Geological constraints and modifying factors - Cement

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Key features of cement raw material reserves

- For a modern cement plant, sufficient reserves of suitable quality for >25 years are needed close to the plant (many international companies look for >50 years and some for 100). **Overriding driver for location is quality and quantity of raw materials**
- Mine production rates are considerable, typically 6,400 tonnes of dry raw material per day to produce 4,000 tonnes of clinker (>2M tonnes of dry raw material per year).
- Transport of this raw material over long distances is not economic so plant close to reserves.

Cement manufacture

- Cement clinker is predominantly calcium silicate. Limestone is burnt, releasing CO_2, and combined with silica to produce calcium silicate (with iron and alumina combined with calcium as minor constituents).
- Clay and limestone materials with a combined $CaCO_3$ content at between 78% and 80% (and constraints on Fe_2O_3, Al_2O_3 and SiO_2), heated in a kiln to temperatures greater than 1,200°C to produce CLINKER.
- Clinker ground finely in mills and with the addition of gypsum and/or other materials to produce CEMENT.

EXPORTS

CEMENT KILN ADJACENT TO PRIMARY RAW MATERIALS RESERVES LASTING >20 YEARS

CLINKER

GRINDING PLANT

IMPORTED CLINKER

GYPSUM

CEMENT

COAL OR OTHER **FUEL** DELIVERED TO CEMENT WORKS VIA RAIL, ROAD OR (FOR GAS) VIA PIPELINE

OTHER RAW MATERIALS e.g. IRON OXIDE, SAND AND CLAY

<250km

LOCAL MARKET

READY MIX DISTRIBUTED WITHIN A <30km RADIUS

ON-SITE MIXING

BAG (MERCHANT) MARKET

CONCRETE PRODUCTS

AGGREGATES – BULKY COMMODITY – HIGH TRANSPORT COSTS

EXPORTS

Pre-feasibility/site selection stage.

Increasing the level of confidence

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an

What investigations and analyses will be necessary to reduce geological uncertainty and define and manage the modifying factors?

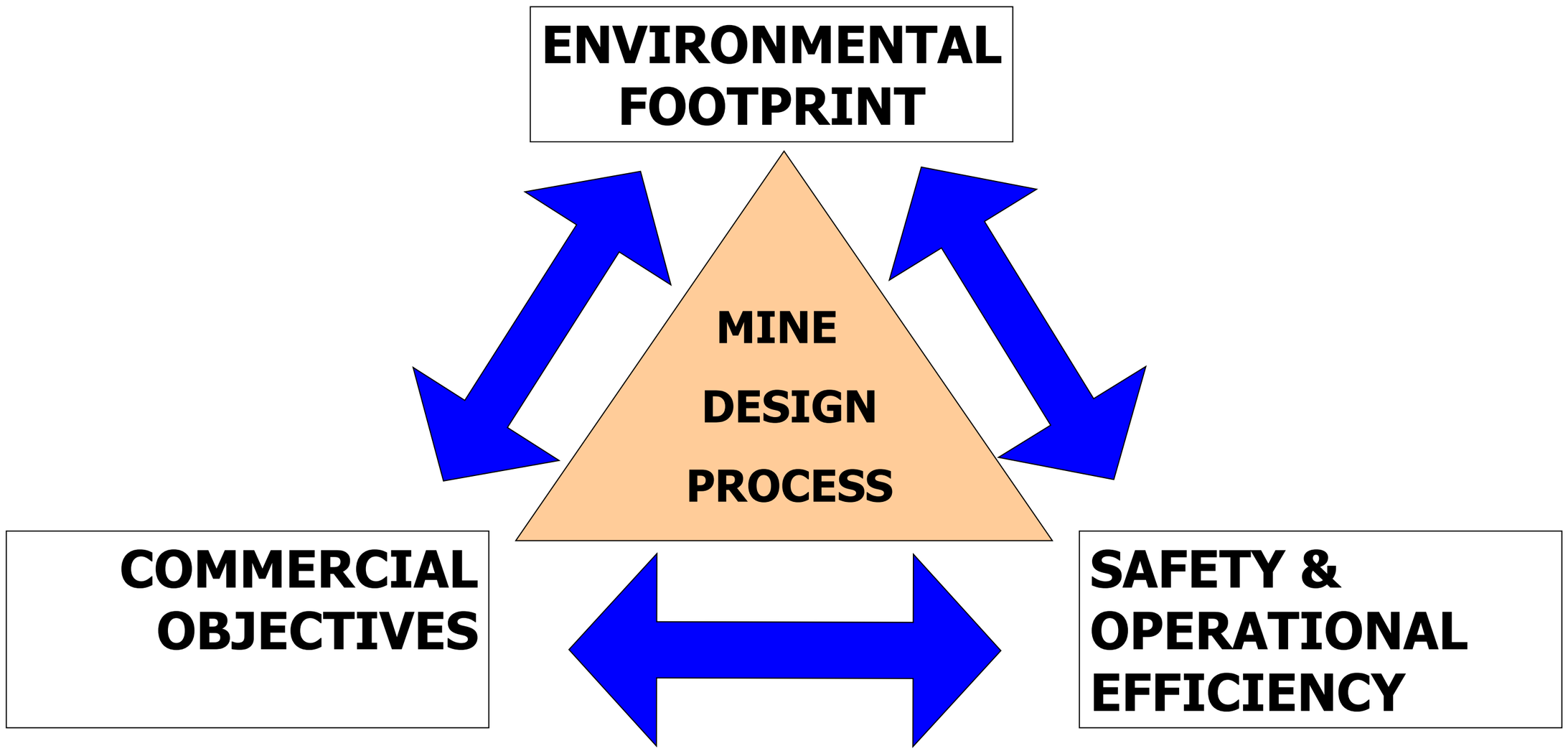
Is there anything about this site we can identify now that is an obvious 'show stopper'?

On balance, which site justifies the effort and expense of following the blue arrows?

Modifying factors

- **Mining** (how to ensure consistency of chemical composition)
- **Markets** (competition, proximity, size, market share – decisions as to kiln capacity)
- **Environmental considerations** (humans and wider environment)
- **Economic** (reducing stockpiling and double handling, efficient working layout, reducing haul distances for raw material clinker and cement)

Mine design – a framework for optimising the modifying factors



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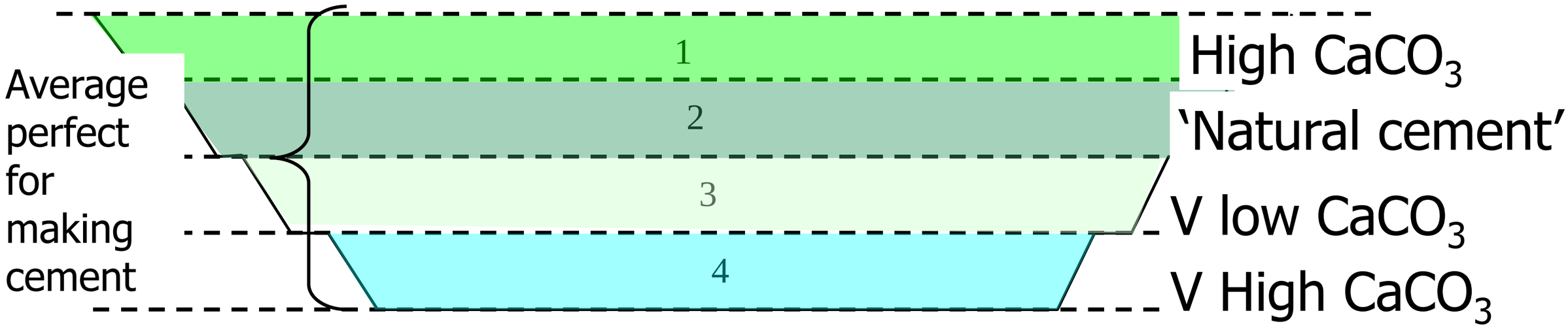
Recurrent questions throughout the design process

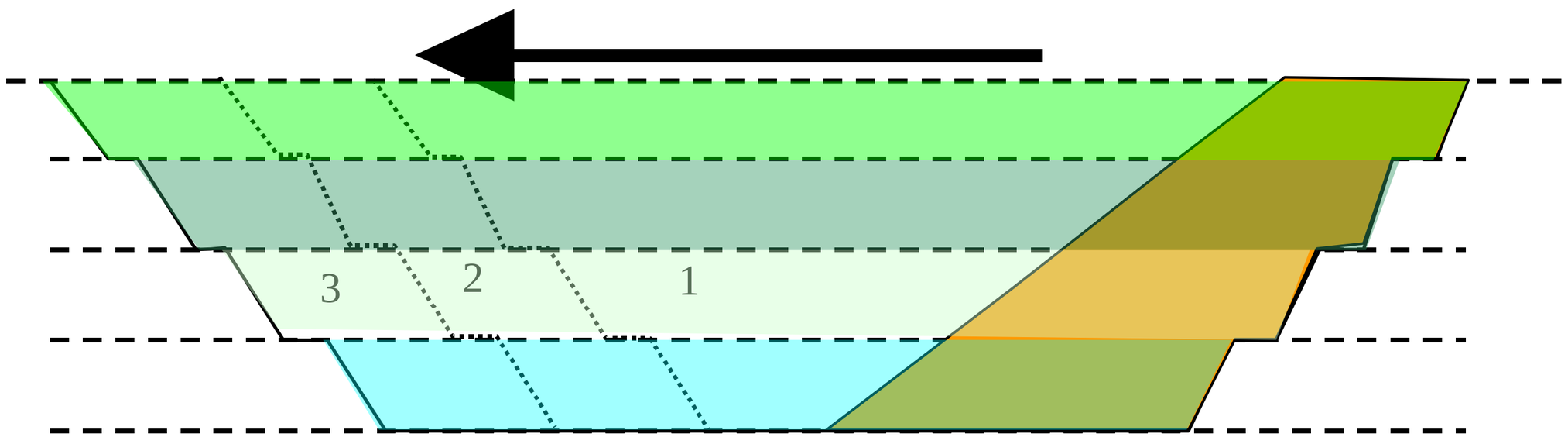
- As more information is gathered throughout the process:
  - 'given the changes that have been made to meet environmental, planning or health and safety constraints, can we still meet our business objectives at this site?'
  - 'if not, is it still worth completing the design and applying for a permit to work?'
  - 'what are our revised business objectives?'

Key features of cement raw material reserves

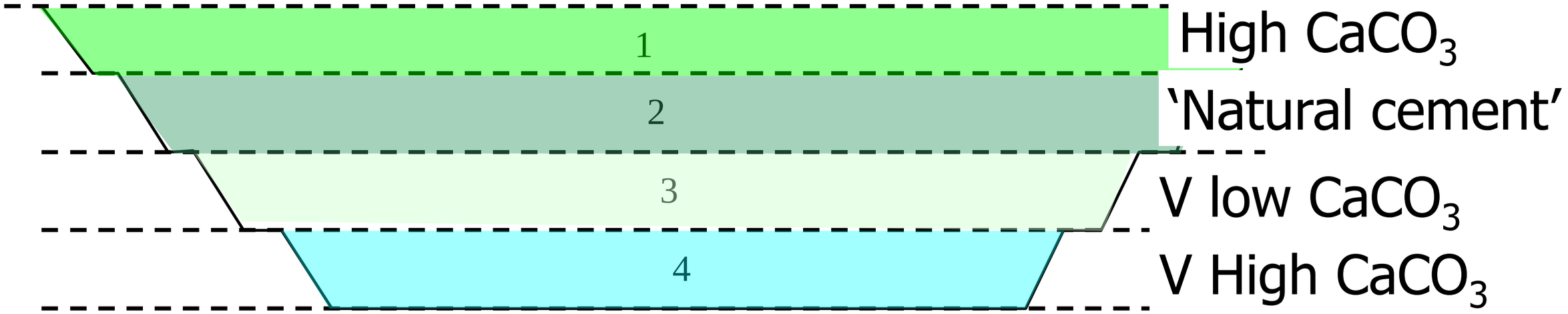
- Chemical consistency of the raw material is important and this needs to be achieved as far as possible through pit design and phasing that yields a consistent product. This avoids or reduces to a minimum the need for blending and homogenising stockpiles (expensive and large) and/or constant 'tweaking' of additives.



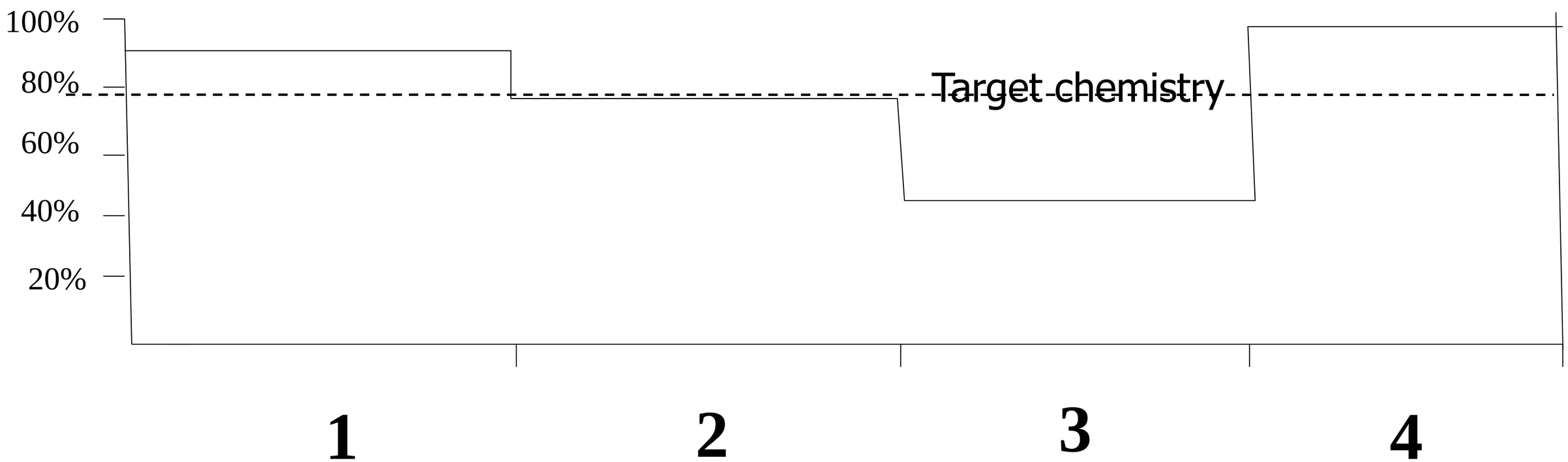
Open pit quarry - method 1

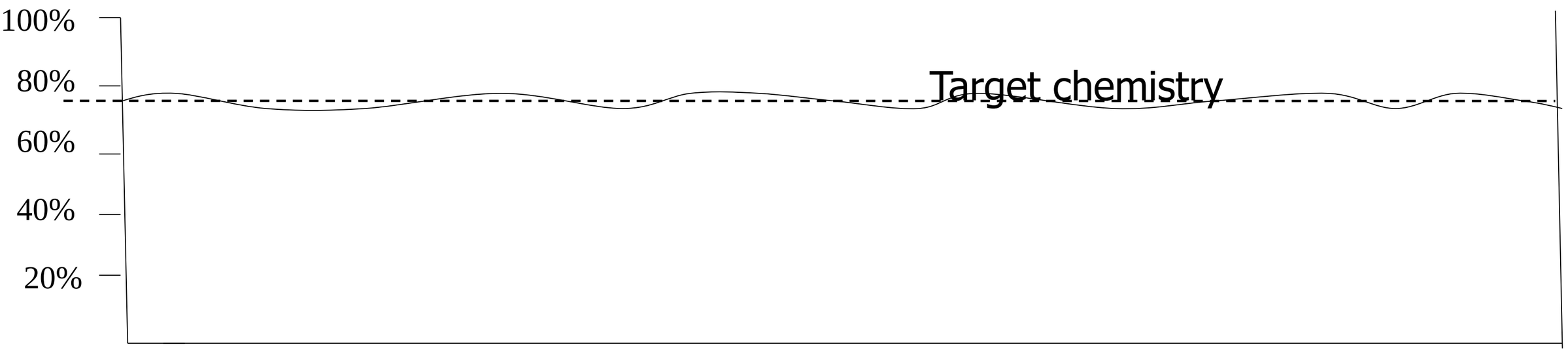


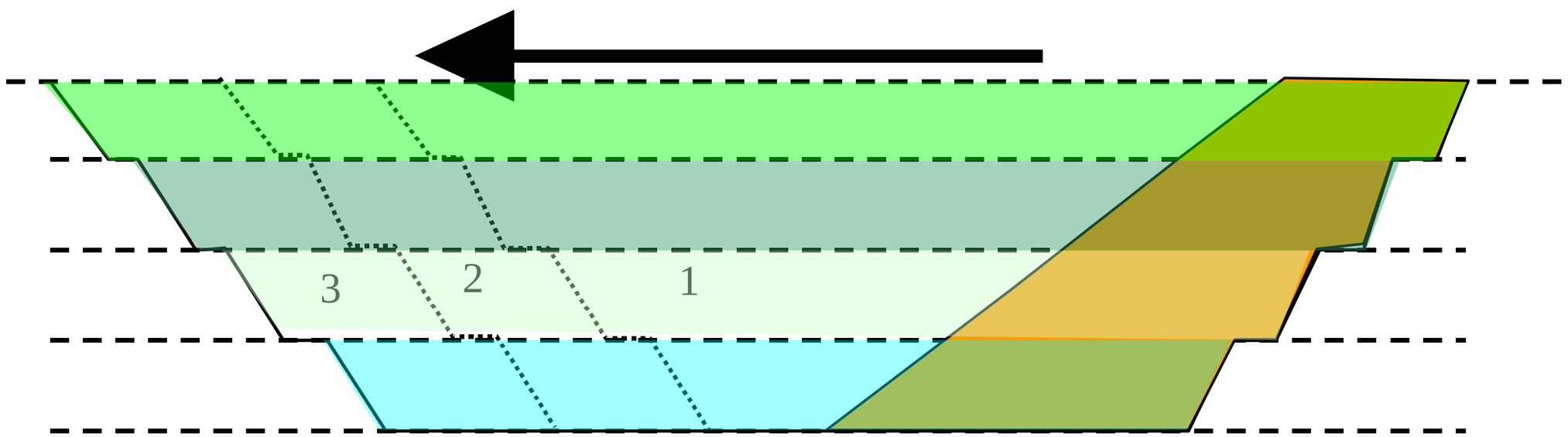
Open pit quarry - method 2



Open pit quarry - method 1







Open pit quarry - method 2

Resource measurement and classification

- Constraints on resource size
  - Geology
  - Geotechnics
  - Hydrogeology
  - Land ownership and permitting
  - Working methods and existing mine layouts
  - Quality release requirements
  - Proximity of local populations
  - Ecological designations

QUARRY I

250mASL

QUARRY II

250mASL

A1

A2

1.5km 'NO GO' ZONE

Haul road

A

A'

B

B'

C

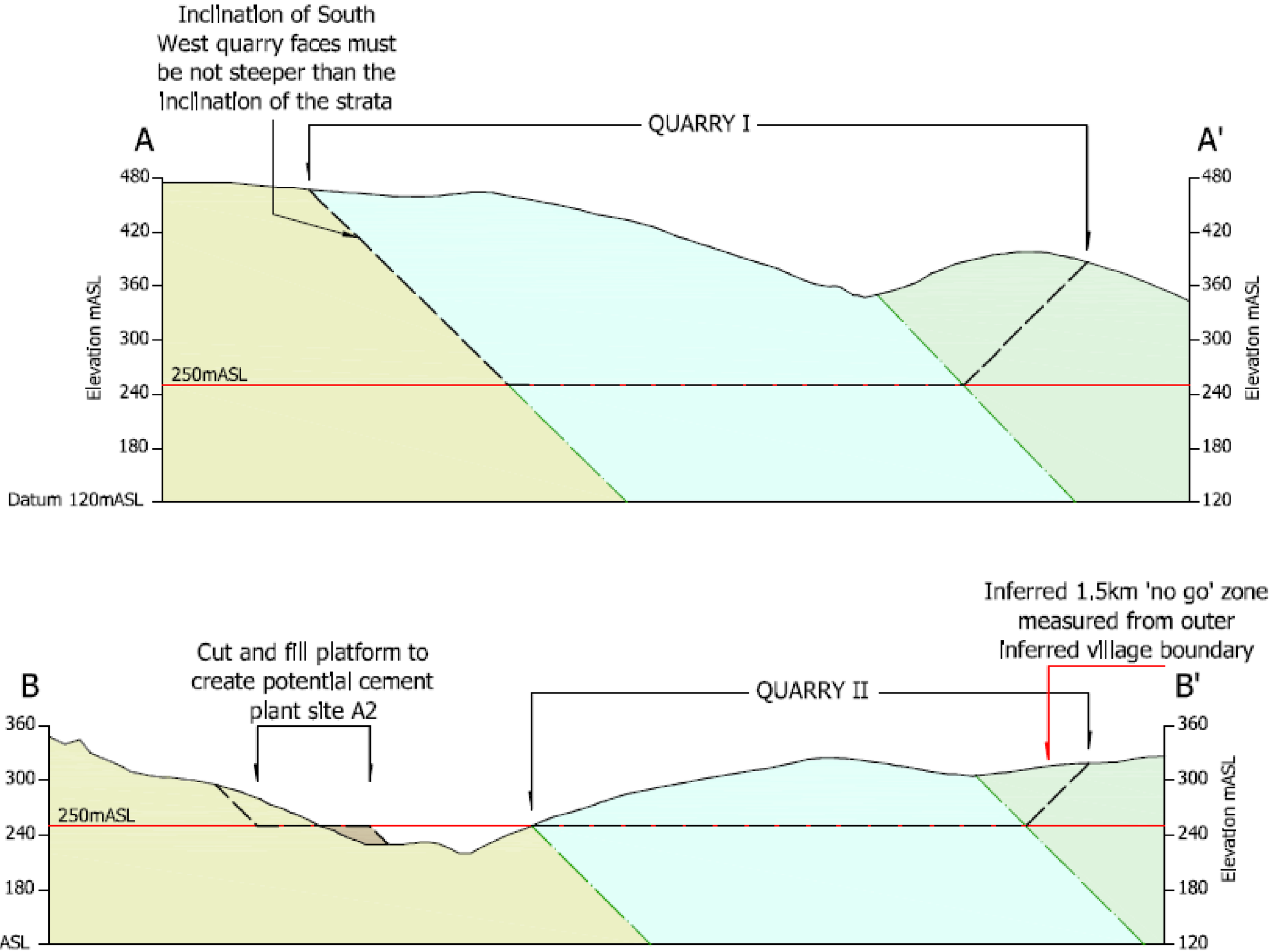
C'

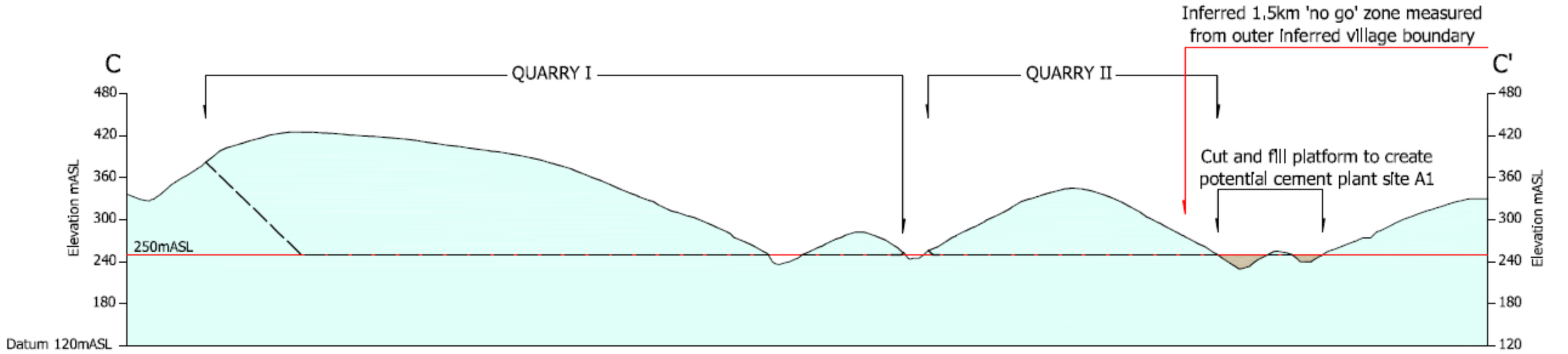
4972000N

4971500N

4971000N

Scale (metres)


Inclination of South West quarry faces must be not steeper than the Inclination of the strata
QUARRY I
A
A'
480
420
360
300
240
180
Elevation mASL
250mASL
Datum 120mASL
120
Cut and fill platform to create potential cement plant site A2
Inferred 1.5km 'no go' zone measured from outer Inferred village boundary
QUARRY II
B
B'



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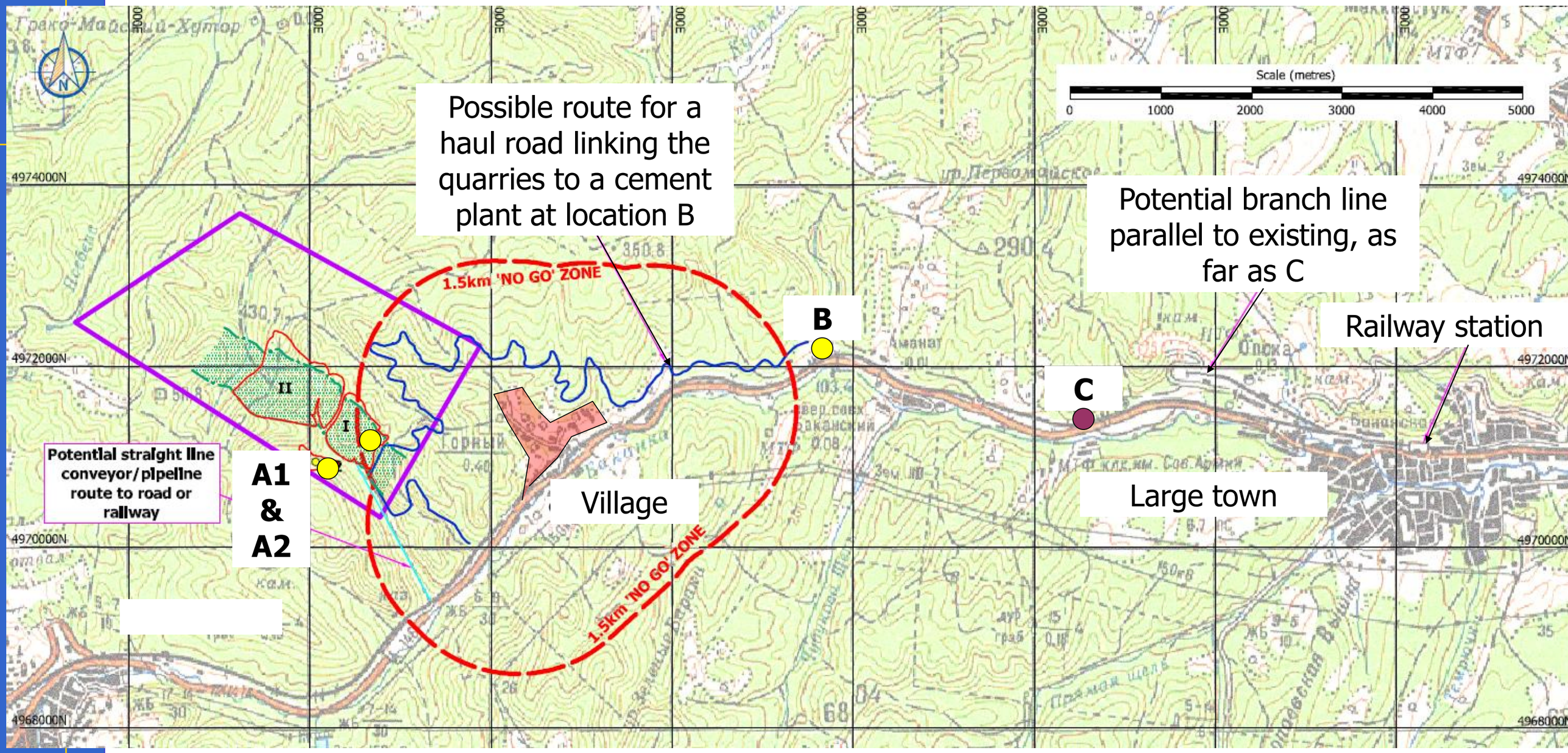

- Potential rail head location
- Alternative sites for a cement plant

2km

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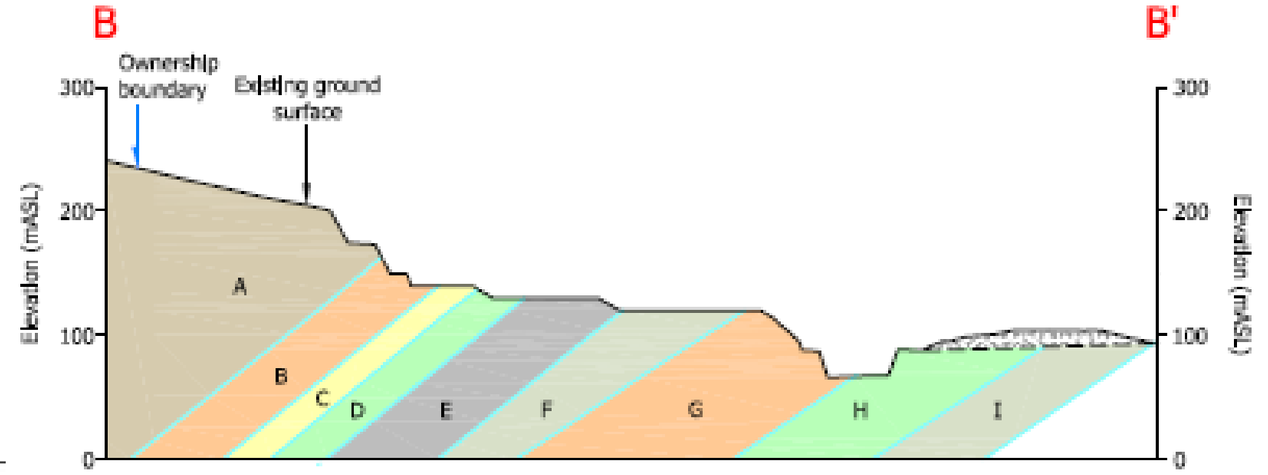

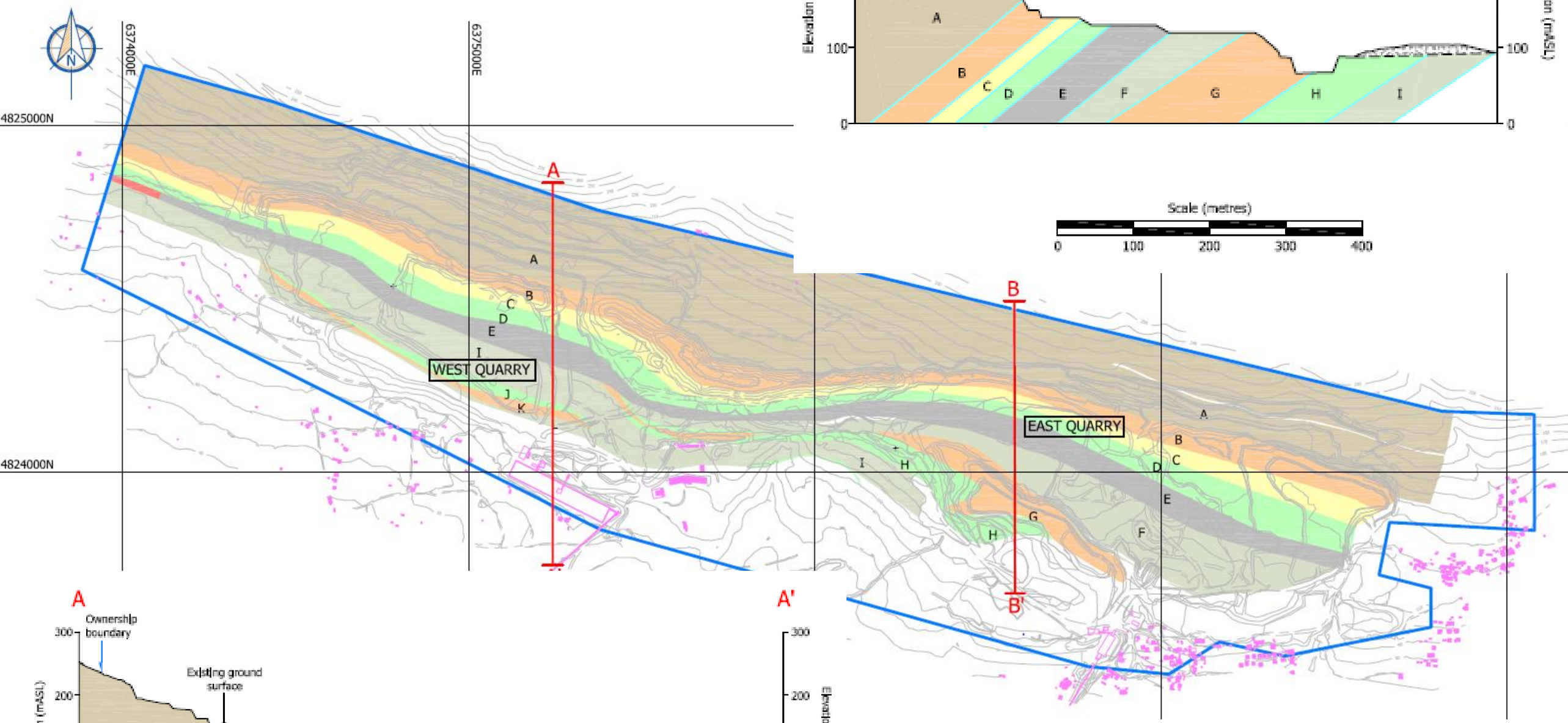

Scale (metres)

0 100 200 300 400

Scale (metres)

0 100 200 300 400

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Juraj
crusher

Homogenisation
stockpile

Kaštela

Solin

Kajo
crusher


Image © 2009 DigitalGlobe


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Data U.S. Navy
©2007 Google
43°32'59.41" N 16°28'06.71" E elev 126 m
Streaming 100%
Eye alt 1.3

Buffer Zone

1000m from Cemetery

Backfill to c.100mASL

c.100mASL

40mASL

1v:3h

Existing spoil mound

c.90mASL

c.90-91 mASL

85mASL

90mASL

100mASL

Conveyor

Spoil mound retained as screen

Fill ramp placed before deepening of conveyor ramp below 70mASL

Juraj crusher

Homogenisation stockpile

Conveyor ramp

Screening bund

Kaštela

Solin

Kajo crusher

Access to 100m level for quarry traffic

5m high screening bund

Buffer Zone

DRAFT

Scale (metres)

0 100 200 300 400

LEGEND

Client
Cemex - Dalmacijacement

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