

الجمهورية اللبنانية

مكتب وزير الدولة لشؤون التنمية الإدارية
مركز مشاريع ودراسات القطاع العام

REPUBLIC OF LEBANON
MINISTRY OF PUBLIC WORKS
GENERAL DIRECTORATE OF URBAN PLANNING

République Libanaise

Bureau du Ministre d'Etat pour la Réforme Administrative

Centre des Projets et des Etudes sur le Secteur Public

(C.P.E.S.P.)



A NATION WIDE STUDY OF QUARRIES

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London
Mar. 1996

EXECUTIVE SUMMARY

1. CONTEXT

There is a strong historical tradition of quarrying in Lebanon which can be traced back to early history. The requirements of the national recovery programme will ensure there is a high demand for quarried material for the foreseeable future and this can be met from the rich deposits of rock available within the country, however, strengthened control over the operation will be necessary to prevent further damage to the environment.

2. THE NATIONWIDE SURVEY OF QUARRIES

A survey was carried out as a major part of the study to establish a data base using official records provided by Government and field data obtained by site visits and interviews.

2.1 Review of Official Records

Initially the records indicated there were some 1800 quarries in the country. Analysis of these figures identified significant amounts of duplication and inaccuracies which when resolved showed there were about 710 operational quarries in Lebanon and these are shown below by area.

Total Number of Operational Quarries - Official Records

Muhafaza	Caza	No. of operational Quarries				Total in Muhafaza (including abandoned)
		BS	Rock	Sand	Total	
Bekaa	Baalbek	19	15	0	34	123
	W Bekaa	14	14	1	29	
	Zahleh	0	56	2	58	
		33	85	3	121	
Mount Lebanon	Aaley	5	30	41	76	367
	Baabda	3	5	0	17	
	Chouf	0	17	18	35	
	Ibail	4	14	31	49	
	Kesrouane	5	9	19	33	
	Marten	0	22	8	30	
		17	97	126	240	
North Lebanon	Akkar	0	12	12	24	154
	Batroun	18	30	8	56	
	Besharr	2	3	12	17	
	Koura	0	0	0	0	
	Tripoli	0	8	0	8	
	Zghorta	0	10	0	10	
		18	72	32	124	
South Lebanon	Bin Ibail	1	4	1	6	66
	Hasbaya	0	0	2	2	
	Jizzine	1	0	0	10	
	Marjayoun	0	0	1	1	
	Nabatieh	0	10	0	10	
	Rashaya	0	1	14	15	
	Saida	0	3	0	3	
	Sour	0	17	1	18	
	2	35	28	65		
Total					710	

2.2 Results of Field Surveys

The field survey considered a representative sample of 280 primarily rock quarries from throughout Lebanon. Although the data obtained is statistically satisfactory some aspects of the survey could have been improved by a better response from quarry operators. The principal findings of the survey were:

- The majority of operating quarries are small 62% having a volume of 15,000 m³ or less with 20% considered large having a volume of 40,000 m³ or more.
- Almost all quarries are independently operated.
- 45 quarries are abandoned and 26 temporarily closed.
- 54% of all operating quarries are licensed.
- There is confusion over the legal procedures involved in licensing crushers for use in quarries.
- Quarrying licences can be obtained by the use of procedures which avoid the technical assessment of proposals.
- Quarries employ between 3 and 70 people.
- National employment in quarries amounts to more than 2000 persons.
- A wide range of mechanical equipment is used in quarries.
- Most quarries exploit the Cenomanian and Jurassic geological formations.
- The main product is concrete and asphalt coarse aggregate.
- The largest quarries are located in Mount Lebanon with particular concentrations in Abu Mizan and Chouf. The output of each quarry exceeding 1,000,000 m³ annually.
- Most quarries have steep faces exceeding 45° and between 20 and 40 m in height. No berms were identified.
- Quarry stability is not a widespread problem but is serious in some areas.
- There are serious environmental effects from traffic, pollution and blasting which affect settlements, the landscape, natural habitats and archeological sites.
- Very little rehabilitation and quarry restoration work has been undertaken.
- Over 2500 heavy goods vehicles are involved in transporting quarry materials.

3. IDENTIFICATION OF MAIN ISSUES

Information from the survey indicates that there are a number of problems which require resolution before the quarrying industry can become sustainable and have a degree of acceptance in the public domain. The issues identified by the study fall into three categories:

- (i) Legal and Administrative
- (ii) Technical and Operational
- (iii) Environmental

3.1 Legal and Administrative

At present there are a number of ways of obtaining a license to quarry and this is causing some confusion and requires clarification. The law regarding the extraction of minerals needs to be clearly defined and fully enforced and a single authority should be responsible for quarry licenses. The responsibilities of the appointed administration in determining any license application should be clearly outlined.

An application for a quarrying licence should be uniform and consistent regardless of the applicant or the location of the quarry. The applicant should provide comprehensive details of his proposal sufficient to allow a complete technical assessment of its geological implications, operational qualities and environmental effects, including the use of crushers. A standard application form should be prepared and only applications submitted in the correct format should be regarded as acceptable. The form could include details of

- The geographical location of the proposed quarry.
- The proposed development including any phasing arrangements.
- The proposed method of operation.
- Site layout including the location of buildings, equipment and plant.
- Access arrangements including the layout of any junction with a government road.
- Anticipated traffic movements.
- Amount and type of rock to be extracted.
- Anticipated environmental effects.
- Methods to be used to control environmental effects.
- Rehabilitation or site restoration.

This information could be supplemented by detailed plans and graphic information to enable a full understanding of the processes to be undertaken during the development. It is always in the interests of the developer to clearly explain and describe his proposals.

3.2 Technical and Operational Issues

The survey identified a number of problem areas which will require further consideration and study.

(i) Operating Existing Quarries:

The survey indicates that the following matters should be addressed in order to enhance the safety and efficiency of active quarries:

- Improvements to the quarry access to provide better visibility and allow vehicles to enter and leave the site without danger.
- The use of settlement lagoons to prevent quarries polluting rivers and streams.
- The installation and operation of dust suppression equipment on crushers, graders and other dust generating equipment.
- The use of water sprays to control dust from roadways and stockpiles.
- Restrictions on the use of explosives to ensure that only the most efficient and safe methods of blasting are used.
- The construction of noise suppression barriers and the re-routing of vehicles to limit noise in sensitive areas.
- The construction and planting of screen mounds to improve the landscape and reduce the visual impact of the quarry.
- The weighing and logging of loads leaving the quarry to reduce the incidence of overloaded vehicles.
- The provision and use of safety equipment and the development of a code of safety measures for work in the quarry.
- The preparation of ongoing schemes for quarry reclamation and restoration.

(ii) Criteria for New Quarries

Any new quarries should be required to comply with standards and criteria which address the following technical issues:

- The use of a single method of considering applications for quarries and issuing licences.
- The establishment of a single government body with full responsibility for new quarries.

- The establishment of locational priorities and the identification of areas where quarrying would not normally be permitted
- Standards defining the design of suitable road access.
- Estimates of annual production, reserves and life span of the quarry.
- Geological guidelines for quarry development particularly safe methods of quarrying.
- Minimum acceptable site sizes.
- Minimum acceptable distances from other activities, land uses and features of interest.
- Site layout and location of crushers, graders, stockpiles and other activities.
- Methods of dust suppression.
- Methods of noise control.
- Schemes for temporary landscaping and the disposal of quarry wastes.
- The use and control of explosives.
- Schemes of restoration, quarry reclamation and after uses.
- Safety programmes and medical facilities.

(iii) Abandoned Quarries:

Further studies are needed to assess the individual problems and opportunities of such quarries and the extent of remedial actions needed. These include:

- Assessments of pollution hazard and risk.
- Geological stability and safety.
- Security of the site and assessment of danger to the public.
- Building condition and appearance.
- Location, quantities, type and appearance of quarry waste.
- Effects on the landscape.
- Economic potential and possible after uses.

Evidence from the survey indicates that not all abandoned quarries will require remedial action and those that do may only require minimal improvement to bring them up to an acceptable standard. Prior to determining what remedial action is necessary consideration should be given to who will be financially responsible for the works and who will carry them out.

3.3 Environment

Quarrying is an industrial activity which often has dramatic and disruptive effects on the environment. The conclusions of the survey indicate that quarrying affects both the natural and built environment and causes damage to human habitation through noise, dust and vibration.

4. POTENTIAL QUARRYING AREAS

As most of the demand for rock extraction is for the production of aggregates and building stone, potential quarrying areas were selected in geologic formations suitable for such products. Moreover, most of the areas, were selected in such areas where urbanism is not dense. Heavily populated areas were difficult to avoid along the coastal strip. As such this study concluded that apart from a few specialised quarries such as those for cement making, quarrying along the coastal strip should be avoided.

Potential areas are shown on map which together with a set of licensing rules should be used in the determination of the suitability of an area for quarrying. These rules will be the subject of phase II of this study.

Notwithstanding the above delineation of potential quarry areas, it is to be noted that almost all wadis have a substantial potential for quarrying if environmental and urban considerations are satisfied.

Table 3.2 : Total Number of Operational Quarries - Official Records.

Muhafaza	Caza	No. of operational Quarries			Total in Muhafaza
		BS	Rock	Sand	
Bekaa	Baalbek	19	15	0	34
	W. Bekaa	14	14	1	29
	Zahleh	0	56	2	58
		33	85	3	121
Mount Lebanon	Aaley	5	30	41	76
	Baabda	3	5	9	17
	Chouf	0	17	18	35
	Ibail	4	14	31	49
	Kesrouane	5	9	19	33
	Maten	0	22	8	30
		17	97	126	240
North Lebanon	Akkar	0	12	12	24
	Batroun	18	30	8	56
	Besharri	2	3	12	17
	Koura	0	9	0	9
	Trinoli	0	8	0	8
	Zehorta	0	10	0	10
		18	72	32	124
South Lebanon	Bin Ibail	1	4	1	6
	Hasbaya	0	0	2	2
	Jizzine	1	0	9	10
	Mariayoun	0	0	1	1
	Nabatieh	0	10	0	10
	Rashava	0	1	14	15
	Saida	0	3	0	3
Sour	0	17	1	18	
	2	35	28	65	
Total				66	
				710	

Table 3.3 : Legal Aspect of Quarries - Official Records

Muhafaza	Licensed (%)	Unlicensed (%)	Under study (%)
Bekaa	15.7	73.5	10.8
Mount Lebanon	40.4	40.4	18.3
North	28.2	33.9	38.7
South	41.5	18.5	40.0

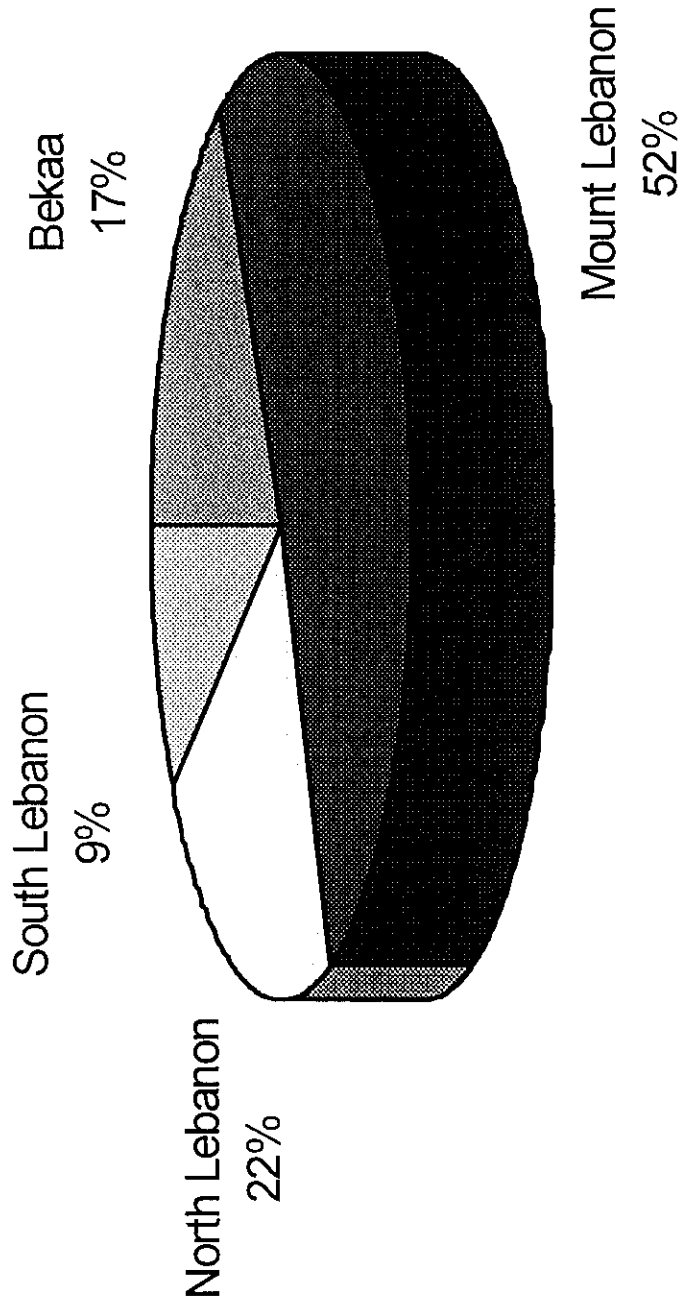


Figure 3.1 Distribution of Quarries in each Muhafaza

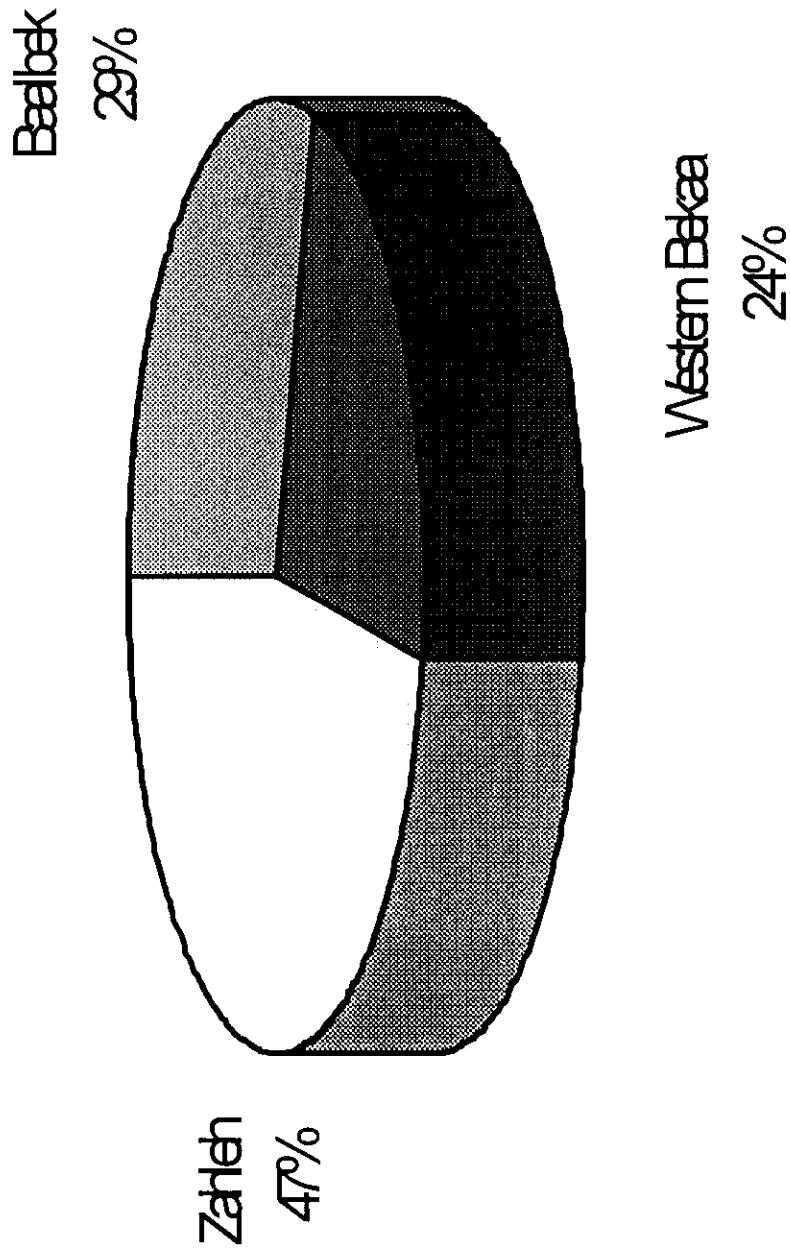


Figure 3.2 Distribution of Quarries in Bekaa

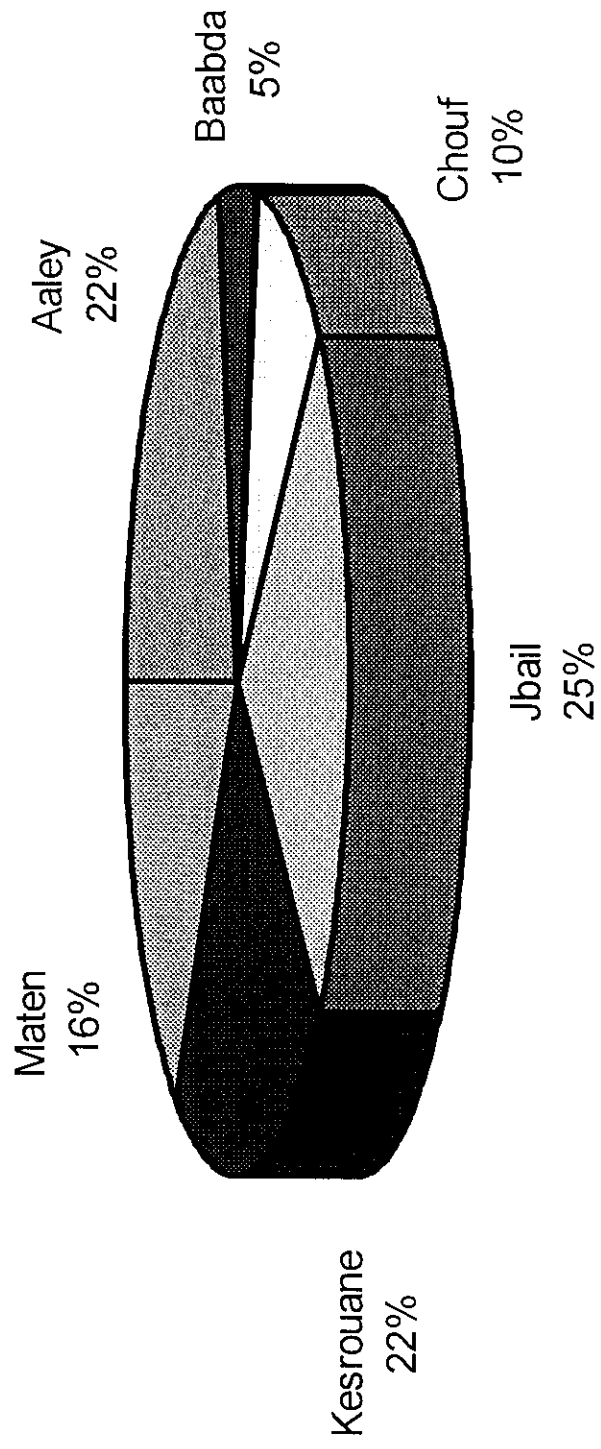


Figure 3.3 Distribution of Quarries in Mount Lebanon

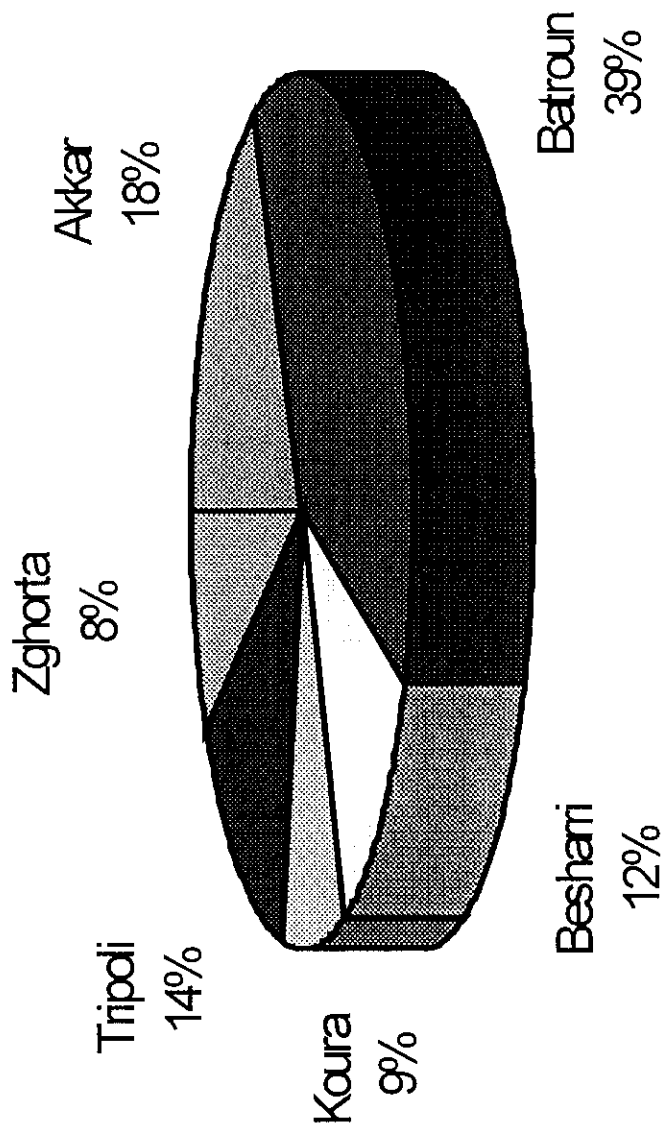


Figure 3.4 Distribution of Quarries in North Lebanon

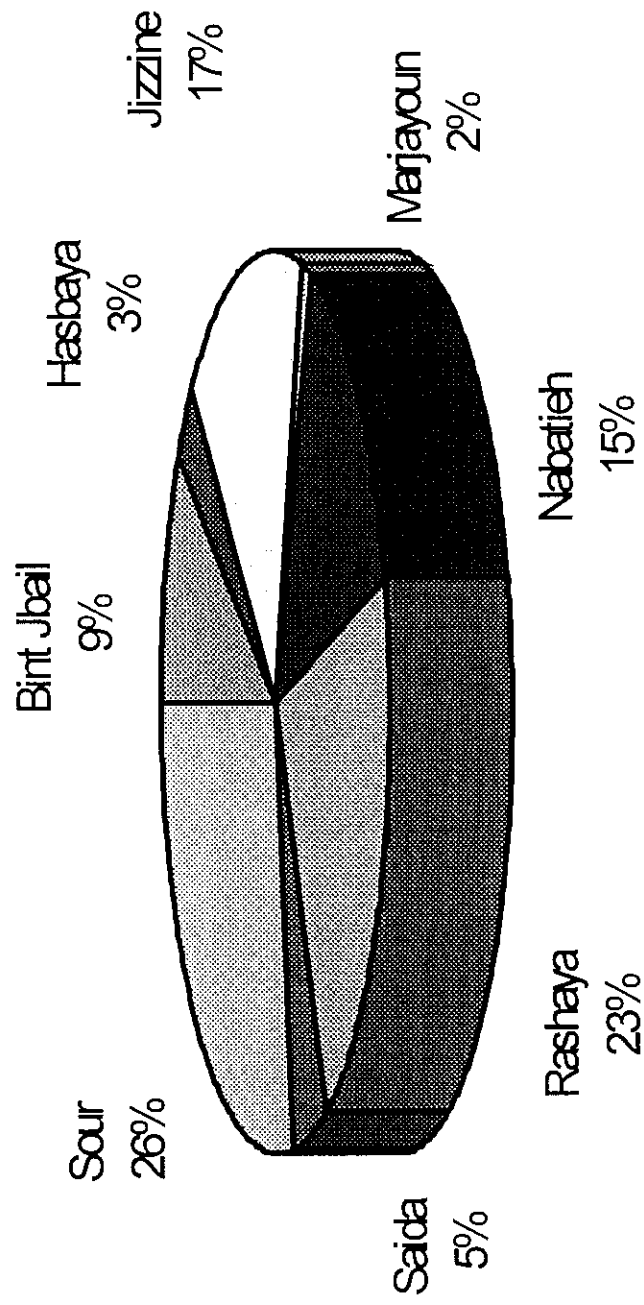


Figure 3.5 Distribution of Quarries in South Lebanon

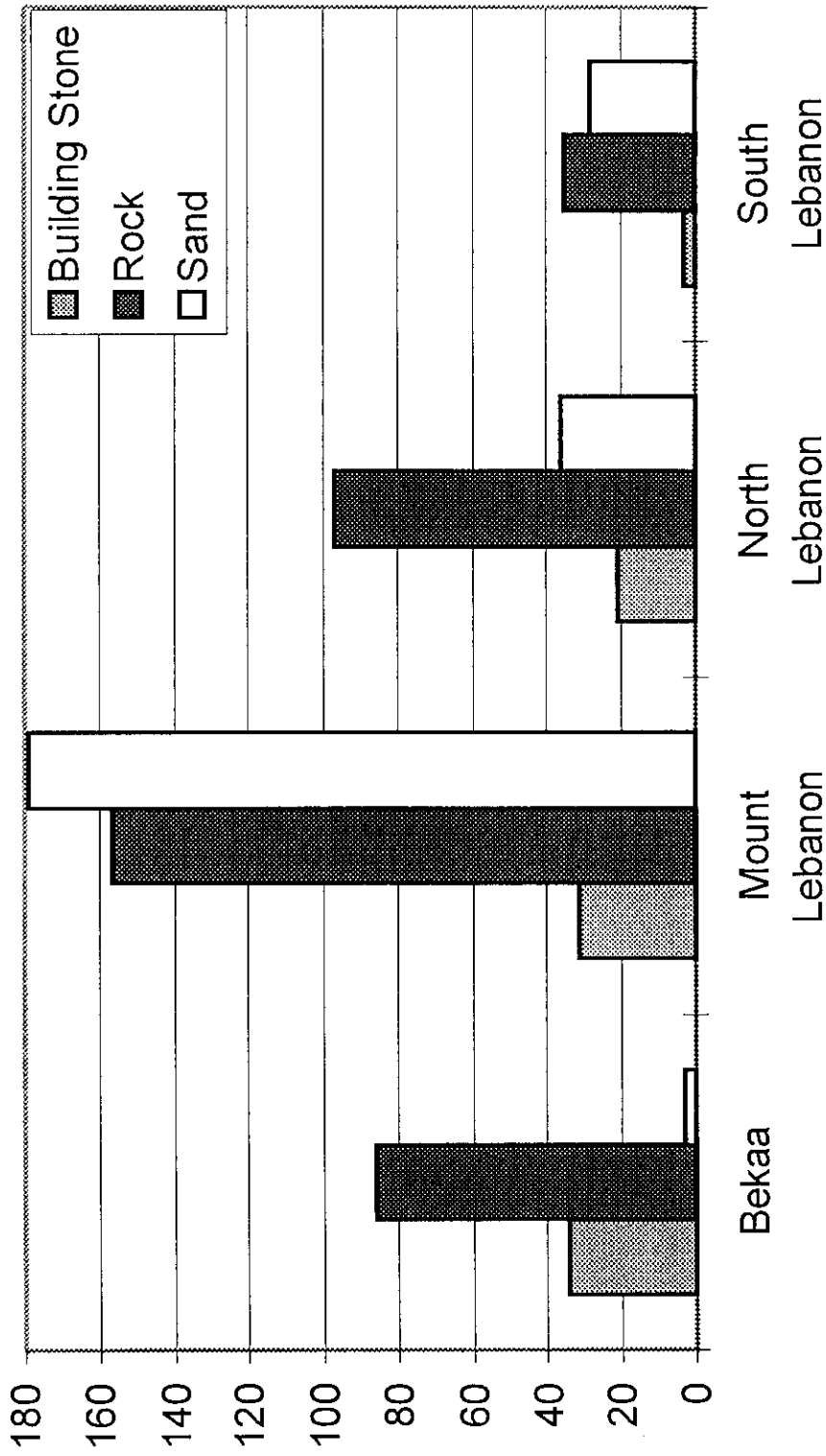


Figure 3.6 Distribution of Quarry Types in Lebanon

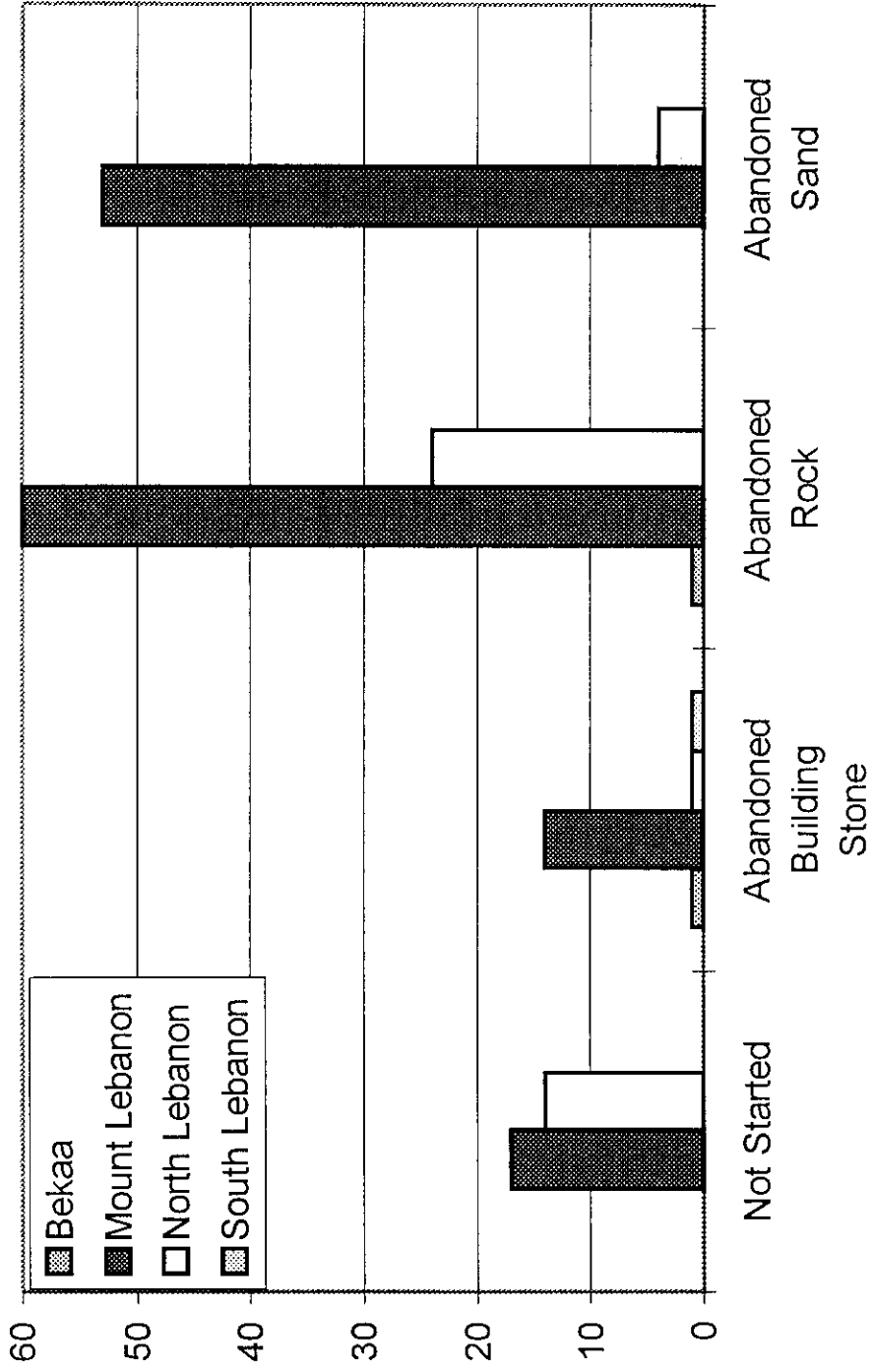


Figure 3.7 Abandoned Quarries by Type in each Muhafaza

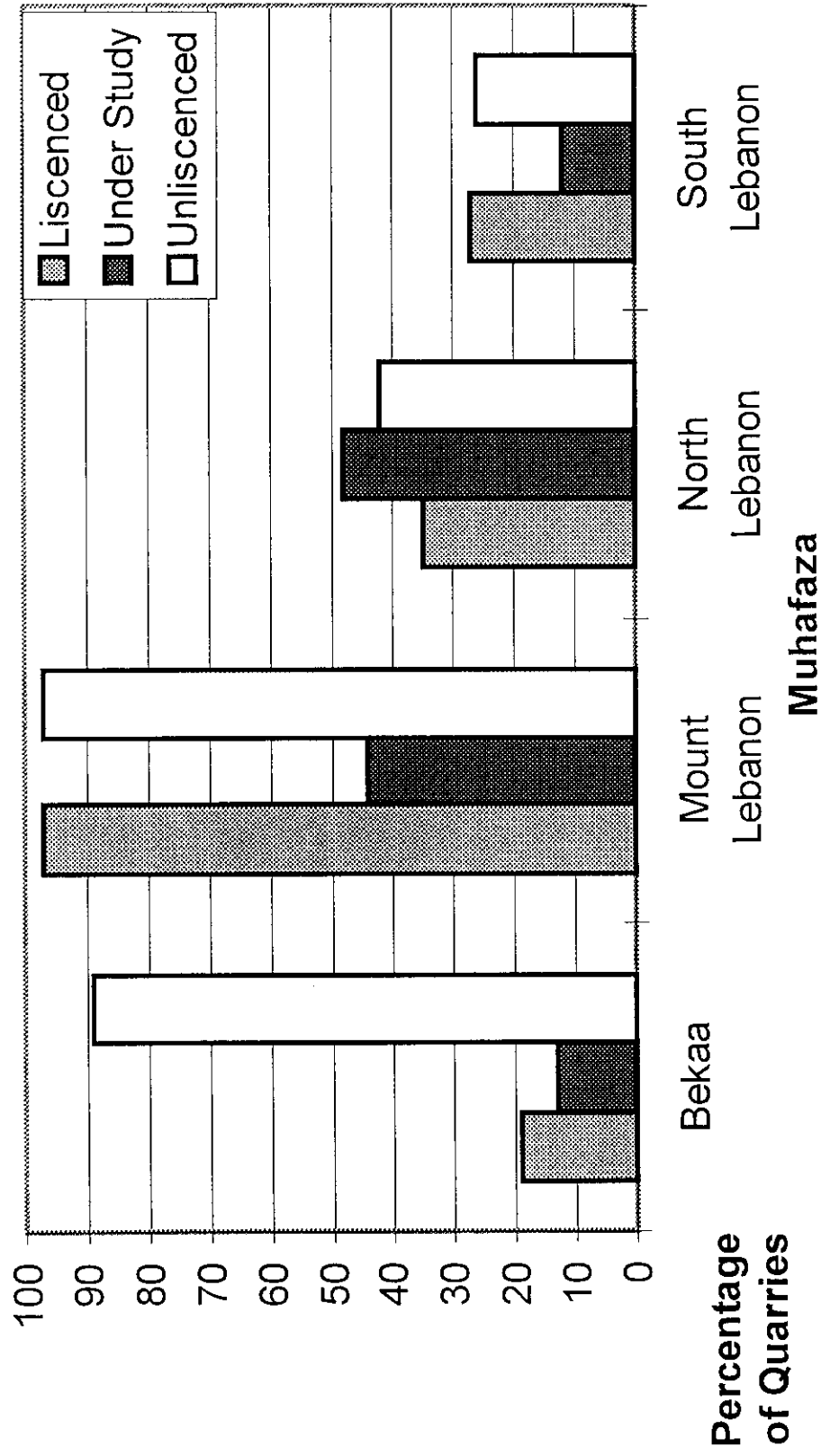


Figure 3.8 Legal Status of Quarries per Muhafaza

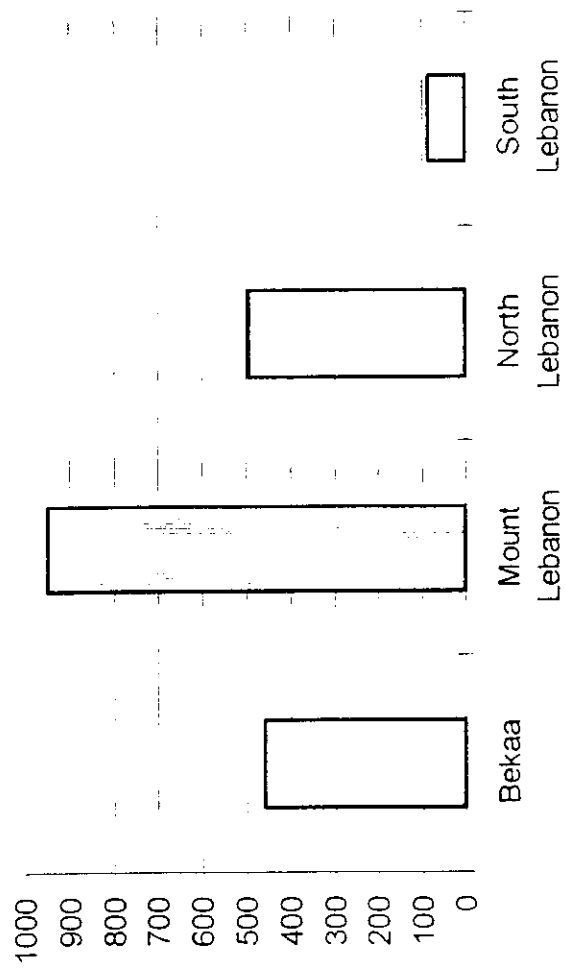


Figure 4.1 Distribution of Quarry Workers by Muhafaza

Table 4.5 : Total number of licensed and unlicensed quarries in each Muhafaza and Caza.

Muhafaza	Caza	Licensed	Unlicensed	No Answer
Bekaa	Baalbek	13	35	9
	Hermel	4	6	
	Western Bekaa	27	2	
	Zahleh	11	5	
		44	54	14
Mount Lebanon	Aalev	9	5	6
	Baabda	3		
	Chouf	8	5	7
	Jbail	11	1	4
	Kesrouane	11	4	9
	Maten	16	6	2
		58	21	28
North Lebanon	Akkar	8		
	Batroun	12	1	
	Besharri	3		
	Koura	9		1
	Tripoli	5		
	Zghorta	5	2	
		42	3	1
South Lebanon	Nabatieh	1	2	
	Saida	3		
	Sour	2	1	
		6	3	
Total		150	81	43

Table 4.6 : Available Crushers and Legal Status

Muhafaza	Available Crushers	% licensed	% Fully Licensed
Bekaa	58	69	60.3
Mount Lebanon	67	55.2	52.2
North Lebanon	36	63.9	61.1
South Lebanon	8	37.5	37.5

Figure 4.4 Number of Quarries by type of Product, Operational Status and Caza

Caza	Total	Type				Liscence		Status					
		Clay	Conglomerate	Building Stone	Rock	Sand	No	Yes	Abandoned	Abandoned Rock	Abandoned Conglomerate	Abandoned Sand	Stopped
Baalbek	57		2	18	34	3	26	12	13	12		1	6
Hermel	6				6		3		3	3			
Western Bekaa	6				6		2	2	0	0			2
Zahleh	43		1	11	30	1	10	27	3	1		1	4
Total	112	0	3	29	76	4	41	41	19	16		2	12

Caza	Total	Type				Liscence		Status					
		Clay	Conglomerate	Building Stone	Rock	Sand	No	Yes	Abandoned	Abandoned Rock	Abandoned Conglomerate	Abandoned Sand	Stopped
Aaley	20			3	14	3	4	7	4	3		1	5
Baabda	3				3			3					
Chouf	20	1		1	16	2	3	8	7	6		1	2
Jbail	16			1	9	6	1	11	4	3		1	
Kesrouane	24			2	18	4	2	10	10	10			2
Maten	24			1	21	2	5	16					3
Total	107	1	0	8	81	17	15	55	25	22		3	12

Caza	Total	Type				Liscence		Status					
		Clay	Conglomerate	Building Stone	Rock	Sand	No	Yes	Abandoned	Abandoned Rock	Abandoned Conglomerate	Abandoned Sand	Stopped
Akkar	8				8			7					1
Balroun	13			1	12		1	12					
Besharri	3			1	2			3					
Koura	10			1	9			9	1	1			
Tripoli	5				5			5					
Zghorta	7				7			5					
Total	46	0	0	2	43	0	3	41	1	1		0	1

Caza	Total	Type				Liscence		Status					
		Clay	Conglomerate	Building Stone	Rock	Sand	No	Yes	Abandoned	Abandoned Rock	Abandoned Conglomerate	Abandoned Sand	Stopped
Nabatieh	3				3		2	1					
Saida	3			1	2			3					
Sour	3				3			2					1
Total	9	0	0	1	8	0	2	6	0	0		0	1

4.12 Summary of Survey Findings

This field survey was the first comprehensive attempt to collect contemporary information on the structure, activities and effects of the quarrying industry in Lebanon. It was a nation wide exercise and information has been gathered from a representative sample of quarries within all accessible parts of the country. The field survey concentrated on rock quarries although a small number of sand sources were identified and considered. In total some 274 quarries or 60% of those featuring in official records were examined.

OFFICIAL RECORDS

- Official records indicate a total of 710 quarry sites exist in Lebanon of which 246 are for extraction of sand and 590 are operational.
- Highest number of quarries is in Mount Lebanon totaling to 367 of which 127 are abandoned.
- Most quarries for the production of building stones is in Bekaa and for rock and sand is Mount Lebanon, both Kesrouane and Chouf.
- The highest percentage of licensed quarries is in South Lebanon and the highest percentage of unlicensed quarries is in Bekaa.

SURVEY RECORDS

General

- In total 280 quarries were visited of which 22 are sand extraction sites. This represents 60% of all rock quarries identified by official records.

Quarry locations

- Rock quarries are either scattered or in agglomeration such as:
 - * Deir Al-Gharzal - Raait in Bekaa.
 - * Abu Mizan, Antelias, Nahr Al Maout and Chouf in Mount Lebanon.
 - * Deir Ammar and Chekka in North Lebanon.

Quarry Area and size

- Based upon exploited volume of a quarry, 61.6% of the rock quarries in Lebanon are classified as small, 18.6% medium and 19.8% large.

Type of Organisation, Current Operational Status and type of product

- Almost all quarries are independent in nature except for those relating to the cement industry.

- Clay is extracted in one quarry in Chouf.

Legal Aspects

- 93% of the quarries in North Lebanon are licensed, 78.6% in Mount Lebanon, 75% in South Lebanon and 50% in Bekaa. The findings do not agree in terms of figures with those from official records but the trend is the same.
- Licensing a quarry is independent of licensing a crusher, if licensed crushers are considered within a licensed quarry site, then the percentages of fully licensed quarries are about 56.5%.

Resources: employment and Equipment

- The average employment of staff per quarry sites is 10.

Geological setting

- Most quarries in Lebanon exploit the Cenommanian and Jurassic rock formations.

Production and Marketing

- Most quarry sites market their products locally within the caza and within the Muhafaza.
- In terms of production, the largest quarries are in Chekka, Abu Mizan and Chouf.

Geotechnical Aspects

- In general most quarry faces are near vertical to vertical. Except for working berms, no benches for stability purposes are provided.
- Most of the quarries employ high cut faces as high as 100m. Open pit mining methods or galleries are not common quarrying methods.
- Most quarries depend on ASTM Los Angeles abrasion test to check the quality of their product. Few quarries carry out other tests upon request.
- Many of the quarries are extracting rock in close proximity to existing private and public property or structures endangering their stability.

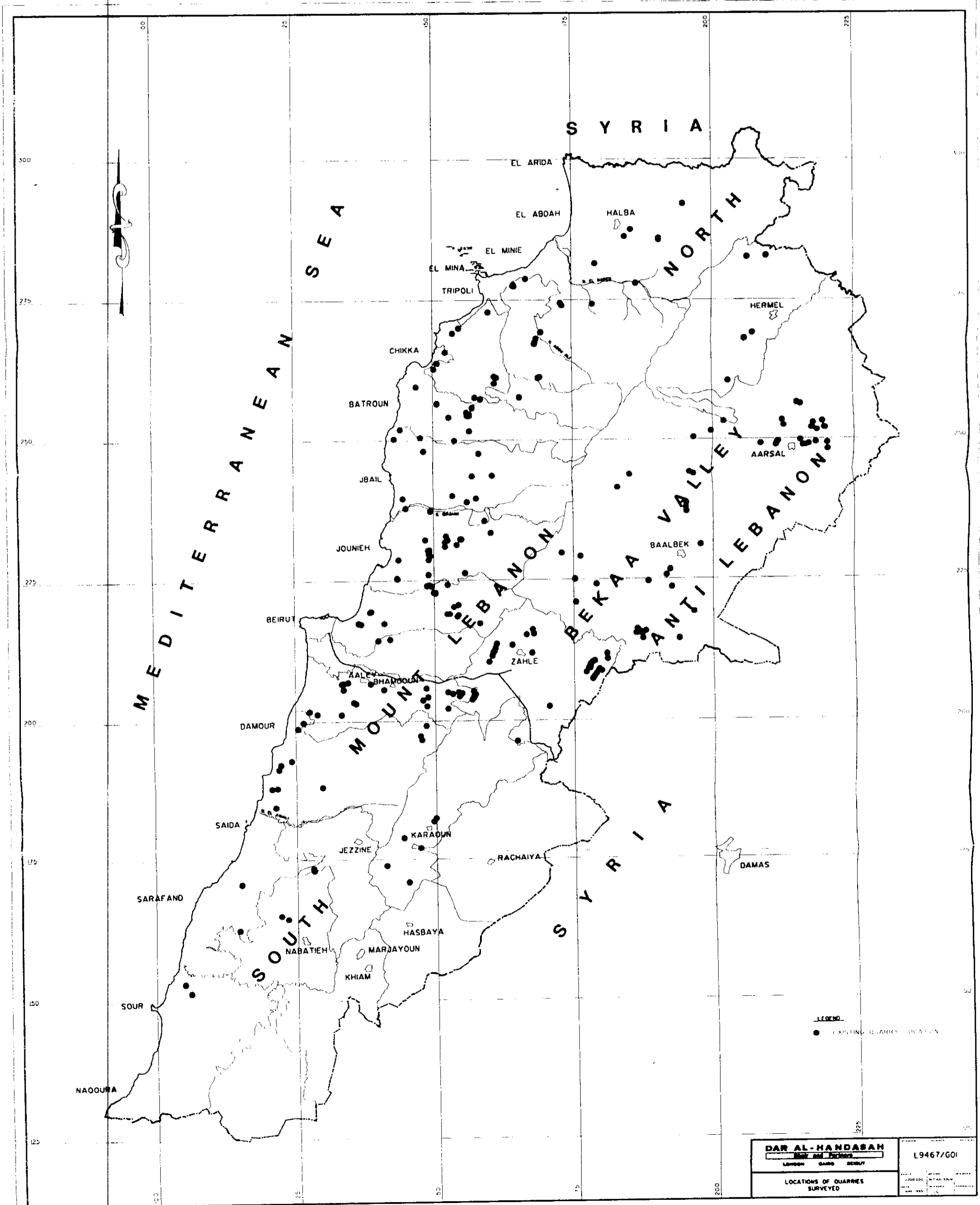
Environmental Consequences of Quarries

- The surveys have identified a number of specific problems caused by quarrying operations, which include blasting, noise, dust, flooding and siltation and uncontrolled movement of heavy goods vehicles
- Despite the wide despread and serious nature of the environmental effects, the survey identified less than 2% of cases where attempts had been made to rehabilitate or restore the worked out quarries by either earth modeling or tree planting.

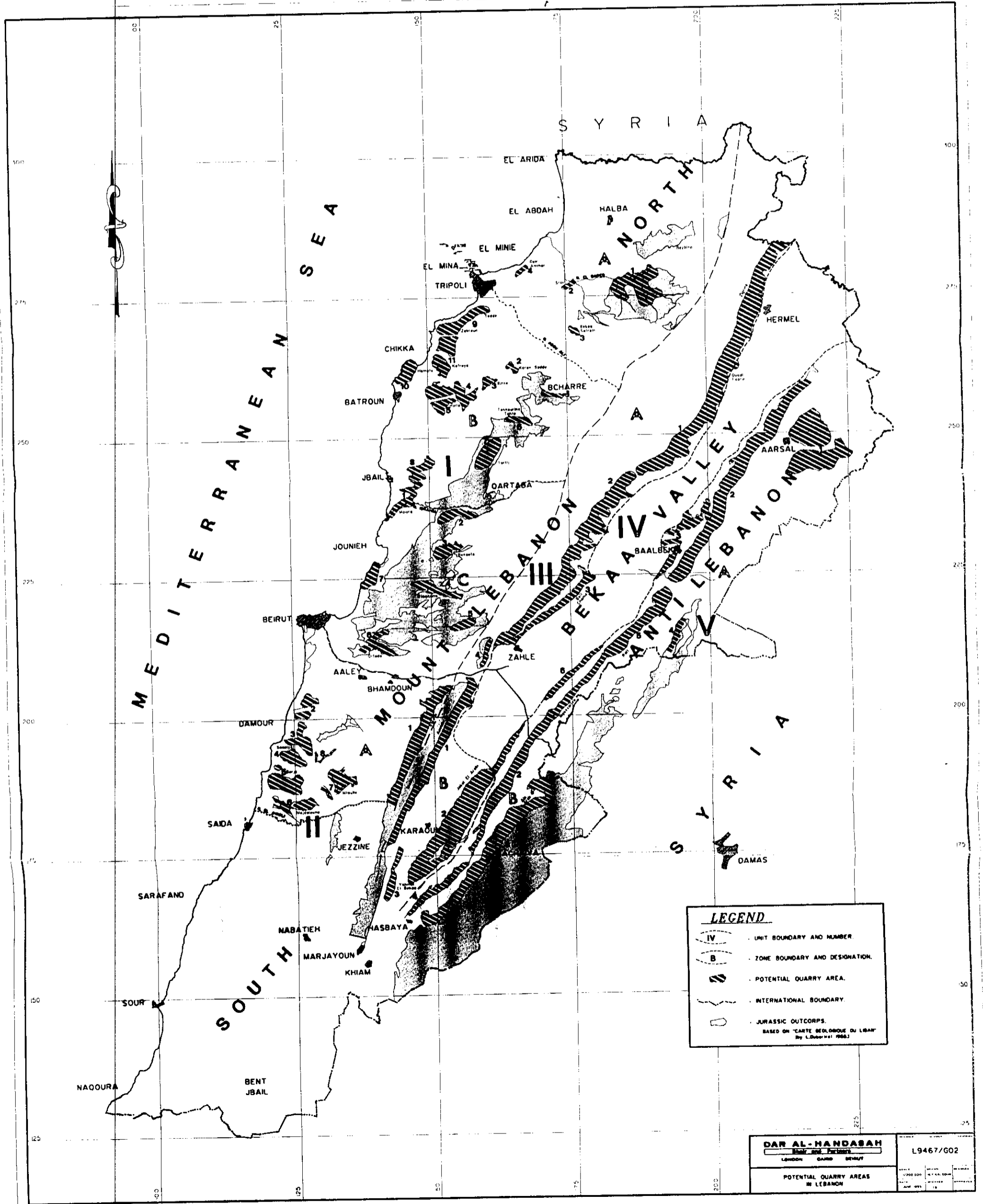
Transport

- A fleet of over 2500 heavy lorries are employed exclusively by quarry operators to supply the market.
- vehicles using public highways carry maximum loads exceeding 30 tones with averages around 15 tones.
- Trucks carrying quarried material are frequently significantly over loaded and are a major contributor to the accelerated deterioration of road surfaces.
- Almost all rock quarries in Lebanon use blasting.
- 54% of quarry operators place the explosives in guarded locations, 17% follow safety procedures, 4% use safety clothing and only 6% have first aid facilities.
- Only 34% of the staff are skilled in the use of explosives.
- 43% of quarries have nearby water supply which is mostly used for domestic purposes. Only in 40% of the quarries the water quality of the nearby source was not adversely affected.
- In 13% of the quarries increased sediment load was observed of which 44% cause local flooding and 64% cause diversion of water courses.
- 56% of the quarry operators reported no complaints from noise during the day and all reported no complaints during the night.

مواقع المقالع و الكسارات الحالية



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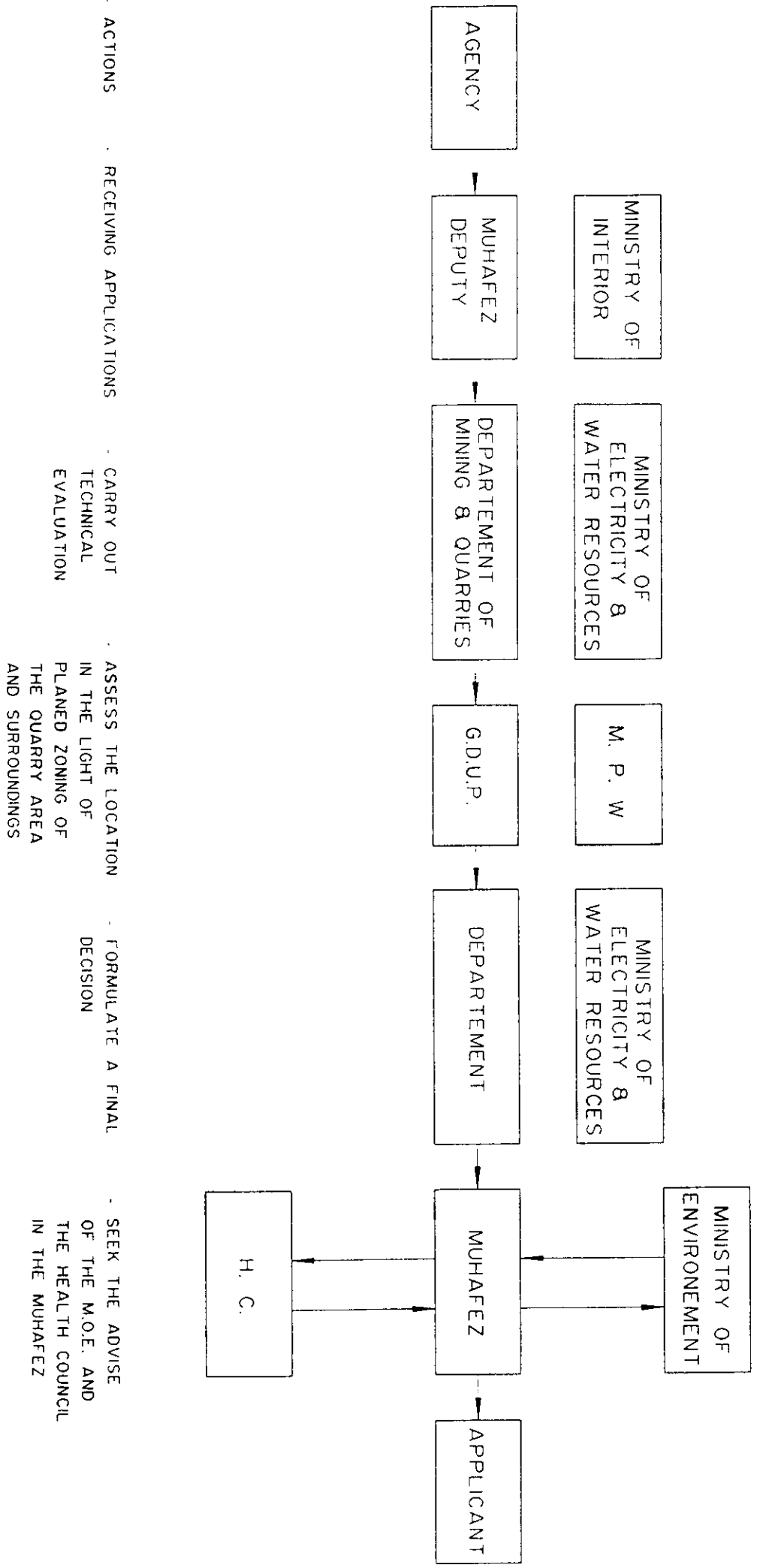


FIGURE 4.1
 EXISTING INSTITUTIONAL STRUCTURE
 AND LICENSING PROCEDURE

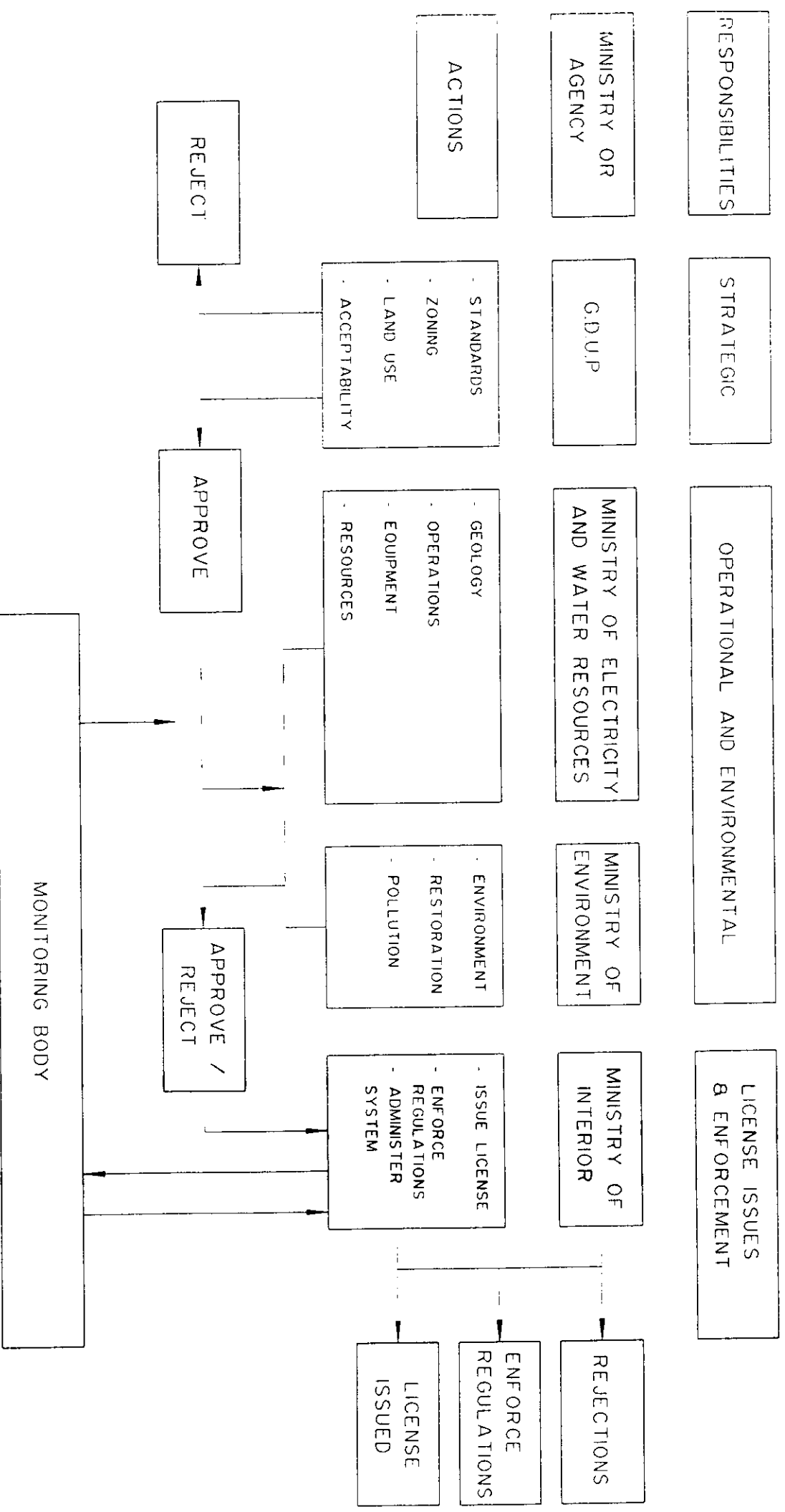


FIGURE 4.2
 INSTITUTIONAL STRUCTURE
 ALTERNATIVE I: INDIVIDUAL DEPARTMENT RESPONSIBILITIES

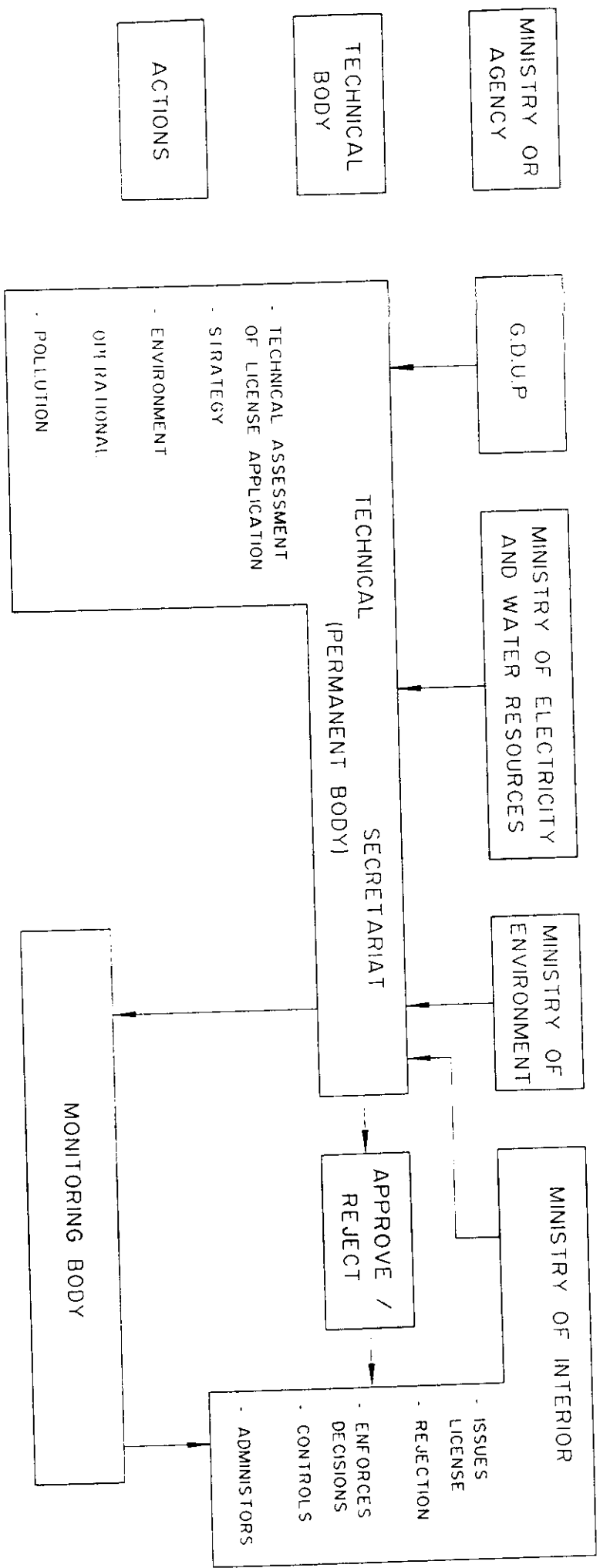


FIGURE 4.3
 INSTRUCTIONAL STRUCTURE
 ALTERNATIVE 2: TECHNICAL SECRETARIAT

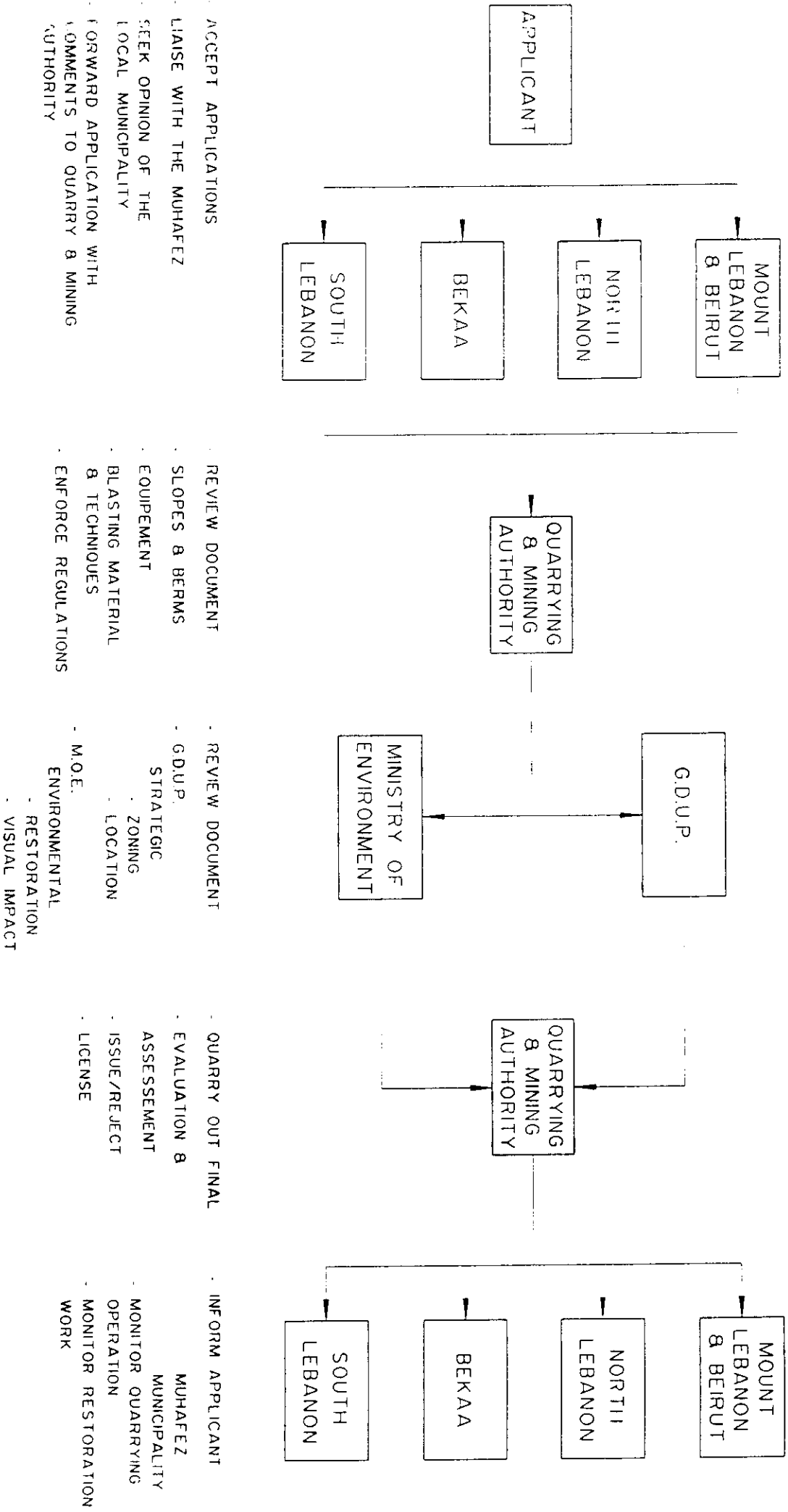


FIGURE 4.4
 ALTERNATIVE 3: A QUARRYING AND MINING
 AUTHORITY APPROACH

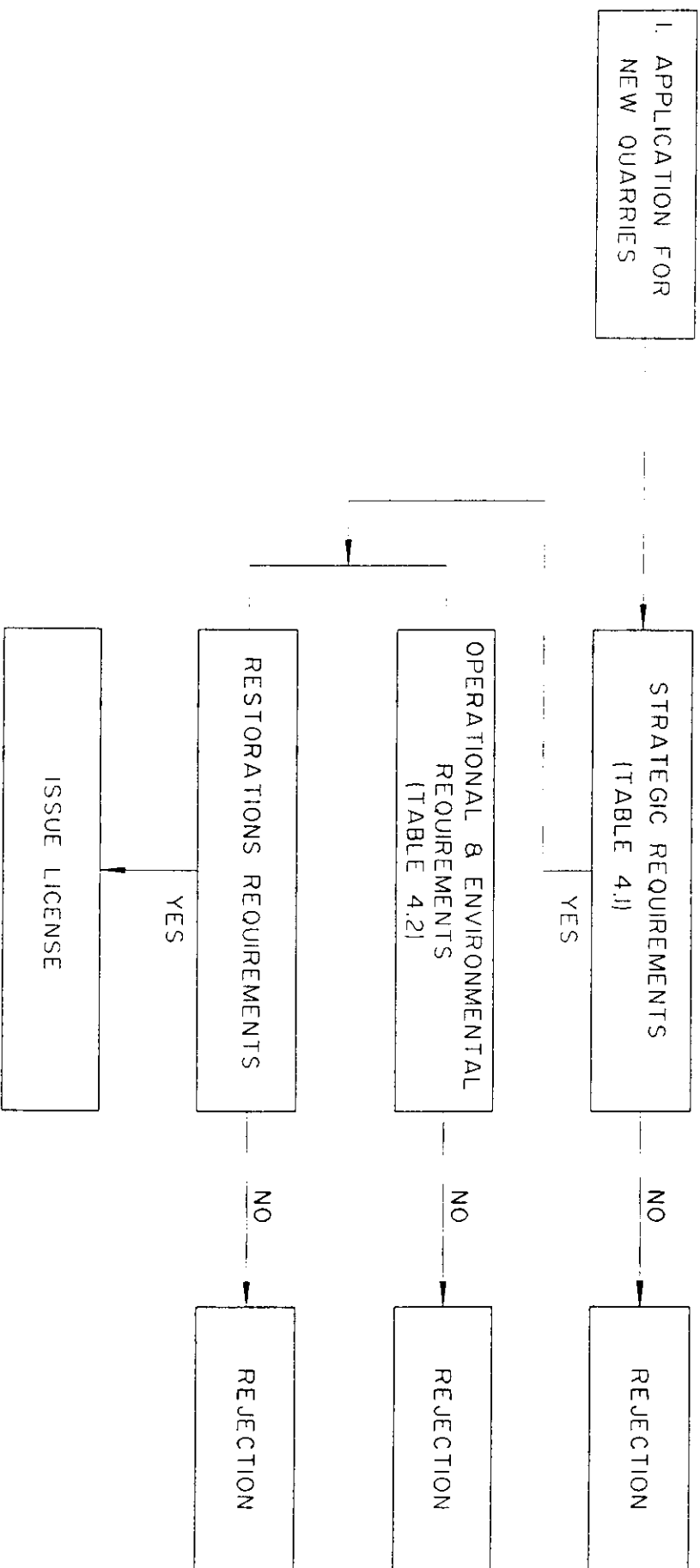


FIGURE 4.5
LICENSING PROCEDURE FOR NEW QUARRIES

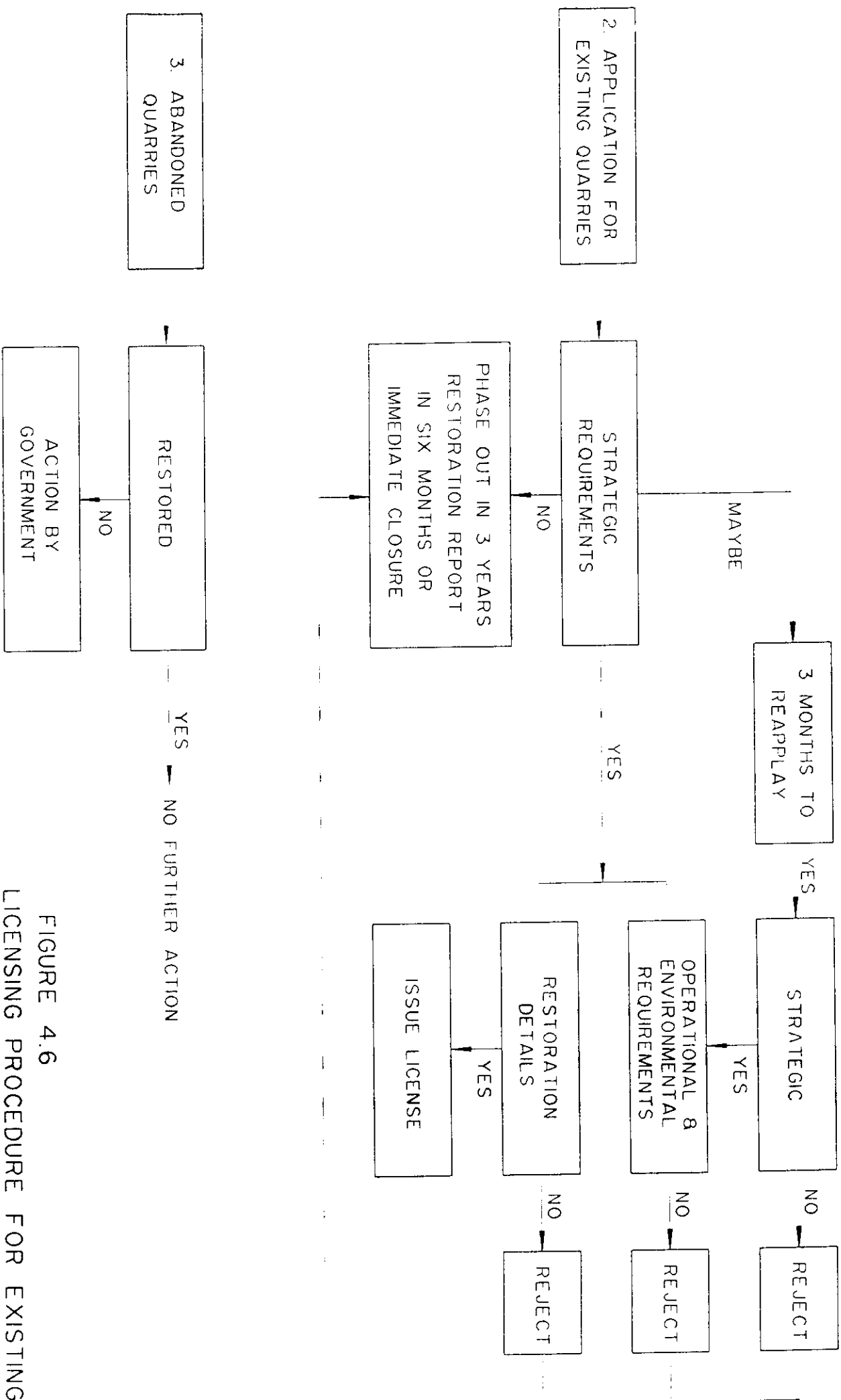


FIGURE 4.6
 LICENSING PROCEDURE FOR EXISTING
 AND ABANDONED QUARRIES

Appendix A - (Cont'd)

Feature	Criteria	
7. Dust Suppression	<ul style="list-style-type: none"> - Dust creating equipment shall be fitting with effective dust suppression systems. Such as those using filtration or sprays. - Unsurfaced quarry roads, stock piles or processing areas shall be treated to reduce dust emission. - All access roads shall be surfaced. 	
8. Safety Measures	<ul style="list-style-type: none"> - Boundary security - Signs - Equipment - Fire protection - First aid kits - Storage of explosives 	<ul style="list-style-type: none"> - A boundary fence at least 2 m in height shall be constructed around the site. - The presence of the quarry shall be shown on signs located 200 m from the entrance - Safety helmets and shoes must be used in the quarry. - Fire extinguishers which comply with the appropriate fire regulations shall be kept on the site at all times. - Fully stocked first aid kits approved by the Ministry of the Interior shall be available at all times in each building, truck, crusher plant and explosives store. At least one stretcher shall be available on the site at all times. - Records shall be kept of all accidents and injuries. - Explosives must only be stored in secured buildings isolated from other quarrying activities such that stores are 100 m away from public footpath etc. and 50 m away from the nearest building.

Appendix A - (Cont'd)

Feature	Criteria
<p>5. Quarrying Operations</p> <ul style="list-style-type: none"> - Size of quarry face - Benches - Covering of lorries 	<ul style="list-style-type: none"> - Shall not be higher than 25 m. - Shall be a minimum of 3 m width. - Lorries shall be adequately covered to prevent stone and dust falling on the road. The cover shall extend for at least 50 cms down the vertical sides of the lorry and be tightly roped.
<p>6. Blasting and the Use of Explosives</p> <ul style="list-style-type: none"> - Time limits - Warnings - Ground vibration 	<ul style="list-style-type: none"> - Blasting shall only be allowed between 11.00 and 13.00 hours on any normal working day. Drilling or blasting shall not take place on Sundays or National Holidays. - Audible and visual warnings shall be given prior to blasting operations. <p>Shall not exceed the following peak particle velocities ppv/(mm/s)</p> <ul style="list-style-type: none"> - Historical building monuments buildings of special value 2 - Houses and low rise residential buildings 10 - Commercial and industrial properties 25
<ul style="list-style-type: none"> - Extra Precautions 	<ul style="list-style-type: none"> - Areas being blasted, particularly in populated areas and those within 200 m of roads, must be covered to reduce dust and flyrock.

Appendix A - Requirements for Correct Site Operation

Feature	Criteria
1. Site Area for Facing stone for aggregates	Not less than 2500 m ² Not less than 10,000 m ²
2. Access - Visibility splays Junction details - - Site controls	100 m in each direction from a point 3 m back from edge of carriageway - Incorporating kerb line defining junction. - Surfaced in the macadam or other dust free material. - Weigh bridges should be installed to ensure quarry trucks do not exceed maximum axle load of 12 tonnes.
3. Site Layout and Structures - Crushers associated with the quarry	- Shall not be built within 10 m of the plot boundary. - Shall be screened.
4. Landscaping - Embankments - Quarry faces - Tree planting - Maintenance	- Shall be 1.5 to 2.0 m high and delineate the quarry site. The slopes shall be planted to prevent erosion. - Redundant quarry faces must be planted with vegetation. Practical measures may include wire mesh, geotextile, hollow mesh matting, compost etc. No redundant face should be without vegetation for more than 6 months. - Trees of a minimum height of 1.5 m shall be planted at a maximum of 7.0 m centers. - Dead or dying trees shall be removed and replaced.

Table 3.1 - Minimum Acceptable Distances between the Quarry and other Activities Features and Land Uses

Feature	Minimum Distance (m)
International Roads	200
National Major Roads	100
Minor and Local Roads	10
Rivers or streams	50
Intermittent Wadis	25
Communal facilities such as schools, hospitals, clinics, nurseries	1000
Residential areas - houses, shops and all other land uses (ex industry)	1000
Industrial buildings	500
Archaeological site or natural habitat defined by special decree	1000
The plot area of any quarry shall not be less than	
for facing stone	2500 m ²
for aggregate producing quarries	10,000 m ²

No quarries shall be allowed in areas allocated as:

- Natural Heritage.
- Public, municipal or governmental property.
- Coastal areas of rivers and wadis.
- Hills overlooking the coastal strip.

The criteria in Table 3.1 are within the framework of the existing temporary regulations concerning industrial installations, which also cover quarry locations. However due to the size and topography of Lebanon, it would be possible that some potential locations would be environmentally suitable, but do not fulfill all the above criteria. Such cases must be considered as 'special' cases. Examples of such locations could be such as quarries in wadis where their visual intrusion is minimal.