Trench Blasting with DYNAMITE

DYNO®
Dyno Nobel
Groundbreaking Performance™

A TRADITION OF INNOVATION

Dyno Nobel's roots reach back to every significant innovation in explosives safety and technology. Today, Dyno Nobel supplies a full line of explosives products and blasting services to mines, quarries and contractors in nearly every part of the world.

DYNAMITE

PRODUCT OF CHOICE FOR TRENCH BLASTING

One explosive product has survived the test of time to become a true classic in the industry. DYNAMITE! The dynamite products manufactured today by Dyno Nobel are similar to Alfred Nobel's original 1860s invention yet, in selected applications, they outperform any other commercial explosives on the market. The high energy, reliability and easy loading characteristics of dynamite make it the product of choice for difficult and demanding trench blasting jobs. Look to Unigel®, Dynomax Pro® and Unimax® to make trench blasting as effective and efficient as it can be.

DISCLAIMER

Cover photo depicts a trench blast using Primacord® detonating cord, MS Connectors and Unimax® dynamite.

SAFE BLASTING REMINDERS

Blasting safety is our first priority. Review these reminders frequently and make safety your first priority, too.

• Dynamite products will provide higher energy value than alternate products used for trenching due to their superior energy, velocity and weight strength.

• All explosives bearing the 1.1 UN classification (High Explosives) are sensitive to shock and heat; therefore, dynamites must be treated with care. They must never be removed from the factory cartridge nor should they ever be tamped vigorously.

• Read and understand the “Always and Nevers” document contained in each case of Dyno Nobel dynamite. When in doubt, always consult the manufacturer.

Causes of Unsafe and Ineffective Trench Blasting

• Drilling Accuracy: Check every borehole for borehole drift from vertical with instrument or inverted flashlight on loading tape. Borehole deviation is a significant safety problem because of the possibility of flyrock, which is compounded in trench blasting due to heavy confinement and close proximity of all the holes.

• Underloading Boreholes: Shoot the trench on paper with the recommended formula for column height, powder factor, stemming and delay pattern before drilling and loading the shot. In addition, test shooting a small section of the trench will improve hole pattern and product selection success.

• Overloading Boreholes: Consider using blasting mats or debris-free dirt cover for added safety against flyrock.

• Geological Analysis: Failure to properly evaluate the rock properties, prominent seams or joining planes may cause poor results.

• Improper Product Selection: Using explosives that deadpress, that have insufficient energy per unit or too little density may cause product failure or poor breakage.

GUIDELINES FOR SUCCESSFUL

EXPLOSIVES SELECTION

Successful trench blasting depends upon proper explosive selection, correct powder factor, proper vertical explosives distribution, correct delay pattern and drilling accuracy.

UNIGEL is recommended for rock conditions that are soft to medium hard, horizontally bedded, laminated and/or fractured formations and where water conditions are not excessive.
DYNOMAX PRO is recommended when saturated ground or severe water conditions are encountered, where drill patterns are reduced for controlled blasting or in hard, massive rock formations. Dynomax Pro should be considered where dead pressing or propagation is a potential problem.
UNIMAX is recommended for all trenching applications where soft, medium, hard and very hard rock are encountered. Drill patterns may be adjusted to accommodate rock types. Unimax is best suited for massive rock formations, surface or moderate water conditions, and where drill patterns can be kept within design parameters.

The best **initiation system** for trench blasting, electric or nonelectric, uses detonators designed to resist transient dynamic shock. Dyno Nobel NONEL® and Electric Super detonators have built-in safeguards to minimize damage from dynamic shock.

SUBDRILLING

Subdrilling is required for proper floor control and is dependent on the depth of the trench.
- Trench depths of 4’ to 12’: subdrilling = 3’
- Trench depths over 12’: subdrilling = 4’

Note: these recommendations are based on borehole diameters of 3.5” or less.

. TRENCH BLASTING

POWDER FACTOR

Power factor is expressed as pounds of explosive per cubic yard of rock and is depth dependent. Cubic yardage is calculated: Burden (ft) x Spacing (ft) x Hole Depth (ft) (not including subdrill) ÷ 27

- Trench depths of 4' to 12': powder factor = 3.5
- Trench depths of 12' to 20': powder factor = 4.0
- Trench depths over 20': powder factor = 5.0

Notes:

1 - Trench depth does not include subdrilling; hole depth does.

2 - In trenches where the overburden is not removed, the overburden is included in the cubic yard calculations.

3 - These recommendations are based on borehole diameters of 3.5" or less.

4 - Recommended subdrill is 6" more than the trench advance.

5 - Recommend no more than 1" difference between the borehole diameter and powder diameter.

STEMMING

Stemming material should always be clean, minus ⅜" crushed stone to improve fragmentation and reduce flyrock potential. Drill cuttings will yield less than satisfactory results and increase the potential of flyrock and poor blasting results.

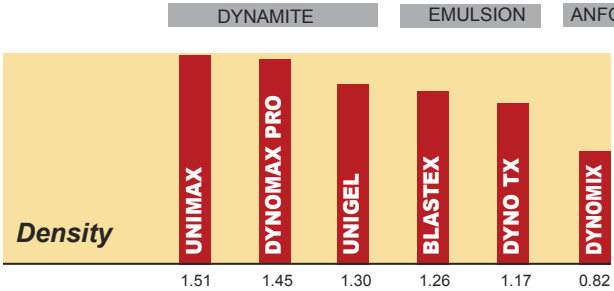
Stemming depths should be at least 20 times the borehole diameter *-or-* one foot below the top of the rock with overburden, when the depth of the overburden is at least 20 times the borehole diameter.

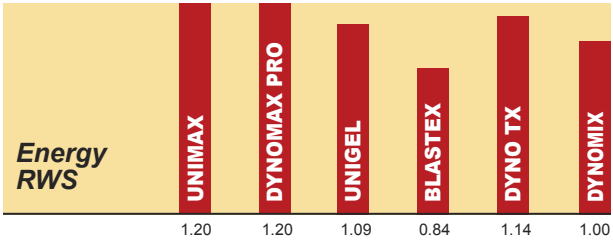
DECKING

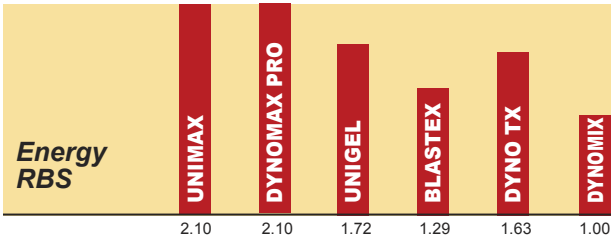
In boreholes that are decked, the decks should consist of at least 2.5 feet of clean, minus ⅜" crushed stone to avoid interaction of explosive charges.

The firing sequence should be top-to-bottom. Top deck first, bottom deck last.

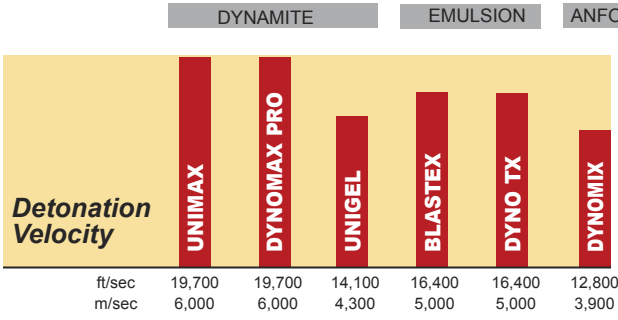
EXPLOSIVE COMPARISON

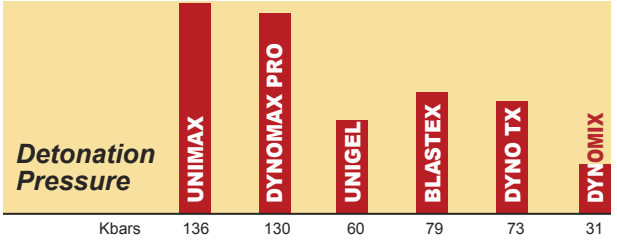


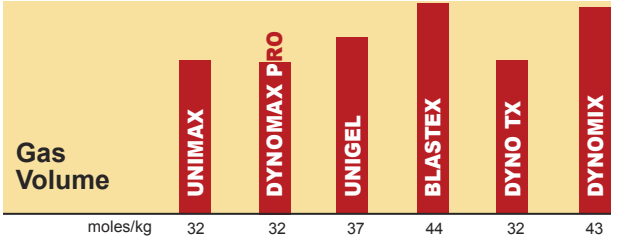




FOUR REASONS FOR POOR TRENCH BLASTING







1. Underloading the boreholes.
2. Overloading the boreholes.
3. Failure to deck through a prominent seam or joint.
4. Poor product selection for the application.

UNIMAX®

TECHNICAL

Best All Around

EXTRA GELATIN NITROGLYCERIN DYNAMITE

MSDS #1019

2 x 16 Convolute Shell Tamptite

Properties

Density (g/cc)	1.51
Energy (cal/g) (cal/cc)	1,055 1,510
Relative Weight Strength	1.20
Relative Bulk Strength	2.10
Velocity (ft/sec) (m/sec)	19,700 6,000
Detonation Pressure (Kbars)	136
Gas Volume (moles/kg)	32
Water Resistance	Excellent
Fume Class	IME1 & NRCan1

Unimax is susceptible to sympathetic detonation when used in very wet conditions.

INFORMATION

Packaging

Diameter x Length inches	Diameter x Length mm	Cartridge Weight lbs	Cartridge Weight kg
1 x 8	25 x 200	0.34	0.16
1⅛ x 8	29 x 200	0.44	0.20
1¼ x 8	32 x 200	0.54	0.25
1¼ x 16	32 x 400	1.07	0.49
1½ x 8	40 x 200	0.77	0.35
1¾ x 8	45 x 200	1.05	0.48
2 x 8	50 x 200	1.37	0.62
2 x 16	50 x 400	2.74	1.24
2¼ x 16	60 x 400	3.47	1.57
2½ x 16	65 x 400	4.28	1.94
2¾ x 16	70 x 400	5.18	2.35
3 x 8	75 x 200	3.08	1.40
3 x 16	75 x 400	6.17	2.80

Borehole Loading Calculation

Explosive Diameter inches (mm)	Pounds of UNIMAX per Foot of Blast-hole	Kilograms of UNIMAX per Meter of Blasthole
1 (25)	0.51	0.76
1⅛ (29)	0.65	0.97
1¼ (32)	0.80	1.19
1½ (40)	1.16	1.72
1¾ (45)	1.57	2.34
2 (50)	2.06	3.07
2¼ (60)	2.60	3.87
2½ (65)	3.21	4.78
2¾ (70)	3.89	5.79
3 (75)	4.63	6.89

DYNOMAX® PRO

Best In Water

DESENSITIZED EXTRA GELATIN NITROGLYCERIN DYNAMITE

MSDS #1019

2 x 16 Spiral Tube Shell with Tapered End

Properties

Density (g/cc)	1.45
Energy (cal/g) (cal/cc)	1,055 1,510
Relative Weight Strength	1.20
Relative Bulk Strength	2.10
Velocity (ft/sec) (m/sec)	19,700 6,000
Detonation Pressure (Kbars)	130
Gas Volume (moles/kg)	32
Water Resistance	Excellent
Fume Class	Not for underground use

Dynomax Pro minimizes sympathetic detonation when used in very wet conditions.

TECHNICAL INFORMATION

Packaging

Diameter x Length inches	Diameter x Length mm	Cartridge Weight lbs	Cartridge Weight kg
1 x 8	25 x 200	0.33	0.15
1¼ x 8	32 x 200	0.50	0.23
1¼ x 16	32 x 400	1.03	0.47
1½ x 8	40 x 200	0.75	0.34
1¾ x 8	45 x 200	1.00	0.45
2 x 8	50 x 200	1.30	0.59
2 x 16	50 x 400	2.60	1.18
2¼ x 16	60 x 400	3.30	1.50
2½ x 16	65 x 400	4.00	1.81
2¾ x 16	70 x 400	5.00	2.27
3 x 8	75 x 200	3.00	1.36
3 x 16	75 x 400	6.00	2.72

All Dynomax Pro shells have a built-in capwell, and incorporate a barrier film to reduce nitroglycerin exposure.

Borehole Loading Calculation

Explosive Diameter inches (mm)	Pounds of Dynomax Pro per Foot of Blasthole	Kilograms of Dynomax Pro per Meter of Blasthole
1 (25)	0.49	0.73
1¼ (32)	0.77	1.15
1½ (40)	1.11	1.65
1¾ (45)	1.51	2.25
2 (50)	1.97	2.93
2¼ (60)	2.50	3.72
2½ (65)	3.09	4.61
2¾ (70)	3.73	5.55
3 (75)	4.44	6.61

UNIGEL®

TECHNICAL

Most Economical

SEMI-GELATIN NITROGLYCERIN DYNAMITE

MSDS #1019

2 x 16 Bullet Nose Tube Shell

Properties

Density (g/cc)	1.30
Energy (cal/g) (cal/cc)	955 1,240
Relative Weight Strength	1.09
Relative Bulk Strength	1.72
Velocity (ft/sec) (m/sec)	14,100 4,300
Detonation Pressure (Kbars)	60
Gas Volume (moles/kg)	37
Water Resistance	Good
Fume Class	IME1 & NRCan1

Unigel is susceptible to sympathetic detonation when used in very wet conditions.

INFORMATION

Packaging

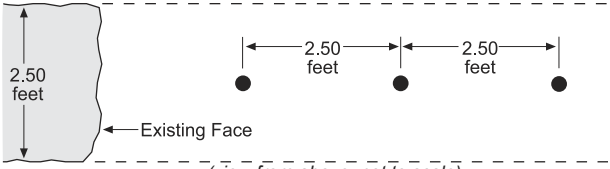
Diameter x Length		Cartridge Weight	Cartridge Weight
inches	mm	lbs	kg
1 x 8	25 x 200	0.30	0.14
1⅛ x 8	29 x 200	0.38	0.17
1¼ x 8	32 x 200	0.46	0.21
1½ x 8	40 x 200	0.66	0.30
2 x 8	50 x 200	1.18	0.54
2 x 16	50 x 400	2.36	1.07
2¼ x 16	60 x 400	2.99	1.36
2½ x 16	65 x 400	3.69	1.67
2¾ x 16	70 x 400	4.47	2.03
3 x 16	75 x 400	5.3	2.41

Borehole Loading Calculation

Explosive Diameter	Pounds of UNIGEL per Foot of Blast-hole	Kilograms of UNIGEL per Meter of Blasthole
inches (mm)		
1 (25)	0.44	0.65
1⅛ (29)	0.56	0.83
1¼ (32)	0.69	1.03
1½ (40)	1.00	1.49
1¾ (45)	1.36	2.02
2 (50)	1.77	2.63
2¼ (60)	2.24	3.33
2½ (65)	2.77	4.12
2¾ (70)	3.35	4.98
3 (75)	3.98	5.92

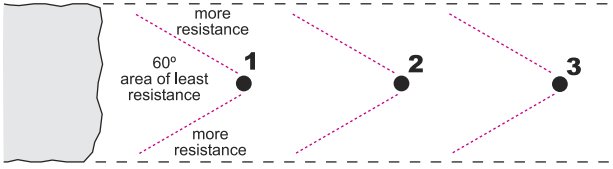
SHOT DIAGRAM
2.5 ft Straight Line Pattern

Maximum trench size for this pattern: 2.5 ft wide x 10.0 ft deep. *This pattern is generally used for narrow and shallow trenches. To minimize risk of propagation, only use Dynomax Pro in this pattern.*

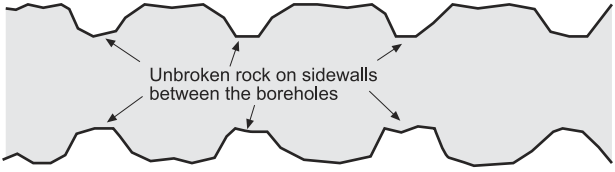


(view from above, not to scale)

Typical firing sequence of holes



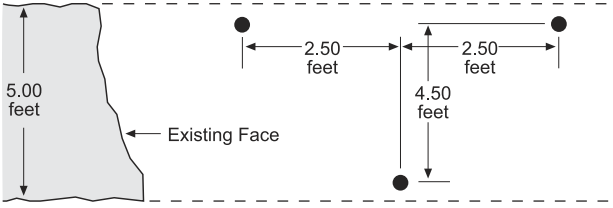
Problems that typically occur when the trench is too wide or too deep for this pattern.



SHOT DIAGRAM

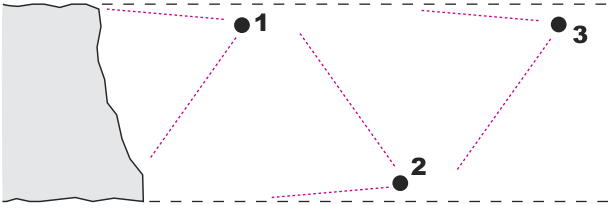
2.5 ft x 4.5 ft Staggered Pattern

Maximum trench size for this pattern: 5.0 ft wide x 15 ft deep. *This pattern is generally used as trenches get wider and/or deeper than those using straight line patterns.*

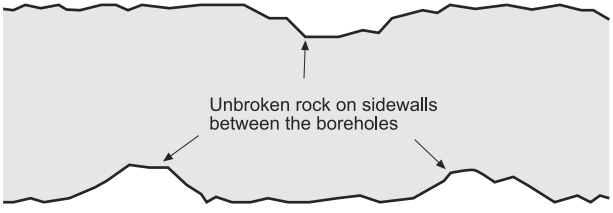


(view from above, not to scale)

Typical firing sequence of holes



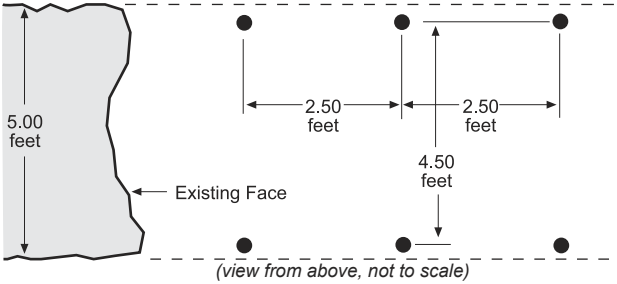
Problems that typically occur when the trench is too wide or too deep for this pattern.



SHOT DIAGRAM

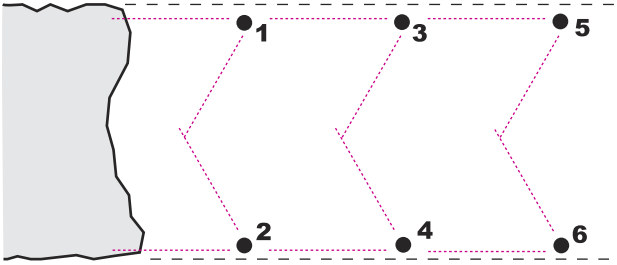
2.5 ft x 4.5 ft Box Pattern

Maximum trench size for this pattern: 5.0 ft wide x 20 ft deep. *This pattern is generally used as trenches get wider and/or deeper than those using staggered patterns. To minimize risk of propagation, only use Dynomax Pro.*

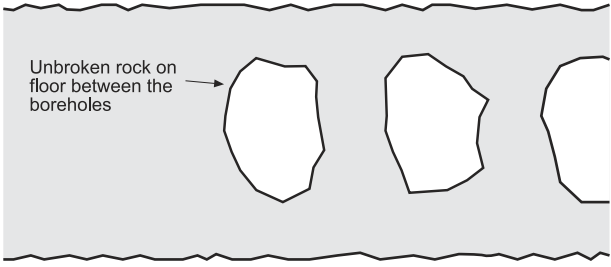


(view from above, not to scale)

Typical firing sequence of holes



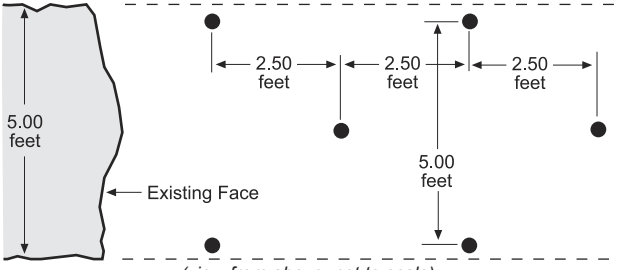
Problems that typically occur when the trench is too wide or too deep for this pattern.



SHOT DIAGRAM

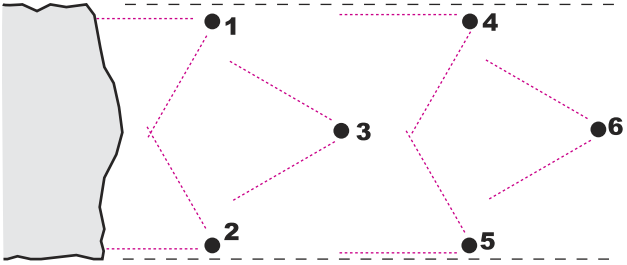
2.5 ft x 5.0 ft Diamond Pattern (5 Dice)

Maximum trench size for this pattern: 5.0 ft wide x 25.0 ft deep. *This pattern is generally used as trenches get wider and/or deeper than those using box patterns.*

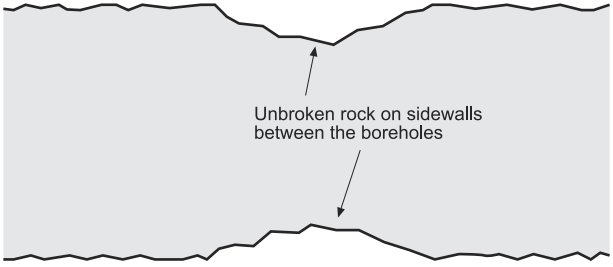


(view from above, not to scale)

Typical firing sequence of holes



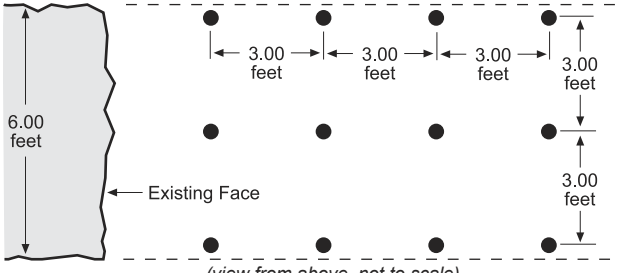
Problems that typically occur when the trench is too wide or too deep for this pattern.



SHOT DIAGRAM

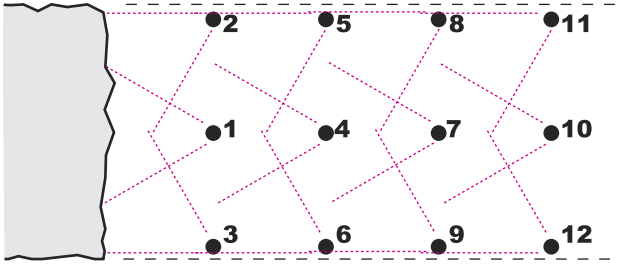
3.0 ft x 3.0 ft Three Hole Box Pattern

Use this pattern for trenches 6.0 ft and wider x 25.0 ft and deeper. *This pattern is generally used as trenches get wider and/or deeper than those using three spot patterns. To minimize risk of propagation, only use Dynomax Pro.*



(view from above, not to scale)

Typical firing sequence of holes



Typical results

Weights of Various Solid Materials

	Weight lbs/ft^3	Weight lbs/yd^3	Loose Weight lbs/yd^3
Basalt	180-185	4860-5075	—
Bauxite	100-160	2700-4325	2020-3240
Diabase	160-185	4200-5075	—
Dolomite	175-180	4725-4860	—
Granite	170	4500	3000-2520
Gypsum	145-205	3915-5535	—
Limestone, massive/hard	160	4200	—
Limestone, seamy/punky	150	4000	2680
Limestone	120-145	3240-3920	2400-2900
Sandstone	155	4140	2980-2610
Shale, riprap	150-175	4050-4725	—
Traprock	185	5075	3400

	Specific Gravity	Swell Factor	Percent of Swell	Suggested Dynamite*
Basalt	2.8-3.0	—	—	Unimax
Bauxite	1.6-2.5	.75	33	Unimax
Diabase	2.6-3.0	—	—	Unimax
Dolomite	2.8-2.9	—	—	Unimax
Granite	2.7	.67-.56	50-80	Unimax
Gypsum	2.3-3.3	—	—	Unigel
Limestone, massive/hard	2.6	.60-.57	67-75	Unimax
Limestone, seamy/punky	2.4	.67	50	Unigel
Limestone	1.9-2.1	.74	35	Unigel
Sandstone	2.5	.72-.63	40-60	Unigel
Shale, riprap	2.4-2.8	.75	33	Unigel
Traprock	3.0	.67	50	Unimax

* Use Dynomax Pro where water saturated conditions exist, regardless of rock type, to minimize the risk of propogation.

We'd like to EXPLODE a few myths about the future of DYNAMITE

myth: Dynamite will soon be unavailable.

fact: Alfred Nobel invented dynamite over 130 years ago and Dyno Nobel has been manufacturing it ever since. Both Dyno Nobel and its affiliated companies are committed to supplying dynamite far into the future.

myth: Dynamite can be easily replaced with other explosives.

fact: Dynamite is superior to any other explosive in difficult blasting conditions. Its high energy, proven reliability and ruggedness dramatically reduce the risk of poor blast results. These unique performance characteristics will always separate dynamite from other explosives.

myth: Dynamite is too expensive.

fact: In difficult conditions, the consequences of not using dynamite often include excessive digging time, oversize muck, undetonated explosives in the muck pile, poor fragmentation, not pulling to grade and missed holes. All of which can be very expensive. As we have in the past, Dyno Nobel will continue to sell dynamite at a fair price.

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