DUST ASSESSMENT STUDY
PROPOSED RESIDENTIAL SUBDIVISION
TYANDAGA - PHASE II

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EXECUTIVE SUMMARY

The dust impacts from the future extension of the Aldershot Quarry, on land adjacent to the proposed Tyandaga - Phase II developments in Burlington, Ontario, was evaluated. The study included an assessment of dust emissions based on the planned quarry operations (500,000 tonnes/yr extraction rate). The total emission of total suspended particulate (TSP) was estimated to be 1.4 kg/hr, providing that the quarry roads are subject to standard dust control measures during dry conditions.

The impact of the dust emissions on the proposed development is deemed minimal, even when the extraction takes place in the area djacent to the proposed developments. The impact was estimated to be less than 20 % of the Ontario criteria for total suspended particulate (120 $\mu g/m^3$, 24 hour average) at the most affected area (block 66, an open space area). The impact at the proposed residential properties is estimated to be negligible.

Dust Assessment Study
Proposed Residential Subdivision
Tyandaga - Phase II

1.0 INTRODUCTION

Jannock Properties (Jannock) retained AGRA Earth and Environmental Ltd. (AEE), to prepare a dust assessment study for the proposed development referred to as Tyandaga - Phase II located on parts of Lots 4 and 12, R.P. 99 in the City of Burlington.

The purpose of the study is to determine the dust impact resulting from the future development of a shale quarry on land adjacent to the proposed housing development.

The residential development is bounded by the following land uses:

- to the north by conservation lands
- to the south by conservation lands, the North Service Road and the QEW/Highway 403 interchange.
- to the east by an existing residential development - Tyandaga Phase I
- to the west by a shale reserve quarry, Aldershot Quarries, which is owned by Jannock.

The location of the site is shown in Figure 1. Figure 2 illustrates the general layout of the proposed developments, as per the Draft Plan of Subdivision drawings prepared by May, Pirie, Dakin & Associates Ltd., revised in April, 1995.

Drawings, descriptions of the residential developments, and the shale quarry operations, were based on material which was included in the Noise Control Feasibility Study, prepared by S.S. Wilson and Associates, dated March 10, 1996.

2.0 AIR QUALITY CRITERIA FOR DUST

Total suspended particulate (TSP) is a generic name for airborne particles including smoke, fumes, dust, fly ash and pollen. Composition varies with place and season but normally includes soil particulates, organic matter, sulphur and nitrogen compounds, and metal oxides. The particle size range is approximately 0.1 to 100 microns in diameter.

The greatest impact on health is from the smaller particles (< 10 micron in diameter) which can penetrate into the lungs and contribute to respiratory disease. Natural sources of particulate matter include wind-blown soil. Man made sources include fuel combustion, construction and industrial activities, motor vehicle exhaust and road dust. TSP levels are monitored by the Ontario Ministry of the Environment and Energy (MOEE) at 116 locations in the province (1993), by drawing air through special filters and weighing the mass of collected particles.

The Ontario criteria for TSP is 120 $\mu g/m^3$ for daily average, and 60 $\mu g/m^3$ for annual geometric average.

EPA Reg 346
24 hr ave 120 } POI
1/2 hr ave 100 }
337 = a planning criterion

Current dust levels in the subject area have not been determined, but are estimated to correspond to typical suburban areas of southern Ontario. The area is still covered by trees and other vegetation, and man-made sources of fine dust such as car traffic are several hundred metres distant. The closest MOEE monitoring station for TSP is located at the intersections of Hwy. 2 and North Shore Blvd. E (Station No. 44008). The TSP levels registered at that station averaged 47 $\mu g/m^3$ in 1993 and exceeded the daily criteria only 2.4 % of the time.

The housing construction activities such as soil grading, digging for services and foundations, top soil surfacing and sodding are likely to temporarily increase the dust levels in the subject area. Once the paving and landscaping are completed, however, the air quality can be expected to return to the cited levels, typical of suburban southern Ontario.

3.0 METHODOLOGY

The methodology to assess the dust impact of the future Area C quarry on the proposed housing development was based on the following considerations:

- Dust emissions from quarry activities were estimated on the basis of US EPA emission factors for fine particles (size< 30 μm), taking into consideration the planned throughput, moisture content of the shale, wind speed, and dust control activities for trucking operations.
- Wind speed and direction corresponding to typical summer season (July), which are deemed to be the most likely to result in dusty conditions.
- Quarry activities conducted in the closest proximity to the proposed housing development (at the northwest corner of quarry Area C)
- Initial surface quarry, as opposed to scraping and grading at the bottom of the quarry cavity.
- No settling of dust between the source and the housing development

4.0 DESCRIPTION OF TYPICAL SHALE QUARRY OPERATIONS

Prior to future extraction of the shale material, the top soil or overburden is removed to expose the material. This is initially used for the construction of a 5 m high perimeter berm (for noise abatement and aesthetics) and later used during the rehabilitation phase of the site. The phasing and the direction of extraction are outlined in the operational and rehabilitation plans, which are shown schematically in Figures 3 to 6.

With the removal of the top soil and overburden, the shale will be exposed and ready for the extraction operation approximately 2 metres below grade. The extraction of shale in the areas adjacent to the proposed housing development, represents the greatest dust concern due to its proximity and shallow depth, therefore the extraction at the northwest corner of the quarry will be used as a reasonable worst case scenario of dust potential.

There are two possible alternatives for the extraction of the shale material: a) a bulldozer, or b) a backhoe. The use of a hydraulic excavation backhoe is limited to certain faces close to the extraction limit, while the use of a bulldozer is the favoured approach for most situations.

The basic operation using the bulldozer method is to create grooves in the ground using ripping teeth which rip the ground while moving up and down on the sloped work face. After weathering, the ripped shale is pushed downward along the sloped face to create a stockpile along the face, as shown schematically in Figure 4. The trucks (with a capacity of 38 - 42 tonnes) are loaded from the stockpiles by a front end loader, and transport the shale off site for processing elsewhere into clay bricks.

A summary of the operating conditions of the quarry are as follows:

- face slope is 4:1
- approximate deck (or lift) height is 20 m (1 or 2 decks will be used, depending on grade elevations)
- bulldozer speed 3 km/hr
- rip spacing 2.1 m apart
- length of the work face: 80 m, approx.
- width of the work face: 40 m , approx.
- front end loader works approx. 36 min/hr around the stock piles
- bulldozer operates 60 minutes/hr on the work face
- front end loader works approx. 24 min/hr loading the haulage trucks
- the quarry will operate from 8 am to 5 pm, Monday to Friday
- annual throughput: 500,000 tonnes/yr
- the truck path will be from the south-west corner of Area C to the stockpile area.
- estimated trucks per hour 2 - 3 per hour
- truck speed 20 km/hr

5.0 DUST EMISSION ESTIMATES

The dust emission estimates were based on the scheduled extraction rate, typical conditions of wind speed and shale moisture content, and emission factors from the US EPA AP-42 handbook.

The effect of three dust emission activities were estimated:

- Bulldozing
- Truck traffic
- Stockpiling and truck loading

Quarry emissions depend on the silt content of the material handled and the moisture level. High content of silt (particles smaller than 75 micron) and low moisture levels are conducent to high dust emissions. The assumed silt content (1.6 %), corresponds to typical stone quarrying operations (Table 11.2.3, AP-42, 1985), and the moisture content (7 %) to actual shale levels at other quarries (Canada Brick, Milton). In estimating dust emissions, the wind speed was assumed to be 6.1 m/s, which is an average wind speed for the area.

5.1 Bulldozing

The equation used to estimate dust emissions from the operation of one (1) bulldozer was the following:

$$\text{dust emissions} = \frac{8.44 \times (s)^{1.5}}{(m)^{1.4}} = 1.12 \text{ kg/hr} = 0.311 \text{ g/s}$$

where:

s = silt content of the shale (%)
m = moisture of the shale (%)

5.2 Truck Traffic

Dust originated by truck traffic to/from the extraction area was estimated using the following empirical equation (Eqn. 1, Section 11.2.1, AP-42, 1985).

$$(\text{kg/vkt}) = k\ (s/12)\ (S/48)\ (W/2.7)^{0.7}\ (w/4)^{0.5}\ (365\text{-}p)/365$$

where:

vkt = vehicle kilometre travelled
k = particle size multiplier, 0.5 for < 15 μm particles
s = silt content of road surface (%)
S = mean vehicle speed, km/hr
W = mean vehicle weight, tonne
w = mean number of wheels
p = number of days in a year with at least 0.254 mm of precipitation, 150 estimated for southern Ontario

On this basis the emissions from truck traffic were estimated to be 0.708 kg/vkt or 2.35 g/s during 8 hours per day. If dust suppression measures, such as road watering during the dry season were implemented, then it is estimated that 98 % road dust suppression can be achieved, in which case the controlled dust emission rate from truck traffic would be approximately 0.05 g/s.

The amount of watering required for a given level of dust suppression can be estimated by *Equation 3-2 on page 3-12 of Control of Open Fugitive Dust Sources, EPA-450/3-88-008:*

$$C = 100 - 0.8\ pdt\ /\ i$$

where:

C = control efficiency of watering (%)
p = potential average daytime evaporation rate, (mm/h),
d = daytime average hourly traffic volume (vehicles/hr),
i = application intensity (litres/m^2)
t = time between application (h)

For southern Ontario, p is approximately 0.23 mm/h. The length of the truck road in Area C is of 1 km and the traffic is 3 truck loads per hour. If watering is performed once every 8 hours at a rate of 3 litres/m^2, then water suppression levels of 98 % can be achieved, as shown in the following calculations:

$$C = 100 - ((0.8 \times 0.23 \times 3 \times 8) / 3) = 98\ \%$$

If calcium chloride or other environmentally acceptable dust suppressant are added to water, then the time between watering can be greatly extended. There are a number of products on the market which, if applied once every few hundred vehicle passes, should be able to achieve a 98 % reduction in dust emissions. Data supporting this conclusion can be found in *Emission Technologies and Emission Factors for Unpaved Road Fugitive Emissions, EPA/625/5-87/022.*

5.3 Stockpiling and Truck Loading

Adding aggregate material to a storage pile or removing it, usually involves dropping the material onto the receiving surface, with release of dust. The quantity of particulate emissions generated by a batch drop may be estimated using the following empirical expression:

$$(\text{kg/tonne}) = k\,(0.0009)\ \frac{(s/5)\ (U/2.2)\ (H/1.5)}{(M/2)^2\ (Y/4.6)^{0.33}}$$

where:

- k = particle size multiplier, 0.5 for <15 micron particles
- s = material silt content (%)
- U = mean wind speed (m/s)
- H = drop height, (m)
- M = material moisture content (%)
- Y = dumping device capacity, (m^3)

On this basis, the emissions from the stockpiling of extracted shale and truck loading were estimated to be 0.028 g/s, during 8 hours per day.

5.4 Summary of Dust Emission Estimates

The dust emissions from the Area C quarrying operation were summarized in the following Table 1.

Table 1
Summary of Dust Emission Estimates

Operation	Emission rate (g/s)	Emission Area
Bulldozing	0.31	80 m x 40 m
Truck traffic	0.05	30 m x 300 m
Stockpiling/loading	0.028	20 m x 20 m
TOTAL	0.388	-

6.0 DISPERSION MODELLING

The transport of fine dust from the quarry sources to the surrounding area was modelled using Industrial Source Complex Short Term (ISCST3), a widely accepted regulatory model of the US Environmental Protection Agency. ISCST3 requires the use of local meteorological information, such as hourly wind speed and direction, to predict the dispersion of contaminants emitted from one or more sources. The program then calculates hourly concentration levels at any point in the area adjacent to the source(s), and the results are integrated in terms of 24 hr concentrations. To facilitate the visualization of results, the values were converted in a graphical form by the program SURFER, which draws lines of equal concentration (isopleths) based on the ISCST3 numerical grid.

The atmospheric data used for this assessment is from the Pearson airport, in Toronto, and corresponds to typical summer months (July) which are deemed to represent conditions of maximum dust potential in the area.

Shale extraction activities were assumed to take place in a 40 m by 80 m area located at the northwest corner of the Area C of the quarry, which is closest to the proposed development. Stockpiling and truck loading were performed at the edge of this area, and the trucks followed a southeast past towards Area B.

Quarry Areas A and B were not considered to be significant dust sources as: a) extraction on these areas are to be completed before exploitation of Area C, and b) Areas A and B are separated from the subject area by a considerable distance.

The results of the dispersion modelling (from 720 hourly periods) are depicted in Figure 7, which shows dust levels in the area surrounding the work face. The isopleths correspond to maximum 24 average concentrations, expressed in $\mu g/m^3$. Figure 7 indicates that the dust originated by the quarry activities will likely increase the dust levels up to 10 - 20 μg/m3, at the corner of Block 66 (an open space area). This increment represents less than 20 % of the Ontario criteria for TSP (120 μg/m3, 24 hour average). The closest residential lots (Street A, lots 16 to 18) will be affected to a lesser extent. Even with the increment resulting from the quarry activities, the TSP levels in the area are likely to fall well within the allowable criteria.

It must be kept in mind, however, that road dust from the Area C quarry must be controlled by periodic watering, as necessary, to avoid potential dust episodes under unfavourable conditions (strong winds during dry summers).

7.0 CONCLUSSIONS AND RECOMENDATIONS

The dust emission levels resulting from future quarry activities at Area C of the Aldershot Quarry, Burlington, were estimated to be 0.39 g/s (1.4 kg/hr) at the scheduled extraction rate and operating conditions. This estimate assumes that the internal quarry roads will be subject to standard dust control measures during dry conditions.

Air dispersion modelling was carried out to determine the impact of these dust emissions on the proposed residential development located on the adjacent lands (Lots 4 and 12, R.P. 99, referred to as Tyanaga Phase II). The impact was estimated to be less than 20 % of the Ontario criteria for total suspended particulate (120 $\mu g/m^3$, 24 hour average) at the most affected area (block 66, an open space area). The impact at the proposed residential properties is estimated to be negligible.

This negligible impact is possible by the implementation of a dust supression program for the internal roads of the quarry, to achieve approximately 98 % dust control and prevent potential dust episodes during unfavorable conditions (dry, windy, summer days).

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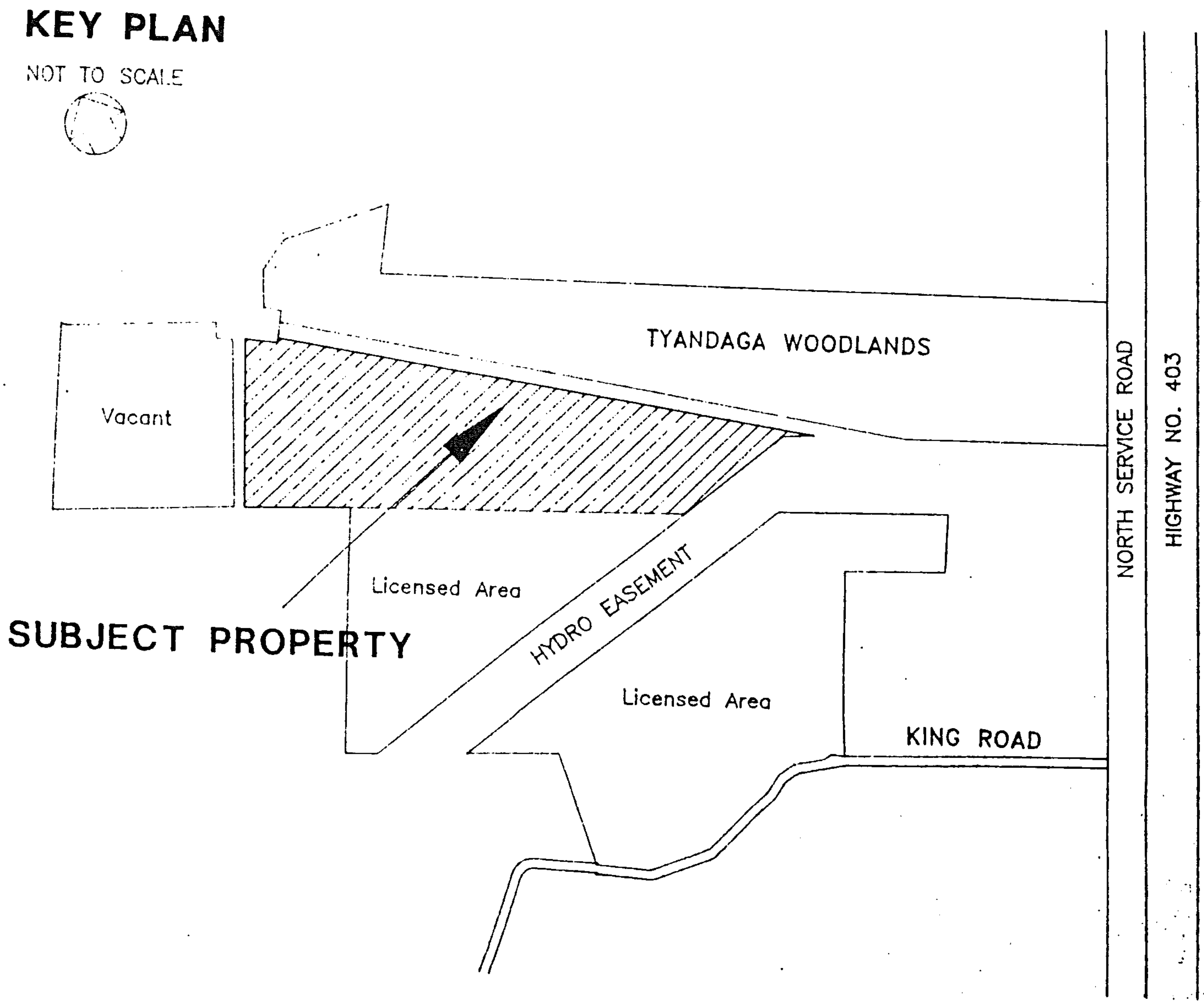

Figure 1
SITE LOCATION

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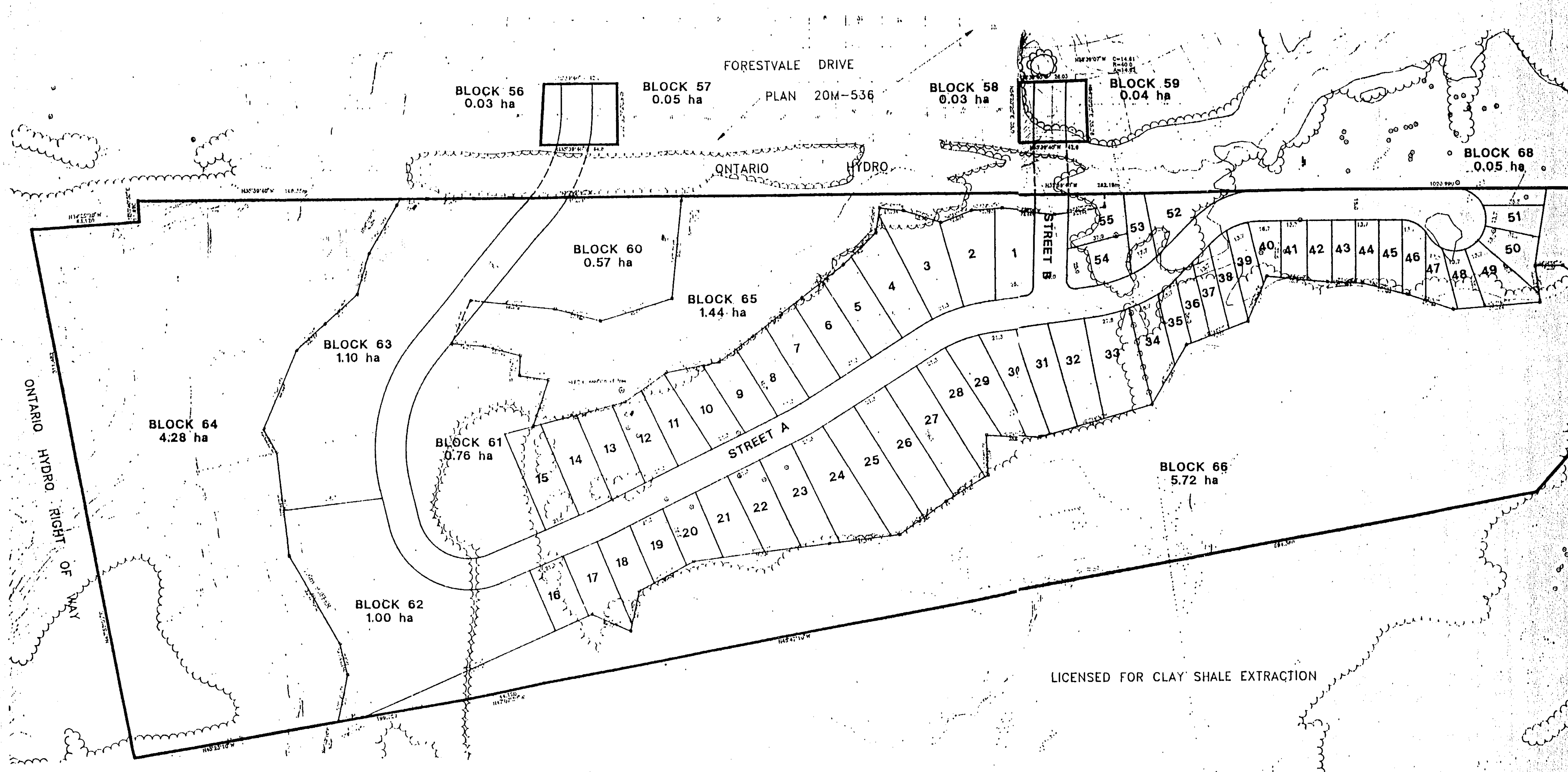

Figure 2
DRAFT PLAN OF SUBDIVISION

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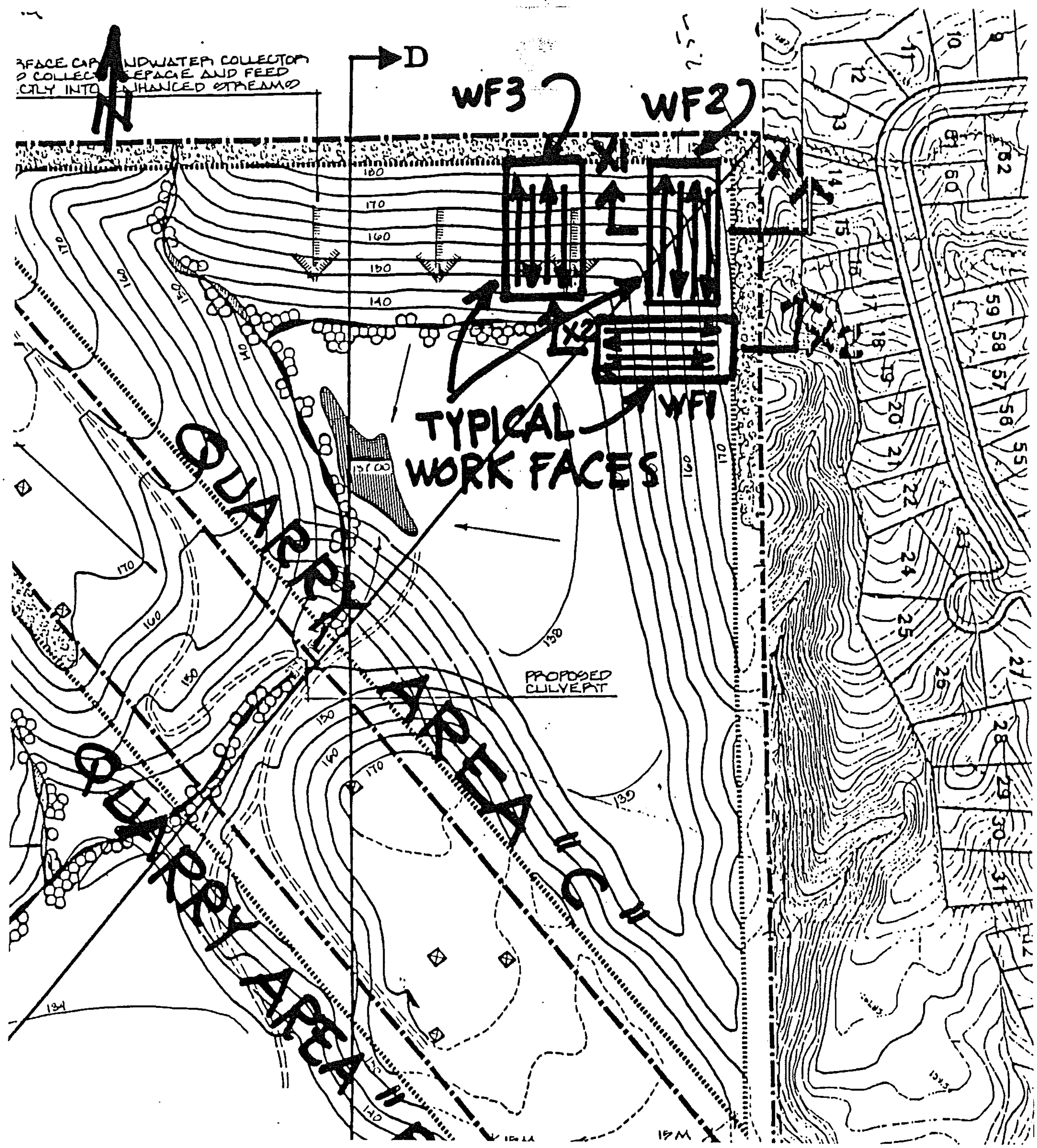

Figure 3
FUTURE AREA "C" QUARRY
REASONABLE WORST CASE FOR DUST IMPACT

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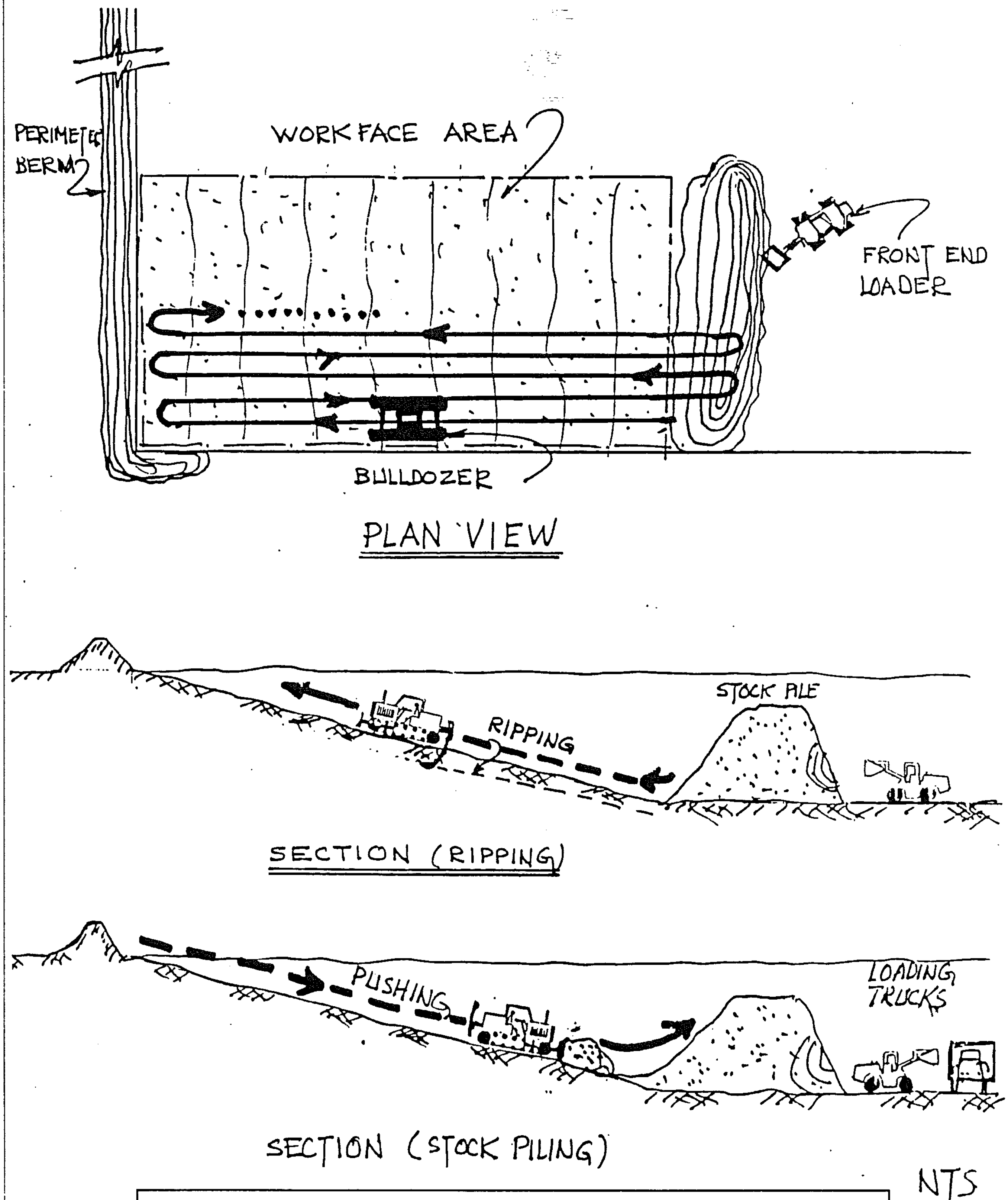

Figure 4
TYPICAL OPERATIONS AND WORK FACE LAYOUT

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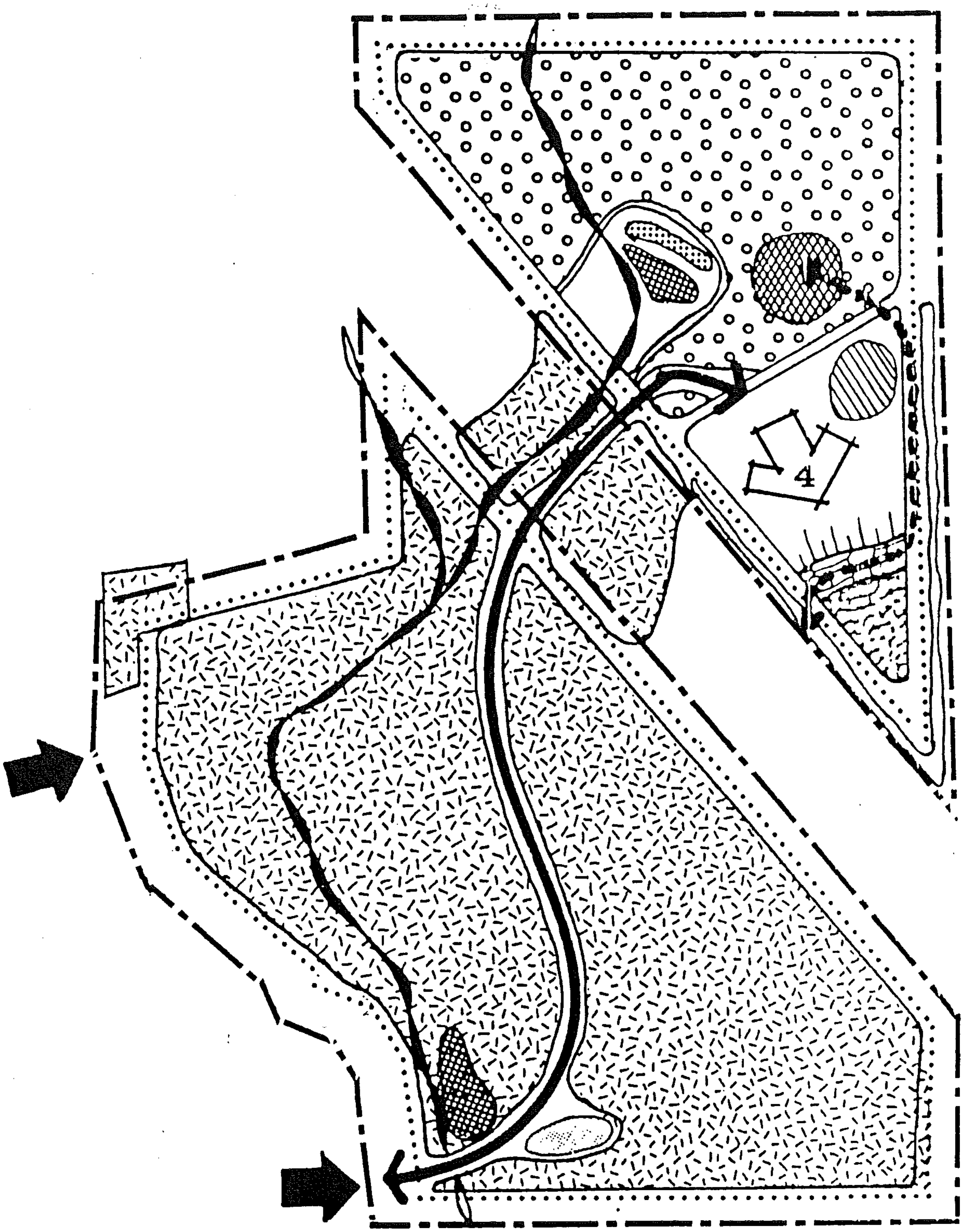

Figure 5
PROPOSED SITE ACCESS AND REHABILITATION

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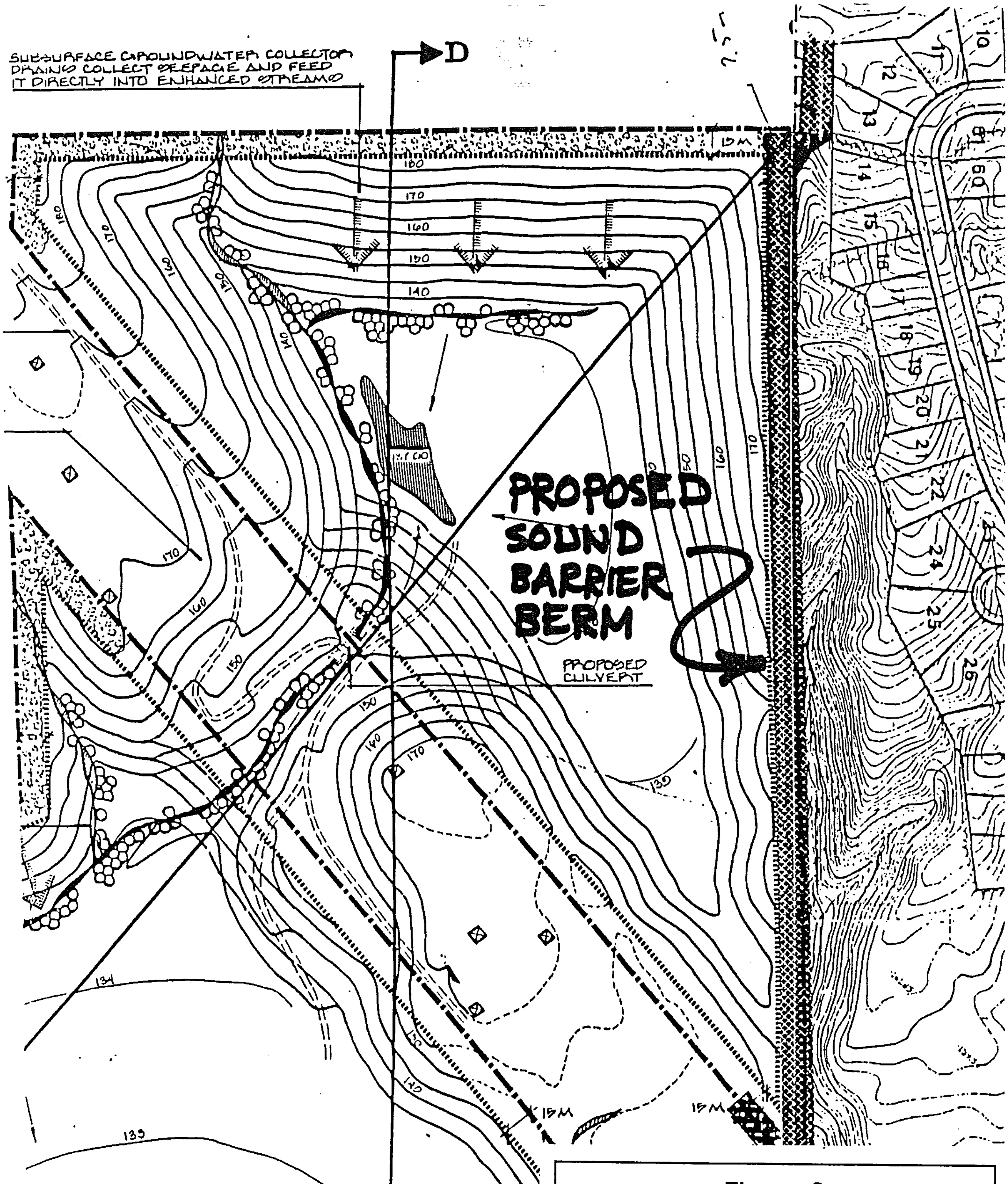

Figure 6
PROPOSED BERM BARRIER
(approx. 5 m. high)

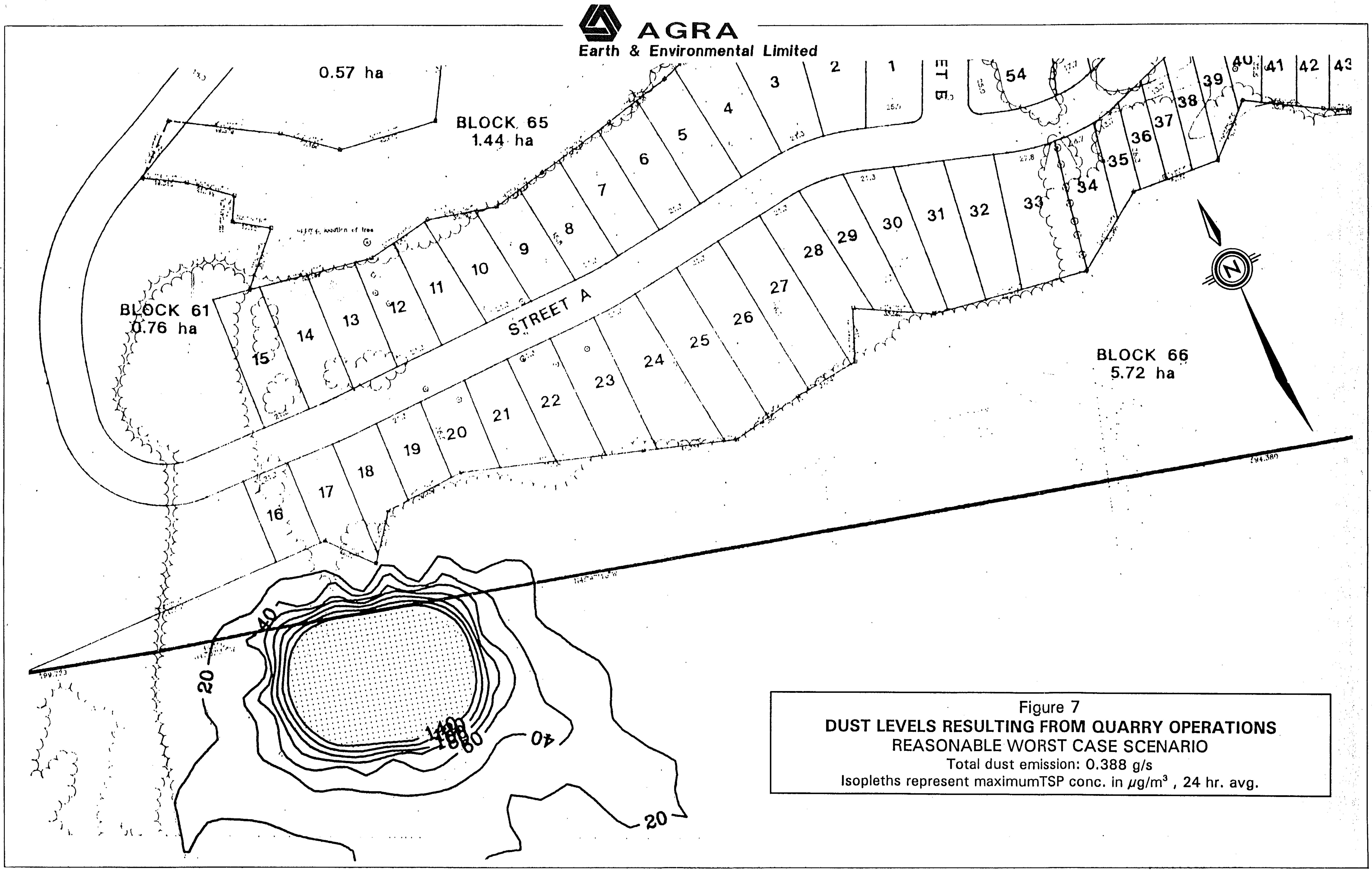

Figure 7
DUST LEVELS RESULTING FROM QUARRY OPERATIONS
REASONABLE WORST CASE SCENARIO
Total dust emission: 0.388 g/s
Isopleths represent maximumTSP conc. in $\mu g/m^3$, 24 hr. avg.