Chapter 1 – History

MILITARY ENGINEERING

1. Military engineers throughout the world are integrated 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 *"Fight, Move and Live"* 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, lines of communications, and bridges. They also provide water, power and other utilities, provide fire, aircraft crash and rescue services, hazardous material operations, and develop maps and other engineering intelligence. In addition, military engineers are experts in deception and concealment, as well as the design and development of equipment necessary to carry out these operations.

2. The mission of the Canadian Military Engineers is to contribute to the survival, mobility, and combat effectiveness of the Canadian Forces. Roles are to conduct combat operations, support the Canadian Forces in war and peace, support national development, provide assistance to civil authorities, and support international aid programs. Engineers serve wherever the need arises, proud of the motto *Ubique* (Everywhere). Few other organizations, civilian or military, can claim to have contributed as much to the defence and development of this nation as have the Canadian Military Engineers.

3. Canadian Military Engineers are highly trained team players who perform their tasks with determination and tenacity. Professionalism and rigorous training allow engineers to operate the most sophisticated equipment yet, when required, place tools aside and fight as infantry. Uniforms, tactics and equipment have changed considerably since the early days of the nation, but the CME's greatest resource, the individual 'sapper,' has remained steady. The term sapper refers to a military engineer and is explained further in Chapter 3. That sapper is still, as described by a Royal Engineer historian Capt T.W.J. Connolly (1815 - 1885): *"The man [now, "and woman"] of all work of the army [now "and to the entire Forces and the public"]: astronomer, geologist, surveyor, draughtsman, artist, architect, traveller, explorer, antiquary, mechanic, diver, soldier and sailor; ready to do anything or go anywhere."* To appreciate this contribution, however, one must have an appreciation of both the long history of military engineering and the unique Canadian experience.

4. Throughout history, military engineers have been innovators, in the forefront of harnessing nature and machines to serve our needs. The early application of the engineering discipline was military engineering. Indeed, the term *"Civil Engineer"* came about to distinguish those engineers who practised the profession uniquely in the civil sector. Unadorned by an adjective, an engineer was presumed to be military. One needs only look at the history of the Royal Engineers, from whom the CME draws much of its history and traditions, for examples of the contributions of military engineers to the science and art of warfare. In many cases, it has been the military engineer who has been responsible for the application of a new technology to warfare and, once mastered, that field has often devolved into a new and separate corps. For example, with the introduction of gunpowder, cannon were sometimes under the control of an engineer and 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. Submarine 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.

EARLY MILITARY ENGINEERING HISTORY

5. The science of military engineering is shrouded in antiquity. There is little doubt that military engineering was the first form of engineering and can be traced to the later stages of the Stone Age. Weaponry was one of the early applications of the first crude metals and the engineering skills to enhance the use of these weapons and to provide defences against them soon followed.

6. The earliest traces of man indicate that he has always sought a refuge from his enemies – be they beast or human. The first evidence of the place of military engineering in human affairs is found in the Middle East where the oldest human settlement that can be called a 'city' is Jericho in Palestine. It has been dated to 4000 BC and its excavation reveals how central military engineering construction was to civilized life. Foundation of the settlement is based on its proximity to a perpetual spring of pure water. To protect their access to this highly valued supply, that they surrounded it with a wall and a system of defence that was supplemented by a tower The wall and tower constitute the essential elements of fixed defences and, in one form or another, they are found in all subsequent defensive systems.

7. In addition to the applications of military engineering to defence, evidence of other remarkable engineering skills can be seen in the construction of the pyramids in Egypt 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.

8. The practising of military engineering was also seen in the Middle East as methods of siegecraft began to be developed and this called for specialists. The army of the Assyrian empire began its rise to power in the second millennium BC and was notable for its adoption of the principle of division of labour or specialization. Theirs was an army of charioteers and foot-soldiers as well as many specialists for the use of particular weapons. Among its specialist units were bodies of engineers who made a science of both the construction and defence of strong places. When on the march, the Assyrian army included siege trains that included battering rams and materials for the building of siege towers. Their engineers were also experts in mining - by which walls and towers could be brought crashing down. Some of their engineers were even taught to begin the attack on enemy strongpoints by crossing the protective moat on inflated animal skins.

9. By 1000 BC, military engineering began to take on the characteristics of an organized science that combined siegecraft and fortification. Ramparts and walls were built around ancient cities to ward off besieging forces in the Middle East and in Egypt. The catapult, originally designed as a defensive weapon, appeared at the Greek city of Syracuse in Sicily in 400 BC. Soon adopted for attack, it became and remained the siege engineer's principal weapon until the invention of firearms. Armies began using simple catapults to hurl huge stones and engineered wheel-mounted battering rams to demolish the defenders' fortifications. In this era, the technique of mining or tunnelling under enemy walls was first used to breach hard defences.

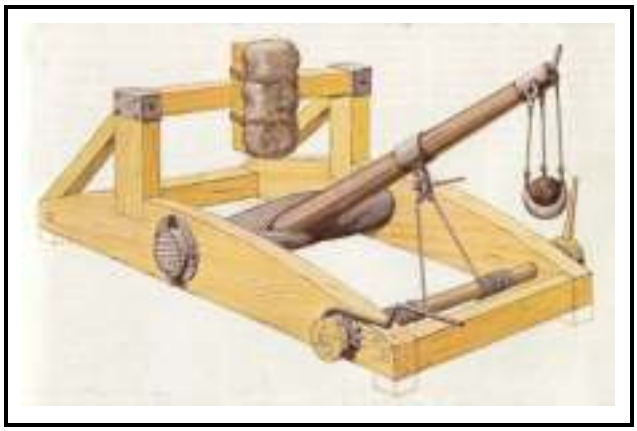

Figure 1-1 Early Catapult

10. The engineer, as a professional soldier, began to exercise influence on tactics and strategy during the period of the Grecian Empire (500-340 BC) when the introduction of floating bridges brought success to several major battles. Engineers provided the scientific basis for much of warfare as they developed the sciences of defensive fortifications and the trajectory related to hurling objects. About 400 BC, 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 was designed. During the same period, Archimedes invented various ingenious defensive devices and 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.

11. Roman Engineers. 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 at each night's stop when on the move. Unless at permanent camp, it would always construct a temporary one. The six thousand legionaries would construct a square earthen rampart, a ditch around the circumference and a palisade of stakes on top. This process of 'castramentation' 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 do 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.

12. The Roman legionaires became experts at siegecraft – illustrated in their siege against the Jews at Masada, 72-3 A.D. where the biggest problem was getting to the enemy. The defenders had 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 mountain side. Only when its crest approached the level of the summit could their siege engines directly attack the defences and defeat the Jews.

Figure 1-2 Roman Siege of Masada

13. Throughout the empire, engineers built large public buildings and networks of aqueducts to support the major population centres. Not the least of the Roman army engineers' accomplishments was the construction of a system of approximately 75,000 kilometres of paved military roads that connected Rome with her outlying colonies. Today, remnants of the Roman Empire stand as testament to the design and construction skills of Roman military engineers.

14. Early Asian Engineers. While the Romans were spreading their military might and culture in the Middle East and in Europe, the Chinese began reorganizing their military and territorial units. To defend the country against the Huns, local defensive ramparts were linked to form the first Great Wall of China starting in 214 BC. The Eastern Turks rebuilt it some 800 years later to prevent invasion. Construction of a new wall began in 1368 AD, a huge undertaking that took almost 200 years to complete. Once finished, the 2,250 kilometre-long wall was 10 metres high with guard stations every 100 metres. The Great Wall of China is considered to be one of the greatest military engineering feats of all time.

15. Medieval and Renaissance Europe. In medieval times, armies laying siege to a fortification commonly breached the defences by digging a trench, or "*sap,*" up to the base of the castle wall. It is from this root word "*sap*" that the term "*sapper*" is derived. A more complete explanation can be found at Chapter 3.

16. After the fall of Rome, there was little change in the techniques of military engineering or tactics for 500 years and the classic Roman techniques for building and attacking fortifications disappeared. The nature of warfare in Europe changed and the foot soldier – the Roman legionnaire was a good example – was largely replaced by cavalry, exemplified by the armoured knight.

17. Defensive warfare, however, increased in importance in the later Middle Ages. Prominent during this period was construction of the feudal castles – first fashioned from wood but later (about 1000 AD) of stone. These castle-fortresses were built in commanding positions, frequently protected by a river. Such impregnable retreats were constructed all over Europe and, until gunpowder began to render such fortresses obsolete about 1500, the medieval castle made it costly to wage offensive warfare since this type of fortress could seldom be reduced by assault alone. Because the strength of mediaeval castles so much exceeded the power that siege engineers could deploy against them, mediaeval sieges were normally concluded by treachery, starvation or the outbreak of disease within the walls. Engineers of this period were kept busy designing and constructing siege engines, using complex systems of counterweights to propel projectiles. It was during this time that the military engineer began to study trajectory, making the engineers the logical choice for commanding the new technology: - guns.

Figure 1-3 A Castle Under Siege

18. 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 enemy fortresses at the siege of Honfleur in 1415. Tunnelling under the walls, they planted heavy charges of gunpowder that were then detonated.

19. Introduction of efficient artillery changed the military life of the whole world.. As the power, accuracy and range of the smoothbore cannon improved, so the demand increased for trained to build fortifications against them. Massive high stone walls and towers were now vulnerable to rapid breaching, so the inventiveness of the military engineer conceived new fortifications that were based on low walls.

20. New applications of military engineering continued to be introduced and, in the early fourteenth century, Guido da Vegevano presented the French Court with major innovations in bridging and tower construction. Seeking to lighten the burden of engineering material that had to be carried while giving it greater flexibility, he introduced the idea of using relatively small interchangeable parts that could be transported on pack animals and could be assembled to make bridges or assault towers.

21. Leonardo da Vinci, the genius, artist, and scientist, was another famous military engineer of this time. He devised new field fortifications, mining techniques, and lighter-weight 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.

22. The Sixteenth and Seventeenth Centuries. 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 engineer's 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. At regular intervals around the fortress walls were placed strong gun platforms (bastions) – the walls and bastions forming a distinctive star shape but with their parapets scarcely rising above ground level. Around the trace, a deep sheer-sided ditch presented an obstacle to infantry, and beyond that again, a gently sloping field of fire constituted a second obstacle to the easy passage of attacking infantry.

23. Adopting the earlier trenching techniques to provide defence in depth, the French military engineer Marquis de Vauban built his fortifications to take advantage of local geography enabling defenders to pour a cross-fire into assaulting troops. Vauban's work and the emphasis placed on fortifications in the seventeenth century generated great impetus in civil engineering. This period 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, when the French dominated the science of military engineering.

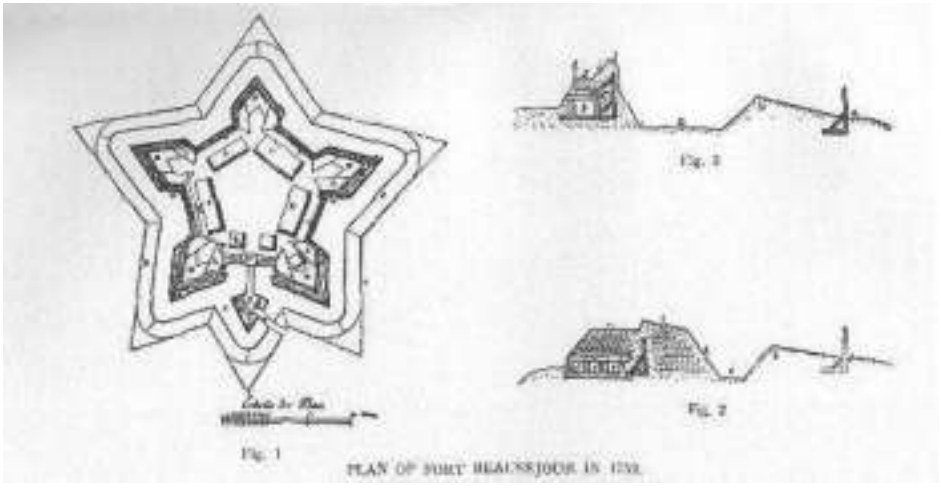

Figure 1-4 Plan of Fort Beausejour

24. Application of engineering to the needs of warfare demanded a profound professional knowledge. Accordingly, the European armies began to found regular engineer corps – the French started in 1697 and the British 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) and the French school at Mezieres (1749), the Paris Polytechnique (1801) and the United States Military Academy, West Point (1803).

25. Meanwhile, the Industrial Revolution was bringing other significant influences to bear on the work of the military engineer. The increasing size of weapons and supporting vehicles placed greater demands on the engineers' road-building ability. The harnessing of steam power improved mobility, transportation, and the ability to move large masses. 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 constant technological change that the military engineer embraced and exploited to benefit not only the military but the civil society as well.

26. In this era, the North American continent was being settled, exploited and contested by European powers. The face of Canada was changed during this period thanks to the engineering skills of both the British and French armies, as well as those of the locally raised militias. Military engineers, with their use of tools, ability to handle explosives, knowledge of mapping and topography, bridging techniques, and construction of fortifications, became indispensable to the armies of that era and to the development of a nation.

THE PIONEERING MILITARY ENGINEER IN CANADA (1608-1903)

27. 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. Their courage, steadfastness, and perseverance etched our country's heritage and history.

28. The first military engineers in Canada were French who in the early 1600s built a number of settlements for the exploitation of natural resources. Notable were the *"abitations"* at Ville de Québec, Sainte-Croix, QC and Port Royal, NS. Major and strategic defensive fortifications such as the Citadel at Québec and Fort Louisbourg, NS then followed to protect France's interests. [For examples of fortifications, go to web site http://www.digitalhistory.org/ffort.html] 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 defence infrastructure and constructing civil works such as dockyards, roads and community structures until the loss of New France to the British in 1763.

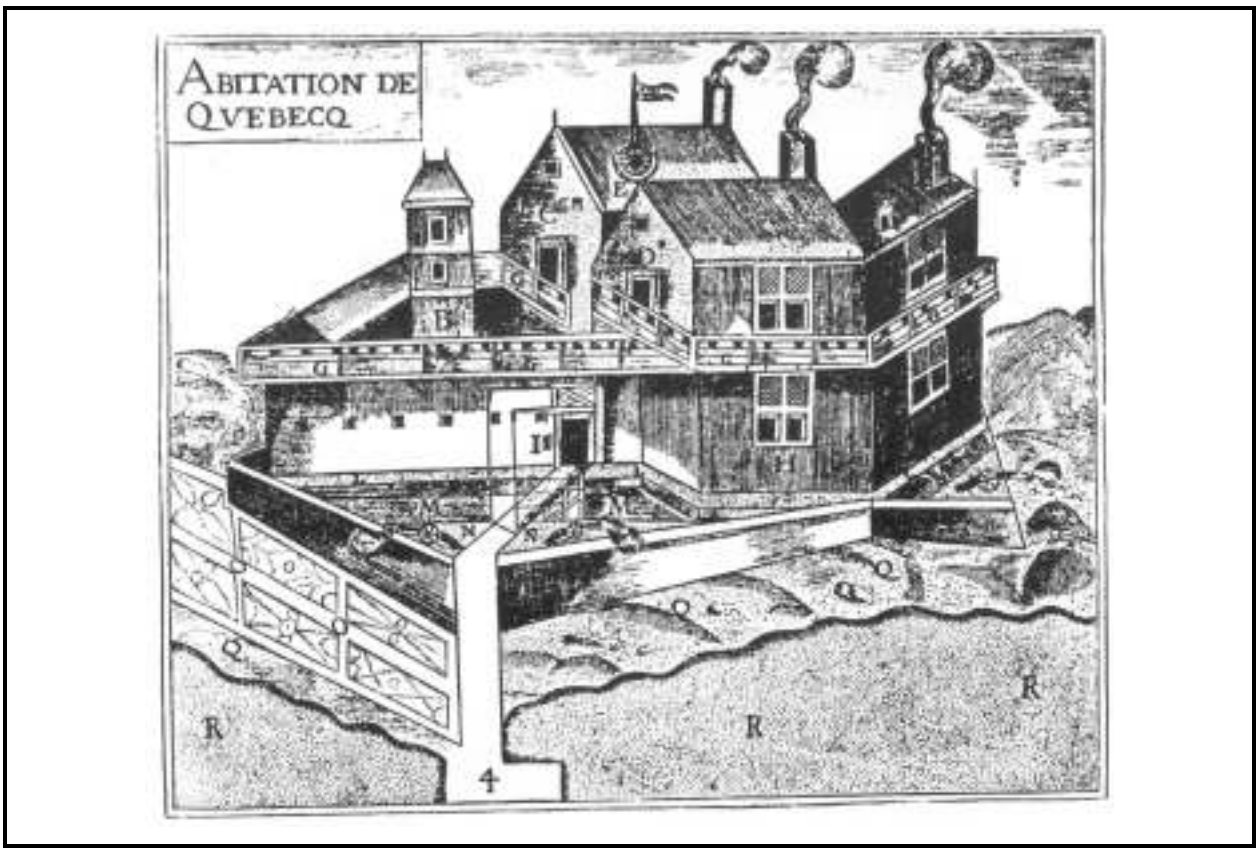

Figure 1-5 Abitation at Ville de Québec

29. With the arrival of British governance, Royal Engineers assumed responsibility for construction for the purpose of defence and national infrastructure development. The Engineers surveyed and marked the Canada-United States boundary and laid-out the original town sites of Toronto, Ottawa, London, ON, and New Westminster, Yale and Hope in British Columbia. They constructed the Cariboo Road [see: http://www.tbc.gov.bc.ca/culture/schoolnet/cariboo/wagonroa/road.htm for more information] 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. [See http://parkscanada.pch.gc.ca/parks/ontario/rideau_canal/Rideau_canal_e.htm for more information] Landmarks such as the Halifax Citadel, Fort Prince of Wales on Hudson Bay, Fort Henry at Kingston, and Fort William, ON, and Fort Rodd Hill and Signal Hill fortifications in Esquimalt, BC that still stand today, attest to the solidity 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

30. 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 reported to the parish captain of militia who employed them on such engineering works as the construction and maintenance of fortifications, roads and bridges, and other government public 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

31. European armies provided for the defence of what would become Canada until the mid-19th century and a Canadian Army did not emerge until 1855. The British Army sought to reduce its presence in North America at that time to focus on military threats elsewhere and, in 1855, the Province of Canada passed a Militia Act that provided for an Active Militia of volunteer troops. Although military engineers were not named in that Act, another in 1863 made them a part of the new Militia.

32. The state of the Canadian Militia was precarious in those early years. For example, by the close of the 19th century, two engineer field companies – the Charlottetown Engineer Company in Prince Edward Island and the Brighton Engineer Company at Woodstock, NB – were all that remained of the 15 Engineer companies which had been organized between 1860 and 1900 in such diverse locations as Saint John, NB, Montréal, QC, Port Hope and Sarnia, ON.

33. The dawn of the 20th century marked a new chapter in the history of the Canadian military engineers. The South African War had just concluded and tensions in Europe were increasing. With the last of the British forces withdrawing in 1906, Canada was left ill prepared for defence in many areas. Efforts were under way, however, 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 their withdrawal. 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.

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

FORMATION OF THE PERMANENT CANADIAN MILITARY ENGINEERS (1903-1911)

35. The 1899 Boer War had 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. As part of that process, the General Officer Commanding the Canadian Militia recommended the organization of a permanent corps of military engineers. The Deputy Minister agreed that *"the development of the Department … made it desirable that the Engineer Services be organised as a Military Branch…under military supervision and discipline."*

Consequently, General Order 168 of November 1903 authorised a Canadian Engineer Corps. But 1 July 1903 is considered to be the official founding date of the Canadian Engineer Corps as a permanent corps, since General Order 158 of 23 October 1903 appointed the first officers to the Corps effective 1 July 1903. The Corps was granted the title Royal Canadian Engineers (RCE) and given a different badge from that of the Canadian Engineers of the Militia. On 1 February 1904, the Royal Canadian Engineers had an establishment of seven officers and 125 non-commissioned members.

36. 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. The period leading up to the start of the First World War saw the foundation laid for what was eventually to become the Corps of Royal Canadian Engineers. 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.

Figure 1-8 First World War Training Camp in Vancouver

37. While these developments were taking place in the Army, the British Admiralty looked after some aspects of Canada's naval interests until 1910 [for information on Canada's role in The Great War, refer to the following paragraphs]. The construction and maintenance of the shore facilities at Halifax and Esquimalt had originally been a Royal Engineer responsibility, but as the dockyards developed their construction and maintenance became the responsibility of civil engineers in conjunction with the Canadian Department of Public Works. With the departure of British forces, the dockyards at Halifax and Esquimalt were transferred to Canada even though a Canadian Navy had yet to be authorized. In May 1910, a Department of Naval Service was authorised and on 29 August 1911 the Royal Canadian Navy came into being. No separate engineer troops were authorized at this time and most Navy construction work was carried out under the direction of a Clerk of Works at the dockyards of Halifax and Esquimalt.

Figure 1-9 Esquimalt Dockyard in 1886

THE FIRST WORLD WAR (1914-1918)

38. Before the declaration of the First World War, Canada had agreed to provide an Army infantry division to Great Britain and that country's entry into the war on 4 August 1914 marked a period of rapid mobilization for the Royal Canadian Engineers. On 7 August, construction began on a project to prepare a new camp at Valcartier capable of accommodating 30,000 men. 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.

Figure 1-10 First World War Pontoon Bridge at Camp Valcartier

39. Most of these sappers were then recruited into the Canadian Expeditionary Force and formed into three field companies for 1 Canadian Division. That formation departed for England in early October, with the Canadian Engineer Training Depot following 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, its divisional engineers concentrated at Ottawa. The Engineer units of 2 Canadian Division departed for England in the spring of 1915.

40. The initial Engineer units that were sent overseas comprised field companies, railway construction troops, signallers and telegraph operators, as well as a training depot. The Permanent Force Engineers remained in Canada to complete the home establishments and to construct and maintain an expanding infrastructure, training facilities and defence works.

41. Throughout the First World War, the Canadian Engineers received their trial by fire participating in the Canadian Corps defensive and offensive operations. Activities ranged from trench raids, bridging, communications, water supply and tunnelling under German lines to place mined charges. 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 decorations beyond their numbers. Captain C.N. Mitchell was most highly decorated with his being awarded the Victoria Cross. One of 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.

Figure 1-11 Engineer Wireless Training at Petawawa

42. 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 the enemy's 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 1-12 Railroad Troops Help Move the Guns Forward

43. 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.

44. Another specialized component was the Canadian Forestry Corps that, although technically linked with the Royal Canadian Engineers, operated relatively independently. It was composed mainly of Canadian loggers whose task was to cut the great quantities of lumber needed for engineer projects from the European forests. It was these troops who provided the lumber for the miles of corduroy roads, the ties for the railroads that were indispensable to the supply efforts, and for the never-ending requirement for timbers for the construction of tunnels, trenches and bunkers.

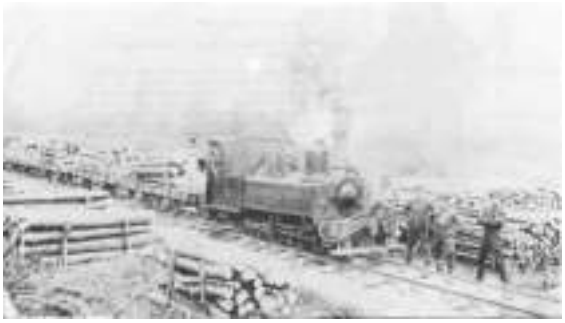

Figure 1-13 Forestry Corps at Work in France

45. The range of specialized Engineer troops continued to expand during the war. 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.

46. Canadian military engineering activities during the First World War were seen primarily in the Army overseas, but there was also activity in the Canadian Navy. Ship repair and refuelling activities increased considerably and both 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.

47. There was little 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. There had been some earlier interest in military aviation in Canada and Canadian Engineers were involved in the early demonstration flights of the *Silver Dart* and the *Baddeck* in 1909, and had proposed adding flying to Canada's military capability. An aircraft was actually taken to England with the Expeditionary Force and a fledgling Canadian Air Force was authorized but never effectively created. It was only after the war, in 1920, that the Air Force was authorized.

Figure 1-14 Engineers Provide Ground Crew for Silver Dart Flights

REORGANIZATION BETWEEN THE WARS

48. 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 in 1922 and this establishment further declined until 1930 when a slow increase in strength began.

49. Then, during the Great Depression, Military Engineers were responsible for the construction and operation of the relief camps at Valcartier, QC, Petawawa, ON, Dundurn, SK, SK, and Shilo, MB. In addition, roads, airfields, barracks, fortifications, rifle ranges, and other works were constructed under Royal Canadian Engineer control using unemployed labour. These projects provided experience and planning expertise that proved invaluable when the Second World War broke out.

Figure 1-15 Engineers Manage Construction Projects During the Depression

50. Between the wars, the non-permanent force of Canadian Engineers amalgamated with the Royal Canadian Engineers. In 1932, General Order 25 officially designated both components as Corps – respectively the Corps of Canadian Engineers and the Corps of Royal Canadian Engineers. These two Corps came together to form a new Corps of Royal Canadian Engineers (RCE) on 29 April 1936, sharing a common hat badge. In 1938 the Corps was honoured when His Majesty the King became Colonel-in-Chief.

51. Meanwhile, the Navy was also emerging from a long period of relative inactivity. Like the Army, the Navy had been severely reduced in size after the First World War, although major construction projects such as the Bedford, NS Magazine, HMCS Naden, the West Coast naval training centre, and dockyard developments continued. Responsibility for the construction requirements of the Navy was still divided among several authorities but was 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. For military engineering, this move provided the pool of civil engineering talent necessary to support wartime expansion plans.

52. 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 but the Royal Canadian Air Force (RCAF) was officially created on 1 April 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 acquire that capability. Meanwhile, the Royal Canadian Engineer 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 Royal Canadian Air Force construction and maintenance capability increased to meet demand and grew to major proportions during the Second World War.

THE SECOND WORLD WAR (1939-1945)

53. Canada's declaration of war on 10 September 1939 initiated another period of mobilization. Not only were the engineers called out to man the Army's field force, they were also required to provide works services and camp accommodations that would support the huge expansion of the Canadian Army and prepare local defences. 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 engineering role with the provision of specialized survey, railway, and tunnelling companies.

54. While the Canadian Army trained in England, various Engineer units constructed defensive works, roads, airfields, and military accommodations. 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. Royal Canadian Engineer personnel were also employed in bomb disposal in southern England during the periods of heavy enemy bombing.

55. When the Army did see action in Europe, there was invariably close engineer support. Engineers rose to high command at the divisional and corps levels, suffered casualties, and were recognized by the award of decorations in numbers greater than their proportionate share. 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 Royal Canadian Engineers played a major role in maintaining communications routes through airfield, road, and bridge construction. Canadian Engineer support was invaluable to the Allied effort and, by the end of the war, Royal Canadian Engineer strength overseas was 685 officers and 15,677 non-commissioned members.

Figure 1-16 Melville Bridge Across the Rhine River

56. Early in the war, the Navy had recognized that the main dockyards at Halifax and Esquimalt were inadequate. Accordingly, in 1941, a Directorate of Works and Buildings was created at Naval Service Headquarters to plan and implement the expansion of shore facilities. This gave the Navy its first separate and identifiable construction engineering organization.

57. The Navy's civil engineers were found in the Special Branch and their skills were put the test to provide wartime shoreside 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 there was only so much that could be physically accommodated at these ports. Accordingly, a series of smaller naval bases at Sydney and Shelburne, NS, Gaspé, QC, QC, St. John's, NF, Botwood, Bay Bulls, NF, Saint John, NB, as well as Prince Rupert and Royal Roads, BC was constructed.

Figure 1-17 Naval Repair Facilities at Sydney, NS

58. Wartime expansion for the Royal Canadian Air Force 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 complete land and seaplane hangars, runways, ammunition depots and other essential facilities on both coasts. In Eastern Area Command, for example, the only operational base was a seaplane base near Shearwater yet, in less than three years, 133 hangars had been constructed in this Area alone.

59. 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 that would be capable of turning out 21,500 aircrew every four weeks. These facilities were required by the end of April 1940, 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 virgin 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 1-18 Constructing a Hangar for the Air Commonwealth Training Plan

60. The new facilities also presented a tremendous demand for 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 sewerage 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 kilometres of water mains were installed, and 120 water-pumping stations constructed.

61. The Royal Canadian Air Force Home War Establishment demand for infrastructure 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 or were not able to meet security requirements, creating 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.

62. By the end of the war, seven Construction and Maintenance Units were deployed across Canada and 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, Construction and Maintenance Units were also involved in building the joint Canada/US Northwest Staging Route from Edmonton, AB to Fairbanks, Alaska. The 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. At about the same time, construction started on the series of radar stations on 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.

Figure 1-19 CMU Personnel Construct Plank Road to a Remote Site

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

Figure 1-20 RCAF Firefighting During Second World War

64. During the Second World War, an Air Force fire protection service was authorized that included fire suppression personnel. To meet the Air Forces increasing requirement for fire services, in 1940-41, there was a recruiting drive to bring firefighters into the Air Force. To this end, 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. Uniformed firefighters were recruited to man the increasing number of shore facilities. The Army also recruited firefighters in the Royal Canadian Engineers and some of its Fire Service personnel deployed to Northwest Europe.

POST-WAR EVOLUTION AND THE COLD WAR (1946-1966)

65. At the end of the Second World War, there was the predictable reduction of the three services and a closure of all 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.

66. The Army returned to a peacetime structure based on two corps that were manned primarily by Reservists and organized in five area commands. Incorporated within the overall organization were more than 40 Militia RCE units, while the sole remaining Active Force RCE units were 23rd Field Squadron and the Royal Canadian School of Military Engineering. These two Army Active Force Military Engineer units were based at Camp Chilliwack that was to be designated as the *"Home of the Engineers."* The Army survey function became the responsibility of the Army Survey Establishment and that unit was given a 20-year program to participate in the federal plan to map more than 3.9 million square kilometres of Canadian Territory at a scale of 1:250,000.

Figure 1-21 CFB Chilliwack Headquarters

67. The School of Military Engineering was originally established in 1907 at Wellington Barracks in Halifax, but it had become dormant during the First World War when most Engineer training was conducted at Camp Petawawa. The school then reopened in Halifax after the war and became the Royal Canadian School of Military Engineering (RCSME) in August 1927, when HM King George V approved use of the title *"Royal."* During the Second World War, the school again became dormant because Engineer training was conducted at 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. As part of the post-war re-organization of the Army, the decision was made in 1946 to establish RCSME permanently in Vedder Crossing, BC, where it remained until December 1997.

68. The Army inherited a new post-war responsibility in 1946 when Canada took over the operation and maintenance of the former Alcan Highway within Canadian boundaries, between Dawson Creek, BC and Beaver Creek, NWT. This highway had been constructed and operated by the US Army Engineers during the Second World War. Included in the hand-over 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 kilometres of road and built over 100 bridges during the 18 years in which the Army held responsibility for the Northwest Highway System.

Figure 1-22 Bridge on Alcan Highway

69. 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.

70. 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 all the 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. One of these, the Manager Civil Engineering, represented Naval Service Headquarters at the Halifax and Esquimalt dockyards.

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

72. The deteriorating international situation of the Cold War soon altered the situation and, 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 expansion of the Canadian Forces as Canada planned to send a brigade group to Korea as well as a brigade group and an air division to Europe while having a third brigade group as a rotation base.

Figure 1-23 Engineers Guard a River Crossing Site in Korea

73. The stationing of Canadian forces in Europe started in 1951. and both the Army and Air Force construction engineers were then heavily tasked to provide operational, support and personnel facilities required in Europe, in record time. Once operational, the NATO commitment of a field squadron in Germany provided a focus for training of the RCE many years.

74. The hostilities in Korea added to a general rearmament that resulted in the Royal Canadian Engineers being expanded from one field squadron to four – with all four eventually serving in Korea. The Engineers met the challenge to maintain the mobility of friendly forces, particularly under adverse weather conditions and difficult terrain, as well as to protect those forces against heavy shelling by constructing major defensive works and fortifications. The squadrons laid and cleared minefields and wire obstacles, constructed major field fortifications, roads, bridges and airfields, assisted with tented camp construction and provided potable water.

75. This was a period of high international tension made worse by the additional threat of the horror of a 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 ("Diefenbunker") at Carp, ON and a public nuclear warning system, and by fielding No. 1 Radiation Detection Unit.

76. The Army accelerated its Station Development Program and started its 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-man brigade and an all-weather training facility for a 10,000-man division. The 1,000-square-kilometre camp was the largest in the British Commonwealth and incorporated 100 permanent buildings and 2,000 married quarters.

77. 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 that included training the fighter squadrons destined for service in Europe with NATO and the training and deployment of squadrons committed to continental air defence. The biggest Royal Canadian Air Force construction undertaking during this period was, by far, 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 co-operative 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 Northwest Territories at Iqaluit (then Frobisher Bay) and Resolute.

Figure 1-24 RCAF Station Cold Lake

78. 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 Line. Construction of these radar defences required extensive pioneering in engineering, made more challenging by 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, NF. 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.

Figure 1-25 Radar Site at Sioux Lookout

79. Construction on the Mid-Canada Line began in 1953 and was completed in 1958. This line ran some 500 kilometres north of the Pinetree Line and comprised numerous individual sites and eight main section control stations. These latter stations had airstrips, as well as accommodations for the full-time staff and were sited at places like Dawson Creek, BC, Portage, MB, Winisk, ON, Great Whale River, QC, and Hopedale, Labrador. 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.

80. The Distant Early Warning Line was situated 1,000 kilometres north of the Mid-Canada Line and extended 3,800 kilometres 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 1954-1958.

81. 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. In 1959, excavation of two large caverns began in the Precambrian rock, 200 metres below ground; plus two, kilometre-long tunnels situated three kilometres apart to connect them. Inside the caverns, a three-storey, 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 was recognized as one of the major engineering accomplishments of the Air Force Construction Engineers.

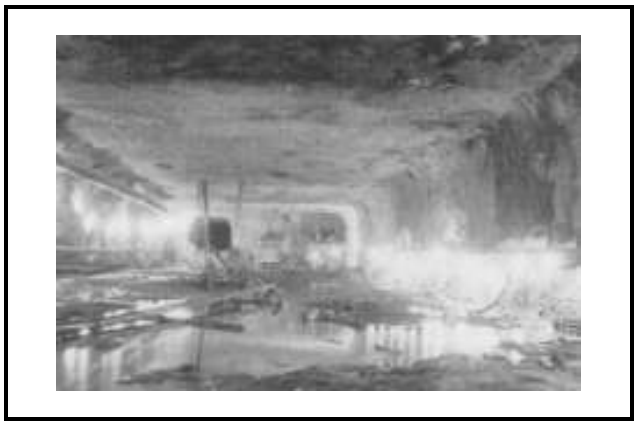

Figure 1-26 Construction of NORAD Control Centre at North Bay

82. A new weapons component of the air defence system in Canada was the Bomarc B surface-to-air missile. Sites were constructed for a squadron of missiles at North Bay, ON and La Macaza, QC between 1959 and 1962. The sites were operated and maintained entirely by Royal Canadian Air Force Construction Engineering personnel.

A UNIFIED CANADIAN MILITARY ENGINEER FAMILY (POST 1966)

83. Although certain elements of the Canadian Forces had supported all three services for decades, the early 1960s saw increased interest in unifying many of the Department's functions as an efficiency and cost-saving measure. To a certain extent, the construction engineering function lead 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.

84. 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 the initial major reorganization, the roles have changed little and alterations to the CME have been evolutionary in nature. Chapter 2 provides a detailed description of the current structure of the CME. Some of the recent activities in each of the functional areas are listed in the following paragraphs.

85. School of Military Engineering. Upon Unification, the Royal Canadian School of Military Engineering assumed responsibility for training the entire Military Engineering Branch in 1968.. Renamed the Canadian Forces School of Military Engineering (CFSME), it took on training of the air element from former Royal Canadian Air Force trades schools in Calgary and Camp Borden. The school conducted military engineering training for the entire Military Engineering Branch (less mapping and firefighting) at Chilliwack for 30 years before moving to CFB Gagetown in 1997 when CFB Chilliwack was closed.

Figure 1-27 Canadian Forces School of Military Engineering, Camp Gagetown

86. The Canadian Forces School of Military Engineering currently conducts more than 80 different courses and more than 100 course serials annually. Training ranges from courses in the combat and construction trades to officer training and includes specialty training for both the CME and other branches. More than 1,400 Canadian Military Engineers attend the school annually.

87. Combat Engineering. The first new combat engineer unit to be created since Korea was 5e Escadron de Génie du Canada, formed in July 1968. However, organizations and equipment continued to evolve with operational commitments and changes in technology. The Army re-organized to an area-based command and control structure with a combination of Regular Force and Militia brigades. Commitments to international peacekeeping and peacemaking activities continued to rise and the Combat Engineer Regiments, in particular, played prominent roles. Engineer forces were committed at a pace unprecedented since the Second World War with the equivalent of three regiments deployed out of the country.

88. The Regular Force Combat Engineers are currently organized into three Combat Engineer Regiments and an Engineer Support Regiment. Militia units comprise a combination of four Engineer Regiments and eight independent Field Squadrons. A complete listing of CME units is at Annex A to Chapter 2.

89. Construction Engineering. Construction engineering was the military engineering function that was most effected 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.

90. The infrastructure sector has been under continual challenge as the Canadian Forces attempts to manage with reduced resources at a time when much of the infrastructure inventory is in need of replacement. A series of base closures and the rationalization of infrastructure presented long-term solutions, but also created some great challenges, requiring innovative thinking and management to meet the short-term demands for reduced spending. Further challenges are being met as the numbers of uniformed tradesmen, supervisors and leaders are being reduced to preserve the limited number of military positions for the deployable forces.

91. 1 Construction Engineering Unit, formed in 1962 from the remnants of the wartime Construction and Maintenance units, remains an operational National Unit with deployable capabilities. It moved from Winnipeg, MB to Moncton, NB in 1995. Today, 1 CEU provides specialist engineering support and construction services to the CF and 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. In 1976, the first Chief of Defence Staff Unit Commendation was awarded to 1 CEU for its service, particularly in the Arctic.

92. Airfield Engineers. The concept of an airfield engineering squadron was initiated in 1986 when the first unit was formed to provide Airfield Damage Repair capabilities in Germany at CFB Lahr. With the closure of the Canadian bases in Europe in 1993, the capability was relocated to Canada and now resides in 4 Airfield Engineering Squadron 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.

Figure 1-28 Airfield Engineer Training

93. The Air Force Engineers have focused their efforts on Airfield Engineering where their role is to enable the air force to live, fly and fight from any location. The mission is to enable the air force to deploy, bed down, conduct sustained operations and recover from an attack. Airfield Engineering missions provide support at Main Operating Bases, Forward Operating Locations and Deployed Operating Bases in any geographic location. A separate Airfield Engineering officer occupation classification was introduced in 1995 and all construction engineering tradespersons and officers are concentrated at the Wings and in the Airfield Engineering squadrons and flights. Airfield Engineering support has also been critical to the success of the Canadian Forces' NATO and United Nations operations as well as during humanitarian assistance and disaster relief operations.

94. Military Mapping. Although the Mapping and Charting Establishment (MCE) printed the last of the northern 1:250,000 map series in 1970, a variety of new projects kept it involved in the Arctic, such as the survey of the east coast of the Arctic Islands for Maritime Command.

95. While the provision of paper maps and charts continues to be the backbone of its operations (during the 1991 Gulf War, MCE printed more than one million maps), introduction of digitized map products has provided a major improvement to the rapid provision of accurate geomatic information.

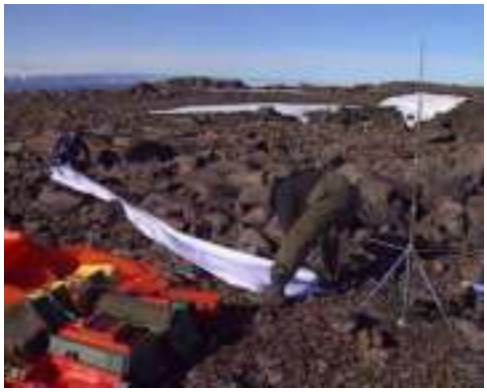

Figure 1-29 Surveying Canada's North

96. MCE continues to lead the way in the application of new technologies to provide improved defence geomantic support and Military Mappers have provided the international lead in the application of digital technology and position finding. In the early 1990s, MCE conducted gravity surveys in support of a Canada-United States 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.

97. 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 despatched in support of United Nations and North Atlantic Treaty Organization 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.

98. Military Mappers also continue to assist at home in times of emergency as they provided invaluable support to Operation ASSISTANCE (the 1997 Red River flood that threatened Winnipeg), the 1998 Ice Storm in eastern Canada and the crash of the Swiss Air in Nova Scotia in 1998.

99. Fire, Crash and Rescue. Upon Unification, the military and civilian firefighters of the three services joined to form the DND Fire Protection Service. Thus emerged a combined civilian and military entity under common management and with common training. Over the years, however, the number of uniformed personnel has been reduced and is now limited to major operational air bases and aboard ship. While the training of these firefighters was initially conducted in CFB Borden at a company that was integral to other schools, in 1985 an independent Canadian Forces Firefighting Academy was created in Borden.

Figure 1-30 Firefighter Training Exercise

100. Northern Development. In Canada's North, military engineers have led the way 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 1-31 Constructing a Northern Airfield

101. Humanitarian Aid and Disaster Relief. Military engineers are actively engaged on humanitarian missions, generally in response to specific requests from the Department of Foreign Affairs and International Trade. These deployments are at times stand-alone activities or are often in conjunction with United Nations peacekeeping operations. 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. In recent times, military engineers continue to provide emergency civil engineering support to major disasters at home such as the 1997 Manitoba flood and 1998 eastern Canada ice storm.

Figure 1-32 Footbridge Constructed in Haiti

102. Landmine Awareness and Clearance. The Canadian Military Engineers have earned domestic and international acclaim for their work in educating civilians about mine awareness and mine clearance in war-torn areas such as Afghanistan, Cambodia, and Croatia.

103. Peacekeeping and Peacemaking. Canada continues to be a strong advocate of United Nations peacekeeping missions and military engineers have played a vital part in most of these operations. [See http://www.dnd.ca/menu/legacy/global_e.htm for a global view of Canada's peacekeeping activities] In addition to United Nations operations, military engineers have participated in multinational forces in Somalia, Kuwait, and the Former Republic of Yugoslavia.

AND TO THE FUTURE

104. The first Militia Canadian Military Engineer unit was formed in Halifax in 1860 and Canadian Military Engineers, now have more than 100 years of Permanent Force service in peace and war. While there have been many changes over the last 140 years, the role and commitment of military engineers has remained fixed. Serving Canada's needs at home or abroad, military engineers are on peacekeeping duties with the United Nations, with NATO, aboard HMC ships, 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 accomplishments, is well prepared for, and eagerly awaits, the challenges of the future.

Annex A – Suggested Reading List

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