2.3 Low-Cost Housing Statistics

Malaysia is said to be more developed, both economically and industrially than the other countries in the Southeast Asia. According to statistics for 1974, the national average monthly income per family was M$216, and 86.7 percent of all families had monthly incomes of less than M$300 (Fig. 2-15). The sampling survey conducted in 1977 under the Cheras Cluster-Link Low-Cost Housing Plan (conducted by the University of Malaya, about 676 families sampled) revealed that 10.5 percent of families had monthly incomes of less than M$300, 30.5 percent had incomes of between M$301 and 400, and 50 percent had incomes of between M$401 and 600. In contrast, in the same year the average monthly income of a squatter family was M$252, and 86.7 percent of all families had an average monthly income of less than M$300 per household.

Further, the proportion of families in the poor bracket is rated (in the Mid-Term review of the 3rd Malaysia Plan) at 49.3 percent in 1970, 43.9 percent in 1975, and 33.8 percent in 1980 (Table 2-18).

2.3.1 Eligibility and Cost

Strict limitations are placed on the tenancy qualifications for low-cost housing with regard to household income and family size, as reflected in the following:

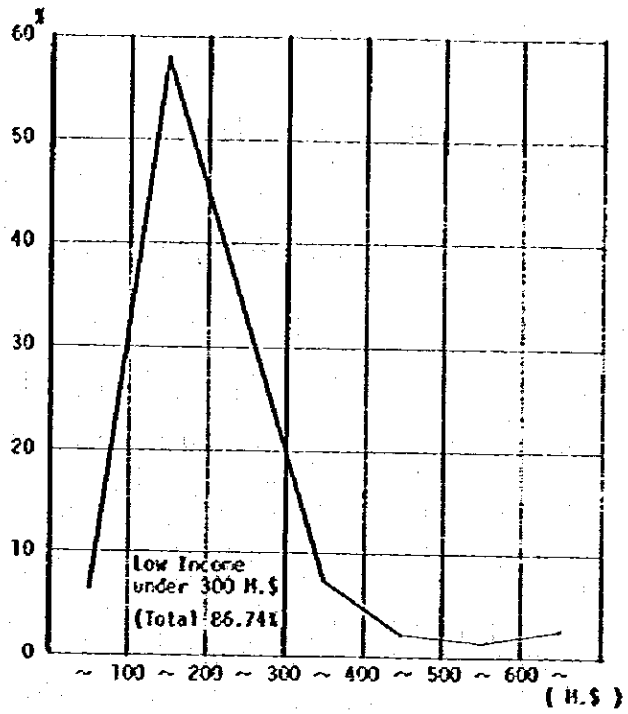


Fig. 2-15 Distribution of Monthly Household Income in Malaysia, 1974

Table 2-18 Number of Poor Households in Peninsular Malaysia, 1970~80

	1970	1975	1980
Total Households	1,606,000	1,901,500	2,270,000
Poor Households	791,300	835,000	768,300
Percentage of Poor Households	49.3%	43.9%	33.8%

1) Malaysians of twenty-one years or over who have lived in the state concerned for five years or more.
2) Families with monthly incomes of less than M$300.
3) If the monthly family income exceeds M$300, income per person must be under M$50, and total household income must not exceed M$800, and
4) Family is defined as spouse, children, and parents.

Lists of names of qualified people who have applied for low-cost housing, by ethnic group, have been prepared. The new houses are allocated to tenants, the ethnic distribution of the tenants being decided in proportion to the number of the enrolled persons of each ethnic group, by taking into account such factors as the number of family members, the number of disabled family members and household income.

Standard costs of houses current in February, 1978, listed according to house-type in the design book of low-cost housing published by the Ministry of Housing and Local Government (1979), are shown in Table 2-19. Costs in 1980 are almost double those listed in Table 2-19 because of rapid hikes in construction and land costs.

Table 2-20, which is cited from the design book of low-cost housing for the 4th Malaysia Plan (Ministry of Housing and Local Government, 1980), shows the occupant income brackets, price ceilings and proportions of units within given price ranges of low-cost houses.

Table 2-19 Estimated Cost of Public Low-Cost Housing

Housing Type	Floor area (Sqft) per unit	Ground area (sqft) per unit	Estimated Costs (M$)			
			Building	Land	Others	Total
2-room single-story terrace house	336	1,624	3,100 (9.23)	338	695	4,133
2-room two-story terrace house	395	1,030	3,600 (9.14)	238	500	4,338
2-room two-story terrace house	581	1,522	3,800 (6.55)	351	675	4,826
3-room single-story terrace house	458	1,519	4,000 (8.74)	351	675	5,026
3-room two story terrace house	479	1,031	4,100 (8.56)	238	500	4,838
3-room single-story terrace house	750	1,814	5,400 (7.20)	419	745	6,563
3-room two-story terrace house	558	1,007	4,800 (8.61)	232	500	5,532
3-room 5-story flat	551	723	6,600 (11.98)	167	1,897	8,664
2-room 5-story flat	381	603	6,000 (15.75)	139	1,328	7,467
2-room 17-story flat	370	147	6,200 (16.58)	34 (1,600)	1,226 costs	9,060 of piles

Note: The estimated costs above were based on rates effective on 1/2/1978

Table 2-20 Selling Price of Public Low-Cost Housing Units According to Monthly Income (1980)

Income(M.$)	Selling Price(M.$)	Percentage of Units
0~200	5,000 and less	20
201~400	10,000 and less	47
401~600	17,000 and less	33

Further, the Federal Government has required developers as a condition of licensing development work, to build low-cost housing at the rate of 30 to 50 percent (30 percent in Kuala Lumpur and 40 percent in Johore) of all units built. The maximum prices of such low-cost houses are set at M$15,000 to M$20,000. Fig. 2-16 illustrates the type of low-cost houses planned to be built in 1980 by a private sector, showing a two-bedroom type to cost M$20,000.

2.3.2 Standards

(1) The Uniform Building By-Laws

Prior to the establishment of the Uniform Building By-Laws in 1976, the architectural standards followed when Malaysia was under British rule were still being used in the states and towns. The uniform by-laws were promulgated because the previous standards specified minimum road width, drainage facilities, the minimum size of rooms and other criteria which were typical of middle-class European communities. Such standards were considered to be too expensive to be applied to Malaysia. Based on British Standard (BS), the Uniform Building By-Laws consist of the following eight (8) chapters and the detailed technical requirements were worked out in conformity with BS or BSCP.

Chapter I	General
Chapter II	Submission of Plan for Approval

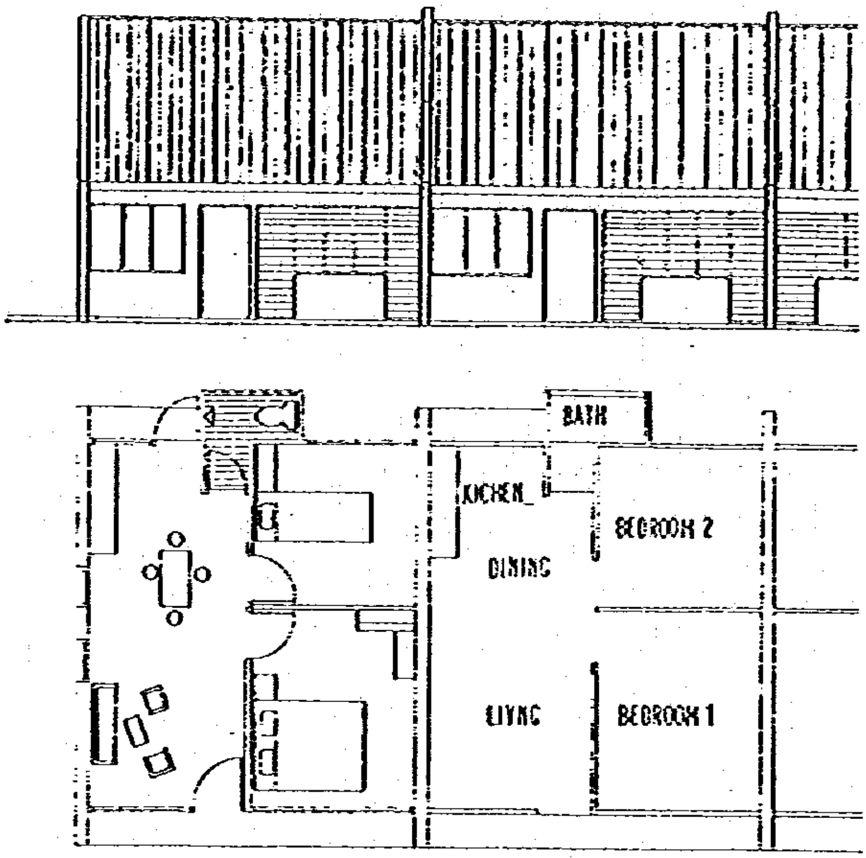


Fig. 2-16 Plan of Low Cost House, by Private Developer, 1980

Chapter III	Space, Lighting, and Ventilation Requirements
Chapter IV	Temporary Works in connection with Building Operation
Chapter V	Structural Requirements
Chapter VI	Construction Requirements
Chapter VII	Fire Requirements
Chapter VIII	Miscellaneous

(2) Malaysian Standards (MS) - Building Materials

As provided for in the Uniform Building By-Laws, the Malaysian Standards for Building are being drawn up. To date, 32 provisions have been finalised, 35 drafted, and 24 planned. Table 2-21 lists up the finalized standards.

(3) Structural Standards for Low-Cost Housing

Provisions to ensure at least a minimum standard of living have been formulated for low-cost housing and workers' housing.

(a) Minimum Standards for Low-Cost Housing

Minimum Standards for Low-Cost Housing were formulated in 1967 by a committee of experts from the Ministry of Local Government and Housing, the Ministry of Public Works, the Ministry of Posts and Telecommunications, the National Electricity Board, the Federal Department of Town and Administration, the Federal Capital of Kuala Lumpur and the Housing Trust Fund. The standards sought to:

Table 2-21 Finalized Malaysian Standards

- Building Materials -

No.	MS No.	Title
1	MS 7.1 : 1971	Methods of Testing concrete
2	MS 7.2 : 1971	Precast concrete blocks
3	MS 7.3 : 1971	Test for water for making concrete
4	MS 7.4 : 1971	Coarse and fine aggregates from natural sources
5	MS 7.5 : 1971	Methods for sampling and testing of mineral aggregate
6	MS 7.6 : 1972	Bricks and blocks of fired brickearth, or shale
7	MS 7.7 : 1973	Hard drawn mild steel wire for reinforcement of concrete
8	MS 7.8 : 1973	Steel fabric for reinforcement of concrete
9	MS 7.9 : 1973	Hot rolled steel bars for reinforcement of concrete
10	MS 7.10 : 1973	Quality of vitreous chinasanitary appliances
11	MS 7.11 : 1976	Mortar testing sand
12	MS 7.13 : 1977	Specification of Portland cement
13	MS 7.15 : 1977	Specification for readymixed concrete
14	MS 7.16 : 1977	Specification for asbestos cement symmetrically corrugated sheets for roofing cladding
15	MS 7.21 : 1977	Specification for concrete porous pipes for underground drainage
16	MS 1.5 : 1971	Titanium dioxide for paints
17	MS 1.4 : 1971	Antimony oxide for paints
18	MS 1:30 : 1973	Paint:Finishing, gloss enamel, air drying
19	MS 1:37 : 1973	Under coating paint for use in paints : Finishing, Gloss enamel, air drying
20	MS 1:38 : 1973	Methods of test for paints
21	MS 1:39 : 1973	Paint : Finishing exterior and interior latex emulsion
22	MS 1:69 : 1973	Priming paint : Red-lead based for iron and steel
23	MS 1:46 : 1973	Water paint/distemper, washable oil bound
24	MS 1:47 : 1973	Paint, road marking, exterior (Traffic paint)
25	MS 1:80 : 1975	Paint, dry, cementitious (cement paint)
26	MS 1:81 : 1975	Paint finishing aluminium
27	MS 1:83 : 1975	Paint remover, solvent type, non-inflammable
28	MS 3:44 : 1977	Code of practice for the structural use of timber
29	MS 3:75 : 1976	Glossary of terms relating to timber and woodwork
30	MS 3:23 : 1974	Nomenclature and uses of commercial timbers of Malaysia
31.	MS 3:22 : 1974	Plywood
32.	MS 3:38 : 1976	Treatment of timber and plywood with C/C/A preservatives

- Standardise low-cost housing design to which conventional and prefabrication construction methods are adaptable.
- Formulate provisions of low-cost, shortened construction period, durability, weather resistance and housing style suited to Malaysians.

The following figures were proposed as the minimum standards of low-cost housing.

1) The rent per house size, minimum living area per room, and standard number of people to inhabit a house of a given size are indicated in Table 2-22.

Table 2-22 Maximum Rent, Minimum Floor Area and Standard Number of Occupants per Unit Proposed as Minimum Standards for Low-Cost Housing, 1967

Type of Flat	Rent (M$/Month)	Minimum Area (ft^2)	No. of Occupants
One Room	18	150	3
Two Rooms	35	300	6
Three Rooms	50	450	9

Note: These rents have subsequently been changed as noted previously in this section.

2) The minimum sizes of rooms;

living room : 120 ft^2

master bedroom: 120 ft^2

kitchen : 48 ft^2

3) The minimum ceiling height: 8 ft

4) Lifts: Furnished in buildings of more than 5-storeys, 1 lift/100 units

5) Building materials : maximum utilisation of locally produced materials

6) Communal facilities:

   i) Site for primary school of 1.5 acre/1000 inhabitants

   ii) 6 shops (7200 ft^2)/1000 inhabitants

   iii) Open space: 0.5 ∿ 1 acre/1000 inhabitants (playground)

   iv) Community centre: 2000 ft^2/1000 inhabitants

   v) Medical clinic : provided in shop houses

   vi) Parking areas to accommodate passenger cars, motorcycles and bicycles

   vii) Funeral parlour : at least one per housing area

(b) <u>Workers (Minimum Standards of Housing) Act, 1966</u>

The Workers Act of 1966 provides the minimum dimensions of both permanent and temporary houses for workers that are build by a company. Provisions with respects to permanent housing for workers are as follows:

1) The size of housing unit shall be 260 ft^2 or more with a habitable room space of 250 ft^2 or more.

2) The number of dwellers shall be five (5) adults or less. If more persons are accommodated, additional habitable area of 40 ft^2 per person is required. Two children aged from three (3) to twelve (12) shall be regarded as one (1) adult.

3) The distance between a house and a road shall be 20 ft or more, and distance between columns shall be 20 ft or more.

4) The minimum width of a habitable room shall be 8 ft.

Additionally, the Workers Act provides quality standards for materials used in roofs, ceilings, walls, and floors, and standards of ventilation and sanitation.

2.3.3 Low-Cost Housing Low-, Medium- and High-Rise Prototypes

(1) Planned Living Unit Density

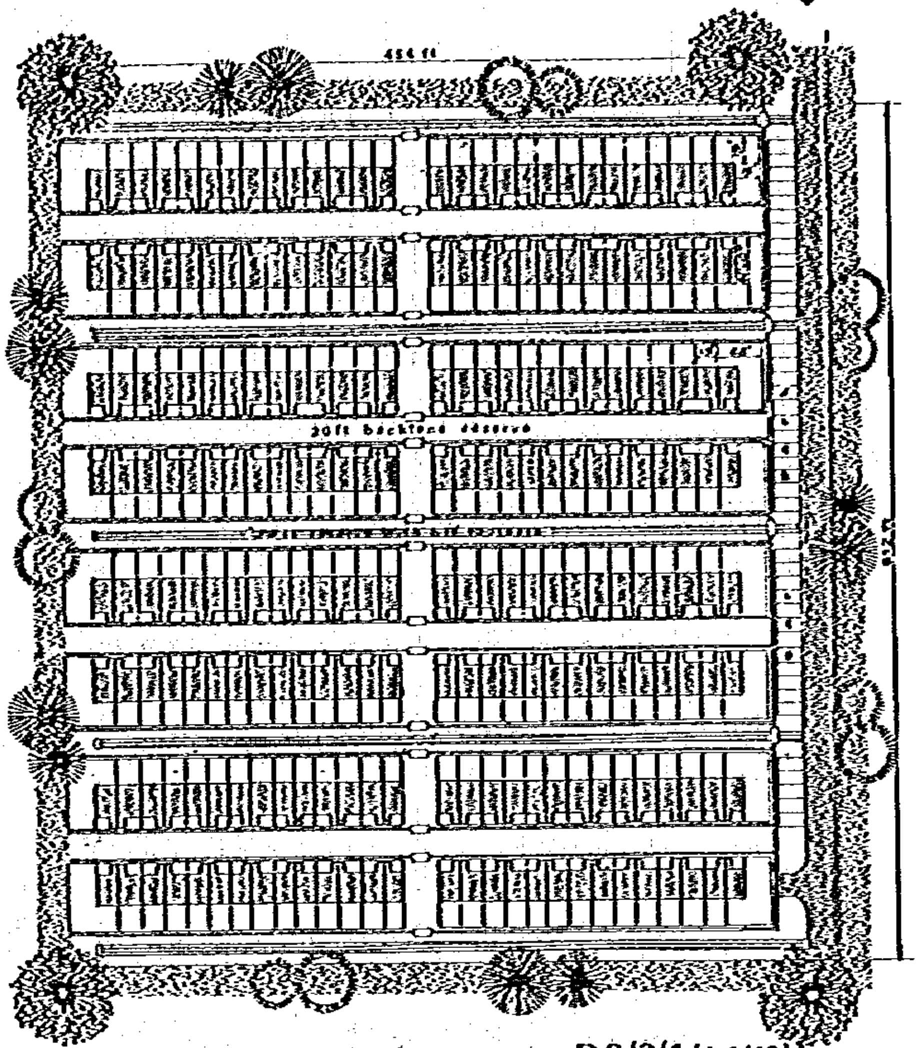
According to the Design Book of Low-Cost Housing published by the Jabatan Perumahan Negara (of the Ministry of Housing and Local Government) in 1979 (Table 2-23), the number of units per apartment complex is planned to be 14 to 43 units per acre in the case of low-rise complexes and 60 to 72 in the case of medium-rise complexes, which are considerably high. Layout plans for low-, medium- and high-rise buildings are shown on Figs. 2-17, 18, and 19.

However, when the space allowed for recreation, community services and roads are considered, the density of low-cost housing units is relatively low. The standard densities per acre are 10 units for low-rise buildings, 20 units for cluster-link terrace buildings, and 40 units for medium-rise buildings.

As seen in Fig. 2-20, the layout plan for the Kampong Pandan Area (including both medium-rise and low-rise buildings), there will be 39 living units per acre of building area, but only 12.3 living units per acre of the entire site (Table 2-24). In the case of high-rise buildings in the City of Kuala Lumpur, however, the number of units per acre is fairly high (Table 2-25).

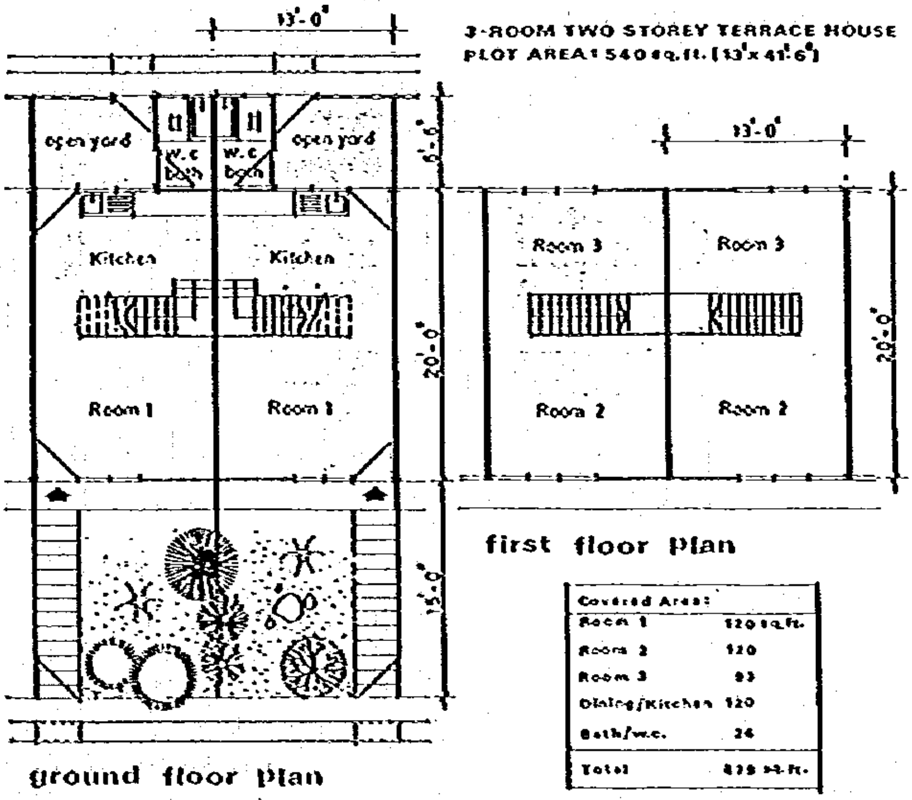
Table 2-23 Density of Public Low-Cost Housing Units Specified in Minimum Standards of Low-Cost Housing Design, 1979

Structure Code	Type and No. of Stories	No. of Units	Ground Area for total No. of Units (acres)	Housing Density (units/acre)
TN/3	Detached - 1	100	5.37	18.62
TB2/1	"	80	4.75	16.84
TV3/2	"	80	5.62	14.20
L2/1	Terrace House-1	160	5.40	29.68
L3/7P	"	160	6.70	23.88
SD2/1	"	112	5.12	21.88
L2/3	Terrace House-2	224	5.33	42.02
TB1/4	"	160	5.62	28.47
L4/16A	"	224	5.20	43.08
F5/1	Flats - 5	300	5.01	59.88
F5/2	"	360	5.01	71.80
F17/1	Flats - 17	1,536	5.22	294.00



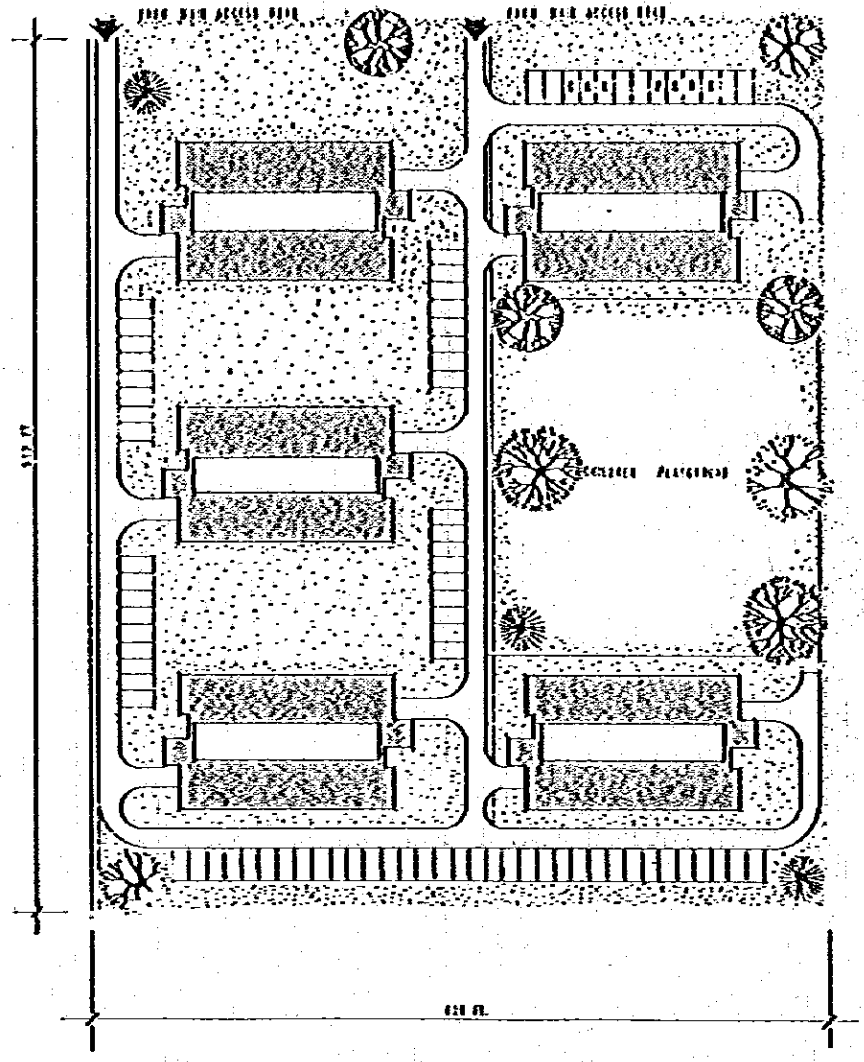
layout plan for type : D 2/3/1 (L 4/18)

3-ROOM TWO STOREY TERRACE HOUSE
PLOT AREA : 540 sq.ft. (13' x 41'-6")



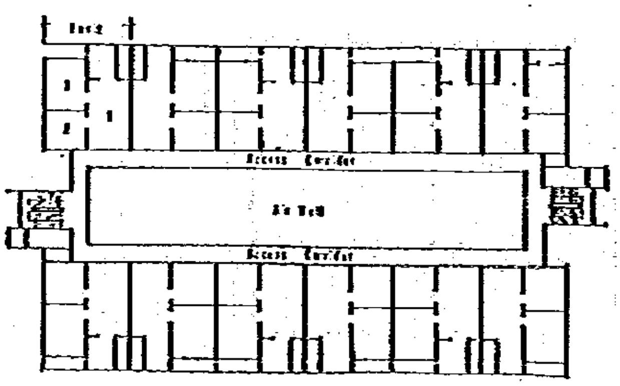
Covered Area:	
Room 1	120 sq.ft.
Room 2	120
Room 3	93
Dining/Kitchen	120
Bath/w.c.	24
Total	479 sq.ft.

Fig. 2-17 Layout Plan of Low-Cost Housing Estate (Terrace Houses)

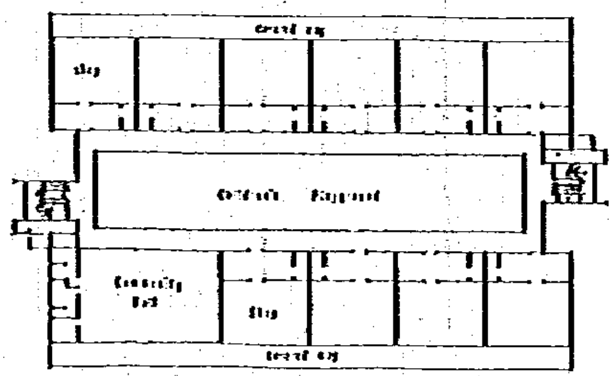


LAYOUT PLAN FOR 5-STOREY FLATS

TOTAL NO OF FLATS	[illegible]
DENSITY OF UNITS/ACRE	[illegible]
AREA OF ACCESS SERVICE ROAD RESERVE AND CAR PARKS	[illegible]
AREA OF OPEN SPACE AND CHILDREN PLAYGROUND	[illegible]
AREA OF BUILT-ON FLATS	[illegible]
TOTAL AREA REQUIRED	[illegible]
PERCENTAGE OF BUILT-ON AREA TO TOTAL AREA	[illegible]
PERCENTAGE OF OPEN AREAS TO TOTAL AREA	[illegible]



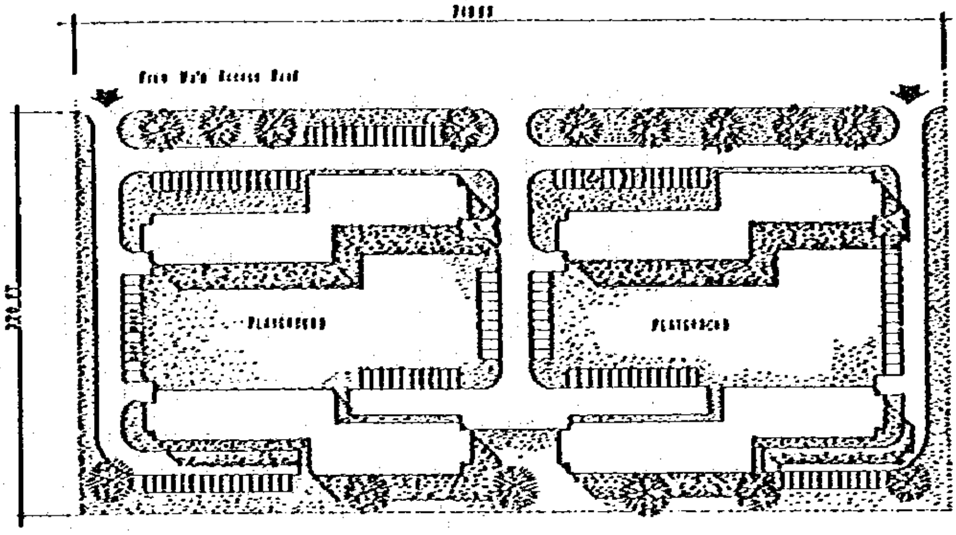
UPPER FLOOR PLAN (flats)



GROUND FLOOR PLAN (shops & other communal facilities)

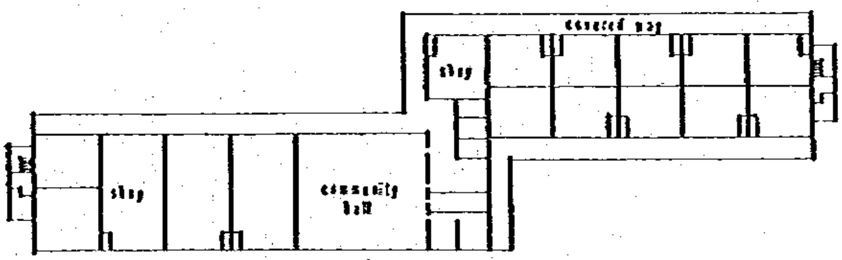
covered area	sq.ft.
room 1	184
room 2	110
room 3	128
kitchen	61
bath/w.c	31
balcony	37
total	551

Fig. 2-18
Layout Plan of Low-Cost Housing Estate (5-story Flats)

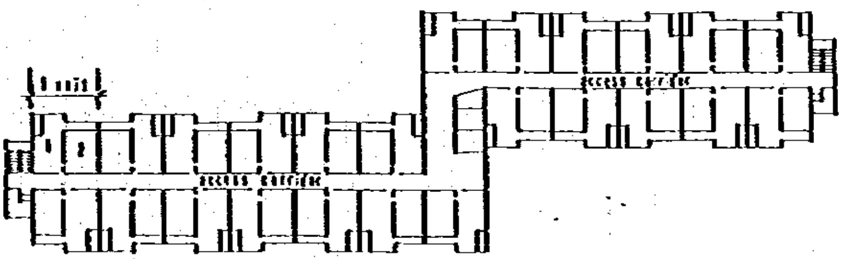


LAYOUT PLAN FOR 17-STOREY FLATS

TOTAL NO OF UNITS	[illegible]
DENSITY OF UNITS/ACRE	[illegible]
AREA OF ACCESS SERVICE ROAD RESERVE & CAR PARK	[illegible]
AREA OF OPEN SPACE AND CHILDREN PLAYGROUND	[illegible]
AREA OF BUILT-ON FLAT	[illegible]
TOTAL AREA REQUIRED	[illegible]
PERCENTAGE OF BUILD ON AREA TO TOTAL AREA	[illegible]
PERCENTAGE OF OPEN AREA TO TOTAL AREA	[illegible]



GROUND FLOOR (shop houses & other communal facilities)



UPPER FLOOR

Covered Area:	sq. ft.
Living	[illegible]
Bedroom	[illegible]
Kitchen	[illegible]
Bath/w.c	[illegible]
Balcony	[illegible]
Total	[illegible]

Fig. 2-19 Layout Plan of Low-Cost Housing Estate (17-story Flats)

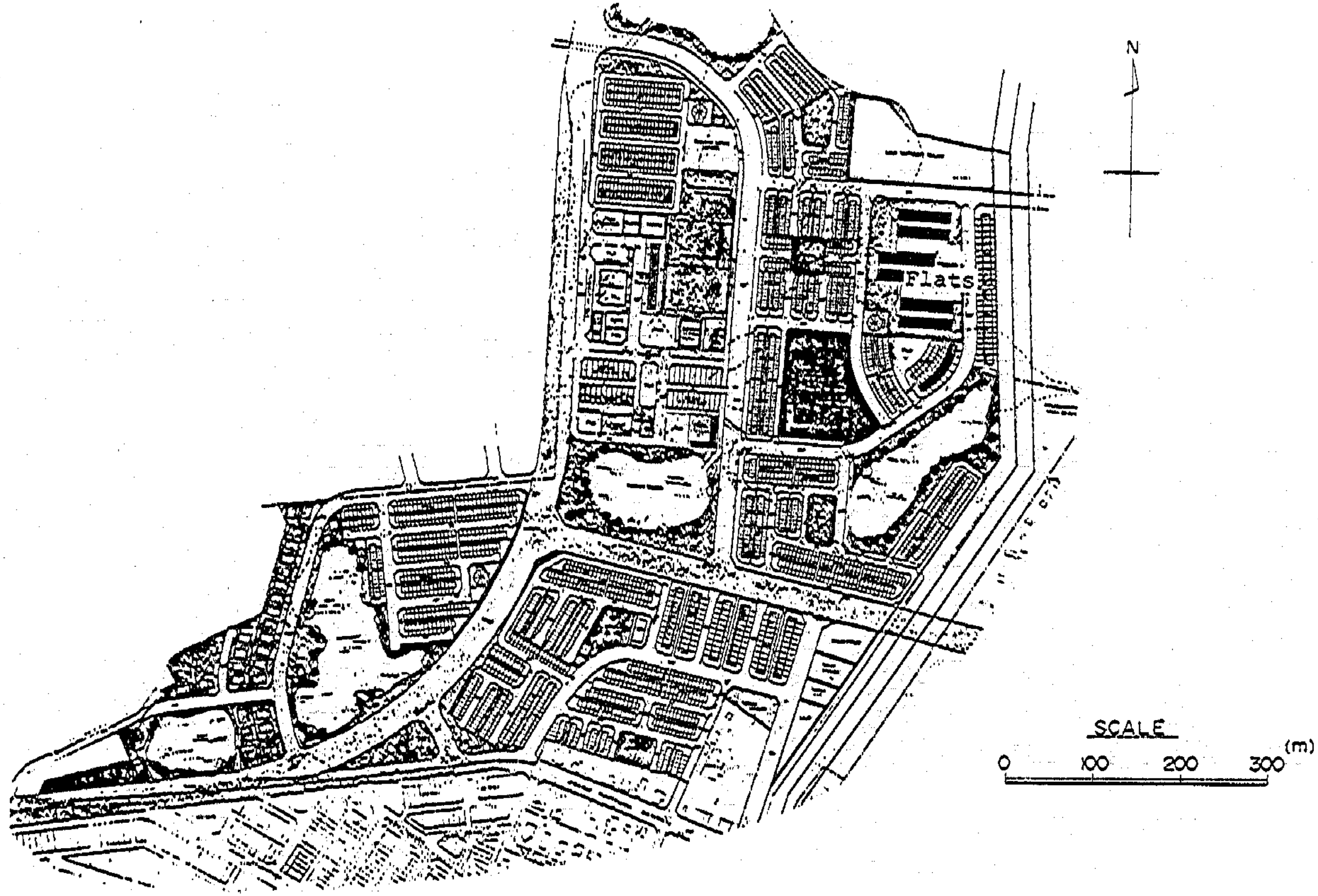


Fig. 2-20 Layout Plan for Housing Development at Kampong Pandan

Table 2-24 Planned Density of Housing Units at Kampong Pandan Estate (Site Area: 134 acres), 1979

Type of Housing	No. of Units	Ground Area for Total No. of Units (acres)	Density (units/acre)
Detached Houses	36	4.76	7.6
Terrace Houses (1)	110	3.88	28.3
Terrace Houses (2)	1,095	27.64	39.7
Cluster Terrace Houses	160	2.75	58.2
Flats	240	3.52	68.0
Total	1,641	42.55	38.6

Table 2-25 Density of Low-Cost Housing Units by High Rise Buildings per Acre of Site Area at Various Estates in Kuala Lumpur

Estate (site area)	No. of Stories	Population	No. of Units	Density per Site Area	
				Persons/ acre	Units/ acre
Jalan Loke Yen (9 acres)	9, 12	6,905	1,036	767	115
Suieman Court (2 acres)	4, 12	1,906	321	953	161
Jalan Pekeliling (18 acres)	4, 17	13,592	3,009	755	167
Jalan Shaw	17	4,708	808	1,177	202

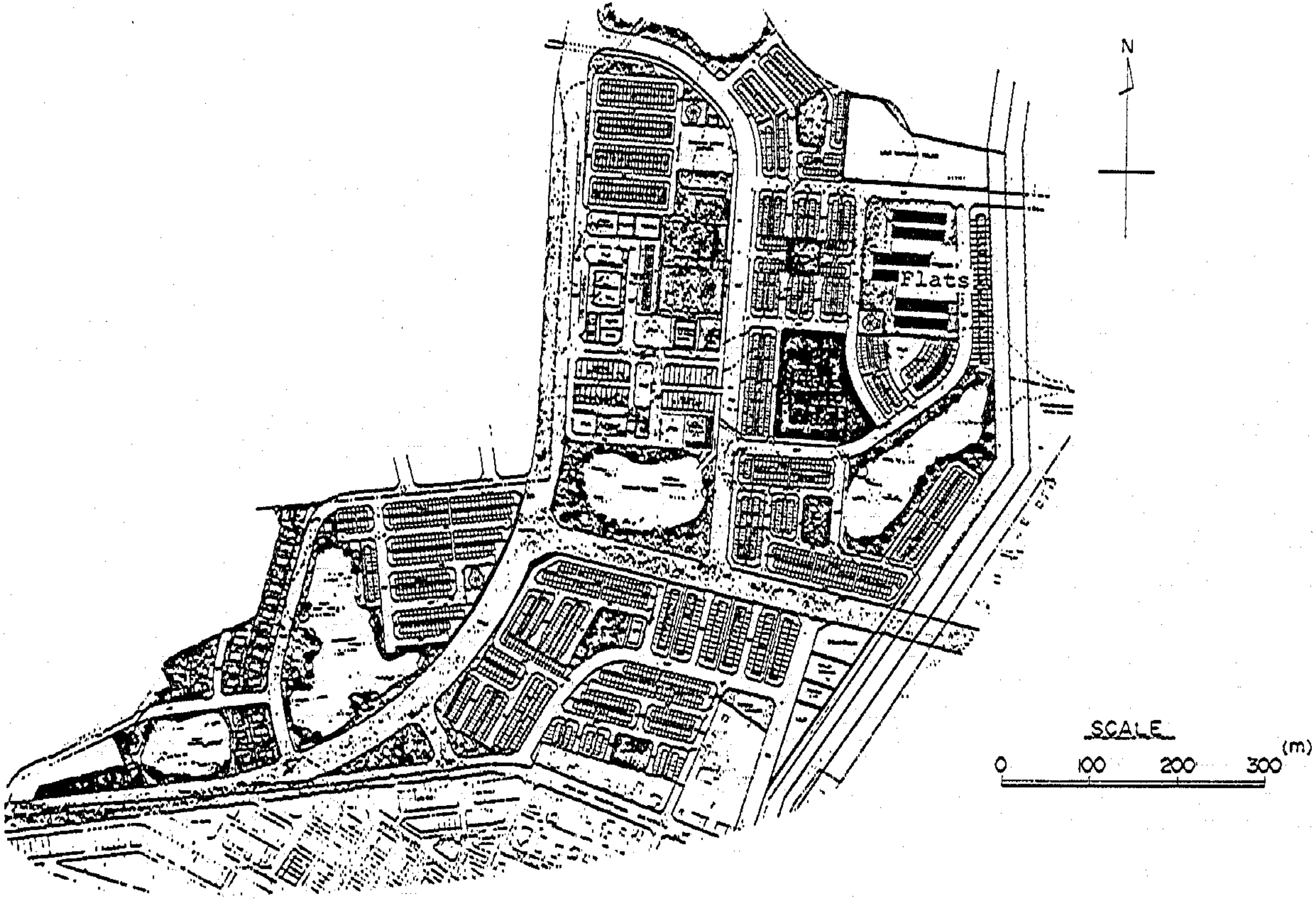


Fig. 2-20 Layout Plan for Housing Development at Kampong Pandan

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Jalan Pekeliling (18 acres)	4, 17	13,592	3,009	755	167
Jalan Shaw	17	4,708	808	1,177	202

The plan for the Sentul area is to construct a housing estate comprised of 4,206 units, including 1,424 units in 17-storey high-rise buildings and 2,782 units in 5-storey medium-rise buildings on a 220.34 acre site. The density of living units per acre of site area will be 20 units/acre (Fig. 2-21).

(2) Block Plan

Plans of public low-cost housing are classified by density according to the number of storeys of each block.

1) Low-density development 1 ∿ 2 storeys
2) Medium-density development 3 ∿ 5 storeys
3) High-density development 17 ∿ 20 storeys

The types of buildings corresponding to each of these criteria are:

1) Bungalow type, terrace houses; single-, or double- or multi-unit houses
2) Medium-rise flats; external corridor, or internal corridor, or TC-type (central air-well access type) corridor
3) High-rise flats; same as medium-rise flats.

In addition to these types, for the purpose of maximising land use and reducing construction cost, cluster-link houses have been built. As indicated in Fig. 2-22, cluster-link houses are low-rise buildings of high density in which 4 units are arranged around an airwell. In the plan for the Cheras area of Kuala Lumpur, cluster-link

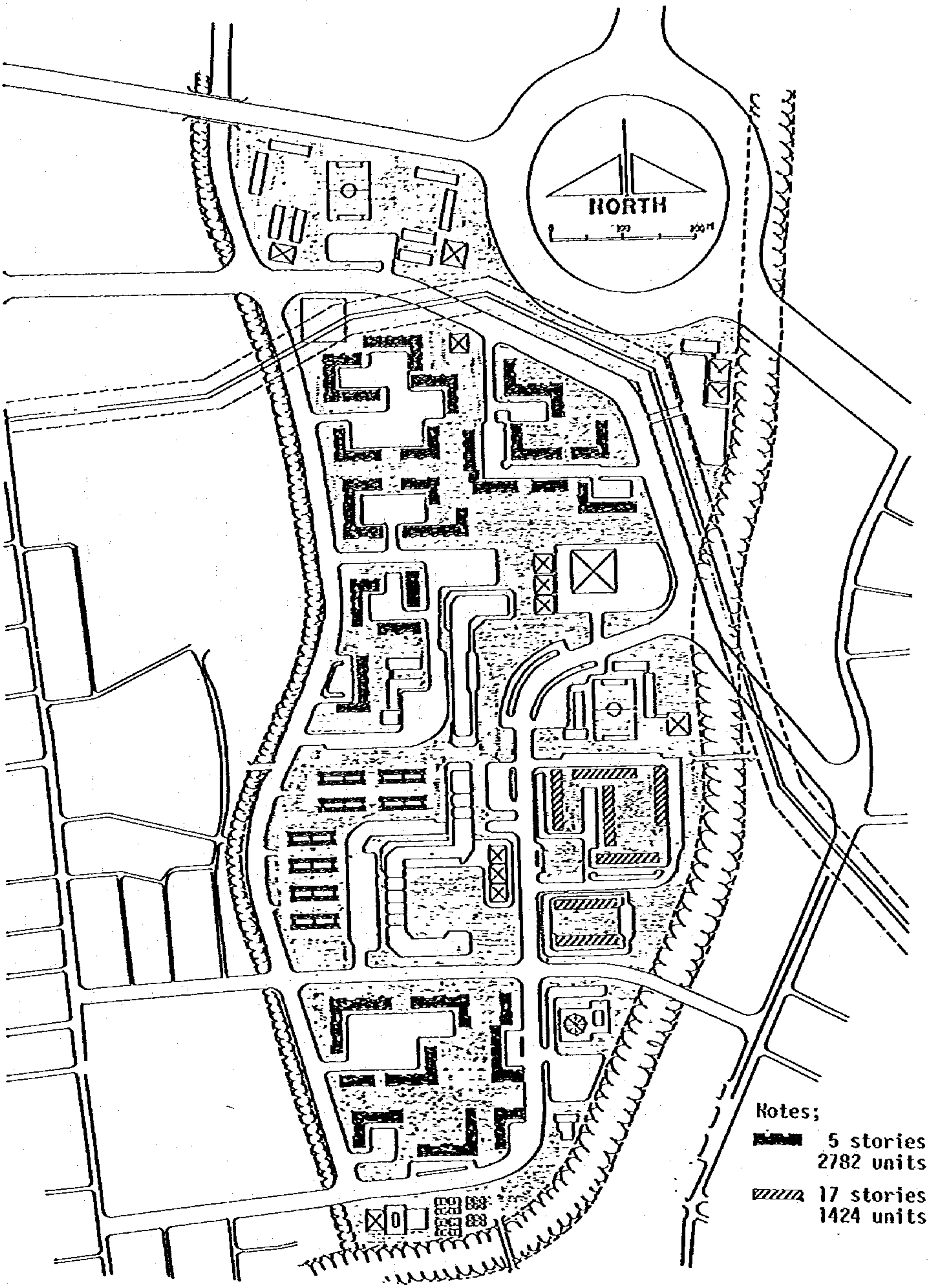


Fig. 2-21 Location of SENTUL Township

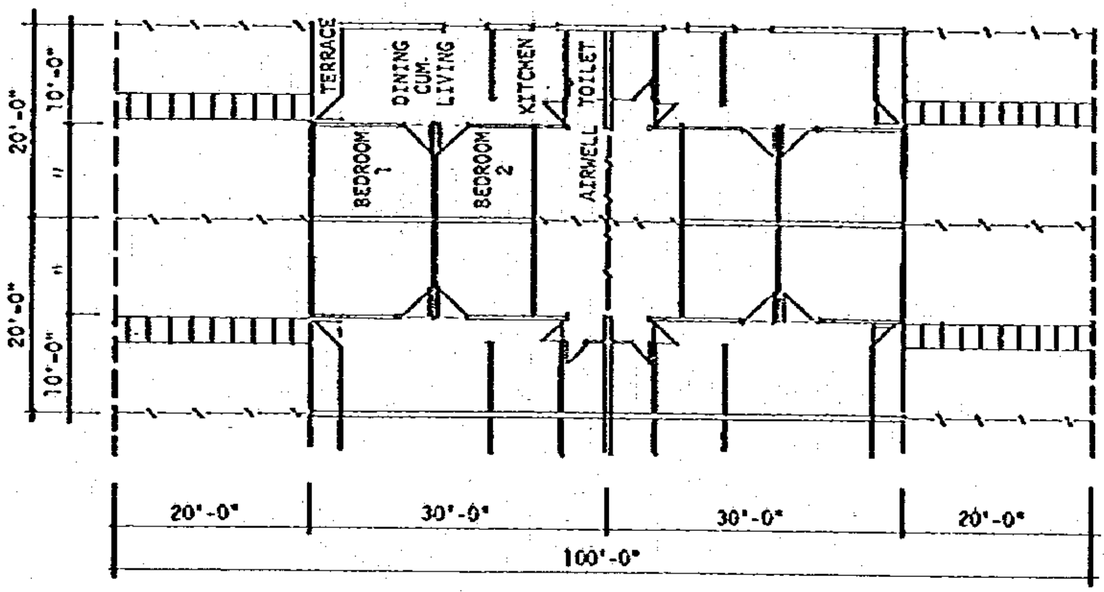


Fig. 2-22 Floor Plan of Single story Cluster-Link Terrace House at Kg. Konggo

units occupy 90 percent of the site area. The density of cluster-link housing units per acre of development site is 58, higher than that of medium-rise buildings.

Apparently because high-rise buildings incur high building costs due to the necessity of providing for lifts and their maintenance, most residential buildings are medium-rise or low-rise buildings. According to a local government officer in charge, the proportion of low-, medium- and high-rise blocks is approximately 10:50:40.

(3) Units Planned

Units are classified as 1-room, 2-room or 3-room units, including living rooms in some cases. Table 2-26 shows the floor area of housing units. Table 2-27 shows number of rooms per unit for several KL housing estates. Assuming that an average of three persons inhabit each room, the average floor space per person falls within the relatively low range of 50 to 65 ft^2.

Fig. 2-23 is a standard plan of 1-, 2- and 3-room units. 2-room units have been predominant, but it seems that the proportion of 3-room units is increasing.

(4) Building Structure

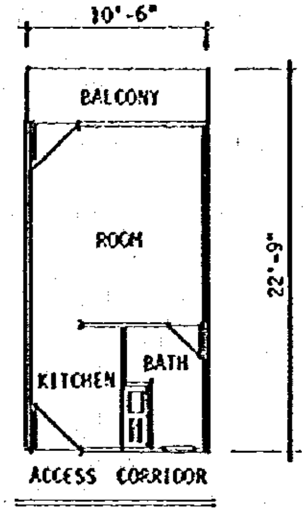
With the exception of wooden bungalows, low-cost housing is built of reinforced concrete rigid frame structure. Internal and external walls are made of bricks or concrete blocks.

Table 2-26 Planned Average Floor Area of Low-Cost Housing Units

Type of Housing	Rooms per Unit		
	1 Room	2 Rooms	3 Rooms
Terrace House (1 Story)	-	336 - 387 ft^2	458 - 750 ft^2
Terrace House (2 Story)	-	395	447 - 553
Cluster-Lin Terrace House (1 Story)	-	-	-
Medium and High-rise Flats	227 - 390 ft^2	381 - 386	505 - 551

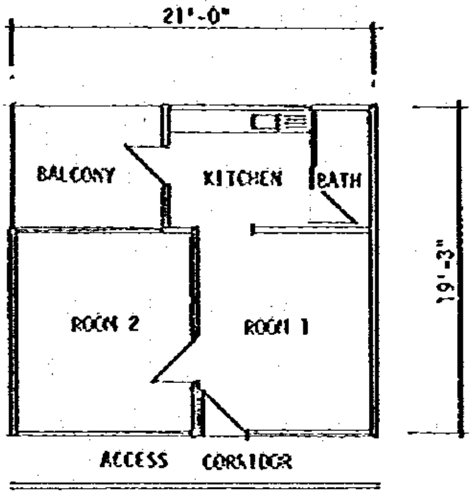
Table 2-27 Number of Rooms in Rented Housing Units of Various Estates in Kuala Lumpur

	No.of Units	No. of Rooms				Public Rooms
		1	2	3	4	
SULEMAN COURT	274	14	216	44	0	1
JALAN LOKE YEN	1,016	32	797	111	76	8
RAZAK MANSIONS	661	0	333	328	0	3
JALAN PEKELILING	2,969	0	2,521	448	0	124
JALAN SHAW	786	0	623	160	3	2
JALAN CHERAS	1,260	0	640	620	0	2
SUKIT BANGSAR	864	0	476	388	0	0
JALAN SAN PENG	802	0	406	393	0	3
HDA CHERAS	672	0	675	0	0	0



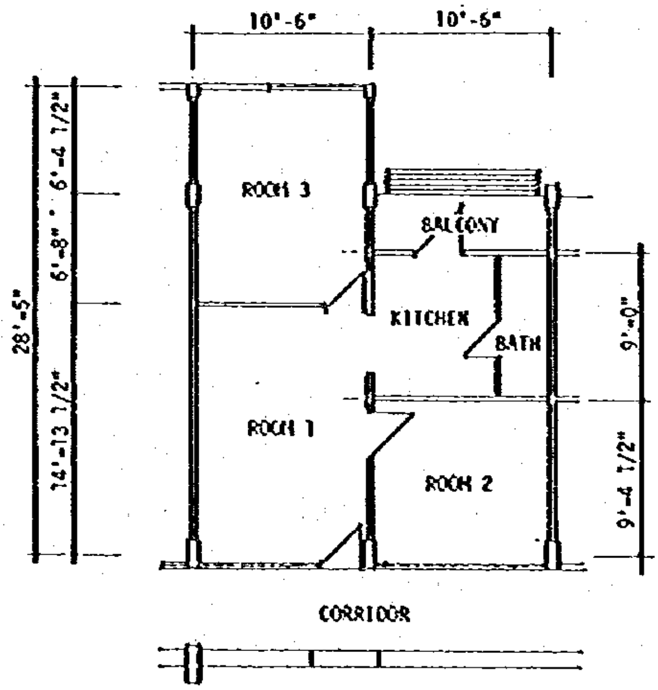
1 ROOM FLAT

Room	120 sq.ft.
Balcony	31
Kitchen	48
Bath & W.C.	23
Total	222



2 ROOMS FLATS

Room-1	120 sq.ft.
Room-2	120
Balcony	61
Kitchen	61
Bath & W.C.	24
Total	386



3 ROOMS SINGLE CORRIDOR FLATS

Room-1	160 sq.ft.
Room-2	98
Room-3	137
Kitchen	63
Bath & W.C.	32
Balcony	42
Total	532

Fig. 2-23 Typical Plan of a Flat Unit

Main framework:	Reinforced concrete rigid frame structure
Floors :	Reinforced concrete except for first-storey floors which are made of plain concrete
Roofs :	Wooden or reinforced concrete truss and asbestos slates or steel sheets
External walls and partition walls:	Reinforced concrete or brick
Internal walls:	Brick or concrete blocks

Malaysia does not experience strong winds such as accompany typhoons and hurricanes, and there is no record of any large earthquakes in the country. Wind load is the only horizontal load referred to in the building standards, which stipulate sufficient strength to resist a wind pressure of 56 miles/hour (25 m/sec) for structures below an elevation of 33 m above the ground surface. Therefore, buildings in Malaysia, with the exception of high-rise buildings, are designed only to support vertical loads (including the dead load of the building and the live loads of people, furniture, etc.). So, reinforced concrete rigid frame structure is regarded as a framework to transmit the loads of floors and beams to the foundation or to the ground. The cross-sections of columns used for low-rise buildings are 5" x 5" and those for medium-rise buildings are 9" x 18". In the case of high-rise buildings (17-storey to 20-storey flats), although bending moments due to wind loads increase and the forces bearing on columns become greater with proximity to the ground, the cross-sectional area of columns is identical throughout the structures.

Average weights of low-, medium- and high-rise buildings are 0.72 t/m^2, 0.78 t/m^2, and 0.93 t/m^2, respectively.

Foundations consist of ground beams, footings and piles. Ground beams serve to absorb stresses of bending due to horizontal forces (wind loads) at the base of columns and to transmit the dead load to the foundation. The cross-sectional sizes of ground beams, reflecting the small wind and vertical loads, are generally 6" x 18"(15 cm x 45 cm) for 5-storey buildings and 12" x 21" (30 cm x 53 cm) for 17-storey buildings. In the case of low- and medium-rise buildings, where there is no wall between columns, ground beams are not provided. This practice undoubtedly evolved because foundations are not usually subjected to major stresses. But if the base of columns are not uniformly secured, the building, because of its low lateral integrity, will not be able to resist the uneven settlement of the ground.

On strong ground, piles are used for high-rise buildings, but not for low-rise and medium-rise buildings. On reclaimed land, friction piles, such as Bakau piles, treated timber piles, concrete piles, or old-rail piles are used. Independent footings are generally employed.

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3. TIN-MINING IN KUALA LUMPUR

Malaysia is the world's largest producer of tin ore and tin-metal, and has been consistently producing between 70,000 and 80,000 tons of tin-metal per year, approximately 35% to 40% of the world's tin-production.

Malaysia's largest tin field is in the Kinta Valley region at Ipoh, the state capital of Perak. The Kinta Valley region produces about 35,000 tons of tin-in-concentrates per year. The Kuala Lumpur region is second in tin output, and there are smaller fields in the states of Selangor, Negri Sembilan and others as indicated in Fig. 3-1. Production of tin-in-concentrates by states is shown in Table 3-1.

As an introduction to the tin-mining industry in Kuala Lumpur, the position and situation of Malaysian tin in the World Market, and the social and economic position of the tin-mining industry in Malaysia are briefly discussed at the beginning of this sections. This is followed by brief explanation of the geologic and mineralogical origin of tin-ore deposits, as well as predominant methods of tin-mining in Malaysia. The main subject of Section 3 is the study of current mining practice and distribution of the tin-mines in the Kuala Lumpur region.

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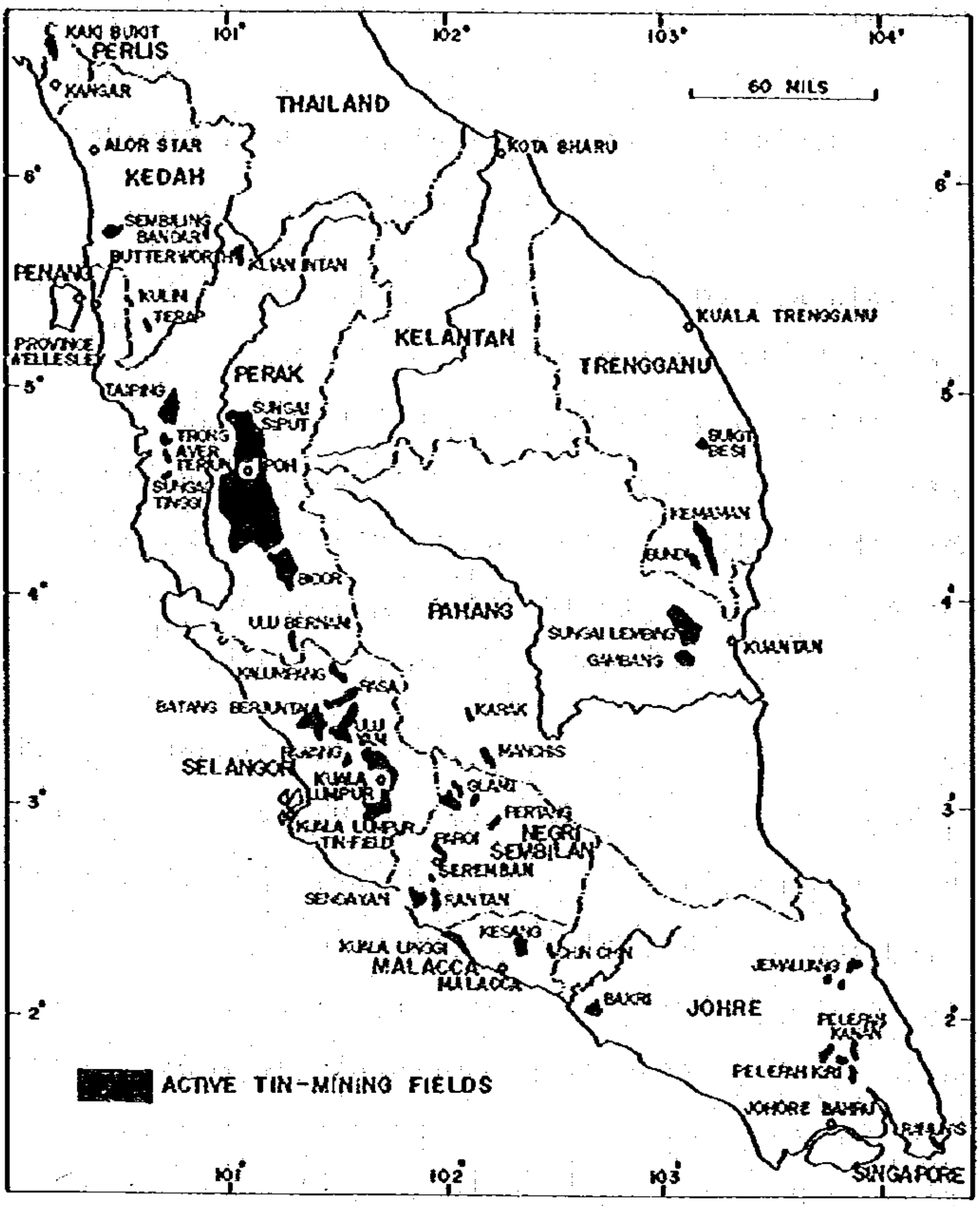


Fig. 3-1 Active Tin-Mining Fields in Malaysia (Yip, 1969)

Table 3-1 Production of Tin-in-concentrates by Malay States

(Metric tons)

Year	Perlis	Kedah	Perak	Selangor	Federal Territory	Negeri Sembilan	Malaka	Johor	Pahang	Trengganu	Kelatan	Total (All over Malaysia)
1963	296	525	34,640	19,349	---	833	97	1,354	2,550	1,264		60,909
1964	280	617	35,525	18,759	---	950	133	1,335	2,561	807		60,967
1965	313	612	37,688	19,610	---	814	131	1,776	2,797	950		64,692
1966	288	756	39,616	21,486	---	908	157	2,576	2,815	1,388		69,991
1967	228	723	41,510	23,190	---	1,050	178	2,269	2,698	1,431		73,278
1968	292	661	44,243	23,078	---	959	192	2,451	2,938	1,459	1	76,274
1969	242	653	42,427	22,435	---	833	314	2,181	2,828	1,412	-	73,325
1970	401	652	43,446	22,189	---	861	298	1,896	2,777	1,274	-	73,794
1971	301	575	45,772	22,208	---	635	218	1,914	2,864	1,004	-	75,441
1972	436	766	45,480	23,771	---	554	144	1,721	3,222	736	---	76,830
1973	384	764	42,165	23,309	---	475	115	1,372	2,870	806	---	72,260
1974	419	808	40,277	21,533	(3,248)	418	82	1,198	2,766	621	---	68,122
1975	231	562	37,436	21,089	(2,709)	395	62	1,272	2,657	660	---	64,364
1976	189	462	34,992	23,075	(2,083)	330	76	917	2,588	772	---	63,401
1977	181	466	32,947	21,287	(2,496)	301	204	613	2,398	306	---	58,703
1978	123	458	34,773	23,034	(2,931)	431	274	895	2,203	459	---	62,650
1979	92	434	35,710	22,424	(2,552)	406	286	897	2,291	455	---	62,995
1980	--- Not available yet ---				(2,423)	----- Not available yet -----						

3.1 Situation of Malaysian Tin in the World Market

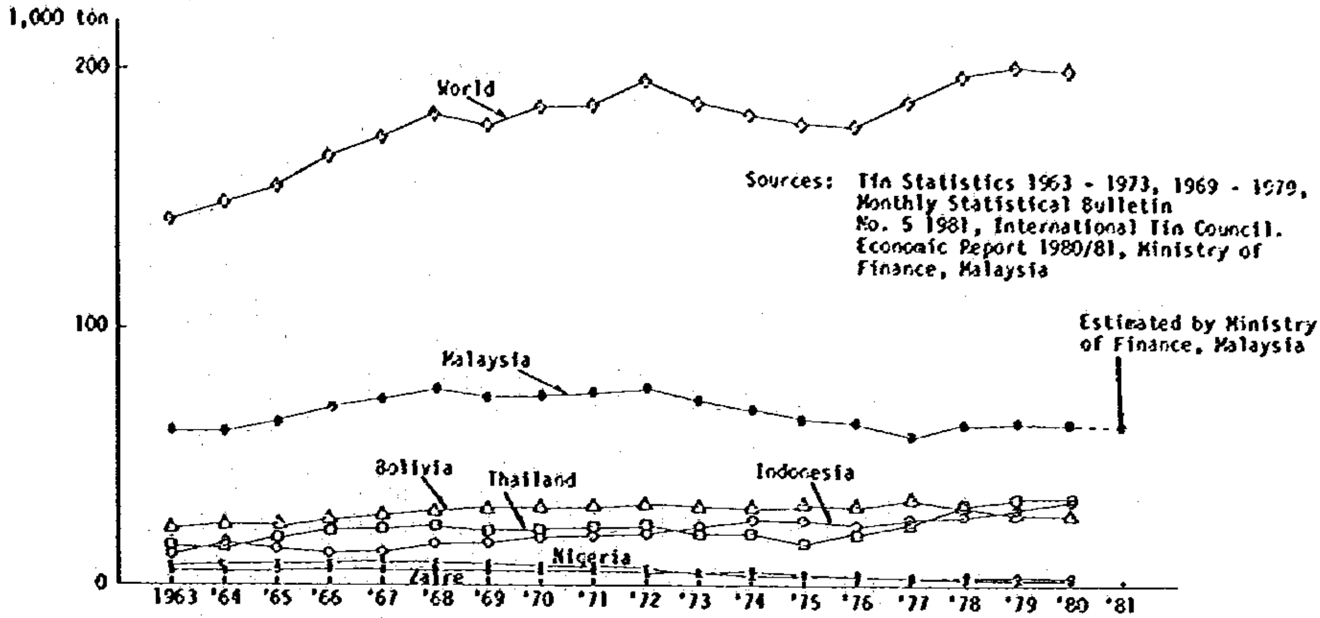
3.1.1 Production of Tin

Malaysia is unrivalled as the world's largest producer and exporter of tin-metal (Figs. 3-2 and 3-3), exporting about 70,000 tons of tin annually which is approximately 35% of the world's tin production. Of Malaysia's production, 60,000 tons are both mined and smelted in the country and the remaining 10,000 tons are smelted from tin-ore imported from other countries such as Australia, Rwanda, Indonesia, Burma, etc. Most Malaysian tin is exported in the form of tin-metal for markets in the U.S.A., Japan and Eurpoean countries as shown in Fig. 3-4. Malaysian domestic tin consumption is very small. In 1979, internal consumption amounted to only about 0.5% of the year's production.

3.1.2 Price of Tin

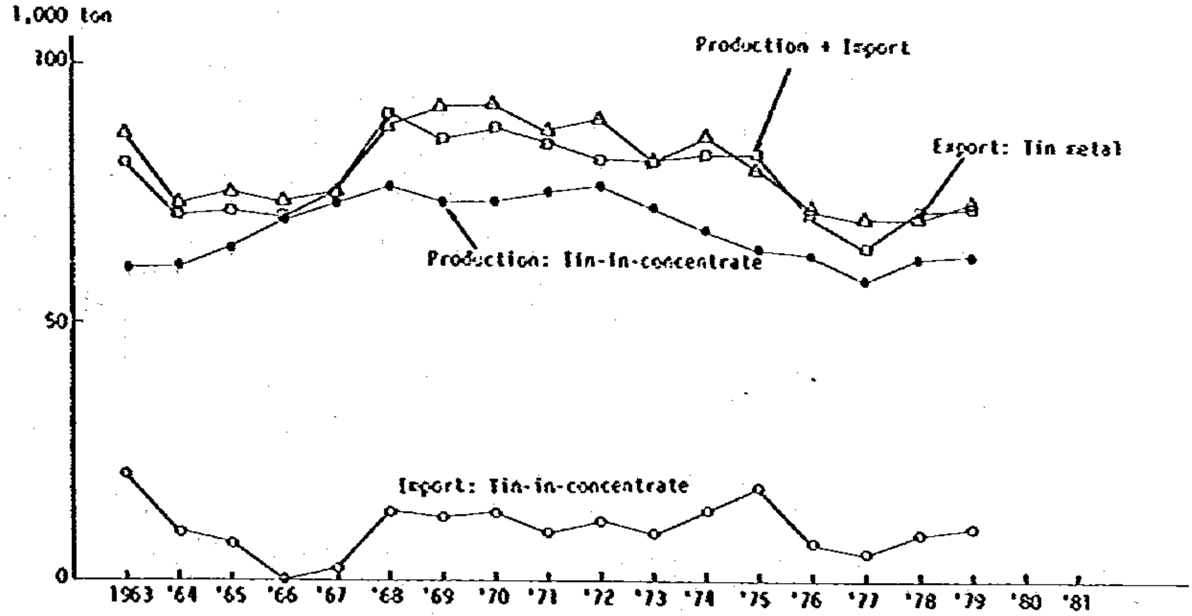
At present the price of tin in the world market is unstable notwithstanding the international controls via the International Tin Council. Since tin is almost entirely imported by Western, industrial countries, slight changes in the political and business climate of these countries can lead to wide fluctuations in the world market price of tin.

The price of tin increased annually from 1973 to 1979 with the exception of a slight drop in 1975 (Fig. 3-5).



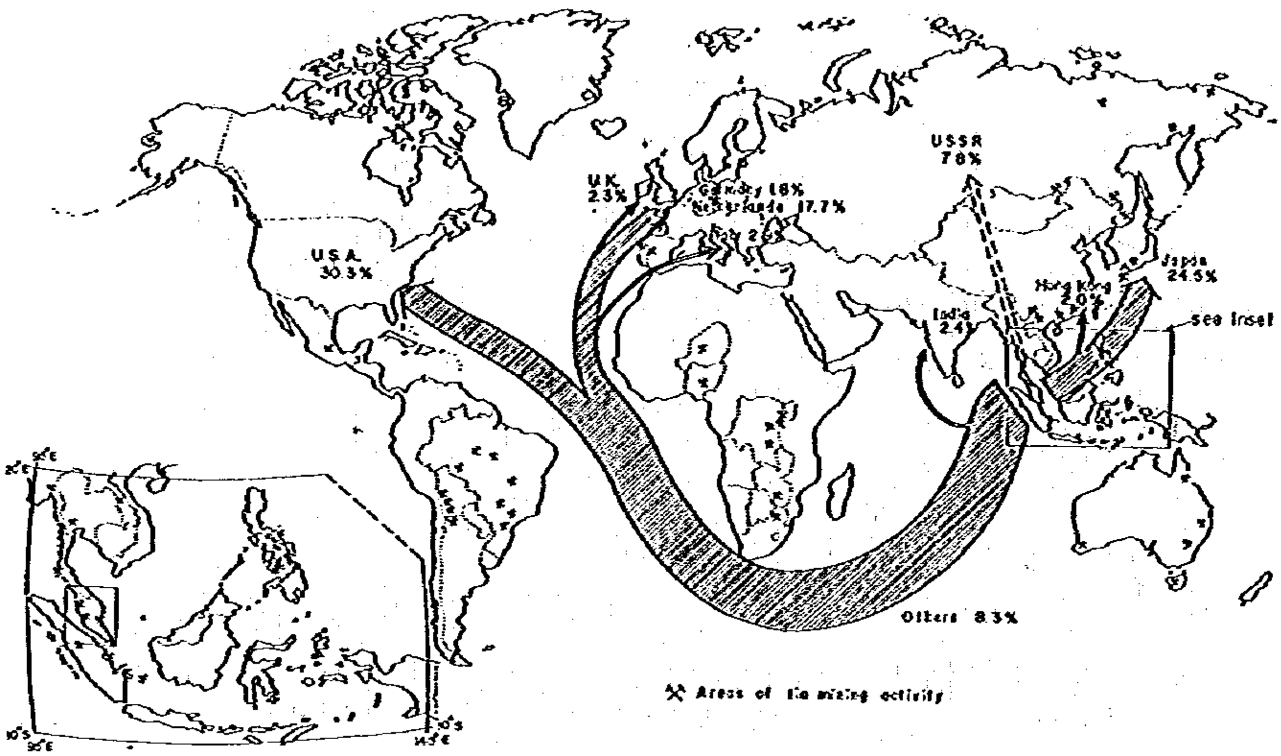
Note: Excluding the People's Republic of China, the Democratic Republic of Germany, North Korea, North Vietnam and U.S.S.R. Includes tin in mixed concentrates from 1968. Figures may include tin in mixed concentrates. Total of figures stated only.

Fig. 3-2 Production of Tin-in-concentrates and Tin-metal



Sources: 1) Economic Report 1973/74, 1979/80, 1980/81, Ministry of Finance Malaysia
2) Tin Statistics 1963-1973, 1969-1979, Monthly Statistical Bulletin No. 8, 1980, International Tin Council

Fig. 3-3 Tin-in-concentrates and Tin-metal: Production in, Import to and Export from Malaysia



Source: Monthly Statistical Bulletin No.8 1980 International Tin Council

Fig. 3-4 Destinations of Malaysian Tin

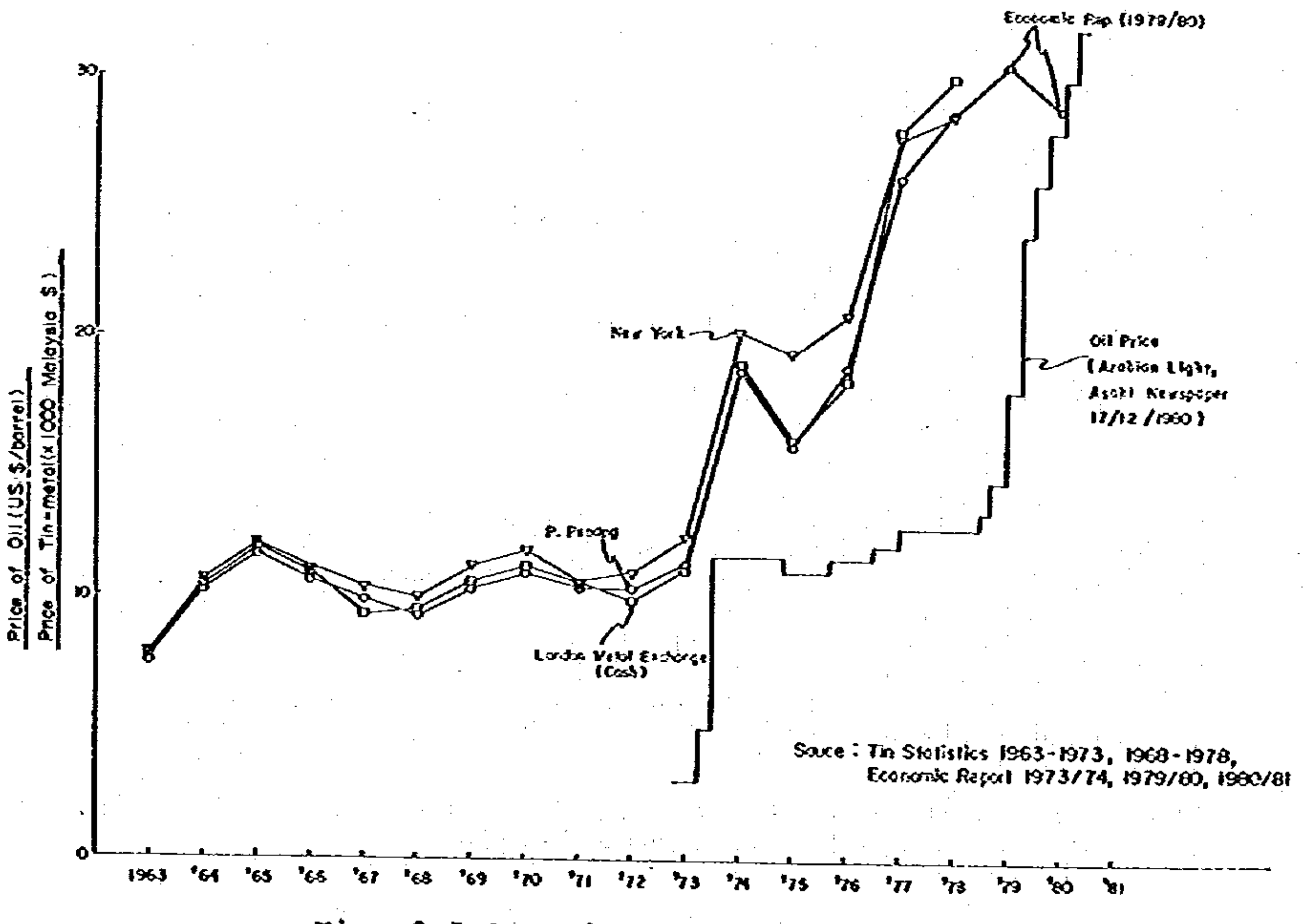


Fig. 3-5 Annual Average Tin Price

Prior to 1973, tin sold for about M$10,000/ton. This increased to M$30,000/ton by 1979. In 1980, tin prices dropped slightly to about M$29,000/ton, probably due to rumours that the U.S.A. was considering releasing its large tin stockpile.

In addition to the slight drop in the price of tin in 1980, the Malaysian tin-mining industry feels the pressure of increasing production costs, caused by inflation and inevitable depletion of the most attractive tin depostis. The price of crude oil increased from US$12/barrel in mid 1978 to US$32/barrel in 1980, and many of the good areas have already been mined, forcing new production into areas of reduced ore concentration and more difficult accessibility.

3.1.3 Production Cost of Tin

The Malaysian mining industry enjoys one of the lowest tin production costs in the world, because the cost of tin extraction from the ground is low and the tin content of Malaysian ore is high. Fully 95% of Malaysian tin is extracted from alluvial placer deposits by surface mining methods, predominantly dredging and gravel pumping. The tin content of Malaysian ore is about 75%, which places it among the richest tin-ores in the world (Table 3-2).

According to Table 3-3 the mining cost by dredging is about M$1.0/$m^3$ (M$0.75/cy to M$0.90/cy) which is about half the cost by gravel pumping. Therefore dredging can be

Table 3-2 Normal Range of Tin Content in Tin-Ores

Sources of Concentrates	Normal Range of Tin Content Percentages
Malaya, Thailand, Indonesia	72-75
China, Kochiu	70-72
Burma	72-73
Indo-China	55-65
Bolivia	18-66

Source: The development of The Tin Mining Industry of Malaysia, 1969

Table 3-3 Tin Mining Costs

(M$/m^3)

		1978 a	1978 b	1979 a	1979 b
Dredging	Power	0.221	0.220	0.230	0.266
	Salaries & labour	0.264	0.239	0.230	0.211
	Materials	0.255	0.212	0.279	0.283
	Depreciations	0.131	0.017	0.119	0.118
	On property exploration & development	0.008	0.003	0.001	0.022
	Other charges & overheads	0.187	0.209	0.216	0.242
	Total:	1.066	0.978	1.075	1.141
Gravel Pumping		1978 a	1978 b	1979 a	1979 b
	Power	0.589	0.593	0.603	0.681
	Salaries & labour	0.661	0.700	0.712	0.814
	Materials	0.382	0.388	0.392	0.506
	Depreciation	0.169	0.224	0.198	0.288
	On property exploration & development	0.034	0.037	0.048	0.064
	Other charges & overheads	0.279	0.285	0.347	0.356
	Total:	2.112	2.226	2.299	2.709

Source: Jabatan Galian, Kuala Lumpur, Malaysia

a: First and Second Quarter
b: Third and Fourth Quarter

workable in poorer tin-bearing deposits which might not be economical for gravel-pump mining.

Tin-ore content of placer deposits varies significantly depending upon location. Before 1950, it was common to obtain 0.4 kati of tin-ore per cubic yard of earth (240 g/m^3) but today a value of 0.25 kati/cy (140 g/m^3) would be considered favourable because areas with richer tin deposits have already been mined. The average yearly recovery from dredging has fallen from 0.32 kati/cy in 1963 to 0.18 kati/cy in 1977 (Table 3-4).

Tin's average production cost is roughly estimated to be about M$4 to M$5 per kati of tin-metal or about M$12,000 to M$15,000 per ton of tin-metal in 1977 (Tables 3-2, 3-3 and 3-4). Using the ratio indicated in Fig. 3-6 and actual price shown in Fig. 3-5, the miners' share is estimated to be on the order of M$150 per picul or M$2,000 per ton.

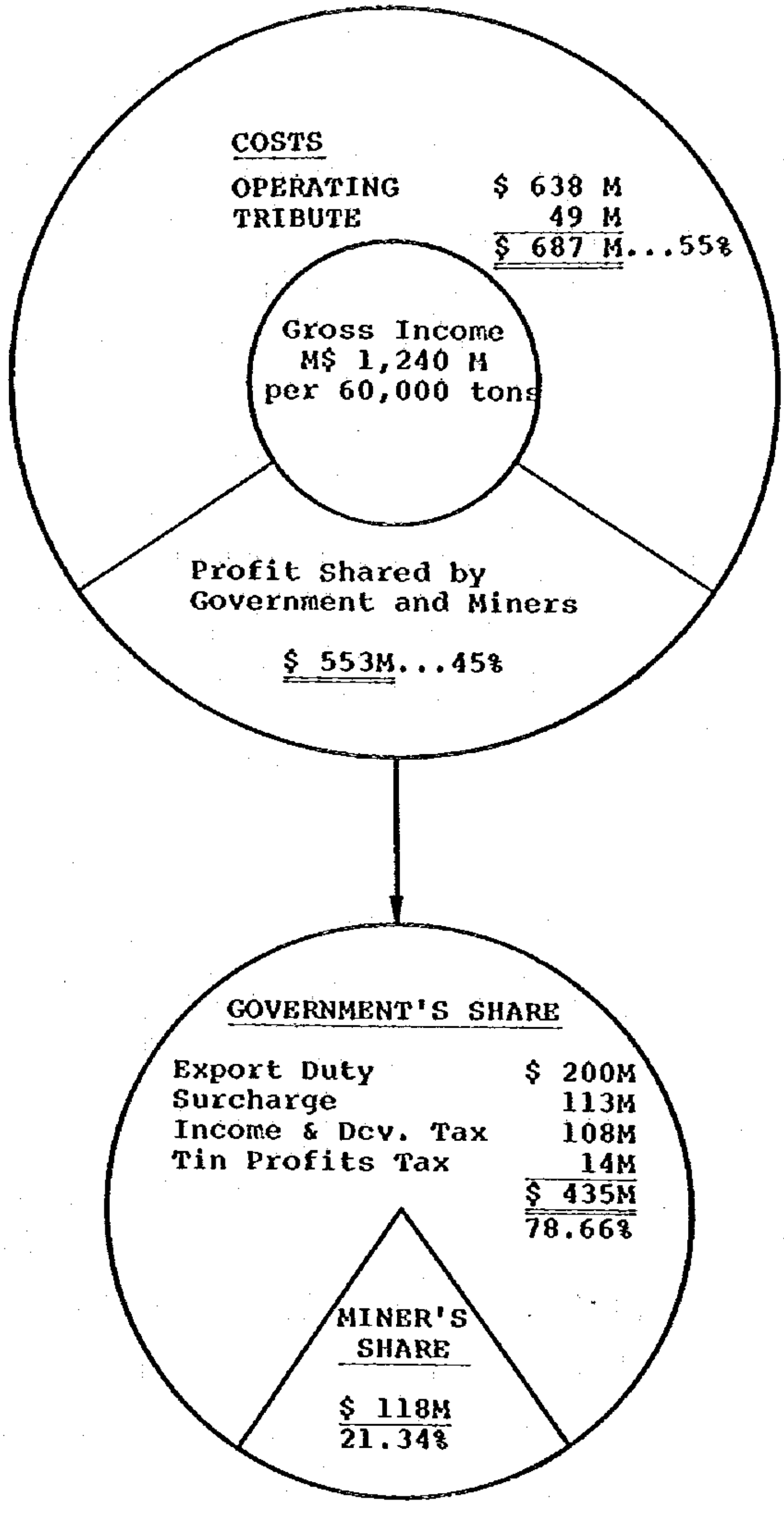
3.1.4 Uses of Tin

Tin is seldom used in its pure state except in the manufacture of collapsible tubes, foils and pipes. As an industrial metal, it is usually alloyed, combined or associated with other metals. The major uses of tin may be divided into three groups: tinplate, alloys and other uses. It does not appear that there will be a drastic drop in the demand for tin in the near future, because the demand for tin is broad based and there is no close substitute for tin thus far.

Table 3-4 Tin-mining Operation Production Statistics

By Dredger

Year	Nos. of Dredger	Output Tin-ore ton (Piculs)	Area worked, Km^2 (Acres)	Volume worked, 1,000,000 m^3 (Cubic yards)	Average Recovery g/m^3 (Katies/ c.yard)	Average output of Tin-in-concentrates per a drege per year, tons (piculs)	Average Mining Cost M$/c. yard
1963	72	37,088 (613,245)	9,235 (2,282)	146.2 (191,147,783)	(0.32)	386.3 (6,388.0)	
1964	72	34,622 (572,467)	9,328 (2,305)	149.4 (195,381,538)	0.29	360.6 (5,963.2)	
1965	71	33,663 (556,610)	9,542 (2,358)	159.5 (208,579,676	0.27	355.6 (5,879.7)	
1966	67	32,104 (530,825)	9,174 (2,267)	152.5 (199,437,110)	0.27	359.4 (5,942.1)	
1967	71	32,238 (533,050)	9,340 (2,308)	155.6 (203,485,425)	0.26	340.5 (5,630.8)	
1968	73	31,293 (517,424)	8,940 (2,209)	158.2 (206,884,809)	0.25	321.5 (5,316)	
1969	69	32,287 (533,860)	8,931 (2,207)	161.7 (211,430,220)	0.25	350.9 (5,802.8)	
1970	69	31,798 (525,772)	9,174 (2,267)	163.7 (214,061,107)	0.25	352.3 (5,714.9)	- - - - - No Data Available - - - - -
1971	63	32,408 (535,857)	8,964 (2,215)	172.6 (225,786,131)	0.24	385.8 (6,379.3)	
1972	63	31,856 (526,729)	8,935 (2,208)	173.1 (226,365,775)	0.23	379.2 (6,270.6)	
1973	64	29,251 (493,660)	8,814 (2,178)	174.6 (228,326,874)	0.22	342.8 (5,785.1)	
1974	58	29,253 (483,690)	8,745 (2,161)	180.9 (236,632,984)	0.20	378.3 (6,254.6)	
1975	57	26,938 (446,240)	8,664 (2,141)	180.3 (235,798,285)	0.19	355.1 (5,871.6)	
1976	56	30,610 (506,120)	7,956 (1,966)	174.0 (227,530,170)	0.22	410.0 (6,778.4)	
1977	53	27,225 (450,162)	8,596 (2,124)	189.05 (247,255,397)	0.18	385.3 (6,370.2)	
1978	53	26,786 (442,894)	- - -	Not Available	Yet - - -	379.0 (6,267.4)	$0.78
1979	54	26,413 (436,723)	- - -	Not Available	Yet - - -	366.8 (6,065.6)	$0.85
1980			- - -	Not Available	Yet - - -		



Distribution of Gross Income of $1,240 Million on Sale of 60,000 tons (991,600 Piculs) Metal at an Assumed Metal Price of $1,250 Per Picul, National Seminar on the Mining Industry, KL 11 & 12, Aug. 1977.

Fig. 3-6 Production Cost and Profit Share of Tin-Mining Industry

(1) Tinplate

About 40% of the primary tin consumed in the world is used in the manufacture of tinplate, which is sheet steel coated very thinly with tin by electrolysis. This plate is used primarily by the can making industry. The proportion of tin in tinplate is about 0.6% and the production of tinplate in 1979 was about 14,000,000 tons.

(2) Tin Alloys

The amount of tin used to manufacture alloys is difficult to estimate due to the diversity of manufactured alloy products. Major products are listed below.

Major Tin Alloys

* tin-lead alloys as soft solders
* tin-aluminium alloys for engine bearings
* tin-antimony-copper-lead alloys for bearing metals such as antifriction metal, babbit and white metal alloys
* tin-copper alloys for bronzes, gun-metals and brass

(3) Other Uses of Tin

Tin is also used in the manufacture of tin-coated copper wire and electrial connections. Pure tin pipe is used to convey distilled water, beer and other beverages. Viscous preparations for toilet and medicinal purposes are popularly dispensed in collapsible, tin-foil tubes.

3.2 Social and Economic Position of the Tin-Mining Industry in Malaysia

Tin-mining dominates the Malaysian mining industry. It accounts for about 35% of the total value of mining production and directly employs about 90% of the mining industry's labour force (Table 3-5).

The early economic development of the Malay States was closely connected with the development of its tin-mining industry. Before the turn of the century, the Peninsular's wealth in tin attracted the Chinese and then the Europeans. In later years tin-mining produced the revenue which supported the country's rapid economic development and expansion. Tin-mining's relative importance to the Malaysian economy has declined considerably during the last ten years as a result of petroleum, rubber, timber and oil-palm industries. However, in absolute terms, its contribution to government revenue and the gross national product remains substantial. Fig. 3-7 shows the contribution of tin and the other major resource commodities to the Gross National Product. Fig. 3-8 shows the same commodities in relationship to Malaysia's total export value. It can be seen that tin accounted for 4% of the Gross National Product and 11% of the total export value in 1979.

Table 3-5 Mining Industrial Statistics (1976)

Mineral Production Peninsular Malaysia	Number of Mines	Labour Persons Employed	Machinery Active Horse-Power	Production (Tons)	Value $
Tin-in-concentrates	811	36,828	954,994	63,401	1,199,860,230
Bauxite	2	250	7,687	660,235	13,125,472
Iron-ore	5	210	4,637	308,184	13,338,204
China Clay	10	244	1,747	26,252	3,500,967
Gold	3	32	990	3,574 ozs	915,444
Wolfram	1	118	1,346	109	1,662,441
Ferro-Manganese	2	225	5,202	94,112	5,909,292
Barite	1	22	270	6,096	*
Scheelite (b)	-	-	-	15	308,661
Columbite (b)	-	-	-	46	692,996
Tin Slag	-	-	-	19,401 (e)	2,168,762
Ilmenite (b)	-	-	-	179,995 (e)	8,188,050
Monazite (b)	-	-	-	1,879 (e)	929,189
Zircon (b)	-	-	-	3,129 (e)	1,217,681
Xenotime (b)	-	-	-	139 (e)	403,286
Oil		1,415	34,501	8,025,743 +	1,941,626,192
Copper concentrates	1	1,175	57,500	77,617	71,855,236
Gold	4	94	1,088	965 ozs	247,214
Antimony	4	121	426	601	654,060
Natural Gas (b)	-	-	-	611,674,140 M3	‡
Total:	844	40,734	1,070,388	-	3,266,603,377

Note

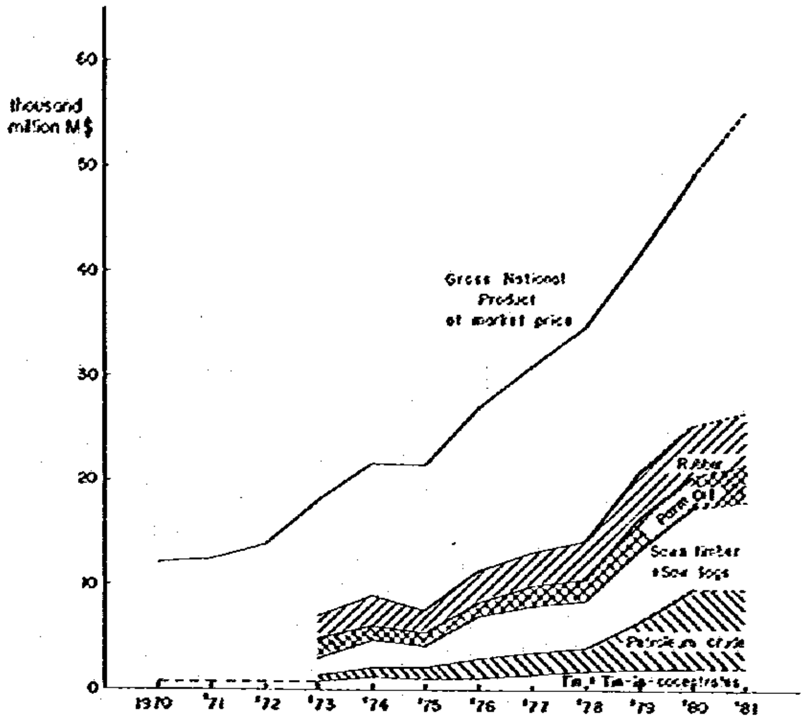
(b) By Products

(e) Exports

\+ Equivalent to 60,546,960 U.S. Barrels

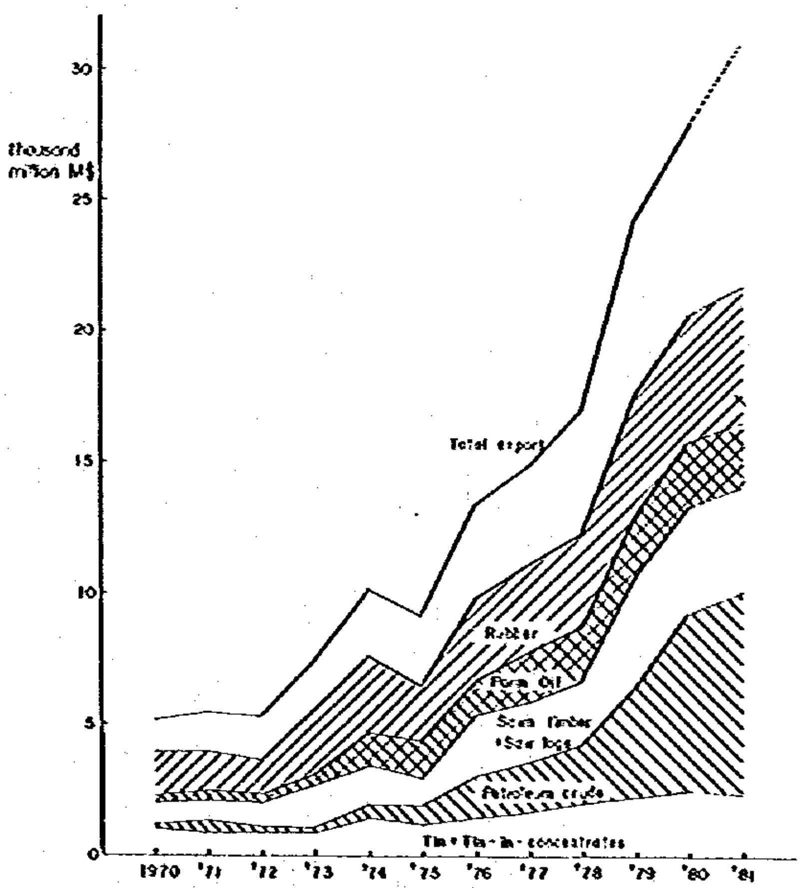
‡ Not known

* Not known as there were no exports.



Source : Economic Report 1979/80, 1980/81, Ministry of Finance
Note : Figures for 1980 and 1981 are estimated by the Ministry of Finance

Fig. 3-7 Gross National Product and Major Commodity Production



Source : Economic Report 1974/75, 1979/80, 1980/81, Ministry of Finance
Note : Figures for 1980 and 1981 are estimated by the Ministry of Finance

Fig. 3-8 Major Commodity Exports from Malaysia

3.3 Origin of Tin-Ore

3.3.1 Tin-Ore

All tin-ore recovered in Malaysia is Cassiterite (SnO_2). The colour of the individual crystals varies from greyish white to black. The shape of well-formed crystal is generally pyramidal or prismatic. Normally, crystal size is similar to that of granular, medium sized sand. But crystals have been found as large as 7cm in length and 4cm in diameter.

Theoretically, the metallic tin content of pure Cassiterite is 78.8%. Because naturally occuring Cassiterite contains some impurities, commercial tin-ore in Malaysia contains about 75% tin-metal.

3.3.2 Origin of Tin-Ore

In Malaysia the origin of tin-ore is known to be associated with the geological process of granitization, which produced the present-day granite backbone of the Malay Peninsula (Fig. 3-9). Fig. 3-10 illustrates the major sequences in the geological formation of tin-ore deposits.

Granite magma containing tin bearing fluids first intruded into older rocks such as limestone and schist during the Mesozoic (about 100 million years ago). In this process Cassiterite was formed within the granite itself. As some of the tin bearing fluid penetrated into the older,

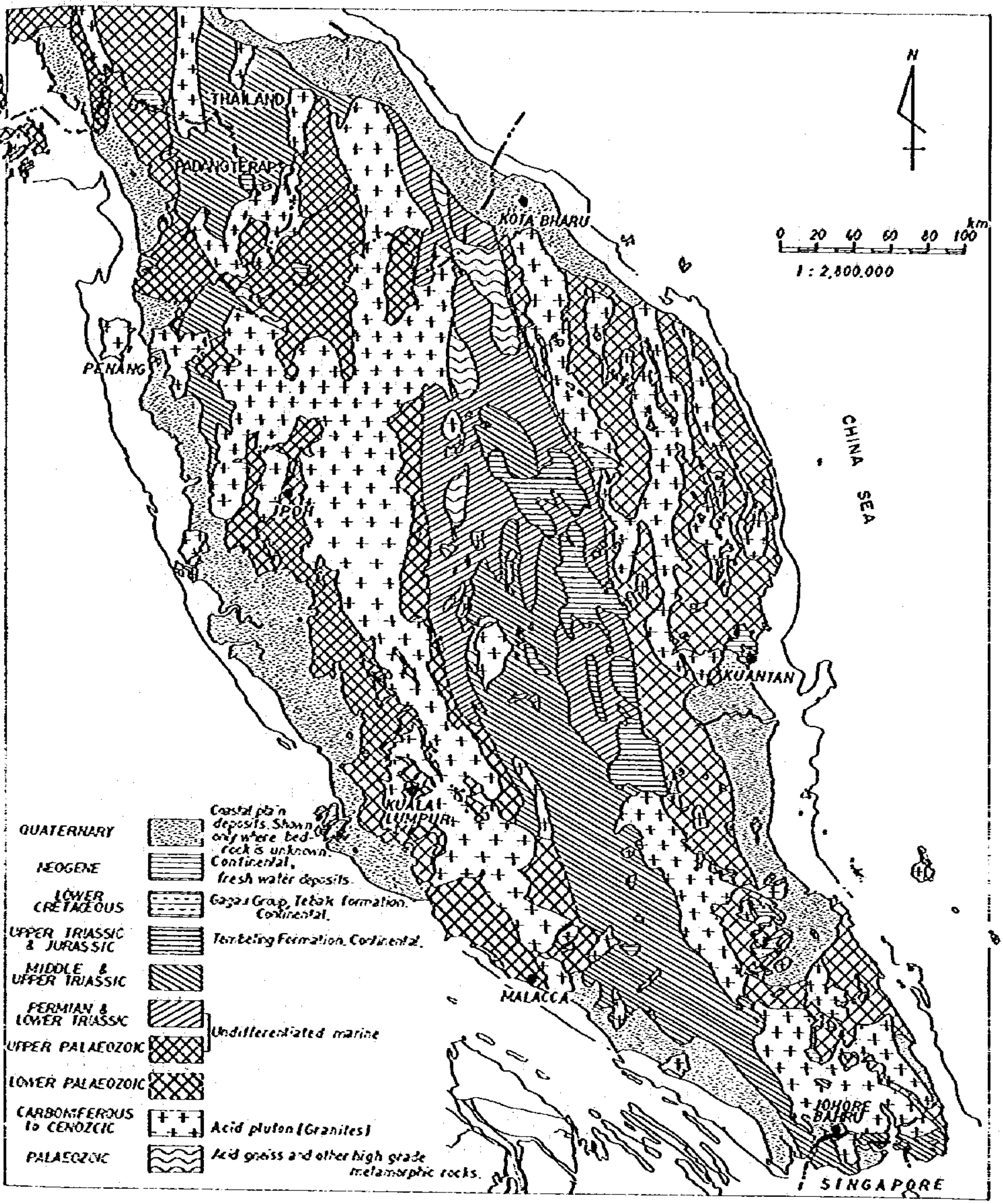
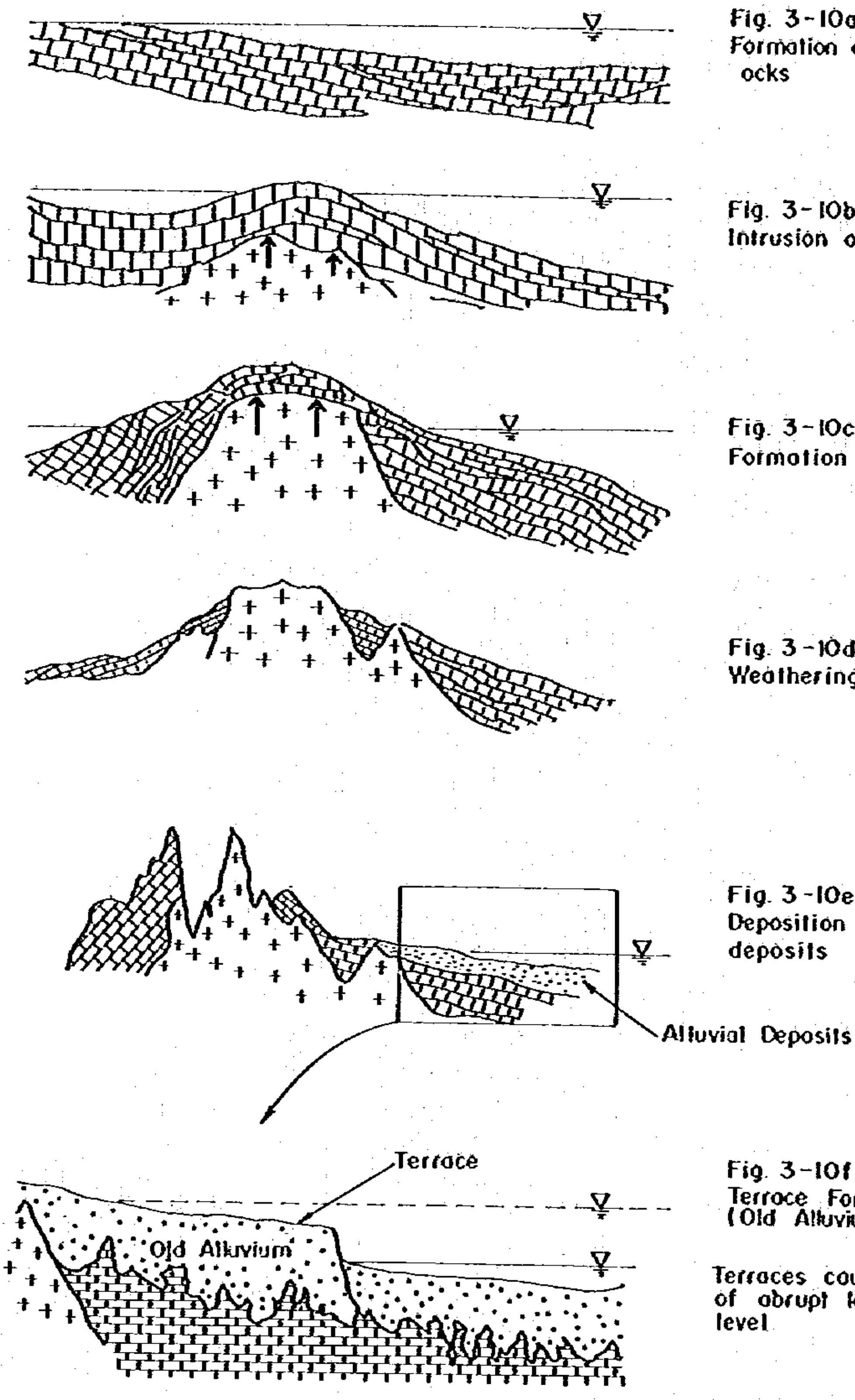


Fig. 3-9 Geological Map of the Malay Peninsula

(After D.J. Gobbett, 1972).



1. Fig. 3-10a Formation of Older ocks

2. Fig. 3-10b Intrusion of Granite

3. Fig. 3-10c Formation of Mountains

4. Fig. 3-10d Weathering and Erosion

5. Fig. 3-10e Deposition of Alluvial deposits

6. Fig. 3-10f Terrace Formation (Old Alluvium)

Terraces caused by episodes of abrupt lowering of water level

Fig. 3-10 Geological Development of Tin-Ore Deposits adjacent rocks, Cassiterite also formed in them. Therfore, tin ore deposits are found today in granite and in older rocks which were in contact with the granite.

Subsequent to the granitic intrusion, the Malay backbone mountain rocks were broken down by weathering and erosion. The eroded tin-ore-bearing materials were transported by run-off and deposited in areas where the speed of water was not sufficient to carry the eroded materials. As deposition continued, the deposits gradually formed alluvial plains. Later erosion of the alluvial plains formed terraces. Terrace deposit material, called Old Alluvium, is the main tin-ore-bearing deposit in Malaysia.

Before the deposition of alluvial terrace deposits, the bedrock in these areas had become weathered and eroded. The erosion of limestone bedrock typically yields karst features, i.e. numerous pinnacles, troughs and deep solution channels. This complex topography formed a series of natural riffles which retained and concentrated the heavy grains of Cassiterite being deposited (Fig. 3-11). This is one of the reasons that most tin-mines are found in areas with limestone bedrock.

This formation process had two advantages for the Malaysian tin-mining industry. First, the ore-containing medium is loose alluvium, and is easy and economical to excavate. Second, the ore has become sifted and concentrated by the action of the limestone riffles which acted like a natural sluice.

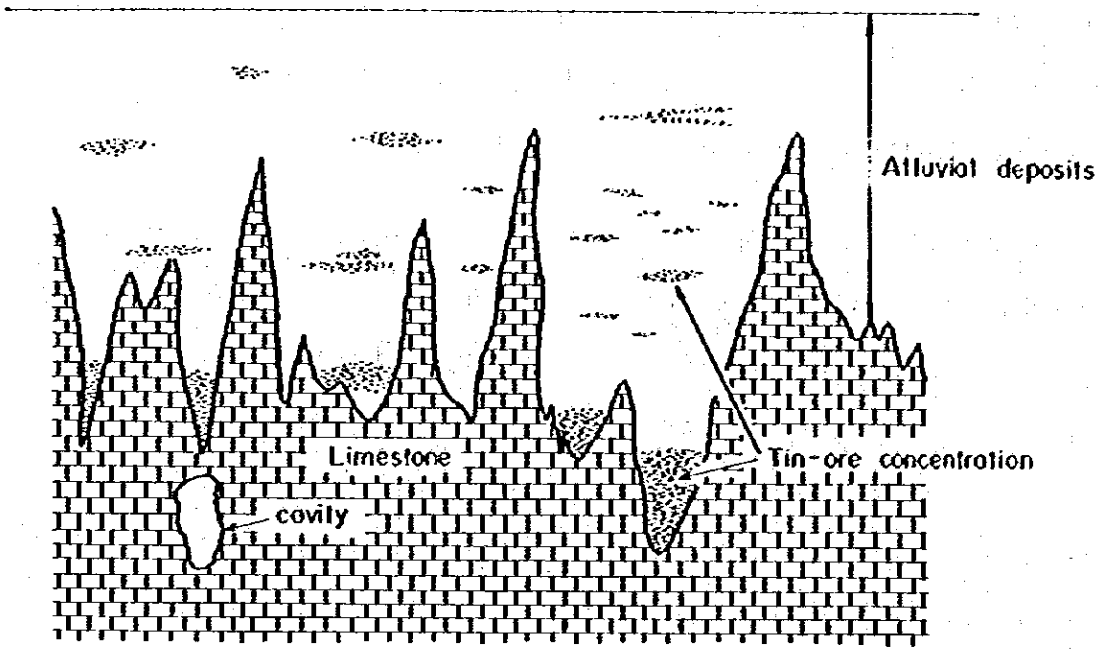


Fig. 3-11 Tin-ore Location in Alluvial Deposits

3.4 Predominant Methods of Tin-Mining in Malaysia

-- Dredging and Gravel-Pumping --

About 95% of Malaysian tin is mined from alluvial deposits by either dredging or gravel-pumping. Table 3-6 shows Malaysia's production of tin-in-concentrates by various mining methods. About 30% to 35% of the tin is obtained by dredging and 50% to 55% of tin is obtained by gravel-pumping. Fig. 3-12 shows an areal photograph of a typical tin-dredging area and Fig. 3-13 shows a typical gravel-pumping area.

Table 3-6 Tin Mining Activity in Malaysia

	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Number of tin mines operating *1												
Dredges	65	65	61	63	58	58	56	55	51	53	53	54
Gravel pumps	994	955	979	965	940	873	932	810	724	784	833	772
Hydraulicing	3	3	2	2	2	-	-	-	-	-	-	-
Opencast	8	8	7	7	10	12	9	12	11	12	22	21
Underground*2	28	25	28	28	27	26	22	30	22	23	23	21
Other*3	12	11	6	13	7	5	6	3	3	2	5	5
Total	1,110	1,067	1,083	1,078	1,044	974	1,025	910	811	874	936	873
Output of tin-in-concentrates by method of mining (tons)												
Dredges	23,526	24,301	23,931	24,417	23,992	22,486	22,047	20,331	23,103	20,547	20,218	19,937
% of total	30.8	33.1	32.4	32.4	31.2	31.1	32.4	31.6	36.5	35.0	32.3	31.7
Gravel pumps	44,151	40,201	40,740	41,508	42,801	38,963	36,332	35,183	31,662	29,926	33,556	34,182
% of total	57.9	54.8	55.2	55.0	55.7	53.9	53.3	54.7	49.9	51.0	53.5	54.3
Hydraulicing	251	271	145	27	27	10	0	-	-	-	-	-
% of total	0.3	0.4	0.2	0.0	0.0	0.0	0.0	-	-	-	-	-
Opencast	2,093	2,250	2,491	2,713	2,579	3,637	2,908	2,534	2,275	2,268	2,825	2,861
% of total	2.7	3.1	3.4	3.6	3.4	5.0	4.3	3.9	3.6	3.8	4.5	4.5
Underground	2,046	1,946	2,253	2,222	2,570	2,337	2,319	1,893	1,832	1,718	1,401	1,220
% of total	2.7	2.6	3.1	3.0	3.3	3.3	3.4	2.9	2.9	2.9	2.3	1.9
Dulang washers	1,483	1,528	1,406	1,753	2,976	3,048	3,070	3,083	3,051	3,093	3,157	3,261
% of total	2.0	2.1	1.9	2.3	3.9	4.2	4.5	4.8	4.8	5.3	5.0	5.2
Other*4	2,724	2,828	2,829	2,803	1,884	1,780	1,446	1,340	1,478	1,151	1,493	1,534
% of total	3.6	3.9	3.8	3.7	2.5	2.5	2.1	2.1	2.3	2.0	2.4	2.4
Total	76,274	73,325	73,795	75,443	76,829	72,261	68,122	64,364	63,401	58,703	62,650	62,995
Deliveries from mines*5 (tons)	75,779	74,358	74,628	76,777	77,846	72,620	71,403	62,589	68,508	59,601	64,531	63,524
Labour employed in tin mines *1	48,190	46,458	46,457	46,360	45,574	41,744	44,050	39,736	36,828	38,478	40,471	39,109

*1 At year-end *2 One major mine; the balance refers to small operators.
*3 Excludes retreatment operations and dulang washers. *4 Includes retreatment operations.
*5 To smelters at Penang and Butterworth.

Source: Tin Statistics 1968 - 1978, 1969 - 1979 International Tin Council

Fig. 3-12 Tin-dredging Area

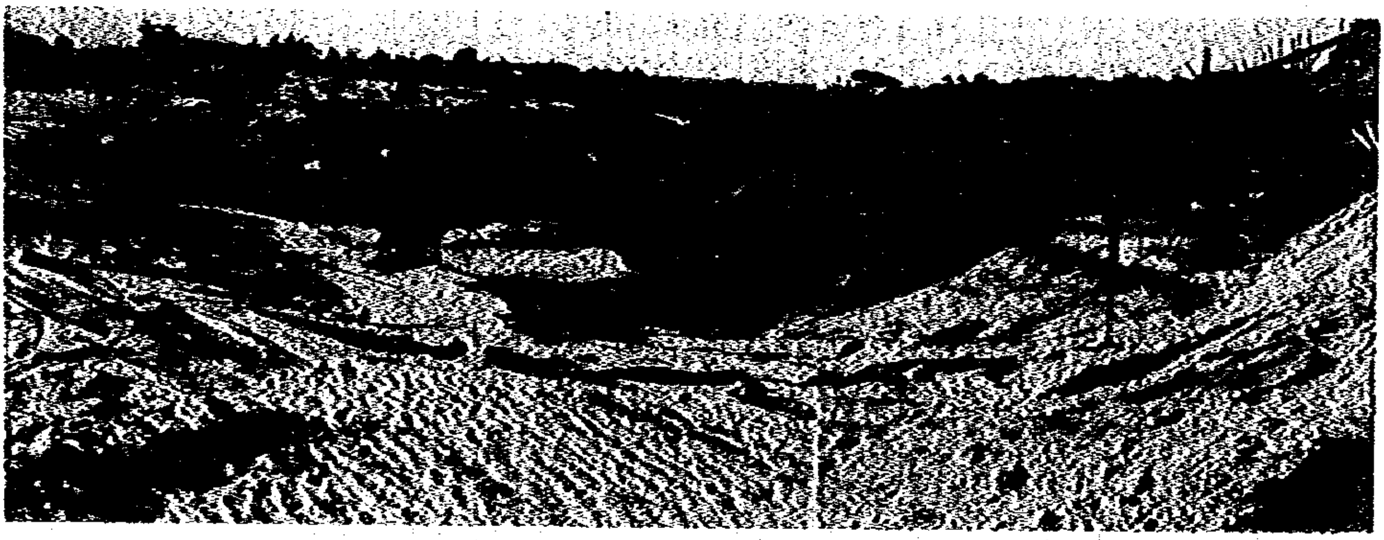


Fig. 3-13 Gravel-Pump Mining

Other methods of alluvial-mining are open-casting and hydraulicing but these are not common. Underground mining is also carried out but production is small compared to that of dredging and gravel pumping. Dulang washing, a traditional Malaysian method of panning in streams or waterways contributes about 5% of the total tin production (1979).

3.4.1 Dredging

Dredging is the largest, single production method in the Malaysian tin-mining industry. In 1979, the average yearly production of one dredge was about 370 tons of tin-in-concentrates. In 1979, production by all of the 54 dredges totalled 20,000 tons, which was about 32% of that year's tin production. Concurrently, the average daily excavation volume per dredge was 10,000 m^3/day (Table 3-4).

Fig. 3-14 shows the picture of a dredge and Fig. 3-15 illustrates a typical dredge mining operation. A typical dredge is comprised of a mechanical excavator, a screening plant and a washing plant which are all mounted on a pontoon which floats on man-made pond.

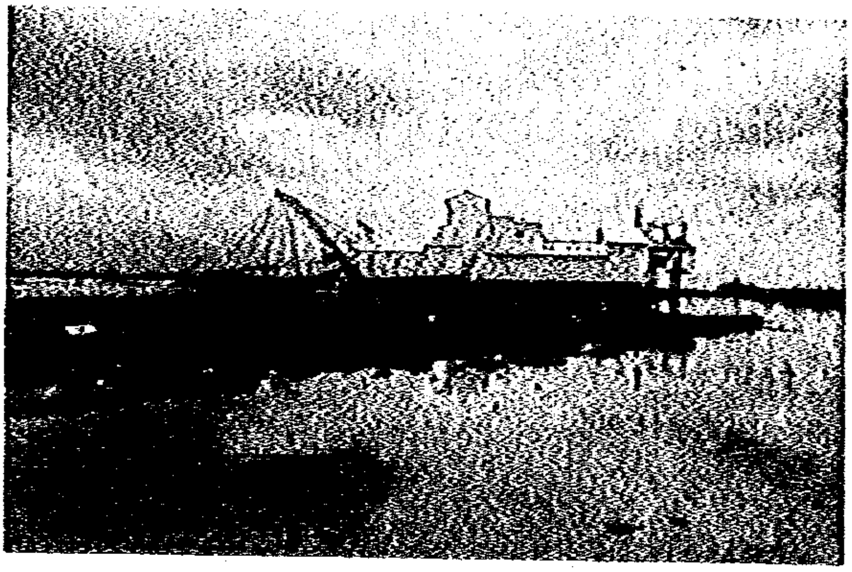


Fig. 3-14 Dredge in Operation

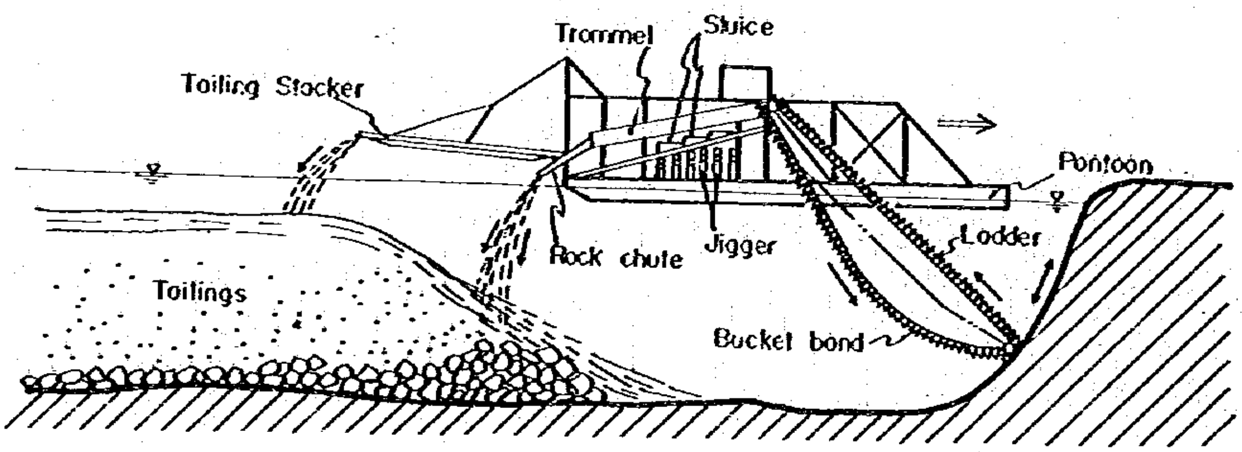


Fig. 3-15 Concept of Dredging Operation

The mining process consists of 4 operations:

1) First the materials are excavated from the bottom and wall of the pond by means of a continuous chain of steel buckets (Fig. 3-16).

2) The collected materials are then chuted into a revolving screen or trommel (Fig. 3-17) where the oversized materials such as gravel, stiff clay ball, and other rubbish are separated and dumped through a rock chute. The screened fines, generally those smaller than 13mm (0.5 in.) in diameter, contain the tin-ore. These fines are then chuted to the tin-ore recovery devices called sluices (Fig. 3-18).

3) In the sluice the lighter fines, i.e. normal gravel, sand and clay are washed away and tin-ore and other heavy minerals are retained. The heavy fine-mixture is sucked out from the bottom of the sluice by jigs and is transferred to subsequent separation processes. Fig. 3-19 is a photograph of tin-ore obtained after separations.

4) At each separation the lighter fines, called tailings, are not retained but are conveyed by a tailing stacker to be dumped at the rear of the dredge (Fig. 3-20).

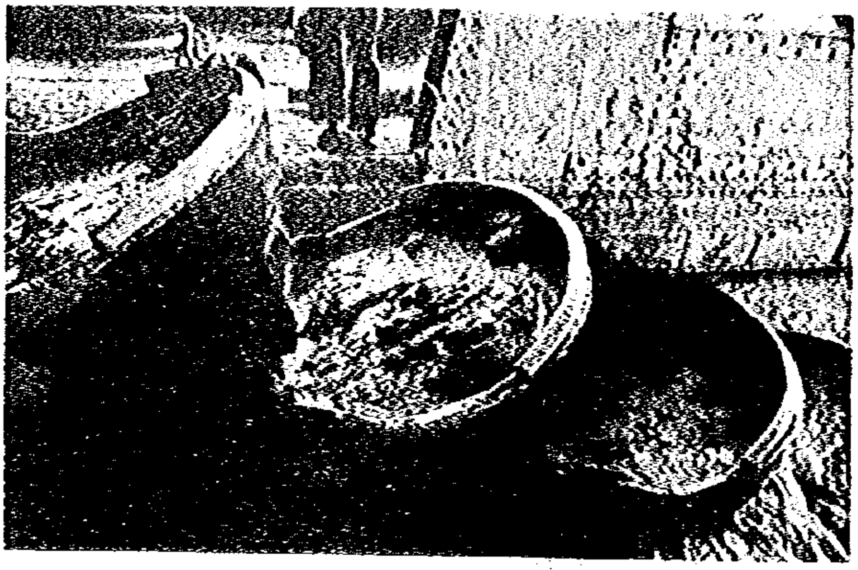


Fig. 3-16
Continuous Chain of Steel Buckets

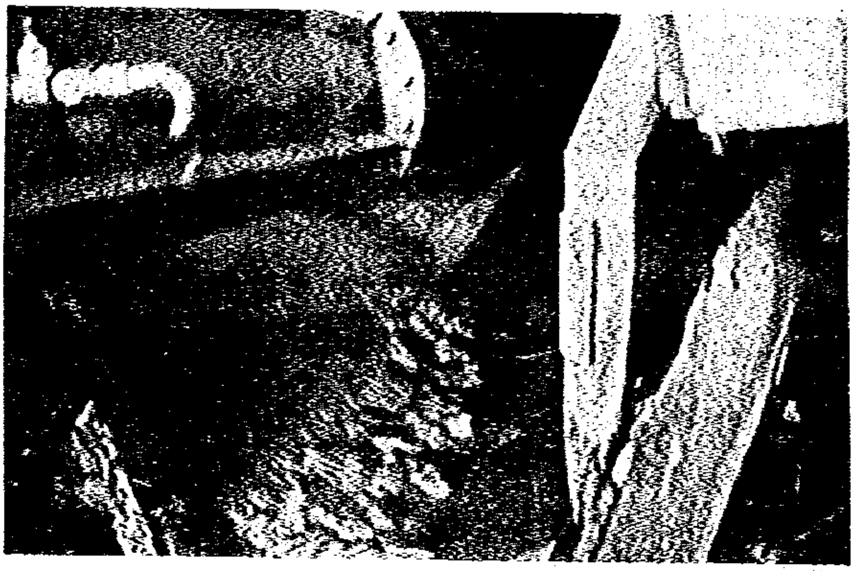


Fig. 3-17 Trommel

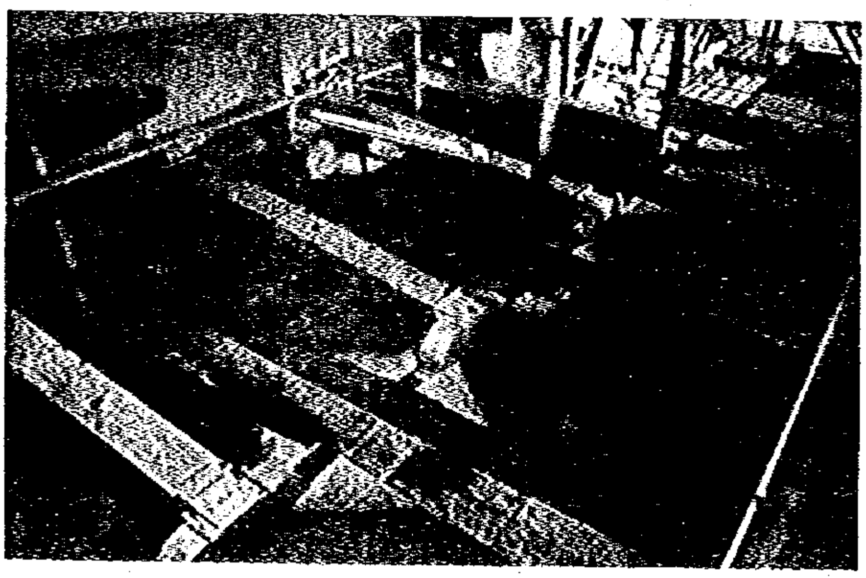


Fig. 3-18
Tin-ore Recovery Devices (Sluices)

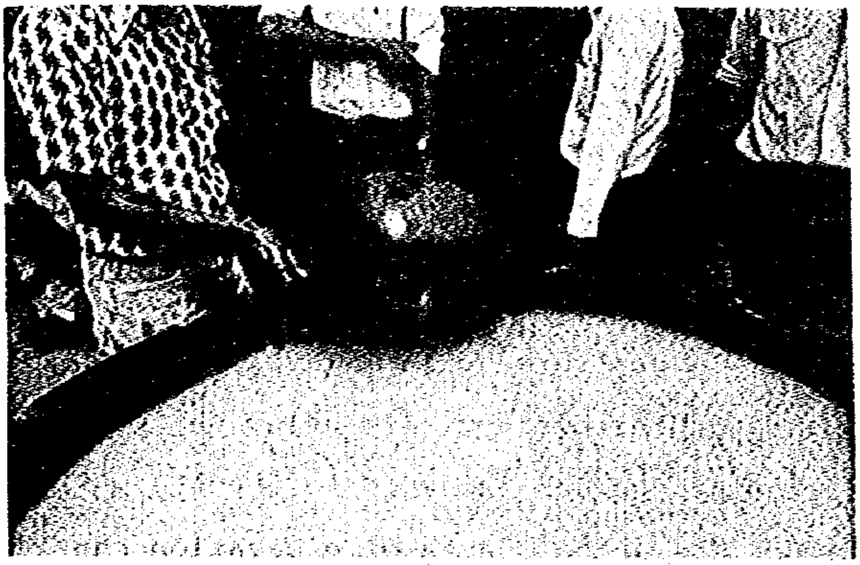


Fig. 3-19
A Sample of Tin-ore

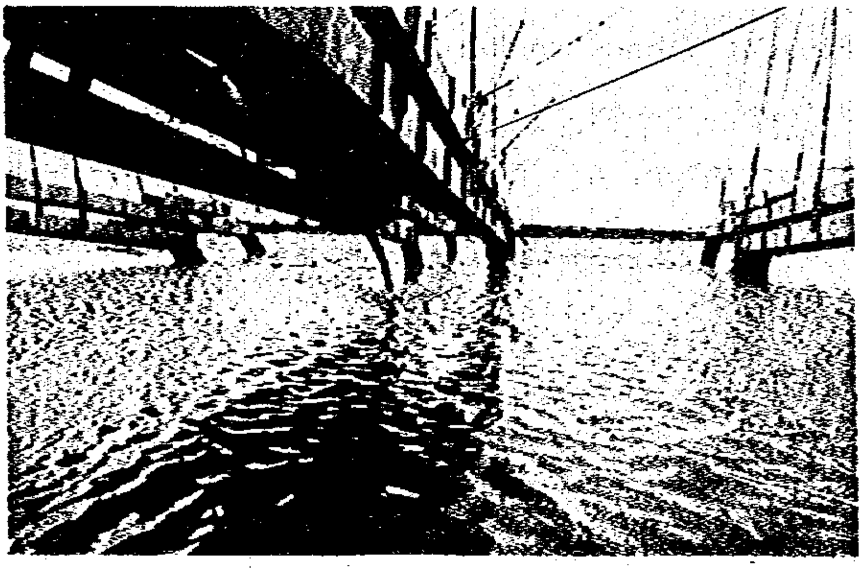


Fig. 3-20 Tailings

As the above operation is in progress, the dredge is winched forward by means of cables anchored on land, in front of the dredge.

The maximum depth of excavation depends on the length of the ladder, which is the component which controls the size of the dredge. The largest dredge in Malaysia is capable of excavating to depths of about 47m below the pond surface. A medium sized dredge can excavate to about 37m below the pond surface. The actual depth of excavation can be increased by lowering the pond water-level to ensure that the distance from the water surface to the pond bottom does not exceed the capability of the ladder.

Dredging is terminated once rock formation is reached, because the buckets cannot excavate rock. Ore deposits located in formation cavities, and between rock pinacles, which cannot be reached by the dredge, are next mined by gravel pumping (Fig. 3-21).

Slime is formed in the course of dredging operations when silt and clay particles settle out of the muddy pond water. This sticky slime causes difficulties in dredging and washing operations. It is therefore pumped out and transported by pipe line to a sedimentation pond. The pond is arranged so that supernatant water flows back into the dredging pond (Fig. 3-22).

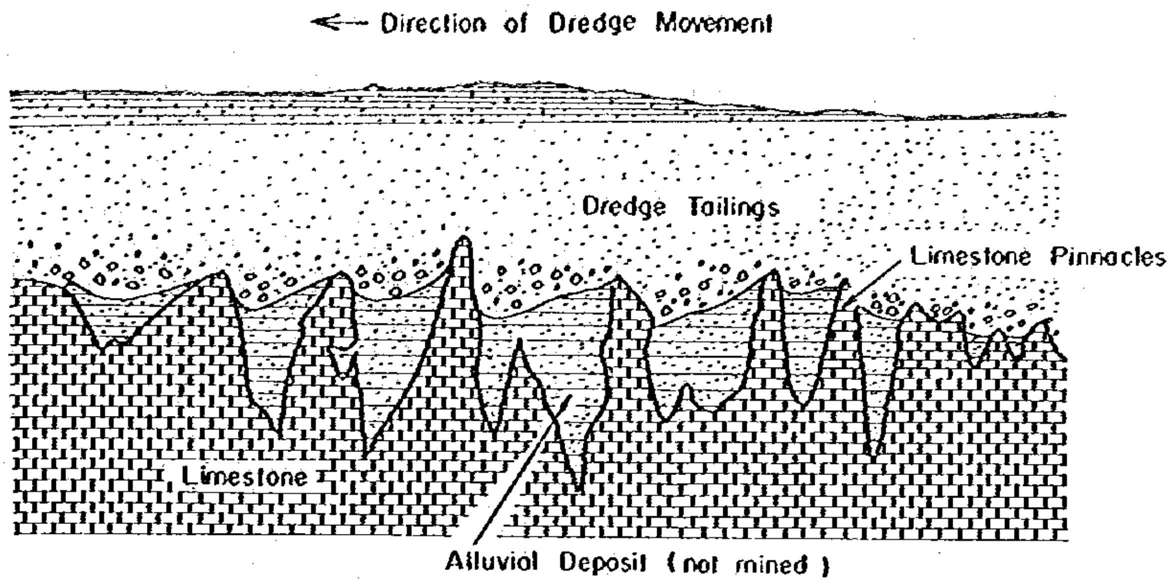


Fig. 3-21 Schematic Soil Profile of Dredged Area

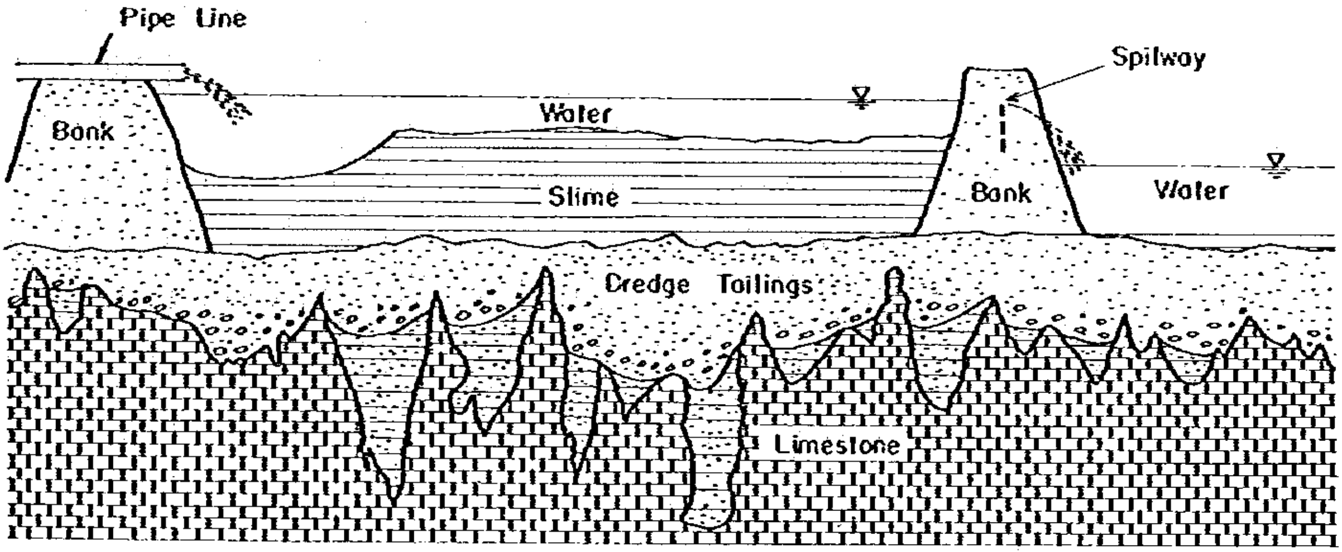


Fig. 3-22 Schematic Soil Profile of Slime Pond in Dredged Area

Dredging has the lowest operational cost among the various mining methods, but initial dredge construction requires a substantial capital investment. The cost of dredge operation can be as low as one-half that of gravel pumping. The dredge's low operational cost manytimes makes dredging of ore-beds with marginal tin concentrations economically attractive, when mining by other methods might not be profitable. In 1980, mining of deposits with tin concentrations as low as 0.1 kati/cy ($80g/m^3$) was still profitable by dredging. In fact, with the advancement of separation technology, dredges are now profitably re-dredging the tailings from previous dredging operations at some areas.

3.4.2 Gravel Pumping

Gravel pumping is the most common tin-mining method in Malaysia. In 1979, 772 of the 873 mining units (88%) were gravel-pumping units. However, this method produced only 54% of the year's tin output (Table 3-6). Average annual production per unit was only about 44 tons (730 Picules) of tin-in-concentrates.

Gravel-pump mining is performed in an open excavation as shown in the photograph in Fig. 3-23 and in the schematic in Fig. 3-24. The gravel pump is placed where the elevation of the bedrock/alluvium interface is at a local minimum.

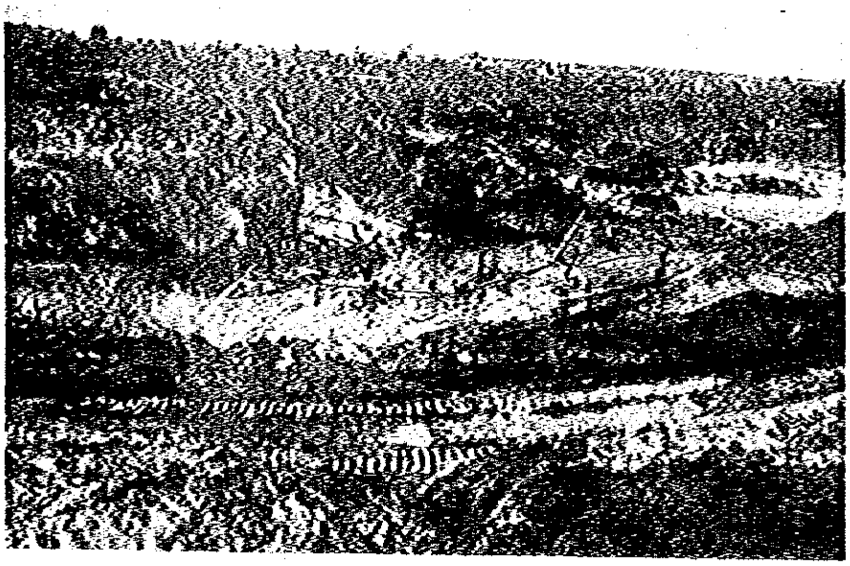


Fig. 3-23 Gravel-Pump Mining in Operation

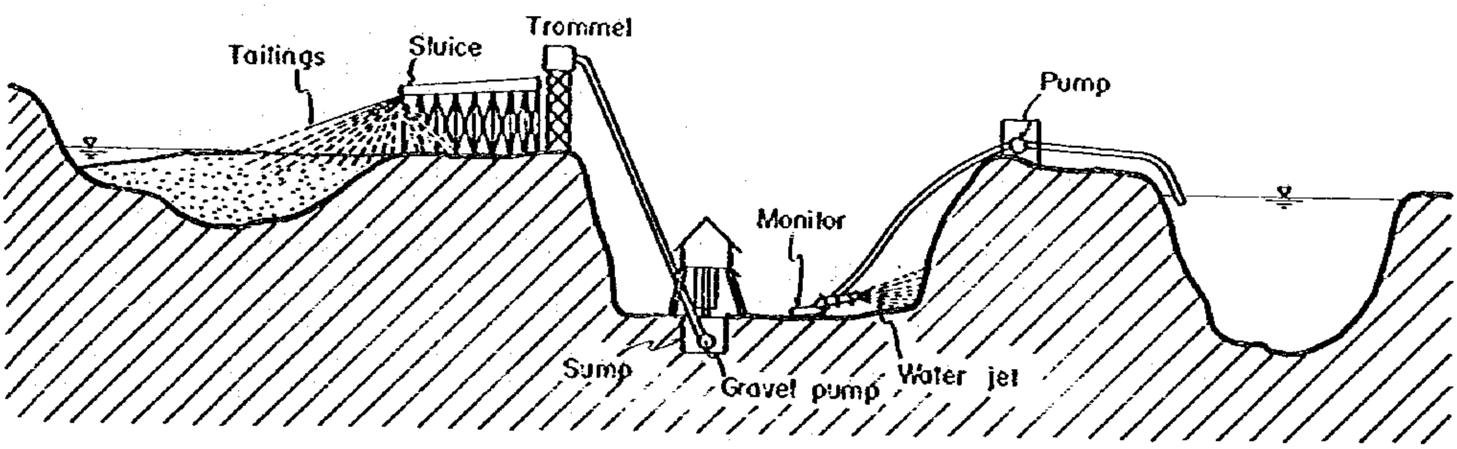


Fig. 3-24 Concept of Gravel-Pump Mining

Interface elevations are established during an advance boring investigation. Locating the pump at the deepest point minimizes the need for pump relocation during mining operations. The pump essentially sits at the centre bottom of a large depression in the bedrock. Alluvial materials in the pump vicinity are loosened by a water jet and washed down into the sump (Fig. 3-25).

The loosened materials having diameters less than 10cm (4 inches) are then pumped up to a trommel by the gravel pump. Here, the trommel separates oversized materials from the ore-containing (Fig. 3-26) and dumps them nearby (Fig. 3-27). The tin-ore continues on to a sluice where the heavy tin-ore particles are recovered (Fig. 3-28). Tailings continue to move out through the end of the sluice, which is generally arranged to deposit the tailings into a previously excavated mine (Fig. 3-29). If the tailings stack up at the end of the sluice, they are removed, and transferred to other areas by means of bulldozers and lorries or by other gravel-pumps and pipe lines (Fig. 3-30). When the tailings are deposited onto a tailings area, coarser materials settle near the tailing point and the muddy water passes into a sedimentation pond if one has been prepared (Fig. 3-31). From the pond, the supernatant water is pumped to be used for jet water. Fig 3-32 illustrates a layout of gravel-pump mining, showing routes of mined materials and mining-water circulation.

Fig. 3-25
Gravel Pump and Monitor (Water Jet Nozzle)

Fig. 3-26
Trommel

Fig. 3-27
Coarse Material Rejected by Trommel

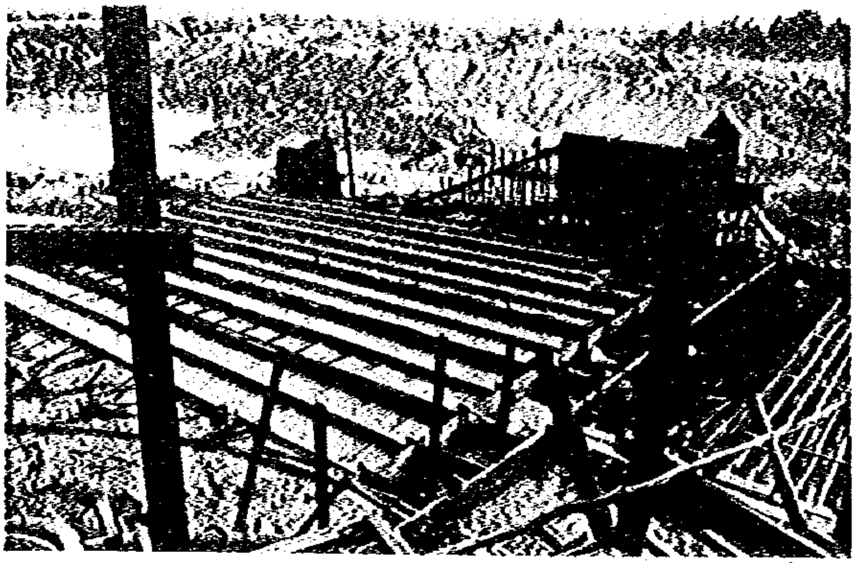


Fig. 3-28
Tin-Ore Separation in Sluice

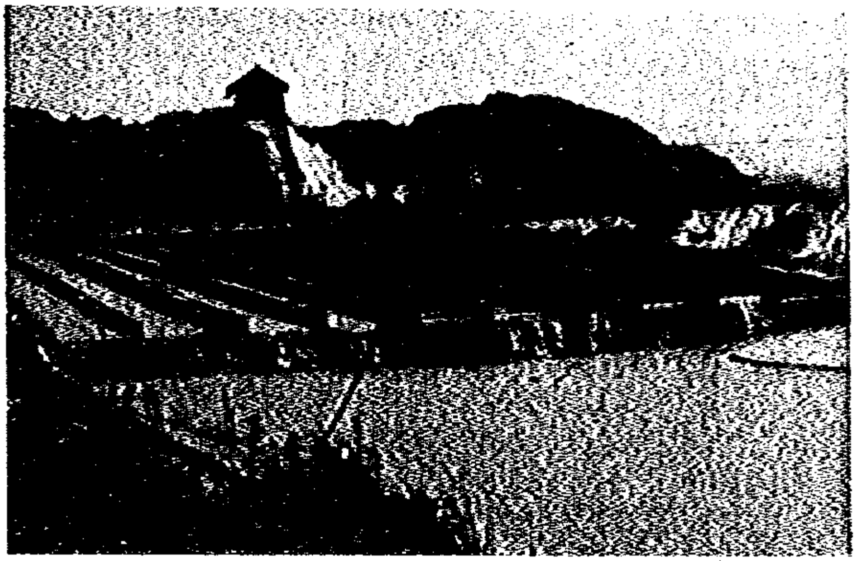


Fig. 3-29
Tailings Being Deposited at the End of the Sluice

Fig. 3-30 Tailings Removal by Gravel Pump

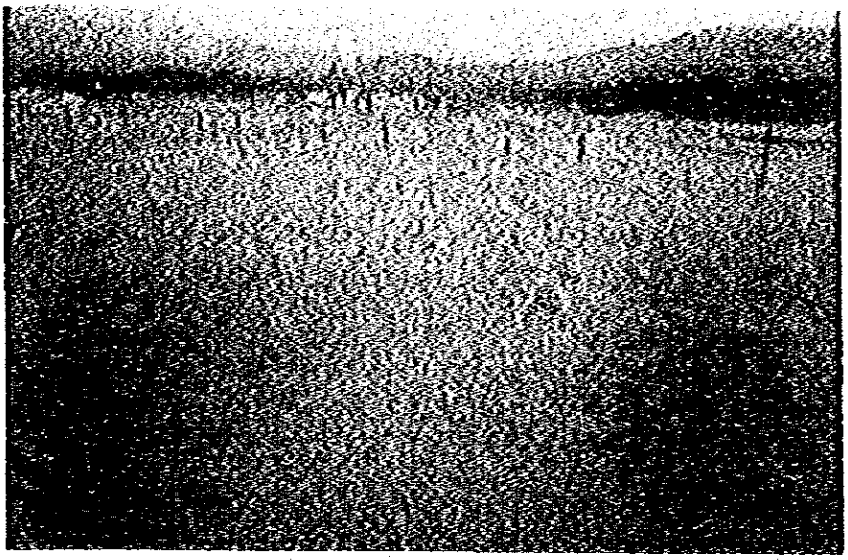


Fig. 3-31
Tailings Outlet

Note: Fig. 3-32 is presented on the next page.

Fig. 3-33
Limestone Pinnacles

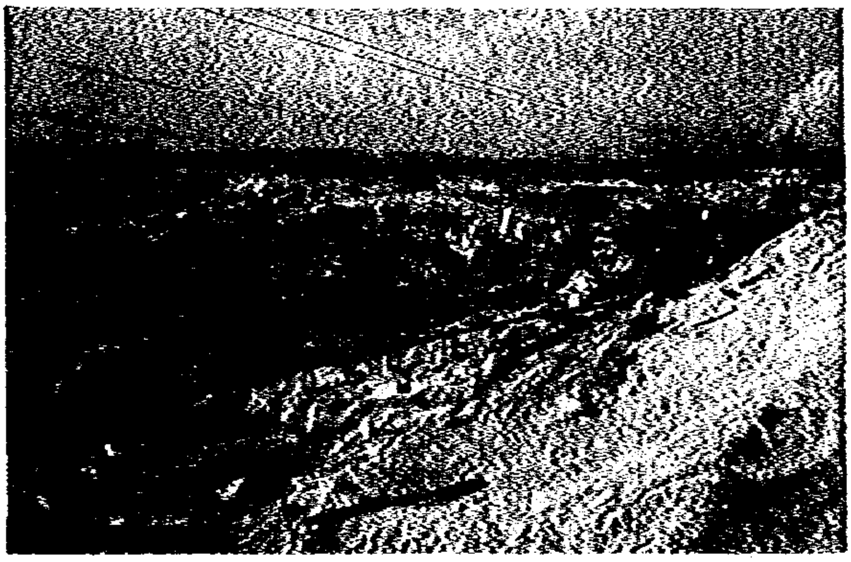


Fig. 3-34
Limestone Pinnacles

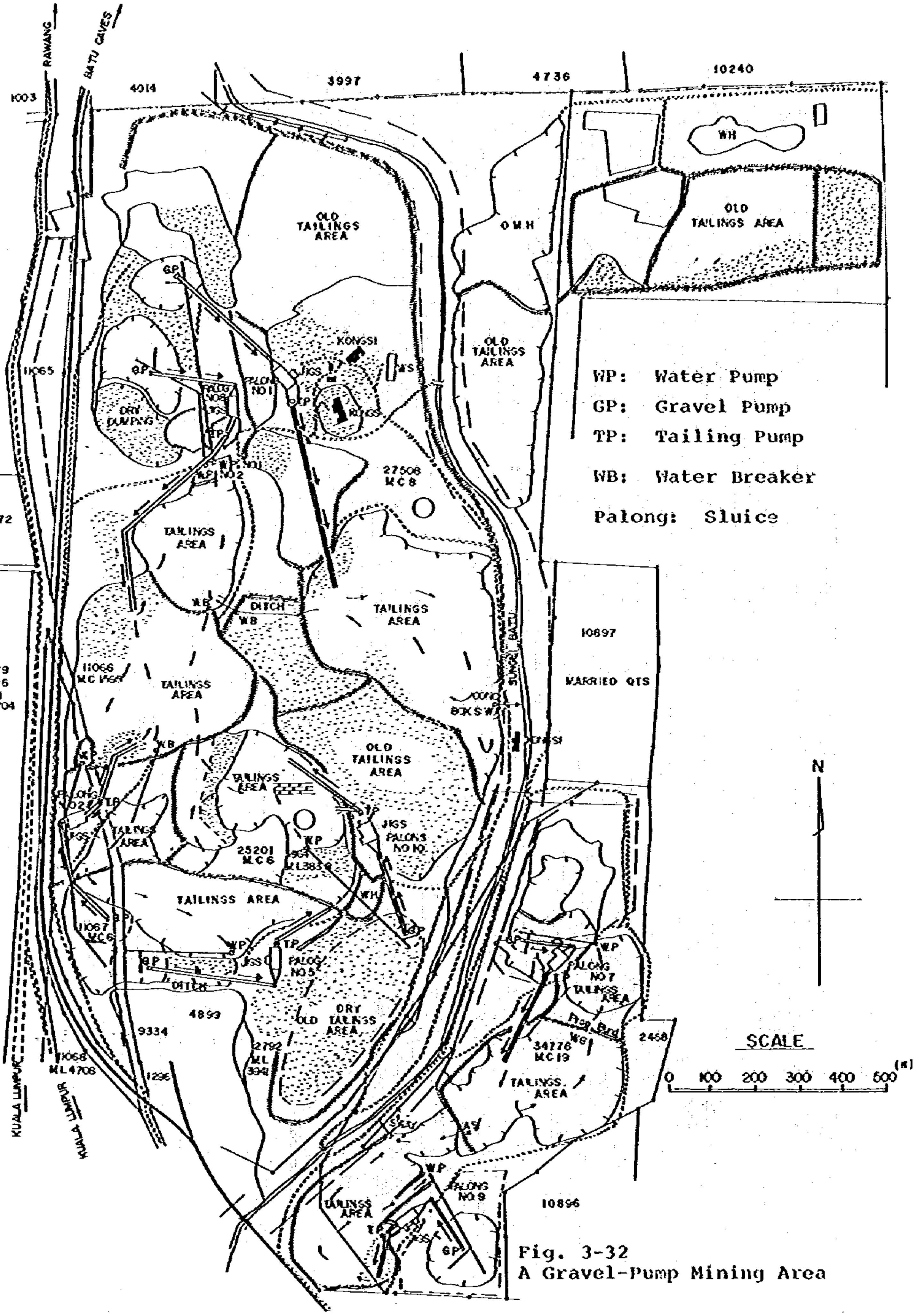


Fig. 3-32
A Gravel-Pump Mining Area

The major advantage of gravel-pumping lies in its relatively small initial capital cost compared with that of dredging. Therfore it is particularly popular with small producers. Another advantage of gravel-pump mining is that tin-rich soils located in small depressions or cavities in the bedrock can be recovered by this method, where dredging would not be effective. Gravel-pump mining results in complete exposure of bedrock, and in previously mined, limestone areas numerous riffles and pinnacles can be seen, which underscore the usefullness of this method of mining (Figs. 3-33 to 3-37 in pages 3-35 and 3-38).

Location of bedrock is the only factor limiting excavation depth for the gravel-pump method. There are cases where tin-ore excavation by this method exceeded 100m (300 ft) in depth. However, the average excavation depth is about 20 to 30m (60 to 90 ft).

Gravel-pump mining gives rise to post-mining ground eithology which depends on the spatial configuration of the mining operation (Fig. 3-38). As already mentioned, coarser materials are deposited near the tailings discharged point. Finer materials are deposited farther away. For this reason, sites near the discharge point are usually sandy, and gradually become clayey with increasing distance from the discharge point (Fig. 3-38 b).

To use the supernatant water for jetting, sedimentation ponds are prepared, which are usually previous mining holes. These ponds are separated from tailings dumps by spillways

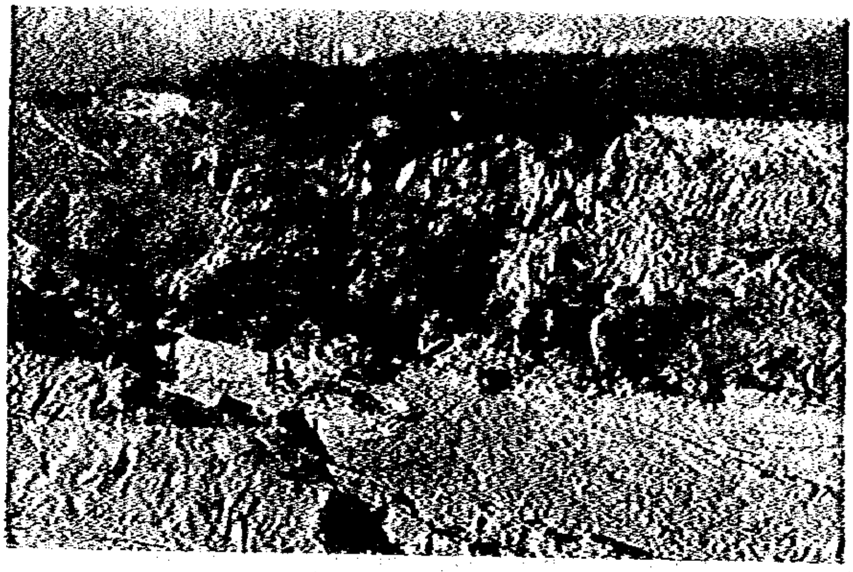


Fig. 3-35
Limestone Pinnacles

Fig. 3-36
Limestone Pinnacles

Fig. 3-37 Limestone Pinnacles

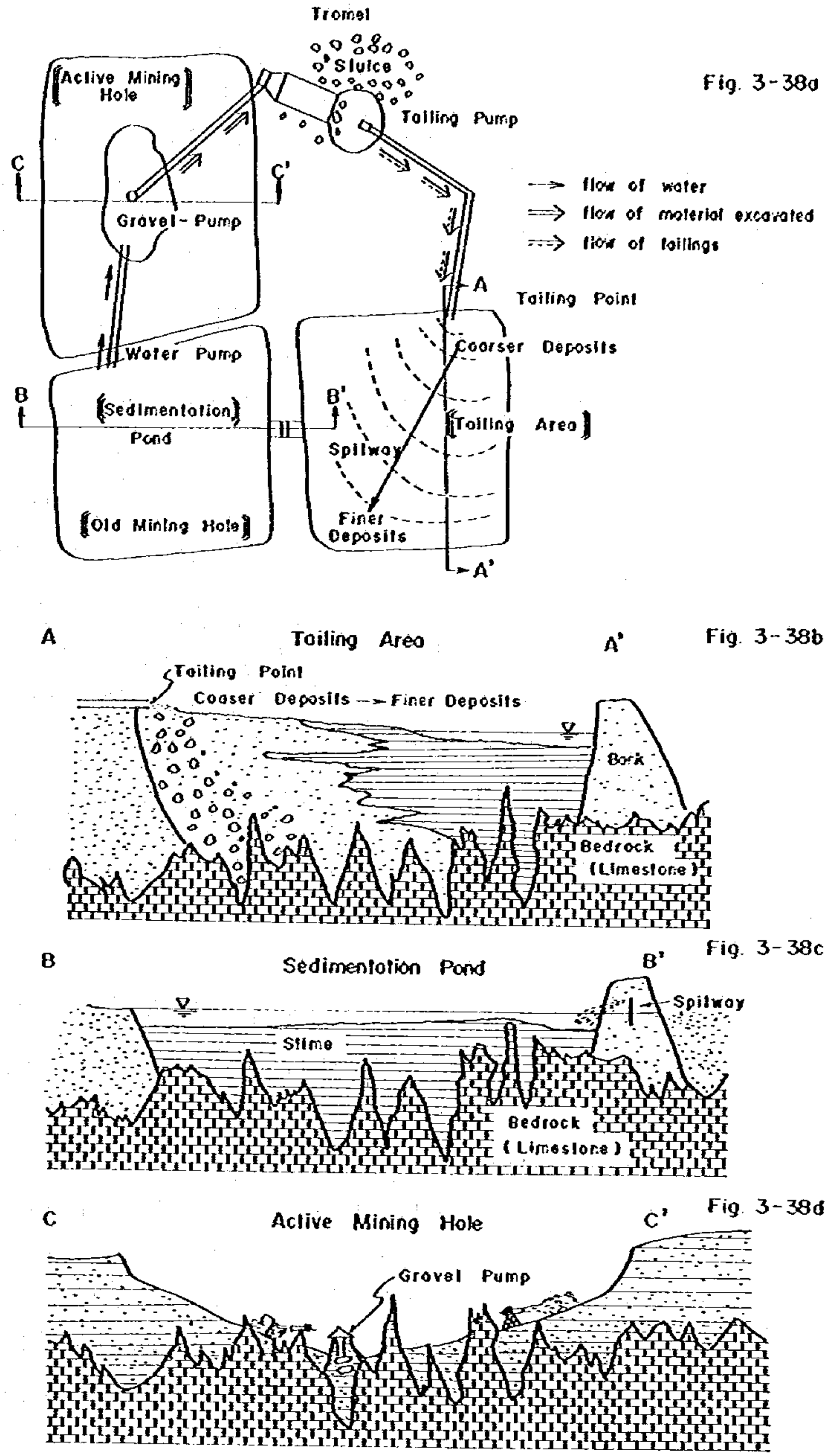


Fig. 3-38 Schematic Soil Profile Caused by Different Usage Histories of Mining Land

which confine the spread of the tailings, allowing the tailings water to flow over into the pond. Major deposits in sedimentation ponds are fine mateials, called slime (Fig. 3-38c).

As previously mentioned, mining holes which are not subsequently filled with tailings exhibit bedrock exposure, typically limestone pinnacles as shown in Figs. 3-33 to 3-37. After some time, rain water accumulates in these holes and they become ponds. Thin fine deposits (slime) are usually found at the bottom of these ponds. This creates very similar ground conditions to those resulting from sedimentation ponds, but the speed of sedimentation is slower than that of the sedimentation ponds.

As discribed above, the present-day site conditions of ex-mining land are very much dependent upon the spatial arrangement of previous mining operations. Site conditions are also affected by the grading texture of the mined materials. To complicate matters, the physical layout of mining operations is never static. Tailings point locations are routinely changed in the course of mine operations. One minehole may be subsequently used for several different purposes. Old tailings and/or surface soil may be physically transported by bulldozers and lorries. All these operations make the soil profiles of ex-mining land very complex, and of course, detailed records of everyday operations are not available. Fig. 3-39 shows one potential soil profile of previously mined land.

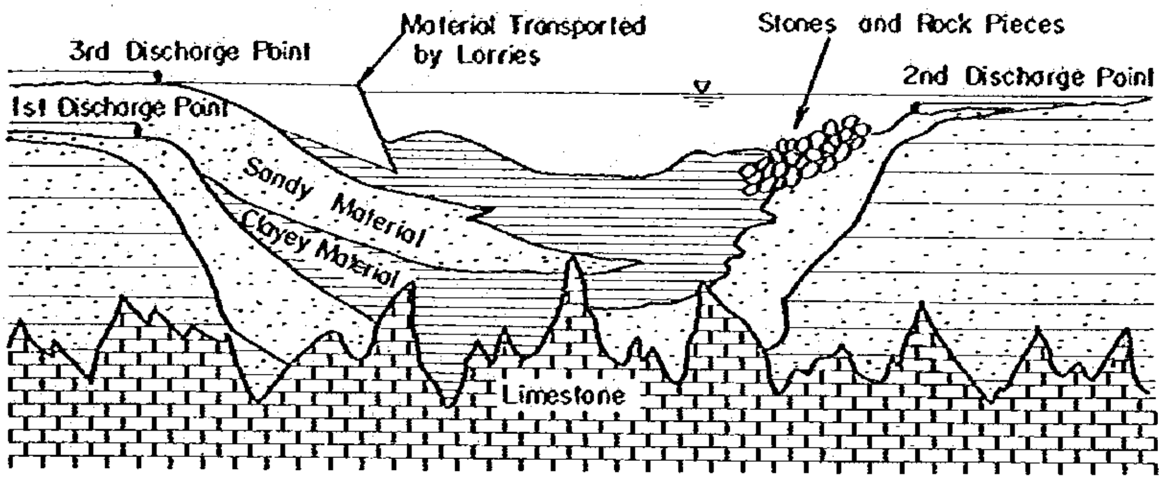


Fig. 3-39 Possible Soil Profile of Previously Mined Land

3.5 Tin-Mining in Kuala Lumpur

As seen in Fig. 3-40, most of the tin mines in the Kuala Lumpur region are located in areas of limestone bedrock formation. At present, there are more than a dozen areas in the Federal Territory where tin mines are still in operation. These areas are shown on the map in Fig. 3-41. The acreage of land currently being mined is about 1,271 ha (3,139 acres). The acreage of mining land which is yet to be worked is about 142 ha (351 acres). Table 3-7 lists all the active mines in the Federal Territory. In these mines, some 24 gravel pump units are employed.

The annual production of Kuala Lumpur is about 2,400 tons (about 4,000 piculs) of tin-in-concentrates, which is about 4% of the total tin production in Malaysia (Table 3-8). From this figure, the annual average production of tin-in-concentrates per unit of gravel pump is estimated to be about 90 to 100 tons (about 1,500 to 1,700 piculs) which is more than double that of the average for the whole country.

Most of the tin-bearing fields in the Federal Territory have been dredged previlously, therefore the unmined, tin-bearing alluvium is not generally found at the ground surface. Today's production involves deposits located between the limestone pinnacles and in cavities which were left behind by the dredges used previously (Fig. 3-21). These deposits are usually covered with 10 to 25m of dredge

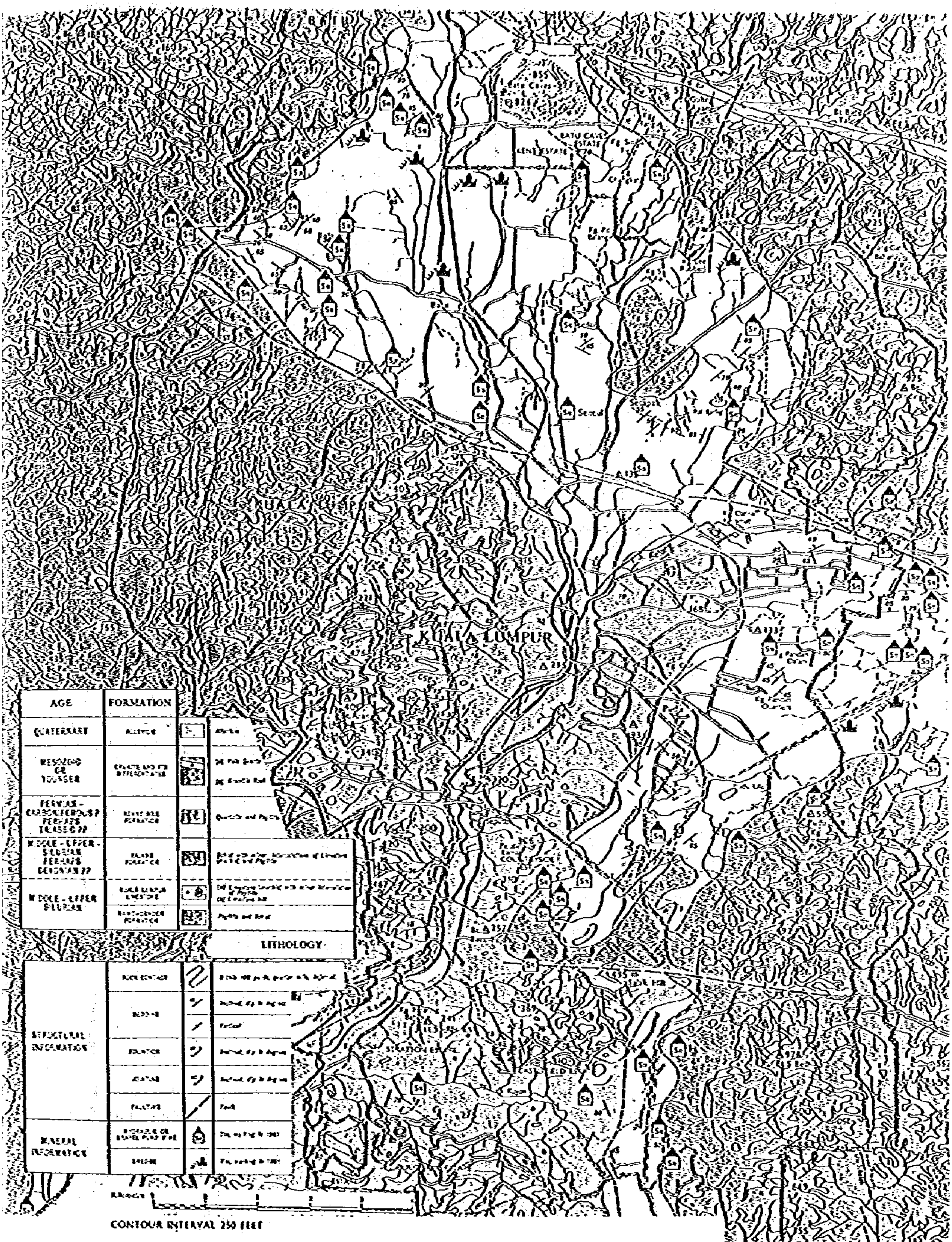


Fig.3-40 Geological Map of the Federal Territory
(Geological Survey of Malaysia 1969)

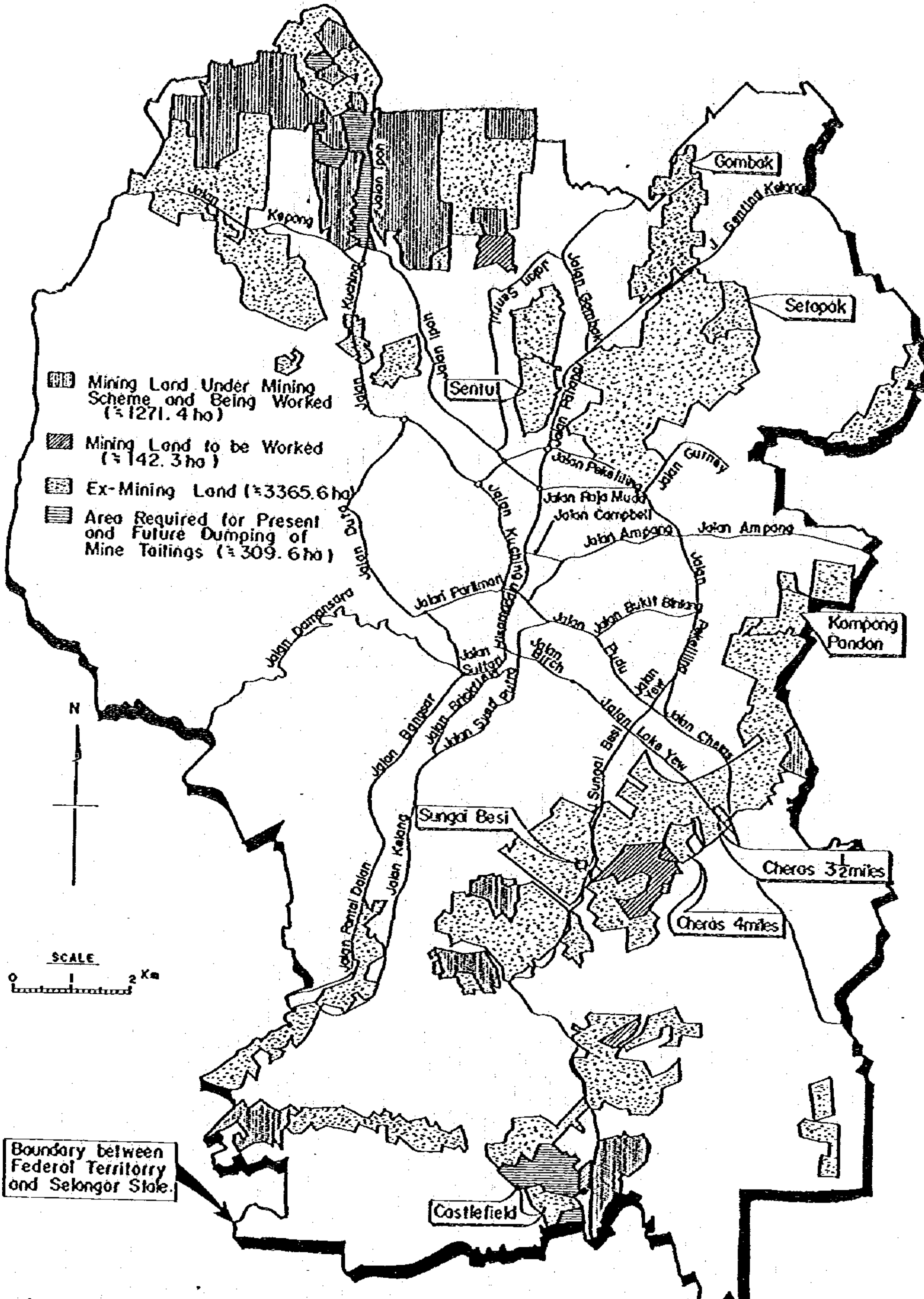


Fig. 3-41 Distribution of Mining Land in the Federal Territory

Table 3-7 List of Active Mines in the Federal Territory

1. Syarikat Trimal Sdn. Bhd.
2. Syarikat Galian Kita.
3. Timah Setapak S/B.
4. Yap Woon Peow Tin Mg. Co. Setapak
5. Kin Yip Mining Co. S/B.
6. Batu Tujuh Mg. Co. S/Bhd.
7. Syarikat Galian Jaya.
8. Weng Kok Mg. Co.
9. Mukim Batu.
10. Chim Lee Tin Mg. Co. S/B.
11. Pacific Oriental Minerals S/B.
12. Nam Seng Tin Mg. (Sel), S/B.
13. Num Num Mg. Co. S/Bhd.
14. Syarikat Belantan S/Bhd.
15. Sungei Kuyoh Mining Sdn. Bhd.
16. Loong Sin Tin Mining Co. Ltd.

Table 3-8 Tin Mining Statistics in the Federal Territory

Year	Number of Gravel-Pumping Units	Labour (Persons Employed)	Machinery (Active Horse-Power)	Production of Tin-in-Concentrates (Tons (piculs))	
				Total	Per Unit
1974	34	1,389	42,414	3,248 (53,697)	95.5 (1,579)
1975	29	1,025	37,095	2,709 (44,792)	93.4 (1,545)
1976	22	798	28,189	2,083 (34,444)	94.7 (1,566)
1977	28	1,057	35,434	2,496 (41,278)	89.1 (1,474)
1978	32	1,092	43,067	2,931 (48,470)	91.6 (1,515)
1979	28	966	38,336	2,552 (42,197)	91.1 (1,507)
1980	24	808	34,450	2,420 (40,064)	101.0 (1,669)

Note: Wilayah Persekutuan (Federal Territory) came into being on 1.2.1974& departmental statistics for the area start in the same year.

tailings. The average excavation depth in the Federal Territory is about 20 to 30m (60 to 90 ft) and the maximum depth is more than 100m (300 ft).

Sometimes, the dredge tailings themselves are also a low grade source of tin and the use of modern, efficient gravel-pumps and separation techniques permits profitable tin extraction from the dredge tailings which could not be efficiently mined using dredges. However, even when re-mining of the dredge tailings is not profitable, in order to gain access to the buried, virgin ore the overlying tailings, including slime, are removed and piled in designated dumping areas.

Large scale tailings transport is accomplished with bulldozers, shoveldozers and lorries, or by gravel-pumps using pipelines. In the case of slime, draglines are also used. Transport of old tailings, as well as re-mining operations, gives rise to even more complex soil profiles than would normally be encountered in areas where mining had previously occurred.

Fig. 3-32 in page 3-36 shows an example of a tin-mining area in the Federal Territory. The mine shown is operated by the Syarikat Trimal Sdn. Bhd. This is one of the largest active mining areas in the Territory, having had six mining units in operation during 1980. A detailed schematic showing water flow lines and mined materials routing is also included in the figure.