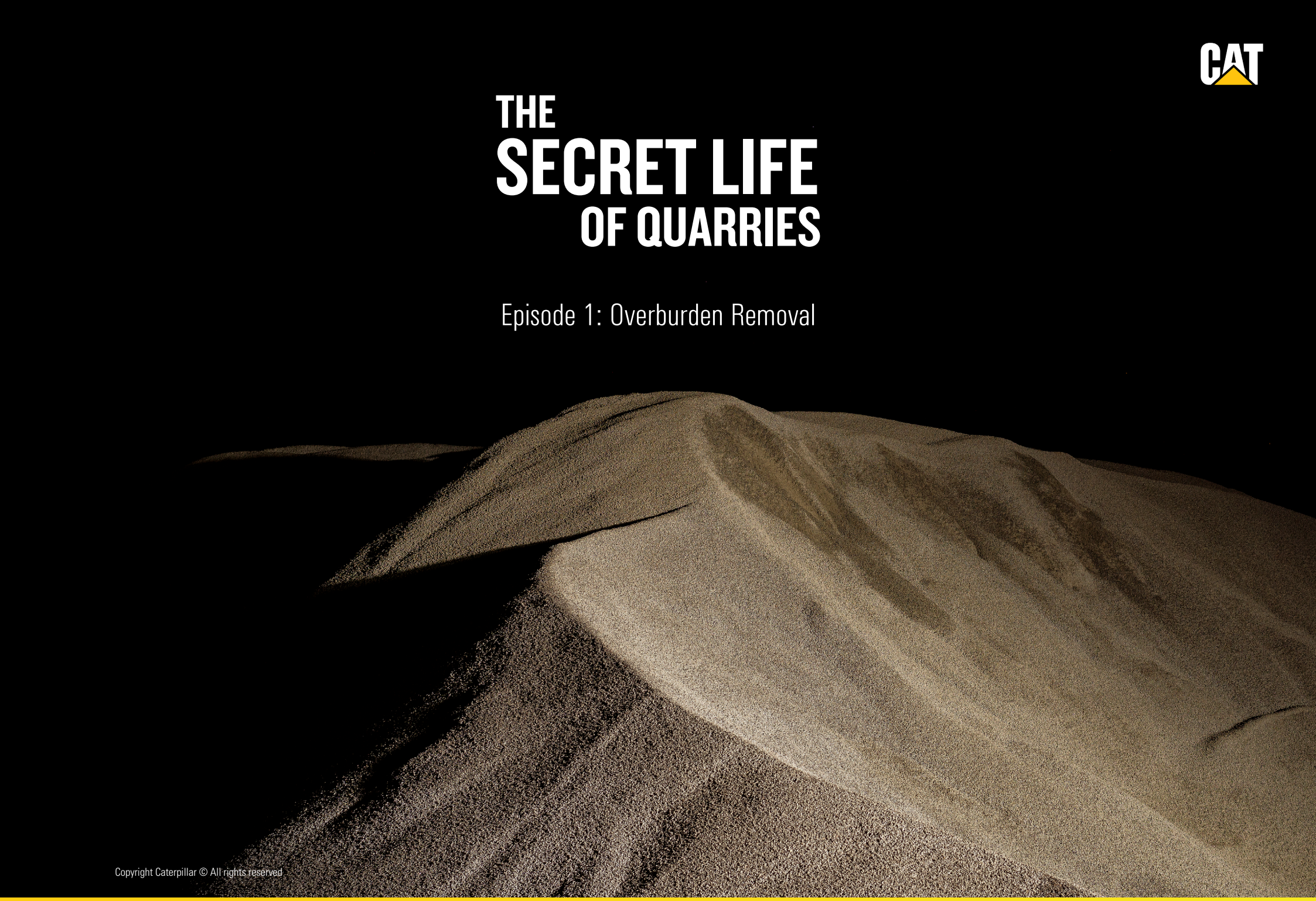
THE SECRET LIFE OF QUARRIES

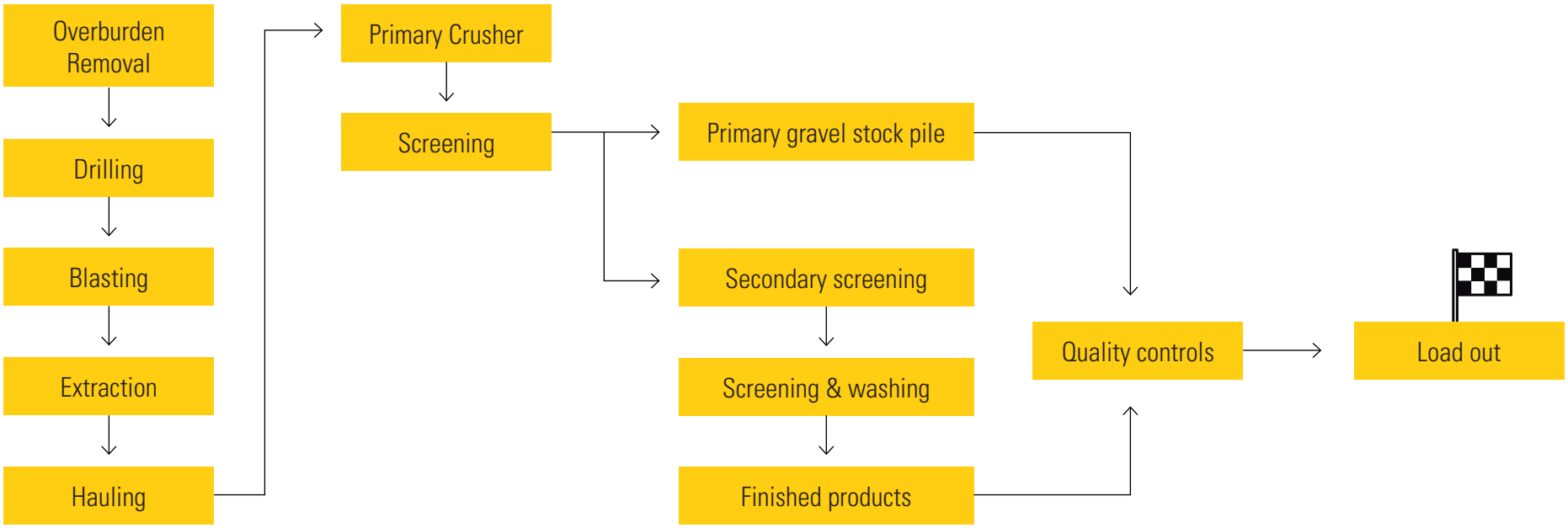
Episode 1: Overburden Removal



QUARRYING STARTS WITH OVERBURDEN

The first step of every quarrying operation is to remove the useless material from over and around the valuable materials being quarries.

We call this useless material *overburden*.



Removing overburden is costly, complicated and absolutely crucial to reach the materials we need.

How the overburden removal operation is handled has huge knock-on effects on every subsequent step of the quarrying process, impacting both production and cost-per-tonne.

THE BURDEN OF OVERBURDEN

A typical quarry's overburden operation can easily exceed 100,00 tonnes. What would it take to shift this material?

ASSUMPTIONS

- 1 x Excavator equipped with a 4.7m3 bucket
- 2 x Articulated Trucks with max. payload of 28 tonnes
- Material Density of 1.5 kg/m^3
- With bucket fill factor of 100%, avg. payload of 7 tonnes

CALCULATIONS

- Truck payload of 28 t/Excavator Bucket payload of 7t = 4 x buckets per truck to target payload
- Hourly production = 8 x trucks x 28t = 224t/h
- Daily production (at 10h shift) = 2.240t/day
- In order to move 100,000t of overburden, 100.000/2.240 = 45 days needed

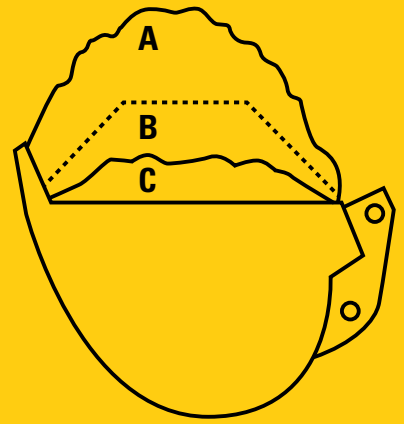
Working ten hour days with a three-machine fleet, a typical overburden operation still takes 45 working days.

So where do these machines come from?

A NOTE ON BUCKET FILL FACTOR

Different kinds of overburden allow different levels of bucket fill.

Overburden materials tend to allow a comparatively high 80-110% fill capacity.



Material	**Fill factor range (% of heaped bucket capacity)**
Moist loam or sandy clay	A – 100-110%
Sand and gravel	B – 95 -110%
Hard, tough clay	C – 80-90%

FLEET UTILIZATION

Where do we get the machines to run our overburden operation? Do we use our extraction fleet for overburden removal too, or do we need a separate fleet? There are pro's and con's to each option, and the right answer depends on many different variables.

USE EXTRACTION FLEET

Pros

- ✓ No extra costs for new machines
- ✓ Potentially no extra operators needed
- ✓ No increase in number of machines requiring maintenance

Cons

- ✗ Cannot use same machine for two tasks at once - must either perform overburden removal after hours, or stop production to clear overburden
- ✗ Extra wear and tear on machine from extra use
- ✗ Real risk to production targets if machine fails

USE SEPARATE FLEET

Pros

- ✓ No risk to production should machine fail
- ✓ Production and overburden removal can be performed simultaneously
- ✓ Less wear and tear to machines that would otherwise be used for both tasks

Cons

- ✗ Higher number of assets increases maintenance costs
- ✗ More operators must be found and more wages paid
- ✗ Increased numbers of machines requiring maintenance

In the end, the right choice is the one which best balances production, costs and risk to machines.

TIMINGS AND ORGANISATION

- Some sites clear overburden as they go, running parallel production and removal operations.
- As discussed above, this requires either retasking part of the existing fleet or paying for an entire secondary fleet.
- Other quarries leave overburden on-site and only clear it periodically. This is often cheaper, but means leaving waste piles around the quarry, which could affect manoeuvring and thus impact productivity.
- Ultimately, we must either use some of our machines all of the time, or all of our machines some of the time.

EQUIPMENT SELECTION

Overburden areas tend to be a mess of ruts, dips and slippery vegetation, making agility and stability the most important qualities for our overburden fleet.

That's why, in the calculation above, we used articulated trucks and excavators.

Excavators can reach almost anything and go just about anywhere, while the adaptability and agility of articulated dump trucks tends to make them a far better choice than their fixed-base cousins.

But beyond machine choice there's an equally important question:

Which bucket works best?

BUCKET SELECTION

Bucket choice – choosing the right size, shape and weight of bucket – is therefore one of single most important factors in any overburden operation. So which excavator bucket – and which GETs (ground engaging tools) – should we use?

BUCKET CONSIDERATIONS

- Every minute spent clearing overburden is a minute lost to primary production
- Overburden tends to be relatively soft and lightweight
- Overburden tends to form relatively stable piles
- Too small a bucket will slow production
- Too large a bucket will increase fuel use, affect stability and even risk damage to the machine
- Under-designed buckets struggle to penetrate harder materials, wear out quickly and need more maintenance
- Over-designed buckets limit material retention, reduce production and increase cost-per-tonne

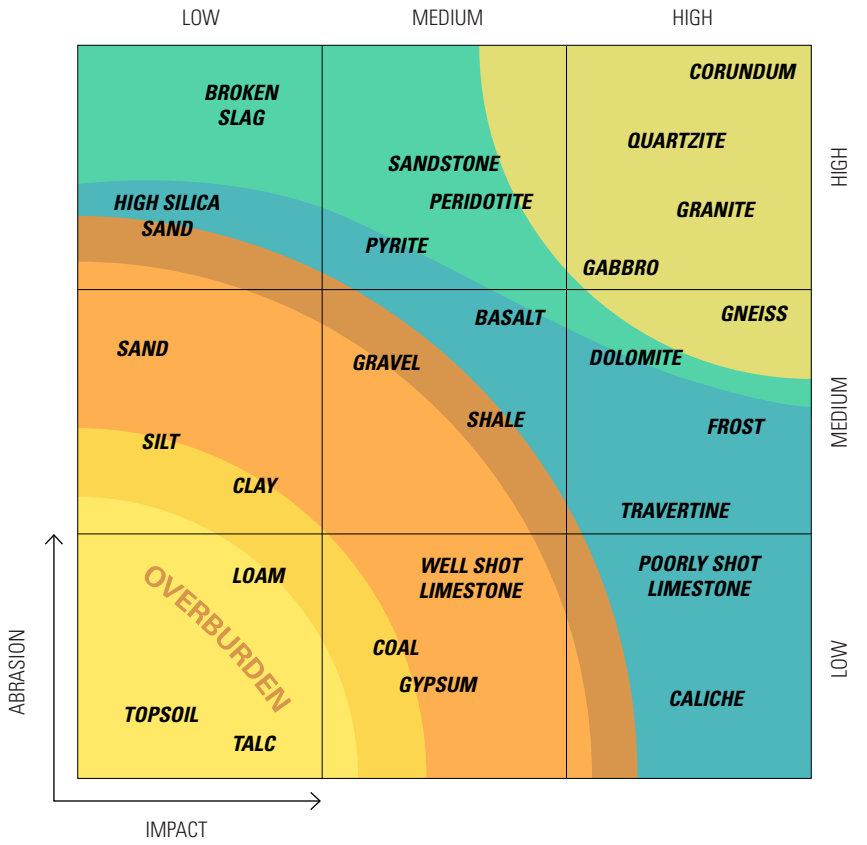
BUCKET CHOICE

Where overburden is mostly soft and low impact (topsoil, loam, talc) General Duty buckets are typically the preferred choice.

But where overburden becomes more abrasive and higher impact (clay, sand, gravel, shale) Heavy Duty buckets are more suitable.

- General duty
- Heavy duty
- Severe duty
- Extreme duty

Recommended material for bucket durability

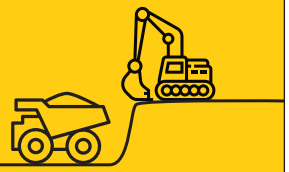


OPERATOR TECHNIQUES

OPERATOR SKILL AND TECHNIQUE CAN MAKE A HUGE DIFFERENCE TO AN OVERBURDEN OPERATION:

- Experienced operator can improve performance, productivity, fuel usage and costs by up to 30%
- Ideal machine positioning can dramatically decrease cycle times
- Minimal idling time extends machine lifespan and uses less fuel

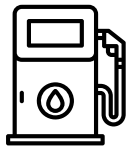
As an example, simply having the loading machine elevated on an overburden bench and set at 45 degrees to the hauler can decrease cycle time by a third and increase fuel efficiency by almost half.

Scenario: Annual production of 500,000 t (approx. 250.000 BCM)	 **SAME LEVEL 90 DEGREES**		 **BENCH 45 DEGREES**	
Production time	1 hour	10 hours	1 hour	10 hours
# of truck loads over duration	20 trucks	200 trucks	30 trucks	300 trucks
Productivity	560 tonnes	5600 tonnes	840 tonnes	8400 tonnes
Fuel burn per hour	374 (54 l/hr)		374 (50 l/hr)	
Fuel efficiency	10.4 t/l		16.8 t/l	
Difference in production	**-30%**		**+30%**	
Difference in fuel efficiency	**-50%**		**+50%**	

COST CONSIDERATIONS

A huge number of factors affect overburden removal costs.

Some of the most common include:

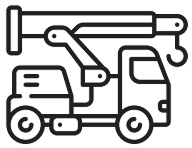


Fuel

Operator wages

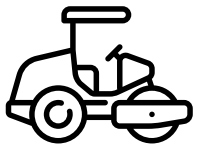
Depreciation

Wear



Maintenance

Fix Costs/Assets



Site Conditions

The effects of all of these must be factored in to any overall operation costs – especially if there's an opportunity to hand the entire operation over to someone else.

THE SECRET

For every overburden operation there's always a contractor ready and willing to take over - for a price.

Is this a price worth paying?

The only way to know for sure is to add up all the costs and risks of running the operation in-house, and compare these numbers to those quoted by the contractor(s).

With a little help from Specialist Fleet Production and Costs Analysis software – or from your local Cat quarrying expert - we can always reach the right answer, and make the right decision.

Because the real secret of overburden removal is knowing when to handle it ourselves, and when to pass it over.

To learn more secrets, watch The Secret Life Of Quarries at www.cat.com/SecretLifeOfQuarries, or get in touch with our experts today.

Thank you