GOVERNMENT OF MALAYSIA

THE RECLAMATION PROJECT OF EX-MINING LAND FOR HOUSING DEVELOPMENT AND OTHER PURPOSES

FEASIBILITY STUDY REPORT

SUMMARY

AND

RECOMMENDATIONS

OCTOBER, 1981

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of Malaysia, the Japanese Government decided to conduct a feasibility study on the Reclamation Project of Ex-Mining Land for Housing Development and Other Purposes and entrusted the study to the Japan International Cooperation Agency (JICA).
The JICA sent to Malaysia a study team headed by Dr. Kakuichiro Adachi, Kisojiban Consultants Co., Ltd. from December, 1979 to July, 1981.

The team exchanged views with the officials concerned of the Government of Malaysia on the project and conducted a field survey in Kuala Lumpur.
After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

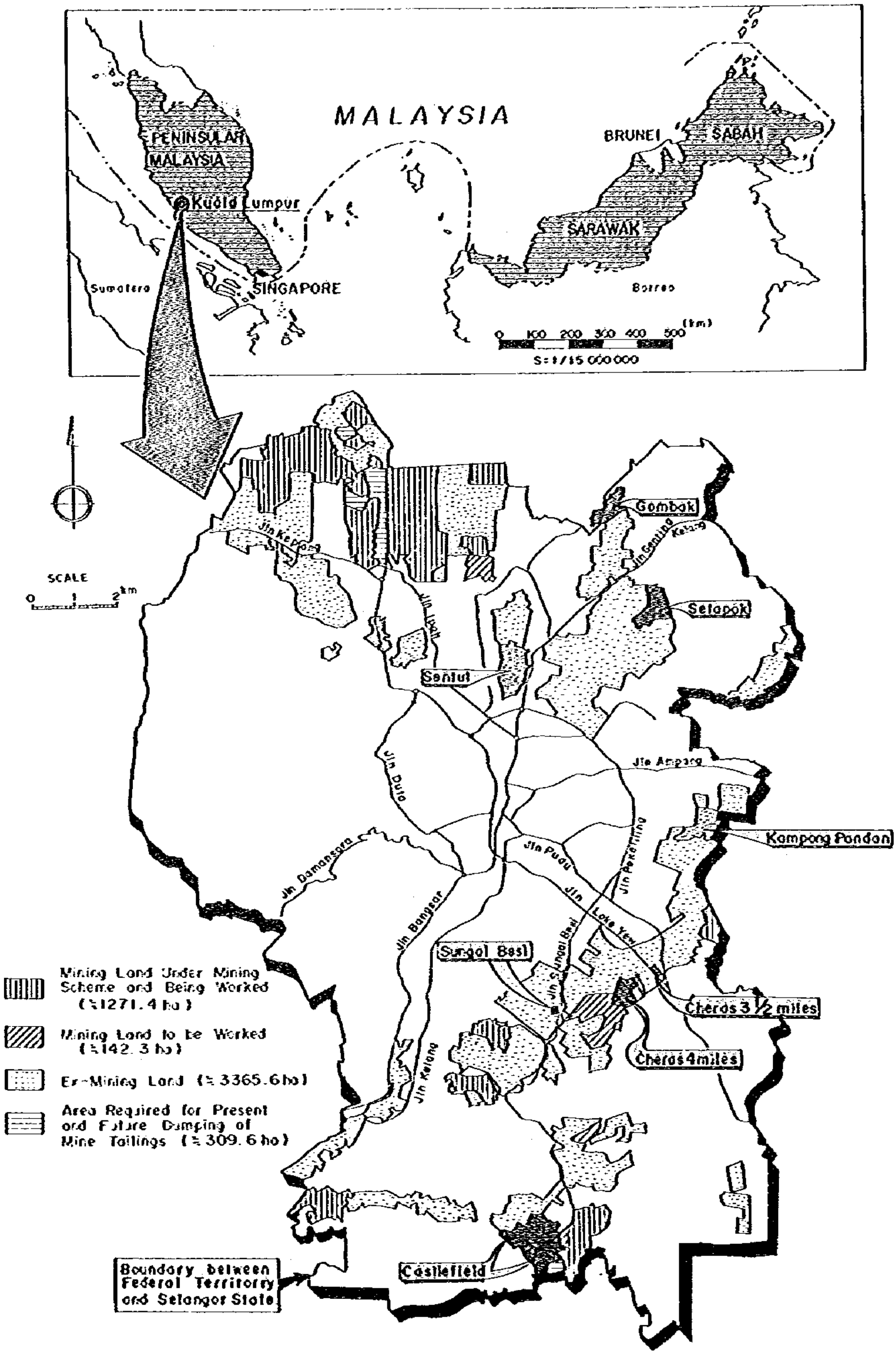
I wish to express my deep appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the team.

October, 1981

Keisuke Arita

President

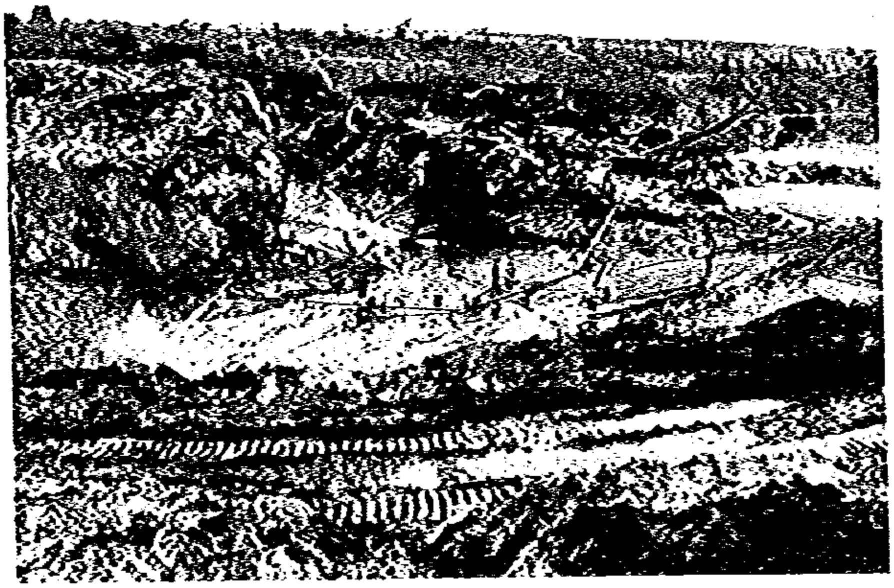
Japan International Cooperation Agency



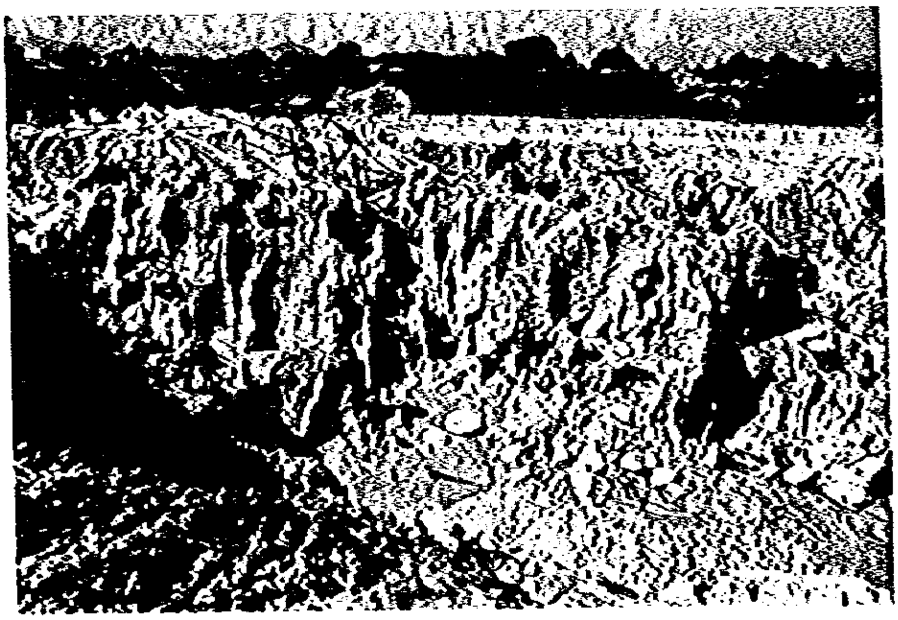
Project Location Map

Tin Mining Areas

Dredge Mining Area



Gravel-Pump Mining



Mining Hole after
Gravel-Pump Mining

SUMMARY AND RECOMMENDATIONS

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SUMMARY AND RECOMMENDATIONS

This report presents the results of the "Feasibility Study for the Reclamation Project of Ex-Mining Land for Housing Development and Other Purposes."

1. METHODOLOGY AND KEY ACCOMPLISHMENTS

Basic methodology to suggest solutions to anticipated problems is outlined in Fig. S-1. Sections of this report which correspond to the subject indicated are also given in the figure. Among the subjects studied comprehensively for the reclamation project of ex-mining land for housing development, the following are the key accomplishments:

(1) Tin mining is thoroughly studied, especially from the viewpoint of foundation engineering. Overall subsurface ground conditions of ex-mining land are clarified by a detailed study of tin-mining operations (Section 3).

(2) Subsurface ground conditions of ex-mining land are investigated in detail. After the investigations, the ex-mining land is classified into 5 typical types. The recommended approach to investigate the subsurface ground conditions of ex-mining land is also presented (Sections 4 and 5).

(3) Foundation engineering problems for structures to be constructed on ex-mining land are carefully studied. The types of foundations and measures necessary to counter soft subsurface deposits are recommended according to the

ground conditions of ex-mining land and the size of the proposed structures (Sections 6 to 9).

(4) In addition to the technical and engineering study, financial and economic studies are also performed. Through these studies, it is found that ex-mining land is feasible for housing development or other purposes (Sections 10 and 11). Conclusions and recommendations reached by the present study are presented below.

2. OBJECT AND CONTENT OF STUDY

This study is conducted by the Japan International Co-operation Agency in response to a request of the Government of Malaysia to the Government of Japan, and follows the results of the prefeasibility study performed by the survey mission of Japan in March, 1979.

The Government of Malaysia plans to overcome the housing shortage for the urban poor in Kuala Lumpur by constructing more low-cost housing units in the suburbs of Kuala Lumpur. However, the areas with relatively good ground conditions have already been developed, and ex-mining lands in the suburbs of Kuala Lumpur are to be used for the proposed housing developments. The ground condition of the ex-mining land is generally poor and complex, and many foundation engineering problems are expected for the housing development at ex-mining lands.

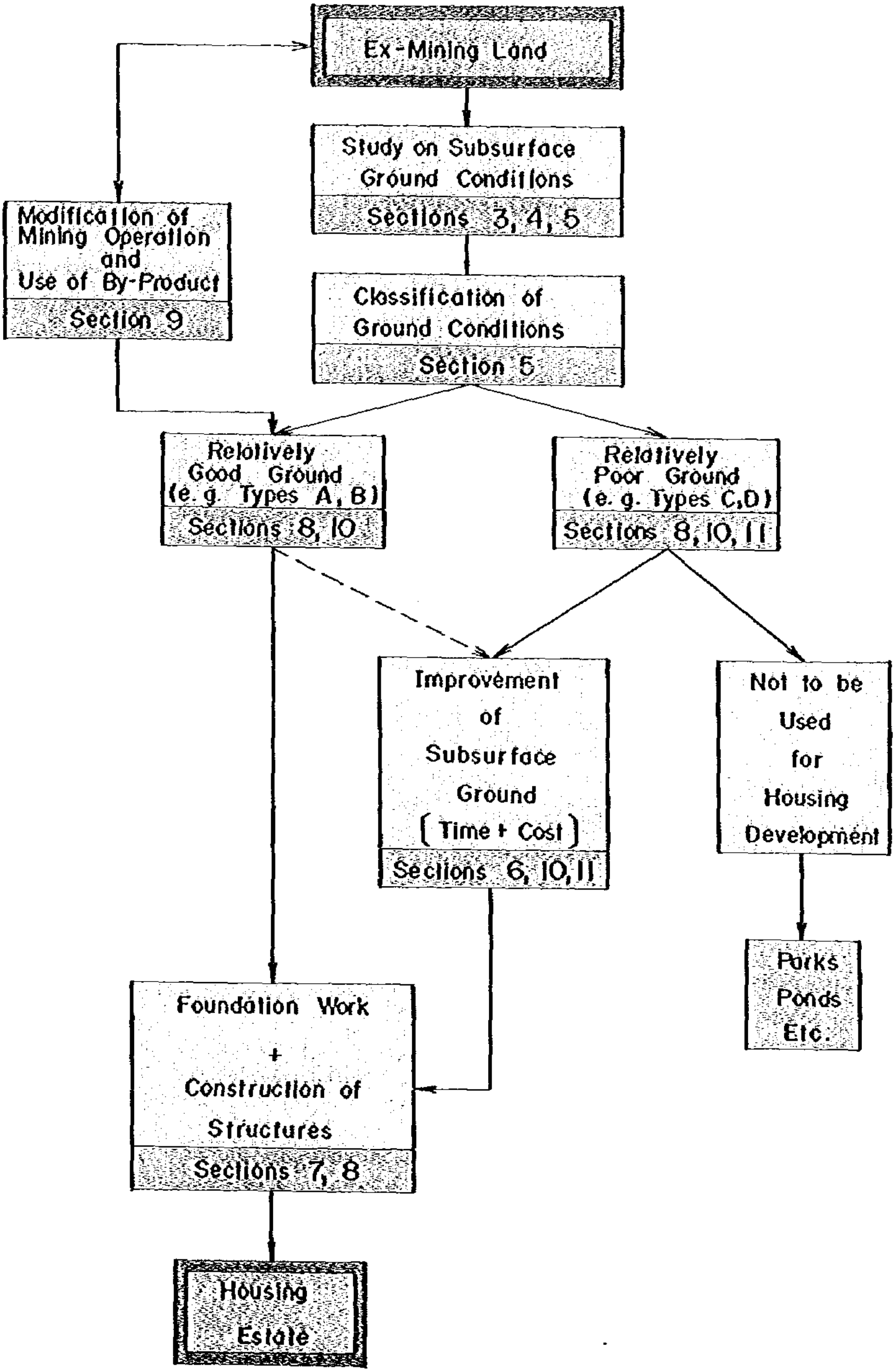


Fig. S-1 Methodolgy of the Study

The feasibility study is comprised of the following contents:-

(1) Reconnaissance Survey and Data Collection

(2) Subsurface Ground Investigation

(3) Engineering Study for Massive Reclamation

(4) Engineering Study for Foundation and Construction Methods

(5) Economic and Financial Studies

The feasibility study was divided into two phases, i.e. Phase I and Phase II. The Phase I study was carried out between December, 1979 and March, 1980, and the Phase II study between August, 1980 and October, 1981. This report presents the results of both Phase I and Phase II studies.

3. SUMMARY AND RECOMMENDATIONS

3.1 Housing Development in Kuala Lumpur

As the basis of the present study, the current housing situation in Malaysia and in Kuala Lumpur is reviewed and presented in detail in Section 2. Firstly, the necessity and benefits of utilizing ex-mining land for low-cost housing development in Kuala Lumpur are studied together with related squatter problems. There are nearly 8,300 acres of ex-mining land in the Federal Territory comprising approximately 14% of the total area. The majority of the ex-mining land is very well located, being 4 to 12 km from the city centre.

About 40% of this land has very favourable ground conditions for low-cost housing development, but large portions are currently being occupied by squatters.

Secondly, the current situation and future needs for housing in Malaysia and for those in the Federal Territory are discussed by studying possible housing production and the population trends. Housing requirements in the Federal Territory are primarily of a low-cost type necessary for the estimated 233,000 squatters who comprised nearly 25% of the territory's population in 1980.

Finally, the construction of low-cost housing is reviwed. Standards for and the state of low-cost housing construction are summarized, together with a study of problems associated with the construction.

3.2 Tin Mining

After a brief review of the tin-mining industry in Malaysia, tin-mining operations are thoroughly studied, especially from the viewpoint of foundation engineering.

Most of the tin mines in the Kuala Lumpur region are located in areas of limestone formation. At present, there are more than a dozen areas in the Federal Territory where tin mines are still in operation. Tin ore, originating from granite at its intrusion into older formations, was eroded and the tin-ore-bearing materials were transported and deposited in areas of deeply weathered limestone formation. Heavy materials bearing tin ore tended to be deposited in areas with a complex topography of numerous pinnacles, troughs, and deep channels.

About 95% of the Malaysian tin is mined by two methods, i.e. dredging and gravel pumping.

Of these two methods, gravel-pump mining is the most common in Kuala Lumpur. Fig. S-2a explains the typical gravel-pump mining method. It must be noted that this gravel-pump mining causes complete exposure of the bedrock. In limestone areas, numerous limestone pinnacles are exposed in mining holes. After the separation of tin ore, soils are deposited in the tailing pond. In the deposition process, coarser materials are deposited near the discharging point of the tailings and the finer materials are deposited far from the discharging point. Due to this reason, the ground condition near the discharging point will be sand rich, and it will be clay rich far from the discharging point. Thus, the ground conditions of the ex-mining land will be greatly dependent on the mining layout. Fig. S-2b shows a possible soil profile of ex-mining land.

Although the ground conditions of ex-mining land are different depending on the method of mining and the method of backfilling, the ground condition of ex-mining land is usually characterized by ① poor ground conditions which will be detrimental to shallow foundations and present difficulties to both excavation and earth filling works, ② very complex stratification of the backfilled layers, and ③ very irregular profile of the bedrock.

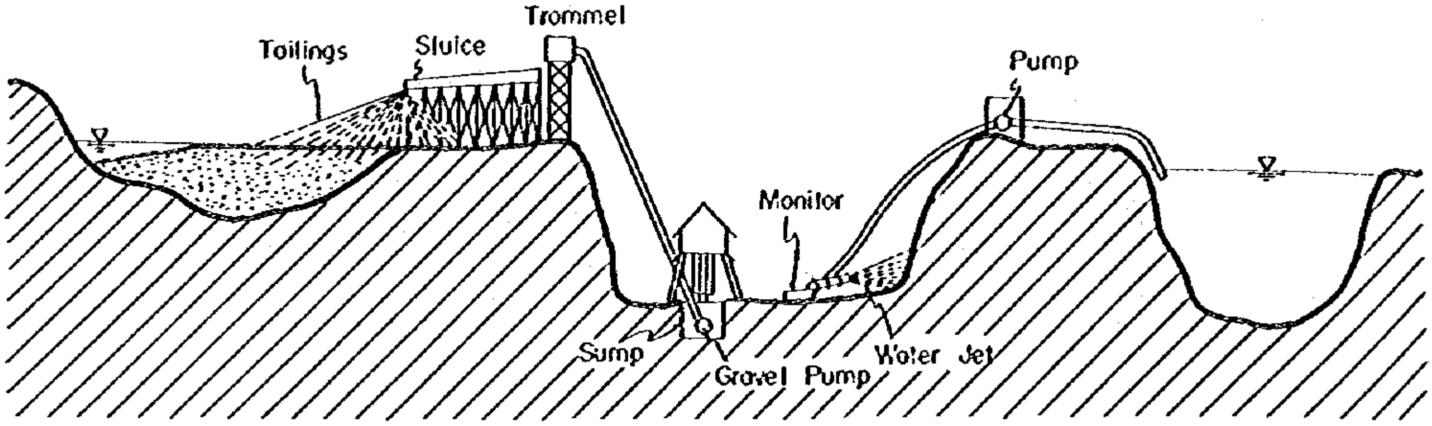


Fig. S-2a Concept of Gravel-Pump Mining

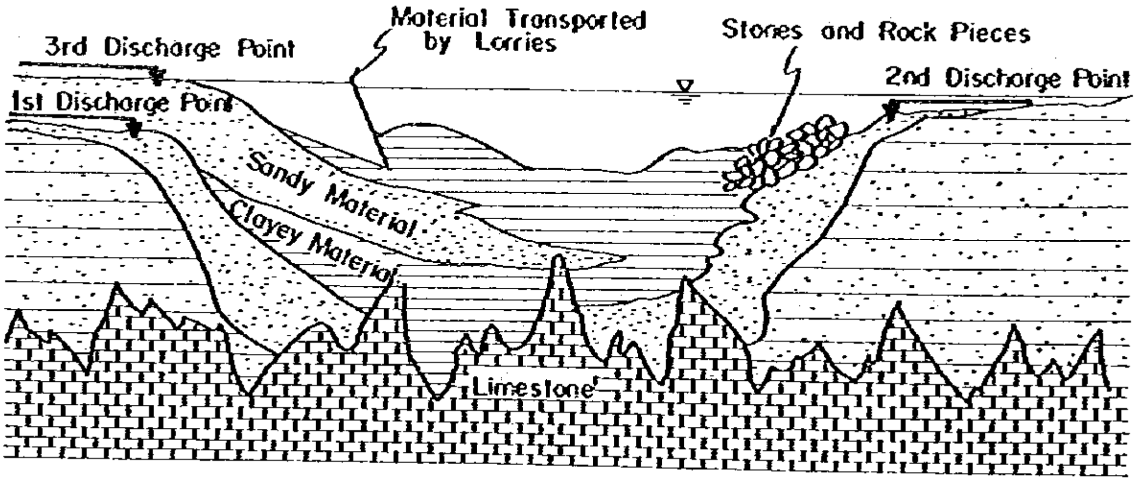


Fig. S-2b Possible Soil Profile of Ex-Mining Land

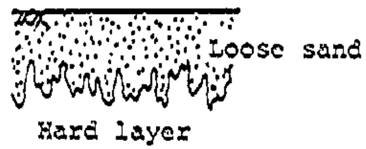
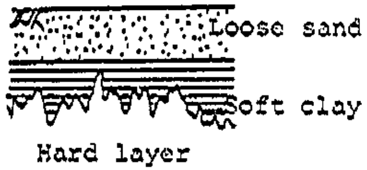
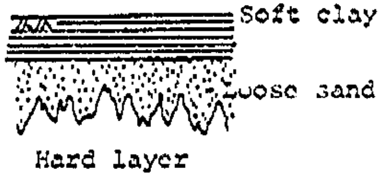
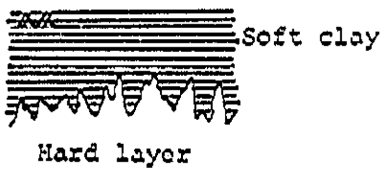
3.3 Ground Conditions of Ex-Mining Land

Ground conditions of ex-mining land are investigated in detail by various types of field exploration and laboratory tests. Kampong Pandan, Sentul, and several other ex-mining sites were investigated. After the investigation, ex-mining land is classified into 5 typical types. Table S-1 summarizes the classification of ex-mining land and the relationship between the occurrence of the five types of foundation ground and the major mining operation performed. Of the sites investigated, relatively numerous examples of sites having foundation ground of each type are listed. Rough estimates of the proportionate distribution of each type of ground are also listed in Table S-1. As seen from the table, the average proportions of the types of foundation ground found at ex-mining sites are; about 20% each of Types A and D; about 25% of Types B and C; and about 10% of Type E.

In Fig. S-3, distribution of the five types of ground at Sentul is indicated by way of a ground type classification map. The map is useful for land-use planning such as the layout of housing estates, etc. However, the map is reliable for locations near the borings and soundings, and further detailed investigation is recommended for the design of each individual structure.

Special attention must be given to the extremely soft, surface clayey deposits. They are softer and more compressible than most natural deposits, and very often , it is difficult for human beings to walk on them. In Table S-2, the representative soil properties of the major layers to be encountered in the ex-mining land are summarized after the results of the present study.

Table S-1 Types of Ground in Ex-Mining Land Classified from Engineering Viewpoint

Type of deposit on bedrock or other bearing layer	Relation to mining operation	Rate of Distri-bution	Example of Ex-mining Land
Type A 	Tailing area near tailing point	19%	Kampong Pandan Cheras 3-1/2 miles Cheras 4 miles Sungai Besi
Type B 	Tailing area and/or slime pond covered later with sandy tailings or sandy dumpings	24%	Gombak, Kampong Pandan, Cheras 3-1/2 miles, Cheras 4 miles Sungai Besi, Castlefield
Type C 	Tailing area far from tailing point, or slime pond	23%	Sentul, Bombak Kampong Pandan, Cheras 3-1/2 miles, Cheras 4 miles
Type D 	Slime pond, tailing area far from tailing point	21%	Sentul, Setapak Castlefield
Type E 	Old mining hole	13%	Pond of Kampong Pandan Setapak

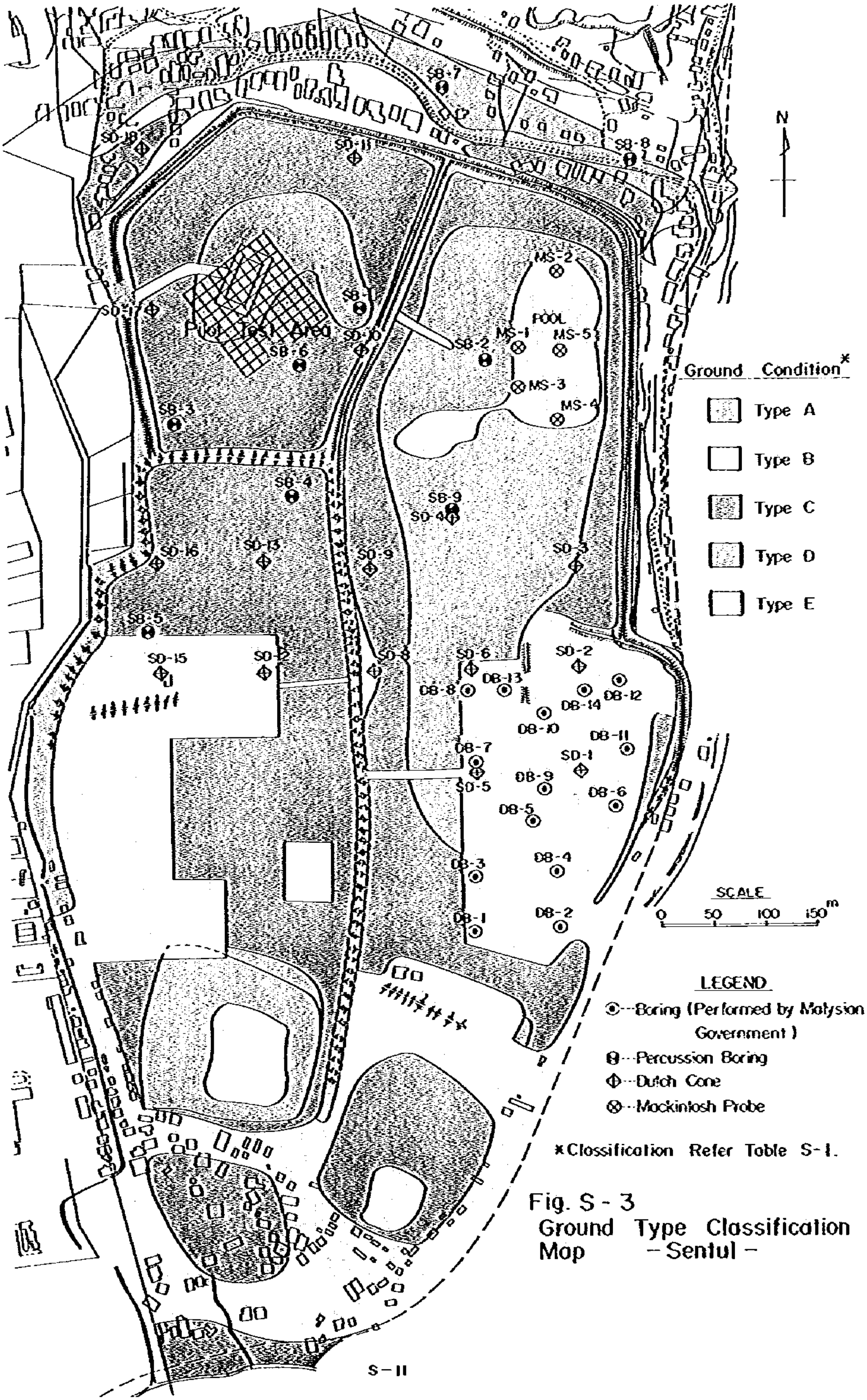


Fig. S - 3
Ground Type Classification Map - Sentul -

Table S-2 Summary of Soil Properties of Each Layer

Type of Soil	Colour	N-Value	N_{sw} *1	Wet Density γ_t (t/m^3)	Undrained Shear Strength c_u (t/m^2)	Angle of Internal Friction ϕ (Degree)	Compression Index C_c	Co-efficient of Consolidation, C_v (cm^2/sec)	Rate of *2 Distribution at Ground Surface (%)	Major Origin and Distribution
Floating Mud	Grey, White, Yellowish Brown, Reddish Brown	0	0	(1.1-1.3)	(0)	-	-	-	0	Young slime in mining pond, e.g. Kampong Pandan, Sentul
Very Soft Clay *3	"	0-1	0	≒1.4 (1.3-1.5)	0.1-0.3	-	0.5-0.8	0.04-0.1	40	Slime deposits, e.g. Sentul Castlefield
Soft Clay *3	"	2-4	0-20	1.5-1.7	1.0-1.5	-	0.5-0.7	0.05-0.2	10	Slime deposits, e.g. Sentapak, Sentul, Castlefield
Medium Stiff Clay	Grey, Reddish Brown, Yellowish brown	4-8 -(15)	20-	(1.7-2.0)	(2.5-5.0)	-	(0.2-0.3)	-	5	Old clayey tailing, unexcavated Old Alluvium, weathered bedrock, e.g. Cheras 3-1/2 miles, Cheras 4 miles
Very Stiff to Hard Clay	Reddish Brown, Yellowish Brown	>15	-	(1.9-2.2)	>10	-	-	-	0	Unexcavated Old Alluvium, weathered bedrock, e.g. Cheras 3-1/2 miles
Very Loose Sand *3	White, Yellowish brown	1-3	0-50	(1.4-1.6)	-	(25-28)	-	-	20	Ex-mining sand, e.g. Kampong Pandan, Cheras 4 miles, Castlefield
Loose Sand *3	"	≒5 (4-10)	50-150	(1.6-1.8)	-	≒30 (28-33)	-	-	20	Ex-mining sand, e.g. Gombak; Kampong Pandan, Sungai Basi, Castlefield
Medium Dense Sand	Grey, Yellowish Brown, Reddish Brown	10-30	150-300	(1.8-2.0)	-	(33-40)	-	-	5	Ex-mining sand, unexcavated Old Alluvium, weathered bedrock, e.g. Cheras 3-1/2 miles
Medium Dense Sand	"	>30	>300	(2.0-)	-	(>40)	-	-	0	Unexcavated Old Alluvium, weathered bedrock, e.g. Cheras 3-1/2 miles
Limestone Bedrock	White, Grey, Yellowish Brown	Refusal	Refusal	2.6-2.8	-	-	-	-	0	-

*1 Required half turn for 1m penetration under 100kg weight by Swedish sounding

*2 Approximate rate of distribution at the ground surface of ex-mining land excluding mining pond

*3 Indicates surface layer

Note: Values in parentheses are estimates based on engineering judgement.

3.4 Recommended Method of Investigation of Ex-Mining Land

The methods of investigating the foundation ground at the ex-mining sites are evaluated and effective investigation methods for the provision of structural design parameters are proposed. Fig. S-4 shows the recommended method of investigation.

3.5 Foundations for Proposed Housing

Results of the test embankment are carefully studied. The effectiveness of sand drains is clearly shown through the experiment. The technical applicability and costs of various types of other ground improvement methods are also studied. The results of the study are summarized in Table 6-5 of Section 6.

Evaluation of the foundations for the proposed housing structures to be constructed on ex-mining land is performed. Suitable types of foundations for different housing structures, i.e. low-, medium- and high-rise, are studied. Costs are also evaluated, and the most recommendable type of foundation is selected according to the size of the structure and the type of subsurface ground. Table S-3 summarizes the findings. The results of the cost study are compiled in Table 8-3 of Section 8.

3.6 By-Products of Tin Mining

Possible uses of the by-products of tin mining are discussed. The by-products can be used for industrial material (clay for ceramics, silica sand, etc.), for construction material (fine and coarse aggregate, etc.), and for fill material. Fig. S-5 outlines the uses of the by-products of tin mining.

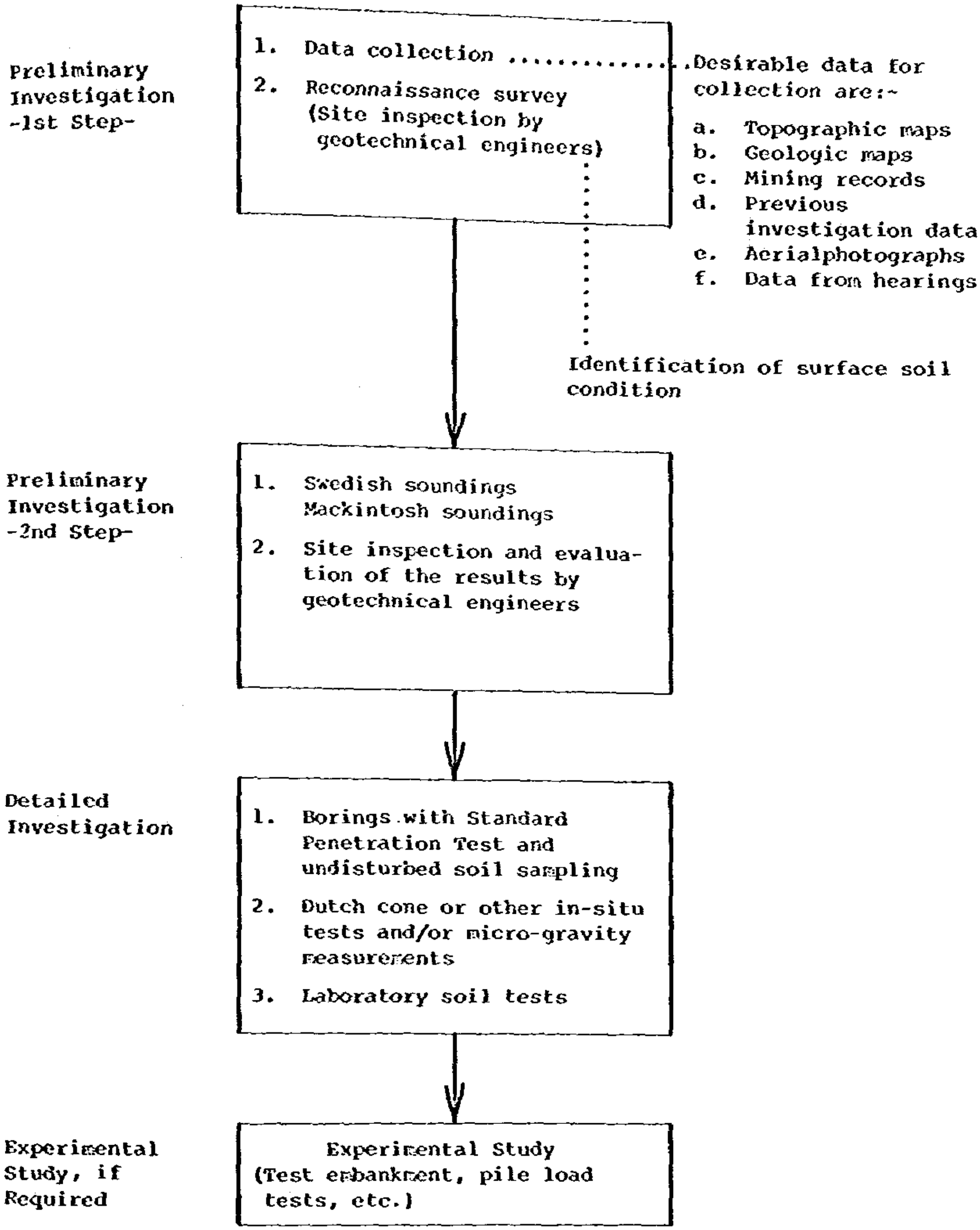


Fig. S-4 Recommended Method of Ground Investigation for Ex-Mining Land

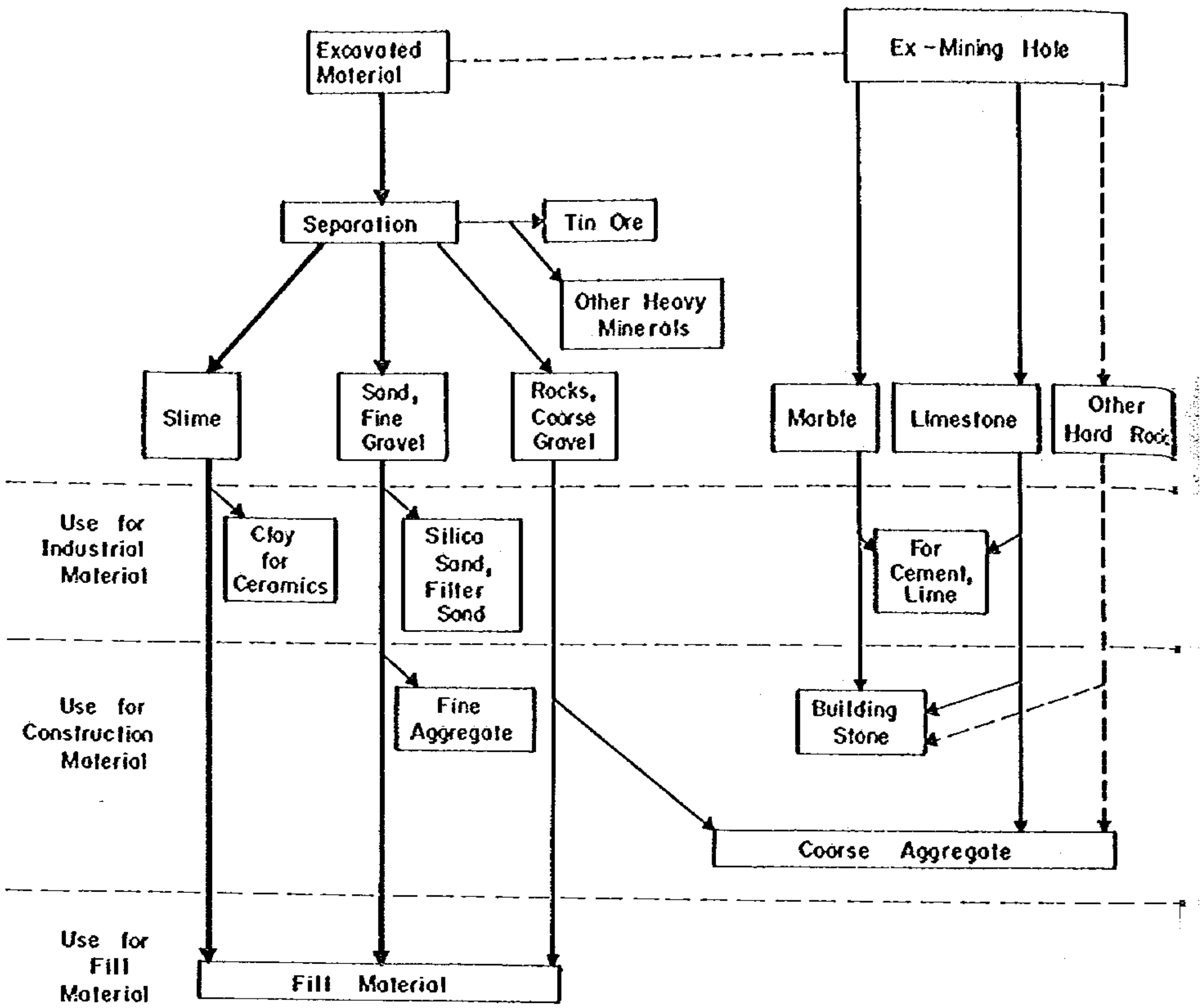
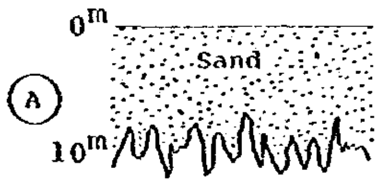
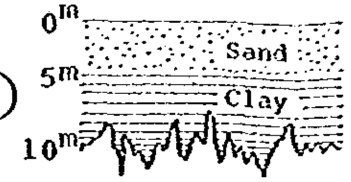
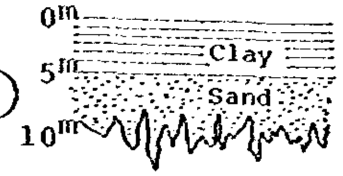
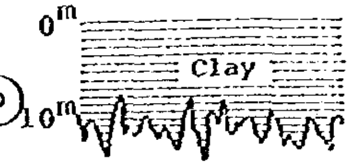
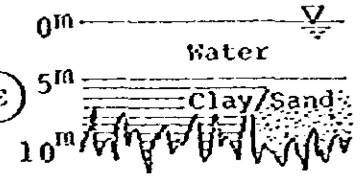


Fig. S-5 Use of Tin Mining By-Products

Table S-3 Recommended Types of Foundations and Ground Improvement Methods

Ground Condition / Size of Structure	(A) 	(B) 	(C) 	(D) 	(E) 
Low Rise (1 - 2F)	Surface Compaction ↓ Direct Foundation (Individual Footing, Strip Footing, Raft)	Preloading (H = 1.5m) + Surface Compaction ↓ Direct Foundation	Sand Mat + Surface Soil (with Compaction) + Preloading (H = 1.5m) ↓ Direct Foundation	Same as (C) * Longer time required for preloading * More settlement by preloading	Not to be used unless necessary as cost of treatment is expensive and time consuming. If necessary, fill with sandy materials and follow procedures as in (B)
Medium Rise (4 - 5F)	Compaction of Sand Layer (D ≒ 5m) Vibro-Rod Dynamic Consolidation Vibroflotation Composer Pile ↓ Direct Foundation [2nd choice] Surface Compaction ↓ Treated Timber Pile (or RC/PC Pile)	Preloading (H = 3m) + Surface Compaction ↓ Treated Timber Pile (or RC/PC Pile)	Sand Mat + Surface Soil (with Compaction) + Preloading (H = 3m) ↓ Treated Timber Pile (or RC/PC Pile) [2nd choice] Replacement of Clay Layer ↓ Direct Foundation	Same as (C) * Longer time required for preloading * More settlement by preloading	Same as above
High Rise (17 - 18F)	Surface Compaction ↓ Steel Pile (or RC/PC Pile, Bored Pile)	Preloading (H = 3m) + Surface Compaction ↓ Steel Pile (or RC/PC Pile, Bored Pile)	Sand Mat + Surface Soil (with Compaction) + Preloading (H = 3m) ↓ Steel Pile (or RC/PC Pile, Bored Pile)	Same as (C) * Longer time required for preloading * More settlement by preloading	Same as above

Note: Preloading for ground Types B and C can be replaced by 'ground water lowering methods' where applicable.

3.7 Recommendations on Tin-Mining Operations and Massive Reclamation

Suggestions and recommendations on tin-mining operations and massive reclamation are also presented. The details are presented in Sections 7 and 9. Among these, a fundamental recommendation is to produce Type B (or Type A) ground by carrying out preloading concurrent with mining operations. To achieve this aim, advance planning of land use will be essential. Fig. S-6 explains the recommendation.

3.8 Cost Study and Development Model

In the present study, development models of low-cost housing are established according to the following three conditions:-

(1) Ground Conditions: 4 cases (Type A, B, C, and D)

(2) Size of Structure: 3 cases (Low-, Medium-, and High-Rise)

(3) Density of Inhabitant: 4 cases

Low Density	60	Persons/Acre
Medium Density	100	"
High Density	200	"
Very High Density	250	"

In total, the study considers 36 cases. In the cost study, unit prices current in 1980 are used. Details of the development cost for each development model are shown in Table S-4. Figs. S-7a to S-7c show the breakdown of development costs for representative models. The development cost

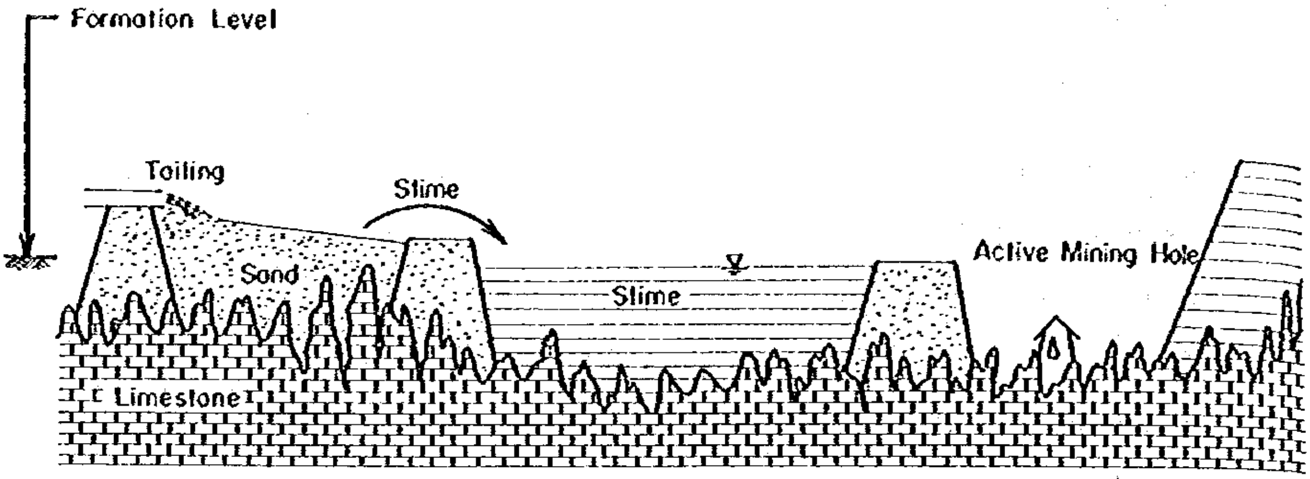


Fig. S-6a

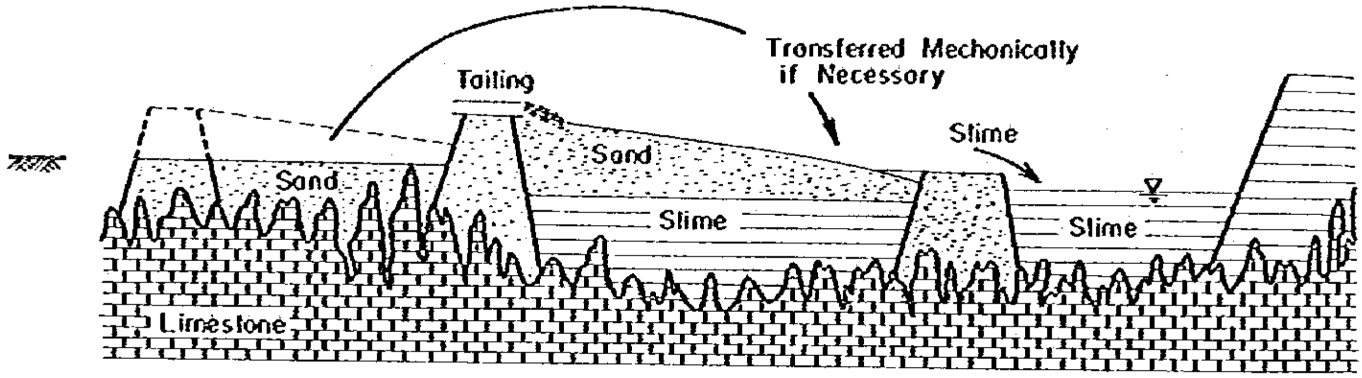


Fig. S-6b

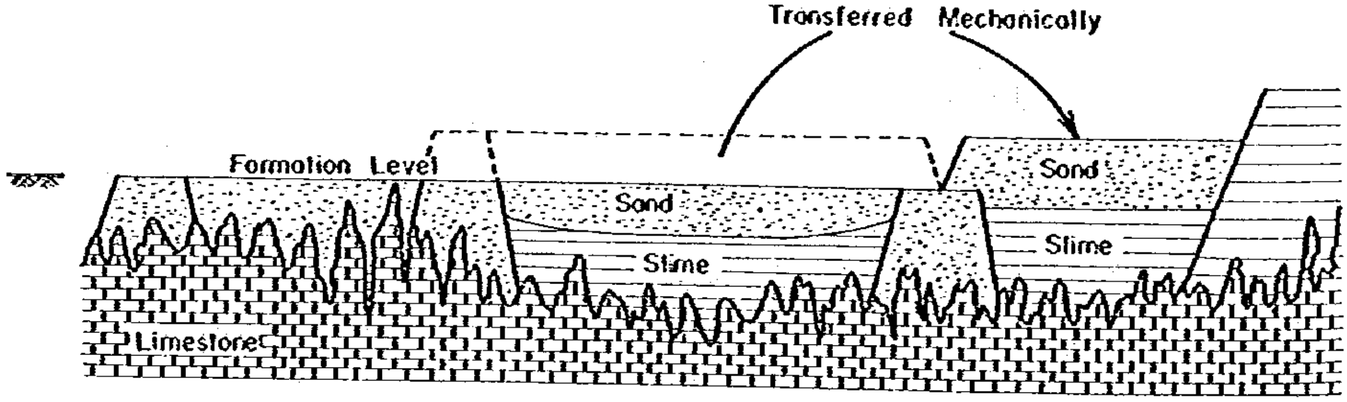


Fig. S-6c

Fig. S-6 Preloading by Sandy Tailings

Table S-4 Development Cost for Each Development Model

Development Model Number	Ground Utilization Model: Development Density	Ground Utilization Model: House Type	Ground Conditions (Type)	Civil Works (M$1,000): Building: Architectural Works	Building: Electrical Works	Building: Mechanical Works	Building: Sub-Total	Foundation*	Land Development: Ground Improvement (Including Interest)	Infrastructure: Road	Infrastructure: Car Park	Infrastructure: Water Supply and Drainage	Infrastructure: Sub-Total	Landscaping: Parks	Landscaping: Open Space	Landscaping: Private Area	Landscaping: Sub-Total	Land Development: Sub-Total	Sub-Total	Investigation, Design, etc. (M$1,000)	Physical Contingency (M$1,000)	Total (M$1,000)	No. of Houses	Unit Cost (M$)	Order in Cost
1	60 Persons/Acre	Low-Rise	A	8,802	852	-	9,654	-	468	1,022	74	1,020	2,116	47	143	63	253	3,090	12,744	637	637	14,018	1,200	11,682	2
2			B						1,664									4,286	13,940	697	697	15,334		12,778	4
3			C						2,764									5,386	15,040	752	752	16,544		13,787	7
4			D						3,247									5,869	15,523	776	776	17,075		14,229	8
5		Medium-Rise	A	12,414	852	132	13,398	703 (2,300)	468	962			2,056		260	26	333	2,857	16,958	848	848	18,654		15,545	16
6			B						958									3,347	17,448	872	872	19,192		15,993	18
7			C						1,063									3,452	17,553	878	878	19,309		16,091	19
8			D						1,225									3,614	17,715	886	886	19,487		16,239	20
9		High-Rise	A	14,262	852	924	16,038	732 (2,716)	468						284	14	345	2,869	19,639	982	982	21,603		18,003	33
10			B						630									3,031	19,801	990	990	21,781		18,151	34
11			C						673									3,074	19,844	992	992	21,828		18,190	35
12			D						760									3,161	19,931	997	997	21,925		18,271	36
13	100 Persons/Acre	Low-Rise	A	14,670	1,420	-	16,090	-	468	1,144	124	1,700	2,968	62	3	105	170	3,606	19,696	985	985	21,666	2,000	10,833	1
14			B						2,438									5,576	21,666	1,083	1,083	23,834		11,917	3
15			C						4,260									7,398	23,488	1,174	1,174	25,836		12,918	5
16			D						5,025									8,163	24,253	1,213	1,213	26,679		13,340	6
17		Medium-Rise	A	20,690	1,420	220	22,330	1,170 (3,829)	468	1,068			2,892		186	44	292	3,652	27,152	1,358	1,358	29,868		14,934	11
18			B						1,262									4,446	27,946	1,397	1,397	30,740		15,370	14
19			C						1,423									4,607	28,107	1,405	1,405	30,917		15,459	15
20			D						1,653									4,836	28,336	1,417	1,417	31,170		15,585	17
21		High-Rise	A	23,770	1,420	1,540	26,730	1,221 (4,529)	468						227	24	313	3,673	31,614	1,581	1,581	34,776		17,388	29
22			B						714									3,919	31,860	1,593	1,593	35,046		17,523	30
23			C						772									3,977	31,918	1,596	1,596	35,110		17,555	31
24			D						879									4,084	32,025	1,601	1,601	35,227		17,614	32
25	200 Persons/Acre	Medium-Rise	A	41,380	2,840	440	44,660	2,340 (7,657)	468	1,337	248	3,400	4,985	111	-	88	199	5,652	52,652	2,633	2,633	57,918	4,000	14,480	9
26			B						2,020									7,204	54,204	2,710	2,710	59,624		14,906	10
27			C						2,326									7,510	54,510	2,726	2,726	59,962		14,991	12
28			D						2,726									7,910	54,910	2,746	2,746	60,402		15,101	13
29		High-Rise	A	47,540	2,840	3,080	53,460	2,441 (9,055)	468						80	48	239	5,692	61,593	3,080	3,080	67,753		16,938	22
30			B						925									6,149	62,050	3,103	3,103	68,256		17,064	26
31			C						1,024									6,248	62,149	3,107	3,107	68,363		17,091	27
32			D						1,178									6,402	62,303	3,115	3,115	68,533		17,133	28
33	250 Persons/Acre	High-Rise	A	59,425	3,550	3,850	66,825	3,005 (11,319)	468	1,483	310	4,250	6,043	130	9	60	199	6,710	76,540	3,827	3,827	84,194	5,000	16,839	21
34			B						1,031									7,213	77,103	3,855	3,855	84,813		16,963	23
35			C						1,149									7,391	77,221	3,861	3,861	84,943		16,989	24
36			D						1,327									7,569	77,399	3,870	3,870	85,139		17,028	25

* Figures in parentheses are for 30 m deep foundations.

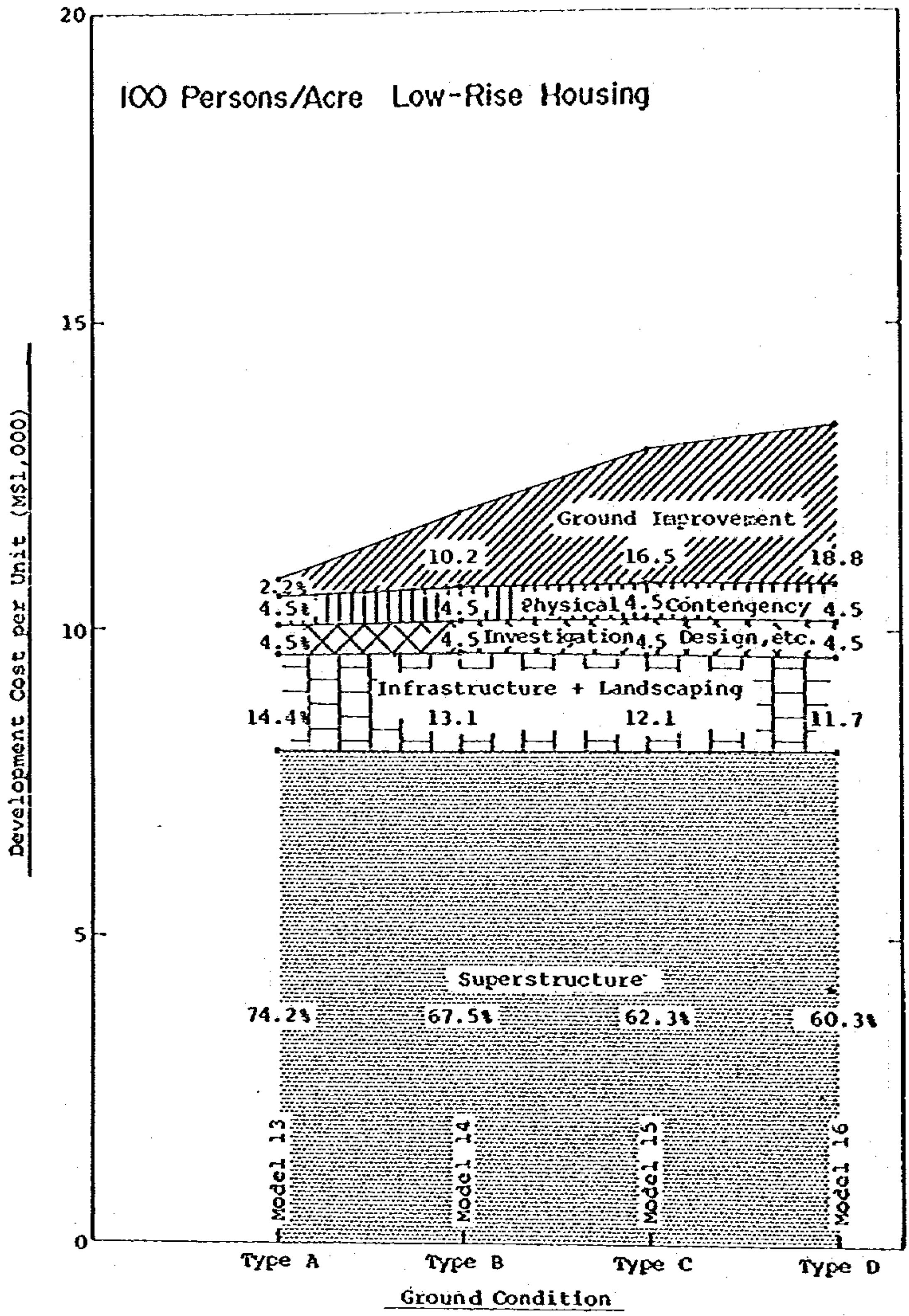


Fig. S-7a Breakdown of Development Cost (1)

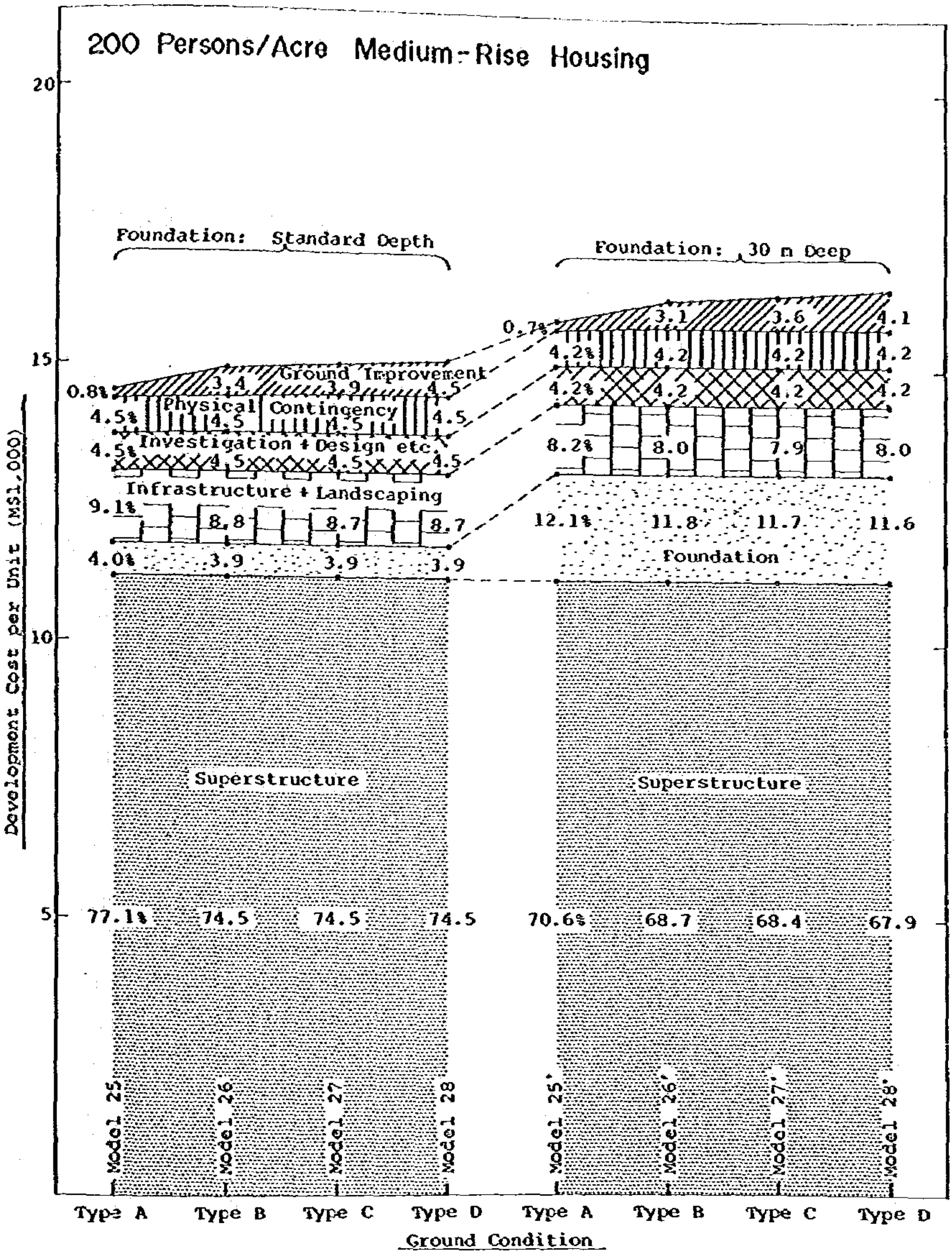


Fig. S-7b Breakdown of Development Costs (2)

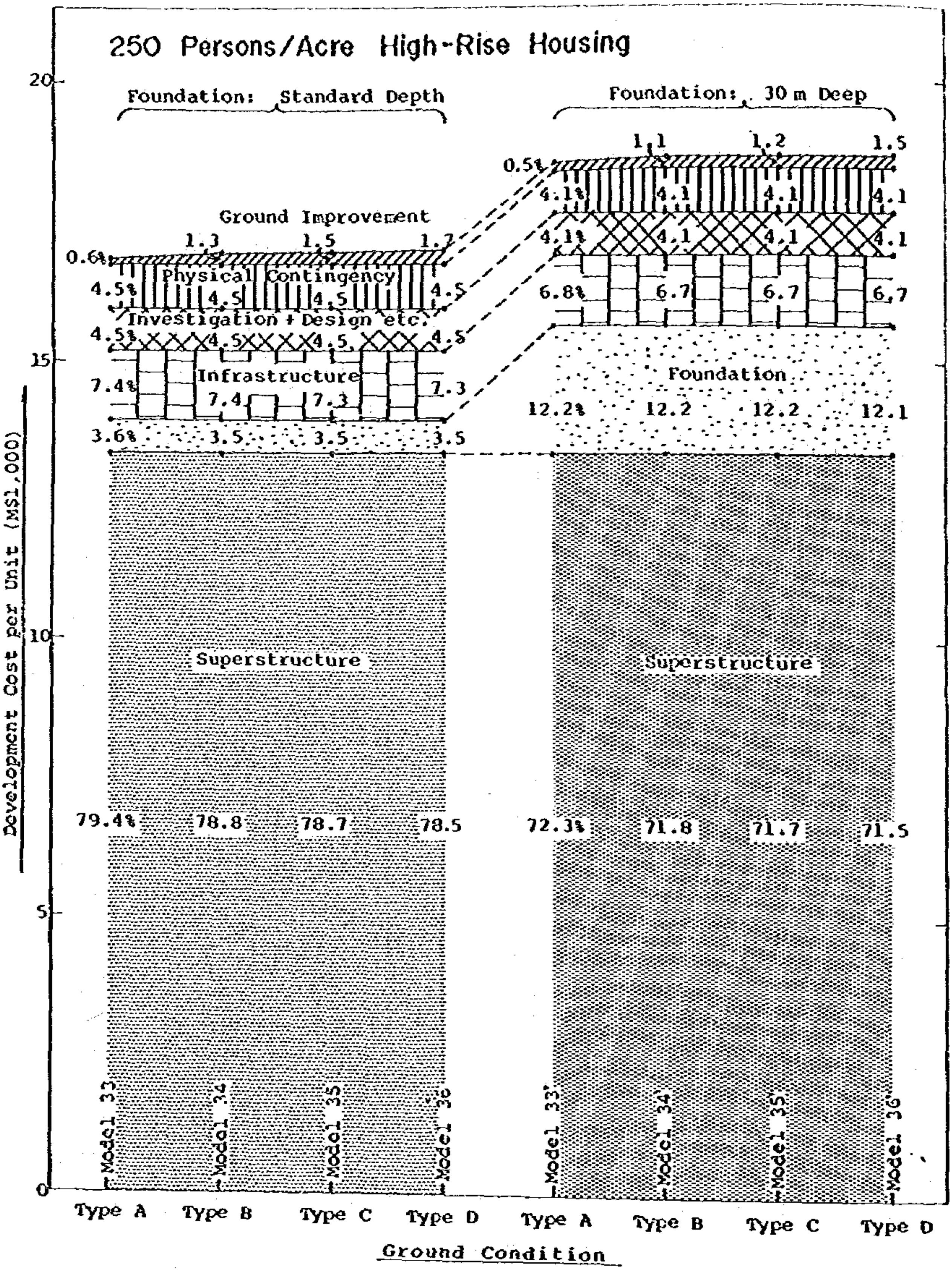


Fig. S-7c Breakdown of Development Costs (3) per housing unit is also plotted versus ground conditions in Fig. S-8. The following observations are made on the results of cost evaluation:-

(1) The cheapest case is Case 13 [Low-rise structures with medium density (100 persons/acre) on Type A ground], and is M$10,833 per unit.

(2) The most expensive case is Case 12 [High-rise structures with low density (60 persons/acre) on Type D ground], and is M$18,271 per unit.

(3) Construction cost for superstructures constitutes major portion of the development cost. The proportion increases with the size of structures, i.e. about 60 to 70% for low-rise, about 75% for medium-rise, and about 80% for high-rise structures.

(4) Development cost per unit increases sharply with the size of structures, i.e. relatively cheap for low-rise housing (between M$10,800 and M$14,300), and considerably more expensive for high-rise housing (between M$16,800 and M$18,300). For medium-rise housing, the unit cost is between M$14,500 and M$16,300. The difference between low-rise and high-rise housing on the same ground or with the same density condition is between M$4,000 and M$6,500.

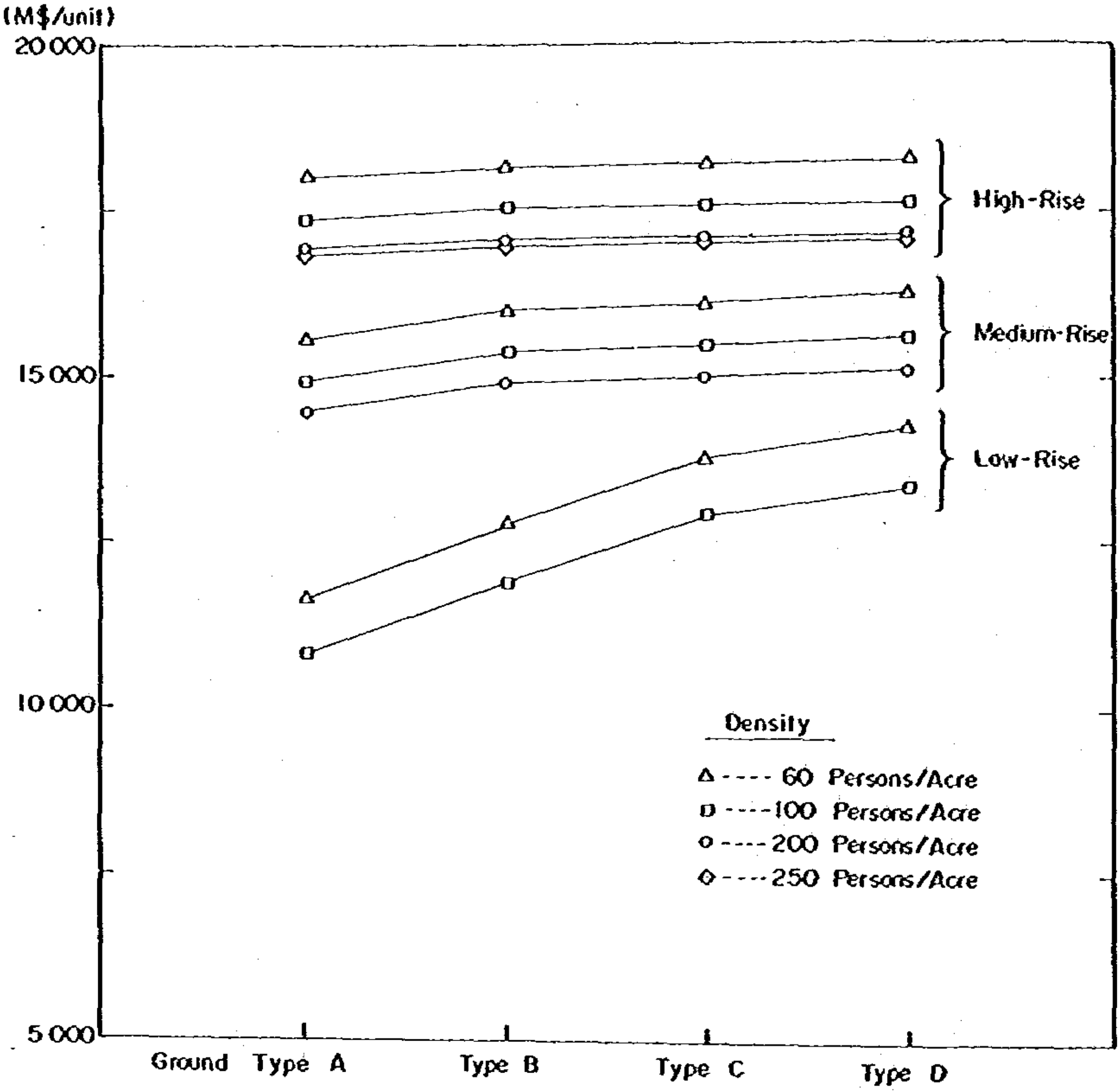


Fig. S-8 Comparison of Development Cost per Unit (w. r. t. Ground Condition)

(5) Ground condition affects the development cost, more sensitive for low-rise structures and less sensitive for high-rise structures. Differences in development cost per unit between ground Types A and D are about M$2,500 (ranges M$2,507 to M$2,547) for low-rise units and about M$200 (ranges M$189 to M$268) for high-rise units.

(6) Development density also influences the construction cost. High-density development gives cheaper unit costs than low-density development.

3.9 Influence of Land Cost and Optimum Development Model

Costs for land acquisition are not included in the cost study presented above. This is because ex-mining land is generally available without cost for housing developments executed by the public sector. However, the various properties surrounding ex-mining land obviously have market values. Therefore, even ex-mining land which is improved and developed for housing development by the public sector must be evaluated and utilised with due consideration for the implicit land value. This consideration is also necessary for the justification of the extra cost and time required for the ground improvement of ex-mining land.

Further evaluation of the development cost of low-cost housing is performed for 3 cases; i.e. for the land price of M$3, 5, and 10 per square foot.

Fig. S-9 shows the difference in development cost per unit between ① housing development using ex-mining land after ground improvement, and ② housing development using general land purchased at the prevailing market price. It is seen from Fig. S-9 that in all cases, housing development using ex-mining land after ground improvement is cheaper than the developments using non ex-mining land purchased at market prices.

For selection of the most appropriate housing development model, due consideration must be given to the implicit land value even in cases where ex-mining land is acquired cheaply by the public sector. For the best use of the available land space, optimum development models must be selected with reasonable consideration of land value as may be represented by the prevailing land price. Fig. S-10 shows the development cost per unit with respect to development density and structure size for various land costs. If we are to consider a housing development in an area with a land value of M$5/$ft^2$, the cheapest model is a medium-rise structure with 200 persons/acre, and the 2nd cheapest being a high-rise structure with 250 persons/acre.

3.10 Financial and Economic Study

A financial feasibility study is performed on the basis of full financial redemption with the establishment of independently estimated financial costs and benefits. The economic aspects of the project are indirectly studied as based on the results of the financial studies.

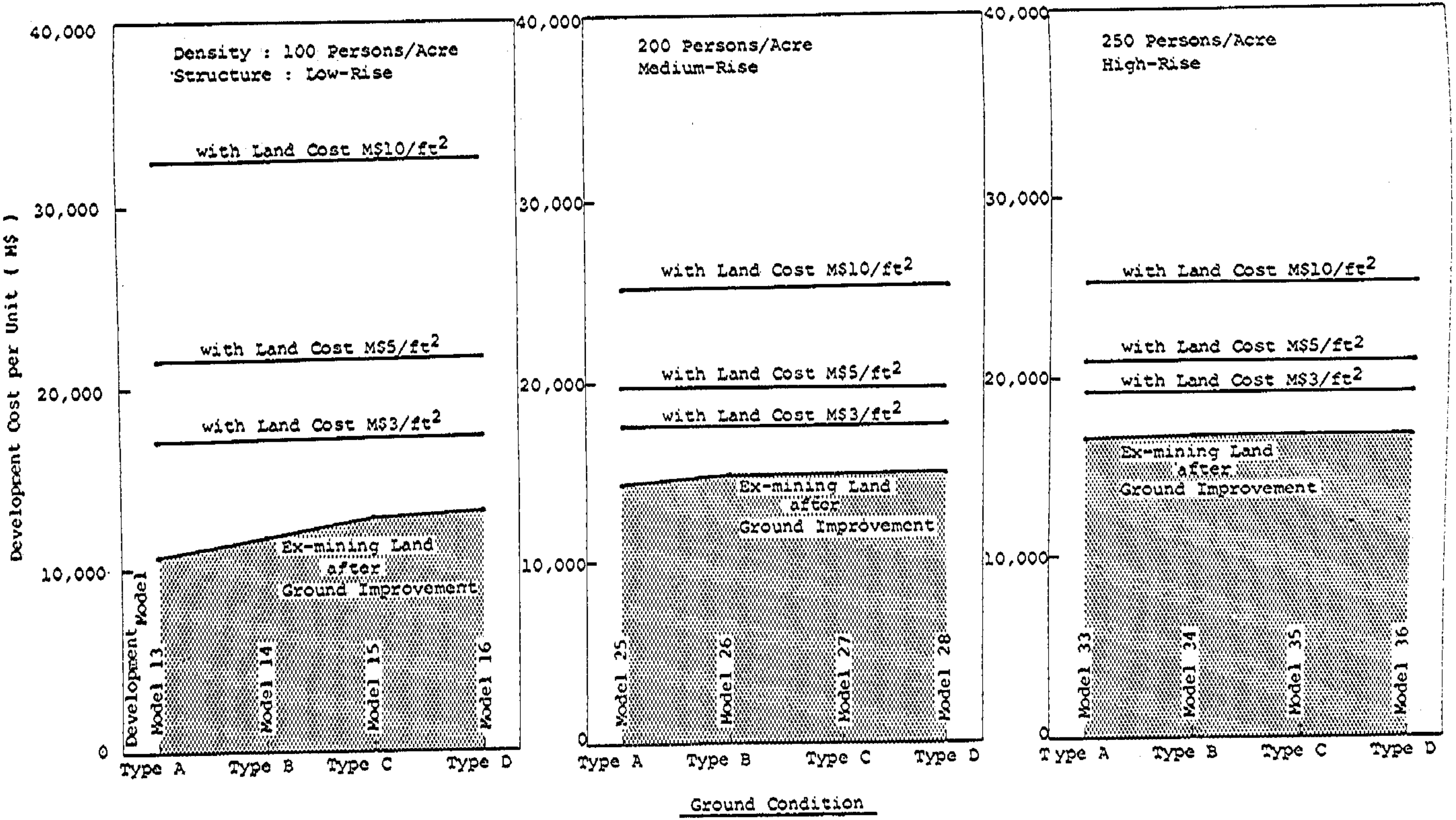


Fig. S-9 Difference of Development Cost by Land Prices

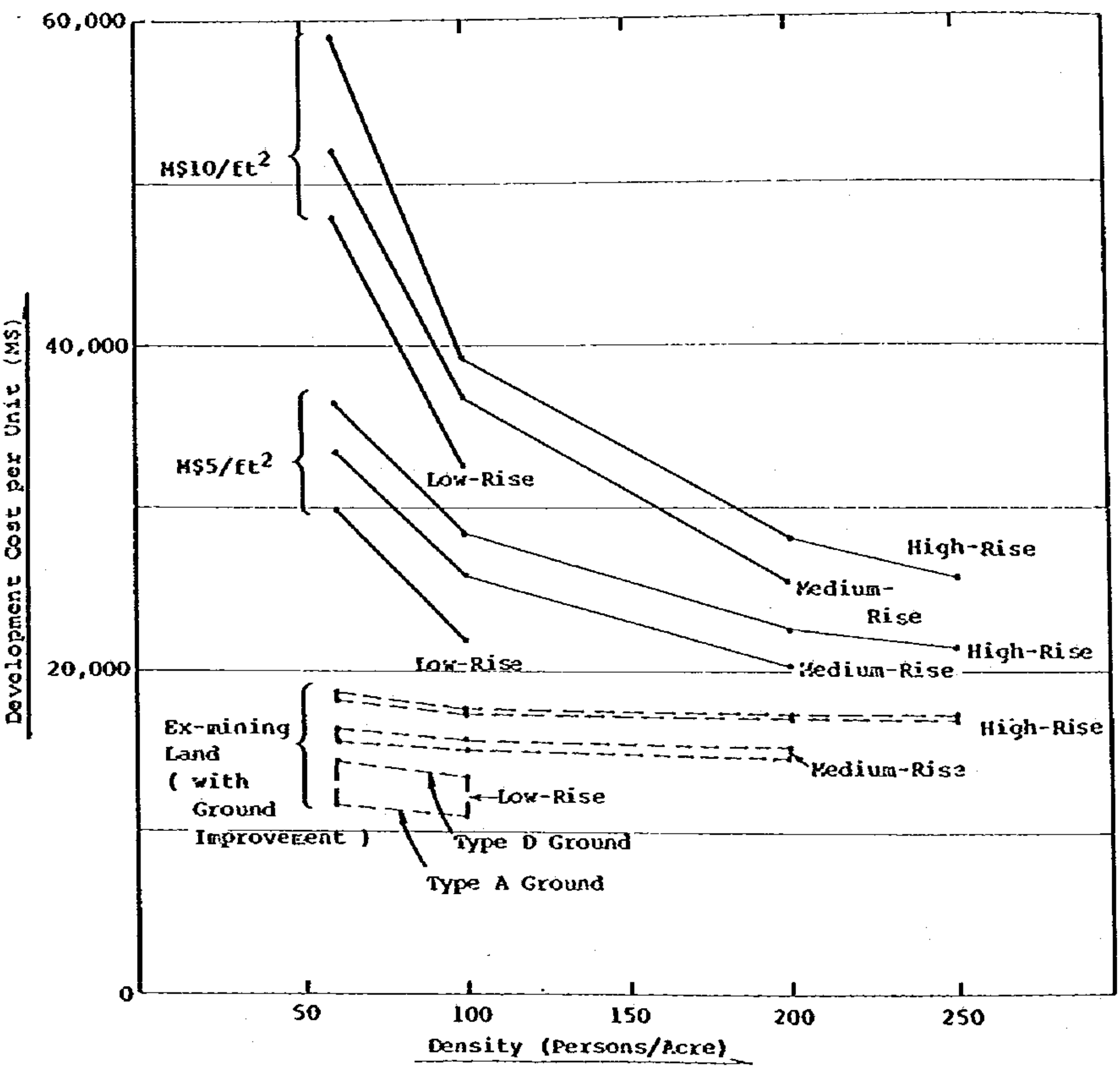


Fig. S-10 Effect of Land Cost to the Development Cost.

3.10.1 Financial Study

Three development models are selected for financial cost analysis from among the 36 development models studied in Section 10. They are Development Models 13, 26 and 34. The financial analysis is performed based on the following conditions:

* Interest Rate: 7.5% and 3.0 %/year
* Ownership : Sale and Rent
* Price Policy : Low-Cost and Commercial

In total, 24 cases are analysed.

The results of the analysis is tabulated and shown in Table S-5. The feasibility of each case and the financial balance 20 years after completion of the project are listed in the right-hand column of the table. According to the results shown in this table, 14 of the 24 cases are financially feasible, while 10 are not. From the same statistics, it also becomes clear that if a commercial price scheme is adopted, all cases become feasible including that embracing a low-cost price policy for low-rise houses on Type A ground when sold.

3.10.2 Equilibrium Price

Among the 24 cases analysed above, financial equilibrium prices are calculated for four cases on Type B ground. The equilibrium price is the selling price or the rent which leads to a financial balance. The equilibrium prices obtained are tabulated in Table S-6.

Table S-5 Financial Balance and Financial Feasibility

Case No.	Development Model No.	Type of House Structure	Ground Condition	Interest Rate	Ownership	Price* Policy	Financial Balance at 20 years after Construction (M$1,000)	Financial Feasibility
1	Model 13	Low-Rise (Single Storey)	Type A	3.0%	Sale	Low Cost	10,626	Yes
2						Commercial	236,419	Yes
3					Rent	Low Cost	-15,997	No
4						Commercial	112,394	Yes
5				7.5%	Sale	Low Cost	4,196	Yes
6						Commercial	229,990	Yes
7					Rent	Low Cost	-65,302	No
8						Commercial	98,299	Yes
9	Model 26	Medium-Rise (5 Storey)	Type B	3.0%	Sale	Low Cost	-24,180	No
10						Commercial	430,965	Yes
11					Rent	Low Cost	-57,496	No
12						Commercial	196,213	Yes
13				7.5%	Sale	Low Cost	-73,955	No
14						Commercial	411,500	Yes
15					Rent	Low Cost	210,967	No
16						Commercial	132,369	Yes
17	Model 34	High-Rise (18 Storey)	Type B	3.0%	Sale	Low Cost	-52,158	No
18						Commercial	487,286	Yes
19					Rent	Low Cost	-87,910	No
20						Commercial	216,994	Yes
21				7.5%	Sale	Low Cost	-144,821	No
22						Commercial	462,002	Yes
23					Rent	Low Cost	-310,174	No
24						Commercial	118,995	Yes

* Low Cost : Low-Cost Policy Price
* Commercial: Commercial Price

Table S-6 Equilibrium Price per Unit

Development Model	Structure	Ground Condition	Interest Rate	Ownership	Equilibrium Price in 1983 (M$)	Equilibrium Price in 1980 (M$)	Low-Cost Policy Price (M$)	Ratio between Equilibrium Price in 1980 and Low-Cost Policy Price
Model 26	Medium-Rise	Type 8	7.5%	Sale	19,250	15,496	11,310	1.37
				Rent	183*	147*	62*	2.37
Model 34	High-Rise			Sale	21,900	17,629	11,310	1.56
				Rent	209*	168*	62*	2.71

* per month

3.10.3 Breakdown of Development Cost

Composition of the development cost is analysed and the breakdown of development cost is prepared. The total development cost is determined by adding 15% of price contingency to the direct cost. A typical example of the breakdown of the development cost is shown in Table S-7. The foreign currency portion of the total cost is about 20%. As the foreign currency portion is relatively low, it is probable that the secondary multiplier effect is quite high.

3.10.4 Economic Study

A certain amount of difficulty exists in estimating economic benefits in the present study due to reasons of uncertainty regarding the concept of benefit for housing projects in general and for this project in particular as it embraces a cost policy for lower income groups.

Table S-7 Breakdown of Development Cost for Development Model 26 (Medium-Rise Houses on Type B Ground)

	100 acre (1,000M$)			Per Housing Unit (M$)		
	Total Amount	Local Currency	Foreign Currency	Total Amount	Local Currency	Foreign Currency
1. Civil Works	54,204	42,470 (78)	11,734 (22)	13,551	10,618 (78)	2,934 (22)
1) Building	44,660	35,028 (78)	9,632 (22)	11,165	8,757 (78)	2,408 (22)
·Architectural Works	41,380	33,104 (80)	8,276 (20)	10,345	8,276 (80)	2,069 (20)
·Electrical Works	2,840	1,704 (60)	1,136 (40)	710	426 (60)	284 (40)
·Mechanical Works	440	220 (50)	220 (50)	110	55 (50)	55 (50)
2) Foundation	2,340	1,989 (85)	351 (15)	585	497 (85)	88 (15)
3) Land Development	7,204	5,453 (76)	1,751 (24)	1,801	1,363 (76)	438 (24)
·Land Improvement	2,020	1,515 (75)	505 (25)	505	379 (75)	126 (25)
·Infrastructure	4,985	3,739 (75)	1,246 (25)	1,246	935 (75)	312 (25)
·Landscaping	199	199 (100)	- (0)	50	50 (100)	- (0)
2. Administration & Supervision	2,710	2,710 (100)	- (0)	678	678 (100)	- (0)
3. Physical Contingency	2,710	2,114 (78)	596 (22)	678	529 (78)	149 (22)
4. Price Contingency	8,944	6,976 (78)	1,968 (22)	2,236	1,744 (78)	492 (22)
Total	68,568	54,270 (79)	14,298 (21)	17,142	13,568 (79)	3,575 (21)

* Figures in parentheses indicate percentage.

(1) Opportunity Cost of Ex-Mining Land

At present, ex-mining land is not fully utilized and thus provides a significant opportunity for development with a relatively small investment. The capital inflow required for ground improvement is almost a zero amount for Type A ground and is about 1 to 10% of the total development cost for Type B ground. These amounts are cheaper than those necessary to acquire land other than ex-mining property for housing development. Thus, the development of housing projects on reclaimed ex-mining land can produce a significant effect on the nation's economy as the said property represents an opportunity cost of almost zero at present.

(2) Aspect of Social Welfare

According to the financial analysis, all projects under the low-cost scheme, with the exception of sale for Type A ground, are not feasible unless the low-cost policy price is adjusted to meet the equilibrium price. In this case, it is necessary to evaluate the project from the viewpoint of social welfare. Although the project is not feasible through simple financial evaluation, consideration of the benefits accrued through a social welfare transfer indicated that a large number of people could enjoy a healthier lifestyle.

(3) Multiplier Effect

i) Multiplier Effect by Flow

Through large capital investment for housing developments on ex-mining land, equally large demand will be produced for cement, steel products, construction equipment, etc. In addition, demand for construction and transportation services will be created, which in turn will create demand for energy, communications, etc.

As the local currency portion of the project is considerably high (about 80%), it is probable that the secondary multiplier effect is quite high and will continue for a considerable period of time. Further, as the proposed projects are located in and around Kuala Lumpur, the employment effect will also be significant.

ii) Multiplier Effect by Stock

In addition to the multiplier effect through the development of the project, a multiplier effect will be produced by the social and economic interaction of the inhabitants of housing developments. This type of multiplier effect will increase demand for general consumer industries and others related to recreation, education, etc.

It is concluded that the multiplier effect of the project is extremely high and the project will contribute to the economical development of Malaysia. This multiplier effect is one important factor in making the proposed project feasible.

(4) Project Feasibility

A conclusion of project feasibility can be supported given the situation where ex-mining land can be procured at an opportunity cost of almost zero and can be used for housing development with reasonably small amounts of capital investment. It is considered that the project is also economically feasible as the economic price approaches the commercial price, and as the project also produces various multiplier effects and social benefits. The following aspects are important for the feasibility of the project:

* Evaluation of Multiplier Effects
* Utilisation of a Low-Cost Fund
* Establishment of a Social Welfare Fund

3.11 Suggestions for Future Activities

Some concluding remarks are prepared for the future action of the proposed project.

(1) Ex-mining land is feasible for housing development, the degree of feasibility depending on the ground conditions and the necessary ground treatment required to make it feasible. Of the 5 ground conditions classified earlier for ex-mining land, Type A is the most suitable for housing development followed by Type B. It is recommended that housing development on ex-mining land should begin with ground condition Types A and B.

(2) When proceeded by well established development planning, ex-mining land, including Type C and D grounds, can be fully utilised for housing developments as well as other purposes. For most cases, cost requirements for the improvement of soft ground are less than 10% of the total development cost and the time required is 1 to 1.5 years.

(3) The following actions should be carried out immediately, especially in the Federal Territory so that more land can be released to ease the housing shortage:

* Investigation and classification of ex-mining lands into 5 types of ground conditions, and preparation of classification maps.
* Establishment of land-use and housing-development planning, and execution of soft ground improvement work according to an established plan.
* Modification of tin mining operations according to recommendations provided in this report.

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