CHAPTER 1
THE HISTORY OF MILITARY ENGINEERING

0101. Military engineers throughout the world are members of the profession of arms. They are concerned with maintaining the mobility of their own forces, denying the same to an enemy and enabling forces to survive in hostile environments. In more simple terms, military engineers permit friendly forces to “Live, Move and Fight” while denying the same to the enemy. Internationally, military engineers share a common background in a discipline that encompasses the use of demolitions and land mines, the design, construction and maintenance of defensive works and fortifications, roads and lines of communication, and bridges. They also provide water, power and other utilities, provide fire, aircraft crash and rescue services, conduct hazardous material operations, and develop maps and other engineering intelligence.

0102. The Canadian Military Engineers (CME) contribute to ensuring Canada remains strong at home, secure in North America and engaged in the world. We do this through ensuring the survival, mobility, and combat effectiveness of the Canadian Armed Forces (CAF). We conduct operations across the entire spectrum of conflict and serve wherever the need arises. We are proud to live up to the motto *Ubique* (which is Latin for “everywhere”). Engineers are highly trained team players who perform their tasks with determination and tenacity. Uniforms, tactics and equipment have changed considerably since the early days of the nation, but the Engineer’s greatest resource - the individual 'sapper'- has remained steady (the term sapper refers to a military engineer and is explained further in Chapter 3).

0103. Few other organizations, civilian or military, can claim to have contributed as much to the defence and development of this nation as the CME and our predecessors. To appreciate this contribution, however, one must have an understanding of both the long history of military engineering and the unique Canadian experience.

The Beginnings of Military Engineering

0104. Throughout history, military engineers have been innovators and firmly in the forefront of harnessing nature and machines to serve our needs. The earliest application of the engineering discipline was strictly military engineering. Without a qualifier, an “engineer” was presumed to be military. The term “civil engineer” came about to distinguish those engineers who practiced the profession solely in the civil sector.

0105. There are many examples of the contributions of military engineers to the art and science of warfare. In many cases, military engineers have been responsible for the application of a new technology to warfare and, once mastered, that field has often devolved into a new and separate branch or corps. With the introduction of gunpowder, cannon were sometimes under the control of an engineer and the ordnance trains were often commanded by engineers. The guns themselves were later handed over to the artillery and mechanical transport was handed to the new transportation corps. Signalling had its origins with the Royal Engineers in Crimea, where it was an engineer responsibility to provide communications up to the brigade level. A separate signalling corps was only established after the First World War. Subsurface mining also had its origins in the Royal Engineers before it was transferred to the Royal Navy. Ballooning and heavier-than-air machines were also a Royal Engineer responsibility until the First World War when separate air forces were formed.

0106. The science of military engineering originated with the civilizations of antiquity. There is little doubt that military engineering was the first form of engineering and can be traced to the latter stages of the Stone Age. Early applications of engineering were directed towards weaponry, and included enhancing weapons made of the first crude metals with engineering skills and, soon thereafter, providing defences against them.

0107. The first evidence of the importance of military engineering in human affairs can be found in Palestine in the oldest human settlement of Jericho that can be called a city. Dating to 4000 BC, Jericho reveals how central military engineering construction was to civilized life. The settlement was founded on a perpetual spring of pure water. To protect access to this highly valuable supply, it was surrounded by a wall and a system of defences that were supplemented by a tower. These essential elements of fixed defences, in one form or another, are found in all subsequent defensive systems. Evidence of other remarkable engineering skills can be found in the construction of the Egyptian pyramids as early as 2760 BC, and in the Mayan and Aztec cultures starting around 1500 BC. Archaeological evidence of these civilizations shows that they had advanced skill in constructing massive buildings, roads, and water supply systems.

0108. By 1000 BC, military engineering began to take on the characteristics of an organized science that combined the aspects of siege craft and fortification. Ramparts and walls were built around ancient cities to ward off besieging forces. The catapult, originally designed as a defensive weapon, appeared around 400 BC and was soon adopted for attack; it quickly became the siege engineer's principal weapon until the invention of firearms. Armies began using catapults and designing wheeled battering rams to breach fortifications. In this era, the technique of mining or tunnelling under enemy walls was first used to breach hard defences.

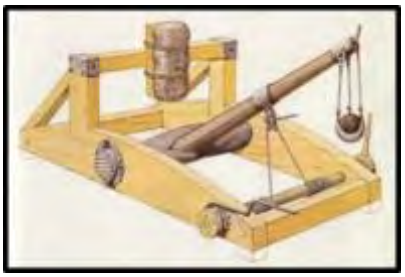

Figure 1-1 An Early Catapult

0109. The engineer, as professional soldier, began to exercise influence on tactics and strategy during the Grecian Empire (500-340 BC) by introducing floating bridges to win several major battles. Engineers provided the basis for many aspects of warfare as they developed the science of defensive fortifications and the mathematics of the trajectory involved with hurling objects. Engineers devised more complicated engines of war such as a catapult that used a twisted cord for its power and, some 150 years later, a magazine-fed weapon for shooting arrows. During the same period, Archimedes invented various ingenious defensive devices, as well as a war engine for hurling missiles against troops and forts. From then and until the seventeenth century many of the outstanding military engineers were concerned with weapons development.

0110. In the Roman army, every soldier was an 'engineer' and was expected to wield a spade as often as a sword. The Roman legion practised its engineering skills when on the move. Unless at permanent camp, it would construct a temporary one every night. Six thousand legionaries would construct a square earthen rampart, a ditch around the circumference and a palisade of stakes on top. This process of 'castrametation' took only three to four hours. The Romans raised their military engineering operations to a highly scientific level and Roman army engineers, operating much as the engineers of modern armies, marched with the advance guard. They were equipped for surveying and mapping, selecting and building camps, and building the roads over which the main body of troops followed. The engineers also secured water supplies and erected camp fortifications.

0111. The Roman Legions became experts at siege craft. In their siege against Masada in 72-3 AD, the biggest problem was getting to the enemy. The defenders occupied a sheer mountain top and were well supplied with food and water. For nearly two years, the legionaries toiled to construct an enormous earthen ramp against the mountainside so their siege engines could directly attack and defeat the defenders. Throughout the empire, engineers built large public buildings and networks of aqueducts to support the major population centres. Roman army engineers constructed a system of approximately 75,000 kilometers of paved military roads that connected Rome with her outlying colonies. Today, remnants of the Roman Empire still stand as testament to the design and construction skills of Roman military engineers.

Figure 1-2 Roman Siege of Masada

0112. The Romans were not the only ones who were developing advanced engineering skills. The Chinese began linking local defensive ramparts to form the first Great Wall of China starting in 214 BC. Construction of a new wall began in 1368 AD. This huge undertaking took almost 200 years to complete and, once finished, the 2,250 kilometer wall was 10 meters high with guard stations every 100 meters. The Great Wall of China is considered to be one of the greatest military engineering feats of all time.

0113. After the fall of Rome, there was little change in military engineering for 500 years and classic Roman techniques for building and attacking fortifications gradually disappeared. The nature of warfare in Europe changed and the foot soldier (the Roman legionary) was largely replaced by cavalry (the knight in armour). Defensive warfare increased in importance later in the Middle Ages, when the construction of feudal castles became prominent. These castle-fortresses were built in commanding positions and were frequently protected by a river. In this era, armies again returned to the ancient practice of laying siege to a fortification. They commonly breached the defences by digging a trench, or as it was referred to in those days, a “sap,” up to the base of the castle wall to conceal their approach. It is from this root word “sap” that the term “sapper” is derived (a more complete explanation is in Chapter 3).

0114. These impregnable retreats were constructed across Europe until gunpowder began to render such fortresses obsolete (about 1500 AD). Engineers of this period were kept busy designing and constructing siege engines that used more complex systems of counterweights to propel projectiles with increased force. It was during this time that the military engineers resumed the study of trajectory, making the engineers the logical choice for commanding a new technology; guns.

Figure 1-3 A Castle under Siege

0115. The introduction of explosives and explosive artillery shells had a tremendous impact on the conduct of war. It is believed that the English were the first to employ gunpowder for demolishing the walls of an enemy fortress at the siege of Harfleur in 1415. Tunnelling under the walls, they planted heavy charges of gunpowder that were then detonated.

0116. The introduction of efficient artillery changed military life across the entire world. As the power, accuracy and range of smooth-bore cannon improved, demand increased for trained engineers to build fortifications against them. Massive, high stone walls and towers were now

vulnerable to rapid breaching so inventive military engineers conceived new fortifications based on low walls. New applications of military engineering continued to be introduced and, in the early fourteenth century, Guido da Vigevano presented the French Court with major innovations in bridging and tower construction. Leonardo da Vinci, the genius, artist and scientist, was another famous military engineer of this time. He devised new field fortifications and mining techniques, designed lighter cannons and mortars, built canals and waterways for fortifications, and drew plans for a rapid-firing weapon that was the forerunner of the machine gun.

0117. During the sixteenth century, the exploding shell came into general use with the introduction of the mortar (a short range artillery weapon that could drop a bomb behind the high wall of a besieged fortress). Countering these new weapons called for fortifications designed with effective patterns and fields of fire for defensive warfare. This started a long epoch of the military engineering art of defensive works whose designs were drawn from the revived science of mathematical geometry. A correctly drawn ‘artillery trace’ would protect the core of a fortress from direct artillery attack while also preventing attacking infantry from attempting to scale the walls. They employed defence in depth, took advantage of local geography and created crossfire for assaulting troops. The emphasis placed on fortifications in the seventeenth century generated great impetus in civil engineering. This period also saw improved engineering skills applied to the construction of canals and railroads in France. Military engineers practised accurate surveying and spent much time in the study of soils related to their work of constructing ditches, canals, and earth ramparts. This was the start of a period that lasted more than a century during which the French dominated the science of military engineering.

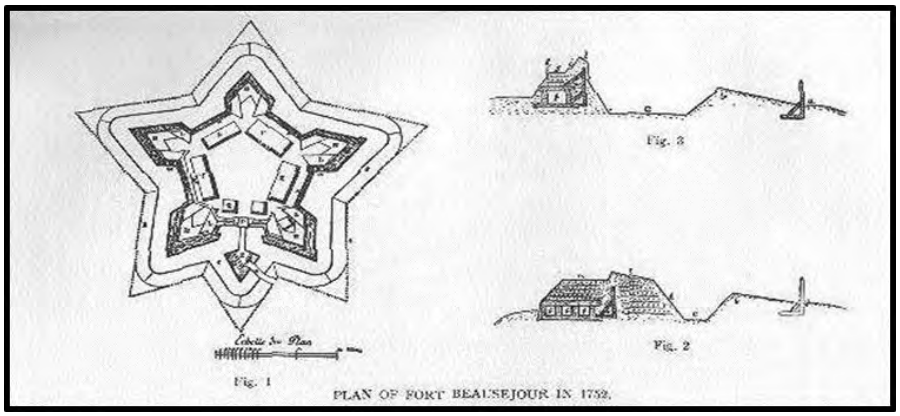

Figure 1-4 Plan of Fort Beauséjour

0118. The application of engineering to the needs of warfare demanded profound professional knowledge. Accordingly, European armies began to found regular engineer corps. The French started in 1697 and the British engineer corps came into being in 1716. The need for this science also led to the foundation of regular military engineering academies such as the Royal Military Academy in England (1741), the French school at Mézières (1749), the Paris Polytechnique (1801) and the United States Military Academy at West Point (1803).

0119. Meanwhile, the Industrial Revolution brought other significant influences to bear on the work of the military engineer. Harnessing steam power improved mobility, transportation, and the ability to move large masses but the increasing size of weapons and supporting vehicles placed greater demands on engineer road construction capabilities. Concrete, masonry and cast iron were replacing wood in construction, and the development of precision instruments enabled engineers to measure and to construct to more exacting standards. This was the beginning of a period of continuous technological change that the military engineer embraced and exploited to benefit not only the military but civil society as well.

0120. During this era, the North American continent was being settled, exploited and contested by European powers. The face of Canada was changed by the engineering skills of the British and French armies as well as those of the locally raised militias. With their use of tools, ability to handle explosives, knowledge of mapping and topography, bridging techniques, and construction of fortifications, military engineers became indispensable to the armies of that era and to the development of our nation.

The Pioneering Military Engineer in Canada (1608-1903)

0121. Military engineers helped penetrate some of Canada's challenging perimeter, opened the nation's heartland to Europeans and their descendants, and helped transform isolated trading posts into what have become today's great cities. They endured hardship, famine, severe climatic conditions, and sickness. But their courage, steadfastness, and perseverance is etched in our country's heritage and history.

0122. The first military engineers in Canada were French and they built a number of settlements for the exploitation of natural resources in the early 1600s. Notable were the "*abitations*" at Quebec, Sainte-Croix, and Port Royal. Major, strategic defensive fortifications such Quebec and Fort Louisbourg then followed to protect France's interests. In 1685, the "*ingénieurs du roi*" became the first military engineer force to be permanently established in Canada. They continued the process of building the defensive infrastructure and constructing civil works such as dockyards, roads and community structures until the loss of New France to the British in 1763.

Figure 1-5 Abitation at Ville de Québec

0123. Under British governance, Royal Engineers assumed construction responsibility for the purpose of both defence and national infrastructure development. The Engineers surveyed and marked the boundary between Canada and the United States and laid out the original town sites of Toronto, Ottawa, London, New Westminster, Yale and Hope. They constructed the Cariboo Road around and then through the treacherous Fraser Canyon in British Columbia, built the Cayuga Road stretching from Niagara to Simcoe in Ontario, and built the Rideau Canal strategic waterway between Ottawa and Kingston. Landmarks such as the Halifax Citadel, Fort Henry at Kingston and others still stand today attesting to the quality of their defensive works. Furthermore, many of these Royal Engineers stayed on as civilian settlers, providing strong foundations and leadership in the settlement and industrialization of Canada.

Figure 1-6 Constructing the Cariboo Road

0124. While early military engineering feats were the products of the continental armies, the origins of the Canadian engineer/soldier can be traced to the local militiaman. As settlements developed, the Governor could call out any able-bodied man between the ages of 16 and 60 to contribute to the defence and betterment of the living conditions in the area. These men were employed on such engineering works as the construction and maintenance of fortifications, roads and bridges, and other government works. The militiaman worked alongside, and was trained on the job, by the engineers of the European armies.

Figure 1-7 Engineers at Work at Halifax

0125. It was the European armies that provided for the defence of what would become Canada until the mid-19th century as a Canadian Army did not emerge until 1855. In 1855 the Province of Canada passed the Militia Act that provided for an Active Militia of volunteer troops. Engineers were not named in the 1855 Militia Act so it was not until another act was passed in 1863 that engineers were formally made part of the Militia. The Canadian Militia did not thrive in those early years. By the close of the 19th century, two engineer field companies, the Charlottetown Engineer Company in PEI and the Brighton Engineer Company in New Brunswick were all that remained of 15 Engineer companies that had been organized after 1863.

0126. The dawn of the twentieth century marked a new chapter in the history of Canadian military engineers. The Boer War had just concluded and tensions in Europe were increasing. With the last of the British forces withdrawing from Canadian soil in 1906, Canada was left ill prepared for defence in many areas; however, efforts were underway to establish a more complete Canadian defence capability. For example, an Intelligence Department was created at Army Headquarters that included a Mapping Branch staffed by Royal Engineer personnel to ensure continuity after the withdrawal of the British forces. This branch was responsible for the surveying and mapping of international boundaries as well as military camps and manoeuvre areas although it mapped many other regions as well.

0127. The task of constructing and maintaining defence facilities soon fell to the Canadian sappers and a new central training camp was built at Petawawa, Ontario. The departure of the Royal Engineers also created a need within the Corps for trained personnel and the first Canadian military engineering school was therefore established at Halifax in 1907.

Formation of the Permanent Canadian Military Engineers

0128. The 1899 Boer War clearly impressed upon Government the need for a permanent army that was larger than the four companies of infantry and two artillery batteries that existed at the time. The Permanent Force engineers were originally tasked to train the Militia and provide engineer services to both components. In practice, however, the need for works services predominated and the Permanent Force engineers were hardly able to train themselves, let alone the Militia.

0129. The period leading up to the start of the First World War saw the foundations laid for what was eventually to become the Corps of Royal Canadian Engineers (RCE). From a low of two field companies at the start of the century, additional companies were formed to provide one company per Army division plus a number of Corps troops. Several field telegraph sections and engineer wireless detachments were also established to provide communications support to other units. Engineers had also been making accurate depictions of the ground for a long time but it was the formation of the Military Survey Section of the Permanent Canadian Engineer

Corps with a mission to prepare defensive maps along the border in the central and eastern provinces that saw the formal establishment of this capability. The Regular component of Permanent Force engineers was authorized under the designation “Canadian Engineer Corps” on 1 July 1903 which is now considered the birth date of the CME.

0130. While these developments were taking place in the Army, the British Admiralty still looked after some aspects of Canada’s naval interests. The construction and maintenance of the shore facilities at Halifax and Esquimalt were a Royal Engineer responsibility but as the dockyards developed their construction and maintenance became the responsibility of civil engineers in the Canadian Department of Public Works. With the departure of the British forces the dockyards were transferred to Canada even though a Canadian Navy had yet to be authorized. When the Royal Canadian Navy came into being in 1911 most Navy construction work was carried out under the direction of a Clerk of Works at each dockyard.

The First World War (1914-1918)

0131. Before the declaration of war, Canada had agreed to provide an Infantry Division to

Figure 1-8 First World War Training Camp in Vancouver

Great Britain and so the entry of Britain into the war on 4 August 1914 marked the beginning of a period of rapid mobilization for the Canadian engineers. On 7 August 1914 construction began on a new camp at Valcartier, Quebec, to accommodate 30,000 soldiers. Small bodies of troops started arriving within the week and more than 1,100 militia sappers had arrived by the end of the first month.

0132. Most of the sappers in Valcartier were then recruited into the Canadian Expeditionary Force and formed into three field companies for the 1st Canadian Division. That formation departed for England in early October and the Canadian Engineer Training Depot followed four months later. Training and camp construction kept them occupied in England until early February 1915 when the division departed for France. By early November 1914, a second division was authorized that had its divisional engineers concentrated at Ottawa. The engineer units of the 2nd Canadian Division departed for England in the spring of 1915. These initial engineer units that were sent overseas comprised field companies, railway construction troops, signalers and telegraph operators, as well as the training depot mentioned. The Permanent Force

Figure 1-9 First World War Pontoon Bridge at Camp Valcartier

engineers remained in Canada to fill domestic establishments and to construct and maintain expanding infrastructure, training facilities and defence works.

Figure 1-10 Engineer Wireless Training at Camp Petawawa

0133. The requirement for more specialized troops in Europe continued to increase as the fighting progressed. One of the most challenging tasks of the war fell to the sappers and miners of the tunnelling companies. The units started to form in Canada in 1915 and the first tunnelling company departed for England in January 1916. They were dispatched to France within a few weeks of arrival in England because of the urgent need for these troops. Besides mining enemy positions and countermining their tunnels they built dugouts and fortifications. Some fought hand-to-hand battles below the surface when they encountered enemy tunnels and many died working in frightful conditions underground. Canadian tunnelling companies played a prominent part in the greatest mining operation of military history when 500 tons of explosives were fired under the German lines on Messines Ridge in June 1917.

Figure 1-11 Railroad Troops Help Move the Guns Forward

0134. Among the other specialized Engineer troops, railway construction and operating companies built rail beds and bridges, laid tracks, ran the trains and repaired rolling stock. Primarily responsible for moving troops and supplies to the front and rapidly transferring the wounded to rear areas, they often operated in the open without cover and were accustomed to receiving their share of shelling. Signal Engineers also formed wireless detachments to provide communications below brigade level.

0135. Although not engineer troops, another special and related entity was the Canadian Forestry Corps. They operated independently and separately from the RCE but they did support the overall engineer effort of the day. On the 16th of September, 1916, the Canadian Forestry Corps was asked by the Home Defence Wing of the Royal Flying Corps for their assistance in clearing land in various parts of Great Britain for landing grounds, and 12 days after receipt of this communication a detachment was at work clearing a site for an aerodrome in the County of Middlesex, England. This work grew with great rapidity and eventually the Corps undertook work on the construction of aerodromes through the length and breadth of Great Britain. Composed mainly of Canadian loggers, this group also cut the great quantities of lumber from the European forests that were needed for engineer projects. It was these troops who provided the lumber for the miles of

Figure 1-12 Forestry Corps at Work in France

corduroy roads, the ties for the railroads that were indispensable to the supply efforts and the timbers for the never ending construction of tunnels, trenches and bunkers.

0136. The range of specialized Engineer troops continued to expand during the war. Canadian survey personnel were initially employed under Royal Engineer command to contribute to the war effort but surveying was added in 1918 when the Canadian Corps Topographic Section was formed in France. In addition to conventional mapping tasks, this organization laid the groundwork for Canadian artillery survey. There was even an Engineer Anti-Aircraft Searchlight Company that was used primarily as protection against enemy aircraft. Elements of this company were also used for many purposes in the forward areas, including the lighting of no-man's land.

0137. Throughout the First World War, Canadian military engineers underwent a trial by fire participating in both the defensive and offensive operations of the Canadian Corps. Activities ranged from trench raids, bridging, communications, water supply and tunnelling under German lines to place explosive charges (or mines). Canadian engineers participated in most major engagements, including the battles of Ypres, St. Julien, Vimy Ridge, Messines Ridge, Menin Road, Polygon Wood and Passchendaele suffering casualties and receiving recognition and decorations in proportions that eclipsed their numbers. Captain C.N. Mitchell was awarded the Victoria Cross and was the most highly decorated engineer. Among the greatest contributions of the Canadian Engineers was their work on bridging, road communications, and water supply during the final advance in 1918. In all, more than 40,000 sappers served in Europe and there were 14,000 engineers on the Western Front at the time of the Armistice.

0138. While the Canadian military engineering activities during the First World War were seen primarily in the Army overseas, there was also activity in the Canadian Navy. The demand for ship repair and refuelling activities increased considerably and both the Halifax and Esquimalt dockyards were equipped with harbour defences. Both dockyards were provided with a civil engineer and staff although most of the infrastructure work continued to be conducted by contract and by the Department of Public Works.

0139. There was no 'Canadian Air Force' participation in the First World War although Canadians flew with the Royal Flying Corps, the Royal Navy Air Service, and the Royal Air Force. The Royal Flying Corps Canada (RFCC) was established in late January 1917 to recruit and train Canadians for service in the British flying services during the First World War. Although the program was run by military staff from Great Britain, by the time the Armistice was declared on November 11, 1918, an estimated 70 percent of the instructors and a large percentage of the non-flying staff were Canadians.

Figure 1-13 Engineers Provide Ground Crew for Silver Dart Flights

0140. There had been some earlier interest in military aviation in Canada and some Canadian military engineers were involved in the early demonstration flights of the Silver Dart and the Baddeck in 1909 at Camp Petawawa. Engineers had proposed adding flying to Canada's military capability and an aircraft was actually taken to England with the Expeditionary Force.

Reorganization between the Wars

0141. At the end of the First World War there was a colossal demobilization of the Canadian defence forces. The Canadian Engineers were reduced to 38 officers and 249 non-commissioned members by 1922 and this establishment further declined until 1930 before a

slow increase in strength began. Some important projects continued between the wars such as the renamed Geographical Section of the General Staff which continued to survey and map the country using topographic mapping and aerial photography techniques developed overseas.

0142. The original School of Military Engineering established in 1907 at Wellington Barracks in Halifax had become dormant during the First World War when most Engineer training was conducted at Camp Petawawa. After the war, the school reopened in Halifax and became the Royal Canadian School of Military Engineering (RCSME) when HM King George V approved use of the title "*Royal*" in August 1927.

0143. During the Great Depression, Military Engineers were responsible for the construction and operation of the relief camps at Valcartier, QC, Petawawa, ON, Dundurn, SK, and Shilo, MB. In addition, roads, airfields, barracks, fortifications, rifle ranges, and other works were constructed under RCE control using unemployed labour. These projects provided the planning expertise and experience and that was to prove invaluable to the nation when the Second World War broke out.

Figure 1-14 Engineers Manage Construction Projects during the Great Depression

0144. There were significant changes in the Army as the Non-Permanent Force of Canadian Engineers amalgamated with the RCE. In 1932, General Order 25 officially designated each component as a Corps; respectively, the Corps of Canadian Engineers and the Corps of Royal Canadian Engineers. These two Corps came together on 29 April 1936 to form a new Corps of Royal Canadian Engineers (RCE) that shared a common hat badge. In 1938 the Corps was honoured when HM King George VI became Colonel-in-Chief.

0145. Meanwhile, the Navy was also emerging from a long period of relative inactivity. Also severely reduced after the First World War, major construction projects such as the Bedford, NS Magazine, HMCS Naden, the West Coast naval training centre, and dockyard developments continued. Responsibility for implementing the construction requirements of the Navy was still chiefly accomplished by the Department of Public Works. Later, with the declaration of hostilities in 1939, the Royal Canadian Navy (RCN) brought a number of architects, engineers, and technicians into the Special Branch of the RCN Volunteer Reserve to become more responsible for its construction requirements. For military engineering, this move provided the pool of civil engineering talent necessary to support wartime expansion plans.

0146. The Canadian Air Force was one of the few organizations that actually grew between the wars. An Air Force was initially authorized in 1922 as an air militia to monitor the country's vast land areas and coastlines; the Royal Canadian Air Force (RCAF) was later officially created in 1924. The initial acquisition of five military air stations brought a need for an Air Force construction engineering capability, but it was to take some time to actually acquire that capability. Meanwhile, the RCE Directorate of Engineer Services provided headquarters construction engineering support for the young Air Force and work was implemented by the Air Board and the Departments of Transport and Public Works. The RCAF construction and maintenance capability increased to meet demand and grew to major proportions during the Second World War.

The Second World War (1939-1945)

0147. Canada's declaration of war on 10 September 1939 set in motion another period of incredible mobilization. Engineers were required in great numbers to support the forces and the

works of the Army, the Navy and the Air Force. This placed great demands on training and thus RCSME in Halifax again became dormant as Engineer training was decentralized to a number of wartime training centres; primarily A5 Canadian Engineer Training Centre (CETC) in Petawawa and A6 CETC at Dundurn, SK. A6 CETC moved to Vedder Crossing, BC in 1942 and operated there until the end of the war.

0148. In the Army, not only were the engineers called out to fill the field force, they were also required to prepare local defences as well as provide works services and camp accommodations that would support the huge expansion of the Canadian Army. Unlike the First World War, this time the Permanent Force Engineer units were among the first to go overseas. By the end of 1939, the first of what would eventually become five Canadian Army divisions was in Britain. As in the First World War, Canada played a major role; in addition to field engineering, Canada again provided specialized survey, railway, and tunnelling companies.

0149. While the Canadian Army trained in England, various engineer units constructed defensive works, roads, airfields, and military accommodations within the United Kingdom. Tunnelling companies were employed for a considerable period at Gibraltar, enlarging and extending the underground fortifications and constructing an aerodrome. Canadian tunnelling companies also carried out valuable work in the United Kingdom on mining and hydroelectric power development. Other Canadian engineer units were employed in special demolitions, including the construction of tank traps and other defensive obstacles. RCE personnel were also employed in bomb disposal in southern England during the periods of heavy aerial bombardment.

0150. When the Army did see action in Europe, there was invariably a need for considerable close engineer support. Engineers rose to high command at the divisional and corps levels, suffered casualties, and were again recognized by the award of decorations in numbers greater than their proportional size. From the expedition to Spitzbergen in 1941, the Dieppe Raid of August 1942 and the expedition to the Aleutian Islands in 1943, to the invasions and campaigns in Italy in 1943-45 and Northwest Europe in 1944-45, engineers were generally the "*first in and the last out*." Throughout the war, sappers laid and breached minefields, carried out demolition tasks, and assisted in amphibious landings and assault river crossings. The RCE played a major role in maintaining communications routes through airfield, road, and bridge construction and four specialized field survey companies sustained the First Canadian Army's advance through Northwest Europe. Canadian engineer support was invaluable to the Allied effort and, by the end of the war, the RCE strength overseas was 685 officers and 15,677 non-commissioned members.

Figure 1-15 Melville Bridge across the Rhine River

0151. Early in the war the Navy recognized that the main dockyards at Halifax and Esquimalt were inadequate. Accordingly, in 1941, a Directorate of Works and Buildings was created to plan and implement the expansion of shore facilities. This gave the Navy its first separate and identifiable construction engineering organization. The Navy's civil engineers' skills were put to the test to provide wartime shore-side facilities. The huge training base at Cornwallis, NS was constructed in record time and the construction of Naval Divisions across the country provided the facilities to recruit and train the Navy Reserve. The dockyards at Halifax and Esquimalt were expanded but, with more space needed, a series of smaller naval bases was constructed at

Sydney and Shelburne, NS, Gaspé, QC, St. John's, Botwood, and Bay Bulls, NL, Saint John, NB, as well as Prince Rupert and Royal Roads, BC.

0152. Wartime expansion for the RCAF took place at a pace and scale that is difficult to imagine today. At the start of the war, there were only six operational air stations to support the large number of Home War Establishment units that had to be rapidly expanded and mobilized. There was, therefore, a huge requirement to quickly construct land and seaplane hangars, runways, ammunition depots and other essential facilities. In Eastern Area Command, for example, the only operational base at the start of the war was a seaplane base near Shearwater yet, in less than three years, 133 hangars had been constructed in this area alone.

Figure 1-16 Naval Repair Facilities at Sydney, NS

0153. No one envisioned the incredible scale of construction that was required to fulfil Canada's contribution to the British Commonwealth Air Training Plan. The initial agreement called for 74 schools capable of turning out 21,500 aircrew every four weeks. These facilities were required less than four months after the formal signing of the agreement. From 1939 to 1944 more than 100 new airfields and 8,300 buildings were erected. As the result of this incredible effort, the construction of entire aerodromes, including buildings and hard surfaced runways, was often completed within eight weeks of arrival at a greenfield site. Due to wartime restrictions on the use of steel, many of the structures were built with non-reinforced concrete columns and wooden trusses. Considered to be temporary wartime construction with a planned life expectancy of only five years, the fact that some of these structures are still in use today is testimony to the excellent design and construction skills of the Canadian military engineers.

Figure 1-17 Constructing a Hangar for the Air Commonwealth Training Plan

0154. The new facilities also required a tremendous supply of utilities and, due to the isolated nature of many of the stations, much of the power and water had to be produced locally. The power plants, heating systems and water and sewer systems were operated by a combination of Air Force construction tradesmen and civilians. Seventy-five electric power plants were designed and built, more than 500 kilometers of water mains were installed and 120 water pumping stations were constructed.

0155. The demand for infrastructure for the RCAF Home War Establishment units had to be met at the same time as those of the British Commonwealth Air Training Plan so new and innovative ways had to be found to expedite this massive construction undertaking. One of the most urgent requirements was the construction of wireless telegraph, direction finding, and radar sites in isolated communities. Civilian contractors were seldom available to build and maintain facilities in remote locations nor were they able to meet security requirements. This created a need for mobile construction and maintenance units that could deploy on short notice to undertake projects in remote areas. This led to the formation of the Construction and Maintenance Units (CMUs) that were composed of service personnel in the construction trades, heavy equipment operators, mechanics and support personnel.

Figure 1-18 CMU Personnel Construct Plank Road to a Remote Site

0156. By the end of the war, seven CMUs were deployed across Canada and they played a central role in the construction of wharves, jetties, roads, runways and hangars. They also carried out the rapid construction of radio direction finding stations in remote areas, laid communications landline, erected telephone poles and cables, and constructed railway lines. In the face of the threat of Japanese raids against North America, the CMUs were also involved in building the joint Canada/US Northwest Staging Route from Edmonton, AB to Fairbanks, Alaska. This air route was designed to transport aircraft and supplies from the continental United States to Alaska and consisted of a chain of aerodromes with intermediate landing fields at 100 mile intervals and radio ranging stations at 200 mile intervals. The project started early in 1941 and within seven months aircraft were flying from Edmonton to Whitehorse.

0157. At about the same time, construction started on a series of radar stations for both coasts, with emphasis on the Atlantic seaboard. Construction of the coastal radar installations was extremely demanding due to the remote and difficult sites but eventually more than 40 sites were operational on both coasts. Although enemy aircraft rarely put in an appearance, the radar sites were indispensable for aircraft control and navigation. The construction experience gained in meeting the demands of these projects prepared the Air Force construction engineers for similar challenges in the future.

0158. The Air Force also led the way in creating a military capability for fighting structural fires as well as providing aircraft crash, fire and rescue services. The Second World War saw great advances in this area as well as fire protection for entire supply lines from the factory to the front. Volunteers and general duty personnel had provided fire protection before 1940 but a War Services Fire Protection Committee was established to oversee this function. One of its early recommendations was that a permanent fire service be established for the Army, Navy, and the Air Force. An RCAF Protection Service was authorized that included fire suppression

Figure 1-19 RCAF Firefighting during the Second World War

personnel. A recruiting drive was started in 1940 to bring firefighters into the RCAF and a firefighting school was established in Toronto using instructors from the Ontario Fire Marshal's office. The RCN Fire Service began when stokers were given the task of fire protection and uniformed firefighters were recruited to protect the increasing number of shore facilities. The Army also recruited firefighters in the RCE and some of its Fire Service personnel deployed to Northwest Europe.

Post-War Evolution and the Cold War (1946-1966)

0159. At the end of the Second World War, there was the predictable reduction of size of the three services and a closure of those facilities that were not necessary for training and maintaining peacetime forces. The immediate post-war activities for all three services emphasized consolidation and improvement of facilities to a permanent, peacetime standard.

0160. The Army returned to a peacetime structure based on two Corps that were manned primarily by Reservists and organized into five area commands. Incorporated within the overall organization were more than 40 Militia RCE units. RCSME was permanently established in Vedder Crossing, BC, from the wartime organization of A6 CETC. The sole remaining Active Force RCE first line units were 23rd Field Squadron and RCSME. These two active units were based at Camp Chilliwack which was later designated as the "*Home of the Engineers*."

0161. The Army Survey Establishment (ASE) was formed in 1946 to maintain valuable war experience with the mission to contribute to completely mapping all of Canada by the Centennial Year. Given a 20 year program to map more than 3.9 million square kilometers of Canadian territory at a scale of 1:250,000, ASE was quick to test, adopt and emplace emerging technology to achieve its mission, such as using helicopters to move remote survey parties, microwave distance measurement devices which gave instantaneous results, and computerized map compilation equipment. During the Cold War, ASE developed the restricted 'Military City Map' series for all medium and large Canadian cities in case of nuclear attack. Military mappers completed 40 percent of the 1:250,000 and 1:50,000 scale sheets of Canada, and 75 percent of the Arctic field surveys before turning the responsibility over to Natural Resources Canada. In 1966, with that assignment nearly complete, ASE was renamed Mapping and Charting Establishment (MCE) and refocused on support to military operations and maps of foreign countries.

Figure 1-20 CFB Chilliwack Headquarters

0162. The Army inherited a new post-war responsibility in 1946 when Canada took over the operation and maintenance of the former Alcan (Alaska-Canada) Highway within Canadian boundaries (between Dawson Creek, BC and Beaver Creek, NWT). This highway was constructed and operated by the US Army Engineers during the Second World War. Included in the handover were the American headquarters facilities, an oil refinery, a railhead camp, and 50 maintenance and construction camps comprising hundreds of buildings. Several unique engineer construction and maintenance units maintained and rebuilt some 2,000 kilometers of road and built over 100 bridges during the 18 years the Army held responsibility for the Northwest Highway System.

0163. The Army works service was also heavily committed to the implementation of a 10 year station development program to provide permanent home station accommodation and training facilities for the peacetime Army. The Army also implemented a major construction program for married quarters. A similar program was established by the Air Force and, between them, new married quarters were provided at a rate of more than 1,000 units per year.

Figure 1-21 Bridge on Alcan Highway

0164. For the Navy, the immediate post-war reductions meant concentrating on the dockyards at Halifax and Esquimalt. This necessitated the closure of numerous wartime secondary port facilities on both coasts. As with the two other services, the Navy was subjected to significant personnel reductions after the war, including its Civil Engineering Branch. At one point, only one officer with a permanent commission remained and engineering and maintenance activities were carried out entirely by civilians.

0165. For the Air Force, only 18 stations were retained after the Second World War and they were developed into permanent flying establishments. The RCAF immediate post-war engineering activity consisted primarily of closing down, transferring, mothballing, or disposing of some 60 stations. The requirement for CMUs was thus drastically diminished and most of these units were disbanded with only two remaining by 1949.

0166. The period of post-war peace was not to last long and the deteriorating international situation of the Cold War soon demanded that more attention be given to the armed forces. By 1947 a program of expansion of the three services and upgrading of their facilities was under way. When the North Atlantic Treaty Organization (NATO) came into existence in 1949, Canada committed (on paper) to an army brigade group (with its field squadron) as well as an air division (with four fighter wings) in France and Germany. In the midst of these military preparations for the defence of Europe and North America, the Army in particular, was called to arms to participate in the Korean Conflict from 1950 to 1953. These commitments resulted in a rapid and significant expansion of the Canadian Forces as Canada planned to send a brigade group to Korea as well as station a brigade group and an air division in Europe while having a third brigade group as a base for troop rotation.

0167. The stationing of Canadian forces in Europe started in 1951 and both the Army and Air Force construction engineers were then heavily tasked to construct infrastructure facilities in Europe for operations, support and personnel needs. They accomplished this in record time and once operational the NATO commitment of a field squadron in Germany provided a focus for training of the RCE for many years.

0168. The hostilities in Korea added to the general rearmament and resulted in the RCE being expanded from one field squadron to four with all four eventually serving in Korea. In Korea the Engineers rose to the challenge of maintaining the mobility of our forces, particularly under adverse weather conditions and difficult terrain, as well as constructing major defensive works and fortifications to protect our forces against heavy shelling. The squadrons laid and cleared minefields and wire obstacles,

Figure 1-22 Engineers Guard a River Crossing Site in Korea

constructed major field fortifications, roads, bridges and airfields, assisted with tented camp construction and provided potable water.

0169. This was a period of high international tension that was made worse by the additional horror of a potential nuclear war. Canada, like many countries, sought ways to protect its populace and to enable the nation to restore itself after a nuclear attack. Military engineers played a role in civil defence by constructing and maintaining underground emergency government headquarters such as the Federal Government Emergency Headquarters (the "*Diefenbunker*") at Carp, ON. They also constructed and maintained a public nuclear warning system and fielded No. 1 Radiation Detection Unit.

0170. To meet the rising tensions, the Army accelerated its station development program and started a massive six year construction engineering effort to design and construct a new camp in Gagetown, NB. This new camp provided a home for a 5,000 soldier brigade and an all-weather training facility for a 10,000 soldier division. With an area of 1,000 square kilometers, the camp was the largest in the British Commonwealth and incorporated 100 permanent buildings and 2,000 married quarters.

Figure 1-23 RCAF Station Cold Lake

0171. As part of its Cold War expansion, the Air Force implemented Operation BULLDOZER to upgrade more than half of its stations. Wartime training airfields were rehabilitated to accommodate renewed aircrew training programs. This included training the fighter squadrons destined for NATO service in Europe and the training and deployment of squadrons committed to continental air defence. The biggest RCAF construction undertaking during this period, by far, was the construction of the air base at Cold Lake, AB and the Primrose Lake Evaluation Range (from 1952 to 1954). When RCAF Station Cold Lake opened in 1954 it was one of the most self-contained training and fighter bases in the British Commonwealth. At the same time, a cooperative project was undertaken with the US Air Force Strategic Air Command to provide air bases with huge concrete runways to accommodate refuelling aircraft and strategic bombers in Churchill, MB and farther north in the former Northwest Territories (present-day Nunavut) at Iqaluit (then Frobisher Bay) and Resolute.

0172. The 1950s also saw improvements to North American air defence with the construction of three electronic aircraft detection systems in Canada: the Pinetree Line, the Mid-Canada Line, and the Distant Early Warning (DEW) Line. Construction of these radar defences required extensive pioneering in engineering that was made more challenging by the extremely adverse weather conditions. Construction of the manned Pinetree Line began in 1951 and, while the first 35 stations were operational by 1955, it took until 1963 to complete the project. Stations were sited in varied locations such as Comox and Kamloops, BC, Penhold, AB, Dana, SK, Gypsumville, MB, Sioux Lookout and Moosonee, ON, Chibougamau and Moisie, QC, St-Margarets, NB, Sydney, NS, and Gander, NL. During the early stages, construction activities were often so compressed that base camps and access roads were established before the building plans were delivered. Foundations were often poured before the overall dimensions of the buildings were known and even before the installed equipment was determined.

0173. Construction on the Mid-Canada Line began in 1953 and was completed in 1958. This line ran some 500 kilometers north of the Pinetree Line and comprised numerous individual sites and eight main section control stations. These latter stations were sited at places like Dawson Creek, BC, Portage, MB, Winisk, ON, Great Whale River, QC, and Hopedale, NL and included airstrips as well as accommodations for the full time staff. To support the construction of the Mid-Canada Line, tractor trains consisting of caterpillar tractors hauling office accommodation, cooking trailers, dog teams, snowmobiles and ski-equipped aircraft, operated along the 55th parallel. The northernmost chain of radars, the DEW Line was situated 1,000 kilometers north of the Mid-Canada Line and extended 3,800 kilometers across the northern rim of the continent from Alaska to Cape Dyer on Baffin Island. Within Canada, there were four main stations and a total of 38 auxiliary and intermediate radar sites. This line was constructed by the US Air Force between 1954 and 1958.

Figure 1-24 Radar Site at Sioux Lookout

0174. The creation of the North American Air Defence Command (NORAD) in 1958 necessitated construction of a northern Combat Control Centre near North Bay that would be capable of operating after a nuclear attack. Excavation of two large caverns began in 1959 into the hard, Precambrian rock. These caverns were 200 meters below ground and there were two, kilometer-long tunnels situated three kilometers apart to connect them. Inside the caverns, a three story, freestanding structure was constructed. Designed to withstand the shock waves from a nuclear explosion, the building was mounted on massive springs and was completely independent of the walls and roof of the cavern. The facility was self-sustaining with its own power plant and water reservoir and is recognized as one of the major engineering accomplishments of the Air Force construction engineers.

Figure 1-25 Construction of NORAD Control Centre at North Bay

0175. At the same time, a new weapons component of the air defence system in Canada, the Bomarc B surface-to-air missile was introduced. Sites were constructed for a squadron of missiles at North Bay, ON and La Macaza, QC between 1959 and 1962. These facilities were operated and maintained entirely by RCAF construction engineering personnel.

0176. Defence Construction Limited (DCL) was created in 1950 when Cabinet authorized Wartime Housing Limited's name change, providing the administrative structure on which to build DCL. The charter for DCL was signed in 1951, creating a fully-fledged Crown Corporation, pursuant to the Defence Production Act and operating as tendering and supervisory authority for the Department of National Defence's (DND) construction requirements. In 1980, DCL got a new name to become the organization we know today – Defence Construction Canada. The organization continued to evolve processes and business practices throughout the 1980s and 1990s while continuing to demonstrate strong value and cement their place as an inseparable

member of the CME Family.

A Unified Canadian Military Engineer Family (Post 1966)

0177. Although certain elements of the Canadian Forces had supported all three services for decades, the early 1960s saw increased interest by the government in unifying many of the Defence Department's functions as an efficiency and cost saving measure. To a certain extent, the construction engineering function led the way in this initiative as the concept of a common works service was studied as early as 1962. Recommendations for a unified construction service were well advanced by 1964 and thus the construction engineering components were prepared for the 7 December 1966 passage of Bill C-243, the Canadian Forces Reorganization Act. The concept of one unified force, one name, a common uniform and common rank designations was implemented on 1 February 1968 when the act became law.

0178. On 3 February 1971, after considerable and often intense debate, it was announced that the formation of the Military Engineering Branch had been approved. The new organization was to conduct combat operations; support combat forces in war and peace; support national development; provide assistance to civil authorities; and support foreign aid programs. Within this single branch were collected those capabilities in the functional areas of combat engineering from the Army, construction engineering primarily from the Army and the Air Force (but also including a small Civil Engineering Branch from the Navy), military mapping primarily from the Army, and firefighting personnel from all three services. Since this initial major reorganization, engineer roles have changed little and alterations to the CME have been evolutionary in nature.

0179. Military engineers have continued to lead the way in Canada's North in building roads, airfields, and bridges as part of a national development program. This program was instrumental in improving communications to Canada's northern communities as well as contributing to Canadian sovereignty. Construction of the strategic North Warning System and projects at CFS Alert (Canada's most northerly community on Ellesmere Island) have taught the CME much about working and surviving in a very hostile environment.

Figure 1-26 Constructing a Northern Airfield

0180. Military engineers have also been actively engaged on humanitarian missions, generally in response to specific requests from the Government of Canada. These deployments are sometimes standalone activities or are often in conjunction with United Nations peacekeeping operations. The formation of a Disaster Assistance Response Team (DART) with engineer capabilities provided a rapid response capability in case of natural disasters to provide reconstruction and disaster relief. Response activities have included the repair and restoration of public buildings, such as schools and hospitals, as well as the provision of potable water and emergency electrical power. The DART has recently provided assistance in Haiti, the Philippines and Nepal. Military engineers have also provided emergency engineering support to major operations at home such as flood relief, fighting forest fires and assisting with the arrival of large numbers of refugees from countries like Syria.

Figure 1-27 Footbridge Constructed in Haiti

0181. Canada continues to be a strong advocate of United Nations peace support operations and military engineers have played a vital part in most of these operations. In addition to United Nations operations, military engineers have participated in missions with multinational forces in Somalia, Kuwait, and the Former Republic of Yugoslavia (Croatia, Bosnia and Kosovo). Canadian military engineers have also earned domestic and international acclaim for their work in educating civilians about mine awareness and for mine clearance in war torn areas such as Afghanistan, Cambodia, and Croatia.

0182. The School of Military Engineering. Upon Unification in 1968 RCSME assumed responsibility for training the entire Military Engineering Branch. Renamed the Canadian Forces School of Military Engineering (CFSME), it took on training of the air element from former RCAF trades schools in Calgary and Borden. The school conducted military engineering training for the majority of the Military Engineering Branch (less mapping and firefighting) in Chilliwack for 30 years before moving to CFB Gagetown in 1997 when CFB Chilliwack was closed. CFSME currently delivers 56 different courses spread across 127 course serials. The School annually instructs over 2300 students in training ranging from the combat and construction trades to officer training and includes specialty training for both the CME and other branches.

Figure 1-28 Canadian Forces School of Military Engineering, CFB Gagetown

0183. Combat Engineering. The first new combat engineer unit created after Korea was 5e Escadron de Génie du Canada in July 1968. Organizations and equipment continued to evolve with operational commitments and changes in technology over the years. In 1977, the Regular Force combat engineers were organized into four Combat Engineer Regiments: 1 Combat Engineer Regiment in Chilliwack, 2 Combat Engineer Regiment in Petawawa, 4 Combat Engineer Regiment in Lahr, Germany and 5e Régiment du génie de combat in Valcartier. An independent squadron was also stationed in Gagetown to support 1st Battalion, Royal Canadian Regiment – 22 Field Squadron. In 1992, with the closure of the Germany based Canadian brigade, 4 Combat Engineer Regiment was removed from the order of battle and 4 Engineer Support Regiment, amalgamating 22 Field Squadron, was added. The organization of the Reserve engineer units had evolved since the Second World War into a combination of regiments and independent field squadrons. In the early 2000s the Army Reserve Force was reorganized into ten Canadian Brigade Groups each with an affiliated Combat Engineer Regiment. Commitments to international operations continued to rise and the Combat Engineer Regiments, in particular, played prominent roles with heavy augmentation from Reserve units. Engineer forces were committed at a pace unprecedented since the Second World War. Unit strengths continued to grow through the years to provide sufficient troop for the assigned missions.

0184. The decision in 2013 to resurrect the Canadian Divisions and Royal Corps in the Canadian Army created an opportunity for the Canadian Military Engineers to celebrate the historic accomplishments of the RCE. Therefore, those Canadian Military Engineers in the Land

component now belong to the Corps of RCE as well as to the larger family of the CME.

0185. Construction Engineering. Construction engineering was the military engineering function that was most affected by integration. Previously, the Construction Engineering establishments of the three services had more than 16,000 military and civilian personnel deployed in support of more than 160 installations. On 1 April 1966, the several hundred units, camps, and stations were reorganized into 39 Canadian Forces Bases and resulted in a reduction of the engineering support requirements.

0186. 1 Construction Engineering Unit (CEU) was formed in 1962 from the remnants of the wartime CMUs as an operational national unit with deployable capabilities. In 1976, the first Chief of Defence Staff Unit Commendation was awarded to 1 CEU for its service, particularly in the Arctic. The unit moved from Winnipeg, MB to Moncton, NB in 1995. The unit was later re-named 1 Engineer Support Unit (1 ESU) and moved again to Kingston in 2013. Today, 1 ESU provides specialist engineering support and construction services to the CAF and other government departments; a quick response capability for civil emergencies, infrastructure assessment, environmental protection, and construction and maintenance requirements; and the organizational nucleus of a deployable engineer support unit.

0187. The concept of an airfield engineering squadron was initiated in 1986 when the first unit was formed to provide airfield damage repair capabilities in Lahr, Germany. With the closure of the Canadian bases in Europe in 1993, this capability was relocated to Canada and now resides in 4 Construction Engineering Squadron (formerly Airfield Engineering Squadron) in Cold Lake. As the result of a growing gap between the Regular Force airfield engineer capacity and forecasted mission requirements, the Airfield Engineer Reserve Program was initiated in 1994 to develop a reserve capability. This resulted in the formation of four Reserve Force Airfield Engineering Flights and one Reserve Force Airfield Engineering Squadron Headquarters. A separate airfield engineering officer occupational classification was introduced in 1995. The term airfield engineering was changed to "*Construction Engineering*" in 2008 to better reflect the breadth of the skills, trades and the units.

Figure 1-29 Construction Engineering Training

0188. The Construction engineers have focused their efforts on construction engineering and their role of enabling the RCAF to live, fly and fight from any location. Their mission is to enable the Air Force to deploy, bed down, conduct sustained operations and recover from an attack. Construction engineering missions provide support at main, forward and deployed operating bases in any geographic location. Construction engineering support has also been critical to the success of Canadian support to NATO and United Nations operations as well as during humanitarian assistance and disaster relief operations. Today, construction engineering tradespersons and officers are found in various places. Within the RCAF, all construction engineering capability is concentrated in the RCAF Wings and in the construction engineering squadrons and flights. The second largest concentration is within the Real Property Operations Group which is responsible for the care and maintenance of the entire DND real property portfolio. Finally, the Army maintains Construction Troops within each of the Regular Force Engineer Regiments.

0189. Military Mapping. The Mapping and Charting Establishment (MCE) printed the last of the northern 1:250,000 map series in 1970 completing one huge project but a variety of new

projects have kept it involved in the Arctic, such as the survey of the east coast of the Arctic Islands for the Navy. While the provision of paper maps and charts continues to be the backbone of its operations (during the 1991 Gulf War and to the admiration of our allies, MCE printed more than one million paper maps), the introduction of digitized map products has provided a major improvement to the rapid provision of accurate geomatic information.

0190. MCE continues to lead the way in the application of new technologies to provide improved defence geomatic support. Military Mappers have provided an international lead in the application of digital technology and position finding. In the early 1990s, MCE conducted gravity surveys in support of a Canada-US agreement and began production of the vector smart map. MCE received the Chief of Defence Staff Unit Commendation for developing a 3-D anaglyph map and a digital nautical chart.

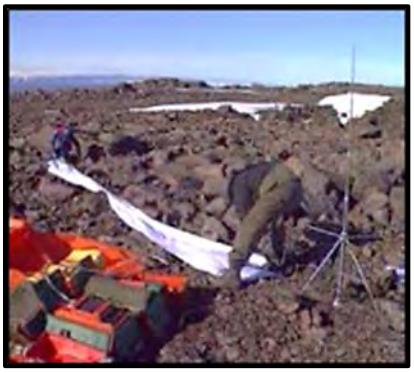

Figure 1-30 Surveying Canada's North

0191. There have also been great strides in introducing terrain analysis to the Army with terrain analysts deployed for the first time to Yugoslavia in 1993. Geomatic Support Teams are regularly dispatched in support of United Nations and NATO missions where they provide terrain analysis, terrain visualization, and field survey, as well as map production and distribution. These capabilities have significantly improved the commanders' ability to understand the impact of the terrain on operations. Military Mappers also continue to assist at home in times of emergency as they provide invaluable support to major domestic operations.

0192. Fire, Crash and Rescue. Upon Unification, military and civilian firefighters of the three services joined to form what is now known as the National Defence Fire Service, creating a combined civilian and military entity under common management and with common training. The position of Canadian Forces Fire Marshal (CFFM) was also established, with a regional concept of fire service delivery. Over the intervening years, the total number of uniformed personnel (both civilian and military) has been reduced, with the majority of military firefighters serving on major operational air bases, and a single military fire station in the Army at Edmonton. From Unification onwards, military firefighters also provided helicopter crash rescue firefighting (HCRFF) on RCN ships. In 2014, the decision was made to transfer HCRFF responsibilities from the Firefighter occupation to occupations managed by the Navy. This transition will be complete in 2019. The training of National Defence Fire Service firefighters (military and civilian) is conducted at the combined Canadian Forces Fire and CBRN Academies at CFB Borden.

Figure 1-31 Firefighter Training Exercise

0193. The year 2003 marked the Centennial of Canadian Military Engineering. The CME Family celebrated its centennial with an ambitious set of events which celebrated the CME as a family as well as involving and informing ordinary Canadians of the military engineering contributions to Canada. These Centennial events were a mixture of commemoration, celebration, competition, education, and legacy. The CME 2003 Centennial was a portfolio of regional activities, nationally facilitated and centered primarily on CME unit execution over a two year period. An anchor for many of the events was a national "Bridges for Canada" initiative undertaken with the TransCanada Trail project. This project provided a meaningful focus and left legacy gifts in almost 80 bridges built across Canada for the TransCanada Trail. In addition, the CME assisted Habitat for Humanity construct eight homes for deserving families.

Figure 1-32 CME 100th Anniversary

The Start of the Second Century of Canadian Military Engineering

0194. Planning the celebration of the CME Centennial had barely started when the 11 September 2001 terrorist attack on New York City changed much of the focus of the CAF for the following decade. The focus of the CAF in the first decade of our second century was clearly the war in Afghanistan. Canada's participation in this war started immediately after the attack on New York City. On 12 September 2001, for the first time in its history, the terms of Article 5 of the NATO Alliance Charter were invoked; an attack on one member was considered to be an attack on all NATO members. Canada's initial involvement in Afghanistan was a brief combat mission in Kandahar in 2002 followed by participation in a stabilization effort oriented in the Afghanistan capital of Kabul in 2003-2004.

0195. Starting in 2006, there was a heavy emphasis on the "provincial reconstruction" mission but this also included stabilization and warfighting. For over five years, Canadian engineers were involved in all facets of the conflict, from reconstruction efforts to close combat support in Kandahar Province. In 2011, Canada's role transitioned from reconstruction and combat to providing advice and assistance as part of the NATO training mission with the preponderance of forces again located centrally in the region of Kabul. This advisory mission ended in 2014.

0196. The entire breadth of the CME family became involved in the Afghanistan War. Regular and Reserve Combat Engineer Regiments all provided close support engineer forces and support throughout the rotations. Extensive construction engineering support was provided by the RCAF's Regular and Reserve Construction Flights and the Army's Construction Troops. The technical expertise of 1 ESU was heavily taxed. Mappers contributed significantly with terrain intelligence and mapping talents as well as firefighters who played an important role in the protection of the facilities and augmenting our allies' aircraft crash rescue firefighting capability. Finally, Defence Construction Canada also played a significant role as they brought their construction and project management expertise to bear in an operational theatre.

0197. The decade long war in Afghanistan tested the CME in the conduct of combat operations

and the support to combat forces in war. The engineer effort throughout the early years of our second century reflected the nature of the modern conflict; constantly evolving and involving myriad military and non-military agencies. Engineer command and control, organizations, employment, policies and procedures, equipment and material, as well as individual and collective training, were all affected over the course of Canada's commitment to Afghanistan. Indeed, much of the experience today within the CME has been shaped by the crucible of Afghanistan from the first major deployments in 2002 through to the end of Canada's training role in 2014. Moving forward, we must not forget that out of the 158 who made the ultimate sacrifice for their country during this conflict, 17 were members of the CME.

Figure 1-33 Clearing Routes in Afghanistan

0198. The first Canadian Military Engineer Militia unit was formed in Halifax in 1860 and Canadian Military Engineers now have more than 110 years of Permanent Force service in peace and war. While there have been many changes since 1860, the role and commitment of military engineers has remained fixed. Serving Canada's needs at home or abroad, military engineers are on operations with the United Nations, with NATO, in the high Arctic and wherever else Canada needs them, proudly living up to the motto *Ubique*. Engineers have served the nation with distinction. The CME is proud of its past accomplishments and is well prepared for, and eagerly awaits, the challenges of the future.

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