ENGINEERING DESIGN OF AN ACCESS ROAD AND DOMESTIC SERVICES.

by

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ABSTRACT

This project objective is to establish the detail engineering design of an access road, water supply and sewage disposal for a proposed country residence according to the terms of reference established by the owner Mr.Serge Rivest in may 1987. Also the project includes a cost estimate of the overall project. This analysis will be leading Mr.Rivest in deciding to build or not his country residence at the site that he has initially selected.

The access road will be approximately 380 feet (115 m.) in length with the addition of a parking of 30 feet (9 m.) long by 30 feet (9 m.) wide at the end of the access road. The sewage disposal facilities will be composed of a septic tank designed for a 2 bedrooms type of house, and the type of absorption field will consist of 4 trenches 55 feet long (16.8 m.) disposed in steps. The water supply will not come from the existing spring of insufficient capacity but from a drilled well near the proposed house. The total capital expenditures of the project is estimated at approximately $ 36 000.00

ACKNOWLEDGEMENT

I would like to express my gratitude to all those who helped me throughout this project: to M.Mckyes and Susel Barrington for their precious time, Daniel Larose for his technical support, Mr. J.L. Courtemanche for his advices and support, and finally to Mr. Serge Rivest for the use of his land without which this project would not have been possible.

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NOMENCLATURE.

W = Widening of road (ft)

n = number of lane

R = radius of curvature (ft)

V = assumed design speed (mph)

M = the offset of the vertical curve.(ft)

g1 = the slope of the first tangent.(%)

g2 = the slope of the second tangent.(%)

L = the length of the curve.(ft)

O = Offset of the tangent relative to the curve

M = the offset of the vertical curve.(ft)

t = the distance raltive to the PI.(ft)

T = the curve lentgh divided by two.(ft)

Tc = Time of concentration in minutes (min)

L = maximum length of flow.(m)

S = Watershed gradient.(m/m)

q = design peak runoff rate. (m^3/s)

C = Run off coefficient

A = Watershed area.(ha)

i = Rainfall intensity for the desired return.

V = Volume of the tank. (m3)

Q = Daily water consumption.(l)

à = retention period.(day)

A = seepage field area.(sqft)

Q = daily wastewater.(Igal./day)

I = infiltration rate.(Igpd/ft2)

INTRODUCTION

In the fall 1986, one of my relatives, Mr. Serge Rivest bought a tract of land in the eastern townships, in the municipality of Mansonville, fronting of lake Memphremagog. He then wanted to build a country residence, but after examining the site realize that he was needing some engineering advices for implementation of this country cottage, the property being hilly. I therefore offered him to examine the feasibility of the access road to reach the selected house site and in addition to do the expert appraisement on the septic accomodation and the water supply system.

This project work was initiated on the basis of this agreement and the final analysis is to be provided to Mr. Rivest by the end of 1987.

OBJECTIVES.

From the terms of reference which covers an access road, water supply and waste water disposal system, one of the objectives is to minimise capital expenditure. Also, the design of the access road, septic system and water supply has to be in relation with a specific location where the proposed house is set by the owner and globally in accordance witn laws and govermental regulation.

Therefore the following subjects should be provided :

-Feasibility study of building an access road.

-Preparation of suitable drawings for construction purposes, for the three components of the project.

-Development of cost estimates based on the market for this type of work.

-Make an estimate of the overall cost of this construction.

2. DESIGN CRITERIA

The following design criteria apply to the site work and general services. It outlines the base rules for the design and construction of the access road, preliminary drainage, water supply and sanitary sewage.

2.1 ACCESS ROAD.

2.1 1 SELECTION OF THE ROUTE.

In selecting the route certain principles should be followed as far as practical. The road should be as direct as possible but sometimes directness is sacrificed and length have to be increased in order to obtain proper grade.

Four points have to be considered in order to lead to a proper design:

First the road should cross the ridge at the lowest possible elevation.

Second, the grade line should be established following as much as possible the natural surface.

Thirdly, The grade line should be established according that the cuts and fill will not be excessive.

Fourthly, The route should be adjusted for the best development opportunity.

2.1.2 DESIGN SPEED.

The design speed will be of 10 mph knowing the high gradient and the sharp curves required due to width of property.

2.1.3 DESIGN VEHICLE.

The road will be designed to accomodate a standard family car and occasionnaly a service truck. Figure 1 shows the dimensions of the standard car. Widening of the curves and the foundations will be designed to accomodate some large vehicles such as service trucks at the time of construction, and to service the septic tank which has to be emptied periodically.

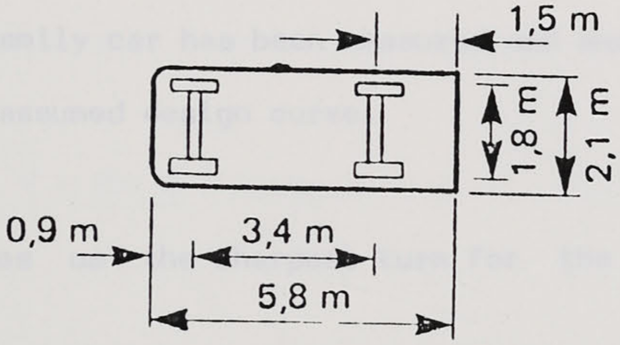


fig.1 Standard car dimensions.

2.1.4 ROAD WIDTH

The road width is selected according to the type of vehicle that will use it and also with respect to the economical factor. The road width will be 10 feet large which is the minimum acceptable.

2.1.5 DEFORESTATION.

The clearing of the land has to be at least 5 feet from the toe of proposed fill or top of cut.

2.1.6 TURNING RADIUS

The characteristics of a turning vehicle will be considered to determine the minimum turning radius for the road. Usually the turns at which the turning radius is controlled are made at relative low speed at which some factors such as the time required to turn the stearing wheel, the rate of approching centripedal acceleration and the slippage of wheels may be ignored.

The relationship between the wheel base and the turning radius for a standard family car has been measured and such measurements are the basis for the assumed design curve.

Figure 2 Indicates us the sharpest turn for the proposed critical vehicle.

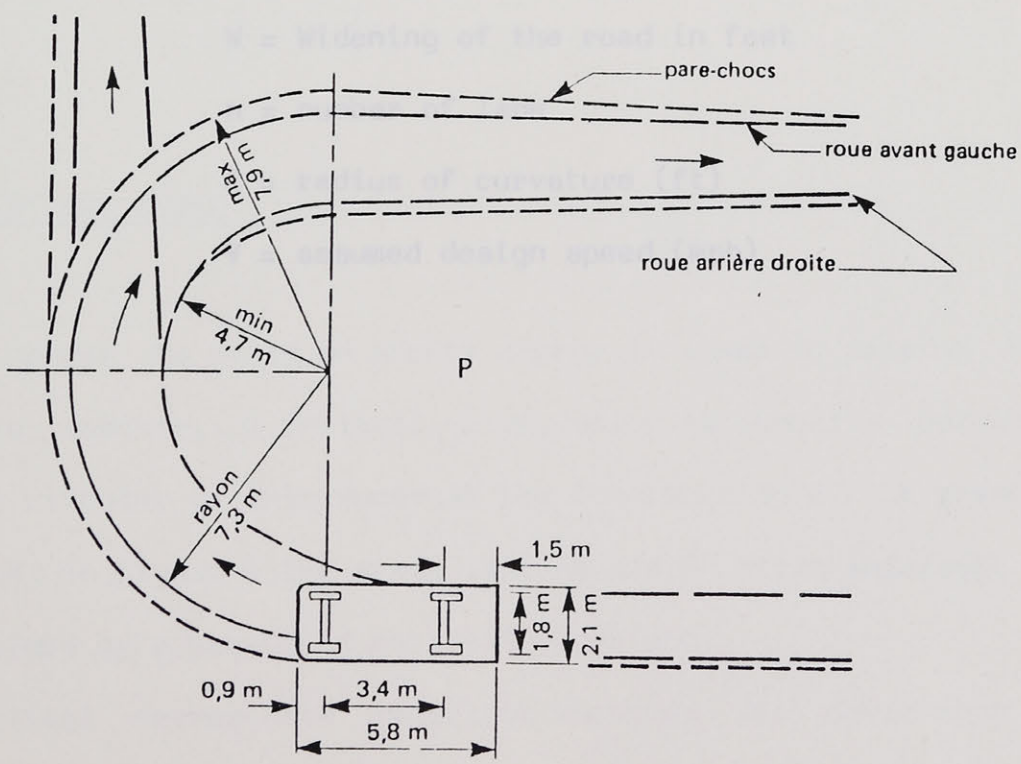


Figure 2. (ref.6)

2.1.7 WIDENING OF CURVES

It is necessary to widen the roadway on any curve especially the radius of which is less than 1000 feet because the rear wheels of a vehicle that is rounding a curve tend to travel on a shorter radius than the front wheels. See figure 3.

The most general practice to determine the widening is with the help of the Barrett formula.

But an approximation of this formula has been found for vehicles having wheelbase of 20 feet long (6.09 m). An approximate and simpler modification of the Barrett formula is:

$$W = \frac{200\,n}{R} + \frac{V}{R} \qquad \text{eq.1}$$

Where,

W = Widening of the road in feet

n = number of lane

R = radius of curvature (ft)

V = assumed design speed (mph)

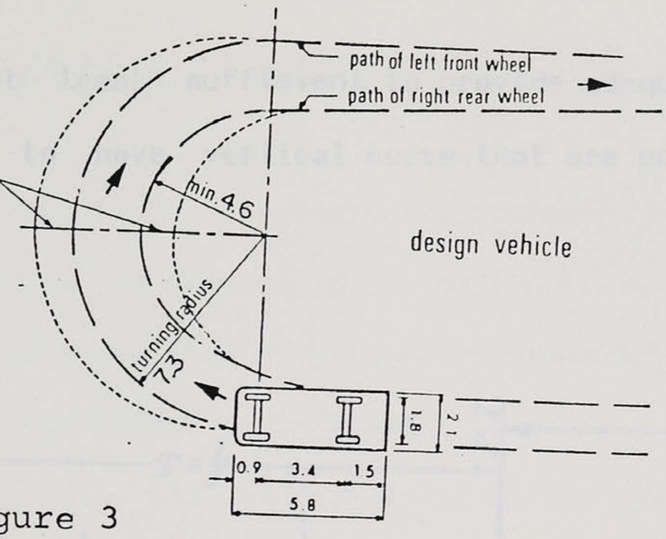


figure 3

2.1.8 GRADE ABILITY.

In the design of a road, the selection of the gradient is one of the most important problems. Knowledge of the hill climbing ability of commercial vehicles is necessary if the engineer is to design a gradient which will produce a minimum of problem caused by the steep grade. A 20% slope will be selected as a maximum gradient. It can be climbed in winter in snowy conditions but requires a minimum of maintenance. This implies snow clearing and abrasives spread when slippery conditions occur.

2.1.9 VERTICAL CURVE.

In order to avoid an abrupt change in slope in passing from one grade to another, a vertical curve, which is usually parabolic but sometime circular is introduced at the intersection of the grades.

Thus in figure 4 the grade line AB and BC which intersect at point b are joined by a parabolic vertical curve abc.

Vertical curves are important whenever the difference between grades exceed .5 %. At summit or peak, the length of the vertical curve must be at least sufficient to provide adequate visibility. It is preferable to have vertical curve that are connected in using long curves.

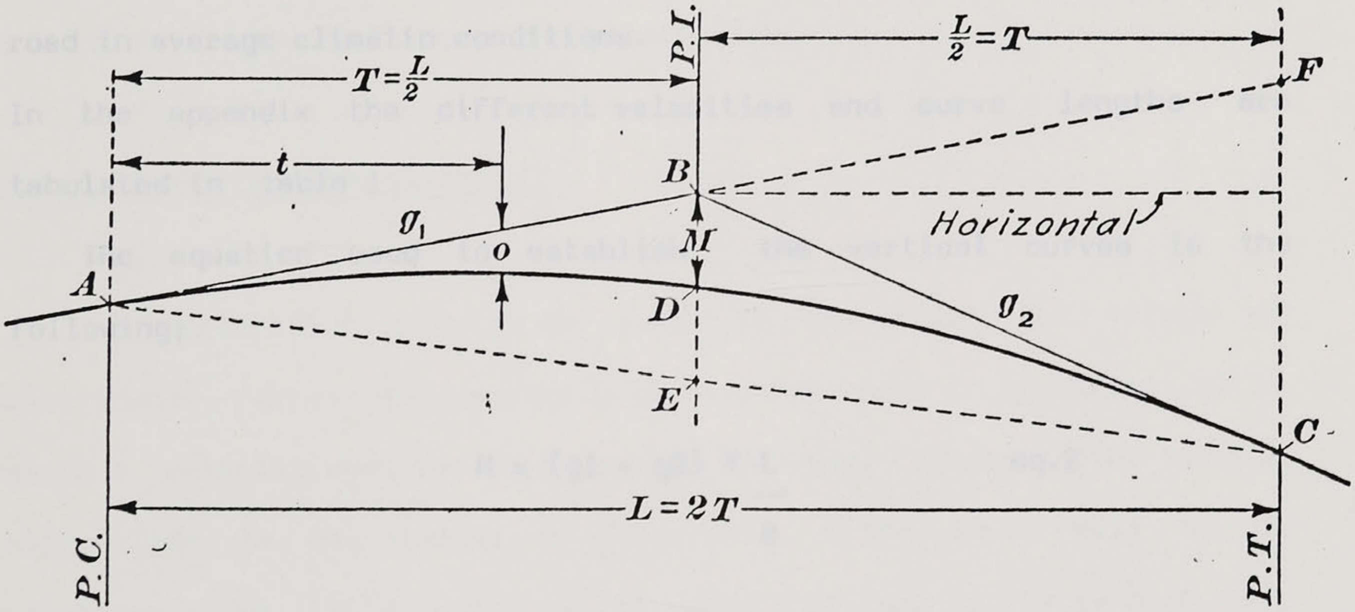


Fig. 4 —A Typical Parabolic Vertical Curve.
from reference 4.

There are three parameters to be considered in the calculation of a vertical curve. (ref.4).First the vertical offset from the tangent to the curve are proportional to the square of the horizontal distance from the point of tangency, second, in the parabola the curve bisect the distance between the PI and the long chord, Thirdly, the offsets are symmetrical to both halves of the curve, but corresponding tangent elevations are different.

2.1.10 THE LENGTH OF THE CURVE.

The length of the curve is determined by the minimum stopping distance which is related to the design speed of the car, the driver time to react and the friction coefficient between the tires and the road in average climatic conditions.

In the appendix the different velocities and curve lengths are tabulated in table 1

The equation used to establish the vertical curves is the following;

$$M = (g1 - g2) * \frac{L}{8} \qquad \text{eq.2}$$

Where,

M = the offset of the vertical curve.(ft)

g1 = the slope of the first tangent.(%)

g2 = the slope of the second tangent.(%)

L = the length of the curve. (ft).

Also the offset at each desired distance is calculated with the help of the following formula.

$$O = M * (t / T) \qquad \text{eq.3}$$

Where,

O = Offset of the tangent relative to the curve (ft)

M = the offset of the vertical curve.(ft)

t = the distance raltive to the PI.(ft)

T = the curve length divided by two.(ft)

Therefore we will be able to determine the surface road elevation at any point along the center line.

2.1.11 SUPERELEVATION ON CURVES.

Superelevation curves are made to counteract the effect of centrifugal force. But superelevation curves need to be taken at a minimum velocity when ice is formed on the road. Otherwise the vehicle will slide in the inside of the curve. Since there will be no maintenance or little during winter, chance of forming ice is high and the average velocity of vehicles will be low, therefore no superelevation is planned.

2.1.12 SIDE SLOPES

In making excavations and embankments, the side slopes must be given an inclination wich will prevent slippage of the soil. The slopes of cuts will depend on the type of material and the geographic location and on whether or not excess water, springs, etc. are present on side hill. Cut slopes in solid rock are commonly vertical or nearly so. In unstable material they maybe as flat as one vertical to three horizontal or 1 to 3. Observations of existing cuts in the vicinity of the project site give an indication of the behavior of the natural soil.

2.1.13 SELECTION OF SURFACE TYPE

The surface of the road must be able to resist the action of the vehicles passing over it without suffering excessive damage.

The subgrade, or the soil under the road structure, is helpfull in sustaining the traffic load because the structure distributes the concentrated wheel load over a larger area and protects it from the softening action of water.

According to the "Guide de preparation des projets routiers", for the case of a private driveway the choice of the surface type will be gravel or crushed stone of 19-0b type, and the subfoundation will be sand or pit run gravel.

2.1.14 FOUNDATION DEPTH

According to the airfield pavement management handbook, for a typical tank truck of 80 kilonewtons, with double tires 40 centimeters apart, a foundation depth of 23 centimeters (9 inches), made of crushed stone or gravel on top of 30 centimeters (12 inches) of sand is selected.

2.1.15 CUT AND FILL.

The choice of a very good alignement and satisfactory grade will generally take precedence over the cuts and fills.

In fact it is more desireable to select the road alignment where there will be more fill than cut considering the maximum grade design criteria. In establishing the grade line, attention should be taken to balance the volume of fill and cuts as much as possible, and the material excavated will therefore be sufficient to form the embankment. Furthermore the grade should be selected in order to minimise earthwork movements, especially where rock excavation is encountered.

The calculation of the cut and fill is worked out using several sections of the road at a maximum of 50 feet (16 m) apart, therefore with the help of a planimeter the surface area of each section is evaluated and an average volume between sections is calculated.

2.1.16 COMPACTION FACTOR.

If the natural soil in place is compacted at the degree that is usable for a road, its volume would decrease by 20 %. (ref 6).

2.1.17 EXPANSION FACTOR.

When a portion of rock that has been cut is utilised for road construction, an expansion factor is applied since the volume of rock is higher once it has been blasted, this factor being 1.47 for schist.

2.1.18 UTILISATION FACTOR.

Another factor is considered in the calculation of the volumes of soil needed for the road construction, which is the utilisation factor. This factor takes into consideration the fact that not all the material cut will be utilised in the construction, and the percent utilisation is proportional to the volume excavated per metre. The factor is taken from figure 7 in the appendix.

2.2 DRAINAGE

The design criteria that follow are applicable to the construction of the drainage ditches.

2.2.1 ECONOMIC LIFE

The economic life factor attached to the project is related to the expansion and future development. The drainage system will have an approximate 10 years of life span as suggested by "le guide des projets routier".

2.2.2 PRECIPITATION CURVE

The intensity duration frequency curve for the municipality of Mansonville not being available, the data used are from the nearest metering station which is Sherbrooke.

2.2.3 TIME OF CONCENTRATION

The time of concentration is the time required for water to flow from the most remote (time of flow) point of the area to the outlet when the soil has become saturated and minor depression filled.(ref.8)

The time of concentration is function of the slope of the land and the nature of the soil.

Where the time of concentration is defined as the following:

$$Tc = .0195 * L^{.77} * S^{-.385} \qquad \text{eq. 4}$$

Tc = Time of concentration in minutes (min)

L = maximum length of flow. (m)

S = Watershed gradient.(m/m)

2.2.4 STORM DURATION

The total watershed surface area being less than 800 hectares, application of the rational method is acceptable. This method considers that maximum flow occur when all the surface drained contributes to the runoff at the point under study.

2.2.5 INTENSITY AND RETURN PERIOD OF THE STORM

The selection of the return period varies according to the importance of the design system, the selection being between 2 to 10 years.

The intensity of the precipitation is in inches per hour and selected according to defined duration i.e. the time of concentration, and the return period.

2.2.6 RUNOFF COEFFICIENT

The runoff coefficient C is defined as the ratio of the peak runoff rate to the rainfall intensity and is dimensionless. Also it is function of:

-% surface impermeable.

-Soil type.

-Soil saturation.

-Geometric shape of the watershed area.

2.2.7 SURFACE AREA

The surface area tributary to a certain point will be mesured with the help of the topographic map of the lot 1115-23.

2.2.8 CALCULATION OF THE DESIGN PEAK SURFACE RUNOFF

Since the overall drainage area is smaller than 800 hectares,the rational method of predicting a design peak runoff rate will be used.

$$q = .0028\ C\ i\ A \qquad \text{eq.5}$$

q = design peak runoff rate. (m^3/s)

C = Run off coefficient

A = Watershed area. (ha)

i = Rainfall intensity for the desired return period equal to the time of concentration of the watershed. (mm/hr)

To determine the different features of the ditch, the following formula is used.

$$R = \frac{b*d + z*d}{b+2*d*(z^2+1)} \qquad \text{eq.6}$$

R= Hydraulic radius. (m)

b= Bottom width. (m)

z = side slope of the ditches.

d = depth of water in the ditch. (m)

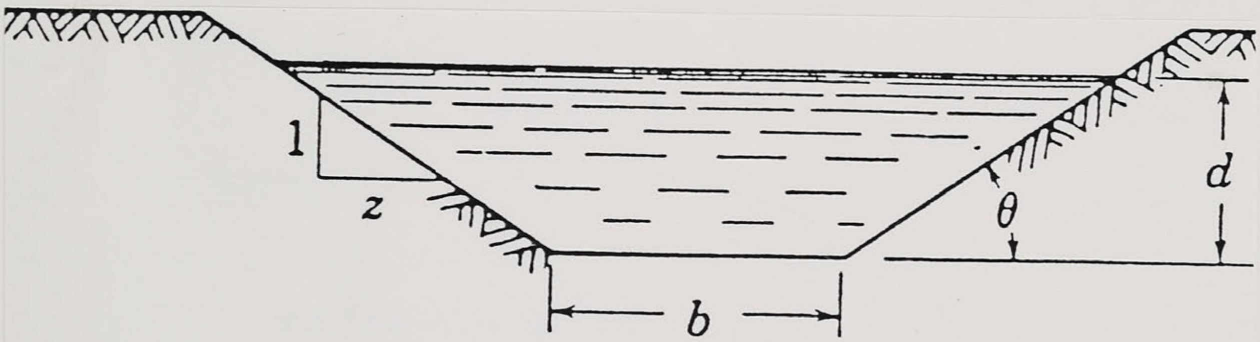


Fig. 5 Elements of an open channel cross section. (ref.8)

2.2.9 CULVERT DESIGN.

In the design of a culvert we have to consider the local constraint like the type of culvert available, its shape, the water uphill admissible, permissible speed in the culvert and construction cost. All of these will be determined by the hydraulic study.

Manning's equation will be used to determined the hydraulic capacity of the culvert.

$$V = 1.49\, R^{2/3}\, S^{.5}/n \qquad \text{eq.8}$$

Where,

V = Average velocity of the flow. (m/s)

n = Roughness coefficient of the channel.

R = Hydraulic radius (m)

S = Hydraulic gradient. (m/m)

Also,

$$Q = A * V \qquad \text{eq.9}$$

Where,

Q = Flow rate (m^3/s)

A = Cross section area of the pipe. (m^2)

Limits of the flow velocity in the ditch.

Minimum velocity : .76 m/s

Maximum velocity : 3.05 m/s

2.2.10 EROSION CONTROL AT THE CULVERT OUTLET.

For culverts having 3% slope and more, protection is required for erosion control at the outlet of the culvert. Requirements are subject to the type of soil slope and water velocity.

2.3 DOMESTIC SEWAGE DISPOSAL

2.3.1 COMPOSITION OF SEWAGE

The composition of the water sewage is water plus solids in suspension and in solution. Average sewage contains over 99.9% water, remainder of less than 0.1% solids. Solids are composed of inorganic matter such as sand, silt, dissolved salts, and organic material derived from living organisms. Sewage also contains certain gases dissolved in the water such as oxygen, carbon dioxide and hydrogen sulphide.

2.3.2 BACTERIOLOGICAL CHARACTERISTICS

Sewage contains large numbers of bacteria. It has been estimated that ordinary sewage contains over 300 billion bacteria for each person connected to the sewer or septic tank, and bacteria is the key element to purify the waste water. For these reasons, when no municipality sewage system is available, according to the ministry of environment, there has to be a septic installation in order to avoid pollution from home wastewater and protect the environment.

2.3.3 SEPTIC INSTALLATION

A septic installation is provided to treat the waste water for isolated houses. It consists of two parts, the septic tank and the absorption fields.

2.3.4 TYPE OF SYSTEM AVAILABLE.

Possibilities that are offered to us are the following:

-septic tank (with or without aerator), connected to

-Classical absorption field.

-Modified absorption field.

-Sand filter out of the soil.

-Classical sand filter.

The selection being made according to the soil conditions.

2.3.5 THE SEPTIC TANK.

The septic tank is a tight reservoir where the waste water is evacuated. The waste water will stand there for about 48 hours to let solids to settle and to catch oil and grease on the surface. The role of the septic tank is to prepare the waste water for the eventual distribution in the absorption field.

During the retention period most of the suspended solids (especially the heavier material) settles to the bottom and undergoes decomposition by anaerobic bacteria

2.3.6 SEPTIC TANK.

2.3.6.1 TYPE OF SEPTIC TANK.

The type of septic tank will be selected according to the recommantions made by the governement or ministry of environment. Which suggestion is a precast reinforced concrete tank.

2.3.6.2 PREFAB TANK

Note that Prefab tanks should be certified by the " bureau de normalisation du Quebec,"

2.3.6.3 SEPTIC TANK LOCATION.

The location of the septic tank is be made taking into account the topography of the site, road and major obstruction and according to the ministry of environment regulations which stipulate specific distances at which the tank and absorption field should be. They are the following.

At least 15 metres from water supply for consumption.

11 metres from lake, water course.

3 metres from water supply pipes.

2 metres from any house.

2.3.6.4 MAINTENANCE AND CARE.

Successful operation of the tank is dependent upon bacterial and biological action, so extreme care must be exercised to exclude disinfectants and acids from the sewage.

At least once a year the depth of the sludge should be determined in the septic tank and when the sludge depth exceeds 40% of the total liquid depth, most of the sludge should be removed from the tank. The recommendation of the environment ministry of Quebec states that it is about once in every four years for seasonal use. Never remove all the sludge from the tank.

Unsatisfactory operation of the absorbtion field is known at once by the appearance of sewage at the surface of the ground. This may be caused by clogged pipes, excess sewage or insufficient absorption capacity of the field.

2.3.6.5 VENTILATION.

The gases produced go back through the building plumbing system and out through the vent to the atmosphere. The liquids produced by this decomposition join the settled sewage and go out into the disposal field for further treatment. The septic tank itself will be ventilated with a 4 inches (10 cm) diameter duct.

2.3.6.6 CAPACITY

Total capacity of the septic tank varies with the total number of bedrooms. Recommendations are that for 2 bedrooms, which implies that there are two persons per bedroom each one using 38 imperial gallons (173 liters) per day and the retention time of that waste water in the tank is 2 days.

The capacity is calculated as the following.:

For 2 bedrooms $V = Q * à$ eq.9

V = volume of the tank.

Q = daily water consumption.

$à$ = retention period.

2.3.6.6 CONSTRUCTION FEATURES.

The sewer line from the house to the septic tank will be of plastic PVC and comply with the standard plumbing code. The diameter shall not be less than that of the house drain and the grade not be less than 1% .

2.3.7 THE ABSORPTION FIELD

From the septic tank, the clarified water goes through the absorption field. It consists of a series of drains under the surface of the soil which spread the water on the entire surface area of the collecting soil.

During slow percolation through the soil, the water from the septic tank is purified by the aerobic nutrifying bacteria which stabilize the effluent before it is absorbed by the ground adjoining the trenches.

2.3.8 DESIGN OF THE ABSORPTION FIELD.

The total surface area of the absorption field is related to the number of bedroom in the house, or 76 Imperial gallons per bedroom.(346 1)

The absorption field area is calculated as the following.

$$A = \frac{Q}{I} \qquad \text{eq.10}$$

A = seepage field area. sqft

Q = daily wastewater. Igal./day

I = infiltration rate. Igpd/sqft

2.3.9 LOCATION.

The type of absorption field is defined according to the rock level, or underground water table, the slope of the land and the properties of the soil, related to the percolation test.

The absorption field should be at least:

30 metres from water supply for consumption.

15 metres from lake, water course.

3 metres from water supply pipes.

6 metres from any house.

2.3.10 CONSTRUCTION CRITERIA:

Nature of soil:

The soil has to be permeable, the rock level at a minimum 1.2 metres below the soil surface and the slope of the ground below 30 percent.

Construction:

Each trench has a maximum length of 18 metres (60 feet). The trench should be at least 60 centimetres wide (2 ft). Between the centre line of the trench the distance should be at least 1.8 metres (5.8 ft). The depth of the gravel on top of the perforated pipe should be at least 15 centimetres or (6 in.)

The perforated pipes should be placed on at least 30 centimetres depth of gravel (1 ft). The size of the gravel should between 1.5 and 6 centimetres and free of any particles.

The gravel layer on top of the perforated pipes should have a layer of non tar paper under 60 centimetres of soil. The perforated pipes are non flexible and made of non corrosive material, and at leat 7.5 centimetres of diameters. The bottom of the trench should be at least 60 centimetres from the bedrock, water table or an impermeable layer of soil. From the recommendation of the ministry of environment, a 2 bedroom should have at least 65 linear metres of trenches (213.5 feet), based on a permeability of .026 cubic metre of clean water per square meter per day (.53 Igal/sqft/d), equivalent of heavy clay. The covering material of the trench should be of permeable soil and lawn will be covering it, the system will be made according to the type of geometry of the land.

2.3.11 PERCOLATION TEST.

Evaluation of site suitability is the most important aspect on site disposal management. Basic determinations include a percolation test, depth of ground water, soil depth, lot size and ground slope.

A percolation test is traditionnaly the primary indicator of the acceptability of soil for wastewater disposal, but for certain practical reasons like the lack of water and type of land, a percolation test has not been performed. Simple class soil texture can give a fairly good idea of about the range of the soil infiltration rate.

.4 WATER SUPPLY

2.4.1 GENERAL

The first step in the design is to plan an adequate water supply system in accordance of the daily demand in water.

2.4.2 DAILY USE OF WATER

Daily uses of water include the kitchen, laundry and bathing use as well as the exterior needs like gardening and lawn sprinkling.

2.4.3 ADEQUACY OF EXISTING SOURCE.

Once the daily needs are known, the next question is to evaluate the present type of water source. If the water source does not supply enough water , ways of increasing the capacity will be looked into.
Consideration will be made of

- type of water source
- determining the water available.
- possibility of increasing the water yield.

Also the quality and the freedom from any contamination will be studied. These are evaluated once the source with enough water available is to be found.

2.4.4 TYPE OF WATER SOURCE.

-wells -drilled
 -jetted
 -dug
 -bored
 - spring
-cistern
-lake or pond.

2.4.5 AMOUNT OF WATER AVAILABLE.

Ounce the best water source is selected how much water it will provided is determined.

2.4.6 PROTECTION OF WATER FROM POLLUTION.

When selecting the site, consideration will be made in order to avoid contamination from the septic tank or the absorption field.

2.4.7 PUMPING AND PLUMBING.

The plumbing system will be considered in terms of the placement of the source of water and the type of water source. The type of pump required will depend on the type of well that will be drilled, and the rate that water will be supplied from that well.

2.4.8 PUMP CAPACITY.

The pump capacity will be selected according to the average water demand and is coupled to a pressure tank that will take peak demand. The pump capacity is designed according to the average water demand, Nevertheless the ultimate solution is only made after adequate well testing for safe yield.

3.SITE EVALUATION

The project site is the land of Mr.Rivest located at a latitude of 45°00' 48'' and longitude 72°15' 41'', 11 kilometers east of Mansonville, 200 kilometers east of Montreal, in the province of Quebec.

A topographic land survey was made of the .84 acres (.34 ha) field, and a topographic map was then produced. A soil survey has also been performed in order to know the depth of the topsoil, gravel and rock. The field has a very hilly topography with a maximum difference in elevation of 95 feet (29 m). The property is 150 feet (45 m) wide and 500 feet (152 m) long. The type of forest is deciduous, with rock appearing at the surface at some places. A spring is located at the upper part of the property which drains into a brook.

Present.y there is a private road going through the land at countour elevation 110 to 95 feet on the map. The site of the proposed house is located at the 175 to 180 feet countour line, just on top of the cliff.

Ounce the field was surveyed, a topographical map with countour lines every 5 feet (1.5 m) has been produced, the design of the road has been possible with a plot of the best road profile according to the design criteria selected. Several sections were drawn at a maximum of 50 feet (15 m) in order to establish the total fill and cut related to each section.

An auger investigation was performed on the overall working area in order to evaluate the depth of permeable soil, and the results have been graphically tabulated in graph 13 in the appendix. But because of the inacuracy of the method, some assumptions had to be made in order to derive the soil permeable depth in view of establishing the septic system. Also, an approximation has been made from the fact that the soil has been excavated at some 50 feet from the future site of the absorption field and it shows a depth of soil over 6 feet, therefore it was assumed that the minimum requirement of six feet is met at the location of the disposal field.

In order to validate a final proper design at the time of construction, the soil depth will have to be measured, and if the requirements are not met, another solution will have to be developed. The different types of soil and slopes are recorded in order to select the type of septic accomodation needed. Also the components like road, house and streams have been considered in the location of the septic accomodation. A simple textural class analysis has been performed to evaluate the quality of the soil. It has revealed that the soil is a sandy loam.

The spring flow has been measured and the water output is too low to meet the proposed needs. Improvement of the present yield is doubtful and will not be considered because of unaccessibility of the spring with to well drilling rig.

4. RESULTS

4.1 ROAD RESULTS.

4.1.1 SOIL DATA

In general the soil consists of a thin upper layer of organic matter on top of a permeable soil of variable depth up to more than 6 feet of a sandy loam type of soil, having small gravel particles of mica schist. The bedrock found at the top of the cliff is not much weathered compared to that one appearing near the existing road. The rock has variable consistency over the working area. Details of the soil parameters are found in the appendix.

4.1.2 ROAD

4.1.2.1 REQUIREMENTS

Design vehicle	standard family car
Design speed	10 mph 16 kmh
Road width	10 ft 3.05 m
Shoulder width	1 ft .305 m
longitudinal slope	.5%
Maximum vertical slope	20%
Foundation depth	9 in. gravel 230 mm
Subfoundation	12 in. sand 300 mm
Embaquement slope	1:1 grassed
	10:1cutin rock

Minimum inside turning radius	15 ft 4.6 m
Outside turnig radius	25 ft 7.6 m
enlargement	10 ft 3.05 m
culvert slope	minimum .2%

4.1.2.2 CONSTRUCTION MATERIAL.

base material	crushed stone or gravel 19-0b
foundation	sand
Culverts	corrugated steel pipe
lawning	sowed.
cushion	Type A gravel.

4.1.3 DEFORESTATION.

Instead of clearing trees 5 feet on each side of the road, a more practical solution will be adopted which is the deforestation of the property from the actual ditch to the 175 feet countour line. This surface area is equivalent to 30 000 square feet or 2850 square metres, as indicated on the map. This solution will open the view on the lake and avoid leaving isolated trees that may be uprooted by storms or high winds, having lost their forest protection.

4.1.4 VERTICAL CURVE CALCULATION

At the point where the 15.8% grade meets the 11.8% grade the station value is 1+25 and the elevation at that point is 125 feet. The length of the vertical curve is 100 feet and the objective is to find the elevation at each 10 feet point on the vertical parabolic curve that is to join the two grade lines.

There are three chainages where two different gradients are meeting. Between the 15.8% and the 11.8%, 11.8% and 20.5% and between 20.5 and 0%. The values calulated for the curve elevation are given in table 2 3 and 4 in the appendix.

4.1.5 WIDENING OF CURVES.

From the following formula, we have found the widening of the curves.

$$W = \frac{200\ n}{R} + \frac{V}{R} \qquad \text{eq.1}$$

where, n = number of lane, 1

R = radius of curvature, 20 feet.

V = assumed designed speed, 10 mph.

therefore,

$$W = \frac{200 * 1}{20} + \frac{10}{20} \text{ mph} = 10.5 \text{ feet.}$$

Thus a widening of 10 feet will be added to the actual road width with 5 feet inside the curve and 5 feet outside the curve.

4.1.6 SIZE CALCULATION OF THE DRAINAGE DITCH AND THE CULVERT.

Since the time of concentration is defined as the following:

$$Tc = .0195 * L^{.77} * S^{-.385} \qquad \text{eq.4}$$

Tc = Time of concentration in minutes (min)

L = maximum length of flow. = 100.61 m

S = Watershed gradient. = .3224 m/m

Therefore,

$$Tc = .0195 * (100.61 \text{ m})^{.77} * .3224^{-.385}$$

and $Tc = 1.0504$ minutes

Corresponding to that time concentration, from figure 9 in the appendix, the rainfall intensity for a 10 year return period is 7 inches per hour. (177 mm/hr).

The surface runoff is calculated as:

$$Q = .0028\ C\ I\ A \qquad \text{eq.5}$$

Q = design peak runoff rate m^3/s

C = runoff rate coefficient = .3

A = Watershed area = .34 hectare

i = rainfall intensity for the 10 year period

equal to the time of concentration = 177 mm/hr

Therefore,

$Q = .0028 * 177.8\ mm/hr * .3492\ ha * .3$

$Q = .0521\ m^3\ /s$

now the road ditch can be designed according to this runoff.

4.1.6.1 DITCH DESIGN.

Using a trial and error solution, and the following equation:

$$R = \frac{b\ d + z\ d}{b + 2\ d\ (\ z^2 + 1)} \qquad \text{eq.6}$$

keeping constant embankment slope : z = 1

maximum velocity : Vmax = 3.05 m/s

minimum velocity : Vmin = .76 m/s

roughness coefficient : n = .04

maximum depth : d = 66 cm

maximum flow : $Q = .05\ m^3/s$

bottom width : $b = .30\ m$

From the results tabulated in table 5 in the appendix, this ditch has a flow of 10 cm in depth at the moment of a 10 years storm period and a water velocity of 1.873 m/s.

4.1.6.2 EROSION CONTROL.

Since the water velocity in the ditch is 1.873 m/s or 6.14 ft/s, erosion prevention method will be implemented. In order to avoid erosion of the ditch sides and the road, rip rap was first considered, However the price of that solution being so high, another solution was considered which consists of sowing plants with long root systems in the bottom of the ditch (this kind of plant are able to substain 6 ft/s of water velocity.) (ref. 6). The locations of plant sowing are designated on plan number 2. The total surface area has been evaluated has being 78.78 square metres.

4.1.6.3 CULVERT SIZE:

For the determination of the culvert diameter, we have to select another drainage area since the water is coming from the private road, so another time of concentration will be calculated in order to determine the runoff flowing in that culvert.

Using the rational method again,

Therefore,

$$Q = .0028 * 106.68 \text{ mm/hr} * 6 \text{ ha} * .3$$

$$Q = 18.98 \text{ m}^3 \text{/s}$$

From figure 4.18, page 161 of the Handbook of steel drainage and highway construction products for the control at the inlet,

given

$\frac{H}{W} = 1$ q = 18.98 ft^3 /s, diameter of the culvert is = 27 in.

The inlet elevation is 106 ft.

The outlet elevation is 104 ft.

The length of the culvert is 30.5 ft.

The slope of the culvert is 6.6%.

The culvert being on top of hard surface, there is a need for a coushen under it, the coushen surface area has been evaluated to be 4.25 ft . The material used for this coushen will be type A gravel,and the total volume need is 129.65 ft .

The reader will find the culverts design specifications on the plan number 3 in the appendix.

4.1.6.4 EROSION CONTROL.

A culvert having more than 3% slope should have protection against erosion,(ref 6) at the culvert outlet. Since the culvert has a slope of 6.6% recommendations for erosion protection will be required. These recommendations are as in figure 5.

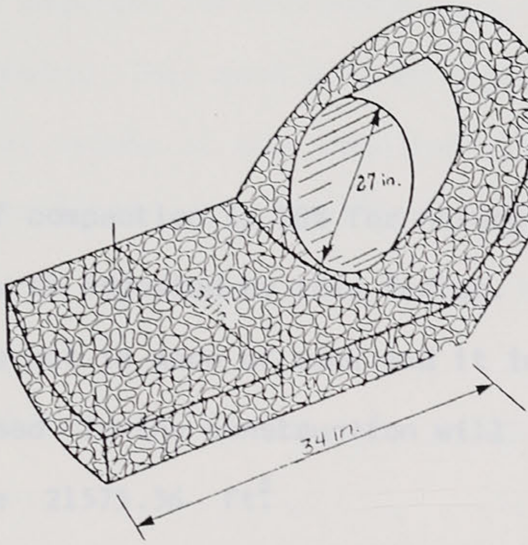


Figure 5 (ref. 6)

Note that the specific location of the ditches and culvert are shown on plan number 3.

4.1.7 CUT AND FILL CALCULATION:

In order to find the amount of material to be handled for the construction of the road, a calculation of cut and fill has been made with sections made at a maximum of 50 feet and at other pertinent locations. One will find the typical sections in the appendix at the end.

The method of calculation used average areas between successive sections.

The tabulated data of the cut and fill volumes estimated using the typical sections are found in appendix at table 6 at the end. The results are the following.

Volume needed for fill: 19627.5 cubic feet

Volume of cut: 29565 cubic feet

Sand (borrow) = 8917.7 cubic feet

Gravel (borrow) = 6688.3 cubic feet.

4.1.8 COMPACTION FACTOR

Since the factor of compaction is 20% for natural soil, the amount of soil available will now be adjusted by this factor. Considering that the portion of the volume cut is made of rock and it is 2595.8 ft^3, the amount of soil utilised in the construction will now be 26969 ft^3. compacted by 20% to give 21575.36 ft^3.

4.1.8.1 EXPANSION FACTOR.

The expansion factor for schist is 1.47 (ref.6) thus the total volume of rock is now 3815.83 ft^3.

4.1.8.2 UTILISATION FACTOR.

From graph 7 in the appendix, using average value of 7.4 m^3/m of cut, the utilisation factor will be selected according to the fact that the soil is GC or a gleyed gravel type of soil which has B for classification, which gives us a utilisation facto of 37% (ref 6).

Therefore, (21575.36*.37) = 7982.8 ft^3

Finally, 3815.83 ft^3 + 7982.8 ft^3 = 11798.7 ft^3

This value is now the volume of soil utilised for the construction.

4.1.8.3 FINAL VOLUME OF SOIL AVAILABLE.

The volume of sand required for the subfoundation is calculated on a compacted volume. Knowing that sand will be compacted to 88% of its loose volume and the total volume of sand required will be:

$$8917.7\ ft^3/88\% = 101133\ ft^3 (287.17\ mc)$$

The volume of gravel can be compacted until 89% therefore the volume required will be:

$$6688.3\ ft^3/89\% = 7514.94\ ft^3.\ (212.93\ mc)$$

The volume required as fill is 19627 ft^3. compacted. Some 11798.7 ft^3 will come from surplus uncompacted.

The volume of soil required has fillis now 19627.5 ft uncompacted by 20% gives 23 553 ft^3.

Therefore the volume of uncompacted borrowed soil needed is:

$$23\ 553\ ft^3 - 11\ 798.7\ ft^3 = 11754.3\ ft^3.$$

Volume of sand required: 287.17 m^3

Volume of gravel required: 212.93 m^3

Volume of borrowed soil: 333 m^3

4.1.9 COMPACTION OF THE NATURAL GROUND

To determine the soil needing to be compacted before the construction, an evaluation of the soil surface area gives 5554.5 ft^2 to be compacted or 516.27 m^2.

4.1.10 PRICE AND QUANTITIES ESTIMATION.

ESTIMATED MESUREMENT	UNITOF PRICE	TYPE OF WORK	QUANTITIES	TOTAL
.216	ha.	tree cleaning	2850	617.20
764.3	m^3	natural soil cut	6.5	4967.7
108.3	m^3	rock cut	60	6488.11
10.5	t	culvert sur.	7.46	78.85
321	t	gravel 19-ob	7.46	2398.9
407.78	t	sand 63-0	6.70	2732.14
6.79	t	culvert sup.	8.00	54.86
9.29	m	culvert 27 in.	120	1115.85
78.78	m^2	sow plants	1.00	78.78
7.62	m	guard rail.	50	381
516.27	m^2	compaction	.19	98
333	m^3	borrowed soil	13.32	4435.56
			subtotal:	$ 23 446.95
			Contengencies 10%	$ 2344.6
			Total	$ 25 791.55

4.2 SEPTIC ACCOMODATION REQUIREMENTS.

4.2.1 CONDITIONS MET.

-number of persons:	4,or 2 bedrooms.
-time of utilisation:	temporary.
-Quality of waste:	domestic.
-Utilities:	WC, Showers and washing machines.
-Waste per person per day:	38 Imperial gallons per day.
	173 liters per day.
-Quality of the soil:	Mica schiste, gravel, rock,loam
-Infiltration rate:	.625 Igal/day .
-Textural class analysis:	Loam. Sandy loam
-Retention time in the septic tank	2 days.

4.2.2 PERCOLATION RATE.

No percolation rate test has been performed but from a textural class analysis,the soil is considered as having an infiltration rate of about .625 Igal/day, For more precise results, it is recommanded that the percolation rate test be made by qualified persons and proper equipment, prior to actual tion.

4.2.3 CONSTRUCTION CRITERIA:

Nature of soil:

The soil his permeable,the rock level is lower than 1.2.

metres below the soil surface, the slope of the ground is 27 percent on the average.

Construction.

- Each trench has a maximum length of 55 feet (16.8 m))
- The trench will be at 3 feet wide (.90 m)
- Between the centre lines of the trenches the distance will be 6 feet (1.83 m)
- The depth of the gravel on top of the perforated pipe will be at 6 inches (15 cm).
- The perforated pipes shall be installed at 1 foot (30 cm) under the gravel.
- The size of the gravel will bebetween .6 and 2.4 inches (1.5 and 6 cm) and free of any fines particles.
- The gravel layer on top of the perforated pips should have a layer of non tarred paper under 2 feet (60 cm) of soil.
- The perforated pipes are not flexible and are made of corrosion resistant material, having 3 inches (7.5 cm) in diameter.
- The bottom of the trench will be at least 3 feet (90 cm) above bedrock, water table or impermeable soil layer.

From the recommandation of the ministry of environment, a 2 bedroom residence should have at least 65 metres of trench. based on a permeability of .026 cubic metre of clean water per square metre per day.(.53 Igal/sqft/day)

The covering material for the trenches should be of permeable material and lawn will cover it. The system layout will be adapted to the geometry of the land available.

4.2.4 SEWER PIPES.

The pipe connecting the house to the septic tank will be insulated since it cannot be installed into the ground below frost penetration since the rock surface at its proposed location is very shallow.

It shall be installed during road construction and the length will be 60 feet,(18.5 metres.)

4.2.5 VOLUME OF THE TANK

For 2 bedrooms V = Q * à eq.9

V = volume of the tank.

Q = daily water consumption. 38 Igal./day * 4 p

= 152 Ig/d

à = retention period. 2 days.

V = 152 Igal.per days * 2 days = 304 Igal.

But we have to add the equivalence of another bedroom for visitors = 304 Ig.

The total volume is then

$$304 \text{ Igal.} + 304 \text{ gal.} = 608 \text{ Igal.}$$

or 2.76 cubic metres. Recommendations are for a 2.8 cubic metres tank. Therefore a 2.8 cubic metre tank will be provided. See figure 6 for dimensions.

Internal size:

HI	= 3.94 ft	1.2 m
HT	= 4.92 ft	1.5 m
l	= 3.11 ft	0.95 m
L	= 6.23 ft	1.90 m

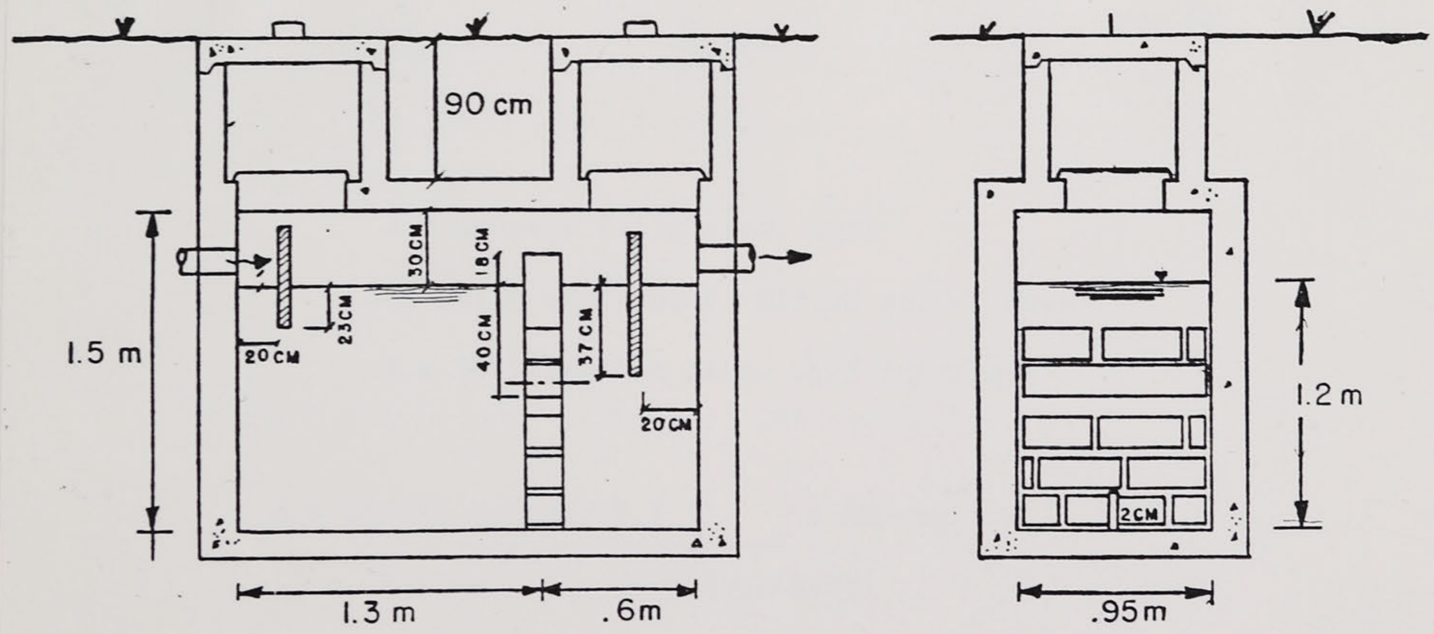


Figure 6. The SEPTIC TANK (ref.5)

4.2.5.1 LOCATION OF THE SEPTIC TANK

The septic tank will be located at the following place:

- 7.6 metres from the property limits.
- 19.8 metres from the house
- 67 metres from the lake.
- 33.8 metres from the brook.
- 1.22 metres from the absorption field.
- 30.5 metres from the water well.
- 8.05 metres from the road

For more precise locations see plan number 4.

4.2.6 ABSORPTION FIELD AREA.

$$A = \frac{Q}{I} \qquad \text{eq. 10}$$

A = seepage field area. sqft

Q = daily wastewater. 615.92 gal./2 days

I = infiltration rate. .625 igpd/sqft

$$A = \frac{615.92 \text{ gal/day} * 1}{2 \text{ days} \quad .625 \text{ igpd/sqft}} = 492 \text{ sqft.}$$

A = 492 sqft

Using 55 feet long perforated pipes and 3 feet wide it will take:

492 sqft / (55ft * 3 ft) = 2.98 drains → 3 drains.

The recommendation is 65 metres or 213.2 feet length of trench. Since the value that we obtain is less than what is recommended by the government, we have a soil suitable to accept an absorption field, but we will have to install 213.5 feet / 55 feet long trench = 3.87 trenches or 4 trenches in order to meet regulations.

4.2.7 LOCATION OF ABSORPTION FIELD.

The trenches will be located at the following site.

- 7.6 metres from the property limits.
- 10.8 metres from the house.
- 60.9 metres from the lake.
- 15.24 metres from the brook.
- 1.22 metres from the septic tank.
- 30 metres from the water well.
- 3.05 metres from the road

For more precise locations see plan number 4

4.2.8 PRICE AND QUANTITIES ESTIMATION

	Quantity	price	total
1.Prefab septic tank.	1 unit	$2000	$2000
2.Ventilation duct.	15 feet	$1	$15
3.Absorption field.			
a) perforated and non perforated pipes			
4 inches pvc	244 ft	$4.20	$1024
b) insulated pipes			
4 inches pvc	60 ft	$ 12	$720
c)non tarred paper	660 sqft	$ .11	$72
d) crushed stone			
.6 in.-2.4 in.	660 cuft	$ .44	$264
e) lawning (sowed)	1440 sqft	$.09	$129
f) excavation	2100 cuft	$ .15	$315
3.Ditch	30 ft	$ 8.00	$240
		Subtotal:	$ 4779.00
		Contengencies 10%:	$ 479.00
		Total :	$ 5256.90

4.3 RESULTS

4.3.1 DAILY WATER USE.

The daily water use is 243.2 Igal (1106 litres) for the type of house that we have.

4.3.2 ADEQUACY OF EXISTING WATER SOURCE.

A spring was located on the property 50 feet from the future site of the chalet. The next step was to verify if the present water source would supply the amount of water required daily or throughout the year.

As illustrated in figure 8 a simple method was used to determined the spring flow. It was evaluated by making a little earth dam and calculating the overflow per unit of time. The water output was not measured in the driest period of the year which was late August this year, the driest period being February. From this evaluation the spring was yielding .501 liters per minute or 721 liters per day, which is about 385 litres less than what is required for 4 persons per day, and even less if the condition of lawn and garden water is taken into consideration.

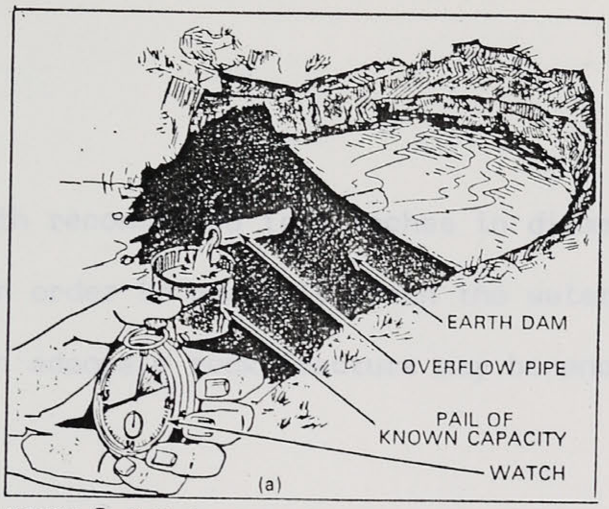


FIGURE 8 Methods of checking spring flow, ref.(1).

4.3.3 POSSIBILITY OF INCREASING YIELD.

Since the present location of the spring is not readily accessible to heavy equipment, increasing the yield of the spring is not considered.

4.3.4 PROTECTION OF WATER FROM POLLUTION.

The water source, if it is a drilled well can not be closer than 15 metres from the absorption field, according to the regulation of the ministry of environment. No other possible source of pollution has been detected at the present time during site investigation.

4.3.5 WELL LOCATION.

Different possible well sites are located in the vicinity of the proposed residence which are accessible from the road. These different locations are suggested on the map.

4.3.6 WELL DEPTH.

The well depth recommended is 6 inches in diameter and approximately 200 feet deep in order to possibly reach the water table created by the lake and so that an adequate rock fracture may be encountered.

4.3.7 PIPING.

Depending on the location of the future well, the length of the pipe will vary and the cost estimate will be based upon the first location proposed for the well. The distance from the house to the latter location is 15 feet (4.6 m).

4.3.8 FREEZING.

The water supply pipe will be located at a depth of 5 feet in the ground in order to avoid freezing problems. If rock is encountered, insulated pipes are required. In the cost analysis, insulated pipes are beeing assumed as the final decision.

4.3.9 PUMPING.

At least one pump will be required to create the pressure needed for consumption. A standard submersible electrical pump coupled with a pressure tank will be suggested. The pumping rate required can not be state at the present time since the static level, pumping level and total well capacity are unknown until drilling is completed.

4.3.10 PUMP CAPACITY.

household use

	Igal per min.
Bath tub.	1.7
2 lavatories	.84
toilet	.63
sink kitchen	.83
dishwasher	.42
clothes washer	1.7
total	6.12 Igpm

The suggested pump capacity is 10 Igal per minute.

4.3.11 TYPE OF PUMP TO USE

The type of pump is selected according to the depth of water table, well size, pressure range, height of water lifted above the pump, the pump location, the pump durability and the dealer service.(ref 1)

4.3.12 COST ANALYSIS.

	Quantity	Unit price	total
1- Well drilling 6 in. dia. Including well head.	200 feet	15$ ft	$3000
2- Pipe 1 inch Insulated PVC	15 feet	$12 ft	$ 180
3- Pump including wiring, pressure tank	1 unit	$800	$ 800
		subtotal	$ 3980
		Contingencies 10 %	$ 398
		total	$ 4378

4.4 OVERALL COST ESTIMATION.

The following estimate does not include field supervision and financing.

Road construction.	$ 25 791.55
Septic System	$ 5256.90
Water Supply	$ 4370.00
Total:	$ 35 418.45

5.CONCLUSION.

The principal objective was to evaluate the possibility of having an access road at the site designated by Mr.Rivest. The design has proved the feasibility of construction of this access road without excessive cost, although it may be difficult to negotiate winter conditions and will require adequate maintenance.

In relation to the septic accomodations, a percolation test should be performed by qualified personnel in order to have a better appreciation of the infiltration rate of the leaching system. Also, permeable depth should be measured at the time that the road construction proceeds.

The water supply design cannot be further developed a this point with respect to the pumping and plumbing system since the well must first be drilled and the system developed afterwards.

The overall cost of the construction, including the water supply the septic system and the construction of the road, is estimated at $ 35418.26 excluding construction supervision.

BIBLIOGRAPHY

1. AAVIM, Planning for an individual water system, Engineering center, May 1973, 156 pages.

2.AISI,Handbook of steel drainage and highway construction product. second edition,Lakeside press, USA, 1971,P161

3. ASAE,Proceeding of the third national symposium on individual and small community sewage treatment. December 1981 palmer house Chicago, Illinois, P.51 to 98.

4.Bruce and Clarkson, Highway design and construction, Third Edition, Scranton, Pennsylvania, International Textbook Company, 1954,734 page.

5. Ministere de l'environnement, L'epuration des eaux dans les regions touristiques et rurales. , Gouvernement du Quebec, Quebec, Avril 1981, 63 pages.

6. Ministere des transport, Guide de preparation des projets routiers, Gouvernement du Quebec, Quebec, 1983, 603 pages.

7. MWPS-24, On site domestic sewage disposal handbook., First edition, 1982,40 pages.

8. Schwab O., R K. Frevert, Soil and water conservation engineering., 3rd Edition 1981, 525 pages.

9. Service de la protection de l'environnement, Guide pour l'essai de percolation Gouvernement du Quebec, 15 pages.

10. Timothy Winneberg J.H., Septic tank systems, a consultant toolkit. 1984, 222 pages.

11. U.S. Environmental protection agency, Manual of individual water supply systems, U.S. government printing office, 1973, 155 pages.

APPENDIX.

The Brome Missisquoi soil survey made in 1954, revealed that the type of soil is Bel/ 3.4 Berkshire loam having good drainage and strongly rolling to hilly. The parent material is sandy loam to loam till derived from schistose material.

The typical horizon is the following.

A0 0-.5 in. Organic matter with leaf bed

A1 .5-1 in. Black sandy loa with granular structure

A2 1-2 in. fine sandy loam, friable.

B1 2-3 in. brown coffee loam

B2 3-12 in. yellowish loam.

B3 12-20 in. brown-yellow loam with some cobbles

C1 20- in. yellow grey loam, altered till.

C2 28-36 fragment of shist grey.

Textural analysis of this soil is:

80% sand 1-.05 mm

5 % silt .05-.005 mm

15% clay -.002 mm

Table 1

From the table 2.3.3.2 of the Normes, At a velocity of

10 mph the minimum length is 52.40 feet.

15 mph the minimum length is 79.22 feet.

20 mph the minimum length is 105.63 feet.

25 mph the minimum length is 132.04 feet.

30 mph the minimum length is 158.45 feet.

The tabulated data below are for the meeting of the different grade.

Table 2.Here the tabulated data according to the meeting of the 15.8% and 11.8% grade. All the values are in feet.

STATION (ft)	TANGENT ELEVATION (ft)	OFFSET (ft)	CURVE ELEVATION (ft)
75	117.10	0	117.10
80	117.89	.004	117.89
85	118.68	.016	118.66
90	119.5	.036	119.54
95	121.05	.10	120.36
105	121.84	.144	121.15
110	122.63	.196	121.98
115	123.42	.256	122.83
120	124.21	.324	123.67
125	125.00	.400	124.53

130	125.59	.324	125.04
135	126.18	.256	125.914
140	126.77	.196	126.436
145	127.36	.144	126.97
150	127.95	.100	127.50
155	128.54	.064	128.05
160	129.13	.036	128.60
165	129.72	.016	129.66
170	130.31	.004	130.31
175	130.90	0	130.90

Table 3.Results of the curve and road elevation between the 11.8% and 20.5%

STATION	TANGENT ELEVATION	OFFSET	CURVE ELEVATION
176	132.1	0	132.1
181	132.69	-.01	133.7
186	133.28	-.04	133
191	133.87	-.098	133.96
196	134.46	-.174	134.48
201	135.05	-.27	135.77
206	135.64	-.39	136.03
211	136.23	-.53	136.76
216	136.82	-.696	137.52
221	137.41	-.881	138.29

226	138	-1.0875	139.07
231	139.03	-.881	139.91
236	140.05	-.696	140.7
241	141.08	-.53	142.67
246	142.1	-.39	142.47
251	143.13	-.27	143.40
256	144.15	-.17	144.32
261	145.10	-.098	145.27
266	146.20	-.04	146.24
271	147.23	-.01	147.24
276	148.25	0	148.25

Table 4.Results of the curve and road elevation between the 20.5% and 0%

STATION	TANGENT ELEVATION	OFFSET	CURVE ELEVATION
340	161.83	0	161.83
345	162.85	.034	162.82
350	162.88	.138	163.74
355	164.9	.310	164.59
360	165.93	.55	165.38
365	166.95	.86	166.09
370	167.95	1.24	166.71
375	169	1.69	167.31
380	169	1.24	166.71

385	169	.86	168.14
390	169	.55	168.45
395	169	.310	168.69
400	169	.55	168.45
405	169	.034	168.97
410	169	0	169

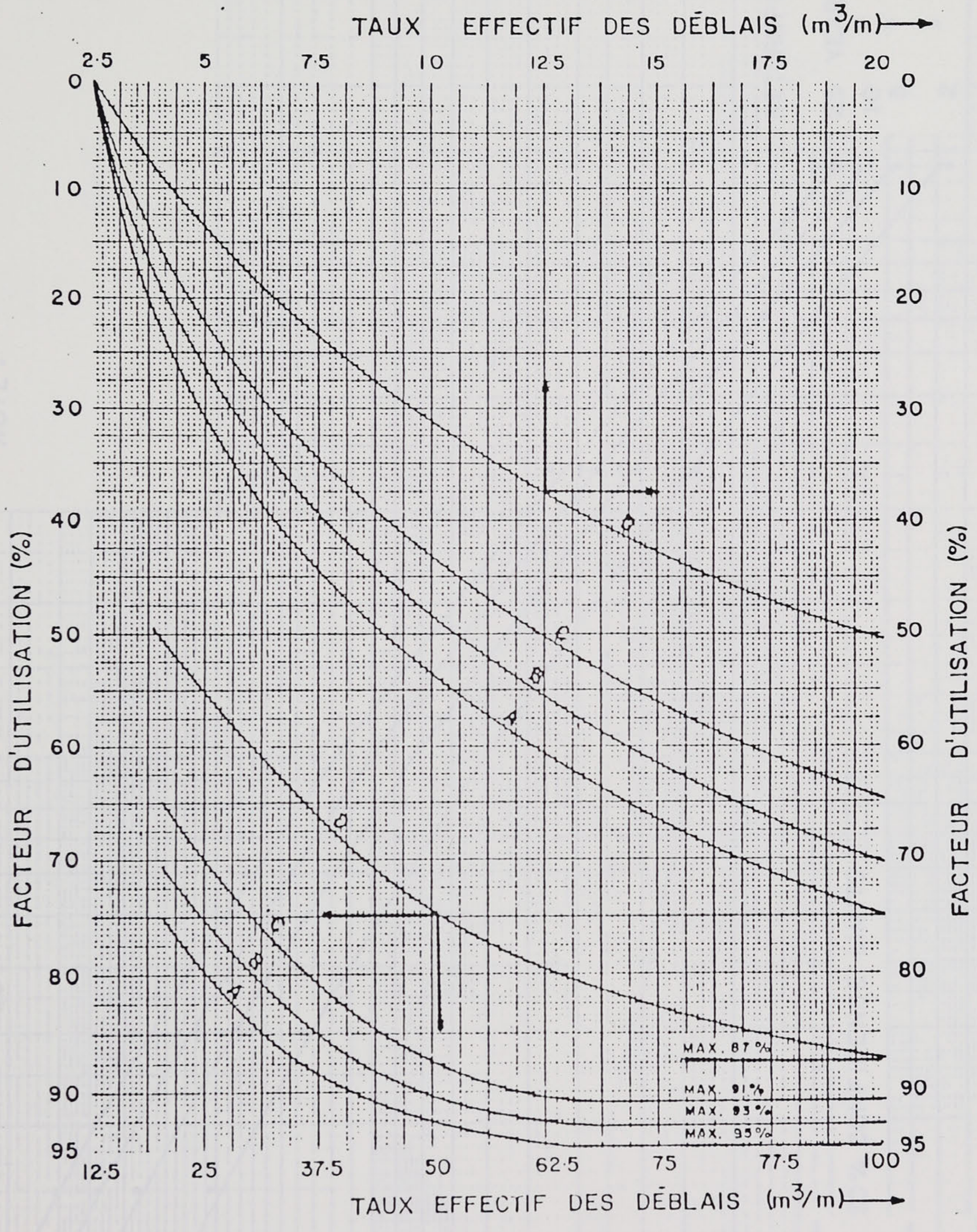
table 5. Trial and error solution to find the depth of water at 10 year return period storm duration.

b meter	d meter	R meter	V m/s	A m^2	Q m^3/s
.3	.1	.08	1.966	.04	.0798
.3	.6	.27	2.5	.18	.45
.3	.05	.039	.98	.015	.015
.3	.075	.055	1.5	.023	.034
.3	.09	.051	1.55	.027	.042
.3	.095	.065	1.75	.0285	.0499
.3	.0975	.0673	1.873	.0293	.055

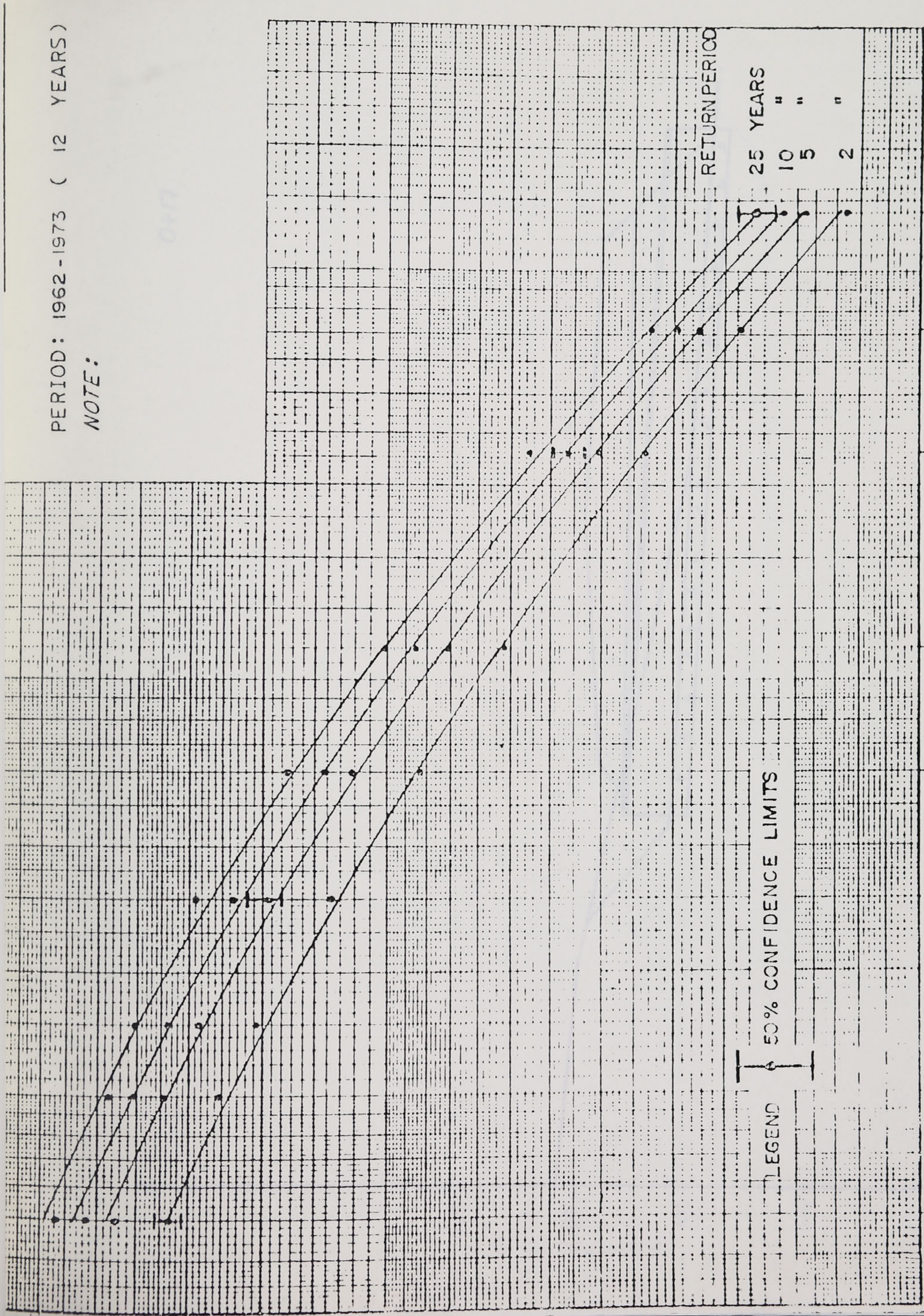
Table 6. Fill and cut volume associated with the typical sections.

STATION (ft)	DISTANCE (ft)	VOLUME CUT SOIL (cuft)	VOLUME FILL SOIL (cuft)	VOLUME FILL GRAVEL-SAND (cuft)
0+31	31	3244	----	1715
0+57	26	5174	----	1096.3
0+97	40	8680	----	1160
1+47	50	3225	2482.5	1450
1+75	28	----	2206.4	1106
2+07	32	228.8	996.8	1264
2+44	37	843.6	634.6	1073
2+99	55	951.5	7763	1595
3+42	43	571.9	5418	1941.5
3+75	33	2144.5	----	1489.95
3+85	10	1067	----	290
4+00	15	1575	63	712.5
4+15	15	1560	63	712.5
		29565	19627.5	15603

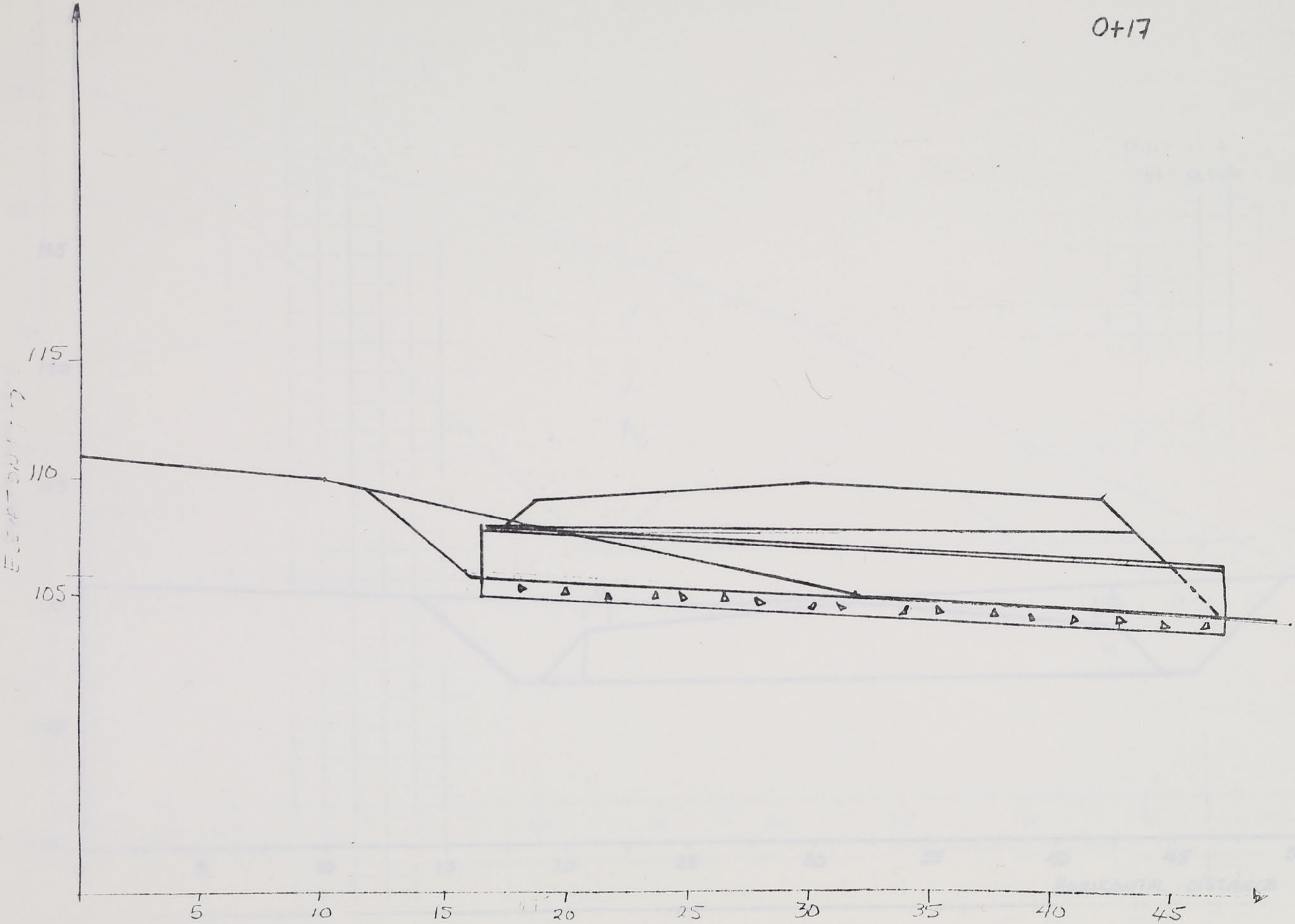
graph 7 - Le facteur d'utilisation des déblais (ref 6)

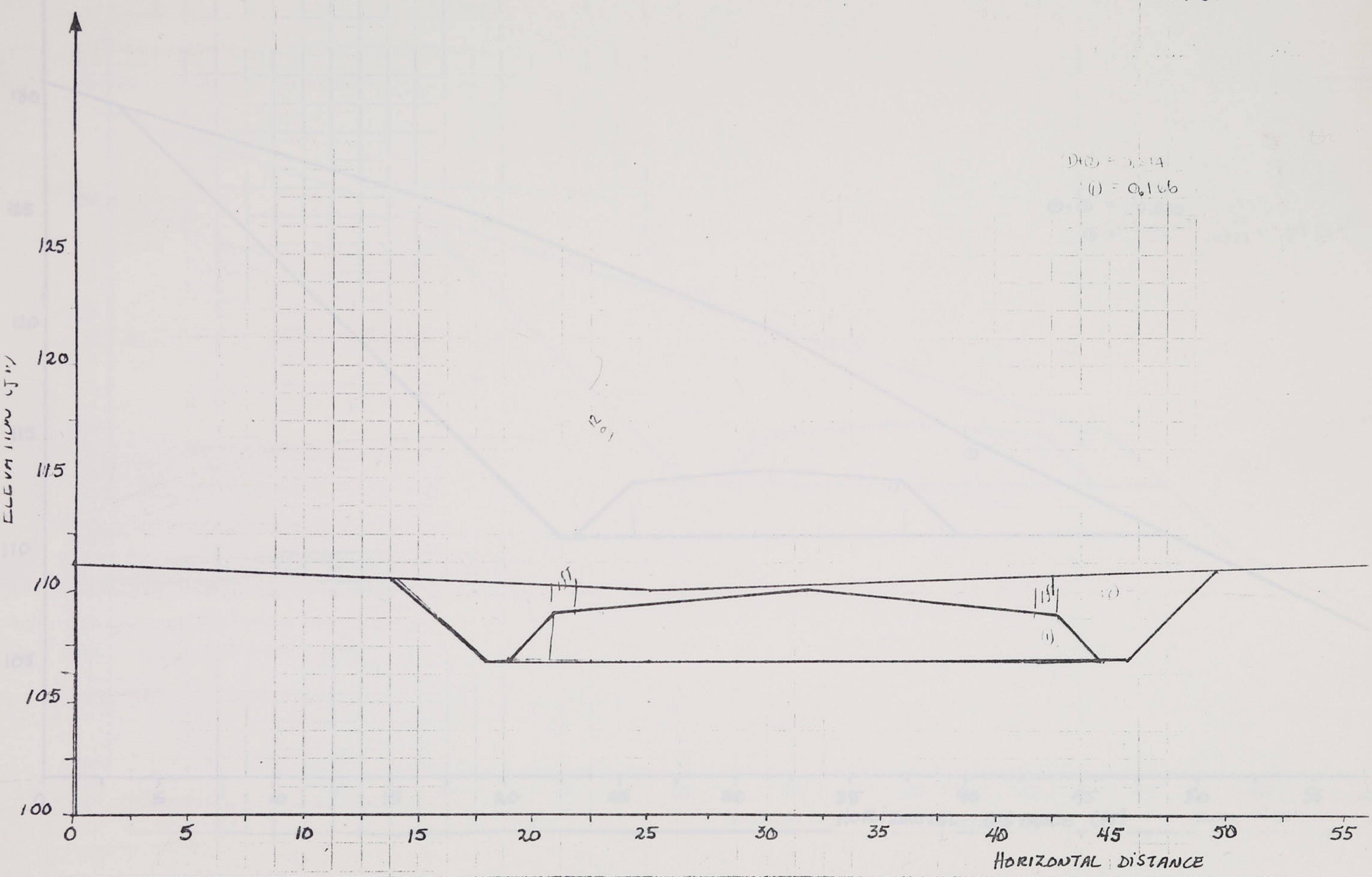


Graph 9 (ref Trans>ort Cana^a)

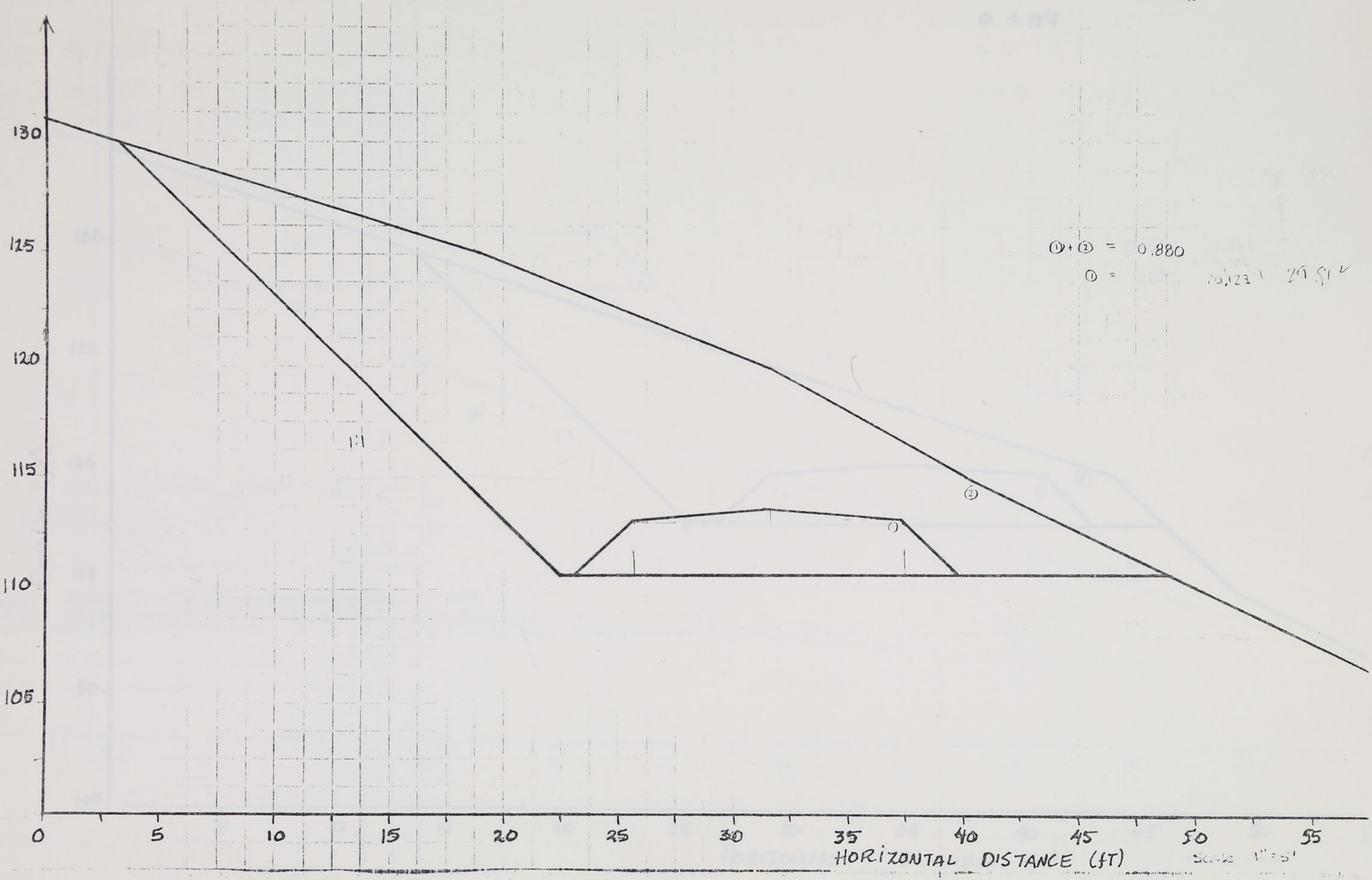


0+17

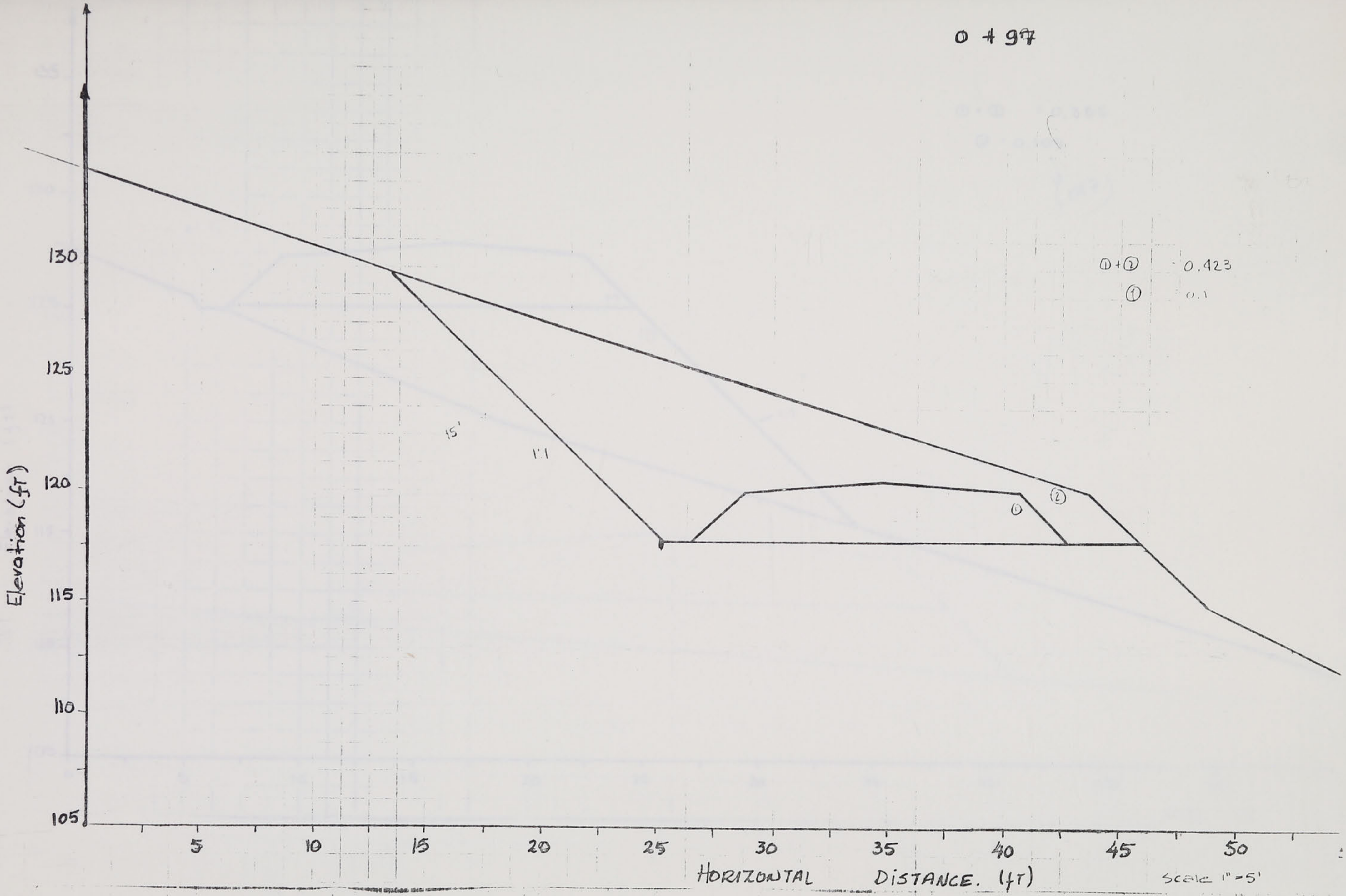



125
120
115
110
105
100
0
5
10
15
20
25
30
35
40
45
50
55
HORIZONTAL DISTANCE
(1) = 0.166

0+57

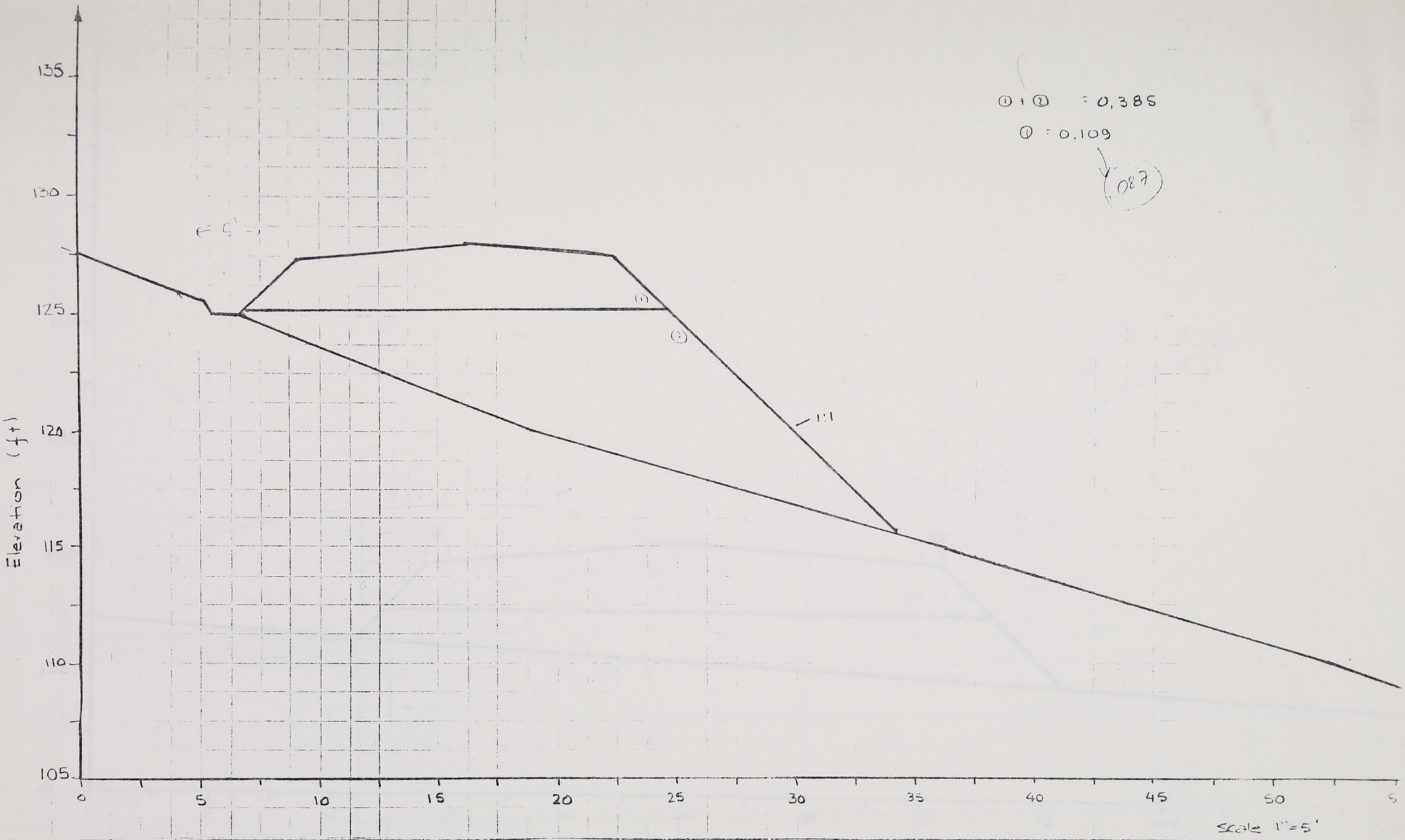


130
125
120
115
110
105
0
5
10
15
20
25
30
35
40
45
50
55
HORIZONTAL DISTANCE (FT)
1:1
①+② = 0.880
① =



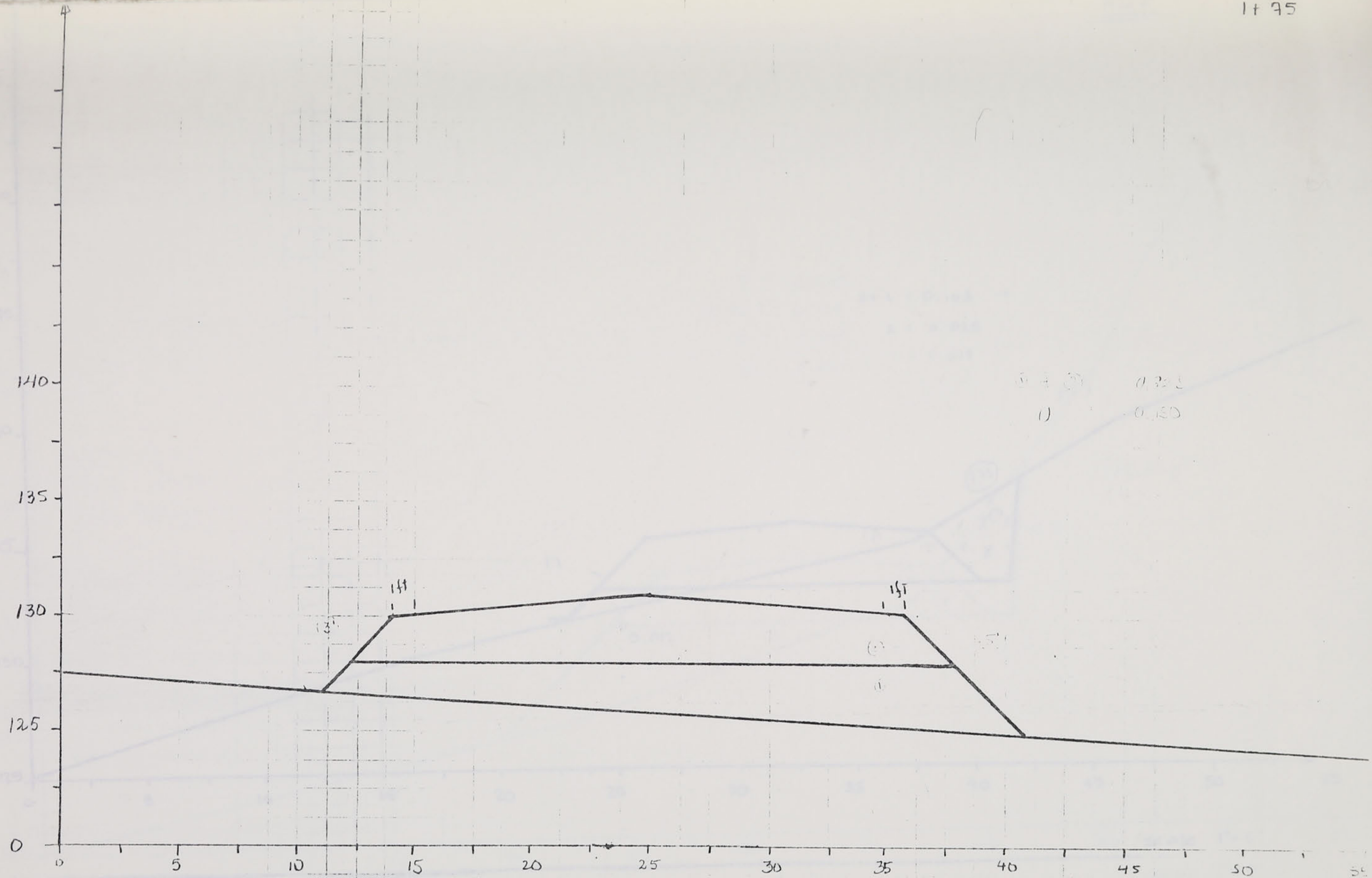
0 + 97
① + ② 0.423
① 0.1
15'
1:1
①
②
Elevation (ft)
130
125
120
115
110
105
5
10
15
20
25
30
35
40
45
50
HORIZONTAL DISTANCE. (ft)
Scale 1" = 5'

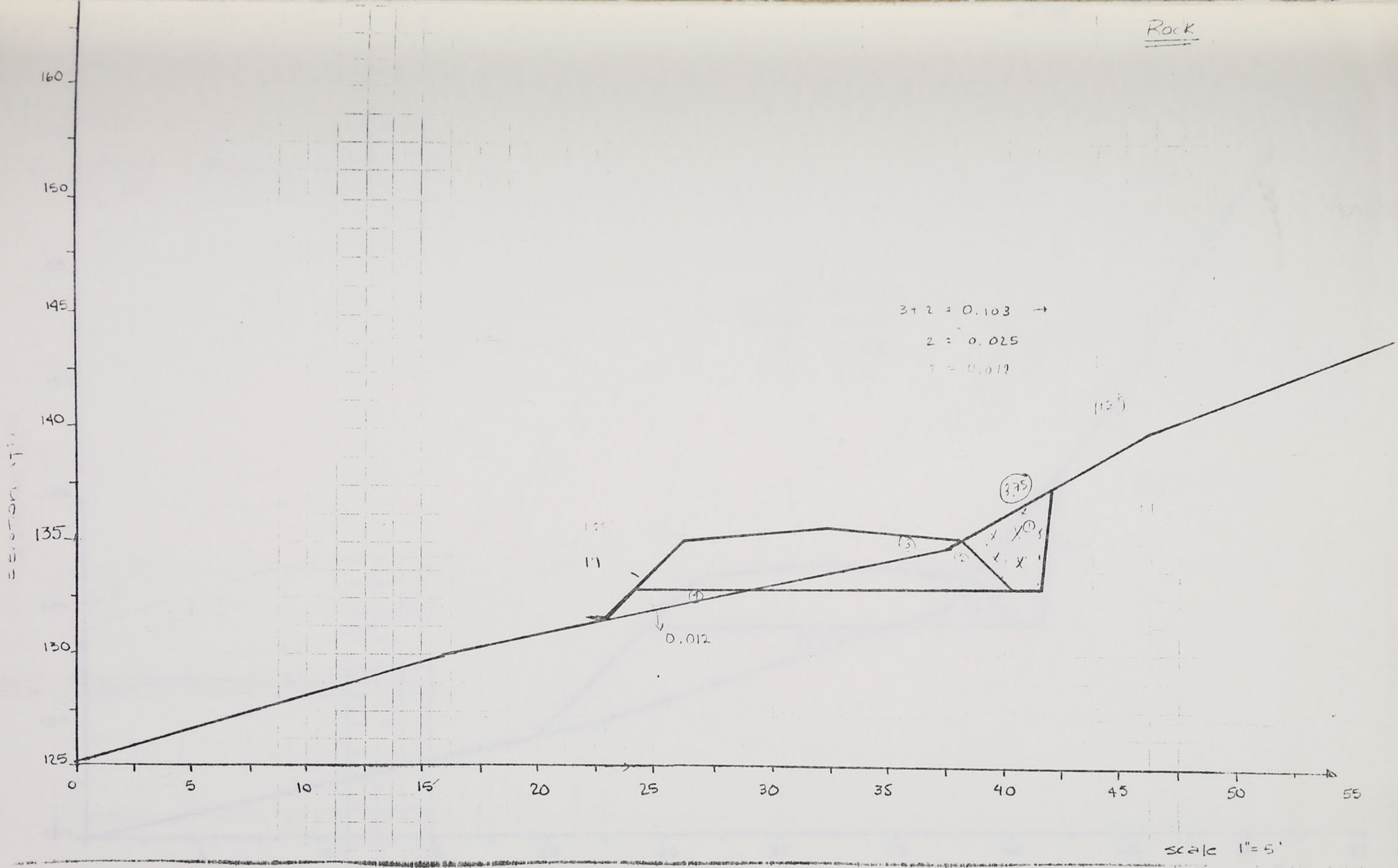
1+47



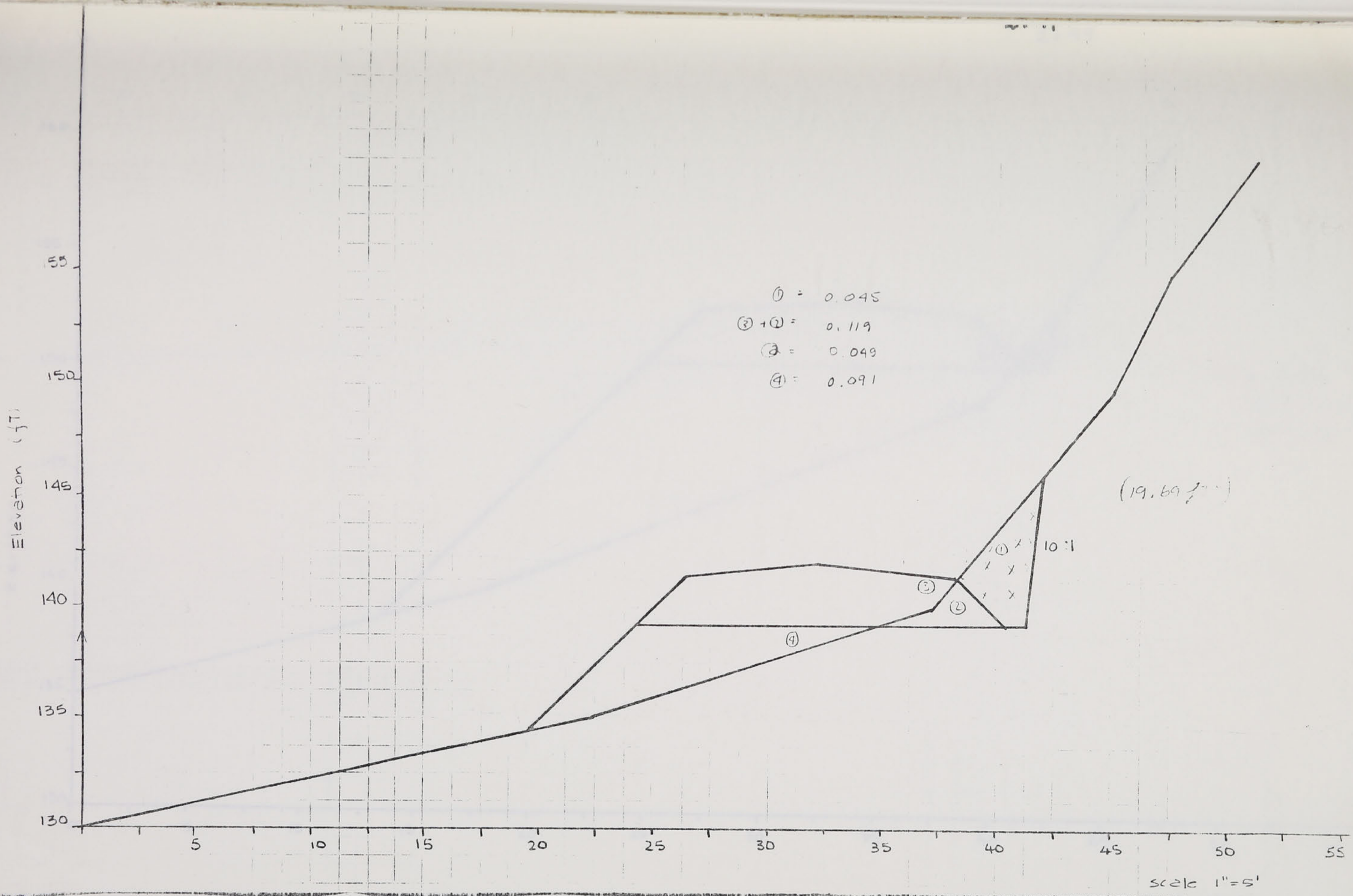
①+② = 0.385
① = 0.109
.087
← 5' →
1:1
Elevation (ft)
135
130
125
120
115
110
105
0
5
10
15
20
25
30
35
40
45
50
5
Scale 1" = 5'

1+75



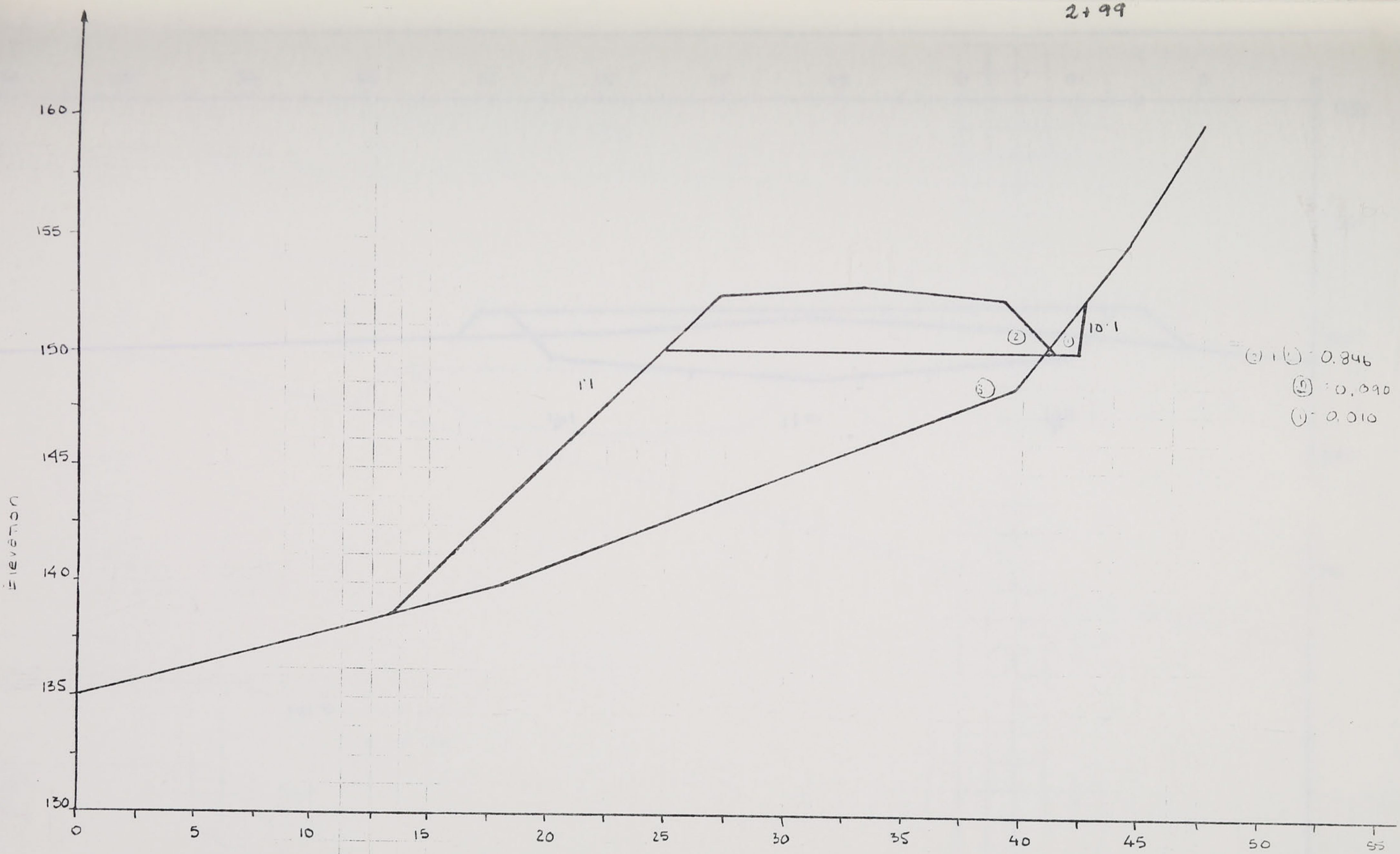


Rock
3+2 = 0.103
2 = 0.025
1 = 0.012
3.75
0.012
1:1
160
150
145
140
135
130
125
0
5
10
15
20
25
30
35
40
45
50
55
scale 1" = 5'



① = 0.045
③ + ② = 0.119
③ = 0.049
④ = 0.091
10:1
(19.69 ...)
Elevation (ft)
155
150
145
140
135
130
5
10
15
20
25
30
35
40
45
50
55
scale 1" = 5'

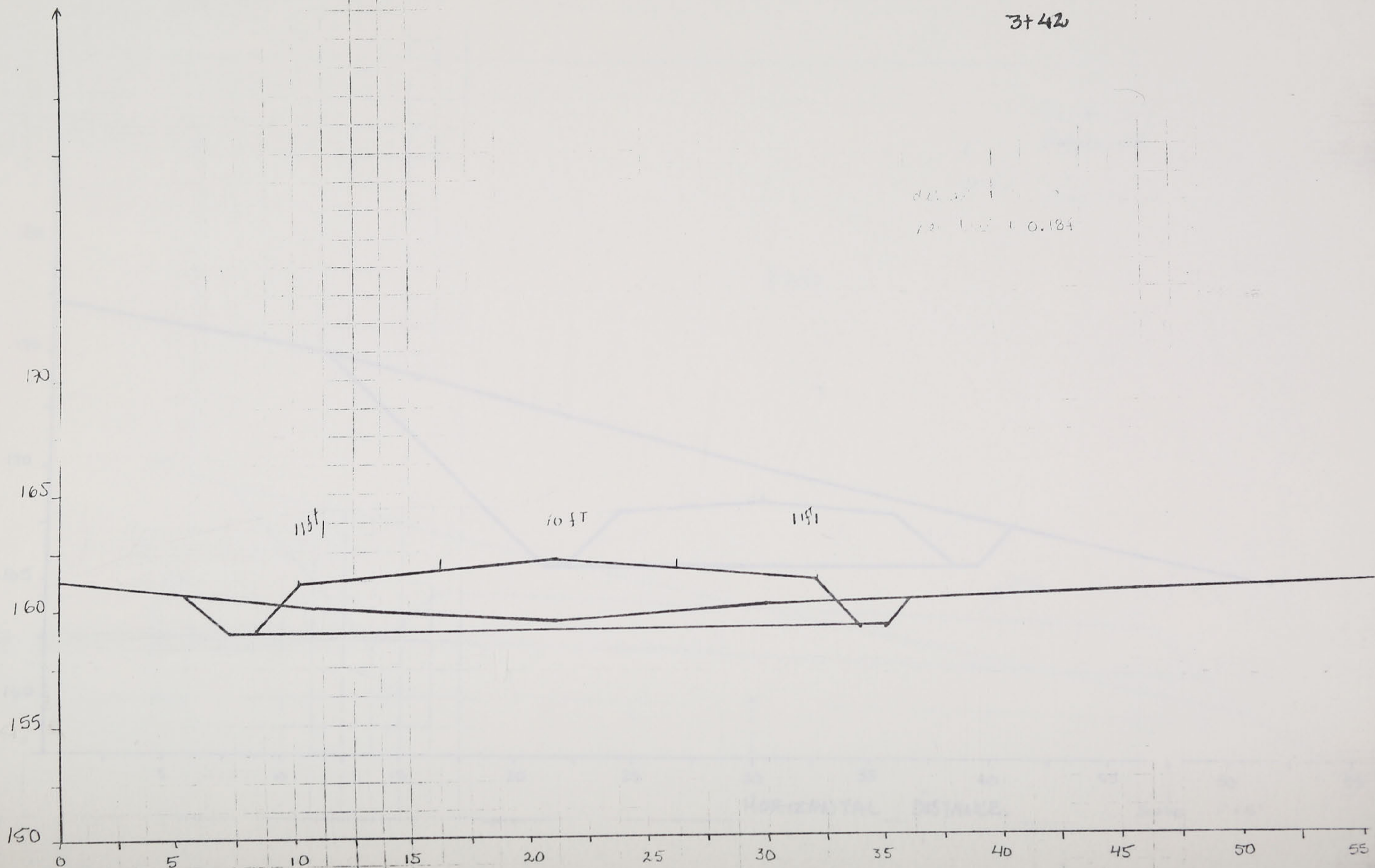
2+99



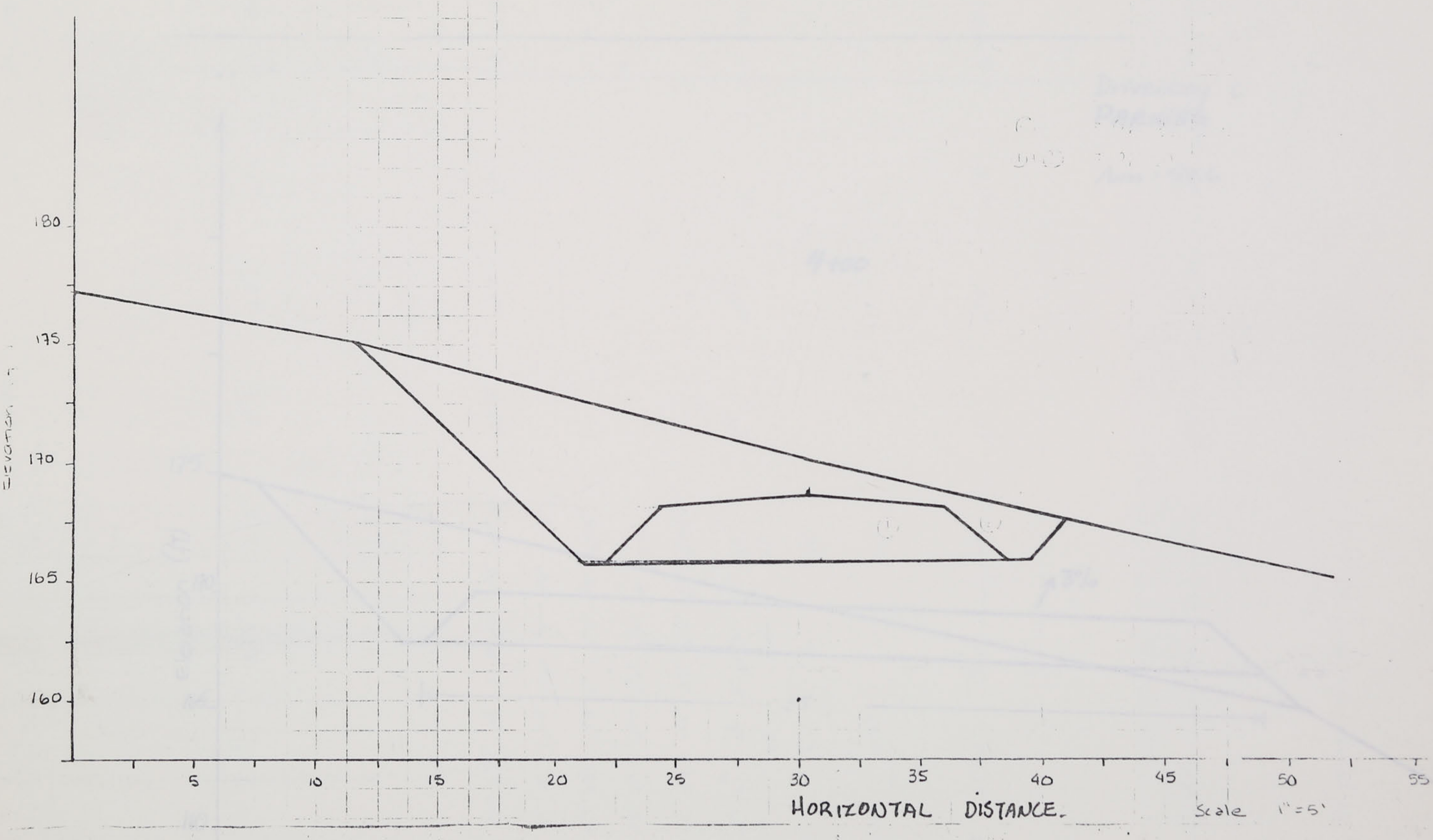
160
155
150
145
140
135
130
Elevation
0
5
10
15
20
25
30
35
40
45
50
55
1:1
10:1
(2)
(1)
(3)
(2)+(1) = 0.846
(3) = 0.090
(1) = 0.010

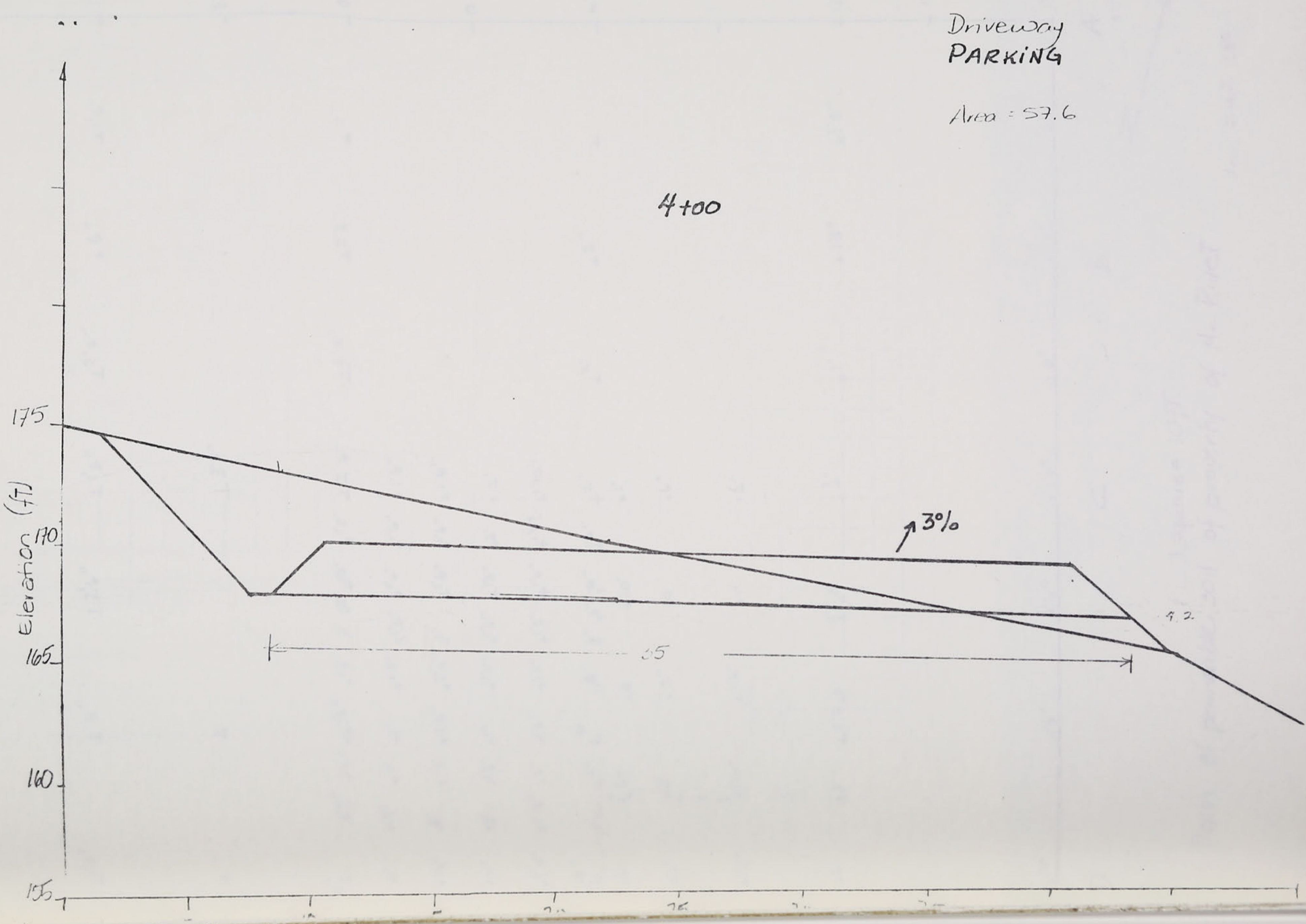
Scale 1" = 5'

3+42

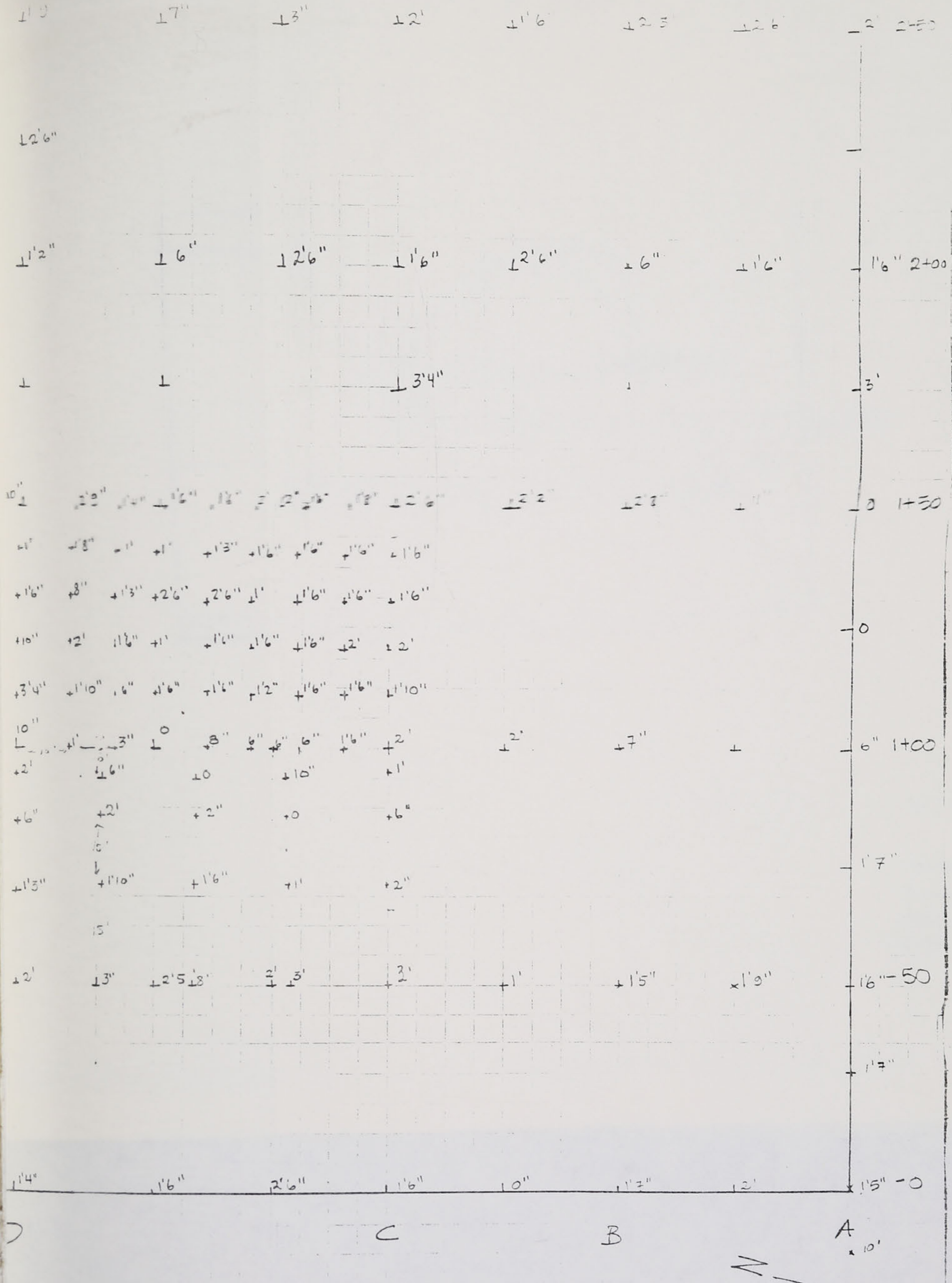


170
165
160
155
150
0
5
10
15
20
25
30
35
40
45
50
55
11.5ft
10 ft
11.5ft


Elevation
180
175
170
165
160
5
10
15
20
25
30
35
40
45
50
55
HORIZONTAL DISTANCE.
Scale 1" = 5'



Driveway
PARKING
Area = 57.6
4+00
Elevation (ft)
175
170
165
160
155
3%
35
4.2

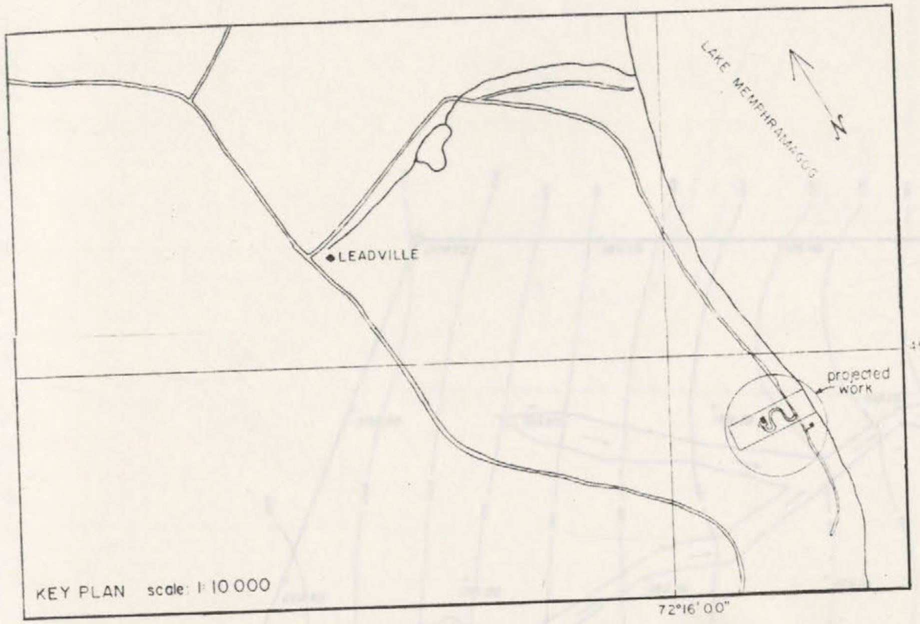


1 square = 10 ft

Depth of permeable soil of property of Mr. Rivet

done 21 sept 1957

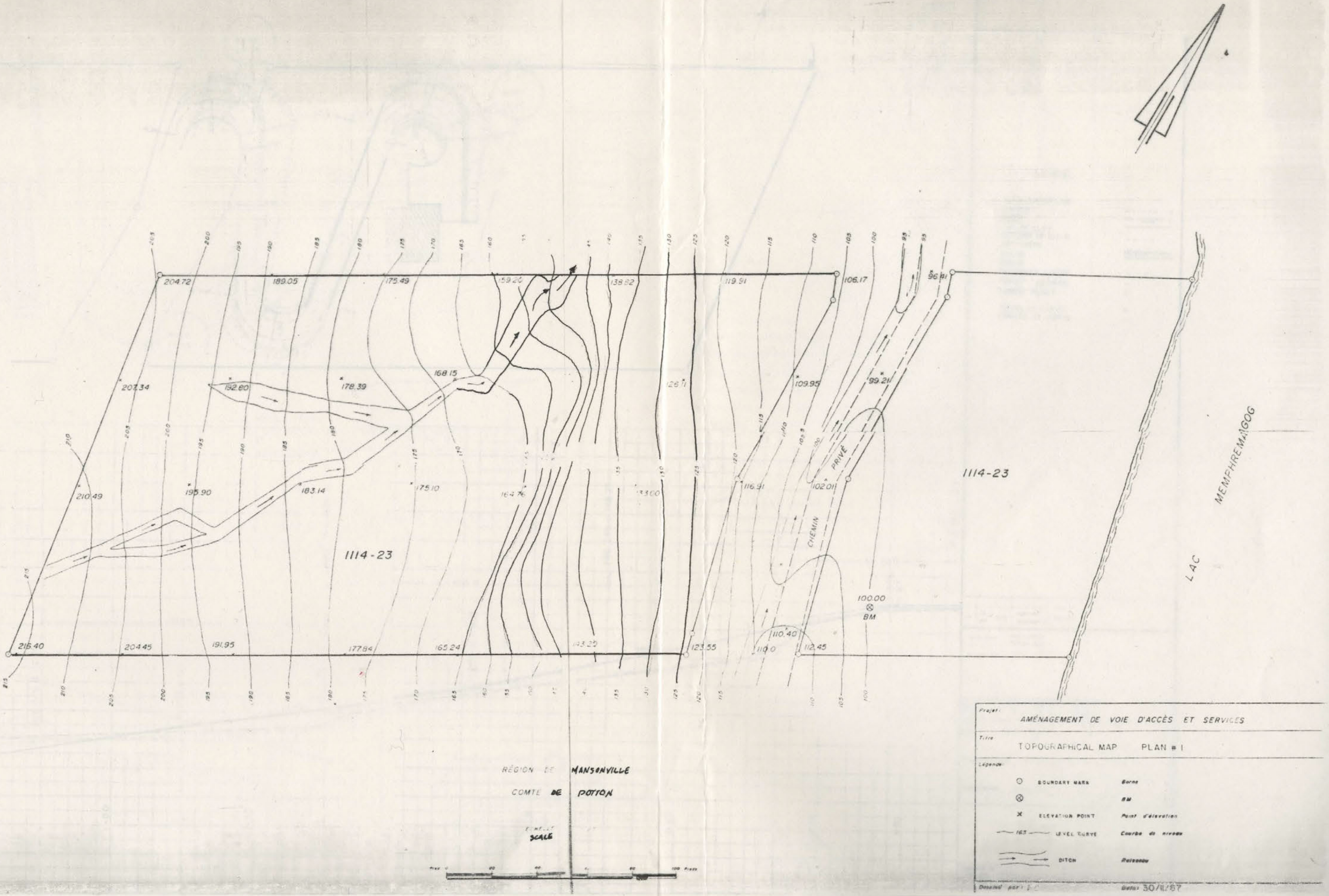
Graph 13

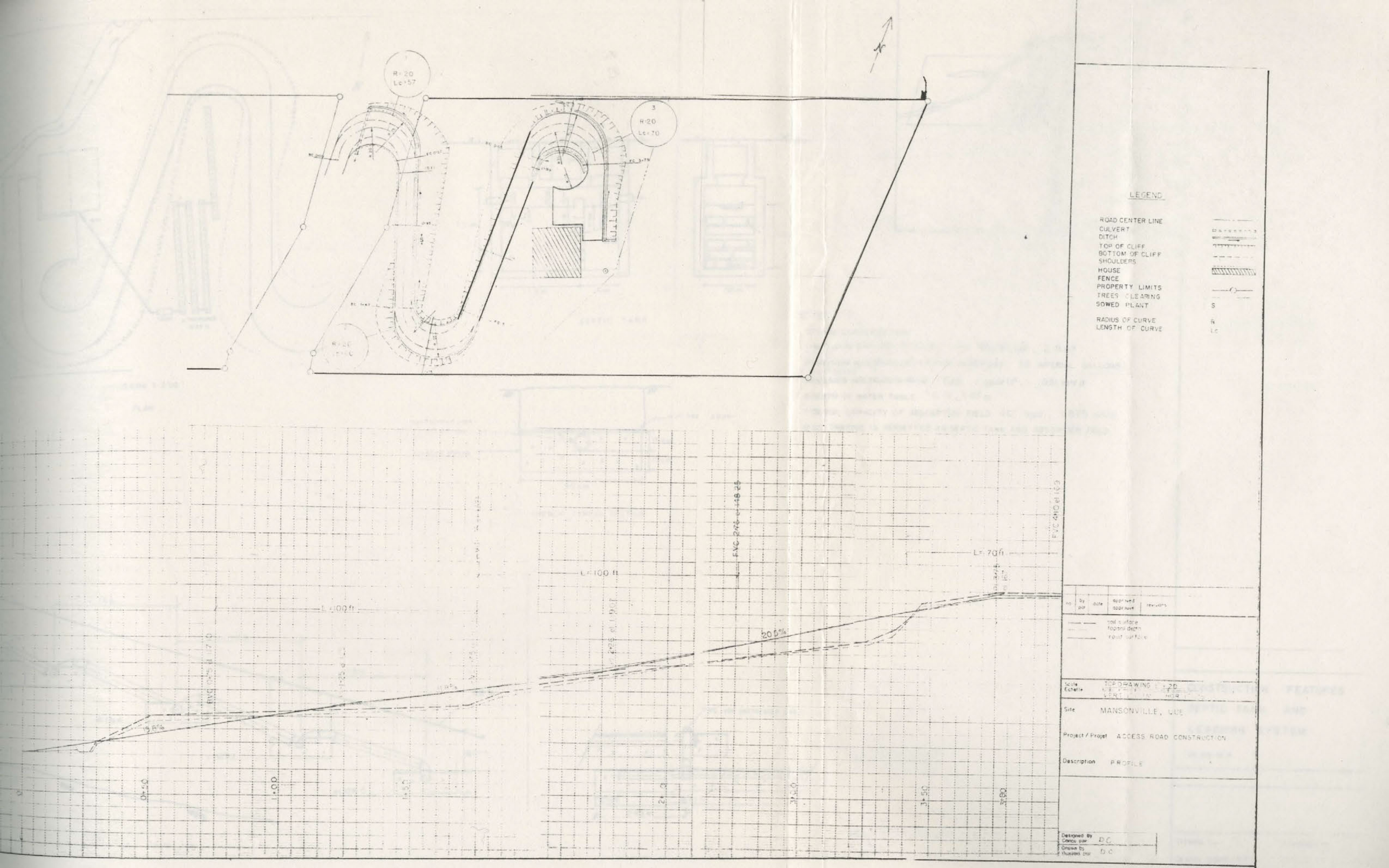


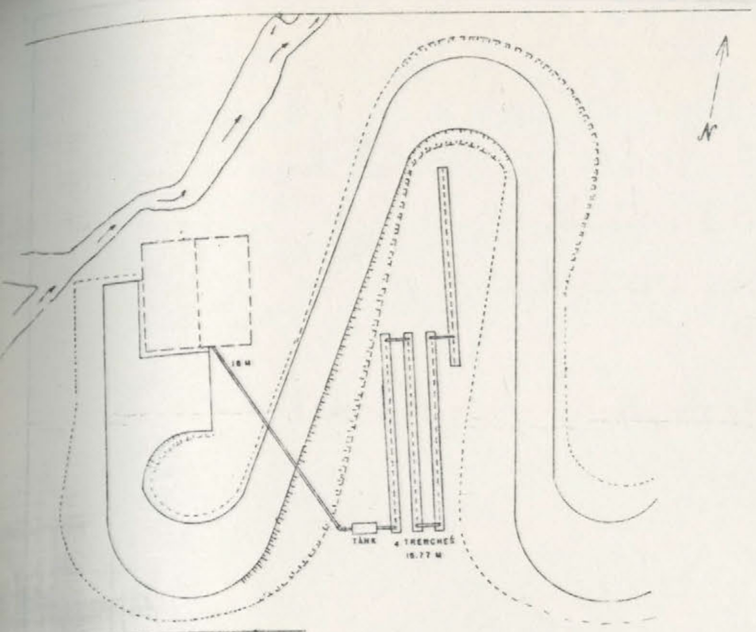
MANSONVILLE, QUÉ.

PROJECT: CONSTRUCTION OF AN ACCESS ROAD AND SERVICE

LIST OF DRAWINGS

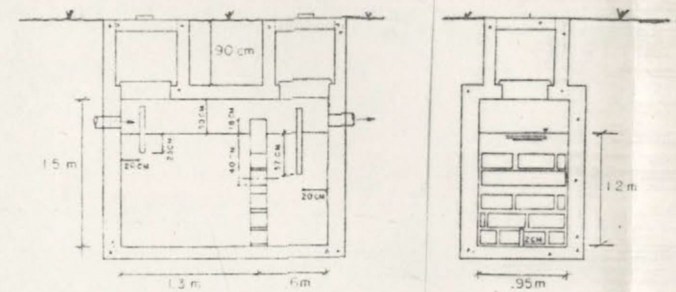

204.72
189.05
175.49
159.20
138.82
119.91
106.17
96.81
207.34
192.80
178.39
168.15
126.71
109.95
99.21
210.49
195.90
183.14
175.10
164.76
133.00
116.91
102.01
1114-23
1114-23
CHEMIN
PRIVÉ
100.00
BM
110.40
110.0
215.40
204.45
191.95
177.84
165.24
143.25
123.55
112.45
LAC
MEMPHREMAGOG
RÉGION DE MANSONVILLE
COMTE DE POTTON
SCALE
Projet:
AMÉNAGEMENT DE VOIE D'ACCÈS ET SERVICES
Titre
TOPOGRAPHICAL MAP PLAN # 1
Légende:
BOUNDARY MARK Borne
BM
ELEVATION POINT Point d'élévation
163 LEVEL CURVE Courbe de niveau
DITCH Ruisseau
Dessiné par:
Date: 30/11/67


R=20
Lc=57
3
R=20
Lc=70
R=20
LEGEND
ROAD CENTER LINE
CULVERT
DITCH
TOP OF CLIFF
BOTTOM OF CLIFF
SHOULDERS
HOUSE
FENCE
PROPERTY LIMITS
TREES CLEARING
SOWED PLANT
S
RADIUS OF CURVE
R
LENGTH OF CURVE
Lc
L=100 ft
L=100 ft
L=70 ft
20.0%
9.8%
0+50
1+00
3+50
3+80
no
by par
date
approved approuvé
revisions
soil surface
topsoil depth
road surface
Scale Echelle
TOPDRAWING 1" = 20
Site
MANSONVILLE, QUE
Project / Projet
ACCESS ROAD CONSTRUCTION
Description
PROFILE
Designed by Conçu par
D.C.
Drawn by Dessiné par
D.C.

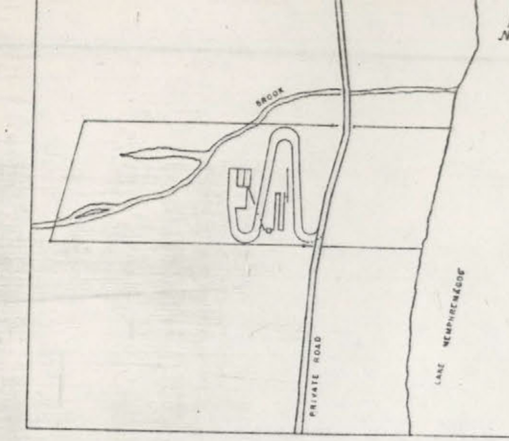


Scale 1:250

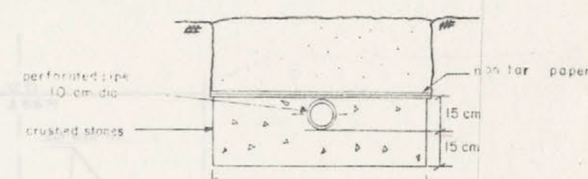
PLAN



SEPTIC TANK



KEY PLAN



TRENCH TYPICAL SECTION

NOTES

DESIGN CONSIDERATIONS

1- MAXIMUM CAPACITY OF SEPTIC TANK: 615.9 Igal., 2.8 m³

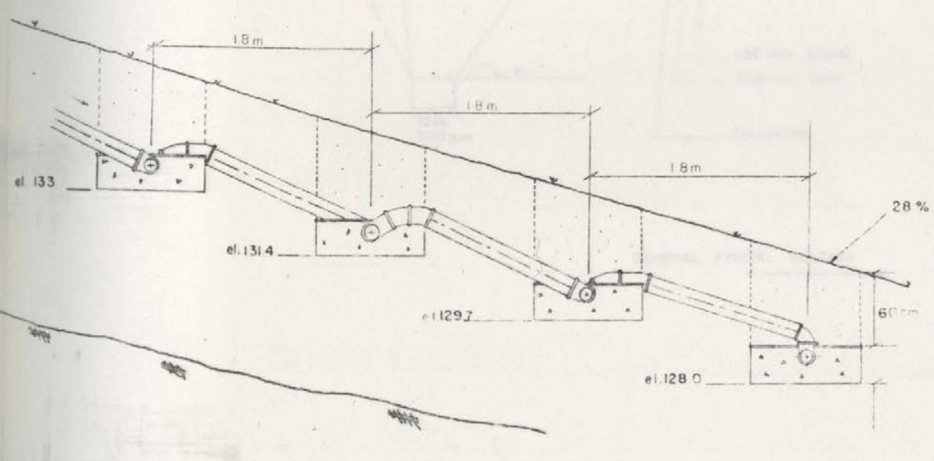
2- MAXIMUM WASTEWATER PER PERSON PER DAY: 38 IMPERIAL GALLONS

3- ASSUMED INFILTRATION RATE: .625 I gpd/ft², .031 m³/d

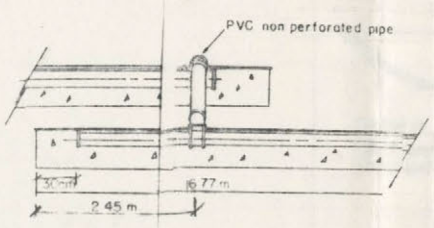
4- DEPTH OF WATER TABLE >6 ft, 1.83 m

5- DESIGN CAPACITY OF ABSORPTION FIELD: 412 Igpd, 1.875 m³/d

6- NO TRAFFIC IS PERMITTED ON SEPTIC TANK AND ABSORPTION FIELD



scale 1:25

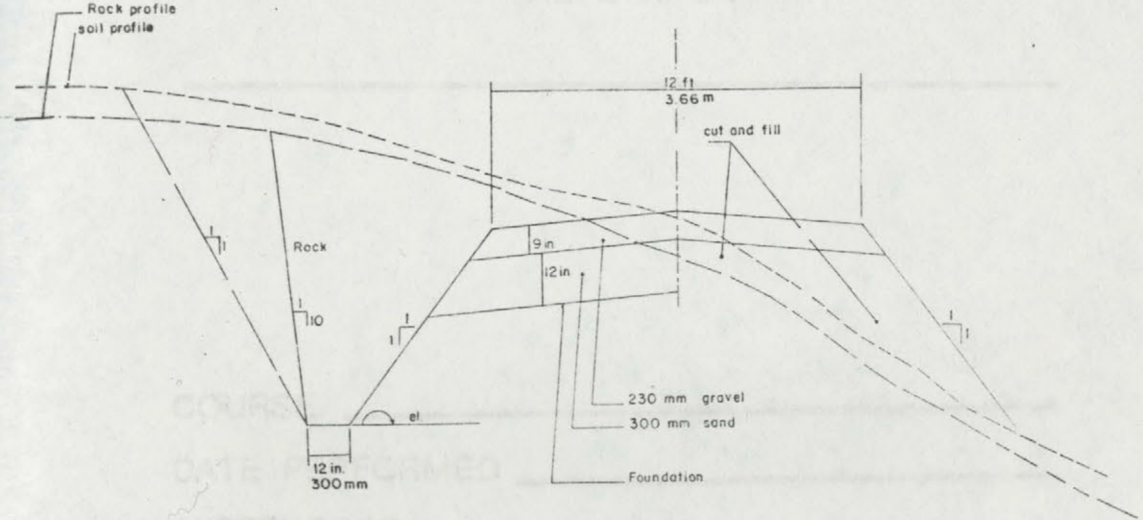


CONSTRUCTION FEATURES:
SEPTIC TANK AND
LEACHING SYSTEM

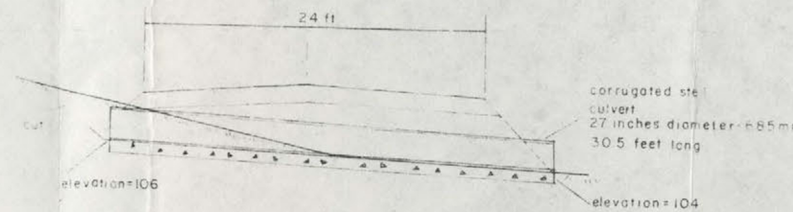
PLAN # 4

Drawn by J.C.   Checked by

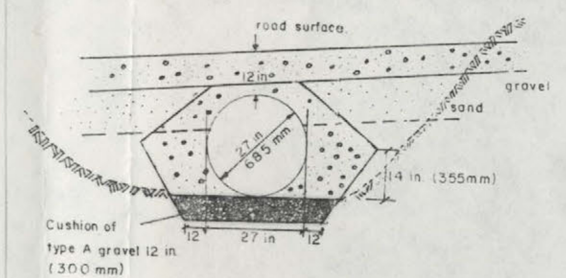
Date: 30/11/87



GENERAL TYPICAL SECTION



TYPICAL SECTION
at 0+17



CULVERT SECTION

CONSTRUCTION DETAILS
PLAN # 3