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QUEBEC'S CROSS-SECTORAL AND MULTIDISCIPLINARY ENVIRONMENTAL WORKFORCE: A SNAPSHOT OF EMPLOYMENT AND HIRING NEEDS TO 2033

MARCH 2024

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QUEBEC'S ENVIRONMENTAL JOB OUTLOOK SNAPSHOT

The province's transition to a resource-efficient, low-carbon economy requires a thriving environmental workforce across all industries, regions and occupations.

TOTAL ENVIRONMENTAL WORKFORCE

The total environmental workforce includes core environmental workers (those who require environmental-specific knowledge, skills and competencies) and workers employed by environmental goods and services organizations.

WE ESTIMATE THAT 1 IN 16 WORKERS IN QUEBEC ARE PART OF THE TOTAL ENVIRONMENTAL WORKFORCE.

279,570 Environmental workers in 2024 (**6%** of Quebec's total workforce)

+ 4,220 Net new jobs by 2033 (**1.5%** growth from 2024)

+ 71,350 Job openings due to retirements (**94%** of net job openings)

75,570 Net job openings to 2033 (**27%** of 2024 environmental employment)

Top industries

- Public administration **(12,070 job openings)**
- Health care and social assistance **(10,210)**
- Professional, scientific and technical services **(9,850)**

Top specializations

- Sustainability **(44,110 job openings)**
- Natural Resource Management **(29,660)**
- Fisheries & Wildlife **(27,450)**

Top occupations

- Home building and renovation managers **(3,770 job openings)**
- Other managers in public administration **(2,150)**
- Sales and account representatives – wholesale trade (non-technical) **(1,520)**

CORE ENVIRONMENTAL WORKFORCE

Core environmental workers require environmental-specific knowledge, skills and competencies.

85,260 Core environmental workers in 2024 (**30%** of Quebec's environmental workforce)

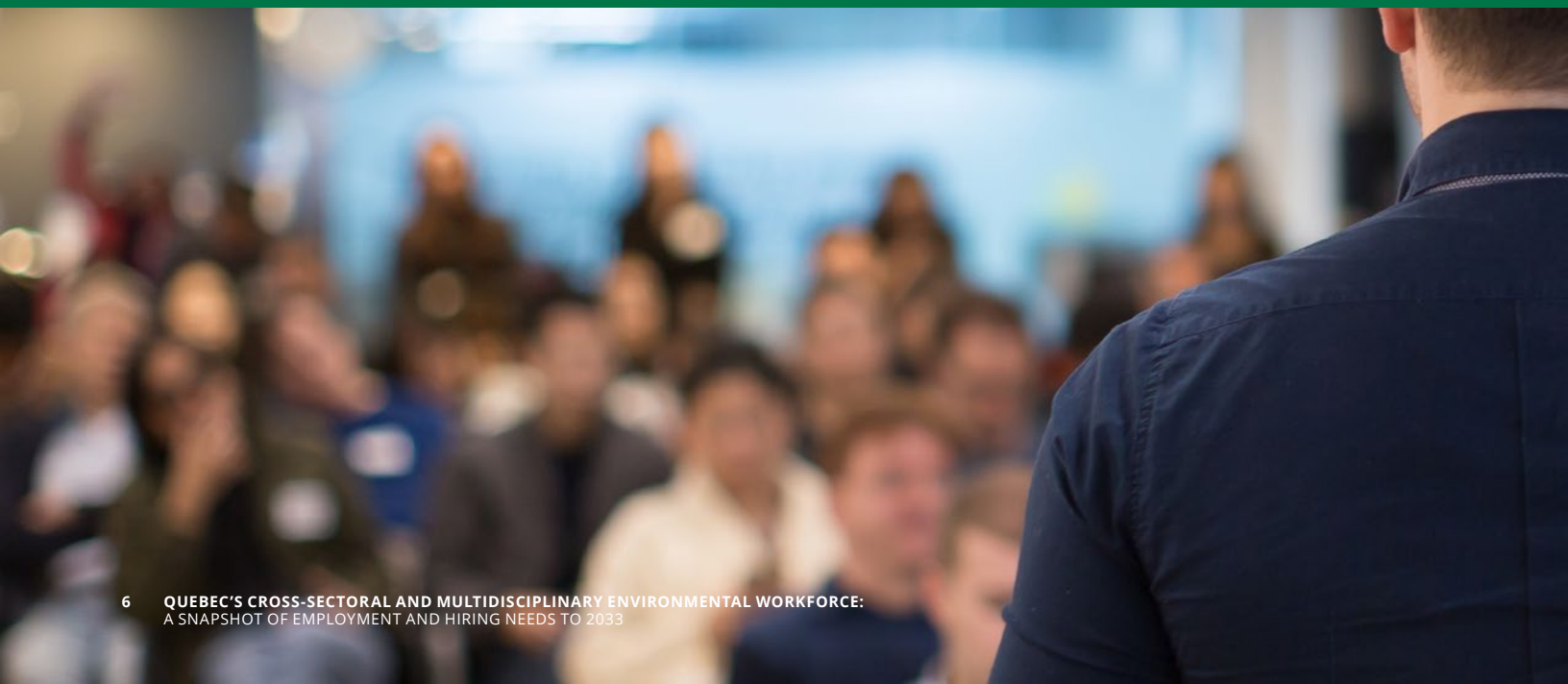
– 5,470 New jobs by 2033 (**–6%** growth from 2024)

+ 21,410 Job openings due to retirements by 2033 (**134%** of net job openings)

15,940 Net job openings to 2033 (**19%** of 2024 core environmental employment)

Top core occupations

- Professional occupations in business management consulting **(1,290 job openings)**
- University professors and lecturers **(1,220)**
- Civil engineering technologists and technicians **(1,010)**



INTRODUCTION

Quebec has witnessed a strong recovery post-pandemic, with substantial real Gross Domestic Product (GDP) growth of 2.6% and economic expansion leading to a record level of employment in 2022. At the same time, the unemployment rate dropped to a record low of 4.3%, the lowest across Canada.[1]

Quebec's real GDP growth is anticipated to slow to approximately 1% in 2023, reflecting a pullback in the residential sector lower household consumption, and higher interest rates.[2] [3] Ongoing economic challenges for the province include tightness in the labour market, inflation and higher interest rates.[4]

Quebec is the world's fourth-largest electricity producer and is a global leader in hydroelectric generation, power transmission and renewable energy integration. It boasts North American's lowest greenhouse gas emissions per capita, with over 99 percent of its electricity sourced from clean energy.[5] The province was an early leader in carbon pricing, zero-emission-vehicle mandates, and low-carbon fuel standards. Quebec is also one of the leading provinces in generating new, globally competitive low-carbon transition companies.[6]

In addition, Quebec contains the second-largest inventory of building stock for low-carbon retrofitting in Canada. The province also has some of the strongest existing policy frameworks and financing tools for retrofitting existing infrastructure. Quebec is one of the only provinces where mandatory provincially led retrofit targets are being developed. Investment in low-carbon retrofits will require a skilled and growing workforce, as well as an accessible supply chain to source low-carbon products and materials.[7]

Canada is calling for a more responsible and sustainable way toward economic growth. This report intends to shed light on where environmental jobs and talent exist today and where new opportunities lie ahead for the remainder of this decade.

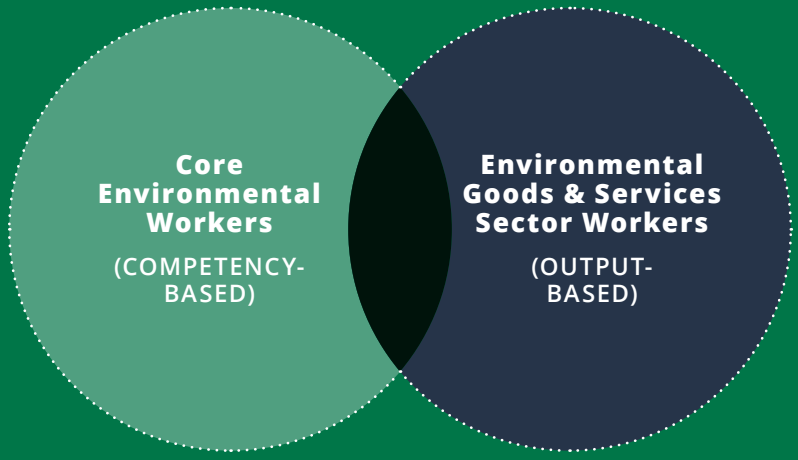
The data and insights from this report can help inform business, policy, program, and career decisions. They can dispel misconceptions and uncover opportunities for various stakeholders, including industries, employers, governments, communities, academic institutions, and individuals. Ultimately, nurturing environmental talent across different sectors and jobs will be essential for Quebec to achieve a sustainable, prosperous, inclusive, and equitable future.

1 Stokes Economic Consulting, 2023
2 Ibid.
3 https://economics.td.com/provincial-economic-forecast
4 https://www.conferenceboard.ca/insights/quebec-fall-2023-economic-fiscal-update/
5 https://cdn-contenu.quebec.ca/cdn-contenu/adm/min/relations-internationales/publications-adm/autres-publications/Brochure-COP26-Octobre-2021-EN-MRIF.pdf
6 https://climateinstitute.ca/wp-content/uploads/2022/05/Provincial-summary-EN.pdf
7 Green-Retrofit-Economy-Study-20220602.pdf (delphi.ca)

SPOTLIGHT: THE ENVIRONMENTAL WORKFORCE DEFINED

Canada's environmental workforce drives or supports the goals of natural resource management, environmental protection, and sustainability. Our definition includes:

- Core environmental workers (i.e., those in roles requiring specialized environmental competencies) regardless of industry, and
- Those directly employed within the environmental goods and services firms, regardless of occupation.



A Chief Sustainability Officer and Remediation Specialist working in oil and gas; a Conservation Officer in government; a Water and Wastewater Treatment Operator in utilities; an Energy Auditor and Environmental Engineer in construction; and an Environmental Advisor, Accountant, and Human Resource Advisor working in an environmental consulting firm are all included in our definition (see our Career Profiles to explore over 100 roles that are part of Canada's growing environmental workforce).

We also classify environmental workers according to 13 key environmental specializations or sub-sectors, from Air Quality to Fisheries & Wildlife, Natural Resource Management, and Environmental Education & Training (see our sector model for the complete list of specializations/sub-sectors).

This study presents estimates for environmental employment and net hiring requirements in Quebec from 2024 to 2033. Our labour demand outlook integrates multiple sources of data:

- Online job postings from TalentNeuron,
- Statistics Canada's Census and Labour Force Survey,
- Employment and Social Development Canada's Canadian Occupational Projection System,
- GDP growth in accordance with an average of long-term growth forecasts published by the Parliamentary Budget Office, the Department of Finance Canada, and the Organization for Economic Co-operation and Development (OECD), and
- Sectoral trends for industries within this framework are provided by Stokes Economics.

Environmental employment is estimated by identifying the 2023 EnviroShare—the proportion of environmental workers compared to all workers at the occupational level—and applying these to forecasted employment data. **Net hiring requirements** are derived by combining jobs created from employment growth (expansion demand) and jobs that become available as workers retire (replacement demand).

Numbers have been rounded in many cases for readability.

Refer to Appendix A for more information about our labour demand forecast and Appendix B for a list of all occupations included in our study, including those mapped to core environmental workers.

COMPOSITION OF THE ENVIRONMENTAL WORKFORCE IN QUEBEC

Roughly 1 in 16 workers in Quebec (**279,570**) were in an environmental role in 2024. About **85,260** were core environmental workers.

TOP OCCUPATIONS

The top job families[8] in the environmental workforce are:

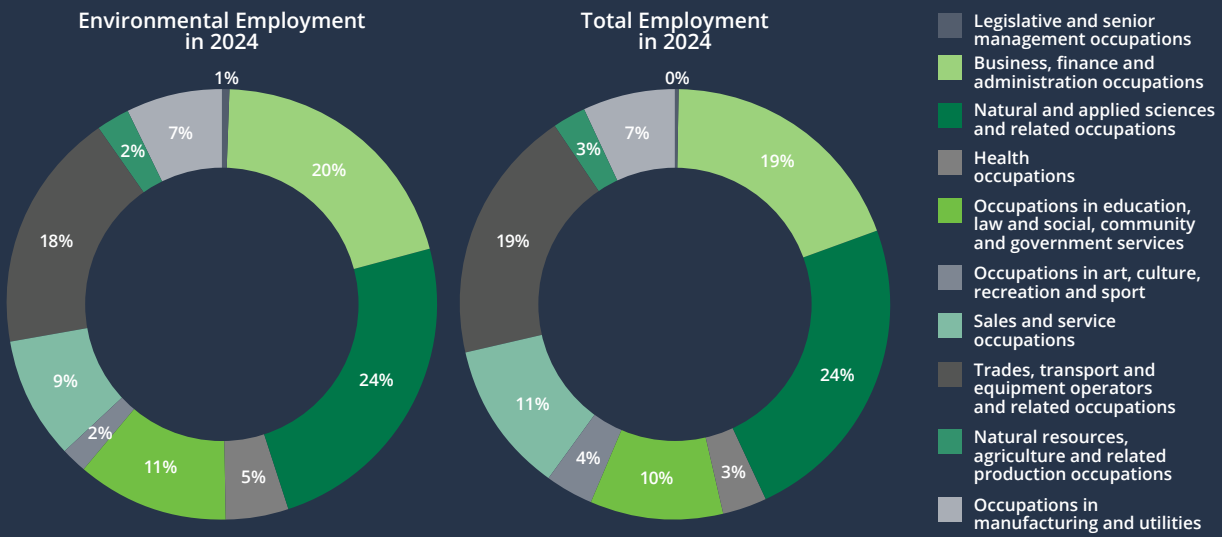
- Natural and applied sciences and related occupations (**66,200**)
- Business, finance and administration occupations (**53,200**)
- Trades, transport and equipment operators and related occupations (**53,100**)

Nearly **25%** of environmental workers are in Natural and applied sciences and related occupations, a job family that includes scientists, engineers, engineering technologists and technicians, and information technology specialists, while comprising only 10% of Quebec's total workforce. Business, finance and administrative occupations and Trades, transport and equipment operators and related occupations each comprised another 19% of Quebec's environmental workforce.

In contrast, Sales and service occupations made up 24% of Quebec's total workforce but only 11% of the environmental workforce.

Figure 1

Total and Environmental Employment in 2024, by Job Family



8 1-digit National Occupational Code (NOC). For more information, visit https://noc.esdc.gc.ca/.

The top occupations[9] for environmental employment are entirely different than the top occupations by environmental employment share:

- Administrative Officers (**9,630**), Civil engineers (**8,620**) and Home building and renovation managers (**6,870**) round out the top three occupations for environmental employment.
- The highest environmental employment shares are observed for Conservation and fishery officers (**82%**), Water and waste treatment plant operators (**80%**) and Forestry professionals (**75%**).

Except for Home building and renovation managers, all of the occupations listed above involve core environmental workers (i.e., those in roles requiring environmental-specific competencies).

9 5-digit National Occupational Code (NOC). For more information, visit https://noc.esdc.gc.ca/.

TOP INDUSTRIES

As of 2024, the largest industry employers of environmental workers are the Professional, scientific and technical services and Public administration sectors, each representing 13.5% of total environmental workers in Quebec.

Industries and Occupations Crosscut

Industries interact with environmental objectives differently, requiring different environmental workers to achieve the desired results. As such, the top occupations employed in Quebec's key industries are very different. For instance, under the umbrella of Manufacturing, industrial millwrights and managerial roles are more frequently observed. In contrast, the Professional, scientific and technical services sector has a larger proportion of engineers. The Utilities sector has notable needs for Water and waste treatment plant operators and Power system electricians.

Table 1

Top Occupations by Industry

Industry (NAICS)	Environmental Employment in 2024	Industry Share of Environmental Employment in 2024	Top occupations (based on environmental employment)
All industries	**279,570**	**100%**	• **Professional occupations in advertising, marketing and public relations (26,300)** • **Home building and renovation managers (15,400)** • **Civil engineers (12,900)**
Professional, scientific and technical services (54)	37,860	13.5%	• Civil engineers (5,000) • Lawyers and Quebec notaries (1,500) • Civil engineering technologists and technicians (1,300)
Public administration (91)	37,680	13.5%	• Other managers in public administration (2,100) • Firefighters (1,700) • Administrative officers (1,600)
Manufacturing (31)	33,220	11.9%	• Manufacturing managers (3,200) • Sales and account representatives - wholesale trade (1,100) • Construction millwrights and industrial mechanics (1,000)
Construction (23)	24,310	8.7%	• Home building and renovation managers (6,800) • Construction managers (2,500) • Contractors and supervisors, heavy equipment operator crews (1,300)

Industry (NAICS)	Environmental Employment in 2024	Industry Share of Environmental Employment in 2024	Top occupations (based on environmental employment)
Educational services (61)	15,320	5.5%	• University professors and lecturers (2,500) • College and other vocational instructors (1,800) • Post-secondary teaching and research assistants (1,100)
Utilities (22)	9,630	3.4%	• Water and waste treatment plant operators (900) • Utilities managers (800) • Power system electricians (800)
Other services (except public administration) (81)	8,720	3.1%	• Administrative assistants (500) • Human resources professionals (500) • Contractors and supervisors, mechanic trades (400)
Wholesale trade (41)	8,210	2.9%	• Sales and account representatives - wholesale trade (1,200) • Technical sales specialists - wholesale trade (900) • Retail and wholesale trade managers (400)
Agriculture, forestry, fishing and hunting (11)	7,610	2.7%	• Forestry technologists and technicians (1,300) • Managers in agriculture (1,200) • Silviculture and forestry worker (800)
Mining, quarrying, and oil and gas extraction (21)	3,040	1.1%	• Underground production and development miners (300) • Geological and mineral technologists and technicians (300) • Managers in natural resources production and fishing (200)

TOP SPECIALIZATIONS

The top specializations for environmental employment in the province are:

- Sustainability (**167,800**)
- Natural Resource Management (**110,200**)
- Fisheries and Wildlife **(98,000**)

Note: A worker or job could be mapped to one or more specializations or sub-sectors.

Figure 2

Environmental Employment by Specialization, 2024

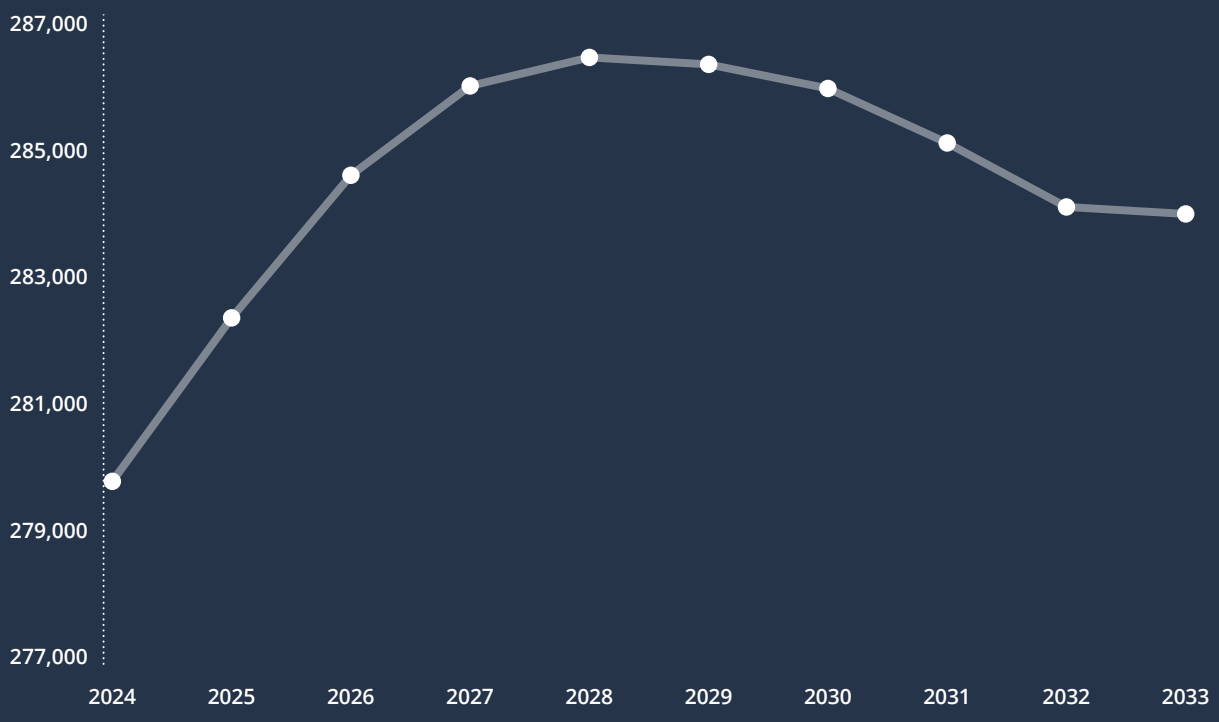
LOOKING FORWARD: ENVIRONMENTAL HIRING NEEDS IN THE NEXT DECADE

Investment in the innovation and adoption of clean electricity, electrification of the economy, emission reduction strategies (e.g., cap-and-trade system), development of renewable energies (green hydrogen and bioenergies), improving waste management practices and moving towards a circular economy, and low-carbon retrofits to existing infrastructure, will contribute to the rise of Quebec's green economy.

Our employment forecast indicates growth for the province's environmental workforce until 2028, followed by a modest decline and plateau into 2033. The estimated average change in environmental employment between 2024 and 2033 is 0.2% compared to 1.4% in total employment. Approximately **4,200 net new environmental jobs** will be added in the next decade. Expansion demand is expected to occur entirely between 2025 and 2028, after which growth is expected to either stall or reverse for the remainder of the decade. This is due in part to declines in environmental work associated with the Construction, Manufacturing, and Mining sectors.

Figure 3

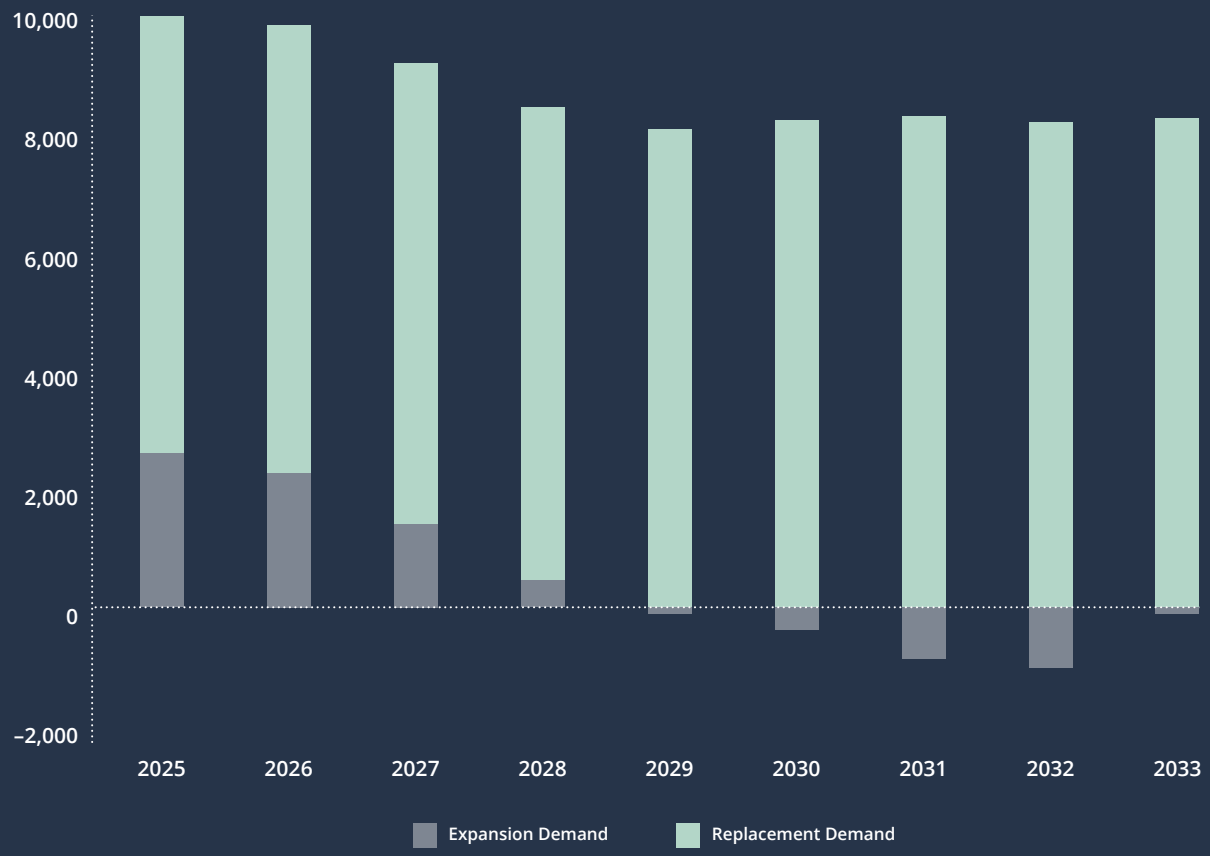
Environmental Employment in Quebec, 2024 to 2033



When expansion demand is combined with replacement demand, we estimate that **75,600 net environmental job openings will need to be filled by 2033**. This hiring number equates to 27% of 2024 environmental employment and provides a career stream for new and existing talent. Quebec's aging population is a cause for concern in the medium to longer term. This trend is also prevalent in the environmental workforce, where our forecast shows an estimated 26% of the current environmental workforce will be retiring over the next 10 years. Employers must engage and develop both new and experienced workers to meet labour demand through 2033.

Figure 4

Environmental Net Hiring Requirements to 2033



TOP INDUSTRIES

The largest growth will come from the Health care and social assistance sector (**3,700** new environmental jobs) followed by the Public administration sector (**1,700**), Arts, entertainment and recreation (**1,700**), Professional, scientific and technical services (**1,000**), and Educational services (**900**).

Table 3

Environmental Net Hiring to 2033, by Industry

Industry (NAICS)	Environmental Employment 2024	Expansion Demand 2024 - 2033	Replacement Demand 2024 - 2033	Net Hiring Requirements 2024 - 2033	Net Hiring Requirements as a % of Environmental Employment in 2024
All Industries	**279,570**	**4,220**	**71,350**	**75,570**	**27%**
Public administration (91)	37,680	1,750	10,320	12,070	32%
Health care and social assistance (62)	23,880	3,700	6,510	10,210	43%
Professional, scientific and technical services (54)	37,860	990	8,870	9,850	26%
Manufacturing (31)	33,220	-2,350	9,040	6,690	20%
Construction (23)	24,310	-320	6,340	6,020	25%
Educational services (61)	15,320	950	3,910	4,860	32%
Retail trade (44)	13,310	200	3,530	3,730	28%
Arts, entertainment and recreation (71)	6,490	1,750	1,550	3,290	51%
Transportation and warehousing (48)	11,070	260	3,000	3,260	29%
Wholesale trade (41)	8,210	450	2,240	2,690	33%
Accommodation and food services (72)	7,740	820	1,680	2,500	32%
Finance and insurance (52)	12,610	-440	2,860	2,430	19%
Utilities (22)	9,630	-60	2,320	2,260	23%

Industry (NAICS)	Environmental Employment 2024	Expansion Demand 2024 - 2033	Replacement Demand 2024 - 2033	Net Hiring Requirements 2024 - 2033	Net Hiring Requirements as a % of Environmental Employment in 2024
Administrative and support, waste management and remediation services (56)	10,280	-650	2,530	1,880	18%
Other services (except public administration) (81)	8,720	-420	2,120	1,700	19%
Real estate and rental and leasing (53)	4,200	200	1,280	1,490	35%
Agriculture, forestry, fishing and hunting (11)	7,610	-660	1,990	1,330	17%
Information and cultural industries (51)	4,310	-710	780	70	2%
Management of companies and enterprises (55)	80	-20	0	-20	-25%
Mining, quarrying, and oil and gas extraction (21)	3,040	-1,210	490	-710	-23%

A handful of industries are projected to see negative expansion demand between 2024 and 2033. For these industries, net hiring requirements are projected to be driven entirely by replacement demand.

Figure 5

Environmental Net Hiring Requirements to 2033, by Industry

TOP OCCUPATIONS

Net hiring requirements are highest for:

- Home building and renovation managers (**3,770** job openings)
- Other managers in public administration (**2,150**)
- Sales and account representatives – wholesale trade (non-technical) (**1,520**)

Table 4

Net Hiring Requirements to 2033 for Top Environmental Occupations

Occupation (NOC)	EnviroShare in 2023	Environmental Employment in 2024	Expansion Demand 2024-2033	Replacement Demand 2024-2033	Net Hiring Requirements 2024-2033	Net Hiring Requirements as a % of Environmental Employment in 2024
All Occupations	**6%**	**279,570**	**4,220**	**71,350**	**75,570**	**27%**
Home building and renovation managers (70011)	28%	6,870	1,290	2,480	3,770	55%
Other managers in public administration (40019)	28%	2,070	1,030	1,130	2,150	104%
Sales and account representatives - wholesale trade (non-technical) (64101)	6%	3,450	580	940	1,520	44%
Information systems specialists (21222)	5%	2,670	770	720	1,490	56%
Professional occupations in business management consulting (11201)	10%	1,840	610	680	1,290	70%

Refer to Appendix B for the net hiring requirements for 100 top environmental occupations.

TOP SPECIALIZATIONS

The top three specializations for expansion demand are the same as the top three for 2024 employment:

- Fisheries & Wildlife (**3,700**)
- Natural Resource Management (**2,600**)
- Sustainability (**2,300**)

The top three specializations for replacement demand are:

- Sustainability (**41,800**)
- Natural Resource Management (**27,100**)
- Fisheries & Wildlife (**23,800**)

Net hiring requirements are highest for:

- Sustainability (**44,110** job openings)
- Natural Resource Management (**29,660**)
- Fisheries & Wildlife (**27,450**)

Table 5

Environmental Net Hiring Requirements, by Environmental Specialization

Specialization	Environmental Employment in 2024	Expansion Demand 2024-2033	Replacement Demand 2024-2033	Net Hiring Requirements 2024-2033
Sustainability	167,820	2,280	41,830	44,110
Natural Resource Management	110,250	2,570	27,100	29,660
Fisheries & Wildlife	97,950	3,680	23,760	27,450
Energy	76,200	-110	18,300	18,190
Environmental Health & Safety	63,040	130	16,050	16,180
Waste Management	56,780	-190	13,280	13,090
Water Quality	55,360	160	12,810	12,970
Site Assessment & Reclamation	53,230	30	12,710	12,750
Air Quality	38,320	130	8,970	9,100
Policy & Legislation	24,550	-970	5,870	4,900
Education & Training	12,220	160	2,730	2,890
Communications & Public Awareness	6,180	390	1,320	1,710
Research & Development	3,680	140	770	910

CORE ENVIRONMENTAL WORKFORCE NET HIRING REQUIREMENTS

The EnviroShare for core environmental workforce occupations (i.e., those in roles requiring specialized environmental competencies) is **17%**, as opposed to **6%** for all occupations. The three occupations with the highest EnviroShares (Conservation and fishery officers, Water and waste treatment plant operators, and Forestry professionals) are also core environmental occupations.

The top three occupations with the highest number of core environmental workers vary from the overall environmental workforce, including:

- Administrative officers (**9,630** workers)
- Civil engineers (**8,620**)
- Construction managers (**4,460**)

Looking ahead to 2033, the highest net hiring requirements for core environmental workers are expected to be for Professional occupations in business management consulting (**1,290**), University professors and lecturers (**1,220**), and Civil engineering technologists and technicians (**1,010**).

The three core occupations with the largest projected expansion demand include Professional occupations in business management consulting (**610**), Civil engineering technologists and technicians (**400**) and Police officers (except commissioned) (**360**).

As a result of retirements, deaths, and provincial outmigration Administrative officers (**2,860**), Civil engineers (**1,580**), and Construction managers (**1,130**) are predicted to see the greatest replacement demand among core environmental workers.

Table 6

Environmental Net Hiring Requirements, by top 20 Core Environmental Occupation

Occupation (NOC)	2024 Environmental Employment	Expansion Demand 2024-2033	Replacement Demand 2024-2033	Net Hiring Requirements 2024-2033	2023 EnviroShare
All Core Occupations	**85,260**	**-5,470**	**21,410**	**15,940**	**6%**
Professional occupations in business management consulting (11201)	1,840	610	680	1,290	10%
University professors and lecturers (41200)	2,480	260	960	1,220	13%
Civil engineering technologists and technicians (22300)	2,530	400	610	1,010	31%
Administrative officers (13100)	9,630	-1,880	2,860	980	14%
Manufacturing managers (90010)	3,300	-140	1,050	910	12%
Police officers (except commissioned) (42100)	1,080	360	420	780	7%
Construction managers (70010)	4,460	-360	1,130	770	21%
Lawyers and Quebec notaries (41101)	2,700	210	550	760	10%
Construction millwrights and industrial mechanics (72400)	1,750	160	550	710	10%
Biologists and related scientists (21110)	1,550	230	340	570	31%
Other professional engineers (21399)	3,200	-180	740	560	42%
Contractors and supervisors, mechanic trades (72020)	2,140	-150	710	560	13%
Computer and information systems managers (20012)	1,590	30	480	510	9%

Occupation (NOC)	2024 Environmental Employment	Expansion Demand 2024-2033	Replacement Demand 2024-2033	Net Hiring Requirements 2024-2033	2023 EnviroShare
Firefighters (42101)	1,750	-110	590	480	24%
Conservation and fishery officers (22113)	1,120	210	220	430	82%
Electrical and electronics engineers (21310)	2,540	-210	600	390	25%
Natural and applied science policy researchers, consultants and program officers (41400)	750	220	160	380	15%
Facility operation and maintenance managers (70012)	800	40	300	340	15%
Managers in social, community and correctional services (40030)	610	90	240	330	6%
Human resources professionals (11200)	2,400	-150	460	310	6%

SPOTLIGHT: TES CANADA – PROJECT MAURICIE

A PIONEERING GREEN HYDROGEN INITIATIVE FOR QUÉBEC'S DECARBONIZATION AND RENEWABLE ENERGY INVESTMENT

- Project Mauricie[10] is a green hydrogen production site that upon its commissioning in 2028, will produce 70,000 tonnes of green hydrogen exclusively dedicated to Québec end users.
- The project consists of constructing an electrolyzer and renewable energy production assets, totalling $4 billion in regional investments.
- The project aims to reduce annual CO_2 emissions by 800,000 tonnes, making it among the largest decarbonization projects announced in Québec to date.
- The hydrogen site will be powered mainly by its wind and solar farm, which will have an installed capacity of 1 GW.

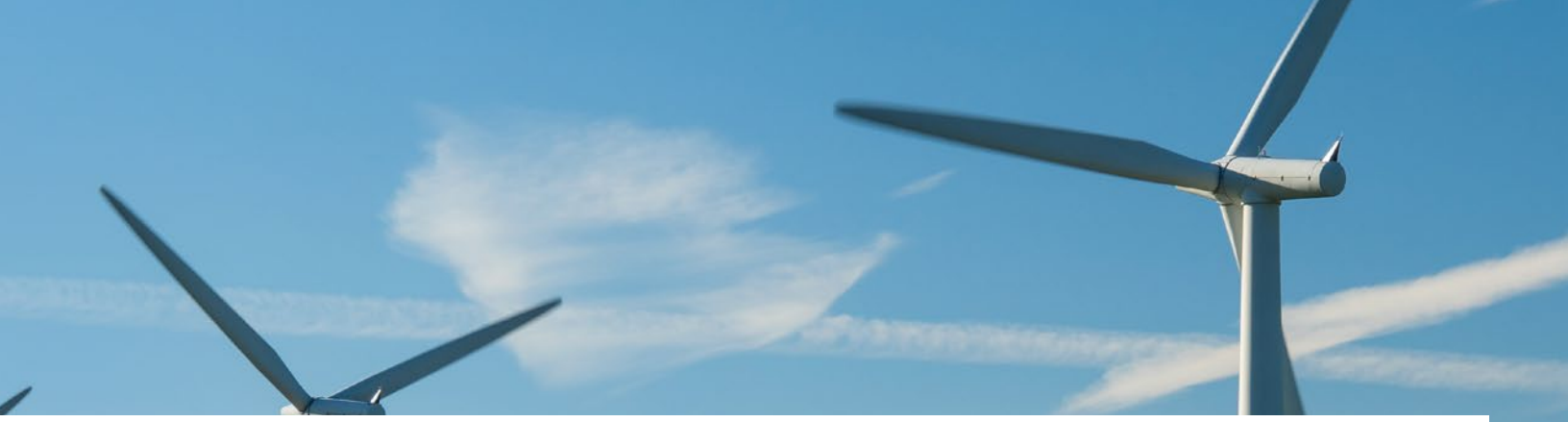
KEY CHALLENGES RELATED TO THE PROJECT

- Attracting skilled labour with expertise in the renewable energy sector and enhancing the skill set of the local workforce through training and upskilling to prepare them for new roles.
- Involving local communities and stakeholders to discuss concerns regarding the wind farm's expansion potentially encroaching on agricultural land.
- Lack of affordable housing in the province may reduce labour mobility to meet hiring needs.

LONG-TERM CONSIDERATIONS

- The project will contribute to the region's economic development and all of Québec, creating high-quality job prospects and lasting economic benefits.
- Boost activity across multiple sectors, including Construction, Manufacturing and Maintenance.
- TES Canada's Project Mauricie alone will contribute to achieving 3% of Québec's GHG reduction targets by 2030.

10 https://tes-h2.com/news/tes-presents-projet-mauricie-a-crucial-initiative-for-quebec-s-decarbonization-through-green



EMPLOYMENT OPPORTUNITIES AND WORKFORCE DYNAMICS

The project is anticipated to generate 1,000 jobs during construction and 200 permanent jobs.

Primary occupations involved during construction:

- Construction managers (NOC 70010)
- Construction trades helpers and labourers (NOC 75110)
- Mechanical engineers (NOC 21301)

Primary occupations involved in operation and maintenance:

- Supervisors, petroleum, gas and chemical processing and utilities (NOC 92011)
- Central control and process operators, petroleum, gas and chemical processing (NOC 93101)
- Industrial instrument technicians and mechanics (NOC 22312)

While Quebec's utilities and construction sectors are not anticipated to see job growth over the outlook, the province's aging workforce and impending retirements will drive hiring requirements to support future clean energy projects that come onstream over the next decade.

APPENDIX A: METHODOLOGY

The purpose of this research is to estimate employment of, and project labour market requirements for environmental workers. This analysis estimates the demand for skilled trade workers in the environmental workforce using an analysis of quarterly job postings from a broad range of job posting boards provided by TalentNeuron.[11] The process for doing so is two-fold: first, it identifies which job postings relating to each occupation (5-digit NOC) are for environmental positions using a keyword search. Second, it applies environmental shares to an industry and occupation model of the Canadian economy to develop an estimate of current and future labour dynamics for each occupation.

JOB SHARE ANALYSIS

The core dataset for the analysis is the job posting database, an aggregation of job postings collected from a broad array of job posting websites in French and English from across Canada, maintained by TalentNeuron. The data points collected from job listings include (but are not limited to):

- Job location (Province)
- 8-digit level 2010 O*NET-SOC occupation
- Posting company
- Job title
- Full text of the job listing

ECO Canada identifies postings for environmental positions by applying a filter of sentence fragments related to environmental activity to the TalentNeuron dataset. The text in each job posting is searched to see if each fragment can be found in the job posting and the results are tracked by post and fragment. Postings with enough matched fragments to meet a fragment-specific minimum match threshold are counted as matches for each linked area of focus.

11 For more information about TalentNeuron, visit https://www.talentneuron.com/.

Some further filtering is required on the job posting data before being used to compare to occupational employment data, however, since job posts in the TalentNeuron dataset are mapped to the 2010 O*NET-SOC occupation hierarchy, rather than the 5-digit 2021 NOC hierarchy. This does allow the potential for higher detail since the 8-digit O*NET-SOC has 1110 classifications compared to the 516 5-digit NOC codes. However, this hierarchy does not have unique mappings to the NOC hierarchy. We have developed a concordance that allows us to align O*NET-SOC many occupations to NOC occupations. Where no direct unique match is available, we used additional text analysis to attribute occupations within environmental positions. In attributing totals to occupations, however, this approach is too computationally intensive and non-unique matches were distributed according to their distribution in the Canadian economy.

The research team also assigns individual job posts to industries using an algorithm based on the following rules in the following order:

- where a job post contains industry-specific language, it was assigned to that industry; and
- where the job post was posted by a company with a known industry categorization, the post is assigned to that company's industry.

In cases where the company posting the job ad is a federally registered corporation, it is categorized into an industry based on its name and NAICS classification in the national corporation register. Some small businesses are classified based on identifiers within the business name (for example, a posting company called "AAA plumbing" would be classified within the Plumbing, heating and air-conditioning contractors NAICS).

ESTIMATING AND FORECASTING ENVIRONMENTAL LABOUR FORCE DYNAMICS

Estimating Baseline Environmental Employment

The environmental workforce is defined in this analysis as the environmental share of jobs[12] times the number of jobs for each occupation (5-digit NOC) and province/territory. To estimate this share, the research team compares characteristics of identified environmental positions with their prevalence in TalentNeuron's full database. This allows the researchers to estimate an occupation and province/territory-specific share of total positions linked to each environmental area of focus. The result is the EnviroShare, a province/territory and occupation-specific proportion of employment considered to be environmental.[13]

12 This measure reflects the proportion of positions advertised online that indicate that either the employer engages in the production/provision of environmental goods/services or the job requires environmental-related knowledge, skills, or aptitudes. This is used as a proxy for the proportion of current employment with these characteristics and may overstate the true environmental employment share if the newly advertised positions reflect an increase in the demand for environmental work.

13 For example, suppose that the total number of job postings for NOC 21300 (Civil engineers) in Ontario in the current period is 4,000 and the number of job postings that are considered to be environmental within that NOC and region is 800. Then the enviroshare is 20%.

Mathematically, the job posting counts and the totals are both arranged in *p* X *n* matrices (**J** and **T**), where *p* is the number of provinces and *n* the number of 5-digit NOC occupations. The workforce share matrix (**W**) is a similar *p* X *n* matrix for each year and quarter calculated by:

$$\boldsymbol{W} = \boldsymbol{J} \odot \boldsymbol{T}$$

To estimate the number of jobs, the research team uses quarterly occupational employment data from the Labour Force Survey (LFS). Each share is calculated with respect to the labour force composition within that quarter and then annualized based on a weighted average reflecting each quarter's contribution to the annual labour force. This data is augmented by projections from Census data where detailed occupation data was outside the survey. Employment estimates were organized into the same *p* X *n* matrix (**L**) for each year and quarter to create the Environmental Workforce (**E**):

$$\boldsymbol{E} = \boldsymbol{W} \odot \boldsymbol{L}$$

For industry matches, the approach is somewhat more complicated. Industry-level job posting totals are not available within the TalentNeuron database. As such, the industry categorizations from the job posting analysis is counted within occupations, such that industry data is organized into an *in* x *p* matrix, where *i* is the number of two-digit NAICS industries and *n* the number of 5-digit NOC occupations. This matrix (**I**) is the share of each industry within the job posts for each 5-digit NOC and province/territory. The *in* x *p* Environmental Workforce by Industry matrix (Ė) is:

$$\dot{E} = \boldsymbol{E} \odot \boldsymbol{I}$$

The total size of the environmental workforce is be calculated as the grand sum of Ė.

Projecting Future Environmental Employment

The research team projects future environmental employment by extending occupation and industry-level share trends over a labour market forecast provided by Prism Economics. That forecast is built on the macroeconomic model provided by Stokes Economics and deaths and retirement distributions based on the Canada Occupation Projection System ("COPS") forecast maintained by Employment and Social Development Canada, as well as Prism's computable general equilibrium model of occupational and industry labour dynamics.

Prism's model provides a forecast of **employment change** and **job replacement**, representing the labour demand for environmental jobs. The baseline jobs forecast will further be adjusted to reflect observed changes in environmental job shares over time. All variables are forecasted at the five-digit NOC and two-digit NAICS levels, in keeping with the underlying share estimates of environmental employment.

CHALLENGES AND LIMITATIONS

Job posting analysis provides us with an opportunity to collect large amounts of data about the demand for different types of workers. However, the methodology also has limitations:

- Not all jobs are posted online. The job posting database does not gather information about jobs that are hired through other means (e.g., signs in the window, temporary employment agencies, head hunters, union halls, etc.). This may be especially common for Red Seal Trades, as many opportunities are hired through word of mouth, personal connections, or union halls. As this is our first foray into environmental Red Seal Trades modelling, we have very little information about the impact that this may have on employment estimates and projections. To address this concern, we are incorporating information about the number of apprenticeships from the RAIS and certification skills requirements from Prism's CANTRAQ model.
- There is no standardized multiplier to adjust job posting data to actual labour market (employment) data. For example, job postings appear more frequently for certain occupations that have higher turnover rates. In this instance, a higher number of job postings does not translate directly into higher employment.
- The vendor job posting data collection processes and algorithms vary and are not systematically linked to Government of Canada hierarchies for occupations and industries. The quality of the job posting data mapping to NOC and NAICS varies with the processes and algorithms used. This impacts the quality of the employment estimates based on the job posting analysis.
- The number of job postings within a particular region of Canada can be very small. When the sample of job postings for an occupation is small, environmental shares are estimated with lower confidence levels and can vary widely from period to period.
- Hiring demand for environmental workers does not directly measure environmental work within the current labour force. Rather, it is a proxy for the environmental employment share. At the present time, given the growing interest in environmental activity throughout the economy, we assume that the share of job postings that are considered environmental is greater than the share of employment that is considered environmental. It is also reasonable to assume, however, that workers currently employed may be increasingly required to gain additional skills and knowledge related to environmental activity and would thereby be considered environmental workers.

A key assumption of ECO Canada's analysis is that job postings reflect the occupations at large. As such, we are planning on conducting further work to refine this methodology to take these issues into account.

APPENDIX B: 100 TOP OCCUPATIONS – ENVIROSHARE, ENVIRONMENTAL EMPLOYMENT IN 2024 AND NET HIRING REQUIREMENTS TO 2033

Occupations marked with an asterisk (*) have been mapped to core environmental workers.

Occupation (NOC)	EnviroShare 2023	Environmental Employment 2024	Expansion Demand 2024-2033	Replacement Demand 2024-2033	Net Hiring Requirements 2024-2033
All Occupations	**6%**	**279,570**	**4,220**	**71,350**	**75,570**
Senior government managers and officials (00011)*	29%	530	30	260	290
Senior managers - financial, communications and other business services (00012)	8%	380	130	220	350
Financial managers (10010)	8%	1,330	-150	390	240
Financial auditors and accountants (11100)	6%	2,940	90	730	820
Financial and investment analysts (11101)	7%	1,230	330	220	540
Financial advisors (11102)	6%	1,720	530	470	1,010
Human resources professionals (11200)*	6%	2,400	-150	460	310
Professional occupations in business management consulting (11201)*	10%	1,840	610	680	1,290
Professional occupations in advertising, marketing and public relations (11202)	6%	2,590	500	370	870
Supervisors, finance and insurance office workers (12011)	8%	1,040	-60	310	250
Supervisors, supply chain, tracking and scheduling coordination occupations (12013)	6%	1,170	30	340	370
Executive assistants (12100)	10%	1,250	-90	450	360
Procurement and purchasing agents and officers (12102)	10%	1,900	-30	580	550

Occupation (NOC)	EnviroShare 2023	Environmental Employment 2024	Expansion Demand 2024-2033	Replacement Demand 2024-2033	Net Hiring Requirements 2024-2033
Administrative officers (13100)*	14%	9,630	-1,880	2,860	990
Administrative assistants (13110)	6%	4,340	-630	1,290	660
General office support workers (14100)	6%	990	310	360	670
Accounting and related clerks (14200)	3%	1,040	370	410	780
Shippers and receivers (14400)	3%	740	150	240	380
Computer and information systems managers (20012)*	9%	1,590	30	480	500
Chemists (21101)	11%	330	140	120	260
Other professional occupations in physical sciences (21109)	32%	400	90	130	210
Biologists and related scientists (21110)*	31%	1,550	230	340	570
Information systems specialists (21222)	5%	2,670	770	720	1,490
Software developers and programmers (21232)	2%	460	180	80	250
Mechanical engineers (21301)*	19%	1,950	-120	340	220
Electrical and electronics engineers (21310)*	25%	2,540	-210	600	390
Chemical engineers (21320)*	21%	500	160	130	290
Industrial and manufacturing engineers (21321)*	18%	770	100	130	230
Other professional engineers (21399)*	42%	3,200	-180	740	560
Chemical technologists and technicians (22100)*	13%	810	100	170	270
Conservation and fishery officers (22113)*	82%	1,120	210	220	430
Computer network and web technicians (22220)	11%	1,270	100	250	340
User support technicians (22221)	9%	3,130	330	740	1,070
Occupational health and safety specialists (22232)	22%	1,360	100	440	540
Construction inspectors (22233)	24%	1,140	80	360	440

Occupation (NOC)	EnviroShare 2023	Environmental Employment 2024	Expansion Demand 2024-2033	Replacement Demand 2024-2033	Net Hiring Requirements 2024-2033
Civil engineering technologists and technicians (22300)*	31%	2,530	400	610	1,000
Electrical and electronics engineering technologists and technicians (22310)	15%	1,470	200	470	670
Electronic service technicians (household and business equipment) (22311)	11%	1,180	210	460	670
Nursing coordinators and supervisors (31300)	8%	610	40	170	200
Registered nurses and registered psychiatric nurses (31301)	1%	990	150	200	360
Nurse aides, orderlies and patient service associates (33102)	6%	3,920	1,190	1,000	2,190
Other managers in public administration (40019)	28%	2,070	1,030	1,130	2,150
Managers in social, community and correctional services (40030)*	6%	610	90	240	330
Lawyers and Quebec notaries (41101)*	10%	2,700	210	550	750
University professors and lecturers (41200)*	13%	2,480	260	960	1,220
Post-secondary teaching and research assistants (41201)	7%	1,150	450	100	550
College and other vocational instructors (41210)	6%	2,510	120	720	850
Natural and applied science policy researchers, consultants and program officers (41400)*	14%	750	220	160	390
Health policy researchers, consultants and program officers (41404)	18%	1,070	360	240	600
Other professional occupations in social science (41409)	66%	1,240	-30	490	470
Police officers (except commissioned) (42100)*	7%	1,080	360	420	780
Firefighters (42101)*	24%	1,750	-110	590	480
Social and community service workers (42201)	2%	1,000	70	200	280

Occupation (NOC)	EnviroShare 2023	Environmental Employment 2024	Expansion Demand 2024-2033	Replacement Demand 2024-2033	Net Hiring Requirements 2024-2033
Early childhood educators and assistants (42202)	1%	740	130	170	300
Registrars, restorers, interpreters and other occupations related to museum and art galleries (53100)	66%	1,770	410	500	900
Program leaders and instructors in recreation, sport and fitness (54100)	7%	2,400	810	310	1,130
Retail and wholesale trade managers (60020)	4%	2,990	80	1,150	1,230
Restaurant and food service managers (60030)	3%	580	110	170	270
Accommodation service managers (60031)	5%	560	200	300	500
Managers in customer and personal services (60040)	20%	940	-30	290	260
Retail sales supervisors (62010)	3%	1,270	480	310	790
Technical sales specialists - wholesale trade (62100)	8%	1,910	590	600	1,190
Insurance agents and brokers (63100)	3%	440	130	120	240
Cooks (63200)	5%	2,050	370	420	790
Retail salespersons and visual merchandisers (64100)	1%	1,210	130	220	350
Sales and account representatives - wholesale trade (non-technical) (64101)	6%	3,450	580	940	1,520
Other customer and information services representatives (64409)	2%	870	270	200	470
Security guards and related security service occupations (64410)	6%	1,570	250	410	660
Cashiers (65100)	1%	760	130	120	250
Store shelf stockers, clerks and order fillers (65102)	2%	1,470	110	220	330
Food and beverage servers (65200)	2%	740	250	100	350
Food counter attendants, kitchen helpers and related support occupations (65201)	2%	1,930	190	240	430
Light duty cleaners (65310)	2%	1,560	290	580	870

Occupation (NOC)	EnviroShare 2023	Environmental Employment 2024	Expansion Demand 2024-2033	Replacement Demand 2024-2033	Net Hiring Requirements 2024-2033
Janitors, caretakers and heavy-duty cleaners (65312)	3%	550	110	210	320
Construction managers (70010)*	21%	4,460	-360	1,130	770
Home building and renovation managers (70011)	28%	6,870	1,290	2,480	3,770
Facility operation and maintenance managers (70012)*	15%	800	40	300	340
Contractors and supervisors, mechanic trades (72020)*	13%	2,140	-150	710	560
Contractors and supervisors, heavy equipment operator crews (72021)	20%	2,190	-380	660	280
Supervisors, railway transport operations (72023)	58%	810	40	250	290
Supervisors, motor transport and other ground transit operators (72024)	8%	540	110	180	280
Welders and related machine operators (72106)	3%	700	120	190	310
Industrial electricians (72201)	13%	490	150	160	310
Electrical power line and cable workers (72203)	19%	460	120	100	210
Plumbers (72300)	26%	1,890	510	290	810
Construction millwrights and industrial mechanics (72400)*	10%	1,750	160	550	700
Heavy-duty equipment mechanics (72401)	5%	630	90	150	240
Automotive service technicians, truck and bus mechanics and mechanical repairers (72410)	3%	1,060	0	240	240
General building maintenance workers and building superintendents (73201)	11%	2,040	-150	890	740
Transport truck drivers (73300)	3%	2,230	230	720	960
Railway conductors and brakemen/women (73311)	48%	660	180	180	350

Occupation (NOC)	EnviroShare 2023	Environmental Employment 2024	Expansion Demand 2024-2033	Replacement Demand 2024-2033	Net Hiring Requirements 2024-2033
Heavy equipment operators (73400)	6%	960	20	250	270
Public works maintenance equipment operators and related workers (74205)	17%	1,620	-60	390	330
Boat and cable ferry operators and related occupations (75210)	30%	420	130	110	240
Managers in agriculture (80020)	6%	1,510	-290	590	300
Manufacturing managers (90010)*	12%	3,300	-140	1,050	910
Supervisors, petroleum, gas and chemical processing and utilities (92011)	16%	430	60	140	210
Power engineers and power systems operators (92100)	11%	340	130	90	220
Industrial sewing machine operators (94132)	7%	420	80	180	260

CONTACT US

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ECO Canada
Suite 400, 105 12 Avenue SE
Calgary, Alberta T2G 1A1

P : 1-800-890-1924
E : research@eco.ca
W : eco.ca

We are located in the heart of Calgary, Alberta, and have representatives located in Vancouver, Edmonton, Windsor and Halifax.

Visit our website or contact us for more information.

@ecocanada

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