History of Materials Research Division

In 1913, the Country Roads Board (CRB) was established, making the Board responsible for the care and management of roads within the State, considered to be Main Roads. At that time, the roads in Victoria were generally in deplorable conditions. Many of them, particularly in various hilly areas of the State, were little better than primitive tracks, and even those roads which had been well constructed as the principal coach routes had been allowed to deteriorate to a very serious extent, before the advent of railways.

The importance of good roadmaking materials was recognized right from the start of the CRB as indicated in their first Annual Report in 1914 which provided great detail on the requirements for such materials. In particular, the suitability of stone for road metal depends upon the following factors: 1. Hardness. 2. Toughness. 3. High cementing value. At this early stage, the Board's intention was, as soon as practicable, to enter upon this research into samples obtained throughout the State to determine their suitability for road-making purposes.

In the first 10 years of operation, John Mathers was responsible for metropolitan projects and the testing of materials. However, it is most likely that such testing work was carried out as part of the function of other engineers rather than being assigned specifically to be the sole responsibility of one person. CRB engineers were housed in a small room in the Tit1les Office located in Queen Street, Melbourne (subsequently demolished to make way for the Law Courts). By the mid-1920's, the CRB had entered into a joint program with the engineering school at the University of Melbourne for the testing of road construction materials. And in 1926, the CRB financed the establishment of a laboratory at the university, for the testing of such materials.

Near the end of 1928, the Board Officers moved from the Titles Office to premises in the Exhibition Building and there, a small "back room" laboratory was established in a converted parliamentary kitchen with some benches, a few sieves, some equipment for testing bitumen and a lot of empty space. However, due to the University having more specialised machines for undertaking most of the tests, it was not considered economical for the Board to install the full range of testing equipment.

Exhibition Street Laboratory – 1929

Alf Gawith – 1970 (on retirement)

It was not until 1929 that materials testing, and research work became a regular feature in CRB annual reports. Also in 1929, Alf Gawith was appointed as an Assistant Engineer in charge of laboratory testing. Initially he was involved with the testing of gravel,

screenings and bituminous materials. In 1930 Alf obtained a Batchelor Degree in Civil Engineering from Melbourne University and a Master of Civil Engineering in 1948.

1929. Testing of Materials. Particle Size Gradings of soils, gravels, crushed aggregates, Plasticity Index (PI) and Linear Shrinkage (LS) tests were being undertaken; all based on procedures from Bureau of Public Roads, Washington but assumed were used right from the start in 1913. Note: PI = LL – PL

Equipment for Grading, PI and LS Testing:

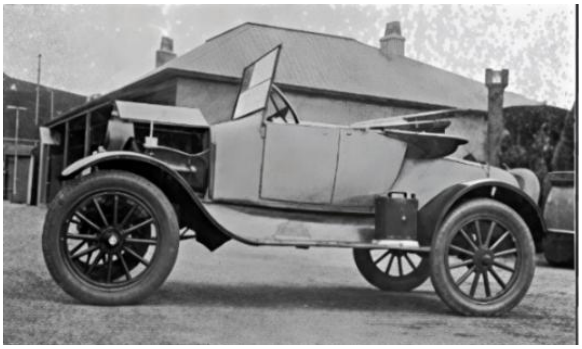
1. Grading Sieves 2. Liquid Limit (LL) 3. Plastic Limit Plate (PL) 4. Linear Shrinkage 5. Small Tins for holding samples from PL & LL tests for MC testing

1930. Introduction of Crushed Rock. An experiment using crushed rock for road construction was carried out on the Prince's Highway West, between Portland and Heywood. The material was spread in two even layers to a loose thickness of 3 to 4 inches, the lower coat being consolidated before spreading the top course. To date, the results of these investigations and experiments were very encouraging by reducing the cost of work and achieving a smoother ride.

1931:

- **Laboratory Work** had been particularly extensive during the year, mainly with soil analysis, research into various bituminous materials and correlation of tests from the routine testing of materials. The excellent, though generally simple, laboratory equipment used at that time, and the qualified staff were again extremely valuable in reducing the costs of Works.

- **Road roughness** testing was undertaken in 1930 using a Morris Cowley car, but results proved unreliable. In 1931, a T Model Ford was purchased for £15. A modification to the suspension system was made by fitting the front with helical springs instead of the conventional laminated springs. The front chassis was then loaded up with two 100lb pigs of lead. These two changes produced more reliable results.



T-Model Ford -1931

Helical Springs & Lead weights

- **Viscosity of Bitumen** was undertaken (but again was most likely being tested right from the start in 1913) is a measure of its resistance to flow crucial for mixing with aggregates in sprayed sealing and asphalt works.

1932:

- **Cut-Back Bitumen**. Tar, which had been used in sealing work would deteriorate by oxidisation and crumble under traffic. It was therefore decided to experiment with the use of bitumen cut-back with partly volatile oils to a viscosity suitable for thorough mixing, but which would set up in about a week by the evaporation or dispersion of the lighter fractions of the fluxing medium. Results proved that Cut-Back Bitumen would prove suitable for sprayed sealing work.

- **The number of tests** being undertaken during the year by staff indicating the importance being placed on such testing:

• Tests on gravel & metal submitted by tenderers or from current contracts	700
• Tests on Refined Tar produced by the Bitural process	370
• Tests on samples of bituminous materials from Suppliers	80
• Tests on Tenderer's' samples of bituminous materials	150
• Special tests on fluxing of various bituminous materials	100
• Soil samples tested	70
• Concrete test cylinders with materials from bridge contracts	20
• Research on Paint, Timber, test apparatus & new test methods	110
Total Number of Tests in 1932	**1,600**

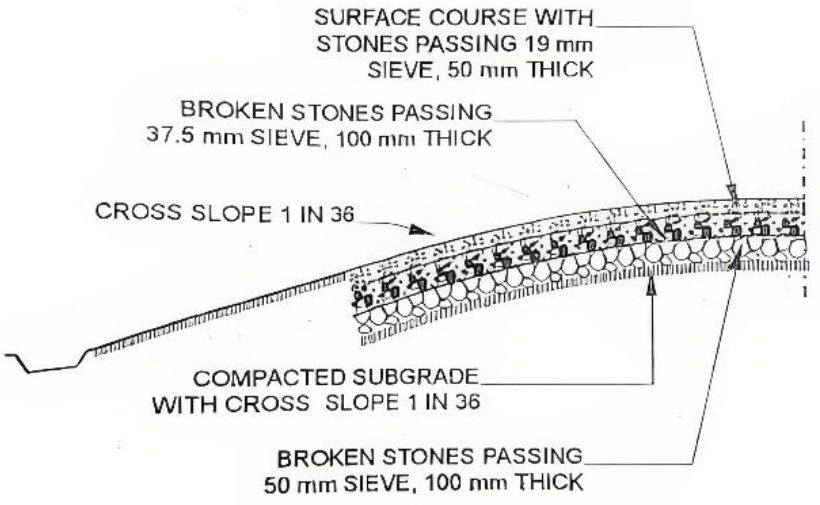
1933. Road Research is an important factor in deciding on the design of a roadway and on the type of surfacing that will best serve the needs of traffic at the lowest possible cost. The work done in the laboratory, equipped at the Board's Office for the testing of materials, has been of great advantage in the work of roadbuilding in this State. Continuous research carried out in the laboratory in the testing of soil and roadmaking materials has resulted in the utilization of only such materials that have been proved suitable for the purpose, and at the same time, the work has contributed to no small degree to the reduction in construction costs. In the research work, considerable savings can be made by ascertaining accurately the suitability of materials in different localities for particular works.

1934. Value of Testing. In the Board's report to government, it advised that one of the most outstanding features in road construction during the past few years, as the result of research in the testing of soils and road-making materials, was the introduction of the lightly constructed pavement. The work done largely contributed to a substantial reduction in construction costs and has proved the suitability of materials in different localities as pavement material. The development of stabilization of clay soils by the addition of varying percentages of sand as determined by laboratory tests has also been an important factor in the reduction in costs.

1935:

- **Modified Macadam.** Some years ago, prior to the general adoption of fine crushed rock, modified macadam was largely used by the Board in areas where gravel was not available, and where bitumen penetration macadam had previously been commonly used.

  Now a Modified Macadam (see sketch below) is virtually a water bound macadam with the road surface sealed at the time of construction. Penetration macadam appears to have no theoretical advantages over this type of road.



Macadam Pavement

- **Formation of Materials Research Committee.** Alf met with his counterparts from New South Wales and Queensland and from that meeting, a national Materials Research Committee was formed. He attended every meeting of the committee except one. He was respected by all that worked with him.

1936:

- **Los Angeles Abrasion** – a method to evaluate the resistance of aggregates to withstand wear and tear under traffic and weathering. This test involves placing a portion of aggregate in a steel drum, fitted with an internal baffle, with a specified number of steel balls, with the drum then being at rotated at constant speed for a fixed number of times.

  The aggregate breaks down due to impact and abrasion with the steel balls and other aggregate particles. The amount of material worn away is measured and expressed as a LA abrasion value. A low value indicates a tougher, more durable aggregate that is more resistant to wear and tear. Higher values suggest a weaker, less durable aggregate.

Modern Los Angeles Abrasion Equipment

- **Research work** in the Board's laboratory has made good progress in finding solutions to the many problems relating to design and construction of roads. These solutions have been a material factor in reducing costs and contributed generally to supplying improved road surfaces on an economical basis.

- **Laboratory**. The Board has found that a laboratory is an essential part of its organization in order that close control may be exercised over the quality of materials supplied, both to ensure durability of the work performed, and to provide an equitable basis for tendering.

- **Extraction of Bitumen from bituminous materials** – used to determine the percentage of bitumen in surfacing samples necessary both for research and control purposes.

1938:

- **Concrete & Asphalt Mixes.** Design procedures for these products were developed.

- **Routine Testing**. It has been found that much of the time of the staff of the Board's laboratory has been occupied with testing the routine samples. Due to the overtaxed testing facilities and space available at the head office of the Board (Exhibition Street premises), it has been found necessary to provide facilities for carrying out simpler routine tests at each of the five outer district offices located at Bairnsdale, Bendigo, Benalla, Stawell and Warrnambool.

1939:

- **Adhesion of Binder to Stone** - measures the ability of bitumen to stick to aggregates crucial for the performance of road surfaces.

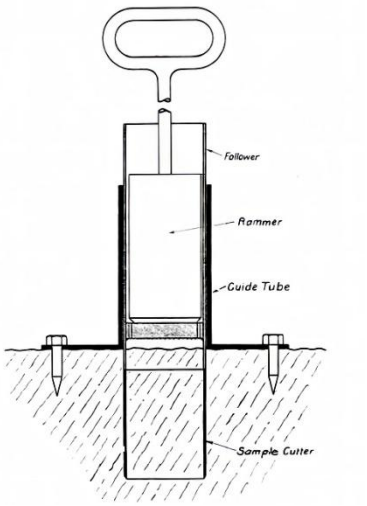
- **CBR Testing Machine.** Alf designed a California Bearing Ratio (CBR) testing machine, which was built by the CRB workshop. The CBR test had been developed by the California Highways Department in 1932. It is a penetration test that measures the strength of subgrade soils; crucial for designing flexible pavements. Alf is shown here calibrating a proving ring used in the test.

Alf and the CBR testing machine

The machine was later moved with the laboratory to Drummond Street, Carlton where it remained in use until the laboratory was moved to Kew in 1963, at which time it was replaced by a commercially available machine.

- **Macadam pavements** in rural areas were largely replaced by fine crushed rock, primarily for lower initial costs in good weather and improved riding quality.

1940. Compaction Testing. The Board had faced costly pavement repairs due to slow settlement of underlying soil, so it was now focusing on proper soil compaction during earthworks. Special apparatus was obtained during the year to assist in checking the field density of placed fillings of fine-grained material. It consists of a steel cylindrical punch of 1/30 cubic foot capacity driven by a hand operated rammer dropping upon a diaphragm inside a follower which rests on the upper rim of the punch. An outer cylinder guide is provided to keep the punch and the follower at right angles to the ground. The weight of the struck-off sample is determined at once in the field, indicating the level of compaction achieved.



Field Compaction Device

1942. During World War II, the Materials staff (Alf Gawith, Tom Russell and Keith Moody) provided considerable advice to the construction teams building the North South Road from Alice Springs to Darwin (Stuart Highway). In particular, they provided the

design for all the road making materials including Bituminous Concrete (Asphalt) used for surfacing.

While working there, Alf made use of a portable laboratory to conduct his tests. The laboratory was built on a two-wheeled trailer adapted from a holiday caravan. The trailer would normally be left at the principal headquarters in the area whilst the towing vehicle is available either at the same location or at any desired point on the works. The equipment provided includes that required for mechanical analysis of gravel, soil and consistency tests for bituminous materials.

Tom Russell and Keith Moody - 1943

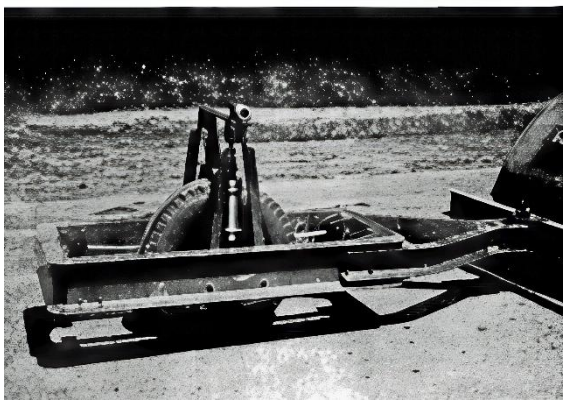
1945:

- **Staff Numbers.** In the construction of both roads and bridges, an ever-increasing application of research is becoming necessary. Before the war the testing division of the engineering branch comprised a total of five officers, whilst at **present the total number is ten**, and to cope with investigation work which is essential to the efficient undertaking of the Board's future program of work, further increases in this staff are urgently required.

- **Testing Numbers** over the years continued. By 1939, the total number of tests performed at MRD had increased to 3680 and by 1945, the number of tests had further increased to 6715.

1946. Laboratory Equipment. Standard equipment has been acquired and stored for upcoming laboratories at Divisional offices.

1947. **Roughometer**. A trailer-type device was constructed with a single wheel, built on a sturdy frame supported by two single-leaf springs attached to a standard car wheel axle. As the trailer was pulled along the road, it measured and recorded the axle's up-and-down movement in inches relative to the frame.



Single wheel trailer-type Roughometer

1948:

- **Regional Laboratories.** Alf had recommended the establishment of regional laboratories with suitably trained staff. At that time, the testing of materials was conducted by either supervising engineers or untrained staff. However, it took a few years for this to occur. Such staff were initially trained in the Drummond Street, Carlton laboratory. The list below identifies staff who were appointed as Experimental Officers in Charge of these regional laboratories, the first listed being the inaugural appointee:

  - Bairnsdale: Sandy McLeod (1959), Steve Prosser.
  - Ballarat: John O'Keeffe (Early 1960s), Trevor New, Richard Fugiel.
  - Benalla: Rupe Cheetham (1955), Rob Lee.

- Bendigo: Stan Hopkins (1950s), Joe Goossens, Dennis Carolan, Leon Shanks, Brian Hogan.
- Geelong: Leo Jurka (late 1950s), Roger Plumridge, Greg Cullen.
- Horsham: Bill Coad (Circa 1957), Brian Francis, Gary Knight.
- Traralgon: Val Fachas (1957), Geoff Proudfoot, Ross Wells, Rob Butler.
- Warrnambool: Max Harper (1950s), Stuart Porter.

- **Alf Gawith** undertook a mission overseas to examine methods adopted in major road research organizations abroad. He left in May 1948, and returned to Melbourne on the 4th November 1948, after visiting United Kingdom, Europe, and United States of America.

- **Dissemination of Technical Information.** To keep officers in the outer Divisions advised of matters of technical interest which are being considered at Head Office, or in other Divisions, the Chief Engineer decided to distribute suitable information from time to time in three forms, which were:

(a) Research Memoranda
(b) Technical Bulletins
(c) Engineering Notes.

Research memoranda consisted generally of detailed accounts of original research or investigation into the application of original to practical problems. They are generally too theoretical to be of general interest. Technical Bulletins give a brief account of the result of research and its application in a form which can be understood by practicing engineers They frequently consist of conclusions reached in papers distributed as Research Memoranda. Engineering Notes comprise of information of practical and frequently minor application culled from periodicals, observations, or any other source. Note: Over the years, the following documents were also listed:

- Codes of Practice
- Published Papers
- Specifications for Road and Bridgeworks
- Technical Notes
- Technical Reports
- Test Methods

1949:

- **Materials Research Engineer.** As laboratory research and testing of materials have become an increasingly important section of road engineering necessitating expansion of the Board's laboratories and expert control of an enlarged staff of research engineers, chemists, and physicists, the Government following his return from overseas, approved the appointment of Mr. A. H. Gawith, M.C.E., A.M.I.E. (Aust.), Senior Divisional Engineer, Materials Research Division reporting to the Chief Engineer.

- **Publication.** Technical Bulletin No. 4 – *The Design of Flexible Pavements*. Issued 25 January 1949.

1950:

- **A Chemical laboratory** was established and is being equipped to carry out simpler identification tests on paints used for the protection of structures and will ultimately be able to detect unauthorized changes in the composition of this material.

- Publications:

- **Technical Bulletin No. 5** - *Design of Concrete Mixes - Graphical Method*. Issued 14 September 1949.
- **Engineering Note No. 21** - *Earthwork Consolidation and use of good material in upper layers of banks*. Issued 25 October 1949.
- **Technical Papers** by Mr. A. H. Gawith, Materials Research Engineer issued 1950:
  (a) Requirements for aggregates suitable for making concrete.
  (b) Plasticity limits for gravel in base courses of pavements which are to be sealed

1951:

- Laboratory Moves. A new home was found for the Exhibition Street laboratory at an old Hoadley's Chocolate factory in Drummond Street, Carlton.

Drummond Street Laboratory, Carlton

All the ground floor and part of the first floor were occupied by the laboratory. The rest of the 1st floor housed the Bridge Division drawing office. The top floor was a lunchroom/ recreation area. The vehicle service station and petrol bowser are out of shot to the left of the photo.

Since Alf's appointment to the CRB in 1929, the laboratory workforce grew in numbers and records show in 1951, Alf had 13 staff as follows:

Alf Gawith – MRE	Keith Soloman – Soils Engineer	John Hanks – Physicist
John Scala – Physicist	Ian Cederholm - Chemist	Leon Bolton – Chemist
Ken McCarthur – Soils	Jim Alford – Soils	Bob Purtle – Soils
Roy Conaughton – Soils	Brian Francis – Soils	Tom Horsfield – Soils
Ivan Romey -Workshop	Harold Brown – Cleaner	

Brian Francis – possibly 5th from left, John Hanks - 4th from right, Tom Horsfield – 3rd from right and Alf Gawith – far right.

- **Road Making Materials**. The increasing costs of quarrying have necessitated the need to investigate the possibility of using local materials. These investigations have been carried out by various members of the Boards supervising engineering and partly with special assistance from the Board's geologist, soils engineer, and other members of the Materials Research Division.

- **Divisional laboratories** have now been established, or are in course of being established, at each of the Board's eight country divisional offices: Bairnsdale, Ballarat, Benalla, Bendigo, Geelong, Horsham, Traralgon and Warrnambool.

- **Publication**: Research Memoranda No. 6 - *Estimation of California Bearing Ratio at 100 per cent, modified compaction* issued in 1951.

1952:

- **Drummond Street Laboratory –** The following occurred:

  - A 400,000 lb capacity Amsler Concrete Testing Machine installed. It was relocated to Kew and remained in operation until the early 1990s.
  - Average Least Dimension (ALD) Testing and Flakiness Index testing method introduced into Sprayed Sealing design.
  - A Pavement Thickness Design curve for low traffic suburban streets developed.

Wally Knight crushing concrete with the Amsler Testing Machine

- **Publications.** Technical Paper by Mr. Alf Gawith issued on 6 June 1952 - *The use of insitu shear tests in the design of flexible pavements.*

Somewhere during the period 1952 and 1966, the following people had appointments in MRD:

- **Assistant Materials Research Engineers to Alf:**

  - Hugh Bubb, Bruce Foster, John Scala, Keith Moody, David Currie

- **Engineers seconded from Chief Engineer's Department:**

- Harold Gray, Bob Gooch, Ian Hay, Ken Scott, Dave Nicholson, Albert Winnett, George Pearson, Jack Jervis

There were also quite a few staff from various countries who joined MRD after the war up to and before the move to Kew in 1964:

- England: Joe Rush, Bill Weeden, Tony Bartlett, Anthony Rees
- Hungary: Mike Tamas, Tony Babos, Karl Pallaghy, John Szendroe, Elemer Nyoeger, Pearl Sinnott
- Latvia: Leo Jurka* Peter Konings, Gus Veismanis, Larry Vartis, George Rumbens
- Italy: Alex Galimbertie
- France: Frank Hamzie
- America: Al Pitzen, Mif Roberts
- Bavaria: Emil Horbelt
- Ireland: John O'Keeffe
- Yugoslavia: Vic Vucic
- Ceylon: Alan Ratnarajah
- Canada: Reg Gaskill
- Rhodesia: Alan Campbell
- Germany: Steve von Gneilenski (supposedly a Count)
- Val Fachas*

Note: * EO in Charge of Divisional Laboratory but trained at Drummond Street.

1953:

- **Standard Paints:** The Board uses approximately 1,500 gallons of white paint per annum and during the year, a standard specification for white paint and for timber priming paint was formulated by MRD staff.

- **Publication.** Technical Bulletin No. 10 - *Average least dimension of aggregate for bituminous surface treatment* issued on 17 September 1952.

- **Static and Dynamic Cone Penetrometers (SCP and DCP)** used to measure the strength of subgrade soils (CBR values) were developed by John Scala, a Physicist who joined MRD in 1948. Both methods are described in Technical Bulletin No. 40 – *Pavement Investigation*.

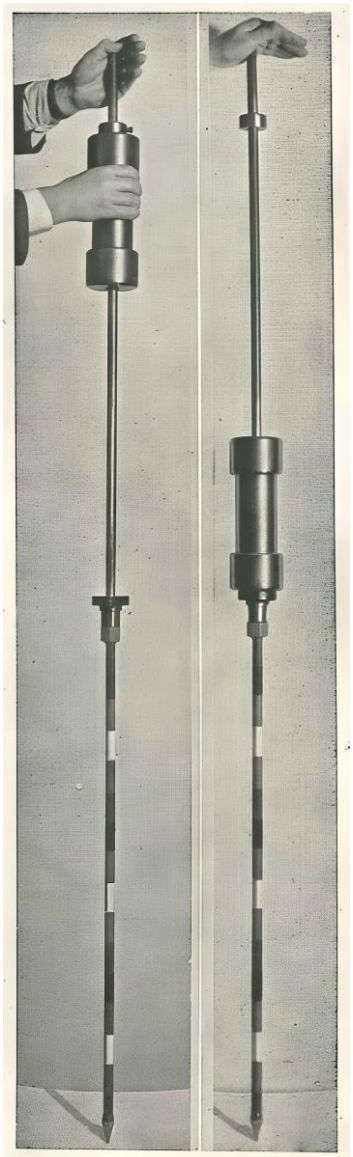
John Scala – 1991

The SCP is usually attached to the Pavement Investigation vehicle to provide an anchor for the test. The device consists of a standard 28mm diameter "XRT" steel drill rod with a cone tip of 36mm diameter and point angle of 60°. The cone is forced into the soil by means of a rack and pinion type loading apparatus. The penetration resistance in Kilonewtons is measured by a load ring. Readings are normally taken at each 30mm penetration down to one metre or until a sufficiently high CBR value is obtained compared to the layers above. The cone is forced into the soil at a convenient speed, but when a reading is being taken, the penetration rate should be one mm per minute. The CBR is usually determined from a chart that compares CBR against load expressed in kN's.

The DCP consists of a 16 mm steel rod, upper shaft length of 600mm and lower shaft length of one metre to which a steel cone with a 20 mm base diameter and 60° cone tip is attached. The cone is driven into the soil by a 9 kg hammer with a falling height of 510 mm. In testing, the DCP is held vertically to the surface of the soil to be tested, and two operators are required. One person holds the device, lifts the hammer to the top stop position and then repeatedly drops the hammer freely 510mm onto the anvil to drive the DCP into the soil. The other person is required to record the readings. These readings are then correlated to CBR values.

Static Cone Penetrometer – David Simpson, the operator (in white)

Mobile Laboratory - 1945



Dynamic Cone Penetrometer

1954:

- **On-Site Laboratories.** Following the end of the 2nd World War, there was a boom in major road construction involving long lengths of highway duplication and town By-passes and the demand for construction control testing became onerous. This led to the establishment of on-site laboratories manned by one or more laboratory assistants who were deployed from the Head Office laboratory for the duration of the job. An example of such was in 1954 when mobile (see above) laboratories were located at:

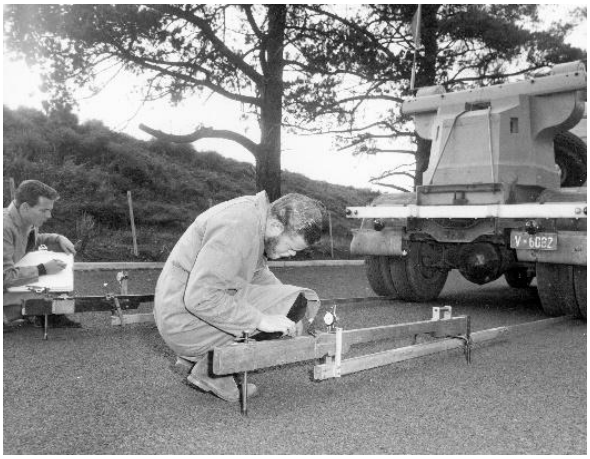
  - Avalon Airstrip near Lara. Brian Francis was the Testing Officer.
  - Widening of the Western Highway pavement at Rockbank; and
  - Princes Highway East at Pakenham.

- **Publication.** Engineering Note No. 43 - Grading of Fine Crushed Rock issued during 1954.

1955:

- **Cement and Concrete**. The establishment in Victoria of new works for the manufacture of Portland cement has made it necessary for the laboratory to investigate in greater than normal detail the strength of concretes made with these new materials.

- **Benkelman Beam.** An instrument, developed by Benkelman in the USA, was constructed by the Materials Research Division to be used to measure pavement deflection under load. The beam tip is placed between and forward of the rear dual wheels and as the truck moves slowly forward, the downward movement of the pavement is observed. At the point of maximum deflection, the reading is recorded.



Benkelman Beam with Operator Peter Konings testing the Maltby Bypass, Princes Highway West

1956. Soil Testing of Foundations for Bridges and Embankments. The need for such testing was realized and that there was a need for more complete investigation of the foundations of bridges and embankments. Enter the "Pie Cart".

The unit consisted of a towed modified caravan built to undertake foundation investigations. The vehicle affectionately known as the "Pie Cart" included a cone penetrometer that was wound down into the subsoil using a laborious man-operated winding device. Sometime later, a petrol driven winder was used.

Pie Cart

As the cone is pushed into the underlying soil, the load is measured by strain gauges. The results of these measurements are used by the geotechnical engineers in the design of foundations.

One of the first uses of the Pie Cart was in the investigation of the foundations for the King Street bridge where the cone was taken down to a depth of about 130 feet .

1958: The following tests were introduced:

- **Adhesion of Bitumen**. Materials used to promote the adhesion of bitumen to stone continued to be studied.

- **Marshall stability test** is a standard procedure to evaluate the stability and flow of compacted asphalt mixtures. Cylindrical specimens are prepared, placed in the Marshall testing equipment on their circumference, and then loaded at a rate of 50.8 mm (2 inches) per minute to failure at a constant temperature of $60°C$.

Anthony Rees conducting a Marshall Stability test

The **stability** is the maximum load expressed in kN that the specimen can withstand, while the **flow** is the corresponding deformation expressed in mm's before failure. Results from this test are used to determine the optimum asphalt content for a mix design and to ensure the mix has sufficient strength and durability. Standard values for stability range between 8 to 18kN and between 2 to 4mm for flow.

- **Sand Equivalent Test.** The California "Sand Equivalent" test is being examined as a possible test for such materials as gravel, crushed rock and sands. It can be used as a quick means of quality control of fines in granular material. If it is performed regularly at a particular crushing plant, any change in the SE value obtained will alert the testing officer to perform the more elaborate Plasticity Index and Sieve Analysis tests to check that these qualities are still within the specified ranges. Refer also to Engineering Note No. 104 issued later on 17 January 1974.

1959. **Plant Quality Control**:

Ollie O'Flynn was in charge of the Asphalt laboratory, which was in the old service station building adjacent to the main building. Ollie and Experimental Officers did inspections of asphalt and concrete mixing plants to measure temperatures, take samples, and to guard against easily recognizable bad practice. Sometime after the move to Kew, Keith Moody employed Clerks of Works to carry out the inspections at production plants (crushed rock, asphalt and concrete) instead of Experimental Officers.

Ollie O'Flynn - Circa1965

1961:

- **Skid Resistance.** A portable pendulum type skid resistance tester has been obtained from England to test stone for its tendency to polish and become slippery (Polished Stone Value Test - PSV). The test is performed either on a laboratory prepared sample or on an actual road surface. The apparatus pendulum rotates about a spindle attached to a vertical pillar.

Portable Skid Resistance Tester

At the end of the tubular arm, a head of known mass is fitted with a rubber slider. The pendulum is released from a horizontal position, so it strikes the sample surface at a constant speed. The distance travelled by the head after striking the sample is recorded from the graduated scale which correlates to the PSV of the stone.

- **Proposed New Laboratory.** It soon became apparent that the Drummond Street premises in Carlton were still inadequate for the growing demand for such services. The CRB Board recognised a need for significantly expanded facilities and decided to investigate building a new stand-alone laboratory building at a location adjacent to the new head office being built at 60 Denmark Street, Kew. In 1961, Keith Moody the Assistant Materials Research Engineer at that time, took on the task of fine-tuning Alf's basic design for the new laboratory and he became the driving force behind the construction of the building over the next 3 years. Note in 1975, Keith became the CRBs Engineer in Chief.

Dr Keith Moody – Circa 1960s

- **Publication**s. The following were issued:

  - Technical Bulletin No. 20 - *Design of Concrete Mixes* issued on 20th July 1960
  - Technical Bulletin No.22 - *Water bound and Dry Macadam* issued 20th July 1960
  - Technical Bulletin No.21 – *Design of Flexible Pavements* issued on 28th Nov 1960

1962:

- **Traffic Line Marking**. Research work in connection with the application of reflective glass beads to traffic lines was progressed.

- **Publication.** "Permeable Subbases – Application to Winter Construction of Metropolitan Roads". Presented by Alf Gawith at the 1st ARRB Conference in Canberra in 1962.

1963:

- **Benkelman Beam** apparatus continues to be used and found to be a good indicator of pavement strength.

- **A Petrological microscope** was obtained to examine salt specimens and identify minerals which are liable to further decompose.

Elemer Nyoeger with Petrological Microscope

- **In Place Coarse Aggregate Density (IPCAD) device**. In the 1960s, Keith Moody developed a test to measure the density in place of soils and granular pavement materials. He visualized a particular sized cylinder which he sourced from the legendary "Ma Dalley's" Kew Junk yard. He found a piece of pipe that suited his purpose which then became the test. It subsequently transpired that it was not a standard sized pipe so that a standard 200mm diameter (Ø) cylinder and tray was adopted for the test.

IPCAD Device

The method involved digging a hole in the pavement layer slightly larger than 200mm(Ø) and the mass of the excavated material determined. The depth of insertion of the IPCAD device is measured accurately with a depth gauge and hence the volume of the hole occupied by the device is measured.

Sand is poured into the annular gap between the cylinder and the outside wall of the hole. By knowing the mass of the sand used and its pouring density, the volume of the sand used can be determined. The volume of the hole is the sum of the volume of sand and the volume occupied by the cylinder. The field density of the layer is then calculated by the formula "Mass of material excavated ÷ Volume of the hole."

The relative compaction (RC) of the layer is expressed as a percentage of the appropriate laboratory compaction result:

%RC = (Field Density ÷ Laboratory Compaction Standard) x 100

1964:

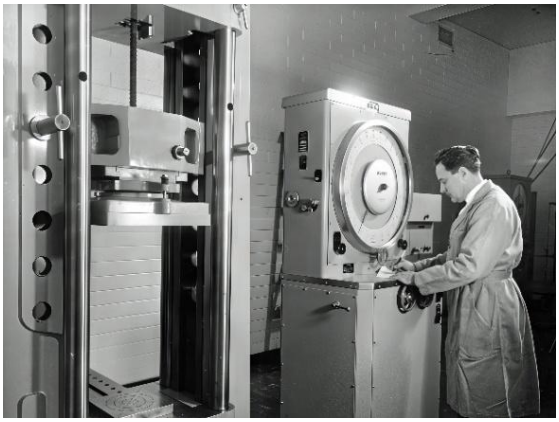
- **New Kew Laboratory.** In November, the new laboratory opened for operation and 47 staff relocated from Drummond Street to the new Kew premises. A list of their names is included as Appendix 1. The laboratory comprised six floors, four of which were mainly laboratories where materials testing was performed. A workshop, storeroom, concrete, steel and stone testing equipment were located on the lower ground floor, soils testing including CBR on the ground floor, offices for the MRE, Geotechnical and Pavement engineers on the 1st floor and bitumen, chemical, Asphalt and bituminous analysis on the 2nd floor.

  Initially the Traffic Commission were located on the 3rd floor, and the Australian Road Research Board (ARRB) were accommodated on the 4th floor.

  Note that the creation of a national road research facility was originally proposed by William Calder, the initial Chairman of the CRB. Again in 1947, the CRB, through its Chief Engineer, Caleb Roberts, advocated for a national road research activity. However, it was not until 1960 that State Road Authorities finally agreed on the establishment of the Australian Road Research Board (ARRB).

The laboratories were fitted out with durable bench tops, even stainless steel for the bitumen test area to enable adequate cleaning. Fume cupboards which vented to the roof were installed in the chemistry, bitumen and asphalt laboratories on the second floor. Even the noisy equipment such as stone crushers and the Los Angles Abrasion Loss machine had a special room on the lower ground floor.

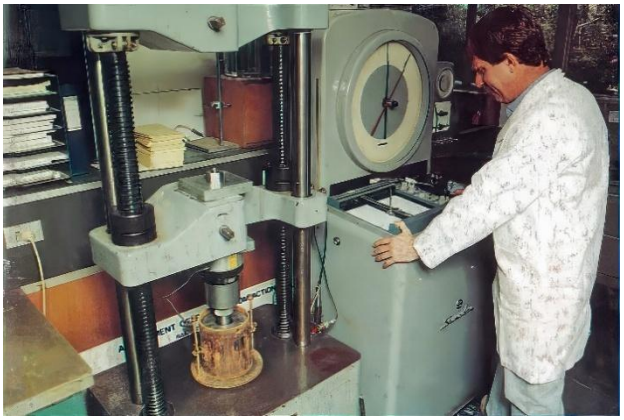
New Laboratory – 60 Denmark Street, Kew



Concrete & Steel Testing Laboratory – Vic Vucic Operating the Avery Machine used for tensile testing steel, reinforcing bar and prestressing steel.

Kew Workshop – Graeme Briant operating a milling machine used to make precise steel surfaces for Laboratory equipment.

Soils staff undertaking PI and Sand Equivalent testing



Vish MacKowski operating a modern CBR Testing Machine

The building incorporated some special spaces such as the concrete fog room, dust extraction systems, air conditioning and sample disposal chutes from the 2nd floor to the lower ground floor where it could be dropped directly into trucks. It also contained a

strong room floor area with a crane mechanism able to lift large test items and for testing significant loadings for steel beams and a scale model bridge.

As mentioned above, office and library space was provided on the 4th floor for the ARRB as well as a modest laboratory area supplemented by access to the CRB laboratories. In 1965, additional laboratory space was arranged for ARRB in a building at an old Tramways depot in nearby Wallan Road, Hawthorn where the soils, bitumen, human factors, and instrumentation activities were housed. Sometime before 1972, ARRB staff vacated the 4th floor and moved into premises in Prospect Hill Road, Kew. Finally in 1972, a permanent home for ARRB operations was established at a site at 500 Burwood Highway, Vermont South.

Following the departure of ARRB in 1972, the Asphalt Division moved into the 3rd floor and Metropolitan Division into the 4th floor.

Since the Regional labs came into full production, their testing contribution added to the expanding testing of materials since 1940 by the Kew laboratory as shown in the table below, clearly demonstrating the importance of such testing needed by the CRB to achieve a lasting and satisfactorily performing road structure.

Description of Test	**Kew Lab 1968 – 1973**	**Regional Labs 1969 – 1973**	**Total Tests**
Pavement Materials	15,775	14,541	30,316
Sealing Aggregates	2,109	14,914	17, 023
Rock Properties	2,414	0	2,414
Lab. Compactions	3,163	1,637	4,800
Field Densities	30,374	13,146	43,520
Pavement Investigations	319	713	1,032
Pavement Deflections	539	84	623
Asphalt Mix Design	1,701	0	1,701
Asphalt Cylinders	4,103	0	4,103
Paint	597	0	597
Bitumen	4,419	0	4,419
Steel Tension	15,739	0	15,739
Totals	**81,252**	**45,035**	**126,287**

Regional laboratories were well staffed by up to five technicians and equipped with resources to undertake most tests including Concrete testing & design, Gradings, CBR, ALD, Plant Control testing of Asphalt, Crushed Rock and Concrete, Pavement Investigation & Design service. With the establishment of rural regional laboratories, MRD's retained its responsibility for servicing the Metropolitan and Dandenong Divisions for their routine materials and construction control testing needs.

- Publications:

- Control of the Quality of Road Materials by Alf Gawith - Presented to the Highways and Traffic Engineering Branch of the Melbourne Division of the Institution of Engineers, Australia on 13th November 1963
- Technical Bulletin No. 25 - *Construction Technique for Water bound Macadam Pavements* issued 15 May 1964

Following the move to Kew, Alf and his staff contributed to the introduction of the following over the next 6 years:

1965:

- Following the collapse of the King Street bridge in 1962, the Royal Commission report recommended that the CRB employ a metallurgist with experience in steel manufacturing and welding technology. Roy Gilmour was the appointee. His role was to establish a metallurgical laboratory able to ensure that the steels being used for bridge construction conformed to the relevant Australian Standards and that the welding procedures used during bridge construction produced satisfactory welds.

- Preliminary studies into the skid resistance of pavements.

- The estimation of C.B.R. from grading and plasticity tests.

1966:

- **A** high-powered microscope was obtained to enable the Board's metallurgist to undertake investigations particularly those concerning welding procedures and special steel.

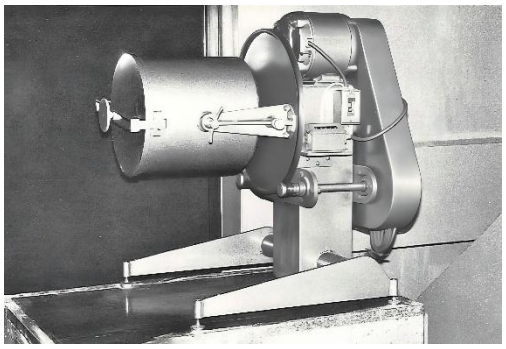
Roy Gilmour with high-powered microscope

1968:

- **Preparation** of specifications and test methods for traffic linemarking paints, materials for reflective signs and markings, bituminous products, concrete and related materials.

- **Detailed** foundation investigations for embankments, bridges and interchange structures were carried out before designs were completed.

- **Texas Ball Mill** test was adopted which is a procedure where a sample of sedimentary material is tumbled in a mill with steel balls and measures how much breakdown occurs when subjected to grinding and abrasion. It is aimed at simulating the materials ability to withstand degradation during construction and under traffic loads, and it can also detect soft aggregates susceptible to weathering.



Texas Ball Mill equipment

1969:

- Progressed the following:

- Development of seismic and resistivity techniques to investigate landslips.
- Development of reliable test methods for measuring aggregate-bitumen adhesion.
- Feasibility of determining, by chemical means, the secondary mineral content in rocks.

- **R&D.** A greater demand for research and development had emerged aimed at solving problems that had occurred in the organization. A list of 77 R&D projects covering a wide range of topics were reported by Alf – refer Appendix 2 for descriptions.

- **Values** specified for Washington Degradation, Sand Equivalent. Los Angeles Abrasion, Unsound Stone, Liquid Limit and PI tests.

- **Papers** published during this six-year period were:

  - 'Petrological investigation into the secondary minerals of an older basalt flow north of Melbourne' by Elemer Nyoeger from *Proceedings of the 2nd Australian Road Research Board Conference*, Vermont South, Victoria, 1964.
  - Paper by Keith Moody in 1966 on the specification of Natural Materials for roadmaking purposes.
  - Technical Bulletin No. 26 – *Design of Flexible Pavements* was issued in September 1969 superseding TB No 21.
  - Use of the Benkelman Beam in Pavement Evaluation - presented to the Highways and Traffic Branch of the Victorian Division of The Institution of Engineers, Australia, September 1969.
  - General Criteria Required of Road Pavement Materials by David Currie - published in Australian Road Research Bulletin No.5, October 1969.
  - David Currie, Assistant Materials Research Engineer in 1970, specified values for Washington Degradation, Sand Equivalent. Los Angeles Abrasion, Unsound Stone, Liquid Limit and Plasticity Index tests.
  - Compaction. of Road Pavement Materials – presented by David Currie to an Australian Road Research Board Symposium on Compaction, Hobart, April 1970.
  - Brittle Fracture Performance of Bridge Steels by Roy Gilmour - Presented to a Seminar on Steel Bridges, B.H.P. Research Laboratory, June 1970.

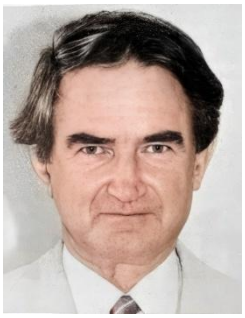
In 1970, Alf retired after 41 years of service, 22 as the Materials Research Engineer. Throughout his career, Alf was solely connected with materials testing and research. He acted on several technical committees but perhaps he was most interested in the Materials Research Committee of NAASRA.

Alf receiving a retirement gift from Chairman Paddy O'Donnell

Alf Gawith and MRD staff's involvement in the quality of work being constructed was not always readily accepted by engineers in the field (much like contractors these days). His work in setting standards for quality control of materials and compaction standards of subgrades and pavements was of the utmost importance. A biography of his service is listed under People in the VicRoads Association Website - Click on the following link to download Alf's story: Alf Gawith

Following his retirement, David Currie was subsequently appointed as MRE.

David Currie was the first recipient of a Melbourne University CRB established Fellowship in Highway Engineering. He commenced work with the CRB in 1956 investigating the strength of multi-layer systems of granular materials under static loads. The multi-layer system simulates in a simplified way the construction of a flexible pavement.



Dr David Currie – 1970s

The results of this work were published in a thesis for which he was awarded the degree of Doctor of Philosophy by the University. Following his doctorate degree, David was appointed the Assistant Materials Research Engineer in circa 1966 and the MRE in 1970.

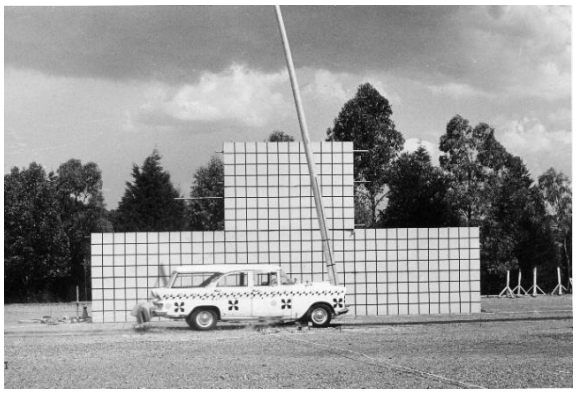
Some of the more significant events that occurred during David's reign as MRE were as follows:

1970:

- **John Bethune** appointed as the Assistant Materials Research Engineer (AMRE).

- **Foam Bitumen Stabilization of Non-Cohesive Sands**. Following a trial at Cranbourne in 1969, foamed bitumen stabilized sand was used as a 6-inch sub-base pavement layer in the construction of 2.3 miles of the Frankston Freeway.

- **Slip-Based Light Poles**. MRD officers conducted tests on a slip-base light pole designed to break away at the base when hit by a vehicle. The pole slid off its base, was thrown into the air and bounced off the car roof. It was concluded that, although the slip base had performed reasonably satisfactorily, its performance could be improved with the probability of lessening both damage to the vehicle and injury to the occupants, by reducing the slip base bolt torque from 80 ft./ lb.f. to 60 ft./ lb.f.



Vehicle crashing into Slip Base Light Pole

Slip Based Light Pole Anchorage

- **New Sections Established:**

- **Signs and Road Furniture Section** to provide specialist advice on the design and testing of reflective signs, materials and road furniture including the testing of guard rail, frangible signposts, light poles and similar devices. Note Bob Field, a road furniture expert recruited from USA was listed as the Leader in 1973 followed by Ted Vincent in 1977 according to the Internal Directory.

- **Quality Control at Metropolitan Quarries** staffed by an Engineer Kevin Haddingham, Scientific Officer Michael Stomm, an Experimental Officer, and 14

Clerks-of-Works. who were employed in plant control of quarry products for both direct control and municipal control work.

1971:

- **Friction Welding Machine**. A prototype friction welding machine was designed and built by MRD staff to investigate the use of friction welding for attaching stud shear connectors to the flanges of mild steel bridge girders. Mild steel studs of sizes from ¾ inch to 1 ¼ inch in diameter have been attached to mild steel girder. Tensile tests have indicated that joint strength consistently at more than 60,000 psi can be achieved with axial pressures greater than 11,000 psi. A production machine was subsequently designed and built, for use by the steel fabrication shop at Syndal.

Prototype friction welding machine

Production Friction welding machine

- **Effect of Climatic Factors on Benkelman Beam Deflections.** A long-term program to evaluate the effects of seasonal climatic variations on Benkelman beam deflections was initiated in March jointly by the Board led by Alan Ratnarajah and the Australian Road Research Board. Groups of sites were selected in each of the following geological areas:

  - Quaternary organic sand and clay deposits
  - Pliocene (newer) basalts
  - Oligocene (older) basalts
  - Devonian granites
  - Silurian sandstones and mudstones

  The results show that in the selected older basalt areas, which have a comparatively high rainfall (over 40 in. per year) with a marked spring maximum, permeable subgrades and poor surface drainage, a correction factor as high as 1 .4 could be appropriate if a Benkelman Beam test is performed at the driest time of the year. The pattern is not as clear for other areas. It would seem at present that a factor of 1.1 would suffice for areas having lower rainfall with a less marked seasonal maximum and/or relatively impermeable subgrades.

1972:

- **Open Graded Asphalt.** Test sections of bituminous concrete surfacing (forerunner of OGA) on the Maroondah Highway at Blackburn were laid. The object of the experiment

was to produce surfaces with increased skid resistance. Subsequently it was also found to have a beneficial effect on reducing water spray.

- **Plastic Subsoil Drainage Pipe** supplied in either a corrugated flexible form or a plain rigid form, both with longitudinal slots about 0.1 inch wide in the walls was introduced into CRB practice.

- **Carried out research into**:

  (a) Corner-cube Guide-post Delineators
  (b) Road Marking Luminance and Illumination Measurements
  (c) Weathering Rack for Signing Materials
  (d) Evaluation of Safety Jackets for illumination
  (e) Effect of wet road conditions on Driver visual perception

1973:

- **Staffing.** The Board reported to government that at its Head Office in Kew, a modern well-equipped laboratory was operating employing 160 personnel, including 34 qualified officers and 81 technicians. Most of the remaining staff were employed outside of Kew at metropolitan quarries, at six field laboratories on jobs in Metropolitan and Dandenong Division, and at three on Major Projects Division jobs.

- **SCRIM**. MRD took delivery of a British-made test vehicle known as a Sideways-force Co-efficient Routine Investigation Machine. The vehicle is used to measure the sideways force (friction) ogenerated when a specially designed vehicle capable of driving at constant speeds between 25 to 80 km/h and incorporating rubber-tyred wheels in each wheel path angled at 20 degrees that is dragged sideways across a wet road surface.

1973 SCRIM Vehicle

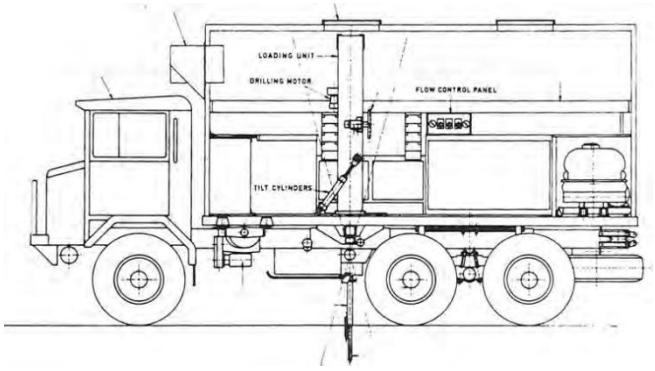
Modern Day SCRIM

Low friction results indicate a surface with low skid resistance. (Refer Technical Note No. 110 issued much later in 2018).

- **Additives to Fine Crushed Rock**. The addition of up to 2% to 3% Flue dust from cement works at Geelong was used on Hume Freeway Wallan to Broadford Project. It was considered at that time that this additive to fine crushed rock had no deleterious effect on properties as determined by strength or quality control tests. Refer Engineering Note No. 102 issued 6 August 1973. (See subsequent comment below on Hume Freeway – Wallan to Broadford Project**).**

- Cone Penetrometer Testing Vehicle (CPT):

Cone Penetrometer Testing Vehicle



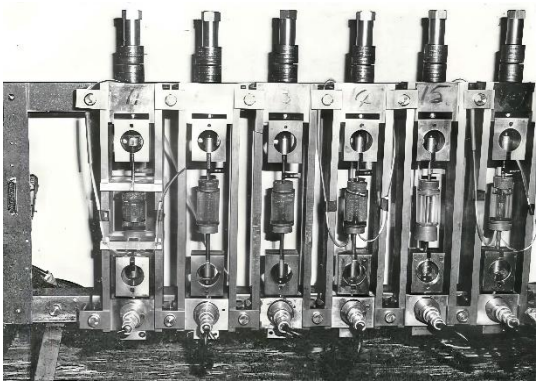
Diagrammatic view of CPT

A CPT vehicle replacing the Pie Cart was built in the early 1970s made from a six-wheel drive army truck. It was fitted with an Electrical Friction Cone Penetrometer (FCP) (refer photo below in Year 1982) and is much smaller than the original version developed in 1958. The updated device is pushed into the ground at a steady rate by a hydraulic ram and measures cone resistance and sleeve resistance. From these two measurements it is possible, in most instances, for a geotechnical engineer to determine the soil profile, including the strength of the soil.

- Asphalt Pavements. It was reported that the Board and municipalities are making increasing use of Full Depth and Deep Strength Asphalt pavements.

- Stress Corrosion Testing of Prestressing Tendons. Research work was undertaken by MRD to test the integrity of steel prestressing tendons maintaining their applied tendon force in bridge construction. Occasionally, failures of prestressing tendons have occurred in bridges, although most recorded failures have been found in prestressed concrete. One failure mode involved in these circumstances is called stress corrosion cracking, which is produced by the combined effect of stress and a corrosive environment.

Several brands of prestressing tendon were tested in various environments including water saturated with hydrogen sulphide, 3.5% sodium chloride solution, distilled water, methocel and saturated calcium hydroxide solution. A testing technique was developed using short lengths of tendon loaded in tension in a special test frame which allows the load to be monitored hy means of a loadcell. The corrosive environment is contained in a tube around the tendon. The research is ongoing.



Tendon Prestressing Jig

- Field Laboratory Accommodation. The use of field laboratories is becoming more common on larger construction jobs, where the increasing work output and the consequent need for testing on a regular basis required full-time attendance of one or more testing officers. The MRD is currently operating six field laboratories on Metropolitan and Dandenong Division jobs, and three on Major Projects Division jobs.

These laboratories (see below) are constructed on a steel sub-frame and can be transported fully loaded with their testing equipment from site to site.

Field Laboratory

Interior of Field Laboratory

1974:

- **Noise Measurement**. Measurement of noise and vibration from traffic and construction equipment commenced.

- **Pavement Testing Vehicle**. The first vehicle to test pavement strength was a Lacroix Deflectrometer, made in Switzerland and mounted on a French Berliet truck. The purchased vehicle had been modified for use with a Benkelman Beam. As the truck moves forward at a speed of 2 km/h, the vertical downward movement of an existing pavement surface under a standard 8.2 tonne single axle dual wheel load is measured. This vehicle replaced the Benkelman Beam method of measuring the strength of pavement.

Berliet Deflectrometer

- **Concrete**. An investigation into concrete shrinkage & creep was undertaken.

- **Roy Gilmour** appointed AMRE on John Bethune's departure, the latter being promoted to the position of Asphalt Engineer in charge of Asphalt Division.
- **Publications**:

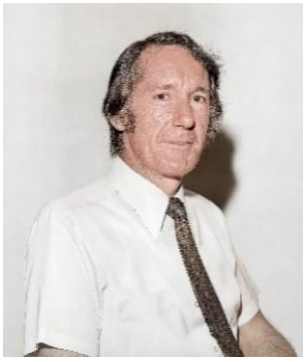
  - A paper by John Bethune, AMRE on Full Depth Bituminous Concrete Pavements, Part I: Design, Materials and Economics was published in Highway Engineering in Australia, June 1971.
  - Skid-resistance and its Measurement presented by John Bethune to a Symposium on Stormwater Drainage, Adelaide, October 1971.
  - Quality of Stone - Some New Tests by David Currie published in Highway Engineering in Australia, July 1971.
  - Cement Modified Crushed Rock by David Currie Published in Proceedings of the XIVth World Congress - Permanent International Association of Road Congresses, Prague, 1971.
  - Engineering Note No. 98 - *Guide Post Paint* was published in 1972.
  - Technical Report No. 57 - *Bitumen Stabilization Using an Emulsion* was published in 1972.
  - Design, Instrumentation and Construction of a Continuously Reinforced Concrete Road Pavement by Barry Munce, R B Russell and Dom Meadley. Presented at The Institution of Engineers, Australia, Symposium on Concrete Research and Development, Sydney, September 1973.

- Surfacing of Orthotropic Steel Decked Bridges by Bruce Phillips. Report on overseas mission for the Lower Yarra Crossing Authority, August - September 1973.
- Friction Welding Stud Shear Connectors to Steel Beams by Roy Gilmour. Published in Metal Construction and British Welding Journal, Vol. 6, No. 5, May 1974.
- Photometric Testing of Retro-reflective Materials used for Highway Signing and Delineation. Presented at the Seventh Australian Road Research Board Conference, Adelaide, August 1974. R N Field, G W Knox, AMTC (Mech Eng), MIE (Aust).

In 1976, **a group photo** of staff present at that time was taken outside the front entrance of the laboratory on the occasion of Doctor David Currie's farewell as the MRE (see photo below). He had recently been appointed as Divisional Engineer, Traralgon Division. The names of each person in the photo are given Appendix 3.

Materials Research Division Staff - 1976

Following the departure of David, Peter Lowe was appointed MRE in 1976. Peter had a distinguished career in VicRoads and a biography of his service is listed under People in the VicRoads Association Website - Click on the following link to download the document: Peter Lowe's Story



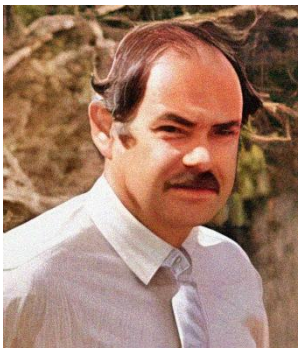
Peter Lowe – 1977

Some of the more significant events that occurred during Peter's 8-year reign as MRE were as follows:

1976:

- **Name Change.** One of Peter's first decisions was to change the MRD name to Materials Division (MD) to better reflect that the division was more than a research organisation but also was a strong centre for advice on technical matters.

- **Bruce Phillips** won the inaugural Australian Road Research Board (ARRB) Director's prize in 1976 for developing an artificial aggregate from crushed bricks which produced high skid resistance properties. Such aggregates were applicable at locations such as approaches to pedestrian crossings and intersections, where conventional aggregates did not have sufficient skid resistance for use to address concerns.



Bruce Phillips – 1983

1977. Hume Freeway – Wallan to Broadford Project. Following heavy rains in the Spring of 1976, some sections of this project had rutted and cracked under the wheel paths of heavy trucks and had caused the bituminous surfacing to break up under wet weather conditions. In 1977, the Board engaged Dr David Croney, an eminent UK pavement research engineer, assisted by MD staff, to investigate the cause of the failure. The primary causes of failure were found to be:

1. The use of a cementitious additive which was intended to improve the grading of the crushed stone base but rendered the material both brittle and difficult to compact.

2. The use of an unsatisfactory asphalt mixture in repair work containing a large proportion of soft degraded aggregate.

1978:

- **Additives to Crushed Rock.** As a result of doctor Croney's findings and because of the cementitious nature of the flue dust additive from cement works at Fyansford or Waurn Ponds, the Engineer in Chief (Keith Moody) issued Engineering Note No. 117 – Additives to Crushed Rock dated 13 February 1978 which contained the following instructions:

  (a) The additives should not be used in crushed rock which will be less than 200 mm below the finished road surface.
  (b) The mixed material should not be stockpiled.
  (c) The amount of additive in any situation should not exceed 3 percent by mass of mass of crushed rock.
  (d) Approval for use of additives should only be given after consultation with the Materials Research Division for advice on the suitability of the additive, quantity of additive to be used, method of incorporation in the mix, special precautions to be observed in use and appropriate testing procedures.

- **Raised Reflective Pavement Markers**: Studies into the performance of RRPM's by MD staff saw an amended specification produced where acceptance was based on performance after trafficking.

- **Design of Rock Sockets** - The design of rock sockets in Silurian mudstone based upon recent research carried out by Board officers in conjunction with the Monash University School of Civil Engineering over 5-year period was adopted in the design of piles for structures on the Westgate Freeway – South Melbourne Section

- **A Statistically based Compaction Control Procedure** was developed by MD staff and adopted into use on the Hume Freeway - Seymour to Euroa Project for earthwork and pavement construction.

- **Control of Stone Quality**: Because of serious difficulties encountered in identifying unsound rock by visual methods, more thorough methods of inspection of source rock, were introduced into the Board's quality control procedures. These new procedures required regular sampling of all quarry faces in active use, and a complete classification of the rock by appropriate laboratory testing. This included a Petrological examination of rock samples to clearly identify sound, marginal and unsound material in igneous and metamorphic rocks.

Assessment of Unsound Stone – Sample Jars of Sound, Marginal and Unsound Rock

- **Metropolitan Division** relocated from the 4th floor to new premises at 700 High Street, East Kew. At that stage, the Administration staff and the expanding Pavements Section moved onto the 4th floor.

1979:

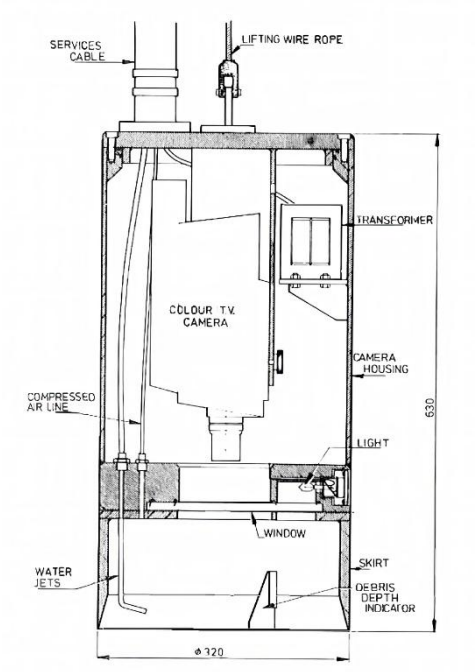
- **Quality Control and Plant Mixed Quarry Products**. Such control is carried out in laboratories provided at each mixing plant by MD field staff now totaling 18 Clerks of Works.

- **Metropolitan and Dandenong Divisions Laboratories** were established in the 1970s (Newlands Road, Coburg, then Broadmeadows and at Mulgrave then Hallam) with staffing and overall supervision provided by MD (Neil Tull and Doug Dick as EO's in charge respectively).

- **Degradation Factor - Fine Aggregate** test was developed to assess the quality of crusher fines (minus 5 mm) used as a component in crushed rock and asphalt mixes.

1980. Socket Inspection Device (SID) was developed utilising remote video technology, to verify the cleanliness of the bases of the 60+ metre deep bored and rock socketed piles for the West Gate Freeway through South Melbourne.

Lowering SID into the cylindrical pile casing



Socket Inspection Device – SID

The design assumptions relied on end bearing at the base of the piles as well as friction between the piles and the rock over the depth of the sockets. It therefore became necessary to inspect the cleanliness of the bases before casting concrete. SID enabled this inspection and with its amenity, procedures were developed to assist in the cleaning of the bases by air lifting.

1981:

- **Pavement Testing Vehicle**. The Deflectrometer vehicle (now called Deflectrograph) was rebuilt to test at 4km/h A new recording system compatible with the Board's IBM computer was installed together with improvements to the mechanical system of measurement to reduce maintenance. The deflection data and curvature bowl measurements which are used to assess the pavement's strength and identify areas of concern, can now be readily reported.
- **Treatment of Expansive Clays**: Following studies by compacting clays at close to its OMC and quickly stabilizing the upper layer with 4% Lime, then covering the stabilised layer with a non-expansive low shrinkage material, and selection of verge materials that will provide adequate insulation of the clays from moisture change, all aimed at minimizing the swell potential of the general clay earthworks. Such procedures were adopted on the construction of Western Freeway Bypass of Melton.

1982:

- **A Piezo-Cone Penetrometer** (PCP) was developed as an enhancement on the Friction Cone Penetrometer (FCP). The PCP provided additional information to the geotechnical engineer in that it provides a continuous record of two parameters; cone resistance (qc) and pore water pressure (u), which are functions of all major soil properties. The PCP is now used throughout Australia. The PCP (Right) with standard FCP (Left) are shown in the photo. Both devices are described in VicRoads Technical Note No. 24 issued in August 1988.

Piezo-Cone Penetrometer (R) and Friction Cone Penetrometer (L)

- **Testing of large elastomeric bridge bearings**: The design of the elevated section of the West Gate Freeway in South Melbourne incorporates large elastomeric bearings which are designed to support vertical loads of up to 10 MN and allow shear deflections of up to 120mm. A special purpose test machine was constructed consisting of two large reinforced concrete end blocks separated by a reinforced concrete base slab and two upper hollow steel columns. The bearings are placed between this platen and the other end block using an overhead crane, and compressive and shear forces are adjusted using a hydraulic control system. The performance of the bearings under any set of design loadings can then be assessed.

During this period, 22 publications were issued and a sample is given below:

- **Materials for subsoil and subgrade drainage** by P Lowe. Presented at the NAASRA subsoil drainage workshops, Sydney, November 1976.
- **Superplasticising Admixtures in High Strength Concrete** by S B Bromham, Scientific Officer, Materials Research Division. Presented at the Institution of Engineers, Australia, Concrete Symposium, Brisbane, August 1977
- **Ultrasonic Inspection of Welded Structures** by Roy Gilmour, Assistant Materials Engineer Presented at Joint Australasian Welding and Testing Conference, Perth, October 1977
- **CRB Asphalt Mix Design**: The State-of-the-Art by W (Bill) Sherwin, Experimental Officer Materials Division, 1980.
- **Specification of durability of source rocks**: Amendments to the specification limits for igneous and metamorphic source rock durability and hardness requirements have been approved and introduced in all source rock specifications as from 1 July 1981. Under the terms of the new specifications, source rock is divided into sound, marginal or unsound – refer Specification Section 812 for details.
- **Air Quality in the Vicinity of Roads:** David Ford, Scientific Officer, Materials Division Presented at the Tenth Australian Road Research Board Conference, Sydney, August 1980.
- **Technical Bulletin No 31** - *The Design of Flexible Pavements* issued in 1980.
- **Assessment of Asphalt Compaction Using Lot Testing**: John Rebbechi, Assistant Asphalt Engineer, and Kel York, Scientific Officer, Materials Division. Presented at the Australian Asphalt Pavement Association Australasian Conference, Surfers Paradise, July 1981.
- **Design of Foundations to Suit Geological Conditions-West Gate Freeway, Melbourne**: Warren Pump, Engineer, Materials Division and Robert Evans, Scientific Officer, Materials Division. Presented at the Annual Conference of the Institution of Engineers Australia, Hobart, February 1982.
- **Relative Compaction Testing**: Kel York, Scientific Officer, Materials Division. Presented at the 11th ARRB Conference in Melbourne, August 1982.

In 1982, the number of MD staff was 137 as counted in the head Office telephone directory. At that time, the structure was made up of the **11** Sections providing the following services:

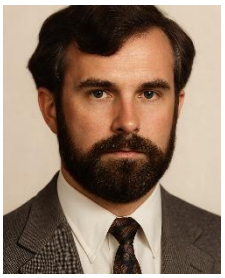
1. Pavement Section – Leader David Anderson

- Evaluation of existing Pavements including strength (Deflection), Roughness and skid Resistance testing and advice
- Pavement Design and Rehabilitation Treatments
- Subsoil Drainage (Filter Design)
- Pavement Performance Monitoring
- Pavement Research & Development

David Anderson - 1982

Note: David was later appointed VicRoads Chief Execuive in 2001.

2. Geotechnical Section – Leader Peter Balfe



- Bridge Foundation Investigations and design
- Soft Ground Embankment Design
- Slope Stability Investigations
- Bridge Structural Strength Measurements
- Geotechnical Research & Development

Peter Balfe - 1982

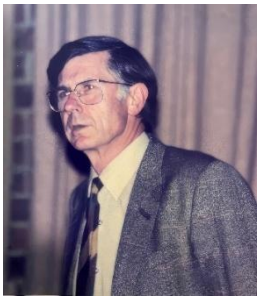
Note: Peter was later appointed VicRoads Deputy Chief Execuive in 1998.

3. Concrete Section – Leader Barry Bromhan

- Routine Concrete Testing and Advice
- Testing of Reinforcing and Prestressing Steel
- Concrete Mix Design
- Concrete Compressive Strength Testing of specimen cylinders
- Testing of Elastomeric Bearings
- Concrete Research & Development

Barry Bromham - 1983

4. Geology Section – Leader Alan Muir



- Search for Suitable Roadmaking Materials
- Future Freeway Aligment Investigation
- Landslip Investigation
- Rock Durability Research & Development

Alan Muir – Circa 1985

As mentioned throughout the Board's Annual Reports, the value that Alan and his group of Geologists in finding suitable deposits of quality road making materials particularly in their natural form contributed greatly to the CRB's success in road building. Materials found offerring a 'fit for purpase" and economical product included granitic sand, limestone gravel, hill gravel, scoria, volcanic tuff, river gravel, and the harder rock deposits such as basalt, granite, hornfels, sandstone and others were a feature of their contribution.

-

Some of Alan's Geologists (L to R): John Jobson, Doug cromie, Graeme Newman, David Tilley and Barry Fielding.

5. Soil Testing Section – Leader Elemer Nyoeger

- Routine testing of soils and Aggregates (PI - Liquid & Plastic Limits, Linear Shrinkage, Sieve Analysis, Flakiness Index, CBR)
- Specialised testing of stone (PSV, Permability, LA Abrasion, TBM, Unsound Stone, Degradation Factor (Source Rock), Accelerated Soundness Index, pH and Conductivity Tests.
- Petrological Examintion of Rock Specimens

Elemer Nyoeger - 1991

6. Metallurgy Section – Leader Roy Gilmour

- Steel Testing for Bridges
- Welding Testing and Investigation
- Steel Research & Development

Note. As mentioned earlier, Roy set up the Metallurgy Section in 1965. In 1976, he was appointed Assistant Materials Research Engineer. At that stage, the Metallurgy Laboratory was merged with Arie Meydan's Chemistry Section. In 1983, Roy was secondment to the Lower Crossing Authority Directorate for aproximateuly four years followed by another secondment to the then International Atomic Energy Agency for five years. In Roy's absence, Andrew Walker and Bill Pinches carried on this testing.

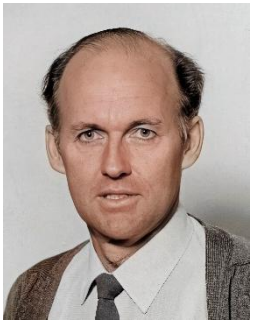
Roy Gilmour - 1983

7. Chemistry & Environmental Section - Leader Arie Meydan

- Testing of Soils, bitumen binders and aggregates
- Design and Testing of Asphalt Mixes
- Chemical Analysis of Paint, Cement, Metals and Glass Beads
- Sign Testing and Development
- Linemarking Materials Testing and Illuminence Measurement
- Mycology Laboratory for identifying "Cinnamon Fungus"
- Overhead Lighting Design
- Measurement of Noise, Air Quality & Water Quality
- Measurement of Road Luminence and levels of illumination
- Chemical Research and Development

Arie Meyden - 1990

8. Field Inspection Section – Leader Kel York



Kel York – 1990

- Quality Control Testing of Constructon
- Core Sampling & Measurement of Placed Asphalt Compaction
- Quality Assurance Testing of Asphalt, Crushed Rock and Concrete Production
- Advice on Features of Construction
- Development of New Specifications
- Introduction of new testing equipment
- Data Bank Queries of test results

9. Special Research Section – Leader John Hanks

John Hanks - 1982

- Materials Test Methods
- Statistical Analysis and Experimental Design Method
- Soils and Foundation Research & Development

Note: John Nugent Hanks retired in 1991, being the longest serving MRD officer at that stage, having spent 45 years with the division, his first and only employment. Click on the link to download his story: John Hank's Story

10. Technical Services Section – Leader Alan Griffiths

Alan Griffiths – 1982

- Electronic Equipment Design, Manufacture & Maintenance
- Workshop for Maintenance of Mechanical Equipment
- Strain Gauge Instrumentation of Structures
- Mechanical Drafting Service
- Technical Research & Development

11. Administration Section – Leader Jim Kemp

Jim Kemp - 1982

- Care & Maintainance of Routine Testing and Technical Reports
- Typing Service
- Distribution of all Mail and Circulars to MRD staff
- Pay Sheets for Technical Officers

1983. Peter became General Manager Works under Laurie Jones as Chief General Manager – Operations. With Peter's departure, John Bethune was appointed ME.

Note: In 1987, following a restructure by CEO Ian Stoney, Peter was appointed as Director - Technical Resource.

John had previously worked in MRD as the Assistant MRE from circa 1970 to 1974. He was then appointed as the Board's Asphalt Engineer. In 1978, John moved into the Works Department under Laurie Jones, Chief Works Engineer, before being appointed back into the division as Materials Engineer in 1983. During John's reign, over 80 technical publications were issued; many are listed below.

John Bethune - 1985

Some of the more significant events that occurred during John's reign as ME were as follows:

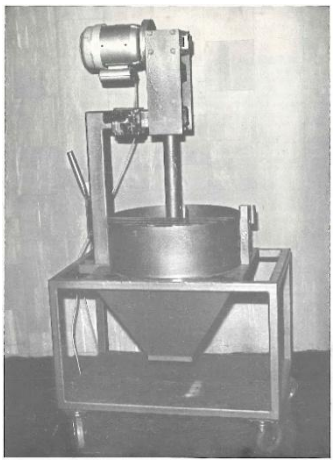
1984:

- **Superplasticised Concrete for Bridgeworks**. Admixtures have become available. These chemicals are now generally referred to as superplasticisers and when added to concrete mixes, can produce high strength concrete with extremely good workability compared to normal concrete mixes. Note a paper on this subject by Barry Bromham was subsequently presented to the Concrete Institute of Australia.

- **Sulphides in Metasedimentary Rocks**: Certain metamorphic and sedimentary rock types have been found to contain significant amounts of sulphide mineralization. When quarried and exposed to the atmosphere, oxidation of the primary sulphides produces highly soluble sulphate compounds. When used as a crushed rock base, the soluble sulphates migrate in solution to the pavement surface and damage to thin and relatively permeable asphalt overlays occurs. The addition of lime to sulphate bearing crushed rock pavement material has been found to provide a solution which will allow continued use of these materials where it is planned to overlay with thin asphalt surfacing.

- **New Developments in Laboratory Equipment:** Two new pieces of laboratory equipment have recently been developed to improve the test procedures used in laboratories:

1. **A soil grating machine** which achieves a rapid break up of soil for compaction/density determinations. This task, usually performed over a 19mm screen by hand sieving and pounding with a mallet, is generally a time-consuming and arduous process. The machine comprises a power-driven circular disc 600mm diameter rotating at 50 revs/min. The disc is made from expanded metal of the type usually used for walkway grid mesh. The sharp edge of the deformed section produces an ideal cutting: surface to the soil sample which is placed on the disc and pressed onto the disc with an inclined flat plate. The shredded soil falls through the disc into a tray.



Soil Grating Machine

2. **A motorised mechanical soil compactor** used for carrying out compaction of material in moulds for moisture/density and CBR testing. The machine has interchangeable feet which can be set to undertake a Standard Compaction Test (Place soil in a cylindrical 100mm diameter mold in three layers compacting each layer with 25 blows from of a 2.75kg hammer dropped from 300mm) and a Modified Compaction Test (Place pavement material in a cylindrical 100mm diameter mold in five layers compacting each layer with 25 blows from a 4.5kg hammer dropped from 450mm and distributing the blows uniformly across the surface).
   The test method is detailed in the Australian Standard 1289.5.1.

Modern Style Mechanical Compactor

   The Standard Compaction test provides moisture/density values applicable to earthworks while the modified test better represents the result applicable to heavier compaction plant used when compacting pavement material.

- **High Strength Reinforcing Bar:** A new edition of AS 1302 - Steel Reinforcing Bars for Concrete, was issued which included a new higher strength bar - Grade 410Y. This grade is designed to have a high minimum yield stress and restricted amounts of alloying elements. These two features are used to reduce the quantity of steel required in reinforced concrete components and to allow easier welding during manufacture of cages and placement of reinforcement.

- **Publications:**

- "**Dynamic Testing of Piles Socketed into Weak Rock**" P.J. Balfe, Geotechnical Sub-Group Manager, Materials Division. Presented at the 4th Australia-New Zealand Conference on Geomechanics, Perth, May 1984.
- "**Construction of Load Bearing Elements under Bentonite"**: Bored Piles in Weathered Rocks" by Jim Holden, Research Engineer, Materials Division. Presented at the Australian Geomechanics Society Meeting, Melbourne, July 1983.
- "**Dynamic Testing of Piles**:" P.J. Balfe, Geotechnical Group Leader, Materials Division. Presented to a joint meeting of the Geomechanics Society and the Institution of Engineers, Australia, July 1983.
- "**Steam Curing of High Strength Concrete**" S.B. Bromham, Scientific Officer, D Meadley, Experimental Officer, Materials Division. Presented at I.E.A. (Institute of Engineers, Australia) Symposium on Concrete, Perth, October 1983.
- "**Behavior of Socketed Piles in Weathered Basalt**" R.S. E-vans, Scientific Officer, P. McDonald, Geotechnical Section Head and G.A. Worotnicki, Engineer, Materials Division. Presented at the 4th Australia-New Zealand Conference on Geomechanics, Perth, May 1984.
- "**Optimisation of Pavement Design and Construction Practices for Rural Freeways**" R.S. Gilmour, Assistant Materials Engineer, Materials Group. Presented at the 4th Conference of the Road Engineering Association of Asia and Australasia, Jakarta, August 1983.

- "**Construction of Load Bearing Elements under Bentonite: Bored Piles in Weathered Rocks"** by J.C. Holden, Research Engineer, Materials Division. Presented at the Australian Geomechanics Society Meeting, Melbourne, July 1983.
- '**The Construction of Bored Piles in Weathered Sedimentary Rock**" by J.C. Holden, Research Engineer, Materials Division. Presented at the 4th Australia-New Zealand Conference on Geomechanics, Perth, May 1984.
- "**Economic Analysis of different Bituminous Surfacing based on their Comparative Performance**" A. Kumar, Engineer. Materials Division. Presented at the 4th Conference on Asphalt Pavements of Southern Africa, Cape Town, March 1984.
- "**Characterising River Gravels for Freeway Pavement Construction**" P.W. Lowe, Materials Engineer, and D.T. Anderson, Engineer, Materials Division. Presented at New Zealand Roading Symposium, Wellington, August 1983.
- "**Settlement of Embankments on Thick Compressible Soil**" P McDonald, Geotechnical Section Head, and D. Cimino, Engineer, Materials Division. Presented at the 4th Australia-New Zealand Conference on Geomechanics, Perth, May 1984.
- "**Pile Settlement in Clay**" P. McDonald, Geotechnical Section Head, Materials Division, and P. Moore, Reader in Civil 39 40 Engineering, University of Melbourne. Presented at the 4th Australia-New Zealand Conference on Geomechanics, Perth, May 1984.
- "T**echnical Report No 70. - Surface Aggregate Durability Vol. I and 2**" authored by B.J. Fielding, Research Scientific Officer, Materials Division and published during the 1980s.

1986:

- **Research & Development.** In 1986, John Bethune reported on 43 research development activities currently undertaken by the branch aimed at solving problems which were being experienced by the organization. Many of these projects have been in progress for several years - refer Appendix 4 for titles of these projects.

- **Nuclear Density Gauge (NDG)** was adopted for rapid determination of compaction acceptance of earthworks, granular pavement materials and thin asphalt layers. (Refer Technical Note No. 106). The NDG largely replaced the laborious IPCAD Device and Known Volume Displaced (KVD) methods for determining compaction standard.

Nuclear Density Gauge

- **Accelerated Loading Facility Testing:** ALF was used to test a surface sealed unbound base pavement on the Hume Freeway, Benalla bypass. The ALF machine (see photo of ALF below when was used at Mulgrave) can apply a 9-tonne single axle dual wheel Michelin rubber truck tyred load to a pavement at a test speed of 20km/h over a length of 12 m every 9 seconds. During this trial, which lasted 8 months, 3 x 10^7 Equivalent Standard Axles were applied. The results of this trial confirmed that granular pavements of this type can withstand high traffic loadings for many years**.**

1987:

- **Year of Change at the RCA** – New Age Thinking introduced.

- **Technical Resources Division Established:** Peter Lowe was appointed as Director and John Bethune remained listed as Manager Materials Branch (MB).

- **Nuclear Density Gauge Calibration**: The RCA was approved as the authority for the calibration of nuclear density and moisture gauges. The RCA is at present the only body in Australia so registered. Members of the RCA Materials Branch were actively involved in development of the standard.

Nuclear Gauge Calibration Blocks

They have since produced a set of standard blocks for calibrating density and moisture measurements. Refer Test Method AS 1289.5.8.4 Nuclear surface moisture-density gauges - Calibration using standard blocks.

- **CULWAY Monitoring of Heavy Vehicles**: During the year the RCA began using five high-tech specialized CULWAY measuring units developed by ARRB in collaboration with MB to monitor traffic patterns and identify the types of vehicles used on highways throughout the State. CULWAY measures the mass of traffic in motion. It uses a computer-based data collection unit in a concrete culvert placed under highways at strategic points. Sensors attached to the culvert automatically register each vehicle, plus its speed, axle spacing and axle mass, which are then recorded in the computer unit.

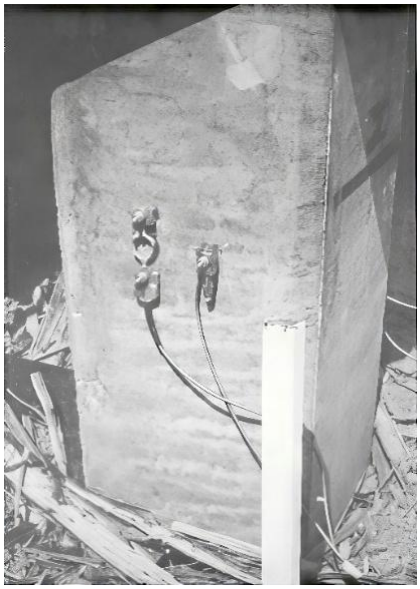
1988:

- **Dynamic Pile Load Testing**: A team of Engineers in the Laboratory won a 1987 Special Innovation Award for the development of a technique checking the load capacity of 100 doubtful piles that had already been constructed on the West Gate Project – South Melbourne Section. The team investigated the correlation between instrumented Dynamic Pile Load testing and Static Pile Load testing. These piles were up to 1.5 m in diameter and extended down to a maximum depth of 65 m through silt and gravels and socketed into the underlying mudstone and basalt foundations.

  The test involves dropping a 20-tonne hammer onto the head of the pile from a height of up to 2.5 m. Up to 5 piles can be tested each day at a cost of less than $4000/pile. The static test takes 2 to 3 days/pile at a cost of at least $25,000 and takes 2 to 3 weeks to prepare – not viable.

  In preparation for the dynamic test, a set of strain gauges and accelerometers were bolted to the top of a pile. The gauges allow the force in the pile at any time after the impact of the driving hammer to be measured. Computer programs were also developed to measure the force in the pile at any time after the impact of the driving hammer which assisted pile driving supervisors to decide when the required pile load capacity is achieved on site.

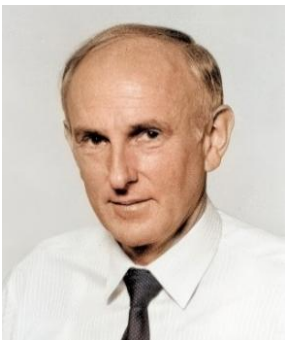
20-tonne hammer dropping onto pile



Strain gauges and Accelerometers

The technique surpassed expectations and was used on many subsequent VicRoads projects. The RCA had the only complete facility for carrying out this testing in Australia and the equipment was in demand from other interstate Road Authorities, Government Departments and Consulting Engineers. One of the team members, Julian Seidel, became a nationally-recognised expert as a consultant for this testing.

- **Another Merger.** Later in 1988, the Materials Division and Asphalt Division merged to form Materials and Asphalt Branch (M&AB). Asphalt and bituminous surfacing advice and investigations were now part of the Pavement Technology Group (PTG) led by John Rebbechi who previously was the Asphalt Engineer.



John Rebbechi - 1990

- **R&D.** John Bethune again reported on the progress of 37 research and development projects, many were a continuation of those reported in 1986.

- **A Surfacing Inspection/ Rating Procedure (SIRP)** was developed by Walter Holtrop and Chris Starr (from Horsham Division) in the 1980s as a fundamental input for determining the need and priority for resurfacing. The procedure involves a visual assessment of the following conditions for a Sprayed Seal Surface: Extent of cracking, Loss of Aggregate (Stripping), Extent of Patching, Assessing Binder Condition (Oxidation), Loss of Binder, and Loss of Surface Texture.

Walter Holtrop – 1990

A similar procedure was developed for asphalt surfaces. An update on both procedures is described in VicRoads Technical Bulletin No. 50 issued in September 2009.

- **New Branch Manager**. Following John's departure from the Division in 1988, Colin Roy was appointed as the manager of the M&AB. Colin had been Regional Manager Barwon and was successful in convincing Ian Stoney (CEO) and Max Lay (Director Technical Resources) that a manager with a background in design, construction and maintenance of roads would be a good blend with the specialist engineers and scientists currently working in the branch. Colin's appointment was part of a managers' rotation scheme involving the following other staff:

Colin Roy - 1989

  - Burke, Kerry John Hardie. Manager, Bridge Branch
  - Meggs, Robert Charles. Manager, Career Development.
  - Solly, Robert Henry. Manager, Design and Traffic Branch
  - Kemp, Brian Trevor. Manager, Road Design

1989:

- **RCA renamed VicRoads.** As part of the government restructuring in 1989, the Road Construction Authority and the Road Traffic Authority were merged into one organization now trading as VicRoads. As a result of this merger, the opportunity was taken to rename Materials and Asphalt Branch to what was a more applicable description, the Materials Technology Department (MTD).

During Colin's 2-year reign as the manager of MTD, the following more significant events occurred:

- **PASE** (Pavement Strength Evaluator): The vehicle was further modified with a new body shape. In addition, the electronic and data acquisition systems used in the vehicle were further enhanced.

Pavement Strength Evaluator – PASE (1995)

This enhancement is expected to be up to twice as productive compared to the previous vehicle. The vehicle previously known as the Deflectrograph was given a new name, "PASE" – refer Technical Bulletin No. 40. for more details.

- **Geotechnical investigations**: A significant advance has been achieved over the last year by the Geotechnical Group in developing an integrated system for processing seismic refraction data in the field. These developments have greatly simplified seismic data processing and significantly reduced the turnaround time for what had been a most laborious process.

- **Concrete Pavements Technical Bulletin**: An interim Technical Bulletin titled 'Guidelines for the design, construction and maintenance of concrete pavements' was produced but not published. The Bulletin defined the types of concrete pavement used, the functions of base and sub-base, properties required of the materials involved, thickness, reinforcement design, construction and rehabilitation techniques. See further comment below titled "History of Rigid Pavements".

- **Innovation Award.** Barry Bromham and Dom Meadley were recognised for their work in improving the safety of testing personal when handling concrete products:

1. Use of a rubber pad fitted into a metal cap which holds the pad in position for compression testing replacing the Sulphur caps and the inherent risk of fires from molten sulphur and the corresponding unpleasant odour when making the cap.

2. Reduction in size of concrete test cylinders from 150mm diameter weighing about 27kgs including the steel mould to 100mm diameter weighing about 9kg including the steel mould with the consequential saving in back strains.

Barry Bromham and Dom Meadley displaying the old and the new; the old-style cylinder system on the left and new system on the right

The new system with rubber pad and metal cap

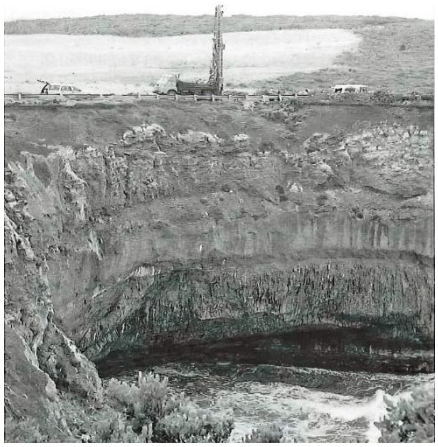
1990:

- **Laboratory management**: The laboratory management system developed by MTD has been introduced into most VicRoads laboratories throughout the State. It provides a system of tracking samples being tested, reporting test results, a means of charging both internal and external clients and enables reports on performance to be made to managers monthly.

- **Skid Resistance Survey**: MTD carried out skid resistance testing on 16,000 km of New Zealand Highways TRANSIT New Zealand using the SCRIM testing vehicle.

- **Great Ocean Road – Port Campbell:**

The sudden collapse of the "London Bridge" tourist attraction in January caused concern about the safety of several other areas where natural groundwater and the action of waves had undercut the cliffs. In these locations the road passes close to these undercut areas. The Geotechnical Group was immediately commissioned to carry out an evaluation of these areas. A program of drilling and remote sensing techniques, together with control survey and the adaptation of photogrammetry techniques were used to produce accurate cliff profiles.



Drilling investigation of undercut areas

Following the preparation of information about the potential risk of failure at each location a decision was made to deviate the Great Ocean Road immediately and construction was started in April.

In 1990, Colin moved across to manage the Road Design Department and Robert (Bob) Meggs moved in to manage the Materials Technology Department (MTD). Bob's story can be found in the VicRoads Association Website - Click on the following link to download the document: Bob Meggs Story

Bob Meggs – 1992

1990:

- **Research & Development.** Bob advised on progress with 62 projects being undertaken by the department summarized as follows (too many to list individually):

  - Foundations and Geotechnical 18 No.
  - Aggregates, soils and rocks 17 No.
  - Bitumen and asphalt 17 No.
  - Pavements 9 No.
  - Concrete 1 No.

- **A Group photo** of MTD staff indicated that numbers had reduced to the low 60s. This downsizing was also progressively occurring with regional laboratories closing and their testing services outsourced during the 1990s and early 2000s.

1991: **Expanded Polystyrene Filling (EPS**). VicRoads adopted an MTD innovative solution for embankments at the site of Lynch's Bridge over the Maribyrnong River at Footscray. Polystyrene blocks are used to minimize load on the soft foundation soils with a relatively low cost piled roadway approach to the main bridge structure. This treatment saved $500,000 over the nearest cost of an acceptable alternative. See also use of EPS in 1997.

1992:

- **Mulgrave ALF trial.** The trial conducted during 1989/91 evaluated the fatigue characteristics of asphalt and cement treated crushed rock, both of which are required to design deep strength and Full Depth asphalt pavements.

Test site of ALF on Mulgave Freeway

A report on the trial by Geoff Jameson, MTD's Manager Pavement Design together with staff from ARRB was published in the Proceedings of the 16th ARRB Conference held in Perth. Results from that trial meant a refinement to the Austroads mechanistic design procedure making asphalt pavements more economical.

Geoff Jameson - 1986

- **Further staff reductions** saw the Department vacating the 3rd floor. Further demand for accommodation space would have incurred considerable expense due to the presence of fixed laboratory equipment on the 2nd floor.

1993:

- **Technical Bulletin No. 37** – *VicRoads Pavement Design Manual* was issued to align with not only the new Austroads "Guide to the Structural Design of Road Pavements" issued in 1987 but also taking on board the results from the Mulgrave ALF trial conducted in 1989/91. The previous VicRoads Pavement Design Guide (TB No. 31) issued in 1980 used equivalencies for the design of asphalt pavements. Note, see further comment on TB 37 in year 2004.

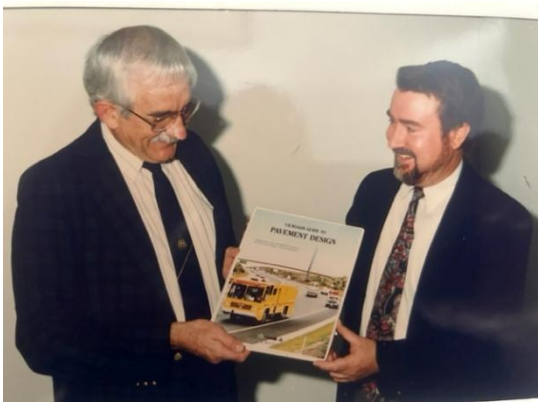


Photo of Max Lay (Director Technical Services and Lance Midgley (Manager Pavement Technology) at the launch of TB 37.

- **Code of Practice 500.00** - *Source Rock Investigations* details the process for source rock investigations, subsequent inspections and accreditation of materials supply for use in VicRoads works. Source rock investigations are an integral part of VicRoads accreditation process and the assessment of the quality of crushed rock and aggregate products. The current Version 4 released in December 2012 was first produced by MTD staff and released in February 1993.

- **Load Testing of the Latrobe River Bridges – Gippsland**: These reinforced concrete bridges were constructed in 1935 and whilst generally in good structural condition are now substandard in terms of their width between kerbs and in the strength of their barriers. The capacity of the bridges for current highway loading was also in question. Static and Dynamic load tests were carried out. These tests revealed that the bridge could be widened, and only minor strengthening was required. The testing was extremely useful in fine tuning the theoretical analysis with confidence and avoided unnecessary major strengthening.

- **Use of Remote Sensing to Locate Road Making Materials:** Data from the Landsat Thematic Mapper satellite covering parts of North-Western Victoria has been purchased and analysed. A classification map based on known deposits of calcrete and sandstone has been produced. Classified sites have been checked in the field and found to be successful in locating suitable materials for road making.

- **Metropolitan Labs:** The Hallam laboratory with Doug Dick as the EO in charge transferred to Metropolitan South East Region and the Broadmeadows Laboratory with Neil Tull as the EO in charge transferred to Metropolitan North West Region.

- **Overseas travel** by MTD staff funded by the Overseas Projects Corporation Victoria:

  - Geoff Jameson – Hong Kong Pavement Management System Project.
  - Walter Holtrop – Saudi Arabia sprayed sealing of roads project.
  - Ivan Haustorfer – Fiji road rehabilitation study.
  - Geoff Jameson – Philippines National Road Maintenance Management Improvement Project.
  - David Tilley – Laboratory Manager in Lesotho and Fiji

1994:

- **Research and Development Program**: An Austroads study led by MTD staff identified that the optimum application rates for the use of sealing aggregates could be reduced by as much as 20% and still provide an excellent coat. This would reduce the *cost of road construction and maintenance by about $500,000 per annum.

- **Technical Training**: MTD staff undertook a training program which has involved VicRoads, municipal industry personnel. Courses offered in the program have included the following subjects where over 850 people took part in the program:

  - instruction on the skid resistance program and site evaluation of results,
  - cost effective surfacing rehabilitation treatments,
  - developments in asphalt and bitumen surfacing technology,
  - sub surface drainage,
  - fundamentals of construction materials,
  - geotextiles selection and application,
  - design assessment of piles,
  - quarried construction materials, and de
  - VicRoads pavement design procedures.

- **Publication.** Bituminous and Concrete Surfacing Trial - Initial Results comparing the degree of water spray generated by a vehicle travelling over the following surfaces: Conventional Sprayed Seal, Dense Graded Asphalt, Open Graded Asphalt, Stone Mastic Asphalt, and an Exposed Aggregate Concrete Surface. Prepared by Lance Midgley and Graham Foley and presented at the 9th AAPA International Conference, Queensland in 1994.

1995:

- **Relocation of Laboratory.** In September 1994, the decision was made to move MTD to East Burwood. An allocation of 700 m^2 for office space, 600 m^2 for laboratory space, and 50 m^2 storage space was provided. This was a sizable reduction from the 4000 m^2 the Department occupied at that time in the Kew building. Dom Meadley was given the challenge to arrange the move, and various scenarios were developed to fit everyone in. However, starting with a new building with quite a different shape, considerable efficiencies needed to be made.

The laboratory was allocated the area on the Ground Floor to the left of the main central entrance, and the pavements and geotechnical engineering staff were to be located on the first floor again to the left of the central entrance. The new modern laboratory albeit of reduced size, was adequate for the services currently being provided.

New Laboratory Accommodation at East Burwood

Soils Laboratory

Geotechnical Laboratory

Asphalt Laboratory

Bob Body with MATA Testing Apparatus

- **Code of Practice 500.20** - *Assignment of CBR and Percent Swell to Earthworks Fill and Pavement Materials* sets down the principles and procedure for the assignment of California Bearing Ratio (CBR) and Percent Swell for:

  • Type A or Type B earthworks fill material supplied to the road from a single source,
  • Insitu cementitiously stabilised earthwork materials, and
  • Pavement materials, where a minimum CBR value is specified and the material source does not have an assigned Los Angeles Value.

  The current version released in October 2019 was first produced by MTD staff and released in January 1995.

- **Traffic Noise**. Traffic noise was monitored at more than 150 sites near major road and freeway works during the year. Measurements were made as part of planning studies to gain information on current noise levels for developing proposals.

- **Air Quality.** An air quality study was undertaken as part of the EES for the Southern and Western Bypasses. The area investigated was 162 square kilometres of inner Melbourne suburbs linking the Tullamarine Freeway to the West Gate Freeway, the West Gate Freeway to the South Eastern Arterial and widening of the South Eastern Arterial to Toorak Road.

  A key finding was that total emission rates from vehicles in the Melbourne region are expected to decrease over the next several years with the introduction of stricter Australian Design Rules for controlling vehicle emissions, resulting in improved air quality.

- **Technical Bulletin TB 40 –** *Pavement Investigation* was issued in December 1995. The purpose of this bulletin is to provide guidance for the conduct of pavement investigations and how to record field observations for use in pavement design.

1996:

- **Investigatory Skid Resistance Levels.** VicRoads and the RTA NSW jointly issued a document in August 1995 titled "*Guide to the Measurement and Interpretation of Skid Resistance using the SCRIM*.

- **Move to East Burwood.** In late June, 63 MTD staff moved from Kew to East Burwood made up of 27 Professional Officers, 33 Technical Officers and 3 Administration Officers. Section Leaders at that time were:

Pavement Technology - Lance Midgley	Geotechnical & Materials - Gerry Turner
Testing Equipment - David Veith	Laboratory & Surveillance - Hank De Goede
Business Administration - Chris Adams	Quality & Standards - Dom Meadley

- **ARRB Directors Prize.** Jim Holden, along with two others outside of VicRoads, won the 1996 ARRB Director's Prize for the development of a new construction method for vertical moisture barriers beside highway pavements. The role of these barriers is to stop the seasonal lateral migration of moisture to and from the subgrade beneath the pavement, a significant factor causing pavement cracking and loss of shape. The barrier also prevents the invasion of plant roots – refer to VicRoads Technical Note No.13 for details of the method.

Dr Jim Holden – 1990

1997:

- **MTD Annual Report**. Bob Meggs issued a report on services being provided:

  - **Geotechnical Services:** Over 50 projects delivered including major bridge foundation and alignment investigations of the Thomastown Section of the Western Ring Road, the Black Forest Section of the Calder Freeway, and the Exhibition Street Extension over the Melbourne Railyards. Continued to undertake quarry investigations and material searches, as well as surveillance and audit of steel fabrication, corrosion protection and quarry products.

- **Pavement Services:** Tested over 2500 kms of pavement with the PASE vehicle, provided 155 unique pavement designs, and provided 133 items of technical advice including highly specialized advice on contractors' proposals for design and construct contracts. In addition, the bituminous surfacing business was transferred to a separate stand-alone business to be known as Sprayline.

- **Laboratory Services:** Merged the Metropolitan and Dandenong Division laboratories into MTD's East Burwood operation. Together with the closure of 4 regional laboratories where most services were being outsourced to private testing companies, MTD took on leftover services not provided by those providers.

- **Technical Equipment Services:** With Move to East Burwood, the department's workshop remained operational at Kew. New markets were sought with success in securing a substantial maintenance contract of the Board's twelve Culway Stations. They also provided the instrumentation when testing an old bridge to destruction over the Yackandandah Creek on the Kiewa Valley Highway.

- **R&D Projects.** Advised on the progress on a diminishing number of projects covering the following topics:

• Pavements	10 No.	Structures	4 No.
• Road Safety	2 No.	Surfacing	5 No.

- **11 Papers Presented** by MTD staff at National and International conferences on the following topics: Structures, Materials, Pavements, and Surfacings.

- **17 Internal Specialised Reports** were issued on the following topics: Materials, Pavements, Bituminous Surfacing's and Structures.

In 1997, Bob Meggs left VicRoads and took up a bridge consulting position with consulting firm Hardcastle and Richards. Lance Midgley was subsequently appointed as the new Manager of MTD.

During his three-year term as the manager, he oversaw the strong continuation of pavement and geotechnical services supported by a small but efficient laboratory. However, he had to deal with the demise of practically all funded R&D activities, the focus for this work now being funded through the Austroads National Research Program where VicRoads were a major contributor. Click on the following link to download Lance's VicRoads story: Lance Midgley's Story

Lance Midgley 2001

1997:

- **GeoPave**. The organization took the decision to require the Technical Services departments of VicRoads (MTD, Road & Bridge Design, Survey, SprayLine, Information Services and Plant Sub-branch) to operate on commercial business lines. To emphasize this transition and after receiving suggestions by MTD staff, MTD was renamed GeoPave reflecting the principal reason for the department's existence being **Geo**technical and **Pave**ment services.

- **Innovation**: During this year, GeoPave was involved in the following:

  - Flexible Pavement and Chip Sealing Technology (FPCS) marketed to the Chile Ministry of Public Works. Information brochures have been produced in both Spanish and English as well as a short six-minute video with Spanish voiceover describing FPCS.

  - Increased use was made of Geotextile Reinforced Sprayed Seal surfacing's to rehabilitate cracked and distressed pavements. This has led to cost savings of up to 80 per cent compared with alternative reconstruction solutions.

  - Properties of asphalt containing 20 per cent recycled asphalt (RAP) from old pavements were found to be different from new asphalt. Tests on 10% and 30% RAP mixes continued. Note the current 2025 Standard Specification for Hot Mix Asphalt – Section 407 allows up to 30% RAP in new mixes depending on its use. The Premium heavy-duty asphalt (Type H) remained at 10% max.

  - Developed a method for using a hand pushed device to measure road surface smoothness in terms of the International Roughness Index. This unit became a convenient and accessible measuring device following the introduction of Specification Section 180 – Ride Quality for Pavements in 1999.

Photo of Ian Rogers with Hand Pushed Smoothness Measuring Device

The principal method for measuring road smoothness was by using Laser Profilers – High-speed automatic systems mounted on vehicles that use laser sensors, accelerometers, and gyroscopes to measure road profiles without touching the surface. However, these vehicles were not always available when contractors needed them.

  - Use of Expanded Polystyrene Filling (EPS**)** was further refined in the repair of a significant number of landslips which occurred in Otway's within a couple of months. These landslips mostly occurred where road formations had been constructed as sidelong cut and fill. The method is described in VicRoads Technical Note No. 25. Over the next 10 years, the method was used to repair over 300 slips**.**

Russell Brown with a Pad of EPS

1998:

- **Monitoring Slips**: GeoPave geotechnical engineers undertook surveys of earth movements and slips in several areas of the Victorian Alpine Region. The survey procedures were designed to offer maximum technical assistance to geologists and to suit the rugged terrain. This included establishing lines of monitoring pins in the vicinity of the slip areas.

- **Code of Practice 500.09** – *Testing Aggregates for Sprayed Bituminous Surfacing* sets down the procedures to be followed when sampling and testing Classes A, B and C aggregates for use in sprayed bituminous surfacing. The current Version 4 released in July 2018 was first produced by GeoPave staff and released in February 1998.

- **Code of Practice 500.11** – *Surveillance of Materials, Testing and Components* covers surveillance of materials, testing and components supplied or manufactured by contractors and their subcontractors, as applicable to VicRoads Contracts for:

  (a) VicRoads Register of Testing Companies.
  (b) road and bridge materials; and
  (c) structural components.

  The Code details requirements for VicRoads Technical Services surveillance officers, the conduct of the surveillance and the action to be followed based upon the results of the surveillance. The current Version 3 released in September 2014 was first produced by GeoPave staff and released in February 1998.

- **Road Roughness**: A draft standard Specification Section 180 for ride quality of new pavement construction was produced. This is a first for Victoria and, once implemented, will ensure that new road works are constructed to an acceptable standard with payment deductions applying for non-compliance.

- **Skid Resistance and Road Safety**: A method was identified for predicting the level of skid resistance for spray seals, using criteria such as commercial vehicle volumes, age of surface and properties of the sealing aggregate. Results to date have provided a useful tool for selecting the most appropriate sealing treatment for critical locations.

1999:

- **Research** found that with modification of conventional asphalt surfaces by using aggregates with higher PSVs in the mix could improve skid resistance by up to 20% with minimal additional cost. It. Is expected that the improved skid resistance would lead to a 10-20% reduction in accidents at critical locations and would reduce the cost of accidents to the community by about $2m each year. Refer also to Technical Note No. 60 – Skid Resistant Surfacing issued May 2002.

- **Research** into the use of Recycled Asphalt Pavement (RAP) in new asphalt confirmed that adding up to 20 per cent of RAP with new materials provided performance equivalent to that of asphalt made totally from new materials. This is expected to provide potential savings of $600,000 each year.

2000:

- **Code of Practice 500.05** - *Acceptance of Field Compaction* sets down the procedures to be followed when carrying out acceptance testing of field compaction of asphalt, other pavement materials, earthworks, trench bedding and backfill. This Code must be read in conjunction with the particular contract specification and relevant test methods. The contract specification must be checked to see whether acceptance is based on testing the work in lots. The current Version 10 released in June 2017 was first produced by GeoPave staff and released in May 2000.

- **Code of Practice 500.16** - *Selection of Test Methods for Testing of Materials and Work* sets down the appropriate test methods to be used for testing of materials and

work and extra detail where the test method permits alternatives. The current Version 16 released in July 2018 was first produced by GeoPave staff and released in May 2000.

- **Technical Bulletin TB 42** – *Curing of Concrete* was issued in June 2000 to provide guidance to personnel involved with the curing of concrete. Information on the various methods of curing concrete is given and its importance in achieving desired properties such as low permeability (low volume of permeable voids (VPV)), design strength, stripping times, serviceability and, very importantly, durability.

- **VicRoads support of Austroads.** In 1992 when Lance was appointed to MTD as Manager Pavement Technology, he took on the additional role as its representative on the Austroads Pavement Research Group (APRG), a position he held for over 8 years with 5 years as their Chair. During his time with APRG, significant progress was made in the following areas:

  - Updating the 1987 version of the Austroads Pavement Design Guide -refer current edition titled "Guide to Pavement Technology Part 2 – Pavement Structural Design". Austroads Publication No. AGPT 02-25.
  - Progressed the development of a National Bituminous Surfacing Manual -refer current edition titled "Guide to Pavement Technology Part 4K – Selection and design of Sprayed Seals. Austroads Publication No. AGPT 04K-18.
  - Commencement of reviewing all other existing Austroads/NAASRA pavement publications.
  - In partnership with AAPA, initiated and issued of over 30 Austroads/AAPA Pavement Work Tips. Note, there are currently 57 of these publications that have been issued – go to Austroads website and under Publications – search for the Pavement Work Tips Index.
  - Commenced producing a Glossary of Pavement Terms. Latest version issued in 2015 – refer Austroads Publication No. AP-C87-15.
  - Led the management of the ALF program where a variety of pavements were tested including the relocation of the ALF to a VicRoads unused freeway reserve site next to the VicRoads Fowler Road Patrol depot at Dandenong.

- **APSaRC/CPEE**: An additional duty Lance took on in 1995 was his appointment as the inaugural Chair of a newly established entity by Austroads & AAPA, known as APSaRC (Australasian Pavement Studies and Research Centre). Established by Austroads & AAPA offering tertiary qualifications in pavement engineering through distant learning and short courses. He spent over 4 years in the chair. In 2000, APSaRC was renamed the Centre of Pavement Engineering Education (CPEE) and at that stage were offering Graduate Certificates, a Master of Pavement Technology and a Master of Pavements.

  On 15 December 2010, a Certificate of Appreciation was awarded to Lance by CPEE in recognition of the valuable contribution made towards the establishment and successful development of entity from its inception in 1995.

- **Austroads Award:** As a result of his leadership at the national level, Lance was recognised by Austroads in 2000 with a Fellowship Award for his outstanding achievement of major national significance in the delivery of Austroads objectives in the field of pavement research.

Lance receiving the award from Tony Wilson – Austroads Chairman

- **Later in 2000:** Lance was appointed as VicRoads Regional Director Western Victoria and Steve Brown was appointed as the new Manager GeoPave in January 2001.

2001:

- **Steve** reported it was a busy time for GeoPave as it continued to develop commercial business practices. Staff were involved in developing several Austroads research papers, Work Tips, Technical Notes, etc. It was an important time in documenting lots of the knowledge and experience held by older staff members to ensure that information was not lost when people retired.

Steve Brown – 2002

- **Code of Practice 500.22** - *Selection and Design of Pavements and Surfacings* is now the definitive document that sets out pavement design requirements in Victoria. The current Version 13 released in November 2025 was first produced by GeoPave staff and released in January 2001. Prior to that it was in the form of 'Special Clauses' to be inserted into Design & Construct Contracts.

2002:

- **A Major Land Slip** had occurred on the Princes Highway East at Morwell where the expanding Hazelwood Open Cut Mine came close to the previously realigned freeway. Combined with the slip, major ground movements in the open cut mine caused cracking in the Freeway. This led to the closure of the freeway for some time.

  The Geotechnical Group became heavily involved in setting up several ground movement measurement stations on the freeway. Steve was involved in many meetings with the mine managers, the mine regulator and a number of technical experts who were trying to blame VicRoads and dodging the responsibility of the mine manager – who had stopped the recharging of water in the mine. The matter was resolved when the rewatering the mine face reassumed which led to the pavement stabilizing – no more cracking which in turn led to the reopening of the freeway.

- **GeoPave's success** in bidding for interstate and overseas projects including skid resistance testing in Tasmania, deflection testing in South Australia, triaxial testing in New South Wales and laboratory testing of pavement materials in Fiji.

- **External Representation**. Steve continued the involvement of his predecessor on Austroads projects including being the Austroads representative on the CPEE Board. He also represented Australia and New Zealand on the PIARC (World Road Association) committee on Road Vehicle Interaction (i.e. road surface issues).

- **NATA Milestone**. A celebration was held to mark the occasion of 50 years of NATA accreditation for soils testing first granted on 7 February 1951. An accreditation of this nature proves competence and integrity in undertaking such tests by using fully calibrated equipment and procedures that met high quality standards. An afternoon tea and a few speeches were made by Peter Young (NATA), Steve Brown (Manager GeoPave) and Miranda Douglas (Director Technical Services).

Steve Brown (standing) and Miranda Douglas (seated left side of photo)

- **Publications:**

  - Technical Bulletin TB48 - *Guide to Surveillance of Protective Coatings of Structural Steelwork* was issued in May 2003.

  - Technical Bulletin TB46 - *Guide to Surveillance of Structural Steelworks* was issued in November 2003.

  - Technical Bulletin TB47 - *Guide to Surveillance of Precast Concrete* was issued in November 2003.

2004:

- **New Manager GeoPave.** Steve was appointed as Regional Director Metropolitan South East followed by his subsequent appointment as Executive Director Regional Services in 2009. Praveen Reddy was subsequently appointed as the new Manager GeoPave.

  On Praveen's appointment, he took on the added responsibility of chairing the Austroads Asphalt Research Reference Group while Andrew Papacostas retained his position as the VicRoads representative on the Austroads Pavements Reference Group.

Praveen Reddy – 2023

- **Technical Bulletin 37** was discontinued after a major update of the Austroads Pavement Design Guide. A significant amount of text from TB37 was shifted into the Guide. Further, there was TB37 text that was overwritten by Austroads due to advancements.

- **Technical Bulletin No. 45** – *VicRoads Bituminous Sprayed Sealing Manual* was issued as an updated version in April 2004. This 455-page hard copy manual has had a long history of existence, the first version being published in July 1933 and signed off by the then Asphalt Engineer HH (Harry) Grey. It was known as the "Blue Book". In August 2018, Austroads published its first edition of the guide with the current 120-page version AGPT4K "Guide to Pavement Technology Part 4K: Selection and Design of Sprayed Seals" published in November 2019. The Austroads guide supersedes TB45 and made it obsolete.

  TB 45 provided a summary of three key points:

1. It was a manual for bituminous sprayed surfacing that describes required materials, processes, and equipment for applying sprayed seal surfaces.
2. It updated an earlier 1982 manual from the Country Roads Board on bituminous surfacing.
3. It acknowledges the contributions of various organizations including VicRoads, GeoPave, Sprayline, and AH Plant in updating the CRB manual.

TB 45 and the Austroads Guide provide details on the different types of seal treatments that had been developed over the years including the original Single/Single seal which in 1935 was influenced by the Hansen method of seal design from New Zealand. For convenience, a brief description of different sprayed seal treatments together with some additional comments on the specialised types were supplied by Ross Paul and Paul Donovan who were involved in the developments. Click on the following link to download their comments: Specialised Sprayed Seals

2005:

- **GeoPave's Business Plan** for 2004/05 was based on 45 staff with three Sections and their Leaders as follows:

  - Pavement Services – Andrew Papacostas
  - Geotechnical Services – Nelson Fok
  - Laboratory Services – Hank De Goede

- **Recycling Excavated Basalt**. GeoPave's Geotechnical expertise was used to promote the onsite use of excavated materials. One million tonnes of basalt was excavated on the Craigieburn Bypass Project with approximately one-third being crushed and recycled on-site for use in pavement and other engineering applications. The recycling of **of**

- **Code of Practice 500.01 –** *Registration of Bituminous Mixes* describes the process to be undertaken when registering bituminous mix designs, a must do requirement to comply with the following Standard Sections where those sections are included in contract specifications:

  - Section 404 Stone Mastic Asphalt
  - Section 405 Regulation Gap Graded Asphalt
  - Section 407 Dense Graded Asphalt
  - Section 417 Open Graded Asphalt
  - Section 418 High Modulus Asphalt (EME2)
  - Section 421 High Binder Crumb Rubber Asphalt
  - Section 422 Light Traffic Crumb Rubber Asphalt
  - Section 427 Microsurfacing

  The current Version 16 of the Code issued in December 2025 was first produced by GeoPave staff and released in September 2005.

2006:

- **Delivering technical training**. GeoPave and Design business areas continued to build knowledge within VicRoads and industry by providing a technical training program. The program covers specialist areas such as pavements, geotechnical investigation and road and bridge design. The courses are also open to external participants. This assists in improving technical knowledge and awareness of VicRoads standards in other road building organisations, many of which deliver projects on VicRoads behalf. About 480 people attended the training program in the year.

- **PIARC Committee**. Steve Brown (RM- Metro SE) remained an active member of his technical committee developing best practice in sustainable road vehicle interaction.

- **Technical Note No. 78** – *Guide to Planning Geotechnical Site Investigations* was issued in May 2006. The purpose of this technical note is to provide a simple and practical guide for planning geotechnical site investigations to allow completion on time, to the required quality and to budget.

2007. Delivering technical training. GeoPave and Design business areas continued to build knowledge within VicRoads and industry by providing a technical training program. During the year they delivered courses to 812 participants, an increase of almost 75 per cent compared with last year.

2008. **Standards Australia Award**. Even though he had departed in 2002, Dom Meadley continued his association with Standards Australia and was presented with a Meritorious Contributions Award for his 33+ years' work with the Soils, Asphalt, Aggregates and Earthworks committees. Dom's story can be found in the VicRoads Association Website - Click on the following link to download the document: Dom Meadley's Story

Dom Meadley – 2002

2009:

- **Director – Technical Consulting.** With Peter Mitcham's departure in late 2008, Praveen was appointed as Director. The name GeoPave disappeared, Andrew Papacostas led the Pavements & Construction Materials group including the Laboratory, and Nelson Fok looked after the Geotechnical Group; both positions reporting to Praveen. The Technical Consulting directorate included pavements, construction materials, geotechnical, traffic engineering, road, survey, bridge & landscape and urban landscape design (freeway aesthetics and noise walls) providing services to VicRoads. It also provided a consulting service to other parts of Government and the private sector across all disciplines.

- **Publications:**

  - **Technical Basis 801** - *VicRoads Standard Specification Section 801 - Source Rock for the Production of Crushed Rock and Aggregates* was issued in March 2009. The purpose of the Technical Basis document is to provide background information on elements of the specification namely:

    - Source rock factors covering:

      - Weathering
      - Rock forming minerals
      - Durability and Hardness tests
      - Quarrying procedure
      - Degradation Factor test
      - Secondary minerals content
      - Los Angeles value
      - Texas Ball Mill value
      - Accelerated Soundness Index
      - Polished Stone Value

    - Minimum testing requirements

  - **Code of Practice 500.02 –** *Registration of Crushed Rock Mixes* describes the process to be undertaken when registering crushed rock, a must-do requirement to

comply with Standard Sections 812, 815 and 818 where those sections are included in contract specifications. The current Version 4 released in June 2017 was first produced by GeoPave staff and released in June 2009.

- **Technical Basis 610** - *VicRoads Standard Specification Section 610 – Structural Concrete* was issued in April 2009. This comprehensive Technical Basis document has been prepared to provide background information on 24 (too many to list) of the specification clauses together with references to 11 related papers and documents.

- **Dry Back Clause** was included in VicRoads Specification Section 310 – Preparation of Granular Pavements for Bituminous Surfacing, in the July 2009 version. This requirement was deemed necessary to ensure the pavement had "dried back" sufficiently as measured by Moisture Content Testing and if the Mean Moisture Ratio was not within a particular range, then Ball Penetration Testing was required to demonstrate compliance. The previous method was to use the end of a Pick hammered onto the surface of the prepared granular pavement and listen for a "ping" sound; a very subjective method and very difficult to specify.

  From 2009, moisture content testing to RC 316.14 was the principal test, and in 2025, this VicRoads test was subsequently adopted as an Austroads Test Method – refer ATM 940. For borderline cases, a new Austroads test method was developed in 2005 based on using the Ball Penetrometer device – refer AG:PT/T251.

- **Technical Basis 407** - *VicRoads Standard Specification Section 407 Hot Mix Asphalt (HMA)* was also issued in July 2009. TB47 provided a background to the development of the hot mix asphalt specification and provides guidance in identifying important elements of the specification. Reference was made to the various types of asphalt, viz: Types N (Normal) H (Heavy duty), L (Light duty) and B (Base course). In 2025, the number of different types of HMA asphalt had grown to 17 as detailed in the updated version of TB47.

  TB47 references the related Austroads publication on Asphalt titled *AGPT04F-17 Guide to Pavement Technology Part 4B: Asphalt* first issued in May 2007. Information on the following specialized asphalt types was included:

  - Open Graded Asphalt
  - Stone Mastic Asphalt
  - Crumb Rubber Asphalt
  - Ultra Thin Asphalt
  - Lean Mix Asphalt
  - Warm Mix Asphalt
  - Regulation Gap Graded Asphalt

  Some additional comments and references to specialised asphalt treatments were supplied by John Rebbechi who was a VicRoads authority on the subject. Click on the following link to download John's comments: Specialised Asphalt Mixes

  TB47 also discusses bituminous binders used in asphalt mixes and references the related Austroads publication: *AGPT04F-17: Guide to Pavement Technology - Part 4F: Bituminous Binders* first issued in September 2008.

2010:

- Publications:

- **Technical Basis 812** - *VicRoads Standard Specification Section 812 - Crushed Rock for Base and Subbase Pavement* was issued in February 2010. The purpose of the Technical Basis document is to provide background information on essential elements of the specification namely:

  - Function of Granular Base and Subbase Materials
  - Definitions of Pavement Courses
  - Source Rock
  - Components of crushed rock
  - Product requirements including PI, Permeability and Unsound rock
  - Water quality
  - Grading requirements
  - Moisture content
  - Minimum testing requirements

- **Technical Bulletin No. 51** – *Guide to the Assessment, Maintenance and Rehabilitation of Concrete Bridges* was issued in April 2010. This Guide provides precise and up-to-date information for the guidance of personnel involved in these works. It attempts to raise awareness of concrete deterioration and associated mechanisms and highlights the importance of systematic and thorough inspection and assessment of the structural condition. It highlights the importance of proper practices, procedures and standards in the design and construction stages. It also discusses the kind of repair method, material or protection that is chosen which depends on the deterioration mechanism, the quality of concrete to be repaired or protected, and the specific environment.

- **Technical Basis 304** - *Standard Specification Section 304 – Unbound Flexible Pavement Construction* was issued in September 2010. The purpose of the Technical Basis document was to provide background information on the elements of the specification namely:

  - Definitions
  - Materials
  - Delivery Dockets
  - Conformity with Drawings including Lot testing and Compaction
  - Joints
  - Testing and Acceptance of Compaction
  - Maintenance of Compacted Layers
  - Frequency of Testing

2011:

- New Director. Praveen left VicRoads to take up a position with the National Transport Commission. Elaine Wyatt was subsequently appointed Director – Technical Consulting. Andrew Papacostas and Nelson Fok retained their respective group positions.

- Publications:

- **Technical Basis 408** - *Standard Specification Section 408 for Sprayed Bituminous Surfacing* was issued in August 2011. The purpose of the Technical Basis was to provide background information on the elements of the specification namely:

  - Definitions e.g. Primes and Primerseals, Double/double seals
  - Programming of Work
  - Limits of Work
  - Bituminous materials including PMB's and Emulsions
  - Aggregates
  - Sprayed Seal Design
  - Removal of Loose aggregate
  - Acceptance of sprayed sealing work
  - Job completion reports
  - Defects Liability Period

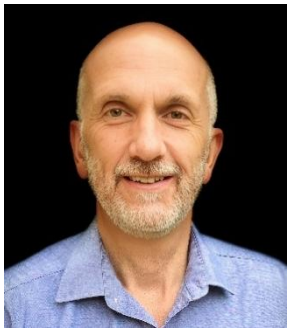
- **Technical Note 107** - *Use of Recycled Materials in Road Pavements* was first published in September 2011. It provides a summary and general guidance on the use of selected recycled materials in road pavements. The current updated version was issued by the DTP in July 2023. It should be noted that many of these recycled materials were in use well before 2011, e.g. Crushed Concrete in the 1990s, trials of Reclaimed Asphalt Pavement in the 1990s, Crumb Rubber in Sprayed Seals in the 1970s and Crumb Rubber in Asphalt well before its use was first published in Section 407 in 1992.

2013:

- Technical Basis 409 – *Warm Mix Asphalt* provides an explanation of some of the provisions of the standard section and is supplementary to the Guide Notes on the Standard Specification. It was issued in January 2013.

- Code of Practice 500.03 - *Management of Quarry Reference Specimens* details current Quarry Reference Specimen Lists to be used by quarries, testing laboratories, contractors and the Department of Transport and Planning (DTP) staff for assessing the quality of crushed rock and aggregate. When quarry laboratories carry out "unsound stone counts", i.e., visual assessments of aggregate quality in accordance with Test Methods RC 372.01 or AS 1141.30.1, the reference set used must be the set identified by the current version by this code. The original version was produced by GeoPave staff and released in June 2013. The current version, No. 7, was released in February 2024.

- Another Restructure of VicRoads occurred which included a significant reduction in staff numbers. The Technical Consulting Directorate was renamed Technical Services and was led by Agnelo Duarte as Director (Agnelo had previously undertaken a graduate rotation position in the pavement design team). Andrew Papacostas became Principal Advisor – Pavements, Geotech & Materials (PGM Group), responsible for all these services. At that time, the PGM Group had about 38 No. staff (no Administration staff).



Andrew Papacostas – 2023

- **End of "Surfacing Chat"** an internal publication on pavement surfacing that commenced in GeoPave in 1998 by Ian Cossens, ended in June 2013 at Edition 138. Its aim was to keep VicRoads personnel involved in these works informed on developments in sprayed sealing technology. However, it was becoming onerous to produce as Head Office reviewers were turning them into VicRoads Technical Notes rather than continue with the relaxed 'chat' style of issue.

Ian Cossens – 1997

- **Technical Note No. 22** - *Acid Sulphate Soils* was issued in March 2013. Such soils have a corrosive effect on iron, steel and aluminum components of engineering works. These soils also attack concrete, causing the concrete to expand, weaken and subsequently expose reinforcement to corrosion. The Note was issued to provide a simple and practical guide covering:

  - the formation, occurrence and effects of acid sulfate soils; and
  - how to identify and manage acid sulfate soils during road construction activities.

2017. The Technical Services Directorate was renamed Asset Services with Catherine Dear as Director. Andrew Papacostas PGM Group reported to Catherine. PGM were still located at East Burwood whilst Catherine was based at the Kew office. Nelson Fok, Andrew Walker, and Arthur Apostolopoulos headed up Geotechnical, Construction Materials, and Pavement Technology Services, respectively.

2019. Department of Transport: On 3 April 2019, it was announced that VicRoads and Public Transport Victoria would transition to the Department of Transport (DoT) as of 1 July 2019, to become one transport agency delivering integrated planning, delivery and management of transport in Victoria. The PGM group remained at East Burwood.

Note: On 1 January 2023, the DoT became the Department of Transport and Planning (DTP).

2022. **The end of the Materials Research Division** and its successor named departments/group came when the Asset Services directorate became part of the Assets & Engineering (A&E) Division within the DTP. The Pavement, Geotechnical and Construction Materials group was separated and further split into various teams across various groups within the Assets & Engineering Division. At that time, PGM staff comprising about 25 officers moved from East Burwood to new premises in Ringwood. All laboratory equipment and testing services including vehicles (PASE, SCRIM, etc.) were transferred to the National Transport Research Organisation (ex ARRB) free of cost as part of a contractual arrangement to provide testing and mix registration services.

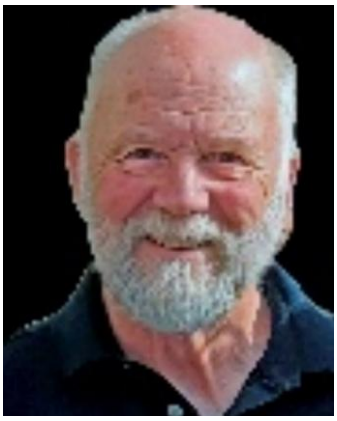
With the transfer of testing services, DTP no longer required NATA accreditation for soil and aggregates testing. However, a staff member in the A&E Division retained NATA approval for conducting Unsound Stone Counts including petrographic examination of coarse aggregates under Accreditation No. 21 (Note the original NATA approval for the basic soils tests Group was granted in 1951).

Throughout this story, reference has been made to some Technical Notes but there are many more - 112 Notes have been issued to date. A consolidated list of such documents can be found at DTP *Technical Note No. 000 – Index to Technical Notes* issued in August 2023. This list relates to pavements, geotechnical and construction materials and

provides information on best practice and/or latest techniques used within the road making industry.

Post 2022. Although the emphasis on internal research and development had long passed, the organization in its final years still played a leading role of influence in the Austroads research program – Andrew Papacostas for Pavements, and John Esnouf for Bituminous Surfacing. Also, the following staff were representatives on Standards Australia Committees, national working groups, industry liaison, etc:

- Fred Andrews-Phaedonos for concrete (see further comment below),
- Andrew Walker for steel, and
- Nelson Fok for geotechnical issues.



John Esnouf – 2024

*

Andrew Walker – 2018

Nelson Fok – 2024

All these members of the various technical disciplines continued to influence both State and National practices and remained closely involved with Academia in general, but particularly in post graduate studies.

Today (2026). Whilst PGM staff have retired or are close to retiring, current DTP Assets & Engineering staff of the various technical disciplines continue to influence both State and National practices and work with Academia on targeted research projects.

History of Rigid Pavements. While flexible pavements were the favoured type of pavement used by the CRB, RCA and VicRoads, the MRD history story would be incomplete without including reference to the rigid pavement story and its use in Victoria. Click on the following link to download a brief albeit incomplete description of the story: Concrete Roads in Victoria

Long Serving Staff. One of the noticeable traits with MRD staff was their loyal and dedicated service to the division. Here is a list of staff with significant lengths of service up until 2022 when the remaining staff transferred over to DTP:

Name	Position	Years of Service	Year Departed
Andrew Walker	Metallurgist	49	2022*
John Hanks	Scientific Officer	45	1991
Graeme Newman	Scientific Officer	41	2022*
Alf Gawith	Engineer	41	1970
David Capon	Experimental Officer	≈40	Circa 2006
John Jobson	Scientific Officer	≈39	Circa 2001
Dom Meadley	Experimental Officer	37	2002

Bruce Ennor	Experimental Officer	≈37	Circa 2004
Terry Lawless	Clerk of Works	≈37	Circa 2000
Nelson Fok	Engineer	36	2022*
Barry Fielding	Scientific Officer	≈36	1998
Cliff Parfitt	Experimental Officer	≈36	Circa 2006
Andrew Papacostas	Engineer	35	2022*
Ken Mitchell	Experimental Officer	35	1997 (VDP)
David Simpson	Experimental Officer	≈35	2000

* Service ongoing with DTP since 2022

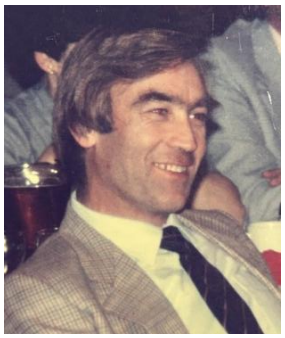
A complete list of officers who worked in MRD for 20 and more years can be found under Materials Research Division in the History page of the VicRoads Association website – Click on the following link to download the document: MRD Staff Years of Service

Champions of MRD

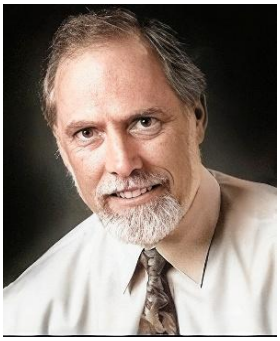
Alf Gawith - Father of materials research.
John Scala – For development of Static & Dynamic Cone devices & Benkelman Beam.
David Currie – For his oversight of many innovations and the documentation of such.
John Bethune – For his leadership in Asphalt and Sprayed Sealing innovation.
Roy Gilmour – For his research work in steel performance.
Alan Muir and his geology team – For their valuable gravel/quarry searches.
Elemer Nyoeger – For his work in Petrological Examintion of rock specimens.
Jim Holden – The pre-eminent Geotechnical Engineer involved in many developments.
David Veith – Use of Electronics in testing equipment, e.g. PASE, SID, CPT vehicle, etc.
Barry Fielding – For developing Durability Tests for road aggregates.
Adrian Williams – For design methods of socketed piles founded in weathered mudstone.
Peter McDonald – For design methods of socketed piles founded in weathered basalt.
Kel York – For his leadership in Construction Control Testing.
Barry Bromham – For developments in concrete testing.
John Hanks – Contributed highly to the quality of the laboratory function.
David Anderson – For rationalizing CRB's approach to Asphalt Overlay design.
Geoff Jameson – For work on Mulgrave ALF Testing further advancing pavement design.
John Foote – His leadership over Quality Control Clerks of Works at contractors' plants.
Bill Sherwin – The expert in Asphalt Mix Design laboratory testing.
Emil Horbelt – An expert in Soils and CBR laboratory testing.
David Capon – His leadership in charge of the Cone Penetrometer Testing vehicle.
Walter Holtrop – An expert in Sprayed Sealing Technology.
David Simpson – His Leadership in charge of Pavement Deflection Testing e.g. PASE.
Russell Brown – For his development in the use of EPS in Slip Repair.
Dom Meadley – His commitment to testing standards through NATA and Standards Aust.

Photos of those champions not already included above are now included:

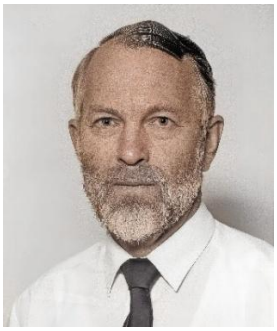
David Veith – 1990



Adrian Williams – 1980s

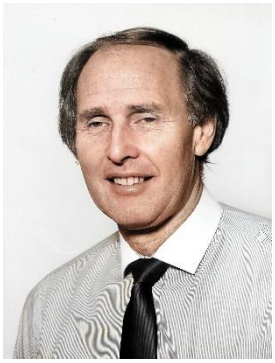


Peter McDonald – 1990

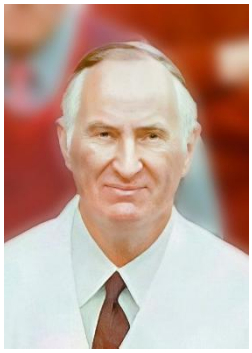


John Foote – 1990

Emil Horbelt – 1980s



David Capon – 1990



Bill Sherwin – 1976

David Simpson - 1976

One member of staff worthy of mentioning was our much-loved Canteen Officer Eileen Walsh. She looked after her MRD and Asphalt Division staff for 20 years, finishing in 1994. Everyone had fond memories of Eileen serving morning and afternoon tea, taking lunch orders, and serving lunches in the dining room on the 3rd floor. She was quoted as saying "*I didn't mind what job I did as long as it was in Materials*".

Eileen Walsh – 1984

Eileen was famous for her catering skills and regularly displayed them at all social events. In particular, the Australia Day, Melbourne Cup and end of the year Christmas parties provided a genuine excuse for a good feast. Bob Meggs mentioned at her retirement function "*Eileen had a wealth of jokes which she would share at lunchtime.*" A heart of gold.

John Rebbecchi recalled Eileen was a legend. She was the tea lady in the days when the tea lady would come around and provide morning and afternoon tea in the various officers or in the canteen that was the major gathering of personnel with the availability of meals sent over from the HO café. Eileen did more than just providing morning an afternoon tea with her contribution to the social interaction within the building. In the 1980s, the role of tea lady was abolished with the installation of self-service tea and coffee machines. They were initially equipped with provision for payment but that was never activated. This was around the same time as the introduction of time clocks that required staff to turn on and off on entering and leaving the building. With her role as tea lady becoming redundant, a little manoeuvring was able to find her continued employment as a Laboratory Attendant.

Another outstanding feat worthy of mentioning was the contribution by Fred Andrews-Phaedonos to the concrete industry. He is the author and co-author of more than 95 published concrete related technical papers and the author of numerous technical reports, technical notes, materials alerts, test methods, standard technical specifications, and bulletins. For his service, he has received awards from VicRoads (2), Industry (2), Austroads (1) and ARRB (1). In 2015, he was awarded Life Membership of the Concrete Institute of Australia.

Fred Andrews-Phaedonas – 2014

VicRoads can be very proud of the achievements by MRD staff in the Research and Development area over the years, addressing the many problems which were experienced by the organization designing and constructing roads and bridges. Many of these R&D projects led to significant improvement in VicRoads procedures, standards and specifications many of which are summarized in a separate document authored by Lance Midgley titled "MRD Notable Achievements". That document can be found under Materials Research Division in the "History" view of the VicRoads Association website – Click on the following link to download the document: MRD Notable Achievements

Lance Midgley
Manager GeoPave
1997 – 2000

Acknowledgements

I am indebted to Dom Meadley whose previous work on MRD's materials and departments together with his reminiscences encouraged me to produce a consolidated history of the Division/Department from the start of the CRB in 1913 to the finish in 2022. Many of the photos included in this document came from Dom's collection of photos. The 108 Annual Reports issued by the organization provided a wealth of information on our MRD history.

To Phil Symons, whose help with enhancing all the photos using his AI Apps was most appreciated.

A big thank you to Kel York for his input and meticulous proof reading of the document.

Thanks to Andrew Papacostas, Ross Paul, Paul Donovan and John Rebbechi for their input. Thanks also to the many other staff who provided details of the part they played in the MRD story.

APPENDIX 1

List of Staff who relocated from Drummond Street to Kew Laboratory in 1964

Arthur	Max	EO
Bain	Gordon	EO
Campbell	Alan (Stuart)	EO
Cromie	Doug	EO
Douglas	Vivian	EO

Enderby	Keith	Divisional clerk
Ferguson	Tim	EO
Fielding	Barry	EO
Foote	John	Geophysicist
Francis	Brian	EO
Freeman	Roy	Chemist
Gawith	Alf	Materials Research Engineer
Hamley	Alan	EO
Hanks	John	Scientist
Harris	Alf	Storeman
Haslett	Albert	Admin
Haslett	Ernie	Scientist
Horbelt	Emil	EO
Horsfield	Tom	EO
Jones	Ernie	Handyman
Konings	Peter	EO
Langford	Noel	EO
Masters	Harold	EO
Moody	Keith	AMRE
Muir	Alan	Geologist
Newbiggen	David	EO
Nyoeger	Elemer	EO
O'Flynn	Ollie	Chemist
O'Keeffe	John	EO
Palagy	Carl	Chemist
Parkinson	George	Driver
Purtle	Bob	Technical Assistant
Ratnarajah	Alan	EO
Rees	Anthony	EO
Rush	Joe	EO
Russell	Barry	Scientist
Sinnot	Mrs	Tea lady
Tamas (Stomm)	Mike	Chemist
Taskis	Harold	Chemist
Veismanis	Gus	Scientist
Von Gnielensky	Steve	Geographer
Vucic	Vic	EO
Watson	Alec	EO
Whittam	George	Technical Assistant
York	Kel	EO

APPENDIX 2

Summary of R&D Projects – 1968/69

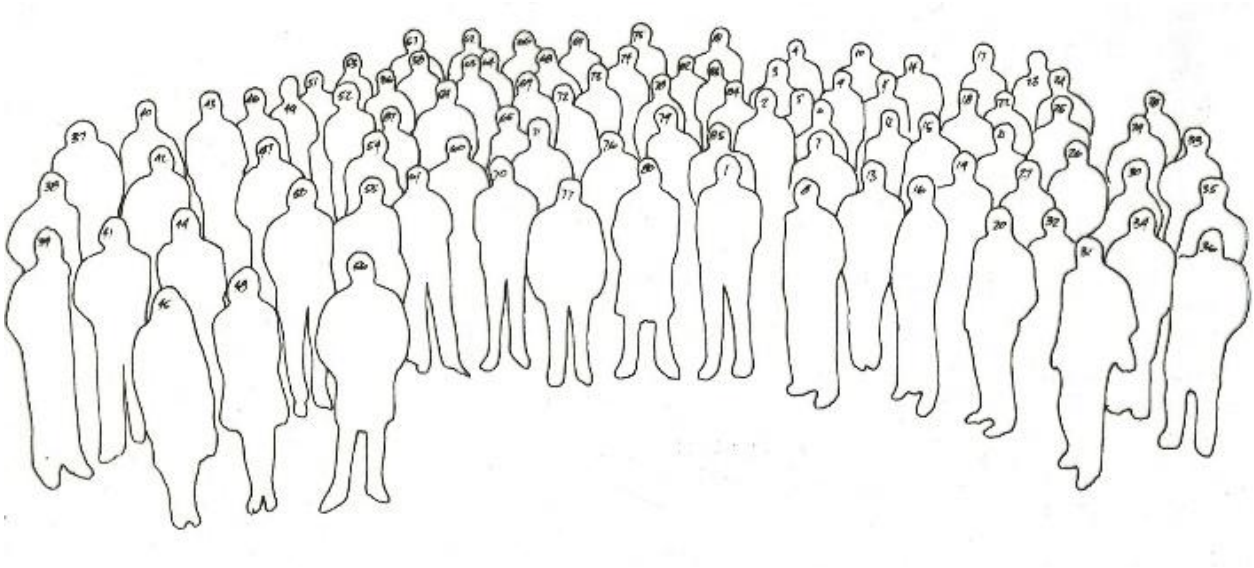
- 6 No. Road Roughness (Project Numbers 72 to 77)
- 5 No Steel Investigations (1, 2, 5, 70, 71)
- 1 No Weighing Vehicles (3)
- 8 No Soil & Aggregate Testing (4, 24, 54, 55, 58, 59, 63, 68)
- 10 No Pavement Density Testing (5, 6, 44 to 50, 57)
- 3 No Pavement Design (7, 64, 65)

- 9 No Roadmaking Materials Testing (8, 11, 12, 13, 51, 53, 61, 62, 69)
- 16 No Geotechnical Investigations (9, 10, 30 to 43)
- 1 No Bitumen Testing (14)
- 2 No Chemical Testing (15, 17)
- 1 No Signing Investigations (16)
- 2 No Skid Resistance Testing (18, 19)
- 4 No Asphalt Mix Design (20, 21, 22, 23)
- 5 No Concrete Mix Design (26, 27, 28, 29, 60)
- 2 No Laboratory Equipment (52, 56)
- 2 No Computer Programs Investigations (66, 67)

Note: The detail on each project is available from Lance Midgley.

Appendix 3

Names of MRD Staff in Photo – 1976



1. Peter Low	19. Tom Horsfield	37. Grey Scott	55. Alan Muir	73. Ray Batty
2. John Hanks	20. Mike Tamas	38. Bob Parker	56. John Lucas	74. Ron Gunn
3. Paul Billington	21. Bob Stamp	39. Andrew Walker	57. Joe Rush	75. Rodney Binks
4. John Sandrow	22. John Stephenson	40. Peter McDonald	58. Jeff Larkin	76. Joe Goldyn
5. Lois Riddell	23. Bruce Ennor	41. Laurie Watson	59. Dave Brewer	77. Albert Haslett
6. Lance Midgley	24. David Bloor	42. Tony Dann	60. Graeme Briant	78. Joyce Arthur
7. Elemer Nyoeger	25. Ron Lilley	43. Adrian Williams	61. Bob Barron	79. Gus Versmanis
8. David Currie	26. Peter Rye	44. Geoff Jameson	62. Kel York	80. Bill Scherwin
9. Vic Weldon	27. Gordon Wilson	45. Margaret Jobson	63. Kevin Hadingham	81. Neil Tull
10. Jim Fowler	28. Neville Hogan	46. Peter Salisbury	64. Lloyd Wilson	82. Emil Horbelt
11. Dan Baker	29. Edgar Sandy	47. David Simpson	65. Joe Scherf	
12. Bob McPherson	30. Peter Colgrave	48. Glenda Rushbridge	66. Christine Panezzola (nee Gilbert)	
13. Tony Babos	31. Bruce Phillips	49. George Black	67. Chris Stewart	
14. Bill Pinches	32. Patrick Baptiste	50. Jim Holden	68. Peter Mahler	83. Max Arthur
15. Peter Scott	33. George Rumbens	51 Harold Masters	69. Peter Hillard	84. Edgar Kayak
16. Harold Taskis	34. Andy Masterson	52. David Williams	70. Geoff Knox	85. David Veith
17. Vish Makowski	35. Alan Griffiths	53. Dom Meadley	71. Stan McDonald	86. John Jobson
18. Ted Vincent	36. Ken Williams	54. John Ennor	72. Bill Harman	87. Steve Newcomb

Research & Development Report – 1986

1. Soils and Flexible Pavements

1.1	Soil Moisture Content by Microwave Drying	Kel York
1.2	Variability of Measurement of Compacted Pavement Materials	Simone Servais
1.3	Interlaboratory Studies of Testing Soils and Aggregates	Simone Servais
1.4	Description of Classification of Soils and Rocks for Engineering Purposes	Bob Barron Geoff Jameson
1.5	Characterisation Tests for Pavement Materials	Geoff Jameson
1.6	Structural Adequacy of Roads	Geoff Jameson
1.7	Monitoring of Heavily Trafficked Rural Roads	Geoff Jameson
1.8	Monitoring of Skid Resistance	Geoff Jameson
1.9	Deformation of Basaltic Clay Embankments	Jim Holden

2. Aggregates and Rock

2.1	Accelerated Soundness Test for Altered Basalt	Barry Fielding
2.2	The Durability of Sulphide-Bearing Source Rocks	Barry Fielding
2.3	Inservice Durability of Basaltic Materials	Barry Fielding
2.4	The Assessment of Precoating Agents Applied to Calcrete Surfacing Aggregates	Barry Fielding
2.5	The Use of Physico-Chemical Tests to Characterise Basalt	Barry Fielding
2.6	The Use of Wet/Dry Strength Variation Test for the Characterisation of Basaltic Source Rocks	Barry Fielding
2.7	The Specification of Sedimentary Source Rocks	Barry Fielding
2.8	Tests for the Specification of River Gravels	Barry Fielding
2.9	Determination of Degree of Weathering and Excavation Characteristics of Newer Basalt using Seismic Refraction Techniques	Barry Fielding

3. Asphalt and Bitumen

3.1	Fatigue Characteristics of Asphalt	Geoff Jameson
3.2	Trial Wearing Course Asphalt Mixes	Geoff Jameson
3.3	Flexible Overlays for Concrete Pavements	Geoff Jameson
3.4	Asphalt Acceptance Testing Specifications	Kel York
3.5	Properties of Bituminous Binders	Arie Meydan
3.6	Evaporation of Oils from Bitumen	Arie Meydan
3.7	Rheology of Bitumen Nearing Distress Condition	Sam Maccarrone
3.8	The Absorption of Bitumen by Aggregate	Max Arthur
3.9	Bitumen Scrap Rubber Asphalt	Max Arthur
3.10	Rapid Bitumen Content Determination	Max Arthur

4. Foundation Systems

4.1	Identification of Soil Types using Quasi-Static Cone Penetrometer	Russell Brown
4.2	Performance of Piezo-Cone Penetrometers	Jim Holden
4.3	Site Investigation using Dilatometers	Russell Brown

4.4	Ground Movements under Road Embankments on Compressible Foundation Soils.	Peter McDonald
4.5	Acceleration of Embankment Settlement on Soft Compressible Soils	Peter McDonald
4.6	Performance of Piles under Lateral Loads	Peter McDonald
4.7	Dynamic Load Testing of Piles	Sam Plesiotis
4.8	Performance of Spill-Through Abutments on Relatively Incompressible Foundation Soils	Tom Flintoff
4.9	Stability of Cut Batters in Stiff Fissured Clays	Tom Flintoff

5. Environmental

5.1	Air Quality in Vicinity of Roads	David Ford
5.2	The Effect of Trees on Road Pavements	Geoff Jameson

6. Paints, Coatings and Roadmaking Materials

6.1	Adhesives for Road Pavement Markers	Arie Meydan
6.2	Protection of Timber Bridges from Bushfires	Arie Meydan

7. Concrete

7.1	Rubber Caps on Concrete Cylinders	Barry Bromham

8. Miscellaneous

8.1	Stable Survey Marks in Expansive Soils	Jim Holden