Canada and the Atom Bomb

Canada's direct participation in the creation of the atom bomb became public knowledge through newspaper reports the day after the atomic bombing of Hiroshima on August 6, 1945. (70,000 human beings were killed immediately in the bombing and another 70,000 would die from injuries and radiation poisoning by the end of the year). The *Edmonton Journal*, in "New Bomb in Wrong Hands Could Tear World to Pieces," for example, revealed that "Canadian science and Canadian uranium played a large part in the epochal achievement by Allied research staffs—an achievement so fantastic that hours after it had been told around the world military and scientific experts remained reluctant to hazard an estimate of its potentialities."

The paper reported that "Necessary supply of uranium, basic element in production of the atomic bomb, was ensured by the action of the Canadian government in 1944 in taking over the Eldorado mine and refining development near Great Bear Lake. Canadian and British scientists working in Montreal and other Canadian cities pooled their effort with American and British scientists to harness the unprecedented power the force of which in peace as well as war alter the course of civilization." An accompanying article cited C.D. Howe, the Minister of Munitions and Supply in Prime Minister Mackenzie King's government, "that government action in taking over the Eldorado Mining and Smelting Co. was part of the atomic development program."[1]

How could Canadian newspapers provide such extensive coverage of Canada's involvement in the creation of the atom bomb within a day of the atomic bombing of Hiroshima and two days before the atomic bombing of Nagasaki?

The answer is that Canada was a direct participant in the Manhattan Project which developed the uranium and plutonium atom bombs dropped on Japan. The National Research Council of Canada began designing and operating atomic fission laboratories at the Montreal Laboratory starting in 1942 and at the Chalk River Laboratories in Ontario beginning in 1944. In January of 1944, the Canadian government nationalized Eldorado Mining and Refining Limited and converted the company into a Crown Corporation to secure Canadian uranium for the Manhattan Project. Eldorado's refinery in Port Hope, Ontario, was the only refinery in North America capable of refining the uranium ore from the Belgian Congo, the bulk of which (along with Canadian uranium) was used in the manufacture of the Hiroshima and Nagasaki atom bombs.

As a result of the Quebec Agreement signed by President Roosevelt and British Prime Minister Winston Churchill in August of 1943, C.D. Howe was appointed the Canadian member of the

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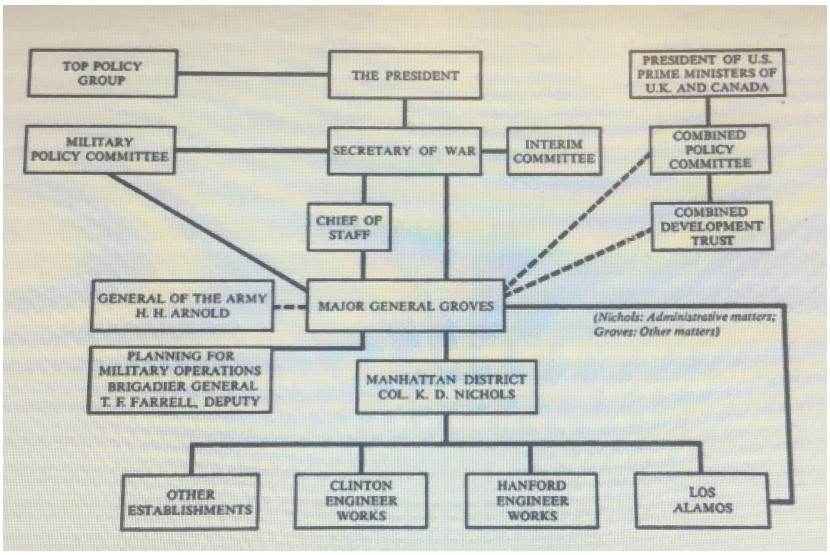
[1] C.R. Blackburn, "New Bomb in Wrong Hands Could Tear World to Pieces" and "Taking Over of Eldorado Property Was Part of Atomic Bomb Program," *Edmonton Journal*, August 7, 1945, p. 2 https://news.google.com/newspapers?id=yuVkAAAAIBAJ&sjid=KoENAAAAIBAJ&pg=5621%2C2841878

Combined Policy Committee that co-ordinated the U.S.-U.K.-Canadian research efforts to produce the atom bomb. The American members were Henry Stimson, the U.S. Secretary of War (and Chair of the Committee), Vannevar Bush, head of the U.S. Office of Scientific Research and Development, and James Bryant Conant, President of Harvard University and chair of the U.S. National Defence Research Committee. The two British members were Field Marshall Sir John Dill, head of the British Joint Staff Mission in Washington, and John Llwellin, the Minister of Aircraft Production.

According to Vincent Jones, "The British had felt that the Canadians, even though they were not a party to the Quebec Agreement, should have representation on the high-level committee because they would be making important contributions to the atomic energy project in Montreal."[2]

Chalmers Jack Mackenzie, President of the National Research Council (and future first President of Atomic Energy of Canada Limited), was a member of a technical subcommittee of the Combined Policy Committee. George C. Bateman, President of the Canadian Institute of Mining and Metallurgy appointed Metals Controller by an Order in Council on July 14, 1940, a deputy minister and member of the Combined Resources Board, represented Canada on the Combined Development Trust, which was chaired by General Groves.[3]

General Leslie Groves, the military head of the Manhattan Project, provided the following organizational chart for the Manhattan Project in his history *Now It Can Be Told* that reflects this direct Canadian involvement by Prime Minister Mackenzie King, C.D. Howe, C.J. Mackenzie, and George C. Bateman. He also noted that "there were about a dozen Canadian scientists in the Project."[4]



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[2] Vincent C. Jones, *Manhattan: The Army and the Atomic Bomb*, Washington, D.C.: Center of Military History United States Army, 1985. p. 241. https://history.army.mil/html/books/011/11-10/CMH_Pub_11-10.pdf

[3] Ibid., p. 299.

[4] See "Quebec Agreement," https://en.wikipedia.org/wiki/Quebec_Agreement. Leslie R. Groves. *Now It Can Be Told: The Story of the Manhattan Project*. Da Capo Press, 1983, 1, 407.

Donald Avery, in *The Science of War: Canadian Scientists and Allied Military Technology During the Second World War*, records that "C.J. Mackenzie's diary entries for July-August 1945 are replete with references to the forthcoming use of the bomb."

> On July 5, for instance, he recorded an important conversation with C.D. Howe, who had just returned from a meeting of the Combined Policy Committee where the decision to use the bomb had been announced: 'The main event [the Trinity tests] will take place in the immediate future. The Americans have all their press releases ready and it is going to be a most dramatic disclosure. They are going to tell a great deal about the project in general terms, all the money spent, where they are working, etc. Mr. Howe said we must get busy immediately and get our press releases ready as it is the biggest opportunity Canada will ever have to participate in a scientific announcement.'"[5]

Prime Minister Mackenzie King also knew that the atom bomb would be used against Japan. On July 26, he recorded in his diary that "Between the use that will be made of the atomic bomb and the possible coming into the war of Russia, I shall be surprised if negotiations from now on do not relate primarily to the speediest methods of ending the Japanese war." The following day he added, "Within a few days at the latest the power of the atomic bomb will be disclosed and with it Japan will be faced with either immediate complete surrender or complete devastation within a very short time." On August 6, while presiding over a Dominion-Provincial Conference in Ottawa, he "received a note from Howe saying a bomb had been dropped and that he was giving a report to the press…He then sent me down a copy of his own statement which he had prepared."

The Prime Minister thought "It is quite remarkable that it should have been given to me to be the first in Canada to inform my own colleagues [members of his Cabinet] and the premiers of the several provinces and their ministers of this most amazing of all scientific discoveries and of what certainly presages the early close of the Japanese war." Mackenzie King then added his infamous racist statement, "We now see what might have come to the British race had German scientists won the race [to develop the atom bomb]. It is fortunate that the use of the bomb should have been upon the Japanese rather than upon the white races of Europe."[6]

The Canadian public's awareness immediately after August 1945 of Canada's direct participation in the atomic bombings of Hiroshima and Nagasaki has all but disappeared from our collective consciousness over the past eight decades. The summaries and chronology that follow aim to restore that awareness of our historical past.

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[5] Donald Avery, *The Science of War: Canadian Scientists and Allied Military Technology During the Second World War*. Toronto: University of Toronto Press, 1998. p. 196.
[6] *The William Lyon Mackenzie King Diaries*, July 26, 27, and August 6, 1945.
See http://www.bac-lac.gc.ca/eng/discover/politics-government/prime-ministers/william-lyon-mackenzie-king/Pages/diaries-william-lyon-mackenzie-king.aspx

Eldorado: Canadian Uranium "feed materials" for Atom Bombs

Gilbert LaBine and his brother Charlie founded Eldorado Gold Mines Limited in 1926. Its name was changed to Eldorado Mining and Refining Limited on June 3, 1943. The company was expropriated by the Canadian government on January 28, 1944.

Gilbert LaBine discovered uranium oxide in pitchblende on the shore of Great Bear Lake in the Northwest Territories in April 1930, in what later became known as Port Radium. The only other known locations for pitchblende—refined for radium used in the treatment of cancer—were in the Joachimsthal in Czechoslovakia and in the Belgian Congo. The Belgian Union Minière de Haut-Katanga monopolized the international radium market.

Eldorado required fifteen tons of ore to refine one gram of radium. It established a refinery on John Street in Port Hope, Ontario, in 1932. The uranium concentrate from its Great Bear Lake mine at Port Radium was carried in thousands of sacks on the backs of Dene hunters and trappers from Deline to barges for transport along a 3,400 km "Highway of the Atom" of rivers, rapids and portages to Fort McMurray, Alberta, and then by train to the Port Hope refinery on Lake Ontario. Each sack weighed 200 pounds and was worth $400 [$7,100 in 2020 dollars] in radium content. Eldorado dumped 1.7 million tons of uranium waste into Great Bear Lake. Many Dene died of cancer, leaving Deline a "village of widows." The Dene had never been informed about the dangers of radiation poisoning.[7]

Germany seized the uranium deposits in Czechoslovakia in October of 1938.

Competition from the Union Minière and the outbreak of World War II forced Eldorado to close its radium mine in 1940 after stockpiling sufficient ore to satisfy the normal future commercial market for approximately five years.

As scientists in Germany, England, France and the United States raced to split the uranium atom with the aim of releasing undreamed amounts of energy in the process, uranium ore became an extremely rare commodity. As Gordon Edwards writes in "Canada and the Bomb: Past and Future," "Early in 1939, German scientists proved uranium atoms could be split, or fissioned, releasing energy. If a chain reaction could be achieved, an 'atomic bomb' was possible. Within months, French scientists, using heavy water smuggled from Norway as a moderator, were trying to provoke a chain reaction. They fled to England with the heavy water when Germany invaded France. In 1940, the British figured out how to make an atomic bomb by enriching natural uranium—a slow, difficult, expensive process. In utmost secrecy, they asked the Americans for cooperation, and the Canadians for uranium."[8]

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[7] See Robert Bothwell, *Eldorado: Canada's National Uranium Company*. Toronto: University of Toronto Press, 1984. pp. 37, 57. Fred C. Bond, *It Happened to Me*. Kindle Edition, 2011. Chapter 79. For the effect of uranium mining on the Dene, see Andrew Nikiforuk, "Cancer Kills Fourteen Aboriginal Uranium Workers" and "Uranium Haunts a Northern Aboriginal Village," *Calgary Herald*, March 14, 1998, accessed at http://www.ccnr.org/deline_deaths.html and Peter Blow's 1999 Lindum Films documentary *A Village of Widows: The Story of the Sahtu Dene and the Atomic Bomb* accessed at https://www.transcend.org/tms/2018/08/village-of-widows-the-story-of-sahtu-dene-and-the-atomic-bomb/

[8] Gordon Edwards, "Canada and the Bomb: Past and Future," Canadian Colition for Nuclear Responsibility http://ccnr.org/opinion_ge.html

The American Manhattan Project similarly stated in its in-house history, "The discovery in 1939 that uranium-235 atoms can be made to yield tremendous quantities of energy brought the element uranium from its position of relative obscurity to one of transcending importance." The Manhattan Project engaged in a world-wide geological search to secure sufficient quantities of uranium deposits to ensure the success of its atom bomb project. In its *Manhattan District History*, the Project described this process as "locating adequate sources of raw materials, procuring the raw materials, refining them, and finally converting them in a series of treatment operations to obtain feed for the processing plants."

It identified the best sources for uranium ore as the Shinkolobwe mine in the Belgian Congo, owned by Union Minière. "The second richest source of raw materials for the Project was the Eldorado mine, located on the southeast shore of Great Bear Lake in Canada." Much lower grade uranium ore could also be obtained from various mines in the Colorado Plateau region of the western United States but entailed much higher refining costs.[9]

Drawing on its stored stockpiles, Eldorado began supplying ten to fifteen tons of uranium ore to British scientists as well as to American physicists investigating nuclear fission at Columbia University in New York in October of 1939.

The Americans' failure to come to an agreement with Union Minière in early June of 1940 "left the uranium research program dependent on Canadian sources. Fortunately, by the end of 1940, small amounts of Canadian uranium were available" from Eldorado.[10]

In its comprehensive survey of the Manhattan Project and the development of the atom bomb, *Wikipedia* highlights that "the key raw material for the project was uranium, which was used as fuel for the reactors, as feed that was transformed into plutonium, and, in its enriched form, in the atomic bomb itself." By the time the Manhattan Project terminated on December 31, 1946, it had spent nearly two billion U.S. dollars [$35,737,755,000 Canadian in 2020 dollars] and employed a work force of over 130,000 people.[11]

Following a sixty-ton order for uranium oxide from the American Office of Scientific Research and Development (the precursor to the Manhattan Project) in 1941, Eldorado was able to reopen its mine in Great Bear Lake with Canadian government assistance in 1942.

According to C.P. Stacey, "the evidence all suggests that from 15 July 1942 LaBine was quite prepared to see to it that Eldorado carried out any instructions issued by the Canadian government." C.D. Howe wrote Gilbert LaBine on July 28, 1943 notifying him that "This will advise you that the Government of Canada is taking delivery of all uranium ore produced in this country, for resale to governments requiring this product. From this date your Company is instructed to make deliveries

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[9] *Manhattan District History*, Book VII, Volume 1, pp. 1.5, S2, S5, S6, 1.3. All the Books can be accessed at Manhattan Project Historical Resources https://www.osti.gov/opennet/manhattan_district
[10] Jones, *Manhattan: The Army and the Atomic Bomb*. p. 25. https://history.army.mil/html/books/011/11-10/CMH_Pub_11-10.pdf
[11] See "Manhattan Project," *Wikipedia* https://en.wikipedia.org/wiki/Manhattan_Project

solely on orders from Dean C.J. Mackenzie, President of National Research Council, who is my agent in dealing with this product."[12]

The U.S. Army Corps of Engineers took charge of the American bomb project in June of 1942 and established the Manhattan Project, headed by Brigadier General Leslie Groves. The *Manhattan District History* notes of the Canadian uranium procurement that "At the outset of the program, the objective was to procure approximately 1,700 tons of black oxide (uranium 238), or its equivalent in ore concentrates by the middle of 1944, for conversion to feed materials."

According to Robert Bothwell's company history, Eldorado signed exclusive contracts with the Manhattan Project in July and December of 1942 for 350 and then an additional 500 tons of uranium ore to be delivered before December 31, 1944.

The *Manhattan District History* reports of the contracts with Eldorado that "There had been contracted for, to 1 January 1947, approximately 4,149 tons of ore, at a cost of approximately $5,082,300 [$91,144,485 Canadian in 2020 dollars], to be delivered as 1,137 tons of black oxide. To 1 January 1947, 921 tons of uranium-238 have been delivered…The last contract with Eldorado, which was negotiated with the Canadian government, set a top price of $4.20 [$35 Canadian in 2020 dollars] per pound of black oxide."[13] It provided the following summary of Manhattan Project contracts with Eldorado:

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CANADIAN RAW MATERIAL PROCUREMENT SUMMARY

Contract or Purchase Order Number	Date of Contract	Delivery Period	Tons of Ore Contracted For	Tons of Black Oxide to be Delivered (as U_3O_8)	Estimated Cost of Ore Contracted For*	Total Cost of Black Oxide Contracted For
Stone and Webster						
P. O. 135	July 15, 1942	Aug-Dec. 1942	490	140 1.54	$ 430,600.	$ 668,200
Boris Pregel						
W-7405 eng-145	May 22, 1943	Jan.-June 1943	868	---	554,100**	---
Gilbert A. LaBine, Agt.						
W-7405 eng-252	Sept. 11, 1943	June 1943 to date	1621	687 .97	1,332,400	2,161,760
W-26-021 eng-6	Dec. 1, 1944	May 1945 to date	1170	310	2,765,200	3,825,400
		TOTAL	4149	~~1147~~ 1137	$5,082,300	$6,655,360

*Contract costs include the sale and refining of ore to black oxide. The costs in this column are calculated.

**This contract was terminated and the requirements of black oxide were transferred to W-7405 eng-252. The cost shown is for the ore obtained before termination of the contract.

[12] C.P. Stacey, *Arms, Men and Governments: The War Policies of Canada 1939-1945*. Ottawa: Queen's Printer, 1970. pp. 516, 523. file:///C:/Users/Owner/Desktop/CP%20StaceyAMG_e.pdf

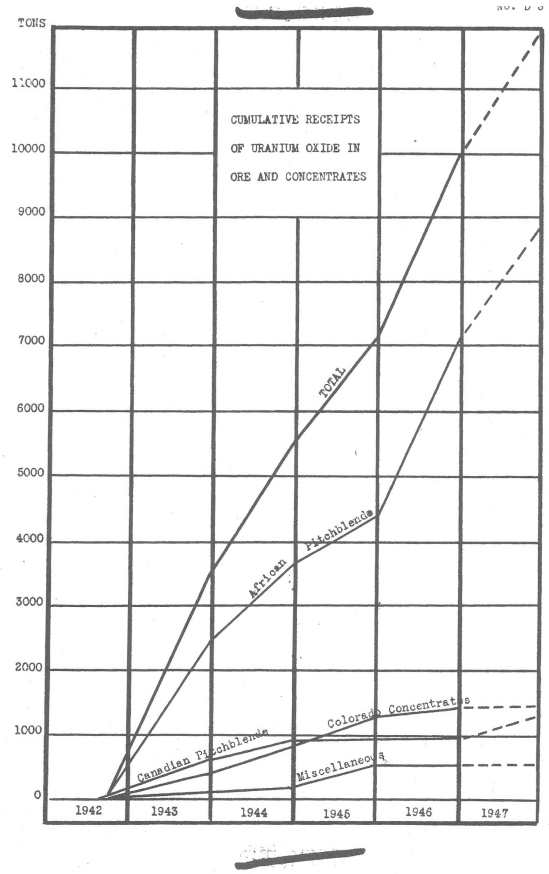
[13] *Manhattan District History*, Book VII, Volume 1, pp. S6, S1, 3.3. Bothwell, *Eldorado*, 109, 110.

The Italian-American Nobel Prize winner Enrico Fermi succeeded in creating the world's first self-sustaining nuclear chain reaction at the University of Chicago on December 2, 1942 using Canadian uranium.[14]

Another Nobel Prize winner, Arthur Compton, was responsible for producing this first nuclear reactor, the Chicago Pile-1. Compton was charged by the Manhattan Project with producing nuclear reactors that could convert uranium into plutonium. His Metallurgical Laboratory at the University of Chicago also designed the world's second nuclear reactor, the X-10 Graphite Reactor, at the Oak Ridge National Laboratory in Tennessee. Three nuclear reactors in Hanford, Washington, began producing plutonium in November of 1944. They provided the plutonium used in the first test nuclear explosion in New Mexico on July 16, 1945 and for the bombing of Nagasaki on August 9.[15]

The *Manhattan District History* summarized, "both the procurement and production objectives of the program have been successfully achieved. As to the procurement goal: the project has procured a total of about 10,000 tons of uranium-238 in ore concentrates. Of the raw material delivered to 1 January 1947, 72% has come from the Belgian Congo, 9% from Canada, 14% from the Colorado Plateau region, and 5% from miscellaneous sources."[16]

It also provided the following chart:



[14] Bothwell, *Eldorado*, 111.
[15] See "Arthur Compton," https://en.wikipedia.org/wiki/Arthur_Compton.
[16] *Manhattan District History*, Book VII, Volume 1, p. 1.14.

Eldorado erected a cement marker at the site of its Port Radium mine that read in capital letters, "This mine was reopened in 1942 to supply uranium for the Manhattan Project (the development of the atomic bomb)."[17]

Eldorado's Port Hope Refinery

The U.S. Army Corps of Engineers purchased 1,200 short tons of the much purer uranium from the Union Minière in August of 1942, but only the Port Hope refinery was able to process its high grade concentrates by the end of 1946. The *Manhattan District History* reported that "Eldorado had its own refinery at Port Hope, Ontario, where ore concentrates were refined to produce black oxide. Therefore, it was possible to purchase black oxide directly from Eldorado, and there was no need for the storage, the weighing, sampling, and assaying, and the preliminary refining steps, as in the case of the African ores."

> The first material refined by Eldorado at Port Hope, Ontario, Canada, consisted of the initial 100 tons of 65% uranium-238 ore procured from African Metals Corporation, as a trial lot to determine the efficiency of refining operations. These ores were delivered to Eldorado in November 1942 and refining was started a month later. At the time of the delivery of the ores, the plant was small and did not have a production capacity of more than 30 tons of black oxide per month. However, the plant was expanded at the expense of the contractor to a point where he was able to deliver 150 tons of black oxide per month when working on 65% African ore. Expansion was started late in 1942 and by February 1943 the capacity had been raised to 100 tons of black oxide per month. Refining operations have continued to date both on African ores supplied under refining contracts and on Canadian ores from which the black oxide produced was sold to the Government.
>
> To 1 January 1947, Eldorado produced, from African ore, approximately 1,832 tons of uranium-238. The total cost of the work performed under eight contracts was $2,823,310 [$50,490,055 Canadian in 2020 dollars], the cost of refining uranium-238 was $2,528,560 [$45,218,956 Canadian in 2020 dollars], and the average processing cost was approximately $0.69 [$35.22 Canadian in 2020 dollars] per pound of uranium-238 in black oxide. In addition to the African ores processed, approximately 847 tons of black oxide have been produced to date from Canadian ores.[18]

The *Manhattan District History* also provided the following summary of Eldorado refining contracts:

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[17] Robert Del Tredici, "From Arctic Canada to Hiroshima," *Nikkei Voice*, October 1998, p. 1.
[18] *Manhattan District History*, Book VII, Volume 1, pp. S7 1.10, 7.2-7.3.

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No. F 7

SUMMARY

REFINING OF ORES AND CONCENTRATES

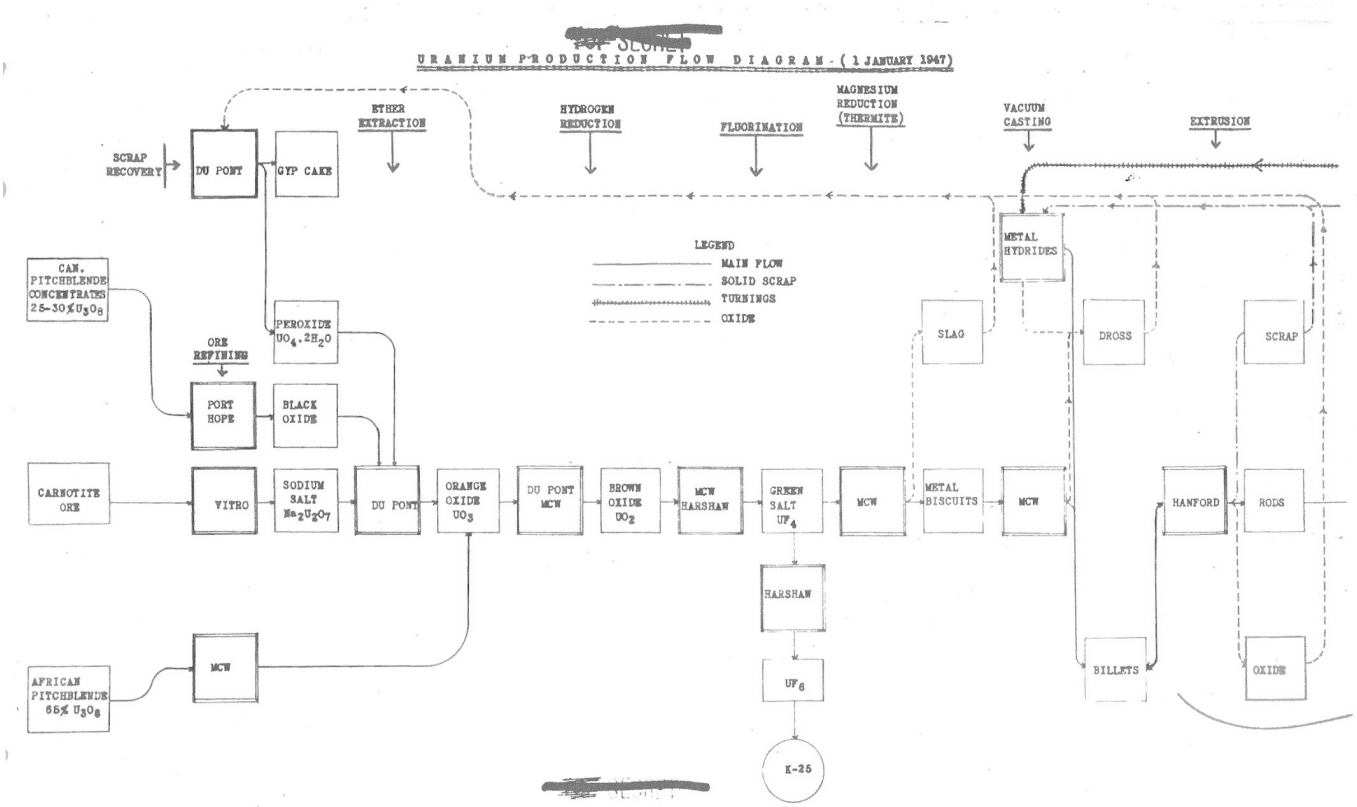
To 1 January 1947

Contract Number	Date of Contract	% U_3O_8 in Ore (Approx.)	Total Tons U_3O_8 in Ore (Approx.)	Tons U_3O_8 Recovered To Date	U_3O_8 Refining Cost To Date	Other Refining Costs	TOTAL
ELDORADO CONTRACTS:							
W-7405 eng-6	10/21/42	6	73	68	$ 83,900	$ --	$ 83,900
W-7405 eng-17	10/17/42	25	1,251	1,164	1,418,600	--	1,418,600
W-7405 eng-20	11/24/42	82	48	46	37,500	--	37,500
W-7405 eng-264	10/25/43	20	168	160	392,090	231,170	623,260
W-7405 eng-281	1/15/44	20	54	52	127,450	--	127,450
W-7405 eng-281	1/15/44	50	111	105	126,820	18,800	145,620
W-7405 eng-318	9/1/44	20	76	71	116,210	--	116,210
W-7405 eng-318	9/1/44	26	74	69	106,210	34,220	140,430
W-26-021 eng-21	7/30/45	20	29	27	44,320	10,560	54,880
W-26-021 eng-26		65	75	70	75,460	--	75,460
African Ore			1,959	1,832	$2,528,560	$ 294,750	$2,823,310
W-7405 eng-145	5/22/43	30	222)				
W-7405 eng-252	9/11/43	30	532)	687	$ 829,360	$ --	$ 829,360
W-26-021 eng-6e		30	344	20	40,000	--	40,000
Stone & Webster Purchase Order 135	7/15/42	30	172	140	237,600	--	237,600
Canadian Ore			1,270	~~862~~ 847	$1,106,960	--	$1,106,960
ELDORADO TOTAL			3,229	~~2,698~~ 2,679	$3,635,520	$294,750	$3,930,270

As Robert Bothwell writes in his company history *Eldorado*, "Thus, Eldorado's principal importance in the wartime atomic energy Project was established…it was the Eldorado refinery that became crucial to the bomb Project…a critical link in the American supply chain." General Leslie Grove, in his history of the Manhattan Project, *Now It Can Be Told*, also confirms that it was through Eldorado's Port Hope refinery "through which we eventually funneled all the Belgian Congo ore."[19]

The *Manhattan District History* provided the following flow chart demonstrating Eldorado's Port Hope refinery's critical link in the American supply chain:

[19] Bothwell, *Eldorado*, 109, 110, 111, 112, 132. Groves, *Now It Can Be Told*, 178.



The 1943 Quebec Conference Agreement

The United Kingdom, too, could not carry out its atomic bomb research without Canadian uranium. On June 15, 1942, Malcolm MacDonald, the British High Commissioner in Canada, came to see Prime Minister Mackenzie King with the scientists George Thomson and Michael Perrin who described the British atom bomb project, codenamed "Tube Alloys." King recorded in his diary, "The whole business was very secret but it was represented that it was quite possible that it might, within a very short time, lead to a development that whichever country possessed this mineral in time would unquestionably win the war with its power of destruction in development processes being so great."[20]

On July 15, 1942, a secret Order in Council allocated $4,900,000 [$75,500,000 in 2020 dollars] for the Canadian government to buy sufficient Eldorado stock to have effective control of the company. The military historian C.P. Stacey, noted in his *Arms, Men and Governments* that "the evidence all suggests that from 15 July 1942 LaBine was quite prepared to see to it that Eldorado carried out any instructions issued by the Canadian government." These instructions came from C.D. Howe.[21]

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[20] King Diary June 15, 1942.
[21] Bothwell, *Eldorado*, 126. Stacey, *Arms, Men and Governments*, p. 516.

Prime Minister Mackenzie King with President Roosevelt and British Prime Minister Winston Churchill at the Quebec Conference, August 18, 1943.

The development of the atom bomb was one of the main items of discussion when Prime Minister Mackenzie King hosted Winston Churchill and President Roosevelt in Quebec City for the first Quebec Conference in August of 1943, two weeks before the Allies invaded Italy on September 3.

King was closely consulted about the disposition of Eldorado's uranium and refinery in Port Hope and the production of heavy water in Trail, B.C.

On August 8, he met with Sir John Anderson, a member of Churchill's War Cabinet whom Churchill appointed to be in charge of the British atom bomb project at the end of 1941. Anderson had drafted an agreement for Churchill's and Roosevelt's signatures that—in Mackenzie King's words—"made Canada also a party to the development" of the atom bomb.

As King recorded in his diary, "Much of the uranium and heavy water are in our country. He had explained to the Americans that Britain cared nothing about the post-war profit making industries of the matter, but was concerned for war purposes. They knew that both Germany and Russia were working on the same thing. Germany had made certain developments [in heavy water production] in Norway, near Oslo, which the British had destroyed once; they had restored it, and the British had destroyed it again."

Anderson thought Russia "with its enormous scientific development along mechanical lines might perfect the discovery first of all which would be a terrific thing for that country, should such be the case. He, himself, said that while the war might be over before the development came, it would be a terrific factor in the post-war world as giving an absolute control of whatever country possessed the

secret. At the same time, if anyone of the competing nations came first, they would be sure of immediate victory, so powerful was the destruction this discovery was capable of effecting."[22]

On August 10, Churchill showed King "a draft of a communication which he wished me to read in regard to the project which is known as tube alloys. It suggested a Canadian member of the combined policy committee, and asked me if I would be agreeable to his suggesting to the President that Mr. Howe should become a member of the Committee. I agreed to this and to our seeing Sir John Anderson in the morning." Five days later, Churchill informed the Prime Minister about his talks with Roosevelt about the American and British atom bomb projects. "Said that the President had agreed to Howe being on the Committee. Asked me if I had seen the text of the agreement. I told him I had not. He said that he would see that I did see it. It contained references to not using this [the atom bomb] against each other, etc. It was important to get under way. He did not want the Russians particularly to get ahead with the process."[23]

John Anderson's draft accord for U.S.-U.K. co-operation in the development of the atom bomb "was approved with certain changes by the Prime Minister [Churchill] and the President [Roosevelt] and was signed as the Quebec Agreement on August 19, 1943. Shortly thereafter British teams joined the Americans in their work on the bomb at Los Alamos, New Mexico, and the Chalk River nuclear project was founded on a joint Canada-United Kingdom basis." The accord for U.S.-U.K. co-operation in the development of the atom bomb provided that "There shall be complete interchange of information and ideas on all sections of the project between members of the Combined Policy Committee and their immediate advisers."[24]

In his *Now It Can Be Told*, General Leslie Groves noted that under the Quebec Agreement a combined Policy Committee was set up—with C.D. Howe as the Canadian member—"which was to meet in Washington and to supervise the joint efforts of the United States, the United Kingdom and Canada."

> Its operations went smoothly at all times and there were never any serious differences of opinion among its members over the conduct of its business during the war…The decisions of the Combined Policy Committee did not at any time interfere with the United States Program. On the contrary, it supported our efforts to the fullest extent that could be desired…The Combined Policy Committee…appointed a subcommittee consisting of Dr. James Chadwick (U.K.), Mr. C.J. Mackenzie (Canada) and me to establish rules for the interchange of information between the group of scientists working on Canadian projects and their colleagues in the United States."[25]

Under the terms of the Quebec Agreement signed by Roosevelt and Churchill, "neither country would use them [nuclear weapons] against other countries without consent." Churchill thus was given a veto over the use of the atom bomb against Japan, and he readily gave that consent. Canada was not a signatory to the Agreement and so had no such veto power. King agreed with the American and British view that "They would wish to take the position that jointly they have supreme direction of the

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[22] King Diary August 8, 1943, p. 2.
[23] King Diary August 10 and 15, 1943.
[24] John W. Wheeler-Bennett. *John Anderson: Viscount Waverley*. New York: St. Martin's Press, 1962. pp. 295, 330.
[25] Groves. *Now It Can Be Told*, p. 136.

war. I have conceded them that position." At a meeting with Churchill and the Canadian War Committee, the PM repeated that "we fully understood the position as to Churchill and the President being the directing heads [of the war]."[26]

Churchill and Roosevelt had already determined that massive bombing of German and Japanese cities was the most effective strategy for defeating the Axis powers. On August 16, Churchill "showed me through the large magnifying glasses, the photographs of the effects of bombing on Hamburg and other cities, showing complete destruction. He told me that Britain intended to bomb Berlin in the same way that they had Hamburg. That they would wipe out the whole city. It would be kept up for days until that was accomplished." Three days later, King recorded in his diary that "Both Churchill and the President agreed that the bombing of Japanese cities would bring things quickly to a close. I remarked upon their style of houses, etc., what devastation bombing would bring."[27]

According to the *Manhattan District History*, "On 15 September 1943, the Canadian Government issued orders reserving to the Crown all radio-active substances henceforth produced in the Yukon Territory and the Northwest Territories of Canada. The Canadian Government also indicated its preference to control the ownership of such resources and to prosecute a comprehensive exploration program at its own expense. This plan envisioned a complete interchange of information on the program and the Canadian Government indicated its willingness to discuss with the United States Government ways and means of producing and disposing of the desired resources for the mutual benefit."[28]

The National Research Council and the Montreal and Chalk River Nuclear Laboratories

Because of Nazi bombing and a possible invasion of England, Prime Minister Mackenzie King agreed in August of 1942 that a British scientific team could establish an atomic facility in Montreal to develop a nuclear reactor. The Montreal Laboratory was first located at McGill University and received its first scientists at the end of 1942. From March 1943 on, the Laboratory was housed at the University of Montreal. In May of 1944, the British physicist John Cockcroft (winner of a Nobel Prize in Physics in 1951) became the director of the Montreal Laboratory and E.W.R. Steacie of the National Research Council of Canada his deputy.[29] The British placed an order for two, then twenty and then another hundred tons of uranium ore from Eldorado.

Wikipedia reminds us of the importance of the Montreal Laboratory by stating that it "was established by the National Research Council of Canada during World War II to undertake nuclear research in collaboration with the United Kingdom, and to absorb some of the scientists and work of the Tube Alloys nuclear project in Britain. It became part of the Manhattan Project, and designed and built some of the world's first nuclear reactors."[30]

C.J. Mackenzie, President of National Research Council, strongly recommended a proposal from the Combined Policy Committee's technical subcommittee to C.D. Howe on April 10, 1944 that called for

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[26] See "Quebec Agreement," https://en.wikipedia.org/wiki/Quebec_Agreement#Agreement King Diary July 19 and August 11, 1943.
[27] King Diary August 16 and 19, 1943.
[28] *Manhattan District History*, Book VII, Volume 2, p. 2.3
[29] Stacey, *Arms, Men and Governments*, 527.
[30] See "Montreal Laboratory," https://en.wikipedia.org/wiki/Montreal_Laboratory

the construction of a heterogeneous heavy water pilot nuclear reactor as a joint American-British-Canadian project. "Mackenzie estimated the total capital cost of the project in Canada at $8,000,000 [$119,650,000 in 2020 dollars] and the yearly operating cost as $1,500,000 [$22,435,000 in 2020 dollars]. Assuming that the U.S. Army would supply the raw material and that other expenses would be shared between the United Kingdom and Canada, he suggested the cost to Canada in 1944 and 1945 would be in the order of $4,500,000 [$67,300,000 in 2020 dollars]."

Mackenzie advised Howe that "Since 1941 active research in the United Kingdom, the United States and Canada has been carried out and it is now certain a bomb can and will be made that will be, if not a million times, at least hundreds of times more powerful than anything yet known." He explained that "Our ownership of uranium ores, our early interest in the production of heavy water at Trail and the presence of a highly expert group of workers in Canada gives us a special interest and facility for this work. In my opinion Canada has a unique opportunity to become intimately associated in a project which is not only of the greatest immediate military importance, but which may revolutionize the future world in the same degree as did the invention of the steam engine and the discovery of electricity. It is an opportunity Canada as a nation cannot afford to turn down."

Mackenzie King's Cabinet War Committee considered C.J. Mackenzie's and Howe's proposal on April 12, 1944 and "approved an expenditure up to $4,000,000 capital [$59,825,000 in 2020 dollars] and $750,000 [$11,217,000 in 2020 dollars] operating expenses."[31]

In his diary, the Prime Minister recorded that at the War Committee, he "decided to take a step in the way of further developing in Canada the secret process which has such appalling possibilities of enormous destruction. A committee of which England, the U.S. and Canada are represented are anxious to have this development continued in our country because of the near proximity and of the resources we have. If perfected, as believed, the process will not only have terrific destructive powers but may be used for many purposes for which electric power is used. Howe mentioned that a fountain pen filled with the desired substance would propel a steamship across the Atlantic." King added, "It is a solemn business dealing with matters of this kind. Whatever will end this war before the enemy becomes possessed of like inventions is necessary in the interests of mankind."[32]

George C. Laurence, one of the Canadian scientists who worked at the Montreal nuclear energy laboratory and at the Chalk River Nuclear Laboratories, recorded that "a remarkable amount of good research was done in the Montreal Laboratory…It provided scientific data that were needed for the design of a fission reactor and of chemical plants for the extraction of plutonium and uranium-233 produced in the reactor." Its small experimental nuclear reactor, the Zero Energy Experimental Pile or ZEEP, was built at Chalk River and achieved nuclear fission on September 5, 1945, the first operational nuclear reactor built outside the United States.[33] Japan had formally surrendered three days before.

The *Manhattan District History* reports that the materials furnished by the Manhattan Project to the Montreal Laboratory "have included over 19 tons of heavy water and 5 tons of pure uranium metal, on loan, and also samples of pure thorium and uranium, dozens of irradiated samples of uranium and

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[31] Stacey, *Arms, Men and Governments*, 526, 527.
[32] King Diary April 12, 1944.
[33] George C. Laurence, "Early Years of Nuclear Energy Research in Canada," 7. Institute of Electrical and Electronics Engineers https://www.ieee.ca/millennium/nuclear_power/NuclEnerg.PDF

thorium metals and salts for development of extraction processes, and samples of fissionable material."

> Instruments and drawing, and hundreds of reports and other items of pertinent information, as well as the advisory services of experienced United States scientists, have also been furnished. The United States has also sold outright to Canada 10 tons of machined uranium rods for use in the pilot plant, of pure metal not obtainable outside the United States. The irradiated samples (or slugs) of uranium and thorium carbonate which were furnished by the United States for the Canadian project came from the pile [nuclear reactor] of the Clinton Laboratories in Oak Ridge, Tennessee. Some calibrations and irradiations of samples prepared in Canada have been carried out at the Argonne Laboratory [operated by the University of Chicago]. The heavy water which was furnished was the product of the P-9 project [at Consolidated Mining and Smelting Company in Trail, B.C.]…The pile [ZEEP nuclear reactor] itself consists principally of an aluminum tank…manufactured to close specifications by the Andale Corporation of Philadelphia.[34]

According to George Laurence, "The long-awaited decision to proceed at once with the design construction of a heavy water-moderated nuclear reactor in Canada was made at a meeting of the Combined Policy Committee in Washington on April 13, 1944 which was attended by both the Hon. C.D. Howe and Dr. Mackenzie [of the National Research Council]. General Groves was present and we are told that he assisted greatly in reaching agreement. It was agreed that there would be full exchange of information relevant to design of the reactor and the extraction of the plutonium it produced." Funding for the nuclear reactor was provided by the U.K. and Canada. "General Groves approved an isolated site previously selected by the Canadians, near Chalk River, Ontario."[35]

Like the ZEEP, the much more powerful NRX (National Research Experimental) heavy water moderated, light water cooled nuclear research reactor was also built at Chalk River, which opened in 1944. According to the *Manhattan District History*, the original set completion date was February 1945. But because of the complexity of the design and various delays the NRX achieved nuclear fission only on July 22, 1947.

The *History* gives the total construction cost of the NRX reactor at Chalk River, not including the cost of the heavy water, as $21,232,000 [$331,715,235 Canadian in 2020 dollars]. It listed the benefits expected to accrue to the United States as "Procurement of fissile material. For example, under a tentative agreement, the United States will, if desired, receive a substantial portion of the production of uranium-233, one of the two major products expected to be obtained from the pile." There was also substantial value in obtaining "General scientific and engineering information."

> Much of the operational and experimental information which will be forthcoming from the Canadian pile may be of direct interest and utility to the United States project. Such information may involve, for example: production of uranium-233 in a thorium blanket (breeder and converter piles); chemical extraction of uranium-233; effects of high level irradiation on materials (heavy water and many other substances); biological data to

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[34] *Manhattan District History*, Book I, Volume 4, pp. 9.5, 9.11.
[35] Laurence, "Early Years of Nuclear Energy Research in Canada," 13. Jones, *Manhattan: The Army and the Atomic Bomb*, 246.

supplement the United States information; supplementary information on the production and use of tracers; and results of pure research in many phases of the atomic energy sciences.

Comparative efficiency. Information will be available to the United States as to the efficiency of the water-cooled, heavy-water-moderated type of reactor compared with other types, as to: construction costs, production of fissile materials, versatility (convertibility from research to production uses), fluxes, plant life, etc. This was one of the major considerations which influenced the original decision to build the Canadian pile.[36]

In 2002, Duane Bratt summarized in the *Bulletin of the Atomic Scientists* that "Canadian uranium exports were initially used to fuel the nuclear weapons programs of both Britain and the United States. Chalk River, which contained the NRX and the Nuclear Research Universal reactors, was designed both to advance Canada's civilian nuclear program and to assist the U.S. military program by producing plutonium for American bombs."[37]

These were the Chalk River site and the ZEEP and NRX nuclear reactors referred to in the August 7, 1945 *Edmonton Journal* article, "New Bomb in Wrong Hands Could Tear World to Pieces," that cited C.D. Howe. "In Ottawa, Munitions Minister Howe said Canada, in co-operation with Britain and the United States, has undertaken to establish a pilot plant near Petawawa military camp to investigate 'one of the methods of making materials required for the atomic bomb.' Work on the mighty new weapon was carried out the morning of July 16 in the New Mexico desert [the first plutonium atom bomb explosion]…Scientists agreed that a new epoch in both war and peace is probably at hand."[38]

Two days after the publication of the *Edmonton Journal* article, Nagasaki was devastated by an atom bomb created from Canadian and Belgian uranium refined at Port Hope and fed to nuclear reactors that produced plutonium. 70,000 people died from blast injuries and radiation illness from this second atomic bombing.

But Montreal and Chalk River were not the only branch plants of the Manhattan Project in Canada.

Producing Heavy Water at the Consolidated Mining and Smelting Company in Trail, B.C.

The Consolidated Mining and Smelting Company in Trail, B.C. was founded in 1906 and changed its name to Cominco in 1966. It received a letter, marked "Secret," in February of 1941 from the National Research Council of Canada, acting for the British Government, inquiring about the company's ability to produce heavy water. The same year, the American Office of Scientific Research and Development assigned the British physicist, Hugh Taylor, an expert on heavy water working at Princeton University, to investigate whether Consolidated Mining could be contracted to manufacture heavy water. According to C.D. Andrews, "the British and American Governments were actually interested in buying 2000 pounds of heavy water a *month*." The engineering and scientific community at the company "understood that heavy water was a component in atomic research. Also, names like Taylor and [Harold] Urey were both well known and quickly identified with atomic matters. There was even speculation among a few of the brighter scientists that a bomb was possible through atomic fission."

[36] *Manhattan District History*, Book I, Volume 4, pp. 9.25, 9.26, 9.27-9.28.
[37] Duane Bratt, "Canada's Nuclear Schizophrenia," *Bulletin of the Atomic Scientists*, 58:2 (March/April 2002). p. 49. https://journals.sagepub.com/doi/pdf/10.2968/058002014
[38] C.R. Blackburn, "New Bomb in Wrong Hands Could Tear World to Pieces," *Edmonton Journal*, August 7, 1945, p. 2.

The president and general manager of Consolidated Mining, S.G. Blaylock, contacted C.D. Howe, the Minister of Munitions and Supply, before signing a contract with the secretive American government. (The company was told to refer to heavy water by its code name "Product No. 9" and the project as "Project No. 9.") Howe wrote Blaylock on July 31, 1942, "I am familiar with the whole project to which you refer…go on with whatever representatives of the United States Government may wish you to do in this connection." Consolidated Mining signed a contract with the Americans to build a plant to produce heavy water in November of 1942. "The plant would be built at American expense, the actual cost being anticipated at close to two million dollars [approximately $42,750,000 Canadian in 2020 dollars]. Throughout the war, the company "would sell to the American Government, at cost, the heavy water produced."[39]

The *Manhattan District History* extensively describes the Consolidated Mining heavy water production facility in Trail, B.C. "The Purpose of the so-called P-9 Project was to provide 'heavy water,' or deuterium oxide, for the manufacture of plutonium and for other war uses which might develop" such as:

(1) As an essential material to be used in developing a 'heavy water' method of manufacturing plutonium. This was an alternate process, or insurance, in the event that the 'graphite' full-scale production method (making use of graphite instead of heavy water) encountered unpredictable and delaying obstacles which could not be overcome in time for the end product to be of use during the war.

(2) As a material whose scientific possibilities, which the enemy might uncover, had yet to be fully explored. It was known that the Germans were making serious efforts to produce heavy water…Regardless of what final plans for continuing peace may be developed, it is certain that peace for this country can be made secure only if the Government maintains a leading position in the development of potential new war materials and war methods.[40]

[39] C.D. Andrews, "Cominco and the Manhattan Project," *BC Studies*, No. 11, (Fall 1971), 51-53, 54, 58, 59, 60. file:///C:/Users/Owner/Downloads/710-Article%20Text-3049-1-10-20100430%20(1).pdf
[40] *Manhattan District History*, Book III, The P-9 Project, S1, 1.1, 1.3.

The general exterior of the primary tower of the Consolidated Mining and Smelting Company heavy water production plant in Trail, B.C.

Similarly to the global search for uranium ore, the Office of Scientific Research and Development obtained statistics in 1941 "of all existing hydrogen producing plants on this continent, for the purpose of determining which was best suited for use in conjunction with one of the proposed processes for manufacture of heavy water. It was found that the plant of the Consolidated Mining & Smelting Company of Canada Limited, located at Trail, B.C., was the only one in either the United States or Canada in which the hydrogen was manufactured by the electrolytic method in the required quantities. This automatically determined the location of one of the heavy-water producing plants, as described hereinafter, and precluded the possibility of rapid development of production by the same process anywhere else."

The Trail plant, normally producing ammonia, was located seven miles north of the Washington State border and about 102 miles north of Spokane, Washington. It had highway connections as well as existing track facilities by the Canadian Pacific Railway direct to the project site. For the contracted "hydrogen gas" process of manufacturing heavy water, the company could use natural water from the Columbia River and pure hydrogen already generated electrolytically for the manufacture of ammonia at the plant. The principal advantages of the company's Chemical and Fertilizer Division at Warfield, B.C., about 630 feet above the Columbia River two miles west of Trail, were "the existing plant facilities, including particularly the hydrogen gas which was available; and the benefit of the experience of the personnel at the plant, in connection with design, construction and operation. The only disadvantage was location outside the United States, and the advantages far outweighed this disadvantage."[41]

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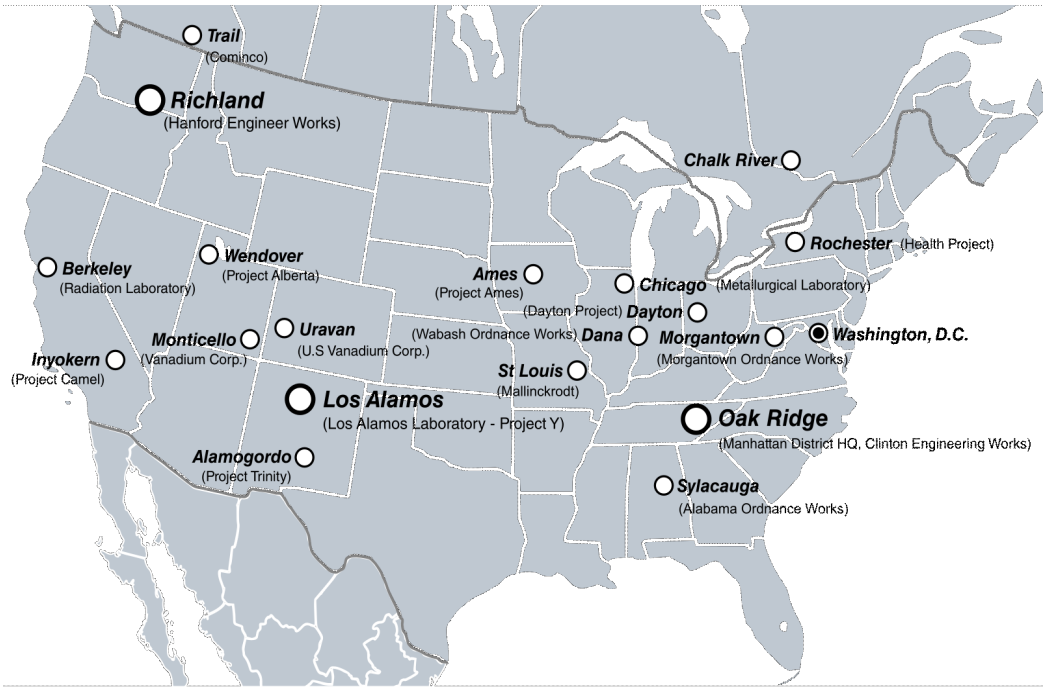
[41] *Manhattan District History*, Book III, The P-9 Project, 2.5, 3.1, 2.7, 2.8, S4.

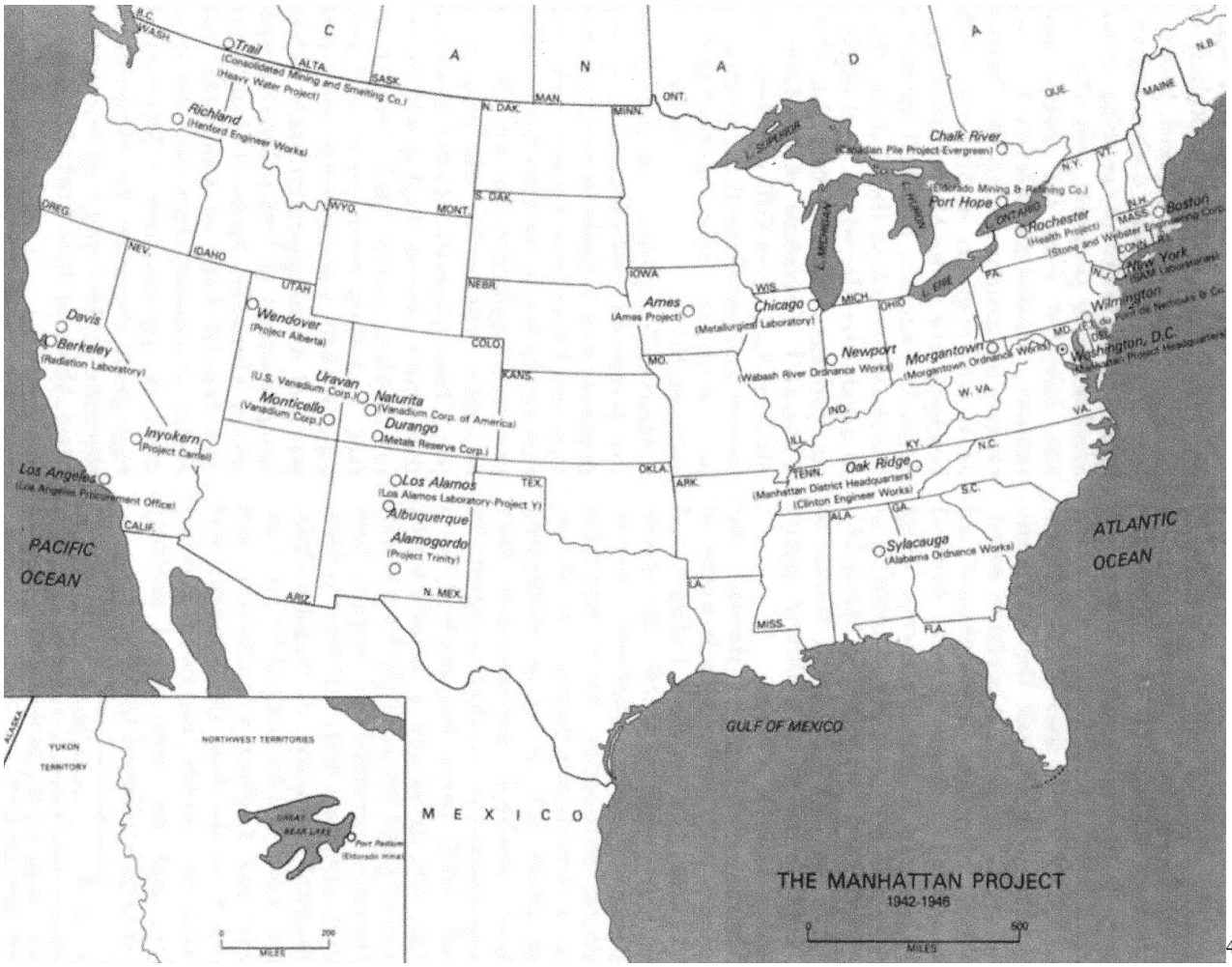
Construction started on September 1, 1942 and was completed June 30, 1943. Consolidated Mining leased six parcels of land to the U.S. Government. A seventh parcel for a steam plant was leased from the Allied War Supplies Corporation, an agency of the Canadian government. Costs for design, engineering, construction and equipment totalled $2,604,622 [$52,454,327 Canadian in 2020 dollars]. The history of operation of the plant from its start up in June 1943 was "for the most part a continuous struggle to get into the full production of 1000 lbs per month, originally proposed, as quickly as possible. This goal was finally reached in December 1944 instead of August, the month first estimated…Since December 1944 the production at the Trail Plant has averaged more than 1,100 pounds per month." The total cumulative production costs for the plant to December 31, 1946 were $1,418,120 [$25,337,117 Canadian in 2020 dollars].[42]

Like Eldorado's Port Hope refinery and the National Research Council's nuclear reactors at Chalk River, the Consolidated Mining and Smelting Company's heavy water plant in Trail, B.C. was thus fully integrated in the Manhattan Project's North American atom bomb production system. "Heavy water from Trail was used for Chicago Pile 3, the first reactor using heavy water and natural uranium, which went critical on 15 May 1944."[43]



The U.S. Army Center of Military History provided the following North American map of the Manhattan Project showing Canadian installation sites in Chalk River, Port Hope, Trail, B.C. and on Great Bear Lake in the Northwest Territories:

[42] *Manhattan District History*, Book III, The P-9 Project, S9, 3.3, S13, S15.
[43] See "Manhattan Project," https://en.wikipedia.org/wiki/Manhattan_Project fn.119.



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The same day on September 5, 1945 that the ZEEP reactor at Chalk River achieved nuclear fission, Igor Gouzenko, the cipher clerk at the Russian Embassy in Ottawa, defected and revealed Russian spy rings seeking atomic bomb secrets in Canada, Great Britain and the U.S. Prime Minister Mackenzie King traveled to Washington on September 29 to inform President Truman of the newly-discovered spy ring. King arrived in London on October 7 and met with newly-elected Prime Minister Attlee to confer about the Russian spy ring in Canada and the U.K. King and Attlee arrived in Washington on November 10 to discuss the Russian spy ring and the control over atomic energy and the atom bomb with President Truman. Truman suggested that Vannevar Bush, Sir John Anderson and the Canadian ambassador to Washington, Lester Pearson, draft an agreement regarding the control over atomic energy and the atom bomb.

On November 15, 1945, President Truman announced at a press conference "that the three Powers had agreed on the need for international action, under the auspices of the United Nations, for the provision of controls over atomic energy to ensure its use for peaceful purposes only; to outlaw atomic weapons and other major weapons capable of mass destruction; and to provide for effective safeguards through

[44] Jones, *Manhattan: The Army and the Atomic Bomb*, p. 63.

inspection. At the same time the President and the two Prime Ministers had approved the text of a memorandum which ran as follows: 1. We agree that there should be full and effective co-operation in the field of atomic energy between the United States, the United Kingdom and Canada. 2. We agree that the Combined Policy Committee and the Combined Development Trust should be continued in a suitable form. 3. We request the Combined Policy Committee to consider and recommend to us appropriate arrangements for this purpose."[45]

But this agreement between President Truman, Prime Minister Clement Attlee and Prime Minister Mackenzie King did not reach fruition. Alarmed by Igor Gouzenko's spy revelations and the discovery that the Russians had penetrated the Manhattan Project with scientists betraying atom bomb secrets to Russia, the U.S. Congress passed the Atomic Energy Act of 1946 (the McMahon Act), signed by President Truman on August 1, 1946. It established the civilian United States Atomic Energy Commission to control nuclear weapon development and nuclear power management and prohibited the sharing of nuclear information with other countries.[46]

Except for the continuing sale of Canadian uranium to the United States, Canada's collaboration with the U.S. and the United Kingdom in the development of the first atom bombs came to an end and our collective memory of that direct participation in the Manhattan Project began to fade. But it has not been forgotten.

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[45] Wheeler-Bennett, *John Anderson: Viscount Waverley*, 335. The Combined Development Trust supervised the acquisition of raw materials, particularly uranium and thorium ores, outside American and British territory. See "Combined Development Trust," Atomic Heritage Foundation https://www.atomicheritage.org/history/combined-development-trust

[46] See "Atomic Energy Act of 1946," https://en.wikipedia.org/wiki/Atomic_Energy_Act_of_1946