December 19, 2019

Colonel William M. Conde
New England District
U. S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742

Subject: File Number NAE-2017-01342 Presidential Permit (PP-438) for CMP's New England Clean Energy Corridor (NECEC)

Dear Colonel Conde:

The surface layer of estuarine and coastal sea waters is where the power that fuels regional upwelling currents is generated by fresh water run-off.

In a 1964 Study, (Reference 9 of the attached Report) Dr. Hans Neu, a renowned Canadian oceanographer, found that the amount of sea water transported by these upwelling currents is controlled by the amount of fresh water being discharged into the estuary and gulf waters and made the following calculations:

> *". . . a reduction of 10,000 m^3/s in the spring discharge of 1964 decreased the inflow of sea water to the Estuary by about 1.5 x 10^5 m^3/s, or 35 percent of its natural volume, an amount equivalent to 17 times the flow of the St. Lawrence at Montreal. On the other hand, during January and February 1964, the river discharge was augmented through regulation by about 2500 m^3/s. This must have increased the flow of salt water into the Estuary by 0.4 x 10^5 m^3/s or 31 percent above the natural condition."*

In the above example, there is a 1 to 15 correlation between volume of freshwater inflow and upwelling currents, e.g., a reduction of 10,000 m^3/sec in spring discharge decreased the inflow of sea water to the estuary by 150,000 m^3/sec and an increase of 2500 m^3/sec in the river discharge increased the inflow of sea water to 37,500 m^3/sec, which Dr. Neu rounded up to 40,000. (Annual discharge of the Mississippi River is about 17,000 m^3/sec)

These stupendous man-made alterations of the natural pattern of river run-off by Hydro Quebec have produced colossal changes in the inflow of sea waters, catastrophic impacts on the biological balance of the whole ecosystem and heat pollution warming downstream estuaries and seas.

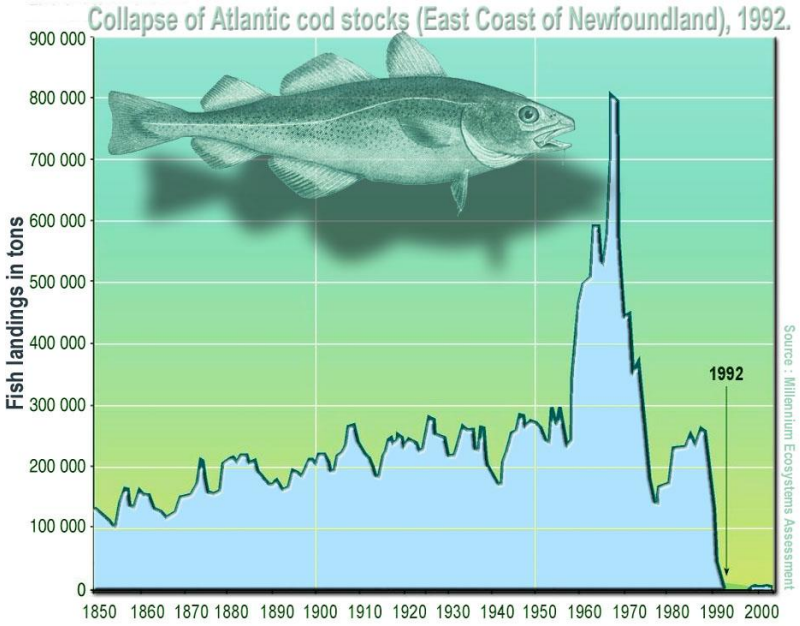
The alterations in spring and winter discharges from all the mega reservoir dams built by Hydro Quebec since 1964 is much greater than the above numbers For example, the increased winter discharge on the LaGrande River is 123,000 cubic feet/sec, compared to the 1964 increase of 2500 m^3/s (88,218 cubic feet/s) on the Saint Lawrence River.

The capture and storage of the spring run-off behind reservoir dams has starved the fisheries by eradicating prodigious and nutrient enriched upwelling currents.

The extreme depletion of the cod fisheries (as Dr. Hans Neu predicted) took place shortly after the LaGrande power Scheme was implemented.

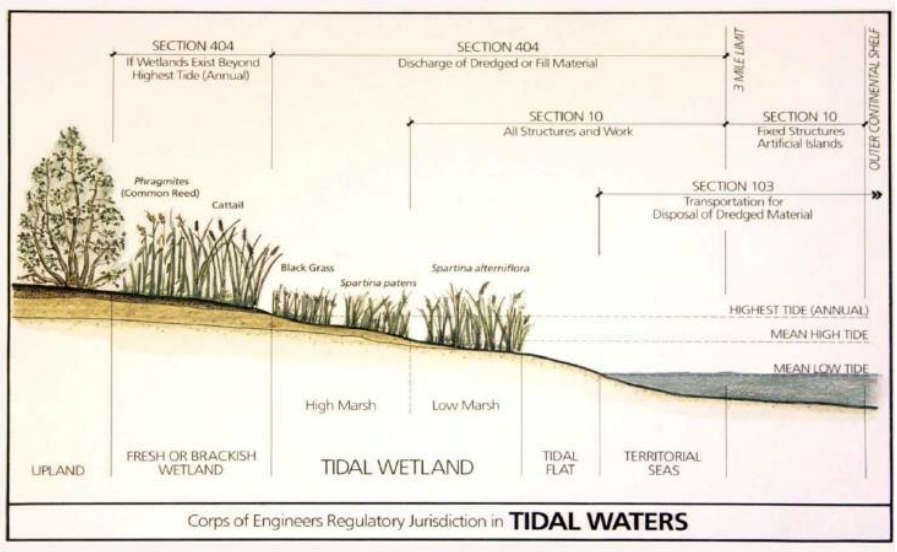
STARVATION OF ATLANTIC NORTHWEST COD FISHERY

There have been two collapses of the Atlantic northwest cod fishery in the past fifty years, and they are illustrated in the graph below. Both collapses have been analyzed as one and the cause blamed on overfishing and global warming. There is no doubt that over fishing caused the spike in cod landings during the 1960's and the subsequent decline in the 1970's. However, the second more lasting decline occurred in the 1989-91 period, shortly after many mega reservoir hydro electric dams came online in the preceding decade. (see Appendix 1 of the attached report).



Moratoriums on cod fishing will never restore the cod population. There is only one solution - restoration of the natural spring flows to fuel the upwelling currents.

This is why I am writing to ask the USACE, as part of your review of CMP's application for PP-438 to expand the jurisdiction of your Environmental Assessment (EA) to include the surface layer of the Gulf of Maine between mean low tide and high tide shoreward to the mean high water mark and seaward over the entire surface to the outer continental shelf, as shown in the diagram below.



"The surface layer is where river water meets the ocean, a circulation is induced in the latter which the oceanographer calls a haline circulation and the engineer a density current. The characteristics of this circulation are governed by five dynamic influences:

a. the density difference between the river water and ocean water;
b. the head needed to produce a net seaward flow of fresh water;
c. the tide with its currents;
d. the wind-induced currents;
e. the Coriolis force, friction and the effects of bottom topography.

The role of these forces and their primary effects have been studied widely in the field and laboratory. For the purpose of this discussion, only the factors (a) and (b) are described. They form the basis for the large-scale internal circulation by which salt water is transported into the Gulf and Estuary. The other factors also play an important role in the circulation of the system, especially the wind and the tide. They greatly affect the intensity of mixing in a particular section of the system; however, the haline

circulation and its transport as a whole would prevail in their absence."(Emphasis by me. Reference 9 of the attached Report)

The major rivers of Canada impact salinity concentrations as far away as the surface layer of the Scotian Shelf and Georges Banks as documented by Dr. Neu in reference 9:

> *"The effect of such changes on the salinity of the surface layer is shown on Fig. 9. On this graph, the approximate monthly river discharges and the respective surface salinities are given for two locations, one on the south side of Pointe des Monts and the other on the Nova Scotian side of Cabot Strait. Also provided are the variations in the extreme seasonal salinities with changes in the river discharge. It is shown that a fresh-water regulation of 10,000 m³/s causes a change to the salinity of the surface layer at these two locations by 3.5 and 1.3% respectively. Changes can even be noted as far south as Halifax."*

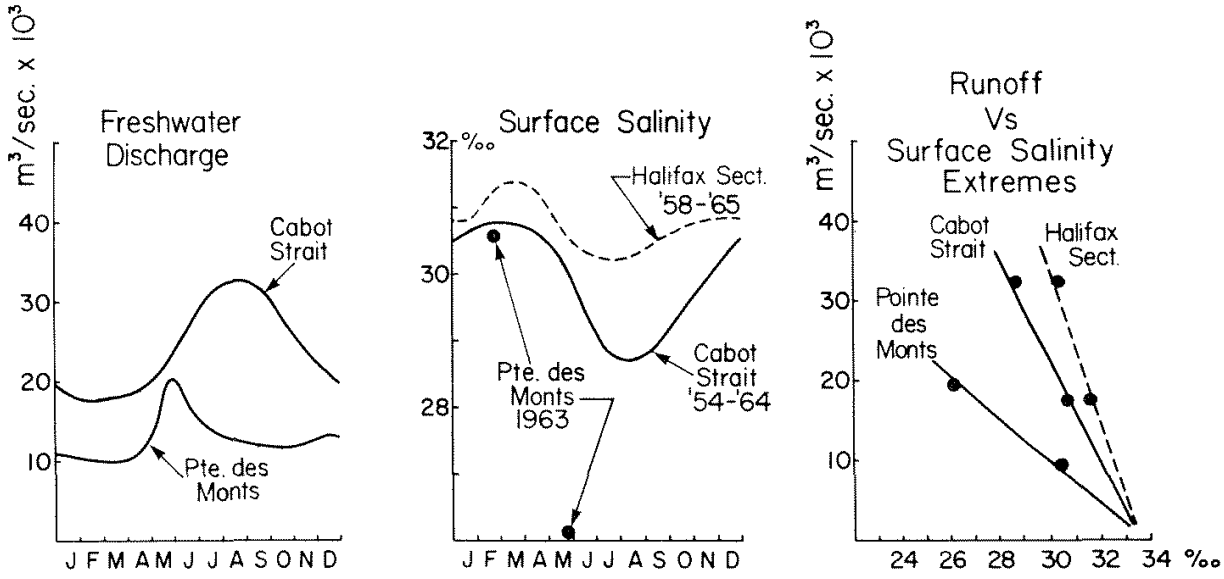


Fig. 9 – Effect of runoff on surface salinities.

SUMMARY

Regulation of river discharge in the St. Lawrence system for power production since the turn of the century has caused appreciable changes in the dynamics and physics of the water of the Estuary, Gulf and adjacent Scotian Shelf as follows:

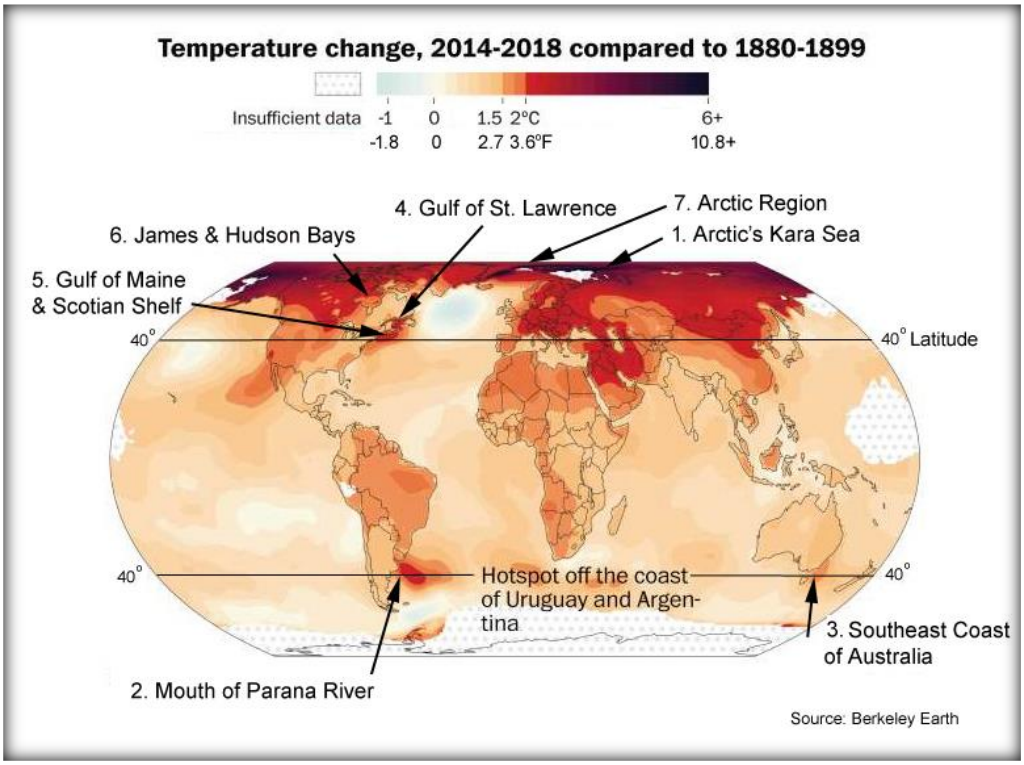
1. *Changes in the seasonal strength of the haline circulation. The reduction in the quantity of sea water entering the system could exceed 150,000 m³/s in the Estuary*

in spring and subsequently up to 2 or 3 times more in the Gulf at Cabot Strait in summer.

2. *Changes in the salinity of the water of the surface layer and changes in the seasonal heat budget. From a comparison of all the data available along the southern side of the system the surface salinity has, since the turn of the century, increased in spring at Pointe des Monts by about 3.5% and in summer at Cabot Strait and near Halifax by 1.3% and 0.8% respectively. The temperature has probably increased in winter as well as in summer."* (Emphasis by me)

Dr. Neu wrote the following in the conclusion in Reference 11 of the attached Report:

> *"As seasonal flow of fresh water is modified for power production, the strength of this circulation is altered and with it upwelling, mixing, flushing of the system and near-coast water masses, and the composition of the water with respect to salinity and temperature. These changes must result in climatic modifications which influence the heat budget and therefore the ice conditions.*
>
> *A reduction in upwelling during spring and summer has decreased the nutrient supply and this, in addition to the change in the composition of the water in the upper layer, must have affected the reproduction of many species. It can, therefore, be concluded that seasonal discharge regulation, as implemented in the St. Lawrence for powerproduction since the turn of the century, has imposed large-scale modifications upon the ecosystem of the Estuary, Gulf and coastal zone. This applies to any other system in which similar conditions prevail."* (Emphasis by me)
>
> I am also asking the Corps to perform an Environmental Impact Statement (EIS) as part of your review, which evaluates how heat pollution from Hydro Quebec's mega reservoir hydroelectric dams has warmed the surface layer of the hot spots 4, 5 and 6 on the map on the next page.



The salinity concentrations of the surface layer of all of the downstream waters that are described in the following quotes are impacted by Quebec's Manicouagan River's natural spring freshet. Dr. Hans Neu wrote, in Reference 12 of the attached Report, that the bulk of the natural spring freshet of the Manicouagan River as measured by salinity:

> *"passes quickly through the St Lawrence Estuary in May, then slows over the Magdalen Shoal in the southwestern Gulf in summer and arrives at Cabot Strait by the beginning of August. From here it can be traced to Halifax and even to Georges Bank at the entrance to the Gulf of Maine in autumn."*

and

> *" . . . that both winter and summer temperatures of the surface layer will increase, in winter due to an increase in upwelling of deeper warmer water, and in summer due to slower surface currents which will allow the surface layer to absorb more heat during its passage through the system. It can be assumed*

therefore that fresh water regulation modifies the climate of the coastal region to be more continental-like in the summer and more maritime-like in the winter."

In this same Report Dr. Neu wrote the following about Hydro Quebec's Churchill Falls power scheme and LaGrande Power Scheme on James Bay:

> *"Beyond any doubt, similar reductions in the shoreward transport of sea water and nutrients have occurred at other places during the summer, such as in Hamilton Inlet below the Churchill Falls power development in Labrador, and will now occur in James Bay after the first power scheme there is in operation."*

I am also asking the Corps to analyze in the EA, and hopefully an EIS, how warming of the Gulf of Maine has altered natural seasonal changes in temperature and thereby disrupted life cycles of aquatic creatures in the surface layer. The breeding, hatching and the metamorphosing of larvae in tidal waters and their tributaries to the head of the tide often depend on thermal cues. The Gulf of Maine is Essential Fish Habitat (EFH) for the federally listed endangered Maine Atlantic Salmon and North Atlantic right whale. My April 2, 2019 letter to USACE is also part of the record for PP-438 and contains more observations and evidence on how Hydro Quebec's mega hydroelectric dams are not only starving the Maine Atlantic salmon, the North Atlantic right whale, cod and other fisheries, but also warming the waters in the Gulf of Maine.

Hydro Quebec's mega reservoir hydroelectric dams are facilitating Russia's national security and economic objectives of a warmer and ice-free Arctic Ocean. Both countries' ideology as it pertains to mega reservoir hydro electric dams is detailed below, and is in direct conflict with the Corps mission statement.

THE IDEOLOGY BEHIND HYDRO-QUEBEC'S MEGA RESERVOIR HYDROELECTRIC DAMS

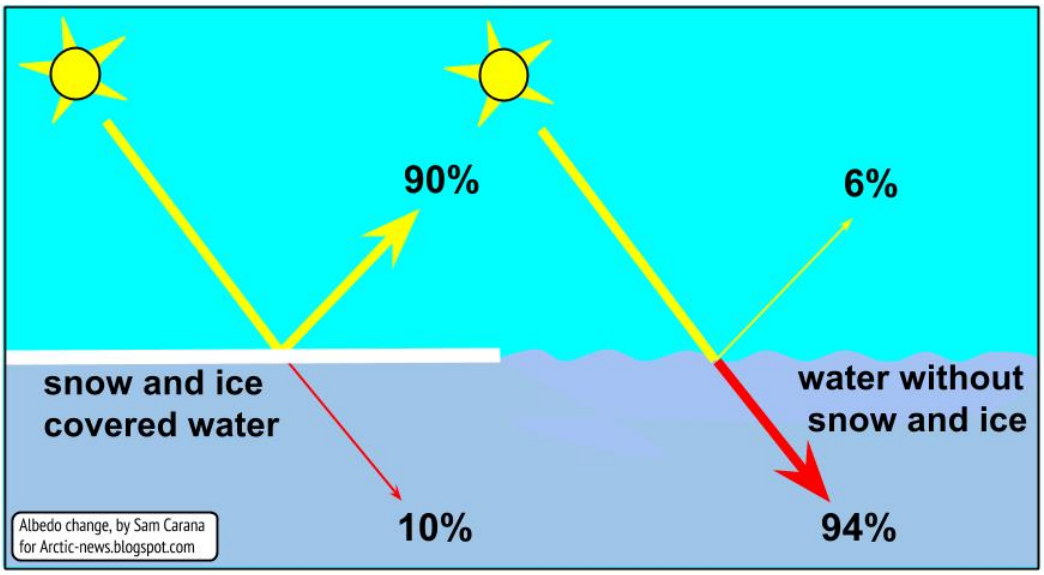
"*Quebec is a vast hydroelectric plant in the bud . . . and every day millions of potential kilowatt hours flow downstream and out to sea. What a waste!"* Robert Bourassa, Power from the North, 1983, (McCully 1996)

Robert Bourassa Dam on Lower LaGrande River

The Robert Bourassa Dam went online in 1979 and is one of eight mega dams in the LaGrande Power Scheme, which *"has increased the winter flow on the LaGrande River by eight times (from 18,000 to 141,000 cubic feet per second, and in order to store water for the following winter they have eradicated, ie, captured and stored, the spring flow (flow reduced from 176,000 to 53,000 cubic feet per second").* LaGrande River by Harper

The LaGrande Power Scheme has increased the winter flow by 123,000 cubic feet per second and reduced the spring flow by the same amount. The average flow of Niagara Falls is approximately 85,000 cubic feet per second. This is equivalent to eliminating, during the spring months one and a half Niagara Falls flowing into the shallow waters of James Bay and then increasing the flow by one and a half Niagara Falls in the winter months.

These huge and warm discharges in the winter months have decreased the duration and extent of sea ice and increased the surface area of ice free water during spring and summer. In its liquid state, water absorbs more than 90% of the heat from solar radiation and snow and ice-covered water reflects 90% of the heat.



For over 40 years the Robert Bourassa Dam has not only fueled the generation of hydroelectricity, but also heat pollution in James and Hudson Bay *"as the duration* and extent of sea ice *cover decreased during the 1980's and 1990's."* Britannica.com

This decrease has accelerated in the past 20 years as *"ice loss fuels Arctic amplification - the force that's speeding up northern warming. As the ocean's protective lid thaws, more sunlight enters the water, causing more warming, leading to yet more ice loss in a feedback spiral."* J. Stroeve by C. Katz National Geographic 2019

It is my hypothesis that heat pollution from these mega dams is the driving force behind the decrease in the extent and duration of sea ice in the sub-Arctic and Arctic regions.

The world can stop burning fossil fuels tomorrow, but it will not stop the continuing heat pollution from these dams and the warming of these waters and the climate.

THE IDEALOGY BEHIND RUSSIA'S MEGA RESERVOIR HYDROELECTRIC DAMS

Russia considers heat pollution from its mega reservoir hydroelectric dams to be a great by-product and not a pollutant, because it is warming the Arctic Ocean and

climate, accelerating the melting of the ice and leading to an ice-free Arctic Ocean. These have been long-term goals of Russia for over 100 years as documented by the following quotes:

> *" . . . until we know a law of nature, it, existing and acting independently of and outside our mind, makes us slaves of "blind necessity". But once we come to know this law, which acts (As Marx repeated a thousand times) independently of our will and our mind, we become the masters of nature."*
>
> V. I. Lenin 1908

> *"Water which is allowed to enter the sea is wasted."*
>
> Joseph Stalin 1929

P. Borisov wrote the following in 1973, in "Can Man Change the Climate."

> *"That is why the task which the Communist Party of the Soviet Union has set Soviet science -reducing to the minimum the dependence of the economy on natural elements and elaborating methods of influencing the climatic conditions - is of such great economic importance."*

and

> *"The north of the Atlantic Basin may be compared to a bathtub into which cold water is poured from two taps (the Labrador and East Greenland currents) and warm water (the Gulf Stream) through one. By regulating the taps we can change the thermal balance of the Atlantic and with it the climate of the surrounding continents. The recognition of the important role of the ocean currents in forming the climate has determined regional improvements of the climatic regime since the end of the last century by changing the direction of the warm and cold currents. At the same time extensive hydrotechnical measures have been devised to regulate and transfer the river run-off. We shall deal with the main hydrotechnical projects of meliorating the natural conditions."*

This cold water tap consists of the Labrador Current, which is being warmed by Hydro Quebec's reservoir hydroelectric dams, which are listed in Appendix 1 of my attached Report and the East Greenland Current, which is being warmed by Russia's mega reservoir hydroelectric dams listed on the next page.

Large and Major Reservoir Hydroelectric Generating Stations
Discharging into the Arctic Coastal Seas

Name	Capacity in Mega Watts (MW)	Commissioned	Discharges Watershed	Into
Irkutsk	662	1956	Angara River	Kara Sea
Bratsk	4,515	1964	Angara River	Kara Sea
Bukhtarma	675	1960-66	Irtysh River	Kara Sea
Vilyuy	650	1967	Vilyuy River	Laptev Sea
Ust-llimsk	3,840	1977	Angara River	Kara Sea
Krasnoyarsk	6,000	1977	Yenisei River	Kara Sea
Sayano Shushenskaya	6,400	1990	Yenisei River	Kara Sea
Kolyma	900	1994	Kolyma River	East Siberian Sea
Boguchany	2,997	2012	Angara River	Kara Sea
	26,639			

Note: Angara River is tributary to Yenisei River

The two largest reservoir dams were built by Russia in 1977 and 1990 on the Yenisei River, which flows into the Kara Sea. Since 1998, the average temperature in this area has increased by as much as 9°F, and the duration and extent of sea ice cover has decreased significantly as documented by Britannica in my attached Report.

The Arctic sea ice decline is happening much faster than models had predicted because, in my opinion, the models have only been focused on increased carbon emissions fueling climate change and warming of the Arctic and not on the proliferation of mega reservoir dams since the 1950's on major rivers north of latitude 40°.

However, as early as 1964, Dr. Hans Neu predicted that the installation of the Manicouagan power scheme in the Gulf of St. Lawrence watershed would most likely cause *"large-scale heat pollution with ecological implications."* Reference 9 of my Report.

He predicted the warming of the Gulf of St. Lawrence, Gulf of Maine, Scotian Shelf, James and Hudson Bays and the Arctic:

"There is no doubt in the mind of the author that if Canada continues this development and the USSR follows its lead, the hydrological balance of our globe would be threatened . . . . " *Reference* 12 of my Report. The passage of time has proven his prediction to be true.

In Appendix 1 is a more detailed analysis on how Manicouagan Power Scheme is warming the Gulf of St. Lawrence, Scotian Shelf and Gulf of Maine. There are examples on page 7 of how Hydro-Quebec has tried to silence Dr. Neu and other scientists for over 50 years.

The Natural Resource Council of Maine, State Senator Brownie Carson, I and many others are asking the USACE to perform a comprehensive EIS before taking any action on approving CMP's application for a Presidential Permit on its proposed NECEC.

An EIS needs to be performed, in order to determine if Hydro Quebec's mega reservoir power stations are a major, if not the driving, force warming hot spot 4 (Gulf of St. Lawrence), 5 (Gulf of Maine) and 6 (James and Hudson Bays) on the map on page 5 and also contributing to the warming of the climate.

I have attached, for easy reference, a copy of my Report "Heat Pollution from Reservoir Hydroelectric Dams Is Warming Our Oceans and Climate," Condensed Version*, December* 4, 2019 for easy reference. This Report and my December 5, 2019 letter to Mr. Jay Clement were e-mailed to Maine Project Office on December 9, 2019 and have been accepted as part of the public hearing record. Both documents provide additional observations and evidence to support the above request for the USACE to expand its jurisdiction beyond the physical boundaries of the proposed NECEC transmission line and to include the surface layer of the tidal waters of the Gulf of Maine to the outer continental shelf.

Sincerely,

Stephen M. Kasprzak

SMK/gcl
Encs.
cc: Jay Clement
Senator Susan Collins
Senator Angus King
Representative Chellie Pingree
Representative Jared Golden
Governor Janet Mills
Senator Brownie Carson
Senator David Woodsome
Senator Sara Gideon

Hot Zones #4 & #5 The Gulf of St. Lawrence and The Gulf of Maine

MEGA RESERVOIR AND POWER STATION ON MANICOUGAN RIVER WARM THE SEA TEMPERATURE OF THE GULF OF ST. LAWRENCE ONTO THE SCOTIAN SHELF AND THROUGH THE GULF OF MAINE

We are told by Hydro-Quebec that the Daniel Johnson Dam (Figure 22) and its hydropower generating station (Manic 5) (shown in the lower right hand corner of the photo) are fueled by green (clean) energy from natural hydraulic cycle.

This is not true! It is fueled by stolen energy.

Under natural conditions, that are before this Dam was built in 1970, the Manicouagan River, seen in the lower right hand corner of Figure 22, typically had low monthly summer and winter flows of about 7,000 cubic feet per second (ft^3/sec,) which would not generate much electricity.

However, the natural spring run-off was 105,000 ft^3/sec or 15 times greater.

Hydro-Quebec designed, built and operates this reservoir hydroelectric dam to steal the river flow (kinetic energy) of the spring run-off and to store the water as potential energy.

This dam is 700 ft. tall and almost a mile long, and it is storing 139.8 billion cubic meters of water, which is equivalent to the amount of water in 27 Moosehead Lakes.

These stolen waters are warmed by solar energy and released months later as discharged heated river flow (manmade kinetic energy) to fuel the power station at flows 10 to 20 times greater than during the near dormant natural river flows of summer and winter.

Daniel Johnson Dam and Manic-5 Generating Station on the Manicouagan River in Quebec (Source: Hydro-Quebec) Figure 22

HYDRO-QUEBEC KNOWS THEY ARE STEALING THE KINETIC ENERGY OF THE SPRING RUN-OFF, WHICH PLAYS A PROMINENT ROLE IN THE GENERATION OF LARGE-SCALE MOTIONS IN THE COASTAL ENVIRONMENT, AS DEMONSTRATED BY DR. HANS NEU IN HIS 1964 STUDY.

Before Hydro-Quebec built the Daniel Johnson Dam and Power Station, Dr. Hans J. A. Neu, an oceanographer at the Bedford Institute, Dartmouth, Nova Scotia, did an extensive Study (Figure 23), which was completed in early 1964 but was not allowed to be seen until December 1970, after the Daniel Johnson facility went online (Reference 9).

This Study was abbreviated in scope, released with a limited circulation and labeled "*unpublished manuscript*." Obviously, the Provincial Government of Quebec did not want the following conclusions of Dr. Neu's to be published:

6.7 The most important conclusion is that the intensity of the estuarine circulation in the St .Lawrence Estuary can be characterized solely by the fresh water inflow. The volume of sea water brought into circulation is controlled by the amount of fresh water being discharged into the system.

6.8 From this it follows that modifications to the fresh water run-off (e.g. hydro-power developments and water diversions) alter the flow regime and with it the salinity and temperature structure of the system.

The regulation of the fresh water discharge of the St. Lawrence system since the turn of the century should have decreased the circulation during the summer and increased the water temperature in the surface layer. This could have affected the climate of the adjacent region.

Furthermore, the installation of the Manicouagan power scheme, which changes the natural run-off of the 'group' of rivers, will alter the Gaspe´ Current, modifying the seasonal salt and temperature balance not only of the estuary, but probably also of the Gulf of St. Lawrence.

6.9 Whether these changes were or are beneficial is undecided, though the possibility exists that their consequences may be likened to large-scale heat pollution with ecological implications. Thus, to avoid

such consequences, future modification of this type should be carefully studied." (Emphasis by SMK)

Paragraphs 6.7 and 6.8 contain declaratory statements, and mega reservoir hydropower advocates to date have provided no evidence to disprove them.

APPENDIX 1
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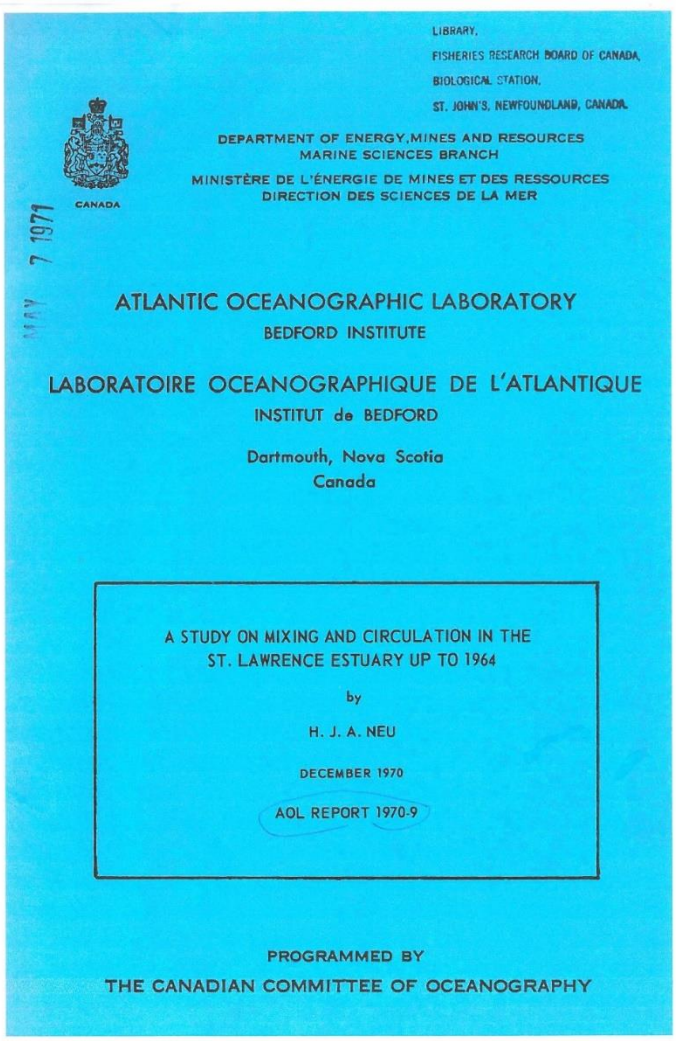
This Study was found this summer in the library at St. John's, Newfoundland, and it is extremely important because Dr. Neu collected the data, which was used to write the Study, before the reservoir was created on the Manicouagan River.



LIBRARY,
FISHERIES RESEARCH BOARD OF CANADA,
BIOLOGICAL STATION,
ST. JOHN'S, NEWFOUNDLAND, CANADA.

CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES
MARINE SCIENCES BRANCH

MINISTÈRE DE L'ÉNERGIE DE MINES ET DES RESSOURCES
DIRECTION DES SCIENCES DE LA MER

MAY 7 1971

ATLANTIC OCEANOGRAPHIC LABORATORY
BEDFORD INSTITUTE

LABORATOIRE OCEANOGRAPHIQUE DE L'ATLANTIQUE
INSTITUT de BEDFORD

Dartmouth, Nova Scotia
Canada

A STUDY ON MIXING AND CIRCULATION IN THE
ST. LAWRENCE ESTUARY UP TO 1964

by

H. J. A. NEU

DECEMBER 1970

AOL REPORT 1970-9

PROGRAMMED BY
THE CANADIAN COMMITTEE OF OCEANOGRAPHY

Figure 23

Both of the following quotes are taken from this Report:

"This is a manuscript which has received only limited circulation. On citing this report in a bibliography, the title should be followed by the words, "Unpublished Manuscript," which is in accordance with accepted bibliographic custom."

"It should be noted that this report is an abbreviated version of an unpublished manuscript prepared in early 1964 which has only now become available for publication."

DR. NEU'S CONCERNS THAT THE MANICOUGAN POWER SCHEME "MAY BE LIKENED TO LARGE-SCALE HEAT POLLUTION WITH ECOLOGICAL IMPLICATIONS" TURNED OUT TO BE TRUE WITH THE PASSAGE OF TIME

In a September 17, 2018 article in Science Daily (Reference 10) the following observations were made:

1. *"The Gulf of St. Lawrence has warmed and lost oxygen faster than almost anywhere else in the global oceans."*
2. *"Observations in the very inner Gulf of St. Lawrence show a dramatic oxygen decline, which is reaching hypoxic conditions, meaning it can't fully support marine life,"* Claret said. This area is next to the mouth of the Manicouagan River.
3. *"The research confirms a recent study showing that, as carbon dioxide levels rose over the past century due to human emissions, the Gulf Stream has shifted northward and the Labrador Current has weakened. The new paper finds that this causes more of the Gulf Stream's warm, salty and oxygen-poor water to enter the St. Lawrence Seaway.*

Observations 1 and 2, 3 are true but reasons given for why warm, salty and oxygen-poor water are entering the St. Lawrence appear to be very weak compared to Dr. Neu's conclusions on page 20.

His conclusions were based on data collected along seven survey sections in the St. Lawrence Estuary with three or four stations along each section and water samples were taken from the surface to the bed, using Knudsen reversing bottles from 18-25 February and from 21-24 May 1963. (9)

Dr. Neu reinforced his earlier 1964 conclusions in his 1976 Report (11) in which he explains how the Labrador Current would be weakened as the seasonal spring run-off was significantly reduced:

"Fresh water from the drainage of rivers plays a prominent role in the generation of large-scale motions in the coastal environment. In the St. Lawrence system, it initiates a circulation in which huge quantities of sea water are transported from the ocean into the Gulf and up the Estuary, a distance of more than 1500 km (932 miles). As the seasonal flow of fresh water is modified for power production, the strength of this circulation is altered and with it upwelling, mixing, flushing of the system and near-coast water masses, and the composition of the water with respect to salinity and temperature. The changes must result in climatic modifications which influence the heat budget and therefore the ice conditions.

A reduction in upwelling during spring and summer has decreased the nutrient supply and this, in addition to the change in the composition of the water in the upper layer, must have affected the reproduction of many species. ***It can, therefore, be concluded that seasonal discharge regulation, as implemented in the St. Lawrence for power production since the turn of the century, has imposed large-scale modifications upon the ecosystem of the Estuary, Gulf and coastal zone. This applies to any other system in which similar conditions prevail****."*

In his 1976 Report (Reference 11) Dr. Neu also wrote the following about the Manicouagan power scheme shown in Figure 19:

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"To regulate the natural flow of rivers is to interfere with the hydrological cycle, that is, the circulation
of water between the ocean, the atmosphere, the land, and its return to the ocean. It is this last link of the cycle which is principally affected by regulation.

The output of a river power station depends on the available discharge of the river and the difference in water level. The latter is usually fixed, but the runoff, if unregulated, varies seasonally, particularly in latitudes where precipitation during the winter is stored in the form of snow. In spring the melting snow adds large quantities of water to the system. This additional discharge can be several times larger than the average flow and, in some rivers, may be ten to twenty times the winter discharge.

Such wide variations in natural runoff limit economic development of power; therefore, great efforts are made to obtain more uniform flow by storing water during the high runoff season. Optimum power output is obtained when a river is so regulated that water is always available to meet the demand for power which is usually greater in winter than summer.

In the basin of the St. Lawrence River, Estuary and Gulf, the tributaries have relatively little natural storage. Their discharges are therefore variable, being low in the winter and high in the spring. To optimize their utilization for power generation, many large storage reservoirs have been constructed.

A series of large storage reservoirs installed since 1964 has resulted in almost total regulation. A plan and longitudinal section of the Manicouagan scheme are shown in Fig 24. With the exception of the upper tributaries there is no stretch of the river in

which the discharge is unregulated. Every drop of water must pass through a series of large artificial lakes the largest of which, Manic 5, has a storage capacity of about 139.8 km³ which is comparable with Lake Nasser in Egypt. It would take the full discharge of the St. Lawrence River at Montreal more than 200 days to fill Manic 5. This type of storage was designed to control the system completely and to govern the discharge solely by power demand.

This drastic alteration of the natural pattern of runoff has caused significant changes in the physics and dynamics of the waters of the Estuary, Gulf and adjacent coastal region. It is argued that such modifications produce a profound impact on the biological balance of the whole ecosystem, as well as changes in the seasonal heat budget.

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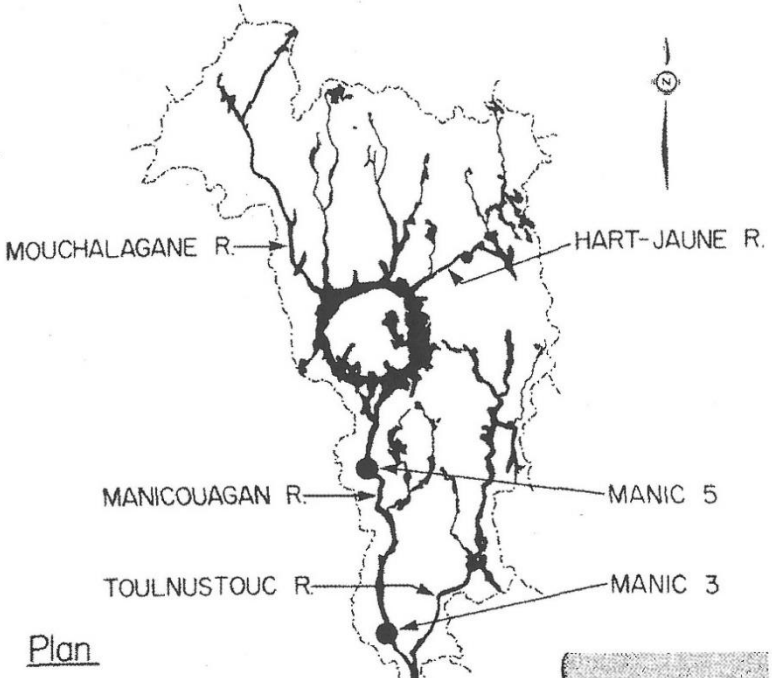

APPENDIX 1
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HYDRO-QUEBEC HAS NO SCIENTIFIC RESPONSE TO COUNTER DR. NEU'S OBSERVATIONS

The government of Quebec and Hydro-Quebec has muzzled Canadian scientists for over 50 years. (complete newspaper articles are attached) to my April 2, 2019 letter to

the U.S. Army Corps of Engineers, File Number NAE-2017-01342 Presidential Permit for CMP's New England Clean Energy Corridor (NECEC PP-438)

1. **Science Abandoned, Scientists Muzzled** Andrea Hill, Postmedia News in "The Leader Post" January 10, 2014 "The federal government 'really doesn't grasp what science is about' and could be unable to respond to adverse environmental changes because it has abandoned research into climate change and water pollution, say scientists interviewed for CBC's The Fifth Estate"

2. **MPs panel to probe allegations fisheries scientists were silenced** in Vancouver Sun, November 1, 1997 "Allegations in a published article by scientists allege they were muzzled and their work is tainted by politics".

3. **James Bay seen as test on environment** Star Phoenix January 8, 1976 "The man in charge of assessing the environmental impact of Quebec's massive James Bay hydroelectric project admitted Wednesday no one is sure just what its impact on the environment will be. 'We are using this project as an experience to see what will happen,' Alain Soucy said in an interview. 'We have about $100 million to spend over the next 3 years on remedial action, though.' The head of James Bay Energy Corporation's environmental department said that even if there were severe environmental problems caused by the project it would not be curtailed. 'We can't change the scale of the project or it will not work.' he explained."

4. **Dams stop nature's ways on mighty rivers** by Bruce Little in Calgary Herald February 25, 1974 "Protests over the environmental effects of huge power dam projects usually focus attention on what happens to the land above the dams that will be drowned in water. Hans Neu does not go along with that assessment. He is an expert in hydrology at the Bedford Institute of Oceanography here and he feels hydro power may be far dirtier than most people realize. Instead of looking upriver for the effects of a dam, Neu looks at the ocean into which the river waters eventually spill."

5. **Research shows Canada's dams are salmon's doom** by Dianne Murray in Windsor Star March 5, 1974 "Canadian oceanographer Hans Neu has shown we've already got the world's highest rate of blocked freshwater flow. For his trouble in trying to alert the federal government to his research, he was virtually run out of his job at the Bedford Institute"…."Also, biologist Wilfred Carter makes it sound like there's no relevant research, when in fact Canadian government scientists have been muzzled by their director general on this issue for some time."

6. **Environment Studies Lacking** in Ottawa Journal October 26, 1971 "Dr. J. S. Nelson, president of the Canadian Society of Environmental Biologists, says the Canadian government has not called for a single environmental study at the outset of any major development"….. "Hans Neu, an engineer-scientist with the Bedford Institute near here, said the environment is becoming another business…."a political football"…. "We have to take a closer look at the environment before we continue exploitation."

APPENDIX 1
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