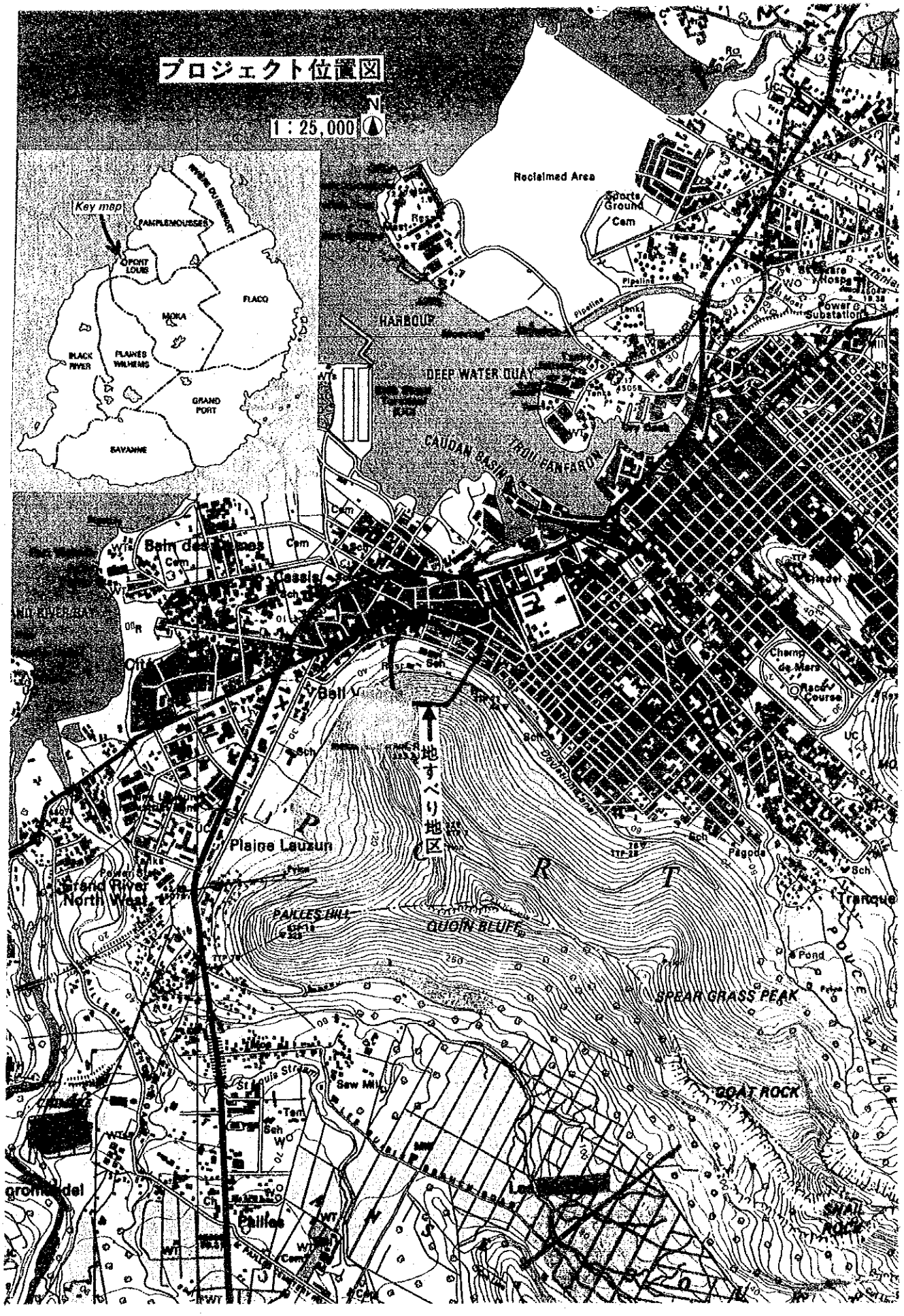
社会開発協力部報告書

モーリシァス国
ポートルイス市
ラ・ビュット地区地すべり対策調査(短期専門家)
調査報告書

昭和63年10月

国際協力事業団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DEEP WATER QUAY
CAUDAN BASIN
Bain des Dames
Cassis
Champ de Mars
Race Course
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地すべり地区
Plaine Lauzun
Grand River North West
PAILLES HILL
QUOIN BLUFF
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GOAT ROCK
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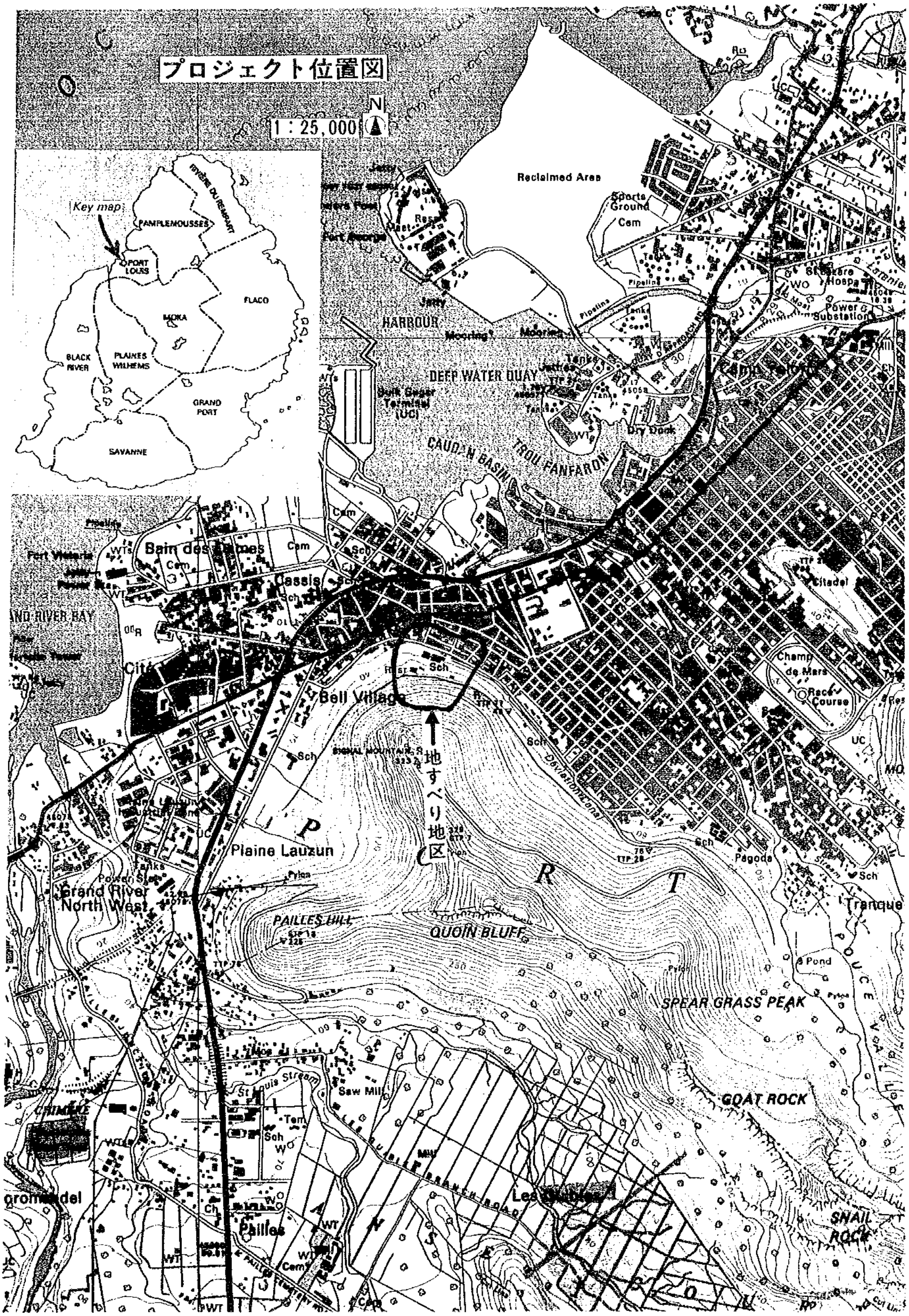
St Louis Stream
Saw Mill
Phillips
SNAIL ROCK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Champ de Mars
Race Course
Power Substation
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Plaine Lauzun
Grand River North West
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GOAT ROCK
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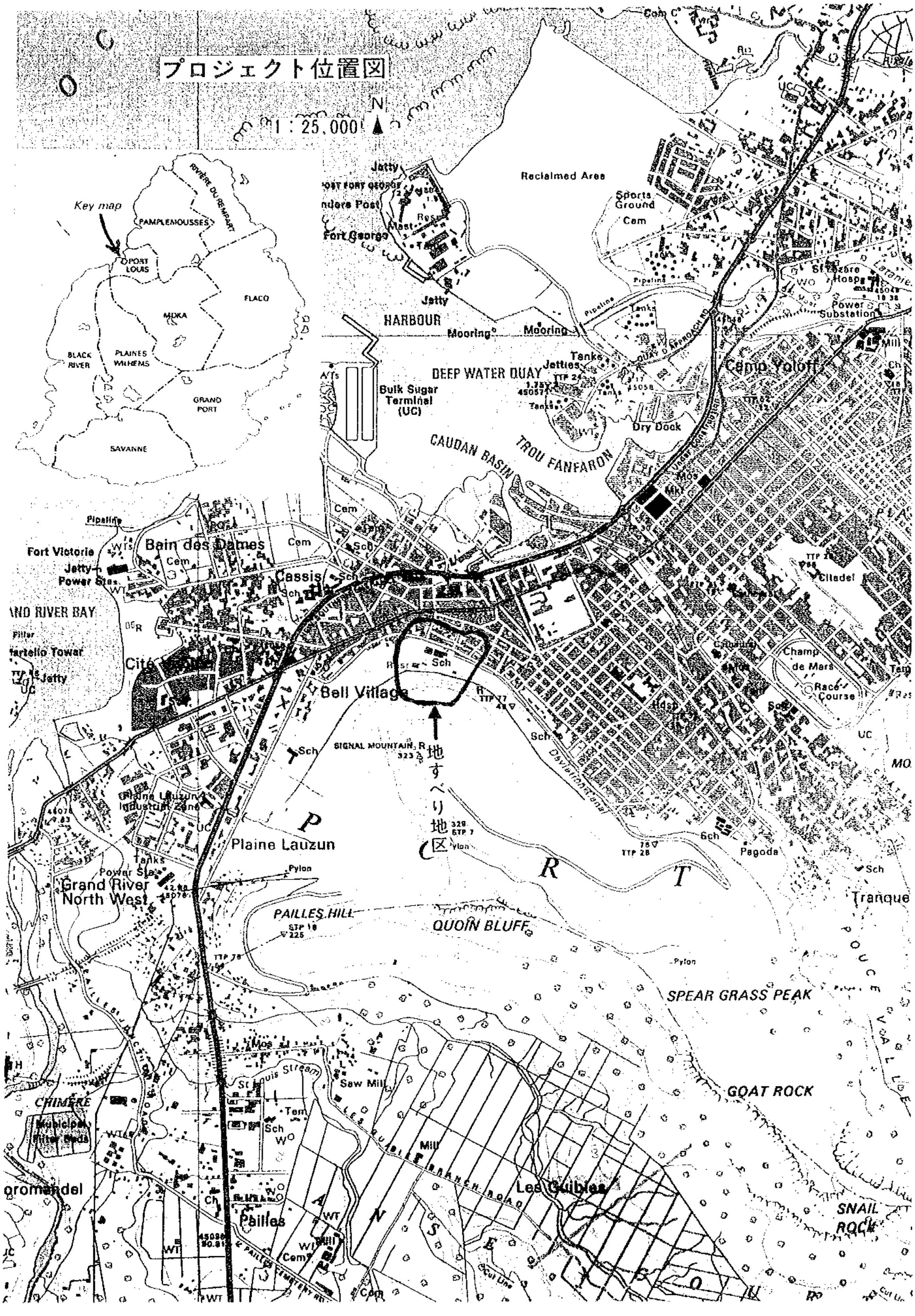
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Grand River North West
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QUOIN BLUFF
Pagoda
Tranque
SPEAR GRASS PEAK
GOAT ROCK
SNAIL ROCK
CHIMÈRE
Municipal Filter Beds
Saw Mill
Mill
Les Guibles
Pailles
Coromandel

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I　調　査　概　要

1. 要請の背景及び経緯

(1)　モーリシァス国ポートルイス市内ラ・ビュット（La Butte）地区において数年前から地すべりが発生、住民避難、学校閉鎖。

(2)　発生地区の麓（ふもと）は海岸まで約 100 m、空港と首都を結ぶ幹線道路、首都への水道管が走っているところ。モーリシァス国、ポートルイス市とも事態を重視、英国へ調査を要請。

(3)　1987 年 9 月 28 日～ 10 月 7 日、英国専門家予備調査。

(4)　日本政府に対し調査のための専門家派遣を要請。

5 名 × 12 カ月

(5)　日本側は短期派遣で対応。

目的　①　地すべり発生機構、運動機構の想定。

②　①に基づく緊急対策工の策定。

③　緊急時における避難計画の策定。

2. 派遣団の構成

団　　長	渡　正亮	（地すべり学会　会長）
地すべり調査専門家	小林　英昭	（建設省近畿地方建設局河川部　河川調査官）
地すべり対策専門家	仲野　公章	（建設省河川局砂防部傾斜地保全課　課長補佐）
地質専門家	池田　精寿	（㈱池田自然開発調査　代表取締役）
砂防専門家	黒川　興及	（(財)砂防地すべり技術センター技術課　課長代理）

3. 派遣期間

昭和 63 年 9 月 3 日から 9 月 24 日の 22 日間

うち、モーリシァス国滞在 9 月 5 日から 9 月 20 日

マダガスカル国滞在 9 月 20 日及び 9 月 21 日

4. 調査結果の概要

" TECHNICAL STUDY REPORT ON THE LANDSLIDE AT LA BUTTE IN MAURITIUS, SEPTEMBER 1988 "

" MEMORANDUM "

(1) 現況について

○ 大規模な地すべり（主な活動範囲と認められる部分だけでも幅約600m，長さ約400m）がモーリシャス国の首都であるポートルイス市の市街地で発生し、住家をはじめ道路等、公共施設に甚大な被害を与えている。

○ 地すべりの上部には、クラックや段差が明瞭に認められる。よって、次期雨期には地すべり現象の活性化が十分予想される。

(2) モーリシャス国への提言について

○ 応急対策

雨期を目前に控えて、当面、人的被害を最小限にとどめるために、警戒避難体制の確立と応急工の実施が必要である。

前者については、本国から携帯した機器の設置をし、その利用の方法について技術移転を行った。

後者については、当面実施可能と思われる表面水の排除工について提案した。

○ 今後の調査計画

地すべりの規模並びに被害が大きい割合には技術的情報が不足しているので、警戒避難基準の精度を上げるためにも、また今後の対策工の諸元等を決定するためにも、より充実した調査が必要である。（地形調査、ボーリングによる地質調査及び地下水調査、移動量調査、データ解析、設計等）

○ 恒久対策

最終的には、地すべりを安定させなければ住民の生命・財産及び公共施設を地すべり災害から守ることができないので、ラ・ビュット地区の地すべりにおいて、現在までの調査では集水井工、鋼管杭工及び押え盛土工等が必要となると思われる。

なお、これらの対策工法及び諸元の最終的決定は、今後の調査をまたなければならない。

(3) モーリシャス国の派遣団への協力度合

今回の調査にあたって、モーリシャス国の関係機関及び地元ポートルイス市のラ・ビュット地区の地すべりに対する関心は極めて高く、今回の調査団への協力は、すこぶる満足のいくものであった。

また、担当窓口であるMinistry of Local Governmentからは日本国に対する今後の協力に対して強い要請が出され、調査団としてはモーリシャス国側の意向はマダガスカル大使館をはじめ、本国関係機関に伝えると回答した。

(4) 今後のモーリシャス国への協力に関するコメント

1) モーリシャス国にとっては、地すべり現象そのものが全く初めての経験であり、とまど

いが感じられた。1987年に地すべり活動が活性化して以来、この地すべり問題がマスコミでしばしば取り上げられてきた状況等から判断すると、かなり大きな社会問題になっていると考えられる。モーリシァス国側の日本国の地すべり対策技術の評価は高く、また、我が国からの協力に対する期待は非常に大きなものがある。したがって、ラ・ビュット地区の地すべり対策については、積極的に協力を推進する意義は大きいと考えられる。

2) まず、地すべり対策に関する本格的な技術移転が必要となろう。そのためには、地すべり専門家の長期派遣とカウンターパートの我が国での研修が有効であろう。

3) 地すべり対策はモーリシァス国の技術者などにとっては初めての体験となるため、工事の施工能力や管理能力及び施工歩掛等に不確定要素が多い。したがって、開発調査においては、モデルテストを実施するなど、入念な調査内容とする必要があろう。

4) 本格的な地すべり防止工事については、少なくとも技術的側面からみてモーリシァス国政府が独自では実施し得ないであろう。また、ラ・ビュット地区の地すべり対策がその発生場所からして非常に公共性が高く、また、災害対策という事業の性格上、経済的な収益性が比較的低いことを考え合わせると、無償資金協力を検討する意義も深いと考えられる。

Ⅱ TECHNICAL STUDY REPORT

ON

THE LANDSLIDE AT LA BUTTE

IN

MAURITIUS

SEPTEMBER 1988

THE TECHNICAL STUDY MISSION

JAPAN INTERNATIONAL COOPERATION AGENCY

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1. Foreward

This report has been prepared by the technical study mission of the Japan International Cooperation Agency dispatched by the Government of Japan to study possible measures for the landslide at La Butte in Port Louis City in Mauritius. The mission consisting of the team leader of Dr. M. Watari and other four experts carried out a field survey and data collection of the previous investigations during the period from 6th September, 1988 to 19th September, 1988. The mission has raised several proposals and advices for the landslide protection measures through assessment of the findings from the field survey and examination of the previous studies.

The mission wishes to express heartfelt thankfullness for patronage and kind cooperation extended by the Ministry of Local Government and the organisations concerned of the Government of Mauritius in connection with successful completion of this study with targeted engineering depth.

Lastly the mission hopes that this report will be helpful for the Government of Mauritius in undertaking necessary measures for the landslide at La Butte in Port Louis.

2. The Study

2.1 Background of the Study

At La Butte, Port Louis City, the capital of Mauritius, large scale landslide has been observed for these several years in the northern slope of the Signal Mountain. The movement was suddenly accelerated in March-June, 1987 and appears to be still developing continuously. The Government of Mauritius designated the area of about 12.5 ha as the landslide danger area.

The Government of Mauritius submitted in March 1988 an official request to the Government of Japan for technical assistance for the detailed investigation and study with a view to establishing counter-measures for the landslide. In response to the request the Government of Japan despatched the technical study mission to Mauritius through the Japan International Coorperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan. The mission headed by Dr. Masasuke Watari, president of the Japan Society of Landslide, conducted a field survey and had discussions on the project with the officials concerned of the Government of Mauritius.

2.2 Objectives of the Study

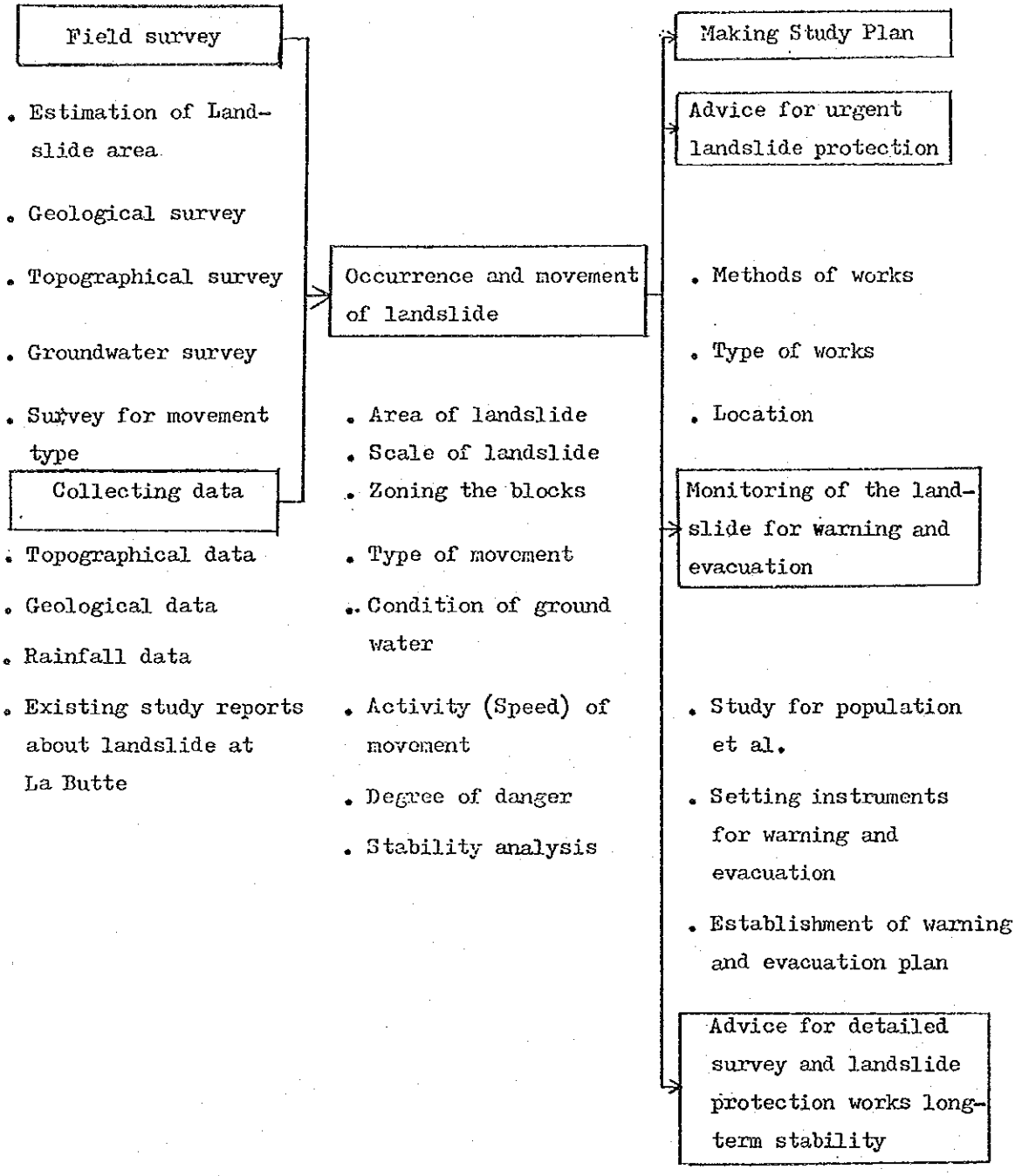
The major objectives of the study are as follows:

1. to examine the mechanism of the occurrence and movement of the landslide by means of field survey and obtained data,
2. to make a plan for urgent landslide protection works,
3. to establish a temporary warning evacuation system in an emergency,

   and
4. to advise an outline of detailed survey and landslide protection works of long-term stability.

2.3 Plan of the Study

The survey and study were carried out in line with the following work flow chart.



3. Assessment of Landslide

3.1 Geomorphology

(1) General geomorphology

Mauritius island is entirely composed of volcanic formations except for small marginal tracts of uplifted coral reef and beach.

The volcanic formation is mainly devided into two series, older volcanic and younger volcanic one. The old volcanic series distributed in some places forming rugged mountainous features through the process of long-term erosion. On the other hand the younger volcanic series spread widely in the slope of lava plateau.

It is presumed that the geological time of the old volcanic series and the younger series are respectively, miocene and pleistocene.

Geological compositions consist of mainly basalt lava associated with pyroclastic flow materials and ashy materials in minority.

(2) Geomorphology in the landslide area

La Butte, the landslide area is located on the skirt of the Signal Mountain (300 m in elevation, of old volcanic series). Steep ridge and slope are formed on the top part and mountainside. In the lower part the shape of slope is gradually changed into gentle one 10 to 15 degrees in grade which is related to the landslide movement.

Geological composition principally consists of three layers, namely basalt rock, pyroclastic flow and tuffaceous one. Basalt rock layer and basalt lava of old volcanic series are distributed under the ground 20 to 30 m in depth. Pyroclastic flow which shows talus condition is spread with thickness of about 20 m on the upper part. While tuffaceous layer, possibly the deposit in the water such as marsh is interlaid between the clastic basalt layer and the basalt rock layer. This tuffaceous layer is impermeable clay and consequently slide surface of landslide is formed along this layer.

3.2 Present Landslide Movement and Previous Studies and Measures

(1) Previous Works

After acceleration of landslide in the rainy season of 1987, the Government of Mauritius carried out first preliminary investigation. The findings have been summarized as follows:

- Although the movement was suddenly accelerated in March - June 1987, it is assumed that landslide occurred in long time ago and will continue to develop in the future.
- The sliding mass is composed of thick colluvial materials having low shear strength of $c' = o'$ and $\phi' = 9.5°$
- Sliding area is about 600 m in width and 400 m in length.
- Slide surface is assumed at 15 - 30 m in depth.
- Landslide is assumed to be caused by not only heavy rainfall but supplied water from the Maupin reservoir and water pipes.

Based on the results of first preliminary investigation, the Government of Mauritius decided to take the following measures; relocation of water pipes, demolition of the Maupin reservoir, tentative closing of Ecole de la Montagne, evacuation of damaged buildings including Yamaha Trading Building and Mosque, filling of cracks, displacement survey of landslide movement and installation of inclinometer.

(2) Present Condition of the Landslide

The program mentioned above is mostly completed and relevant displacement survey and measurement of inclinometer have been continued by the Ministry of Works to date.

According to the existing displacement data, ground subsidence in the Line-1 located at head portion in sliding area is remarkable. Especially in the section between survey point 1/20 and 1/33, subsidence rate is about 12 cm during the period from 16 December 1987 to 6 June 1988 in maximum. In the Line-2 and Line-3 located at the middle and the toe portion, respectively, there is a general tendency of upheaving.

According to the measurement results of inclinometer and observation of drilling cores, slide surface is probably formed about 25 m - 28 m deep at the middle portion and 5.5 m - 20 m in the lower portion.

The findings based on the site reconnaissance are as follows; development of cracks is sporadically found in the head portion of sliding area. Upheaving parts are continuously observed on the road at the lower portion, accordingly the toe portion boundary of the main sliding area is clearly identified. It is observed that in the main sliding area, subsidence at the upper portion and upheaving at the lower portion have been taking place judging from the shape of cracks and deformation of building. In the adjacent area of eastern boundary of main sliding area, although buildings deformation is widely observed, subsidence or upheaving due to sliding are not found. Therefore, building deformation in this area is probably caused by main landslide.

Considering the present condition mentioned above, the landslide movement appears to be developing continuously. Therefore, detailed study and investigation are required to establish measures to stabilize the landslide permanently.

3.3 Mechanism of Landslide

(1) Area and Zoning

In the landslide area tension cracks occur in the upper part and upheavings take place at the tip part. Through detailed tracing in-situ of tension cracks and upheaving in the natural slope, the area of active zone of landslide is identified as shown in Figure 1. In addition, three influenced zones are observed. In these zones at present distribution of tension cracks and upheaving is not obvious; however, in future, those influenced zones will be possibly developed to active zones due to inter-related force. This possible development will be checked in subsequent investigation. Influenced zones exist in eastern side, western side and northern side to the main zone and particularly the eastern side is 200m from the main zone, where deformation of houses is observed. Active zone exists in 450 m in width from east to west as a whole. Active zone is assumed to comprise two blocks, western block and eastern block in view of different length. The condition of landslide of each zone is described below.

(a) Western Block : width 300 m, length 330 m, area 10 ha, depth 30 m. This block bears the largest scale of movement associated with minor block on the upper part.

(b) Eastern Block : width 150 m, length 230 m, area 4 ha, depth 15 m.

(c) Entire Active Zone (sum up of western block and eastern block) : width 450 m, length 330 m, area 14 ha, depth 30 m.

(d) In the eastern side influenced zone, the upper limit of (southern limit) of landslide area is bordered below the lower location, the French Drain Channel, 32 m in elevation, where deformation is not found. Judging from the scale of plan it is assumed that the depth of landslide mass is less than half of western block of active zone.

(2) Distribution of slide surface and scale of landslide

According to the previous test boring carried out in the lower part of the western block of the active zone, geological composition consists of following three layers, from the ground surface to the below, pyroclastic flow (clastic basalt with minor talus), tuffaceous mud layer and basalt lava. (Fig. 2)

Basalt lava in the lowest layer is stiff and fresh, therefore it is regarded as a base rock. Tuffaceous mud layer overlying the basalt lava consists of clay with a little quantity of volcanic breccia. As a shearing properties, cohesive strength C = 0t /m^2, interfrictional angle $\phi = 9.5^{\circ}$ were measured. (Laboratory test was carried out in the University of Mauritius). Thickness of its layer is estimated from 3 m to 7 m, in the upper part of slope. Along with the slope it increases in thickness. This layer is an impermeable one. Pyroclastic flow which distributes the upper part of the ground is mainly composed of angular gravels with ashy soil except for the local part showing the lava condition. Its thickness is 8 to 20 m and it carries with loose and high permeable condition.

Sliding surface is principally formed along with the top of the tuffaceous mud layer. In the measurement of inclinometer in the bore-holes, like-wise, the sliding surface is confirmed near the level of the tuffaceous mud layer. The surface of this layer lies nearly level. It means that its area is located in not the tension zone (driving zone) but the compressive zone (passive zone).

Based on the plain distribution and typical section, scale of landslide is summarized as follows:

(a) Area of tension zone spreads widely in the location of school and its upper area.
(b) Main driving force of the western block takes place in the flat area of the old reservoir location.
(c) Average depth of landslide mass is estimated at 20 to 25 m, therefore its volume is estimated at 2.0 to 2.5 million m^3 in the western block of active zone. On the other hand in the eastern block, its volume is estimated at 0.5 to 0.6 m^3 on the assumption of the average depth of 15 m.

Consequently, volume of landslide mass of active zone is estimated at 2.5 to 3.0 million m^3.

(d) Compression zone (upheaving zone) ranges from MGR Leen Avenue to Mootoosamy Street where many houses locate very closely.

All engineering views are formulated through the short-term survey and study in the limited time. Therefore it is recommended further detailed investigation will be carried out for confirmation.

(3) Rainfall

Mauritius has a tropical maritime climate having summer season from December to April and winter season from June to September. During summer season it is warm and humid, while it is cool and dry during winter season.

Port Louis is located in drier part of Mauritius with annual rainfall of less than 1000 mm. Sometimes the amount of rainfall can be very large in certain period but usually rainfall concentrates in one or two months during the period from December to April.

At La Butte Station there were 6 days with rainfall greater than 20mm per day during the period from January to August in this year. Extreme value of 24 hourly rainfall was 187 mm on 18 January 1985 at La Butte.

(4) Groundwater

Groundwater is one of the causes for landslide movement.

The northern slope of Signal Mountain has very pervious geomorphology and therefore rainfall infiltrates into the ground and supplies the groundwater around the surface of tuffaceous muddy layer. Thus stored groundwater is assumed one of the main causes of the landslide at La Butte.

In the landslide area there are apparently two zones, one is very pervious and the other is impervious as described in (1) of this chapter. However there are no groundwater out-springs nor wells and groundwater level is not clearly measured in boreholes. Therefore further detailed investigation for groundwater will be necessary.

(5) Possibility of movement in future

In the tension zone the scale of displacement in the past is assumed to exceed 50 cm in width, more than 15 mm per year on the average. This assumption is due to the fact that the width of tension crack in the head part of sliding area amounted to 50 cm at least in the past 4 years.

On the other hand displacement in the compression zone is assumed relatively small. As a consequence average velocity of movement in the active stage in future is assumed to be 1mm/day and/or less than that.

Rainfall and water leak through the old reservoir and pipe line are possibly main causes of this landslide. At present reservoir has been filled, in addition pipe line has been removed. Therefore serious problem of water leak is avoided. However surface drainage system is insufficient in the upper part of natural slope, quantity of groundwater infiltration increases in the rainy season.

In case much quantity of rainfall than usual in this rainy season takes place the possibility of dangerous sliding is anticipated. Above all in the cyclone season the probability of this occurrence is very high. Consequently in such cases close watch of slope movement is required. If the velocity of movement comes to 1 cm/day in minimum warning system should be taken in the active zone and northern adjacent area about 100 m in distance.

3.4 Preliminary Stability Analysis

According to the field survey and review of geological data, the slide surface is assumed to exist along the surface of the taffaceous muddy layer.

The preliminary stability analysis is made in the conventional slice method along the typical section of E, F and G as shown in Figure 1.

The equation used for the stability analysis is:

$$F S = (\tan \phi \ (N - U) + C \times L) / T$$

Where F S : Safety factor

N : Normal force attributable to gravity of slices (t/m^2)

T : Tangentional force attributable to gravity of slices (t/m^2)

U : Pore water pressure acting on slices (t/m^2)

L : Length of slide surface (m)

ϕ : Internal friction angle of slide surface (degree)

C : Cohesion of slide surface (t/m^2)

At tention portion, cohesion of slide surface is assumed about 2.0 t/m^2 because vertical thickness of sliding mass is more than 20 m. At compression portion, strength properties of muddy layer have been measured, C = 0 t/m^2, by labo-test. Thus average cohesion of slide surface is estimated to be 1.0 t/m^2.

Pore pressure during rainy season is estimated to be high on the assumption that groundwater level probably rises in about 8 metres above the slide surface.

Internal friction angle can be estimated with the formula for stability analysis under the following conditions:

- safety factor against landslide is 1.0 before occurrence of movement
- Cohesive strength is 1.0 t/m^2 on the slide surface
- unit weight of the sliding mass is 1.8 t/m^3

Factors of sliding mass such as T, N, L and U, and internal friction angle are estimated as follows:

Section	T	N	L	U
B	1776.68	11,104.11	355.47	2600
F	1975.00	11,324.09	320.21	2423
G	668.48	4,025.63	208.60	736

Internal friction angle

B $\tan \phi = (1776.68 - 355.47) / (11,104.11 - 2600) = 0.167$
F $\tan \phi = (1975.00 - 320.21) / (11,324.09 - 2423) = 0.186$
G $\tan \phi = (668.48 - 208.60) / (4,025.63 - 736) = 0.140$

It has been known that drawdown of water level is well effective for restraint against landslide. The analysis indicates that the safety factor increases as follows when water level is lowered by about 2 m from high water level.

B $FS = (0.167 (11,104.11 - 1920) + 1.0 \times 355.47) / 1776.68 = 1.063$
F $FS = (0.186 (11,324.09 - 1788) + 1.0 \times 320.21) / 1975.0 = 1.060$
G $FS = (0.140 (4025.63 - 348) + 1.0 \times 208.60) / 669.48 = 1.080$

Drainage well work will be considered to be effective in order to lower groundwater level.

However in most cases to lower groundwater level by more than 2 m in a short period is rather difficult.

In case safety factor for landslide protection works is more than 1.10, resisting force needed in order to stabilize landslide movement is as follows:

B $P = (1.10 - 1.063)\ 1776.68 = 65.74$ t/m
F $P = (1.10 - 1.060)\ 1975.00 = 79.00$ t/m
G $P = (1.10 - 1.080)\ 668.48 = 13.34$ t/m

From the above, steel pile works will be recommendable in addition to the drainage works mentioned above.

4. Monitoring

4.1 Method of Monitoring

(1) Objective of Monitoring

It is important to establish warning and evacuation system to prevent damages to inhabitant from landslides. Therefore a monitoring system is required to monitor landslide activities.

It is proposed to introduce an extensometer for simple measurement as urgent measure of monitoring.

However as a result of further detailed investigation more accurate system might be introduced in addition to an extensometer.

(2) Measuring Items and Instrument

In addition to recording of rainfall by rainfall gauge and observation of deformation of the ground by survey and deformation of the underground by inclinometer it is additionally proposed to measure displacement of the ground by an extensometer as well as inclination of the ground by a tiltmeter.

Observation of landslide activities must be carried out after comprehensive analysis of data obtained from the above works.

Given hereunder are two measurement items and relevant instruments as newly proposed.

Measurement Item	Instrument	Nos	Remarks
ground displacement	extensometer	4	E - 1 - 4
ground inclination	tiltmeter	7	T - 1 - 7

(3) Measurement Interval

Given hereunder is an explanation of measurement reading interval of extensometer and tiltmeter.

(a) Extensometer

Measurement reading is once a week in case of small variation of value.

However when there is large variation in measurement value as described in 4.2 measurement reading must be done in an interval as specified therein.

(b) Tiltmeter

Measurement reading is once a week if there is no large variation of measurement value. However if daily variation of extensometer exceeds 2 mm daily reading of tiltmeter must be done.

4.2 Warning, Evacuation and Release Standard

Simple warning and evacuation system which has been introduced during this study depends in principle upon measurement value of the ground variation by extensometer. Therefore warning and evacuation standard is mainly classified according to the extensometer value.

(1) Warning evacuation standard

Warning and evacuation standard is classified in four stages as follows:

1st Stage (preparatory stage)	$d \geqq$ 2mm/day $R \geqq$ 30mm/day
2nd Stage (warning stage)	$d \geqq$ 1 cm/day
3rd Stage (evacuation stage)	$d \geqq$ 2 mm/hour
4th Stage (emergency stage)	$d \geqq$ 4 mm/hour

where, d : displacement
R : amount of rainfall

(2) Measure in each stage

1st Stage (Preparatory Stage) : daily measurement reading of extensometer

2nd Stage (Warning Stage) : switch-on of alarming equipment connected to the extensometer (E - 1, 3, 4).

- daily patrol to check abnormal phenomena of slopes, roads and housings.

3rd Stage (Evacuation Stage) : to check whether the extensometer is in proper measuring condition when alarming buzzer starts to work because in this stage alarming buzzer is set to work automatically.

- continuous reading of the extensometer when it is confirmed that alarming buzzer is forced to work due to coincident proper function of the extensometer.

- commencement of evacuation of inhabitants from the active zone, the influenced zone and the area about 100 m from the end-line of those zones where damage is anticipated.

4th Stage (Emergency stage) : continuous reading of the extensometer

- road closing in the above-mentioned area.

- off-limit order for the active zone.

- forecasting of sliding time according to SAITO's method (See Appendix 9)

(3) Release standard of warning and evacuation

Warning and evacuation is released in principle in an adverse manner of the aforementioned, as follows:

Warning Releasing Stage	Standard	Warning Tightening Stage
Ordinary Stage		
⇑ 1st Stage (evacuation release)	d ≧ 2mm/day or R ≧ 30 m/day	⇓ 1st Stage
⇑ 2nd Stage (continued evacuation)	d ≧ 1cm/day	⇓ 2nd Stage
⇑ 3rd Stage	d ≧ 2mm/hour	⇓ 3rd Stage
⇑ 4th Stage	d ≧ 4mm/hour	⇓ 4th Stage

However it is to be noted that in the 2nd stage of warning release evacuation of inhabitants must be continued, and that evacuation of inhabitants must be released at the 1st stage.

5. Recommendation

5.1 Urgent Measures

Several measures should be contemplated to secure lives and assets of inhabitants as well as public property from damages of landslides.

There are long-term measure and urgent measure for landslide.

Long-term measures require in advance detailed survey, investigation and study before implementation which takes time to some extent for completion.

For the landslide at La Butte it is important to establish a warning and evacuation system and to implement emergency protection works as urgent measures which should be started before coming rainy season.

Given hereinafter are urgent measures while warning and evacuation system is as written in the Chapter 4.

For stabilization of the landslide at La Butte it is very efficient to lower the groundwater level. Therefore it is important to prevent infiltration of rainfall into the ground which will supply groundwater. As well it is important to drain groundwater immediately from the landslide area. Taking into account limited allowable time the following is proposed as a possible and efficient measure.

It is construction of surface drainage ditches of which work items are as follows:

(1) Bottom lining of the existing ditches in the mountain slope with asphalt or vinyl.
(2) Bottom lining of the French Drain Channel with concrete, asphalt or vinyl.
(3) Prevention works for rainfall infiltration into tension cracks with vinyl or clay.
(4) Maintenance and repair works and water leakage prevention works of the side ditch as well as water discharging to non-landslide area by the side ditch of Mgr. Leen Avenue, Lime Street (Dickens Street - Andrews Street) and S. Mootoosamy Street.
(5) Maintenance and repair (possible by vinyl lining) of the side ditch and water discharging to non-landslide area by ditches along the roads above 55 m elevation from the sea level.

5.2 Further Study Plan

Since this study is so called as preliminary one, there are uncertain issues to be confirmed through the detailed investigation. Required contents of detailed investigation are as follows: Please refer to Fig. 1 regarding the location.

(1) Topographic Survey

To carry out in order to confirm the accurate shape of landslide morphology.

(a) Plain survey, Scale = 1/1000, in the relevant area 20 ha.

(b) Profile survey (cross section) 4 measurement lines.

(2) Installation of Landslide instruments

(a) Extensometer. 2 nos. each measurement line in active zone and 5 nos. in the residential area. Total 11 instruments.

(3) Geological survey including the groundwater prospecting work

Geological composition, especially the layer of slide surface is confirmed, and condition of groundwater is made clear.

(a) Core drilling 18 holes, approximately 430 m long in total. 10 holes are used for the groundwater prospectings. Strainer pipes are placed.

8 holes are used for the installation of inclinometer.

(b) Groundwater prospecting in boreholes
This is carried out excluding the holes for the installation of inclinometer.

5.3 Long-term Measure

The landslide has been taking place at La Butte which is located in the residential area of Port Louis, capital of Mauritius. Therefore it is very important to stabilize the landslide with long-term stability measures.

In preparing a plan for long-term stability measures it is necessary to carry out in advance detailed investigation for landslide morphology, geology, groundwater, landslide movement and those respective observation. And subsequent analysis and design works are required.

Given herein are 3 long-term stability measures which is assumed the most effective. The landslide at La Butte basing on the result of the field survey and preliminary study of this time as well as the previous studies and investigations.

They are construction of drainage wells with horizontal drainage boring, steel pile works and counter weight embankment.

The following are to be noted.

(1) Drainage well

Water drainage well is considered effective to lower the groundwater level.

Intermediate well will be required due to long drainage boring.

Main feature is as follows:

Water drainage well	:	3.5 m in diameter and 20 m in depth
Intermediate well	:	3.5 m in diameter and 15 m in depth

(2) Steel pile works

Steel piling works is considered effective to encounter large force by landslides. Steel pipe must be placed in the compression zone through the slide surface, steel pipe will be 35 cm - 40 cm in diameter and 20 m - 30 m in length.

(3) Counterweight embankment

Counterweight embankment along the lower edge line of landslide is efficient for most cases of landslides.

It is recommended that counterweight embankment will be constructed at the evacuated places of YAMAHA Trading Building and Al Madina Mosque.

It is anticipated that all of the above three measures will be required. It is apparent that independent implementation of those three measures in terms of construction year will still contribute to stabilization of the landslide in each stage. In undertaking those measures, each construction method, coordination and work quantity should be determined incorporating the result of further detailed study.

Appendix 9

SAITO'S METHOD OF FORECASTING THE TIME OF RUPTURE

1. Creep - Rupture Phenomena of Soils

In case of creep-rupture test with soil specimens, an application of stress leads first to a period of transient creep followed by creep with steady - state rate and then it turns to accelerating stage, finally leading to failure. These three stages are usually termed as primary, secondary and tertiary, as shown in Fig. 1 (a).

In case of model tests of slope failure by artificial rainfall, the primary creep does not appear, but the secondary creep can be seen, directly followed to daily variation of creep, and the tertiary creep range is rather small as shown in Fig. 1 (b).

Actual slope failure or landslide is similar to the case of model test with no primary creep range, but the tertiary creep range is very large, especially regarding total strain and strain rate, as seen in Fig. 1 (c).

2. Saito's Forecasting Method

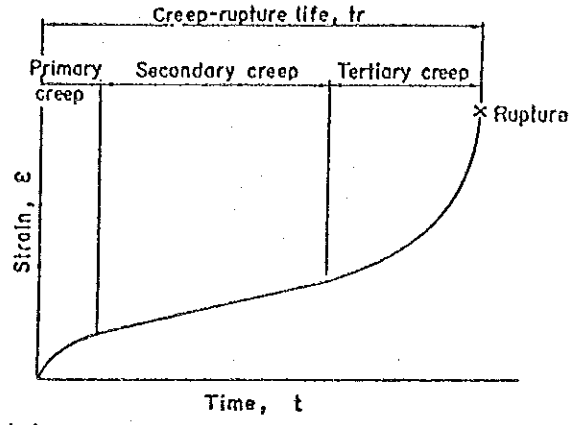
For forecasting the time of occurrence of rupture of landslides, the Saito's method based on creep theory is often utilized, and many successful examples have been reported. The general formula of the method based on creep theory is given by equation (1).

$$\log t_r = a - b \log \dot{\varepsilon} \qquad \cdots\cdots\cdots (1)$$

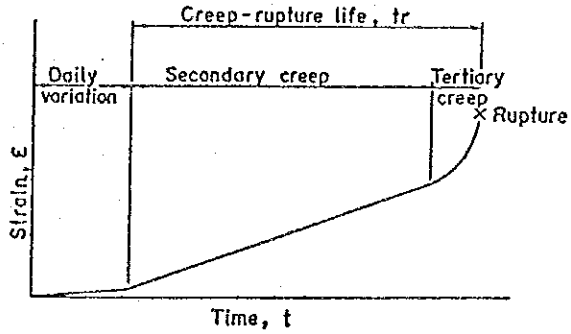
where, t_r : creep - rupture life,

$\dot{\varepsilon}$: steady - state strain rate,

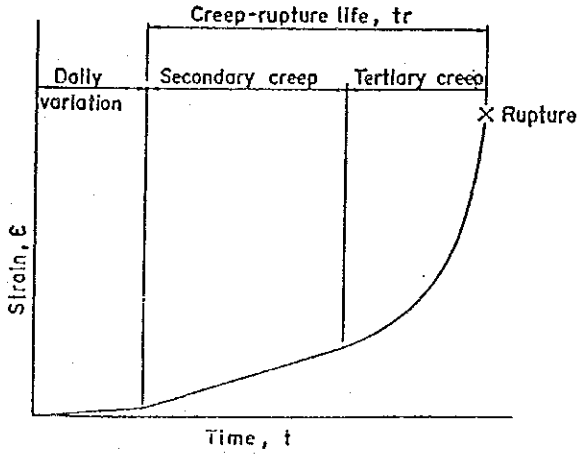
a, b : constants.



(a) Creep rupture test on test piece



(b) Model test of slope failure



(c) Actual slope failure

Fig. 1 Typical expression of various creep - rupture curves

Through full-scale slope failure tests, Dr. Saito found that strain measurement of slope surface is the most effective as forecasting factor. It was turned to creep-rupture tests in laboratories as phenomenological approach. The results are shown in the forecasting diagram indicating inversely proportional relationship between steady-state strain rate and creep-rupture life as shown in Fig. 2. This relationship was examined with actual slope failure records and verified effective to forecast the rupture life as shown in Fig. 3. Furthermore, Dr. Saito found, through the case study at Asamushi Landslide, that the inversely proportional relationship can be extended to the tertiary creep range with some modification, that is called as graphical analysis and explained with the direction of arrows in Fig. 4. Fig. 5 shows the result of application of this method to Asamushi landslide in Japan.

Thus, the Saito's forecasting method based on creep - rupture characteristics has been established and is expressed as follows:

In the secondary creep range, rupture life of slope is found in the forecasting diagram (Fig. 2) or calculated with the following formula

$$\log_{10} tr = 2.33 - 0.916 \log_{10} \dot{\varepsilon} \pm 0.59 \qquad \cdots\cdots\cdots (2)$$

where, tr : creep-rupture life, in minute.

$\dot{\varepsilon}$: steady-state strain rate, in $\times 10^{-4}$ per minute.

In the tertiary creep range, a following logarithmic formula is applicable as an empirical one

$$\varepsilon - \varepsilon_o = A \log \frac{tr - t_o}{tr - t} \qquad \cdots\cdots\cdots (3)$$

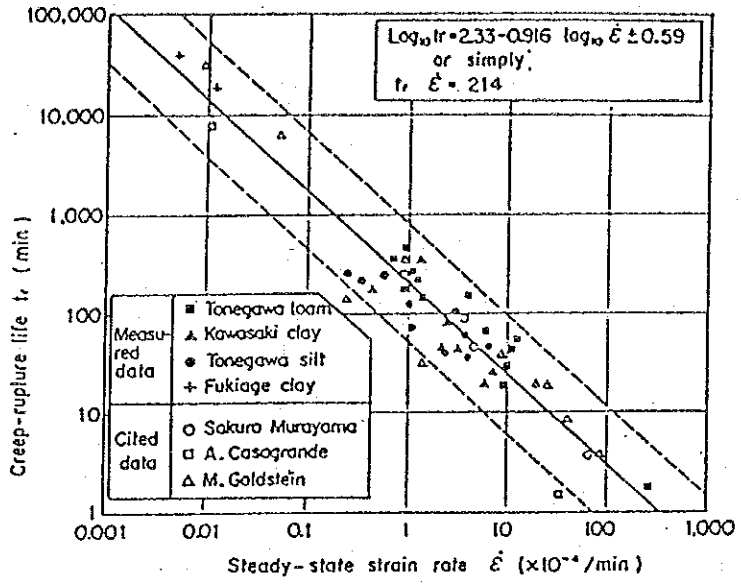


Fig. 2 Forecasting diagram using the relation between steady-state strain rate and creep-rupture life

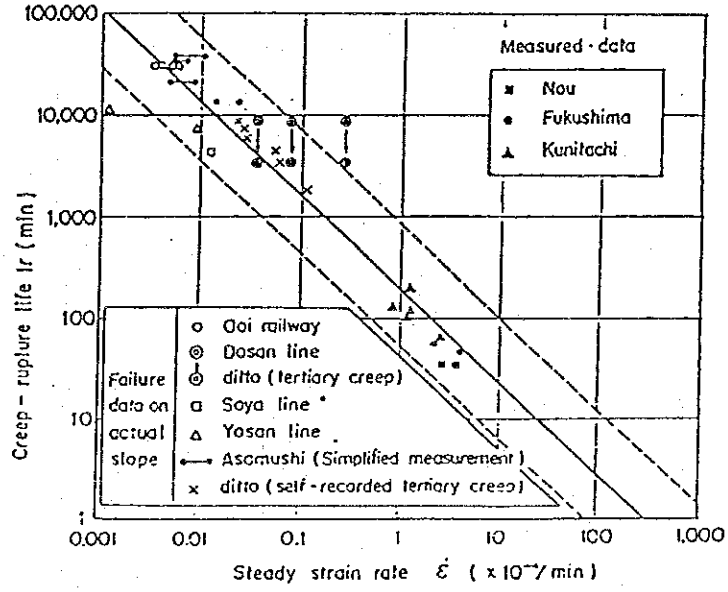


Fig. 3 Validity of Forecasting diagram using data of slope failure tests and actual slope failures

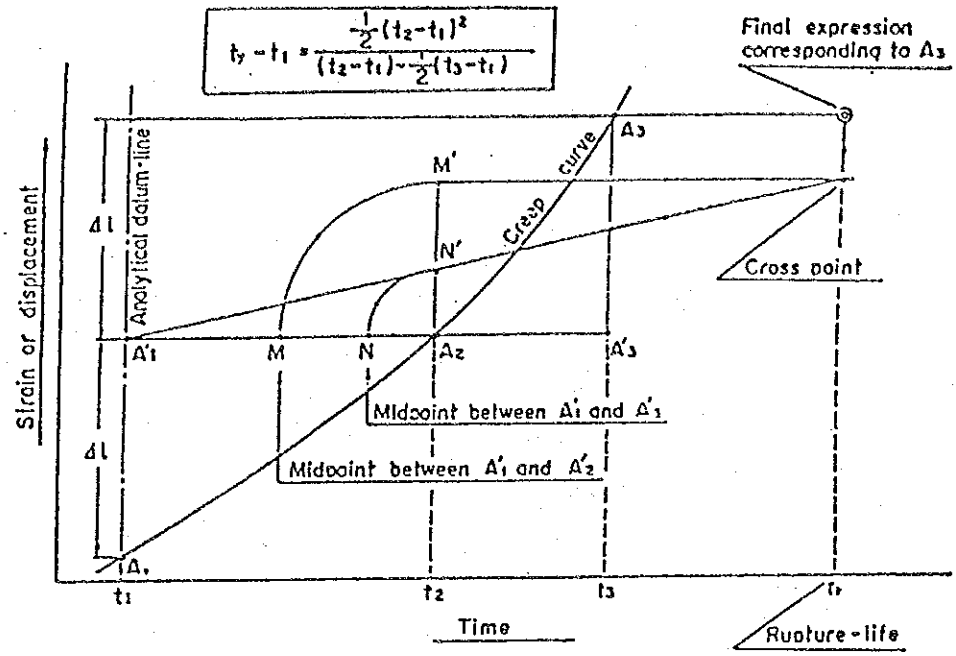


Fig. 4 Procedure of graphical analysis for creep-rupture life in tertiary creep range

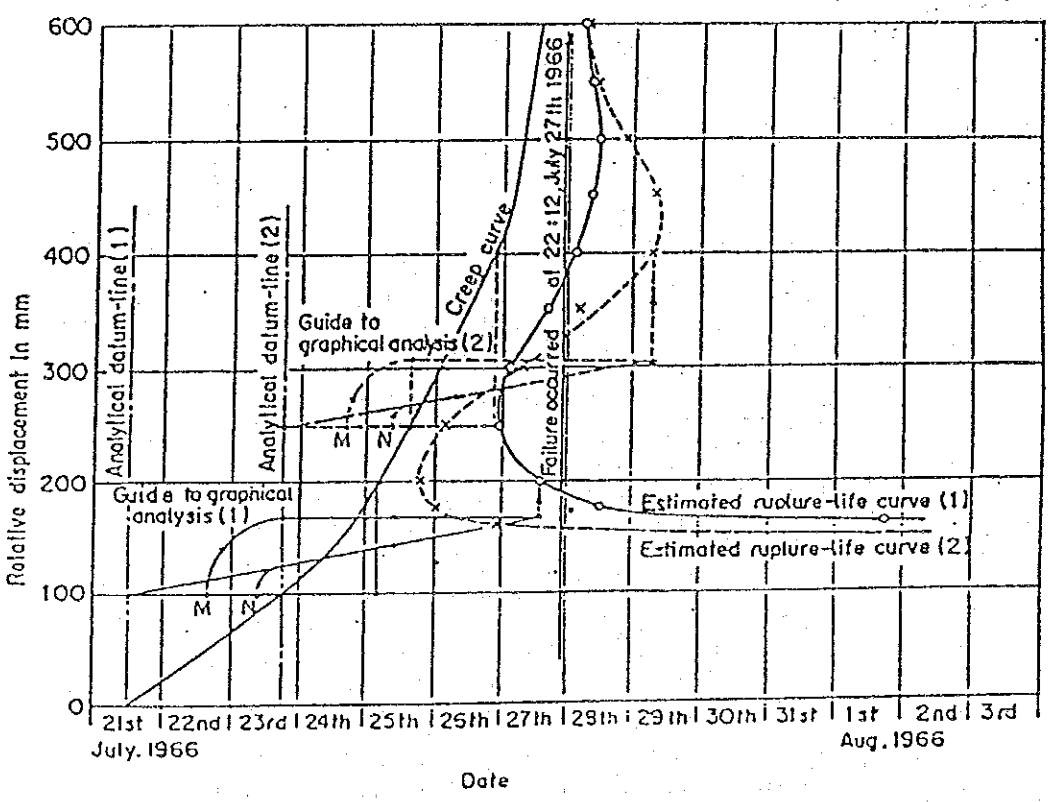


Fig. 5 Forecasting failure time of Asamushi Landslide by means of graphical analysis

or

$$\Delta l = l\, A \log \frac{tr - t_o}{tr - t} \qquad \cdots\cdots\cdots (4)$$

where, tr : creep - rupture life left before failure,

t_o : reference time,

ε : strain at optional time,

ε_o : strain at t_o,

$\Delta l = \varepsilon \cdot l$: relative displacement

A : constant

Rupture life before failure is obtained with the empirical logarithmic formula (2), (3), (4) by calculation, by graphical analysis or by plotting on semi-logarithmic graph applied with measured values.

It is, therefore, advisable that the time of initiation of rupture is roughly estimated with steady-state strain rate in the secondary creep range, and closely estimated using substituted logarithmic formula (3) or (4) in the tertiary creep range. Besides, the estimation method in the secondary creep range may be used for forecasting in the tertiary creep range as rough estimation, but warning should be paid to be in danger side within one hour before failure.

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- Saito, M and Vezawa, H.; Failure of soil due to creep, Proc. Fifth Int. Conf. in Soil Mech. and Found. Eng'g., Paris I, pp. 315 - 318, 1961
- Saito, M.; Forecasting the time of occurrence of a slope failures, Proc. Sixth Int. Conf. on Soil Mech. and Found. Eng'g., Montreal, 2, pp. 537 - 541, 1965
- Saito, M.; Forecasting time of slope failure by tertiary creep, Proc. Seventh Int. Conf. on Soil Mech. and Found. Eng'g., Mexico City, 2, pp. 677 - 683 - 1969
- Saito, M.; Evidential study on Forecasting occurrence of slope failure, Annual Report of OYO Corporation. No. 1, pp. 1 - 23 - 1979.

附　　属　　資　　料

附属資料 1.

M E M O R A N D U M

Technical Study on the La Butte Landslide

In response to the request made in June 1988 by the Government of Mauritius for a comprehensive study of the landslide at La Butte, the Japanese Government despatched to Mauritius from the 6th - 19th September a technical mission to undertake a preliminary study. The technical mission was headed by Dr Watari, President, Japan Landslide Society and consisted of the following members:

Mr. Hideaki KOBAYASHI
Vice Director, River Rempart, Kinki Regional Construction Bureau, Ministry of Construction

Mr. Masaaki NAKANO
Deputy Director, Slope Protection, Sediment Control Department, River Bureau, Ministry of Construction

Mr. Senju IKEDA
Consultant, Geologist

Mr. Okichika KUROKAWA
Deputy Chief, Technical Section, Sabo Technical Center

2. The objectives of the mission were as follows:

1) To examine the mechanism of the occurrence and movement of the landslide by means of field survey and data obtained,

2) To make a plan for urgent landslide protection works,

3) To establish a temporary warning and evacuation system in emergency, and

4) To advise an outline of detailed survey and landslide protection works for long-term stability in the future.

3. During their stay in Mauritius the mission carried out a field survey, installed monitoring equipment, and held discussions with representatives of the Ministry of Local Government and other departments/organisations concerned.

4. The Mission submitted at the end of its assignment a report containing recommendations relating inter alia to

(i) the setting up of a warning and evacuation system

(ii) execution of urgent landslide protection works

(iii) the need to conduct a detailed investigation (topographical, geological, geomorphological etc) of the area with a view to the preparation of a long-term stability programme for the area.

5. The discussions between the Japanese and the Mauritian sides took place in an atmosphere of cordiality and friendship characterizing the good relations that exist between the two countries. The Mauritian side was appreciative of the work done by the technical mission and felt that further cooperation between the two Governments would bring about a solution to the landslide problem at La Butte.

6. In witness whereof the Mission and the Government of Mauritius have caused this document to be signed on the 19th September 1968 by their respective representatives.

.....

(Mr. R. Honore)
Permanent Secretary
Ministry of Local Government

H. Kobayashi

(Mr. H. Kobayashi)
for Dr. M. Watari
Leader of the Mission
Japan International Cooperation Agency

ANNEX I

ATTENDANTS' LIST

Mauritian Side

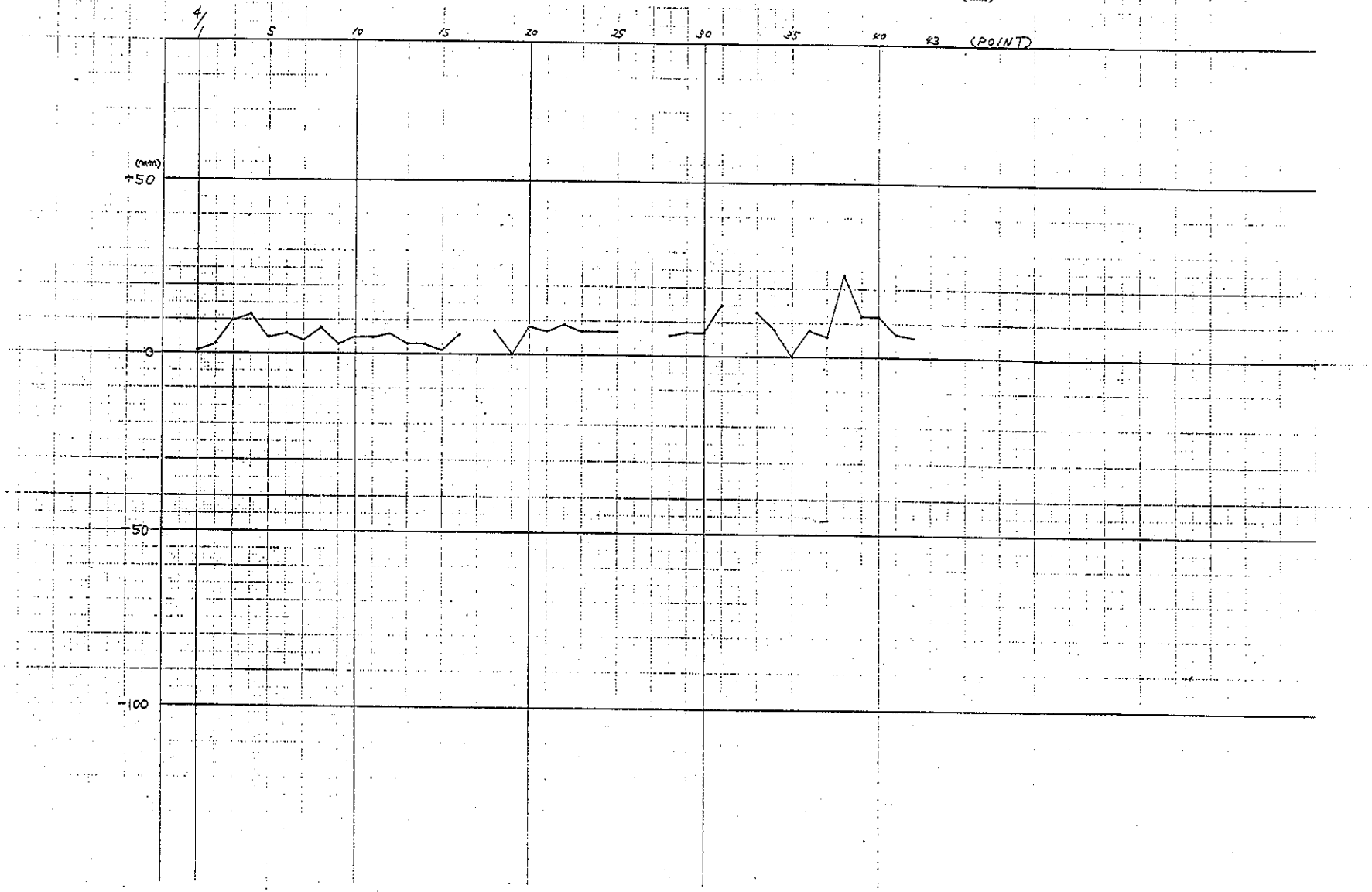
1. Mr. R. E. C. Honore
   Permanent Secretary, Ministry of Local Government
2. Mr. R. Hosany
   Principal Assistant Secretary, Ministry of Local Government
3. Mr. H. Jeanne
   Administrative Officer, Ministry of Local Government
4. Mr. C. Hurree
   Principal Engineer, Ministry of Works
5. Mr. S. Gooljar
   Civil Engineer, Ministry of Works
6. Mr. J. Shimada
   JICA Expert, Ministry of Works
7. Mr. B. Kistnasamy
   Principal Economist, Ministry of Economic Planning and Development
8. Mr. Seeraz
   Land Surveyor, Ministry of Housing, Lands and the Environment
9. Mr. R. Tegally
   Town Clerk, Municipality of Port Louis
10. Mr. G. Lefebure
    City Engineer, Municipality of Port Louis
11. Mr. C. Ng Tung Hing
    Acting Deputy City Engineer, Municipality of Port Louis
12. Dr. A. Chan Chim Yuk
    Lecturer, School of Industrial Technology, University of Mauritius
13. Mr. V. Proag
    Principal Engineer, Central Water Authority
14. Mr. R. R. Vaghjee
    Assistant Director, Meteorological Services

Japanese Side

1.	Dr. Masasuke Watari	-	Leader of Study Team
2.	Mr. Hideaki Kobayashi	-	Sub Leader
3.	Mr. Masaaki Nakano	-	Member
4.	Mr. Seiju Ikeda	-	Member
5.	Mr. Okichika Kurokawa	-	Member

Appendix 8

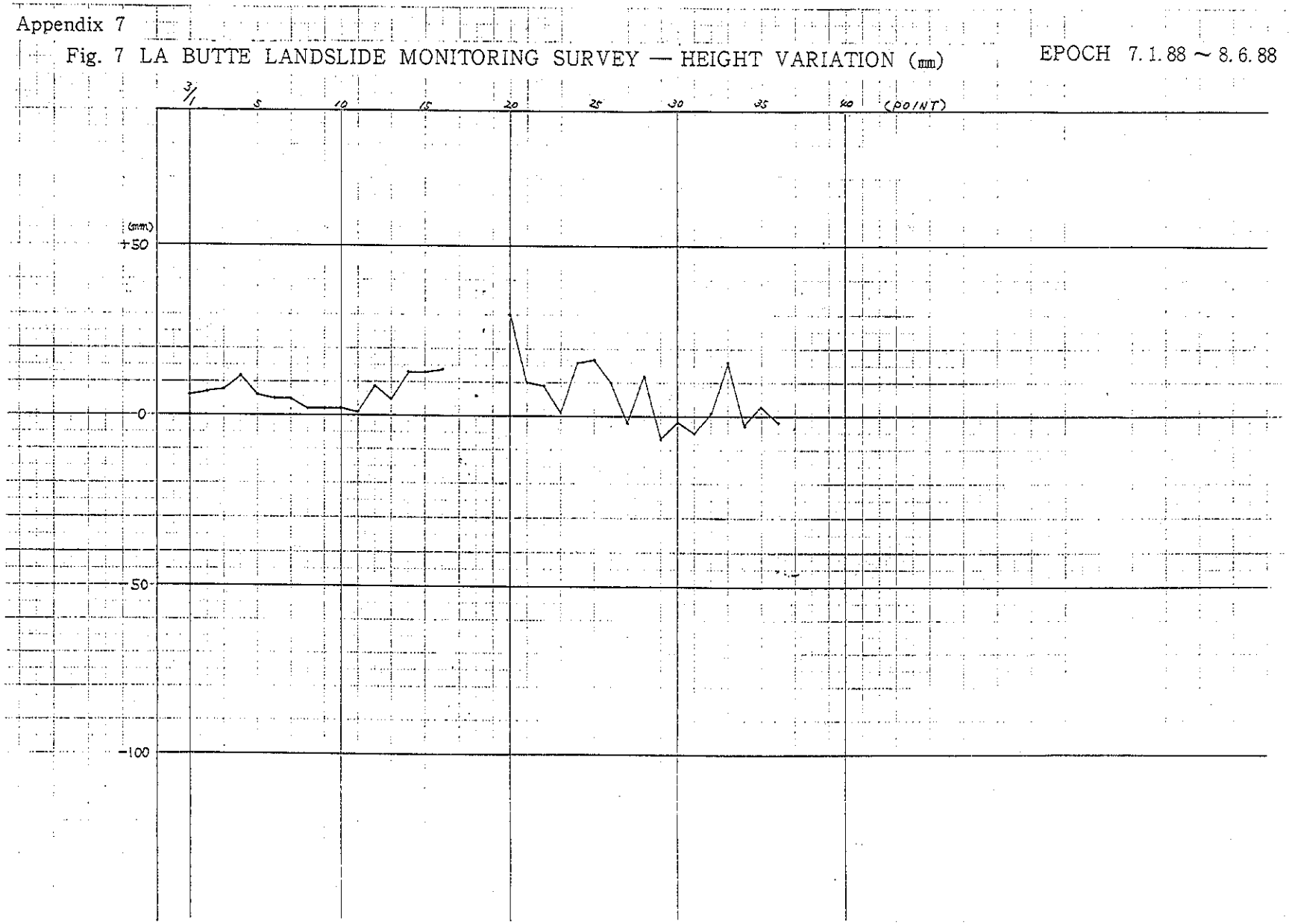
Fig. 8 LA BUTTE LANDSLIDE MONITORING SURVEY — HEIGHT VARIATION (mm) EPOCH 28. 12. 87 ~ 7. 6. 88



Appendix 7

Fig. 7 LA BUTTE LANDSLIDE MONITORING SURVEY — HEIGHT VARIATION (mm)

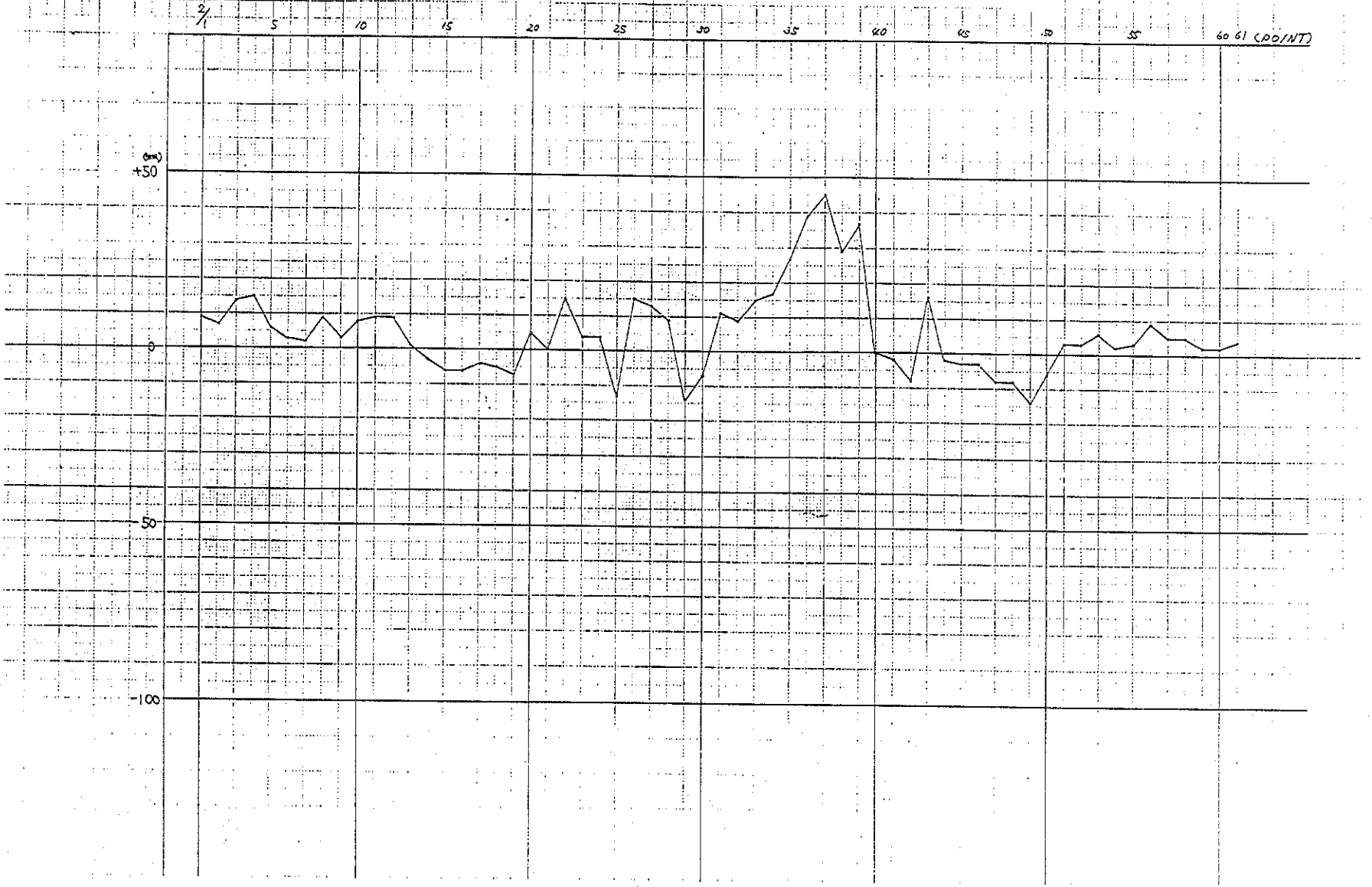
EPOCH 7.1.88 ~ 8.6.88



Appendix 6

Fig. 6 LA BUTTE LANDSLIDE MONITORING SURVEY — HEIGHT VARIATION (mm)

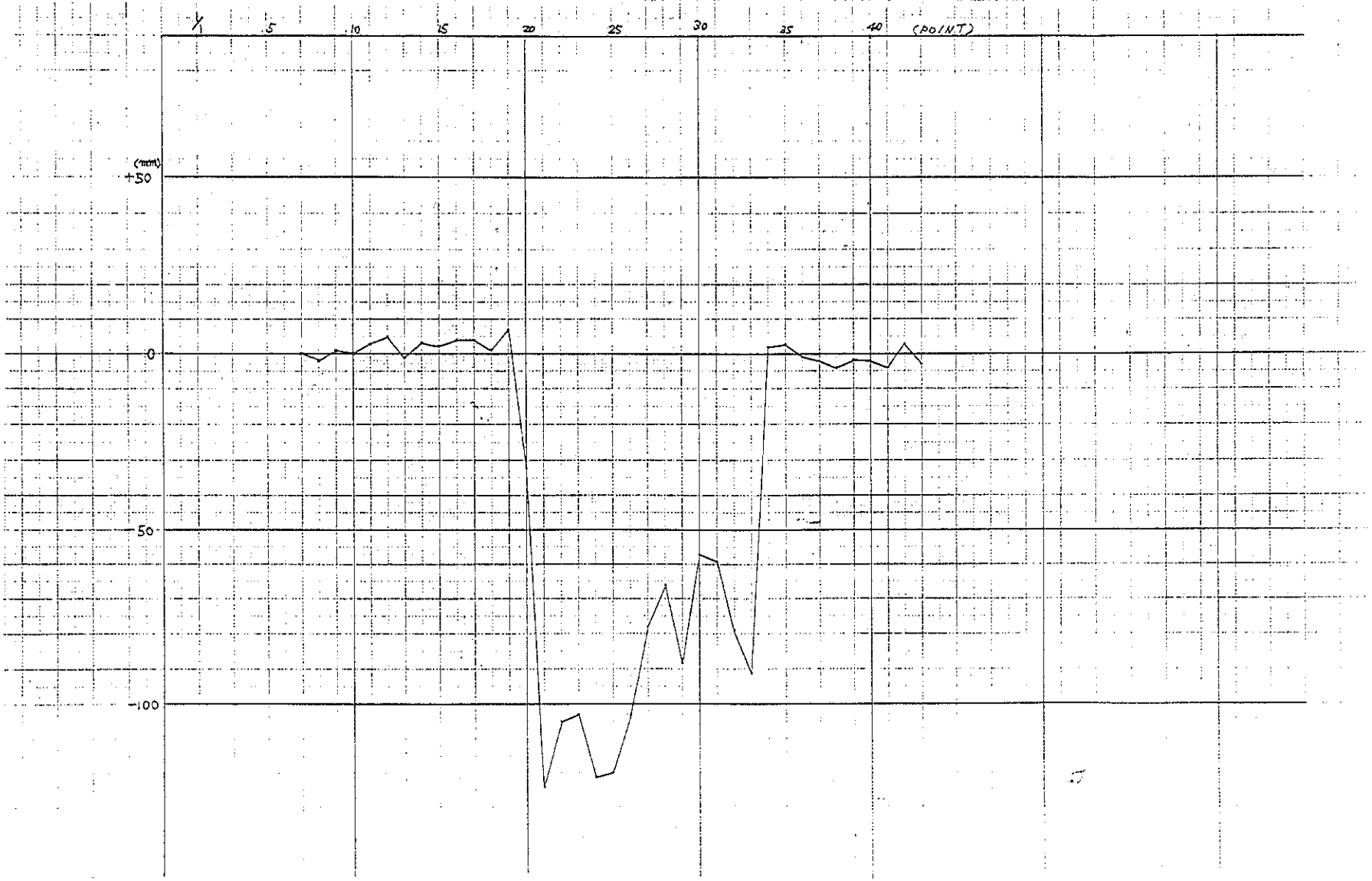
EPOCH 6.1.88 ~ 9.6.88



Appendix 5

Fig. 5 LA BUTTE LANDSLIDE MONITORING SURVEY — HEIGHT VARIATION (mm)

EPOCH 16. 12. 87 ~ 6. 6. 88



Appendix 4

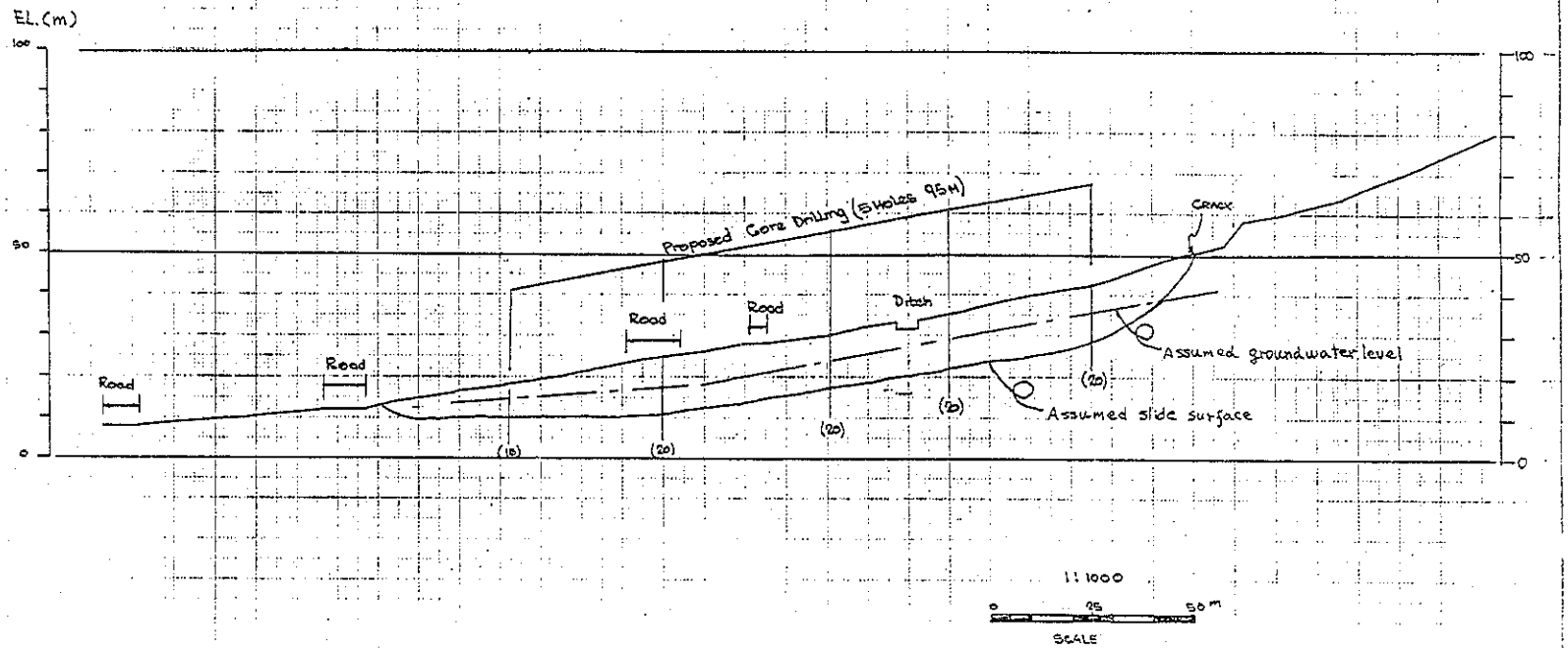


Fig. 4 TYPICAL PROFILE OF LANDSLIDE (ALONG THE G–G SECTION)

Appendix 3

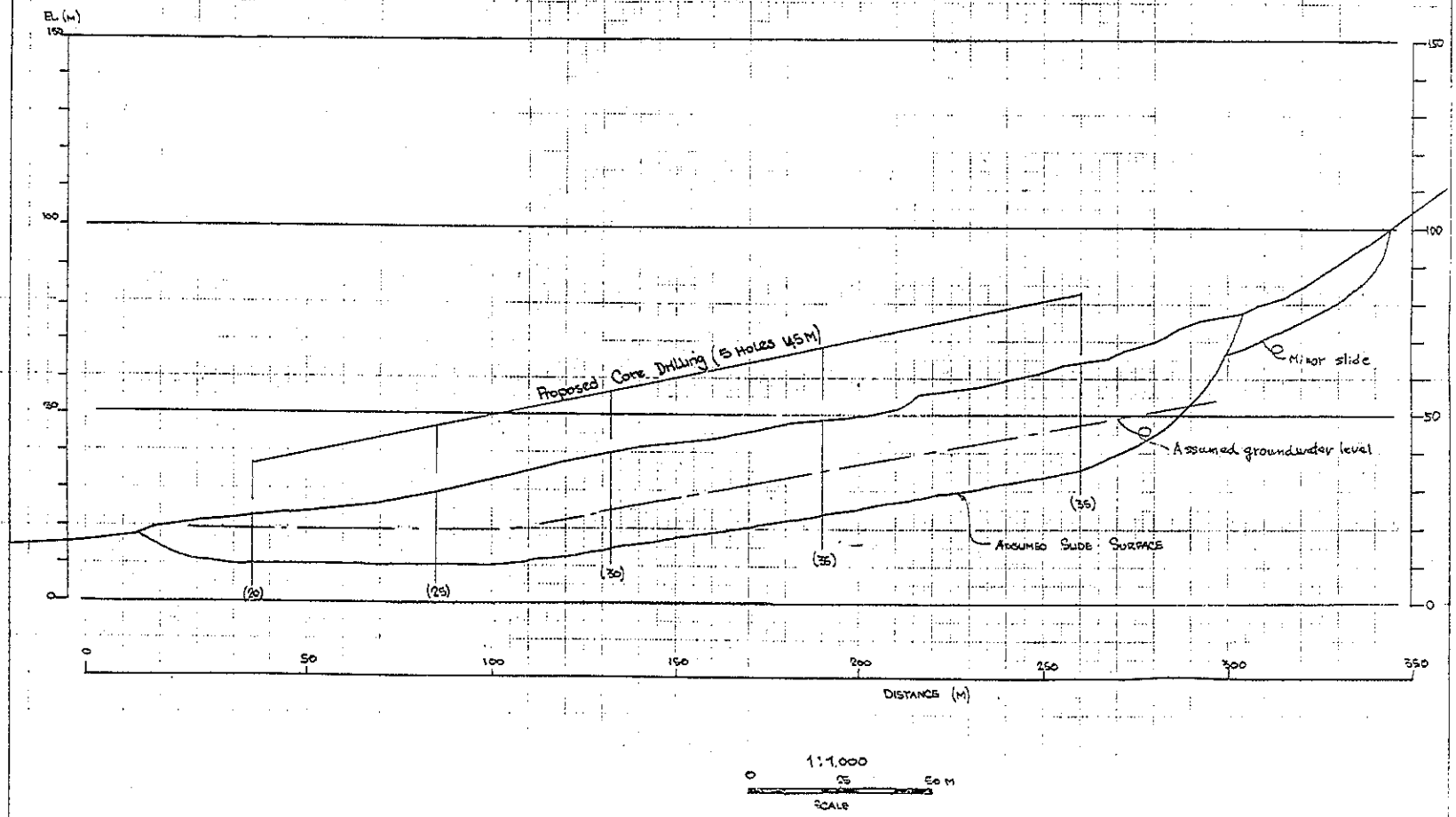


Fig. 3 TYPICAL PROFILE OF LANDSLIDE (ALONG THE F–F SECTION)

Appendix 2

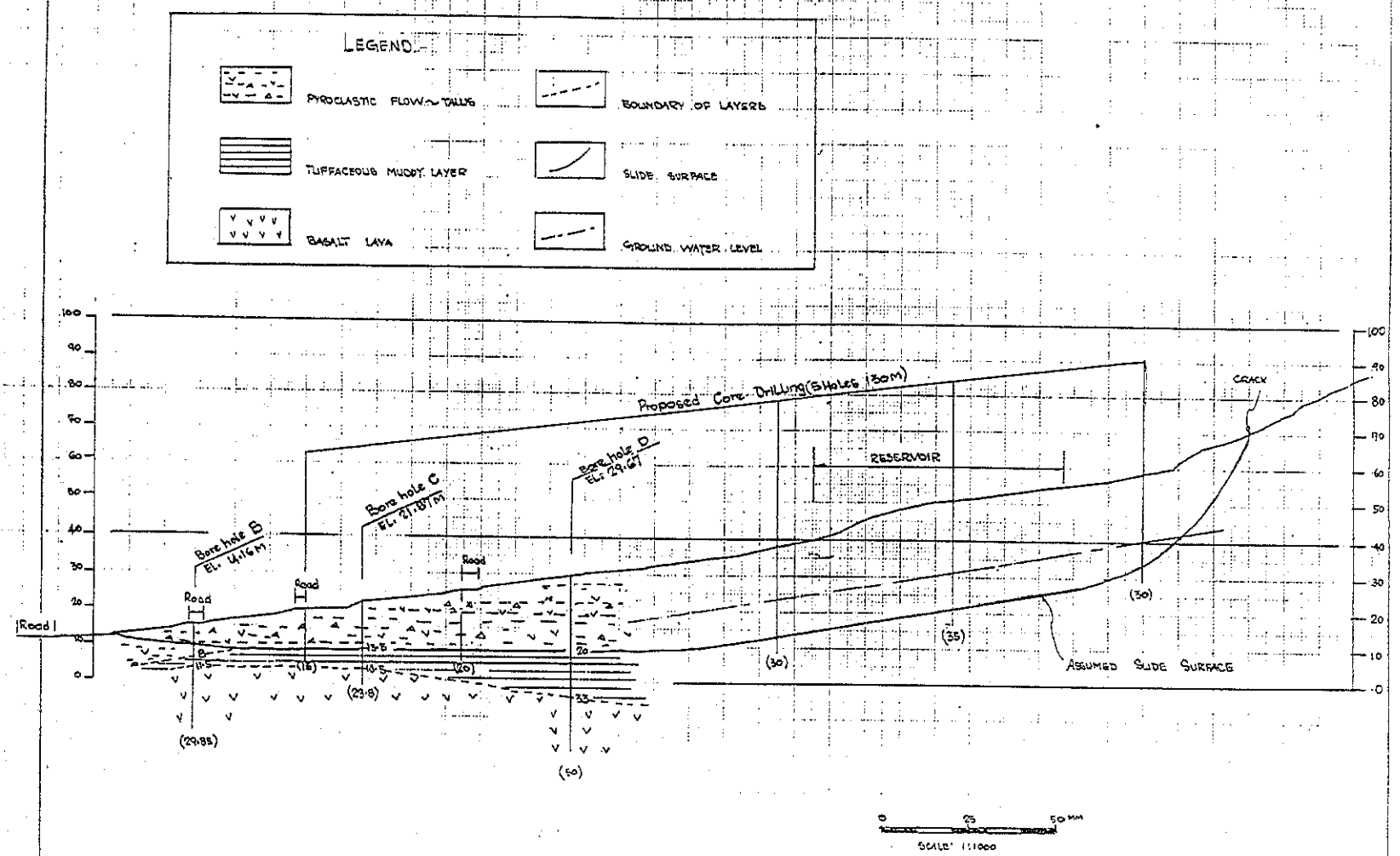


Fig. 2 TYPICAL PROFILE OF LANDSLIDE (ALONG THE B–B SECTION)

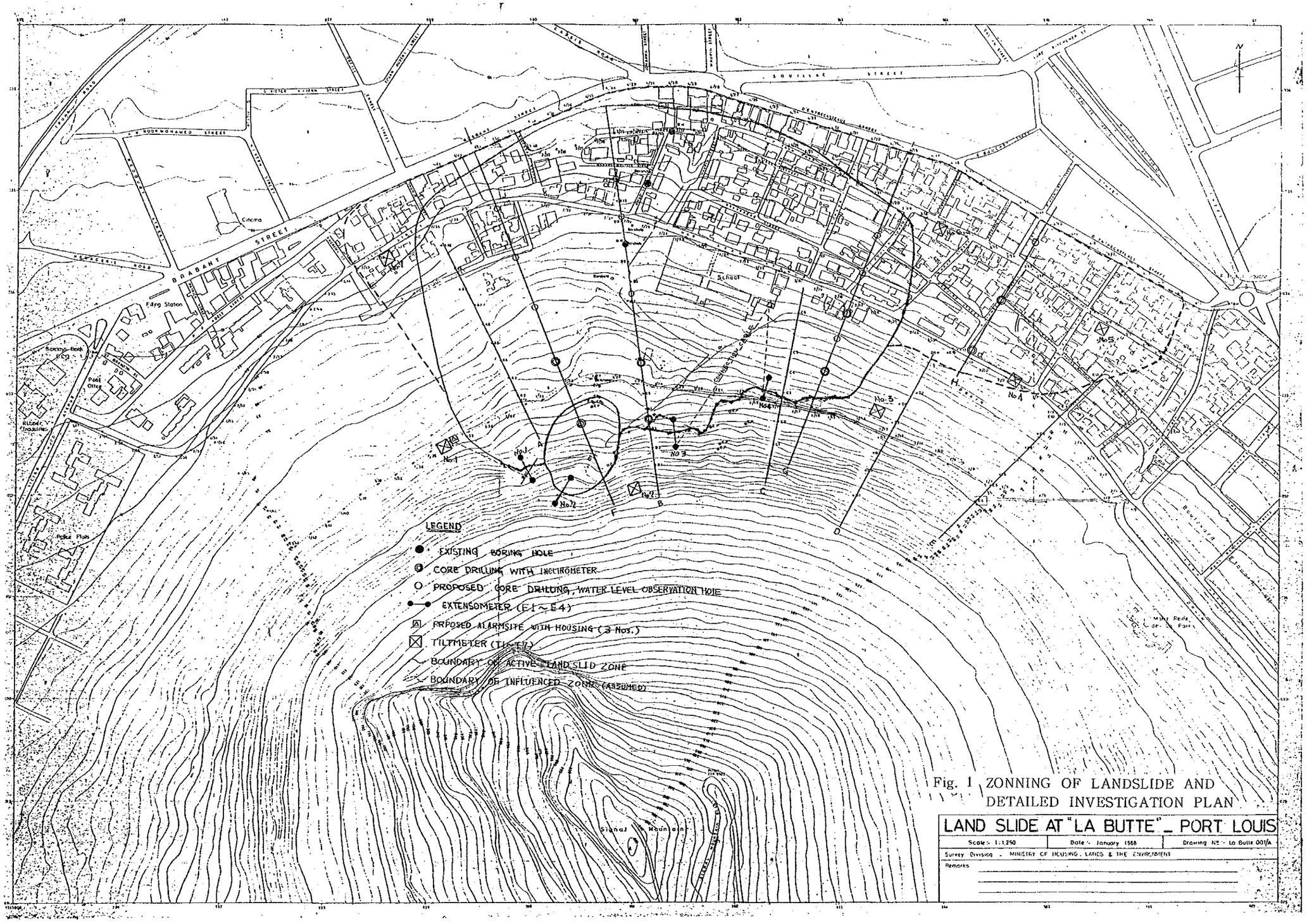


Fig. 1 ZONNING OF LANDSLIDE AND DETAILED INVESTIGATION PLAN

附属資料 2.

Terms of Reference for a team of Experts for landslide at La Butte

1. Background Information

A large slow-moving landslide is causing extensive building damage in the La Butte area. When the problem was first identified in early 1987, the Governmer sought the services of foreign experts to make a preliminary assessment of the extent, causes and risks of the landslide. The Overseas Development Administratic (ODA) agreed to offer the services of Mr. Ian Longworth, geologist, Building Research Establishment Department of the Environment, UK for the preliminary stud

It is now established that the landslide extends 600 m sideways from Orange Street to Dickens Street. It extends 400 m up the slope of the Signal Mountain. The toe lies along Brabant and d'Entrecasteaux Streets and terminates upwards in tension cracks about 500 m long.

In his reports to the Government of Mauritius, Mr. Ian Longworth made a numbe of recommendations to reduce the risks of the landslide. All these recommendatior have been implemented. These include

(a) the displacement of water mains that go through the area along safer alignments;

(b) the closure of the primary school "Ecole de la Montagne";

(c) the cleaning of all catchment drains and opening of new drains;

(d) the sealing of tension cracks to prevent ingress of water; and

(e) the installation of inclinometres to monitor the movement of the landslide.

The study conducted by the British Expert has been in terms of geological assessment of the nature, extent and damages that may be caused by the landslide. This study needs now to be followed by a global research by a multi-disciplinary team of experts in order to enable the elaboration of long-term planning and policies for the area. The need for further technical studies has also been indicated to the Government of Mauritius by Mr. I.Longworth who, in a report had recommended that a comprehensive geotechnical study of the landslide and design of remedial works for long term stability be carried out by consulting engineers of international standing.

2. Objectives of the study

The objectives of the study are to provide an understanding of the mechanism of the landslide and to prepare the landslide protection plans for subsequent implementation. The objectives of the study shall be, in the short term, to prov plans for urgent landslide protection works and in the long term to work out appr priate schemes for long term stability of the area.

3. Scope of the study

The study shall include, but not be limited to, the following:

(a) to take cognizance of available data, results of surveys and previous reports on La Butte;

(b) to undertake site investigation and carry out surveys as may be required;

(c) to carry out works and to install appropriate equipment to monitor the landslide;

(d) to establish guidelines for monitoring of the soil movement;

(e) to prepare appropriate design for long term and short term land protection works;

(f) to make recommendations on future land use for the area; and

(g) to carry out stability analysis of the area in order to evaluate protection works.

4. Duration of the study: The duration of the project shall be for a period of one year as follows:

Inception Work	:	1 month
Field Investigation	:	3 months
Monitoring & Analysis	:	8 months

5. Expertise Input

For the purpose of the study, foreign experts shall be required as follows:

(a)	One Landslide Engineer and Team Leader	– 9 m/m
(b)	One Engineering Geologist	– 5 m/m
(c)	One Civil Design Engineer	– 5 m/m
(d)	One Construction Planner	– 5 m/m
(e)	One Project Economist	– 3 m/m

6. Government of Mauritius Contribution

(i) To nominate a counterpart group including a project coordinator, engineers and surveyors;

(ii) To arrange for the foreign experts all necessary immigration procedure such as entry, stay, exit and work permits and exempt them from income tax and charge of any kind imposed on or in connection with the living allowance remitted from abroad and from import and export duties imposed on their personal effects, and instrument and materials necessary for the services;

(iii) To provide a sufficient and suitable office space during the period of the services;

(iv) To provide official vehicles with drivers for execution of the services;

(v) To provide available documents, such as reports, drawings, topographic maps and other relevant data and information;

(vi) To provide facilities for field surveys;

(vii) The Ministry of Local Government will be responsible for the project

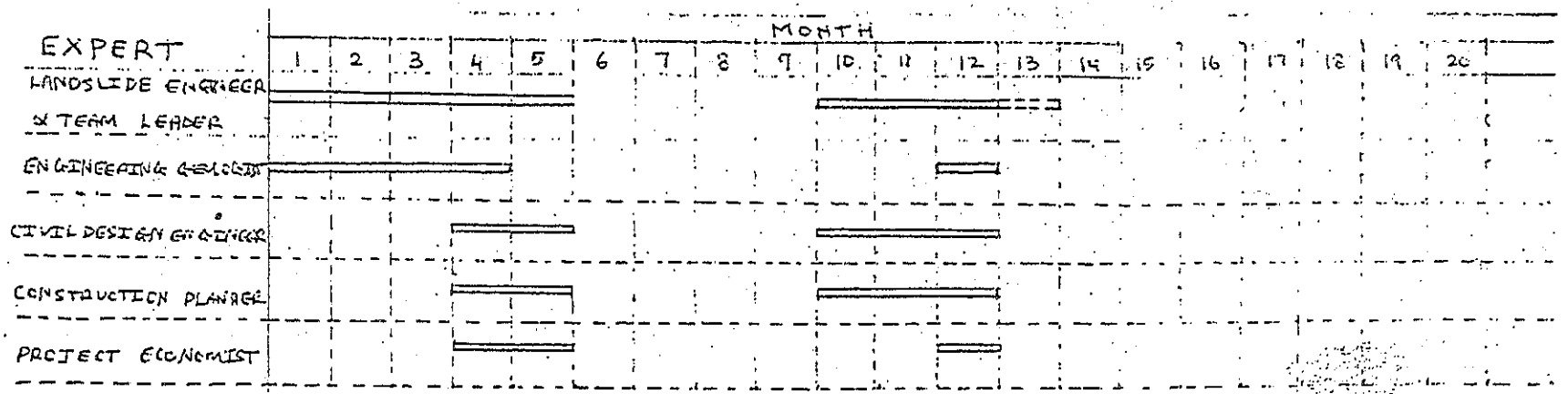
7. Reports

Inception Report, Interim and Draft Final Reports shall be prepared including occasional progress reports as may be required.

M/M SCHEDULE FOR E

ON

LANDSLIDE PROTECTION PROJECT L



LANDSLIDE AT LA BUTTE

The geologist Longworth report had recommended an extensive study at the site of Labutte where an important land slide has affected the whole area. For this reason, Yesterday a team of expert has arrived from the Japan International Coperative Authority for a survey of two weeks. Since their arrivals, they are expected to verify the extent of the disaster, after which they shall recommend the appropriate measures to be taken for long term. Also they shall define the precautions to be taken in emergency case and the possibility of using the land of that area.

An another team of expert is expected next week in order to start working on recommendations.

Le Mauricien
Wednesday 7th September 1988.

... prix sur le marché mondial ... intéressants mais que l'île Maurice n'a, paradoxalement, pas de sucre à vendre sur ces marchés. "My only hope is that the climatic conditions during the crop season allow for high extraction rates", a-t-il ajouté.

Au sujet de la production et de la commercialisation des sucres spéciaux, le ministre apprécie les efforts entrepris par le syndicat, mais il laisse entendre, d'une part, qu'il est essentiel que les droits acquis soient préservés, et, d'autre part, qu'il est impérieux que l'île Maurice recherche de nouveaux marchés, la Nouvelle Zélande, la "European Free Trade Association Countries" ou les pays de l'Extrême-Orient.

L'objectif déclaré du gouvernement est que 30% au moins de l'énergie électrique utilisée à l'île Maurice soit produite par la bagasse au cours des cinq prochaines années (17% actuellement), mais le gouvernement s'assurera que les planteurs et usiniers "get their due".

Sur un plan plus politique, M. Dulloo fait ressortir que "remunerative markets are not enough" et que "cost efficiency must be constantly improved".

C'est dans cette optique que l'on compte compléter la "Sugar Industry Efficiency Study" (SIES) dont la deuxième phase (réévaluation des avoirs de 15 compagnies sucrières) débutera dans une quinzaine de jours pour ne prendre fin qu'à la mi-décembre. Cette étude, a pour but d'améliorer l'efficience de l'industrie sucrière, de s'assurer que toutes les retombées positives du Protocole Sucre bénéficient à tous les partenaires de l'industrie et au pays en général et de corriger certaines anomalies pour rendre l'industrie "more participative". "The bid for increased efficiency is therefore the concern of everybody and everyone most be involved therein", a conclu M. Dulloo en rappelant que nos concurrents "are busy improving their productivity and reducing their costs". C'est dans ce contexte que "le marketing du sucre mauricien est crucial", a souligné M. Dulloo qui note les efforts entrepris par le syndicat dans ce domaine tout en le conseillant de "pénétrer de nouveaux marchés".

JACQUES CATHERINE

... de séance ...

Il est très peu pro... la CEE achète les ... plus cher et ... fait ressortir M. ... ministère have ... cated through their ... sman, our Minister ... ure, that they will ... ner price freeze this ... négociations à ce ... ndront à Bruxelles ... ore prochain. ... côté, le ministre de ..., M. Madun Dulloo ... ent sur l'importance ... sucre qui, dit-il ... uestion de vie ou de ... le pays tout en ... que les prix offerts ... éteurs de la CEE pur ... n'a pas augmenté ... ans. Mais, a-t-il ... ACP ont réussi à ... CEE qu'elle de ... sur pied un méca... réduire les effets ... gel des prix et ce ... tation avec les pays ... stre a également été ... ement sévère à l'é... CEE qui continue de ... des quantités plus ... es de ce qui est ap... courtiers sugar de ... le marché portugais ... es "repeated state... CEE à l'effet que ... ges supplémentaires ... en provenance des ... sauraient entrer au ... "The government ... to press for access of ... sugar supplies from ... ountries to Portugal ... ourable terms", a dé...

...nion des météorologues de la région

...embres du sous-... Tropical Cyclone ...e, pour la région ... ouest de l'océan ... se sont réunis au service météorolo... Vacoas du 31 août ... tembre derniers ... ir les responsabi... définir le fonction... des trois centres du ... Cyclone Advisory ... installés à Mau... Madagascar et à la ... dées par le Tropical Cyclone Committee qui s'était réuni à Madagascar l'année dernière. Ce comité, qui s'occupe des questions météorologiques pour cette partie de l'océan Indien, est une émanation de la branche africaine de l'*Organisation Météorologique Mondiale*.

Le sous-comité, présidé par la Tanzanie, est composé de Madagascar, Maurice, la Réunion et le Zimbabwe. Lors des travaux du

... gosse de onze ans habitant Pointe-aux-Sables. Celui-ci marchait tranquillement avec des amis lorsqu'il fut hélé par un homme d'une trentaine d'années qui lui demanda d'aller présenter un reçu à un bookmaker.

En se rendant compte que le reçu était un faux au nom d'un cheval qui avait remporté une épreuve, le bookmaker fit arrêter le petit commissionnaire.

Ce dernier, qui est détenu depuis samedi, a indiqué aux enquêteurs du CID (Sud) que l'homme qui lui avait remis le reçu lui avait offert dix roupies pour ce "petit service".

Me Ahmad Jeewah, dont les services ont été retenus par les parents de l'enfant, a réclamé la remise en liberté de ce dernier en raison de son âge et des circonstances qui entourent cette affaire.

Signalons que la loi interdit formellement aux mineurs de se livrer à des jeux du hasard. Cela implique donc que tout bookmaker qui permettrait à un mineur de miser sur un cheval quelconque ou de négocier un reçu sur un cheval ayant remporté une épreuve, se rendrait coupable d'un délit.

KOOMARA VENKATASAMY

GLISSEMENT DE "LA BUTTE"

Des experts japonais sur place

Le rapport du géologue Longworth avait recommandé une étude plus approfondie du site de La Butte, où un important glissement de terrain a bouleversé tout un quartier. Dans ce contexte, est arrivé, hier, pour deux semaines, une équipe d'experts japonais de l'Agence japonaise de coopération internationale.

Dès leur arrivée, les experts japonais est attendue lieux afin de constater de visu l'ampleur du phénomène et préconiser, après de multiples rencontres avec des autorités concernées, les mesures à prendre à long terme. Ainsi, ils définiront les précautions en cas d'urgence et la possibilité d'utilisation des terrains du quartier.

Une autre équipe d'experts japonais est attendue le mois prochain, qui mettra les recommandations en route.

À CITÉ LACURE

Fouille fructueuse de la fumerie de "Hypolite"

Les éléments de l'ADSU ont frappé un grand coup hier. En effet le dénommé "Hippolite", dont les agissements étaient surveillés de près, a été pris en flagrant délit.

Une importante quantité de Brown Sugar, estimée à plusieurs milliers de roupies, des aiguilles, des morceaux de papier cellophane et une importante somme d'argent ont été saisis.

Par ailleurs, un employé du secteur portuaire qui se trouvait chez le dénommé "Hippolite" a été également arrêté.

De plus, un colporteur habitant Vallée Pilot a été appréhendé hier au sommet de la Colline Monneron. Il avait en sa possession une cuillère portant des traces d'héroïne et une seringue. Un homme qui était en sa compagnie a pris la fuite en apercevant les policiers.

Les trois hommes ont été traduits en Cour ce matin.

K.V.

Témoin vedette lors du procès de Alexandre

Il est condamné pour voies de fait sur une dame

Le colporteur Abedeen Goolamally témoin vedette lors du procès d'assassinat sur la personne d'une dame.

A. Goolamally a plaidé

... ot a mis l'accent sur les réformes, entreprises par son ministère. À l'issue de ce symposium, un plan d'action sera dressé qui touchera tous les secteurs de l'éducation.

Classique à la Citadelle

Les jeunes aiment-ils la musique classique? Les mélomanes et ceux qui désirent s'initier à ce genre de musique peuvent se rendre à la Citadelle le 15 septembre à 19h 00. Le ministère du Tourisme, y organise en effet, avec le concours de la Bonne Marmite, un concert en plein air. Au programme, des extraits "Amadeus" de Mozart, Adagio d'Albinoni, Water Music de Haydn et le concerto pour piano et orchestre de Grieg.

Télécommunications spatiales

La coopération entre l'île Maurice et la France touche à tous les secteurs: culture, santé, éducation etc. Cet après-midi, le ministre des Affaires étrangères, M. Madun Dulloo et le chargé d'affaires, M. Stéphane Chrelevsky signeront une convention de financement ayant trait aux télécommunications intérieures et extérieures. Aux termes de cette convention d'un montant de deux millions de francs (Rs. 4,5 millions), un groupe électrogène de secours sera fourni à la station terrienne d'Agaléga, à celle de Saint Brandon et à celle de la Montagne des Signaux. Un expert de France Câble et Radio, sera chargé de l'assistance à l'exploitation et de la maintenance des équipements de télécommunications spatiales, et de parfaire la formation des techniciens mauriciens.

Des activités

Des activités pour un 27 septembre

A l'occasion de la Journée mondiale du Tourisme, un programme d'activités a été dressé. De 9 h 30 à midi, au M.G.I. une série de conférences destinées essentiellement aux élèves de la Form VI se déroulera. Y seront

LANDSLIDE

JAPANESE EXPERTS FOR LANDSLIDE AT LA BUTTE

A team of Japanese experts arrived Mauritius begining of this week in order to carried out a research in the regioh of La Butte.

The main objective of the project is to study the present position at La Butte with a view to providing an understanding of the landslide and preparing the landslide protection plans for subsequent implementation. This study will also set up measures to be taken in order to assure the stability of the long term site and will make recommendation for the utilization of the land in this region.

During their stay of two weeks, the experts, all from Japanese Agency of International Cooperation (JICA) will have working sessions with officials of the Ministry of Housing, Works and Local Government.

They will meet also technicians of the C.W.A as well as the officials of the Municipality of Port Louis. The arrival of this team follows the report carried out by the British Geologist who has recommended further technical studies of the site.

The recommendation of this team will be executed by another team of experts coming from Japan next month.

Yesterday afternoon, the experts have visited the site accompanied by the Minister of Local Government, Mr Régis Finette, and other officials of the Ministry.

L'EXPRESS 10 SEPTEMBER 1988

GLISSEMENT DE TERRAIN

Des experts japonais font des recherches à La Butte

UNE équipe d'experts japonais est arrivée au pays en début de semaine en vue d'entamer un projet de recherche dans la région de La Butte.

Ce projet de recherche consiste à étudier la situation actuelle à La Butte en vue de définir toutes les mesures à prendre en cas d'urgence. L'étude établira également les mesures à prendre afin d'assurer une stabilité à long terme du site et fera des recommandations à propos d'une éventuelle utilisation des terrains de la région.

Durant leur séjour de deux semaines, les experts japonais, tous cadres de l'Agence japonaise de Coopération internationale, auront des séances de travail avec des cadres des ministères du Logement, des Travaux du Plan et des Administrations régionales.

Ils rencontreront également les techniciens de la CWA, ainsi que les officiels de la municipalité de Port-Louis.

L'arrivée de cette équipe fait suite au rapport du géologue britannique Longworth qui avait recommandé, entre autres, une étude technique plus approfondie du site.

Les recommandations de cette équipe seront mises à exécution par une autre équipe d'experts attendue, toujours du Japon, le mois prochain.

Les experts ont hier, après-midi effectué une reconnaissance des lieux en compagnie du ministre des Administrations régionales, M. Régis Finette, et des cadres du ministère.

Vingt autobus de la CNT pour la navette intergares

L'INTRODUCTION d'une vingtaine d'autobus au moins pour faire la navette entre la gare du Nord et la gare Victoria, sera le dossier auquel la direction de la CNT donnera priorité dans les semaines à venir.

Il est fort possible que ces autobus couvrent le trajet en empruntant la voie intra-urbaine reliant le Sud et le Nord dont la construction vient d'être complétée.

Les autobus auront un plus grand nombre de places pour les passagers qui voyageront debout. Les quelques places assises seront réservées particulièrement aux personnes âgées et aux handicapés entre autres.

Le coût du billet pour le trajet sera très abordable, apprend-on dans les milieux concernés.

Du poisson frigorifié

(Suite de la page 1)

Au marché de Port-Louis, on ne peut parler de queue, car il y avait une foule hier après-midi devant les différents étals, chacun voulait être servi en premier provoquant ainsi une bousculade, mais heureusement la situation est rentrée dans l'ordre peu après.

M. V. Singh invite Maurice à un maximum de sous-produ

(Suite de la page 1)

moment où toute l'industrie sucrière mondiale passe par une période cruciale, il y a de la place pour le progrès et ce n'est qu'en progressant que cette industrie pourra survivre".

Selon l'expert indien, le coût de production augmente sans cesse dans le monde, et partout l'on tente de le réduire. Des choses ont été faites en Inde pour améliorer l'efficience: ces choses peuvent être appliquées ici. L'utilisation maximale des sous-produits de la canne a aussi été appliquée ailleurs et dans ce domaine aussi l'île Maurice peut progresser.

"La situation est telle qu'en Inde le gouvernement a décidé de faire du sucre, le produit de base, un sous-produit alors que plus d'importance est accordée aux sous-produits eux-mêmes. Il n'en est pas de même à Maurice mais si jusqu'à récemment les sous-produits étaient négligeables, ils peuvent aujourd'hui être utilisés avec profit — ces profits étant à leur tour utilisés pour le développement global de l'industrie", a souligné M. Singh.

Notre visiteur a suggéré le traitement des eaux quittant l'usine comme une dépense valant la peine, dans la guerre que doit mener le monde moderne contre la pollution.

POTENTIEL ÉNORME

M. Singh considère qu'il y a un potentiel énorme en ce qui concerne les échanges entre les deux pays, et a souligné que la délégati indienne représente "crème" de la Grande Péni sule dans le domaine — que ce n'est que le progrès le développement qui se veront l'industrie sucrièr

Il a remercié la socié coopérative mauricien pour son invitation. Il aussi remercié le Premi ministre, le ministre l'Agriculture et le gouve nement pour leur accueil, le management des usin visitées pour sa collabor tion — collaboration q sera encore nécessaire pe dant la semaine qui vient.

Parlant de l'industr sucrière indienne, M. Sin a dit qu'elle est une des tr plus importantes du mon avec celles du Brésil et Cuba. En 1987/88, elle a é le plus gros producte mondial de sucre avec 9 millions de tonnes — et el vise une production de millions de tonne, en 1988 89 (pour une producti d'environ 175 millions tonnes de cannes).

Le gouvernement, le se teur privé et les coopér tives produisent tous sucre avec efficience — l usines coopératives prod sant environ 50% du suc global. Tout le sucre indi est fourni au marché local

PRUDENCE

C'est M. J. Goburdhu secrétaire de la "Mauriti Planters' Agricultural a By-Products Processing C operative Society Limite qui a présenté M. Singh les autres membres de délégation à la presse, en p sence du président de société, M. J. Nundlall.

Vc/Ph alloue 476 permis de développe

地すべり専門家の派遣（報告）

1.　今般、9月5日から20日まで、モーリシァスにて、地すべり調査を行った専門家4名（小林建設省河川調査官、仲野同課長補佐、黒川地すべり技術センター課長代理、池田コンサルタント）は、21日当館を来訪し、本使及び館員に、上記調査結果につき次の通りの報告を行った。なお調査終了時に調査団が「モ」側と作成したメモランダム（写し）別添送付する。

(1)　現　　況

(イ)　大規模な地すべり（主な活動範囲と認められる部分だけでも幅約600m，長さ約400m）がポートルイス市の市街地で発生し、住家をはじめ道路等公共施設に甚大な被害を与えている。

(ロ)　地すべりの上部には、クラックや段差が明瞭に認められる。よって次期、雨期には地すべり現象の活発化が十分予想される。

(2)　モーリシァスへの提言内容

(イ)　応急対策：雨期を目前に控えて、当面、人的被害を最少限にとどめるために、警戒避難体制の確立と応急工事の実施が必要である。

前者については、我が国から携帯した器機の設置をし、その利用の方法について技術移転を行った。

後者については、当面実施可能と思われる表面水の排除工について提案した。

以上の応急対策については、モーリシァス側が独自に出来ると思われる。

(ロ)　今後の調査計画：地すべりの規模並びに被害が大きい（日本のレベルでも第1級の規模）割合には技術的情報が不足しているので、警戒避難基準の精度を上げるためにも、また、今後の対策工事の詳細を決定するためにも、より充実した調査が必要である。（地形調査、ボーリングによる地質調査及び地下水調査、移動量調査、データ解析、設計等）

(ハ)　恒久対策：最終的には地すべりを安定させなければ住民の生命・財産及び公共施設を地すべり災害から守ることができないので、問題の地すべり箇所において、現在までの調査では、集水井工（井戸を掘り排水することにより地すべりを防ぐ）、鋼管杭工（鉄のパイプを打ち込み力で押える）及び押え盛土工等が必要となると思われる。

なお、これ等の対策工法及び諸元の最終的決定は今後の調査をまたなければならない。

(3)　モーリシァス側の反応

今回の調査にあたって、モーリシァスの関係機関及び地元ポートルイス市の地すべりに対する関心は極めて高く、今回の調査団への協力はすこぶる満足のいくものであった。また担

当窓口であるMinistry of Local Governmentからは、我が国の今後の協力に対して強い要請が出され、調査団としては、モーリシァス側の意向はマダガスカル大使館をはじめ、本国関係機関に伝えると回答した。

2. 上記報告の通り、モーリシァスにおける地すべりの状況は深刻なものであり、それだけに本件に関する「モ」側の関心は高く、日本の協力への期待は大なるものがある。今次調査団の活動状況もテレビで放映され、広く一般の注目の的となった趣である。

今後のステップとしては、上記1.(1)(ロ)で提言されている本格調査が必要となるところ、「モ」政府はこれを日本の協力で実施してもらいたいとの強い希望を表明しており、今次調査団一行にも本格調査団派遣の予定期日につき、さかんに尋ねるところがあった由である。（調査団としては勿論一切のコミットは行わなかった）

ついては、「モ」政府の本件我が方協力への強い期待にも鑑み、本格調査団派遣の要請に応ずることは、日・「モ」関係強化の全般的見地からも極めて好ましいと思料するので、開発調査等の形により右実現方是非とも御検討願いたく、結果御回示いただきたい。

なお「モ」側は本格調査の内容は既提出のＡ１フォーム中のterms of referenceに述べられているので、改めて要請を出す迄もなく日本側で検討されるものと考えている趣であるが、新たに要請を提出せしめる要あるのであれば、そのように当館からとりはからうこととするので、その旨御回示願いたい。

更に、本格調査の後、必要となる上記1.(2)(ハ)の恒久対策については、「モ」側の意向は未だ明らかでないが、円借款供与を希望越すこととなる可能性は考えられる。

別 添

M E M O R A N D U M

Technical Study on the La Butte Landslide

In response to the request made in June 1988 by the Government of Mauritius for a comprehensive study of the landslide at La Butte, the Japanese Government despatched to Mauritius from the 6th - 19th September a technical mission to undertake a preliminary study. The technical mission was headed by Dr Watari, President, Japan Landslide Society and consisted of the following members:

Mr. Hideaki KOBAYASHI
Vice Director, River Rampart, Kinki Regional Construction Bureau, Ministry of Construction

Mr. Masaaki NAKANO
Deputy Director, Slope Protection, Sediment Control Department, River Bureau, Ministry of Construction

Mr. Senju IKEDA
Consultant, Geologist

Mr. Okichika KUROKAWA
Deputy Chief, Technical Section, Sabo Technical Center

2. The objectives of the mission were as follows:

1) To examine the mechanism of the occurrence and movement of the landslide by means of field survey and data obtained,

2) To make a plan for urgent landslide protection works,

3) To establish a temporary warning and evacuation system in emergency, and

4) To advise an outline of detailed survey and landslide protection works for long-term stability in the future.

3. During their stay in Mauritius the mission carried out a field survey, installed monitoring equipment, and held discussions with representatives of the Ministry of Local Government and other departments/organisations concerned.

4. The Mission submitted at the end of its assignment a report containing recommendations relating inter alia to

(i) the setting up of a warning and evacuation system

(ii) execution of urgent landslide protection works

(iii) the need to conduct a detailed investigation (topographical, geological, geomorphological etc) of the area with a view to the preparation of a long-term stability programme for the area.

5. The discussions between the Japanese and the Mauritian sides took place in an atmosphere of cordiality and friendship characterizing the good relations that exist between the two countries. The Mauritian side was appreciative of the work done by the technical mission and felt that further cooperation between the two Governments would bring about a solution to the landslide problem at La Butte.

6. In witness whereof the Mission and the Government of Mauritius have caused this document to be signed on the 19th September 1988 by their respective representatives.

R. Honore

(Mr. R. Honore)
Permanent Secretary
Ministry of Local Government

H. Kobayashi

(Mr. H. Kobayashi)
for Dr. M. Watari
Leader of the Mission
Japan International Cooperation Agency