.

"If it would have hit the house it would have come right through," said an angry Kirsty yesterday.

She figures the chunk was rocketed nearly 1,200 feet from a nearby quarry.

"What would have happened if I was walking around outside with the baby?" asked Kirsty, holding her 10-month-old daughter.

Kirsty said she was stopped on the Rama Road by a construction worker, who was controlling traffic before a blast at the Rama Stone Quarry Tuesday afternoon.

The quarry is operated by Fowler Construction of Bracebridge.

When she arrived home a few minutes later her dog Norman ran off the front porch to a rock that had struck the front yard.

"I went over and looked at it and couldn't believe it," she said.

Yesterday morning, Fowler representatives went to the site, inspected the rock and talked with Kirsty.

"You don't expect to have rocks falling out of the sky," Kirsty told them.

Paul Kirk, aggregate sales manager and safety officer for Fowler, did not confirm the rock came from his quarry.

"We're investigating the incident," he said.

In a brief discussion with Kirsty, Kirk said this is only the second incident of a rock being blasted out of the quarry in the past seven years.

A similar incident damaged the roof of her neighbor's house seven years ago, Kirsty said.

"We can't have that happening," agreed Kirk.

Kirk said he would talk to the employees responsible for the blast. He said the incident may be related to human error.

Kirk said the company does go door-to-door to tell residents when blasts are taking place.

"We don't have to do that. It's a courtesy," he said.

Kirk promised Kirsty a similar incident would not happen again.

The Spencers have owned the house for the last two years.

Kirsty said there are several blasts every week during the summer.

This is the first incident of a rock striking their property, she said.

THE ISSUE OF QUARRY FLY ROCK
June 2021. REVISED August 2021

ADVISORY TO REGISTERED PROFESSIONAL PLANNERS

On January 1, 2022, Rule 28 of subsection 0.13 (1) in Ontario Regulation 244/97 of the *Aggregate Resources Act*, comes into effect. It stipulates that the licensee of an aggregate quarry shall ensure that the quarry is in compliance with the Rule as follows:

> a licensee or permitted shall take all reasonable measures to prevent fly rock from leaving the site during blasting if a sensitive receptor is located within 500 metres of the boundary of the site.

Fly Rock discharge from quarry blasting is a contaminant as determined by the Supreme Court of Canada. It is likely to cause an adverse effect under the *Environmental Protection Act.*

Members of OPPI are advised to also consider the directions provided under Policy 1.2.6 under Provincial Policy Statement 2020 to establish the appropriate municipal planning policies as a preventative measure to achieve land use compatibility between quarries that undertake blasting and sensitive land uses.

Aggregates Resources Act and O. Reg. 244/97

The issue of blasting rock in a quarry is addressed by the Ministry of Northern Development, Mines, Natural Resources and Forestry ("NDMNRF") in consideration of applications for a licence under the Act. As of **April 21, 2021**, Ontario Regulation 244/97 under the *Aggregate Resources Act,* was amended to provide the following licence conditions and standards:

Licence Conditions

- No blasting on a holiday, or between 6 p.m. and 8 a.m.
- The Licensee shall monitor all blasts for ground vibration and blast over pressure in accordance with provincial guidelines on limits on blast over pressure and ground vibration for blasting operations.
- The Licensee shall prepare blast monitoring reports according to provincial guidelines on limits of blast overpressure and ground vibration for blasting operations.
- The Licensee shall retain blast monitoring reports for a period of seven years after each blast.

NDMNRF Standards require the following for applications:

Blast Design Report

In the application for a licence to extract or remove more than 20,000 tonnes of aggregate annually, a Blast Design Report is required to be submitted by the applicant if a sensitive receptor is located within 500 metres of the limit of extraction. The Report must demonstrate that provincial guideline, NPC-119-blasting, for blast overpressure and ground vibration can be satisfied.

Site Operations Plan

The applicant's Operations Plan must:

(a) provide details about the frequency and timing of blasts;

(b) provide the number of sensitive receptors that are located within 500 metres of the boundary of the site and the distance from this boundary to each sensitive receptor. A sensitive receptor is defined as a school, child care centre, or any residence or facility at which at least one person sleeps.

Land Use Compatibility - Provincial Policy Statement 2020

Section 1.2.6 sets out provincial policies with respect to Land Use Compatibility. In particular, Section 1.2.6.1 applies to the consideration by NDMNRF and municipalities of proposed quarries as a defined "Major Facility", as follows:

> *Major facilities* and *sensitive land uses* shall be planned and developed to avoid, or if avoidance is not possible, minimize and mitigate any potential *adverse effects* from odour, noise and other contaminants, minimize risk to public health and safety, and to ensure the long-term operational and economic viability of *major facilities* in accordance with provincial guidelines, standards and procedures.

This policy is mandatory, and it is to be considered by the ministries and the municipalities.

Conversely, where sensitive land uses are proposed in the vicinity of an existing or planned quarry (major facility), the Province directs the municipalities to apply the following provincial policy 1.2.6.2:

> Where avoidance is not possible in accordance with policy 1.2.6.1, planning authorities shall protect the long-term viability of existing or planned industrial, manufacturing or other uses that are vulnerable to encroachment by ensuring that the planning and *development* of proposed adjacent *sensitive land uses* are only permitted if the following are demonstrated in accordance with provincial guidelines, standards and procedures.

a) there is an identified need for the proposed use;
b) alternative locations for the proposed use have been evaluated and there are no reasonable alternative locations;
c) *adverse effects* to the proposed *sensitive land use* are minimized and mitigated; and
d) potential impacts to industrial, manufacturing or other uses are minimized and mitigated.

The Legal Obligations

The Supreme Court of Canada considered an appeal by Castonguay Blasting Ltd. and dismissed the appeal in favour of the Province of Ontario. The Court decided (October 17, 2013) that "Castonguay was required to report the discharge of fly-rock forthwith to the Ministry of the Environment" (Paragraph 40). In its decision, the Court stated the following relevant reasons:

"Applying these elements to this case, s. 15(1) (*Environmental Protection Act)* was clearly engaged. Castonguay "discharged" fly-rock, large pieces of rock created by the force of a blast, into the "natural environment". There is also no doubt that fly-rock meets the definition of "contaminant". The discharge in this case was "out of the normal course of events" - it was an accidental consequence of Castonguay's blasting operation. Had the blast been conducted routinely, the fly-rock would not have been thrust into the air." (Paragraph 37).

"The adverse effects were not trivial. The force of the blast, and the rocks it produced, were so powerful they caused extensive and significant property damage, penetrating the roof of a residence and landing in the kitchen. A vehicle was also seriously damaged. The fly-rock could easily have seriously injured or killed someone." (Paragraph 39).

The *Environmental Protection Act* is preventive with respect to the discharge of contaminants. The Act and the Regulations apply to prevent the accidental impact of fly rock. Since the licensee is required to keep fly rock on the site during blasting, any discharge of fly rock beyond the controlled blast environment that is not a normal event, i.e. it would have been prevented, must be reported forthwith to the MECP, if the contaminant may likely cause an adverse effect. The Ministry may issue an order for remediation and preventive measures.

Analysis

The new provision for regulating and managing fly rock at a quarry site is contained in Ontario Regulation 244/97 under the *Aggregate Resources Act.* All quarries, both existing and those that are licenced after January 1, 2022, are required:

> "to take all reasonable measures to prevent fly rock from leaving the site during blasting if a sensitive receptor is located within 500 metres of the boundary of the site"

These following observations should be considered by Planners:

- There is no existing provincial government guideline indicating how the licensee is to keep fly rock within the quarry site when blasting. We understand from NDMNRF that this guidance is being prepared.

- The Act and/or the Regulation do not indicate how the proponent is to take all reasonable measures to demonstrate that fly rock can be contained within the quarry site during blasting. We understand from NDMNRF that this guidance is being prepared.

- At least one existing sensitive receptor must be located within 500 metres of the licenced boundary. If a new sensitive receptor is located within 500 metres of the quarry after it is operational, the fly rock rule would apply.

- If there are vacant lots that are designated and/or zoned for sensitive receptors, these are not recognized by this obligation. When these lots are developed and used as sensitive receptors, the fly rock rule will apply where they are within 500 metres of the boundary of the quarry.

- If during blasting, fly rock discharges off the site within the 500-metre area, the municipality should be aware of the obligation by the operator to report this contamination forthwith to MECP.

Blasting is referred to in section 49 of O. Reg. 419/05 "Air Pollution - Local Air Quality". There is a prohibition on the emission of any contamination beyond the limits of the property upon which blasting is being carried out.

At the request of officials in the Ministry of Northern Development, Mines, Natural Resources and Forestry, a meeting was conducted with the advisory authors and staff at the Ontario Professional Planners Institute. At this meeting, several updates were provided, facts and observations were discussed. We made amendments to this advisory to address these matters. The assistance of Ministry officials is greatly appreciated.

The Ministry advised OPPI that it is currently in the process of developing a guideline to assist quarry operators in implementing the fly rock rule.

This Advisory, as revised, is prepared by Mark L. Dorfman, RPP, and George McKibbon, RPP. The views expressed within this Advisory are their own based on research of existing legislation, policies and court records and do not necessarily reflect the views of OPPI or its affiliates. This is not legal advice. Members should rely on relevant laws, standards, by-laws, regulations and legislation that govern this issue.

Addendum

(provided by the Ministry of Northern Development, Mines, Natural Resources and Forestry)

Fly rock risks are managed through a matrix of policies and legislation that deal with a wide range of related topics including operational requirements for blasting, land-use compatibility, protection of the environment as well as public health and safety. The ministry takes this issue seriously and offers the following for OPPI consideration, and further discussion:

Land-use Planning

The Provincial Policy Statement (PPS) provides the policy foundation for regulating development and the use of land in Ontario. It deals with a variety of subjects including public safety, protection of the environment, and natural resources as well as provides for policies for economic growth. It is important to note the PPS exists as a comprehensive framework of policies which cannot be viewed in isolation from other policies. Part III of the preamble states the following:

"*The Provincial Policy Statement is more than a set of individual policies. It is to be read in its entirety and the relevant policies are to be applied to each situation. When more than one policy is relevant, a decision-maker should consider all relevant policies…*"

In addition to the land-use compatibility policies section 1.2.6 referenced in the OPPI paper, the PPS also contains detailed policies related to Mineral Aggregate Resources in section 2.5. Of note, the PPS requires that extraction"*…be undertaken in a manner which minimizes social, economic and impacts*".

These policies are reflected in specific requirements outlined in the *Aggregate Resources Act* (ARA), associated regulations, standards, and policies (discussed further, below) for existing operations and new applications.

The PPS also requires that development, and activities being considered near existing aggregate operations and aggregate deposits, consider and address "*…issues of public health, safety and environmental impact*." In undertaking development, municipal planners are required to consider public health and safety for new developments in relation to existing mineral aggregate operations and resources areas. Municipal planners need to ensure that new development near existing operations, or known resources, do not create or exacerbate public health and safety issues.

Aggregates

Ministry of Northern Development, Mines, Natural Resources and Forestry (NDMNRF) regulates blasting, including fly rock, in quarries (on Crown lands and designated private lands) under the following policy framework which prioritizes the safety and wellbeing of people, the environment and property, while enabling the extraction of aggregate resources:

- *Aggregate Resources Act* — The purpose of the ARA is, among other things, to minimize adverse impact on the environment in respect of aggregate operations (Section 2). Further, the contravention of the Act or Regulations under the Act (including the below-listed Regulation and Standards) is considered an offence[1].
- *Ontario Regulation 244/97* under the ARA — lists prescribed conditions[2] pertaining to blasting, including blasting hours, requirements for blast monitoring[3] (in conjunction with blasting policies; see below), and the new flyrock rule[4].
- The Aggregate Resources of Ontario Provincial Standards
  - *Aggregate Resources of Ontario Technical Reports and Information Standards* — lists requirements for the submission of blast design reports by quarry applicants proposing to extract over 20,000 tonnes/year.
  - *Aggregate Resources of Ontario Site Plan Standards* — require quarry applicants to include details of proposed blasting activities, and information regarding sensitive receptors within 500 m of the quarry boundary.
- The Aggregate Resources Policy and Procedures Manual
  - Policy *A.R. 5.00.10* — covers blasting restrictions across approval instruments
  - Policies *A.R. 2.01.09* (licences), *A.R. 4.01.08* (permits), and *A.R. 3.01.07* (wayside permits) — lay out the Ministry's approach for Blast Design Report and blast monitoring requirements.

Therefore, the new fly rock rule should not be viewed in isolation but rather within the larger ARA regulatory context within which it is nested.

Further, our Ministry is currently working on developing guidance to provide greater clarity and detail on the intent and implementation of the new fly rock rule; guidance may include best management practices and policy guidance.

Environmental Protections

The Ministry of the Environment, Conservation and Parks (MECP) administers the *Environmental Protection Act* (EPA) under which flyrock can be considered a contaminant (pollutant), and the off-site discharge of flyrock is considered a spill[5]. The EPA requires that every person who spills or causes or permits a spill of a pollutant is required to notify MECP's Spills Action Centre[6] and take action to address any adverse impacts caused by the spill[7]. Both NDMNRF and MECP take fly rock incidents very seriously and when off-site discharge of fly rock is reported, or a complaint of off-site impact is received, MECP staff will work with the NDMNRF to assess the incident and determine the appropriate action, which may include additional measures which need to be taken to prevent future off-site fly rock incidents.

[1] Subsection 57(3) of the ARA
[2] Prescribed conditions are placed on the approval instrument (licence, permit, wayside permit) at the time of approval, and cannot be changed or varied.
[3] Subsection 0.12(5) of O. Reg. 244/97
[4] Subsection 0.13(1) of O. Reg. 244/97
[5] Subsection 91(1) of the EPA
[6] Subsection 92(1) of the EPA
[7] Subsection 91(1) of the EPA

Worker Safety

The Ministry of Labour, Training and Skills Development (MLTSD) administers the *Occupational Health and Safety Act* (OHSA) under which *Regulation 854 (Mines and Mining Plants; R.R.O. 1990*) lists requirements pertaining to blasting, including in quarries. The OHSA and Regulation 854 require that:

- quarry operators conduct a risk assessment of the workplace to identify, assess, and manage hazards, and potential hazards, that may expose a worker to injury or illness. Under such a risk assessment, fly rock would also have to be addressed.
- each blast be designed by a competent person, appointed by the quarry operator. The blast design:
    - must be documented (prior to start of blasting), as well as reviewed and followed.
    - must include guarding procedures to protect workers on site.
- prior to each blast, a siren warning of blast is to be given, and where there are public roads nearby, traffic must be warned of the impending blast, and stopped.
- where workers are required to be present near the blast, blasting shelters must be provided.

Further, in the event of an accident (unintended event), premature or unexpected explosion or defective explosives or detonators, which could result in fly rock leaving the quarry site, the operator must notify the MLTSD

Preventing the Potentially Deadly Consequences of Flyrock: Mandatory Minimum Setbacks Required (Revised 31-Oct-2021)

Tony Sevelka, AACI, P.App, MAI, AI-GRS, SREA, FRICS (Contact: info@intval.com)

Flyrock is an ever-present danger wherever blasting occurs, and, therefore, *flyrock* must be dealt with proactively and explicitly by the municipal/regional planning authorities as part of an application to permit a blasting quarry operation.

> ***"Flyrock…needs to be considered before…[an accident] happens [p. 13]," an approach which is consistent with the precautionary principle.***[1]

> ***Flyrock is one of the most contentious issues in bench blasting. Unlike ground vibrations, flyrock has the propensity to cause fatality and severe injuries. Although the kinematic equations present a basis for the estimation of flyrock distance, these suffer from the drawback of ignoring the post-release effects of trajectory motion in air. Predictive models that are based on such equations not only suffer from this anomaly, but also fail in flyrock distance prediction due to the gross approximations of initial velocity calculations and shape of the fragments*** (Raina et al., 2015)***.***[2]

Flyrock is characterized as follows:

> *'Flyrock' is defined as 'blasted material cast into the air, or traveling along the ground, that is cast from the blasting site more than half the distance to the nearest dwelling, public building, school, church, commercial, community or institutional building; or any occupied structure; or is cast beyond the permit boundary [p. 1].*[3]

> ***Flyrock events historically have not been limited to blasting operations within the distances which require the submission and approval of an 'anticipated blast design'…prior to blasting. Rather, flyrock events occurred and impacted dwellings, vehicles, persons, animal life, and other physical structures thousands of feet from the blast site resulting in death and the destruction of property [p. 1].*** [emphasis added]

> *…[F]lyrock in blasting operations has a major impact on the external environment…due to the hazards involved and is more significant than vibrations and airblast….[E]ven if it is normal practice in these zones to take into account the impact of possible vibrations and even the effects of airblast when modeling the project, flyrock risks are not dealt with in initial studies, other than by way of integrating general safety distances. These risks are only sometimes taken into account much later in the operation and most often, following an accident or significant flyrock being recorded externally [offsite] [p.549].*[4]

> *Flyrock can be as large as a car. It is propelled with great force. Flyrock may come from high in the air, roll down a hillside, or come straight at you like a bullet. That is why the blaster places guards at*

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1 Jackson, Brett Christopher, "Total Cost Optimization For Contour Blasting In The Appalachia Region," (2015). *Theses and Dissertations-Mining Engineering. 20*. https://uknowledge.uky.edu/mng_etds/20.

2 Avtar K. Raina, V.M.S.R. Murthy and Abhay K. Soni, "Flyrock in surface mine blasting: understanding the basics to develop a predictive regime,", *Current Science,* Vol. 108, No. 4, 25 February 2015: 660-665, https://www.currentscience.ac.in/Volumes/108/04/0660.pdf.

3 "Reclamation Advisory Memorandum," https://eec.ky.gov/Natural-Resources/Mining/Mine-Permits/RAMS/RAM140.pdf. "During calendar year 2007, the Commonwealth of Kentucky had a [known] total of thirteen (13) flyrock events on surface coal mining sites, including one (1) that resulted in a fatality. To date [July 18] there have been nine (9) [known] flyrock events, including one (1) that resulted in a minor injury that very easily could have resulted in a fatality."

4 A. Blanchier, "Quantification of the levels of risk of flyrock," Rock Fragmentation by Blasting: The 10th International Symposium on Rock Fragmentation by Blasting, 2012 (Fragblast 10); Leiden: 549-553.

entry roads around the area where rocks might fly—to keep people out and protect workers from death and injury. Yet people have still been killed inside [and outside] the blast area [p. 7].[5]

Pearson et al. [1994] referenced flyrock weighing approximately three tons [6,000 pounds] thrown to a distance of 980 ft [299 metres].[6] [emphasis added]

Flyrock [from surface mining blasting operations] contributes about 68% of total injuries worldwide.[7] [emphasis added]

The designated blast zone or blast area is confined within the boundary of a quarry operation, and all of the *adverse effects* associated with blasting must remain or be contained on site:

"designated blast area" includes the danger area, which is the zone in which there exists a possibility of hazard to a person or property from flyrock, fume, air blast or ground vibrations, and is the area where the blaster has made arrangements to evacuate all persons whose safety might be threatened by the blasting operation. (Province of Newfoundland and Labrador, Department of Natural Resources, https://www.gov.nl.ca/iet/files/Quarry-Permit-Standard-Terms-Conditions.pdf)

- Proponent-driven Blasting Impact Assessments (BIAs) prepared in Ontario do not address *flyrock* in the hypothetical estimation of the designated blast area, as the BIA is prepared solely for the benefit of the proponent, and is strictly confined to a superficial (generic) analysis of airblast and ground vibration under static environmental conditions, above and below ground. (The proponent has no legal right of trespass to conduct or commission any investigations, whatsoever, over privately owned third-party real property.)

- A hypothetically determined blast area makes no provision for *safety factors* to protect onsite equipment from damage (safety factor of 2), and quarry employees from injury or death (safety factor of 4), and ignores entirely land use incompatibility of adjoining public and private third-party real property, and the deleterious effects and potentially deadly consequences of blasting on those who live, work, play (e.g., golf, ski, fish, hike, cycle) or drive/walk in the surrounding area.

"*Flyrock* is an integral part of blasting. However, *flyrock* that is projected past a defined safety [blast] zone is not acceptable:

It is well known that rock and/or debris can be thrown over a kilometer [1,000 metres] from the blast site, and in a recent case rocks travelled approximately 1.3 kilometres [1,300 metres] (Explosives information bulletin no. 69 | 27 February 2009 | Version 1)[8] [emphasis added]

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[5] "Tool Box Lesson A – What is Flyrock?" NIOSH, https://www.cfins.com/wp-content/uploads/2019/01/blasting-safety-toolbox-complete.pdf.

[6] T. S. Bajpayee, Harry C. Verakis and Thomas E. Lobb, "An Analysis and Prevention of Flyrock Accidents in Surface Blasting Operations," https://www.cdc.gov/niosh/mining/UserFiles/works/pdfs/apfasbo.pdf.

[7] Nirlipta P. Nayak, Abhinav Jain and Saubhagya Ranjan Mahapatra, "Application of Mine Excellence software in flyrock prediction & mitigation," *Materials Today*, © 2021, Application of Mine Excellence software in flyrock prediction & mitigation - ScienceDirect.

[8] https://www.rshq.qld.gov.au/safety-notices/explosives/flyrock-incidents2.

As reported in the 2014 issue of the *Journal of Rock Mechanics and Geotechnical Engineering*, *flyrock* is an inevitable consequence of blasting rock and can never be entirely eliminated:

> *Due to the explosive force, rock fragments are propelled and thrust high into the air and beyond the safety limit of [the] blast area, thus termed as "flyrock". This is mainly due to the flaws presented in the blast design and also due to the misinterpretation of rock mass behavior. The phenomena of flyrock are always uncontrolled and can never be brought down to zero [p. 26].*[9] [Flyrock launched beyond the designated blast area is sometimes referred to as "wild flyrock."]

According to the Mine Health and Safety Council (MHSC) of South Africa, *flyrock* is the ultimate *adverse effect*, and must be avoided at all costs:

> ***Human response to flyrock is generally extreme. Apart from any consideration of damage, it is the only blasting-related hazard that can cause serious injury and death. It is the ultimate adverse effect of blasting and must be avoided at all costs.***[10] [Milestone 4, p. 31] [emphasis added]

As *flyrock* is an inevitable and uncontrollable by-product of quarry blasting,[11] and is not to leave the site, according to the Ontario Aggregate Resources Act (ARA), mandatory minimum setbacks are the only known remedy that can effectively eliminate *flyrock* from being launched off-site.

> On January 1, 2022, a licensee and permittee shall take all reasonable measures to prevent fly rock from leaving the site during blasting if a sensitive receptor [often code for human target] is located within 500 metres of the boundary of the site. (O. Reg. 466/20, s. 2(2))

An appeal before the Supreme Court of Yukon (2012)[12] involved two *flyrock* incidents, where *flyrock* debris caused damage to a number of houses in the Lobird subdivision as far as 350 metres from the blast site, and penetrated the roof of one house, landing in the living room (Flyrock 120 – Nov 1, 2007 and May 6, 2008).[13] The expert blaster that testified on behalf of the Director of Occupational Health and Safety made the startling comment:

> ***Had it not been for the fly rock incident,…he would have considered the blast a success [para. 23].***

This is akin to saying "The operation was a success, but the patient died!"

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[9] https://intval.com/articles/Flyrock-and-Other-Impacts-from-Quarry-Blasting-Operations.pdf.
[10] https://mhsc.org.za/sites/default/files/public/research_documents/SIM140901%20Final%20Report.pdf.
[11] "There was…evidence that 'the fly rock' is uncontrollable and results in making unavailable a large area of the petitioner's land by its inability to conduct blasting operations within 800 feet [244 metres] of the new turnpike, para. 435]," *Lee Lime Corp. v. Massachusetts Turnpike Authority*, 337 Mass. 433 (1958) 149 NE 2d 905, https://scholar.google.ca/scholar_case?case=8453729559483718978&q=flyrock&hl=en&as_sdt=2006.
[12] *Director of Occupational Health and Safety v. Government of Yukon, William R. Cratty and P.S. Sidhu Trucking Ltd.*, 2012 YKSC 47 (CanLII), <https://canlii.ca/t/fs6vt>, retrieved on 2021-10-23
[13] Waddell, Stephanie. "Blasting charges made public; Lang declines all discussion," *Whitehorse Daily Star*, May 8, 2009, https://www.whitehorsestar.com/News/blasting-charges-made-public-lang-declines-all-discussion.

Minimum Clearance Distance as Safety Zone Against Flyrock Based on Recorded Flyrock Distances and Experimental/Theoretical Estimation

According to GEO REPORT No. 260, Halcrow China Limited, 2002,[14] separation distance (setbacks) is the only totally effective safety measure against *flyrock*:

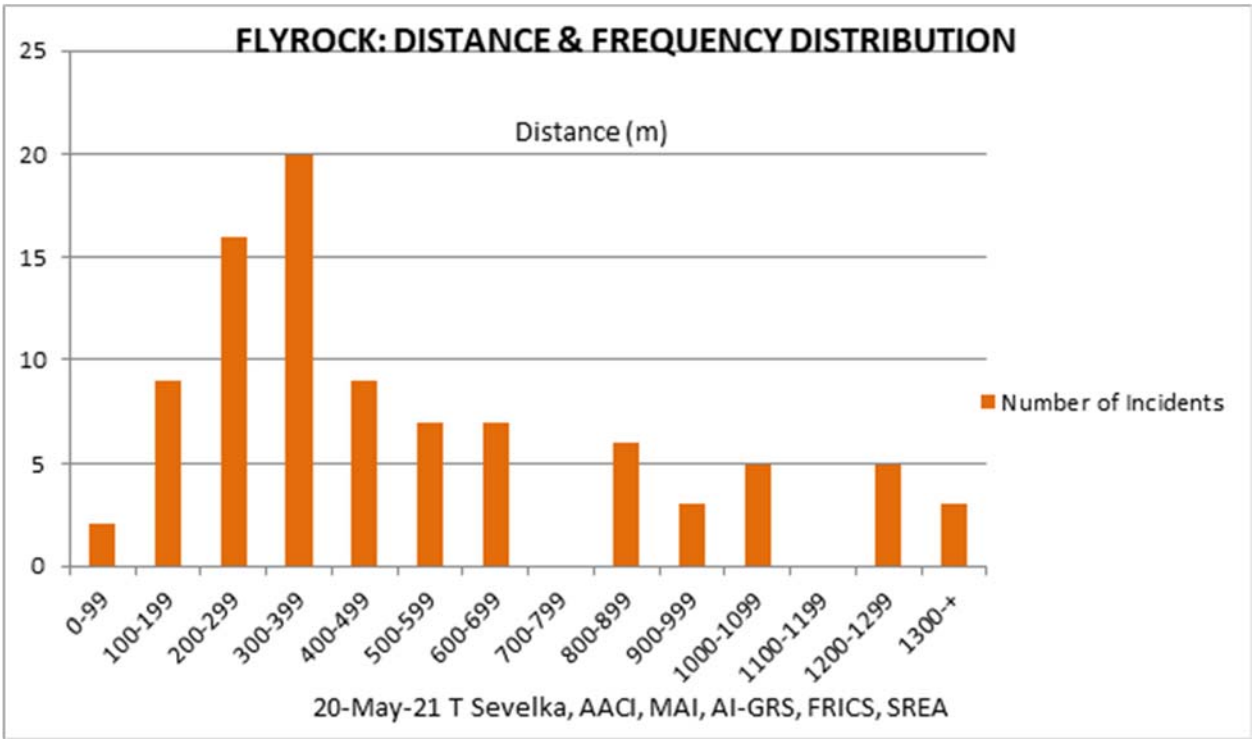
> *The only totally effective safety measure [against flyrock] is a minimum clearance distance, acting as a safety zone. In order to determine the required minimum clearance distance, it is necessary to ascertain the 'flying distance', (the distance to which flyrock may be thrown).* ***The available [flyrock] data is of two types: reported instances and experimental/theoretical estimation****. [emphasis added]*
>
> - **Recorded instances**. The data on recorded flyrock projection is based on published HSE and Mines & Quarries Division of GEO data. Both indicate significant numbers of rocks passing beyond 200 m. Very few (4 out of 80, or 5%) travelled beyond 300 m. Only one exceeded 450 m, and this travelled to 800 m. **It should be noted that these numbers are the minimum number that occurred, being those that were reported. Numerous incidents at shorter ranges (up to 500 m) may not have travelled outside the quarry boundary or may not have caused injury and therefore were not treated as reportable incidents. In the UK, under-reporting by factors of 5 to 10 are considered possible below 500 m (Davis, 1995)**.
> - [In the United Kingdom, over a five-year period, 85 flyrock incidents had been reported and documented: 25 incidents (29%) were between 200 and 300 metres; 15 incidents (17%) were between 300 and 500 metres; 5 incidents (6%) were between 500 and 700 metres; and only one incident (1%) exceeded 700 metres. Overall, 95% of the analyzed flyrock incidents occurred within 600 metres. p. 26[15]]
> - **Experimental data**. Research on flyrock was undertaken by the Swedish Detonic Research Foundation (Lundborg et al., 1975). It was summarized in more accessible form by Hoek & Bray (1981) in their textbook "Rock Slope Engineering". It has been established that maximum 'flying distance' is about 540 m for a 200 m diameter (about 15 kg) block. For fragments of 75 to 100 mm size (about 2.5 kg) the maximum range is 410 to 470 m.
>
> **From the foregoing, it is apparent that the only absolute guarantee for safety from flyrock is a large minimum clearance distance, the size of which depends on the blasthole diameter in use. The Safety Zone would need to extend 400 to 600 m from the blast**. [emphasis added] [pp. 182-83]

A more recent study of discovered *flyrock* incidents undertaken by Sevelka (2021), where the *flyrock* distances are known, resulted in an analysis of 92 *flyrock* incidents. The results of the *flyrock* study, the most comprehensive and largest known of its kind, are as follows:

[14] This report was prepared by Halcrow China Limited in August 2002 under Consultancy Agreement No. GEO 10/98 for the sole and specific use of the Government of the Hong Kong Special Administrative Region, https://www.cedd.gov.hk/filemanager/eng/content_475/er260links.pdf.

[15] https://intval.com/articles/Flyrock-and-Other-Impacts-from-Quarry-Blasting-Operations.pdf.

Analysis of Flyrock Travel Distances



An analysis of 92 *flyrock* incidents, where the distance from the blast is known, indicate that 91% (84) of the *flyrock* incidents occurred within 1,099 metres, and 97% occurred within 1,299 metres.

The number of *flyrock* incidents within each interval, starting at between 300 and 399 metres, and the average distance travelled within each interval are summarized as follows:

- 20 (22%) of the flyrock incidents occurred between 300 and 399 metres (330 metres avg)
- 9 (10%) of the flyrock incidents occurred between 400 and 499 metres.(446 metres avg)
- 7 (8%) of the flyrock incidents occurred between 500 and 599 metres (515 metres avg)
- 7 (8%) of the flyrock incidents occurred between 600 and 699 metres (622 metres avg)
- 6 (7%) of the flyrock incidents occurred between 800 and 899 metres (802 metres avg)
- 5 (5%) of the flyrock incidents occurred between 1200 and 1299 metres (1225 metres avg)
- 3 (3%) of the flyrock incidents occurred over 1300 metres (2307 metres average)

At 80%, which accounts for the first 74 *flyrock* incidents in ascending order, *flyrock* reached a distance of 800 metres, and, at 90%, which accounts for the first 83 *flyrock* incidents in ascending order, *flyrock* reached a distance of 1,020 metres.

On the basis of the most recent study of *flyrock* incidents (Sevelka, 2021), the designated blast area would have to be approximately 1,200 metres to effectively prevent *flyrock* from leaving the boundaries of a blasting quarry site, equivalent to a 1,200-metre setback.

Examples of Flyrock's Deadly Consequences For Sensitive Receptors (i.e., Human Targets)

Listed below is a sample of *flyrock* incidents at different blasting quarries in various geographic locations, which have killed onsite quarry employees, offsite residents while in or outside their homes, off-site employees and customers in places of business, children in schools, pedestrians while walking near quarries, and occupants in vehicles on roads near quarries.

- **Flyrock 6:** On March 22, 2016, a blast at a quarry launched *flyrock* debris 366 metres that penetrated a pickup truck striking and killing 42-year old Tracy Hockemeier, a quarry employee positioned 366 metres from the blast and preventing others from entering the blast area.
- **Flyrock 12:** On July 19, 2013, a blast at a quarry showered *flyrock* debris as far as 1,000 metres that damaged 18 cars and 14 factories; injured 10 workers and residents in a housing estate; and struck and killed a factory worker in his 30s in a factory penetrated by numerous rocks at a distance of 500 metres.
- **Flyrock 34:** On June 4, 1993, a blast at a surface mine launched a large amount of *flyrock* debris approximately 91 metres that struck a car on Interstate 75, Tennessee, and 16-year old Brian Agujar, a passenger in the car driven by his parents, was killed as a result of the *flyrock* impact. The blaster was sent to prison for five months. (Prior *flyrock* incident occurred in April 1992.)[16]
- **Flyrock 36:** On July 11, 1990, a blast at a quarry launched *flyrock* debris 283 metres that struck a resident who was mowing grass on his property, who later died on July 17, 1990 from head injuries.
- **Flyrock 38:** On April 5, 2017, a blast at a quarry launched *flyrock* debris 280 metres that struck and killed the blaster's helper.
- **Flyrock 40:** On December, 21, 1999, a blast at a quarry launched *flyrock* debris that struck 32-year old Lee Messner, a quarry equipment operator, at 244 metres, who subsequently died from his internal injuries, with *flyrock* debris also damaging a building at 457 metres from the blast. Messner left behind a wife and one child. (Prior *flyrock* incident occurred in 1996.)[17]
- **Flyrock 41:** On August 15, 2019, a blast at a quarry launched *flyrock* debris, some of which bore through the roof of a home and struck and killed 36-year old Shupikai Chitsana while in her kitchen, and her aunt was also struck by *flyrock*, but she survived. Shupikai leaves behind her five children and husband.

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[16] Courtney W. Shea and Dennis Clark, "Avoiding Tragedy: Lessons To Be Learned From A Flyrock Fatality," © 2020, *International Society of Explosives Engineers*, https://www.osmre.gov/resources/blasting/docs/Flyrock/1993SugarRidgeFatality.pdf.

[17] MSHA - Metal and Nonmetal Mine Fatal Accident Investigation Report: 12/21/1999.

- **Flyrock 48:** On July 15, 2015, a blast at a quarry launched *flyrock* debris 200 metres that struck and killed a factory worker, and seriously injured two others. *Flyrock* debris also struck a building at 50 metres, and damaged and destroyed several vehicles 150 metres from the blast site.
- **Flyrock 68:** May 27, 2020, a blast at a quarry launched *flyrock* debris that struck and killed 10-year old M. Nanhini, and that struck and injured her brother Soundarrajan.
- **Flyrock 74:** On July 16, 2007, *flyrock* fragments from a quarry blast were launched 483 metres and struck and killed 40-year old Bobby Messer, a quarry mechanic, and damaged the mechanic's truck. Messer is survived by his wife and three children.
- **Flyrock 86:** On December 4, 2013, a blast at a quarry launched *flyrock* debris, including a 96-pound boulder that struck and killed 63-year old Stephen Hetzler, an experienced blaster, standing 47 metres from the blast. Investigators determined the *flyrock* was travelling approximately 400 miles per hour (644 kilometres per hour).
- **Flyrock 94:** On December 13, 2017, a blast at a quarry showered *flyrock* debris over an area of 800 metres, striking and killing 71-year old Ronald Sutherland (an experienced blaster), injuring five people, wrecking 10 vehicles, significantly damaging 14 houses and causing minor damage to 20 other houses.
- **Flyrock 100:** One July 16, 1997, a blast at a quarry launched one employee, Skip Sibley, over a quarry ledge, leaving him seriously injured with face and chest burns, and another employee, Joel Kanute, had his body impaled by *flyrock* debris, killing him instantly. Both were experienced blasters.
- **Flyrock 103:** In 2015, a blast at a quarry launched *flyrock* debris that struck and killed a baby on her mother's back, and "the child was ripped in half" by the force of the impact from the flying rock. The baby's mother and a motor rider were also struck by *flyrock* and sustained injuries.[18]
- **Flyrock 104:** On April 12, 2007, a blast at a quarry launched *flyrock* debris 300 metres that struck and killed a 12-year old boy standing in his courtyard.
- **Flyrock 114:** On February 28, 2021, a blast at a quarry in Senemal village of Lakhanpur Block, launched *flyrock* debris that struck 36-year-old Harekrishna Bhoi, a supervisor at the quarry. Bhoi died after being struck on the head by *flyrock* debris.[19]

[18] "Joma residents protest as CP's quarry operations kills baby," *3News*, August 15, 2015, Joma residents protest as CP's quarry operations kills baby | 3NEWS.

[19] "1 killed in Jharsuguda quarry blast," *the pioneer*, March 3, 2021, https://www.dailypioneer.com/2021/state-editions/1-killed-in-jharsuguda-quarry-blast.html.

- **Flyrock 121:** On September 19, 2011, a blast at a quarry near Perne in India, launched *flyrock* debris that struck 18-year-old Balu Namdeo Kolpe, a sheppard who was tending his sheep. Kolpe was struck in the head and "died on the spot."[20]

- **Flyrock 153:** On November 19, 2017, a blast at a quarry in Katombola, Southern Province, launched *flyrock* debris 50 metres that struck and killed an 11-year old boy on the spot (ripping his stomach, cutting his head and breaking his ribs) and seriously injured three other children, aged four and seven.[21]

- **Flyrock 154:** On May 29, 2021, a blast at a quarry in Chittoor, launched *flyrock* debris 500 metres that struck and killed 25-year-old Jakir, a daily wager who had just completed loading mangoes into a trailer at a mango orchard abutting the quarry.[22]

- **Flyrock 155:** Sometime in the early 1990s, a blast at a quarry in Coboconk, Ontario, launched *flyrock* debris that penetrated the roof of a man's home, striking and killing the homeowner. A Coroner's Inquest followed. (Source: Retired Legal Counsel. This is the same *flyrock* incident cryptically alluded to during the MOE investigation of the two *flyrock* incidents at the Pakenham Quarry in 2009.)

- **Flyrock 158:** On February 6, 2000, a blast at the Makkah Quarry, Saudi Arabia, launched *flyrock* debris that showered a nearby shopping district, killing an Egyptian passer-by and injuring five others.[23]

- **Flyrock 159:** On June 21, 2021, a blast at a quarry in Thrissur, India, launched *flyrock* debris that struck and killed Abdul Naushad, the brother of the quarry owner, injured five others, and damaged several houses.[24]

- **Flyrock 160:** On March 14, 2018, a blast at a quarry in Kiyuni Sub County launched *flyrock* debris that penetrated a public school at a distance beyond 250 metres, and struck Sylvia Gwoliranye, a 14-year-old pupil at the school. Sylvia was struck in the head by the *flyrock* while seated in class, and eventually died after losing a lot of blood.[25]

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[20] "Stone from quarry blast kills 18-year old," *The Times of India*, Sept 21, 2011, https://timesofindia.indiatimes.com/city/pune/stone-from-quarry-blast-kills-18-year-old/articleshow/10058714.cms.

[21] Funga, Mukosha. "Quarry flying stone kills nearby juvenile," *News Diggers*, November 20, 2017, https://diggers.news/local/2017/11/20/quarry-flying-stone-kills-nearby-juvenile/.

[22] Pradesh, Andhra. "One killed in quarry blast in Chittoor," *The Hindu*, May 29, 2021, One killed in quarry blast in Chittoor - The Hindu.

[23] "One Killed, Five Injured in Makkah Quarry Blast," *Kuwait News Agency (KUNA)*, 06/02/2000, https://www.kuna.net.kw/ArticlePrintPage.aspx?id=1058118&language=en.

[24] "One killed, five injured in quarry blast in Thrissur," *Kaumudi Online*, 21 June, 2021, https://keralakaumudi.com/en/news/news.php?id=576544&u=.

[25] "Stone from quarry hits, kills pupil inside class," *Daily Monitor*, March 15, 2018, https://www.monitor.co.ug/uganda/news/national/stone-from-quarry-hits-kills-pupil-inside-class-1745402.

- **Flyrock 161:** On September 4, 2020, a blast at a construction site at Gochas in the Hardap region launched *flyrock* debris that struck 50-year-old Anna Ida Jaars in the head, killing her while sitting outside a house, at a distance of 700 metres from the bast site.[26]

- **Flyrock 162:** On March 27, 2020, a blast at KTH Quarry in Kampong Speu Province launched a 5 kg rock that penetrated the roof of an onsite office, more than 70 metres from the blast site, and struck 20-year-old Chhoeun Sopheak, a company administrator, who succumbed to his injuries while being transported to a hospital.[27]

- **Flyrock 163:** On May 27, 2016, a blast at a stone quarry at Gaurhari village of Mahoba district, launched *flyrock* debris that showered and killed four quarry labourers, and critically injured one.[28]

As noted, of the 163 discovered *flyrock* incidents, 26 incidents of *flyrock* ended in loss of life (29 people were killed), resulting in a "kill" rate of 16%. An additional 36 people were injured in the 26 *flyrock* incidents that resulted in loss of life.

[26] Cloete, Luqman. "Family wants redress after flying rock kills woman," *namibian*, Sept 9, 2020, https://www.namibian.com.na/204296/archive-read/Family-wants-redress-after-flying-rock-kills-woman.
[27] "Office Worker Killed After Quarry Blast," *Cambodia News English*, March 28, 2020, https://cne.wtf/2020/03/28/office-worker-killed-after-quarry-blast/.
[28] Xinhua. "Blast inside stone quarry kills 4 in India," *The Citizen*, May 27, 2016, https://www.citizen.co.za/news/news-world/1135041/blast-inside-stone-quarry-kills-4-in-india/.

Setbacks in Land Use Planning and Their Function

In land use planning, a setback is the minimum distance which a building or other structure must be setback from a street, road or highway, a river or other stream, a shore or flood plain, or any other place deemed to need protection. Other things such as fences, landscaping, septic tanks, and various potential hazards (e.g., blasting quarry operations) or nuisances (e.g., noise, odour) are regulated and prohibited by minimum setbacks for reasons of public policy (e.g., health, safety, welfare, privacy and environmental protection).

Setbacks are important in preventing (or containing onsite) the *adverse effects* (Provincial Policy Statement 2020, p. 139) associated with blasting quarry operations:

a) impairment of the quality of the natural environment for any use that can be made of it;
b) injury or damage to property or plant or animal life;
c) harm or material discomfort to any person;
d) an adverse effect on the health of any person;
e) impairment of the safety of any person;
f) rendering any property or plant or animal life unfit for human use;
g) loss of enjoyment of normal use of property; and
h) interference with normal conduct of business.

Flyrock debris is known to have the potential to cause all of the above-noted *adverse effects*, and *flyrock* launched offsite onto privately-owned third-party property constitutes actionable "trespass."

The *working-from-home* and *home-based* economy spawned by the COVID-19 pandemic means that more residents and occupants of home-based businesses[29] in communites surrounding existing or new blasting quarry operations will be subjected to the potential *adverse effects* of *flyrock* on an on-going and uninterrupted basis.

> *The COVID-19 pandemic has changed the work location of thousands of Canadian workers. From April 2020 to June 2021, 30% of employees aged 15 to 64 who worked during the Labour Force Survey (LFS) reference week had performed most of their hours from home. In contrast, about 4% of employees did so in 2016.*
>
> *Of all Ontario workers—employees and self-employed—aged 15 to 64 who were working during the LFS reference week, 37% worked from home from April 2020 to June 2021.* [30]

According to the *Cessnock Development Control Plan* (2010) for the Cessnock City Local Government Area (LGA),[31] policies addressing *encroaching development* and *separation distances* have been implemented to eliminate or avoid land use conflicts.

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[29] For example, the Town of Caledon restricts *home occupation* to "no more than 25% of the *dwelling unit* area" and "permits one additional employee." "Home Occupation means an occupation or business which is conducted entirely within a *dwelling unit* and which is clearly subordinate or incidental to the principal use of the dwelling unit for residential purposes." (Section 3-17, revised October 23, 2019)

[30] "Working from home: a new experiment for many Canadian workers." 2021-08-04, https://www150.statcan.gc.ca/n1/daily-quotidien/210804/dq210804b-eng.htm.

Where an application is received which is likely to result in a conflict with existing or likely future adjoining land uses, it will be the responsibility of the 'encroaching development' to provide the recommended buffer areas or satisfactorily reduce or remove the conflict through some other approved method. [emphasis added]

It will be generally required that where a physical separation is required it will be located on land in the ownership or control of the owner or operator of the encroaching development *[4.2.4].* [emphasis added]

Minimum separation distances refer to a measurement from the offending development to the property boundary of the affected land use unless otherwise stated [4.2.5].

Appropriate site selection can avoid or reduce many of the environmental problems associated with proposals and:

- reduce the need for technically based environmental mitigation measures and on-going management measures;
- result in substantial savings in establishment and operational costs;
- reduce levels of public concern; and
- avoid potential delays in approval processes

Site selection should therefore be based on the following principles:

- is the land use permissible in the zone?
- are environmentally sensitive areas avoided?
- is the use compatible with nearby land uses?
- do initial site investigations indicate that the site is fundamentally suitable for the use proposal?

This is an essential step in locating developments which require buffers, and applicants may be required to provide an analysis of a number of sites to justify the preferred location, should that site not meet minimum separation guidelines [4.2.6].

While compliance with the separation distances will assist in reducing conflicts, it will not guarantee that no conflict will occur, or that the proposal will be acceptable *[4.2.8].* [emphasis added]

Quarries – Potential Conflicts
Potential conflicts include noise, dust, vibration, blast over-pressure, fly-rock from blasting, disruption and contamination of ground and surface waters. Potential for significant visual impact. Impacts on vegetation and habitat from clearing.

- ***Minimum self-contained buffer of 1000 metres from Category A [Sensitive Land Uses]…****, which warrant protection from amenity reducing off-site effects from other land uses [e.g., Quarry]. These include all dwellings, caravan parks, community facilities, hospitals, pubs, serviced apartments, restaurants, schools, tourist facilities, seniors housing or other place of permanent or temporary occupation.* [emphasis added]

[31] Part C: General Guidelines, Chapter 4: Land Use Conflict and Buffer Zones, file:///C:/Users/Windows%207%20PC/Downloads/Land-Use-Planning- -Cessnock-DCP-2010- -C4-Land-Use-Conflict-and-Buffer-Zones- -CCC-website-doc%20(2).pdf.

Setback requirements prohibiting quarrying uses, regardless of whether blasting is involved, are traditional land use regulations within a municipality's/planning board's jurisdiction. [32]

Municipal Setbacks and General Welfare Provisions – Case Law Commentary

The following commentary with respect to the powers enjoyed by municipalities under municipal jurisdiction appeared in a September, 2010, Webinar presented by Laura Bowman, Staff Counsel, Environmental Law Centre:[33]

> *An early municipal jurisdiction case over gravel pits was Uxbridge Township v. Timber Brothers Sand and Gravel Ltd., [1975].[34] In that case the Ontario Planning Act explicitly provided for the power for municipalities to make bylaws prohibiting pits and quarries in certain areas. Uxbridge Township had imposed a bylaw providing land uses and residential setbacks for pits and quarries. A further bylaw regulated the operation of pits including rehabilitation and safety requirements.*
>
> *The court interpreted this to allow only the prohibition of new pits, not the regulation of existing ones. The court considered that the Municipal Act in Ontario provided the power to regulate the "operation" of pits and quarries. The operator challenged an Uxbridge Township bylaw on (among other grounds) the basis that the province already regulated quarry rehabilitation and setbacks. The court found that the Municipality could provide additional setbacks:*
>
> > **The provincial legislation does no more than set the minimum set-back requirements or standards and in no way attempts to restrict the right of a municipality to enhance these standards**. This the municipality may do provided it acts within its delegated legislative powers and does not enact provisions in by-laws which are inconsistent with statutory provisions. [emphasis added]
>
> *The court held that municipal setbacks that were less than those provided for in provincial legislation, were invalid. The court allowed an injunction against the pit based on the other portions of the gravel regulation bylaw.*
>
> *The case was referenced by the Supreme Court of Canada in Spraytech* [2001][35] *specifically for the proposition that municipalities may regulate the environment more than the province does.*
>
> *The SCC went on to hold that general welfare provisions in municipal statutes, including in Alberta, authorize environmental regulation within a municipality relating to pesticides, notwithstanding the existence of provincial laws relating to the same subject.*

A proponent seeking municipal planning approval of an application to permit a new or expanding blasting quarry is responsible for ensuring *flyrock*, a common underreported occurrence (Davis 1995), does not injure or kill onsite quarry employees or leave the boundaries of the site and cause harm to the environment and injure or kill human and non-human life offsite.

In *City Sand and Gravel Limited v. Newfoundland (Municipal and Provincial Affairs)*, 2007,[36] in which the quarry operator had leased land restricting quarry operations to the leased

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[32] *Tinicum Township v. Delaware Valley Concrete*, 812 A. 2d 758 (2002), Commonwealth Court of Pennsylvania, para. 764, https://scholar.google.ca/scholar_case?case=15752167703902735334&q=flyrock+and+%22setbacks&hl=en&as_sdt=2006.

[33] https://elc.ab.ca/media/7529/GravelPitsHandout.pdf.

[34] [1975] O.R. (2d) 484 (Ont. C.A.) Leave to appeal to Supreme Court of Canada Dismissed.

[35] 114957 Canada Ltee (Spraytech, Societe d'arrosage) *v.* Hudson (Town) 2 S.C.R. 241, 2001 SCC 40.

land, the Supreme Court of Nova Scotia upheld the trial court's finding that creation of an (external) buffer zone "would not authorize City Sand to eject fly-rock outside the quarry site and onto land comprising the buffer zone [para. 42]."

> *[38] The quarry operation, apparently conducted in compliance with the requirements of regulatory authorities, involving blasting of rock face with the resultant inherent danger of fly-rock. Throughout the relevant period, the successive quarry leases under which City Sand derived its rights forbade quarrying within 300 meters of a residential development without ministerial approval. City Sand understood from discussions with the Department of Mines and Energy, which issued the quarry leases, that there was a buffer around the quarry site. However,* ***the quarry leases did not confer upon City Sand rights over property outside the quarry****.* [emphasis added]

On May 20, 1988, a blast at the quarry launched *flyrock* debris offsite, which landed in the buffer zone, and resulted in complaints from nearby residents. A second *flyrock* incident occurred on July 3, 1998, causing damage to one resident's garage and the roof of another resident's house in the nearby Jane Heights subdivision.

> *The buffer zone, by definition, is a neutral area designed to separate, in this instance, two inconsistent and adjoining land uses. From an occupational health and safety perspective, it is a safety mechanism in the sense that should fly-rock or debris be ejected from the quarry site, as a result of blasting or other techniques, the likelihood of injury or damage to others is minimized. No evidence was placed before me to suggest the buffer zone is an area of usage to the plaintiff, that is, granting plaintiff [City Sand and Gravel Limited] permission, in its operations, to eject rock or debris into this area and outside the boundaries of its leasehold realty property [para. 56].*[37]

The implication of the trial court's observations is that the only way for a quarry operator to prevent *flyrock* from leaving the site is for the quarry operator to provide its own internal safety buffer, the equivalent of a setback. By 1996, it become clear that a 300-metre buffer for a blasting quarry was inadequate, and in 1996 the Department of Municipal and Provincial Affairs, in its conditions for approval of a blasting quarry, required a buffer zone of 1,000 metres from a cottage or residence.

In 2014, Austin Powder Ltd. pleaded guilty before the Justice of the Peace for failing to report to the Ministry of the Environment (MOE) "discharging flyrock" that resulted in off-site environmental impacts from blasting at the 98-acre Pakenham Quarry, licenced by Ministry of Natural Resources on March 22, 2006.

> *Austin Powder Ltd. and Keith Taylor…at Pts E1/2 26 & 27, Concession 9, Township of Lanark did commit the offence of discharging or causing or permitting the discharge of a contaminant, to wit fly rock from quarry blasting operations, into the natural environment which caused or was likely to cause an adverse effect contrary to Sec. 14 (1) of the Environmental Protection Act, R.S.O. 1990, c. E. 19, as amended, thereby committing an offence under Sec 186 (1) of the said Act.*

On July 20, 2009, and, again, on July 23, 2009, blasting at the Pakenham Quarry launched *flyrock* off-site. (The July 23, 2009 flyrock incident also struck the onsite quarry scale house

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[36] *City Sand and Gravel Limited v. Newfoundland (Municipal and Provincial Affairs),* 2007 NLCA 51 (CanLII), <https://canlii.ca/t/1sfnv>, retrieved on 2021-10-03. Leave to appeal to the Supreme Court of Canada denied.

[37] *City Sand and Gravel Ltd. et al. v. Newfoundland (Minister of Municipal and Provincial Affairs)*, 2005 NLTD 67 (CanLII), <https://canlii.ca/t/fwvrv>, retrieved on 2021-10-03.

230 metres from the blast, which Austin Powder Ltd. failed to report to the Ministry of Labour.)

> *According to the press release the official version of events is as follows: "In the first incident,[July 20, 2009] a small rock struck a worker at a neighbouring business on the arm. In the second incident, [July 23, 2009] rocks were observed flying well beyond the control area. A [quarry] scale house located 230 metres from the blast was struck by a number of rocks.*
>
> *Two [civilian] vehicles [occupied by passengers] held at a controlled stop along nearby Young Road on the edge of the quarry property located about 300 metres from the blast were also struck by rock resulting in extensive damage. There were no injuries even though the blast damaged property and impaired the safety of people."*[38]

During the MOE investigation (Case File Number: 2283-83MN69), Explotech Engineering, retained by MOE in response to the July 23, 2009 *flyrock* incident, testified and concluded even though "it appears that blast procedures were followed and that while not probable, the potential exists for a recurrence," and "strongly recommend[ed]" the "hazard zone" (i.e., safety zone, the equivalent of a setback) be increased to 500 metres:

> *"We strongly recommend that the hazard zone be increased to 500m when firing any future blasts.* (Source: Explotech Report, September 25, 2009)*"*

Despite Explotech stating that "**while not probable the potential for [flyrock] reoccurrence exists**," unbeknownst to Explotech, only three days earlier on July 20, 2009, another flyrock incident had occurred at the Pakenham Quarry.

In a follow-up July 16, 2010 report prepared by Explotech, in response to the first *flyrock* incident of July 20, 2009, Explotech concluded that

> *A review of the video of the July 20, 2009 blast clearly shows flyrock rifling from the toe area in two areas along the face of the blast. Based on additional witness and video evidence, it is our opinion that Austin Powder staff had to have been or ought to have been aware of flyrock being projected beyond the quarry boundaries. It is further evident that Austin personnel failed to verify that flyrock did not cause damage and failed to review their blasting procedures to ensure that the potential for flyrock was eliminated in subsequent blasts.*
>
> *…[T]he incident of July 20, 2009 should have served notice to Austin employees that the safety zone [i.e., setback] was not sufficient and that a review of the drilling and blasting operation was required.*

Both the blasting company, Austin Powder Ltd., and the quarry owner, Thomas Cavanagh Construction Ltd., argued unsuccessfully in their defence of not being aware of the reporting requirements under the Environmental Protection Act:

> *Statements from company officials for both Thomas Cavanagh Construction Ltd. and Austin Powder Ltd. confirmed that they did not report the said incidents, had no knowledge that fly rock constitutes a contaminant or, that fly rock incidents, which may cause an adverse effect must, be reported to the Ministry of the Environment.*

Flyrock is an uncontrollable and inevitable by-product of blasting, as confirmed by Keith Taylor, General Manager, Austin Powder Company Ltd:

> ***90% of fly rock incidents are "unexplainable."*** [emphasis added]

[38] Dunn, Derek. "Company guilty of Pakenham blasting mishap," *Arnprior Chronicle-Guide,* May 08, 2014.

THE ISSUE OF QUARRY FLY ROCK
June 2021. REVISED August 2021

ADVISORY TO REGISTERED PROFESSIONAL PLANNERS

On January 1, 2022, Rule 28 of subsection 0.13 (1) in Ontario Regulation 244/97 of the *Aggregate Resources Act*, comes into effect. It stipulates that the licensee of an aggregate quarry shall ensure that the quarry is in compliance with the Rule as follows:

> a licensee or permitted shall take all reasonable measures to prevent fly rock from leaving the site during blasting if a sensitive receptor is located within 500 metres of the boundary of the site.

Fly Rock discharge from quarry blasting is a contaminant as determined by the Supreme Court of Canada. It is likely to cause an adverse effect under the *Environmental Protection Act.*

Members of OPPI are advised to also consider the directions provided under Policy 1.2.6 under Provincial Policy Statement 2020 to establish the appropriate municipal planning policies as a preventative measure to achieve land use compatibility between quarries that undertake blasting and sensitive land uses.

Aggregates Resources Act and O. Reg. 244/97

The issue of blasting rock in a quarry is addressed by the Ministry of Northern Development, Mines, Natural Resources and Forestry ("NDMNRF") in consideration of applications for a licence under the Act. As of **April 21, 2021**, Ontario Regulation 244/97 under the *Aggregate Resources Act,* was amended to provide the following licence conditions and standards:

Licence Conditions

- No blasting on a holiday, or between 6 p.m. and 8 a.m.
- The Licensee shall monitor all blasts for ground vibration and blast over pressure in accordance with provincial guidelines on limits on blast over pressure and ground vibration for blasting operations.
- The Licensee shall prepare blast monitoring reports according to provincial guidelines on limits of blast overpressure and ground vibration for blasting operations.
- The Licensee shall retain blast monitoring reports for a period of seven years after each blast.

NDMNRF Standards require the following for applications:

Blast Design Report

In the application for a licence to extract or remove more than 20,000 tonnes of aggregate annually, a Blast Design Report is required to be submitted by the applicant if a sensitive receptor is located within 500 metres of the limit of extraction. The Report must demonstrate that provincial guideline, NPC-119-blasting, for blast overpressure and ground vibration can be satisfied.

Site Operations Plan

The applicant's Operations Plan must:

(a) provide details about the frequency and timing of blasts;

(b) provide the number of sensitive receptors that are located within 500 metres of the boundary of the site and the distance from this boundary to each sensitive receptor. A sensitive receptor is defined as a school, child care centre, or any residence or facility at which at least one person sleeps.

Land Use Compatibility - Provincial Policy Statement 2020

Section 1.2.6 sets out provincial policies with respect to Land Use Compatibility. In particular, Section 1.2.6.1 applies to the consideration by NDMNRF and municipalities of proposed quarries as a defined "Major Facility", as follows:

> *Major facilities* and *sensitive land uses* shall be planned and developed to avoid, or if avoidance is not possible, minimize and mitigate any potential *adverse effects* from odour, noise and other contaminants, minimize risk to public health and safety, and to ensure the long-term operational and economic viability of *major facilities* in accordance with provincial guidelines, standards and procedures.

This policy is mandatory and it is to be considered by the ministries and the municipalities.

Conversely, where sensitive land uses are proposed in the vicinity of an existing or planned quarry (major facility), the Province directs the municipalities to apply the following provincial policy 1.2.6.2:

> Where avoidance is not possible in accordance with policy 1.2.6.1, planning authorities shall protect the long-term viability of existing or planned industrial, manufacturing or other uses that are vulnerable to encroachment by ensuring that the planning and *development* of proposed adjacent *sensitive land uses* are only permitted if the following are demonstrated in accordance with provincial guidelines, standards and procedures.

a) there is an identified need for the proposed use;
b) alternative locations for the proposed use have been evaluated and there are no reasonable alternative locations;
c) *adverse effects* to the proposed *sensitive land use* are minimized and mitigated; and
d) potential impacts to industrial, manufacturing or other uses are minimized and mitigated.

The Legal Obligations

The Supreme Court of Canada considered an appeal by Castonguay Blasting Ltd. and dismissed the appeal in favour of the Province of Ontario. The Court decided (October 17, 2013) that "Castonguay was required to report the discharge of fly-rock forthwith to the Ministry of the Environment" (Paragraph 40). In its decision, the Court stated the following relevant reasons:

"Applying these elements to this case, s. 15(1) (*Environmental Protection Act)* was clearly engaged. Castonguay "discharged" fly-rock, large pieces of rock created by the force of a blast, into the "natural environment". There is also no doubt that fly-rock meets the definition of "contaminant". The discharge in this case was "out of the normal course of events" - it was an accidental consequence of Castonguay's blasting operation. Had the blast been conducted routinely, the fly-rock would not have been thrust into the air." (Paragraph 37).

"The adverse effects were not trivial. The force of the blast, and the rocks it produced, were so powerful they caused extensive and significant property damage, penetrating the roof of a residence and landing in the kitchen. A vehicle was also seriously damaged. The fly-rock could easily have seriously injured or killed someone." (Paragraph 39).

The *Environmental Protection Act* is preventive with respect to the discharge of contaminants. The Act and the Regulations apply to prevent the accidental impact of fly rock. Since the licensee is required to keep fly rock on the site during blasting, any discharge of fly rock beyond the controlled blast environment that is not a normal event, i.e. it would have been prevented, must be reported forthwith to the MECP, if the contaminant may likely cause an adverse effect. The Ministry may issue an order for remediation and preventive measures.

Analysis

The new provision for regulating and managing fly rock at a quarry site is contained in Ontario Regulation 244/97 under the *Aggregate Resources Act.* All quarries, both existing and those that are licenced after January 1, 2022 are required:

> "to take all reasonable measures to prevent fly rock from leaving the site during blasting if a sensitive receptor is located within 500 metres of the boundary of the site".

This following observations should be considered by Planners:

- There is no existing provincial government guideline indicating how the licensee is to keep fly rock within the quarry site when blasting. We understand from NDMNRF that this guidance is being prepared.

- The Act and/or the Regulation do not indicate how the proponent is to take all reasonable measures to demonstrate that fly rock can be contained within the quarry site during blasting. We understand from NDMNRF that this guidance is being prepared.

- At least one existing sensitive receptor must be located within 500 metres of the licenced boundary. If a new sensitive receptor is located within 500 metres of the quarry after it is operational, the fly rock rule would apply.

- If there are vacant lots that are designated and/or zoned for sensitive receptors, these are not recognized by this obligation. When these lots are developed and used as sensitive receptors, the fly rock rule will apply where they are within 500 metres of the boundary of the quarry.

- If during blasting, fly rock discharges off the site within the 500-metre area, the municipality should be aware of the obligation by the operator to report this contamination forthwith to MECP.

Blasting is referred to in section 49 of O. Reg. 419/05 "Air Pollution - Local Air Quality". There is a prohibition on the emission of any contamination beyond the limits of the property upon which blasting is being carried out.

At the request of officials in the Ministry of Northern Development, Mines, Natural Resources and Forestry, a meeting was conducted with the advisory authors and staff at the Ontario Professional Planners Institute. At this meeting, several updates were provided, facts and observations were discussed. We made amendments to this advisory to address these matters. The assistance of Ministry officials is greatly appreciated.

The Ministry advised OPPI that it is currently in the process of developing a guideline to assist quarry operators in implementing the fly rock rule.

This Advisory, as revised, is prepared by Mark L. Dorfman, RPP, and George McKibbon, RPP. The views expressed within this Advisory are their own based on research of existing legislation, policies and court records and do not necessarily reflect the views of OPPI or its affiliates. This is not legal advice. Members should rely on relevant laws, standards, by-laws, regulations and legislation that govern this issue.

Addendum

(provided by the Ministry of Northern Development, Mines, Natural Resources and Forestry)

Fly rock risks are managed through a matrix of policies and legislation that deal with a wide range of related topics including operational requirements for blasting, land-use compatibility, protection of the environment as well as public health and safety. The ministry takes this issue seriously and offers the following for OPPI consideration, and further discussion:

Land-use Planning

The Provincial Policy Statement (PPS) provides the policy foundation for regulating development and the use of land in Ontario. It deals with a variety of subjects including public safety, protection of the environment, and natural resources as well as provides for policies for economic growth. It is important to note the PPS exists as a comprehensive framework of policies which cannot be viewed in isolation from other policies. Part III of the preamble states the following:

"*The Provincial Policy Statement is more than a set of individual policies. It is to be read in its entirety and the relevant policies are to be applied to each situation. When more than one policy is relevant, a decision-maker should consider all relevant policies…*"

In addition to the land-use compatibility policies section 1.2.6 referenced in the OPPI paper, the PPS also contains detailed policies related to Mineral Aggregate Resources in section 2.5. Of note, the PPS requires that extraction"*...be undertaken in a manner which minimizes social, economic and impacts*".

These policies are reflected in specific requirements outlined in the *Aggregate Resources Act* (ARA), associated regulations, standards, and policies (discussed further, below) for existing operations and new applications.

The PPS also requires that development, and activities being considered near existing aggregate operations and aggregate deposits, consider and address "*...issues of public health, safety and environmental impact*." In undertaking development, municipal planners are required to consider public health and safety for new developments in relation to existing mineral aggregate operations and resources areas. Municipal planners need to ensure that new development near existing operations, or known resources, do not create or exacerbate public health and safety issues.

Aggregates

Ministry of Northern Development, Mines, Natural Resources and Forestry (NDMNRF) regulates blasting, including fly rock, in quarries (on Crown lands and designated private lands) under the following policy framework which prioritizes the safety and wellbeing of people, the environment and property, while enabling the extraction of aggregate resources:

Aggregate Resources Act — The purpose of the ARA is, among other things, to minimize adverse impact on the environment in respect of aggregate operations (Section 2). Further, the contravention of the Act or Regulations under the Act (including the below-listed Regulation and Standards) is considered an offence[1].

Ontario Regulation 244/97 under the ARA — lists prescribed conditions[2] pertaining to blasting, including blasting hours, requirements for blast monitoring[3] (in conjunction with blasting policies; see below), and the new flyrock rule[4].

The Aggregate Resources of Ontario Provincial Standards

Aggregate Resources of Ontario Technical Reports and Information Standards — lists requirements for the submission of blast design reports by quarry applicants proposing to extract over 20,000 tonnes/year.

Aggregate Resources of Ontario Site Plan Standards — require quarry applicants to include details of proposed blasting activities, and information regarding sensitive receptors within 500 m of the quarry boundary.

The Aggregate Resources Policy and Procedures Manual

Policy *A.R. 5.00.10* — covers blasting restrictions across approval instruments

Policies *A.R. 2.01.09* (licences), *A.R. 4.01.08* (permits), and *A.R. 3.01.07* (wayside permits) — lay out the Ministry's approach for Blast Design Report and blast monitoring requirements.

Therefore, the new fly rock rule should not be viewed in isolation but rather within the larger ARA regulatory context within which it is nested.

Further, our Ministry is currently working on developing guidance to provide greater clarity and detail on the intent and implementation of the new fly rock rule; guidance may include best management practices and policy guidance.

[1] Subsection 57(3) of the ARA

[2] Prescribed conditions are placed on the approval instrument (licence, permit, wayside permit) at the time of approval, and cannot be changed or varied.

[3] Subsection 0.12(5) of O. Reg. 244/97

[4] Subsection 0.13(1) of O. Reg. 244/97

Environmental Protections

The Ministry of the Environment, Conservation and Parks (MECP) administers the *Environmental Protection Act* (EPA) under which flyrock can be considered a contaminant (pollutant), and the off-site discharge of flyrock is considered a spill[5]. The EPA requires that every person who spills or causes or permits a spill of a pollutant is required to notify MECP's Spills Action Centre[6] and take action to address any adverse impacts caused by the spill[7]. Both NDMNRF and MECP take fly rock incidents very seriously and when off-site discharge of fly rock is reported, or a complaint of off-site impact is received, MECP staff will work with the NDMNRF to assess the incident and determine the appropriate action, which may include additional measures which need to be taken to prevent future off-site fly rock incidents.

Worker Safety

The Ministry of Labour, Training and Skills Development (MLTSD) administers the *Occupational Health and Safety Act* (OHSA) under which *Regulation 854 (Mines and Mining Plants; R.R.O. 1990*) lists requirements pertaining to blasting, including in quarries. The OHSA and Regulation 854 require that:

quarry operators conduct a risk assessment of the workplace to identify, assess, and manage hazards, and potential hazards, that may expose a worker to injury or illness. Under such a risk assessment, fly rock would also have to be addressed.

each blast be designed by a competent person, appointed by the quarry operator. The blast design:

- must be documented (prior to start of blasting), as well as reviewed and followed.
- must include guarding procedures to protect workers on site.

prior to each blast, a siren warning of blast is to be given, and where there are public roads nearby, traffic must be warned of the impending blast, and stopped.

where workers are required to be present near the blast, blasting shelters must be provided.

Further, in the event of an accident (unintended event), premature or unexpected explosion or defective explosives or detonators, which could result in fly rock leaving the quarry site, the operator must notify the MLTSD

[5] Subsection 91(1) of the EPA
[6] Subsection 92(1) of the EPA
[7] Subsection 91(1) of the EPA