ROAD GRAVELS IN QUEBEC

R. H. PICHER

MINES BRANCH
DEPARTMENT OF MINES
OTTAWA
1935
NO. 751

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INTRODUCTORY

This report presents under one cover the results of field and laboratory work undertaken on gravels in Quebec in relation to their use as road material.

Although the information presented has been obtained at various times since 1915, the major part is the result of extensive field and laboratory investigations conducted during the years 1929, 1930, and 1931. This report is not solely a compilation of the progress reports published in English[1] from time to time, but is a re-arrangement with amplifications of details and gives additional information on certain phases of the subject.

Gravels used for road construction and surfacing are much the same in appearance as those used for other purposes, but their suitability or superiority for road work depends upon apparently minor characteristics. The size of the gravel constituents, the hardness and freshness of the pebbles, and the predominating shape of the pebbles are important considerations as they all have a marked effect on the character or life of the road surfaced with the gravel.

The purpose of the report is to direct attention to the various deposits of gravel suitable for road material and to state the characteristics of the gravels and give their limitations of usefulness.

No attempt has been made to record and describe all the gravel deposits of the province, but only those of some importance from an economic or commercial standpoint, their importance being estimated from the quality of the gravel, the amount available, or the accessibility of the deposits. The greater part of the deposits examined have been opened and developed to some extent, particularly those, both good and bad, that are close to the highways, but, with few exceptions, the poor gravels have not been included in the report. It is probable that in some areas deposits of importance have been overlooked, but an endeavour has been made to cover as far as possible the available resources of good road gravel throughout the main settled districts of the province. In the sections dealing with the gravel deposits by counties attention is drawn to the areas covered.

[1] Geol. Surv., Canada, Rept. No. 1686, Mem. 99, Road Material Surveys in 1915, Part II, Appendix C.
Geol. Surv., Canada, Rept. No. 1684, Sum. Rept. 1916, pp. 198-205.
Geol. Surv., Canada, Rept. No. 1728, Mem. 106, Road Materials in a Portion of Vaudreuil County, Quebec.
Mines Branch, Dept. of Mines, Rept. No. 509, Sum. Rept. 1918, p. 177.
Mines Branch, Dept. of Mines, Rept. No. 619, Invest. in Ceramics and Road Materials, 1923, pp. 8-55.
Mines Branch, Dept. of Mines, Rept. No. 672, Invest. in Ceramics and Road Materials, 1925, pp. 30-34.
Mines Branch, Dept. of Mines, Rept. No. 697, Invest. in Ceramics and Road Materials, 1927, pp. 71-75.
Mines Branch, Dept. of Mines, Rept. No. 722, Invest. in Ceramics and Road Materials, 1928-1929, pp. 82-133.
Mines Branch, Dept. of Mines, Rept. No. 726, Invest. in Ceramics and Road Materials 1930-1921, pp. 84-164.

Requirements regarding the qualities that a gravel should have as road material are incorporated in specifications following observations of the results obtained in numerous service tests. These requirements vary somewhat with the importance of the road from the standpoint of traffic and with the character of the gravel available. The recommendations given represent current practice for the average main road carrying not over 500 vehicles a day. Under heavier traffic, difficulty is experienced in keeping the road surface from being disrupted particularly during long spells of dry weather. The usual practice is to protect the compacted surface by maintaining over it a "floating mulch" or thin course of loose gravel which acts as a buffer. Under these conditions daily maintenance is a necessity, in order to keep the loose material from being tossed to the sides of the road by the passing vehicles. It is found in such cases that better riding qualities are obtained and maintenance work is made easier by using somewhat finer gravel than is usually recommended under less severe conditions.

In the last few years several highway organizations have obtained greater stability of gravel roads under heavy traffic by carefully grading the aggregate constituents as to size, particularly the finer particles, using a plastic material as binder and maintaining a certain degree of moisture in the road structure. In practice this is done by combining materials from two or three different sources, as in only few cases will a gravel be found to be properly graded and to have the right kind and amount of binding material. The cost of this extra handling and manipulating is claimed to be more than offset by the good results obtained, such as a firm, smooth, dustless road surface without loose material or floating mulch, and a substantial reduction in maintenance charges. It would be worth trying with the Quebec gravels, many of which when used alone are too fine to be suitable according to the present standards of construction. As one of the essential points of a stabilized road surface is the proper grading of the finer aggregate particles, fine and sandy gravels would find a use as one of the constituent materials. The adoption of this method would of necessity bring about changes in the requirements included in the present specifications for road gravels.

INCREASING USE OF GRAVEL AS ROAD MATERIAL

Nearly all gravel excavated in eastern Canada is used as road material, railway ballast or cement concrete aggregate. In the last decade road improvement contributed more than any other factor to the enormous increase in production of this material. The greater demand for concrete aggregate is in large centres of population, and most of these are well supplied with crushed quarry stone, which is used in preference to gravel because more economically available. A considerable quantity of gravel is used as railway ballast, but the rate of increase in its use for such purpose has not been so great as that in the highway field. In fact, there has been for sometime a tendency to replace gravel with broken stone on railway lines carrying fast passenger trains. The large amount of gravel absorbed in road work may be judged from the mileage of gravel roads in Canada as given by the Dominion Bureau of Statistics. In 1923, there

were 48,659 miles of improved roads, of which 34,839 miles, or 72 per cent, were of gravel. In 1930, out of 80,498 miles of improved roads, 71,348 miles, or 89 per cent, were of gravel. Annual reports of the Roads Department for the province of Quebec give 3,719 miles of gravel roads for 1924, representing 63 per cent of the total mileage of improved roads, and 13,239 miles of gravel roads for 1932, or 85 per cent of the total mileage of improved roads. In the United States, according to the Highways Handbook, 1929 Edition, the mileage of gravel roads increased from 199,899 in 1921 to 370,921 in 1928, these two numbers representing respectively 52 and 59 per cent of the total mileage of improved roads for the country. Increase in traffic makes it necessary to replace each year stretches of gravel with more permanent types of surfacing, but at the same time a much greater mileage of roads, mostly earth roads, is given a gravel surfacing. In the province of Quebec the mileage of gravel roads has increased annually by well over 1,000 during the past eight years, which means an annual increase in gravel consumption of over one million cubic yards, based on the conservative estimate of 1,000 cubic yards of gravel for each mile of road. Gravel is also used as aggregate in the building of cement concrete pavements, but the amount thus absorbed is small when compared to that going into gravel roads, as cement concrete pavements form less than 2 per cent of the mileage of improved roads in Canada. In Quebec, concrete roads are usually built where broken stone can be easily obtained for use as aggregate instead of gravel.

AREA COVERED

The investigational work on gravels covered that part of the province lying south of St. Lawrence river and a belt of land north of that river lying between Chichester township in Pontiac county and Quebec city. In a general way, the work included all the settled parts of the province, with the exception of the northern counties, such as Témiscamingue, Abitibi, Laviolette, Lake St. John, Chicoutimi, Saguenay, Charlevoix, and Montmorency. A more detailed statement as to the area covered in each of the counties included in the investigation will be found in that part of the report dealing with the occurrence, distribution, and description of deposits.

DEFINITION AND EXPLANATION OF TERMS

Gravel and sand are of such common occurrence that the mere mention of the names conveys sufficiently clear meaning as to what they are. A few words of explanation, however, may be useful for the better understanding of the subject. Broadly speaking, gravel and sand are natural deposits of unconsolidated mineral fragments, the difference between the two being that gravel is coarser than sand. In general, the term sand applies where the maximum size of the fragments is not over $\frac{1}{4}$ inch, and the term gravel where the maximum size is greater than $\frac{1}{4}$ inch.[1] In this report the term gravel is used for mineral fragments grading in size from 3 inches downward, and the term sand for those from $\frac{1}{4}$ inch downward. Stones above

[1] For certain purposes the ruling maximum size of fragment for sand is $\frac{1}{10}$ instead of $\frac{1}{4}$ inch.

3 inches in size are called boulders and when occurring mixed with smaller fragments constitute boulder deposits. When boulders form but a small proportion of the whole, the word gravel is retained and the deposit is named bouldery gravel; and, similarly, sand holding a small proportion of fragments above ¼ inch in size is termed gravelly sand. The finer part of the sand that passes a sieve of 200 mesh to the inch is designated silt and clay; the clay is the finer of the two and is plastic, whereas silt is devoid of plasticity.

In their order of decreasing coarseness, the gravels are described as very coarse, coarse, medium coarse, medium fine, fine, and very fine. These terms refer to the average size or coarseness of the pebbles (between ¼ and 3 inches) rather than to their amount, although the percentage of pebbles in a well-graded gravel as a rule increases with their coarseness.

MODE OF FORMATION

Gravel deposits are composed of a heterogeneous mixture of rock fragments, each fragment being derived from some kind of solid rock. The kinds of rock predominating are usually those of the local rock formations, but some of the less abundant kinds can be traced to rocks occurring farther away, and others, still rarer, may be traceable to any known formation. Through weathering agencies, fragments become detached from the solid rock and are transported and sorted by water to be laid down finally to form a stratified deposit. The presence of large blocks of stone in many deposits, however, suggests a more powerful transporting agent than water alone, and is referable to the agency of ice, unmistakable signs of such action occurring throughout Canada. The northern part of the American continent was at one time covered with a vast sheet of ice comparable in size to that now covering the Antarctic continent. Under the weight of accumulated snow and ice, the sheet moved radially outwards from the centres of accumulation. Some idea of the great thickness and weight of the sheet may be formed by the fact that the direction of the movement was but very slightly influenced by topographical features, such as valleys and mountain ranges. It is easily conceived what a powerful agent of transport such a mass of ice would be, removing all loose and disintegrated material, tearing off solid rock, and leaving on the planed rock surface traces of the direction of its movement in the form of grooves, called glacial striae. The detrital material becoming incorporated into the ice-sheet, moved with it and was later dumped here and there as the ice melted; part being assorted and deposited by streams issuing from the melting ice, to form glacial gravel. Much of the unsorted material called glacial drift or till, remains undisturbed and can be seen today in the same state as when dropped by the melting ice. It is a mass of debris of all sizes, laid down without any order whatever. Ice action alone can account for those innumerable boulders and large blocks of stone scattered throughout this country, some of them hundreds of miles from the parent rock from which they were derived. Part of the material left by the ice, whether glacial drift or gravel, was taken up and re-worked by later streams; in fact, the process is still going on, and the abundance of gravel in this country is largely attributable to conditions prevalent during the Glacial period.

SUITABILITY OF GRAVELS AS ROAD MATERIAL

Glacial Gravel as Road Material

As road material, glacial gravels[1] are claimed to be superior to others by road engineers in the United States, after comparing results obtained with glacial gravels found in the northern part of that country and non-glacial gravels found farther south. The reason advanced is that the average glacial gravel contains friable pebbles, which crumble in the process of compacting on the road and yield binding material. The function of cementing the road surface is borne by the finer material, that is, that part passing the 200-mesh sieve. In a well sorted, stratified gravel, the percentage passing the 200-mesh sieve is very small, too small in fact to yield the needed amount of binder, so that a binding medium, such as clay, has to be added, if not provided by the crumbling of some of the larger fragments.

Glacial gravels exhibit a more regular gradation in hardness of fragments than others, owing to the greater variety of rocks contained. This might appear to be a disadvantage, as a gravel made up entirely of hard rocks, other than the small amount of friable material necessary to provide the binding medium, should have better wearing quality than one of materials of different hardness. The disadvantage, however, is not so apparent when considering the ability of the road structure as a whole to stand the grinding and pounding of traffic instead of the wearing quality of the individual constituents. In the average water-worn or stratified gravel, the pebbles are all more or less round and smooth, the smoothness generally increasing with the hardness. A gravel, however, the pebbles of which are almost all hard, smooth, and rounded, packs with difficulty and a road surface built of it lacks stability because there is no strong interlocking action between the fragments, and a heavy load is put on the binding medium. Gravels with angular pebbles give as a rule very good results as road material, but in general, roads built with hard gravels, if not rolled, require particular attention until the mass has sufficiently compacted under traffic.

The objection raised some years ago against using crushed glacial boulders for building waterbound macadam roads, because of the uneven wear of the surface resulting from the heterogeneous character of the boulders, is not true in the case of gravels. In these the fragments of different hardness are intimately mixed, a condition more difficult to obtain with crushed boulders.

Glacial gravels are often bouldery, which is a disadvantage when deposits are worked by hand labour, because the larger stones have to be handled and separated from the useful material. When crushed, however, they are superior to the finer gravels because the crushing provides angular fragments that are usually lacking in the ordinary gravel. In large-scale development work by mechanical means, bouldery gravels are often preferred because the additional expense incurred by crushing is more than compensated by the improved quality of the product.

[1] In its broad sense, as used here, glacial gravel means gravel largely made up of glacial material, irrespective of the time of deposition.

Beach and River Gravels

Beach and river gravels are not so desirable as bank gravels for road construction because they are deficient in binding material and in many cases hold a large proportion of hard, rounded, smooth pebbles. Also the range of size of pebbles and grains is more limited than in bank gravels, with consequent higher proportion of voids. Such gravels do not compact so readily, nor form so smooth a surface as does the ordinary bank gravel, but they wear better and roads built of them have a long useful life if well maintained. The addition of fine bank material is sometimes necessary to keep the surface from being disrupted by fast motor traffic. Not all beach and river gravels are equally suitable, but their quality varies within narrower limits than that of bank gravels, very good as well as very poor gravels being less common than in bank deposits. Beach and river gravels are extensively used in parts of Quebec and the Maritime Provinces.

PHYSICAL CHARACTERISTICS OF ROAD GRAVEL

The increased use of gravel as a cheap road-surfacing material has led to a closer study of its characteristics and a better understanding of the qualities it should have in order to meet satisfactorily the demands put upon it. These demands vary with the importance of the road, that is, the character and amount of traffic over it. It should not be forgotten, however, that gravel has its limitations, and will give best results under light or moderately heavy traffic, up to 500 vehicles a day on the average, although well maintained gravel roads will sometimes stand satisfactorily a traffic of over 800 vehicles a day.

Gravel is a bulky and heavy material for its cost and can not be economically transported long distances, as transportation charges generally fix the price of the material delivered on the job. In one of the eastern provinces, good crushed gravel is occasionally transported by rail over 100 miles, which may be regarded as an exceptionally long haul. The distance that a gravel can be economically transported depends on local conditions. Where it is necessary to bring in gravel by rail or water, it is sound economy to get the best material obtainable. Where the hauling is done by road, quality is sometimes sacrificed for the sake of economy, as the cost of the material on the job is roughly proportional to the length of haul. A gravel nearer at hand that is plentiful and easy of access may be used in preference to better but not so easily available gravel, if the extra cost of hauling the more suitable material be not fully compensated by its greater durability. On a main road, however, where resistance to wear is a prime requisite it will prove economical to pay the higher price for the better gravel, a sound procedure practised by some highway departments being to build a good and substantial foundation with local gravel and to reserve the more expensive gravel for the wearing course.

As gravels vary widely in character, it is not advisable to draw specifications within too narrow limits, although a gravel must have certain

qualities to make it suitable for road material. These qualities are related to the composition and grading of the fragments and to the cementing value, and will be briefly reviewed.

Composition

The composition of a gravel refers either to the lithological character of the rocks forming it, or more particularly to their soundness and hardness. Although there is a wide difference in road-making qualities of the various rocks considered individually, the qualities or defects inherent to each kind of rock are modified by the fact that the different rocks are intimately mixed in the ordinary gravel, and show only when one kind of rock predominates greatly over others.

Unsound and friable pebbles, on the other hand, have a marked influence on the road-making quality of the gravel, even if present in comparatively small amount and intimately mixed with the harder constituents. Most specifications for road gravel require that it shall not contain more than 15 per cent of soft, friable, or disintegrated material. This objectionable material may be in the loose form, such as dust, or it may be rock fragments, soft by nature, such as highly schistose, laminated, or shaly rocks, or else as fragments rendered friable through weathering. The smaller the amount of soft material the better is the wearing quality of the gravel, although soft material is often desirable in limited amount for reasons that will be explained when discussing the cementing value of gravels.

The erroneous idea that soft gravels make better roads than hard gravels is no longer entertained. The idea was based on the fact that soft gravels compact readily and quickly, forming a smooth surface, and requiring but little maintainence work, at least for a time, and was prevalent when traffic was light and wear was only a secondary consideration. Some soft gravels in which the more friable material is of a clayey nature do make roads that are remarkably firm and smooth and show hardly any wear in dry summer weather, but lose their stability and resistance to wear in a prolonged spell of wet weather, and may fail lamentably during the spring thawing, necessitating a re-surfacing. All soft gravels, whatever their condition and quality when dry, are adversely affected by weather changes and do not answer the prime purpose for which they are used, that is, to provide an all-weather road.

Loam is very objectionable and should not be tolerated, as, even in small quantity, it badly affects the condition of the road, by retaining moisture and softening the road structure. Loam is found almost only in the upper part of gravel deposits and should be removed while stripping the gravel of its overburden.

In nearly all gravel deposits, that part near the surface is more or less oxidized and decayed owing to long exposure to the weathering agents. The weathering is most intense at the surface and gradually decreases at depth. The depth of weathering varies in different deposits and in many cases even within the same deposit, and usually no sharp parting exists between the fresh gravel and the weathered material above it, although where an impervious layer limits the depth of the weathering action there

may be a sharp parting between them. Gravel, which is normally of various shades of grey colour, assumes a buff, rusty or dirty brown tint when weathered, and the fresh gravel appears by contrast to have a bluish tint when seen in the bank beside the weathered material. Weathering lowers the quality of a gravel by weakening the cohesion of its constituents and rendering them friable. Some decayed rocks are highly absorbent and by retaining moisture have about the same adverse effect as loam on the condition of a road surface. Intensely weathered gravel is worthless and should be treated as overburden in working a deposit. As in most cases there is no sharp demarcation between the fresh and weathered gravel, the thickness of material to be removed as worthless is governed largely by the percentage of soft, friable, disintegrated or otherwise objectionable material tolerated in a gravel, usually 15 per cent for a road gravel, and less if the gravel is to be used as concrete aggregate.

Grading

Gravels are made up of fragments ranging in size from very fine powder up to 3 inches and more. The relative proportion of each size varies in different deposits and even in different parts of the same deposit, and the range of sizes is not the same for all deposits. Road service tests have shown that for optimum results the range of size and the relative proportion of each size within that range should not vary beyond certain limits. The maximum pebble size of a gravel to be used in the wearing course of a road is generally fixed at $1\frac{1}{2}$ inches, whereas in the foundation course a maximum size of 3 inches is allowed. The percentage of pebbles (over $\frac{1}{4}$ inch) should not be less than 50 nor more than 75. Some specifications also fix a maximum limit to the percentage of particles passing a 200-mesh sieve. This applies particularly to gravels high in silt or clay. In the average stratified gravel, the percentage passing the 200-mesh sieve is very low, seldom over 3, although occasional layers or lenses may hold a much higher proportion. In fixing limits for fine material, account should be taken of the proportion of friable fragments present in the gravel, for these on being ground up by traffic yield much material finer than the 200-mesh sieve. Some fine material is not only desirable but necessary as a filler and binder.

As is explained later when discussing the testing of gravels, coarseness and grading are determined by passing the material through a set of screens and the proportion passing each screen and retained on the next smaller screen recorded. Specifications for gravel, sand, and broken stone used for certain purposes usually require that the material to be used shall conform to a certain grading as determined by screen analysis. For road gravels, it is neither necessary nor advisable to prescribe a definite grading, because a gravel may vary within comparatively wide limits as regards grading and still be suitable, the only limits set being the maximum size, the proportion retained on the $\frac{1}{4}$-inch screen (pebbles), and sometimes the proportion passing the 200-mesh sieve.

A few typical irregularities in grading may be pointed out, together with their effect on the condition of the road. Where there is a large proportion of material in the gravel passing the 200-mesh sieve, the condition

of the road is greatly affected by the weather. If wet it will be soft, muddy and slippery, and may be badly rutted by traffic. If dry it will generally be in good condition, if properly maintained, and may be either very dusty or else remarkably free from dust, depending upon the character of the fragments. It may even be in such good condition as to be comparable to a paved road as regards firmness, smoothness, and freedom from dust. A gravel with about the right proportion of sand, but in which the sand is mostly fine, will not compact readily on the road, and under traffic the pebbles will float about in the loose fine sand. Such roads are usually dusty when dry. Wet weather may render them firmer, or may leave them as bad as in the dry state, except for the dust.

Gravels with a low proportion of pebbles, although satisfactory in some respects, lack wearing quality and are more subject than others to form corrugations under fast-moving motor traffic. Under favourable conditions, for instance where the sand is very coarse and there is no deficiency in binding material, these gravels have proved satisfactory. Very good results even have been obtained with sandy, but otherwise well-graded, gravels on clay soils. Generally, however, roads built of these gravels are of an intermediate type between true gravel and earth roads, somewhat like sand-clay roads. As the primary object in improving an earth road with gravel is to impart to it the qualities inherent in a stone road, a gravel high in pebbles should answer the purpose better than a sandy one.

Coarse and bouldery gravels make too rough a surface to be used in the wearing course, and are more suited for the foundation course. As a rule, however, they are not used as such, as it is generally a comparatively easy matter to get rid of the oversize stones. If there is but a small amount of oversize, it is raked off as the gravel is applied on the road; in larger proportion, it is screened off in the pit while loading. The large stones gradually accumulate in the pit and are wasted, unless crushed later. If the amount of oversize stones is fairly large, a good practice is to pass the whole through a crusher. In this way wastage of stone is avoided, and the crushed angular fragments, intimately mixed with the uncrushed, greatly help the compacting of the gravel on the road and improve its stability and wear. The extra cost incurred in crushing is more than compensated by the improved quality of the material. A soft gravel may not be much improved by crushing and may sometimes be injured, on account of the excess of very fine material produced in the process of crushing in addition to that derived from the grinding of the soft particles under traffic, but such a gravel may be too soft for use, either crushed or uncrushed. Under certain conditions a soft gravel may not warrant the cost of crushing, and yet may be economically screened from its oversize and used, but this is exceptional. As a rule, a gravel worth using is worth crushing, if it holds so much oversize as to require screening.

Although any irregularity in grading can be rectified by proper treatment, such as removing some of the excess material by screening or washing, separating the material into different parts and re-combining in the proper proportion, it is a costly process when the irregularity in grading occurs in the intermediate or smaller size particles. It is usually done only when the irregularity is confined to the coarser part, for instance when there is

an excess of oversize stones, because in this case the desired result can be obtained by simply screening off the oversize. Plants equipped for crushing and screening gravel can supply a road gravel of more uniform grading than is commonly found in natural deposits.

Binder

The binder is very fine material, the function of which is to fill the voids between the larger fragments making up a gravel road surface and cement them together. When present in a gravel it is either as a loose powder, or as a coating on the pebbles, or else it is derived from the crumbling of the softer material under traffic. The three most common binders are clay, calcium carbonate, and iron oxide. The firmness of a gravel road surface and its ability to withstand traffic wear depend partly on the mutual interlocking of the pebbles and partly on the cementing medium. Because of the rounded shape of the pebbles and the smoothness of their surface, their interlocking alone is not strong enough for the purpose, so that a binding agent is always necessary. Most stratified gravels of eastern Canada hold little loose material passing the 200-mesh sieve, but hold friable or partly disintegrated particles that on being ground by traffic yield a fairly good cementing material. In addition to this there is often other material coating the pebbles, especially in clayey and rusty gravels, and in gravels high in limestone. If the gravel is devoid of binder, it will be necessary to use cementing material from nearby sources, and if only clay be available, care should be taken to add just the proper amount, about 10 per cent, and it is essential that the gravel be well graded to lessen the weakening action of the clay during wet weather, and prevent the formation of mud.

Clay is objectionable in a gravel road if present in amounts more than sufficient to fill the voids in the compacted gravel. When in excess of this amount it will, in wet weather, act as a lubricant and lose its cohesive or binding properties. However, when the grading of the aggregate and the amount of clay are carefully controlled, good stability is obtained. This will be referred to again when discussing stabilized road surfaces.

Calcium carbonate and iron oxide have the advantage over clay of not being affected by weather. Calcium carbonate is a white substance usually found coating one side of the pebbles in gravels rich in limestone. Limestone itself is composed essentially of calcium carbonate, diversely coloured by impurities. If the limestone is not too impure, the powder derived from the rock has about the same cementing value as the pure carbonate. Some impurities increase rather than decrease the binding power of the stone. The presence of iron oxide is easily detected by the rusty colour it imparts to the gravel, or it may be formed later by the oxidizing of the iron-bearing minerals present in the pebbles after the gravel has been exposed for some time. All common rock powders have some cementing value, but it varies a great deal with different rocks. In general, trap rocks, limestone, marble, schist, slate, and shale have a high cementing power, whereas granite, quartzite, dolomite, and sandstone have a low value. Colour affords a simple but not a very accurate means of judging

the cementing value of the rocks, for, with few exceptions, dark-coloured rocks have a better cementing value than light-coloured. Another ready criterion is how a gravel stands in the pit bank; if it stands firmly it will generally cement readily on the road, but it should not be inferred that a gravel is deficient in binding quality because it is loose in the bank.

Testing

A careful inspection of gravel roads should reveal the suitability of the gravel used in building them, provided all factors affecting their condition are taken into consideration, such as the method of construction, drainage, nature of subsoil, amount and character of traffic. If there is no opportunity to observe the results obtained in service tests, a field examination of the gravel deposit will furnish information as to its road-making quality, but this cannot be regarded as conclusive. Service tests are undoubtedly the best and most reliable method of ascertaining the quality of the material but they have the disadvantage of requiring much time before conclusions can be drawn from the results obtained, and they are expensive, particularly if the gravel tried prove of poor quality. Laboratory tests cannot duplicate the conditions found in the service tests, but are much less expensive and the results afford a quick means of ascertaining the suitability of the gravel by comparing them with recognized standards established from extensive service tests. The samples for this purpose should be collected so as to be fair representatives of the material it is proposed to use. Laboratory tests on gravel and sand comprise granulometric analysis, the determination of the character and shape of constituents, specific gravity, percentage of voids, wear, percentage of silt and clay, organic impurities, and strength in cement mortar and concrete.

Granulometric Analysis

The sample is first passed through a screen having round holes, ¼ inch in diameter; the part retained on the screen is weighed and recorded as " pebbles," and that passing through is weighed and recorded as " sand." The pebbles are then subjected to screen analysis, using screens with round holes of the following sizes: 2½, 2, 1½, 1, ¾, ½, and ¼ inch; and the weight of material retained on each screen is reported in terms of percentage of the total weight of the pebbles. About 500 grammes of the material passing the ¼-inch screen is then run through standard Tyler sieves of the following mesh: 8, 14, 28, 48, 100, and 200; that retained on each sieve, as well as that part passing the 200-mesh sieve, is weighed separately, and all weights are finally converted into percentages. This test gives an indication of the coarseness of texture or grading of the material.

On account of the wide range in grading of different gravels, it is not advisable to set too strict rules as to what proportion of each size a gravel should have, for it to be considered suitable. In general a good road gravel should contain at least 50 per cent of pebbles, and that part passing the ¼-inch screen should be fairly coarse, that is, the percentage retained on each sieve should decrease with the sieve opening.

Character and Shape of Constituents

About 100 pebbles are picked at random from the sample, and their nature and soundness determined by breaking and examining them. The usual way followed in this laboratory is to classify them into three grades:

Durable, which includes all very hard rocks;

Intermediate, which includes sound rocks of medium hardness, and partly weathered rocks that still retain a certain hardness;

Soft, which includes fresh rocks that are soft and friable, and rocks that are partly disintegrated from weathering.

The shape of the pebbles varies from rounded to angular, and from flat to about equal in all dimensions. The shape of the largest number of the picked pebbles is judged and recorded as the average shape of the pebbles. The nature and soundness of the gravel pebbles greatly influence the ability of the road surface to resist the grinding action of traffic, and their shape has a direct bearing on its resistance to disruption.

The gravel should not contain more than 15 per cent of soft or disintegrated particles. The ideal shape for gravel pebbles is that of broken stone fragments, that is, angular and chunky. Flat pebbles and rounded, smooth-surfaced pebbles are particularly objectionable. The importance of the shape of the pebbles increases in proportion to their hardness.

Specific Gravity

Separate tests are made for pebbles and for sand.

For pebbles, the test is made as follows: About 1,000 grammes of the pebbles retained on the ½-inch screen are dried to constant weight at a temperature between 100° and 110° C., cooled in a desiccator, and weighed to within 0·5 gramme. They are then immersed in water for 24 hours and weighed in water. The weight in water is obtained by placing the pieces in a wire basket which is suspended in water from the centre of the scale pan. The difference between this weight and that of the empty basket suspended in water is the weight of the saturated sample in water. After the pieces have been taken out of the water, they are surface-dried by means of a towel or blotting paper and immediately weighed in air. The specific gravity is calculated by dividing the weight of the dry sample by the difference between the weights of the saturated sample in air and in water. The weight in pounds per cubic foot of the rock is obtained by multiplying the specific gravity by 62·4, which is the weight in pounds of a cubic foot of water.

The specific gravity of sand is determined by the method used for Portland cement and other fine aggregates, i.e. by the Le Chatelier specific gravity bottle, into which kerosene or benzene is poured through a funnel to a point on the stem between the zero and the 1-c.c. graduation, and the level of the fluid is read. The funnel is withdrawn and 64 grammes of the sand is slowly introduced, care being taken that the material does not adhere to the inside of the flask above the liquid. The material is freed from air by rolling the bottle in an inclined position. The level of the fluid is read as before. The specific gravity is calculated by dividing the weight of the sample (64 grammes) by the difference between the two readings.

Percentage of Voids

In this test a truncated steel cone having a capacity of 5,975 cubic centimetres is completely filled with the gravel, which is thoroughly compacted by oscillation and kept full until no more gravel can enter. Then, if A equals the weight in grammes of the cone empty, B equals the weight in grammes of the cone filled with compacted aggregate, and C equals the specific gravity of the aggregate.

$$\text{The percentage of voids} = \left\{1 - \frac{(B-A)}{5975C}\right\}100$$

The specific gravity and voids tests are useful in converting yardage into tonnage and vice versa.

Abrasion

The material is separated by screening into the various sizes required for grading the test charge according to whichever of the following four gradings most closely approaches that of the sample.

Grading A	Passing	0·75-inch	screen,	retained	on	0·5	-inch	screen	.. ..	1,250
	"	1	"	"	"	0·75	"	"	.. ..	1,250
	"	1·5	"	"	"	1	"	"	.. ..	1,250
	"	2	"	"	"	1·5	"	"	.. ..	1,250
Grading B	"	0·75	"	"	"	0·5	"	"	.. ..	1,250
	"	1	"	"	"	0·75	"	"	.. ..	1,250
	"	1·5	"	"	"	1	"	"	.. ..	2,500
Grading C	"	0·75	"	"	"	0·5	"	"	.. ..	2,500
	"	1	"	"	"	0·75	"	"	.. ..	2,500
Grading D	"	0·5	"	"	"	0·25	"	"	.. ..	2,500
	"	0·75	"	"	"	0·5	"	"	.. ..	2,500

The gravel of the required sizes is washed and dried, care having been taken to have material slightly in excess of the weights given, to allow for loss in washing and drying. When added together, the total weight of the test charge should weigh within 10 grammes of 5,000 grammes. It is then placed in the cylinder of a Deval machine. Six cast-iron balls, 1·875 inches in diameter and weighing approximately 0·95 pound (0·45 kilogramme) each, are placed in the cylinder as an abrasive charge. The machine is run 10,000 revolutions at the rate of 30 to 33 per minute. At the completion of the run, the material is taken out and screened over a No. 12 (U.S. Series) sieve. That part retained on the sieve is washed, dried, and weighed, and the percentage loss by abrasion of the material passing the No. 12 sieve calculated.

This test is in the experimental stage, and no definite factor has yet been established for comparing the wearing quality of a gravel and its percentage of wear, as obtained by the laboratory test.

Percentage of Clay and Silt

This and the following tests are made on gravel and sand intended more particularly for use as aggregate in concrete mixtures. For this test, the sample is moistened and thoroughly mixed, then dried at a temperature

between 100° and 110°C. The pan or vessel used in the determination should be approximately 12 inches in diameter and 4 inches deep. A representative portion of the dry material weighing not less than fifty times the weight of the largest stone in the sample is selected from the sample and placed in the pan, which has been dried and accurately weighed. Sufficient water is poured into the pan to cover the gravel, which is then agitated vigorously for 15 seconds with a trowel or stirring rod. After it has settled for 15 seconds the water is poured off, care being taken not to pour off any sand. This is repeated until the wash water is clear. The washed material is finally dried to constant weight in a hot-air oven at a temperature between 100° and 110°C., and weighed. The percentage of clay and silt is equal to one hundred times the difference between the initial and final weights, divided by the initial weight.

Although some clay and silt is not objectionable, if it amounts to 5 per cent or more, a mortar test should be made to determine whether the material is suitable.

The percentage of clay and silt given in Table I of this report was not determined by the standard method just described, but was simply taken as the total material passing the 200-mesh sieve, as obtained from the sieve analysis. The procedure followed is less accurate and gives lower values than the standard test, but with a clean gravel holding a small amount of clay and silt, which is the case of nearly all gravels dealt with in this report, the difference between the values obtained by the two methods is very small, and for road purposes alone is negligible.

Organic Impurities

For this test, all fragments retained on the ¼-inch screen having circular openings are first removed and from the residue 200 grammes is taken for testing. This is added to 100 c.c. of a 3 per cent solution of sodium hydroxide. The sand and solution are then allowed to stand for 24 hours, with occasional stirring. If organic impurities are present in the sand, the solution will have a colour ranging from light yellow through red to black. By comparing the colour of the solution with a colour scale made up of 10 different solutions of alkaline sodium tannate, an indication is given of the amount of impurities and of their effect on the strength of mortars made with the sand.

The solutions for the colour scale are numbered from 1 to 10, starting with the palest. The percentage reduction in compression strength of 1:3 mortars caused by the presence of organic impurities is given as follows:

Colour	value	of	3,	reduction:	10 to 20	per	cent
"	"		5,	"	15 to 30	"	"
"	"		10,	"	20 to 40	"	"

Mortar Tests

By comparing the tensile and compressive strengths of a 1:3 mortar composed of Portland cement and the sand to be tested, with a 1:3 standard Ottawa sand mortar made with the same cement, an indication is given of the suitability of the sand for concrete work. The pebbles are first removed

from the sample by screening through a ¼-inch screen with circular openings. The sand is mixed with one-third its weight of Portland cement, after which it is brought to a definite consistency with water and moulded into briquettes and cylinders. Six briquettes and six cylinders are made for each sand to be tested. They are left in the moulds and allowed to stand 24 hours in moist air. They are then taken out of the moulds and immersed in water. A similar number of briquettes and cylinders are prepared the same way with one part cement and three parts Ottawa standard sand. Ottawa standard sand is obtained from the Ottawa Silica Company of Ottawa, Illinois, and is of such size as to pass a 20-mesh sieve and be retained on a 30-mesh sieve. On the seventh day after mixing and moulding, one-half the number of briquettes for each sample and the standard are tested for tensile strength in the briquette testing machine, and one-half the number of cylinders for compressive strength in the compression testing machine. On the twenty-eighth day the remaining briquettes and cylinders are tested the same way. For a sand to be used in concrete pavements the results of the tests should be at least equal to those obtained on the standard mortar, and for concrete foundations, culverts, and retaining walls should be at least 70 per cent of the standard.

Sampling

There are two general classes of natural gravel and sand deposits: the bank, and the beach or river deposits; and the methods for sampling them are different. In sampling a pit face in a bank deposit, a narrow strip of material running the full depth of the face should be taken, with the exception of the top soil and that part of weathered material usually lying immediately below the top soil. If the excavation is of large size, several samples should be taken in this way at equal distances along the face, because only in exceptional cases will a single sample be a fair representative of the average of the deposit. In most deposits the coarseness varies both in depth and in the horizontal direction. If the pit face is partly covered with talus, this should be shovelled off so as to uncover the full face, or else only the material from that part of the face above the talus should be included in the sample. A sample which is to be tested for coarseness or grading in size of particles should never include any talus material. In order to collect samples from undeveloped deposits, it is necessary to dig test pits. These should be as deep as practicable and the samples taken in the same manner as in ordinary pits, that is, by removing a vertical strip of material to the full depth of the test pit, not including, however, the top soil and weathered material below it. In fine gravel and sand deposits, satisfactory samples can be taken by boring auger holes.

The method of sampling beach deposits will vary with the method of exploitation. When the gravel is loaded directly with hand shovels into carts or trucks, the material is usually dug to a very shallow depth, but over a comparatively large area, and the way to sample such a deposit would be to take strips of material at right angles to the shore and at regular intervals along it. As the surface material is generally much coarser than that below, the strips should be dug deep enough to include also the finer material, but not so deep as to include material that will not be used.

Samples of gravel should weigh at least 25 pounds, and samples of sand, 10 pounds. When an abrasion test on gravel is required, an additional sample of pebbles, weighing at least 20 pounds, is included. The pebbles should range from one-half inch to 2 inches in size. One sample of pebbles is generally sufficient, as their composition and shape are generally fairly uniform within the same deposit.

STABILIZED ROAD SURFACE

During the last few years road subsoils in the United States have received much attention and study. It was thought that if more supporting power could be given to the soil by proper treatment, some of the cost of building high-grade pavements to take care of heavy traffic would be saved, and if the surface of unpaved roads could be rendered more stable under all weather conditions then the cost of maintenance would be materially reduced. The Bureau of Public Roads, of Washington, D.C., conducted extensive laboratory tests on soils, so as to determine the proper method of treatment for each particular soil to ensure maximum stability. Several state highway departments co-operated with the Federal Bureau in building experimental sections of road in accordance with the principles developed as a result of the laboratory tests. The encouraging results obtained have induced further experiments in that direction, particularly on low-cost roads, such as broken stone, gravel, and sand-clay roads, with the idea that the marked improvement might do away with paving, or at least put off the time when paving would be considered necessary on some of these roads.

To ensure stability, the aggregate must be well graded from coarse fragments down to the clay. The aggregate may be broken stone, gravel or sand, with the necessary amount of silt and clay, and is finer than that recommended in usual specifications for road gravel and given above under "Grading," the cohesion of the fragments as well as their carefully graded size imparting to the stabilized road surface its ability to resist disruption by traffic. In practice, proper grading and stability can be obtained more easily with comparatively fine than with coarser aggregates. The gravel and sand provide structural strength and hardness in the stabilized road surface; silt "packs" in the voids and helps in keeping the larger fragments in place; clay acts as cohesive cement. It is generally admitted that the true cohesive agent is not clay alone, but a moisture film assisted by the finer clay particles (clay colloids). Depending upon the moisture content, the degree of cohesion in a soil may be very high or practically zero. An example of the use of moisture film to induce cohesion is the racing course at Daytona Beach, Florida, which is formed solely of perfectly cohesionless, fine-grained sand cemented together temporarily by a film of sea water.

In order to obtain the maximum stability a road surface must not be allowed to become either too dry or too wet. The admixture of a regulated quantity of a deliquescent chemical, such as calcium chloride, maintains the proper amount of moisture at the surface. This salt can absorb moisture from the air, when necessary, and in addition retains the proper

amount of that furnished by precipitation. In dry weather the low vapour tension of the calcium chloride solution retards evaporation from the road, whereas in wet weather, the impervious stabilized surface sheds off water falling upon it.[1]

Calcium chloride has been used for a number of years on ordinary gravel and waterbound macadam roads, with the primary object of preventing the formation of dust on the road surface. In a stabilized road surface, the more important function of calcium chloride is to impart strong cohesion to the structure by retaining the proper amount of moisture, dust prevention being an added advantage. Another advantage resulting from the greater stability of the road surface is a reduction in loss of surfacing material. It has been stated by the Bureau of Public Roads of the United States that the annual wear on gravel roads is equivalent to 0·5 to 1 inch of surfacing material, which, in the case of an 18-foot surface, would be 150 to 300 cubic yards per mile. The use of calcium chloride greatly reduced this loss. The cost of using calcium chloride is estimated in the United States as about equal to the cost of replacing the lost gravel where calcium chloride is not used; the application of calcium chloride, however, ensures the alleviation of dust, whereas a replacement of gravel offers no such assurance. An additional advantage of stabilized road surfaces is a reduction in maintenance work. On the ordinary gravel road surface, there is nearly always a certain amount of loose material called floating mulch. Under the action of traffic, this material is tossed about and would gradually be dispersed to the sides and lost, if not kept on the road surface and uniformly distributed over it by maintenance work. Where traffic is large, daily maintenance is necessary on such roads to keep them in proper condition. On a stabilized road surface, there is no loose material, and daily maintenance is not only unnecessary but even detrimental, as it weakens the cohesion of the surface material and is a serious cause of loss of calcium chloride through dispersion. The best time for maintenance work is immediately after a rain, as the leaching action of water brings the salt down to the lower layers, so that surface manipulation will not disturb it. Dry weather brings the salt up again near the surface by capillary action. Additional maintenance, such as honing every four weeks, is recommended where traffic reaches over 800 vehicles per day.

Calcium chloride is more effective in bare or stabilized road surfaces than in loose surfaces. Maximum effectiveness requires minimum surface disturbance, manipulation, or maintenance. It is also more effective if used in solid form rather than pre-dissolved in water, and if applied to the surface rather than mixed with the surface soil. The amount of calcium chloride required varies with the intensity of traffic and prevailing climatic conditions. Whatever the amount required, better results will be obtained if two or three smaller applications are made at different intervals instead of a single large one. For instance, if 1·5 pounds per square yard be the required amount, it will be preferable to make an application of 1 pound followed by another application of 0·5 pound a few weeks later, instead of applying the whole 1·5 pounds at one time.

[1] For further details regarding soil stability, the reader is referred to publications by the Bureau of Public Roads, United States Department of Agriculture, Washington, D.C.

Near Elmsdale, Nova Scotia, an experimental section of stabilized gravel surface was built in 1932 on the Halifax-Truro highway, which is the most travelled road in that province. Salt (sodium chloride) from the Malagash mines, and local plastic clay were used in the experiment.

Stabilized gravel roads should certainly prove as economical in Quebec as they have been elsewhere, as there is almost everywhere in that province an abundance of the materials required, that is, fine gravel, sand and clay, in fact they are much more common than the kind of coarse gravel generally required for road surfacing according to the ordinary methods. Even glacial drift, or boulder clay, generally considered useless for roads except perhaps for foundations, may find a use as surfacing material, because the average grading of boulder clay, once the oversize stones are screened out, comes closer to the grading of maximum stability than that of gravel or sand. The proper study and combination of two and possibly three different materials, so as to get the desired grading, will incur some expenditure, but the saving in maintenance of the stabilized road surface will more than pay this cost and the public will be provided with a smooth and dustless road surface.

ROAD CONDITIONS

It would be outside the scope of this report to give the condition of all gravel roads examined during the course of the investigation. In this chapter the results obtained in service are given only in so far as they bear any relation to the characteristics of the gravel used. As already mentioned, other causes affect the condition of a road besides the quality of the material used in surfacing, such as method of construction and maintenance, drainage, character of subsoil, amount and character of traffic. Specifications for the construction and maintenance of gravel roads, however, cover the question of drainage and character of subsoil in their requirements for adequate foundations, so that the condition of a road built and maintained according to specification depends mostly on the quality of the gravel and the amount of traffic, and it is sufficient in most cases to take into account these two factors only, in interpreting results obtained in service. In Quebec, gravel roads are under a patrol system of supervision and maintenance. As regards traffic, figures were taken from the 1929 Report of the Quebec Roads Department. A traffic census was taken daily for a period of seven days in the beginning of August, 1929, by the Quebec Roads Department, and numbers given in this report represent the daily average for that period. The traffic reached a maximum during mid-summer, or at about the time the census was taken, so that the daily average for the season would be lower. In this report light or small traffic means traffic up to 150 vehicles a day; moderate traffic, between 150 and 300 vehicles a day; heavy or large traffic, above 300 vehicles a day.

Owing to the extent of the territory covered by the investigation, it may be conveniently divided into three areas: the northern area, including that part of the province north of St. Lawrence river and west of Quebec City; the southern area, including that part south of St. Lawrence river and west of the Levis-Armstrong highway; the eastern area, including that part south of St. Lawrence river and east of the Levis-Armstrong

highway as far as the end of the Gaspe peninsula. Roads in the northern area were examined in the summer of 1929, under normal weather conditions. Those in the southern area were examined in the fall of 1929 and 1930, under normal weather conditions, and in the summer of 1930, with weather unusually dry, and the roads more dusty than in normal weather. The roads in the eastern area were examined in the summer and fall of 1931, under weather conditions drier than usual. Normally the amount of rainfall is greater in the eastern than in the western part of the province. It is lighter on the average in the Ottawa and Gatineau valleys than in other districts.

For the sake of brevity, gravels are referred to by numbers. Their location and ownership are given in Table IV, page 200.

Northern Area

At the west end of the area, in the Ottawa valley, a stretch of road built from west of Chapeau to west of Waltham with gravels Nos. 1 and 2 and carrying light traffic was in good condition where more than one year old, slightly rough where more recently improved, owing to the coarseness and looseness of the gravel. Gravel Nos. 5, 6, and 7 have given good service for several years on stretches of the main river road between Fort Coulonge and Bryson, under light to moderate amount of traffic. A road leading from Portage du Fort to the main highway west of Shawville and surfaced with gravel No. 12 was in good condition and quite smooth. The gravel is sandy but well graded and stands up satisfactorily under the light traffic. Gravel No. 22 recently used in surfacing the side road leading to Norway Bay compacts firmly and should be durable. East of Shawville a long stretch of the main road surfaced with gravel No. 21 was in good condition where more than one year old and where not too corrugated. Traffic on this stretch is as heavy as 450 vehicles a day. Farther east, traffic was still heavier on the main river road and the condition of the road poor, but was said to have been better earlier in the season. Most of the gravels used were not able to stand the heavy traffic prevailing at the time the road was examined, although some of them such as Nos. 27, 28, and 31 proved satisfactory on roads of lesser traffic.

In the Gatineau valley, many sections of roads have been surfaced with rather fine and sandy gravel, owing to the lack of better material. This is particularly noticeable in Wakefield, Aylwin, Wright, and Bouchette townships. In Aylwin and the southern part of Wright townships, the main road crosses a wide sandy tract and requires careful maintenance during dry summer weather, in order to keep the gravelled surface from being disrupted by traffic, which reaches 400 vehicles per day. Coarse and bouldery gravels found farther south, such as No. 35, south of Brennan, and No. 37, between Low and Venosta, could profitably be crushed to suitable size and either shipped or hauled for use in surfacing the road through the sandy tract. These gravels are of only fair quality, but have a good cementing power, owing to their high limestone content, which is a particularly valuable feature in a sandy soil. A short stretch of sand road leading from Danford lake to the main road at Kazabazua recently surfaced with gravel No. 38 and carrying very light traffic was in good condition.

Gravels Nos. 44 and 45 have given good service for several years on sections of the main road between Burbridge and Maniwaki. Deposit No. 44 also holds much sandy gravel, and stretches of road built with this material were not firmly compacted.

The gravelling of the Maniwaki-Mont Laurier road, which passes through sparsely settled land most of the way and carries light traffic, was completed in 1926. A long stretch of the road in Aumond township built with gravel No. 53 and another one in Robertson township built with gravel No. 54 were in very good condition after three years. West of St. Jean, a short stretch recently re-surfaced with gravel No. 55 was rather sandy but otherwise in good condition.

East of Mont Laurier, a stretch of the main road to Montreal maintained with gravel No. 61 was in fair condition under a traffic of nearly 500 vehicles a day. Another stretch of the same road near La Conception recently built with gravel No. 73 was in very good condition under a traffic of over 1,100 vehicles per day. This gravel is slightly clayey, which probably accounts for the ability of the road surface to remain firm and smooth under such traffic. Farther east none of the gravels used stood satisfactorily under the traffic, which reached over 1,650 vehicles at the beginning of the paved portion at Piedmont, although some of them, such as Nos. 109, 110, 111, 112 and 113 are said to have given good service on the main road when the traffic was not so great. Roads of lighter traffic built with gravels Nos. 109 and 113 were in very good condition. No. 113 is very sandy but hard, well graded, and wears well under light traffic, once sufficiently compacted. Gravel No. 119 is similar to 113 but more sandy. A road built with No. 119 along rivière du Nord, northwest of St. Jérôme, and carrying light traffic presented a smooth surface, but did not have the hardness of a true gravel road.

Gravel No. 85 has been for several years successfully used on a stretch of the Hull-Montreal road near Montebello, but its use on the main road has been discontinued, and another one, No. 86, is now being tried. The amount of traffic on this part of the main river road was certainly large, that is, over 300 vehicles per day, although exact figures were not available. Stretches on a road of smaller traffic improved with gravel No. 85 were in good condition. Good results have been obtained in surfacing stretches of the main road near Pointe au Chêne with gravels Nos. 90, 91, and a group of others of a similar kind found in the vicinity. These deposits are small and what is left exposed in the pits is quite likely more sandy than what has already been used. Gravel No. 103 has been used for many years on a long section of the main road between Lachute and Belle Rivière. When examined in 1929, this section was badly corrugated all the way by traffic, which reached 1,500 vehicles per day near Lachute. The road has been subsequently paved by stretches, and in 1933 the pavement was completed as far west as Lachute.

In the southern part of Montcalm county, gravels Nos. 125, 126, and 127 have been used for several years in surfacing roads with very good results. Particularly smooth and firm road surfaces have been built with gravel No. 127 in the clay land south of the deposit. The gravels have proved equally good on sandy soils to the north. A stretch of the main road through Ste. Julienne surfaced with gravel No. 125 and subjected to

a traffic of over 500 vehicles per day was in good condition. No. 135 is a similar gravel, which has been used on the main road west of Rawdon, and proved as satisfactory. This road carries about the same amount of traffic as the Ste. Julienne road.

Good and durable road surfaces have been obtained with gravel No. 166 in the clay land of the southern part of Maskinongé county. More recently gravel No. 167, which possesses much the same characteristics as No. 166, has been used in the same district with equally good results. Traffic on the gravelled roads varied from light to moderate. A stretch of the main road between Beauvallon and St. Alexis surfaced with gravel No. 172 and carrying a moderate amount of traffic was firmly compacted and the surface quite smooth. The road was examined after several days of dry weather. Gravel No. 178 has been used at different times for surfacing stretches of the Yamachiche-Charette road. The road was in good condition where the gravel surface was at least one year old. More recently applied gravel was slow in compacting under the light traffic using the road.

A stretch of the main road near St. Tite in Champlain county improved with gravel No. 183 in 1927 and 1928 stood up well under a traffic of over 350 vehicles per day. The same gravel was used in 1928 for surfacing part of the road between St. Tite and Ste. Thècle. The road which carries a moderate amount of traffic was in very good condition. Gravel No. 185 used in improving the road between Ste. Thècle and Hervey Junction in 1928 made a firm, smooth surface wearing well under light traffic. Sections of the two roads paralleling Ste. Anne river north of Ste. Anne have been surfaced with gravel taken from several river flats and include No. 186. The two roads, which carry light traffic, were in good condition and quite smooth when examined a short time after a heavy rain, but some sections were undoubtedly too sandy. Part of the road between St. Raymond and St. Léonard in Portneuf county was surfaced with gravel No. 193 which was well compacted under light traffic and made a hard and smooth surface.

Southern Area

In the western part of the area, that is, west of Richelieu river, the roads were examined in late summer at a time when unusually dry weather prevailed, so that they were found probably more dusty than under normal weather conditions. Some of the gravels, however, produced a great deal of dust under traffic and roads built with these gravels were constantly dusty when dry. This condition applies particularly to gravels high in dolomite, which are of common occurrence in the western part of the area. Calcium chloride treatment has proved effective in keeping down the dust, but its use has been limited to short sections, mostly through built-up districts.

In Huntingdon county many roads have been improved with gravel in the last few years, and some of them have been gravelled for a good number of years. The gravels in the county may be divided into two types as regards composition: a gravel high in dolomite, which is the more common, and a gravel high in sandstone, found in the high land close to the International border. The dolomite gravel is, as a rule, well graded and makes a smooth road surface, but is only moderately durable and is dusty, on account of the dolomite particles being easily ground up even under

comparatively light traffic. The sandstone gravel holds good binding material in the form of iron oxide but is generally poorly graded. Some of the better graded ones have been used in building firm, well-bound and durable roads. Traffic is comparatively light on most gravel roads of the county, more so on the sandstone gravel roads. Good road surfaces, almost as smooth as rolled broken stone, have been built on the side road between lots 20 and 21, Cons. I and II, Dundee township, with gravel No. 206; on the side road between lots 17 and 18, Cons. III and IV, Dundee, with gravel No. 208; on roads between Cons. VII and VIII, Dundee, and between Cons. IV and V, Godmanchester township, with gravel No. 210; on road between Cons. III and IV, Godmanchester township, with gravel No. 211. These four dolomite gravels, though only moderately durable, are somewhat harder and of better quality than gravels of similar composition found elsewhere in the county. Gravel No. 208 has been in use only a short time and roads built with it were less dusty than older surfaces built with other gravels. A long stretch of the road between Kilbain and Huntingdon surfaced with gravel No. 213 was very dusty and the surface wore rather fast under light to moderate traffic. Of the sandstone gravels, Nos. 223, 226, and 229 have proved especially suitable. A stretch of the road between Huntingdon and Rockburn surfaced with gravel No. 223 was well compacted and cemented under moderate traffic. The same gravel has also been used with good results on other roads of smaller traffic. No. 226 is rather sandy and has given better results on clay soils than on lighter soils. A stretch of clay road in Chateauguay county, which is the continuation eastward of the road between Cons. I and II, Franklin township, improved with gravel No. 226 was in good condition. Sand roads in Franklin township surfaced with the same gravel were dusty and the material had not packed firmly. The road between Russeltown and the International border improved with gravel No. 229 was in good condition, quite hard and fairly smooth, considering the coarseness of the material used.

In Napierville county, sandy gravels have been used for improving roads which are mostly of clay, with good results where the traffic is small. A firm and smooth surface, comparatively free from dust, has been built with gravel No. 244 on the road running south from St. Michel and carrying light traffic. Gravels Nos. 245 and 248 also compact readily and firmly on clay roads, but stretches of the main road through St. Rémi, St. Edouard, and Napierville improved with these two gravels and carrying over 400 vehicles a day were dusty, and the surfacing material wore evenly but fast. Gravel No. 247 has recently been used in surfacing a stretch of the same main road west of Douglasburg. This was in very good condition and was but slightly dusty, in contrast to other sections of the road. It is, however, more of a sand-clay than a gravel surface, and quite likely will wear as fast as other sections. All the gravels are very sandy, but the four just mentioned are generally of better quality than the other few found in the county.

Smooth but dusty surfaces have been built with crushed gravel No. 251 on several roads west and south of Odelltown, in St. Johns county. The greater part of the dust is not the result of traffic wear, but is present in the crushed gravel before it is laid on the road surface. It has been observed that the crushing of a gravel high in dolomite, such as gravel No. 251 and others farther west in Huntingdon and other counties, produces a

great deal of dust. The same observation has been made in the case of crushed stone from dolomite quarries. A remedy sometimes applied when crushing soft gravels is to screen out and discard all the fine. Gravels Nos. 257 and 258 have been used on a number of roads near Ste. Blaise; they consolidate firmly on sand as well as clay roads, wear evenly and are durable under light traffic. A stretch of the main road between Napierville and St. Johns that has been surfaced with gravel No. 259 and carries over 400 vehicles a day looks more like a good earth road than a true gravel road and wears fast. Before being applied to the road, the gravel, which is soft, is crushed, screened over a ¼-inch screen and all material passing the screen is thrown to the waste pile as useless.

In the northern part of Iberville several roads of small traffic have been improved with sandy gravels, such as Nos. 265, 268, 269, and 270. These gravels are, however, too sandy to produce lasting results and, with the exception of Nos. 269 and 270, are generally soft. No. 265 appears to be the least durable of the four. A stretch of clay road through St. Alexandre improved with this gravel was in much better condition than the unimproved part of the road, but wore fast under light traffic and was very dusty. Deposit No. 270 carries streaks of coarse, well-graded gravel besides a great deal of sandy material. In Missisquoi county good results have been obtained with gravels Nos. 276, 279, and 280 on roads of small or moderate traffic. Nos. 279 and 280, however, wear fast under heavy traffic, as judged by stretches of road in and around Cowansville. Other gravels have been used and found unsatisfactory even on roads of small traffic.

A considerable amount of gravel has been used for road purposes from a number of deposits near St. Dominique and St. Liboire, in Bagot county, the more important being listed in Table IV, page 203, from Nos. 287 to 295. All these gravels carry a large amount of friable material, pack and bind readily on the road and have been serviceable, if not durable, under light traffic. Roads surfaced with these gravels were examined during a spell of dry weather and were very dusty. On the main road from St. Hyacinthe to Acton Vale, which carries heavy traffic, 1,000 vehicles per day at St. Dominique, the gravels wear fast and frequent renewals of the road surface are necessary. When examined, the main road was badly corrugated all the way from St. Hyacinthe to St. Dominique, as were other stretches farther east. Sections treated with calcium chloride were in better condition but not free from corrugations. Gravel No. 299 near St. Nazaire has the same characteristics as the St. Dominique and St. Liboire gravels, and has given the same service under light traffic. A stretch of the road leading north from Acton Vale and surfaced with gravel No. 301 was in good condition after one year's service. The gravel makes a firm road surface and wears well under light traffic. Gravel No. 303 has been used very little for road purposes, but should prove even more durable than No. 301, as judged by results of laboratory tests (Table I, page 153, and Table II, page 179).

In Brome county, stretches of the main road at Gilman recently re-surfaced with gravel No. 315 and east of Knowlton re-surfaced with gravel No. 323 were in good condition and the surface quite smooth. Gravel No. 324 has given good service on the road leading north to the Montreal-Sherbrooke highway at Eastman, but has not stood up so well on a stretch

of this highway that carries 1,500 vehicles a day. These three gravels, although of only fair quality, have given better satisfaction than some used in other parts of the county. A stretch of road between Glen Sutton and Dunkin improved with river gravel hauled from the nearby Missisquoi river was in good condition and withstood the wear of traffic better than sections surfaced with bank gravel.

Gravel No. 345 has given good service for several years on roads of small and moderate traffic around Lawrenceville, in Shefford county, and is probably the best wearing gravel in the county. A stretch of road leading south from Waterloo and carrying well over 300 vehicles a day was in good condition one year after having been re-surfaced with gravel No. 336. Gravel No. 333 consolidates firmly and makes a durable road under light traffic, as judged by results obtained on several roads around Roxton Falls. A smooth and firm surface has recently been built with gravel No. 343 on a stretch of road between Waterloo and Ste. Anne that carries a moderate amount of traffic. Older surfaces on the same road showed that the gravel wears evenly but rather fast.

In Drummond county, gravels Nos. 350 and 353 have given good service on several roads around South Durham and Ulverton, carrying light and moderate traffic. Gravel No. 356 used on several roads around Wickham wears well under light traffic but is dusty after being in service for some time. Smooth and firm surfaces have been built with gravel No. 358 on several roads of small traffic, but the material grinds up fast on the main road near Carmel, where it is subjected to fairly heavy traffic. On a stretch of the same road carrying somewhat smaller traffic, gravel No. 359, though rather slow to consolidate properly, has proved fairly durable.

Stretches of the main road between Ayers Cliff and Coaticook in Stanstead county that carried a moderate amount of traffic, were surfaced with crushed gravels Nos. 362 and 363 and were in good condition after one year of service. Gravel No. 375 made a firm and smooth surface on roads of small traffic. Several gravels, including No. 379, have been used in surfacing stretches of the Montreal highway west of Magog. Heavy traffic, reaching 1,500 vehicles a day, is the chief cause of the poor condition of this section of the highway.

Gravel from the many deposits along St. François river in Sherbrooke and Richmond counties has been used for a number of years in the improvement of the main river road, for which the traffic census gives close to 1,200 vehicles a day at Bromptonville. When the road was examined in the fall, traffic was not so great. At that time the road was in fair condition on the average, but rather soft in many places after rains, owing apparently to the surfacing material being too fine or sandy. On account of the many gravels used and the difficulty of identifying them on the road, it was impossible to judge and compare their quality from the main road service tests alone. It may be said, however, that the gravels are generally fresh and hard, but many are interstratified with much sand, which it is difficult to discard without screening, so that the excess of sand adversely affects the grading and quality of the material on the road. The more important ones are listed in Table IV, pages 204 and 205,

under Nos. 386 to 401, of which Nos. 386, 387, and 389 are particularly good, because harder and less sandy than the others. A good road surface has recently been built with crushed gravel No. 403 on a long stretch of the main road between Danville and Kingsey. Most gravels in the district are unsatisfactory because either too sandy or too bouldery.

The gravels of Compton county carry much friable, slaty, or schistose metamorphic rocks and wear fast, particularly on main highways. Traffic on the three main highways passing through the county is given as between 450 and 900 vehicles a day, but was much smaller when the roads were examined in the fall. Gravels from the deeper deposits, being less friable because less weathered, gave better results than those from the shallower deposits. Good and smooth surfaces were observed on the main road near Bury where gravels Nos. 418 and 419 were used. A stretch of the main road northeast of Lingwick surfaced with gravel No. 421 which is from a comparatively shallow deposit, was found in good condition and particularly smooth, but not hard. Similar conditions were observed elsewhere with other gravels from shallow deposits; a large proportion of the gravel fragments crumble under traffic and the road surfaces, though smooth, are hardly any firmer than those of good earth roads. Gravel from a number of rather shallow deposits, similar to No. 427, has been used recently in surfacing the main road between East Hereford and the International Boundary and good results were obtained. These gravels are well graded, but apparently rather soft. In Wolfe and Megantic counties difficulty is experienced in finding good road gravels. In Megantic, river gravels, such as Nos. 451 and 459, have lately been used where available in place of bank gravels, which were becoming scarcer with the increasing road requirements. The river gravels, particularly on main roads, have withstood traffic wear more successfully than the bank gravels. Good results have been obtained with river gravel No. 451 on a stretch of the main road east of St. Ferdinand. The river gravel is nowhere common and is easily available only at low water level, usually in late summer, when it is hauled and stored at some convenient points along the road to be used when needed.

The gravel deposits in Frontenac county hold a rather high proportion of soft fragments and there is a great deal of bouldery, sandy, or otherwise poorly graded material interstratified with the better graded gravel. Those around lake Megantic are somewhat more uniform in grading than most, and have been much developed for road gravel, particularly Nos. 473, 475, 479, and 480. A good road surface has been recently built on a stretch of the main road between lake Megantic and St. Hubert with gravel No. 480. The Beauce county gravels resemble those of Frontenac county as regards composition, softness, and lack of wearing quality. On the main road paralleling Chaudière river, gravel has been used for many years. As a result, much of the better graded material close to that highway has been excavated and what is now left in the old pits is of inferior quality. Well-graded gravel was seen in the pit banks of deposits Nos. 492, 493, and 499. Gravel No. 492 is also harder than the average, apart from river gravels, such as Nos. 501 and 508. The river gravels are available at low water level at several places along Chaudière river upstream from Valley Junction, and have lately been used on the main road, which carried a traffic of 1,500 vehicles per day between Ste. Marie and St. Georges. When examined in

late summer, this section was generally in poor condition, badly corrugated at many places, but stretches surfaced with river gravel fared better than where bank gravel had been used and some stretches were in decidedly good condition.

Eastern Area

Road improvement with gravel has been confined to the more important routes of travel over most of this area. It will, therefore, be more convenient in reviewing road conditions to alter the plan followed in the northern and southern areas and to deal with the condition of each gravelled road separately and in their order of relative importance, instead of proceeding by districts or counties.

The Levis-Rivière du Loup road follows the south shore of St. Lawrence river. It is paved with bituminous concrete from Levis to Montmagny and gravelled from there to Rivière du Loup. Paving work is being continued farther eastward and will eventually reach Rivière du Loup. Over the gravelled part, traffic was from 450 in the eastern end to over 1,000 vehicles a day in the western end, according to the 1929 census of the Roads Department. When examined in the summer of 1931, the gravelled road was generally in poor condition, and corrugated most of the way. The eastern end, where traffic is comparatively smaller and the average quality of gravel better, was in better condition than the western end. The lack of good gravel, as well as the heavy traffic, is responsible for the present condition of the road. From Levis to the border between L'Islet and Kamouraska counties, there are many small and shallow deposits of gravel, most of which contain a large proportion of soft shale or slate, are well graded and make particularly smooth road surfaces, but wear fast under heavy traffic, and some of them readily crumble even under light traffic and form what resemble sand-clay rather than gravel roads. On roads of small traffic satisfactory results have been obtained with gravel No. 545 west of Beaumont, with No. 546 southeast of Beaumont, with No. 547 southeast of St. Vallier, with No. 594 southeast of St. Jean, and with Nos. 601 and 602 southwest of St. Roch. The percentage of shale or slate is lower in Nos. 545, 594, and 602 than in the others.

In Kamouraska county, gravels Nos. 630, 637, 638, 639, and 640 are among the best between Levis and Rivière du Loup, apart from a few deposits worked solely for concrete aggregate, such as Nos. 619 and 623. They wear rather fast on the main road, but have proved durable on roads of smaller traffic. A stretch of the side road running from the river road to St. Alexandre and surfaced with gravel No. 640 was in excellent condition as regards smoothness and hardness. Other gravels in this county are either soft or sandy, the latter being devoid of binding power and corrugating badly under the fast traffic of the main road. Beach gravels, which are available at a few places only and in limited amount, have been in use for a comparatively short time. So far they have proved to be as good as the best local bank gravels and should be more durable because of holding less soft fragments. The paving of the main road as far as Rivière du Loup will do away with the expensive maintenance of the present gravel surface, and will solve the problem of getting suitable material. Except for a few large ones, the gravel deposits in proximity to the main road are

becoming rapidly depleted. There is, on the other hand, an enormous amount of stone in the steep ledges, ridges, and knolls found almost everywhere. The fracture planes in the rocks and steep faces of the exposures make quarrying easy, with little stripping. The rocks consist of quartzite and quartzitic-sandstone, and when crushed make a good aggregate for bituminous pavements.

The St. Lawrence River road between Rivière du Loup and Ste. Flavie carried 500 vehicles a day, with larger traffic near the towns of Rivière du Loup and Rimouski. The road was on the whole in fair condition. On both sides of Rivière du Loup, the road is badly corrugated in places and maintenance is a difficult problem on account of the volume of traffic and poor quality of gravel. A stretch of road between Isle Verte and Tobin surfaced with gravel No. 686 was somewhat rough on account of the material not being sufficiently consolidated, and another stretch near Tobin surfaced with gravel No. 688 was decidedly corrugated. Gravel No. 686 has proved durable on the side road leading from the river road to St. Eloi, which carries light traffic. The gravel, however, takes long to compact. No. 688 has also been used with good results on roads of smaller traffic. From Trois Pistoles to St. Fabien, the road though fairly smooth is soft and wears fast. Gravels along this section are quite sandy and most of them are made up of friable pebbles. No. 689, composed of harder material, stood up under traffic better than the others, the difference being particularly noticeable when the road was wet. East of St. Fabien, gravel No. 690 was firmly consolidated and wore evenly but fast. A stretch surfaced with gravel No. 691 was in good condition in places, badly corrugated in others. These two gravels were found more satisfactory than others used on the St. Fabien-Rimouski section. Gravel No. 693 used on the side road leading south from Bic was well compacted and made a hard, even-wearing surface. From Rimouski to Ste. Flavie, the river road is surfaced with beach gravel, which can be obtained anywhere along the shore from Father Point eastward, and is in very good condition, with the exception of a three-mile stretch from the town limits of Rimouski to Rimouski Wharf, where the traffic is larger. Under normal conditions this stretch can be maintained in proper shape with beach gravel, but during a prolonged spell of dry weather late in the summer, when traffic was at its height, considerable difficulty was experienced in keeping the gravel from being thrown to the sides by the fast-moving vehicles, and the road was eventually covered with a thin layer of clayey sand as binding medium, in order to keep the gravel in place.

The Rivière du Loup-Edmundston road is gravelled all the way. Traffic was 380 in the northern end and 680 vehicles a day in the southern end near the New Brunswick border, but was greater than either of these two figures for a few miles outside of the town limits of Rivière du Loup. The road was in very good condition, except on a four-mile stretch of straight, level road just outside of Rivière du Loup. This stretch, part of which passes through a peat bog, was surfaced with gravel No. 670, and was in poor condition, badly corrugated and very dusty. Another stretch of the same road farther south surfaced with the same gravel was in much better condition, less dusty, and corrugated only in places. The same gravel used on a stretch of the road leading from the main road to St. Modeste and

carrying light traffic was firmly compacted, wore evenly, and the road was in good condition. Good gravel is fairly common along the main road as far as the New Brunswick border. Particularly good stretches of road have been built with gravel No. 655 between St. Honoré and Vauban, with No. 658 west of St. Louis, with No. 659 west of Cabano, with No. 660 at Notre Dame, and with No. 664 between Ste. Rose and the Provincial border. Gravel No. 655 is slightly clayey, compacts firmly to a smooth road surface that shows good wearing quality and is but slightly dusty. The long stretch of road near the Provincial border surfaced with gravel No. 664 and other gravels of the same character was in excellent condition, dustless, and as smooth as a good pavement. Owing to the high slate content of these gravels, the condition of the road may be much influenced by weather.

The Ste. Flavie-Matapedia road, entirely surfaced with gravel, carried on the average over 300 vehicles a day, with smaller traffic between Ste. Florence and Matapedia, where the country is for the most part unsettled. The condition of the road is on the whole very good. Gravels are fairly common throughout the Matapedia valley, but scarce from lake Matapedia to the St. Lawrence. They are as a rule well graded, consolidate readily on the road, and make smooth surfaces. With the exception of a few deposits, however, roads built with these gravels soften appreciably when in a wet condition, and wear fast even when dry. This is due mostly to the large proportion of soft shale or shaly limestone common to nearly all these gravels. Mention will briefly be made of the gravels that have been more serviceable and particularly more durable than others. Deposit No. 709 holds, in its lower part, gravel which has been used with good results on a stretch of the main road near Ste. Angèle. A stretch of the same road surfaced with gravel from the upper part of the same deposit, which is of different composition and softer than the lower gravel, wore fast and was dusty. Gravel No. 713, which lies close to 709 and is probably continuous with it, has not yet been used on the main road, but a good and hard surface has been built with it on a side road crossing the deposit. A long stretch of road near St. Moise recently surfaced with gravel No. 714 was in good condition and quite firm after a rainy day. Gravel No. 718 has recently been used on a stretch of the newly improved colonization road between Amqui and Matane. The road examined after a rainy day was well compacted, smooth and firm. On account of the short time of service and light traffic passing over the road, no conclusion can be drawn as to the wearing quality of the gravel, but judging from the small amount of friable pebbles that the material in the pit holds, it should be durable. A section of the road southeast of Amqui improved with gravel No. 719 was slightly rough but otherwise in good condition and was less adversely affected by weather changes than stretches covered with other gravels. Sections surfaced with gravels Nos. 723 and 725 near Causapscal were smooth, withstood well the main road traffic wear and were not affected by rainy weather. No. 725 in particular, which was used in Causapscal, consolidated firmly and showed good wearing quality under the village traffic, which is greater than the average for the main road as given above. The section of the main road, both sides of Sayabec, which is approximately at the height of land, was in poor condition and even slightly muddy when

wet, owing to the lack of suitable material. Between Ste. Flavie and St. Joseph, the road is surfaced exclusively with beach gravel hauled from the shore at Ste. Flavie, and is in good condition irrespective of the weather.

The road along the north shore of the Gaspe peninsula runs through fairly level land from Ste. Flavie to Ste. Anne. From there to Gaspe the country is very hilly and long grades are numerous, some of them fairly steep. The census taken by the Roads Department in 1929 gives a traffic on this road of 350 vehicles a day near Ste. Flavie and 200 vehicles per day near Mont Louis, which is in the hilly section of the road. On account of the rapid increase in traffic over this road during the past few years, the traffic in 1931 may be conservatively estimated as at least double that of 1929. The road, surfaced entirely with beach gravel, was in very good condition, particularly in the hilly section, which was more recently improved and upon which traffic proceeds at reduced speed, down grade as well as up grade. Bank gravel is very scarce along the shore, being found only at the mouth of some of the larger rivers, and is very poorly graded from the road-building standpoint. Beach gravel, on the other hand, is available almost anywhere between Ste. Flavie and Cap des Rosiers, is fairly uniform in coarseness and composition, and made up of quartzite, quartzose sandstone, and slate, the slate seemingly keeping the road surface properly compacted and bonded. It has given good results, except in a few places between Metis and Matane, where it is made up largely of hard quartzose rocks, and difficulty was experienced during a long, dry spell of weather in the latter part of the summer of 1931 in having the gravel properly compacted on the road and keeping the surface from ravelling under traffic.

On the south side of the peninsula the land in the immediate vicinity of the shore is either fairly level or gently undulating and grades on the main road are for the most part easy. The volume of traffic, particularly local traffic, is larger than on the north shore. The road is surfaced with beach gravel wherever it can be obtained, or all the way except between Broadlands and St. Jean, around Gaspe bay and a few other short stretches. The road is on the whole in very good condition, with beach gravel stretches better on the average than those surfaced with bank gravel, except a few places where the beach gravel used was too coarse and carried but little sand, with the result that it did not consolidate sufficiently, and the road surface was uneven, especially on clayey subsoil. Beach gravel is not so uniform as along the north shore, but except where too coarse material was used, it has made good and durable road surfaces. No. 763 is a large bar of particularly good hard beach gravel, and material of any desired coarseness is available right at the surface. On the section between Broadlands and St. Jean, where bank gravel is almost exclusively used, gravels Nos. 733, 736, 737, 739, and 740 have given particularly good results. Deposit No. 733 has been just recently developed, and the gravel should give good service, judging from the present condition of a stretch of the main road at Broadlands improved with this gravel and also from the results of laboratory tests (Table I, page 167, and Table II, page 193). Deposit No. 736 is sandy and also holds much poorly graded material; the better graded part, although sandy, shows good wearing quality on the

road. Nos. 737 and 739 are hard gravels, which do not consolidate firmly, but are quite durable. During a prolonged spell of dry weather in late summer, it was found necessary to add clayey sand as a stabilizing and binding medium on some stretches where the surface material was easily loosened by fast-moving traffic. No. 740 made a firm and smooth surface. The side road from Cross Point north, improved with gravel No. 735, was in very good condition when dry, but lost some of its firmness after rainy weather, owing to the weakening of the clayey binder. Farther east, near Bonaventure, a stretch of the main road surfaced with No. 751 was in good condition and firm after several days of rainy weather. Good road surfaces have also been built with the same gravel on roads of smaller traffic. Gravel No. 753 is coarse and bouldery but if crushed to proper size should prove a good and durable road material, as it consolidates quickly and firmly. A stretch of the side road leading north from the main road at Shigawake just improved with this gravel was in good condition, well cemented but rather rough, owing to the coarseness of the material. Around the Gaspe bay, there is no beach gravel and even bank gravel is scarce. Some of the gravels used around the bay hold much friable sandstone, which crumbles readily under traffic, and the sand-clay-like surface, though smooth, is dusty and wears fast.

In the southwest part of the area, there are a number of roads that have been recently improved over their entire length. Some of them are part of the Provincial system of highways, others are secondary roads. One of these roads runs from St. Georges to St. Pamphile, in a direction approximately parallel to the St. Lawrence River road, and the others lead off at different points from the St. Lawrence road inland to near the International border; they are the St. Henri-Ste. Germaine, Beaumont-St. Philémon, St. Vallier-St. Camille, L'Islet-St. Adalbert, St. Jean-St. Pamphile and St. Alexandre-Rivière Bleue roads. The St. Georges-St. Pamphile road passes through high land all the way, almost level in Bellechasse and Montmagny counties, gently rolling with an occasional fairly steep grade in Dorchester and L'Islet counties. The St. Henri-Ste. Germaine road follows level land to Ste. Malachie station, then passes rather abruptly into the high land. The other roads run through level land for only a few miles after they leave St. Lawrence river, and then pass gradually into the high land. Throughout the high land, grades are almost continuous and some are fairly steep along the St. Henri-Ste. Germaine, Beaumont-St. Philémon, St. Vallier-St. Camille roads, and at both ends of the L'Islet-St. Adalbert road, whereas longer and gentler grades, with occasional level stretches are encountered along the St. Jean-St. Pamphile, St. Alexandre-Rivière Bleue roads and the centre part of the L'Islet-St. Adalbert road. The northwest slopes are as a rule steeper than the southeast slopes, owing to the general southeast dip of the country rock.

In the more undulating parts of the southwestern end of the area, it is the usual practice to haul road gravel in winter and stock it in piles at the higher points along the road, so that when road work is started in the spring, only a short down-hill haul is necessary to bring the material where needed. There are several advantages to this. Most of the deposits are situated along streams in valley bottoms, with steep up-hill grades from deposit to road. In many cases the land around the deposits is saturated with water

in late spring and early summer, making hauling almost impossible at a time when gravel is most urgently needed. In winter the deposits are more easily accessible, and the hauling is done through fields along lines of easy grade, enabling larger loads to be carried. Labour also is more readily available in winter. On account of the heavy snowfall throughout the territory, however, the work of clearing the pits from snow after each storm is a serious drawback.

The St. Georges-St. Pamphile road carries light traffic, except near St. Georges where traffic is over 300 vehicles a day. The road is a Provincial highway but when examined in the summer of 1931 had not yet been built all the way up to the standard for that class of road as regards sub-base grading and drainage, and width of travelled way. The surface in some of the steep grades encountered in L'Islet county was somewhat rough, owing to rain water running over the surface in places, and washing away the fine material. Between the Beauce-Dorchester county border and Ste. Justine, the gravel is loose at many places, wears rather fast, and the road is dusty. There is very little gravel found along this section, and most of it is poor. Calcium chloride applied on some stretches through built-up districts greatly improves conditions in keeping down the dust and holding the gravel in place. A four-mile section between Ste. Rose and the road leading to Ste. Germaine was improved with partly disintegrated slate, loosened from outcrops and broken up at the same time by ploughing along the direction of lamination, the lamination plane being almost vertical. This stretch was in excellent condition, smoother and less dusty than any gravel surface, but under heavy traffic the material would probably wear faster than a good gravel. Farther east the road is in good condition, and most of the gravels used, although rather soft, wear evenly and not too fast under the light traffic prevailing on the road. The poor condition of a stretch of the road surfaced with gravel No. 614, between St. Adalbert and St. Pamphile, was largely due to bad drainage combined with steep grades.

The only unimproved stretch on the St. Henri-Ste. Germaine road had just been surfaced with gravel when this road was examined in the summer of 1931. Rather coarse gravel from deposit No. 540 was used, as is the usual practice in the first improvement of an earth road, the coarse material serving as a foundation course for further improvement with finer gravel. Outside of this newly improved portion, where the gravel was still loose, the road, which carried light traffic, was in good condition, but wore fast between St. Henri and St. Anselme, where traffic is larger than farther south, and where the gravels used, Nos. 522 and 529, carry much soft slate or shale. Stretches near St. Léon, surfaced with soft schist gravels, were in fair condition but hardly firmer than good earth roads when examined after a heavy rain. Gravels Nos. 533, 537, and 540 have withstood traffic wear more satisfactorily than others. A section of the road between Ste. Claire and Abenakis, surfaced with gravel No. 533 and others taken from a group of deposits lying between these two places, was almost worn after five years' service but still quite smooth and in good condition.

The Beaumont-St. Philémon road, which carried heavy traffic as far south as St. Gervais, and rather small traffic from there to St. Philémon,

was in good condition all the way, but wore fast and was dusty in the low level land between Beaumont and St. Gervais, where the gravel is soft and shaly, though well graded. On a section of the road adjoining the main river road, and surfaced with gravel No. 546, the gravel fragments crumble readily under traffic and the smooth road looks like a sand-clay road. Throughout the higher land to the south the road is in excellent condition and the gravels of good quality, although somewhat soft, due to the large amount of more or less friable schist that they hold. Particularly good surfaces were obtained with gravel No. 556 at St. Damien and No. 564 west of St. Philémon. A stretch built with gravel No. 554, which is softer than others, was in excellent condition, almost as smooth, dustless, and impervious as a bituminous surface, but was said to soften considerably during the spring thawing.

Traffic on the St. Vallier-St. Camille road reaches nearly 450 vehicles per day between St. Vallier and St. Raphael, and is rather light farther south. The road is in good condition, except for several miles around St. Raphael, where the surface, though fairly good, is corrugated in places, loose in others. This is due, in part at least, to the irregular grading of the local gravels, which are made up of large pebbles and sand with but little intermediate-size fragments and take long to consolidate properly on the road. Gravel No. 559, though not exempt from this defect, is better graded than the others. Near St. Lawrence river, gravel is similar to that in other parts of the low land, being made up mostly of soft shale. The road surfaced with gravel No. 547 is good and smooth but wears fast and is somewhat dusty. The gravel has a deeper red colour than elsewhere in the low land and is said to stain vehicles when the road surface is wet. Very good stretches of road were observed on the higher land, particularly around St. Philémon, where gravel is of common occurrence for miles east and west of that place, although not all of it is equally suitable. The better phase, represented by No. 565, though only of moderate hardness, makes a smooth road that remains firm and gritty even when wet.

On the St. Jean-St. Pamphile road, traffic reaches 250 vehicles per day between St. Jean and Ste. Perpétue, and is small farther south. From St. Damase, the road runs through woods as far as Tourville, and through sparsely settled land farther on, apart from the two villages of Ste. Perpétue and St. Pamphile, so that over most of the way it is not practicable to go far from the road in search of material, because of the difficulty of hauling it. All gravels used on the road were sandy, lacked binding quality, and remained more or less loose under traffic. The road was slightly corrugated and was dusty at many places. Gravel is particularly scarce near St. Pamphile, where, according to the road patrolman, all the cleared up land has been well searched for gravel and only a few small deposits of sandy gravel found.

The L'Islet-St. Adalbert and St. Alexandre-Rivière Bleue roads traverse wooded or sparsely settled country over most of their way and carry light traffic. Both roads are in good condition, but some of the gravels used are very sandy and, though satisfactory under present conditions, would not do so well under larger traffic. The thickly wooded country and comparatively small amount of gravel needed make it impracticable and unnecessary to go beyond the immediate vicinity of the road for

material, but as the land becomes more opened up, other and probably better deposits will be developed. Deposits of good gravel have been worked in the settled part at both ends of these two roads. On the L'Islet-St. Adalbert road, gravels Nos. 589 and 609 have given good and long service. Both are rather sandy, and No. 609 takes long to consolidate under the very light traffic prevailing where the gravel was used. On the St. Alexandre-Rivière Bleue road, a stretch near the main river road surfaced with gravel No. 640 was in excellent condition, and another stretch nearer to the river road and surfaced with No. 639 was also in very good condition, although slightly corrugated in places. Farther south, gravels Nos. 644, 645, 646, and 649 have proved durable under the very light traffic using the road. No. 649 takes long to compact properly.

DESCRIPTION OF DEPOSITS

Over 750 deposits were examined, about half of which are described in the following pages. The deposits left out are as a rule of very small size, hold material of inferior quality, or are about exhausted. A number of deposits, in which excavation was started in good gravel but has been extended into less suitable material, are also described, unless the material left in the deposit is known to be as poor as what is exposed in the pit bank. In sampling deposits for laboratory testing, the same general rule of including only the more important ones was also followed. Some large deposits, however, were not sampled, on account of the difficulty of obtaining a representative sample. On the other hand, it was deemed advisable to sample a number of deposits holding gravel of doubtful quality, only some of which are described in these pages.

On account of the large extent of the territory covered, the wide variations in the distribution and quality of the gravels in the different parts of the area, and the number of deposits dealt with, it is thought best to divide the subject according to counties. The description of the more important deposits in each county is preceded by a statement giving the occurrence, distribution, and general character of the gravels. The location and owner's name of the deposits described or tested are found listed in Table IV, page 200. A number of counties bordering St. Lawrence river are not referred to because, the subsoil being marine clay, gravel is either absent or very scarce. The small deposits occasionally found along streams become depleted soon after being uncovered and worked.

Pontiac County

The investigation work covered that part of the county bordering Ottawa river, from Chicester township to the eastern limit of the county, and extending up to 7 miles inland.

Gravel deposits are fairly common between Vinton and the eastern border of the county, and scarce west of Vinton, particularly so west of Chapeau, where the surface soil for miles consists of sand, probably a continuation of the Petawawa sand area south of Ottawa river. The country west of Vinton, apart from a narrow strip along Ottawa river, is thickly

wooded, and prospecting along the several streams emptying into the Ottawa would be likely to reveal workable gravel deposits within hauling distance of the main road.

Few of the deposits carry high-grade material, but several are of particular importance on account of their size and the ease with which the gravel can be excavated.

All deposits examined occur as isolated patches of limited area, but some of them form knolls up to 75 feet in height and carry a considerable amount of gravel. In nearly all the larger deposits, the coarseness of the gravel varies a great deal from place to place. Where there is a high proportion of large hard stones, such as in Nos. 1, 2, 16, 30, and other smaller deposits, passing the run of the pit through a crusher would improve its quality and make use of the oversize that otherwise would go to the waste pile.

1. *Lot 9, Con. I, Chichester; near where road to Chapeau joins Provincial highway.*

The deposit is flat-lying and may be of large size, as there are surface indications of gravel over an area of several acres. The excavation having a maximum depth of 20 feet does not reach the bottom of the deposit. The gravel varies much in coarseness, is generally coarse and bouldery, and carries pockets of unsorted glacial drift. Pebbles of sample No. 1 taken from rusty gravel at a depth of 6 to 10 feet, had a percentage of wear of 16·5 (Grading A) in the abrasion test. It is the only easily available gravel for miles west of Chapeau and has been used with good results in the improvement of the river road following its recent inclusion into the Provincial system of highways. Crushing the gravel would improve its quality as surfacing material.

2. *Lot 1, Con. I, Chichester; ⅓ mile west of intersection of Provincial highway with township line.*

In a large pit, 25 by 100 yards in area and up to 40 feet in height, dug in the steep slope of a knoll facing Ottawa river the bank was largely concealed behind talus when visited. In the upper bank the gravel is uniformly coarse and bouldery; finer clayey gravel is seen exposed at one place near the bottom of the pit. The large amount of fresh gravel easily available with but little stripping would make it advisable to improve its road-surfacing quality by crushing.

5. *Lot 1, Con. I, Mansfield; ½ mile northwest of intersection of Provincial highway with township line.*

The deposit lies in low level land and is of unknown extent. Two shallow excavations now aggregate 4,700 square yards in area and have an average depth of 5 feet. Bad drainage prevents deeper digging. The gravel is more or less weathered throughout the exposed part, uniformly well graded, and carries 40 to 45 per cent of sand and no boulders. It has given good results as a surfacing material on the main highway but is not fresh enough for use as concrete aggregate. Pebbles had a percentage of wear of 17·0 (Grading A) in the abrasion test.

6. *Lot 13, Con. V, Litchfield; ¼ mile southeast of Goldwin.*

7. *Lot 21, Con. IV, Litchfield; at Campbell's Bay.*

Both Nos. 6 and 7 are large deposits similar in outline and character. They occur as steep knolls which are part of a bluff facing Ottawa river. Large pits in the form of side-hill[1] cuts, up to 75 feet in height, have been opened in both deposits, and show gravel that varies in coarseness, but is generally coarse and somewhat bouldery. Apart from the material close to the surface of the deposits, the gravel is free from weathering, and half of the pebbles is made up of fresh limestone and dolomite. Thick layers of gravelly sand (approximately 75 per cent sand) are exposed in part of the lower bank of deposit No. 7. Although any size gravel can be obtained by digging at the proper place, crushing and screening would be the better and more economical plan in large-scale development work, as all the oversize would thus be utilized. The size and shape of the deposits make them particularly favourable for extensive development because, on account of the height of bank, comparatively little stripping would have to be done. Pebbles of sample No. 7 taken in fresh gravel had a percentage of wear of 11·2 (Grading B) in the abrasion test.

13. *Lot 19, Con. I, Clarendon; ⅔ mile west of junction of Provincial highway with road to Portage du Fort Station.*

A large shallow pit, 4 to 5 feet deep, dug in a low-lying deposit, which is part of a large flat bordering Ottawa river, shows sandy gravel interstratified with thin sand layers. It is on the whole too sandy for road use. The deposit apparently covers a large area, but the gravelly part does not extend below the present pit depth.

16. *Lot 9, Con. VI, Clarendon; just west of Shawville.*

Gravel occurs in the lower part of the south slope of a large ridge of boulder clay trending east and west. The gravel is made up of about 15 per cent boulders, 55 per cent pebbles, and 30 per cent sand, but coarseness and grading vary from place to place. The gravel pocket looks about exhausted, but more gravel is said to occur towards the crest of the boulder clay ridge. The pit which has now a 30-foot face was originally opened in finer gravel, and as the excavation proceeded farther into the ridge, coarser material was dug. It is now thought too coarse and bouldery for use without crushing. Another obstacle to further development is the thickness of overburden, which reaches 5 feet.

18. *Lot 7, Con. V, Clarendon; 1 mile south of Shawville.*

The deposit holds much more sand than gravel. A large pit in the steep bank of a brook shows sand interstratified with thin layers of gravel,

[1] The term "side-hill" is found convenient to use in describing the shape of excavations opened in sloping ground, and does not necessarily mean the side of a hill. In excavations opened in level ground, the pit bank is of about the same height all around, whereas in side-hill excavations the height of bank gradually increases from the down-slope to the up-slope side of the pit. In side-hill cuts there is practically only the up-slope bank.

the whole very fresh and clean. Much of this material has been used as aggregate in concrete works with good results. The opposite bank appears to be more gravelly, as judged from several shallow test pits dug by the owner.

20. *Lot 1, Con. IV, Bristol; at the intersection of Provincial highway with township line.*

The deposit is in the form of a flat-topped ridge. The bank of an excavation, 1,500 square yards in area and from 7 to 18 feet in depth, is now largely concealed behind talus. Sample No. 20, taken above the talus, at a depth of 1·5 to 3·5 feet, represents coarser material than the average of the exposed bank, which is on the whole very sandy. Although the volume excavated is small compared to the size of the ridge, the amount of gravel of suitable coarseness for roads remaining in the deposit is probably small.

21. *Lot 6, Con. IV, Bristol; ¼ mile southeast of where Provincial highway crosses Silver brook.*

A large excavation, oval in outline, cuts through part of the flat top of a low ridge trending northwest-southeast, and measures 45 by 95 yards, with a maximum depth of 40 feet. The gravel deposit proper is in the shape of a steep-sloped ridge or knoll and is overlain by sand, the latter in the form of a flat-topped ridge, so that the thickness of sand cover varies from 2 feet at the crest of the gravel ridge to 10 feet and more towards the foot of the slopes. The gravel is coarse and bouldery at the northwest end of the pit, and decreases gradually in coarseness towards the other end, where it is replaced by sand, so that any desired size of material can be obtained by selection. An abrasion test run on pebbles of sample No. 21, which was taken at a depth of 7 to 10 feet, gave a percentage of wear of 21·5 (Grading A). Sample No. 21 represents the coarse material at one end of the pit; sample No. 21a was taken in fine and fresh gravel overlain with 10 feet of sand in the southwest bank; sample 21b is fine sand from the southeast end. The low result obtained in the mortar test on sample 21b (Table III, page 195) is due to the fineness of the sand, over 70 per cent of which passes through the 28-mesh sieve. The coarser sand and gravel are undoubtedly suitable as aggregates in concrete mixtures. There is a large amount of both gravel and sand available, but the removal of the weathered and useless sand covering the more suitable material increases the cost of winning.

22. *Lot 8, Con. III, Bristol; along side road ¾ mile northeast of Norway Bay.*

The deposit is almost flat-lying and of unknown extent, but probably covers at least 2 acres, as judged by a very slight rise of the surface over that area. A small trench-like pit, reaching a depth of 13 feet at its centre, shows coarse and bouldery but otherwise well-graded, fresh, and hard gravel. The small amount used so far on local roads has given good results. Boulders make up about 10 per cent of the whole and are mostly confined

to the upper part of the pit bank. Screening out the larger stones common in the upper bank hampers development work, but the quality of the gravel would make it worth crushing. Owing to its low situation, the gravel should be used preferably on the river road and other local roads, so as to avoid up-grade hauling towards the north.

26. *Lot 9, Con. VII, Onslow; at fork of roads.*

Irregularly graded, loose gravel is seen in a pit 2,600 square yards in area and 15 feet in average depth. The gravel is coarse and bouldery at one end of the excavation and fine and sandy at the other. The coarser material runs about 5 per cent boulders, 65 pebbles and 30 sand, and the finer is at least 80 per cent sand. Gravel for road use is now taken from pit No. 27 a short distance to the northwest, where the material is better graded. Both pits are in the same gravel deposit, which is part of a large sand area and in places is thickly covered with sand.

27. *Lot 8, Con. VII, Onslow; near fork of roads.*

The deposit at this place slopes steeply south and a large side-hill excavation, 1,700 square yards in area and 50 feet in maximum depth shows well-graded gravel. The gravel in the upper 10 feet of the bank is all more or less weathered. Farther down, the bank is talus-covered. Fresh, hard gravel is seen in the bottom of the pit. Sample No. 27 was taken at a depth of 2½ to 5 feet, in partly weathered gravel with a high proportion of soft stones. Sample No. 27a is fresh, medium-fine sand taken at the edge of the deposit. The gravel is well graded for road purposes, but the great depth of weathering is a serious disadvantage. The low results obtained in the mortar test (Table III, page 195) are probably due to the mica and weathered grains contained in the sampled material.

28. *Lot 22, Con. VII, Onslow; near line of Con. VI.*

The deposit occurs at the foot of a syenite hill and is beachlike in form. It is of unknown extent and apparently shallow, as it lies between syenite outcrops, and the rock is also seen in places in the bottom of the pit, which averages 6 feet in depth and is 1,500 square yards in extent. The gravel is medium coarse throughout and made up of half pebbles and half sand. Over 75 per cent of the pebbles is gneiss. Although of rusty colour, the gravel is not too weathered and is fairly hard. It has proved satisfactory on the road between lots 21 and 22, Con. VI, which carries light traffic.

29. *Lot 24, Con. VII, Onslow; near line of Con. VI.*

The deposit occupies the steep lower slope of a syenite hill and is of large size, but the depth varies much from place to place, owing to the irregular surface of the rock upon which the gravel lies. A large side-hill pit, covering 2,500 square yards and having a maximum height of bank of 50 feet, shows medium-fine gravel averaging half sand. The proportion of sand varies with the different layers from 30 to almost 100 per cent. Apart from an occasional big block of syenite, there are no boulders. The gravel is fresh and the pebbles are made up almost exclusively of hard syenite and gneiss.

30. *Lot 24, Con. IV, Onslow; just south of C.P.R. track.*

Close to half of the amount of gravel in the deposit, or about 10,000 cubic yards, has been excavated. What is left exposed in the old pit bank carries at least 15 per cent boulders and is useless for roads unless crushed. The deposit has the shape of a low knoll, the central part of which has been excavated to the underlying clay, 30 feet below the top of the knoll.

Hull County

All developed deposits, except those situated in Hull township and part of Wakefield township, have been covered by the present investigation.

Gravel is fairly common throughout the larger part of the county, particularly along the Gatineau river, but much of it forms either small and shallow deposits, or carries a high percentage of sand. Large deposits of good road gravel occur south of Low, around Maniwaki, and northeast of Ste. Famille, but are scarce elsewhere. A wide sand area extending from Gracefield to several miles south of Kazabazua and covering almost four townships shows hardly any gravel on the surface.

31. *Lot 17, Con. X, Eardley, near Provincial highway and line of Con. IX.*

The amount of gravel and sand taken out, 8,300 cubic yards, probably represents half the volume of the deposit, which is flat-lying and thickly covered with sand, so that its size can only be approximately estimated. Fine sandy gravel, interstratified in places with boulder sand and sand, is exposed to a depth of 6 to 12 feet in the bank of a pit 2,400 square yards in area. Coarseness, grading, and amount of sand vary much between the different layers. The gravel is fresh and the pebbles are mostly hard.

33. *Lot 2, Con. VII, Wakefield; along Provincial highway, 2 miles north of Alcove.*

Fine gravel and gravelly sand are exposed in a pit dug in the lower slope of a hill. The pit has an area of over 600 square yards and a maximum height of bank of 40 feet. The volume excavated, 4,000 cubic yards, is but a small proportion of the total amount avaliable. The material is fresh and well graded, but on account of its high sand content, over $\frac{2}{3}$ on the average, it is more suitable as concrete aggregate and very little is now used on roads.

35. *Lots 50 to 52, Con. II, Low; between Provincial highway and C.P.R. track.*

The deposit lies in the west bank of Gatineau river, which forms at this place a steep bluff, about 100 feet in height. Several pits have been worked: the largest, over 100,000 cubic yards in size, in the slope of the bluff; another, over 5,000 cubic yards in size, in a low knoll lying on the top and edge of the bluff; and a third, 3,900 cubic yards in size, in a high, steep knoll a short distance back from the bluff. The Hull-Maniwaki line of the Canadian Pacific railway skirts the foot of the bluff and passes alongside the larger excavation, which is owned by the railway company. The

gravel is on the whole coarse and bouldery, with large streaks poorly graded. Half of the stones are crystalline limestone, mostly fresh. The importance of the deposit lies not so much in the high quality of the material as in its large size and its close proximity to the Provincial highway. The gravel is not deeply weathered and if passed through a crusher would make a fair road-surfacing material.

37. *Lot 47, Con. X, Low; between Provincial highway and line of Con. IX.*

A pit has been opened recently in the upper slope of a knoll. The pit bank, up to 20 feet in height when visited, shows coarse and bouldery gravel of much the same character as No. 35. It needs to be crushed.

38. *Lot 12, Con. XI, Aylwin; where road to Danford Lake crosses county line.*

The deposit lies at the western border of the county. An excavation extending over 1,200 square yards apparently reaches the bottom of the deposit at an average depth of 9 feet. The gravel is partly weathered and rather soft, but well graded and uniform throughout as regards size of constituents. Pebbles of sample No. 38, taken from weathered gravel at depth of 2 to 3·5 feet, had a percentage of wear of 25·4 (Grading D) in the abrasion test. The amount of gravel available is probably not much more than that already taken out, but it is the only gravel available for miles, as the deposit lies at the western edge of the wide sand area already mentioned, in which no suitable road gravel has been found. It has been used on a stretch of the road leading to Kazabazua and has given good service under light traffic.

39. *Lot 49, Con. X, Aylwin; near line of Con. IX.*

Like No. 38, it is a flat-lying stream deposit of limited extent. The gravel is uniformly well graded, fairly fresh, rather high in sand. Although satisfactory on local road carrying very light traffic, it is too fine to stand the wear of the traffic prevailing on the main road farther east.

40. *Lot 49, Con. XI, Aylwin; on west bank of Pickanock river.*

There is apparently a large amount of gravel lying in the west bank of Pickanock river. The deposit has remained so far untouched, except for shallow test pits dug by the owner, which show bouldery and rather poorly graded gravel, but the pits were not deep enough to obtain a good idea as to the general character of the deposit. The remoteness of the deposit from any travelled road may not justify the expense of developing it for road purposes, even though no other deposit of comparable size is known to occur for miles to the east.

41. *Lot 15, Con. I, Wright; near intersection of Provincial highway with Concession line.*

The deposit is in the form of a steep knoll or ridge, cut across by an excavation 735 square yards in area and 35 feet in maximum depth. Except for a 6-foot lens of boulders directly underneath the top of the knoll, the

bank holds mostly loose, fresh, fine gravel or rather gravelly sand, more suitable for concrete than for roads. The amount taken out is but a small proportion of the total volume of the deposit. The upper 2½ to 5 feet of the bank is fine sand and may be considered as overburden.

43. *Lot 21, Con. III, Bouchette; near line of Con. IV.*

The deposit is flat-lying and of unknown extent, but probably large. When visited in 1929, the pit measured over 3,000 cubic yards and a local contractor was then taking out gravel by machinery at the rate of 250 cubic yards per day to surface a stretch of the Provincial highway near Bouchette. The gravel is uniformly well graded but rather fine, carrying over 75 per cent of sand. It is a better road material than other local gravels, which are all very sandy. The thick zone of weathering renders the gravel unsafe for use as concrete aggregate, unless taken only below the weathered zone.

44. *Lot 43, Con. IV, Bouchette; along Provincial highway.*

A large pit, 470 square yards in area and with a maximum height of bank of 25 feet, shows gravel that is generally fine and mixed with much sand. Sample No. 44 is from the coarser, 44a from a finer gravel, the latter nearer the edge of the deposit. The gravel is comparatively free from weathered material, though slightly dusty. The deposit forms a large ridge, but much of it is too fine for road work. The coarse gravel lies apparently in pockets or zones underneath the crest of the ridge. Another large excavation in the same ridge, a short distance to the northeast, is now abandoned, as all the coarse gravel at that place has been taken out. Sample No. 44a (Table III, page 195) gave a rather low result in the mortar test. This is owing to dust or clay clinging to the stone fragments and keeping the cement from adhering to them. This coating is seen only in certain layers in the bank. Washing the material would very likely make it suitable as concrete aggregate.

45. *Lot 1, Range W, Gatineau Road; near intersection of Provincial highway with township line.*

The surface of the deposit is level with the surrounding land and the amount of gravel it contains is unknown but apparently large. The excavation extends over 960 square yards and has a maximum height of bank of 25 feet. The gravel is fresh and uniformly coarse with about 5 per cent of boulders. Sand pockets up to 4 feet in thickness found in places on top of the gravel would increase the cost of stripping.

46. *Lot 31, Con. III, Kensington; near fork of roads.*

When the deposit was visited in 1929, a pit was being opened for material to surface the road leading to Montcerf. The deposit covers only a small area and its depth is unknown. Outside of the new excavation, several shallow test pits were dug by the owner and all show gravel that is uniform in size throughout, being medium coarse with not more than half sand. It packs readily on the road and is apparently of good quality.

47. *Lot 42, Con. I, Kensington; near east shore of Gatineau river.*

Gravelly sand is exposed in a large pit in the upper slope of a ridge facing Gatineau river. It is too sandy for road use as it carries at least 75 per cent of sand, but may be suitable as concrete aggregate, as the sand is coarse and well graded.

53. *Six miles N.E. of Ste. Famille; near Provincial highway.*

The deposit is in the form of a low, flat-topped knoll. Along the northern slope, there is a side-hill excavation covering 2,200 square yards with the inner bank 10 to 15 feet in height. The gravel is more or less weathered throughout, only moderately hard, and carries much sand, but the sand is mostly very coarse and the gravel is on the whole uniformly well graded. Gneiss and granite make up from 80 to 90 per cent of the pebbles. A test pit dug 100 feet back from the main pit face shows similar material, so that the amount of gravel is at least twice that already taken out. All the excavated material, 6,500 cubic yards, has recently been used in the surfacing of a stretch of the new Provincial highway between Maniwaki and Mont Laurier that is in very good condition.

Labelle County

Investigation work was confined to that part of the county adjacent to the Maniwaki-Mont Laurier-Montreal provincial highway, and probably includes all the developed deposits of the county.

Gravel is comparatively scarce throughout the area examined, and most of it is hardly of size suitable for road surfacing. Fairly large deposits of good gravel are found only near Mont Laurier, Nominingue, La Conception, and west of St. Jean, whereas large areas around Labelle and Guenette are almost totally devoid of gravel. Drift boulder deposits are everywhere of common occurrence. In these are occasionally found pockets of coarse and bouldery gravel, some of which have been excavated and the material crushed to the proper size for road work. The scarcity of good gravel has resulted in an intensive search being made for such material, as attested by the large number of small pits, particularly along that section of the highway between Mont Laurier and the eastern border of the county.

54. *Four miles west of St. Jean; along Provincial highway.*

The deposit is in the form of a steep ridge 75 feet in height and several hundred yards in length. The Provincial highway crosses the ridge through a large cut 50 feet in depth, from which gravel is taken for surfacing the highway. The large faces of the cut mostly concealed behind talus, show in the upper part coarse and bouldery gravel directly underneath the crest of the ridge, and somewhat finer material down the slopes, with an average of 30 per cent boulders in the exposed part. Crushing the gravel would make it more suitable and would prevent the oversize stones from going to waste. The size and shape of the deposit make conditions favourable for large-scale development. The importance of the deposit is further enhanced by the fact that for many miles west no other large deposit is found close to the main highway.

55. *One mile west of St. Jean; near Provincial highway.*

In the bank of a brook, a pit 2,900 cubic yards in size and 6 to 9 feet in depth shows uniformly well-graded, fine, and very sandy gravel, carrying at least 75 per cent of sand. A stretch of the Provincial highway surfaced with the gravel has a fairly smooth surface, but the material does not compact firmly, owing to the excess of sand. The pit reaches the bottom of the deposit and the amount available is probably twice that already taken out. Betweeen deposits 54 and 55 there are surface indications of gravel at several places.

61. *Lot 23, Con. I, Campbell; west of fork of roads on Provincial highway.*

A large excavation 3,300 square yards in area and 30 feet in greatest depth shows well-graded gravel varying in size from medium coarse to very fine and sandy. Generally it carries a high proportion of sand. In the upper bank the material is partly weathered and in places strongly rusty. Pebbles from sample No. 61, taken at a depth of 3·5 to 5·5 feet had a percentage of wear of 14·7 (Grading A) in the abrasion test. The amount of gravel available is probably large, but is difficult to estimate because the gravel is concealed under a blanket of sand of variable thickness. In the same sand area are found two other pits in sandy gravel, one, now abandoned, 250 yards, and the other one-half mile northwest of pit 61. It is not known whether gravel forms a continuous deposit over that distance, or occurs as pockets within the sand. The three excavations aggregate 40,000 cubic yards in size.

67. *Lot 41, Con. V, Loranger; along Provincial highway and C.P.R. track.*

A large quantity of gravel has been taken from the deposit by the Canadian Pacific Railway Company for ballast. The long pit bank, up to 50 feet in height, shows gravel that is interstratified with much sand. Coarseness of gravel alone varies much between the different layers. Over 90 per cent of the pebbles are of gneiss. There are large streaks of good road gravel seen in the bank, but none of it is economically available, on account of being too thickly covered with poorer material.

71. *Lot 14, Range S.W. Rivière Rouge, Marchand, between Provincial highway and Rouge river.*

The deposit forms a small, gently sloping knoll and holds fresh and hard gravel that varies from coarse and slightly bouldery to fine and sandy. The coarse gravel has given satisfactory results in road surfacing.

73. *Lot 27, Con. III, Clyde; at La Conception.*

The deposit lies in a steep bluff facing Rouge river, and is apparently of small size. A road, cut through the upper part of the bluff, has exposed a 15-foot bank of fresh, medium-coarse, well-graded gravel carrying about 35 per cent of very coarse clayey sand, but the bank farther from the edge of the bluff shows mostly sand. A stretch of the Provincial highway surfaced with the clayey gravel was smooth and firm when visited in July 1929 and August 1930.

Papineau County

All deposits covered by the investigation are included in a strip of land bordering Ottawa river and varying in width from 4 to 9 miles, and occur grouped in four different localities, namely: near Perkins, Buckingham, Valdor, and Montebello. Outside of these, gravel is very scarce.

None of the deposits examined can be considered high-grade road material, but some hold gravel and sand that are particularly suitable as aggregates in cement mortar and concrete and are worked almost solely for that purpose.

74. *Lot 13, Con. VII, Templeton; west of road running along Blanche river.*

Fresh coarse sand and fine gravel are available in large amount in the deposit and have given good results as aggregates in concrete mixtures. There is very little gravel of proper size for roads.

76. *Lot 7, Con. IX, Templeton; south of road to lake Plumbago.*

The deposit forms a flat ridge or knoll 1·5 to 2 acres in extent. A pit opened in the west slope has exposed gravel that decreases in coarseness gradually from the edge towards the centre of the knoll, the proportion of sand, which is largely coarse, varying from one-half to two-thirds. The gravel is well graded throughout and though rather deeply weathered is fairly hard. It is found entirely satisfactory on local roads that carry light traffic. Pebbles had a percentage of wear of 14·2 (Grading B) in the abrasion test. There are other similar knolls or ridges in the neighbourhood, and the amount of gravel is undoubtedly large, but difficult to determine without sounding.

79. *Lot 13, Con. IX, Buckingham; where Provincial highway crosses line of Con. VIII.*

The 50-foot bank of a large side-hill excavation in the steep slope of a bluff facing a brook was talus-covered over three-quarters of its height when visited in 1929. Coarse and bouldery gravel is exposed in the upper part, and mostly coarse sand in the lower part of the pit. The zone of weathering is thick, but apart from the intensely weathered material in the upper three feet, the gravel is fairly hard and would be suitable for roads if crushed to the proper size. Sample 79 is from the coarse gravel in the upper bank, and 79a from fresh coarse sand in the pit bottom. An abrasion test run on pebbles of sample No. 79 gave a percentage of wear of 11·6 (Grading A).

80. *Lot 14, Con. VII, Buckingham; near line of Con. VI.*

The deposit forms a bench or terrace facing Lièvre river to the east. Gravel that varies much in coarseness from place to place is exposed in an excavation, 1,500 square yards in area and 50 feet in greatest depth, opened along the north edge of the bench. The gravel lies under a blanket of sand that varies in thickness from 1 foot at the end of the pit nearest to the east slope of the bench to over 6 feet at the opposite end. The gravel is partly weathered and rusty in the upper bank, particularly that part lying under thin cover. The amount of work involved in stripping the gravel from its overburden hampers further development.

81. *Same location as No. 80.*

A short distance southeast of No. 80, a large pit in the steep slope of a gully cutting through the bench shows much more sand than gravel, and is worked almost solely for the production of mortar sand and concrete gravel. The material is fresher than No. 80, but too fine for road work. Sample No. 81 was collected in the upper part of the pit bank and contained some weathered material, which probably accounts for the low tensile strength in the mortar test (Table III, page 195).

In a lower bench at the river shore, another large pit is worked in the winter for road gravel, which is hauled over the frozen river. The sand overburden is thinner than in the upper bench.

82. *Lot 14, Con. VI, Buckingham; west of road running along west side of Lièvre river.*

A short distance south of Nos. 80 and 81, in the lower slope of a rocky hill is a large side-hill excavation over 3,000 square yards in area. Coarse and bouldery gravel is exposed in the up-hill bank, which is 30 feet high, and finer gravel in the down-hill side of the pit, where sample No. 82 was taken. The coarser gravel in the higher bank is rusty in streaks, whereas the finer material in the lower bank is clayey and fresher. The average coarseness for the whole pit is roughly as follows: boulders, 10; pebbles, 60; sand, 30. It is probable that the pit was originally opened in gravel of the right size for road work and has now reached up hill into the more bouldery gravel. The finer gravel looks almost exhausted, but more may be available below the floor of the pit.

83. *Lot 15, Con. VIII, Lochaber; near fork of roads and line of Con. IX.*

Very fine gravel is seen in a large excavation that is worked at several levels. The excavation extends over an area of 2,300 square yards and there is a difference in elevation of 40 feet between the top of the bank and the floor of the lower level. The gravel is very uniform in size throughout and holds at least 75 per cent of sand, which is rather too sandy for best results in road work. There is an overburden of fine sand 2 to 4 feet in thickness on top of the gravel.

85. *Three miles northwest of Montebello; Côte St. Hyacinthe, on farm of E. Arbique.*

The deposit forms a ridge several hundred yards in length, at one end of which gravel has been excavated over an area of 2,600 square yards. The pit bank has a maximum height of 30 feet, the lower two-thirds being talus-covered when the deposit was examined. In the upper bank the gravel is weathered and pebble size varies much from place to place but the finer material is uniformly well graded. Sample No. 85 taken in the weathered zone at a depth of 5 to 8 feet, represents more sandy gravel than the pit average. Most of the excavated gravel has been used in road surfacing with better results than could reasonably be expected from the material exposed in the pit. The high pit talus quite likely conceals the better gravel from view.

86. *Two miles northwest of Montebello; Côte St. Hyacinthe, farm of A. Périard.*

In the upper slope of a steep bluff facing a brook, a pit just opened at the time of the examination (1929) in what promises to be good road gravel. The opening now covers 380 square yards and reaches at one place 20 feet in depth. Although somewhat sandy, the gravel is fairly uniform in coarseness and quality throughout the exposed part, and comparatively fresh.

88. *One and a half miles southeast of St. Amédée; along road, farm of O. Gagnon.*

The deposit occurs at the summit of a pass in a range of low hills, is flat-lying and of unknown but probably large size. A trench-like excavation reaching a depth of 15 feet shows gravel that is irregularly graded, that is, it carries an excess of fine sand. Sample No. 88 represents better graded material than the pit average. Although fresh throughout, it holds a rather high amount of friable material.

Argenteuil County

The work covered nearly all the townships fronting Ottawa river and a small area in the northwest corner of the county.

Gravel is scarce immediately north of Ottawa river, and common farther north. All the deposits, with one exception, are small and shallow. The only large deposit, No. 103, lies near the eastern border of the county. The small and shallow deposits, particularly numerous in Chatham township, are strikingly alike in character, the only variation being in the relative proportion of pebbles and sand. They are all sandy and made up of very hard, well-graded, strongly rusty material, with hardly any boulders or oversize pebbles. The less sandy deposits have proved good for road surfacing, but most, if not all of them, hold little sand or gravel suitable for use in mortar or concrete mixtures. Owing to their small size and similarity of character, no further description is necessary. The more important are found listed under Nos. 90, 91, 92, 97, 98, and 101, in Table IV, page 201, and the results of tests on a few of them in Tables I, II, and III. An abrasion test run on pebbles from sample No. 92, which was taken at a depth of from 3 to 6 feet, gave a percentage of wear of 11·8 (Grading A).

103. *Six miles east of Lachute; East Settlement, near intersection of Provincial highway with county line.*

The deposit forms a bluff facing a brook to the east and is over one mile in length. It lies just west of the border line between Argenteuil and Two Mountains counties. As it is the only local deposit, it has been extensively worked for road material. The gravel is well exposed in several large excavations, the larger being an old railway pit, parts of which have been later worked for road gravel. The gravel is softer and less uniform in coarseness than the rusty gravels found elsewhere in the county. It is on the whole very coarse and bouldery. At several places a considerable thick-

ness of fine, sandy, poorly graded gravel overlies the coarser material. As a rule the coarser gravel is well graded and once crushed to proper size makes a good road-surfacing material. Although there is a large volume of gravel left, its lack of uniformity would be a detriment in large-scale development of the deposit.

Terrebonne County

Nearly all gravel deposits that have been worked for road or other purposes are found along or very close to the route of the Mont Laurier-Montreal highway so that the present investigation was confined to a narrow strip of land bordering that highway.

Gravel is fairly common all along the road except west of St. Jovite and between Ste. Agathe and Ste. Adèle, but the deposits though numerous are nearly all of small size. Large deposits of good road gravel are found east of St. Faustin, north of Ste. Agathe, south of Shawbridge, and west of St. Jérôme, the latter by far the largest.

Surface indications of gravel were noted at many places following a cursory examination of the ground for a short distance both sides of the highway, so that systematic prospecting work for gravel would probably reveal the presence of other deposits.

109. *Lot 24, Con. VI, Wolfe; along Provincial highway, ⅔ mile east of St. Faustin.*

The deposit, which is flat-lying, extends on both sides of a brook and abuts on one side against a boulder clay ridge. A large excavation, which cuts through both banks of the brook over a distance of 135 yards and an average depth of 15 feet, shows gravel that is fairly uniform in size but rather coarse and bouldery, with 10 per cent of boulders on the average. It is comparatively free from weathered fragments, and would be a good road-surfacing material if brought to the proper size by passing through a crusher. Submitted to an abrasion test, pebbles showed a percentage of wear of 13·8 (Grading A). As judged by the result of the mortar test on sample No. 109 (Table III, page 195) the gravel is unfit for use as aggregate in concrete mixtures, on account of streaks of material coated with rusty dust. The extent of the deposit is unknown but apparently large. The gravel lies under 1½ to over 3 feet of fine sand as overburden.

110. *Lot 2, Con. VI, Wolfe.*

111. *Lot 42, Con. VI, Beresford.*

112. *Lot 35, Con. VI, Beresford.*

These are small deposits not over 6 feet in depth. Similar shallow deposits are seen at several other places in the flat land bordering Noire river, between Nantel and Degrosbois. They all carry good road gravel, uniform in coarseness throughout, although somewhat sandy in places.

113. *Lot 13, Con. V, Beresford; alongside road, near line of Con. VI.*

The deposit is flat-lying and surrounded by low, marshy soil. A large excavation covering 18,100 square yards in area and reaching the bottom of the deposit at an average depth of 6 to 7 feet, shows fine gravel carrying from 50 to 75 per cent sand and no oversize stones, apart from an occasional large anorthosite boulder. The gravel is hard and fresh, uniform in size throughout, but the high sand content is a disadvantage. The material makes a smooth road surface and wears well, once sufficiently compacted. The amount available is at least as much as that already taken out.

115. *One-half mile north of Piedmont; between Provincial highway and North river.*

In a shallow pit opened in the top and edge of a steep bluff facing North river, there is exposed fresh, well-graded gravel carrying over 65 per cent sand. The pit reaches the underlying clay at a maximum depth of 7 feet and the extent of the deposit is unknown.

116. *Piedmont; between Provincial highway and North river.*

Near the top of a steep bluff facing North river, the 12-foot bank of a side-hill excavation shows hard and fresh gravel varying much in size from coarse and bouldery to medium fine, and thickly covered with sand in places. Sample No. 116 is from a depth of 4 to 7 feet in medium-coarse, well-graded gravel overlying coarser, more bouldery, less regularly graded material. The extent of the deposit is probably large.

117. *Three-quarters of a mile south of Shawbridge; between Provincial highway and C.P.R. track.*

Gravel is exposed in the high bank of a side-hill excavation opened in the steep upper slope of a bluff facing North river. The deposit which is of large size extends all the way down the slope, but the necessity of hauling the material up hill has limited the excavation work to the upper part of the bluff. The gravel is generally hard and fresh, composed almost exclusively of anorthosite, and shows wide variation in coarseness between layers, particularly in the upper part where in places a layer of very coarse and bouldery gravel may succeed another of almost clean sand. In the lower bank the gravel is slightly more uniform in coarseness and grading and of better quality for all purposes. A large proportion of the gravel used in concrete sidewalks in Shawbridge comes from this deposit. High-grade material can undoubtedly be obtained by digging with hand shovel into layers of proper coarseness. This method of working, which accounts for the irregular shape of the pit, is unsafe and wasteful if not properly supervised. In large-scale development work it would be advisable to crush and screen the run of the bank, so as to make use of the large stones and remove the excess of fine.

119. *Two and three-quarter miles northwest of St. Jérôme; Côte Dalhousie Est; on the farm of A. Durant.*

The deposit is flat-lying, extends over a large area, and may be continuous with the large ridge or terrace found farther to the southeast. A large excavation covering 8,900 square yards reaches sand at an average depth of

5·5 to 6 feet. The gravel is uniformly well graded, fine and sandy, carrying at least 75 per cent sand. Sample No. 119 represents the coarser and less sandy part. It is a hard gravel composed almost exclusively of anorthosite. Although admittedly too sandy, it is found satisfactory for improving local roads of light traffic. The gravel is too shallow to be used safely as concrete aggregate, as shown by the mortar test, Table III, page 195. The sand underlying the gravel in the bottom of the pit may be suitable for that purpose. The thickness of the sand is unknown but apparently small.

120. *One and a quarter miles west of St. Jérôme; Con. Nord, North river, on the farm of A. Lemay.*

The deposit occupies the east slope of a large terrace or flat ridge trending north-south for several miles. An excavation over 2,000 square yards in area and 12 feet in average depth shows gravel in the north and south banks that varies in coarseness from place to place but is on the average coarse and carries from 35 to 50 per cent sand. Pebbles are over 90 per cent anorthosite. In the east and west banks it is mostly gravelly or unmixed sand. The layers dip east at a steeper angle than the surface slope of the terrace. It looks as if the excavation, originally opened in a thick gravel layer, has now run east and west into gravelly or unmixed sand.

121 and **122.** *One and a half miles west of St. Jérôme; Con. Nord, North river, on the farm of A. Lebeau and H. Danis.*

Two large pits are opened side by side on neighbouring properties in the gentle east slope of the same ridge or terrace as No. 120. No. 121 measures 10,100 square yards in extent and 12 feet in average depth, and No. 122, immediately south of it, 2,800 square yards in extent and 18 feet in average depth. In both pits the gravel varies much in coarseness and grading between the different layers, which run irregularly in thickness and direction, but generally dip towards the east. Considerably more sand than gravel is seen in the west bank of both pits. The gravel is fresh and hard, and pebbles are over 90 per cent anorthosite. The thickness of overburden is 2·5 to 3 feet at No. 121, and 5 feet at No. 122.

As seen at Nos. 120, 121, and 122, gravel appears to be limited to the east slope of the ridge or terrace, but the amount available, if smaller than that of the sand, is nevertheless considerable. In large-scale development work, the excavation would extend along the face of the terrace, or in a north-south direction. As this is about at right angles to the property lines, it may add to the cost of acquiring the land.

123. *Two miles southwest of St. Jérôme; Con. Nord, North river, on the property of Coulombe and Limoges.*

On top of a flat, dome-like elevation are two excavations side by side, one 1,800 square yards in area and 6 feet in average depth, the other 850 square yards in area and 18 feet in average depth. The shallower pit shows fine, rusty gravel carrying half to two-thirds sand. The gravel is everywhere uniform in size. Pebbles are 75 per cent anorthosite, and about 15 per cent are soft, owing to partial weathering. In the deeper pit, rusty gravel layers are seen in places in the upper 6 feet of the bank, and largely

sand in the remainder of the pit. A stretch of the road along the northwest bank of North river surfaced with gravel from the shallower pit was in good condition. Although the thickness of gravel does not appear to be over 6 feet at the pits, the deposit may extend more or less continuously as far as Nos. 121 and 122, one and a quarter miles to the north.

Montcalm County

All deposits that have been worked for road or other purposes are in the southern part of the county and are included in the present investigation.

Gravel deposits are of common occurrence everywhere except in the southeast corner of the county, where they are very scarce in the sandy area bordering Joliette county, and totally wanting in the clay land bordering L'Assomption county. Gravel is particularly abundant near Ste. Julienne and Rawdon. Good road-surfacing material has been obtained from the Ste. Julienne deposits, Nos. 125, 126, and 127, which have been extensively drawn upon for improving the roads throughout the large clay area lying immediately to the south.

125 and **126.** *Lots 5 to 7, Con. II, Rawdon; west and north of Ste. Julienne.*

The deposit is flat-lying and is said to cover over 100 acres and to have a maximum depth of 20 feet, as determined by test pits that are now refilled. The gravel is exposed in several large pits in the northern part of the village of Ste. Julienne, and is found to be uniform in coarseness throughout. It is a fine gravel carrying about 75 per cent of exceedingly coarse sand. A peculiar feature of this gravel is its grading. Over 90 per cent of the total material is smaller than ¾-inch and is retained on the 14-mesh sieve. Sample No. 125, Table I and II, is from the coarser phase. The great success attained with this type of gravel in road surfacing, particularly on clay roads, is chiefly due to its grading. The gravel is fresh, very hard, slightly clayey in the upper part of the deposit, and composed of over 75 per cent anorthosite. The failure of the gravel in the mortar test, as shown in Table III, page 195, is due to the dust coating on the sand grains. In two of the excavations, under 7 feet of gravel similar to that just described, is seen a one-foot layer of bouldery sand, and under it 7 feet of fine sandy gravel as represented by sample No. 126. Very fine white sand lies at the bottom of the two excavations. The gravel from the lower 7 feet is different from the upper gravel, in that it carries more large pebbles and more fine sand, or in other words it carries a wider range of sizes. The extent of the lower gravel could not be ascertained. It is a good road material but not of such high grade as the upper gravel. As a mortar and concrete aggregate it is satisfactory.

127. *Two and a half miles southwest of Ste. Julienne; near fork of roads and border of Kilkenny township.*

In the upper slope of a bluff, a large side-hill excavation, extending for several hundred yards along the face of the bluff and having a maximum depth of 20 feet, shows gravel much like the upper part of No. 125, but coarser. It is a good road gravel, even better than No. 125 on account of

being coarser and holding a smaller percentage of sand. Sample 127 represents the coarser part, and No. 127a the finer part. The pit is connected by spur to the Canadian National railway line at Bissonnette. The gravel is excavated by a gasoline shovel having caterpillar traction, loaded directly into standard gauge railway gondolas and distributed by rail to the level, gravel-free land lying to the south, for use in surfacing roads.

128. *Lot 7, Con. III, Chertsey; near road intersection southeast of St. Théodore.*

The deposit forms a flat-topped knoll sloping towards a brook to the south and east, and abutting against a larger knoll of glacial drift to the north. An excavation in the upper east slope and top of the knoll measures 1,900 square yards and has an average depth of 9 feet. Gravel varies in coarseness with the different layers and is interstratified with much sand. The sand and gravel are hard and fresh, apparently suitable for mortar and concrete. It is generally too fine for roads, but thick layers of proper coarseness for road use are exposed in the west and north banks, that is, in that part nearer to the top and also nearer to the glacial drift. It is likely that more of the coarse gravel would be exposed if the pit were extended in that direction, but the amount of fine material available exceeds by far that of the coarser gravel. Several shallow test pits dug in the south and east slopes of the knoll at a lower level than the bottom of the main pit show sandy gravel in the south and mostly sand in the east slope.

129. *Lot 9, Con. VII, Chertsey; near line of Con. VIII.*

In a large side-hill excavation in the south slope of a knoll, there is exposed very bouldery gravel near the top, and very sandy gravel farther down. Well-graded gravel of proper coarseness for roads forms but a small proportion of the whole and lies everywhere under a great thickness of poorer material. There are in the vicinity several other knolls that are gravelly on surface, and the amount available is undoubtedly very large.

132. *Lot 17, Con. VI, Chilton; at Notre Dame.*

133. *Lot 25, Con. III, Lussier; ¾ mile southeast of St. Donat.*

These are small, shallow stream deposits of uniformly well-graded, fine gravel, carrying from 70 to 75 per cent sand. In No. 132, pebbles are about half anorthosite and half gneiss, whereas in No. 133 they are over 75 per cent gneiss. Although partly weathered and very sandy, the gravel is fairly hard and has been used successfully in surfacing stretches of the main highway between Notre Dame and St. Donat. Similar shallow deposits are found along other brooks between these two places.

134. *Lot 11, Con. III, Lussier; alongside road to Ouareau lake.*

Gravel is exposed in the 20-foot bank of a side-hill excavation in the east slope of a knoll. Except for a streak of bouldery material at one end of the bank, the gravel is fine, carries over 75 per cent sand with a few small boulders, and is slightly weathered and rusty throughout. It is too sandy for roads. The amount of gravel available is probably large, even on the assumption that it is limited to the east slope of the knoll.

135. *Lot 13, Con. VI, Rawdon; near fork of road.*

In the northern slope of a terrace, an excavation covering 2,500 square yards reaches the bottom of the gravel deposit at an average depth of 6 feet. The gravel is well graded, fine, and carries half to two-thirds sand, most of which is very coarse. Sample No. 135 is from the less sandy part. Pebbles are 75 per cent anorthosite and very few of them are over ¾ inch in size. Although rather sandy, it makes a smooth, firm, and durable road surface, owing to its grading, which is somewhat similar to that of Nos. 125 and 127, 80 per cent of the total material passing a ¾-inch screen and being retained on a 14-mesh sieve. The gravel is but slightly weathered, but apparently not fresh enough for safe use in concrete, as judged by the result in the mortar test (Table III, page 195). The gravel deposit has a maximum depth of 10 feet and is underlain by sand. It is not known how far the gravel extends into the terrace, but even if limited to a narrow strip along the face of the terrace, the amount available is probably large.

139. *Lot 15, Con. III, Rawdon; along C. N. R. track.*

A large sand deposit forms a high steep bluff facing low level land along Ouareau river to the east. A pit originally opened in the lower slope has gradually been extended up the slope. The excavation is now very large and has reached almost the top of the bluff, cutting through a thick layer of gravel that overlies the sand and gradually becomes thicker as the digging operations progress farther into the bluff. Where the pit bank stood in August, 1929, the gravel measured a thickness of from 10 to 17 feet. Under the gravel is 12 feet of medium-coarse sand, underlain by 35 feet of coarser sand, which in turn is underlain by 10 feet of fine sand. The pit has a total depth of 75 feet and is worked in four different levels, corresponding to these changes in coarseness of the material. The fine sand from the lower level is shipped to Montreal as moulding sand, and the coarser is sold as concrete aggregate. Some of the gravel from the upper level is sold for road use. The gravel is medium coarse and well graded, the grading approaching that of Nos. 125 and 127, which have proved good road material. Two samples were collected, No. 139 from a depth of 3 to 7 feet, No. 139a from a depth of 7 to 10 feet. The pit is connected by spur to the Canadian National railway line which passes near the foot of the bluff.

The low result obtained in the mortar test (Table III, page 195) is due to the material being slightly weathered in the case of sample No. 139, but the cause is not so clear in the case of sample No. 139a, taken from gravel that seemed quite fresh and free from injurious matter. A peculiar feature of the mortar test is the lower result obtained in the 28-day test as compared with the 7-day test. The same was observed in the case of samples Nos. 119 and 135. No attempt was made to determine the probable cause of this decrease in tensile strength, but the fact that all these gravels are made up almost entirely of anorthosite and gneiss, with the anorthosite predominating, suggests that the mineralogical composition may be a contributing factor. No 126, taken from fresh gravel of similar composition, gave good results in the test, but with very slight increase after 28 days. No. 125, of the same composition, showed low tensile strength at both 7 and 28 days, owing to impurities in the form of clayey dust, and No. 134, also

of the same composition but in which gneiss predominates over anorthosite, showed about normal increase. In connection with No. 139 suitable aggregate for use in making concrete foundations for power-line towers was found by digging a pit on top of the bluff a short distance behind the main pit face. The depth of the pit could not be ascertained when visited, being partly refilled, but it was certainly over 10 feet.

141. *One mile west of Les Dalles; Con. S.O. Rivière Ouareau, on the farm of L. Lachapelle.*

The gravel forms a well defined ridge over 400 yards in length, 35 yards in width, and 7 feet in height at the crest. It is well graded, medium coarse and carries 70 to 75 per cent sand. Half of the pebbles are anorthosite. A pit dug to the underlying clay or glacial drift measures 900 cubic yards.

Joliette County

Sand covers most of the southern part of this county and is easily available in well-nigh unlimited quantity, but the few gravel deposits noted are shallow and small in extent. Sand has been excavated at a number of places, the largest excavation, No. 153, being situated at the border between St. Félix and Ste. Emélie parishes, and operated by the Standard Sand Limited, of Joliette.

153. *Four and a quarter miles southwest of St. Félix; at parish line between St. Félix and Ste. Emélie.*

Different grades of sand are exposed in a large excavation dug to a depth of 40 feet in flat sandy land covering many miles. The pit is connected by spur to the Canadian Pacific railway line and operated for the extraction of sand suitable for asphalt, plaster, mortar, and concrete, most of which is shipped to Montreal. All the gravel seen consists of a few layers confined to one part of the excavation. Gravel sample No. 153 and sand sample No. 153a are not representative of those parts of the deposit holding the better material for concrete and mortar aggregates.

Berthier County

Gravel is scarce in the area examined, which comprises most of the southern half of the county, and totally wanting in the flat land in the southern end of the county underlain by Palaeozoic rocks. The few developed deposits are very sandy, the larger being found immediately west and south of the village of St. Gabriel. The St. Gabriel deposits have been extensively developed for roads and concrete works, owing more to their easy access than to their quality, although the deeper hold streaks of good concrete sand. The better graded gravels, such as No. 159, have been used satisfactorily in surfacing roads, but they are too fine and sandy.

159. *Lot 9, Con. V, Brandon; one mile west of St. Gabriel.*

The deposit, which lies on top of a small, flat knoll, is very shallow, averaging only 3·5 feet in thickness and is probably of small extent. The gravel is uniformly well graded, fine, and carries 70 per cent sand. It is a better road material than other local gravels, as judged by results obtained in service, but, like the others, is not durable under traffic.

160. *Lot 8, Con. III, Brandon; near C.P.R. track.*

The deposit forms a high, steep bluff facing low land to the west. In the 12-foot bank of a side-hill pit in the upper slope and top of the bluff, there is exposed well-graded fine gravel carrying 75 per cent sand. Pebbles are 90 per cent gneiss. The material is not economically available by the usual method of extraction, that is, digging with hand shovel and hauling by horse wagon or motor truck. On top of the bluff the gravel is thickly covered with sand, and up-grade hauling makes it impracticable to dig too far down the steep slope where the overburden is thinner.

161, 162, and **163.** *Lots 7 to 9, Con. IV, Brandon; just west of St. Gabriel.*

In a big deposit extending westwards from the village of St. Gabriel, are several large excavations, including Nos. 161 and 162, and a smaller one, 163, recently opened (1929). All openings show much the same material, namely, sandy gravel or gravelly sand, made up on the average of 30 per cent pebbles and 70 per cent sand. Pebbles are 65 per cent granite-gneiss. The deposit holds also much sand, and occasional layers of coarse and bouldery gravel in the upper part. The material has been used extensively for road surfacing and concrete works, including all the concrete sidewalks in the village. It is too sandy for road use but generally suitable as concrete aggregate, except where the sand is too fine.

Maskinongé County

Gravel investigations were made in that part of the county bordering lake St. Peter and extending 10 to 20 miles inland. The southern half of this territory is clay-covered and devoid of gravel, whereas in the northern half are numerous small and shallow gravel deposits, many of which have so far remained untouched. Deposits of fairly large size are found near Ste. Ursule Station, St. Alexis, and St. Paulin.

165. *One mile southwest of Ste. Ursule Station; Range Fontarabie, near C.N.R. track.*

A large railway pit in flat sandy area is intermittently worked for ballast. Gravel is interstratified with large sand layers, the high pit bank showing more sand than gravel. Although there is much good road gravel, it would be impracticable to extract it in large amount without getting much sand mixed with it.

166. *One and a half miles northwest of Ste. Ursule Station; along road of Range Fontarabie.*

Fresh, hard, uniformly well-graded, fine gravel is seen in a large excavation 3,600 square yards in area and 20 feet in depth, opened in a low terrace. The gravel carries coarse sand, the proportion of which increases with depth from one-third to two-thirds. Pebbles showed a percentage of wear of 9·3 (Grading B) in the abrasion test. At a depth of 20 feet the gravel is underlain by sand. Sample No. 166 is from the coarser, 166a from the finer part. Good results have been obtained with the gravel in road surfacing. It is also suitable as aggregate for concrete work. The terrace is of large extent, but it is not known whether it is all gravel.

167. *Two miles northwest of Ste. Ursule Station; along road of Range Fontarabie.*

The 25-foot bank of a pit, 1,400 square yards in area, opened in the slope and top of a steep bluff, shows gravel similar to No. 166, but more uniform in coarseness, and carries about 50 per cent of sand, mostly very coarse. Sample No. 167 is more sandy than the pit average. Both Nos. 166 and 167 have been extensively used in surfacing roads in the clay land to the south and have proved good and durable. The deposit apparently is not deeper than 25 feet, as material near pit bottom is very sandy. The bluff is the face of a large terrace that probably holds a considerable amount of gravel.

168. *Four and a quarter miles northwest of St. Léon; Range Barthelemy, ½ mile northwest of fork of roads.*

Gravel forms a shallow deposit on top of a low flat ridge of boulder clay. Five pits dug to the bottom of the gravel aggregate 6,400 square yards in area, and vary from 3 to 10 feet in depth. The variation in depth is due to surface irregularities in the underlying boulder clay, which makes it difficult to estimate the amount of gravel in the deposit. The gravel, which is slightly rusty, more or less weathered and soft, but well graded and uniform in coarseness, has been used in building good, if not durable, road surfaces in that part of the clay land lying south of the deposit.

172. *Three miles west of St. Paulin; along rivière du Loup, on the farm of T. St. Louis.*

Glacial gravel with partly sorted drift is exposed in the 35-foot bank of a side-hill excavation in the steep slope of a knoll that is part of a bluff facing rivière du Loup. The material is fresh and hard but poorly graded and made up roughly of 3 per cent boulders, 25 pebbles, 72 sand, silt and clay. Sample No. 172, taken from a large pile that had just slid down from the bank, represents material that is more gravelly, less clayey, and better graded than the average. It compacts readily on the road and forms a firm and smooth surface. The river road surfaced with this gravel was in very good condition when examined in dry summer weather. The amount already taken out of the pit, 5,700 cubic yards, forms but a small proportion of the total volume of the knoll.

173. *Lot 6, Range S.E., Rivière du Loup; at St. Alexis.*

Immediately south of the village of St. Alexis several pits have been dug in the steep west bank of rivière du Loup, and in knolls a short distance from the river bank. The knolls are largely sand in which are seen gravel layers pitching at high angle, but the river bank appears to be more gravelly. The gravel is of about the right coarseness and grading for road use. Pebbles are entirely granite and gneiss with granite predominating. Nearly 16,000 cubic yards has already been taken out and the amount available is thought to be large. There are numerous surface indications of gravel for a distance of four miles south of the village, but the few exposures seen in pits show that the gravel is very shallow and is underlain by sand.

175. *Lot 26, Range S.W., Rivière du Loup; along rivière aux Ecorces.*

Gravel forms a shallow deposit on top of a steep sand bluff facing rivière aux Ecorces. In a narrow pit, over 150 yards in length, there is exposed well-graded, fine gravel, uniform in coarseness throughout, although high in sand, the proportion of sand increasing with depth from one-half to two-thirds. Pebbles are 50 per cent granite and 25 gneiss. The underlying sand is reached at depth of from 3 to 6 feet. The pit measures over 3,500 cubic yards, and conservative estimates give 37,000 cubic yards as the size of the gravel deposit.

St. Maurice County

Gravel is scarce throughout the southern part of the county. With the exception of a small area of clay land around Yamachiche, sand covers most of the southern part, and no deposits worth developing are known to occur within 14 miles of St. Lawrence river, but more detailed investigation may reveal the presence of gravel lying close to the surface, particularly along St. Maurice river. For several miles around the city of Three Rivers, however, search has been made at different times for gravel with negative results. Two large deposits from which much gravel has been taken for roads are found, one north of Charette, the other one southeast of St. Boniface. Near St. Elie and for several miles northeast there are numerous surface indications of gravel, and unless the deposits are very shallow, there should be a considerable amount of gravel available.

178. *Lot 5, Range IV, Augmentation of Caxton; ¾ mile north of Charette Station.*

The deposit forms a flat-topped ridge covering a large area. An excavation opened in the west end of the ridge measures over 3,000 square yards in extent and reaches a depth of 20 feet. The gravel is generally coarse and uniform in size, except in the upper 10 feet of the east end of the pit, where it is finer and carries 75 per cent sand. Sample No. 178 represents the average run, 178a, the finer gravel of the upper east bank. An abrasion test run on pebbles of sample No. 178 gave a percentage of wear of 9·4 (Grading A). The gravel is partly weathered in the upper 10 feet and fresh below that depth. It has been used at different times for surfacing stretches of the Charette-Yamachiche road, which is now improved over its whole length. Except for stretches recently re-surfaced, the road was in good condition when examined in the summer of 1929. Freshly applied gravel, however, takes long to compact under the light traffic using the road.

179. *Lot 12, Range IV, Caxton; at St. Elie.*

Coarse, well-graded gravel carrying 3 per cent boulders is exposed in a small side-hill excavation opened in the upper half of a low bluff facing a brook. Pebbles of sample No. 179, taken from weathered gravel at depth of 3 to 6 feet, showed a percentage of wear of 11·8 (Grading A) in the abrasion test. The pit has a maximum depth of 9 feet and does not apparently reach the bottom of the deposit, although the pit floor is sandy in places. For several miles to the northeast of the village of St. Elie there

are numerous surface indications of gravel. The depth of gravel probably is not uniform over the whole area and can not be judged from the small pit just described, which lies in the slope of a bluff along the bank of a brook, whereas most of the gravel area to the northeast is level and does not lie along any stream.

180. *Lot 67, Range I, St. Etienne; on edge of escarpment facing St. Maurice river.*

The deposit is in the form of a narrow ridge on top of a high clay bluff facing St. Maurice river to the east. The ridge trends north-south and is said to be over one mile in length. An excavation covering 3,500 square yards on top and at the north end of the ridge reaches the underlying clay at an average depth of 6 feet. The gravel is uniformly coarse throughout the pit and carries 35 per cent sand. The coarseness is due to the high percentage of large pebbles. Through a portable screen the oversize is easily removed and a good road material is thus obtained, as the gravel is otherwise well graded. A smaller pit 350 yards farther south in the west slope of the ridge, which is here wider and flatter, shows gravel that is more sandy and not quite so coarse.

Champlain County

The investigation work covered only the southern part of the county, that is, from St. Lawrence river to about 25 miles inland.

Gravel is scarce throughout the area examined, more so near St. Lawrence river. Good results have been obtained in surfacing roads of small traffic, both sides of Ste. Anne river, with gravel hauled from flats along that river at low-water level, usually in late summer. This is the only gravel known in that part of the county.

182. *Three miles south of St. Tite; on the farm of E. Gagnon.*

The deposit is flat-lying and of unknown extent. Four excavations varying in depth from 3 to 18 feet and the larger one covering 4,800 square yards have been opened in the deposit, which is largely composed of sand carrying large layers or pockets of gravel, also smaller pockets of boulders and unsorted drift. About 25,000 cubic yards have been taken out, and judging from what is left exposed and from the somewhat irregular outline of the pits, it looks as if the better graded material was now almost exhausted.

183. *One and a half miles northwest of St. Tite; west of fork of roads.*

Gravel forms the core of a steep-sloped ridge, with sand in both slopes. A road cut through the ridge has been gradually enlarged and deepened so that the excavation measures now over 10,000 cubic yards and has a maximum depth of 30 feet. The gravel is well graded, medium fine, fairly uniform in size and carries on the average 50 per cent sand, mostly coarse. The depth of weathering is about 5 feet. Sample No. 183 is from the upper 2 to 5 feet in the weathered zone, and 183a from a depth of 22 to 25 feet

in fresh gravel. All excavated gravel has been used on roads, most of it on the newly improved road between St. Tite and Ste. Thècle, which is now in very good condition. The amount of gravel in the central part of the ridge alone is conservatively estimated at 50,000 cubic yards.

185. *Two and three-quarter miles northeast of Ste. Thècle; at fork of roads on county line.*

The deposit forms a low terrace about 200 to 250 yards in length and 35 to 40 yards in width. An excavation covering 1,200 square yards and reaching the bottom of the deposit at a maximum depth of 7 feet shows gravel that is well graded, fairly coarse, uniform in size throughout the pit and carries about 40 per cent sand. Pebbles are mostly gneiss and granite, 15 per cent of which are more or less weathered and friable at a depth of 5 feet. The gravel makes a firm, smooth surface and wears well under light traffic.

186. *One and a half miles northwest of Ste. Anne; along Ste. Anne river.*

There are several gravel flats along both banks of Ste. Anne river. A considerable amount of this material has been hauled for surfacing local roads as it is the only gravel found for miles around. Horse-drawn drag shovels carry the gravel up an incline to a storage bin, from where it is loaded by gravity into motor trucks. Near the surface of the flats the gravel is of about the right size and grading for road surfacing with but few oversize pebbles, but becomes very sandy at depth. For that reason not more than the upper 1 to 2 feet of the deposit is used. Good road surfaces under small traffic have been built with the gravel where care was taken not to use too sandy material. The gravel flats are of large extent but parts of them are very sandy on surface.

Portneuf County

There is a very little gravel throughout the southern part of the county, and the few deposits noted are nearly all of small extent or very shallow. One large deposit is found in the high, steep bluff facing St. Lawrence river half way between Neuville and St. Augustin.

Crushed limestone can be easily obtained at a reasonable cost from a number of quarries near St. Marc and has been used a great deal in the building of broken stone roads with bituminous surface treatment in the southwest part of the county, where there is no gravel.

193. *One and three-quarter miles west of St. Raymond; on the farm of E. Moissan.*

In a small pit opened in a shallow deposit not more than 4 feet deep there is exposed medium-coarse gravel, uniform in size and carrying about 45 per cent sand. Iron oxide gives the material a strong rusty colour and in places cements it together in lumps. Notwithstanding its shallow depth and rusty colour, the gravel is fairly fresh and hard and makes a very

smooth and firm surface, the iron oxide binding it strongly on the road. The soil is very gravelly for several miles to the west, but the gravel is everywhere shallow, and No. 193 appears to be of better quality for road use than that seen at other places.

195. *One mile southeast of Ste. Catherine; along road to St. Augustin.*

The deposit forms a slight, ridge-like elevation several hundred yards in length and 45 yards in average width. As seen in the exposed bank of a shallow excavation, 4,800 square yards in area, the gravel is well graded, medium coarse and carries about 40 per cent sand, mostly coarse. Pebbles are two-thirds granite and one-third gneiss, with 10 per cent weathered at a depth of 4 feet. The deposit has a maximum depth of 7 feet and is underlain with sand.

198. *Three and a quarter miles northwest of St. Augustin; along road to Ste. Catherine.*

Gravel occurs as a pocket in the lower slope of a large sand ridge. A large excavation in the pocket reaches sand at one end and in the bottom, or 12 feet from surface. The gravel is poorly graded and very coarse and bouldery. Boulders make up about one-third and sand one-quarter of the whole. Pebbles and boulders are 55 per cent gneiss, half of which is more or less weathered, and 30 granite. Crushing is necessary in order to obtain a satisfactory road material. Other smaller pockets in finer and better graded gravel are seen elsewhere in the slope of the same ridge.

200. *Three and three-quarter miles west of St. Augustin; along Provincial highway and near parish line.*

In the upper steep slope of a high bluff facing St. Lawrence river, the 20-foot bank of a side-hill excavation shows gravel which varies much in coarseness, but is on the average very coarse and carries 20 per cent boulders. Pebbles and boulders are over 75 per cent limestone. The gravel is used for surfacing shoulders of the Montreal-Quebec paved highway, which passes here along the upper edge of the bluff. A good road material for surfacing local roads could be obtained by passing the run of the bank through a crusher, as the gravel is generally free from weathering. The excavation has been limited to the upper slope of the bluff, owing to the necessity of hauling up slope. Because of its size, shape, and situation, the deposit would be more advantageously worked by mechanical means, in which case part of the paved highway would have to be re-located farther away from the bluff.

Quebec County

Gravel is nowhere common in the southern part of the county, and particularly scarce along St. Lawrence river and for several miles inland. A large excavation over 25,000 cubic yards in size, opened in the lower slope of a rocky hill west of Loretteville, now shows more drift than gravel and the latter looks almost worked out. Another large pit north of St. Michel cuts through glacial drift only. Farther north, in the area underlain by crystalline rocks, there are few deposits developed, and most of them

are of small size and hold poor road gravel, with the exception of No. 202, southeast of Valcartier, where good, though bouldery, gravel is exposed in a small pit alongside of the road. Systematic search may reveal workable deposits of good gravel in the Precambrian area, which is as yet sparsely settled. Good gravel is scarce, however, along that part of the new Provincial highway leading to the Lake St. John district that passes through this county.

202. *Two miles southeast of Valcartier; along road to Loretteville.*

The 9-foot bank of a small pit opened in a flat-topped ridge shows well-graded but very coarse and bouldery gravel, made up approximately of boulders 30 per cent, pebbles 50, and sand 20. Pebbles and boulders are about half gneiss and half granite. When the oversize stones are screened out, it makes a good road material as although it does not pack readily on sandy roads, it wears well. Owing to the high proportion of oversize, it would be better to pass the run of the bank through a portable crusher so that no stones go to waste; moreover, the crushed material packs more firmly on the road. The ridge is well over 10,000 cubic yards in size.

Vaudreuil and Soulanges Counties

Large areas of gravel occur in different parts of the Rigaud hills; other deposits are found along the Ontario border at Pointe Fortune, and between Ste. Justine and lake St. Francis. A large sand tract near St. Lazare holds streaks or pockets of gravel and gravelly sand. Elsewhere gravels are scarce, particularly in the flat clay land covering most of Soulanges county and the eastern part of Vaudreuil county.

The gravel areas of the Rigaud hills appear to be segregations of fine material within boulder deposits. These boulder deposits occupy wide areas and in places are almost entirely made up of boulders. Part of one large deposit near Rigaud holds nothing but boulders. Owing to the fact that it is entirely bare of vegetation, it has attracted considerable attention and has been named "Devil's Garden" ("Champ de Guérets"). The amount of gravel in the different deposits throughout the hills is unknown, but is certainly very large, and the amount of boulders is practically unlimited. The rock types predominating in the deposits are the same as those outcropping in the hills, that is, syenite, granite, and syenite-porphyry. The deposits carry also a certain amount of Potsdam sandstone, and a small proportion of Precambrian gneiss and anorthosite. Near Pointe Fortune there are several deposits of moderate depth but fairly large extent. The gravel is generally coarse and carries from 10 to 20 per cent boulders. A long narrow ridge of gravel at Rivière Beaudet rises rather sharply from 15 to 45 feet above the surrounding flat. If the whole ridge be of gravel, the amount present is in the neighbourhood of ten million cubic yards. If only the upper part were of gravel the amount available would still be very great. The gravel is coarse, carries up to 50 per cent boulders and is only moderately hard. A large sand area north of the ridge holds occasional pockets of gravel. Most of the gravel is either very sandy or thickly covered with sand. A number of gravel deposits are found between St. Justine and the large ridge at Rivière Beaudet. The greater number of these deposits occur in close association with glacial drift. In some cases

the gravel lies in a rather thin blanket on the top of a boulder clay ridge, in others as a pocket of gravel in boulder clay or sand. The large sand tract near St. Lazare apparently holds more gravelly sand than gravel. The gravelly sand and gravel are said to have a maximum depth of 10 feet, including an overburden of sand up to 5 feet in thickness.

Huntingdon County

Gravel is fairly common throughout the greater part of the county, but nearly all important deposits lie within 2 to 3 miles of the southern border. It is scarce around the town of Huntingdon and in that part of the county bordering lake St. Francis. As a result of the large amount of road work done in the last few years, all known deposits have been developed to some extent, and some of them are now abandoned, either on account of the gravel being exhausted or because of its grading into inferior material. An almost continuous chain of boulder clay ridges runs parallel to lake St. Francis and at a distance of from 3 to 5 miles from the lake shore. It gradually becomes lower and less clearly outlined as it passes northeastward into Beauharnois county, where the boulder clay forms disconnected patches and occasional low ridges. Boulder clay resembles gravel in character, but makes a less desirable road material, on account of being poorly graded and carrying much fine sand, silt, and clay. As such deposits are more impervious than gravel deposits, they are less adversely affected by weathering agents and where the proportion of pebbles and medium-size boulders is high, a fair road-surfacing material can be obtained through crushing and screening. Northwest of the town of Huntingdon, where gravel is totally lacking, a pit has been opened along the crest of a ridge of boulder clay and the stony material is crushed and screened for road use.

206. *Lot 20, Con. I, Dundee; alongside road and near line of Con. II.*

The deposit, which lies alongside of a ridge of glacial drift, has been excavated over an area of 3,900 square yards and a maximum depth of 13 feet, which is the full depth of the gravel. The gravel is coarse and carries 10 per cent boulders but is otherwise well graded. Pebbles showed a percentage of wear of 20·1 (Grading A) in the abrasion test. Drift is exposed at one place in that part of the gravel bank nearest to the ridge of drift. The gravel is used for surfacing local roads, all material over 1½ inches in size being screened out and piled in the pit. The amount of gravel available is estimated at four times that already taken out, or about 35,000 cubic yards.

207. *Lot 18, Con. IV, Dundee; just south of C.N.R. track.*

The deposit, which is mostly gravelly sand, covers a large area and has been excavated at several places, the larger pit covering 3,800 square yards, with a maximum depth of 12 feet. The excavations are no longer worked for road purposes, on account of the material being too fine and sandy. Much fresh, coarse sand, suitable as concrete aggregate, is exposed in the larger excavation, but very little road gravel is left. The banks of the smaller pits are concealed behind sand talus, and the deposit as a whole appears to be very sandy.

208. *Lot 18, Con. IV, Dundee; on the International Boundary.*

A small flat gravel ridge measures at least 10,000 cubic yards including overburden, which is said to be thick in places. The size estimate does not take into account the southern end of the deposit, which lies past the International border. The gravel is of about the same grading and coarseness as No. 206. Very little has been used so far in road surfacing, but judging from the good results obtained it appears to be of the same quality as No. 206.

210. *Lot 61, Con. V, Godmanchester; along C. N. R. track.*

Gravel forms a large, flat-topped ridge, which lies at the southwest end of a chain of ridges trending across the county in a southwest-northeast direction and made up largely of glacial drift. One excavation in the gravel ridge worked by the township for road purposes, covers an area of 17,000 square yards, and another, worked by the Canadian National Railway company for ballast material, is at least four times as large. The coarser gravel is now about exhausted, but there is a large amount of fresh, fine, sandy gravel left in the bottom of the two excavations. Underground water, however, lies a few feet below the bottom, and deeper digging would require an excavator suitable for working under water, such as a drag-line scraper. Most of the material taken out of the township pit has been used in surfacing local roads and good results have been obtained. The roads were examined after prolonged dry weather and were very smooth, but rather dusty.

211. *Lot 55, Con. IV, Godmanchester; ¼ mile from line of Con. V.*

Fine, sandy and clayey gravel is exposed in a side-hill excavation covering 850 square yards opened in the slope of a terrace lying along the lower northwest slope of a large ridge of glacial drift. It is not known whether the whole terrace is gravel; if so, there would be well over 10,000 cubic yards. The gravel is covered with 2 to 4 feet of fine sand, which should not be a serious obstacle in the development of the deposit, because the steep slope of the terrace would make it possible to open a large side-hill cut with a high bank and thus minimize the relative cost of stripping. The gravel has been used in surfacing a stretch of the road between concessions III and IV. Although high in sand, it compacts readily to a smooth surface, but is rather dusty when dry.

213. *Lot 42, Con. IV, Godmanchester; along forced road.*

Gravel has been excavated over an area of 4,800 square yards and to the full depth of the deposit, which averages 9 feet. Further development would require the removal of several farm buildings, including two houses. The amount of gravel that can be obtained is unknown. The deposit forms part of a long, narrow ridge of glacial drift. The gravel has been used on the main road leading to Huntingdon and other local roads. It is well graded though soft, coarse, and holds about 10 per cent boulders. It consolidates readily on the road, wears evenly, but is not durable under moderate traffic and makes a dusty surface when dry. Pebbles had a percentage of wear of 29·1 (Grading A) in the abrasion test.

214. *Lot 47, Con. II, Godmanchester; at Cazaville.*

Nearly all gravel of size and coarseness suitable for road use has been removed from the deposit. A large excavation extending over 10,000 square yards shows almost entirely sand and gravelly sand, of which there is a large amount, and which makes a good cement-concrete aggregate. Gravel for road purposes is now being hauled from deposit No. 215.

215. *Lot 47, Con. I, Godmanchester; 1 mile northwest of Cazaville.*

The deposit forms a pocket in a low ridge of sand. The gravel is well graded, but soft and interstratified with much sand. It is used in maintenance work on a stretch of the nearby Provincial highway, which will soon be covered with surface-treated macadam. Gravel is scarce in this part of the county.

216. *Lots 25, 26, Con. II, Godmanchester; near line of Con. III.*

A narrow and shallow pit opened along the crest of a ridge of glacial drift now extends over 5,000 square yards. The drift carries a larger proportion of stone beneath the crest than in the remainder of the ridge, and looks like coarse and bouldery gravel. The material is dug by gasoline shovel, and is crushed and screened with a portable plant. The product is used in the surfacing of unimproved roads, and in the maintenance of local gravel roads, including a stretch of Provincial road. It is a durable road material, which wears evenly, but is dusty when dry. The dust on the road is not all produced by traffic wear; a great deal of it is formed in the crushing of the material. Although gravel is almost totally lacking in this part of the county, there is an abundant supply of boulders available from the many ridges of glacial drift. This deposit appears to be richer in stone than the average glacial drift of the district.

218. *Lot 9, Con. II, Elgin; near line of Con. I.*

Over 15,000 cubic yards has been taken from this deposit, which forms a flat-topped ridge, with a maximum depth of gravel of 15 feet. The gravel is generally fine and sandy, but outside of the weathered zone in the upper part of the pit bank, the sand is very coarse. In the upper bank, the gravel is less sandy, but the sand finer, and the material as a whole not so well graded and is softer. Much poorly graded gravel including layers of fine sand and silt is seen in that part of the bank that runs parallel to the direction of the ridge, and is assumed to be on the edge of the deposit. The larger part of the gravel taken out has been used in surfacing local roads. Stretches of the road between concessions I and II recently surfaced were found on inspection to be in excellent condition, whereas older stretches were decidedly dusty when dry.

223. *Lot 38, Con. III, Hinchinbrook; near line of Con. II.*

The larger part of the gravel used now, in the improvement of the Provincial highway leading to Huntingdon, is hauled from this deposit. The excavation measures over 4,000 cubic yards, and although the deposit

does not average more than 7 feet in depth, it covers a fairly large area. The gravel is remarkably uniform in grading, and carries on the average 50 per cent of coarse sand. The material compacts firmly on the road and is reasonably free from dust.

226. *Lot 27, Con. II, Franklin; ½ mile east of St. Antoine.*

The excavation extends over an area of 9,000 square yards and to a depth of 5 feet, which is the full depth of the deposit. The gravel is well graded, uniform in coarseness, and carries a high proportion of sand, all of which is coarse. Slightly finer and much less sandy gravel than the average is seen in that part of the pit nearer to the north edge of the deposit. The gravel is extensively used on local roads and on the county road leading to St. Chrysostôme in Chateauguay county. The gravel works best on clay subsoils, but does not consolidate so firmly and produces much dust on light sandy soils, although sections with sandy subsoil which had been surfaced and travelled over for some time were found in good condition and quite smooth. The gravel from the north end of the deposit is particularly well graded for road purposes.

229. *Lot 81, Con. II, Havelock; at Covey Hill.*

In an excavation partly talus-covered, the exposed part shows rusty gravel which varies much in coarseness, but is on the whole coarse and bouldery, and carries a small amount of sand, some streaks being almost entirely free from sand. Pebbles of sample No. 229, taken close to the surface of the deposit, had a percentage of wear of 15·0 (Grading A) in the abrasion test. When the larger stones are screened out the gravel gives good results in road work and compacts readily. It has been used for the improvement of the road between Covey Hill and Vicar, the surface of which is now in excellent condition. The deposit forms a terrace that can be traced for miles, but the gravel is not all of proper size and grading for road use.

231. *Lot 106, Con. III, Hemmingford; near line of Con. II.*

The deposit lies along the southeast slope of a ridge of glacial drift. In the lower slope, the gravel is uniform in size and grading, carries about the right proportion of sand, but the sand is too fine. Towards the crest of the ridge, the gravel merges into irregularly sorted material, made up largely of sand and boulders. Pebbles of sample No. 231, from fairly fresh gravel, had a percentage of wear of 21·2 (Grading A) in the abrasion test. The gravel has been extensively used in surfacing the road from Hemmingford to the International Boundary and a section of the Provincial highway between Hemmingford and Corbin. Although only moderately durable, the gravel makes a smooth and firm surface. It is said to take a long time to compact properly under traffic, undoubtedly owing to the fineness of the sand.

232. *Lot 178, Con. V, Hemmingford; ⅓ mile south of road intersection.*

The deposit forms a small, flat-topped ridge and has a maximum depth of 10 feet. The gravel is slightly bouldery, coarse, well graded, but somewhat soft on account of partial weathering. Several local roads have been

surfaced with the material, which is now being used in the improvement of a section of the new Provincial highway east of Hemmingford. It compacts readily and smoothly on the road, but is not durable and produces much dust under traffic when in a dry state. Excavating the deposit to its full extent would necessitate the removal of a house with farm buildings.

Châteauguay County

Gravel is totally wanting over the greater part of the county. The only important deposits are found grouped together in the northeast end, close to the Laprairie county border. A few small deposits scattered over the southern part of the county are now becoming rapidly depleted. The deposits described below are all, apart from No. 237, situated in the northeastern end of the county.

237. *Three-quarters of a mile southwest of Cairnside; just south of road between Ranges IV and V.*

The deposit lies along the southeast margin of a wide, flat-topped ridge of glacial drift. Gravel, which varies much in coarseness but is generally coarse, bouldery, and sandy, is seen exposed for a distance of over 150 yards in a long, narrow pit. Patches of bouldery drift are also exposed, and it seems that the excavation has reached beyond the gravel into the drift, so that the gravel is now almost exhausted. The road from Cairnside to Brysonville is now being surfaced with gravel from this deposit. The material consolidates readily and makes a smooth but dusty road surface.

Another larger excavation in the same ridge, one mile and a quarter to the northeast, shows almost entirely bouldery drift. Boulders are for the most part hard sandstone, and if crushed to proper size would make a fair aggregate for any type of pavement except waterbound macadam. The amount of boulders is very large.

240. *Three miles south of Ste. Philomène; Côte Ste. Marguerite, farm of T. Thibert.*

The deposit is largely medium-fine sand. A 30-foot face in a large excavation, dug in the steep slope of a bluff, shows occasional large streaks or pockets of coarse gravel running irregularly through the sand. Pebbles of sample No. 240, taken from a streak of fresh gravel at a depth of 17 feet, showed a percentage of wear of 9·4 (Grading A) in the abrasion test. Outside of the gravel streaks, the sand is uniform in coarseness and grading, and has been extensively used on local clay roads. The sand is rather fine, but is found to compact quickly and form a smooth, hard surface, which, however, has not the durability of a gravel road. Older stretches of these sand-clay roads are found to be dusty when dry.

241. *One and three-quarter miles southeast of Ste. Philomène; Côte Ste. Marguerite, farm of E. Vallée.*

The deposit occupies the southeast slope of a flat-topped knoll or ridge of glacial drift. The gravel is generally coarse and in places bouldery, but coarseness varies a great deal from place to place The finer gravel is

as a rule the more regularly graded, on account of not carrying so much fine sand as the coarser material. Crushing and screening the gravel is advisable in order to obtain a uniform product. As regards composition and soundness of pebbles, it is much the same as deposit No. 242. About 4,200 cubic yards have been taken out and the amount available is unknown but in all probability large.

242. *Two miles southeast of Ste. Philomène; Côte Ste. Marguerite, one-half mile northwest of C.N.R. track.*

A large excavation in the form of a side-hill cut, 2,300 feet in length, shows gravel that is more uniform in coarseness and grading than the other local deposits. Although there is much coarse and bouldery gravel and also much sandy material exposed in the long pit face, most of the coarser and more bouldery gravel is concentrated in the central part of the deposit, from where the gravel decreases regularly and gradually in coarseness towards both ends. The material is used only for ballast. Pebbles of sample No. 242, taken from fresh gravel at depth of 11 feet, had a percentage of wear of 9·2 (Grading A) in the abrasion test.

243. *One and a half miles southeast of Ste. Philomène; Côte Ste. Marguerite, farm of A. Bannan.*

A 30-foot excavation in the steep northwest slope of a flat-topped ridge shows material that is much the same as in deposit No. 240, that is, sand with occasional streaks or pockets of fine to coarse gravel. The sand, though not so uniform in size, is on the whole coarser than in deposit No. 240. The deposit lies along the northwest slope of a wide, flat-topped ridge of glacial drift.

Deposits Nos. 240, 241, 242, and 243 form part of a wide, flat-topped ridge of glacial drift that trends in a northeast-southwest direction and has a length of several miles.

Napierville County

A large gravel area between St. Rémi and St. Michel, including deposits Nos. 244 and 245, has been extensively worked in the past for railroad ballast and road building. Although there is still a considerable amount of material available, most of what is left is very sandy. In the remainder of the county, the few deposits found are of small size and are becoming rapidly exhausted. All gravels are sandy, and some of them hold weathered or soft pebbles, but they all consolidate readily and form smooth surfaces on the clay soils that cover the greater part of the county. Some stretches resemble more sand-clay than gravel surfaces. The gravel roads were examined during a spell of dry weather, and outside of recently surfaced stretches, were found quite dusty.

244. *One and a quarter miles southwest of St. Michel; near border of Con. V of Sherrington township.*

This small and shallow deposit lies at the south end of a large gravel area, which runs for several miles northwards and includes No. 245. Gravel does not form a continuous deposit over that distance, but occurs as a series

of streaks or pockets through a large sand area. In addition to Nos. 244 and 245, there are several other excavations, including a railway pit, which are now abandoned on account of the material turning too sandy. Gravel from deposit No. 244 is also sandy but well graded, holds much coarse sand, and consolidates readily on local clay roads.

245. *One mile east of St. Rémi; Con. S. Sanguinet Monnoir, farms of O. Robert and F. Houle.*

The deposit rises but a few feet above the level of a sand area in which it is included. Sandy gravel is seen throughout a large excavation extending over 8,000 square yards and dug to the full depth of the deposit, which averages 9 feet. The gravel is used on local roads and in the adjacent part of Laprairie county. Good results are obtained on roads with clay subsoil. Stretches that have been gravelled for at least one year are dusty when dry.

247. *Douglasburg; near border of Con. VIII of Sherrington township.*

About 4,800 cubic yards of gravel have been taken out of this deposit, which is now more than half exhausted. The gravel holds from 15 to 30 per cent of friable pebbles and is sandy, the proportion of sand being nowhere less than two-thirds. Best results are obtained on clay roads, where it compacts readily to a smooth and firm surface, which is more of the sand-clay type of road surface, and does not possess the wearing quality of the average gravel road. A good example of this kind of surface can be observed on a stretch of Provincial highway a short distance west of Douglasburg.

248. *One and a quarter miles west of Napierville; Con. VIII, De Lery; farms of E. Cyr and N. Fortin.*

A large excavation, 15,400 cubic yards in size, cuts through the whole width and depth of a gravel deposit occupying the southwest end of a ridge. The amount excavated represents probably less than half of the size of the deposit, for the entire recovery of which it would be necessary to remove a house and farm buildings. The gravel carries on the average 60 per cent sand, and although rather sandy it is used with good results on clay soils in the making of road surfaces of the sand-clay type. After some time on the road, the gravel becomes dusty during dry weather: this is apparently due not so much to the high proportion of sand as to its fineness.

St. Johns County

The few deposits found in the county have been worked extensively for road gravel and most of them are now more than half exhausted. The only deposits of comparatively large size are found west of Odelltown, southwest of Ste. Blaise and of St. Johns. The few other deposits are of small size and are situated at the south end of the county. A considerable amount of gravel has been taken from the large deposit west of Odelltown both for railway ballast and road building. There is still much gravel available, but it is coarse and has to be crushed and screened

to make it a satisfactory road-surfacing material. Several shallow deposits of fine and sandy gravel southwest of Ste. Blaise are included in a large sand tract several miles in length. Several large pits have been opened in the gravel, but an estimate of the amount available is difficult to make on account of sand covering the whole area. Two fairly large deposits southwest of St. Johns hold soft gravel. One may be considered as depleted, as what is left is weathered, soft, and sandy. The other is now more than half exhausted, and the remainder is being rapidly absorbed in road building. It is rather soft for the most part, but holds large streaks of fresh, clean, well-graded material.

251. *Two miles west of Odelltown; Con. IV, Lacolle.*

Over 15,000 cubic yards have been excavated for road use, mostly in the last few years, and previous to this a much larger amount had been taken out for railway ballast. The gravel is coarse and holds a low proportion of sand and boulders. An abrasion test on pebbles (Grading A) gave a percentage of wear of 13·2 in the abrasion test. It is now crushed and screened for road-surfacing purposes in a portable plant erected in the pit. The crushed material is extensively used in surfacing local roads. The gravel surfaces were firm and smooth, but dusty when inspected during a spell of dry weather. A stretch of road treated with calcium chloride was found exempt from dust. The greater part of the dust is not the result of wear on the road, but is in the gravel screenings before they are laid on the road as a finishing course.

255. *Two miles west of St. Valentin; near county line and D. & H.R.R. track.*

The deposit holds gravel that is much weathered and soft. It is irregularly graded, but owing to its softness compacts readily on the road.

257. *Two and three-quarter miles southwest of Ste. Blaise; Con. III, Seconde Grande Ligne; on the farm of B. Breault.*

Several large but shallow deposits of sandy gravel are found included in a large sand area trending north-south from the village of St. Blaise to a short distance south of No. 257. Some of the deposits are now exhausted or not worked any longer on account of being too sandy. In No. 257, the gravel is fresh, hard and, although carrying a great deal of sand, is well graded and the sand mostly coarse. It has been extensively used for road purposes: it consolidates firmly, wears evenly, and is durable under small traffic.

258. *Two miles southwest of Ste. Blaise, Con. II, Seconde Grande Ligne; on the farm of A. Gagnon.*

The deposit occurs in the same large sand area as No. 257, and the gravel possesses much of the road-making qualities of No. 257. Most of the gravel used on local roads comes from one of these two deposits.

259. *Three and a half miles southwest of St. Johns; Con. II, Barony of Longueuil; on the farms of A. Tremblay and A. Roulier.*

Close upon 20,000 cubic yards of gravel has been excavated, which is more than half the size of the whole deposit. Most of the gravel exposed in three large excavations is partly weathered, soft, irregularly graded, coarse, and sandy. It carries a large proportion of coarse pebbles and fine sand, but not enough medium-size material. One of the pits dug at the south end of the deposit shows in places thick streaks of gravel that is much fresher and better graded than the average. Pebbles from sample No. 259, which was taken in the fresher and better graded gravel, showed a percentage of wear of 14·1 (Grading A) in the abrasion test. The streaks lie under 3 feet of overburden, whereas the average thickness of overburden for the whole deposit is not over 2 feet. Outside of the better graded material, which is sold solely as cement gravel, the larger part of the gravel excavated is used for road work. For this purpose the material is crushed and screened in a portable plant erected at the pits. On account of the softness of the gravel, there is much dust produced in the process of crushing, and for this reason the screenings (material passing ¼-inch screen) are considered as useless and thrown away. The crushed and screened gravel is now used in maintenance work on a section of the Provincial highway between St. Johns and Napierville that is treated with calcium chloride as dust preventive. The gravel wears fast and is not considered of good quality for main highways. It is intended to re-surface this highway in the near future with surface-treated macadam, for which purpose there is plenty of good, crushed quarry rock available near the city of St. Johns.

Chambly County

The only gravel occurring in the county is found in the slopes of mount St. Bruno. A considerable amount of gravelly sand covers the lower southern slope of the hill, but it is not coarse enough to be considered of good quality for road surfacing. Coarse gravel is found higher up the slope, and although not covering such a large area as the finer material of the lower slope, it is known to be in large amount. One deposit has been extensively worked in the southeast slope of the hill.

262. *One-half mile north of St. Bruno; farm of E. Goyer.*

A pit has recently been opened in gravelly sand, lying under 3 feet of sand. The gravelly sand carries about 25 per cent pebbles in the coarser part, and not more than 10 per cent as pit average. The pit is in the lower south slope of mount St. Bruno, and according to information gathered from several land owners, the gravelly sand probably underlies a considerable area in the lower south slope, but is everywhere concealed under a thick blanket of fine sand. The material, as judged by that part exposed in pit 262, is too sandy for road purposes.

263. *One and a quarter miles west of St. Basile; property of F. H. Clergue.*

The deposit, which is an old gravel beach, lies in the middle southeast slope of mount St. Bruno and a short distance from a Provincial highway that skirts the flank of the hill. The gravel exposed in a large excavation

20 feet in maximum depth is rusty, very hard, coarse, and bouldery and carries but a small amount of sand. As regards size of constituents, it is made up on the average of 10 per cent boulders, 65 per cent pebbles, and 25 per cent sand. Boulders are for the most part 6 inches in size and sand is very coarse. About 95 per cent of boulders and pebbles are composed of fine-grained, fresh, and very hard trap rock. Pebbles showed a percentage of wear of 4·9 (Grading A) in the abrasion test. Nearly all gravel excavated, 43,000 cubic yards, has been absorbed in road work and it is thought that there is a larger amount still available in the deposit. On the road the gravel consolidates firmly and is durable, but does not make so smooth a surface as do finer and softer gravels. Smoothness is attained by applying to the surface a thin course of finer material.

Iberville County

There are several large deposits of sandy gravel in the north and northeast part of the county, but elsewhere gravel is scarce. All deposits have been extensively worked, either for road or for cement gravel. Most of the gravel used for concrete works in the city of St. Johns comes from the several deposits of the north end of the county. The length of haul to St. Johns is 6 miles. With the exception of one deposit, the gravels are rather too sandy for good results in road surfacing.

265. *Two miles northeast of St. Alexandre; farm of J. Breault.*

A large sand area, that trends in a north-south direction for a distance of over 6 miles, includes several deposits of sandy gravel, carrying on the average not more than 25 per cent pebbles. No. 265, which is the more southerly, is slightly less sandy, but more weathered and softer, than the others. It carries on the average 25 to 30 per cent pebbles, over half of which are weathered or soft. A section of the road leading to Iberville, and shorter stretches of other local roads, have been surfaced with gravel from deposit No. 265. Although carrying much fine sand, the gravel compacts satisfactorily and wears evenly but would probably not stand too heavy traffic, because a large proportion of the pebbles crumbles readily. It is found satisfactory on local clay roads carrying light traffic. The roads were inspected during a period of dry weather and were more dusty, but in far better condition than the unsurfaced sections.

268. *One mile northeast of St. Grégoire; on the farm of E. Tétreau.*

The material is more properly gravelly sand than gravel, as it does not carry on the average more than 20 per cent pebbles. Although sandy, it is well graded and uniform in coarseness throughout that part exposed in a large excavation, 5,500 square yards in extent. On the road it does not compact readily, and is probably not durable, but improves earth roads considerably. South of the pit there is a much larger excavation, now all covered with talus, from which gravel was hauled in the past for railway ballast. The deposit forms a wide terrace occupying the lower south slope of mount Johnson. The gravel or gravelly sand lies under 2 to 4 feet of fine sand.

269. *One and a quarter miles northeast of St. Grégoire; farm of U. Benoit.*

The deposit lies in the lower south slope of mount Johnson, but at a higher level and in steeper ground than No. 268. The material is largely gravelly sand carrying not more than 25 per cent pebbles on the average, but coarseness varies and large streaks of properly graded road gravel are not uncommon. On account of the great depth of the deposit, fresh material is available. Most of the sand and gravel taken out now is used as aggregate in concrete works. A large number of essexite blocks or boulders, some over 5 feet in diameter, interfere with development work. These blocks are largely confined to the upper part of the deposit.

270. *Two and a quarter miles northwest of St. Grégoire; farm of E. Metras.*

Although large sections are sandy, the deposit carries coarser and better graded road gravel than any other large deposit of the county. Pebbles showed a percentage of wear of 8·8 (Grading A) in the abrasion test. A considerable amount of road gravel was taken out at one time, as judged by the size of the several excavations, the larger one of which measures over 100,000 cubic yards. There is a stationary crushing and screening plant erected in the main pit, with drag shovel, steel cable, and steel mast resting on concrete foundations. The plant has been idle for some time and is in need of repairs. The deposit is flat-lying, rather shallow, but covers a large area. The large amount of material still available is probably more sandy than what has been already taken out.

Missisquoi County

Gravels are fairly common in the southern half of the county but are scarce in the northern half, particularly in the northwest corner, around the town of Farnham. Although all gravels are well graded as regards size of constituents, most of them have poor wearing qualities on account of being weathered and soft. The pebbles crumble readily under traffic and the road surface soon becomes dusty or muddy. In the eastern part of the county, where the land is more hilly, the deposits are deeper and the gravels fresher and of better road-making qualities than those of the western part. The muddy and somewhat slippery condition observed on old gravel roads when wet is due to the large proportion of more or less soft slate pebbles found in all deposits. The fresher gravels of the eastern part of the county, although not entirely exempt from this defect, are much less seriously affected than the weathered gravels.

273. *Lot 6, Con. VII, Stanbridge; near line of Con. VI.*

Between Bedford and the International Boundary there are several deposits of gravel of about the same character as No. 273 here described. The gravel is well graded and uniform as regards coarseness, but soft, even when fresh. It compacts readily on the road and stands well under light traffic but wears fast under a moderate amount of traffic. Its use has been discontinued on main roads.

274. *Lot 19, Con. VI, Stanbridge; near road intersection.*

Coarse and bouldery gravel is exposed in a large excavation extending over 5,700 square yards. The pit was originally opened in finer gravel and has been gradually extended into coarser and more bouldery material. Although a well-graded, uniform product could be obtained by screening out the larger stones, it would be suitable only for roads carrying light traffic, as it holds a high amount of soft and friable pebbles. Old gravel-road surfaces are dusty.

276. *Lot 14, St. Armand; near road to Frelighsburg.*

The deposit forms a steep-sloped, round knoll in which a side-hill cut, up to 30 feet in height, shows fresh, well-graded, sandy gravel carrying on the average 50 to 60 per cent coarse sand. The gravel is only moderately hard and durable, even where free from weathering. On local roads, which carry light traffic, it compacts well and makes a smooth surface.

277. *Lot 3, Con. X, Dunham; west side of forced road.*

The gravel is similar to No. 276 as regards regularity of grading, but more weathered and softer.

279. *Lot 28, Con. V, Dunham; along Yamaska river.*

The deposit lies in the bank of Yamaska river, and forms a flat-topped ridge, the slopes of which are thickly covered with clay. An excavation has been opened along the crest of the ridge, where the overburden is thinner, and shows fresh, well-graded, coarse gravelly sand, carrying on the average not more than 25 per cent pebbles. The gravel is too fine and sandy for good results in road work, but makes a good aggregate in concrete. All the gravel taken from the deposit is used in municipal works in Cowansville.

280. *Lot 28, Con. VI, Dunham; along Yamaska river.*

The deposit occupies the slope of a steep bluff facing Yamaska river, and can be traced more or less continuously as far as No. 279, three-quarters of a mile to the southeast. Fresh, clean, well-graded gravel is exposed in a large side-hill excavation 600 feet in length and 40 feet in maximum depth. Although coarseness varies in places, it is on the whole uniform, taking into consideration the large section exposed. It is a medium-coarse gravel carrying on the average 50 per cent coarse sand. Pebbles of sample No. 280, taken from fresh gravel at depth of 25 feet, had a percentage of wear of 8·8 (Grading A) in the abrasion test. The gravel consolidates readily and firmly on the road, forming a smooth surface that wears evenly. It holds a large proportion of slate pebbles, and for that reason old gravel-road surfaces are slightly muddy when in a wet state. It is without doubt the best road gravel of the county, though not so durable as some gravels found in other counties. It is extensively used in road improvement and is hauled for miles in all directions for that purpose. The gravel makes also a good aggregate in concrete.

Rouville County

A considerable amount of gravel, or more properly gravelly sand, is found in large sand benches at the foot and south side of mount Yamaska, mount Rougemont, and mount St. Hilaire. Beaches of coarse gravel are also known to occur in the slopes of the three hills, but the amount of gravel excavated in these beach deposits so far has been small. Outside of these three areas, gravel is found in a large, narrow ridge of glacial drift in the southeast corner of the county. In the remainder of the county gravel is totally lacking.

The gravels from the large sand benches at the foot of the three hills are all hard but vary a great deal in coarseness. Although most of them are poorly graded and sandy, there are also large streaks of well-graded material. Divergent results have been obtained in road surfacing, depending not only on the character of the material used but also on the type of road subsoil. For example, fine sandy gravels give generally indifferent results on the sand roads in the immediate vicinity of the deposits, but prove quite satisfactory on the clay roads farther away from the hills.

281. *One and a quarter miles south of Canrobert; Range Nord Casimir; farm of A. Mercure.*

The deposit occupies part of the east slope of a long ridge of glacial drift, and carries gravel that is generally fine and sandy near the surface, and coarse and rather bouldery at depth. A large excavation, 5,000 square yards in area, has been opened in the slope of the ridge. At one end the gravel in the lower part was found too coarse and bouldery and was left in place. The gravel has been extensively used for road making, as outside of this ridge there is no other gravel for miles around. It contains a large amount of friable limestone or calcareous slate pebbles, wears fast, and becomes quite dusty. On roads carrying very light traffic, good and smooth surfaces have been built with the material.

282. *Two and a half miles east of Abbotsford; Range St. Charles; farm of C. Ball.*

The deposit forms a long narrow ridge which is part of a wide sand bench stretching southeast from the foot of mount Yamaska. There has been a considerable amount of material excavated for various purposes, as attested by the size of several pits, either in the ridge proper or in the sand bench. The gravel in the ridge varies much in coarseness within short distances. In Ball's pit thin layers of sandy gravel alternate regularly with thicker layers of coarse and rather bouldery gravel, so that on the whole the grading is fairly uniform. Although the bulk of the gravel finds a ready market as concrete aggregate in the town of Granby, much well-graded, road gravel is obtained from a large section of the pit bank by screening out the larger stones. This part of the bank shows less sandy and coarser gravel than the average. About 4 feet of worthless sand or gravelly sand has to be removed from the top. Below that depth the material is fresh and carries but a small amount of soft pebbles. An abrasion test run on pebbles of sample No. 282, taken from fresh gravel at depth of 15 feet, gave a percentage of wear of 5·7 (Grading A).

283. *Three-quarters of a mile west of Mont St. Hilaire; farm of A. Guertin.*

The deposit is mostly coarse sand, with not more than 15 per cent pebbles. The material is only moderately hard, and compacts firmly to a smooth surface on clay roads carrying light traffic. It is much too sandy to produce durable results.

Bagot County

Gravels are common throughout the county, with the exception of the western end. The larger deposits are found grouped together in four different areas: east of St. Dominique, east and west of St. Liboire, north of Acton Vale, and northeast of St. Nazaire. A number of smaller deposits are scattered in the remainder of the county. Along the western border of the county gravels are almost totally lacking. The St. Dominique deposits have been extensively worked for road gravel to take care not only of local roads but also of roads in parts of Shefford and St. Hyacinthe counties. A considerable amount of gravel from these deposits for use in concrete is also hauled to St. Hyacinthe. The other deposits found elsewhere in the county have been worked intermittently for road gravel.

From the road-material standpoint the Acton Vale gravels have proved the more durable and the less dusty. Good road surfaces have been built with the St. Dominique and St. Liboire gravels, but their lack of durability has necessitated renewal at relatively frequent intervals on the more travelled roads. The St. Nazaire gravels have been used on roads of small traffic only and are much the same as the St. Liboire gravels as regards composition and wearing quality.

287. *Two miles southeast of St. Dominique; Range N.E. St. Dominique; farm of F. X. Breault.*

Pits Nos. 287 and 288 are in the same large, flat-lying deposit, which averages between 10 and 11 feet in depth. Pit No. 287, which extends over an area of 40,000 square yards, cuts away the central part of over one-half of the deposit. Although there is a considerable amount of material left on the edges, most of it is either sandy or coarse, and little is used at present. Sample No. 287 was taken at depth of 5 to 11 feet, from fairly fresh, regular-size gravel exposed only in a small section of the large pit bank. Pebbles had a percentage of wear of 26·7 (Grading A) in the abrasion test. The character of the gravel is much the same as that exposed in pit No. 288, which is situated in the other half of the deposit.

288. *Two miles southeast of St. Dominique; Range N.E. St. Dominique; farm of A. Lebeau.*

The pit, which lies alongside of No. 287, is over 10,000 square yards in area. The gravel is generally soft, coarse, and sandy, a large proportion of the sand being fine. Pebbles of sample No. 288, taken at depth of 7 to 13 feet, from fairly fresh gravel, had a percentage of wear of 23·9 (Grading A) in the abrasion test. It consolidates readily on the road, makes a smooth surface, but wears rather fast and is dusty. Sections treated with calcium chloride are almost entirely free from dust. For concrete work, care is taken to use only the fresh gravel. Although the amount available can not be estimated, it is probably large.

289. *Two and a half miles east of St. Dominique; Range IX; farm of M. Deslandes.*

Pits Nos. 289 and 290 lie alongside of each other in the same deposit, which forms a ridge trending northwest-southeast. The depth of gravel along the crest of the ridge is generally over 25 feet. In pit No. 289, the gravel is generally of medium coarseness, but rather high in fine sand, with an occasional layer of sand. Although on the whole soft and sandy, the gravel in the lower bank is fresher, less sandy, and better graded than in the upper bank. As road material it compares with Nos. 287 and 288, but the greater depth of the deposit makes it possible to use fresher and less friable gravel.

290. *Two and a half miles east of St. Dominique; Range IX; farm of A. Dubreuil.*

In the northwest end of the deposit is a large excavation close to 11,000 square yards in extent. The gravel varies in coarseness along the pit face and in depth, but is generally medium coarse and sandy in the upper 7 to 8 feet, and coarser and less sandy farther down. Where the gravel is deemed too coarse, it is left in place, so that the depth of the pit runs irregularly from 5 up to 25 feet. Some layers of the lower gravel hold a low proportion of sand, whereas others are just as sandy as the upper gravel. As regards grading and composition, it is about the same as Nos. 287, 288, and 289, but on account of the greater depth, the gravel is fresher and less friable on the average than Nos. 287 and 288. Pebbles of sample No. 290, which was taken at depth of over 15 feet, from fresh gravel, showed a percentage of wear of 18·3 (Grading A) in the abrasion test. It is at the best only a moderately durable road material, which makes a smooth but dusty surface. Some layers in the lower part of the deposit contain gravel that is particularly well graded for use as concrete aggregate.

291. *One and a half miles south of St. Liboire; Range St. Georges; farm of J. Rodier.*

A large excavation over 10,000 square yards in area cuts through the full width, and half of the length, of a ridge-like deposit averaging 15 feet in depth. The gravel, which is coarse in the upper part of the deposit, turns gradually finer in depth. The proportion of sand varies from 40 per cent near the surface to 90 per cent near the bottom. The gravel is well graded but carries an excess of fine sand and is soft. On the road it consolidates readily, makes a smooth and even surface, but wears fast and is dusty.

292. *One and a half miles southeast of St. Liboire; Range St. Patrice; farm of A. Desmarais.*

The deposit lies in the southwest slope of a ridge of glacial drift trending in a northwest-southeast direction, and has a maximum depth of 13 feet in that part of the pit nearer the crest of the ridge. The gravel, fine and sandy near the edge of the ridge, turns gradually coarser and less sandy towards the crest. It is well graded but soft. An abrasion test on pebbles

of sample No. 292, which was taken at depth of 8 to 13 feet, from fairly fresh gravel, gave a percentage of wear of 24·3 (Grading A). On the road a large proportion of the pebbles crumble readily under traffic and the smooth road surface wears fast and is dusty. As road material it resembles No. 291.

295. *One and a half miles northwest of St. Liboire; Range St. Patrice; farm of H. Montmarquette.*

The deposit occupies the east edge of a slight elevation composed partly, if not mostly, of glacial drift. A pit opened along the east edge has a maximum depth of 13 feet, which is about the greatest depth of the gravel. The gravel is medium coarse, with a rather high percentage of sand, a large part of which is fine. Apart from turning gradually finer in depth, it is uniform in coarseness. It is of about the same character and gives the same results in road surfacing as Nos. 291 and 292. Pebbles of sample No. 295, taken from fairly fresh gravel at depth of 6 to 12 feet, had a percentage of wear of 30·7 (Grading A) in the abrasion test.

299. *Lots 2, 3, Con. XII, Grantham; along line of Con. XI.*

In the upper slope and top of a low bluff facing south, there is a large deposit which was in the past worked for railway ballast by the Intercolonial (now Canadian National) Railway, and more recently for road material. The railway pit, in the slope of a side-hill cut along the upper slope of the bluff, is no longer in operation, owing to the poor quality of the gravel. The spur line that connects the pit to the main line at Duncan Station has not been removed and is now used for storing box cars. Several smaller excavations opened on top of the bluff for road material show coarse, well-graded, soft gravel. An abrasion test run on pebbles gave a percentage of wear of 27·6 (Grading A). The gravel used on several local roads of small traffic compacts readily and makes a smooth and firm surface, but wears fast and is dusty. The deposit, which has a maximum depth of 15 feet at the edge of the bluff and is underlain by glacial drift, gradually decreases in thickness away from the edge. With an average depth conservatively estimated at 9 feet, there should be well over 100,000 cubic yards of gravel available.

301. *Lot 33, Con. VI, Acton; alongside road and about half way between lines of Cons. V and VII.*

The deposit forms a flat-topped ridge, in which two excavations have been opened side by side on different properties. The two pits aggregate 2,900 square yards in area and have a maximum depth of 10 feet below the crest of the ridge. The gravel is medium coarse, well graded and fairly hard, though more or less weathered throughout. An abrasion test on pebbles of sample No. 301, taken at depth of 5 to 8 feet, gave a percentage of wear of 14·0 (Grading A). The excavated gravel has been almost entirely absorbed in road construction and maintenance. It compacts firmly and wears well under light traffic. As judged by the size of the ridge and the average depth of gravel, which is 6 or 7 feet, there should be over 30,000 cubic yards available.

Two other deposits of similarly graded, though somewhat softer, gravel are found, one on lot 34 of the same concession, the other on lots 32 and 33 of Concession V.

303. *Lot 29, Con. VI, Acton; near line of Con. VII.*

The deposit lies on top of a wide, high rocky ridge. It was originally covered with 10 to 15 feet of sand, which, since the beginning of cultivation, has been gradually blown towards the east, under the influence of the prevailing winds. At many places the gravel is now bare of drifting sand. A small shallow pit has been dug into the gravel, which is fresh, well graded, and carries from 40 to 65 per cent sand, mostly very coarse. It is a good road gravel, but little has been used for that purpose up to the present. Owing to its almost complete freedom from weathering, it makes a particularly desirable concrete aggregate. According to the owner, the deposit was found to have a maximum depth of over 20 feet through test pits dug by the Canadian Pacific Railway Company, but these are now entirely refilled. An area of about 10 acres has been freed of its overlying sand, which has been blown away farther east.

Brome County

The hilly character of the greater part of this county makes it impracticable to haul gravel from far afield, so that all developed deposits are found along or close to some public road. Gravels are relatively common throughout the northeastern part of the county but scarce elsewhere, particularly so in the southwestern part. Most of the gravels are well graded as regards size of constituents, but because of their high content of soft pebbles can be considered of but fair quality at best. A few deposits contain gravel, which is also either very sandy or irregularly graded. Good road-surfacing gravel was found in only three deposits, No. 315 at Gilman, No. 323 east of Knowlton, and No. 324 south of Eastman.

The common defect of the gravels is that they wear fast under traffic, requiring frequent renewal of the road surface. River gravel from the bed and flats of Missisquoi river, available at low-water level between Glen Sutton and Dunkin, is found to have more lasting qualities than the local bank gravel.

313. *Lot 4, Con. II, Brome; east of West Brome Station.*

The 25-foot face of a side-hill excavation in the steep slope of a knoll shows mostly sand. At one end of the pit bank there is a large streak of well-graded gravel varying from very fine to medium coarse. Sample 313 represents the coarser part. The deposit forms three knolls in line, covering, according to the owner, an area of 4 acres and measuring 40 feet in average height. The deposit holds probably more sand than gravel. Between here and the International Boundary, over 11 miles to the south, gravel is exceedingly scarce, and a number of knolls have been prospected for gravel but found to be made up largely of sand. One such knoll in the town of Sutton has been extensively worked for concrete sand.

315. *Lot 7, Con. II, Brome; near fork of roads.*

The deposit forms a large steep knoll in the slope of which a deep side-hill excavation has exposed gravel that varies a great deal in coarseness, but large streaks of uniformly graded, fresh gravel are also common. Pebbles of sample No. 315, taken from fresh gravel at depth of 13 to 17 feet, had a percentage of wear of 9·4 (Grading A) in the abrasion test. Good results in road surfacing are attained with the gravel. It consolidates firmly to a smooth surface that wears well under traffic. As a matter of fact, it is one of the few gravels of the county that possesses lasting qualities. The amount of gravel available is large. Several other knolls a few hundred feet to the east are gravelly on surface. All the knolls aggregate in size well over 100,000 cubic yards.

316. *Lot 10, Con. VI, Brome; west of road intersection.*

Coarse, uniformly well-graded gravel is exposed in a pit cutting through almost the whole width of a ridge. When the larger stones are screened out, the gravel makes a fair road material. It is on the average better graded than No. 315, but softer and not so durable. Pebbles of sample No. 316, taken from fairly fresh gravel at depths of 15 to 19 feet, had a percentage of wear of 17·2 (Grading A) in the abrasion test.

323. *Lot 11, Con. I, Bolton; along brook, near township line.*

A side-hill excavation, 30 feet in greatest depth, has been opened in the steep slope of a knoll or ridge, and exposes well-graded, fine gravel carrying 50 to 60 per cent of sand, mostly coarse. Although coarseness is not uniform throughout the exposed part, the material is on the whole regularly graded as regards size, with the exception of a thick sand layer, which runs more or less continuously all along the bank at middle height. An abrasion test on pebbles of sample No. 323, which was taken from fresh gravel at depth of over 20 feet, gave a percentage of wear of 8·7 (Grading A). The gravel has been used for the surfacing of several local roads with good results. Although somewhat fine and sandy, it is durable and may be considered one of the best gravels found in the county. The deep excavation makes it possible to get fresh material that makes a good aggregate in concrete work.

324. *Lot 21, Con. VIII, Bolton; just east of C.P.R. track.*

Several knolls have been worked for gravel, and a considerable amount taken out, as judged by the size of the excavations, some of which are now abandoned. Well-graded, fresh and hard gravel, covered with 1 to 5 feet of fine sand, is exposed in the pit from which road gravel is taken at present. This pit covers an area of 600 square yards and has a maximum height of bank of 20 feet. Another pit in a separate knoll, not worked for road material, shows largely sand. The amount of gravel available is difficult to estimate even approximately, because of the sand cover which varies much in thickness.

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Shefford County

Gravel deposits are fairly evenly distributed throughout the county, but nowhere common, except around Waterloo and Lawrenceville. The gravel from nearly all deposits is well graded as regards coarseness, but only moderately durable as road material. The larger Lawrenceville deposit, some of the Waterloo deposits, and a small deposit near Roxton Falls are the only ones from which gravel with good wearing qualities has been obtained. A few small and shallow deposits from around Granby hold a large amount of soft shale or slate, which crumbles readily under traffic and causes the road surface to become muddy when wet. The use of this gravel is now confined to unimportant roads.

327. *Lot 13, Con. II, Milton; two-thirds of a mile south of Ste. Cécile.*

A large shallow excavation, 3 to 8 feet in depth and covering over 5,500 square yards, has been opened in a flat-lying gravel deposit trending in a north-south direction. Bedrock is exposed in the bottom and centre of the pit, 3 to 4 feet below the surface, and is probably close to the surface over the larger part of the deposit, but deeper digging has been prevented by the presence of occasional large boulders or blocks of the same nature as the underlying bedrock. The greatest depth, 8 feet, is at the north end of the pit, where a test pit is said by its owner to have been dug to an additional depth of 7 feet, without reaching the bottom of the deposit. The gravel varies in coarseness, but is on the average fairly coarse and well graded. It consolidates readily on the road, and builds a smooth surface. It wears rather fast, but is better in that respect than other local gravels. The poor results obtained in the mortar test (Table III, page 197) are due to impurities in the gravel near the surface, where the sample was taken.

329. *Lot 2, Con. I, Milton; near township line.*

The deposit occupies a depression between rock ledges that limit it three-quarters of the way around. It has been excavated to a depth of 12 feet, which is not the full depth of the deposit, but a deeper excavation would be difficult to drain. The gravel is well graded and varies from coarse to fine, the coarser part being found at about middle height. It gives about the same results as No. 327 as road-surfacing material, being only moderately durable. The much better results obtained in the mortar test (Table III, page 197), as compared with No. 327, are not due to a difference in grading but to the fact that sample No. 329 was taken at a depth of 6 to 10 feet, in fresher and cleaner gravel than is usually found nearer the surface. An abrasion test on pebbles gave a percentage of wear of 18·0 (Grading A).

333. *Lot 16, Con. X, Roxton; near line of Con. IX.*

The deposit is 6 to 8 feet in depth and lies in level ground on the top and edge of a steep clay or boulder-clay bluff facing White river. The gravel has been excavated down to the underlying clay over an area of 3,600 square yards, which is about one-quarter of the extent of the deposit. The gravel is well graded and fairly uniform in size throughout, and fairly

fresh, considering its shallow depth. Pebbles of sample No. 333, taken at depth of 1·5 to 6 feet, showed a percentage of wear of 12·6 (Grading A) in the abrasion test. The gravel has given good service on local roads, where it consolidates firmly and makes a hard and lasting surface.

336. *Lot 23, Con. I, Shefford; west of C.P.R. track and near county line.*

The deposit forms a large flat-topped ridge. A side-hill cut, 40 feet in height and covering over 1,150 square yards, in the slope of the ridge, shows coarse and bouldery gravel in the upper 8 feet, and less coarse gravel in the remainder of the bank. Outside of the upper bouldery zone, the material is fairly uniform in size throughout the large pit bank and varies in a gradual way from medium coarse underneath the bouldery zone to very fine in the lower bank. The coarser part carries about one-third sand, and the finer part about two-thirds sand, which is everywhere very coarse. An abrasion test on pebbles of sample No. 336, which was taken from fresh gravel at depth of 15 to 18 feet in the central part of the bank, gave a percentage of wear of 8·7 (Grading A). Sample No. 336a was taken from a part of the pit bank farther down the slope of the ridge, at depth of 5 to 9 feet. Both samples are of about average coarseness. The gravel is found satisfactory under moderate to large traffic. If the ridge is all gravel, there should be well over 100,000 cubic yards available.

Another small pit in a low knoll north of the large ridge has not been worked for some time, on account of the better grade gravel being almost exhausted. What is left is very sandy.

337. *Lot 23, Con. V, Shefford; 1 mile northeast of Waterloo and near side road.*

A rectangular pit, over 1,700 square yards in extent and 12 feet in average depth, cuts through the crest and upper slopes of a small gravel ridge. At both ends of the excavation, underneath the crest of the ridge, there is exposed well-graded, coarse gravel carrying on the average 40 per cent sand, whereas the side banks show almost exclusively sand. The gravel part has a width of about 60 feet and an average depth of 12 feet. The ridge can be traced for a distance of over 1,000 feet, which should give approximately 25,000 cubic yards as the size of the deposit.

339. *Lot 23, Con. VII, Shefford; along brook and east of C.P.R. track.*

The deposit is in the shape of a straight, steep-sloped ridge trending in a north-south direction along a brook bank. A pit at the north end cuts through the crest and half way down both slopes of the ridge, and shows gravel that varies much in coarseness, including large streaks of well-graded road gravel, but also much coarse and bouldery gravel and a large streak of sand. The sand is all confined to the lower east slope and can be left in place without interfering with the development, but the coarser gravel lies in the upper part of the ridge and can not be left in place without sacrificing good gravel lying underneath. Very little gravel has been used lately for road material. An abrasion test on pebbles of sample No. 339, which was taken from fresh gravel at depth of 7 to 11 feet, gave a percentage of wear of 14·9 (Grading A).

343. *Lot 27, Con. VIII, Shefford; just east of fork of roads.*

A side-hill excavation with a face up to 25 feet in height, in the steep slope of a flat-topped ridge, shows well-graded, fine gravel carrying about 50 per cent coarse sand, topped with 4 to 8 feet of bouldery, weathered gravel. The ridge measures approximately 50,000 cubic yards. According to information received from the road patrolman, the same gravel was encountered in two test pits dug near the crest of the ridge, a short distance back of the pit face, with 2 and 8 feet of bouldery material lying on top of the better graded gravel. In the pit face, outside of the upper bouldery zone, the gravel is comparatively free from weathering, yet rather soft. A stretch of the Waterloo-Richmond highway surfaced with this gravel was found in good condition. The gravel packs down solidly to a smooth surface, but wears fast.

345. *Lot 16, Con. IX, Stukely; just east of C.P.R. track at Lawrenceville.*

Near Lawrenceville, there is a large gravel deposit in the form of a straight, steep-sloped ridge 40 feet in height and measuring over 200,000 cubic yards. According to the road patrolman, gravel underlies a large area outside of the ridge proper, including the greater part of the village. A big excavation, not dug to the bottom of the deposit, cuts through the full height and width of the ridge over a distance of 100 yards. Although the large pit face shows much variation in coarseness of the material, the greater part of the gravel exposed is well graded and of the proper size for road work. Good and durable road surfaces have been built with it. It is not so uniform in grading as some other deposits, but is the most durable gravel found in the county. On account of the great depth and steep slope of the ridge, fresh gravel holding little friable material can be obtained in large amount with comparatively little stripping. Pebbles of sample No. 345, taken from fresh gravel at a depth of over 15 feet, showed a percentage of wear of 7·8 (Grading A) in the abrasion test.

Drummond County

The investigation covered all but the eastern corner of the county.

Gravels are of common occurrence only in the southern part of the county. Elsewhere they are very scarce, particularly so in that part bordering Yamaska county to the northwest. The largest deposits are found in Durham township, some of which, however, carry much more sand than gravel. The other deposits that have been examined in the county are of small size, with the exception of No. 356, near Wickham, which is rather shallow but is known to cover a fairly large area. Gravel deposit No. 350 and sand deposit No. 352 near South Durham have been worked for years and the excavations are now of considerable size.

350. *Lot 11, Con. X, Durham; on line of Con. IX.*

The deposit occurs as a steep-sloped knoll, part of which has been completely levelled by a large excavation dug to its base. The pit face, up to 80 feet in height in the centre, shows gravel that is generally coarse, but varies from place to place.

The pit is connected by spur to the Canadian National railway. The gravel is dug by steam shovel and either loaded directly into railway cars or crushed and screened in a stationary plant erected at the pit with storage bins, from which the gravel is loaded by gravity into railway cars. The product is sold as railway ballast, road gravel, or concrete aggregate. The gravel as it comes from the bank is sufficiently free from fine sand or large stones to make a suitable railway ballast without crushing and screening. On account of the great depth, the gravel is clean and almost free from weathered or friable particles. Sample No. 350 was taken primarily for the abrasion test, and does not represent the average run of the large pit bank. The sample was taken from a layer of fresh gravel holding but a small amount of sand, in the lower part of the 80-foot pit bank, and showed a percentage of wear of 10·0 (Grading A) in the abrasion test.

351. *Lot 10, Con. IX, Durham; near where side road crosses brook.*

A round pit, 35 feet in maximum depth, dug in the upper half of a steep-sloped, round knoll, shows mostly clean, coarse sand, interstratified with a few thin layers of gravelly sand. Close to the bottom, there is a thick layer of well-graded gravel which is about the right coarseness for road use. Outside of this layer, the material is undoubtedly too fine for road work but makes a good concrete aggregate, as it is everywhere clean and coarse below the weathered zone.

352. *Lots 14, 15, Con. IX, Durham; near line of Con. X.*

A large excavation opened in the steep slope of a knoll over 100 feet in height is worked at three different levels. A standard gauge track on each level is linked to a spur line that connects the pit with the Canadian National railway at South Durham. The pit was originally opened in sand and for years worked solely as a sand pit. As the excavation proceeded farther into the knoll, gravel layers were found and now the pit is operated for both sand and gravel. The material is dug by steam shovel and loaded directly into railway cars. For gravel, a slanting screen of the proper mesh is fitted on top of the car, to separate the oversize which rolls down to the side of the track and is wasted. Although there is considerably more sand than gravel exposed in the large pit face, gravel layers have gradually increased in size and number during the last few years, and it is now planned to erect a crushing and screening plant in the fall or early spring. Both sand and gravel are clean and almost free from weathered or soft particles. The product is sold for concrete aggregate, road gravel, and railway ballast. Moulding sand is also obtained from a large streak of fine sand lying deep in the bank. Sample No. 352 was taken primarily for an abrasion test and is not representative of the average run of the gravel; sample No. 352a is from coarse sand. Sample No. 352 was taken from a layer of fresh gravel holding but a small amount of sand, in the lower part of the pit bank, and showed a percentage of wear of 13·4 (Grading A) in the abrasion test.

353. *Lot 6, Con. IV, Durham; between Provincial highway and St. François river.*

Several large pits have been opened in a deposit that lies in the slope of a bluff facing St. François river. The gravel is generally coarse in the

upper slope and finer in the lower slope, where it is interstratified with layers of sand. Outside of the sand layers, the gravel is uniform in grading. It is, however, practically impossible to prevent the mixing of gravel and sand in working the deposit. Sample No. 353 was taken from an excavation in the lower slope of the bluff and included both gravel and sand layers, so that the percentage of sand in the sample (Table II, page 181) is somewhat higher than the average for the deposit. Although rather soft, the material has given satisfactory service under light to moderate traffic.

355. *Lot 24, Con. I, Durham; near line of Con. II.*

A large side-hill excavation dug in the upper slope of a steep bluff or knoll, shows considerably more sand than gravel. The pit floor slants slightly inwards, following the surface of glacial drift that underlies the gravel. In the lower half of the pit face, which has a maximum height of 23 feet in its central part, there are several layers of fine gravel carrying 60 to 75 per cent coarse sand, but by far the larger part of the bank is sand, fine and silty in the upper third, and coarse under. The amount of gravel sufficiently coarse for road use is small and is used entirely for maintenance work. Although there is much clean and coarse sand of excellent quality for concrete aggregate, it is topped by several feet of fine, in places silty, sand that is not so suitable.

356. *Lot 15, Con. IX, Wickham; on line of Con. X.*

In a flat-lying deposit, said by the local road patrolman to have an area of about 15 acres, a large pit averaging 7½ feet in depth has been dug to the bottom of the deposit. The gravel is well graded, uniform in size, and carries about 60 per cent sand, mostly coarse. Although partly weathered, it does not contain too much friable material and is fairly durable. A section of the road leading to Acton Vale, and other local roads have been covered with the gravel and apart from being rather dusty when in a dry state are in good condition.

358. *Lot 1, Con. VIII, Wendover; west of intersection of Provincial highway with concession road.*

The deposit forms a small, flat ridge overlying glacial drift and averaging 5 feet in depth. The gravel is well graded, uniform in coarseness, and carries from 30 to 50 per cent of coarse sand. About 80 per cent of the pebbles are flat slate or shale. The gravel consolidates readily on the road and builds a firm and smooth surface, but wears rather fast under a moderate amount of traffic, and old roads are muddy when in a wet state. There are several other small, shallow deposits of similar gravel. One much larger deposit was extensively worked years ago for railway ballast. It is now exhausted, or what little left is very sandy.

359. *Lot 1, Con. XIII, Wendover; on line of Con. XII.*

Fairly well-graded, fine, sandy gravel is seen in a large, shallow excavation extending over 20,000 square yards and dug to the bottom of the deposit, which averages 4½ feet in thickness. The gravel is partly weathered,

yet fairly hard, and wears well under light traffic. The deposit forms a large, flat-topped ridge, part of which includes bouldery or poorly graded material, so that the amount of good road gravel is unknown and is probably small.

Stanstead County

The northern part of the county was fairly thoroughly examined for gravel, whereas in the southern part investigation was confined to the territory adjacent to the Sherbrooke-Stanhope, Sherbrooke-Rock Island, and Magog-Coaticook highways. Most of the gravel deposits are of large size and of common occurrence in the northern half of the county, but in the southern half good surfacing gravel is scarce along the three main highways. The majority of excavations measure well over 10,000 cubic yards in size, and few are under 5,000 cubic yards. Highway improvement work has absorbed by far the larger part of the gravel excavated, with the exception of gravel No. 361 which is used entirely as railway ballast.

361. *Lot 26, Con. III, Barnston; west of C.N.R. track at Coaticook.*

A large railway pit cuts through the centre of the deposit, which is in the form of a flat-topped hill. The pit, which has a maximum width of over 200 yards and a length several times the width, is worked at four different levels, which are linked by track with the spur line at the lower level. The maximum height of bank above the lower level is about 80 feet. Except near the entrance in the southeast slope of the hill the large pit bank shows gravel throughout, which is remarkably uniform in coarseness, considering the large area exposed. It is not used as road material, but is suitable for that purpose, as judged by the laboratory tests (Table I, page 155 and Table II, page 182). An abrasion test on pebbles of sample No. 361b, which was taken from fresh gravel at depth of about 50 feet, gave a percentage of wear of 7·5 (Grading B). The gravel is in places strongly cemented together with calcium carbonate and occasionally has to be loosened by blasting. The deposit is of large size and holds probably millions of cubic yards of gravel.

No. 362 is a large pit in the form of a side-hill cut in the steep north slope of the same deposit as No. 361. The gravel is here coarser and less uniform in size than in the railway pit. It carries a rather low proportion of sand, mostly coarse. The weathered material from the top of the deposit is first removed and sold for filling. The fresh gravel is then crushed and screened into four different sizes, from 1¼ inch down, and is used in various municipal works. Part of the crushed but unscreened gravel, such as represented by sample No. 362 (Table I, page 155 and Table II, page 182), is sold and used for road surfacing with good results.

363. *Lot 9, Con. II, Barnston; along brook near line of Con. I.*

Coarse and bouldery gravel carrying a low proportion of sand, most of it coarse, is exposed in a round pit dug in the central part of a small knoll. The pit covers about 1,400 square yards and has a maximum height of bank of 17 feet. In certain layers, particularly in the lower part of the bank, the gravel is strongly cemented together with calcium carbonate, and also

holds some iron oxide in the form of rusty dust, derived from the oxidation of the pyrite crystals occurring in the slate pebbles. The gravel was crushed for road surfacing in a portable crusher that has been removed from the place, as the pit is only worked intermittently. It has given good results on roads of light and moderate traffic. The knoll covers about 1·5 acres. The depth of the deposit is not known but is probably not more than the depth of the excavation which averages 10 feet.

364. *Lot 5, Con. II, Hatley; near line of Con. I.*

A large side-hill excavation covering 1,700 square yards has been opened in the western slope of a hill. In the pit bank, which has a maximum height of 40 feet, there is exposed gravel similar to No. 363 as regards composition and low proportion of sand, but coarser and more bouldery. It seems that the up-slope pit bank has now reached beyond the better grade of gravel into bouldery material, of which apparently a large amount is available.

365. *Lot 17, Con. III, Hatley; on line of Con. II.*

The deposit is rather shallow, but of large extent. In a large excavation covering over 9,000 square yards and reaching the bottom of the deposit at an average depth of 11 feet, there is exposed more or less weathered and soft gravel, which varies much in size from place to place but is generally coarse and bouldery. It is being crushed and screened for use in road surfacing. This is the only gravel available for miles around.

369. *Lot 1, Con. VIII, Stanstead; near line of Con. VII.*

Two large excavations aggregating over 5,000 square yards in area have been dug in the deposit that lies in the upper slope and part of the top of a high steep bluff forming the bank of a brook. The gravel is soft and varies in a gradual and regular way from coarse to fine, but the regularity of grading is broken by sand layers running through the gravel. The sand layers increase in size and number at depth. The extent of the gravel deposit is unknown as the ground surface everywhere shows only sand.

372. *Lot 13, Con. IX, Hatley; near fork of roads.*

The deposit carries almost exclusively coarse sand. Gravel is seen only in places near the top of the deposit and is generally fine and sandy. The fresh sand makes a good aggregate in mortar and concrete. It is found satisfactory as a road-surfacing material on local clay roads carrying light traffic.

375. *Lot 18, Con. IX, Hatley; near fork of roads.*

The deposit forms a large ridge, at one end of which there is exposed in a large excavation over 3,100 square yards in extent, uniformly well-graded, medium-fine, fresh, and hard gravel. The gravel carries a rather high proportion of sand, mostly coarse, but is on the whole a high-grade road material that consolidates firmly and wears evenly on roads of small traffic. The amount already excavated, 11,100 cubic yards, is but a small part of the volume of the ridge.

379. *Lot 1, Con. XIV, Magog; at intersection of Provincial highway with county line.*

The deposit occupies the slope and top of a steep bluff facing a brook to the south. A large railway pit in the form of a side-hill cut along the face of the bluff shows more sand than gravel, and a great deal of the gravel exposed is coarse and bouldery. A highway pit 2,000 square yards in area and 30 feet in maximum depth has been opened in the slope of a large knoll on top and near the edge of the bluff. The gravel in the road pit varies much in coarseness and grading from place to place and is generally coarse and bouldery. It is intended not to use the gravel any more, on account of its coarseness. As gravel from this deposit is harder than the average for this part of the county, where good road gravel is scarce, the cost of crushing this material to proper size for road surfacing would in all probability be justified by the results obtained.

Sherbrooke County

Developed deposits are found almost exclusively in the eastern half of the county. Nearly all large deposits lie along St. François river and have been extensively developed, northwest of the city of Sherbrooke, for concrete aggregate as much as for road material. The gravel exposed in most of the pits visited is well graded and hard, but very sandy in some deposits.

381. *Lot 27, Con. X, Orford; near where brook crosses county line.*

Uniformly fine and sandy gravel is exposed in an excavation 3,400 square yards in area, opened in a flat-lying deposit averaging 7·5 feet in depth. The sand is mostly coarse and makes up about two-thirds of the deposit, rather a high proportion for road use. Samples No. 381 and 381a taken one at each end of the pit represent the coarser and less sandy part of the gravel. It is likely that the gravel taken out was less sandy than what is left exposed in the bank, or about the same coarseness as the two samples.

383. *Lot 10, Con. V, Ascot; near where Provincial highway crosses Massawippi river.*

The deposit is in the shape of a steep ridge and holds probably hundreds of thousands cubic yards of gravel, which, however, is thickly covered with sand on top of the ridge. In a large side-hill cut opened along the south flank of the ridge, gravel is exposed that varies much in coarseness from place to place, with large streaks of proper coarseness and grading for road material. On the whole the gravel is coarse, slightly bouldery, low in sand, outside of an occasional large pocket of sand. In the lower slope of the ridge, where the overburden is generally thinner than higher up, are streaks of clayey gravel and also streaks of rusty gravel. The large cut covers an area of 4,300 square yards and a maximum height of over 60 feet.

385. *Lot 28, Con. I, Ascot; west of intersection of road with county line.*

The deposit forms a steep knoll 100 feet in height, at the foot of a high bluff facing St. François river. A large, round pit opened in the lower

slope has now reached the central part of the knoll, with the inner bank cutting into the other slope past the top. The gravel is well-graded and uniform in size, taking into consideration the large area exposed, and is generally fine, about two-thirds being sand. It carries a rather high proportion of sand, but the latter is exceedingly coarse, 90 per cent being retained on the 28-mesh sieve, as seen by sample No. 385 (Table II, page 183), which was taken at the foot of the talus from freshly fallen material, and is thought to represent the average run of the bank. Although the gravel carries a rather high proportion of soft fragments and is not free from weathered material, it is sufficiently fresh for use as aggregate in mortar and concrete.

386. *Lot 7, Con. I, Orford; along Provincial highway and at city limits of Sherbrooke.*

Gravel and sand are exposed in a large side-hill excavation along the steep bank of St. François river. Except in the north end of the long pit, the gravel is thickly covered with sand, and from the central part of the pit to the south end the thickness of sand exposed in the pit bank is greater than that of the underlying gravel. The thickness of sand apparently also increases as the excavation is extended farther into the river bank. The pit is worked in two steps, the lower one in gravel and the upper one in sand. The excavation in gravel proper has a length of over 150 yards and a maximum width of over 30 yards. South of the gravel pit, sand has been excavated for some distance. The gravel is well graded, medium coarse to fine, and carries from one-third to two-thirds sand, outside of an occasional sand layer. Gravel and sand are used in various municipal works and are also sold to individuals. The gravel is generally fresh and hard, particularly where it is overlain by sand. An abrasion test on pebbles of sample No. 386, which was taken from fresh gravel in the lower pit bank, gave a percentage of wear of 5·1 (Grading B). Both gravel and sand appear to be available in almost unlimited amount.

387. *Lot 6, Con. I, Orford; along Provincial highway and just outside of city limits of Sherbrooke.*

The excavation covers 10,000 square yards with a maximum height of bank of 40 feet, and is probably a continuation of the same deposit as No. 386, a short distance to the south. The large pit bank shows almost exclusively gravel, apart from an occasional layer or lens of sand. The sand cover is much thinner than at No. 386. It has now a maximum thickness of 8 feet, but is said to grow gradually thicker as the excavation is extended farther into the river bank. The character of the gravel is much the same as No. 386. Neither pit No. 386 nor No. 387 is dug to the bottom of the gravel deposit on account of underground water.

389. *Lot 2, Con. II, Orford; along Provincial highway.*

The deposit is in the form of a steep knoll at the foot of a bluff facing St. François river. The gravel exposed in the 40-foot bank of a side-hill excavation is fresh and hard, varies much in coarseness from place to place, but is generally coarse, slightly bouldery, and sandy. The sand is exceed-

ingly coarse, 95 per cent being retained on the 28-mesh sieve. Layers of sand running through the gravel in the upper 10 feet of the deposit make the grading irregular. The sand segregated in layers is not so coarse as that mixed with the gravel. Below the upper 10 feet there are no unmixed sand layers, and the gravel is finer and more uniform in size.

390. *Lot 1, Con. II, Orford; near where Provincial highway crosses county line.*

The deposit is of small extent and not more than 8 feet deep on the average. Nearly 6,000 cubic yards of gravel have been taken out, and about as much remains in the deposit, but is covered with at least 3 feet of sand as overburden. The pit bank is now largely talus-covered. At one end, there is exposed in the upper half, fairly regularly graded, coarse gravel carrying about 40 per cent sand. The material is said by the owner to become finer with depth.

Richmond County

Investigations in this county were confined to the territory adjacent to the Sherbrooke-Three Rivers and Richmond-Levis highways. Gravel is common, although sandy in places, along the Sherbrooke-Three Rivers highway, which in this county follows St. François river, and it is scarce along the other highway. Deposits holding material of fair quality have been much drawn upon for road use, and the excavations in these deposits range in size from 4,000 to 14,000 cubic yards. One large pit in deposit No. 403 north of Danville measures over 30,000 cubic yards.

391. *Lot 33, Con. V, Brompton; near where Provincial highway crosses county line.*

Fine gravel is exposed in a pit opened in a low bluff facing St. François iver. The gravel is uniform in coarseness throughout, but some layers and lenses of sand interstratified with the gravel increase the proportion of sand to two-thirds of the whole. The deposit is said to cover 10 acres, but judging from conditions observed in other excavations along the same bluff the material along the edge of the bluff, where the pit is, is probably coarser, less sandy, and less thickly covered with sand than farther into the bluff. The sand layers adversely affect the grading of the gravel and lower its quality as road material.

392. *Lot 32, Con. V, Brompton; where Provincial highway crosses line of Con. IV.*

A long excavation opened a short distance north of No. 391 and apparently in the same deposit, shows well-graded, medium-coarse gravel, interstratified with thin sand layers and a few thick lenses of sand. The sand layers and lenses bring the proportion of sand up to nearly half of the whole. The gravel is coarser and less sandy than No. 391, but the sand is finer, as seen by the sieve analysis of samples Nos. 391 and 392 in Table II, page 183. The pit, which extends over an area of 3,100 square yards, reaches the bottom of the deposit at a depth of 13 to 14 feet.

393. *Lot 21, Con. XIV, Windsor; between Provincial highway and C.N.R. track.*

The deposit lies in the slope of a steep bluff facing St. François river. A large pit shows medium-coarse gravel carrying about 40 per cent sand in the inner bank, the gravel gradually turning fine and sandy towards the outer edge. The whole bluff appears to be gravel, but development work has been limited to the upper 12 feet because the gravel has to be hauled up-slope to reach the road.

394. *Lot 9, Con. XII, Windsor; between Provincial highway and river.*

Good road gravel varying regularly from coarse to medium fine and carrying about 50 per cent sand is seen exposed in a pit near the top of a high bluff facing St. François river. The gravel is not more than 9 feet thick and is covered with 2½ to 4 feet of fine loamy sand as overburden.

395. *Lot 1, Con. XV, Cleveland; near intersection of Provincial highway with township line.*

Well-graded, coarse gravel, bouldery in places, is seen exposed in a side-hill excavation opened in the steep slope of a knoll. The lower part of the bank is very bouldery and marks probably the edge of the gravel deposit, which should be more than half exhausted. Over 11,700 cubic yards of material have been taken out of the deposit. The pit measures over 2,900 square yards in area and has a maximum height of bank of 25 feet.

396. *Lot 11, Con. XV, Cleveland; along Provincial highway.*

The deposit holds both sand and gravel and forms a small, steep knoll, almost half of which, or 10,000 cubic yards, has now been excavated. The 30-foot pit bank shows mostly sand in the upper bank, fine sandy gravel in the lower slope of the knoll at one end of the pit, and very coarse and bouldery gravel in the lower part of the opposite slope, at the other end of the pit, where sample No. 396 was taken. Boulders make up about 15 per cent of the material represented by the sample. The bouldery gravel carries a relatively small amount of weathered or soft stones, and could be made into fair road material by crushing it to proper size, but the amount of easily available gravel may be limited, as the thick sand cover towards the centre of the knoll would probably be an obstacle in extending the excavation in that direction, unless the sand can be disposed of economically. An abrasion test on pebbles of sample No. 396 gave a percentage of wear of 13·4 (Grading A).

399. *Lot 7, Con. VIII, Melbourne; along Provincial highway.*

The gravel is fine, fresh, and hard, and is thickly covered with fine clayey sand which is worthless. The gravel, on account of its fineness, is more suitable as a concrete aggregate than as a road-surfacing material. It is underlain by clay at a depth of 15 feet.

401. *Lot 9, Con. XIV, Cleveland; near Steele brook.*

The deposit forms a large, steep knoll well over 75,000 cubic yards in size. A 50-foot cut in the slope was all talus-covered, the talus material being composed of fresh, hard gravel of about the proper size for road surfacing. According to the owner, a few layers of clean sand run through the gravel.

402. *Lot 11, Con. XII, Cleveland; along the C.N.R. track.*

A large shallow pit, covering 4,600 square yards shows gravel that varies gradually in size from coarse and slightly bouldery at one side of the pit to fine at the opposite side. The fine gravel is mixed with a high proportion of sand but the sand is everywhere very coarse, and in places carries some clay. Sample No. 402 is from medium-coarse clayey gravel. The gravel is all more or less weathered and carries a rather high proportion of soft pebbles.

403. *Lot 22, Con. I, Shipton; along Provincial highway.*

The deposit forms a high steep ridge in the slope of which there is a large excavation over 30,000 cubic yards in size. In the high pit bank there is exposed fresh and hard gravel that varies much in coarseness from place to place but is generally coarse and bouldery. About one-third of the pebbles are rather soft, shistose rocks. A portable crushing and screening plant has been erected in the pit. The crushed and screened product makes a good road material, which is extensively used in this part of the county, where good gravel of suitable size and grading for road purposes is very scarce. The gravel excavated forms but a small part of the total amount available. Another smaller excavation cutting through the crest of the same ridge, 750 feet north of the main pit, shows mostly coarse sand.

Arthabaska County

The work of investigation covered the whole county outside of Tingwick township, which was not examined. Gravels are fairly common in the eastern part of the county and scarce elsewhere. Nearly all deposits are of small size or very sandy, so that suitable road gravel is nowhere common. River gravel is available at many places from flats along Nicolet river and some of its tributaries. Sample No. 409 is from Nicolet river, southeast of Arthabaska, and No. 406 from a brook southeast of Princeville. Gravel No. 406 is sandy, a great deal of the sand, being fine, takes long to compact on the road and lacks cementing quality. It is the only gravel available in that part of the county. Gravel No. 409 also lacks cementing power but is found more satisfactory than bank gravel because of its better wearing quality.

404. *Lot 15, Con. I, Warwick; along Provincial highway.*

A large excavation covering 1,700 square yards and having a maximum depth of 20 feet, shows regularly graded, though sandy, gravel varying gradually in size from fine to coarse and slightly bouldery. Sample No. 404 represents the least sandy and the better grade from the road material

standpoint. The sample was taken at a depth of 15 to 20 feet, in material which is suitable for use as mortar and concrete aggregate. The pit has been opened in the steep slope of a knoll facing a brook and the pit bank now reaches the top of the knoll. The knoll is of fairly large size, but a large proportion of the material is probably not of the proper coarseness and grading for roads. A 4- to 5-foot layer of bouldery and sandy material in the upper part of the pit bank renders the extraction of the more suitable gravel costly.

Nicolet County

Gravel is scarce throughout the county. Small deposits are occasionally found along the steep banks of Nicolet river, and most of the gravel is rapidly absorbed in road work, so that the deposits become depleted a short time after being uncovered. Most of them hold hard, slightly rusty gravels which have given good results on roads. A great deal of good concrete gravel has been obtained from large flats along the same river at a number of places. The same gravel has also been used in road improvement, but is found deficient in cementing quality and does not consolidate readily on the road, on account of holding a large proportion of hard, smooth, rounded quartzose pebbles.

Compton County

Investigations in this county were largely confined to the territory adjacent to the Sherbrooke-Beauceville and East Angus-Hereford highways. Gravel is very common in three different areas, where deposits appear to be grouped together. The first group, including the largest deposits, occurs between Bury and past East Angus; the second group lies between East Clifton and past St. Malo; and the third group between East Hereford and the International Boundary. Outside of these areas suitable road gravel is scarce. In some places there are large deposits of gravelly sand, the coarser part being occasionally used for road maintenance. Bouldery material from depleted gravel deposits is also crushed for road purposes, where no suitable gravel is available. Near Sawyerville and Waterville good results are obtained in surfacing local roads with river gravel.

413. *Lot 13, Con. IV, Westbury; near fork of roads on Provincial highway.*

The deposit is in the shape of a small ridge and averages 8 to 9 feet in depth. Over 14,900 cubic yards, or about two-thirds of the deposit, has now been excavated. In the upper half of the pit bank, which reaches a height of 15 feet in its central part, there is exposed coarse and slightly bouldery gravel, fairly uniform in coarseness, with 5 per cent boulders and 30 per cent sand. In the lower half the gravel is much finer, with about two-thirds sand, and not so uniform as in the upper half on account of sand layers running through it.

414. *Lot 13, Con. IV, Westbury; near fork of roads on Provincial highway.*

Good road gravel is seen in two out of three large pits aggregating over 23,000 cubic yards in size. The gravel is fairly uniform in coarseness throughout, but somewhat high in sand. Samples Nos. 414 and 414a repre-

sent less sandy material than the average of the deposit. The remainder of the deposit may contain more sand than in the exposed part; excavation work has been stopped in one of the pits on account of the material becoming too sandy.

418. *Lot 1, Con. VII, Bury; along C.P.R. track.*

The greater part of the deposit, which is in the form of a ridge, was excavated years ago for railway ballast. There are now no traces left of former railway operation, not even the road-bed. A large pit opened at the end of the ridge, which still holds much gravel, and operated by the owner of the land, has a 30-foot face, the upper part of which shows coarse and slightly bouldery gravel which gradually merges into finer material at depth. About 60 per cent of the pebbles are slate or slaty metamorphic rocks, half of which are more or less soft. Small clay lenses are seen in the lower bank. The gravel has given good results on a stretch of the main road nearby.

419. *Lot 5, Con. B, Bury; near fork of roads.*

Thick streaks of fresh gravel of suitable coarseness and grading for road use are seen in two excavations aggregating 6,000 square yards in extent, opened in a large, steep, flat-topped ridge. The larger pit is in the flank of the ridge facing a brook with the pit bank reaching the top of the ridge at a height of about 35 feet, and the smaller pit cuts through almost the full width of the ridge at one end of it. The amount excavated, over 35,000 cubic yards, forms but a small portion of the volume of the ridge. The uniformity in coarseness and grading of the gravel is broken by sandy streaks, but as the sand is everywhere very coarse it would not affect the grading of the gravel to any extent if mixed with it. The upper part near the crest, however, is too coarse and bouldery for use as road-surfacing material. An abrasion test run on pebbles of sample No. 419, which was taken from fresh, medium-coarse gravel at a depth of 20 feet, gave a percentage of wear of 14·5 (Grading A). The gravel compacts readily on the road and wears evenly under heavy traffic.

420. *Lot 18, Con. D, Lingwick; near intersection of Provincial highway with road to Scotstown.*

The deposit averages 18 feet in depth, and in the upper half, as seen in a large excavation over 10,000 cubic yards in size, carries coarse and bouldery, partly weathered gravel, regularly graded and uniform in coarseness, whereas the lower half carries fresh sandy gravel, not so uniform in size as in the upper half. The upper gravel is too weathered and soft, and the lower gravel too sandy for good results in road surfacing, except perhaps on roads of small traffic. Over 55 per cent of the pebbles are slaty, half of which are more or less friable.

421. *Lot 37, Con. K, Lingwick; along Provincial highway.*

The deposit averages 7 feet in depth and covers a large area. Partly weathered, well-graded gravel is exposed in the bank of a pit 100 yards in length. The gravel varies in a gradual way from coarse and slightly boul-

dery at one end of the pit to very fine at the other end. Roads surfaced with this gravel are remarkably smooth, but not hard when wet. The weathered or soft slate pebbles crumble readily into black dust which acts as a strong binding medium.

423. *Lot 16, Con. III, Clifton; near Provincial highway.*

Fine, fresh and well-graded gravel is exposed in the 20-foot bank of a side-hill excavation opened in the steep slope of a knoll. In places the proportion of sand is rather high, but the latter is everywhere very coarse, and the gravel is on the whole fairly uniform in grading and quality throughout, and has proved satisfactory on roads, although not durable. About 30 per cent of the pebbles are limestone and 40 per cent more or less soft schistose and slaty rocks. Another knoll nearby is said to hold gravel of about the same character, a rough estimate placing the amount excavated, 3,500 cubic yards, as one-tenth of the total volume of the two knolls. No. 424 is another knoll of about the same size half a mile farther south, and the same gravel as No. 423 is seen in an excavation measuring 3,600 cubic yards.

426. *Lot 3, Con. II, Auckland; near line of Con. I.*

The deposit lies in the lower slope of a low knoll, composed largely of glacial drift or very bouldery material. The gravel is well graded, coarse, fresh, and carries a low proportion of sand, probably not much over 25 per cent, and most of the sand is coarse. Medium-soft schist or slate forms a high proportion of the pebbles, and the material presumably is not durable. Except for coarseness it closely resembles Nos. 423 and 424.

427. *Lot 6, Con. I, Hereford; near intersection of Provincial highway with line of Con. II.*

The deposit is one of many shallow deposits found between East Hereford and the International Boundary, no less than 15 cuts or pits being encountered in that distance. All these deposits lie in the bank of Hall stream, which empties into Connecticut river just past the border, and they may be more properly regarded as a single deposit, as the gravel is everywhere similar in size and composition. It is well graded and of about the right coarseness for road surfacing, but carries a high proportion of rather soft schist or slate pebbles, and for that reason it is not thought to be durable as road material. An abrasion test on pebbles of sample No. 427 gave a percentage of wear of 18·4 (Grading A). Although of shallow depth, the deposit is almost continuous over the 5-mile distance between the border and East Hereford. North of that place the road follows a tributary of Hall stream for several miles, and deeper deposits in the form of low knolls are encountered, but the gravel is coarse and bouldery, interstratified with a great deal of sand in places. Although streaks of good gravel are not uncommon, the material is on the average not so well graded and not so uniform in coarseness as the gravel along Hall stream.

Wolfe County

Investigation in this county has beeen largely confined to the eastern half. Although gravel is by no means uncommon, most of it occurs in small or moderately small deposits. Deposits of large size occur almost solely along St. François river. The large amount of work done for highway improvement during the last few years has absorbed most of the higher grade gravel from the deposits lying close to the improved highways, so that lower grade material only is left exposed in the pits. A great deal of good road gravel would probably be found by sounding and digging test pits in both banks of St. François river between St. Gérard and the south end of the county.

432. *Lot 26, Con. I, Ham; near intersection of Provincial highway with line of Con. II.*

An excavation covering 880 square yards and dug to the full depth of the deposit which averages 7·5 feet, shows well-graded coarse gravel holding about one-third sand. The gravel is interstratified with thin layers of sand, which increases the total percentage of sand to 45. Pebbles of sample No. 432, which was taken from a depth of 5 to 9 feet and represents the pit average as regards coarseness, had a percentage of wear of 18·1 (Grading A) in the abrasion test. The deposit extends over several acres.

433. *Lot 45, Con. A, Ham; near junction of two brooks.*

The deposit runs through a low, flat-topped sand knoll, and forms a band or streak over 100 feet in width and 7·5 feet in average depth. The gravel is coarse and slightly bouldery, carries on the average 5 per cent boulders and 35 per cent sand, and is uniform in coarseness but becomes much finer on both sides where it merges into the sand.

436. *Lot 10, Con. XII, Stratford; on edge of bluff facing St. François river.*

A large, shallow excavation cuts across nearly the full width of the deposit and shows well-graded, fine gravel carrying a high proportion of sand, from 60 per cent in the central part of the deposit, where sample No. 436 was taken, to 75 per cent towards the sides. The objectionable feature of a high proportion of sand is somewhat lessened by the fact that the sand is exceedingly coarse. The gravel is slightly rusty and more or less weathered to the full depth of the pit, which has been dug to the bottom of the deposit, or an average depth of 8 feet. The deposit occupies the top of a steep river bank and is of unknown extent, but apparently covers several times the pit area, which is about 2,850 square yards.

437. *Lot 6, Con. XII, Stratford; along St. François river.*

Several large excavations, aggregating over 25,000 cubic yards in size, have been opened in the bank of St. François river and worked for sand and gravel. Gravel of suitable coarseness for road purposes is seen only

in one of the pits, where a 17-foot face shows medium-coarse gravel carrying from 40 to 50 per cent sand, interstratified with thin layers of sand, in places silty. The medium-coarse gravel is topped by 2 to 3 feet of coarser material. The proportion of sand gradually increases with depth, and in places the lower half of the bank is almost entirely sand. Pebbles are approximately 40 per cent serpentine and peridotite, 25 per cent quartz and 35 per cent more or less soft schistose or slaty rocks. On the whole, the exposed banks of the several pits show more sand than gravel. River flats of sand and gravel are also exposed at several places at low-water level.

446. *Lot 5, Con. III, Dudswell; along Provincial highway and 1 mile northeast of South Dudswell.*

A 50-foot side-hill excavation in the steep flank of a ridge shows gravel that varies much in coarseness between the different layers. It is generally coarse and bouldery in the upper bank and turns finer at depth. The lower bank is at one place almost entirely sand. On account of the wide variation in coarseness, it would be preferable to pass the whole through a crusher, leaving in place the sandy material in the lower slope. This would probably be the most practical plan in large-scale development work, and advantage could be taken of the height of the deposit and the sloping ground at the foot of the ridge in designing a gravity system of crushing and screening. It may also be profitable to excavate the sand and dispose of it as concrete sand in East Angus, 5 miles distant, after investigating market conditions for such a product. The size of the pit, 5,500 cubic yards, is hardly one-tenth of the size of the ridge.

Megantic County

Outside of Inverness and Leeds townships, almost the entire county was covered by the investigation.

Gravel is nowhere common and occurs mostly in shallow deposits of small or moderate extent, scattered throughout the county. The bank gravels in the northern part of the county are generally well graded but carry a large amount of soft shale or slate, and those in the southern part are poorly graded, so that good bank gravel is very scarce. For that reason gravel from river flats, fresher and harder than the bank gravel, is extensively used for road purposes wherever available, such as at Thetford Mines, Black Lake, St. Ferdinand, Plessisville, and Ste. Anastasie. Sample No. 451 is from a gravel flat in Bécancour river between William lake and Trout lake, and sample No. 459 is from the same river near Ste. Anastasie. Both have been found more satisfactory as road material than bank gravels, as they were better.

Lotbinière County

Gravel is very scarce over the greater part of the county, except in the northern corner, near the Levis county border, where there are many small and shallow deposits of well-graded gravel carrying much shale or slate,

of which No. 465 is typical. The few other gravels found in the county are soft, except No. 462, which is different in composition from any of the other gravels examined, and is undoubtedly the best for road use.

460. *Two miles northeast of Dosquet; along C. N. R. track.*

In a large excavation, over 7,000 square yards in area, there is exposed well-graded gravel varying in a gradual way from coarse in one end of the pit to fine at the other, and carrying on the average 50 per cent sand. The deposit is in the form of a flat dome covering a large area, and averages not more than 8 feet in depth. Most of the excavated material, 30,000 cubic yards, has been used in road improvement. It compacts readily on the road, wears evenly but fast even under light traffic.

461. *Three miles west of Issoudun; near fork of roads on line between ranges IV and V of Ste. Croix.*

The deposit forms a ridge covering 25,000 square yards with a height of 13 feet at the crest. Two kinds of gravel are exposed in an excavation covering 2,900 square yards, dug in one slope of the ridge to the full depth of the deposit. In the upper 4 to 5 feet of the bank is a very sandy gravel carrying only 25 per cent pebbles, 75 per cent of which are flat and friable sandstone. The remainder of the bank shows fresher, coarser, and better graded gravel, carrying about 35 per cent sand near the crest and 50 per cent in the middle slope. Limestone makes up about 50 per cent of the pebbles and sandstone hardly 5 per cent. The lower gravel is a good road material but the upper sandstone gravel is worthless and a serious obstacle to the development of the deposit.

462. *Two and three-quarter miles northeast of St. Flavien; Con. Bois Franc de l'Ail; on the farm of J. B. Demers.*

Gravel forms part of a large, ridge-like, sandy elevation several miles in length. The gravel is said to have been traced for a distance of two miles and to have in places a depth of 25 feet. Coarse, well-graded gravel is seen in a large, shallow excavation in the southwest end of the deposit. The excavation covers an area of 6,500 square yards with a maximum depth of 9 feet, which is not the full depth of the gravel. A peculiarity of the gravel is the relatively high proportion of trap pebbles, 35 per cent, derived from local intrusive rock, of which there are many outcrops between St. Flavien and St. Nicholas in Levis county. Good results have been obtained with this material in surfacing the road leading from the pit to the main road at St. Flavien, and also a stretch of the main road. Sample No. 462 was taken from the side of a hole dug in the bottom of the main pit and was from coarser and less well-graded material than the pit average. The gravel below the level of the excavation is apparently coarser, bouldery, and not so uniform in grading as the upper part of the deposit, and this may be the reason why the excavation has not been extended deeper. On account of the good quality of the stones making

up the gravel pebbles, particularly the trap and limestone, it would be advisable to dig deeper, pass the gravel through a crusher and screen it if necessary, in order to obtain a product of uniform grading for the main road.

465. *One and a half miles southeast of St. Apollinaire; Con. Gaspe, one-third mile east of road intersection.*

Well-graded fine gravel carrying from one-half to two-thirds sand is seen exposed in a shallow excavation dug to the full depth of the deposit, which is in the form of a low, flat ridge and averages between 5 and 6 feet in depth. Deposits of similar gravels are common in this part of the county. The gravels are made up of 50 to 65 per cent slate or shale, pack quite readily on the road, wear very evenly and give good service under light traffic. The road surfaces lose much of their firmness when wet and would probably wear fast under larger traffic. Pebbles of sample No. 465 had a percentage of wear of 23·4 (Grading A) in the abrasion test.

Frontenac County

All the developed deposits of the county, apart from a few small ones, have been included in the investigation.

Gravel is fairly common in the eastern half of the county and comparatively scarce in the western half. On account of the high proportion of soft pebbles none of the gravels can be regarded as high-grade, durable road material, and more than half are either too coarse or too fine to make a satisfactory road surface. Between Megantic and St. Hubert, gravel is more common and of somewhat better quality for road use than in other sections of the county.

468. *Lot 27, Con. A, Lambton; one-third mile of where Provincial highway crosses Tierney river.*

Gravel lies in the north slope of a low, flat-topped knoll made up largely of glacial drift. A round pit, 2,600 square yards in area and 20 feet in greatest depth, has been dug to the level of the underlying drift and shows large streaks of well-graded, sandy gravel of uniform coarseness, and also much poorly graded material and partly sorted drift. Sample No. 468 represents the average run of the good gravel. The streaks, however, form but a small part of the deposit, which carries more boulders and sand than gravel.

473. *Lot 57, Con. I N.E., Whitton; along brook, one-third mile northeast of Provincial highway.*

The deposit forms a steep, narrow ridge or " horseback " and measures approximately 135 by 30 yards, with a height of 17 feet at the crest. An excavation along the side has been dug to the full depth of the deposit and in places reaches the crest of the ridge. The pit bank, 75 yards in length shows dusty, weathered and soft, coarse and bouldery, but otherwise well-graded gravel, of fairly uniform coarseness throughout and carrying 10 per cent boulders and 35 to 40 per cent sand on the average.

About 70 per cent of the pebbles are slate or slaty metamorphic rocks, two-thirds of which are more or less soft. It is a good material for road foundation, and it would probably make a fair surface on roads of light traffic by screeening out the larger stones, but is too soft and dusty to warrant the cost of crushing it; crushing may even injure it, as a large proportion of the stones would crumble instead of breaking into angular fragments.

475. *Lot 55, Con. II, Spalding; near line of Con. I.*

The deposit forms a steep ridge, over 600 feet in length, and from 150 to 300 feet in width. The height at the crest varies from 15 in the wider part to 30 feet in the narrower part of the ridge. A large excavation, over 2,500 square yards in extent, cuts into the full depth and two-thirds of the width of the deposit, and shows coarse and slightly bouldery gravel, fairly uniform in size throughout, and carrying about 35 per cent sand, mostly coarse. Boulders form 5 per cent of the total and are generally uniformly distributed, although somewhat more numerous near the crest. Only the lower part of the deposit carries gravel that is free from weathered fragments, and the material as a whole is only moderately hard and durable. Over 50 per cent of the pebbles are slate or slaty rocks, three-quarters of which are more or less soft.

476. *Lot 1, Con. II, Woburn; near fork of roads on Provincial highway.*

The deposit forms a steep ridge or knoll 60 feet in height. A side-hill pit measuring 39,000 cubic yards in size cuts through the full depth and width of the deposit. Apart from a few bouldery and sandy pockets in the upper part of the large pit bank, the gravel is fairly uniform in size and generally fairly coarse and somewhat sandy. The deposit is worked solely for road surfacing, as its clay content precludes its use as aggregate in mortar and concrete. The amount of gravel available is conservatively estimated at twice that already taken out, and is probably much larger.

477. *Lot 27, Con. I, Ditchfield; near shore of lake Megantic and along Provincial highway.*

The 30-foot face of a side-hill excavation opened in the end of a large, steep ridge, shows well-graded, fine gravel carrying about two-thirds sand in the upper bank, and finer and more sandy gravel farther down. Over 50 per cent of the pebbles are slate or slaty rocks, two-thirds of which are more or less soft. A great deal of sand is also exposed in the large pit bank. The gravel is undoubtedly too sandy for road use but appears to be the best available locally. Over 6,000 cubic yards have been taken out, which is but a small part of the deposit.

478. *Lot 10, Con. III, Ditchfield; along line of Con. II and north of C.P.R. track.*

The deposit lies in the steep slope of a bluff facing a brook. In a 25-foot pit face there is exposed well-graded, medium-coarse gravel carrying about 5 per cent boulders and 45 per cent sand, topped by 4 to 5 feet of bouldery, clayey, and rusty gravel, thickening to 7 feet in one place.

The thickness of the upper bouldery gravel, which is worthless and may be considered as part of the overburden, constitutes a serious obstacle to the development of this deposit, which, except for the bouldery topping, carries fair surfacing material. About 70 per cent of the pebbles are slate or slaty metamorphic rocks, half of which are more or less soft. The ground surface in the slope and top of the bluff shows mostly sand and the extent of the gravel deposit is unknown.

479. *Lot 47, Con. IV, Spalding; near where Provincial highway crosses Nebnollis river.*

The deposit forms a ridge over 11,000 cubic yards in volume, and carries coarse gravel that is uniform in size, as judged by that part exposed in the face of a side-hill cut, 45 yards in length, in the slope of the ridge The uniformity of size is broken only at one end of the pit face by a large layer of bouldery gravel. Except for this layer, the gravel carries on the average 5 per cent boulders and 40 per cent sand. About 50 per cent of the pebbles are slate or slaty metamorphic rocks, half of which are more or less soft. The many rusty streaks through the gravel are an advantage from the road-surfacing standpoint, but preclude the use of the material in mortar and concrete works

480. *Lot 38, Con. IV, Spalding; ½ mile northeast of where Provincial highway crosses Kokombis river.*

A side-hill cut, 60 feet in height, in the steep slope of a knoll, shows coarse and bouldery gravel alternating with fine gravel in a series of thin layers. The gravel carries on the average 40 per cent sand and not more than 5 per cent boulders. Except near the surface, the material is fresh throughout and carries some clay in the lower part of the cut. About 70 per cent of the pebbles are slate or slaty metamorphic rocks, one-third of which are more or less soft. The gravel has been used with good results on a stretch of the main road between St. Hubert and Lac Megantic. The amount of gravel taken, 23,600 cubic yards, is but a small part of the volume of the knoll.

481. *Lot 15, Con. II, Spalding; halfway between lines of Cons. I and III.*

Fairly well-graded, coarse and in places bouldery gravel is exposed in a shallow pit opened in the slope of a low, flat-topped terrace. The gravel is clayey and carries about 40 per cent sand. About 75 per cent of the pebbles are slate or slaty metamorphic rocks, half of which are more or less soft. The excavation which covers 1,900 square yards and averages 6 feet in depth was from all appearances originally opened in finer gravel and has been extended gradually inwards into coarser and more bouldery material, the latter probably merging into boulder clay behind the pit face. One end of the pit bank shows a small pocket of boulder clay, which probably makes up the bulk of the terrace. Several other pits have been opened in this vicinity in the face of the same terrace. On account of the large proportion of more or less soft slaty stones, there would be no advantage in crushing the coarse gravel to proper size for road work.

Beauce County

Gravels are fairly common and evenly distributed throughout the northern part of the county. In the southern part bank gravel is scarce, but a large supply of river gravel from the bed and flats of several streams is easily available at low-water level. A great deal of river gravel is hauled at low water and stored in stock-piles for use in road improvement. It is found more satisfactory on main roads than bank gravels. Nos. 501 and 508 are two samples taken from Chaudière river. Along the Levis-Armstrong highway, which has been improved with gravel for many years, much of the good bank gravel has been used up, and most of the old pits now show inferior material. Of the bank gravels, Nos. 492, 493, and 499 are of better quality for road work than the average in the county.

492. *Two and a half miles northwest of Ste. Marie; one-quarter mile northwest of fork of roads on Provincial highway.*

Fairly hard and fresh, medium-coarse gravel is exposed in an excavation opened in the bank of a brook. The gravel is uniform in coarseness throughout the pit and carries about 50 per cent sand. An abrasion test on the pebbles of sample No. 492, which was taken at a depth of 5 to 8 feet, gave a percentage of wear of 17·1 (Grading A). The pit covers 1,600 square yards, cuts through the full depth of the deposit and has a maximum height of bank of 12 feet on the up-slope side. It is not known how far the gravel runs along or into the brook bank. For several miles to the south, there are many surface indications of gravel, but the few pits examined show gravel that is more sandy and less well graded than No. 492.

493. *Ste. Marie; along Provincial highway and one-quarter mile southeast of bridge over Chaudière river.*

The deposit lies in the steep bank of Chaudière river, and is said to cover an area of about 115 by 90 yards. An excavation covering 1,400 square yards reaches the bottom of the deposit at an average depth of 12 feet. The up-slope pit face has a maximum height of 17 feet and shows partly weathered, coarse, and slightly bouldery gravel in the upper 6 to 8 feet, and fresher and finer gravel below. The gravel is well graded and carries about 50 per cent sand. Pebbles are 50 per cent slate or slaty metamorphic, one-third of which are more or less soft. The gravel deposit is underlain by clay and carries in its lower part rounded clay lumps resembling pebbles and boulders. Deposit No. 494, which is in the shape of a knoll measuring 150 by 50 yards, holds apparently gravel of the same character as No. 493, judging from what is seen in the talus-covered bank of a pit.

497. *Valley Junction; along Provincial highway and near bridge over Chaudière river.*

The deposit forms a high, steep-sloped knoll which is part of a bluff facing Chaudière river. A large side-hill cut reaching a height of almost 100 feet in the slope facing the river shows gravel that varies widely in

coarseness from place to place and carries on the average a high proportion of sand. Several much smaller pits have been dug in the lateral slopes of the knoll and in places have exposed material which is of more proper grading for road surfacing than in the main excavation. The deposit is of considerable size and the material easy to get, with but little stripping, but the wide variation in coarseness and the large amount of sand would not warrant developing the deposit on a large scale for road work.

499. *One and a third miles southeast of St. Joseph; between Provincial highway and Chaudière river, farm of J. Jacques.*

An excavation, cutting through the full width and depth of a small ridge, shows well-graded, medium-fine gravel, uniform in coarseness throughout the exposed area and carrying about 55 per cent sand. About half the length of the ridge, or 15,000 cubic yards, has now been excavated to the underlying clay, and the levelled land turned back to cultivation. The deposit has an average depth of over 6 feet and what is left of it covers an area of 100 by 75 yards. The gravel is but slightly weathered and fairly hard, but not fresh enough to make a good aggregate in concrete work.

506. *Lot 83, Range I, Aubin de l'Isle; between Provincial highway and rivière du Loup.*

The deposit, which is underlain by clay, occupies the edge of a river terrace and averages about 10 feet in depth. The gravel is medium coarse to fine, fresh and slightly clayey. Sample No. 506 represents material that is coarser than the average. Clay and sand lenses, which are seen in places in the up-slope bank of an excavation covering 1,300 square yards, are said to increase in size as the excavation work proceeds farther into the bank, and probably mark the limits of the gravel in that direction. Surface indications of gravel were observed in the slope of the terrace at several other points in the vicinity.

514. *Lots 16, 17, Con. IV, Broughton; near intersection of Provincial highway with line of Con. III.*

The deposit forms a flat ridge and has an average depth of 10 feet. Good gravel, of about the right size and grading for road work, occurs in the upper two-thirds of the deposit, but the lower third is rather fine and very sandy. Sample No. 514, taken in the upper two-thirds, represents slightly finer gravel than the average for that part. The pit covers 4,300 square yards and the total area of gravel is several times that of the pit, including a few other ridges in the vicinity.

515. *Lot 16, Con. X, Broughton; between Provincial highway and Q.C.R. track.*

A large pit, 2,250 square yards in area, cuts through the full depth of the deposit, which averages 10 feet, with a maximum of 15 feet in the central part. The upper two-thirds of the pit bank where sample No. 515 was taken show more regularly graded material than the lower third represented by sample No. 515a. Although the relative proportion of pebbles and sand is the same in both, the pebbles are much coarser in the lower part. The clay

of the lower gravel explains the poor showing of sample No. 515a in the mortar test (Table III, page 197). The lower gravel, although fresher, carries a higher proportion of soft pebbles than the gravel from the upper part. The deposit forms a flat-topped, dome-like elevation covering several acres. All gravels in this part of the county are relatively soft and wear fast under traffic.

516. *Lot 19, Con. XI, Broughton; one-third mile from county line.*

The deposit forms a large irregular ridge 30 feet in height at the crest. A large excavation, dug to the full depth of the ridge and cutting it almost in two, shows more sand than gravel. Streaks of gravel suitable for road work are confined mostly to the upper part near the crest, but large sections of the bank carry fresh, fine gravel and coarse sand suitable for concrete and mortar aggregates. Pebbles are 90 per cent slate or schist, half of which are more or less soft. The amount excavated, 11,500 cubic yards, is but a small part of the ridge.

Levis County

Except along Chaudière river, gravel is very scarce, and occurs in the form of small, shallow deposits carrying a great deal of soft shale. Along the Chaudière, there is an almost continuous string of deposits from the mouth of the river to Ste. Marie in Beauce county. Numerous pits have been opened in these deposits, particularly in the southern part of the county for the improvement of the Chaudière River road, which leads directly to the Quebec bridge. Rather coarse gravel was selected for the improvement of this road as is the usual practice in surfacing a newly improved road, the coarse material serving as a foundation course for further improvement later with finer gravel. The gravel surfacing had just been completed when the road was examined and the gravel was still loose. A brief description of the Chaudière River gravels is given below under No. 523. A few of the small deposits of shaly or slaty gravels found elsewhere in the county have been worked for road material. No. 522 stood well on roads of very small traffic, but wore fast under heavy traffic. Nos. 517 and 518, which are almost entirely shale, are used only on roads of very small traffic, and make firm and smooth surfaces which, however, soften considerably when wet, and the finer one, No. 517, turns even muddy and slippery, somewhat like clay.

Dorchester County

There is a considerable amount of gravel along or close to the Chaudière and Etchemin rivers in the northern part of the county, but elsewhere gravels are scarce, particularly so in the southern end of the county. The gravels along Chaudière river are a continuation southward of the string of deposits mentioned for Levis county. Gravel has been obtained at many places along the river, and is generally of good quality for road use, but is in places interstratified with much sand. Sample No. 523 is from one of the many exposures and represents the coarser and better road gravel. Along Etchemin river, there is a large deposit or group of

deposits between Ste. Claire and Abenakis and several others farther up the river. Some of the Etchemin River deposits also carry much sand interstratified with the gravel. The few deposits found in the southern part of the county are of small size and only two hold gravel of fair quality.

523. *Four miles north of St. Bernard; ⅔ mile east of intersection of Provincial highway with county line.*

In the 9-foot bank of an excavation covering 2,600 square yards, there is exposed well-graded, fairly fresh, coarse and slightly bouldery gravel, turning fine and sandy in the lower bank. The average coarseness runs about 5 per cent boulders, 55 pebbles, and 40 sand. An abrasion test run on pebbles of sample No. 523, which was taken at a depth of 2·5 to 7 feet, gave a percentage of wear of 16·4 (Grading A). The deposit forms a flat ridge, averages 10 feet in depth and is underlain with clay or drift.

The gravel in this excavation represents the coarser part of the Chaudière River deposits, in which numerous pits have been opened between St. Lawrence river and Ste. Marie in Beauce county. The deposits are in the form of narrow, flat-topped ridges or beaches with the shore slope steeper than the opposite slope. Some of the ridges are gravelly all through, whereas others carry gravel near the top and sand below. In many gravel is interstratified with sand. The thickness of gravel ranges in the different deposits from a few up to 15 feet and averages 8 feet. Apart from local variations in coarseness, the gravel is generally fine and sandy near the mouth of the river and gradually turns coarser and less sandy up the river. As regards composition, the proportion of slate or shale, which is on the average 20 or 25 per cent in Dorchester county, runs up to 50 per cent near the mouth of the river in Levis county. The better gravel for road work is generally the coarser and lies in the southern part of Levis and the adjoining part of Dorchester county, where sample No. 523 was taken.

527. *Coulombe; east and south of road intersection.*

No. 527 is one of several shallow deposits lying a short distance from one another. The deposits are not more than 6 feet in depth and hold material of about the same composition and quality. The gravel is generally fine with but a small proportion of boulders, is more or less weathered to the full depth of the deposits and carries a large amount of soft pebbles, mostly shale. Small streaks of coarse and bouldery gravel are occasionally found in some of the deposits, but the larger stones break down readily to smaller size. Like typical shale gravels, they pack readily on the road, form smooth surfaces, wear fast, and become very soft when wet. Gravel No. 524, which lies 3 miles farther north, is of the same character, although not quite so shaly and soft.

528. *Two and a half miles north of St. Maxime; along Bras river and two-thirds of a mile east of Provincial highway.*

The deposit forms a steep bluff facing Bras river. A large side-hill cut, 30 to 35 feet in height and over 150 yards in length, shows mostly boulders, with gravel exposed only at one end of the cut. At that end, fresh, medium-fine, well-graded gravel, carrying 50 per cent coarse sand

is overlain with 6 to 12 feet of boulders, including 3 to 5 feet of loam and clay on top of the bank. Sample No. 528, taken at depth of 15 to 18 feet, is from the coarser part of the fine gravel. The gravel, though rather soft, is less shaly and somewhat harder than others found farther north. It is more suitable as concrete aggregate than as road gravel, and the thick overburden is a serious handicap to the development of the deposit. The gravel is about exhausted along the excavated part of the bluff, except at one end where, it is claimed, there is a large amount available.

532. *Two and three-quarter miles west of Ste. Claire; on the southwest bank of Etchemin river and near railway crossing.*

Well-graded, fine gravel carrying at most 50 per cent sand is exposed in the 20-foot bank of a small pit opened in the slope of a knoll that lies on the top and edge of a high, steep bluff facing Etchemin river. About 40 per cent of the pebbles are slate, half of which are more or less soft. A stretch of the road along the southwest bank of the river, which carries light traffic, was recently surfaced with this gravel and was in very good condition and particularly smooth. The size of the excavation is 3,100 cubic yards, which is about one-quarter the size of the knoll.

533. *One-half mile east of Ste. Claire; along road following northeast bank of Etchemin river.*

Gravel and sand deposits form an almost continuous string of knolls along the shore of Etchemin river between Ste. Claire and Abenakis, and pits have been opened in nearly every knoll, the size of the openings varying from a few up to 17,500 cubic yards. The gravel is generally interstratified with sand, the sand layers being few in the upper part of the knolls and gradually increasing in number or size with depth, so that the lower part of the knolls is almost entirely sand. The coarseness of gravel varies also with the different layers, but on the average the gravel is fine. The deeper excavations show sand and gravel highly suitable for concrete. Most of the excavations are worked primarily for road gravel, because of the greater demand for road material, and this probably explains the irregular shape of some of the larger excavations, in which much material too fine or sandy for roads is left in place. Although the total amount of gravel available in the group of deposits is undoubtedly very large, well over 100,000 cubic yards, the amount varies much with each individual knoll, and some of the knolls appear to be almost depleted. There is, however, an almost unlimited amount of sand, gravelly sand, and fine gravel suitable for concrete aggregate. Much good road gravel is said to have been taken out of this group of deposits for the main road and other local roads. Some is also hauled in winter to the adjoining part of Bellechasse county.

In deposit No. 533, the core of the knoll has been excavated and the pit, which is the largest one opened in the string of deposits, covers an area of 2,900 square yards. The large and irregular pit bank shows gravel that varies much in coarseness with the different layers and also sand, the latter as a rule confined to the lower part and bottom of the pit. Fine gravel is much more common than coarse. Judging from the good condition

of a stretch of the main road surfaced with this gravel, the material used was probably better graded and particularly less sandy than the average exposed in the pit bank. Two abrasion tests on pebbles of sample No. 533, which was taken from a layer of coarse, fresh gravel at a depth of 11 to 13 feet, gave percentages of wear of 11·2 (Grading A) and 10·6 (Grading B).

534. *Three-quarter mile east of Ste. Claire; along road following northeast bank of Etchemin river.*

A pit just opened (1931) in the west slope of a small knoll, which is part of the string of deposits already referred to, has been dug to a depth of 10 feet and shows well-graded, partly weathered gravel carrying 65 per cent sand on the average. The gravel varies in a gradual way from medium coarse in the down-slope pit bank to fine in the up-slope bank. An abrasion test on pebbles of sample No. 534, taken from the coarser gravel at a depth of 2 to 7 feet, gave a percentage of wear of 22·9 (Grading D). An older pit on top of the same knoll is no longer worked for road gravel on account of the gravel being too fine.

536. *Two miles northwest of Ste. Malachie Station; along road following northeast bank of Etchemin river.*

An excavation, 1,900 square yards in extent and 18 feet in greatest depth, opened in a flat ridge along the shore of Etchemin river, shows in the central part of the ridge well-graded gravel of medium coarseness carrying about 50 per cent coarse sand. The gravel is but slightly weathered in the upper 10 feet, and is quite fresh under a thin layer of fine sand at depth of 10 feet. Away from the central part of the deposit, that is, in both slopes of the ridge, the material is finer and in some places almost entirely sand. The gravel lies under an overburden of 2 feet of fine silty sand and the deposit is said to cover 3·5 acres. The pit, which reaches its greatest depth in the better graded material underneath the crest, is rather shallow in the sandy gravel and averages about 9 feet in depth.

537. *Lot 14, Con. IX, Frampton; between road and Etchemin river.*

The deposit lies in the bank of Etchemin river and is in the shape of a flat-topped knoll sloping steeply towards the river. In a round excavation covering 1,100 square yards and cutting into the upper slope and top of the knoll, there is exposed well-graded, medium-coarse, fairly fresh gravel carrying about 30 per cent sand. The gravel is uniform in coarseness, except in the slope near the pit entrance where the material is largely sand. Two abrasion tests on pebbles of sample No. 537, which was taken from slightly coarser and less sandy gravel than the average, gave percentages of wear of 17·5 (Grading A) and 18·5 (Grading D). The size of the pit, which reaches the bottom of the gravel at a maximum depth of 20 feet, is 4,500 cubic yards, or about one-tenth the size of the knoll. A stretch of the main road to Ste. Malachie recently surfaced with this gravel was in very good condition.

540. *Lot 4, Con. IV, Ware; halfway lines of Cons. III and V.*

The deposit forms several small knolls at the foot of a hill and along a brook emptying into Etchemin river, and is said to cover 8 to 10 acres as ascertained by test pits. As seen in the large bank of an excavation, which covers an area of 2,700 square yards and has a maximum depth of 24 feet, the material varies widely in coarseness and grading from straight sand to over half boulders. Development work for road material is now confined to one end of the pit, where the gravel is of uniform coarseness, though bouldery, from top to bottom of the 24-foot face. The average coarseness at that end runs approximately 20 per cent boulders, 55 pebbles and 25 sand When the larger stones are screened out, it makes a uniformly well-graded road material which has been in use on a stretch of the main road near Ste. Germaine and has given good results. An abrasion test on pebbles of sample No. 540, which was from the run of the bank at the end of the excavation worked for road gravel, gave a percentage of wear of 13·2 (Grading A). The amount of suitable road gravel in the deposit is certainly large but may lie in places beneath a great thickness of poorer material, as seen in a large part of the pit bank. Outside of this large deposit, gravel is locally very scarce.

544. *Lot 7, Con. IX, Langevin; along brook, on the farm of R. Lecours.*

Fresh, fine, sandy gravel is exposed in the bank of an excavation dug in the slope and top of a low bluff facing a brook. The gravel is clayey in places, carries from 40 to 80 per cent sand and lies under an overburden of 3 to 5 feet of clayey and slightly gravelly sand. The gravel has been excavated to a depth of 9 to 10 feet, which is close to the depth of deposit, and the pit extends 55 yards into the bluff, which is probably the average width of the deposit, as glacial drift is exposed at one place in the pit face. The deposit runs for at least 200 yards along the bluff so that its size would be about 33,000 cubic yards, including the thick overburden. Sample No. 544, taken at a depth of 4 to 9 feet, is from the coarser and less sandy part. The gravel is hard and fresh and should probably make a good road material if it were not so sandy. A stretch of the main road to Ste. Justine recently surfaced with the gravel was in fair condition. The material was firmly compacted in the wheel tracks but loose elsewhere, owing probably to the high sand content of the gravel combined with light traffic, a large proportion of which is horse-drawn.

Bellechasse County

There are a large number of deposits in the central part of the county and between St. Raphael and Lafayette. Elsewhere gravels are less common, and most of the deposits near St. Lawrence river are shallow and small.

The gravels in the central part extend from St. Damien to St. Paul, past the county border. Coarseness varies a great deal between the different deposits, some being coarse and bouldery, and others carrying more sand than gravel. They compact readily on the road, make smooth and hard surfaces, even when wet, and are fairly durable under light traffic. Good

roads have been built with these gravels around St. Damien, St. Philémon, and St. Paul. All gravels carry a rather high percentage of schist or slate, part of which is more or less soft or friable, so that the hardness of the gravels as a rule varies conversely with the percentage of schist and slate. Many pits have been opened in the deposits. Only those more important on account either of the quality of the gravel or of the quantity taken out for road use are described in the following pages.

Good gravels, somewhat similar to those near St. Philémon, but harder, are found near St. Cajétan, including Nos. 562 and 563. Farther north, near St. Raphael, gravel is still harder, not so well graded, and is slow to compact properly on the road, except No. 559, which is better in that respect than other local gravels.

In the low land bordering the St. Lawrence, gravel occurs in the form of low ridges. Most of the deposits are small and shallow, and several are now exhausted. They carry from 50 to 75 per cent of rather soft red and green shale or slate, are well graded although rather fine, pack well and make smooth roads, but wear fast. Some of them, such as Nos. 545 and 547, are less shaly than the others and give satisfactory service where the traffic is not too great. When the road is wet, the red shale or slate common to all these deposits is said to stain vehicles.

Several deposits have been developed for road gravel near St. Camille and St. Magloire, in the southeast end of the county. The gravel is generally coarse, takes long to form a compact surface, but wears well.

A number of deposits are worked only during the winter, and the gravel is hauled and stocked at convenient points along the road. These winter pits were in poor condition when visited, as the bank was concealed behind talus, and even trees had fallen in some. Information regarding them was obtained in part from road patrolmen, and samples were taken from stock-piles along the road.

547. *Three and a half miles southeast of St. Vallier; along Provincial highway, Range III.*

Fresh, well-graded gravel of medium coarseness and carrying about 50 per cent coarse sand is exposed in a shallow excavation opened in the middle slope of a large, rather flat ridge. The material near the surface of the ridge is mostly glacial drift, with outcrops of sandstone and shale or slate near the top, and the gravel deposit appears to be confined to the middle southeast slope and trends parallel with the ridge, i.e. in a southwest-northeast direction. It has been excavated to its full depth, which averages 3·5 feet, over an area of 8,600 square yards. Another deposit averaging 5 feet in depth and holding gravel of the same character lies also in the middle southeast slope of a large ridge of glacial drift, one-half mile to the northwest. Gravel from both deposits has been extensively used on all local roads and has given good service under light traffic, but wears fast and is somewhat dusty on the main road to St. Vallier, which carries heavy traffic. Pebbles are about 50 per cent slate or shale, one-third of which is more or less soft. It is difficult to ascertain the extent of the two deposits without sounding, on account of the surface of the deposit having the same gentle slope as that of the drift. Drift and small knobs of rock are exposed in the floor of both pits.

550. *One and a quarter miles southeast of St. Gervais; along Provincial highway, Range II, near line of Range I.*

The deposit is part of a large terrace facing low, level land to the northwest. Partly weathered, well-graded, coarse and slightly bouldery gravel is exposed in the bank of an excavation opened a short distance behind the terrace slope and dug to the bottom of the gravel, which averages 9 feet in thickness. The coarseness of the gravel runs about 5 per cent boulders, 45 pebbles, and 50 sand. An abrasion test run on pebbles of sample No. 550, which was taken at a depth of 4 to 9 feet, gave a percentage of wear of 30·3 (Grading A). The amount of gravel available is practically unlimited, according to information received from the local road patrolman. A stretch of the main road southeast of St. Gervais surfaced with this gravel wears fast and is dusty. Another stretch of the same road northwest of St. Gervais was recently surfaced with river gravel No. 549 and was in good condition and but slightly dusty. Gravel No. 549 is taken from behind a brook dam, where some accumulates every spring at high water. It is a harder gravel than No. 550 and is available only in relatively small quantity, although a fresh supply is deposited every year.

551. *Two miles northeast of Honfleur; Range III; on the farm of T. Dion.*

The deposit is in the shape of a flat ridge covering 250 by 70 yards, and has a height of 15 feet in the centre. The gravel, exposed only at one end of an excavation covering 875 square yards, is well graded but coarse and slightly bouldery. Coarseness runs on the average 5 per cent boulders, 55 pebbles, and 40 sand. Pebbles are 75 per cent slate, one-third of which are more or less soft. The material has been recently used to surface a stretch of the road to Honfleur and of the main road to St. Lazare. It has not been in service long enough to compact properly under the small traffic prevailing on both roads, but should prove satisfactory. On account of the high slate content, however, it would probably wear fast under heavy traffic.

554. *Four miles southeast of St. Lazare; near parish limits, on the farms of A. and E. Mignault.*

The deposit is worked during the winter only and is said to hold coarse and bouldery gravel. Sample No. 554 was taken from a stock-pile along the road, from which the larger stones had been screened off. A stretch of the main road between St. Lazare and St. Damien, surfaced with the gravel was in excellent condition when examined in dry summer weather, almost as smooth and dustless as a pavement, but the road is said to soften much and even turn muddy in prolonged wet weather, and trouble is experienced every spring and fall on this account. The gravel carries a larger amount of schist and slate than other gravels of the district.

555. *One-half mile northeast of Goulet; Range V, near fork of roads.*

A side-hill cut in the steep slope of a bluff facing Abenakis river shows gravel which is generally coarse and well graded in the upper bank, coarse and bouldery in the lower bank. With the boulders taken off, the material

is, on the whole, uniform in coarseness and grading. The pebbles are over 50 per cent slate, one-third of which is more or less soft. About 3,700 cubic yards of gravel has been excavated. The bluff can be traced for a long distance, but it is not known how far the gravel runs. A stretch of the road leading to the main road at St. Damien and carrying very small traffic was improved with the gravel and was in good condition. According to the road patrolman, it was tried on the main road through St. Damien and found not so durable as No. 556 which is now used on that road.

556. *St. Damien; near where Provincial highway crosses brook.*

A side-hill excavation opened in the steep slope of a knoll facing a brook covers an area of approximately 2,000 square yards and has a height of bank reaching 40 feet in the centre. The gravel exposed in the pit face varies much in coarseness with the different layers, is on the whole coarse and bouldery and carries on the average not more than 35 per cent sand, most of the sand being very coarse. Pebbles of sample No. 556, taken from fresh gravel at a depth of 8 to 10 feet, had a percentage of wear of 15·4 (Grading A) in the abrasion test. With the larger stones screened out, it makes a well-graded and good road material, as it is generally fresh and hard. The extra work and cost incurred in screening out and throwing the oversize to waste, of which there is a large amount, is apparently justified by the results obtained, judging from the very good condition of that part of the main road surfaced with the material. A better plan would be to pass the whole through a crusher and thus make use of the oversize, which is now piled up in the pit and is wasted. The pit measures roughly 12,000 cubic yards, or about one-tenth the size of the knoll, and has not been dug to the full depth of the gravel. It is not known whether the whole knoll is gravel.

557. *Two and a half miles northeast of St. Damien; northeast of fork of roads on Provincial highway.*

The gravel is similar to No. 556 as regards composition, grading, and coarseness but more weathered and softer, although a deeper excavation might expose fresher and harder material. The deposit is in the form of a knoll measuring approximately 10,000 cubic yards and the excavation work has been limited to the upper 10 feet of the deposit. An abrasion test on pebbles of sample No. 557, which was taken at a depth of 3 to 6 feet, gave a percentage of wear of 19·9 (Grading A). The material has been used with good results on a stretch of the main road to St. Damien.

558. *Lot 2, Con. X N.W., Buckland; where Provincial highway crosses brook.*

In a side-hill cut opened in the lower slope of a steep ridge or knoll lying along a brook, there is exposed gravel which is on the average bouldery and sandy. There is too much variation in coarseness between the different layers to give an approximate estimate of the average proportion of pebbles and sand. Boulders make up between 15 and 20 per cent of the total. Pebbles are about 50 per cent quartzose rock, 35 schistose rock, and 10 sandstone, one-third of the schistose pebbles being soft at a depth of 20

feet. The gravel, with the oversize screened out, has been used recently for surfacing a stretch of the main road to Buckland, over which traffic is small. The road surface was firm and smooth, although the screened gravel carries a high proportion of sand. The amount of gravel excavated, 3,400 cubic yards, is but a small part of the ridge or knoll and even if the gravel were limited to the slope facing the brook, the quantity available would be several times that already taken out.

559. *Two and a half miles southwest of St. Raphael; Range I; on the farm of J. Raby.*

The deposit which is flat-lying and shallow is said to cover one acre. Hard, well-graded, coarse gravel carrying about 50 per cent sand is exposed in the bank of a pit which extends over 1,800 square yards and reaches the bottom of the deposit at a maximum depth of 9 feet. Pebbles of sample No. 559, taken at a depth of 3 to 9 feet, had a percentage of 7·4 (Grading B) in the abrasion test. The deposit is smaller than others found near St. Raphael, where gravel is of common occurrence but poorly graded, being made up of large pebbles and sand, with but small amount of material of intermediate size. On the main road they take long to compact properly and corrugate badly under the heavy traffic of midsummer. No. 559, although low in binding quality, has given better results on roads than other local gravels.

560. *One and a quarter miles southeast of St. Raphael; near junction of roads on Provincial highway.*

The deposit forms a steep knoll of over 30,000 cubic yards, one-third of which has been excavated and used for road purposes. The large pit face shows mostly sandy gravel with an occasional layer or pocket of bouldery sand. Outside of the bouldery sand, the material is well graded and though too sandy for good and durable results on roads makes a good aggregate for concrete work, judging from the results obtained in the mortar test (Table III, page 198) on a sample taken at a depth of 15 feet.

562. *Lot 12, Con. II, Armagh; along rivière du Sud.*

The deposit lies in the bank of rivière du Sud and is said to cover two acres, as determined by test pits. Gravel is taken out during the winter only, and when the pit was visited, only the upper two-thirds of the 12-foot bank was exposed. The gravel varies much in coarseness, but the variation is generally gradual from one end of the pit to the other end, and the material is on the whole fairly well graded. An abrasion test run on pebbles of sample No. 562, which was taken from a stock-pile along the road, gave a percentage of wear of 10·0 (Grading A). The pit has a maximum depth of 12 feet and reaches the underlying boulder clay at that depth. A pocket of boulder clay is also exposed at one end of the pit bank, which is probably not far from the edge of the gravel deposit. The gravel has given very good results on a stretch of the main road to St. Cajétan, over which traffic is rather light.

563. *Lot 81, Con. I S. E., Armagh; near line of Con. Ouest.*

Gravel has been excavated to a depth of 15 feet and a distance of 100 yards along the bank of a brook. In the upper half of the pit face, there is exposed well-graded, fine, and sandy gravel. The sand is mostly coarse and varies in amount from 50 per cent near the top to 80 per cent in the middle part of the bank, averaging about 70 per cent. The lower bank, which is largely concealed behind talus, appears to be at least as sandy as the middle part. The gravel is fresh, hard, and has the same composition as No. 562. Were it not for the high sand content, it would make as good a road material as No. 562, if not better. The road leading to the railway station of Armagh and thence to the main road was surfaced with the gravel. The road surface was firmly compacted and quite smooth. Traffic on this road is very small. The extent of the deposit is estimated by owner at 40 acres, but only part of that area is said to have been tested.

564. *Lot 20, Con. S.W., Mailloux; 2 miles southwest of St. Philémon.*

Coarse and bouldery gravel is seen in the 25-foot bank and a side-hill excavation in the steep slope of a knoll. Boulders make up about 15 per cent of the total, but the proportion of pebbles and sand could not be estimated even approximately, on account of the variation in coarseness between the different parts of the large pit bank. As regards composition, it is much the same as No. 565, which is given in Table I, page 161. The gravel is fresh and hard, carries mostly coarse sand, and with the oversize screened out makes a road material of fairly uniform grading. The gravel takes long to consolidate properly on the road but then makes a firm, smooth surface unaffected by weather conditions. The knoll measures roughly 40,000 cubic yards in size.

565. *Lot 11, Con. N.E., Mailloux; 1 mile north of St. Philémon.*

The deposit is worked only in winter for road gravel, because it is difficult of access by wagon at other times. The pit bank was all covered with talus when visited. This gravel is preferred to others more easily accessible on account of its more uniform grading and smaller proportion of oversize material. It does not pack readily on the road but once sufficiently consolidated makes a hard and durable surface. A stretch of the main road through St. Philémon, which carries small traffic, was surfaced with the gravel and, apart from a small amount of loose material, was in very good condition. The road surface, examined one day after a heavy rainstorm, was found firm and gritty. Pebbles of sample No. 565, taken from a stock-pile along the road, had a percentage of wear of 15·3 (Grading A) in the abrasion test. The deposit is in the shape of a knoll covering over 7,000 square yards and is said by the road patrolman to have a depth of over 25 feet at the top.

566. *Lot 2, Con. N.E., Mailloux; ¾ mile northeast of St. Philémon.*

The gravel varies in coarseness with the layers, but is on the average fine and carries 40 to 45 per cent sand, most of which is coarse. It is similar in composition to No. 565 and is generally fresh and hard. Gravel forms an almost continuous string of knolls for a distance of several miles in a

southwest-northeast direction, and the amount available is practically unlimited. Composition is fairly uniform throughout and is about the same as that given in Table I, page 161, for sample No. 565, but coarseness and grading vary much even within the same deposit. In most of them, however, there is but little fine sand or other finer material mixed with the gravel, and but a small amount of friable fragments in the fresh gravel, so that once screened from its oversize, the gravel is fairly well graded and makes a good road material.

570. *Lot 12, Con. III, Bellechasse; near Black river.*

A pit has been recently opened (1931) in a low, flat, ridge-like elevation lying along the bank of Black river. In the small excavation, which reaches the bottom of the deposit at a depth of 8 feet, there is exposed fresh and hard, uniformly well-graded gravel, which is very coarse near the surface and gradually turns fine towards the bottom. It carries on the average 40 per cent sand, most of which is coarse. An abrasion test on pebbles of sample No. 570, which was taken at a depth of 2·5 to 7 feet, gave a percentage of wear of 15·1 (Grading A). The ridge-like elevation measures well over 30,000 cubic yards.

571. *Lot 30, Con. N.E., Bellechasse; near line of Con. IV.*

Several low ridges lying in low level land a short distance from Black river have been excavated for road gravel. The excavation work is done almost entirely during the winter, and when the deposit was visited the pit bank was nearly everywhere concealed behind talus. One part of the pit, where gravel is occasionally obtained for maintenance work during the summer, showed gravel that varies much in coarseness from place to place and is interstratified with much sand and in some places covered with as much as 6 feet of sand. The material is fairly fresh and the pebbles are about 60 per cent slate, one-quarter of which is soft. The pit measures 7,900 cubic yards and the amount available is roughly estimated at five times the amount taken out.

572. *Lot 35, Con. VI, Bellechasse; between C.N.R. track and Daaquam river.*

The 10-foot face of an excavation opened in the bank of Daaquam river shows coarse and bouldery gravel carrying about one-third sand. In places the gravel turns much finer in depth and carries as much as 75 per cent sand, but the larger part of the pit face holds coarse gravel. The gravel is fairly hard all through and holds but 5 per cent of friable pebbles at depth of 9 feet. The excavation averages 6 feet in depth and covers an area of over 2,500 square yards, which is about half the total area of the deposit. Most of the gravel taken out was used recently (1931) to surface a stretch of the main road through St. Camille, over which traffic is small. When the road was examined, the surface was rough everywhere outside of the wheel tracks, on account of the looseness and coarseness of the material.

573. *Lot 42, Con. VI, Bellechasse; between C.N.R. track and Daaquam river.*

Gravel is occasionally taken for road maintenance work from the bank of an old railway pit in a large, shallow deposit lying along the bank of Daaquam river. The deposit averages 6 to 8 feet in depth and holds hard but fine and sandy gravel. The pit face, 300 yards in length, was mostly covered with talus when visited, and, according to the road patrolman, most of the gravel left in the deposit is too sandy for road use.

Montmagny County

Except around St. Paul, Lac Frontière, and south of Montmagny, gravels are scarce, at least throughout the settled part.

The group of deposits found around St. Paul forms the eastern end of the large gravel area in the central part of Bellechasse county. The gravel is similar in composition to that in the adjoining part of Bellechasse county, but much finer, being made up largely of very coarse sand. It makes a firm and smooth road surface, even smoother than the roads built with the Bellechasse gravels, and stands satisfactorily the wear of traffic, which is lighter than in the adjoining part of Bellechasse. There are a number of gravel deposits between Lac Frontière and Panet, some of which have yielded good surfacing material. They compact readily on the road, make smooth surfaces, and although only moderately durable, wear well under traffic. In the south corner of the county, good road gravel has been obtained from two deposits lying between the main road and Daaquam river, including No. 581, and also from the river bed.

South of Montmagny, there are several deposits lying a short distance from the foot of a high, steep escarpment, which marks the southeast limit of the St. Lawrence lowland. They carry a high proportion of friable, grey sandstone, which crumbles readily under traffic and makes the road surface sandy. No. 576 compacts more firmly than the others, particularly on clay soils. In a shallow deposit near St. Pierre, hard, coarse, red sandstone is found in addition to the soft, grey sandstone. A stretch of road built with this material was firmer and less adversely affected by rainy weather than stretches surfaced with other local gravels. Good results obtained with the red sandstone gravels have also been observed elsewhere in the county, but these gravels are much scarcer than those made up of the softer and finer grey sandstone.

576. *Three and a half miles south of Montmagny; near fork of roads, on the farm of U. Talbot.*

Well-graded, medium-fine, slightly weathered gravel carrying about 50 per cent sand is exposed in a shallow pit over 4,600 square yards in extent and reaching the bottom of the deposit at an average depth of 6 feet. The pit is in the northwest edge of a flat, ridge-like elevation over 200 yards wide and traced almost continuously for a distance of about one mile to the southwest. Several nearby roads surfaced with the gravel were in good condition, but the surface was rather sandy, though smooth and firm, and it seemed that part of the pebbles either crumbled or sank into

the subsoil, which is clay. On these roads traffic is small and largely horse-drawn. An abrasion test on pebbles of sample No. 576, which was taken at a depth of 3 to 7 feet, gave a percentage of wear of 20·5 (Grading A).

577. *Two and a half miles south of Montmagny; near fork of roads, on the farm of E. Fournier.*

The deposit is part of a low terrace facing level clay land to the northwest, and has been excavated to its full depth, 6·5 feet, over an area of 6,300 square yards. The gravel is about the same as No. 576 as regards grading, coarseness, and composition, but somewhat fresher and harder, and has given good results on several local roads of small traffic, particularly on clay roads, which were firm and smooth in dry summer weather. The surface of the deposit is mostly sand and the extent of the gravel is unknown.

580. *Lot 43, Con. A, Ashburton; along road between Cons. A and B.*

The deposit forms a flat-topped knoll or ridge, which lies in the slope of a larger ridge of boulder clay, and has an average depth of 9 feet. About 9,200 cubic yards have been excavated, which is roughly half the size of the deposit. The coarseness of the material, which is uniform throughout the pit bank, runs approximately 25 per cent boulders, 50 pebbles, and 25 sand. The gravel is fairly fresh but soft. At depth of 10 feet the pebble composition or hardness is roughly 10 per cent durable, 35 intermediate, and 55 soft. Most of the soft pebbles are made up of friable talcose slate. It is too bouldery and soft for use in the wearing course of a road, and is not worth crushing or screening.

581. *Lot 35, Con. VII, Panet; between Provincial highway and C.N.R. track.*

An excavation covering 1,500 square yards opened in a low steep ridge, reaches the bottom of the deposit at a depth of 12 feet underneath the crest of the ridge and shows coarse and bouldery, fresh and hard gravel. Coarseness is uniform throughout and is about 20 per cent boulders, 55 pebbles, and 25 sand. Pebbles of sample No. 581, taken at depth of 3 to 6 feet, had a percentage of wear of 14·3 (Grading A) in the abrasion test. With the oversize screened out, the gravel makes a well-graded road material of good quality, but, on account of the large proportion of stones not passing through the screen and going to waste unless crushed later, it would save time and material to pass the gravel through a crusher as it is excavated from the bank. The deposit covers at least four acres, according to the road patrolman's estimate, which would give about 50,000 cubic yards for the amount of gravel, on the basis of an average thickness of two-thirds the thickness along the crest of the ridge. Another ridge of similar but finer gravel lies between No. 581 and Daaquam river. Gravel from the river flats, available at low water, is also used for road material. Gravel No. 581 and the river gravel have been largely used for the improvement of the main road paralleling Daaquam river. Under the small traffic prevailing on the road, the gravels take long to consolidate sufficiently, but have good wearing quality and are durable.

583. *Lot 9, Con. II, Panet; near line of Con. I.*

In the southeast slope of a flat-topped knoll, a side-hill excavation reaches the bottom of the gravel at a depth of 16 feet, which is close to the height of the knoll. Too much of the bank was concealed behind talus to estimate the average run as regards coarseness, but the larger part of the exposed gravel is fine and sandy. The gravel is generally fresh and hard, and has about 10 per cent soft pebbles at a depth of 10 feet. Under light traffic the gravel has good wearing quality and wears evenly. An area of 290 by 575 feet, owned by the Roads Department, includes approximately the whole deposit.

584. *Lot 37, Con. X, Talon; along Provincial highway, which follows line between Cons. IX and X.*

Fresh, hard, clean sand and gravelly sand are exposed in an excavation of irregular depth and covering 2,700 square yards. The pit was probably opened in material of suitable coarseness and grading for roads and has been gradually extended into finer and more sandy gravel. What is left in the bank is more suitable as concrete aggregate than as road material. Just south of the deposit and separated from it by a gully, there is a steep knoll, 3 acres in area and 30 feet in height, which holds apparently the same material as No. 584, but no excavation work had been done when the deposit was examined.

585. *Lot 32, Con. X, Talon; near line of Con. IX.*

A side-hill excavation cuts across the full width of a ridge, and shows coarse and bouldery gravel throughout. Coarseness runs approximately 25 per cent boulders, 50 pebbles, and 25 sand. The pit reaches a depth of 20 feet underneath the crest of the ridge and measures 3,500 cubic yards, which is hardly one-tenth the size of the ridge. It was originally opened in finer gravel and has been gradually extended into coarser and more bouldery material. On account of its coarseness, very little is used at present, gravel for road use being now taken from other deposits of finer gravel which lie a short distance away. All these deposits, including No. 585, lie along or close to the western shore of lake Frontière, are much alike as regards composition and hardness of gravel. The latter is generally fresh and about one-third of the pebbles are made up of slate, part of which is more or less soft. Firm and smooth road surfaces have been built with these gravels, which, while only moderately hard, have proved fairly durable under the small traffic prevailing on all local roads.

L'Islet County

Several deposits occur near St. Damase, at the foot of an escarpment that marks the limit between the low and the high lands. In the remainder of the low land, deposits are fairly common, but most of them are small and shallow. In the high land there are several deposits scattered around St. Marcel, St. Adalbert, and Ste. Perpétue. Elsewhere, gravel is scarce, leaving out of consideration large areas of wooded land.

Much good gravel has been taken from three deposits along Trois Saumons river at St. Damase. The material takes long to consolidate on the road, but makes a hard, slow-wearing surface. Two of the deposits are sandy and now worked mostly for concrete sand. No. 598 occurring farther north along St. Jean river is a softer gravel that packs more readily than the others. Its use is confined to roads of very light traffic, where it has proved good.

Most of the gravels found in the remainder of the low land, although well graded, carry much soft shale or slate, and stand only light traffic. Nos. 594 and 602 are less shaly or slaty than the others. No. 589, which lies along the edge of the high land, is rather sandy, but free from shale or slate and makes a smooth, hard surface, unaffected by weather conditions.

In the southern corner of the county, from St. Marcel to half way between St. Adalbert and St. Pamphile, several deposits have been worked for road gravel, and good road surfaces built with most of them. The quality of some of the gravels can not yet be judged by service tests, on account of the short time in use and the very light traffic prevailing locally. Coarseness varies a great deal in most of the deposits, and a few are decidedly too sandy, but it may be safely said that, apart from a few sandy ones, they are all suitable under the traffic conditions prevailing at present. The Ste. Perpétue deposits are of large size and carry fresh and hard, but very sandy gravel. They have been extensively used for road surfacing, as they are the only gravels found fairly close to the main road for miles in both directions. The road surface built with these gravels is firm and smooth, if not durable.

589. *Two miles southeast of St. Eugène; one-third mile south of intersection of Provincial highway with road between Ranges III and IV.*

The deposit forms a flat-topped ridge, at one end of which an excavation, 2,100 square yards in area and 6 feet in average depth, cuts across the full width of the ridge. In the pit bank, 9 feet high at the crest, there is exposed fresh, hard, well-graded, coarse, sandy gravel. Pebbles of sample No. 589, which was taken at a depth of 2·5 to 8 feet and represents the pit average as to coarseness, showed a percentage of wear of 9·9 (Grading A) in the abrasion test. According to the owner, the pit does not reach the bottom of the gravel deposit, although patches of sand are exposed at several places in the pit floor. The ridge is approximately 300 yards in length and 75 yards in width. The gravel has given better service than other local gravels, which are either more sandy or softer. As a matter of fact, good road gravels are very scarce outside of No. 589. A stretch of the main road through St. Eugène recently (1931) surfaced with this gravel was in good condition and the surface firm and smooth after a heavy rainstorm. Traffic on the main road is rather small.

595. *One and a quarter miles west of St. Damase; Con. Réaume, on the farm of J. Bélanger.*

Gravel overlies boulder clay in the southern slope of a large rocky ridge, and varies in thickness from place to place. It is on the average coarse, and holds about one-third sand. Pebbles are almost exclusively

hard quartzite and sandstone, and are angular in shape. According to the owner, the deposit covers about 4 acres, but the overburden is thick in places. The greatest thickness of gravel in the pit is 20 feet, which is probably the maximum thickness of the deposit. A stretch of the main road between St. Aubert and St. Damase surfaced with this gravel was in fair condition, but much of the material was loose, due to its low binding power. Once sufficiently consolidated and bound, the gravel is said to have good wearing quality. Another excavation a short distance to the east in deposit No. 596, which is in the form of a steep knoll, shows almost entirely gravelly sand, holding not more than 15 per cent pebbles. The material makes a good aggregate for concrete works and is hauled for that purpose as far as St. Jean, but is too fine for road work.

597. *One-half mile southwest of St. Damase; along Trois Saumons river and near line between Fournier and Ashford townships.*

A rather shallow deposit of gravelly sand overlies boulder clay in the bank of Trois Saumons river. An excavation in this deposit covers over 2,600 square yards and reaches the underlying boulder clay at an average depth of 6 feet. The gravelly sand, which is covered with an overburden of 8 to 24 inches of fine, clayey sand, is generally fresh and hard, and holds not more than 15 per cent pebbles on the average. It is too fine and sandy for road-surfacing purposes, but suitable as concrete aggregate, with the exception of the lower foot, which holds lumps of clay. On account of the rather thick overburden and the uniform slope of the surface of the ground, the extent of the deposit is difficult to estimate without sounding.

598. *One mile north of St. Damase; along St. Jean river and near line of Ashford township.*

A steep knoll along St. Jean river holds gravel, which is coarse and bouldery near the top of the knoll and gradually turns finer in depth and down the slopes, as judged by the part exposed in a side-hill excavation in the upper slope of the knoll. The gravel is generally well-graded and holds not more than one-third sand, most of which is very coarse. The amount of gravel taken out, 3,600 cubic yards, forms but a small part of the total amount in the deposit. The gravel, though fresh, holds a rather high percentage of soft pebbles. It compacts readily and has proved serviceable on roads of small traffic.

601. *Four miles southwest of St. Roch; along Elgin road and three-quarter mile southeast of Provincial highway.*

The deposit lies in the southeast slope of a large, flat-topped rocky ridge, and averages 5 feet in thickness. The gravel is well graded, fairly fresh and coarse, and carries 40 to 50 per cent sand, most of which is very coarse. The smaller pebbles are almost entirely slate, those of medium size are 75 per cent slate and 25 per cent sandstone and quartzitic sandstone, and the larger pebbles are about half slate and half sandstone. An abrasion test on pebbles of sample No. 601, which was taken at a depth of 2·5 to 7 feet, gave a percentage of wear of 32·0 (Grading B; approximately 55 per cent slate and 45 per cent sandstone or quartzitic sandstone). A

stretch of the Elgin road surfaced with the gravel and over which traffic is small was in good condition but the surfacing material was worn out in places. Under the heavy traffic of the main river road, the small slate pebbles quickly ground up and wore away, while the larger and harder sandstone pebbles were left loose on the corrugated surface. The deposit covers at least 23,000 square yards.

602. *Four miles southwest of St. Roch; one-half mile northeast of Elgin road, on the farm of A. Francoeur.*

Well-graded and coarse gravel carrying about 50 per cent sand is exposed in one part of an old railway pit where subsequently material for road-surfacing purposes had been taken out. Although lying under an overburden of at least 4 feet of fine sand, the gravel is slightly weathered almost to the full depth of the deposit, which measures 16 feet, overburden included, in the road pit, and up to 20 feet at one place along the bank of the old railway pit. An abrasion test run on pebbles of sample No. 602, which was taken at a depth of 5 to 12 feet, gave a percentage of wear of 14·9 (Grading A). The gravel has given good service on local roads of small traffic. The size of the gravel deposit is unknown; the level ground surface behind the pit face shows only sand and whatever gravel there is in the deposit probably lies under a thick sand cover.

605. *Lot 11, Con. I, Beaubien; west of Bras d'Apic river.*

Gravel for road work has been taken at several places in what is said to be the bottom of an old railway pit. The original deposit was in the form of a flat-topped ridge, which was excavated down to its base for ballast material when the Transcontinental railway was built, about 1912. There is a great deal of fresh, coarse sand and gravelly sand exposed in the several road pits, but very little gravel. The road pits are apparently opened in gravelly streaks and abandoned when the material turns too fine. A long stretch of the main road between L'Islet and St. Adalbert, which in this part of the county passes through unsettled land and carries very small traffic, was improved with this material.

607. *Lot 32, Con. V, Arago; along road between Cons. V and VI.*

The deposit forms a string of small steep knolls all connected together. In the highest knoll at one end of the deposit, the 20-foot bank of a side-hill excavation shows irregularly stratified but well-graded, medium-coarse gravel carrying 40 to 50 per cent sand, most of which is very coarse. The gravel is fresh and hard, with quartzite and sandstone making up 80 per cent of the pebbles, and slate 15 per cent. Good durable surfaces have been made with the gravel on several roads of small traffic. The aggregate size of the knolls is well over 30,000 cubic yards.

609. *Lot 26, Con. II, Leverrier; along William river and near line of Con. III.*

The deposit forms a steep-sloped, flat-topped ridge or hogsback and is over one mile in length, although parts of the ridge, it is claimed, hold only sand. The 18-foot bank of a side-hill excavation opened at one end

of the ridge is mostly talus-covered, with only the upper 5 feet exposed. Beneath the top of the ridge there is seen well-graded, coarse gravel, which gradually merges into almost unmixed coarse sand down both slopes. The gravel is fresh and hard, takes long to compact under the very small traffic prevailing on local roads, but once well consolidated makes a firm and durable road surface. At the pit the ridge measures over 50 yards in width.

611. *Lot 27, Con. VII, Leverrier; near line of Con. VI.*

A group of small knolls lying in the slope of a hill aggregate about 50,000 square yards in extent and are probably part sand and part gravel, as judged by what is seen exposed in a pit opened in one. On account of the poor condition of the pit, little information could be obtained regarding the coarseness and grading of the material, but there is a great deal of sand as well as gravel in the pit bank and talus. The excavation reaches fine sand at an average depth of between 10 and 11 feet.

612. *Lot 39, Con. V, Casgrain; along brook and near Provincial highway.*

Coarse and slightly bouldery gravel carrying about one-third sand is exposed in the 17-foot bank of a side-hill cut in the steep slope of a knoll. Part of the lower bank shows material that looks more like partly sorted drift than gravel. The knoll covers about 3 acres and the thickness of gravel beneath the top of the knoll may be assumed as 17 feet, as the pit apparently reaches close to the bottom of the deposit at that depth. A stretch of the main road leading to St. Adalbert had just been surfaced with the gravel screened from its oversize and was in good condition even in steep grades. The road, which traverses sparsely settled, hilly country and carries but small traffic, has not yet been improved up to main road standard as regards drainage, width of travelled way, and maximum grade.

614. *Lot 21, Con. VI, Casgrain; along Black river and near Provincial highway.*

The deposit is in the shape of a small ridge which lies in the bank of the Black river and averages 7 feet in depth. The gravel exposed in a pit bank varies in coarseness from place to place, is on the whole coarse and slightly bouldery, and holds about 40 per cent sand. There is a rather high amount of large pebbles, but with these screened out, the gravel is fairly well graded for road work. The amount of gravel excavated, 5,300 cubic yards, represents about half the size of the deposit. Another ridge of the same size lying a short distance farther down the stream is believed to be gravel. Pebbles had a percentage of wear of 14·3 (Grading A) in the abrasion test.

615. *Lot 11, Con. A, Garneau; where Provincial highway crosses brook.*

Fresh, well-graded gravel interstratified with much sand is exposed in the face of a shallow pit opened in the steep upper bank of a brook. The deposit is said to have been traced for over a mile along the river bank. According to the road patrolman the deposit as a whole is very sandy.

616. *Lot 2, Con. I, Lafontaine; along brook.*

A side-hill cut in a steep bluff facing a brook reaches a height of 20 feet in the slope of the bluff. There is much variation from place to place in the coarseness of the material exposed in the face, but on the average the coarseness of the gravel increases from the edge of the bluff inwards. Most of the gravel seen in the pit bank is either too fine or too coarse for road material. Over 75 per cent of the pebbles are quartzite and sandstone, and the remainder largely slate.

Kamouraska County

Gravels are fairly common in the St. Lawrence low land except between Rivière Ouelle and St. André, where no bank gravel is found for a distance of 2 to 5 miles inland, but there is a limited amount of beach gravel at a few points along the shore. A few deposits are also found in a narrow belt of high land along the southeast edge of the low land. The remainder of the county is everywhere wooded and was not examined, except a few deposits along the St. Alexandre-St. Eleuthère road.

Most of the gravels examined are rather poor because of being irregularly graded and sandy, and in the case of a few, very soft. Good gravels, which have been used with a fair amount of success, are found east of St. André, such as Nos. 637, 638, 639, and 640. Good, durable road surfaces have been made with these gravels on roads of light traffic, although none stood successfully the wear of the main road traffic. Gravel from deposits Nos. 619 and 623 is used solely as aggregate in concrete works, but the latter is of the right coarseness and grading for road material. No. 630, northeast of St. Pascal, is a small deposit that holds better gravel than other local deposits. Gravel from two large deposits occurring a short distance north of the Transcontinental (Canadian National) railway on the St. Alexandre-St. Eleuthère road has given good service under small traffic.

619. *Three-quarter mile southwest of Ste. Anne; along Provincial highway.*

The deposit lies in level land between rocky hills and is composed mostly of gravelly sand, with streaks of sandy gravel. The material has a maximum thickness of 16 feet, including at least 3 feet of fine sand as overburden. It is too fine and sandy for road-surfacing purposes, but on account of its freshness makes a good aggregate for concrete works and is sold only for that purpose. Sample No. 619, taken at a depth of 7 to 10 feet, represents the coarser part exposed in the pit bank. The deposit is said by the owner to cover 8 acres.

623. *One-half mile west of St. Pacôme; near fork of roads on Provincial highway.*

The gravel formerly used as ballast by the Canadian National Railway company was found unsatisfactory and is now used only as aggregate in making reinforced concrete pipes for railway culverts. Circular and arched pipes, of 18 to 36 inches in diameter, are made in a small plant erected on the floor of the pit by the company. The pit face is 30 to 35 feet high, which is the depth of the deposit, and is all covered with talus except at one place

where gravel is now taken out for concrete aggregate. The gravel ranges from coarse to fine in different layers, but most of it is of medium coarseness and carries about 50 per cent sand. On account of its grading, freshness, and hardness, it would make a better road material than other local gravels now used. An abrasion test on pebbles of sample No. 623, which was taken at a depth of over 25 feet, gave a percentage of wear of 10·9 (Grading A). There is still a large amount of gravel left.

624. *Three-quarter mile northwest of St. Pacôme, near fork of roads southeast of C. N. R. track.*

The deposit lies in gently sloping ground between rocky knolls, and is said by the owner to cover 5 acres. Fresh but soft gravel is exposed in an excavation 3,500 square yards in extent and 7 feet in average depth. Pebbles are 40 per cent slate, most of which is soft. The gravel is fairly uniform in coarseness but sandy, and much of the sand is fine, so that the material as a whole is rather poorly graded. On one side of the pit, however, well-graded gravel is exposed in the upper half of the pit face, which at this place measures 10 feet in height. The pit floor is gravelly in places, sandy in others, and the thickness of the deposit is probably not much more than the pit depth.

633. *Three miles southeast of Ste. Hélène; Range V of Granville; near fork of roads.*

Fresh, well-graded, coarse gravel carrying about 50 per cent sand is exposed in an excavation opened at the end of a small flat-topped ridge. The deposit covers at least 5,000 square yards and has an average depth of between 5 and 6 feet. The gravel has been used on several local roads over which traffic is very small. The roads were in good condition but dusty when examined after several days of dry weather. The dusty condition is believed to be due, in part at least, to the fine sandy subsoil, as all the roads of the district were affected the same way, irrespective of the surfacing material used. Pebbles of sample No. 633 had a percentage of wear of 20·8 (Grading D) in the abrasion test.

637. *One mile south of St. André; on edge of escarpment along Provincial highway.*

The deposit is in the shape of a terrace and lies on the top and edge of a high bluff facing St. Lawrence river. Boulder clay underlies gravel at a depth ranging from 7 feet on the edge of the bluff to 15 feet in the innermost part of the several pits opened. The gravel is generally fresh, well graded, and coarse. It is coarser, more bouldery, and somewhat less uniform in grading near the top than near the bottom. Sample No. 637 was taken from a depth of 5 to 10 feet, and was slightly coarser than the average for the lower part, but finer and more sandy than the average for the whole thickness. Two abrasion tests on pebbles of the sample gave percentages of wear of 14·3 (Grading A) and 14·7 (Grading D). When the larger stones are screened out the gravel makes a good road-surfacing material. It has been used and has given good service for years on a long stretch of the main road through St. André. Under the heavy traffic pre-

vailing at present over that road, the surfacing material wears fast and forms corrugations. Roads of smaller traffic improved with the same gravel were in good condition. The extent of the deposit is unknown but apparently large.

638. *Two miles northeast of St. André; along side road in Range I, one-half mile southeast of its junction with the main highway.*

The deposit lies in the upper slope and top of a low terrace facing St. Lawrence river, and is underlain by boulder clay at an average depth of 10 feet. In an excavation dug to the full depth of the deposit over an area of 3,600 square yards, gravel is exposed that is about the same as No. 637 as regards grading, coarseness, composition, and hardness. That part of the pit farther away from the edge of the terrace shows very coarse and bouldery material, which probably merges into boulder clay farther inwards. Pebbles of sample No. 638, which was taken at a depth of 4 to 9 feet, had a percentage of wear of 12·9 (Grading A) in the abrasion test. On the road the gravel does not consolidate and bind so firmly as No. 637, probably owing to the fact that No. 637 holds a small amount of slate, which is lacking in No. 638. The deposit has a width of about 70 yards, and is apparently of large size, although its extent along the edge of the terrace is not known.

639. *Three miles northwest of St. Alexandre; west of Fouquette river and one-third mile from main highway.*

Fresh, well-graded, fine gravel is exposed in a shallow pit opened in the low bank of a creek. The gravel holds about 50 per cent sand near the edge of the deposit and gradually becomes more sandy farther in the creek bank. An excavation, which reached a distance inwards of 25 yards, was abandoned on account of the gravel being too sandy. The gravel has a maximum thickness of 9 feet, including an overburden of 2 to 3 feet of fine sand. A firm and smooth surface, although slightly corrugated in places, was built with the gravel on a stretch of the road leading to St. Alexandre. It was also used on a stretch of the main river road as a wearing course on top of coarser gravel and was badly corrugated by traffic. The deposit is small.

640. *Two miles northwest of St. Alexandre; near intersection of road between Ranges I and II with road to St. Alexandre.*

The deposit lies in the bank of a brook, has an average depth of 9 feet, and is said by the road patrolman to extend over 25 acres. Uniformly well-graded, medium-coarse gravel is exposed in a pit opened in the bank of the brook. The gravel is slightly rusty, yet fairly fresh and hard, and carries about 50 per cent sand, most of which is coarse. Pebbles of sample No. 640 had a percentage of wear of 17·1 (Grading A) in the abrasion test. A smooth and firm surface has been built with the gravel on a stretch of the road leading to St. Alexandre which was in good condition and wore evenly under light to moderate traffic.

645. *Three-quarter mile northwest of Pelletier Station; along road.*

A road cut through a ridge of gravel has been gradually enlarged and deepened in digging for road gravel and when examined covered an area of over 1,000 square yards, including the roadway, and had a maximum depth of 17 feet underneath the crest of the ridge. The gravel is fresh and hard but varies much in coarseness and grading between the different layers. Pebbles are roughly 50 per cent quartzite, 30 sandstone, and 20 schist or slate, with but few soft. Gravel No. 644, found along the same road over 2 miles to the northwest, has about the same composition as No. 645 but is more uniform in coarseness and better graded. Good results have been obtained with these two gravels on a long stretch of the road between Verbois and St. Eleuthère, which passes through unsettled land between these two places and carries but light traffic.

Temiscouata County

Gravels are found throughout the settled parts, with the exception of a portion of the high land in the northeast part of the county. They are particularly common in a long ridge, or succession of knolls, extending from St. Antonin northeast to past St. Epiphane. A number of large deposits also occur between St. Honoré and the New Brunswick border, between Estcourt and the New Brunswick border, southwest of St. Hubert, and northwest of St. Eloi. Near the St. Lawrence all deposits are of small size and the gravel of poor quality, excepting, however, the St. Eloi deposits and Nos. 665, 669, and 688. Gravel has been dug at many places in the knolls between St. Antonin and St. Epiphane, and a considerable amount used mostly on local roads. Where care was taken not to use too sandy material, smooth and hard road-surfaces have been built, even on the main road from Rivière du Loup, which passes at the southwest end of the gravel area. Between St. Honoré and the New Brunswick border, there are several large deposits as well as smaller ones. The gravel from the larger, such as Nos. 655, 658, 659, 660, and 664, has been used in making some of the best stretches of road seen anywhere in the district. Some of the deposits between Estcourt and the New Brunswick border are of large size, but in No. 650, what is left appears to be mostly coarse sand. Good gravel has been obtained from all the deposits, the small as well as the large, judging by the condition of the local roads, but the gravel from the shallower deposits is more weathered and dusty than that from the deeper. The district was visited during a spell of dry weather that prevailed for several weeks, and all roads were dusty, but otherwise good. No. 652 is a very large deposit, or hogsback, along the shore of Grande Fourche lake, southwest of St. Hubert. The material makes a smooth and firm road surface which wears evenly but rather fast, and is dusty. On the road from St. Honoré to Lamy there is much gravel, mostly coarse and bouldery, in a ridge that runs parallel to the road. Good road gravel is seen in a large railway ballast pit in deposit No. 687, northwest of St. Eloi. Part of the deposit, which is of large size, is owned by the Canadian National Railways and worked solely for ballast. Gravel for road use is obtained from two smaller deposits, Nos. 685 and 686, near the village of St. Eloi. No. 685 is sandy and works best on clay roads. No. 686 is well

graded but does not bind firmly on light soils. Both have given good results on local clay roads. Gravel from the large deposit, No. 687, although not yet tried on roads, is better for that purpose than other local gravels. No. 688 is a medium-size deposit, which holds better gravel than the average found locally.

646. *One and a half miles west of Estcourt; along C. N. R. track.*

A railway pit opened in the slope of a bluff has been extended inwards a distance of 150 yards. The large pit face, which at one place attains a height of 75 feet, shows fresh and hard, generally fine and somewhat sandy gravel, but coarseness varies much between the different parts of the pit bank. Sand makes up from 50 to 65 per cent of the total and is everywhere coarse, so that the material is on the whole fairly well graded. There are but few sand streaks or layers. Sample No. 646, taken from a small road pit dug in the floor of the railway pit, represents about the average as regards proportion of sand, but holds coarser pebbles than the general run of the bank. Sample pebbles had a percentage of wear of 10·6 (Grading A) in the abrasion test. The railway pit is said to have been originally opened in coarser gravel. On account of its fineness very little is used now for ballast. A short spur line connects the pit with the main line nearby. The gravel is too sandy for road material but has given satisfactory service under the small traffic prevailing locally. There is a very large amount of gravel left.

649. *One-quarter mile west of Rivière Bleue; along St. Francis river.*

The deposit is in the form of a terrace along St. Francis river. It is said by the road patrolman to extend over 2 acres and is underlain by sand at a depth of 10 feet. It has been excavated over an area of 1,300 square yards. The gravel is fresh and hard, uniformly well graded, medium coarse, and carries about 50 per cent sand. On the road it stays loose a long time, owing in part to its hardness and low binding power and in part to the small traffic using the roads, but when properly consolidated makes a firm and durable road surface. Gravel is of common occurrence for several miles west along St. Francis river.

650. *Aubut Station.*

Gravel has lately been dug for road material from the floor of an old railway pit, which was opened at the time of the construction of the Transcontinental (Canadian National) railway, about 1912, and has been abandoned since. The road pit shows largely coarse sand, with gravelly streaks here and there. The material is fresh throughout and fairly hard. Pebbles of sample No. 650, which was taken from the road pit, had a percentage of wear of 13·1 (Grading A) in the abrasion test. As judged by freshness and grading alone, the material should be suitable for use as aggregate in concrete mixtures. The low result obtained in the mortar test (Table III, page 198) is thought to be due to friable slate, which makes up about 15 per cent of the total.

652. *Two and a quarter miles southwest of St. Hubert; at north end of lake Grande Fourche.*

The deposit forms a small knoll in the lower slope of a large steep ridge, or hogsback, 1·5 miles in length and said to be all gravel. The knoll alone measures 8,000 cubic yards, about half of which has been excavated. The 25-foot pit bank shows well-graded fine gravel, more or less weathered in the upper 10 feet, and fresh below. It carries on the average 60 per cent sand. The gravel compacts and binds firmly, wears evenly, but makes a dusty road surface. It is not a durable gravel but proves satisfactory under conditions of small traffic. The amount of gravel in the ridge is practically unlimited.

655. *Two and three-quarter miles east of St. Honoré; between Provincial highway and south branch of Bleue river.*

The deposit lies along the bank of the south branch of the Bleue river and is in the form of a steep-sloped, flat-topped ridge, or hogsback. A side-hill excavation in the flank of the ridge, near its northern end, shows fresh and hard, slightly clayey gravel, which varies much in coarseness in the different layers but is generally coarse, carries an average of 3 per cent boulders and a low percentage of sand, most of which is very coarse. Sample No. 655, taken at a depth of 7 to 11 feet, is from coarser and less sandy material than the pit average. Two abrasion tests run on sample pebbles gave percentages of wear of 9·3 (Grading A) and 10·9 (Grading B). The gravel, with larger stones screened out, is well graded and has given very good results in road surfacing. A stretch of the main road along the deposit was improved with the gravel and was firm and smooth, wore well under heavy traffic and was but slightly dusty. Finer and more sandy gravel is seen in another pit dug at the southern end of the ridge. The ridge is approximately 50 yards in width and 25 feet in height. South of the ridge and along the same river there are other large deposits of good road gravel, but not so well graded on the average as No. 655.

658. *Two miles west of St. Louis; between Provincial highway and C.N.R. track.*

Two excavations have been opened, one in the northern end, the other in the southern end of a large, flat-topped ridge. The northern one was at one time worked for railway ballast and is now abandoned. The other, which covers an area of about 3,000 square yards, is worked mostly for road material. In the 40-foot pit bank there is exposed fresh, fine, well-graded gravel carrying about 50 per cent sand, most of which is very coarse. The coarseness of the gravel is fairly uniform throughout. The gravel makes a good road surface, which is quite smooth, and wears evenly but rather fast under the heavy traffic of the main road, probably on account of the large proportion of more or less soft schist and slate that it holds. The pit reaches the bottom of the deposit at an average depth of over 20 feet, and a maximum depth of 40 feet in that part nearer to the top of the knoll. The aggregate size of the two pits is 40,000 cubic yards and the amount of gravel left in the deposit over 65,000 cubic yards.

659. *Cabano; along Provincial highway.*

The deposit forms a low flat dome and has been excavated to its full depth over an area of 6,400 square yards, or almost half of its total extent. A large section of the pit bank shows well-graded, medium-coarse gravel, being about half pebbles and half sand, and an equally large section of the bank shows poorly graded material, being mostly fine gravel with a high percentage of fine sand and in places almost entirely sand. The well-graded gravel lies under thinner overburden and is less fresh and hard than the more sandy and poorer gravel. Excavation work has been abandoned in that part holding material of poor quality. Sample No. 659, taken at a depth of 4 to 9 feet, is from that part of the bank holding the better graded gravel. An abrasion test on pebbles of the sample gave a percentage of wear of 15·7 (Grading A). The pit has an average depth of 11 feet, which is also the average depth of the deposit. A short distance to the east, in the village of Cabano, there is a ridge of gravel several hundred yards in length lying along the shore of lake Temiscouata. Both gravels have given good service under the heavy traffic of the main road. Except where corrugated, the road was in good condition. On account of being partly built over, the lake shore ridge can be excavated for gravel only in places.

660. *Notre Dame du Lac; near junction of Provincial highway with road to St. Eusèbe.*

In the 45-foot bank of a side-hill cut in the steep slope of a bluff facing lake Temiscouata, there is exposed fresh, coarse gravel holding about 5 per cent boulders and 40 per cent sand, most of which is very coarse. The gravel turns somewhat finer and more sandy at depth. Sample No. 660, taken at a depth of over 20 feet, represents the average as regards coarseness. Sample pebbles had a percentage of wear of 16·2 (Grading A) in the abrasion test. Several roads including the main road have been improved with gravel screened from its oversize and were in good condition. The main road, which carries heavy traffic, was somewhat dusty after several days of dry weather. Over 10,000 cubic yards have been taken out, and the amount available in the deposit is unknown but probably large.

664. *Five and three-quarter miles southeast of Ste. Rose; near C.N.R. track, two miles southeast of Otterburn Station.*

Fresh, well-graded, coarse gravel carrying 50 per cent sand is seen in a side-hill excavation in the lower slope of a bluff facing Madawaska river. The gravel is of uniform coarseness and grading throughout the exposed bank. The bluff, which can be traced almost continuously from Ste. Rose to past the Provincial border into New Brunswick, is gravelly at many places and the amount of gravel available appears to be unlimited. The excavation covers 2,800 square yards and the pit bank reaches a height of 18 feet. The main road between Ste. Rose and the Provincial border was improved with this and other similar gravels. The road was in very good condition, almost as smooth as a pavement and comparatively free from dust and corrugations, notwithstanding the heavy traffic passing over it. On account of the high slate content of the gravel and the clayey character of

the fine material derived from the grinding of the slate pebbles under traffic, the condition of the road is probably influenced to a marked degree by the weather. The road passes through woodland most of the way from Ste. Rose to the border, and when examined in dry summer weather apparently held just the right amount of moisture and was in its best condition.

669. *Two and one-quarter miles northeast of Rivière du Loup; on the farm of A. Sirois.*

The deposit forms a flat ridge covering 25,000 square yards and lies on high land sloping to the southeast. The gravel is fairly fresh, well graded, of medium coarseness and carries 50 per cent sand. It is used only on roads of very small traffic, so that under these conditions the material takes long to consolidate properly. Stretches surfaced for at least one year were in good condition. The pit has an average depth of 6 feet and does not reach the bottom of the deposit. An abrasion test on pebbles of sample No. 669, which was taken at a depth of 5 to 9 feet, gave a percentage of wear of 16·0 (Grading B).

670. *Two and one-half miles northeast of St. Antonin; at intersection of Provincial highway with road to St. Antonin.*

An excavation 5,700 square yards in extent, opened in a slight ridge-like rise of the ground, shows gravel interstratified with much sand in the central part of the rise and mostly sand towards the edges. The gravel is fresh and hard, varies much in coarseness between layers, but is well graded where not interstratified with too much sand. That part of the rise assumed to be gravel covers an area of 25,000 square yards. The gravel is underlain by fine sand and clay at an average depth of 10 feet. Most of the excavated gravel, which amounts to 19,000 cubic yards, has been used in road improvement and has given good service on several roads, including a long stretch of the main road leading to Rivière du Loup. The main road was examined during a long period of dry weather and found badly corrugated in places by the heavy traffic prevailing at the time.

671. *Two miles southwest of St. Modeste; along road leading from Provincial highway to St. Modeste.*

In a side-hill excavation in the slope of a knoll, there is exposed coarse gravel with 40 per cent sand in the central part of the bank and fine gravel with 75 per cent sand towards both ends of the pit. The gravel is well graded throughout, except in a few streaks of sand, and is slightly weathered where coarser, fresher where finer. Sample No. 671, taken at a depth of 2·5 to 6 feet, is from the coarser gravel. The sample pebbles had a percentage of wear of 13·5 (Grading A) in the abrasion test. The gravel was used in improving a stretch of the road leading from the main road to St. Modeste, which was in good condition although dusty. All gravel roads east of Rivière du Loup were examined during a long spell of dry weather and were dusty. Gravelly knolls are of common occurrence for a distance of three miles to the northeast. Some of them carry more sand than gravel.

673. *Three-quarter mile northeast of St. Modeste; along road between St. Modeste and St. Epiphane.*

The 25-foot face of a side-hill excavation in the steep slope of a knoll shows mostly fine sandy gravel and gravelly sand, the proportion of sand varying with layers from 65 up to 80 per cent. Sample No. 673, taken at a depth of 10 to 13 feet, is from the coarser and less sandy gravel. The deposit forms part of a string of knolls extending over a distance of three miles in a northeast-southwest direction. Although considered satisfactory on roads of small traffic, the material is rather too sandy and does not compact firmly.

678. *St. Epiphane; west of road to St. François-Xavier.*

Fresh and hard gravel, covered with an overburden of 2 feet of silty sand, is seen in the round pit dug to a depth of 30 feet on the flat top of a low knoll. The extent of the deposit is unknown and may be in the form of a large pocket enclosed in glacial drift, which occupies a large part of the pit bank. The gravel is irregularly stratified and varies much in coarseness between layers, but is on the whole well graded, medium fine, and holds about 50 per cent sand, most of which is very coarse. Sample No. 678, taken at a depth of 12 to 15 feet, is from the coarser and less sandy gravel. The sample pebbles had a percentage of wear of 10·1 (Grading B) in the abrasion test. Hard and smooth surfaces have been built with the gravel on several roads near the village of St. Epiphane. Traffic is small on all local roads. The pit covers an area of 1,300 square yards and reaches sand at a depth of 30 feet.

680. *Two and a half miles northeast of St. Epiphane; on the farm of J. Gagnon.*

Gravel is exposed in the 20-foot face of a side-hill excavation opened in the northwestern flank of a ridge, which measures over 50,000 cubic yards and has a height of 75 feet. It is not known how much of the ridge is gravel. The gravel is fresh and coarse, although coarseness varies between layers. The gravel is cemented by clay and stands up well in the bank. The proportion of sand is difficult to estimate, but is apparently not more than 50 per cent. Sample No. 680, taken at a depth of 10 to 13 feet, is from finer and more sandy gravel than the pit average. An abrasion test was made on sample pebbles of gravel No. 681, which is of the same composition as No. 680 and probably also of the same wearing quality. Gravel No. 680 has been used only on roads of very small traffic, mostly horse-drawn, and was firmly compacted in the wheel tracks but loose elsewhere. As judged by the character of the gravel, it should withstand the wear of fairly heavy traffic.

681. *Three and a half miles northeast of St. Epiphane; on the farm of O. Gagnon.*

The gravel is similar in composition to No. 680 but of more uniform coarseness and grading and carries not more than 35 per cent sand. It is exposed in a small side-hill excavation opened in the southeastern flank of a flat-topped ridge measuring roughly 25,000 cubic yards. The greatest

depth of the pit is 9 feet and the height of the ridge 15 feet. Sample No. 681, taken at depth of 2 to 4 feet is from the coarser gravel. The sample pebbles had a percentage of wear of 11·9 (Grading A) in the abrasion test. The gravel has been used only on roads of very small traffic, but, like No. 680, should be able to stand much larger traffic than that to which it is now subjected.

686. *One mile northwest of St. Eloi; along road to railway station.*

Gravel occupies the upper slope and part of the top of a large terrace and is underlain with clay at a depth of 10 feet. It is generally fresh and hard, well graded, medium fine, and carries 50 per cent sand, most of which is very coarse. The coarseness and grading of the gravel are fairly uniform throughout the bank of a pit dug to a depth of 9 feet and over an area of approximately 1,000 square yards. The lower foot of the deposit, not excavated, is clayey gravel. Sample No. 686, taken at a depth of 2 to 6 feet, is from slightly finer and more sandy material than the pit average. The gravel has given durable results on clay roads of small traffic, but does not bind firmly on light soils. The deposit is of large size.

687. *Two miles northwest of St. Eloi; along road to railway station.*

A large railway pit is being operated for ballast gravel in the upper slope and top of a high terrace. The pit is connected by a spur to the main line at St. Eloi station. On account of the heavy grade on the spur line, Mikado type locomotives with a tractive force of 53,000 pounds do not haul more than 15 cars at a time. The pit is excavated down to the underlying clay and shows a maximum thickness of gravel of 22 feet. When the pit was first opened in the upper slope of the terrace, the greatest thickness of gravel is said to have been nearly 30 feet. The gravel is fresh, hard, and well graded for road use. Coarseness varies in a gradual way from place to place but is on the whole fairly uniform, considering the large area of bank exposed. Sample No. 687 is from coarse, and 687a from fine gravel. Both samples were taken at a depth of at least 9 feet in different parts of the pit bank. Sample pebbles had a percentage of wear of 6·5 (Grading A) in the abrasion test. The area of gravel land bought by the railway company is said to be now nearly all excavated. The pit covers an area of roughly 40,000 square yards. The remainder of the deposit is of larger extent but probably smaller average thickness than the excavated part.

688. *Two miles southwest of Trois Pistoles; along side road and near main river road, 1 mile northeast of Tobin.*

The deposit is in the shape of a low, flat ridge, and is said to extend over 12,000 square yards and to have an average depth of 9 feet. At one end of the ridge gravel has been excavated over an area of 2,800 square yards and a depth of 8 feet. Rusty and partly weathered, well-graded, coarse gravel carrying at the most 50 per cent sand is seen in the upper 5 feet of the pit bank, and fairly fresh, fine sandy and silty but otherwise well-graded gravel, in the lower 3 feet. Sample No. 688 taken at a depth of 1·5 to 5·5 feet, represents the coarsest gravel, and sample No. 688a, taken at a depth of 5 to 7 feet, represents the average coarseness for the lower 3 feet. The

pebbles of sample No. 688, which is from rusty and partly weathered material, had a percentage of wear of 17·0 (Grading B) in the abrasion test. As road material it is inferior to the St. Eloi gravels, such as Nos. 686 and 687, although of better quality than other local gravels. It does not withstand well the wear and tear of the heavy traffic prevailing over the main river road, but has given good service on roads of smaller traffic.

Rimouski County

Nine gravel deposits of moderate to fairly large size and a large number of smaller ones are found in that part of the county near St. Lawrence river. The majority of the deposits are poor road material, carrying either too much soft slate or too much sand. Nos. 690, 701, and 705 are some of the larger deposits with good gravel. Nos. 693, 696, and 708 are deposits of smaller size, from which good road gravel has been obtained. Nos. 689 and 691 are sandy, but have been used on stretches of the main road with a fair amount of success, and No. 702, which is also sandy, has proved good on roads of lesser traffic. Apart from No. 708, all the gravels just enumerated lie within three miles of the shore of St. Lawrence river. Farther inland, gravels are very poor. Near St. Gabriel, local roads are surfaced with crushed rock. All the gravels lying west of Rimouski have been used on some stretches of the main river road, but none of those found east of that town has been used on the main road, which is entirely surfaced with beach gravel from Rimouski eastward. Beach gravel is available almost anywhere along the shore from Father Point eastward to Cap des Rosiers, in Gaspe county, as already mentioned.

690. *One mile northeast of St. Fabien; along main river road.*

The 20-foot face of a side-hill excavation opened in the steep slope of a knoll shows well-graded, fine, sandy gravel, interstratified with thin layers of very coarse gravel holding but little sand. A large section of the lower pit bank holds very coarse gravel, low in sand, and not so well graded as the finer material. The gravel is fairly fresh and hard throughout. Sample No. 690, taken at a depth of 15 feet, is from the coarser and less sandy material. Two abrasion tests on sample pebbles gave percentages of wear of 17·1 (Grading A) and 16·3 (Grading B). The pit, at depth of 20 feet, does not reach the bottom of the deposit. The knoll covers an area of about 3 acres. The gravel compacts well and makes a smooth road surface, but wears rather fast under the heavy traffic of the main road.

691. *Four and a half miles northeast of St. Fabien; north of main river road, between railway crossing and side road to river shore.*

The deposit lies in the upper slope and top of a steep bluff facing a brook, and is underlain with clay or glacial drift at a depth of 8 feet. In the upper 3 feet of the pit bank, the gravel is well graded, medium fine, and carries about 40 per cent sand. Farther down the bank, the gravel is very fine and sandy. In the upper 3 feet pebbles are mostly flat slate; farther down the pebble composition is such as given for sample No. 691, which was taken at a depth of 3 to 6 feet, and represents the average of the lower

gravel as regards coarseness and grading (Table I, page 165, and Table II, page 191). The gravel is fairly fresh, although weathered or rusty particles are found throughout the full depth of the deposit. The gravel was used in surfacing a stretch of the main road. The road surface was good in places, badly corrugated in others by the heavy traffic passing over it. The material is too sandy for roads, but has proved of better wearing quality than other local sandy gravels. The extent of the deposit is unknown. On top of the bluff, level, sandy land covers several acres and may be underlain with gravel over that area.

693. *One-half mile south of Bic; along side road leading south from main river road.*

In a shallow pit, 1,500 square yards in area and 6 feet in greatest depth, there is exposed medium-fine gravel which is fairly well graded and uniform in size throughout the pit bank. It is slightly rusty, yet fairly fresh and hard, and carries about 50 per cent sand. Sample No. 693, taken at a depth of 3 to 5 feet, is from slightly coarser material than the pit average. Two abrasion tests run on the sample pebbles gave percentages of wear of 10·2 (Grading B) and 9·9 (Grading D). Gravel lies in a flat ridge covering at least 10,000 square yards and is probably not much thicker than 6 feet. It compacts firmly on the road and wears well under light traffic.

701. *One and a half miles southeast of St. Anaclet; near junction of road to St. Anaclet with side road leading to main river road.*

Fresh, well-graded coarse gravel is seen in a small hole dug in the bottom of a pit along the bank of a brook. The 10-foot pit bank is all concealed behind talus, with the exception of the upper 2 feet, which is all sand. An abrasion test on pebbles of sample No. 701, which was taken in the hole in the pit bottom, gave a percentage of wear of 12·5 (Grading A). No. 702 is a similar but more sandy gravel. Firm and smooth road surfaces, fairly durable under small traffic, have been built with these two gravels. Around St. Anaclet, there are a number of small and shallow deposits which carry well-graded but weathered and soft gravel. Deposits Nos. 701 and 702 carry fresher and harder gravel, are deeper, and probably also larger than the others.

705. *One mile northeast of Luceville; along C. N. R. track.*

Gravel for road material is occasionally taken from the bank of an old railway pit covering at least 100,000 square yards, and dug to a depth of 10 feet, which is not the full depth of the gravel deposit. The extent of the gravel left in the deposit is unknown, but is probably large. The gravel is well graded and fine, fresh, and moderately hard near the bottom of the pit, partly weathered and rather soft in the upper bank. Sample No. 705 was taken in fresh material near the pit bottom, and No. 705a, taken at a depth of 1·5 to 4 feet, represents the average run of the upper bank. The gravel has been used in surfacing stretches on several roads of small traffic. The road surfaces were rather sandy, and softened in wet weather,

but wore evenly and withstood satisfactorily the small traffic wear. Stretches improved with beach gravel hauled from the shore of St. Lawrence river were firmer in wet weather and showed better wearing quality than where bank gravel had been used.

Matane County

Investigation work covered only the western corner of the county and a narrow band along the coast. There is a large amount of gravel found around Ste. Angèle, much of it being poorly graded and soft. Good stretches of road have been built of gravel from two large deposits, Nos. 709 and 713, and a smaller one, No. 710, which hold better graded gravel than other local deposits. Gravel from No. 710 and from the upper part of No. 709 is partly weathered, soft, and wears fast on the main road, and gives better and more lasting results on roads of lesser traffic. The gravel from the lower part of deposit No. 709 is fresher and harder than that of the upper part and has given good service on the main road. Gravel No. 713 has been used only on roads of small traffic; it would probably give better service on the main road than any local gravel. Both Nos. 709 and 713 lie in the same river bank a short distance from each other and are probably one continuous deposit.

Behind Metis, there are a few shallow and small deposits of gravel carrying a large proportion of soft shale or slate. The high, steep banks of Matane river show in places much coarse, bouldery and silty, poorly graded gravel, suitable at best for foundation work. Apart from a short stretch between Ste. Flavie and Metis, the shore road is all improved with beach gravel, better and more durable than any of the few bank gravels.

709. *Two and a half miles northwest of Ste. Angèle; where Provincial highway crosses Metis river.*

Two kinds of gravel are exposed in the 20-foot face of a side-hill excavation opened in a steep bluff facing the Metis river. In the upper half of the pit bank, the gravel is more or less weathered, uniformly coarse and well graded; in the lower half, it is fresh, varies much in coarseness between layers, but is on the whole coarse and well graded. Sample No. 709, taken at a depth of 3 to 5 feet, represents about the average run of the upper gravel; sample No. 709a, taken at a depth of over 10 feet, is slightly coarser and less sandy than the pit average for the lower gravel. As seen by Table I, page 166, the two gravels differ in composition and hardness. Abrasion tests run on pebbles of sample No. 709 gave a percentage of wear of 18·7 (Grading A), and on pebbles of sample No. 709a, percentages of wear of 9·0 (Grading A) and 10·5 (Grading B). Both gravels have been used on stretches of the main road between St. Joseph and Ste. Angèle. Good results have been obtained with the lower gravel, but stretches improved with the upper gravel were dusty and wore fast under moderate to heavy traffic. The deposit is of large size and probably continuous with No. 713, which lies in the same river bluff 200 yards to the southwest. The deposit has been excavated to its full depth, 20 feet, and over 20,000 cubic yards of gravel have been taken out, which is probably but a small part of the total amount available in the river bluff.

713. *Two and half miles northwest of Ste. Angèle; near where Provincial highway crosses Metis river.*

About 900 cubic yards of gravel has been lately taken for road use from the upper slope of a 40-foot bluff, which forms the bank of the Metis river. The deposit is probably continuous with No. 709, lying in the same bluff 200 yards away. Uniformly coarse and well-graded gravel is exposed in the 14-foot face of a small side-hill cut. Sample No. 713a, taken at depth of 3 to 5 feet, represents the average run of the bank; sample No. 713 is from a layer of gravel low in sand, and was taken from a hole in the bottom of the pit. Two abrasion tests run on pebbles of sample No. 713 gave percentages of wear of 8·6 (Grading A) and 8·4 (Grading B). As will be seen in Table I, page 167, the composition of the upper gravel of deposit No. 713 resembles that of the lower gravel of No. 709, and the composition of the lower gravel of No. 713 is somewhat similar to that of the upper gravel of No. 709. Gravel No. 713 is weathered to a smaller depth than No. 709 and should be a good road material for the main road. A stretch of the road that runs along the west bank of the Metis river and carries small traffic was surfaced with the gravel and was in very good condition.

Matapedia County

Investigation has been confined to the immediate vicinity of the Ste. Flavie-Matapedia road, and includes all deposits that have been developed to any extent. Gravel is scarce between the northern county border and Val Brillant, and plentiful from there to the southern county border. All deposits are of large size, and from the southeast end of lake Matapedia to Causapscal gravel is seen almost anywhere in the bank of Matapedia river. A number of pits, opened at the time that the road was first improved as a Provincial highway, are now abandoned on account of the gravel either being exhausted or becoming too sandy or stony. Nearly all the pits now worked for road gravel show material well graded as regards size. The majority of the deposits, however, carry much soft, calcareous shale or slate. Road surfaces improved with these gravels are smooth but lose some of their firmness in wet weather and wear fast under moderate to heavy traffic, even when in a dry state. Firm and durable roads, unaffected by weather changes, have been made with some of the harder gravels, such as Nos. 718, 719, 722, 723, and 725, which are less shaly or slaty than the others. Gravel No. 722 would be improved if passed through a crusher.

714. *Two miles southwest of St. Moise; along Provincial highway.*

A large side-hill excavation opened in the steep slope of a ridge covers an area of over 2,000 square yards with a height of bank of 25 feet in the centre. The gravel is generally fresh, very coarse, and slightly bouldery, though well graded. Very bouldery, weathered, and soft gravel lies in the upper 5 to 8 feet of the pit bank, and very bouldery, fresh and clayey gravel, which looks like partly sorted drift, takes up the lower 6 feet of the bank at one place. Outside of these two bouldery zones, the average coarseness runs about 5 per cent boulders, 55 pebbles, and 40 sand. Pebbles are 40 per cent quartzitic sandstone, 40 slate or shale, and 15 limestone. The

fresh gravel makes a good road material, but the great thickness of bouldery and soft gravel in the upper bank is a serious obstacle to the development of the deposit. The ridge is several hundred thousand cubic yards in size, but may be mostly drift. The pocket of what looks like partly sorted drift in the lower pit bank possibly indicates that the gravel merges into glacial drift farther in the ridge. A long stretch of the main road between St. Moise and Ste. Angèle has been recently surfaced with the gravel and was in good condition and firm after a heavy rain.

715. *Three miles west of Sayabec; along brook and road leading southwest from Provincial highway.*

Well-graded, medium-fine gravel is exposed in the 20-foot bank of a pit, 2,600 square yards in area, opened in the slope of a large, flat knoll. Pebbles are about half limestone and half shale or slate. The gravel is soft and wears fast on the main road. Wet weather also adversely affects the condition of the road. Gravel is very scarce locally and holds much soft shale or slate.

716. *Three and a quarter miles east of Val Brillant.*

Gravel and sand are exposed in an excavation opened along the shore of lake Matapedia. The excavation covers an area of 3,600 square yards and reaches a depth of 17 feet, which is as deep as possible without interference by the lake water. Gravel varies in coarseness from place to place, but in a gradual way, and is on the whole well graded, other than the gravelly sand and sand which occupy large sections of the pit bank. Pebbles are almost entirely shaly limestone and calcareous shale, half of which is soft. The pit is said to have been originally opened in coarse gravel at the shore, and as the excavation work proceeded in-shore, streaks of sand appeared and gradually took up more and more of the pit bank area. It is not known how far inwards the gravel runs, but the deposit, whether gravel or sand, is certainly of large size, and the amount excavated, 18,000 cubic yards, is but a small portion of it. The gravel is soft and wears fast. It is used mostly on a stretch of the main road between Val Brillant and Sayabec, along which gravel is scarce.

718. *Three miles north of Amqui; along new colonization road leading to Matane.*

Coarse and bouldery gravel is exposed in a pit opened in the central part of a flat-topped knoll. The pit covers an area of 1,800 square yards and has an average depth of 8 feet, but the depth is irregular, on account of large boulders interfering with digging operations. When the larger stones are screened out, the gravel makes a well-graded road material, but, because of the amount of work involved in getting rid of the oversize, it would be preferable to pass the whole through a crusher. Pebbles are 80 per cent calcareous shale and shaly limestone, only a small proportion of which is soft or friable. Several miles of the new colonization road leading from Amqui to Matane have been recently improved with the gravel. The road, examined after one day's rain, was in very good condition and the surface

firm. The road carries small traffic. The extent and depth of the deposit are unknown. There are several other knolls nearby, which may hold similar material.

719. *Two miles southeast of Amqui; between Provincial highway and Matapedia river.*

The deposit forms a low terrace along the shore of Matapedia river and covers approximately 7,500 square yards. The gravel lies under an overburden of 3 feet of fine silty sand and is underlain by clay at a depth of 7 feet, overburden included. The gravel is fresh, hard, and fairly well graded. An abrasion test on pebbles of sample No. 719, which was taken in the deeper part of the deposit (6 to 10 feet), gave a percentage of wear of 12·7 (Grading A). The gravel takes long to consolidate properly, but wears well under moderate to heavy traffic. Roads improved with it remain firm, irrespective of weather changes.

721. *One mile north of Lac au Saumon; near northwest end of lake.*

A gravel pit opened in the shore of lac au Saumon is worked at two levels, 10 and 20 feet deep respectively. The floor of the lower level is but a few feet above the level of the lake water, which precludes deeper digging. The gravel is uniform in coarseness and composition throughout the exposed face at both levels. It is a well-graded coarse gravel made up of two-thirds pebbles and one-third sand, with hardly 3 per cent boulders. Although but slightly weathered in the upper level and fresh in the lower level, it carries a high amount of more or less soft slate or shale. A large part of the slate or shale pebbles, classified as "Intermediate" in Table I, page 167, would almost as well come under the class "Soft." An abrasion test run on pebbles of sample No. 721, which was taken from fresh gravel in the lower level, gave a percentage of wear of 23·7 (Grading B). The gravel consolidates readily on the road and makes a very smooth surface, but wears fast under the moderate to large traffic of the main road. The deposit probably does not reach far into the lake bank, but runs a long distance along the shore, if not the whole length of the lake.

722. *Three and a quarter miles east of Lac au Saumon; along Provincial highway about one-half mile from southeast end of lake.*

The deposit forms a steep knoll lying at the foot of a hill and but a short distance from the bank of Matapedia river. In that slope of the knoll facing the river there is exposed in a side-hill excavation fresh gravel composed entirely of very hard, angular pebbles of siliceous and shaly limestone. The gravel is, on the whole, fairly well graded, but varies much in coarseness from place to place, and a section of the pit bank near the central part of the knoll is very bouldery. Two abrasion tests on a sample of pebbles, which was taken at a depth of 11 to 12 feet, gave percentages of wear of 5·9 and 6·9 (both of Grading A). Only a comparatively small quantity has been used so far for road material, and, judged by the results obtained, the material takes long to compact firmly and does not make so smooth a road as other softer gravels. On account of the composition and hardness of the gravel, it would be advisable to pass it through a crusher.

The crushed gravel should compact more readily, and make a smoother road surface. Crushing would also obviate the difficulty experienced at present of getting surfacing gravel of suitable coarseness without handling too much useless material. There are several knolls near No. 722, all lying at the foot of a hill and a short distance from the river bank. They are presumed to be gravel, although not likely so homogeneous in composition as No. 722. As a matter of fact, the knolls can be traced more or less continuously as far southeast as Causapscal, including Nos. 723 and 724.

723. *Three miles northwest of Causapscal; along Provincial highway and near Matapedia river.*

The pit bank shows largely sand, silty in places, with streaks of gravel here and there. The gravel is fresh, hard, well graded, and of about the same composition as No. 725. It has been used in surfacing a section of the main road. The road surface, although rather sandy, was not affected by weather and remained in good condition at all times. As judged by what is exposed in the pit bank, the amount of gravel remaining in the deposit would be small. There is, however, an almost continuous chain of gravelly knolls traced for several miles along Matapedia river, and the amount of gravel must be considerable, even if only parts of the knolls are gravel.

724. *Half a mile north of Causapscal; along Provincial highway and Matapedia river.*

The deposit forms a flat-topped knoll, which on its southwestern side slopes steeply towards Matapedia river. In its gentler northeastern slope, a pit has recently (1931) been opened in fairly fresh and hard, very coarse and bouldery gravel, with boulder clay in the lower 2 feet of the 20-foot pit bank. Coarseness runs approximately 25 per cent boulders, 50 pebbles, and 25 sand, and is uniform throughout, outside of the boulder clay. Pebbles of sample No. 724, which was taken in fresh gravel at a depth of 15 feet, had a percentage of wear of 15·3 (Grading A) in the abrasion test. The use of the gravel is confined to roads of small traffic. The gravel is fresh and hard enough to warrant crushing. As about 45 per cent of the material (including 25 per cent boulders) is over 1·5 inches in size and must be treated as oversize and wasted, almost twice as much material has to be excavated and handled as can be utilized. Crushing the material would eliminate wastage and bring down the unit cost. That part of the knoll presumed to be gravel, that is, the upper 18 feet, measures at least 50,000 cubic yards.

725. *Causapscal; along brook emptying into Matapedia river.*

The deposit lies in the steep slope of a gully cut by a brook through a bluff facing Matapedia river. The 30-foot face of a large side-hill excavation opened in the slope of the gully shows gravel that varies much in coarseness, but in a gradual way. It is generally very coarse and bouldery in the upper bank and gradually merges into sand at depths varying between 20 and 30 feet. At the up-brook end of the pit, boulder clay underlies gravel at a depth of 20 feet. The gravel is more or less clayey throughout and probably lies against boulder clay not far back from the pit face. The

deposit appears to thin out gradually in an up-brook direction. Under these conditions it is difficult to estimate even approximately the amount of gravel left in the deposit. Over 8,000 cubic yards have been excavated, most of it for road use. Owing to the great depth of the deposit, weathered and soft material forms but a small proportion of the whole. Outside of the sand and gravelly sand in some parts of the lower bank, the gravel is generally well graded and has given very good results on several roads around Causapscal. A section of the main road surfaced with the gravel was firm and smooth even in rainy weather, and wore well under heavy traffic. An abrasion test on pebbles of sample No. 725, which was taken from fresh, clayey gravel at a depth of 20 feet, gave a percentage of wear of 7·2 (Grading A).

Bonaventure County

The investigation work was confined to a few deposits in the Matapedia valley and a narrow belt of land along the shore of Chaleur bay. Of the few deposits examined in the Matapedia valley, four are of large size, three of which are in the high, steep river bank, and the other one, No. 729, in a large river-flat. Along the bay shore a number of fairly large deposits are seen between Broadlands and St. Jean and near Bonaventure; elsewhere bank gravels are much scarcer, but beach gravel is available at many points along the shore and used in surfacing long stretches of the main road.

The large deposits along Matapedia river hold gravel that is on the average coarse and bouldery, but well graded once the oversize is screened out. The road surface built with these gravels is firm and smooth, but softens when wet, owing to the large proportion of soft slate or shale in the gravels. The road would also wear fast if subjected to the same amount of traffic as in Matapedia county. The bay-shore road is surfaced with bank gravel from Matapedia to past St. Jean, except a short stretch just east of Matapedia, which is surfaced with river gravel available in large amount at low-water level where the Matapedia empties into the Restigouche. Road surfaces of good wearing quality have been built with bank gravels taken from several deposits along this section of the bay road, but some of them, such as Nos. 737 and 739, have low cementing power, owing probably to their great hardness, and it is found necessary, in spells of dry weather, to add a little clayey sand to the road surface as a binding medium. Near the mouth of Bonaventure river, good gravel is obtained from two large deposits, Nos. 751 and 752, also from several smaller ones. All these have been used on the shore road and several other roads, and smooth, hard and durable surfaces made with them. Other deposits also occur farther up the river. From Bonaventure east to the county limits, bank gravel is scarce, at least within a few miles of the shore. A pit has just been opened (1931) in deposit No. 753, three miles inland from Shigawake, for improving local roads. It is a hard gravel that packs readily and firmly on the road.

729. *One and a half miles southeast of Routhierville; along Provincial highway and Matapedia river.*

The deposit lies along the flat bank of Matapedia river and carries very coarse and bouldery, more or less weathered and soft gravel, one-third being made up of boulders. An abrasion test on pebbles of sample No. 729,

which was taken from fairly fresh gravel at a depth of 12 to 15 feet, gave a percentage of wear of 24·7 (Grading A). The deposit has been excavated over an area of 1,200 square yards and a maximum depth of 15 feet, which is 6 feet above the level of the river. The river bank is level over an area of several acres and probably holds a large amount of gravel.

731. *Near St. Alexis Station; along Provincial highway where covered bridge spans a steep gully.*

The deposit lies in the steep slope of a gully cut by a brook through a bluff facing Matapedia river. A large cut, 100 yards in length and 60 feet in greatest height, opened in the bluff facing the river, shows gravel that varies in coarseness between layers, but is generally of medium coarseness, not too sandy, and fairly well graded. Although fresh to within a few feet of the surface, the gravel is only moderately hard, owing to its composition; it is made up largely of calcareous slate and slaty limestone, the two rocks grading into each other and being of the same geological formation. Boulder clay is exposed in places in the lower part of the pit bank and the gravel itself is more or less clayey throughout. A long stretch of the main road improved with the gravel was in good condition, and the road surface quite firm and smooth, when examined in dry weather. Traffic on this section of the main road is small. Nos. 728 and 730 are two other large and deep deposits occurring farther up the river in much the same situation as No. 731, that is, at the point of junction of a stream with Matapedia river. Both Nos. 728 and 730 are very bouldery, shaly or slaty and soft. Sections of the main road improved with these gravels were smooth, owing, in part, to the crumbling of the soft pebbles under traffic. Some stretches where gravel No. 728 was used were more like sand-clay than gravel surfaces.

733. *Half a mile southwest of Broadlands; along bank of Restigouche river.*

In the fall of 1931, a pit had just been opened in the low, level bank of Restigouche river, in what appeared to be good road gravel. It is very coarse, but not bouldery, and is well graded for road material once the larger stones are screened out. The material is hard and fairly fresh throughout the 10-foot pit face. Two abrasion tests run on pebbles of a sample taken at a depth of 2·5 to 6 feet gave percentages of wear of 5·4 (Grading A) and 3·5 (Grading B). The gravel extends for a distance of at least 200 yards inland, according to well records, and the top of the bank is 16 feet above water-level.

735. *Two miles north of Restigouche; along side road, two-thirds of a mile northwest of C. N. R. tracks.*

The deposit holds material which is rather poorly graded as regards size of fragments and is probably partly sorted glacial drift. It is made up largely of hard trap and felsite and has good cementing power. Two abrasion tests run on pebbles of a sample taken at a depth of 3 to 6·5 feet gave percentages of wear of 6·0 (Grading A) and 5·2 (Grading B). A

section of road improved with the material was in good condition, hard and smooth when dry, but it lost some of its firmness when wet, and was not so gritty as the average gravel road. The extent of the deposit is unknown, but apparently large.

736. *Two and a quarter miles east of Oak Bay; along Provincial highway, opposite Battery Point.*

The deposit holds large streaks of well-graded gravel and also much poorly graded material. The gravel is everywhere very sandy and is used largely in road maintenance work. Short stretches resurfaced with the better graded and less sandy gravel show good wearing quality, and remain in good condition and gritty even when wet. The pit, which covers an area of 2,900 square yards and measures 7,200 cubic yards, is of irregular depth, as much of the poorly graded material is left in place. The amount excavated is but a small part of the deposit, which is probably sandy throughout.

737. *Pointe à la Garde; at railway crossing.*

The deposit is in the form of a flat-topped ridge, which gradually increases in height towards one end and merges into a terrace with a steep slope facing Chaleur bay. Several excavations have been opened in the deposit for railway ballast and road gravel and the total amount taken out is well over 50,000 cubic yards. In the ridge proper there remains about 25,000 cubic yards of gravel. In the terrace, it is not known how far inwards the gravel runs; there is said to be a large amount available. The gravel is uniform in composition throughout. Pebbles are almost entirely felsite and trap and are very hard even in the weathered gravel near the surface. The gravel in the ridge is well graded, uniformly coarse, and carries about 40 per cent sand. The pit bank in the terrace which varies in height from 7 to 20 feet, is largely talus-covered. Well-graded, coarse gravel is exposed in the upper bank, but farther down the coarseness and grading are more variable, and the lower bank appears to be very sandy. Sample No. 737 was taken at depth of 2·5 to 6·5 feet from the upper and better graded gravel of the terrace; sample No. 737a was taken at a depth of 7 to 11 feet and represents the average run of the ridge. Pebbles of sample No. 737 had a percentage of wear of 5·4 (Grading B), and those of sample No. 737a percentages of wear of 4·1 (Grading A) and 4·6 (Grading D) in the abrasion test. The average depth of the deposit in the ridge is 12 feet; in the terrace, gravel apparently merges into sand at a depth that varies from place to place. For several miles east and west of the deposit, the ground surface is gravelly, but the thickness of gravel is almost everywhere small. The gravel from several deposits, all much alike in composition, has been used in improving long sections of the main road. It makes a fairly smooth surface and wears well under heavy traffic. It has, however, low cementing power, owing probably to its great hardness, and, during a spell of dry weather in the early fall of 1931, it was found necessary to add clayey sand on some stretches of the road as a stabilizing and binding medium.

739. *One and a half miles southwest of Escuminac; southwest of railway crossing on Provincial highway.*

The gravel is similar in composition to No. 737, but varies more in coarseness between layers. It is on the whole coarse and fairly well graded. The deposit, which averages 6 feet in thickness, is part of the large gravelly area referred to in connection with deposit No. 737.

740. *Three miles west of Nouvelle; west of railway crossing on Provincial highway.*

The deposit lies in the upper slope and top of a bluff facing a brook. In the level land on top of the bluff there are surface indications of gravel over an approximate area of 6 acres. As seen by two excavations over 100 yards apart, gravel grades into sand at an average depth of 7 feet. Except for slight variations between layers, the gravel is uniformly coarse and well graded, partly weathered in the upper bank, fresh in the lower bank. Sample No. 740 was taken at a depth of 2 to 7 feet and includes some partly weathered and some fresh gravel. An abrasion test on the sample pebbles gave a percentage of wear of 14·4 (Grading A). The gravel makes firm and smooth road surfaces, unaffected by weather changes.

741. *One and a half miles southeast of St. Jean; at railway crossing on Provincial highway.*

The 50-foot face of a side-hill cut in the steep slope of a bluff 100 feet in height shows gravel that varies a great deal in coarseness between different layers, from very coarse and slightly bouldery to gravelly sand. Once excavated, the gravel is pretty well mixed as regards pebble size, and with the larger stones screened out makes a fair road material. The fineness of the sand in the gravel is a disadvantage. Pebbles are roughly 40 per cent quartzitic sandstone, 20 limestone, and 30 more or less soft slate or shale. The gravel has given good results in road improvement, although under the heavy traffic of the main shore road it wears fast and is dusty. On account of the great depth of the deposit, and its easy access from the main road, gravel can be easily obtained in large quantity.

747. *Three miles north of Caplan; near road to St. Alphonse.*

Very coarse gravel, holding about 10 per cent boulders, is exposed in an excavation opened in the gentle slope of a flat knoll. The gravel makes a well-graded road material once the larger stones are screened out. In the upper 2 or 3 feet of the pit bank, which reaches a height of 17 feet in the centre, the gravel is weathered, clayey and soft, and fairly fresh below, but only moderately hard, even at depth. Sample No. 747, taken at a depth of 5 to 10 feet, represents slightly finer gravel than the average for the pit face. The sample pebbles had a percentage of wear of 16·6 (Grading A). On roads of small traffic, where it is used exclusively, the gravel packs firmly and makes a smooth surface of good wearing quality. The size of the pit, 3,100 cubic yards, is hardly one-tenth of the size of the knoll, and its average depth, 7·5 feet, is less than that of the deposit.

751. *Half a mile northeast of Bonaventure; near right angle turn on Provincial highway.*

An excavation, 2,000 square yards in extent and over 10 feet in average depth, opened in a low bluff facing Bonaventure river, shows fresh and hard, well-graded, coarse gravel, carrying 25 to 35 per cent sand, outside of a few sandy streaks. Sample No. 751, taken at a depth of 7 to 11 feet, is from slightly fresher, harder, and less sandy material than the average for the whole bank. Two abrasion tests run on the sample pebbles gave percentages of wear of 5·9 (Grading A) and 6·1 (Grading D). Good results have been obtained with the gravel in surfacing stretches of the main shore road and other roads of smaller traffic. The roads, examined after several days of rainy weather, were firm and smooth. The gravel bluff can be traced for several hundred yards along the river. As a matter of fact, both banks of the river are gravelly for several miles. According to the road patrolman, behind the pit face alone, gravel covers an area of 10,000 square yards, and could be excavated to an additional depth of two feet, which would give an average thickness of gravel of over 12 feet.

752. *One and a half miles east of Bonaventure; near railway crossing on road following east side of Bonaventure river.*

The deposit lies close to the bank of Bonaventure river. Gravel has been lately dug for road purposes from the bottom of an old railway pit covering 3,300 square yards and averaging 9 feet in depth. The gravel has much the same quality as road material as No. 751, but is more sandy, being made up of half pebbles and half sand. The gravel grades into sand at depths varying between 10 and 15 feet. Nos. 751 and 752 are the larger of several pits opened on both sides of the river.

753. *Three and a quarter miles north of St. Godfroy near turn of road, one mile northeast of Kelly.*

A pit has just been opened (1931) in the slope of a knoll for material to improve a stretch of the road leading to Huard. The 12-foot pit face shows very coarse and bouldery gravel, uniform in coarseness throughout, and averaging 25 per cent boulders, 50 pebbles, and 25 sand. The gravel is partly weathered in the upper bank and fresh below. Sample No. 753 is from fresh gravel at a depth of 6 to 9 feet, with the boulders taken out. Two abrasion tests on the sample pebbles gave percentages of wear of 6·2 and 6·9 (both Grading A). The gravel packs readily and firmly under small traffic. A good road material could be made out of the gravel by passing it through a crusher. The small demand for road gravel, however, may not warrant the cost of crushing. The pit reaches clay at an average depth of 7 feet, which is less than the average depth of gravel in the knoll, as the inner bank does not reach the top of the knoll. The knoll measures over 20,000 cubic yards. There are several other knolls lying immediately west of No. 753.

Gaspe County

Except around Gaspe bay, good beach gravel is available almost anywhere along the coast, and is used on the shore road with good results, and for that reason is preferred to any other material. By far the larger deposit of beach gravel occurs in the form of a gravel bar over four miles in length between Coin du Banc and Barachois, where an unlimited supply of gravel of any desired coarseness is readily available from the shore road, which runs on top of the bar for a distance of over one mile. Sample No. 763 represents rather fine and sandy gravel used for road maintenance. Coarser gravel is used in surfacing work. It is a much harder beach gravel than found anywhere else in the county, and takes long to compact firmly, but is particularly suitable for the wearing course of a gravel surface. Bank gravel is everywhere scarce, only two large deposits being found, one near Grand Pabos, and the other near Brèche-à-Manon. Good gravel is seen in these two deposits, but none has been used lately for road purposes. Around Gaspe bay, there is no beach gravel, and the little bank gravel available is being rapidly absorbed into the roads, at least one deposit being now completely exhausted.

760. *One and a quarter miles west of Grand Pabos; near where Provincial highway crosses Grand Pabos river.*

The 18-foot bank of a side-hill excavation opened in the steep slope of a bluff facing a cove is largely concealed behind talus. Fresh, well-graded, fine gravel is exposed in a few uncovered spots. The proportion of sand in different layers ranges between one-third to two-thirds of the whole. Pebbles are almost all limestone, half being more or less shaly or slaty, yet fairly hard. The bluff is at least one-half mile in length and has been excavated for gravel at several places, all pit banks being now talus-covered. The amount of gravel is practically unlimited, even if the deposit be limited to the edge of the bluff. Beach gravel available along the shore near Chandler is preferred to bank gravel for surfacing the main road because of its better wearing quality.

761. *One-half mile west of Brèche-à-Manon; where Provincial highway crosses deep gully.*

The deposit occurs on top of a sea cliff. A small amount of gravel has lately been taken from the bank of an old railway pit dug to the bottom of the deposit, which averages 11 feet in depth. The gravel is uniformly coarse, well graded, in places interstratified with thin layers of sand and clay, and does not carry more than 50 per cent sand, including the sand layers. It is much weathered and soft in the upper 2 to 4 feet of the bank and fresh below. Pebbles of sample No. 761, taken from fresh gravel at a depth of 4 to 7 feet, had a percentage of wear of 16·2 (Grading A) in the abrasion test. A short stretch of the main road west of Brèche-à-Manon, which was improved with the gravel, was found in good condition when examined after a rainy day. It is not known how far the gravel extends

in the comparatively level land behind the cliff. The weathered material in the upper 2 to 4 feet may be used for road foundation, but is unsuitable for the wearing course.

763. *Between Barachois and Coin du Banc.*

Gravel forms a large bar that runs from Coin du Banc almost to Barachois, or over a distance of 4 miles. The main shore road passes on top of the bar for a distance of over one mile. The coarseness of the gravel varies in a gradual way from place to place across and along the bar, so that material of any coarseness desired can be obtained right at the surface. The quantity of gravel in the whole bar amounts to millions of yards. The gravel has been used in surfacing long stretches on several roads. It has poor binding quality but, after being mixed with binding material, whether added to it or derived from the road surface over which it is laid, makes a firm and durable road, which is unaffected by weather changes. On account of its great hardness, finer gravel than customary for bank gravels can be used without impairing the wearing resistance of the road. No. 762 is a small and shallow deposit of fine gravel similar to No. 763 as regards composition and quality as road material.

TABLE I

Results of Tests on Gravels

Sample No.	Character of material						Extent of deposit	Size of pit, cubic yards
	Composition of pebbles				Shape of pebbles	Per cent of silt and clay		
	Durable	Intermediate	Soft	Type of stone, per cent				
1	35	50	15	Gneiss, 80	Angular	1·7	Soil gravelly over several acres. Pockets of boulder clay in gravel. Greatest depth is over 20 feet.	Large.
1a	40	45	15			1·6		
5	5	75	20	Mostly syenite and gneiss	Angular to subangular.	0·6	Flat deposit of unknown extent, and probably not much deeper than pit, which is 5 feet deep.	7,900
7	35	60	5	Gneiss, 30; dolomite, 20; limestone, 20.	Angular to subangular.	0·4	Steep knoll. Bank of side-hill pit has a height of 75 feet.	Large.
8	65	30	5	Granite, 75; gneiss, 25	Angular	0·3	Flat ridge several hundred yards in length holds more sand than gravel.	Small.
12	75	15	10	Gneiss, 50; granite and syenite, 50.	Subangular	0·4	Extent unknown.	
13	55	35	10	Mostly gneiss and granite	Angular to subangular.	0·8	Covers large area and grades into sand at depth of 3 feet.	Large.
15	30	45	25	Gneiss, 90	Angular	1·0	Extent unknown. Pit reaches sand at an average depth of 6 feet.	Small.
16	45	45	10	Gneiss, 60; granite, 20; trap, 10	Angular to subangular.	1·6	Large pocket of gravel in ridge of glacial drift is almost exhausted.	Large.
20	50	40	10	Gneiss, 65; granite, 20	Angular	1·1	Large ridge holds mostly sand.	4,900
21	25	55	20	Crystalline limestone, 35; gneiss	Angular	3·0	Gravel forms steep ridge within larger and flatter sand ridge, and is thickly covered with sand. Greatest depth of gravel exposed in pit is over 35 feet.	27,500
21a	50	40	10			0·8		
21b						0·5		
22	50	40	10	Trap, 30; crystalline limestone 30; gneiss, 20.	Various shapes	1·1	Flat-lying and of unknown extent. Covers probably 2 acres.	260
23	90	10	0	Syenite and syenite gneiss, 85.	Angular and flat	1·7	Extent unknown	300

TABLE I—Continued

Results of Tests on Gravels—Continued

Sample No.	Character of material						Extent of deposit	Size of pit, cubic yards
	Composition of pebbles				Shape of pebbles	Per cent of silt and clay		
	Durable	Intermediate	Soft	Type of stone, per cent				
27 27a	45	35	20	Gneiss, 65	Angular	1·1 1·0	Several gravel pits in large sand area. No. 27 is softer but better graded than any seen elsewhere in the area.	15,000
31	75	20	5	Mostly gneiss and syenite	Angular	0·5	Apparently half exhausted and what is left is thickly covered with sand.	8,300
38	50	25	25	Gneiss, 80	Angular	0·9	About half exhausted. Average depth is 9 feet.	3,600
39	50	30	20	All gneiss and granite	Subangular	0·3	Flat-lying deposit of unknown extent in large sand area. Maximum depth of gravel not much over 8 feet.	1,800
41	45	35	20	Gneiss. 55; granite, 30	Angular	0·3	Large knoll 35 feet high. Gravel thickly covered with silty sand.	5,100
43	60	25	15	Granite and syenite, 60; gneiss, 15; trap, 15.	Subangular	0·7	Flat-lying and probably large. Greatest depth of gravel exposed in pit is 18 feet.	Over 3,000
44 44a	60	25	15	Granite and gneiss, 75	Angular to subangular.	0·5 0·5	Large ridge covers several acres and holds more sand than gravel. Greatest depth of gravel exposed in pit is close to 25 feet.	2,400
45	60	30	10	Gneiss, 45; granite, 35	Angular	0·6	Flat-lying and of unknown extent. Pit does not reach bottom of deposit at depth of 25 feet.	4,800
53 53a 55	55 40 65	25 40 25	20 20 10	Mostly granite and gneiss Gneiss, 55; granite, 35	Angular to subangular. Angular	0·7 0·4 0·7	Amount available at least twice as much as already taken out. Probably not over 6,000 cubic yards. Maximum depth is 9 feet.	6,500 2,900

61 61a 61b	35 70 40	50 20 30	15 10 30	Granite and gneiss over 75....	Angular.....	0·5 0·8 0·7	Gravel seen in several pits in large sand area, and thickly covered with sand in places. Pit where samples taken shows better gravel than others.	16,600
71	40	45	15	Gneiss, 90.....	Angular.....	0·4	Small knoll. Pit does not reach bottom of deposit at depth of 20 feet.	3,600
73	60	35	5	Gneiss over 60.....	Angular.....	0·9	Extent probably small. Gravel thickly covered with sand.	Large.
76 76a	75 60	15 25	10 15	Granite and gneiss over 65....	Angular.....	1·0 0·6	Ridge or knoll covers 1·5 to 2 acres. Probably other knolls also hold gravel.	1,600
78	55	20	25	Gneiss, 35; granite, 30; trap, 20.	Angular.....	0·7	Knoll 100 yards across and 60 feet high. Maximum depth of pit is 30 feet.	3,500
79 79a	55	35	10	Granite and gneiss, 55; quartz, 30; trap, 15.	Angular.....	1·6 0·7	Deposit in steep bluff and probably large. Side-hill pit has 50-foot face.	Large.
80 80a	70 65	20 15	10 20	Gneiss and granite, 60; trap, 15	Angular.....	0·9 1·1	Covers several acres, but holds much sand. Much of the gravel lies under thick sand. Maximum depth of pit is 50 feet.	13,100
81	90	5	5	Granite and syenite, 30; quartz, 30; gneiss, 25.	Angular.....	1·0	Same deposit as No. 80. Much more sand than gravel is exposed in pit No. 81.	Large.
82	75	15	10	Granite and gneiss, 75.....	Angular.....	3·5	Road gravel looks about worked out. What is left is bouldery and needs crushing before using. Side-hill pit has a 30-foot face.	21,800
83	75	15	10	Gneiss, 50; granite, 30; trap, 10	Angular.....	0·8	Extent large. Pit does not reach bottom of deposit at depth of 40 feet. Overburden 2 to 4 feet.	18,400
85	45	25	30	Gneiss, 60; granite, 30.....	Angular.....	0·6	Large ridge several hundred yards long. Upper 3 to 5 feet of 30-foot pit bank weathered and in places bouldery.	10,200
86	55	35	10	Gneiss and granite, 85.....	Angular.....	0·6	Steep bluff over 50 feet in height. Newly opened pit cuts through upper 20 feet of bluff.	1,900
88	40	35	25	Mica-gneiss, 75; granite, 20....	Angular to subangular.	0·6	Extent unknown. Greatest depth of gravel exposed in pit is 15 feet.	1,350
90	55	25	20	Granite, 50; gneiss, 35.....	Angular.....	0·5	Covers fairly large area. Average depth between 2 and 3 feet.	3,900

TABLE I—Continued

Results of Tests on Gravels—Continued

Sample No.	Character of material						Extent of deposit	Size of pit, cubic yards
	Composition of pebbles				Shape of pebbles	Per cent of silt and clay		
	Durable	Intermediate	Soft	Type of stone, per cent				
92	80	10	10	Granite, 70; gneiss, 20.....	Angular.....	0·4	Deposit lies in upper part of small ridge, measures 4,800 cubic yards and is not over 7 feet in depth.	125
98	90	5	5	All granite.....	Angular.....	1·3	Covers several acres. Depth not over 4 feet.	Over 7,000
101	70	20	10	All granite and gneiss.....	Angular.....	0·6	Small and not over 7 feet deep. Other small deposits around.	1,700
109	60	30	10	Gneiss, 70; granite, 25.....	Angular.....	1·1	Extent unknown but probably large. Gravel covered with 1·5 to 3 feet and more of sand. Pit, 15 feet deep, does not reach bottom of deposit.	20,250
111	80	15	5	Granite, 35; gneiss, 30; anorthosite, 20.	Angular.....	3·2	Small and not over 6 feet in depth. Other small deposits around.	Over 4,000
113	70	20	10	Gneiss, 65; anorthosite, 30....	Angular to subangular.	0·3	Deposit averages 6 to 7 feet in depth and is about half worked out.	37,200
115	75	20	5	Anorthosite, 75; gneiss, 25.....	Angular.....	0·2	Extent unknown. Depth not over 7 feet.	1,900
116	90	5	5	Anorthosite, 85; gneiss, 10....	Angular.....	0·5	Extent unknown but probably large. Gravel thickly covere d with sand in places.	Large
119	100	0	0	Anorthosite, 95.....	Angular to subangular	0·2	Flat-lying and of large extent. Gravel into sand at depth of 5·5 to 6 feet.	17,800
125	90	5	5	Anorthosite, 75.....	Angular to subangular	0·6	Said to cover over 100 acres and to have a maximum depth of 20 feet.	Large
126	95	5	0	Anorthosite, 50; chert and quartz, 20.	Angular to subangular	0·8	Same deposit as No. 125.....	Large
127	95	5	0	Anorthosite, 60.....	Angular to subangular	0·9	Extent large, but what is left is coarser than sample material. Maximum depth 20 feet.	Over 100,000
127a	95	5	0			1·1		

128 128a	80	15	5	Anorthosite, 70; gneiss, 25.....	Angular.....	1·0 10·5	Deposit of large size, but probably holds more sand than gravel.	5,500
132	75	15	10	Anorthosite, 40; gneiss, 40.....	Angular.....	0·7	Deposit of small extent and not over 8 feet in depth.	1,400
134	85	10	5	Anorthosite, 65; gneiss, 20....	Angular.....	0·5	Probably of large size. Greatest depth of gravel exposed in pit is over 20 feet.	2,100
135	90	5	5	Anorthosite, 75; gneiss, 15	Angular.....	0·2	Extent apparently large. Gravel grades into sand at an average depth of 6 feet.	5,000
139 139a	80 100	15 0	5 0	Anorthosite, 55; gneiss, 35...	Subangular.....	1·8 0·4	Sand deposit of large extent. Gravel limited to the upper 12 to 17 feet of the 75-foot pit bank and amount unknown.	Over one million
147	70	15	15	Gneiss, 65.....	Angular.....	0·7	Probably of large size. Pit does not reach bottom of deposit at depth of 15 feet.	2,000
153 153a	70	25	5	Gneiss, 75.....	Subangular.....	1·2 2·5	Deep sand deposit covers wide area. Amount of gravel probably small.	Over one million
157	55	35	10	Gneiss, 95.....	Angular.....	1·9	Probably of small extent. Maximum depth is 8 feet.	1,300
159 159a	50 50	35 35	15 15	Gneiss, 70; granite, 15.....	Angular.....	0·7 0·5	Deposit of small extent and 3·5 feet in average depth.	4,550
162	60	30	10	Gneiss, over 65.....	Angular to subangular.	0·7	Same deposit as No. 163.....	Large
163	45	40	15	Gneiss over 65.....	Angular.....	0·4	Covers over 100 acres and is at least 15 feet deep.	900
166 166a	70 70	25 25	5 5	Mostly granite.....	Angular Subangular.	0·4 1·4	Gravel lies in terrace of large extent and is underlain by sand at depth of 20 feet.	21,700
167	70	25	5	Granite 65; gneiss, 35.....	Subangular.....	0·3	Gravel lies in terrace of large extent and is underlain with sand at depth of 25 feet.	8,700
168	50	20	30	Gneiss, 60; granite, 30.....	Angular.....	0·6	Gravel overlies boulder clay, varies from 3 to 10 feet in thickness, and probably covers large area.	11,700
172	80	15	5	Granite, 80; gneiss, 20.....	Angular.....	1·2	Large knoll may be part boulder clay. Gravel exposed in 35-foot pit face looks in places like roughly sorted drift.	5,700
178 178a	60 55	30 30	10 15	Gneiss, 65; granite, 20.....	Angular.....	0·5 0·4	Flat ridge of large extent. Gravel not dug deeper than 20 feet, owing to lack of drainage.	15,900

TABLE I—Continued

Results of Tests on Gravels—Continued

Sample No.	Character of material						Extent of deposit	Size of pit, cubic yards
	Composition of pebbles				Shape of pebbles	Per cent of silt and clay		
	Durable	Intermediate	Soft	Type of stone, per cent				
179	55	35	10	Gneiss, 60; granite, 30	Angular	0·6	Ground gravelly for several miles. Depth of gravel unknown.	525
183	45	40	15	Gneiss, 75	Angular	0·6	Gravelly part of ridge is over 50,000 cubic yards in size. Greatest depth of gravel exposed in pit is 30 feet.	Over 10,000
183a	60	35	5			0·8		
186	70	25	5	Gneiss, 50; granite, 30; limestone, 15.	Subangular	0·2	Several river flats. Gravel not dug deeper than 2 feet, because too sandy below that depth.	River gravel
193	60	30	10	Granite, 55; gneiss, 45	Subangular	0·7	Ground gravelly for several miles. Depth of gravel averages 2 to 3 feet.	900
206	20	50	30	Dolomite, 55; limestone, 20	Angular to subangular.	1·6	Gravel ridge about 4 times size of pit; maximum depth is 13 feet.	9,000
210	5	65	30	Dolomite, 80	Angular	2·2	Coarser gravel about exhausted. Fine gravel below pit bottom is hard to get in large amount, because of bad drainage.	Over 200,000
211	5	75	20	Dolomite, 80	Angular	4·6	Gravel terrace along northwest margin of glacial-drift ridge. If whole terrace is gravel, amount is well over 10,000 cubic yards.	3,000
213	0	60	40	Dolomite, 90	Angular	2·7	Gravel found in long narrow, glacial-drift ridge, averages 9 feet in depth. Extent unknown.	14,300
214	3	80	17	Dolomite, 65; sandstone, 20	Angular	4·1	Looks about exhausted. What is left is very sandy.	31,000
216	15	80	5	Dolomite, 50; sandstone, 25	Subangular		Ridge of glacial drift the crest of which holds looser material with a higher proportion of boulders and pebbles than down the slopes.	10,000
216a	15	75	10					

218 218a	5 15	50 70	45 15	Dolomite, 45; sandstone, 35....	Angular to subangular	3·2 1·3	Gravel ridge several times size of pit; maximum depth is 15 feet.	15,500
223 223a	7 3	78 87	15 10	Sandstone, 85.....	Angular to subangular	2·9 1·9	Gravel terrace, average depth 7 feet. Amount is several times that already taken out.	4,100
226 226a 226b	5 7 6	80 73 89	15 20 5	Sandstone, 90.....	Angular.....	1·9 1·2 1·6	Gravel fills slight depression in underlying glacial drift; average depth 5 feet. Gravel said to cover at least 3 times the pit-area, that is at least 34,500 square yards.	15,100
229 229a	5 0	75 80	20 20	Sandstone, 90.....	Angular to rounded	1·0 2·4	Gravel and sand terrace several miles in length. Pit does not reach bottom of deposit at depth of 12 feet.	3,700
231	0	65	35	Dolomite, 85.....	Angular.....	0·4	Amount probably large; certainly as much as already taken out.	11,600
232	10	65	27	Dolomite, 90.....	Angular.....	0·8	Gravel ridge at least 3 times size of pit; maximum depth is 10 feet.	8,900
235	3	81	16	Dolomite, 90.....	Angular.....	3·0	Long ridge of glacial drift; small pit shows material carrying high proportion of pebbles.	100
237	0	75	25	Sandstone, 75.....	Angular.....	0·6	Gravel forms small narrow band, maximum depth 10 feet, along southeast margin of glacial-drift ridge.	5,700
240 240a	25	65	10	Limestone, 60; trap and syenite 20.	Angular to subangular.	2·3 2·0	A few streaks of gravel run irregularly through large sand deposit over 30 feet in depth.	57,000
242	25	65	10	Limestone, 70.....	Subangular.....	1·2	About half of gravel owned by the railway company has been taken out; maximum depth over 40 feet. Large amount available northeast of railway property.	Over 300,000
244	27	50	23	Trap and syenite, 60; limestone, 25.	Angular.....	2·0	Small flat gravel ridge, maximum depth 7 feet. Amount unknown, but certainly twice as much as already taken out.	2,000
245	40	35	25	Trap, 50; limestone, 15.....	Angular.....	3·2	Deposit of sandy gravel covers several acres and averages 9 feet in depth. Overburden 2 to 4 feet thick.	24,000

TABLE I—Continued

Results of Tests on Gravels—Continued

Sample No.	Character of material						Extent of deposit	Size of pit, cubic yards
	Composition of pebbles				Shape of pebbles	Per cent of silt and clay		
	Durable	Intermediate	Soft	Type of stone, per cent				
248	15	67	18	Limestone, 35; trap, 20; dolomite, 10.	Angular	1·8	Gravel lies in southwest end of ridge, maximum depth 10 feet. Amount unknown, but certainly as large as already taken out.	15,400
251	5	80	15	Dolomite, 55; limestone, 35	Subangular to angular.	1·6	Large deposit of coarse gravel. Greatest depth of gravel exposed in pit is 20 feet.	15,200
255	10	23	67	Limestone, 20	Angular	1·3	Gravel ridge about 5 times size of pit; averages 6 feet in depth.	1,800
257	45	47	8	Limestone, 40; trap, 30; gneiss and granite, 20.	Angular to subangular.	1·2	Same deposit as No. 258	19,600
258	33	50	17	Limestone, 35; syenite, 40	Angular to subangular.	1·8	Narrow, flat ridge several miles long, holds more sand than gravel; averages 100 feet in width and 6 feet in depth.	16,700
259	25	55	20	Limestone, 30; trap, 30	Angular	0·9	Flat ridge, averages 7 feet in depth. Gravel more than half exhausted. Overburden up to 3 feet in thickness.	19,900
262	40	25	35	Trap, 20; gneiss, 20	Angular	2·3	Gravelly sand deposit in lower south slope of St. Bruno mountain; averages 8 feet in depth. Much more sand than gravel, and covered with thick overburden of sand.	6,400
263	90	3	7	Trap, 95	Angular	1·2	Gravel terrace in southeast slope of St. Bruno mountain. Large pit 10 to 20 feet deep, reaches bottom of deposit in places only. Large amount available.	43,000
265	13	30	57	Sandstone and shale, 40	Angular	1·3	Gravel ridge several times size of pit; average depth 7½ feet; underlain by fine sand.	13,500

268	25	50	25	Trap, 40; sandstone and shale, 40.	Angular to subangular.	0·7	Gravel terrace at the foot of mount Johnson; maximum depth 22 feet. Large deposit includes more sand than gravel and is covered with 2 to 4 feet of sand as overburden.	27,500
269	30	65	5	Sandstone and shale, 50; gneiss, 35.	Angular.....	0·7	Gravel bluff at the foot of mount Johnson; deep deposit of large size, but includes much sand and is in places covered with thick overburden of sand.	53,700
270	55	30	15	Trap, 45; gneiss and granite, 30	Angular to subangular.	0·4	Flat-lying deposit is over 20 acres in area but probably holds more sand than gravel. Average depth is 7·5 feet.	100,000
270a	25	45	30			1·0		
275	10	30	60	Mostly shale or slate and trap.	Subangular.....	1·4	Small deposit, thickly covered with sand in places. At least 7,000 cubic yards available without too much stripping.	16,600
275a	10	30	60			1·3		
276	20	53	27	Slaty limestone and calcareous slate, 60.	Subangular.....	1·8	Large steep knoll. Side-hill pit does not reach bottom of deposit at maximum depth of 30 feet. Several other gravelly knolls around.	6,400
277	15	38	47	Slate, 50; sandstone, 35.....	Subangular.....	2·5	Gravel forms low, narrow ridge, several hundred yards in length; average depth is 6 feet. Over 10,000 cubic yards available.	1,700
279	27	63	10	Slate, 60; sandstone, 30.....	Subangular and some flat.	0·6	Same deposit as No. 280.....	13,300
280	35	55	10	Slate, 50; sandstone, 30.....	Subangular and some flat.	0·3	Gravel deposit forms steep bluff along Yamaska river, for a distance of over three-quarters of a mile, including No. 279 and other smaller pits. Over 100,000 cubic yards available. Maximum thickness of gravel above river level is over 40 feet.	24,000
280a	45	45	10			0·5		
282	60	35	5	Limestone, 30; sandstone, 25; trap, 20.	Subangular.....	0·5	Deposit forms large ridge over one mile long, with maximum depth of over 25 feet. Overburden 4 feet of fine sand.	8,300
283	33	33	34	Trap, 45; gneiss and granite, 30	Subangular.....	1·7	Gravel deposit forms part of large terrace at the foot of mount St. Hilaire, has an average depth of 7½ feet and is said to have an area of about 25 acres.	7,600

TABLE I—Continued

Results of Tests on Gravels—Continued

Sample No.	Character of material						Extent of deposit	Size of pit, cubic yards
	Composition of pebbles				Shape of pebbles	Per cent of silt and clay		
	Durable	Intermediate	Soft	Type of stone, per cent				
285	90	5	5	Trap, 80; gneiss and granite, 10	Subangular.....	1·2	Deposit of small extent and 4 feet in average depth.	5,500
287	7	48	45	Shale, 40; limestone, 25.....	Angular.....	0·6	Large, flat-lying gravel deposit, with an average depth of over 10 feet. Large amount available, but better grade gravel now almost exhausted.	142,000
288	20	40	40	Limestone, 25; gneiss and granite, 25; shale, 20.	Angular.....	0·8	Probably of large extent. Average depth is between 10 and 11 feet.	36,400
289	15	45	40	Shaly limestone and shale, 70; gneiss, 20.	Angular to subangular.	1·3	Deposit forms large ridge and has a maximum depth of more than 25 feet. Includes both Nos. 289 and 290, and amount available is more than already taken out in both pits.	10,400
289a	12	63	25			0·5		
290	15	55	30	Shaly limestone and shale, 60; granite and gneiss, 25.	Angular to subangular.	1·1	Same deposit as No. 289.....	49,400
291	10	40	50	Limestone and slate or shale, 80.	Angular.....	1·1	Large ridge-like deposit, averaging 15 feet in depth. There remains as much available as already taken out.	50,600
292	5	50	45	Limestone and slate or shale, 80.	Angular and flat..	1·8	Gravel lies in southwest slope of flat ridge, and said to have been traced to the southeast for a distance of at least 1,000 feet, which would place the amount available at 25,000 cubic yards.	7,500
295	5	35	60	Limestone and slate or shale, 80.	Angular.....	1·1	Deposit has an average depth of 7½ feet. Amount of gravel unknown; at least as much as already taken out. Overburden, 2½ to 4 feet of fine clayey sand.	10,100

299	5	72	23	Limestone, 55; calcareous shale, 25.	Angular to subangular.	1·9	Over 100,000 cubic yards. Deposit has a maximum depth of 15 feet. Average depth estimated at 9 feet.	12,000 Also R.R. pit.
301	40	40	20	Sandstone, 55; slate or shale, 30.	Angular and flat.	1·3	Gravel forms flat ridge and averages 6 to 7 feet in depth. Over 30,000 cubic yards available.	6,100
303	20	70	10	Slate, 40; trap, 15; sandstone, 10.	Angular to subangular.	0·8	Large deposit in the upper slope of a steep, rocky ridge. Maximum depth of gravel said to be 20 feet. Original sand covering has been blown off over an area of 10 acres.	Over 1,000
308	5	75	20	Slate or shale, 65; sandstone, 20.	Angular and flat.	1·2	Deposit almost exhausted.....	15,100
313	45	45	10	Slate and schist, 20; many other types.	Angular to subangular.	1·2	Deposit forms three large steep-sloped knolls, which hold more sand than gravel. Knolls cover 4 acres and average 40 feet in height.	1,600
315	40	45	15	Slate and schist, 40; sandstone, 25.	Angular to subangular.	0·5	Several steep knolls, gravelly on surface, aggregate well over 100,000 cubic yards in size.	9,300
316	35	40	25	Slate and schist, 30; many other types.	Angular to subangular.	2·4	Gravel lies in central part of a ridge and grades into sand at depth of 20 feet. Amount of gravel at least ten times size of pit.	2,800
320	40	40	20	Schist and slate, 40; quartzose, 25.	Subangular.....	4·0	Deposit forms steep knoll, 30,000 cubic yards in size. Gravel covered with 4 to 5 feet of sand as overburden.	1,400
321	25	55	20	Schist and slate, 45; quartzose, 35.	Angular to subangular.	1·2	Gravel forms pocket in large sand area; average depth 7 feet. Other similar pockets seen elsewhere in the sand area.	900
323	47	38	15	Schist, 35; trap and metamorphic, 30.	Angular to subangular.	0·7	Gravel forms ridge or knoll at least ten times size of pit. Greatest depth of gravel exposed in pit is 30 feet.	4,900
323a	50	30	20			0·6		
324	60	30	10	Quartzose, 30; metamorphic, 30; schist, 20.	Angular.....	0·5	Extent unknown. Gravel thickly covered with sand.	3,000
327	25	50	25	Slate or shale, 55; sandstone, 35.	Flat and subangular.	1·4	Gravel overlies bed-rock, and depth varies owing to the irregular surface of the rock, but deposit generally very shallow. Pit averages 4 feet in depth. Deposit flat-lying and extent unknown, but apparently large.	7,400

TABLE I—Continued

Results of Tests on Gravels—Continued

Sample No.	Character of material						Extent of deposit	Size of pit, cubic yards
	Composition of pebbles				Shape of pebbles	Per cent of silt and clay		
	Durable	Intermediate	Soft	Type of stone, per cent				
329	20	55	25	Slate or shale, 45; metamorphic, 30.	Angular and flat..	0·8	Flat-lying deposit between rock ledges, covers 3 acres. Not dug deeper than 12 feet because of lack of drainage.	14,300
333	20	65	15	Slate or shale, 55; sandstone, 28	Subangular to angular.	0·3	Deposit lies on top of a steep bluff facing river. It averages 7 feet in depth and is at least 3 times size of pit.	8,400
334	50	45	5	Sandstone, 30; slate, 25; quartzite, 15.	Angular and flat...	0·6	Extent unknown. Gravel grades into sand at depth of from 3 to 7 feet.	3,300
335	15	65	20	Trap, 40; slate or shale, 30.....	Angular.....	5·3	Shallow deposit, 2 to 8 feet in depth, on top of loose rock, covers several acres.	Over 10,000
336	40	50	10	Metamorphic, 35; schist, 30....	Subangular to angular.	0·7	Gravel exposed in 40-foot face of side-hill pit in knoll which measures well over 100,000 cubic yards.	8,200
336a	35	50	15			0·8		
339	35	40	25	Sandstone, 45; slate or shale, 35	Angular to subangular.	0·9	Deposit forms steep ridge along river bank. Part of ridge is sand. Over 10,000 cubic yards of gravel available.	4,600
343	15	50	35	Schist, 30; slate or shale, 20; sandstone, 20.	Angular to subangular.	1·7	Deep deposit forming steep ridge, about ten times size of pit. Upper 4 to 8 feet along ridge crest is bouldery and weathered. Maximum height of pit bank is 25 feet.	4,800
345	50	40	10	Metamorphic, 50; slate, 30.....	Subangular to angular.	0·4	Gravel forms large ridge and its depth is not known; is said by patrolman to underlie large area outside of ridge. Ridge alone measures over 200,000 cubic yards and reaches a height of 40 feet.	27,0

349	33	42	25	Many rock types.....	Angular.....	1·1	Small deposit with an average depth of 6 feet. Amount available about twice as much as already taken out.	1,800
350	35	50	15	Metamorphic, 45; slate, 40.....	Angular to subangular.	1·0	Large deposit. Pit has a maximum depth of 80 feet and does not reach bottom	Over one million.
351	23	62	15	Slate, 60; sandstone, 20.....	Angular to subangular	0·5	Large deposit holds mostly coarse sand. Gravel exposed only in the lower part of the 35-foot pit bank.	20,000
351a	23	67	10			0·6		
352	20	65	15	Metamorphic, 40, slate, 40.....	Angular to subangular.	0·9	Large deposit holds mostly coarse sand, but fine moulding sand and also streaks of gravel are exposed in the side-hill pit face which reaches a maximum height of 100 feet.	Over one million.
352a						0·9		
353	50	20	30	Metamorphic, 30, schistose, 30; quartzose, 25.	Subangular.....	2·3	Covers several acres. Depth of gravel probably not much over 10 feet.	Over 10,000
354	20	70	10	Limestone, in part shaly, 65...	Subangular.....	1·5	Small deposit holds mostly sand.	3,700
355	60	30	10	Many rock types.....	Subangular to angular.	0·0	Knoll holds more sand than gravel. Other knolls around are said to be more sandy.	19,000
356	33	44	23	Sandstone, 50; slate and schist, 35.	Angular.....	1·1	Flat-lying and shallow deposit, said by patrolman to cover 15 acres. Pit depth averages 7½ feet, with bouldery gravel or glacial drift in the bottom.	11,600
358	10	60	30	Slate and shale, 80.....	Flat and angular..	0·6	Gravel forms several small, shallow, ridge-like deposits, 5 feet in average depth. A somewhat deeper and much larger deposit, formerly worked for railway-ballast, is now almost exhausted.	2,300
359	40	25	35	Many rock types.....	Angular.....	1·5	Deposit forms flat-topped ridge and averages 4½ feet in depth. Ridge of large extent, but includes much bouldery, poorly graded material.	31,000
361	30	35	35	Slate and schist, 65; limestone, 15.	Angular to subangular and flat.	5·2	Hill is several millions of cubic yards in size. Greatest depth of gravel exposed in pit is 80 feet.	Over one million
361a	30	50	20			1·0		
361b	15	80	5			2·1		
362	25	60	15	Slate and schist, 55; limestone, 15.	Crushed gravel...	5·6	Same deposit as No. 361. Pit face is 50 feet in greatest height.	Over 25,000

TABLE I—Continued

Results of Tests on Gravels—Continued

Sample No.	Character of material						Extent of deposit	Size of pit, cubic yards
	Composition of pebbles				Shape of pebbles	Per cent of silt and clay		
	Durable	Intermediate	Soft	Type of stone, per cent				
363	10	85	5	Calcareous slate, 80.....	Angular to flat....	2·5	Knoll 1·5 acres in area. Depth of gravel unknown, probably not more than 17 feet the maximum pit depth.	5,000
372	.....	.....	.....	.....	.....	0·4	Knoll holds mostly coarse sand, is 4 acres in area and 40 feet in height.	5,500
375	40	45	15	Serpentine and trap, 40; schist, 40.	Angular to flat....	0·9	Large ridge several times pit size. Greatest depth of gravel exposed in pit is 45 feet.	11,100
381	45	40	15	Serpentine and trap, 50; schist and slate, 25.	Angular to flat....	0·4	Flat ridge. Average depth of gravel 7·5 feet. The pit area, 3,400 square yards, is at most one-third the ridge area.	8,600
381a	30	40	30			0·8		
382	25	55	20	Slate and schist, 45; metamorphic, 30.	Angular to flat....	1·1	Deposit in river bank probably covers large area. Maximum depth is 10 feet.	7,100
385	35	40	25	Schist and slate, 45; serpentine and trap, 25.	Subangular to flat.	0·8	Large knoll 100 feet high which is also the height of the pit bank. Amount available probably as much as already taken out. Gravel lies under thick sand cover in places.	Over 30,000
386	65	30	5	Serpentine and trap, 65.....	Angular to subangular.	0·9	River bank is gravelly and sandy for miles. Gravel lies in places under a great thickness of sand.	Over 100,000
386a	75	20	5			1·1		
389	65	30	5	Serpentine and metamorphic, 60; quartzose, 20.	Subangular.....	0·5	Large knoll. Face of side-hill pit is 40 feet high. Gravel lies under 1·5 to 5 feet of sand.	6,600
391	65	25	10	Metamorphic rocks, 75.....	Angular.....	1·1	Same deposit as No. 392. Pit is 10 feet deep and deposit probably not much deeper. Overburden, 2 to 3 feet of fine sand.	5,000

392	60	30	10	Metamorphic and trap, 65; schist, 25.	Subangular	0·8	Low river bluff is gravelly for over one mile. Pit reaches bottom of deposit at depth of 13 feet.	12,400
396	25	55	20	Schist and slate, 35; limestone, 30; metamorphic, 25.	Subangular to flat	3·1	Deposit carries more sand than gravel and is almost half worked out. Most of the gravel left apparently lies under thick sand cover.	Over 10,000
399	65	20	15	Many rock types	Angular	0·5	Large terrace-like deposit holds more sand than gravel and overlies clay at depth of 15 feet. Overburden, 1·5 to 6 feet of clayey sand.	3,650
402	20	40	40	Schistose, 60; metamorphic, 25	Angular to flat	1·7	Flat knoll covers several acres. Pit is 9 feet deep and deposit probably not much deeper. Overburden, 1 to 3 feet thick.	13,800
404	30	55	15	Metamorphic, 40; limestone, 15, slate and schist, 15.	Subangular	0·3	Knoll measures at least 4 times pit size, and probably holds much sand. Except near top, gravel lies under thick sand cover.	5,100
406	65	25	10	Metamorphic, 35; quartz, 25; schist and slate, 25.	Angular	0·8	Gravel hauled from river flat at low water. Amount available each year more than what is needed.	.....
409	55	20	25	Quartz, 55; schist, and slate, 25	Angular	1·6	Gravel available in large amount at low water from river flats. Fresh supply laid down at flood time each year.	.....
414	40	40	20	Metamorphic, 50; schist, 30	Angular	0·6	Gravel lies in large sand area and has a thickness of 15 feet (maximum). Extent of gravel unknown. Overburden is thick in places.	23,500
414a	40	50	10			0·4		
419	30	55	15	Slate and schist, 65; other metamorphic, 30.	Angular to flat	0·9	High, flat-topped ridge covers at least 5 acres. Face of side-hill pit is 35 feet high. Other gravelly ridges and knolls around.	35,000
421	50	30	20	Granite, 35; schist, 30; trap, 15.	Angular	4·0	Extent unknown but apparently large. Depth averages 7 feet.	9,200
427	5	75	20	Schist and slate, 75	Flat, angular and subangular	1·0	River bank gravelly for 5 miles. Gravel grades into sand at shallow depth.	Several small pits

TABLE I—Continued

Results of Tests on Gravels—Continued

Sample No.	Character of material						Extent of deposit	Size of pit, cubic yards
	Composition of pebbles				Shape of pebbles	Per cent of silt and clay		
	Durable	Intermediate	Soft	Type of stone, per cent				
428	40	40	20	Schist and slate, 45; other metamorphic, 40.	Crushed gravel...	.....	Large boulder deposit originally worked for gravel which is now exhausted. Bouldery material crushed for roads.	Large.
432	30	50	20	Schist, 45; other metamorphic, 45.	Angular to flat....	0·9	Extends over several acres and has an average depth of 7·5 feet.	4,400
436	40	30	30	Serpentine and trap, 50; schist and slate, 30.	Angular.....	0·7	Extent unknown, apparently several times pit size. Depth 8 feet on the average.	7,700
451	35	45	20	Nearly all schistose and quartzose metamorphic.	Angular to flat....	0·5	Large amount of gravel available from river flats at low water, usually in late summer.	.....
458	15	50	35	Slate or shale, 70.....	Angular to flat....	1·7	Deposit measures at least 10,000 cubic yards and averages 8 feet in depth.	1,650
459	50	35	15	Quartzose and schistose metamorphic, 75.	Angular to subangular.	0·5	Gravel from river flats available at low water, usually in late summer.	.....
460	30	25	45	Metamorphic or trap, 25; sandstone, 25; shale, 20.	Angular.....	1·6	Deposit of large extent. Depth not more than 8 feet on the average.	30,000
462	45	35	20	Limestone, 40; trap, 35.....	Angular to subangular.	1·1	Gravel lies in large sand ridge. Gravel deposit said to be 2 miles long and to have a maximum depth of 25 feet.	13,000
465	13	85	2	Shale or slate, 65; sandstone, 15.	Angular.....	0·6	Flat ridge about 3 times pit size and 5 to 6 feet average depth. Other similar ridges around.	3,000
468	25	50	25	Schist and slate, 60; serpentine and trap, 20.	Flat to angular....	2·0	Large deposit, 20 feet in greatest depth, holds more bouldery material than regular gravel.	7,800

476	30	40	30	Schist and slate, 50; other metamorphic, 30.	Subangular	5·1	Ridge or knoll 60 feet high. Amount available is at least twice pit size, and probably more.	39,000
488	15	40	45	Schist and slate, 60; quartz and quartzite, 20.	Subangular to flat	3·2	Extent small and average depth 5 feet.	1,000
492	55	20	25	Sandstone and quartzose, 55; schist, 20.	Angular	0·6	Extent unknown but probably large. Maximum depth 12 feet. Other deposits around are more sandy.	4,900
499	30	45	25	Metamorphic, 45; schist and slate, 40.	Subangular	0·8	Deposit half worked out. Average depth over 6 feet.	15,000
501	50	40	10	Quartzose and schistose, metamorphic, 60; slate, 20.	Subangular	1·1	River gravel available at many places along the Chaudière at low water, usually in late summer.	.....
504	25	25	50	Schist and slate, 70; other metamorphic, 25.	Angular to flat	1·1	Deposit covers 1,250 square yards and is 5 feet deep on the average.	1,200
506	15	55	30	Schist and slate, 75	Subangular to flat	1·1	Upper 10 feet of river terrace gravelly for a distance of several hundred yards.	3,900
508	50	45	5	Metamorphic, 50; schist and slate, 40.	Subangular to flat	0·6	Large flat along river at foot of rapids. Except at flood time, gravel lies above water.	.....
514	20	55	25	Quartzose and schistose metamorphic, 85.	Angular to flat	0·8	Gravel forms small, flat ridge and averages 10 feet in depth. Total area is several acres, including two other gravelly ridges.	12,900
515	20	50	30	Schist, 50	Angular to flat	1·9	Deposit forms flat knoll or dome,	6,750
515a	10	45	45	Schist, 75	.....	2·3	covers several acres and averages 10 feet in depth.	
517	0	5	95	All shale	Angular and elongated.	0·4	Flat ridge averages 4 feet in depth and is of small extent. Other similar ridges around.	1,350
518	0	5	95	All shale	Angular and elongated.	0·6	Flat ridge covers over one acre and averages 5 feet in depth. Other similar ridges around.	4,000
520	40	40	20	Quartzite and sandstone, 50; slate, 30.	Angular to subangular.	1·4	Pit shows more sand than gravel and reaches clay at a maximum depth of 12 feet.	2,200
523	70	20	10	Quartzite and sandstone, 55; slate and schist, 20.	Angular to subangular.	0·5	Banks of river gravelly for miles. Depth of gravel varies along the river, reaches 15 feet in places, but is not over 8 feet on the average.	7,000 Other pits.

TABLE I—Continued

Results of Tests on Gravels—Continued

Sample No.	Character of material						Extent of deposit	Size of pit, cubic yards
	Composition of pebbles				Shape of pebbles	Per cent of silt and clay		
	Durable	Intermediate	Soft	Type of stone, per cent				
524	40	20	40	Metamorphic, 40; schist, 20; slate, 15.	Angular to flat....	0·3	Flat-lying deposit has a maximum depth of 6 feet and is half exhausted.	5,000
528	35	30	35	Metamorphic, 35; sandstone, 30; shale, 20.	Angular.....	1·2	Pit face 175 yards long and over 30 feet high shows gravel only at one end. Gravel lies under several feet of overburden. Amount of gravel said to be large.	Over 10,000
533	86	7	7	Quartzite, 50; sandstone, 15; trap, 15.	Subangular.....	1·0	Over 100,000 cubic yards in several knolls scattered along bank of Etchemin river. Sand underlies gravel at various depths.	17,500 Also other pits.
534	40	50	10	Quartzite, 35; slate, 30; sandstone, 25.	Angular.....	1·6	Deposit is part of the same group of knolls as No. 533.	750
536	33	47	20	Slate, 55; quartzite, 40.....	Angular and some flat.	1·5	Gravel said to cover over 3·5 acres, and pit, which averages 9 feet in depth, does not reach bottom of deposit. Overburden 2 feet of fine sand.	5,700
537	57	28	15	Quartzite, 30; schist, 30; trap, 25.	Angular.....	0·8	Knoll at least 10 times pit size. Pit reaches sand at maximum depth of 20 feet.	4,500
538	40	20	40	Quartzite and sandstone, 40; schist, 30; trap, 10.	Angular and some flat.	1·2	Deposit forms several knolls along river and holds much sand. Pit in upper 13 feet of a 50-foot knoll.	1,050
540	55	35	10	Sandstone, 25; schist, 25; trap, 20; quartzite, 15.	Subangular to angular.	0·9	From test-pit records, 8 to 10 acres. Greatest depth of gravel in pit is over 20 feet.	13,300

544	47	53	0	Slate, 35; sandstone, 25; quartzite, 20; trap, 15.	Angular.....	1·8	Covers 11,000 square yards and is probably not much deeper than pit, which averages 9 feet in depth, including 3 to 5 feet of overburden.	7,100
549	20	65	15	Quartzite, 30; slate, 30; sandstone, 15; trap, 10.	.....	1·2	Gravel deposited back of brook-dam at high water. Fresh supply every year.	.....
550	10	73	17	Slate, 55; quartzite and sandstone, 35.	Angular.....	1·0	Large terrace. Pit reaches clay at an average depth of 9 feet.	5,000
554	10	67	23	Schist, 45; slate, 40.....	.....	0·7	Unknown.	
556	33	55	12	Schist and slate, 45; quartzite, 40.	Angular.....	1·5	Pit in steep slope of knoll, which is about 10 times pit size, but may not be all gravel. More gravel below pit bottom. Pit bank up to 40 feet in height.	12,000
557	20	55	25	Schist, 55; quartzite, 35.....	Angular.....	0·7	Deposit forms small knoll about 10 times size of pit. Pit has a maximum depth of 10 feet and does not reach bottom of deposit.	1,400
559	77	18	5	Quartzite and sandstone, 85...	Subangular.....	0·5	One acre, with maximum depth of 9 feet at pit.	2,700
560	55	45	0	Sandstone, 55; shale or slate, 25.	Angular.....	2·3	Deposit about 3 times size of pit, but the larger part is either too sandy or too stony. Maximum pit depth 20 feet. Overburden, 1½ to 2½ feet of clayey sand.	10,000
562	45	45	10	Sandstone, 45; quartzite, 40...	Angular to subangular.	0·8	Deposit said to cover at least 2 acres, from test-pit records. Pit reaches boulder clay at maximum depth of 12 feet.	2,000
565	83	12	5	Quartzite, 45; schist, 25; sandstone, 20.	.....	0·8	Deposit said to cover at least 2 acres. Maximum depth over 25 feet.	Large.
570	47	50	3	Quartzite, 35; slate and schist, 30; sandstone, 25.	.....	0·8	Well over 30,000 cubic yards. Pit reaches bottom at maximum depth of 8 feet.	400
575	60	33	7	Quartzite, 50; sandstone, 35...	Angular.....	1·2	Steep brook bank, 30 feet high, gravelly on surface for a distance of several hundred yards. Pit cuts through upper 8 feet of bank only.	2,500

TABLE I—Continued

Results of Tests on Gravels—Continued

Sample No.	Character of material						Extent of deposit	Size of pit, cubic yards
	Composition of pebbles				Shape of pebbles	Per cent of silt and clay		
	Durable	Intermediate	Soft	Type of stone, per cent				
576	55	38	7	Quartzite, 45; sandstone, 30; slate, 20.	Angular.....	1·6	Slight ridge-like elevation runs about one mile southwest but may not be all gravel. Average depth of deposit at pit is 6 feet.	9,300
581	45	50	5	Quartzite, 30; schist, 30; sandstone, 15; slate, 15.	Angular.....	0·3	Patrolman's estimate is 4 acres. Average depth of deposit 7·5 feet.	3,100
589	60	33	7	Sandstone, 50; quartzite, 40....	Angular.....	1·3	Said to cover 20,000 square yards. Pit has an average depth of 6 feet and reaches sand in places.	4,200
598	27	53	20	Slate and shale, 55; sandstone, 20; quartzite, 20.	Angular and flat..	0·6	Steep knoll over 5 times size of pit. Pit does not reach bottom at maximum depth of 20 feet.	3,600
601	10	70	20	Slate, 75.....	Flat and angular..	0·5	At least 23,000 square yards. Pit averages 5 feet in depth, which is close to average depth of deposit.	2,600
602	27	55	18	Sandstone, 50; quartzite, 20; slate, 15.	Angular.....	0·5	Unknown, but probably large. Covered with at least 4 feet of sand. Pit has a maximum depth of over 20 feet.	100,000
603	5	75	20	Slate, 65; sandstone, 30.....	.....	1·6	Said to cover several acres, from fence-post indications. Two test pits, 5 and 8 feet deep, through gravel. Deposit flat-lying and probably shallow.	Small.
609	45	43	12	Quartzite, 30; trap, 30; slate, 20	Angular to sub-angular.	0·6	Ridge or horseback runs for over a mile, but said to be sand in places. Maximum depth of pit under ridge crest 18 feet.	4,900

614	45	40	15	Slate and schist, 45; quartzite, 20; trap, 15.	Angular	1·2	Ridge averages 7 feet in depth and is about half worked out. Another ridge of same size is thought to be gravel.	5,300
619	50	47	3	Slate, 35; quartzite, 30; sandstone, 25.	Angular	0·6	About 7 acres said to be available. Pit reaches clay at maximum depth of 16 feet. Gravel covered with at least 3 feet of sand.	10,000
623	55	33	12	Quartzite and sandstone, 75; slate, 20.	.....	0·1	Large. Pit reaches sand at maximum depth of 35 feet.	Large
626	25	30	45	Slate, 45; quartzite, 35.....	Angular	0·8	Gravel common for several miles southwest but all small and shallow deposits.	1,000
633	70	20	10	Quartzite and sandstone, 75; slate, 15.	Angular	1·9	About 5 times size of pit, possibly much more. Pit is said to reach drift at maximum depth of 8 feet.	1,500
637	57	30	13	Quartzite, 65; sandstone 25....	Subangular	0·8	Unknown but apparently large. Pit reaches drift at maximum depth of 15 feet.	10,800 Also other pits.
638	85	15	0	Quartzite, 50; sandstone, 50....	Subangular	0·6	Apparently large. Pit reaches drift at maximum depth of 13 feet.	12,100
640	40	57	3	Quartzite, 45; slate, 35.....	Angular and some flat.	0·5	Over 20 acres and average depth of 9 feet, according to road patrolman's estimate.	3,300
641	.....	.....	.....	.....	.....	1·0	Pit shows almost solely sand, of which there is a large amount; surface of deposit gravelly in places.	600
646	65	35	0	Quartzite, 55; slate (some calcareous), 20.	Angular	0·6	High bluff. Large side-hill pit has a face 75 feet high.	Over 500,000
649	60	37	3	Quartzite, 45; sandstone, 40....	Angular	0·2	Road patrolman's estimate is about 2 acres. Pit reaches sand at maximum depth of 10 feet.	2,500
650	52	33	15	Quartzose and slaty metamorphic rocks..	.....	0·5	Large, but probably mostly sand. Pit bottom is sandy gravel and sand.	Over 250,000
652	25	70	5	Slaty limestone, slate and schist, 70.	Angular and some flat.	1·2	Large horseback, several hundred thousand cubic yards in size.	3,900
655	30	60	10	Quartzite and sandstone, 50; slate or shale and limestone, 45.	Angular to subangular.	2·1	Large horseback over one mile in length. At maximum depth of 25 feet pit does not reach bottom of deposit.	6,200

TABLE I—Continued

Results of Tests on Gravels—Continued

Sample No.	Character of material						Extent of deposit	Size of pit, cubic yards
	Composition of pebbles				Shape of pebbles	Per cent of silt and clay		
	Durable	Intermediate	Soft	Type of stone, per cent				
658	40	45	15	Quartzite and quartzose schist 75; slate, 15.	Angular and flat...	0·9	Over 65,000 cubic yards. Pit reaches sand and clay at maximum depth of 40 feet.	40,000
659	33	50	17	Sandstone, 45; quartzite, 30; slate, 20.	Angular.....	0·9	As much as taken out. Average depth is 11 feet. Larger deposit along lakeshore in village is partly built over.	23,300
660	17	63	20	Slate, 70; sandstone and metamorphic, 20.	Angular.....	1·2	Unknown but probably large. Deposit in high, steep bluff facing lake. Pit bank up to 45 feet in height.	10,300
662	5	70	25	Slate, 85.....	Flat and subangular.	1·2	Deposit half exhausted. Pit reaches drift at maximum depth of 20 feet. Several other deposits around village.	3,000
664	5	85	10	Slate, 80; sandstone, 15.....	Flat.....	0·5	Bluff parallels river for miles and is gravelly at many places. Amount of gravel practically unlimited. Pit bank up to 18 feet in height.	11,200
669	40	43	17	Quartzite and sandstone, 70; slate, 25.	Angular.....	0·5	Gravel ridge covers 25,000 square yards. Pit has a maximum depth of 9 feet under ridge crest and does not reach bottom of deposit.	1,400
670	65	35	0	Quartzite, 35; slate, 30; sandstone, 30.	Angular to subangular.	0·6	Covers 25,000 square yards. Pit reaches fine sand and clay at average depth of 10 feet.	19,000
671	35	62	3	Slate, 45; quartzite, 30; sandstone, 25.	Angular to subangular.	0·8	Gravel knolls common for 3 miles northeast including No. 673 and others. Pit does not reach bottom of deposit at maximum depth of 15 feet.	1,700

673	50	47	3	Quartzite, 35; slate, 35; sandstone, 25.	Angular to subangular.	0·6	*See* No. 671. Pit reaches sand or very fine gravel at maximum depth of 25 feet.	1,800
675	3	95	2	Slate, 90.....	Flat and some angular.	0·2	Over 10 times size of pit. Pit has an average depth of 6 feet and reaches close to bottom of deposit.	2,100
678	70	30	0	Quartzite, 60; sandstone, 30....	.....	0·7	Extent unknown. Looks like pocket of gravel in drift. Thickness of gravel varies; maximum is 30 feet.	7,900
680	40	42	18	Quartzite, 35; sandstone, 25; slate, 20.	Angular.....	1·3	Ridge 50,000 cubic yards in size and 75 feet in height may be only part gravel. Pit has a maximum depth of over 20 feet. Overburden 1 to 2½ feet of clayey sand.	1,700
681	45	35	20	Quartzite, 40; sandstone, 35; slate, 20.	Angular to subangular.	1·2	Pit does not reach bottom of deposit at maximum depth of 9 feet. Ridge 25,000 cubic yards in size and 15 feet in height.	1,200
684	27	67	6	Slaty quartzite and quartzose slate, 80.	Sharply angular and some flat.	10·0	Large amount of boulder clay; gravel scarce.	2,300
685	65	15	20	Quartzite, some slaty, 55; sandstone, 35.	Angular.....	0·7	Deposit said by owner to cover over 4 acres. Pit averages 7 feet in depth and does not quite reach bottom of deposit.	2,700
686	55	27	18	Quartzite, 45; sandstone, 40....	Subangular.....	1·1	Large gravel terrace. Deposit 10 feet in depth.	Over 2,000
687	75	25	0	Quartzite and sandstone, 80....	.....	0·2	As much as taken out. Pit reaches clay at maximum depth of 22 feet.	Over 500,000
687a	70	27	3			0·6		
688	60	20	20	Quartzite and sandstone, 70; slate, 15.	Angular.....	1·6	Gravel ridge covers 12,000 square yards. Deposit averages 9 feet in depth.	6,500
688a	73	27	0			4·8		
689	58	30	12	Quartzite and felsite, 70; schist and slate, 15.	.....	0·7	Several acres, according to road patrolman. Pit averages 4 feet in depth. Coarser gravel below pit bottom.	2,300
690	30	60	10	Quartzite, 50; slate, 30; limestone, 20.	Angular.....	0·9	Covers 3 acres. Pit has maximum depth of 20 feet and is said not to reach bottom of deposit.	4,100
691	50	33	17	Quartzite, 60; sandstone, 30; slate, 10.	Flat and angular...	0·1	Unknown, but deposit apparently covers several acres. Pit reaches clay at maximum depth of 8 feet.	Over 3,600

TABLE I—Continued

Results of Tests on Gravels—Continued

Sample No.	Character of material						Extent of deposit	Size of pit, cubic yards
	Composition of pebbles				Shape of pebbles	Per cent of silt and clay		
	Durable	Intermediate	Soft	Type of stone, per cent				
693	80	15	5	Quartzite, 70; sandstone, 20....	Sharply angular and flat.	0·5	Covers at least 10,000 square yards. Pit reaches close to bottom of deposit at maximum depth of 6 feet.	2,300
697	25	63	12	Shaly sandstone and siliceous shale or slate, 70.	Subangular.....	0·7	Pit in one of several similar knolls. Extent unknown, and maximum depth 6 feet.	1,100
701	40	50	10	Slate and limestone, 55; quartzite and sandstone, 45.	Subangular.....	0·5	Brook bank gravelly for several hundred yards. Pit does not reach bottom of deposit at maximum depth of 10 feet. Overburden at least 2 feet of fine sand.	1,400
702	40	55	5	Slate and shale, 55; slaty quartzite, 30.	Angular.....	1·0	Pit has an average depth of 7 feet and does not reach bottom of deposit. Gravelly for several miles, but gravel generally shallow. Overburden 2 feet of coarse sand.	500
705	45	43	12	Quartzite and igneous, 40; shale, 30.	Subangular.....	0·5	Unknown, but probably large.	Over 300,000
705a	45	35	20			1·2	Pit not dug to bottom of deposit because hard to drain. Pit covers over 100,000 square yards and averages 10 feet in depth.	
708	21	70	9	Slate, 40; limestone, 35.....	Flat.....	0·7	Unknown. Pit reaches clay at maximum depth of 12 feet. Other similar deposits in vicinity, according to road patrolman.	1,500
709	5	50	45	Sandstone, 65; slate and shale, 30.	Subangular.....	1·4	Deposit in high, steep bluff, probably continuous with No. 713,	Over 20,000

709a	10	90	0	Slate, shale and schist, 50; limestone, 40.		2·1	200 yards away. Pit reaches clay or drift at maximum depth of 20 feet.	
710	25	35	42	Sandstone, shaly sandstone and quartzite, 90.	Subangular.....	1·3	At least 10 times size of pit; thickness averages 9 feet, including an overburden of 2·5 to 3 feet of clay.	800
713	45	40	15	Sandstone and quartzite, 60; shale, 25.	Subangular.....	1·3	Gravelly bluff, over 40 feet in height, with pit in upper 12 feet. Deposit probably continuous with No. 709, 200 yards away.	900
713a	9	82	9	Limestone, 45; slate and shale, 30.		2·0		
719	5	85	10	Siliceous and shaly limestone, 75.	Angular to subangular.	0·4	Low gravel terrace covers 7,500 square yards and averages 7 feet in thickness, including 3 feet of fine sand as overburden.	6,200
721	5	85	10	Slate or shale, 75; limestone, 20.	Flat and angular..	0·8	Lake shore gravelly for several miles. Pit bottom is a few feet above lake level and 20 feet below surface of deposit.	4,300
722	0	100	0	Hard siliceous and shaly limestone, 95.	Sharply angular...		Deposit forms knoll at least 5 times size of pit. Pit does not reach bottom of deposit at maximum depth of 18 feet. Several other knolls around are probably gravel.	1,600
724	0	85	15	Limestone, 55; slate or shale, 40.	Angular.....	2·2	At least 50,000 cubic yards. Pit reaches boulder clay at depth of 18 feet.	2,100
725	3	87	10	Limestone, more or less shaly, 95.	Angular.....	1·8	Deposit in steep bluff, Amount probably large. The thickness of gravel which is 30 feet at the edge of the bluff, gradually decreases inwards.	8,300
729	0	60	40	Slate or shale and limestone, 80.	Flat and subangular.	1·4	Deposit in low river bank and probably extends over several acres. Thickness above water-level is over 20 feet.	4,700
733	35	65	0	Limestone, 55; trap and felsite, 25.	Subangular.....	0·9	Deposit in low river bank and said to extend at least 200 yards inland. Thickness above water-level 16 feet.	70
735	80	15	5	Trap and some felsite, 95.....	Sharply angular..	2·3	Unknown. Looks like partly sorted drift, particularly at depth.	2,000

TABLE I—Concluded

Results of Tests on Gravels—Concluded

Sample No.	Character of material						Extent of deposit	Size of pit, cubic yards
	Composition of pebbles				Shape of pebbles	Per cent of silt and clay		
	Durable	Intermediate	Soft	Type of stone, per cent				
736	80	20	0	Felsite and some trap, 90.....	Angular to rounded.	2·3	The deposit is many times the size of the pit and is probably sandy throughout. Pit, dug irregularly from 5 to 15 feet in depth, does not reach bottom of deposit.	7,200
737	95	5	0	Felsite, 50; trap, 30.....	Angular to rounded.	2·3	Amount in ridge 25,000 cubic yards and depth 12 feet.	Over 50,000
737a	95	5	0			0·8	Amount in bluff unknown but said to be large. Nos. 737 and 739 are part of large gravel area several miles in length but depth generally shallow.	
739	85	12	3	Felsite and some trap, 90.....	Angular to rounded.	2·7	*See* No. 737. Pit No. 739 reaches clay at an average depth of 6 feet.	1,200
740	33	47	20	Sandstone, 40; slate or shale, 40.	Subangular.....	2·2	Probably 6 acres. Gravel grades into sand at average depth of 7 feet.	6,500
747	10	70	20	Limestone, 35; shale, 35.....	Angular to subangular.	1·1	Knoll of gravel 10 times size of pit at the least. Pit probably reaches bottom of deposit at maximum depth of 17 feet. Upper 2 to 3 feet much weathered.	3,100
751	35	65	0	Limestone, 35; slate, 25; trap, 15.	Subangular.....	0·5	One end of deposit alone covers 10,000 square yards according to road patrolman. Maximum depth of gravel 17 feet. River banks gravelly for several miles.	7,000 Other pits.
753	10	90	0	Limestone, 70; sandstone, 20..	Subangular.....	0·9	Deposit forms terrace or series of knolls with steep south slope;	460

							traced for over 400 yards. Pit reaches clay at maximum depth of 12 feet.	
761	0	90	10	Limestone, more or less shaly, 100.	Subangular.....	1·9	Unknown. Deposit averages 11 feet in depth and is underlain by drift and bedrock. Upper 2 to 4 feet is weathered and soft.	60,000
762	85	10	5	Chert or felsite, 50; quartz, 45.	Angular.....	3·1	Probably small. Deposit underlain by muck at an average depth of 3 feet.	9,000
763	95	5	0	Chert with probably some felsite, 85.	Subangular.....	0·0	Bar 4 miles long holds millions of cubic yards of gravel.	Sea beach.
766	5	80	15	Sandstone, 50; limestone, 35...	Angular and rounded.	1·1	Unknown, but probably at least 10 times size of pit. Pit reaches close to bottom of deposit at maximum depth of 9 feet.	1,100
767	0	70	30	Sandstone, 100.....	.....	1·1	Covers 8 acres, according to owner. Gravel looks like partly sorted drift, varies much in thickness (maximum 16 feet), and is in places thickly covered with silt (up to 10 feet).	6,900

TABLE II

Results of Tests on Gravels

Sample No.	Proportion of pebble to sand.		Granulometric Analysis														Remarks
			Pebbles							Sand						Per cent passing 200 mesh	
			Per cent retained on screens							Per cent retained on sieves							
	Per cent pebble	Per cent sand	2½″	2″	1½″	1″	¾″	½″	¼″	8	14	28	48	100	200		
1	64	36	8	6	13	30	14	11	18	38	10	10	17	16	4	5	Sample No. 1 is of average coarseness, No. 1a finer than average. Gravel is hard, fresh, coarse, and bouldery. Good road material if crushed.
1a	39	61	0	0	2	12	13	29	44	25	24	21	15	8	4	3	
5	59	41	0	0	16	32	16	16	21	22	13	23	32	8	1	1	Partly weathered, but fairly hard and well graded. Packs readily.
7	65	35	0	0	0	19	14	23	44	53	14	7	13	10	2	1	Sample finer than average. Coarseness varies with layers. Gravel is fresh and well graded. Wears well and evenly under moderate traffic.
8	27	73	0	0	3	9	13	28	47	17	20	27	27	8	1	0	Hard and clean gravel; too fine and sandy.
12	29	71	0	0	0	0	3	12	85	42	17	14	19	6	1	1	Hard and clean gravel; too fine and sandy. Makes smooth, sand-clay type of surface on roads of light traffic.
13	39	61	0	0	2	14	11	30	43	17	13	21	33	13	2	1	Sample coarser than average. Too fine and sandy. Coarser gravel has been satisfactory under light traffic.
15	19	81	0	0	0	0	7	25	68	17	21	28	25	6	2	1	Fresh and hard gravel; too fine and sandy.
16	65	35	0	4	22	21	13	19	21	14	16	23	24	13	5	5	Fresh, hard, coarse and bouldery. Gravel holds 15 per cent boulders and needs crushing.
20	33	67	0	5	5	20	10	20	40	25	33	23	11	4	2	2	Sample coarser than average. Too fine and sandy
21	72	28	0	4	12	17	12	20	35	41	11	9	10	8	10	11	Sample No. 21 is of coarse gravel; No. 21a of fine gravel; No. 21b of sand. Coarseness of gravel varies in a gradual way. Fresh, hard, well graded road gravel. Deposit also holds clean sand.
21a	26	74	0	0	0	9	7	19	65	29	26	22	16	5	1	1	
21b	0	100	0	0	0	0	0	0	0	2	5	22	48	20	3	0	
22	55	45	0	11	12	25	10	16	26	31	26	20	13	6	2	2	Hard, well graded, coarse gravel, holding 10 per cent boulders. Pit recently opened (1929). Gravel packs readily under light traffic and is worth crushing.
23	74	26	0	0	0	3	16	46	35	20	4	4	33	26	6	7	Poorly graded, owing to low proportion of coarse sand. Hard gravel.

27	58	42	0	5	8	18	11	23	35	36	20	17	14	7	3	3	Sample No. 27 is of weathered gravel of average coarseness; No. 27a of fresh gravelly sand. Gravel well graded and uniform in coarseness, but weathered and soft in the upper 10 feet. Good where not too weathered.
27a	10	90	0	0	0	5	0	15	80	18	24	30	18	7	2	1	
31	54	46	6	0	5	15	10	25	39	32	19	18	17	10	13	1	Sample coarser than average. Coarseness, grading, and percentage of sand vary with layers. Good where not too sandy.
38	43	57	0	0	0	12	15	27	46	29	14	11	24	17	3	2	Well graded, partly weathered and rather soft. Packs readily and wears well under light traffic.
39	37	63	0	0	0	14	17	28	41	19	19	34	15	10	2	1	Sample coarser than average. Too fine and sandy.
41	20	80	0	0	9	20	7	21	43	17	26	36	17	3	1	0	Fresh gravelly sand. Too fine for roads, but probably makes a suitable aggregate for concrete.
43	23	77	0	8	20	18	6	16	32	17	26	36	16	3	1	1	Gravel too sandy for roads, but better than other local gravels.
44	39	61	0	15	5	18	15	17	30	22	30	31	12	3	1	1	Deposit holds streaks of good road gravel, but the material as a whole is too sandy. Good road stretches have been built with the coarser and less sandy gravel.
44a	15	85	28	0	26	12	0	10	24	16	33	33	13	3	1	1	
45	46	54	0	0	6	15	12	28	39	27	25	28	14	4	1	1	Fresh, hard, coarse and rather sandy gravel holding 5 per cent boulders. Withstands well the wear of heavy traffic.
53	43	57	0	6	15	18	8	15	38	34	29	21	9	4	2	1	Partly weathered, rather sandy and well graded gravel. Packs readily and wears well under light traffic.
53a	41	59	0	9	12	23	9	16	31	25	32	31	8	2	1	1	
55	17	83	0	0	0	7	9	24	60	18	20	27	23	9	2	1	Sandy gravel of uniform coarseness and grading. Makes smooth road under light traffic, but is too sandy.
61	56	44	15	20	18	12	9	12	14	16	22	34	20	5	2	1	Coarseness varies in a gradual way and decreases with depth. Satisfactory under heavy traffic.
61a	42	58	17	7	20	17	9	11	19	14	21	39	18	5	2	1	
61b	18	82	0	0	5	12	7	12	64	29	30	24	12	3	1	1	Fresh material suitable as concrete aggregate.
71	40	60	0	12	20	17	9	13	29	25	19	23	23	7	2	1	Sample more sandy than average. Gravel varies gradually from bouldery and coarse to fine, and is fresh and hard. The coarser gravel, with the oversize screened out, makes a good road material.
73	64	36	0	2	2	10	13	26	47	62	14	6	6	6	3	3	Sample less clayey than average. Fresh, hard, clayey gravel of medium coarseness. Packs firmly and wears well under heavy traffic.
76	50	50	4	3	5	11	13	19	45	41	26	16	8	5	2	2	Sample No. 76 is of coarse gravel, No. 76a of medium-fine gravel. Partly weathered, fairly hard, well graded gravel. Coarseness varies in a gradual way.
76a	36	64	0	0	12	6	5	21	56	40	29	17	8	4	1	1	

TABLE II—Continued

Results of Tests on Gravels—Continued

Sample No.	Proportion of pebble to sand.		Granulometric Analysis														Remarks
			Pebbles							Sand						Per cent passing 200 mesh	
			Per cent retained on screens							Per cent retained on sieves							
	Per cent pebble	Per cent sand	2½″	2″	1½″	1″	¾″	½″	¼″	8	14	28	48	100	200		
78	30	70	0	6	4	9	6	18	57	41	34	15	5	3	1	1	Uniformly well graded, but too fine and sandy. Gravel more or less weathered and soft to a depth of at least 15 feet.
79	81	19	0	5	13	24	15	22	21	25	15	14	14	14	10	8	Sample No. 79 is of coarse gravel; No. 79a of gravelly sand from pit bottom. Partly weathered, fairly hard, coarse and bouldery gravel. Needs crushing. Upper 3 feet intensely weathered and worthless.
79a	5	95	0	0	0	3	5	10	81	19	33	27	15	4	1	1	
80	37	63	0	0	9	16	12	22	41	27	24	19	17	9	3	1	Sample No. 80 is of fresher gravel than No. 80a; both are of average coarseness. Coarseness and grading vary with layers. There are streaks of good road gravel, but the material is on the whole too sandy.
80a	26	74	0	0	0	12	7	26	55	25	25	22	15	8	3	2	
81	34	66	0	6	2	15	11	27	39	23	22	19	19	12	4	1	Sand deposit holds gravelly streaks. More suitable for mortar and concrete than for roads. Sample No. 81 is from the coarser part.
82	65	35	0	0	9	12	20	27	29	22	15	16	17	12	8	10	Hard, coarse and bouldery gravel, holding 10 per cent boulders. Needs crushing. Sample No. 82 is from finer and better graded gravel than average.
83	20	80	0	12	0	10	11	17	50	18	22	25	15	15	4	1	Uniform in coarseness and grading, but too sandy.
85	35	65	0	7	5	17	7	13	51	40	31	16	8	3	1	1	Sample more sandy and probably less fresh than average. Pebble size varies with layers, but grading fairly uniform. Gravel has given good service under light traffic.
86	43	57	0	0	3	10	13	20	54	45	27	13	7	5	2	1	Somewhat sandy, but well graded and uniform in coarseness and grading.
88	38	62	0	10	13	14	10	17	36	25	22	19	17	13	3	1	Sample is of better graded gravel than average. The gravel is fresh and coarse, but rather poorly graded, owing to too much fine sand.
90	33	67	0	0	8	16	0	19	48	24	24	23	18	9	1	1	Sample less sandy than average. Well graded but too sandy. Has given good results on roads of light traffic.

92	45	55	0	0	24	21	14	17	24	21	23	25	22	7	1	1	Coarseness varies gradually throughout deposit, but grading fairly uniform.
98	16	84	0	0	0	0	8	14	78	34	33	23	4	2	2	2	Hard and well graded, but too sandy.
101	55	45	0	5	16	24	14	16	25	28	22	24	17	6	2	1	Sample coarser than average. Rusty, hard, well graded gravel. Coarseness varies in a gradual way. Packs and binds well under light traffic.
109	59	41	0	16	21	21	10	14	18	21	18	23	24	8	3	3	Fresh, hard, bouldery and coarse gravel, holding 10 per cent boulders. Fairly well graded, though low in small pebbles and coarse sand. Would be improved if crushed.
111	41	59	0	0	0	8	19	30	43	25	17	22	15	9	7	5	Hard, well graded, sandy gravel. Good where not too sandy.
113	49	51	0	0	7	23	20	23	27	29	25	24	16	4	1	1	Sample represents coarser part. Fresh, hard, well graded gravel, carrying from 50 to 75 per cent sand. Good where not too sandy.
115	33	67	0	0	0	26	22	22	30	20	16	21	34	8	1	0	Fresh, hard and well graded, but too sandy.
116	65	35	0	6	3	11	11	22	47	59	21	9	6	3	1	1	Fresh and hard gravel; varies in coarseness and grading with layers. Sample is of better gravel than average.
119	23	77	0	0	0	5	3	14	78	31	32	25	10	2	0	0	Hard and fine gravel, carrying at least 75 per cent sand. Sample represents the coarser and less sandy part. Too fine and sandy.
125	55	45	0	0	2	4	4	29	61	73	24	1	1	0	0	1	Sample represents the coarser and less sandy part. Hard, well graded, fine gravel, carrying 75 per cent sand. Although high in sand, it makes firm and durable roads, owing to the hardness of the gravel and the grading of the sand, which is nearly all very coarse.
126	35	65	0	0	8	13	12	20	47	29	38	11	9	9	3	1	Fresh, hard, well graded, medium-fine gravel. Good road gravel, though not so well graded as No. 125.
127	58	42	0	0	0	5	5	20	70	63	29	2	1	1	1	2	Sample 127 of medium-coarse gravel; No. 127a of fine gravel. Composition, hardness and grading are the same as No. 125, and road-making quality better, because the gravel is on the average coarser than No. 125.
127a	29	71	0	0	0	3	4	13	80	55	38	3	1	1	1	1	
128	38	62	7	11	3	16	8	19	36	23	16	17	26	13	3	2	Sample No. 128 of coarse, sandy gravel; No. 128a of fine sand. Fresh and hard but poorly graded, owing to too much fine sand. Some streaks show good concrete gravel and sand.
128a	0	100	0	0	0	0	0	0	0	0	0	0	6	55	28	11	
132	27	73	0	0	5	13	16	23	43	20	21	25	25	7	1	1	Hard and well graded but too sandy.
134	23	77	0	9	22	13	10	13	33	29	44	18	5	2	1	1	Hard and well graded but too sandy.

TABLE II—Continued

Results of Tests on Gravels—Continued

Sample No.	Proportion of pebble to sand.		Granulometric Analysis														Remarks
			Pebbles							Sand						Per cent passing 200 mesh	
	Per cent pebble	Per cent sand	Per cent retained on screens							Per cent retained on sieves							
			2½″	2″	1½″	1″	¾″	½″	¼″	8	14	28	48	100	200		
135	47	53	0	0	0	1	6	38	55	33	34	18	14	1	0	0	Sample less sandy than average. Hard, well graded, fine and sandy gravel. Although sandy, it withstands well the wear of heavy traffic owing to the hardness of the gravel and the coarseness of the sand.
139	43	57	0	0	0	1	7	22	70	54	29	5	2	3	4	3	Sample No. 139a is of fresher gravel than No. 139; both are of average coarseness. Hard, well graded, fine and rather sandy gravel. Good road material.
139a	35	65	0	0	3	1	6	25	65	40	28	14	10	6	1	1	
147	63	37	0	0	5	22	16	22	35	27	5	23	32	9	2	2	Coarseness, grading and proportion of sand vary irregularly from place to place. Generally hard, coarse and poorly graded. Would be much improved by crushing.
153	60	40	0	0	0	9	20	32	39	26	10	11	16	18	16	3	Sample No. 153 of medium coarse gravel; No. 153a of sand. Coarser gravel is suitable for roads. Deposit carries almost exclusively sand.
153a	4	96	0	0	0	0	6	21	73	7	10	26	29	13	12	3	
157	11	89	0	11	0	10	15	18	46	11	14	16	28	21	7	2	Too sandy.
159	27	73	0	6	4	19	10	16	45	24	22	25	21	6	1	1	Uniformly well graded but too sandy. Better graded for road purposes than other local gravels.
159a	31	69	0	0	0	19	9	22	50	25	23	26	17	7	1	1	
162	27	73	0	27	9	21	10	12	21	8	12	23	37	16	3	1	Too sandy.
163	29	71	0	9	10	22	10	14	35	21	29	32	14	3	1	0	Too sandy.
166	70	30	0	0	10	22	20	24	24	42	24	14	9	8	2	1	Sample No. 166 represents coarser part; No. 166a finer part. Fresh, hard, well graded coarse gravel, sandy in depth. Good and durable on roads of light to moderate traffic.
166a	40	60	0	0	6	14	11	19	50	45	28	12	7	4	2	2	

167	38	62	0	0	2	5	7	19	67	42	23	16	13	4	1	1	Sample more sandy than average. Has the same character and quality as No. 166; somewhat more uniform in coarseness and grading than No. 166.
168	45	55	0	8	5	15	14	21	37	29	31	27	9	2	1	1	More or less weathered and soft but well graded. Gives good results on roads of small traffic.
172	33	67	0	14	9	15	14	16	32	19	18	19	18	18	6	2	Fresh and hard gravel, or partly sorted drift. Coarseness and grading vary from place to place. Packs readily and firmly.
178	60	40	0	7	12	16	17	18	30	39	30	19	7	3	1	1	Sample No. 178 is of average coarseness; No. 178a
178a	26	74	0	0	0	10	16	35	39	18	22	37	17	5	1	0	of fine gravel (upper bank). Partly weathered fairly hard, uniformly well graded gravel. Upper bank sandy in places. Does not pack readily but is durable under small traffic.
179	66	34	0	13	20	21	10	15	21	33	23	17	13	9	3	2	Sample represents coarser part. Hard, coarse gravel; well graded once oversize is screened out.
183	45	55	0	0	11	23	8	22	36	28	24	26	16	4	1	1	Sample No. 183 is of partly weathered gravel
183a	52	48	0	0	0	13	20	33	34	31	25	22	12	4	4	2	from upper bank; No. 183a of fresh gravel at depth of over 20 feet. Hard, uniformly well graded, medium-coarse gravel. Makes smooth and firm road under moderate to heavy traffic.
186	54	46	0	0	0	19	23	29	29	23	14	23	30	9	1	0	Clean, hard, coarse and fairly well graded gravel from river flat. Turns quite sandy under 1 to 2 feet. Good where not too sandy.
193	56	44	0	0	8	22	19	26	25	25	17	22	22	10	2	2	Rusty, hard, uniformly well graded, coarse gravel. Better graded and less sandy than other local gravels. Packs and binds firmly under light traffic.
206	73	27	4	11	14	19	10	19	23	38	24	15	8	5	4	6	Coarse and rather soft gravel holding 10 per cent boulders. All boulders of small size. With coarser material screened out, makes a well graded, good surfacing gravel of moderate durability.
210	45	55	0	4	0	9	7	14	66	58	26	6	2	2	2	4	Fresh, rather soft, well-graded, fine gravel. It is the best road material available locally and makes a smooth surface.
211	34	66	0	0	5	6	9	20	60	47	26	7	6	4	3	7	Fresh, fine, sandy and well-graded gravel. Gives good results under small traffic.
213	61	39	0	9	8	24	16	18	25	42	30	13	4	2	2	7	Weathered, soft, coarse gravel holding 10 per cent boulders. With coarser material screened out, is well graded, but makes dusty road surface.
214	18	82	0	33	12	13	7	10	19	6	32	46	7	2	2	5	Very little used now; too sandy. Coarser gravel looks about exhausted. Sample finer but more regularly graded than average.

TABLE II—Continued

Results of Tests on Gravels—Continued

Sample No.	Proportion of pebble to sand.		Granulometric Analysis													Remarks
			Pebbles							Sand						
	Per cent pebble	Per cent sand	Per cent retained on screens							Per cent retained on sieves						
			2½″	2″	1½″	1″	¾″	½″	¼″	8	14	28	48	100	200	
216	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Very coarse and bouldery glacial drift (boulders 33 per cent). Crushed for road purposes because no gravel available. Samples of crushed material show lower proportion of soft than pit bank.
216a	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
218	55	45	0	0	15	14	11	19	41	39	11	3	17	17	6	7	Fine gravel, sandy in places. Good, though rather dusty. Sample No. 218 of weathered gravel; No. 218a of fresh gravel.
218a	36	64	0	0	0	8	6	16	70	55	12	1	12	15	3	2	
223	42	58	0	0	0	3	4	6	87	60	22	5	3	3	2	5	Fine, well graded gravel, with about 50 per cent coarse sand, and very little weathered material. Makes hard and smooth road. Sample No. 223 average as to coarseness; No. 223a coarser than average.
223a	63	37	0	0	2	6	8	20	64	61	14	7	6	4	3	5	
226	37	63	0	8	9	22	11	18	32	22	47	22	2	2	2	3	Well graded and comparatively free from weathered material, but rather sandy. Much used on roads with good results. Samples Nos. 226 and 226a from average-size gravel; No. 226b is from better graded, less sandy gravel than average, found only in north edge of deposit.
226a	40	60	0	2	2	16	9	23	48	29	20	42	4	2	1	2	
226b	68	32	0	0	0	5	16	27	52	61	10	9	6	5	4	5	
229	93	7	3	7	15	24	12	19	20	23	16	13	14	12	8	14	Generally coarse and bouldery, with low proportion of sand; streaks of finer gravel. The finer gravel makes a hard, smooth surface. Sample No. 229 coarser and less sandy; No. 229a finer and more sandy than average.
229a	70	30	0	5	8	19	10	17	41	39	18	19	8	4	4	8	
231	58	42	0	12	7	25	13	19	24	19	9	10	53	7	1	1	Low proportion of small pebbles and coarse sand. Does not compact readily on road on account of too much fine sand. Sample represents average as to coarseness and freshness.
232	60	40	12	18	11	22	9	12	16	26	24	25	16	5	2	2	Fairly well graded, with rather high proportion of weathered pebbles. Makes smooth but dusty road surface.
235	73	27	0	18	22	20	12	14	14	19	13	16	26	10	5	11	Glacial drift carries enough pebbles to make a fair road surface. Very little used.

237	37	63	0	7	15	16	13	19	30	13	9	15	42	17	3	1	Carries much fine sand and rather high proportion of weathered pebbles. Makes hard, smooth but dusty road surface.
240	71	29	5	7	27	17	10	13	21	48	23	9	5	4	3	8	Sand much used on clay roads because it compacts readily to a hard, smooth surface. Wears fast. Sample No. 240 from streak of coarse gravel, No. 240a from sand.
240a	0	100	0	0	0	0	0	0	0	0	0	22	63	11	2	2	
242	42	58	31	5	9	16	8	12	19	15	21	44	14	3	1	2	Pit bank 2,300 feet in length. Coarseness of gravel varies in a regular way; coarse and somewhat bouldery underneath the top of the hill, fine and sandy in the lower slope, at pit entrance. Sample taken 700 feet from hill top, at depth of 11 feet. A large proportion of the bank shows good road gravel.
244	49	51	0	0	3	11	20	23	43	36	27	19	7	5	2	4	Well graded, but too fine and sandy; averages 75 per cent sand. Sample is from coarsest part. Gives good results on clay roads.
245	37	63	0	4	0	27	15	20	34	32	25	21	10	4	3	5	Well graded but fine and sandy; averages 75 per cent sand. Sample coarser than average. Good on clay roads, although dusty.
248	41	59	0	0	3	17	16	23	41	21	16	17	32	9	2	3	Gravel carries rather fine sand. Makes a smooth but dusty road surface.
251	88	12	4	5	28	25	12	12	14	50	14	8	5	5	5	13	Coarse gravel, with less than 25 per cent sand; sample less sandy than average. Crushed gravel makes smooth but dusty road.
255	35	65	0	0	17	16	13	19	35	18	14	22	37	5	2	2	Gravel weathered and soft. Compacts readily on road but wears fast.
257	41	59	0	0	7	14	13	26	40	23	16	18	28	12	1	2	Fresh, fairly well graded gravel, but a little fine. Makes hard, smooth and durable road surface.
258	40	60	0	3	7	18	14	19	39	26	22	20	18	9	2	3	Same as No. 257 except that grading is more uniform.
259	69	31	0	6	16	21	11	18	28	39	23	16	11	6	2	3	Coarse, sandy, poorly graded, weathered, soft and dusty. Wears fast on road. Part of deposit, under 3 feet of overburden, holds fresher, finer, and less sandy gravel than average. Sample is from fresher part, which is used only for concrete works.
262	23	77	0	0	0	16	12	18	54	20	18	21	24	12	2	3	Soft and sandy. Sample from coarser and fresher part, near bottom of deposit.
263	70	30	11	8	15	22	12	16	16	35	26	19	10	4	2	4	Coarse and bouldery, low in sand, sample from finer than average. Compacts readily to a hard, though somewhat rough surface. Good for foundation course.
265	35	65	3	0	7	17	14	24	35	13	8	15	45	16	1	2	Soft with much fine sand; sample coarser and less sandy than average. Wears fast on road and is dusty, but is the best available for miles.

TABLE II—Continued

Results of Tests on Gravels—Continued

Sample No.	Proportion of pebble to sand.		Granulometric Analysis														Remarks
			Pebbles							Sand						Per cent passing 200 mesh	
	Per cent pebble	Per cent sand	Per cent retained on screens							Per cent retained on sieves							
			2½″	2″	1½″	1″	¾″	½″	¼″	8	14	28	48	100	200		
268	29	71	0	0	5	16	12	25	42	18	16	20	36	8	1	1	Soft and sandy; sample less sandy than average. Does not compact readily.
269	33	67	22	7	8	8	11	16	28	16	12	19	36	13	3	1	Varies much in coarseness. Sample, taken from deep in the bank, is fresher than average. Gravel of suitable coarseness for roads found only in places.
270	56	44	0	7	6	29	15	17	26	27	14	13	27	15	3	1	Coarse and sandy; one large section of pit bank shows fine gravel carrying up to 75 per cent sand and is probably the edge of the deposit. Good road gravel, though somewhat sandy. Both samples less sandy than average.
270a	48	52	0	4	6	8	7	16	59	33	14	9	30	11	1	2	
275	52	48	3	6	8	18	15	19	31	28	28	24	11	4	2	3	Well graded, but weathered, dirty and soft.
275a	33	67	0	0	4	8	13	20	55	33	33	19	8	4	1	2	On roads, has a strong binding power, but wears fast. Sample pebbles had a percentage of wear of 32·2 (Grading A) in the abrasion test.
276	65	35	0	3	9	20	12	21	35	52	27	7	4	3	2	5	Fine gravel carrying 50 per cent coarse sand; sample represents coarsest part. Rather soft and sandy, but makes firm, smooth road.
277	50	50	0	5	14	17	9	16	39	42	28	16	5	2	2	5	Well graded, but partly weathered and soft. Makes smooth, firm road.
279	37	63	0	5	10	15	11	22	37	19	21	35	20	3	1	1	Carries at least 75 per cent sand; sample represents coarsest and least sandy part. Too sandy.
280	66	34	0	11	15	27	11	16	20	33	34	25	5	1	1	1	Sample No. 280 is of coarsest gravel; No. 280a of average coarseness. Fine gravel carrying about 50 per cent coarse sand. Good road gravel; partly worn road surface is somewhat muddy when wet.
280a	50	50	0	18	5	14	10	17	36	46	36	12	4	1	0	1	
282	76	24	0	8	16	29	15	16	16	28	21	17	19	11	2	2	Sample coarser and less sandy than average. Fresh and hard gravel, varying from coarse to fine along pit bank. Coarser gravel gives good results on roads.

283	15	85	0	0	0	3	19	22	56	30	27	26	19	5	1	2	Although mostly sand, material packs readily on clay roads and makes firm, smooth road surface.
285	60	40	0	6	17	22	14	17	24	27	24	28	14	2	2	3	Well graded, hard and coarse gravel. Takes long to consolidate under small traffic. Sample pebbles had a percentage of wear of 4·4 (Grading A) in the abrasion test.
287	44	56	0	9	20	20	11	17	23	14	11	19	45	9	1	1	Soft and carries much fine sand. Makes smooth, fast-wearing, dusty road surface under large traffic.
288	59	41	3	7	9	13	13	23	32	18	7	12	39	16	6	2	About the same character and quality as No. 287.
289	33	67	0	0	6	12	12	23	47	17	14	15	39	12	1	2	Sample No. 289 is of partly weathered, fine gravel;
289a	50	50	4	9	11	21	13	15	27	18	12	11	40	16	2	1	No. 289a of fresh gravel of average coarseness. About the same character and quality as No. 287.
290	82	18	4	22	21	22	9	10	12	27	21	17	13	11	5	6	About the same character and quality as No. 287. Sample No. 290 is of fresh, coarse gravel, less sandy and better graded than pit average.
291	45	55	0	6	18	18	10	18	30	17	14	15	35	15	2	2	Carries rather high amount of fine sand. Wears evenly but fast and makes dust.
292	75	25	13	14	13	22	10	14	14	25	19	15	11	17	6	7	Sample coarser and less sandy than average. Coarse, well graded, soft gravel; coarseness varies in a gradual way along pit face. Makes smooth, fast-wearing, dusty road surface.
295	43	57	0	2	15	22	14	19	28	18	13	19	34	11	3	2	About the same as No. 292, but more uniform in coarseness, more sandy and softer.
299	62	38	0	14	11	20	10	15	30	29	17	24	17	5	3	5	Coarse, well graded, soft gravel. Compacts readily and firmly on the road, but wears fast and is dusty. Some of the dust may be from the soil, as unimproved local roads are very dusty.
301	58	42	6	5	8	12	12	21	36	37	24	20	12	3	1	3	Well graded, medium-fine, fairly hard gravel. Sample coarser and less sandy than pit average. Consolidates firmly on the road and wears well.
303	59	41	0	4	2	16	11	24	43	42	31	19	3	2	1	2	Clean, fresh, well graded gravel, uniform in coarseness. Good results are obtained in road surfacing. Makes also a good concrete aggregate.
308	39	61	0	0	12	12	12	24	40	22	30	26	14	5	1	2	Well graded, fine gravel, but rather too sandy. Sample less sandy than pit average. Gravel of proper size for roads is now almost completely exhausted.
313	61	39	0	12	10	25	12	19	22	30	26	26	11	3	1	3	Pit face shows much more sand than gravel. Sample from layer of well graded gravel represents coarsest part. Better as cement than as road gravel.

TABLE II—Continued

Results of Tests on Gravels—Continued

Sample No.	Proportion of pebble to sand.		Granulometric Analysis														Remarks
			Pebbles							Sand						Per cent passing 200 mesh	
			Per cent retained on screens							Per cent retained on sieves							
	Per cent pebble	Per cent sand	2½″	2″	1½″	1″	¾″	½″	¼″	8	14	28	48	100	200		
315	76	24	5	13	11	17	13	16	25	40	30	16	6	4	2	2	Only part of large pit face exposed. Gravel varies in coarseness and turns sandy in depth, but is generally well graded. Sample from coarser and less sandy layer than average. Compacts readily on the road and makes a smooth, durable surface.
316	70	30	9	7	15	17	10	17	25	39	22	13	8	6	4	8	About the same as No. 315, but more uniform in coarseness, and not quite so fresh and durable. Sample from coarser material than average.
320	67	33	0	19	14	18	12	16	21	32	25	15	7	4	5	12	In upper half of 20-foot pit bank, coarseness varies irregularly; lower half well graded, with 50 per cent sand, mostly coarse. Sample from lower half is less sandy and coarser than average for that part. Gravel is only moderately durable, but is the best available locally.
321	38	62	0	0	7	13	12	20	48	29	26	24	14	4	1	2	Uniform in coarseness and well graded, but too sandy. Has been in use only a short time and compacts well under traffic.
323	63	37	0	12	8	23	10	19	28	35	27	19	13	3	1	2	Sample No. 323 coarser than No. 323a, which is of average coarseness. Fresh, hard, well graded rather fine and sandy gravel. Packs well and makes smooth road.
323a	40	60	0	0	6	15	8	25	46	25	29	33	10	2	0	1	
324	39	61	0	0	8	11	11	23	47	42	32	12	7	5	1	1	Uniformly well graded, rather sandy, but sand very coarse. Good where not too sandy.
327	62	38	0	2	10	16	13	24	35	40	27	16	9	3	1	4	Generally well graded, but coarseness and proportion of sand vary along the pit face. Sample is from the least sandy part. Compacts well, and although only moderately durable is the best gravel found locally.
329	72	28	9	16	12	18	12	17	16	30	19	18	17	10	3	3	Coarseness varies in a regular way and gravel is well graded, though high in sand in places. Sample represents coarser and less sandy part. As road gravel, it is about the same as No. 327.

333	69	31	4	3	14	22	11	17	29	36	27	23	10	2	1	1	Good, well graded road gravel, uniform in coarseness. Makes a smooth, durable road under light traffic.
334	41	59	0	0	15	22	10	21	32	20	19	29	26	4	1	1	Deposit carries high proportion of sand. Sample is less sandy than average. Makes a good, although sandy, road surface.
335	72	28	2	5	10	19	18	27	19	11	10	13	17	19	11	19	Poorly graded; not enough medium-size material; proportion of sand varies much. Sample less sandy and more clayey than average. Does not compact firmly on roads.
336	54	46	3	6	5	18	12	18	38	40	27	18	9	3	1	2	Coarseness varies gradually and decreases in depth. Both samples are of average coarseness. Well graded, good road gravel. Upper 8 feet weathered, bouldery and poor.
336a	45	55	26	0	9	15	12	12	26	25	29	29	11	4	1	1	
339	55	45	13	8	16	15	9	12	27	29	29	27	10	2	1	2	Varies much in coarseness. Sample represents the better graded gravel.
343	57	43	0	0	8	21	10	27	34	40	29	17	6	3	1	4	Well graded and uniform, outside of upper 4 to 8 feet, where gravel is bouldery and weathered. Packs well, wears evenly but fast under large traffic.
345	56	44	23	19	14	11	7	9	17	23	36	32	5	2	1	1	Varies much in coarseness, but is on the whole well graded, fresh, and hard. Good and durable results are obtained in road surfacing.
349	44	56	0	5	3	12	10	23	47	32	25	25	13	2	1	2	Rather sandy, but well graded and uniform in coarseness, with 55 to 65 per cent sand, mostly coarse. Consolidates firmly and wears well and evenly under light traffic.
350	68	32	5	13	14	20	13	15	20	31	16	9	13	21	7	3	Large pit face shows mostly coarse gravel, but also fine gravel and sand. Sample, taken from layer of coarse gravel for abrasion test, does not represent average coarseness and grading. Product is sold for railway ballast, roads, and concrete.
351	55	45	0	3	8	19	14	22	34	32	21	15	16	12	3	1	Deposit holds mostly coarse sand, with an occasional layer of gravel or gravelly sand. Both samples are from gravel layers. The material is fresh and of good quality as concrete aggregate, but most of it is too fine for roads.
351a	36	64	0	0	5	6	8	26	55	26	22	22	19	8	2	1	
352	78	22	6	7	14	19	13	17	24	47	19	12	9	6	3	4	Large pit face shows mostly coarse sand, with a few layers of gravel. Sample 140 is from a layer of coarse gravel; 140a from a layer of coarse sand. Product is sold for concrete, roads, and railway ballast.
352a	6	94	0	0	0	0	12	16	72	14	30	30	19	5	1	1	
353	40	60	0	3	2	14	17	26	38	18	13	17	26	17	5	4	Coarse, partly weathered, well graded gravel interstratified with sand in places. Sample more sandy than pit average.

TABLE II—Continued

Results of Tests on Gravels—Continued

Sample No.	Proportion of pebble to sand.		Granulometric Analysis														Remarks
			Pebbles							Sand						Per cent passing 200 mesh	
	Per cent pebble	Per cent sand	Per cent retained on screens							Per cent retained on sieves							
			2½″	2″	1½″	1″	¾″	½″	¼″	8	14	28	48	100	200		
354	45	55	0	0	10	25	15	21	29	18	14	28	27	8	2	3	Deposit holds mostly sand, suitable for concrete. Sample from gravel pocket.
355	38	62	0	0	2	14	7	25	52	28	19	26	22	4	1	0	Much too sandy (sand averages 75 per cent), but otherwise uniformly well graded. Good results are obtained in road maintenance work with coarser-phase material, as represented by sample.
356	43	57	0	0	6	12	12	27	43	25	25	23	20	4	1	2	Well graded, uniform in coarseness, rather sandy with sand generally coarse. Good and durable under light traffic.
358	72	28	0	5	3	22	20	23	27	54	23	12	4	3	2	2	Uniformly well graded. Compacts firmly and makes a smooth road surface, but wears fast under large traffic, and old roads somewhat muddy when wet.
359	70	30	0	5	10	27	20	17	21	25	14	22	25	6	3	5	Well graded, fine gravel, but rather sandy. Sample represents coarser and less sandy part. Packs and wears well under moderate traffic.
361	62	38	0	2	6	21	16	23	32	31	24	12	8	6	5	14	Sample No. 361 is of weathered and soft gravel; Nos. 361a and 361b of fresh gravel. Except near surface, the gravel is fresh, hard, well graded and suitable for road purposes.
361a	38	62	0	0	7	20	8	17	48	36	30	21	8	2	1	2	
361b	60	40	0	8	3	23	16	21	29	44	30	12	6	2	1	5	
362	62	38	....	3	8	23	3	23	40	26	14	14	13	11	7	15	About the same as No. 361, but coarser and less uniform. Sample is of crushed gravel. Makes smooth road and wears well under moderate traffic.
363	73	27	4	18	15	26	12	10	15	34	26	17	7	4	3	9	Fresh, hard, coarse and bouldery gravel, holding but little fine sand. When crushed, makes a road material of good wearing quality.
372	5	95	0	0	0	7	8	24	61	11	29	49	10	1	0	0	Fresh, hard, coarse sand, suitable as concrete aggregate.
375	45	55	0	0	2	20	16	22	40	32	23	20	15	6	2	2	Hard, well graded, fine gravel. Although rather sandy, it packs firmly and gives good service on roads of small traffic.

381	60	40	6	14	22	8	9	14	27	38	33	19	6	2	1	1	Well graded, fine gravel, carrying 65 per cent sand; both samples are coarser and less sandy than pit average, but probably represent the average run of the gravel taken out for roads, judging by the good results obtained.
381a	48	52	17	3	7	20	9	15	29	26	29	30	10	2	1	2	
382	65	35	0	4	14	26	16	18	22	29	19	18	20	9	2	3	Coarseness and grading vary from place to place; generally coarse and well graded. Good road gravel.
385	35	65	0	0	2	7	10	23	58	44	34	13	5	2	1	1	Too sandy, but sand is very coarse, and the gravel is uniformly well graded.
386	65	35	0	6	4	27	12	18	33	53	28	8	3	3	2	3	Sample No. 386 is of coarse gravel; No. 386a of medium-fine gravel. Coarseness varies in a gradual way. Fresh, hard, well graded gravel. Satisfactorily withstands the wear of heavy traffic.
386a	39	61	0	0	0	9	12	29	50	38	33	14	4	7	3	1	
389	45	55	0	0	13	16	13	21	37	40	39	16	3	1	0	1	Coarseness and grading vary in upper 10 feet; below, gravel is better graded and more uniform in coarseness. Sample is of lower gravel. Gives good results under heavy traffic.
391	46	54	0	0	5	8	17	31	39	21	14	18	26	14	5	2	Fresh, fine gravel, poorly graded owing to sand layers interstratified with the gravel. Sand averages 65 per cent of the whole. Sample less sandy and better graded than average.
392	55	45	0	0	9	26	19	20	26	19	10	19	35	13	2	2	Similar to No. 391 but less sandy. Sand averages about 50 per cent of the whole.
396	62	38	0	19	11	23	10	14	23	35	29	16	7	3	2	8	Fresh, hard, coarse and bouldery gravel; holds 15 per cent boulders and needs crushing.
399	25	75	0	0	0	15	11	22	52	20	21	27	27	3	1	1	Fresh, fine sandy gravel. Too sandy.
402	66	34	6	2	5	22	12	19	34	45	28	12	5	3	2	5	Weathered and soft, but well graded. Coarseness varies in a gradual way. Sample is of medium-coarse gravel.
404	49	51	15	8	11	17	13	14	22	20	19	29	27	3	1	1	Fresh, coarse and sandy gravel, carrying over 50 per cent sand. The less sandy part, represented by sample, makes a good road material.
406	30	70	0	0	0	18	12	27	43	15	11	15	40	16	2	1	River gravel, carries a rather high amount of fine sand, but is more satisfactory as road material than local bank gravel.
409	45	55	0	0	15	16	14	22	33	23	16	21	26	9	2	3	Medium-hard, fairly well graded river gravel. Better for roads than local bank gravel.
414	49	51	0	10	17	19	9	16	29	20	18	24	31	5	1	1	Sandy gravel; both samples less sandy than average. Good where not too sandy. Most of what is left in the deposit is sandy.
414a	42	58	0	12	11	11	11	18	37	32	24	17	20	5	1	1	
419	59	41	6	8	11	15	9	19	32	40	25	17	11	4	1	2	Grading and coarseness vary with layers, but the gravel is on the whole well graded, coarse, fresh, and hard. Wears evenly under heavy traffic.

TABLE II—Continued

Results of Tests on Gravels—Continued

Sample No.	Proportion of pebble to sand.		Granulometric Analysis														Remarks
			Pebbles							Sand						Per cent passing 200 mesh	
			Per cent retained on screens							Per cent retained on sieves							
	Per cent pebble	Per cent sand	2½″	2″	1½″	1″	¾″	½″	¼″	8	14	28	48	100	200		
421	35	65	0	6	7	22	6	19	40	28	33	20	8	3	2	6	Partly weathered, well graded gravel. Coarseness varies in a gradual way along the pit face. Sample more sandy than average. Makes smooth road, but softens in rainy weather.
427	57	43	0	0	12	26	18	17	27	28	25	26	14	4	1	2	Uniformly well graded, coarse gravel. Packs well and makes smooth and firm road, but probably not durable under large traffic, owing to its large proportion of schist and slate.
428	.....	.....	.....	.....	4	32	42	21	1	.....	.....	.....	.....	.....	.....	.....	Crushed and screened boulders. Sample includes only material between 1½ and ½ inch in size. On roads larger and harder stone fragments are dislodged by heavy traffic.
432	57	43	0	15	5	24	13	18	25	27	20	20	19	10	2	2	Coarse, fairly well graded gravel. Packs well and wears evenly under small traffic.
436	39	61	0	0	8	17	12	21	42	32	33	23	8	2	1	1	Sample coarser and less sandy than average. Partly weathered, well graded, but fine and sandy. Too sandy, although satisfactory under small traffic.
451	40	60	0	0	0	11	15	27	47	28	22	21	17	9	2	1	Sandy river gravel. Wears well under moderate traffic.
458	57	43	0	0	0	3	8	22	67	62	20	4	4	4	2	4	Sample less sandy than average. Well graded but too soft and sandy.
459	40	60	0	0	3	8	7	22	60	26	16	16	28	11	2	1	River gravel carries much fine sand, but wears better on roads than local bank gravel.
460	54	46	0	19	9	20	12	15	25	24	24	22	18	6	3	3	Weathered, soft, well graded gravel. Coarseness varies in a gradual way along the pit face. Packs well but wears fast, even under light traffic.
462	73	27	5	13	20	25	14	13	10	21	12	12	24	19	8	4	Well graded but rather soft. Pit bottom, where sample was taken shows bouldery but hard gravel. Worth developing to full depth and crushing. Gives good results under small traffic.

465	45	55	0	8	8	12	16	21	35	18	13	18	43	6	1	1	Fairly well graded, though high in fine sand. Packs readily and makes smooth road. It is rather soft, but satisfactory on local roads of small traffic.
468	58	42	0	6	10	16	11	19	38	42	26	12	8	5	2	5	Sample represents average run of the better gravel, which occurs as streaks through poorer material.
476	51	49	16	6	7	22	9	14	26	26	23	20	13	5	3	10	Coarseness and grading vary with layers, but the gravel on the whole is fairly uniformly coarse and somewhat sandy.
488	47	53	0	12	7	18	11	22	30	25	17	22	19	8	3	6	Rather poorly graded and soft.
492	50	50	9	3	9	13	12	22	32	28	19	22	24	5	1	1	Fresh, coarse, well graded gravel. Although only moderately hard, it has better wearing quality than other local gravels.
499	44	56	0	1	10	20	16	18	35	24	20	26	23	5	1	1	Uniformly fine, well graded, somewhat sandy gravel. Although rather soft, it is a better road material than other local bank gravels.
501	37	63	0	0	2	13	12	28	45	19	11	15	32	16	5	2	Fine and sandy river gravel. Withstands heavy traffic wear better than local bank gravels.
504	40	60	0	5	0	18	11	21	45	23	20	23	23	7	2	2	Sample less sandy than average. Well graded, soft, and sandy gravel.
506	55	45	0	4	10	28	13	16	29	28	21	20	18	8	3	2	Sample coarser than average. Coarseness and grading vary with layers. Fresh but rather soft gravel.
508	58	42	0	2	2	26	22	21	27	24	17	22	28	7	1	1	Hard, well graded river gravel. Coarseness varies much along river flat. Harder and more durable than local bank gravel.
514	47	53	0	0	20	12	11	21	36	28	22	25	19	3	1	2	Coarse and well graded in upper bank; sandy in lower bank. Sample is from upper bank and slightly finer than average for upper part.
515	57	43	0	0	2	7	8	21	62	43	14	10	14	10	5	4	Sample No. 515 is of medium-fine, well graded
515a	53	47	4	3	19	20	10	16	28	24	23	22	14	8	4	5	gravel from upper pit bank; No. 515a is of softer and less well graded gravel from lower bank. Gravel is rather soft throughout.
517	22	78	0	0	0	5	8	23	64	33	36	20	7	2	1	1	Well graded but soft and sandy. Packs well and makes smooth road surface, which is muddy when wet.
518	76	24	0	0	0	5	9	29	57	61	21	7	4	3	1	3	Well graded but soft. Packs and wears well under very small traffic. Road condition affected by weather changes.
520	55	45	0	0	0	13	15	27	45	44	28	8	8	6	3	3	Deposit worked largely for sand, of which there is more than gravel. Gravel is fine, well graded but soft. Sample pebbles had a percentage of wear of 32·8 (Grading D) in the abrasion test.

TABLE II—Continued

Results of Tests on Gravels—Continued

Sample No.	Proportion of pebble to sand.		Granulometric Analysis														Remarks
			Pebbles							Sand						Per cent passing 200 mesh	
	Per cent pebble	Per cent sand	Per cent retained on screens							Per cent retained on sieves							
			2½″	2″	1½″	1″	¾″	½″	¼″	8	14	28	48	100	200		
523	48	52	0	3	8	20	17	23	29	17	14	33	29	5	1	1	Sample represents coarser part of gravel deposits along the bank of Chaudière river. Coarse gravel used recently on river road, presumably as foundation course (road newly improved).
524	38	62	8	0	7	11	12	21	41	21	17	23	25	12	1	1	Sample coarser than average. Soft and sandy gravel of poor quality for roads.
528	61	39	0	0	9	19	16	22	34	36	21	16	14	7	3	3	Sample coarser than average, exclusive of the coarse and bouldery material. Fresh and well graded, but rather soft gravel. Better than other local gravels.
533	74	26	0	4	9	37	22	17	11	24	29	23	11	6	3	4	Gravel varies much in coarseness with layers and is sandy. Sample is from coarse gravel, low in sand. Gravel used on roads probably more uniformly graded and not so sandy as what is now exposed in pit face, as judged by the good results obtained.
534	46	54	0	0	5	17	15	23	40	22	20	34	13	6	2	3	Sample represents the coarser and less sandy part. Makes a firm, smooth, durable road surface.
536	49	51	0	0	4	6	12	24	54	44	25	14	8	4	2	3	Well graded and makes a good road surface. Holds a rather large proportion of soft pebbles.
537	74	26	3	4	13	16	13	23	28	36	28	18	8	5	2	3	Well graded and good road material. Sample represents the coarser and less sandy part.
538	40	60	0	0	8	18	11	21	42	29	26	20	14	7	2	2	Well graded but soft and wears fast. Sample slightly finer than average.
540	55	45	9	11	13	12	13	15	27	32	24	22	15	4	1	2	Well graded, but holds large proportion of boulders and large pebbles. On unimproved roads makes a firm and durable though not smooth surface.
544	55	45	0	3	18	22	11	20	26	24	19	22	20	8	3	4	Holds much sand. Sample from better graded and less sandy part. Does not compact readily on road because too sandy.
549	60	40	0	0	2	15	13	29	41	40	24	16	9	5	3	3	Well graded river gravel. Has more lasting quality on road than local bank gravel.

550	50	50	4	0	15	18	11	20	32	28	25	24	16	4	1	2	Carries boulders and large pebbles; otherwise well graded. Although soft and dusty, is satisfactory under light traffic.
554	29	71	0	0	5	17	10	14	54	34	33	21	9	2	0	1	Sample does not include boulders and large pebbles, of which there is a fairly large amount. Makes a very smooth and firm road surface, but prolonged rains are said to make it soft and muddy. Holds large proportion of soft pebbles but gives good results under light traffic.
556	70	30	3	10	11	16	10	19	31	48	24	9	6	6	3	5	Coarse and bouldery, but very well graded, if oversize screened out. Gravel of good quality and worth crushing.
557	63	37	8	8	16	16	9	15	28	44	33	15	4	1	1	2	Same character as No. 556, but more weathered and softer, owing to shallower depth.
559	47	53	0	8	8	17	11	17	39	39	26	11	12	10	1	1	Well graded and of good wearing quality, but takes long to compact properly.
560	22	78	0	0	20	8	11	13	48	32	35	18	7	3	2	3	Fine and well graded. Sample represents finer part. Makes smooth and firm road surface under light traffic. Too fine to be considered durable.
562	58	42	0	0	10	27	12	20	31	31	22	21	16	6	2	2	Coarseness varies in a gradual way along pit face. Gives good results on local roads.
565	60	40	0	2	11	19	13	22	33	35	26	22	11	3	1	2	Well graded. Does not consolidate readily, but after some time makes a smooth, firm and hard road surface, unaffected by weather.
570	60	40	7	9	13	19	12	16	24	25	21	23	19	8	2	2	Well graded and good, if larger stones screened out.
575	42	58	6	0	8	16	11	22	37	23	22	18	24	10	1	2	Rather sandy. Makes good but not firm road surface.
576	59	41	5	2	6	17	14	22	34	35	25	19	11	4	2	4	Sample coarser than pit average. Makes smooth and firm surface on local clay roads of light traffic.
581	67	33	3	9	16	20	11	16	25	36	26	23	10	3	1	1	Coarse, with 20 per cent boulders. Well graded, if larger stones screened out. Does not consolidate readily on road, but has good wearing quality and is worth crushing.
589	37	63	6	2	12	16	13	20	31	19	19	24	28	6	2	2	Somewhat sandy. Makes smooth, firm and durable road surface.
598	69	31	0	0	2	6	8	27	57	66	20	6	3	2	1	2	Coarse and low in sand; sample finer than average. Although holding many soft pebbles, wears well and evenly under light traffic.
601	55	45	11	6	6	16	8	14	39	32	29	24	13	1	0	1	Soft slate gravel. Consolidates readily to a smooth surface, but will stand only light traffic.
602	47	53	4	4	13	19	12	18	30	22	22	23	27	4	1	1	Coarse and somewhat sandy. Old railway-pit. Gravel used recently on local road makes smooth surface under light traffic.

TABLE II—Continued

Results of Tests on Gravels—Continued

Sample No.	Proportion of pebble to sand.		Granulometric Analysis														Remarks
			Pebbles							Sand						Per cent passing 200 mesh	
			Per cent retained on screens							Per cent retained on sieves							
	Per cent pebble	Per cent sand	2½″	2″	1½″	1″	¾″	½″	¼″	8	14	28	48	100	200		
603	20	80	0	0	0	10	10	23	57	19	19	19	27	13	1	2	Fine slate gravel with much fine sand. Too fine and too soft for main roads. Undeveloped deposit. Sample taken from test pit.
609	38	62	0	4	1	5	5	14	71	70	22	5	1	1	0	1	Well graded, fine gravel carrying very coarse sand. Sample finer than average. Compacts slowly on road under light traffic, but makes hard surface.
614	60	40	17	11	17	20	9	10	16	22	23	25	19	6	2	3	Coarse and slightly bouldery. Would make a good road material if crushed or larger stones screened out.
619	36	64	0	14	8	11	10	16	41	16	20	30	28	4	1	1	Deposit carries much sand; sample represents coarser and better graded gravel. Sold exclusively as concrete aggregate, most of it being hauled to Ste. Anne.
623	42	58	0	6	10	21	14	17	32	24	23	25	22	6	0	0	Varies in coarseness with layers, but is all well graded. Large railway-pit; gravel found unsatisfactory for ballast and now used in making concrete pipes (circular and arched) and culvert slabs. No gravel sold.
626	21	79	0	0	1	15	15	26	43	14	21	30	28	5	1	1	Medium-coarse to fine and sandy. Easily loosened and corrugated by fast-moving traffic. Has low binding power.
633	52	48	6	0	3	16	12	18	45	46	28	14	4	2	2	4	Varies from coarse to fine; sample from coarser part. Consolidates readily under light traffic to a smooth but dusty road surface.
637	60	40	0	5	11	25	17	21	21	17	20	32	23	5	1	2	Well graded, coarse and in places bouldery; sample finer than average. Wears well under moderately heavy, fast-moving traffic.
638	42	58	0	5	9	20	10	20	36	26	36	22	11	3	1	1	Well graded and coarse with 5 per cent boulders. On front road gravel stays loose and forms corrugations in places, due in part to traffic, in part to lack of binder.

640	52	48	0	0	6	20	14	25	35	25	27	28	17	1	1	1	Well graded. Makes smooth, firm surface and wears well under light to moderate traffic.
641	1	99	0	0	0	0	0	0	100	4	13	29	42	10	1	1	Medium-fine sand. Compacts readily on road, but surface soft and in places muddy after heavy rain.
646	42	58	6	6	13	12	9	17	37	31	35	22	8	2	1	1	Well graded, coarse, and sandy. Large ballast-pit, from which a small amount of gravel has been used in road surfacing, with good results.
649	48	52	0	0	0	8	17	28	47	32	17	16	25	9	1	0	Good, hard, and durable, but takes long to bind properly under light traffic.
650	55	45	0	15	16	20	8	17	24	27	32	27	10	2	1	1	Small road-pit in bottom of old railway-pit. Coarse sand with gravel streaks. Sample from coarser gravel. Packs well on road, but too sandy.
652	38	62	3	3	2	20	9	20	43	25	25	22	15	9	2	2	Well graded, uniform in coarseness and sandy. Makes smooth and firm surface, but rather dusty and durable enough only for light traffic.
655	74	26	11	6	13	20	13	17	20	37	25	18	8	2	2	8	Varies in coarseness with layers, but is on the whole coarse, well graded, and holds 3 per cent boulders. Sample coarser than average. Gives excellent results on roads and is durable.
658	55	45	0	3	4	14	11	20	48	54	31	9	2	1	1	2	Medium coarse and well graded. Makes good and firm roads, but will not stand too heavy traffic.
659	55	45	2	2	5	14	11	23	43	36	23	21	15	2	1	2	Medium coarse and well graded. Compacts firmly and wears well under fairly heavy, fast-moving traffic. Poorer gravel also occupies large section of pit bank.
660	60	40	8	0	17	17	12	18	28	36	29	19	9	3	1	3	Well graded, slate gravel. Makes good but somewhat dusty road, and will not stand too heavy traffic.
662	60	40	3	20	15	15	10	14	23	36	34	17	5	3	2	3	Very coarse, slate gravel with 25 per cent boulders. Compacts readily but is rather soft and wears fast. Sample pebbles had a percentage of wear of 17·9 (Grading A) in the abrasion test.
664	49	51	7	13	15	12	9	14	30	26	26	24	15	6	2	1	Well graded, fine slate gravel. Makes very smooth, well bound road surface. Road condition probably affected by weather.
669	46	54	0	6	5	17	15	19	38	29	23	17	19	10	1	1	Uniform coarseness. Does not pack readily but wears well on local roads carrying light traffic.
670	37	63	0	22	4	15	10	15	34	25	26	28	16	3	1	1	Varies in coarseness with layers; generally well graded but sandy. Good where not too sandy and makes hard and smooth road under not too heavy traffic.
671	60	40	0	0	11	17	16	21	35	43	34	14	4	2	1	2	Varies in coarseness, but well graded; sample from coarser part. Makes good road under light traffic.

TABLE II—Continued

Results of Tests on Gravels—Continued

Sample No.	Proportion of pebble to sand.		Granulometric Analysis														Remarks
			Pebbles							Sand						Per cent passing 200 mesh	
			Per cent retained on screens							Per cent retained on sieves							
	Per cent pebble	Per cent sand	2½″	2″	1½″	1″	¾″	½″	¼″	8	14	28	48	100	200		
673	37	63	0	0	2	9	8	21	60	27	22	18	22	8	2	1	Sandy and fine gravel; sample from coarser and less sandy part. Does not pack firmly but is satisfactory for local roads.
675	51	49	0	5	15	23	13	18	26	24	27	33	15	1	0	0	Medium-coarse, well graded, soft slate gravel. Wears fast on front road, which carries heavy traffic. Sample pebbles had a percentage of wear of 28·8 (Grading A) in the abrasion test.
678	77	23	0	2	4	14	16	24	40	64	18	6	4	3	2	3	Medium-fine, well graded; sample from coarser and less sandy part. Makes smooth, firm road and wears well.
680	35	65	7	5	7	19	11	15	36	23	26	28	16	4	1	2	Varies in coarseness with layers but generally coarse; well graded if larger stones screened out. Proportion of sand in sample higher than average. Good under light traffic and suitable for heavier traffic.
681	70	30	3	5	10	22	15	20	25	30	21	29	8	5	3	4	Well graded and coarse; sample from coarser part. Road recently surfaced is smooth and firm in wheel tracks, with much loose gravel in centre. Traffic light and mostly horse-drawn. Gravel suitable for heavier traffic.
684	41	59	18	12	7	11	9	16	27	18	15	13	13	14	10	17	Glacial drift. Makes smooth and hard, not too dusty road. Traffic very light. Road condition probably affected by weather.
685	30	70	0	0	2	7	13	22	56	25	21	23	25	4	1	1	Rather high in sand. Produces decided improvement on local clay roads.
686	43	57	0	0	9	12	7	19	53	53	35	6	2	1	1	2	Well graded and good road gravel, although somewhat slow to bind on light soils.
687	55	45	0	8	12	19	11	20	30	28	24	26	19	3	0	0	Sample No. 687 is of coarse gravel; No. 687a of fine gravel. Fresh, hard, well graded gravel. Used solely as railway ballast, but suitable for roads.
687a	36	64	0	0	7	18	19	22	34	25	29	29	14	1	1	1	
688	61	39	0	5	5	23	14	21	32	35	24	19	11	4	3	4	Sample No. 688 of coarser gravel from upper bank; No. 688a, of sandy gravel from lower bank. Good under small traffic; corrugated under the heavy traffic of the river road.
688a	40	60	0	0	12	15	9	22	42	32	28	11	8	8	5	8	

689	33	67	0	0	4	18	10	19	49	20	19	22	28	9	1	1	Sandy gravel. Found more satisfactory than other local gravels, which carry much soft slate and wear fast.
690	90	10	4	1	10	30	23	20	12	37	16	14	10	8	6	9	Coarseness and proportion of sand vary with layers; sample from coarse gravel with but little sand, and not so well graded as average. Makes firm road but wears fast under heavy, fast-moving traffic.
691	27	73	4	6	0	19	10	22	39	15	19	28	31	6	1	0	Uniform in coarseness, but sandy in depth; sample from sandy gravel. Rather fine and forms corrugations under the heavy traffic of the main road.
693	53	47	0	2	4	21	24	25	24	22	26	28	20	3	0	1	Carries low proportion of small pebbles but fairly well graded; sample slightly coarser than average. Has better wearing quality than other local gravels.
697	33	67	0	0	2	13	14	22	49	25	23	25	22	3	1	1	Carries over 75 per cent sand; sample from coarser and less sandy part. Slow to compact and makes smooth but not firm road; too sandy.
701	53	47	0	6	13	15	13	20	33	29	29	22	14	4	1	1	Well graded, coarse. Makes smooth and firm road under light traffic.
702	50	50	0	0	0	11	9	21	59	47	29	12	6	2	2	2	Rather sandy but otherwise well graded. Makes smooth road, but surface softens in wet weather. Good on clay roads carrying light traffic.
705	49	51	0	0	5	18	15	22	40	33	25	14	20	6	1	1	Sample No. 705 is of fresh gravel from lower bank;
705a	40	60	0	0	2	10	10	23	55	29	26	16	21	5	1	2	No. 705a, of partly weathered gravel from upper bank. Well graded, but upper part rather soft and sandy. Lower gravel satisfactory on roads of small traffic.
708	33	67	0	0	9	12	9	19	51	25	23	21	22	7	1	1	Well graded but weathered and soft in upper bank; sample from fresher gravel in lower bank. On local clay roads of light traffic, compacts firmly and makes smooth surface.
709	53	47	0	3	10	22	15	21	29	25	19	25	22	5	1	3	Sample No. 709 is of upper gravel; No. 709a of
709a	70	30	11	1	13	16	13	17	29	54	26	8	2	2	1	7	lower gravel. Upper gravel uniformly coarse and well graded, but partly weathered and rather soft; lower gravel varies much in coarseness but generally well graded and fresh. Lower gravel packs more readily and makes a more durable and less dusty road surface than upper gravel. The pebble composition is different in both gravels.
710	67	33	4	4	18	23	9	19	23	33	25	25	10	2	1	4	Well graded but soft. Under light traffic makes smooth road surface, slightly muddy when wet. Sample pebbles had a percentage of wear of 18·4 (Grading A) in the abrasion test.

TABLE II—Continued

Results of Tests on Gravels—Continued

Sample No.	Proportion of pebble to sand.		Granulometric Analysis														Remarks
			Pebbles							Sand						Per cent passing 200 mesh	
			Per cent retained on screens							Per cent retained on sieves							
	Per cent pebble	Per cent sand	2½"	2"	1½"	1"	¾"	½"	¼"	8	14	28	48	100	200		
713	82	18	0	2	14	27	18	17	22	56	20	4	3	6	4	7	Sample No. 713 is of upper gravel; No. 713a from near pit bottom. Uniformly coarse and well graded throughout. Small amount used on local road has given good results. Pebble composition different in upper and lower gravel.
713a	61	39	0	3	5	22	14	22	34	37	24	20	9	3	2	5	
719	57	43	0	0	14	23	16	20	27	29	21	26	18	4	1	1	Fresh, hard, well graded gravel. Takes long to consolidate on road but has good wearing quality and road remains firm when wet.
721	72	28	2	9	7	19	13	19	31	41	19	14	12	8	3	3	Varies in coarseness with layers, but on the whole fairly uniform and well graded. Packs readily on road and makes a smooth, hard surface, but wears rather fast under fairly heavy, fast-moving traffic.
722	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Varies much in coarseness, but generally coarse and well graded, although low in sand and small pebbles. Makes a hard, firm, and durable road surface, but coarseness of gravel and low proportion of sand cause the surface to be slightly rough. Gravel would be improved by crushing.
724	68	32	5	21	17	21	7	12	17	36	31	17	5	3	1	7	Coarse and bouldery, but well graded if larger stones screened out. Holds 25 per cent boulders. Crushing the gravel would be better than screening out the oversize. Pit recently opened (1931). Gravel similar to No. 725, but softer.
725	65	35	4	2	14	15	10	20	35	41	27	18	6	2	1	5	Coarseness decreases gradually in depth and gravel generally well graded. Packs readily and forms firm and smooth surface, unaffected by rain. Wears well under fairly heavy traffic.
729	72	28	18	6	15	22	12	11	16	30	24	20	14	5	2	5	Coarse and bouldery, with about one-third boulders. Soft gravel, some of the pebbles crumbling under traffic. Packs readily and forms smooth surface, hard and firm when dry, but softened by rain. Wears rather fast.

733	78	22	4	5	17	21	14	19	20	23	10	21	30	9	3	4	Uniformly coarse, low in sand and small pebbles; well graded if larger stones screened out. Pit just opened (1931). Looks like good road material.
735	55	45	1	6	11	27	14	18	23	19	11	12	23	23	7	5	Partly sorted glacial drift, uniform in coarseness but poorly graded. Compacts readily and firmly on road and makes hard surface, smooth when dry, but softened in rainy weather. Wears well under light traffic.
736	25	75	0	0	4	22	19	20	35	21	29	21	13	9	4	3	Fine and hard gravel, grading varies much from place to place. The better graded and less sandy material, as represented by the sample, is used with good success in road-maintenance.
737	54	46	0	0	4	14	18	26	38	30	22	18	16	5	4	5	Hard, coarse, well graded gravel, of low binding power. As a stabilizing and binding medium, a little clayey sand is added with good results.
737a	62	38	0	0	4	21	22	26	27	26	21	24	22	4	1	2	
739	46	54	3	0	10	22	12	17	36	28	24	17	15	7	4	5	Much the same as No. 737.
740	57	43	0	0	11	22	13	20	34	36	19	12	10	14	4	5	Uniform in coarseness and on the whole well graded. Consolidates readily on road and remains firm even when wet.
747	63	37	6	2	15	23	16	17	21	21	17	33	20	4	2	3	Coarse and bouldery, with 10 per cent boulders, but fairly well graded. Packs well and wears evenly on local roads of light traffic.
751	75	25	0	7	9	23	16	22	23	36	17	21	19	4	1	2	Fresh, hard, coarse, and well graded; sample less sandy than average. Gravel makes smooth, durable road, unaffected by rain.
753	69	31	3	8	27	19	13	13	17	26	23	26	17	4	1	3	Uniformly coarse and bouldery, with over 25 per cent boulders, and low proportion of small pebbles. Pit just opened (1931). Packs readily and firmly uuder light traffic. Good for foundation course.
761	53	47	0	0	11	19	12	21	37	39	29	19	6	2	1	4	Uniformly coarse and well graded. Old railway-pit, from which a small amount of gravel has been taken and used on main road with good results.
762	56	44	0	0	0	3	7	31	59	32	12	11	23	12	3	7	Fine, rather sandy, hard gravel; sample from coarser and less sandy part. Makes good road surface, which remains firm even when wet.
763	21	79	0	0	0	5	5	13	77	50	36	11	3	0	0	0	Hard, well graded beach gravel of low binding power. When mixed with binding material makes smooth and hard surface, unaffected by rain.
766	64	36	0	0	7	21	24	22	26	27	18	22	17	10	3	3	Coarse, fairly well graded gravel. Makes smooth, firm, durable road. Sample pebbles had percentages of wear of 7·1 (Grading A) and 8·6 (Grading D) in the abrasion test.

TABLE II—Concluded

Results of Tests on Gravels—Concluded

Sample No.	Proportion of pebble to sand.		Granulometric Analysis														Remarks
			Pebbles							Sand						Per cent passing 200 mesh	
	Per cent pebble	Per cent sand	Per cent retained on screens							Per cent retained on sieves							
			2½″	2″	1½″	1″	¾″	½″	¼″	8	14	28	48	100	200		
767	88	12	3	10	18	26	14	12	17	53	11	4	6	12	5	9	Partly sorted glacial drift varies much in coarseness; sample less sandy and harder than average. Makes smooth road, like sand-clay road, some of the pebbles crumbling readily under traffic. Surface is not so hard as the average gravel road; wears fast and is dusty. Sample pebbles had percentages of wear of 17·0 (Grading A) and 14·4 (Grading B) in the abrasion test.

TABLE III

Mortar Test*

Sample No.	Fineness modulus	Per cent of water used	Sand mortar: 1 cement, 3 sand				Remarks.
			Tensile strength, per cent of standard		Compressive strength, per cent of standard		
			7 days	28 days	7 days	28 days	
5	3·03	12·0	86	58	89	94	Tensile strength decreased at 28 days.
7	3·78	11·4	118	113	159	151	
12	3·64	11·6	97	89	157	137	Slightly weathered.
13	2·79	13·8	39	51	66	70	Deposit shallow and sand weathered.
20	3·52	13·8	61	68	92	125	Sample taken near surface.
21b	2·12	13·8	82	77	93	99	Fresh but too fine.
27	3·46	12·8	70	83	119	121	Weathered and holds mica.
27a	3·19	11·8	73	90	116	118	Slightly weathered and holds mica.
43	3·32	12·8	87	101	118	142	Slightly weathered.
44a	3·40	13·1	90	88	140	128	Holds some clay.
53	3·71	11·6	108	88	156	145	Slightly weathered.
55	3·06	12·7	67	63	97	94	Deposit shallow and sand weathered.
61b	3·64	11·9	105	101	158	145	
78	3·99	11·4	98	106	157	158	Slightly weathered.
79a	3·42	11·4	124	124	176	176	
81	3·10	12·0	92	82	135	136	Slightly weathered.
88	3·17	12·0	97	76	133	140	Holds mica.
90	3·30	13·0	56	65	109	103	Deposit shallow and sand rusty.
98	3·81	11·3	90	76	110	121	Deposit shallow and sand weathered.
109	3·02	11·9	15	50	4	61	Sand grains rust-coated.
119	3·80	10·6	92	68	167	155	Tensile strength decreased at 28 days.
125	4·66	11·4	62	62	78	105	Sand grains dust-coated.
126	3·57	10·9	138	107	211	203	
134	3·87	11·7	85	81	137	156	Slightly rusty.
135	3·84	11·2	126	79	178	183	Tensile strength decreased at 28 days.
139	4·08	10·3	117	74	188	141	Tensile strength decreased at 28 days.
139a	3·80	10·5	145	87	217	181	Tensile strength decreased at 28 days.
153	2·53	13·8	100	97	128	125	Sand too fine.
153a	2·24	13·8	81	78	123	109	Sand too fine.
162	2·47	12·7	93	86	139	123	Sand too fine.
166a	3·91	10·0	138	111	240	195	
172	2·78	12·4	112	90	164	133	From run of the bank. Sand holds mica.
179	3·43	12·0	58	74	131	131	Sand holds mica.
206	3·52	13·9	125	111	117	123	Slightly weathered.
210	4·18	12·1	134	136	145	141	
211	3·76	13·0	145	122	165	145	

*Only the material passing a ¼-inch screen (sand or fine aggregate) is used for this test. The fineness modulus is an indication of the fineness of the sand; the finer the sand, the lower its modulus. The standard test referred to is made on a mortar composed of one part of cement and three parts of standard Ottawa sand. Mortars giving results of at least 100 per cent of the value of the standard test are considered suitable for all conditions and are classified as high grade; those testing over 70 per cent and less than 100 per cent of the standard are suitable only for certain classes of work; those testing less than 70 per cent of the standard should be rejected.

Nearly all samples were collected primarily for testing as road material, and are not, therefore, truly representative of that part of the deposit best suited for mortar or concrete work.

TABLE III—Continued

Mortar Test—Continued

Sample No.	Fineness modulus	Per cent of water used	Sand mortar: 1 cement, 3 sand				Remarks.
			Tensile strength, per cent of standard		Compressive strength, per cent of standard		
			7 days	28 days	7 days	28 days	
213	3·79	12·8	106	111	144	141	Slightly weathered.
214	3·12	13·8	110	106	111	109	
218	2·99	15·1	85	82	97	96	Sand from sample No. 218, taken near surface is slightly dusty and rather fine; No. 218a, taken deeper, is coarse and clean.
218a	3·65	12·7	139	124	156	158	
223	4·12	12·5	125	114	157	139	
226a	3·61	13·8	85	73	110	110	Sample from near surface. Deposit shallow.
231	2·74	13·9	84	106	85	107	Sand too fine.
232	3·38	11·9	177	137	190	161	
237	2·47	13·7	95	100	90	105	Sand too fine.
240	3·73	14·9	135	111	139	125	Sample No. 240 dusty; No. 240a clean but fine; both samples taken deep in the bank.
240a	2·03	16·0	81	71	61	65	
242	3·22	13·3	116	113	117	127	
244	3·64	14·5	138	109	132	120	
245	3·47	16·5	99	83	70	86	Sample of partly weathered material.
248	2·93	13·8	106	100	106	114	Rather fine and slightly weathered.
257	3·01	13·9	89	111	96	110	Slightly weathered.
258	3·23	15·4	113	103	100	110	Slightly weathered.
259	3·63	12·9	122	117	108	120	Slightly dusty and weathered.
262	2·95	16·1	87	96	93	93	Rather fine and grains slightly dust-coated.
265	2·48	13·8	68	87	81	95	Clean, fresh sand, but too fine.
268	2·94	13·9	111	111	132	134	
269	2·70	13·0	98	113	93	108	Clean, sharp sand, but too fine.
270	2·99	14·6	90	99	85	101	Both samples hold small amount of mica, which accounts for low results.
270a	3·19	13·9	75	88	101	113	
276	4·00	13·9	153	117	135	120	Sand clean and coarse but rather soft.
277	3·82	15·1	91	94	78	81	Weathered, dusty, soft sand.
279	3·27	12·5	147	130	123	123	
280	3·87	10·7	186	165	177	174	
280a	4·19	10·9	183	165	161	173	
282	3·24	12·1	131	135	140	150	
283	3·29	13·5	115	96	129	110	Grains coated with fine dust.
285	3·45	13·7	53	67	46	78	Slightly rusty and dusty. Sample from near surface. Deposit shallow.
287	2·70	13·9	101	110	95	109	Clean, but too fine.
288	2·48	14·6	90	99	85	101	Too fine sand.
289a	2·67	13·8	93	106	100	107	Clean, but too fine.
290	3·07	15·4	114	123	101	104	
291	2·71	13·9	121	110	117	119	
292	2·85	19·1	82	83	71	77	Medium-fine and dusty.
295	2·78	14·3	120	115	100	107	
299	3·24	15·1	109	109	134	157	Sample from near surface; partly weathered and rather soft.
301	3·67	13·9	114	104	108	108	
303	3·99	11·7	170	143	183	164	

TABLE III—Continued

Mortar Test—Continued

Sample No.	Fineness modulus	Per cent of water used	Sand mortar: 1 cement, 3 sand				Remarks.
			Tensile strength, per cent of standard		Compressive strength, per cent of standard		
			7 days	28 days	7 days	28 days	
308	3·41	13·2	113	95	114	119	Grains slightly dust-coated. Sample from near surface.
313	3·57	12·5	151	139	176	146	
315	3·84	11·6	202	165	177	159	
316	3·44	13·9	143	126	135	150	
320	3·23	13·7	125	136	152	147	
321	3·53	13·1	104	111	122	126	
323	3·69	11·4	159	133	157	150	
323a	3·62	12·1	132	127	145	146	
324	3·93	11·2	134	133	171	173	
327	3·77	13·9	57	69	71	87	Sand holds dust and organic matter. Sample from near surface.
329	3·24	13·7	118	140	115	128	
333	3·79	13·1	20	58	10	42	Grains slightly coated with clay mixed with organic matter. Sample from near surface.
339	3·64	12·1	153	136	141	136	
343	3·82	13·4	138	127	118	130	
345	3·67	11·2	159	143	149	153	
349	3·63	13·7	83	87	81	88	Rusty and dusty. Sample from near surface. Deposit shallow.
351	3·33	11·6	162	146	153	140	
351a	3·30	11·6	147	145	157	165	
352	3·71	13·2	143	132	143	158	
352a	3·23	11·3	155	150	122	129	
354	2·92	13·8	115	114	125	138	
355	3·42	10·5	145	136	151	146	
356	3·38	12·4	100	101	101	96	Slightly rusty and dusty. Sample from near surface.
361a	3·81	11·4	150	143	209	175	
361b	3·90	12·4	138	130	172	158	
363	3·43	13·8	113	110	140	132	Dusty sand.
372	3·39	12·1	111	120	116	144	
385	4·07	11·9	136	139	149	164	Sample from run of the bank.
386	4·10	11·0	157	142	217	170	
386a	3·79	12·1	122	136	139	163	
391	2·81	13·5	96	88	129	113	Sand slightly fine.
399	3·22	12·5	110	102	138	112	
404	3·20	11·4	112	120	126	130	
419	3·77	11·3	123	127	170	150	
421	3·51	13·8	84	81	105	130	Dusty sand. Sample from near surface.
432	3·23	12·4	86	99	129	115	Slightly weathered.
436	3·79	13·8	96	92	107	117	Slightly rusty.
460	3·24	15·0	73	72	107	87	Shaly and dusty.
468	3·71	15·4	98	106	103	117	Slightly weathered and dusty.
492	3·35	12·4	107	117	160	138	Slightly weathered.
499	3·29	12·5	110	92	136	110	Fairly fresh sand.
515	3·39	13·8	106	102	121	133	Slightly dusty.
515a	3·14	15·0	94	98	96	112	Clayey sand.
523	3·03	12·7	116	105	152	175	
528	3·47	12·8	130	123	177	147	
534	3·24	12·5	102	109	127	164	
536	3·82	11·7	163	144	191	175	
537	3·67	12·8	120	120	163	185	
538	3·44	11·3	116	130	137	163	
540	3·56	11·4	134	130	181	209	

TABLE III—Continued

Mortar Test—Continued

Sample No.	Fineness modulus	Per cent of water used	Sand mortar: 1 cement, 3 sand				Remarks.
			Tensile strength, per cent of standard		Compressive strength, per cent of standard		
			7 days	28 days	7 days	28 days	
557	4·06	12·5	77	89	96	137	Sample includes partly weathered material from near surface.
559	3·66	10·9	105	129	146	157	
560	3·71	11·9	159	144	209	180	
565	3·70	12·4	137	115	144	184	Sample from stock-pile.
575	3·15	14·9	23	53	25	53	Sample from near surface includes some rusty material.
576	3·58	14·9	80	86	89	113	Sample includes partly weathered material.
581	3·76	10·7	155	133	170	202	
589	3·05	12·1	111	108	150	185	
601	3·75	11·3	109	103	89	80	Sand grains mostly flat slate, hence low compressive strength.
602	3·25	11·5	120	137	134	125	
603	2·95	13·8	102	104	134	117	Fresh but rather fine; sample from test-pit dump.
609	4·56	10·5	118	121	160	145	Very coarse, slightly weathered.
614	3·21	12·3	127	125	151	176	
619	3·10	13·0	129	133	114	117	
623	3·37	12·5	120	130	130	161	
626	3·05	13·8	73	84	96	100	Sample from near surface of shallow deposit.
637	3·12	12·0	121	121	112	127	
638	3·65	11·7	113	123	167	185	
640	3·52	13·8	63	91	92	115	Sample from shallow deposit includes partly weathered material.
641	2·53	15·1	88	95	91	96	Fresh but too fine.
646	3·79	12·4	148	142	150	174	
650	3·66	11·9	41	57	67	104	Coarse and clean; low result may be due to friable slate.
652	3·30	12·8	118	145	144	144	
655	3·57	13·8	155	127	171	170	Coarse; slightly clayey.
658	4·26	12·1	148	137	156	127	
659	3·67	12·1	159	131	175	184	
660	3·74	12·7	137	143	130	160	Coarse; slightly clayey.
664	3·42	12·3	127	125	130	115	Sand grains largely slate.
669	3·36	12·4	111	128	167	157	
670	3·48	12·1	120	131	157	153	
671	4·03	11·9	121	117	174	145	Coarse, slightly weathered and clayey.
673	3·29	13·8	155	133	183	152	
678	4·21	12·8	152	132	194	156	Coarse, slightly clayey.
680	3·39	13·0	150	135	167	139	Slightly clayey but otherwise clean.
681	3·42	13·8	107	127	170	147	
686	4·28	12·7	111	92	171	155	Sample from near surface; coarse, slightly dusty.
687	3·55	12·3	132	149	145	191	
687a	3·57	11·4	145	157	176	165	
688a	3·29	19·3	61	76	87	92	Low result due to clay and silt.
689	3·07	12·7	79	92	126	123	Sample includes partly weathered material.
691	3·03	12·4	86	92	120	111	Sample includes some partly weathered and rusty material.

TABLÆ III—Concluded

Mortar Test—Concluded

Sample No.	Fineness modulus	Per cent of water used	Sand mortar: 1 cement, 3 sand				Remarks.
			Tensile strength, per cent of standard		Compressive strength, per cent of standard		
			7 days	28 days	7 days	28 days	
701	3·59	12·4	130	135	134	152	Large amount of shell fragments.
702	4·01	13·8	136	129	136	120	Large amount of shell fragments.
705	3·53	13·0	130	140	164	150	Large amount of shell fragments.
708	3·31	13·8	136	132	116	105	Clean; sand grains mostly flat slate.
709a	4·04	13·8	150	122	185	195	Coarse; slightly clayey.
713	3·84	12·8	148	135	190	202	Coarse; slightly clayey.
719	3·47	12·8	136	125	135	165	
725	3·81	13·8	148	140	219	175	Coarse; fresh and slightly clayey.
729	3·39	17·2	107	113	115	122	Sand grains mostly shale or slate; soft and slightly clayey.
733	2·87	14·9	113	118	141	163	Clean and fresh but rather fine.
735	2·44	15·5	77	81	82	99	Too fine.
736	3·19	13·8	118	127	150	160	
737a	3·34	13·8	98	96	131	161	Sand grains slightly dust-coated.
740	3·26	16·3	116	107	137	125	Sample includes partly weathered material.
747	3·16	12·8	159	123	165	177	
751	3·53	11·1	173	151	160	205	
753	3·38	12·5	143	123	192	217	Slightly clayey.
761	3·82	11·7	179	139	224	169	Coarse; slightly dusty.
763	4·33	11·0	137	121	199	171	
766	3·17	13·8	120	111	111	166	

TABLE IV

List of Deposits Mentioned in the Report

No.	Location	Owner	See pages
	Pontiac County		
1	Lot 9, Con. I, Chichester	Roads Department	19, 34, 143, 170
2	" 1, " I, "	" "	19, 34
5	" 1, " I, Mansfield	Desjardins	19, 34, 143, 170, 195
6	" 13, " V, Litchfield	W. Cole	19, 35
7	Campbell's Bay		19, 35, 143, 170, 195
8	Lot 26, Con. VI, Litchfield		143, 170
12	Portage du Fort	Howard	19, 143, 170, 195
13	Lot 19, Con. I, Clarendon	Mrs. Paul	35, 143, 170, 195
15	" 19, " VII, "	C. Chamberlain	143, 170
16	" 9, " VI, "	M. Dale	34, 35, 143, 170
18	" 7, " V, "	H. Hodgins	35
20	" 1, " IV, Bristol	W. Thompson	36, 143, 170, 195
21	" 6, " IV, "	Moyle	19, 36, 143, 170, 195
22	" 8, " III, "	J. Dodds	19, 36, 143, 170
23	" 14, " VII, "	M. T. Gallagher	143, 170
26	" 9, " VII, Onslow		37
27	" 8, " VII, "	S. Walsh	19, 37, 144, 171, 195
28	" 22, " VII, "	W. Westbrook	19, 37
29	" 24, " VII, "	Clark	37
30	" 24, " IV, "	Robertson	34, 38
	Hull County		
31	Lot 17, Con. X, Eardley	P. E. Chartrand	19, 38, 144, 171
33	" 2, " VII, Wakefield	W. Meehan	38
35	Lots 50, 51, 52, Con. II, Low	S. O'Rourke; C.P.R.; others	19, 38, 39
37	Lot 47, Con. X, Low	Brooks	19, 39
38	" 12, " XI, Aylwin	J. Heeney	19, 39, 144, 171
39	" 49, " X, "	P. Pétrin	39, 144, 171
40	" 49, " XI, "	A. Desjardins	39
41	" 15, " I, Wright	N. Bénard	39, 144, 171
43	" 21, " III, Bouchette	O. Saumur	40, 144, 171, 195
44	" 43, " IV, "	E. Lafontaine	20, 40, 144, 171, 195
45	" 1, W. Gatineau, Maniwaki	P. Brascoupé	20, 40, 144, 171
46	" 31, Con. III, Kensington	L. Thériault	40
47	" 42, " I, "	J. MacSheffrey	41
53	6 miles N.E. of Ste. Famille	L. Brunet	20, 41, 144, 171, 195
	Labelle County		
54	4 miles W. of St. Jean	Roads Department	20, 41, 42
55	1 mile W. of St. Jean	F. Fleurant	20, 42, 144, 171, 195
61	Lot 23, Con. I, Campbell	M. Valiquette	20, 42, 145, 171, 195
67	" 41, " V, Loranger	J. Gagnon	42
71	" 14, S.W. Rivière Rouge, Marchand	T. Fortin	42, 145, 171
73	" 27, Con. III, Clyde	La Fabrique	20, 42, 145, 171
	Papineau County		
74	Lot 13, Con. VII, Templeton	Madore	43
76	" 7, " IX, "	Mrs. Charette	43, 145, 171
78	" 12, " IX, Buckingham	H. Gorman	145, 172, 195
79	" 13, " IX, "	Laframboise	43, 145, 172, 195
80	" 14, " VII, "	W. Newton	43, 44, 145, 172
81	" 14, " VII, "	W. Newton	44, 145, 172, 195

TABLE IV—Continued

List of Deposits Mentioned in the Report—Continued

No.	Location	Owner	See pages
	Papineau County—Concluded		
82	Lot 14, Con. VI, Buckingham	A. C. Smith	44, 145, 172
83	" 15, " VIII, Lochaber	M. Burke	44, 145, 172
85	3 miles N.W. of Montebello	E. Arbique	20, 44, 145, 172
86	2 miles N.W. of "	A. Périard	20, 45, 145, 172
88	1½ miles S.E. of St. Amédée	O. Gagnon	45, 145, 172, 195
	Argenteuil County		
90	Lot 33, Con. I, Augm. Grenville	Alex. Campbell	20, 45, 145, 172, 195
91	" 29, " I, "	Arch. Campbell	20, 45
92	" 25, " X, Grenville	A. Page	45, 146, 173
97	" 26, " V, Chatham	W. Lafleur	45
98	" 23, " V, "	A. Lavigneur	45, 146, 173, 195
101	" 24, " XII, "	Roads Department	45, 146, 173
103	6 miles E. of Lachute		20, 45
	Terrebonne County		
109	Lot 24, Con. VI, Wolfe	W. Levert	20, 46, 146, 173, 195
110	" 2, " VI, "	J. Ouellet	20, 46
111	" 42, " VI, Beresford	D. Lajeunesse	20, 46, 146, 173
112	" 35, " VI, "	A. Lanthier	20, 46
113	" 13, " V, "	Roads Department	20, 47, 146, 173
115	½ mile N. of Piedmont	Ach. Lalande	47, 146, 173
116	Piedmont	Art. Lalande	47, 146, 173
117	¾ mile S. of Shawbridge	J. Clavel	47
119	2¾ miles N.W. of St. Jérôme	A. Durant	20, 47, 51, 146, 173, 195
120	1½ miles W. of "	A. Lemay	48
121	1½ miles W. of "	A. Lebeau	48, 49
122	1½ miles W. of "	H. Danis	48, 49
123	2 miles S.W. of "	Coulombe et Limoges	48
	Montcalm County		
125	Lots 6, 7, Con. II Rawdon		20, 49, 51, 146, 173, 195
126	Lots 5, 6, Con. II, "	N. Landry	20, 49, 51, 146, 173, 195
127	2½ miles S.W. of Ste. Julienne	Roads Department	20, 49, 51, 146, 173
128	Lot 7, Con. III, Chertsey	L. Tremblay	50, 147, 173
129	" 9, " VII, "	X. Charron	50
132	" 17, " VI, Chilton	La Fabrique	50, 147, 173
133	" 25, " III, Lussier	I. Lavoie	50
134	" 11, " III, "	E. Riopel	50, 51, 147, 173, 195
135	" 13, " VI, Rawdon	J. Brousseau	21, 51, 147, 174, 195
139	" 15, " III, "	Brouillet Sand & Gravel Co., Ltd	51, 52, 147, 174, 195
141	1 mile W. of Les Dalles	L. Lachapelle	52
	Joliette County		
147	5 miles S.E. of St. Alphonse	G. Marchand	147, 174
153	4¼ miles S.W. of St. Félix	Standard Sand, Ltd	52, 147, 174, 195
	Berthier County		
157	Lot 11, Con. X, Brandon	Mrs. P. Phaneuf	147, 174
159	" 9, " V, "	N. Ducharme	52, 147, 174
160	" 8, " III, "	A. Bacon	53
161	" 7, " IV, "	J. D. Gaudet	53
162	" 8, " IV, "	P. Lavallée	53, 147, 174, 195
163	" 9, " IV, "	L. Rondeau	53, 147, 174

TABLE IV—Continued

List of Deposits Mentioned in the Report—Continued

No.	Location	Owner	See pages
	Maskinongé County		
165	1 mile S.W. of Ste. Ursule Station.	Canadian National Ry.....	53
166	1½ miles N.W. " " .	W. Michaud; E. Bergeron....	21, 53, 54, 147, 174, 175, 195
167	2 miles N.W. " " .	Roads Department.....	21, 54, 147, 175
168	4½ miles N.W. of St. Léon.....	.....	54, 147, 175
172	3 miles W. of St. Paulin.....	T. St. Louis.....	21, 54, 147, 175, 195
173	Lot 6, Range S.E. Riv. du Loup	.....	54
175	" 26, " S.W. " "	S. Lambert	55
	St. Maurice County		
178	Lot 5, Range IV, Augm. Caxton.	Roads Department.....	21, 55, 147, 175
179	" 12, " IV, Caxton.....	J. Lessard.....	55, 148, 175, 195
180	" 67, " I, St. Etienne.....	E. Dupont.....	56
	Champlain County		
182	3 miles S. of St. Tite.....	E. Gagnon.....	56
183	1½ miles N.W. of St. Tite.....	Roads Department.....	21, 56, 148, 175
185	2½ miles N.E. of Ste. Thècle.....	O. Champagne.....	21, 57
186	1½ miles N.W. of Ste. Anne.....	(River gravel).....	21, 57, 148, 175
	Portneuf County		
193	1¾ miles W. of St. Raymond.....	E. Moissan.....	21, 57, 58, 148, 175
195	1 mile S.E. of Ste. Catherine.....	A. Denis.....	58
198	3¼ miles N.W. of St. Augustin.....	P. Paradis.....	58
200	3¾ miles W. of St. Augustin.....	A. Soulard.....	58
	Quebec County		
202	2 miles S.E. of Valcartier.....	C. Hicks.....	59
	Huntingdon County		
206	Lot 20, Con. I, Dundee.....	Mrs. Watson.....	22, 60, 61, 148, 175, 195
207	" 18, " IV, "	C. Smallman.....	60
208	" 18, " IV, "	Mrs. M. Holden.....	22, 61
210	" 61, " V, Godmanchester..	Township and C.N.Ry.....	22, 61, 148, 175, 195
211	" 55, " IV, " ..	J. S. Leblanc.....	22, 61, 148, 175, 195
213	" 42, " IV, " ..	S. Barry.....	22, 61, 148, 175, 196
214	" 47, " II, " ..	U. Hurteau.....	62, 148, 175, 196
215	" 47, " I, " ..	O. Caza.....	62
216	Lots 25, 26, Con. II, " ..	A. Mainville; J. Brunet.....	62, 148, 176
218	" 9, Con. II, Elgin.....	F. Brown.....	62, 149, 176, 196
223	Lot 38, " III, Hinchinbrook...	R. Arthur.....	22, 62, 149, 176, 196
226	" 27, " II, Franklin.....	E. Roy.....	22, 63, 149, 176, 196
229	" 81, " II, Havelock.....	C. B. Edwards.....	22, 63, 149, 176
231	" 106, " III, Hemmingford..	R. Hayden.....	63, 149, 176, 196
232	" 178, " V, " ..	Township.....	63, 149, 176, 196
	Beauharnois County		
235	4 miles E. of Valleyfield.....	J. Boyer.....	149, 176
	Châteauguay County		
237	¾ miles S.W. of Cairnside.....	D. Greig.....	64, 149, 177, 196
240	3 miles S. of Ste. Philomène.....	T. Thibert.....	64, 65, 149, 177, 196
241	1¾ miles S.E. of "	E. Vallée.....	64, 65
242	2 miles S.E. of "	Canadian National Ry.....	65, 149, 177, 196
243	1½ miles S.E. of "	A. Bannan.....	65

TABLE IV—Continued

List of Deposits Mentioned in the Report—Continued

No.	Location	Owner	See pages
	Napierville County		
244	1½ miles S.W. of St. Michel	T. Bisson	22, 65, 66, 149, 177, 196
245	1 mile E. of St. Rémi	O. Robert; F. Houle	22, 65, 66, 149, 177, 196
247	Douglasburg	R. Béchard	22, 66
248	1½ miles W. of Napierville	E. Cyr; N. Fortin	22, 66, 150, 177, 196
	St. Johns County		
251	2 miles W. of Odelltown	Parish of St. Bernard	22, 67, 150, 177
255	2 miles W. of St. Valentin	C. Deneault	67, 150, 177
257	2¾ miles S.W. of Ste. Blaise	B. Breault	23, 67, 150, 177, 196
258	2 miles S.W. "	A. Gagnon	23, 67, 150, 177, 196
259	3½ miles S.W. of St. Johns	A. Tremblay; A. Roulier	23, 68, 150, 177, 196
	Chambly County		
262	½ mile N. of St. Bruno	E. Goyer	68, 150, 177, 196
263	1½ miles W. of St. Basile	F. H. Clergue	68, 150, 177
	Iberville County		
265	2 miles N.E. of St. Alexandre	J. Breault	23, 69, 150, 177, 196
268	1 mile N.E. of St. Grégoire	E. Tétreau	23, 69, 70, 151, 178, 196
269	1½ miles N.E. "	U. Benoit	23, 70, 151, 178, 196
270	2½ miles N.W. "	E. Metras	23, 70, 151, 178, 196
	Missisquoi County		
273	Lot 6, Con. VII, Stanbridge	A. A. Coderre	70
274	" 19, " VI, "	P. Clouatre	71
275	" 47, " I, Farnham West	C. Laurin	151, 178
276	" 14, " St. Armand	B. Wilson	23, 71, 151, 178, 196
277	" 3, " X, Dunham	G. Barnes	71, 151, 178, 196
279	" 28, " V, "	Cowansville (Municip.)	23, 71, 151, 178, 196
280	" 28, " VI, "	Roads Department	23, 71, 151, 178, 196
	Rouville County		
281	1½ miles S. of Canrobert	A. Mercure	72
282	2½ miles E. of Abbotsford	C. Ball	72, 151, 178, 196
283	¾ mile W. of Mont St. Hilaire	A. Guertin	73, 151, 179, 196
285	1 mile S.E. of St. Hilaire	R. Desourdy	152, 179, 196
	Bagot County		
287	2 miles S.E. of St. Dominique	F. X. Breault	23, 73, 74, 152, 179, 196
288	2 miles S.E. of "	A. Lebeau	23, 73, 74, 152, 179, 196
289	2½ miles E. of "	M. Deslandes	23, 74, 152, 179, 196
290	2½ miles E. of "	A. Dubreuil	23, 74, 152, 179, 196
291	1½ miles S. of St. Liboire	J. Rodier	23, 74, 75, 152, 179, 196
292	1½ miles S.E. of "	A. Desmarais	23, 74, 75, 152, 179, 196
295	1½ miles N.W. of "	H. Montmarquette	23, 75, 153, 179, 196
299	Lots 2, 3, Con. XII, Grantham		23, 75, 153, 179, 196
301	Lot 33, Con. VI, Acton	H. Guérin; J. St. Amand	23, 75, 153, 179, 196
303	" 29, " VI, "	H. Champagne	23, 76, 153, 179, 196
308	" 14, " III, "	Mrs. Bisaillon	153, 179, 197
	Brome County		
313	Lot 4, Con. II, Brome	W. MacNeil	76, 153, 179, 197
315	" 7, " II, "	Roads Department	23, 76, 77, 153, 180, 197
316	" 10, " VI, "	J. C. Soles	77, 153, 180, 197

TABLE IV—Continued

List of Deposits Mentioned in the Report—Continued

No.	Location	Owner	See pages
	Brome County—Concluded		
320	Lot 16, Con. V, Potton	Roads Department	153, 180, 197
321	" 2, " VI, Bolton	D. Coates	153, 180, 197
323	Lot 11, Con. I, "	M. Hunt	23, 76, 77, 153, 180, 197
324	" 21, " VIII, "	J. Crawford	23, 76, 77, 153, 180, 197
	Shefford County		
327	Lot 13, Con. II, Milton	G. Messier	78, 153, 180, 197
329	" 2, " I, "	S. Paul	78, 154, 180, 197
333	" 16, " X, Roxton	N. Raymond	24, 78, 154, 181, 197
334	" 17, " X, "	A. Parent	154, 181
335	Lots 3, 4, Con. I, Shefford	A. Sirard; M. McMahon	154, 181
336	Lot 23, Con. I, "	Roads Department	24, 79, 154, 181
337	" 23, " V, "	R. Stretch	79
339	" 23, " VII, "	Mrs. C. McLaughlin	79, 154, 181, 197
343	" 27, " VIII, "	Roads Department	24, 80, 154, 181, 197
345	" 16, " IX, Stukely	Z. Gervais	24, 80, 154, 181, 197
349	" 15, " I, Ely	E. Ferland	155, 181, 197
	Drummond County		
350	Lot 11, Con. X, Durham	Bonner Sand & Ballast Co.	24, 80, 155, 181
351	" 10, " IX, "	E. Reed; J. E. Mitchell	81, 155, 181, 197
352	Lots 14, 15, Con. IX, Durham	Dominion Sand & Stone Co.	80, 81, 155, 181, 197
353	Lot 6, Con. IV, Durham	L. Pye	24, 81, 155, 181
354	" 11, " III, "	A. Cross	155, 182, 197
355	" 24, " I, "	T. Labonté	82, 155, 182, 197
356	" 15, " IX, Wickham	A. Lepage	24, 80, 82, 155, 182, 197
358	" 1, " VIII, Wendover	A. Lafond	24, 82, 155, 182
359	" 1, " XIII, "	Roads Department	24, 82, 155, 182
	Stanstead County		
361	Lot 26, Con. III, Barnston	Canadian National Ry	83, 155, 182, 197
362	" 26, " III, "	Coaticook (Municipality)	24, 83, 155, 182
363	" 9, " II, "	C. Smith	24, 83, 84, 156, 182, 197
364	" 5, " II, Hatley	Township	84
365	" 17, " III, "	H. Lebaron	84
369	" 1, " VIII, Stanstead	Township	84
372	" 13, " IX, Hatley	J. Ingalls	84, 156, 182, 197
375	" 18, " IX, "	Roads Department	24, 84, 156, 182
379	" 1, " XIV, Magog	" "	24, 85
	Sherbrooke County		
381	Lot 27, Con. X, Orford	Roads Department	85, 156, 183
382	" 11, " II, "	B. Charest	156, 183
383	" 10, " V, Ascot	J. Mallory	85
385	" 28, " I, "	J. Bélanger	85, 156, 183, 197
386	" 7, " I, Orford	City of Sherbrooke	24, 25, 86, 156, 183, 197
387	" 6, " I, "	W. Brault	24, 25, 86
389	" 2, " II, "	K. Moe	24, 25, 86, 156, 183
390	" 1, " II, "	S. Clark	24, 25, 87
	Richmond County		
391	Lot 33, Con. V, Brompton	H. McLeod	24, 25, 87, 156, 183, 197
392	" 32, " V, "	J. Ross	24, 25, 87, 156, 157, 183
393	" 21, " XIV, Windsor	A. Paquette	24, 25, 88
394	" 9, " XII, "	J. St. Pierre	24, 25, 88

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List of Deposits Mentioned in the Report—Continued

No.	Location	Owner	See pages
	Richmond County—Concluded		
395	Lot 1, Con. XV, Cleveland	J. Leclair	24, 25, 88
396	" 11, " XV, "	W. J. Ewing	24, 25, 88, 157, 183
399	" 7, " VIII, Melbourne	R. Barr	24, 25, 88, 157, 183, 197
401	" 9, " XIV, Cleveland	W. H. Healy	24, 25, 89
402	" 11, " XII, "	Roads Department	89, 157, 183
403	" 22, " I, Shipton	A. Allison	25, 87, 89
	Arthabaska County		
404	Lot 15, Con. I, Warwick	W. Gauthier	89, 157, 183, 197
406	" 9, " XI, Stanfold	(River gravel)	89, 157, 183
409	" 25, " X, Chester	" "	89, 157, 183
	Compton County		
413	Lot 13, Con. IV, Westbury	A. Gilbert	90
414	" 13, " IV, "	Corpor. East Angus	90, 157, 183
418	" 1, " VII, Bury	A. Veilleux	25, 91
419	" 5, " B, "	C. Ord; Township	25, 91, 157, 183, 197
420	" 18, " D, Lingwick	Roads Department	91
421	" 37, " K, "	J. Smith; Roads Dept	25, 91, 157, 184, 197
423	" 16, " III, Clifton	J. Reid	92
424	" 15, " III, "	Mrs. L. St. Germain	92
426	" 3, " II, Auckland	H. Roy	92
427	" 6, " I, Hereford	F. Rowell	25, 92, 157, 184
428	" 19, " V, Eaton	Mrs. McMurray	158, 184
	Wolfe County		
432	Lot 26, Con. I, Ham	H. Ramsay	93, 158, 184, 197
433	" 45, " A, "	O. Aubert	93
436	" 10, " XII, Stratford	A. Gagnon	93, 158, 184, 197
437	" 6, " XII, "		93
446	" 5, " III, Dudswell	J. Labrecque	94
	Megantic County		
451	Lot 4, Con. IV, Ireland	(River gravel)	25, 94, 158, 184
458	" 23, " IV, Nelson	J. Lacasse	158, 184
459	" 15, " VI, "	(River gravel)	25, 94, 158, 184
	Lotbinière County		
460	2 miles N.E. of Dosquet	N. Charest	95, 158, 184, 197
461	3 miles W. of Issoudun	A. Poulin	95
462	2¼ miles N.E. of St. Flavien	J. B. Demers	95, 158, 184
465	1½ miles S.E. of St. Apollinaire	J. Gingras	95, 96, 158, 185
	Frontenac County		
468	Lot 27, Con. A, Lambton	J. Bélanger	96, 158, 185, 197
473	" 57, " I N.E., Whitton	N. Roy	25, 96
475	" 55, " II, Spalding	J. Breton	25, 97
476	" 1, " II, Woburn	A. Roy	97, 159, 185
477	" 27, " I, Ditchfield	Roads Department	97
478	" 10, " III, "	F. Bédard	97
479	" 47, " IV, Spalding	A. Couture	25, 98
480	" 38, " IV, "	Roads Department	25, 98
481	" 15, " II, "	Township	98
488	" 23, " VIII, Marlow	O. Pelchat	159, 185

TABLE IV—Continued

List of Deposits Mentioned in the Report—Continued

No.	Location	Owner	See pages
	Beauce County		
492	2½ miles N.W. of Ste. Marie	H. Gagnon	25, 99, 159, 185, 197
493	Ste. Marie	E. Cliche	25, 99
494	1½ miles S.E. of Ste. Marie	A. Nadeau	99
497	Valley Junction	Roads Department	99
499	1½ miles S.E. of St. Joseph	J. Jacques	25, 99, 100, 159, 185, 197
501	Beauceville	(River gravel)	25, 99, 159, 185
504	Touffe de Pins	H. Poulin	159, 185
506	Lot 83, Range I, Aubin de l'Isle	J. Routhier	100, 159, 185
508	Lot 15, Con. I N.E., Jersey	(River gravel)	25, 99, 159, 185
514	Lots 16, 17, Con. IV, Broughton	G. Gravel; E. Gravel	100, 159, 185
515	Lot 16, Con. X, Broughton	T. Beaudoin	100, 159, 185, 197
516	" 19, " XI, "	S. Paquette	101
	Levis County		
517	2 miles W. of St. Nicholas	J. A. Paquette	101, 159, 185
518	3 miles N.E. "	A. Olivier	101, 159, 185
520	St. Télesphore	P. Bégin	159, 185
522	2¾ miles S.E. of St. Henri	A. Laliberté	31, 101
	Dorchester County		
523	4 miles N. of St. Bernard	N. Fortier	101, 102, 159, 186, 197
524	3 miles N. of Coulombe	J. Brousseau	102, 160, 186
527	Coulombe	A. Allen	102
528	2½ miles N. of St. Maxime	A. Giguère; H. Binette	102, 160, 186, 197
529	2½ miles N.W. of St. Anselme	S. Turmel	31
532	2¾ miles W. of Ste. Claire	J. Laliberté	103
533	½ mile E. "	E. Bissonette	31, 103, 160, 186
534	¼ mile E. "	E. Lacasse	104, 160, 186, 197
536	2 miles N.W. of Ste. Malachie Sta.	A. Leclerc	104, 160, 186, 197
537	Lot 14, Con. IX, Frampton	W. Kelly	31, 104, 160, 186, 197
538	" 25, " XI, "	J. Gosselin	160, 186, 197
540	" 4, " IV, Ware	A. Turmel; J. Turmel	31, 105, 160, 186, 197
544	" 7, " IX, Langevin	R. Lecours	105, 161, 186
	Bellechasse County		
545	1 mile S. of Beaumont	A. Jacques	26, 106
546	1½ miles E. "		26, 32
547	3½ miles S. E. of St. Vallier	L. G. Roy	26, 32, 106
549	1½ miles N.E. of St. Gervais	P. Laflamme	107, 161, 186
550	1½ miles S.E. " "	Roads Department	107, 161, 187
551	2 miles N.E. of Honfleur	T. Dion	107
554	4 miles S.E. of St. Lazare	A. Mignault; E. Mignault	32, 107, 161, 187
555	¼ mile N.E. of Goulet	A. Mercier; A. Guillemette	107
556	St. Damien	C. Lafontaine	32, 108, 161, 187
557	2½ miles N.E. of St. Damien	A. Rouleau	108, 161, 187, 198
558	Lot 2, Con. X N.W., Buckland	J. Corriveau	108
559	2½ miles S.W. of St. Raphael	J. Raby	32, 106, 109, 161, 187, 198
560	1½ miles S.E. "	E. Ménard	109, 161, 187, 198
562	Lot 12, Con. II, Armagh	C. Roy	106, 109, 110, 161, 187
563	" 81, " I S.E. Armagh	J. Cadran	106, 110
564	" 20, " S.W., Mailloux	A. Campagnon	32, 110
565	" 11, " N.E., "	P. Roy	32, 110, 111, 161, 187, 198
566	" 2, " N.E., "	N. Rouillard	110
570	" 12, " III, Bellechasse	J. Prévost	111, 161, 187
571	" 30, " N.E., "	J. E. G. Bolduc	111
572	" 35, " VI, "	Mrs. M. Blais	111
573	" 42, " VI, "	F. Fournier	112

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List of Deposits Mentioned in the Report—Continued

No.	Location	Owner	See pages
	Montmagny County		
575	2½ miles E. of St. Pierre	A. Bernier	161, 187, 198
576	3½ miles S. of Montmagny	U. Talbot	112, 113, 162, 187, 198
577	2½ miles S. "	E. Fournier	113
580	Lot 43, Con. A, Ashburton	H. Mercier	113
581	" 35, " VII, Panet	J. Foley	112, 113, 162, 187, 198
583	" 9, " II, "	Roads Department	114
584	" 17, " X, Talon	J. Labrecque; A. Fournier,	114
585	" 32, " X, "	M. Wilson	114
	L'Islet County		
589	2 miles S.E. of St. Eugène	J. Théberge	33, 115, 162, 187, 198
594	¾ mile N.W. of St. Aubert	L. Bois	26, 115
595	1½ miles W. of St. Damase	J. Bélanger	115
596	1 mile W. "	T. Fortin	116
597	½ mile S.W. "	J. B. Bélanger	116
598	1 mile N. "	H. Gamache	115, 116, 162, 187
601	4 miles S.W. of St. Roch	G. Pelletier; N. Ouellette	26, 116, 162, 187, 198
602	4 miles S.W. "	A. Francoeur	26, 115, 117, 162, 187, 198
603	¾ mile S.W. "	A. Pelletier	162, 188, 198
605	Lot 11, Con. I, Beaubien	P. Cloutier	117
607	" 32, " V, Arago	G. Couillard	117
609	" 26, " II, Leverrier	D. Corriveau	33, 117, 162, 188, 198
611	" 27, " VII, "	E. Bernier	118
612	" 39, " V, Casgrain	E. Thiboutot	118
614	" 21, " VI, "	H. Jean	31, 118, 163, 188, 198
615	" 11, " A, Garneau	W. Flamand	118
616	" 2, " I, Lafontaine	A. S. Pelletier; Roads Department	119
	Kamouraska County		
619	¾ mile S.W. of Ste. Anne	M. Martin	26, 119, 163, 188, 198
623	½ mile W. of St. Pacôme	Canadian Nat. Ry	26, 119, 163, 188, 198
624	½ mile N.W. "	N. Picard	120
626	1½ miles N.E. of St. Philippe	L. Anctil	163, 188, 198
630	2½ miles N.E. of St. Pascal	J. Morneau	26, 119
633	3 miles S.E. of Ste. Hélène	F. Lajoie	120, 163, 188
637	1 mile S. of St. André	A. Saint-Pierre; Roads Department	26, 119, 120, 121, 163, 188, 198
638	2 miles N.E. of St. André	H. Lebel	26, 119, 121, 163, 188, 198
639	3 miles N.W. of St. Alexandre	C. E. Caron	26, 33, 119, 121
640	2 miles N.W. " "	A. Ouellet	26, 33, 119, 121, 163, 189, 198
641	3 miles S.E. " "	E. Lapointe	163, 189, 198
644	3 miles N.W. of Pelletier Station	Roads Department	33, 122
645	¾ mile N.W. " "	" "	33, 122
	Témiscouata County		
646	1½ miles W. of Estcourt	Canadian Nat. Ry	33, 123, 163, 189, 198
649	¼ mile W. of Rivière Bleue	J. Girard	33, 123, 163, 189
650	Aubut Station	Canadian Nat. Ry	122, 123, 163, 189, 198
652	2½ miles S.W. of St. Hubert	A. Thériault	122, 124, 163, 189, 198
655	2½ miles E. of St. Honoré	L. Lebel	28, 122, 124, 163, 189, 198
658	2 miles W. of St. Louis	J. B. Pelletier	28, 122, 124, 164, 189, 198
659	Cabano	J. Bérubé; Roads Dept	28, 122, 125, 164, 189, 198
660	Notre Dame du Lac	M. le Curé E. Gagnon	28, 122, 125, 164, 189, 198
662	Ste. Rose	W. Souci	164, 189

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List of Deposits Mentioned in the Report—Continued

No.	Location	Owner	See pages
	Témiscouata County—Concluded		
664	5¾ miles S.E. of Ste. Rose	D. Griffin	28, 122, 125, 164, 189, 198
665	1¼ miles S.E. of Notre-Dame du Portage	T. Pelletier	122
669	2¼ miles N.E. of Rivière du Loup	A. Sirois	122, 126, 164, 189, 198
670	2½ miles N.E. of St. Antonin	J. Bérubé	27, 126, 164, 189, 198
671	2 miles S.W. of St. Modeste	J. B. Bérubé	126, 164, 189, 198
673	¾ mile N.E. "	C. Beaulieu	127, 165, 190, 198
675	S.W. of Cacouna	E. Roy	165, 190
678	St. Epiphane	A. Gagnon	127, 165, 190, 198
680	2½ miles N.E. of St. Epiphane	J. Gagnon	127, 128, 165, 190, 198
681	3½ miles N.E. of "	O. Gagnon	127, 165, 190, 198
684	½ mile N.W. of St. Cyprien		165, 190
685	½ mile S.W. of St. Eloi	C. Bouchard	122, 165, 190
686	1 mile N.W. "	S. Pettigrew	27, 122, 128, 129, 165, 190, 198
687	2 miles N.W. "	Canadian Nat. Ry	122,123, 128, 129, 165, 190, 198
688	2 miles S.W. of Trois Pistoles	C. Morency	27, 122, 123, 128, 165, 190, 198
	Rimouski County		
689	3½ miles S.W. of St. Simon	D. Rioux	27, 129, 165, 191, 198
690	1 mile N.E. of St. Fabien	F. Coulombe	27, 129, 165, 191
691	4½ miles N.E. "	J. Côté	27, 129, 165, 191, 198
693	½ mile S. of Bic	G. Voyer	27, 129, 130, 166, 191
696	Sacré Cœur	A. Turcotte	129
697	1 mile S.E. of Sacré Cœur	J. Roy	166, 191
701	1½ miles S.W. of St. Anaclet	A. Poirier	129, 130, 166, 191, 199
702	St. Anaclet	E. Heppel	129, 130, 166, 191, 199
705	1 mile N.E. of Luceville	A. Montgrain	129, 130, 166, 191, 199
708	¾ mile S.W. of St. Donat	J. Chasseur	129, 166, 191, 199
	Matane County		
709	2½ miles N.W. of Ste. Angèle	J. B. Gagnon	28, 131, 132, 166, 191, 199
710	1 mile W. "	C. Pelletier	131, 167, 191
713	2½ miles N.W. "	A. Beaulieu	28, 131, 132, 167, 192, 199
	Matapedia County		
714	2 miles S.W. of St. Moise	J. Dufour	28, 132
715	3 miles W. of Sayabec	A. Gagné	133
716	3¼ miles E. of Val Brillant	J. Beaulieu	133
718	3 miles N. of Amqui	D. Pelletier	28, 132, 133
719	2 miles S.E. "	J. B. Roussel	28, 132, 134, 167, 192, 199
721	1 mile N. of Lac au Saumon	M. Pelletier	134, 167, 192
722	3½ miles E. "	E. Desroches	132, 134, 167, 192
723	3 miles N.W. of Causapscal	A. Dufour	28, 132, 135
724	½ mile N. "	E. Morissette	135, 167, 192
725	Causapscal	G. Blais	28, 132, 135, 167, 192, 199
	Bonaventure County		
728	1 mile N. of Routhierville	Roads Department	137
729	1½ miles S.E. "	" "	136, 167, 192, 199
730	1½ miles N. of Millstream	W. Kays	137
731	Near St. Alexis Station	J. Poirier	137
733	½ mile S.W. of Broadlands	E. Nicol	29, 137, 167, 193, 199

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List of Deposits Mentioned in the Report—Concluded

No.	Location	Owner	See pages
	Bonaventure County—Concluded		
735	2 miles N. of Restigouche	F. Fraser	30, 137, 167, 193, 199
736	2½ miles E. of Oak Bay	J. Haynes	29, 138, 168, 193, 199
737	Pointe à la Garde	J. Pitre; J. Low	29, 30, 136, 138, 168, 193, 199
739	1½ miles S.W. of Escuminac	S. Barnes	29, 30, 136, 139, 168, 193
740	3 miles W. of Nouvelle	E. Dugas; J. D'Amboise	29, 30, 139, 168, 193, 199
741	1½ miles S.E. of St. Jean	E. Gauvreau	139
747	3 miles N. of Caplan	J. Poirier	139, 168, 193, 199
751	½ mile N.E. of Bonaventure	F. Arsenault	30, 136, 140, 168, 193, 199
752	1½ miles E. "		136, 140
753	3½ miles N. of St. Godfroy	E. Aubut	30, 136, 140, 168, 193, 199
	Gaspe County		
760	1½ miles W. of Grand Pabos	M. Wall	141
761	½ mile W. of Brèche-à-Manon		141, 169, 193, 199
762	1¾ miles N. of Coin du Banc	N. Thibeault	142, 169, 193
763	Between Barachois and Coin du Banc	(Beach gravel)	29, 141, 142, 169, 193, 199
766	6½ miles W. of Gaspe	R. Patterson	169, 193, 199
767	1½ miles W. "	W. Kenny	169, 194

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