Ministry of Natural Resources

State of the Aggregate Resource in Ontario Study Paper 3 – The Value of Aggregates

Report

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State of the Aggregate Resource in Ontario Study Paper 3 – The Value of Aggregates

FINAL REPORT

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Project Number:

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Date:

December 18, 2009

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December 18, 2009

Brian Hollingsworth
Aggregate and Petroleum Resources Section, 5th Floor South Tower
Ontario Ministry of Natural Resources
300 Water St.
P.O. Box 7000
Peterborough ON K9J 8M5

Dear Brian Hollingsworth:

Project No: 112870/60119329

Regarding: SAROS Paper 3 – The Value of Aggregates Draft Final Report

Please find attached the final report of the SAROS Paper 3 – The Value of Aggregates. We are providing four printed copies of our report and we have made the report available electronically to the MNR.

Please don't hesitate to contact me with any questions or if further clarification is required. This has been a highly challenging and stimulating assignment, and we thank you for the opportunity to have worked on this project.

Sincerely,
AECOM Canada Ltd.

JME Maxwell MBA, PMP
Jme.maxwell@aecom.com

JM:lb
Encl.

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Report Prepared By:	**Report Reviewed By:**
	
Andy Keir, M.Sc. (Econ), MCIP, RPP	JME Maxwell, MBA, PMP

Glossary

Aggregate - The *Ontario Aggregate Resources Act* (ARA*) and Regulation 244/97* (1990), defines aggregates as gravel, sand, clay, earth, shale, stone, limestone, dolostone, sandstone, marble, granite, rock or other prescribed material

Agriculture Land Capability Class Descriptions (Agriculture and Agri-Food Canada, 2008) include -

- **Class 1** - Soils in this class have no significant limitations in use for crops;
- **Class 2** - Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices;
- **Class 3** - Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices;
- **Class 4** - Soils in this class have severe limitations that restrict the range of crops or require special conservation practices;
- **Class 5** - Soils in this class gave very severe limitations that restrict their capability in producing perennial forage crops, and improvement practices are feasible;
- **Class 6** - Soils in this class are capable only of producing perennial forage crops, and improvement practices are not feasible;
- **Class 7** - Soils in this class have no capacity for arable culture or permanent pasture; and
- **Class 0** - Organic Soils (not placed in capability classes).

ANSI – Area of Natural and Scientific Interests.

Biodiversity - defined by the Convention on Biological Diversity as “the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems” (United Nations 1992:Article 2).

CPCA – Canadian Portland Cement Association.

Direct Effects - Initial changes in employment, income and output resulting from production spending in a subject sector.

Downstream Effects – Effects in sectors that purchase goods and services from a subject sector where initial production spending took place.

Economic Outputs – Includes Gross Domestic Product (GDP), Labour Income, Full Time Equivalent (FTE) jobs and Gross Output.

Ecosystem Goods and Services – represent the benefits human populations derive (such as food or waste assimilation), directly or indirectly, from ecosystem functions.

Ecosystem Services – the benefits people obtain from ecosystems. They are subdivided in to five categories:

- **Supporting Service** – provide the basic ingredients that sustain all other ecosystem services;
- **Provisioning Services** – production of food, fiber, energy, genetic resources;
- **Regulating Services** – Regulation of climate, air, water quality, land stability, waste, pests, pollination;
- **Cultural Services** – Research, education, spiritual, recreational benefits; and
- **Preserving Services** – Guarding against uncertainty through the maintenance of biodiversity.

Edge Effects – occur naturally and are induced by human involvement by fractionating a natural area into smaller habitats. The fragmented habitats' new edges experience a different environment , which can change the species composition, gradients of moisture, sunlight, soil, air temperature, wind speed, etc.

FOB (Freight on Board) - Pricing a commodity to include the cost of loading onto freight vehicles at the point of sale but excluding the cost of transporting the goods from the point of sale to the buyer.

Full-Time Equivalent (FTE) Jobs - A ratio indicating the level of employment associated with a business where an FTE of 1.0 represents one person working at full time hours and an FTE of 0.5 represents one person working for half of that time.

Gross Domestic Product (GDP) – The value of all currently produced final goods and services created in a particular time period. This can be considered for the entire economy, or by industry.

Gross Output – The total value of sales related to a good or service, including the value intermediary goods or services used in their production.

Indirect Effects – Subsequent changes in employment, income, and output in all economic sectors that support sectors that are directly affected.

Induced Effects – Subsequent changes in employment, income and output in all economic sectors as a result of income spending by employees in the direct and indirect sectors.

Labour Income – the sum of wages and salaries plus supplementary income.

Model Shock – a "model shock" is the term used for commissioning Statistics Canada to run their Interprovincial Input / Output model for a specific industry account or commodity group using a specified output amount in a selected province. This calibration and subsequent model run, produce a set of multipliers that show how the specified output impacts the Canadian economy directly and indirectly across all industry sectors and commodity groups .

Multipliers - factors of proportionality that measure the effect of one variable on another. For example a $1 million in gross output may result in $1.3 million of GDP. The gross output to GDP multiplier is therefore 1.3.

North American Industry Classification (NAIC) – Standard classification system used by national statistical agencies to collect, analyze, code and report upon industry-related activity.

OMB – Ontario Municipal Board.

PDE – Perceived Direct Experience.

Pit - Land or land under water from which unconsolidated aggregate (usually sand and gravel) is being or has been excavated.

Quarry - Land or land under water from which consolidated rock (bedrock) is or has been excavated via blasting.

Social Value - the value (positive, negative or neutral) that people assign to their environment (building or place), a product or a service.

Statistics Canada Input / Output (Stats Can I/O) Models – Portray the economy of a geographic area for a fixed period of time. The models divide all economic activity into sectors. They initially calculate the effect of spending to produce one dollar's worth of output in a subject economic sector. Subsequently, they calculate the "rippled" effects of this first expenditure in all other sectors of the economy that support the subject sector.

Taxes – the taxes revered to in this document include the following:

Federal

- Federal trading profits on lottery and race tracks
- Federal gas tax
- Federal duty tax
- Federal air tax
- GST

Provincial

- Provincial gallon tax
- Provincial trading profits
- Provincial gas tax
- Provincial amusement tax
- P.S.T
- H.S.T

Municipal

- Municipal amusement tax
- M.S.T

TOARC – TOARC was incorporated in 1997 to act as trustee of the Aggregate Resources Trust, a trust created under the authority of the Aggregate Resources Act and pursuant to a trust indenture between the Corporation and the Minister of Natural Resources for the Province of Ontario.

TOARC has assumed, in the public interest, the responsibilities provided for in an indenture between the Minister of Natural Resources and the Corporation as of the 27th day of June 1997. Those responsibilities include the collection and disbursement of aggregate fees, the rehabilitation of abandoned pits and quarries, the rehabilitation of sites where licences or permits have been revoked, the collection and publication of production statistics and other information and the education and training of those in or interested in the aggregate industry.

Upstream Effects – Effects in sectors that supply goods and services to a subject sector where initial production spending took place.

Executive Summary

The focus of this paper is to determine the value of aggregates in the Province of Ontario. It is one of six papers commissioned by the Ministry of Natural Resources to look at the state of aggregate resources in the province of Ontario. As a collective these six papers are meant to significantly update and expand on the subject matter covered in the 1992 study, "Aggregate Resources of Southern Ontario - a State of the Resource Study" (Planning Initiatives, 1992). The terms of reference for this subject paper specified three areas of investigation.

- Economic Value
- Social Value
- Environmental Value

The economic value of aggregates in Ontario was determined by examining the upstream and downstream flows of aggregates. In the upstream analysis, sector production volumes and values were calculated and then converted later into measures of economic output (i.e. GDP, labour income, full time equivalent (FTE) jobs and gross output). In the downstream perspective assumptions were made based on primary and secondary information about the flow of mineral aggregate to end use sectors. These flows were then valued and converted to measures of economic output. In both the upstream and downstream analyses extensive use was made of information derived from $1 billion industry sector "shocks" of Statistics Canada's Inter-provincial Input Output Model (Stats Can I/O Model). The resulting multipliers were then used as a basis for calculating upstream and downstream economic outputs.

In 2007, aggregate production in the Province of Ontario inclusive of recycling and export was in the order of 181,000,000 tonnes and new production totalled almost 164,000,000 tonnes. The economic value of this production was approximately $1.3 billion.

The aggregate industry generates both upstream and downstream effects in the provincial economy. The upstream effects include spending by the aggregate industry on its industry supply chain and the industry itself. In 2007, taking into account direct, indirect and induced effects the sector generates approximately:

- $1.6 billion of GDP
- $827 million of labour income
- 16,600 fulltime jobs
- $2.9 billion of gross output

The downstream economic effects include economic effects in sectors that purchase goods and services from a subject sector where initial production spending took place. The 2007 aggregate production volumes were tracked downstream to 16 end use sectors. These sectors were subsequently grouped into three categories: Cement and Concrete, Other Products and Construction.

Approximately 21% of the provincial aggregate production, by value, flows to industries in the cement and concrete category and 57% to various forms of construction. The remaining 22% is destined for a suite of industry sectors in the Other Products category. The economic output attributable to aggregate production in the downstream sectors is:

- $1.6 billion of GDP
- $940 million of labour income
- 18,300 fulltime jobs
- $3.2 billion of gross output

In terms of the whole industry categories themselves, the majority of the value add (GDP) falls to construction (59%), The cement and concrete category accounts for 22% and the other products category 19%. The downstream industry categories and sectors referred to in this study generate the following economic outputs:

- $22 billion of GDP
- $13 billion of labour income
- 245,000 fulltime jobs
- $44.7 billion of gross output

This paper concluded that aggregate plays an important role in the Ontario economy. Although it is a low price commodity, its use is in a very high volume. It is an essential ingredient for the preceding end use industry categories. And these categories in turn play a large role in the provincial economy.

Aggregate moves to a wide variety of end users and it is an essential ingredient in the industry sectors associated with construction and manufacturing. Although it is not the dominant input in most sectors in terms of value, it is nevertheless an essential input and one for which there is no obvious substitute at the present time.

To further examine the economic impacts of aggregates, case studies were identified by examining the list of 25 infrastructure projects in Ontario with the largest cost or value between 2005 and 2009. Of the 25 largest infrastructure projects the vast majority were energy and hospital/healthcare projects. Almost half of these projects took place in the Greater Toronto Area.

A short list of five infrastructure projects was selected for case studies. Once identified, project information was gathered through unstructured interviews with relevant Project Managers and other Project Contacts. These case studies were selected through a qualitative assessment to find projects that would be aggregate intensive, represent a wide range in project sizes, project types and cover a wide geographic area.

Through the assessment of the value of aggregates in five case studies selected we can conclude that the value of aggregates in infrastructure projects is a relatively small component of the total project. For each of the five case studies that were looked at, all of the projects had a readily available local source of aggregate to be used in the project. Although the value of aggregates is a relatively small component of project value, it is a product that does not have many readily available substitutes and without aggregates available it is unclear how these major projects would proceed.

The social value associated with aggregates and aggregate extraction was examined to facilitate a better understanding of its role in society in terms of the level of importance and costs and benefits. In this area of the study, two main approaches were used to understand how Ontarians value the built environment and the social costs and benefits associated with aggregate extraction. The first approach was through Public Attitide Research that was administered by telephone to 1,420 Ontario residents. The second approach was a content analysis of recorded public comments related to aggregate extraction from Ontario Municipal Board (OMB) hearings and from 31MNR licence applications. These 31 licence applications were supplied by the MNR to represent the most recent licence applications and were also used in the Environmental Value section of this paper. Approximately nine cases from the Niagara Escarpment Commission (NEC) were also reviewed, though not included in the content analysis.

The social costs and benefits of aggregate extraction were assessed through the telephone surveys of Ontario residents. From the perspective of community well-being, respondents in general do not rank development and infrastructure projects highly among the other things that they value about their community. However, when respondents were asked to rate the importance of various development and infrastructure projects, many were ranked with high importance. This leads us to conclude that respondents did not seem willing to trade the most important things that they value about their community for development and infrastructure projects.

Respondents that live near a pit or quarry were more likely to name nuisance effects as a social cost of aggregate extraction. However, respondents that live near an aggregate truck transportation route were more likely to state economic aspects of aggregate extraction as a social benefit. Based on the findings from the geographical variation study, we can conclude that respondents who live in an urban area (such as Area 4 – GTA) rate parks and trails as an important aspect of their community. Also, respondents from the GTA highlighted new institutional buildings as important. Respondents who live in the far northeast and northwest areas of the Canadian Portland Cement Association geographic

areas are most likely to name development and infrastructure projects as a benefit of aggregate extraction.

As a result of the content analyses from a combination of the MNR (31 cases) and OMB data (76 cases), it is clear that the three most frequently reported public complaints are regarding noise pollution, truck traffic and volume and air pollution and dust. These themes were also common among the case files from the NEC, though the NEC files were not coded and included in the content analysis. The content analysis represents public concerns from a specific group of people who are directly affected by the aggregate activities. However, when surveying a more statistically significant representation of the Ontario population (through the Public Attitude Research), environmental impacts emerge as the main costs to aggregate extraction. Therefore, the results from the different approaches of data collection are varied.

Finally, the base knowledge of the aggregate industry seems to be varied and respondents are not very familiar with the aggregate industry. This lack of familiarity indicates that the aggregate industry is not “top of mind” for a statistically significant representation of the Ontario population and there are opportunities to build awareness and education amongst the public.

The environmental value of aggregates was also evaluated in this paper. The importance of aggregates in achieving environmental objectives are often overlooked when contrasted to the more intuitive assessments associated with the removals of forest and wildlife habitat. A careful analysis of the less visible, but equally important, environmental uses of aggregate is important in order to balance the scale and intensity of environmental effects and to determine the net environmental value of the resource in the context of other landscape resources.

This paper presents a comprehensive list of the ecosystem services provided by the use of aggregates. This is illustrated in a matrix that details the nature of the aggregate, use and the environmental benefit accrued to catalogue the ecosystem services affected by the subject 31 licences, initial impacts, rehabilitation targets and net impacts to environmental value over a specified time frame.

The ecosystem services analyzed were examined at the level of primary services, that is, what the aggregate was used for, rather than secondary services enabled (i.e., buildings, roads, etc.). The matrix was broken down into two categories: *Processes,* in which the products of aggregate extraction are used and *Spatial,* where the extraction itself contributes ecosystem services as a consequence of the ultimate rehabilitation of extraction sites and when the aggregates are used for the creation of fixed structures.

Under the *Processes* heading the majority of the ecosystem services were categorized as regulating. This can be explained by the fact that the practices/procedures that are used by Human Land Use Change; Water Quality Treatment; Removal of Anthropogenic Pollutants; Uses in Mines; Landfills and Waste Disposals; and Maintenance of Biodiversity are used to regulate ecosystem processes. The majority of the ecosystem services provided by under the *Spatial* headings were cultural.

The bulk of the negative effects of aggregates on eco-services fall under either regulating (likely due to the associated bi-products of aggregate processing) and preserving services (likely due to the permanent human impact that buildings, roads, dams, etc. have on the developed landscape).

Of the 31 licences analysed, it was concluded that the sites were largely agricultural and environmental features were almost entirely preserved indicating that the legislation, with respect to natural environment, is having an effect on the outcomes. A small amount of good quality habitat was affected due to quarrying. If habitat was affected, on balance it was replaced through rehabilitation efforts. Across the sample of licences, the most significant losses were agricultural land, balanced between prime agricultural lands (Classes 1, 2 and 3 soils) and other agricultural lands.

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1. Introduction

1.1 Objectives of the Study

The focus of this paper is to determine the value of aggregates in the Province of Ontario. It is one of six papers commissioned by the Ministry of Natural resources to look at the state of aggregate resources in the province of Ontario. As a collective these six papers are meant to significantly update and expand on the subject matter covered in the 1992 study, "Aggregate Resources of Southern Ontario - a State of the Resource Study" (Planning Initiatives, 1992). The terms of reference for the subject paper specified 3 areas of investigation.

- Economic Value
- Social Value
- Environmental Value

The principal objectives to be addressed in the Economic Value section were five-fold:

1) Estimate the annual value added of aggregate to the Province of Ontario
2) Estimate the current value of some existing infrastructure recently built or revitalized within the province
3) Determine the employment generated by aggregate production and consumption
4) Determine the key end use industry sectors that consume aggregate and their overall economic value.
5) Determine the contribution value of aggregate to these end use industry sectors.

In the Social Value section there were three primary objectives:

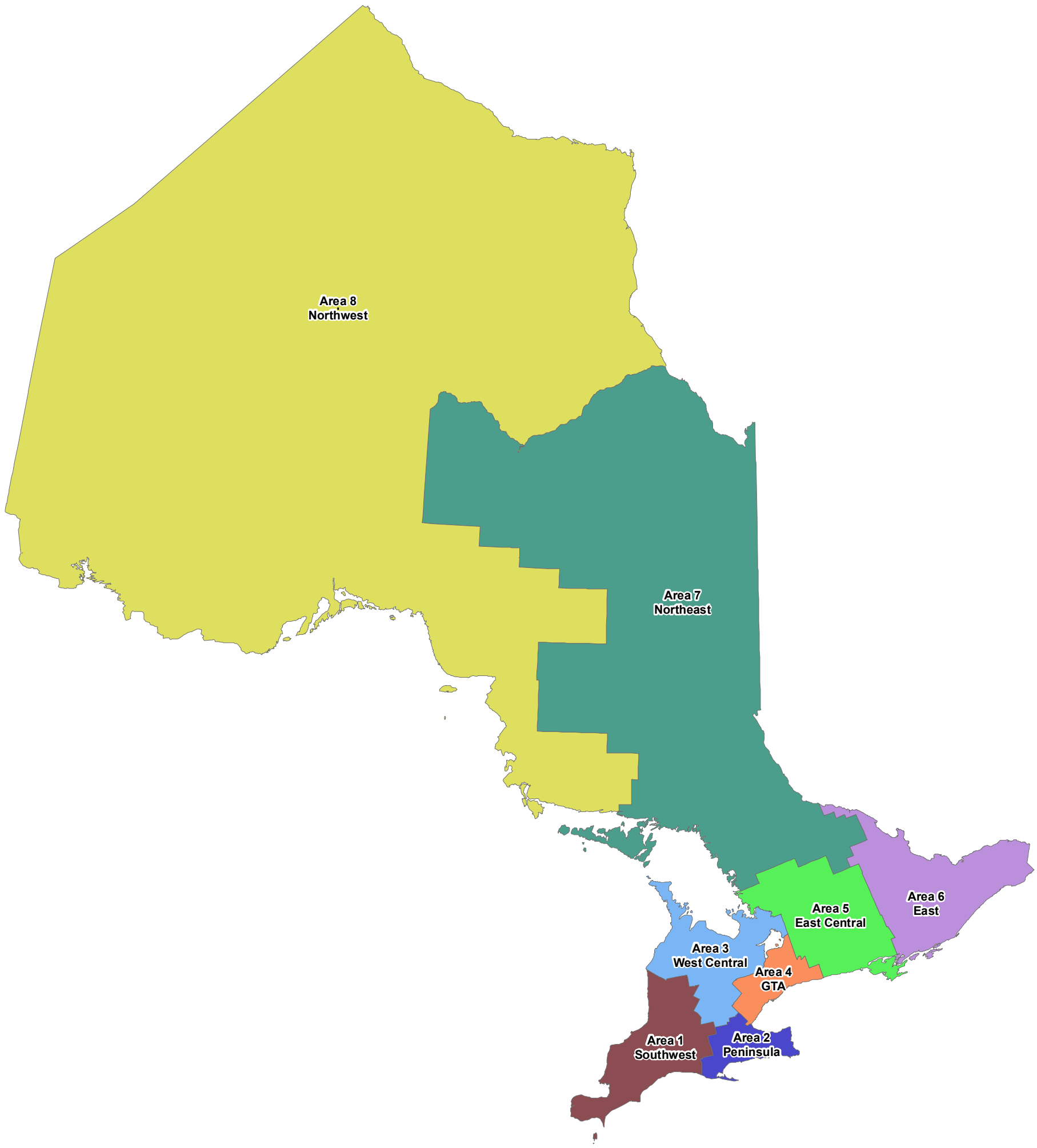
1) Determine how the public values the built environment
2) Understand the social cost if elements of the built environment were not present
3) Determine public attitudes with respect to aggregate extraction

The section addressing Environmental Values had two objectives:

1) Provide an overview of the environmental implications of aggregate extraction
2) Determine the environmental costs/impacts of aggregate extraction on the selected features of the natural environment in Ontario.

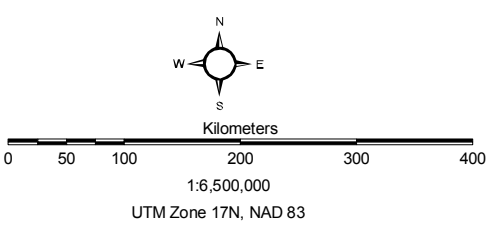
1.2 Scope of the Study

The scope of this study is province-wide. It looks at aggregate production and consumption from a variety of perspectives to assess and draw conclusions on the value of this resource within the province. Where possible, portions of the analysis are presented in terms of the Canadian Portland Cement Association (CPCA) geographic regions (Figure 1-1). This articulation provides a sense of industry scale within different areas of the province. In the discussions that immediately follow, the scope of analysis is discussed is for each of the study components.



Area 1 Southwest	Area 2 Peninsula	Area 3 West Central	Area 4 GTA	Area 5 East Central	Area 6 East	Area 7 Northeast	Area 8 Northwest
Essex	Niagara	Bruce	Toronto	Kawartha Lakes	Prescott & Russell	Nipissing	Algoma
Chatham-Kent	Brant	Grey	Peel	Peterborough	Leeds & Grenville	Parry Sound	Thunderbay
Lambton	Haldimand	Simcoe	York	Haliburton	Stormont, Dundas,	Timiskaming	Kenora
Elgin	Norfolk	Dufferin	Durham	Northumberland	& Glenngary	Cochrane	Rainy River
Middlesex	Hamilton	Wellington	Halton	Hastings	Frontenac	Sudbury District	
Huron		Waterloo		Prince Edward	Greater Ottawa	Greatter Sudbury	
Perth				Muskoka	Lanark	Manitoulin	
Oxford					Renfrew		
					Lennox & Addington		

Basemapping from Ontario Ministry of Natural Resources



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UTM Zone 17N, NAD 83

Canadian Portland Cement Association (CPCA) Geographic Areas

December 2009
Project 60119329

AECOM

Figure 1-1

Map Document: (N:\projects\0-aecom\112870\2009\Final\GISSpatial\MXDs\ReportMXDs\112870PortlandCementAreas.mxd)
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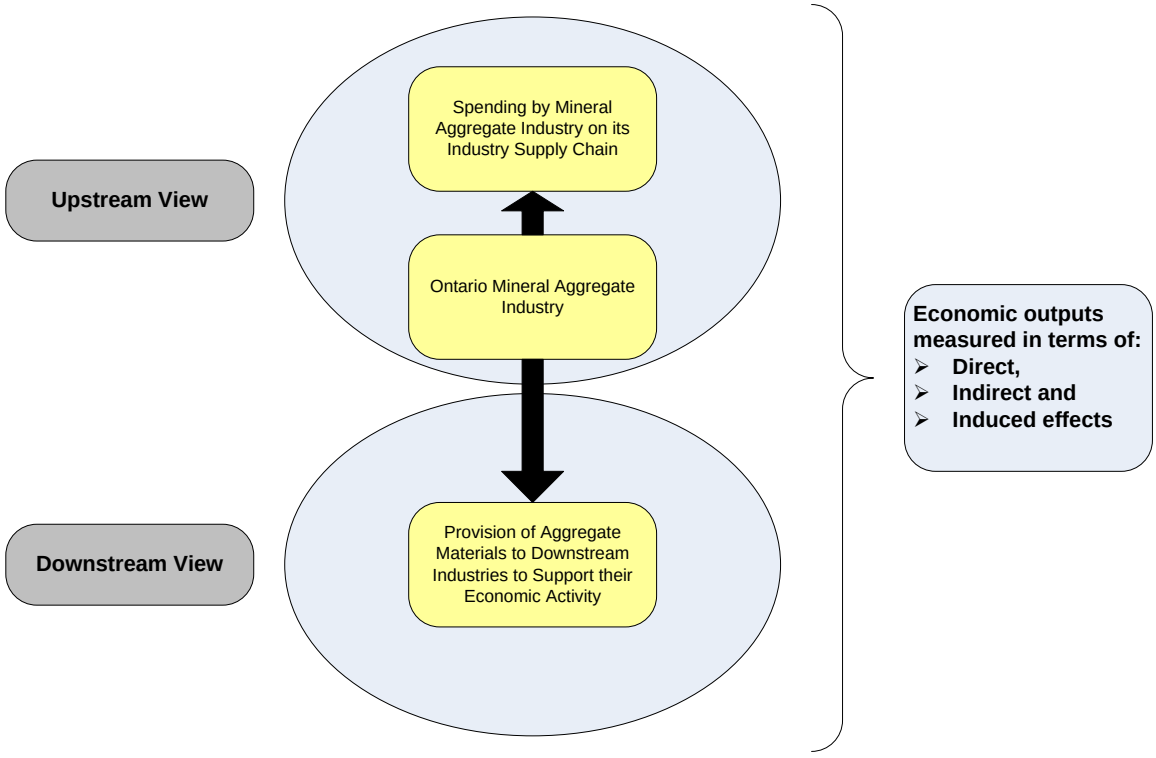
1.2.1 Economic Analysis

The economic value of the mineral aggregate industry in the Province of Ontario is derived from two views. The upstream view incorporates the industry sector itself, as well as the industry sectors that support it. The second view involves looking downstream to the industry sectors that use mineral aggregate in the production of goods and products.

Figure 1-2 illustrates the two views. For the purposes of this study we have used the terms "upstream" and "downstream" in the discussions of economic value that ensue. In combination, the values derived from these two perspectives give an overall indication of the value of the aggregate industry in the Province of Ontario.

Figure 1-2 Aggregate Upstream and Downstream Flows



Source: AECOM, 2009

1.2.2 Case Studies

A selection of case studies of aggregate-intensive projects Ontario were selected to help provide an understanding of the value of projects that are enabled through the use of readily available aggregate resources. They also provide an appreciation for the volumes and value of aggregate consumed and societal benefits that these projects enable.

1.2.3 Social Value

For the purposes of this study, social value is defined as the value (either positive, negative or neutral) that people assign to their environment (building or place), a product or a service. The purpose of assessing the social value associated with aggregates and aggregate extraction is to facilitate a better understanding of aggregates' role in society in terms of the level of importance and their costs and benefits. The social value component of this paper is presented according to three broad areas of interest. These are:

1. The Social Value of Public Places
2. The Social Costs of Not Having Available Resources for Infrastructure and Roads
3. The Social Costs of Aggregate Extraction in Ontario

1.2.4 Environmental Value

This report attempts to present a comprehensive list of the ecosystem services provided by the use of aggregates, a matrix that details the nature of the aggregate, the use and the environmental benefit accrued will be provided, and a catalogue of the ecosystem services affected by the target licences, initial impacts, rehabilitation targets and net impacts to environmental value over a specified time frame.

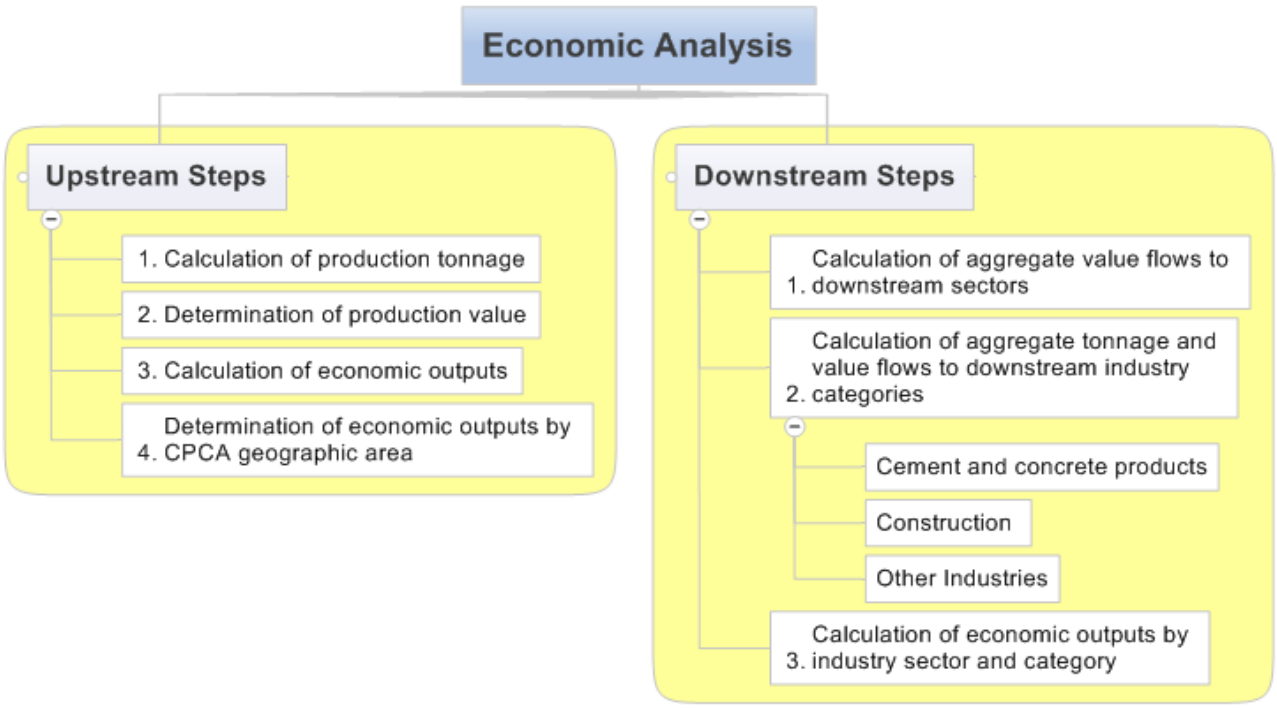
The context of this section will provide an overview of the environmental value of aggregates to the Province of Ontario through extraction and downstream use.

1.3 Study Methodology

1.3.1 Economic Analysis

As previously discussed, determining the economic value of aggregates in Ontario entailed a focus on upstream and downstream perspectives. Assessment of the value of these perspectives involved a number steps (refer to Figure 1-3). In the upstream analysis it was necessary to calculate sector production volumes and values and then convert the latter into measures of economic output (i.e. GDP, labour income, full time equivalent (FTE) jobs and gross output). In the downstream perspective assumptions were made based on primary and secondary information about the flow of mineral aggregate to end use sectors. These flows were then valued and converted to measures of economic output. In both the upstream and downstream analyses extensive use was made of information derived from $1 billion industry sector "shocks" of Statistics Canada's Inter-provincial Input Output Model (Stats Can I/O Model). The resulting multipliers were then used as a basis for calculating upstream and downstream economic outputs

Figure 1-3 Economic Analysis – Overview of Methodology



Source: AECOM, 2009

1.3.1.1 Upstream – Production Tonnage

The determination of mineral aggregate production in Ontario was derived by review and tabulation of information from the annual "Mineral Aggregates in Ontario" reports produced by The Ontario Aggregates Resources Corporation (1998 through 2007). In order to facilitate the analysis a model was developed to enable compilation and manipulation of the production information. The model configuration is illustrated in the figure that follows. It calculated production tonnages by CPCA geographic areas for the following four categories of mineral aggregate:

- Sand and gravel;
- Crushed stone;
- Clay shale; and
- Other.

The most recent figures (2007) were used in the subsequent analyses involving the calculation of upstream and downstream economic outputs.

Figure 1-4 Ontario Mineral Aggregate Flows

Source: AECOM, 2009

1.3.1.2 Upstream – Production Value

It was difficult to obtain information on the value of Ontario aggregate production from primary sources. The principal source of information used in this study to derive values was a report published by the Ontario Ministry of Northern Development, Mines and Forestry (2007) entitled, "Ontario Mineral Exploration Statistics". This document provided production values for the following mineral aggregates over the period 1998 to 2007.

- Sand and gravel
- Stone
- Other material
    - Gypsum
    - Quartz
    - Lime

The values derived from the Ontario Ministry of Northern Development, Mines and Forestry (2007) in conjunction with the tonnages calculated earlier created the platforms for determining upstream and downstream economic outputs.

1.3.1.3 Upstream – Sector Economic Outputs and CPCA Geographic Area Economic Outputs

The aggregate sector outputs were produced using the information from the previous two steps and the multipliers derived from sector shocks of the Stats Can I/O Model. A purpose built model was constructed in this step to perform the calculations. It displayed economic output information in terms of direct, indirect and induced effects for the four categories of economic output previously mentioned (i.e. GDP, labour income, FTE jobs and gross output). It also calculated tax implications according for federal, provincial and municipal regimes. The model also distributed the economic outputs across the eight CPCA geographic areas.

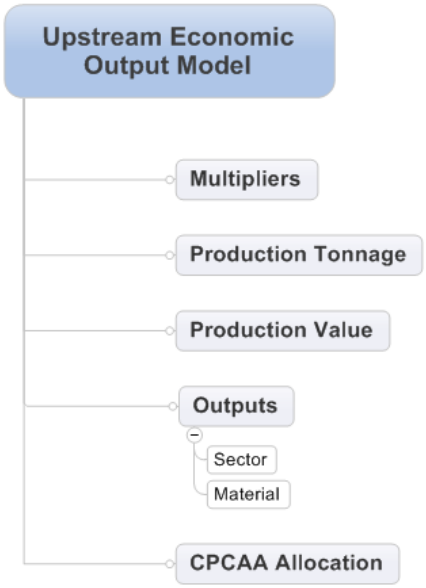
The North American Industry Classification (NAIC) System sectors shocked by Statistics Canada to derive direct and indirect multipliers for the upstream calculations were:

- 212310 – Stone Mining and Quarrying
- 212320 – Sand, Gravel, Clay and Ceramic and Refractory Minerals Mining and Quarrying
- 21239A - Miscellaneous Non Metallic Mineral Mining and Quarrying

A fourth shock was also performed on personal expenditures in order to derive the information needed to calculate the induced effects generated by income spending.

The model structure for this part of the analysis is illustrated in Figure 1-5.

Figure 1-5 Upstream Economic Output Model



Source: AECOM 2009

1.3.1.4 Downstream – Sector Flow

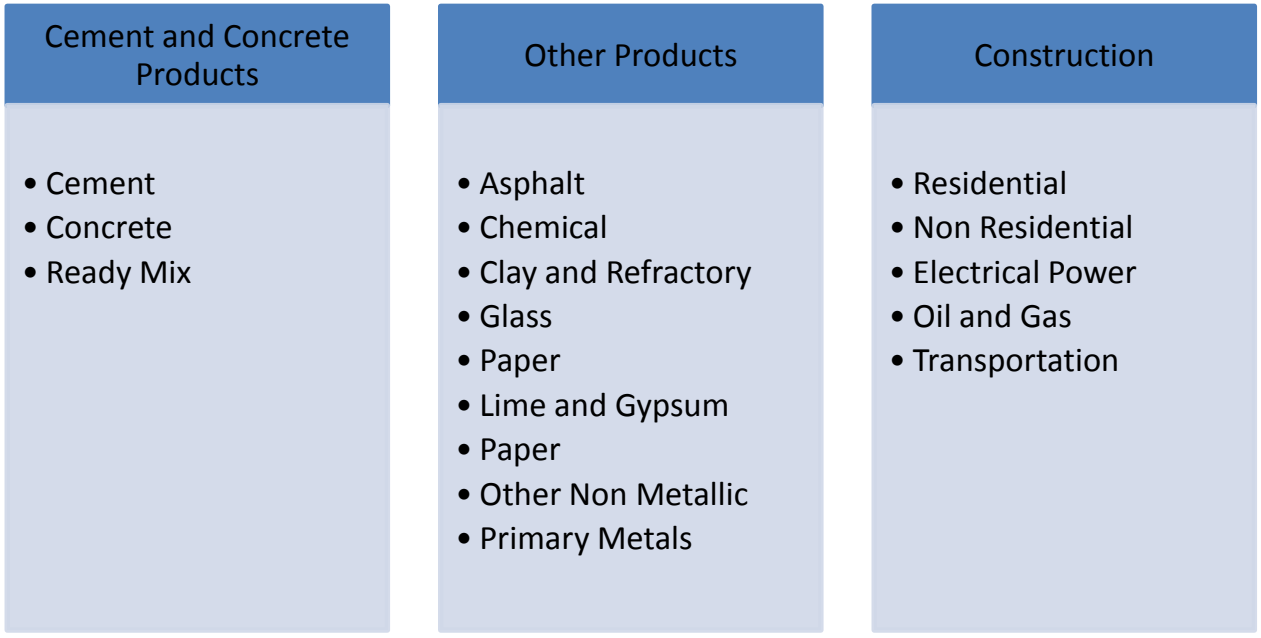
The downstream sectors addressed in this study are listed below by NAIC number and name. For the purposes of this study it was assumed that the industry sectors listed more or less accounted for all aggregate consumption. It is recognized the other industry sectors may also consume aggregate but on an order of magnitude basis it was assumed that their consumption would be relatively minor.

- 2300A0 Residential Building Construction
- 2300B0 Non-residential Building Construction
- 2300C0 Transportation Engineering Construction
- 2300D0 Oil and Gas Engineering Construction
- 2300E0 Electric Power Engineering Construction
- 322 Paper Manufacturing
- 325 Chemical Manufacturing
- 324120 Asphalt Paving, Roofing Material
- 327310 Cement Manufacturing
- 3273A0 Concrete Product Manufacturing

- 327320 Ready Mix Manufacturing
- 327100 Clay Product and Refractory Manufacturing
- 327200 Glass and Glass Product Manufacturing
- 327400 Lime and Gypsum Product Manufacturing
- 327900 Other Non-metallic Mineral Product Manufacturing
- 331 Primary Metal Manufacturing

The industry sectors were subsequently grouped into three categories for purposes of data tabulation and analysis. Figure 1-6 sets out the category groupings.

Figure 1-6 Grouped Downstream Sectors



Source: AECOM, 2009

The Stats Can I/O model was shocked with a $1 billion output value for each of the highlighted industry sectors. The I/O commodity tables for each sector were then studied to determine the GDP value of sand and gravel, stone and other aggregates highlighted in the shock. Summing all the GDP values for aggregate across all the sectors yielded a total GDP value which in turn permitted an overall apportionment of aggregate by industry sector and aggregate category.

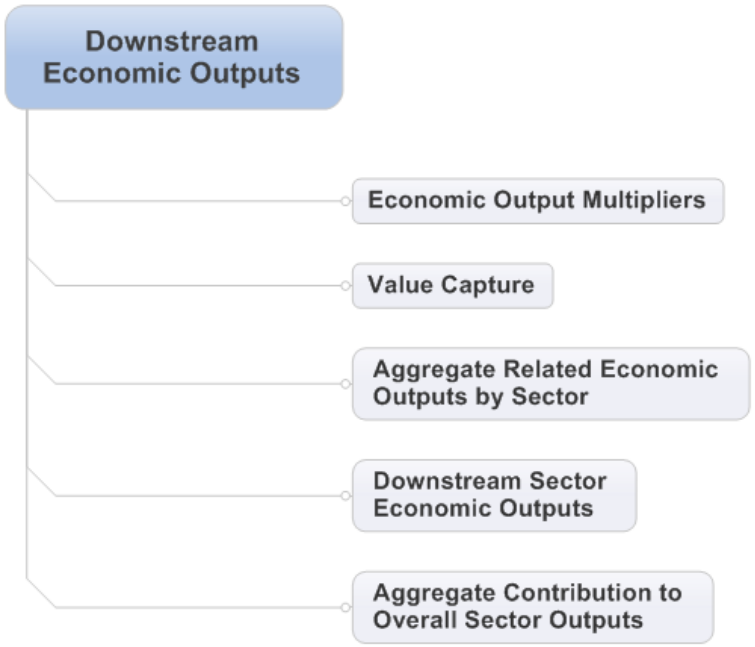
1.3.1.5 Downstream - Sector Contributions

Following on from the analysis and calculations in the preceding step the value flow of aggregate to the different downstream industry sectors was calculated. This calculation involved an apportionment of the mineral aggregate production value derived in the upstream analysis (refer to 1.3.1.2 - Upstream Production Value).

1.3.1.6 Downstream – Economic Outputs

The final part of the economics analysis entailed the calculation of downstream industry sector economic outputs. Direct indirect and induced multipliers derived from the sector shocks of the Stats Can I/O model were used, coupled with the value flow apportionments of aggregate material discussed above. As in previous steps a model was developed to help perform the calculations and manipulate the data. The model structure is set out in Figure 1-7. The end product was a determination of the percentage value of aggregate relative to the overall economic output of each industry sector.

Figure 1-7 Downstream Economic Outputs



Source: AECOM, 2009

1.3.2 Case Studies

Appropriate case studies were identified by examining the list of 25 infrastructure projects in Ontario with the largest cost or value between 2005 and 2009. To be included in the list of projects considered for case studies, projects needed to be under construction in the identified period or have had achieved financial close. From this list of 25 projects, 5 case studies were selected for in-depth examination through qualitative assessment to find aggregate intensive projects, over a wide geographic area and that were inclusive of a range of project types.

Once identified, project information was gathered through informal interviews with relevant Project Managers and other Project Contacts. These informal interviews sought to gain an understanding of the types of aggregate inputs used (or estimated for use) in these projects, their costs and sources. In some cases, not all the information was available. These data were used to calculate the economic impacts of each case study using the methodology identified in section 1.3.1.6.

1.3.3 Social Value

1.3.3.1 Overview

In this area of the study, two main approaches were used to gather and collect data from the public to understand how Ontarians value the built environment and the social costs and benefits associated with aggregate extraction. The first approach was public attitude research, through the use of a telephone survey, that was administered by telephone to 1,420 Ontario residents. The second approach was a content analysis of recorded public comments related to aggregate extraction.

1.3.3.2 Telephone Survey – Public Attitude Research

The survey instrument was designed to gain an understanding of how the Ontario public view, understand and values aggregates as well as the perceived social costs and benefits of aggregate extraction. Since “aggregate” is not a widely used or particularly common-place term, “development and infrastructure projects” was used in the survey to represent aggregate-related uses and “sand, stone and gravel” was used to represent aggregates as a resource. Background information on the aggregate industry was given to each respondent as starting points for key sections throughout the survey. A copy of the survey instrument can be found in Appendix A. The questions for the telephone survey were grouped into 6 sections.

Survey Section 1 - Perceived Engagement with Aggregate Industry

It was assumed that a respondents' perceived engagement with the aggregate industry might influence their level of social value placed on aggregate resources, and so these questions were phrased to provide a basis for cross-tabular analyses. To assess this, respondents were asked if they thought they lived near a pit or quarry, near an aggregate transportation route, or had someone in their household (including themselves) employed by the aggregate or a related industry, such as construction[1].

Survey Section 2 - Factors Contributing to Community Well-Being

Respondents were asked to describe the three things they thought were most important to the well-being of their community, and were also asked which of those three things, if any, were more or less important than development and infrastructure projects. The purpose of these questions was to understand the types of things that people value about their community, and also how they rank the relative importance of aggregate-related projects to their community's well-being.

Survey Section 3 - Value of Development and Infrastructure Projects

In this section, respondents were asked to rank the importance of different types of development and infrastructure projects. These included maintaining or repairing existing highways or roads, building new airports, institutional buildings, energy facilities, new highways or roads, railways, residential buildings and industrial buildings. These questions were rotated at random to avoid bias in response patterns. The purpose of assessing how respondents value different types of major development and infrastructure projects was to allow the study team to forecast the impact of not having the resources available for these projects.

Survey Section 4 - Knowledge of the Aggregate Industry

A subset of questions was posed to assess respondents' knowledge of the aggregate industry. These questions sought to gauge how familiar respondents were with average aggregate use in Ontario per person, generally where aggregates are extracted from, and the main modes of transportation used to move aggregates from their extraction sites to processing or end use locations. This subset of questions was used to assess how well respondents understood the aggregate industry.

[1] *It should be noted that few respondents (3%) stated that they or someone in their household was employed by the aggregate or a related industry. Therefore, in the reminder of this report, perceived engagement with the aggregate industry only refers to perceived proximity to a pit, quarry, or aggregate transportation route.*

Survey Section 5 - Social Costs and Benefits of Aggregate Extraction

In Section 5, two separate questions were used to ask respondents what they thought were the three main social costs and benefits of aggregate extraction. Respondents were prompted to give up to three responses, but in many cases, less than three per question were given. It should be noted that respondents were not asked to weigh the relative costs against the benefits.

Survey Section 6 - Demographic Information

Finally, the last section was used to collect general demographic information from each respondent. The type of information requested included the respondent's postal code, age, gender (by observation) and income. These demographic questions are standard survey protocol, and some of this information was used for cross-tabular analyses of the survey results in the Intellipulse report. The questions were optional and in some cases, respondents did not provide any information.

Survey Implementation

AECOM designed the survey instrument and contracted an independent firm, Intellipulse, to design the survey sample, administer the survey by telephone and compile the raw data. A copy of the full report from Intellipulse can be found in Appendix A.

Respondents were drawn from random sample of 1,420 Ontario Residents. A disproportional provincial sample allocation was developed in order to have a sufficient sample size in each of the eight CPCA geographic areas. Sample sizes in each of the eight areas ranged from 152 to 354 respondents. This sampling approach yielded a minimum accuracy level of +/- 8.1%, 19 out of 20 times, with an accuracy level of +/- 2.6%, 19 out of 20 times, for all of Ontario. A pretest was conducted under direct supervision from Intellipulse and AECOM to ensure quality control and ease of administration. The average survey duration was 15 minutes.

1.3.3.3 Content Analyses

Two sets of content analyses were undertaken to collect, numerate and code the types of concerns the public associated with aggregate operations. These public concerns provided insight to the social costs of aggregate extraction, in Ontario. The data for the two set of content analyses were taken from MNR site licence applications and from Ontario Municipal Board (OMB) hearings.

The MNR provided AECOM with public comments associated with the most recent 31 site licence applications in Ontario. In some cases, no public comments were received for some of these licences. In total, 14 licence applications had recorded public comments. All recorded public comments (e.g., petitions, letters or emails) were reviewed, numerated and coded among common themes.

OMB hearing data were obtained by searching the OMB website for relevant aggregate-related case files from 2001 to 2009. A total of 76 OMB cases were reviewed, numerated and coded for common themes in public concerns.

In addition, approximately 9 case files from the Niagara Escarpment Commission (NEC) were reviewed, though they were not numerated or coded. A more qualitative discussion of these records is provided in the following sections.

It should be noted, however, that the public comments from the OMB, MNR and NEC data are not representative for the Ontario population, but represent a specific group of public stakeholders.

1.3.4 Environmental Value

The focus of this initiative was to analyse the important environmental contributions of aggregate use in Ontario. This analysis is broken down into two sections: Environmental Uses of Aggregates and Environmental Impacts of Aggregate Extraction. The following explains the methodology for each section.

1.3.4.1 Environmental Uses of Aggregates

A literature review was undertaken, focussed on understanding how products of the aggregate industry in Ontario provide environmental value, and how aggregates are used in environmental processes such as water filtration, reduction in energy cost and emissions and the creation of wildlife habitat. The United Nations Millennium Ecosystem Assessment provides an approach to the analysis of ecosystem services that was demonstrated in *Ontario's Wealth, Canada's Future: Appreciating the Value of the Greenbelt's Eco-services* (David Suzuki Foundation 2008). Interviews with experts in the aggregate field were conducted (including the Ontario Sand and Gravel Association; Ontario Aggregate Resources Corporation; and the Ministry of Natural Resources) to fill gaps that were not found in written documents. A matrix of ecosystem services and aggregates versus the natural environment was developed based on this research. Analyses were limited to primary uses, i.e., the immediate products of extraction, and not derived benefits (secondary or indirect uses). For example, aggregates are used to build hospitals, but health care was not identified as an environmental value associated with aggregate extraction.

1.3.4.2 Environmental Impacts of Aggregate Extraction

Aggregate resources are always located in association with other land uses that generally include agriculture and natural areas. In recognition that competition for these resources can create conflicts, the Aggregate Resources Act requires that a rehabilitation plan be identified that is implemented sequentially as extraction progresses. The intent of this section of the study was to examine the existing land uses within the last 31 approved licences, and compare these uses to those identified post extraction through the rehabilitation plans. Ecosystems services provided by the natural environment (outside of benefits provided by the aggregates themselves), provide an estimate of short term impact versus the long term impact following rehabilitation and an estimate of the net change. A catalogue of the ecosystem services affected by the target licences, initial impacts, rehabilitation targets and net impacts to environmental value over a specified time frame was developed as a baseline database against which the environmental benefits of aggregate use could be compared.

The MNR provided the natural heritage reports and rehabilitation plans for the 31 most recent aggregate approvals. The net effects of these were determined by comparing site plans to the associated reporting, historical air photos and Natural Resources and Values Information System (NRVIS) layers in a GIS (Geographic Information System) environment.

Method to determine Area Data:

- Operational and Rehabilitation Plans, for each licence, were geo-referenced into GIS and Licence and Extraction Boundaries were then mapped
- Boundaries were correlated with the report for each licence natural heritage and NRVIS layers to obtain area coverage of forest, wetlands, ANSI, lakes, etc. within the extraction and licenced areas
- Rehabilitation areas were determined by the same process using the Rehabilitation Plans.
- Agricultural areas were determined by obtaining the agricultural overview of Ontario from Agriculture and Agri-Food Canada and then processed via the same manner as noted above.

Once areas were quantified into area of impact, percent of landscape affected and percent change the nature of the environmental features affected by the licences was characterized.

The valuation was limited to areas and qualitative description of the ecosystem services affected. The application of economic models to assign dollar values to the resources was outside of the scope of this report.

1.3.4.3 Limitations of Current Aggregate and Ecosystem Service Valuation Research

Limitations in conducting Ontario's aggregate industry and ecosystem service valuation research include:

1) The availability of ecosystem services information
2) Application of eco-services does not reflect the magnitude of the services (either positive or negative)
3) The data varied by scale and classification which introduced errors into the analysis (e.g. 'lake' was really 'river'; scale of soils mapping was much smaller than that of the mapping in the licences)
4) The NRVIS layers may have conflicted with licence natural areas due to the date of information acquired

Although these methodologies proved to be coarse, these initial steps to provide a framework for assessment of actual environmental effects of aggregate extractions as opposed to intuitive assumptions.

2. The Value of Aggregates

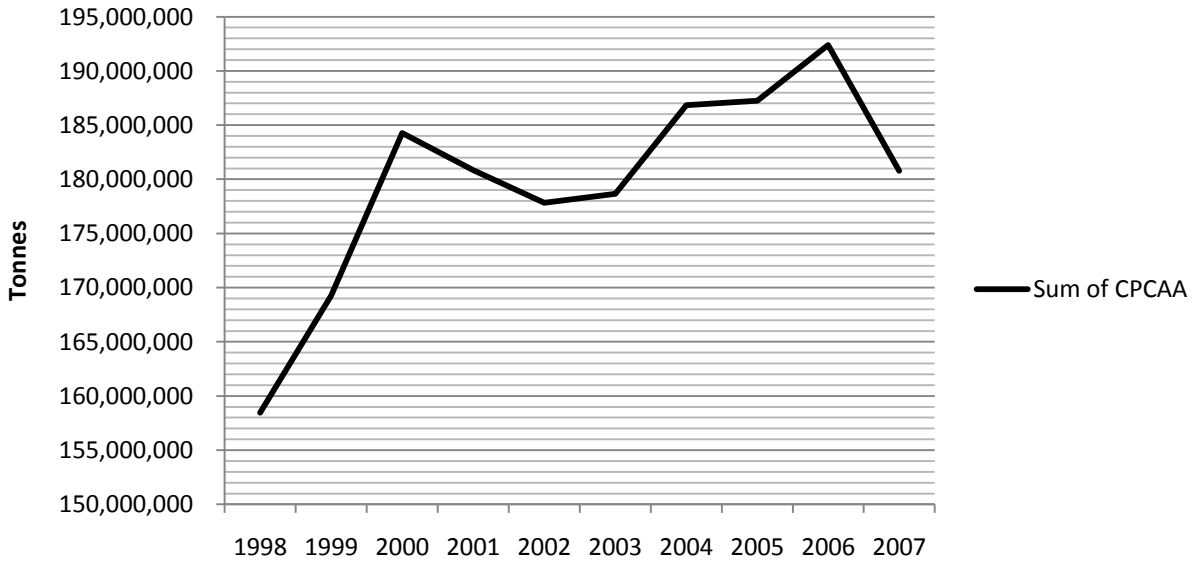
2.1 Economic Analysis – Upstream and Downstream Value

2.1.1 Upstream Value

2.1.1.1 Overall Aggregate Production

Based on the TOARC data the net tonnage of aggregate production in Ontario inclusive of new production, recycling and import of material was in the order of 181 million tonnes in 2007. Figure 2-1 illustrates the trend since 1998. The production peak for the period occurred in 2006 at 192 million tonnes.

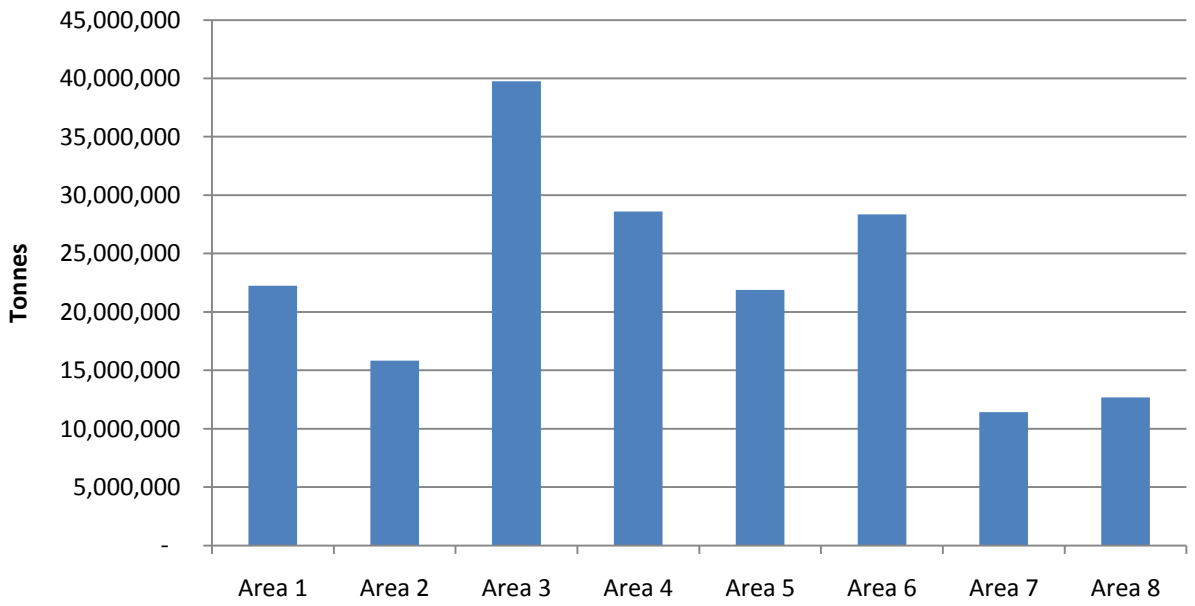
Figure 2-1 Overall Aggregate Production, 1998-2007



Source: TOARC, 1998 - 2007

The distribution of net production by CPCA geographic areas (see Figure 1-1) is set out in Figure 8. Area 4 (GTA) and Area 3 (West Central) are the dominate production areas with annual tonnage in the order of 30million tonnes. These are respectively followed by Area 6 (East) and Area 1 (Southwest) with tonnages between 21 million and 25 million tonnes. Area 2 (Peninsula) and Area 5 (East Central) fall in the 15 million to 20 million tonne range while Areas 7 (Northeast) and 8 (Northwest) fall in a 9 million to 12 million tonne bracket.

Figure 2-2 Net Production of Mineral Aggregate by CPCA Geographic Area (2007)



Source: AECOM, 2009

2.1.1.2 New Production Tonnages and Value

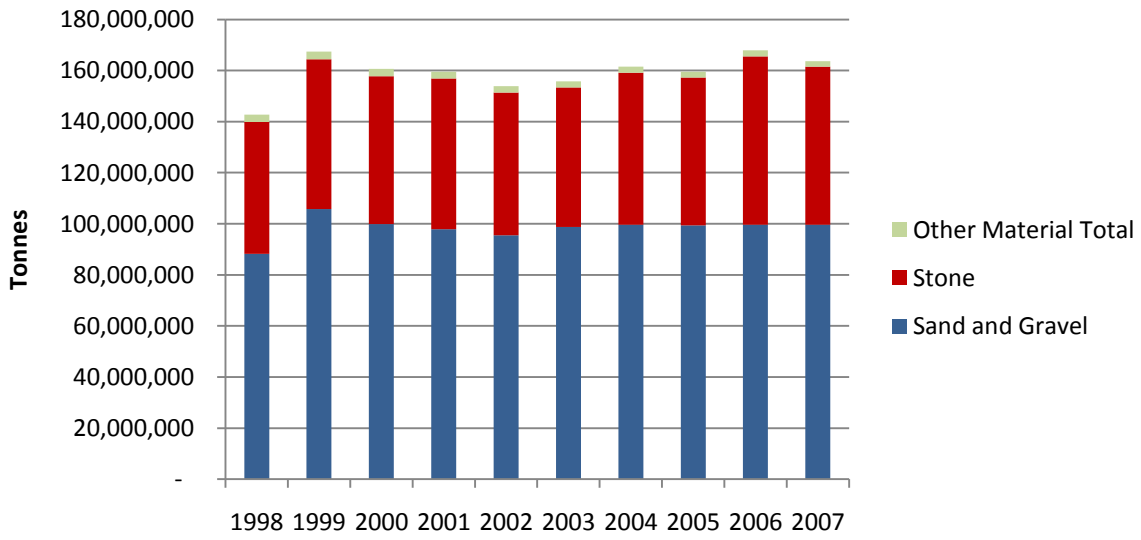
The previous section provided statistics on the overall production of aggregates in the Province including recycling and import. In this section the focus is exclusively on new production by three categories of material namely sand and gravel, stone and other (inclusive of gypsum, quartz and lime). In 2007 total production of these materials amounted to 164million tonnes. Of this total sand and gravel accounted for 61% of the volume followed by stone at 38% and other materials at 1%. Table 2-1 and Figure 2-3 provide statistics over the 1998 to 2007 period.

Table 2-1 New Aggregate Production by Material Category (1998-2009)

	Sand and Gravel	Stone	Other Material Total	Sum of Material
1998	88,186,000	51,639,000	2,859,000	142,684,000
1999	105,714,000	58,704,000	2,993,000	167,411,000
2000	99,848,000	57,969,000	2,768,000	160,585,000
2001	97,878,000	58,972,000	2,615,000	159,465,000
2002	95,464,000	55,945,000	2,514,000	153,923,000
2003	98,726,000	54,622,000	2,444,000	155,792,000
2004	99,581,000	59,584,000	2,316,000	161,481,000
2005	99,382,000	57,876,000	2,219,000	159,477,000
2006	99,671,000	65,860,000	2,325,000	167,856,000
2007	99,646,000	61,822,000	2,232,000	163,700,000

Source: AECOM, 2009

Figure 2-3 New Aggregate Production by Material Category (1998 - 2007)



Source: AECOM, 2009

Based on 2007 statistics compiled by the Province of Ontario, the value of new aggregate production totalled approximately $1.27 billion at the pit gate before delivery (i.e. FOB). Stone accounted for 50% of this value followed by sand and gravel at 39% and other materials at 12%. Table 2-2 sets out the total value trends over the period 1998 to 2007. Table 2-3 translates these values to a per tonne basis.

Table 2-2 Value of Ontario Aggregate Production (1998 - 2007)

	Sand and Gravel	Stone	Other Material Total	Sum of Material
1998	$408,588,000	$437,475,000	$166,636,000	$1,012,699,000
1999	$504,422,000	$476,446,000	$183,334,000	$1,164,202,000
2000	$469,494,000	$595,367,000	$166,651,000	$1,231,512,000
2001	$547,751,000	$592,647,000	$144,248,000	$1,284,646,000
2002	$470,168,000	$584,925,000	$153,458,000	$1,208,551,000
2003	$491,729,000	$575,281,000	$149,312,000	$1,216,322,000
2004	$490,915,000	$636,714,000	$162,825,000	$1,290,454,000
2005	$487,764,000	$581,067,000	$156,577,000	$1,225,408,000
2006	$505,041,000	$681,212,000	$155,244,000	$1,341,497,000
2007	$490,428,000	$628,556,000	$149,716,000	$1,268,700,000

Source: AECOM, 2009

Note: These numbers reflect FOB prices

Table 2-3 Per Tonne Value of Aggregate Production (1998 - 2007)

	Sand and Gravel	Stone	Other Material Total
1998	$4.63	$8.47	$145.84
1999	$4.77	$8.12	$152.67
2000	$4.70	$10.27	$151.44
2001	$5.60	$10.05	$149.50
2002	$4.93	$10.46	$156.32
2003	$4.98	$10.53	$160.11
2004	$4.93	$10.69	$177.05
2005	$4.91	$10.04	$173.14
2006	$5.07	$10.34	$175.80
2007	$4.92	$10.17	$177.53

Source: AECOM, 2009

Note: These numbers reflect FOB. prices

2.1.1.3 Economic Outputs of New Production

The economic outputs of new production are highlighted in the following Tables 2-4, 2-5 and Figures 2-4 to 2-6. In 2007 the $1.27 billion of direct gross output generated by the sector created approximately $1.6 billion of total GDP, $ 827 million of total labour income, a total of 16,600 full time jobs and $ 2.9 billion in total gross output. For the same year the federal provincial and municipal taxes generated by the production respectively totalled $32 million, $45 million and $75,000. Tables 2-4 and 2-5 provide a view of the direct, indirect and induced outputs by material category for the total volume of production. Tables 2-6 and 2-7 convert these figures to a per tonne metric.

The numbers generated in the ensuing tables are derived through the use of Statistics Canada's Inter-provincial Input /Output Model. This model is the preeminent model in Canada for the calculation of industry account information. It is very widely used and its results are accepted by a broad spectrum of users including the Bank of Canada, Conference Board of Canada and the finance departments of the Canadian Provinces and Territories. It is large and comprehensive model designed specifically to produce account information for industry and commodity groups across the country. The model has five main outputs: GDP, labour income, full time equivalent jobs, gross output and taxes. It should be noted that for taxes, the numbers do not include income tax or property tax. The actual tax categories accounted for are listed in the glossary.

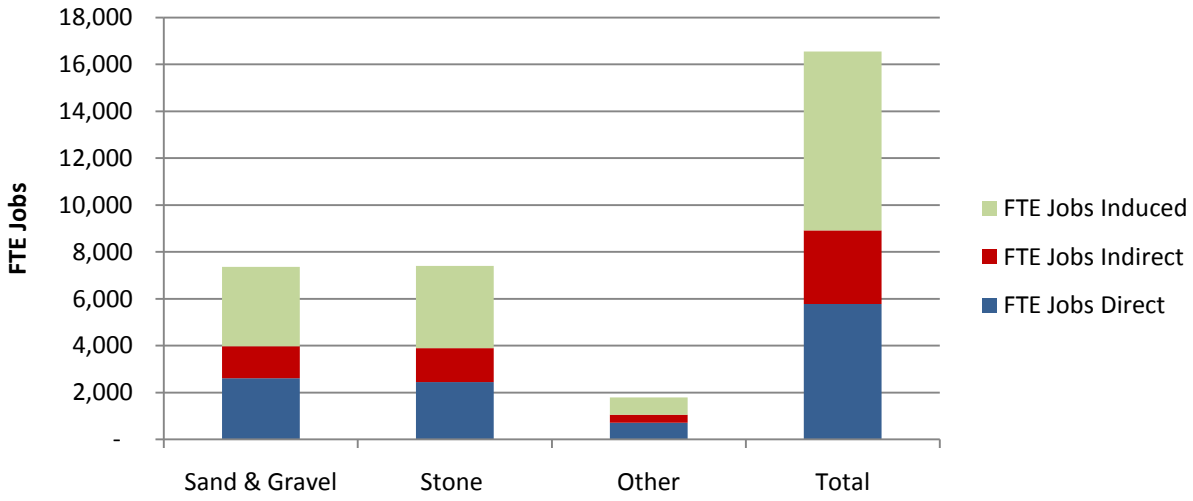
Table 2-4 Upstream Economic Outputs (2007)

		Sand and Gravel	Stone	Other Material Total	Sum of Material
GDP	Direct	$265,290,667	$368,639,294	$77,537,661	$711,467,622
	Indirect	$125,066,971	$138,892,019	$35,604,367	$299,563,358
	Induced	$281,260,493	$290,577,067	$61,576,079	$633,413,640
	Total	$671,618,131	$798,108,381	$174,718,107	$1,644,444,619
Labour Income	Direct	$129,865,594	$128,586,844	$27,577,918	$286,030,356
	Indirect	$74,240,240	$82,279,866	$17,106,768	$173,626,875
	Induced	$163,042,190	$168,442,858	$35,694,664	$367,179,712
	Total	$367,148,025	$379,309,568	$80,379,350	$826,836,943
FTE Jobs	Direct	2,615	2,451	714	5,780
	Indirect	1,358	1,446	339	3,142
	Induced	3,388	3,500	742	7,630
	Total	7,361	7,397	1,794	16,552
Gross Output	Direct	$490,428,000	$628,556,000	$149,716,000	$1,268,700,000
	Indirect	$199,228,038	$270,481,475	$53,982,499	$523,692,012
	Induced	$468,765,380	$484,292,933	$102,626,336	$1,055,684,650
	Total	$1,158,421,418	$1,383,330,408	$306,324,836	$2,848,076,662

Source: AECOM, 2009

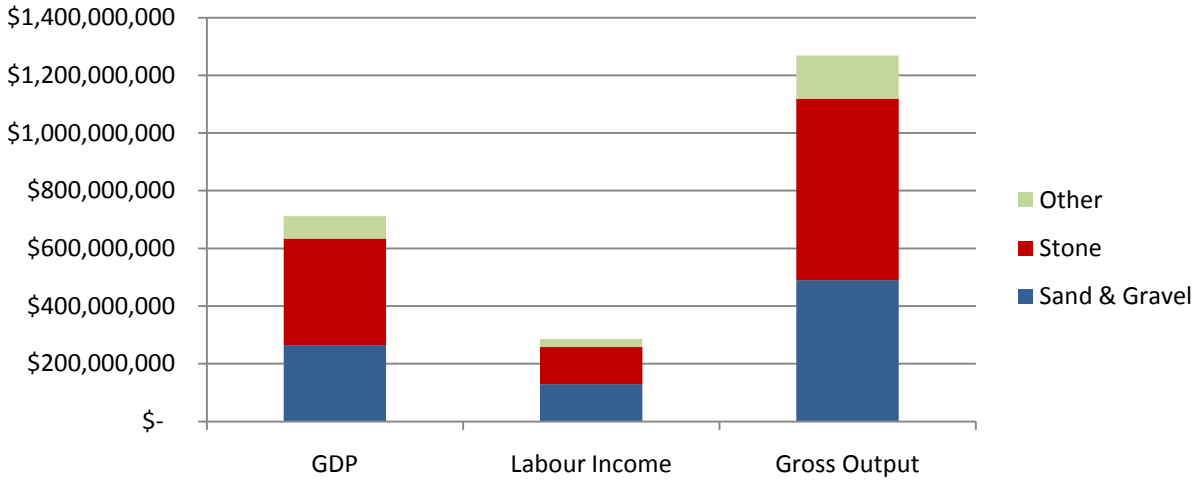
It is noted that there is sometimes confusion surrounding the terms GDP and Gross Output. Gross Output is the value of *sales* generated by the producing sector before subtracting the value of intermediate goods used up in production. By contrast GDP is a net measure. It is the value of *production* in an industry sector after the preceding subtraction has taken place. GDP is the common measure of value add.

Figure 2-4 Upstream Job Creation (2007)



Source: AECOM, 2009

Figure 2-5 Upstream Economic Outputs - GDP, Labour Income and Gross Output (2007)



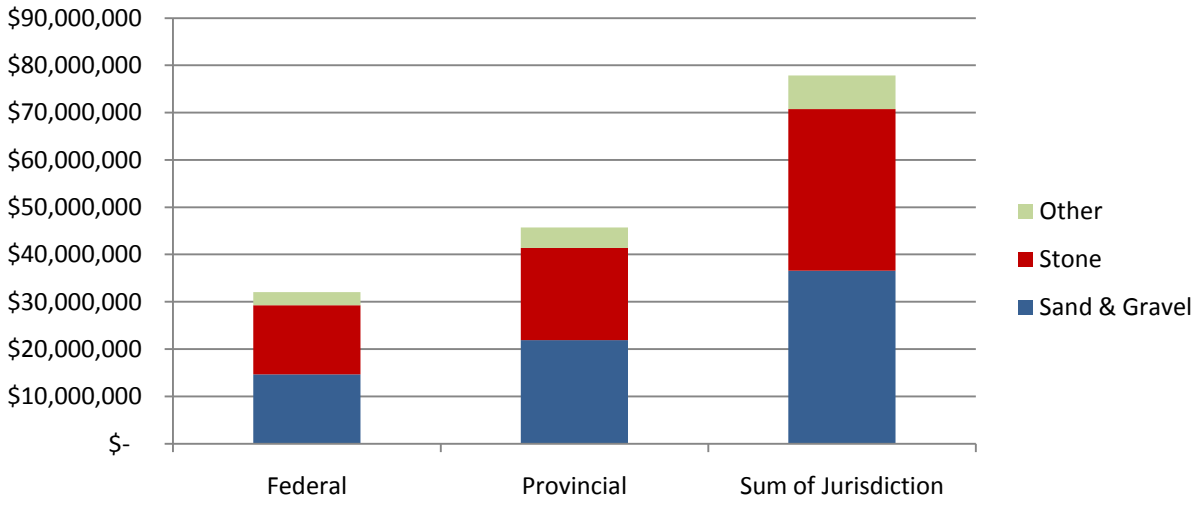
Source: AECOM, 2009

Table 2-5 Upstream Tax Outputs (2007)

	Sand and Gravel	Stone	Other Material Total	Sum of Material
Federal	$14,675,603	$14,566,086	$2,799,757	$32,041,446
Provincial	$21,894,339	$19,515,161	$4,299,777	$45,709,277

Source: AECOM, 2009

Figure 2-6 Upstream Tax Outputs (2007)



Source: AECOM, 2009

Table 2-6 Upstream Economic Outputs per Tonne (2007)

		Sand and Gravel	Stone	Other Material Total
GDP	Direct	$2.66	$5.96	$91.94
	Indirect	$1.26	$2.25	$42.22
	Induced	$2.82	$4.70	$73.02
	Total	$6.74	$12.91	$207.18
Labour Income	Direct	$1.30	$2.08	$32.70
	Indirect	$0.75	$1.33	$20.29
	Induced	$1.64	$2.72	$42.33
	Total	$3.68	$6.14	$95.31
FTE Jobs	Direct	0.00003	0.00004	0.00085
	Indirect	0.00001	0.00002	0.00040
	Induced	0.00003	0.00006	0.00088
	Total	0.00007	0.00012	0.00213
Gross Output	Direct	$4.92	$10.17	$177.53
	Indirect	$2.00	$4.38	$64.01
	Induced	$4.70	$7.83	$121.69
	Total	$11.63	$22.38	$363.24

Source: AECOM, 2009

Table 2-7 Upstream Tax Outputs per Tonne (2007)

	Sand and Gravel	Stone	Other Material Total
Federal	$0.15	$0.24	$3.32
Provincial	$0.22	$0.32	$5.10

Source: AECOM, 2009

2.1.1.4 Economic Outputs of new Production by CPCA Geographic Area

The economic effects of new mineral aggregate production by CPCA area are summarized in Tables 2-8 to 2-12. The numbers presented are a summation of direct, indirect and induced effects.

The mineral aggregate sector in Ontario generates $1.6 billion of GDP. Forty-nine percent is attributable to the stone production, 41 % to sand and gravel production and 10% to the production of other materials.

The total labour income produced amounts to $827 million and of this sum allocations are 46% to stone production, 44% to sand and gravel and 10% to other materials.

Job creation sums to approximately 16,600 fulltime positions. The sand and gravel and stone production each roughly account for 45% of the jobs and other materials make up the remaining 10%.

Gross output totals $2.85 billion with stone accounting for 49% of this figure and sand and gravel and other materials respectively accounting for 41% and 10%.

Taxes generated by the sector amount to $77.8 million and of this amount the federal portion is 40% provincial portion 59% and the municipal portion less than 1 %.

In terms of CPCA areas the dominant area with respect to economic output in the case of sand and gravel is Area 3 (West Central) followed by Areas 1 (Southwest) and Area 4 (GTA). When it comes to stone production Area 6 (East) comes out on top followed by Area 4 (GTA) and then Areas 2 and 5 (Peninsula and East Central). Effects associated with other materials are most strongly represented by Area 6 (East) and Area 7 (Northeast).

Table 2-8 Upstream GDP Outputs by CPCA Areas (2007)

	Sand & Gravel	Stone	Other	Sum of Sector
Area 1	$111,437,643	$52,344,862	$3,034,270	$166,816,775
Area 2	$31,985,952	$121,923,475	$1,541,491	$155,450,918
Area 3	$200,860,127	$88,896,158	$10,510,697	$300,266,981
Area 4	$102,140,693	$128,353,121	$45,236,366	$275,730,180
Area 5	$70,104,732	$120,638,658	$7,878,115	$198,621,505
Area 6	$60,547,934	$197,437,759	$53,240,873	$311,226,566
Area 7	$25,182,291	$68,926,422	$51,968,870	$146,077,583
Area 8	$69,358,759	$19,587,926	$1,307,425	$90,254,110
Sum of CPCAA	$671,618,131	$798,108,381	$174,718,107	$1,644,444,619

Source: AECOM, 2009

Table 2-9 Upstream Labour Income Outputs by CPCA Areas (2007)

	Sand & Gravel	Stone	Other	Sum of Sector
Area 1	$60,918,710	$24,877,457	$1,395,921	$87,192,088
Area 2	$17,485,500	$57,945,439	$709,165	$76,140,105
Area 3	$109,802,573	$42,248,852	$4,835,463	$156,886,888
Area 4	$55,836,423	$61,001,198	$20,811,064	$137,648,684
Area 5	$38,323,584	$57,334,816	$3,624,340	$99,282,740
Area 6	$33,099,247	$93,834,413	$24,493,550	$151,427,210
Area 7	$13,766,198	$32,758,021	$23,908,364	$70,432,583
Area 8	$37,915,789	$9,309,372	$601,483	$47,826,644
Sum of CPCAA	$367,148,025	$379,309,568	$80,379,350	$826,836,943

Source: AECOM, 2009

Table 2-10 Upstream FTE Job Outputs by CPCA Areas (2007)

	Sand & Gravel	Stone Mining	Other	Sum of Sector
Area 1	1,221	485	31	1,738
Area 2	351	1,130	16	1,496
Area 3	2,201	824	108	3,133
Area 4	1,119	1,190	465	2,774
Area 5	768	1,118	81	1,967
Area 6	664	1,830	547	3,040
Area 7	276	639	534	1,449
Area 8	760	182	13	955
Sum of CPCAA	7,361	7,397	1,794	16,552

Source: AECOM, 2009

Table 2-11 Upstream Gross Output by CPCA Areas (2007)

	Sand & Gravel	Stone Mining	Other	Sum of Sector
Area 1	$192,210,047	$90,727,325	$5,319,840	$288,257,212
Area 2	$55,170,059	$211,325,247	$2,702,622	$269,197,928
Area 3	$346,447,873	$154,080,274	$18,427,898	$518,956,045
Area 4	$176,174,468	$222,469,504	$79,310,740	$477,954,711
Area 5	$120,918,152	$209,098,322	$13,812,320	$343,828,794
Area 6	$104,434,381	$342,211,237	$93,344,656	$539,990,274
Area 7	$43,434,958	$119,467,503	$91,114,515	$254,016,976
Area 8	$119,631,481	$33,950,995	$2,292,246	$155,874,722
Sum of CPCAA	$1,158,421,418	$1,383,330,408	$306,324,836	$2,848,076,662

Source: AECOM, 2009

Table 2-12 Taxes

	Federal	Provincial	Municipal	Sum of Jurisdiction
Area 1	$3,438,992	$4,987,396	$7,901	$8,434,289
Area 2	$2,948,826	$4,061,903	$6,899	$7,017,629
Area 3	$6,179,868	$8,980,251	$14,216	$15,174,335
Area 4	$5,299,317	$7,581,443	$12,473	$12,893,232
Area 5	$3,859,856	$5,429,079	$8,997	$9,297,931
Area 6	$5,779,584	$8,111,775	$13,722	$13,905,080
Area 7	$2,640,992	$3,785,244	$6,382	$6,432,618
Area 8	$1,894,011	$2,772,188	$4,334	$4,670,533
Sum of CPCAA	$32,041,446	$45,709,277	$74,924	$77,825,648

Source: AECOM, 2009

2.1.2 Downstream Value

2.1.2.1 Downstream Flows

The calculation of downstream flows in this study was largely accomplished via the use of the commodity tables associated with the Stats Can I/O model. As different sectors were shocked with a $1 billion gross output value, the commodity tables chronicled the GDP contributions for aggregate resources required to underpin this figure. These contributions were summed for all of the sectors and then an apportionment was calculated for each sector. Table 2-13 presents the apportionment summary.

Table 2-13 GDP Apportionment of Aggregate by Downstream Industry Categories and Sectors

Cement and Concrete	Cement	1.54%
	Ready Mix	12.26%
	Concrete	7.44%
	Sum of Cement and Concrete	21.24%
Other Products	Asphalt	6.95%
	Chemical	0.39%
	Clay	0.95%
	Glass	2.25%
	Lime & Gypsum	1.02%
	Paper	5.38%
	Other Non Metallic	3.81%
	Primary Metal	1.20%
	Sum of Other	21.93%
Construction	Residential	20.13%
	Non Residential	10.50%
	Electrical	1.14%
	Oil & Gas	0.13%
	Transportation	24.92%
	Sum of Construction	56.82%
Total		100.00%

Source: AECOM, 2009

The construction category accounts for the majority of aggregate consumption at approximately 57%. Cement and concrete consume another 21% and other products consume the remaining 22%. There is a close tie between construction and cement and concrete products as well asphalt and clay and lime and gypsum products. When the latter are amalgamated, their total apportionment approaches 87% of aggregate consumed.

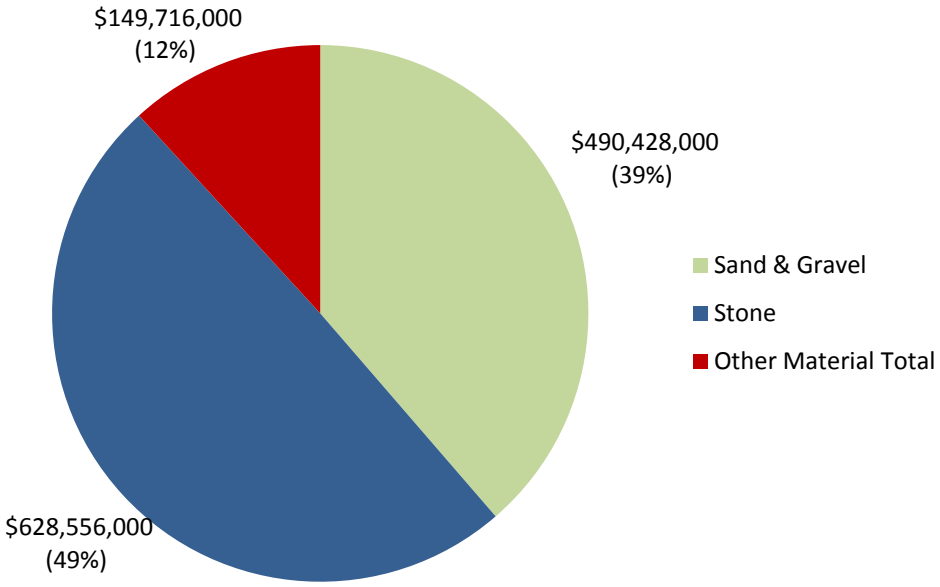
The allocation of the 2007 aggregate production value (i.e. $1.27 billion) across the industry categories and sectors is displayed in Table 2-14 and Figure 2-7. Construction consumes $720 million of the production, cement and concrete consume $270 million and other products consume $278 million.

Table 2-14 Apportionment of Aggregate Production Value by Downstream Industry Categories and Sectors

Cement and Concrete	Cement	$19,544,755
	Ready Mix	$155,558,342
	Concrete	$94,413,684
	Sum of Cement and Concrete	$269,516,781
Other Products	Asphalt	$88,143,433
	Chemical	$4,917,498
	Clay	$12,007,653
	Glass	$28,515,950
	Lime & Gypsum	$12,958,056
	Paper	$68,263,741
	Other Non Metallic	$48,298,380
	Primary Metal	$15,173,032
	Sum of Other	$278,277,742
Construction	Residential	$255,352,170
	Non Residential	$133,253,813
	Electrical	$14,423,517
	Oil & Gas	$1,665,955
	Transportation	$316,210,023
	Sum of Construction	$720,905,477
Total		$1,268,700,000

Source: AECOM, 2009

Figure 2-7 Allocation of Aggregate Production Value by Material (2007)



Source: AECOM, 2009

2.1.2.2 Economic Outputs of Downstream Aggregate Consumption

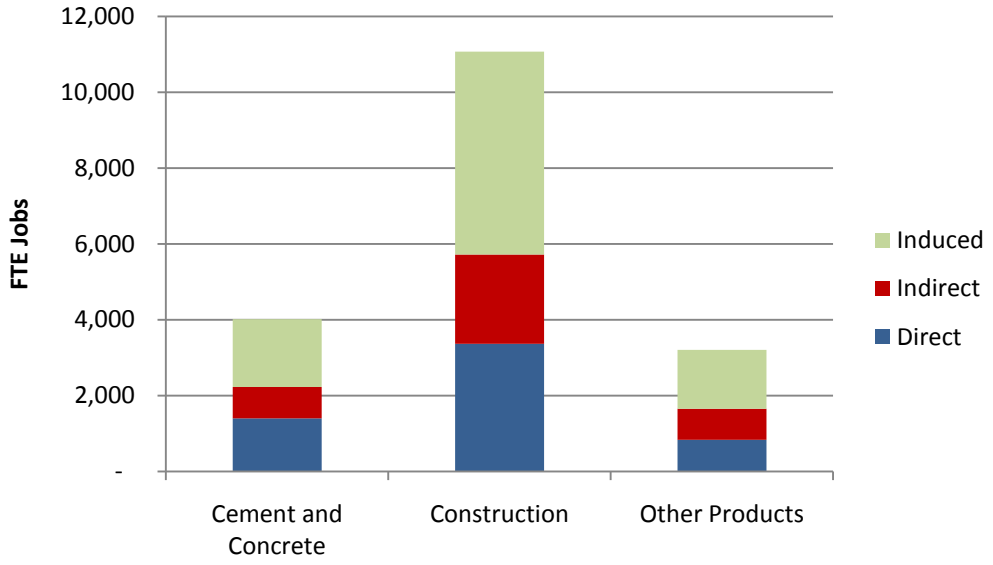
The economic output of aggregate consumption in the downstream sectors is summarized in Table 2-15 and Figures 2-8 and 2-9. The total GDP contribution is $1.6 billion. The labour income generated is $941 million and approximately 18,300 jobs are created. Total gross output approaches $3.2 billion.

Table 2-15 Economic Outputs of Aggregate Consumption in Downstream Industry Sectors

		Cement and Concrete Total	Other Products Total	Construction Total	Sum of Downstream Sectors
GDP	Direct	$113,055,245	$102,930,564	$299,729,046	$515,714,855
	Indirect	$89,325,239	$80,570,147	$198,694,387	$368,589,773
	Induced	$148,335,542	$128,434,896	$444,083,944	$720,854,382
	Total	$350,716,026	$311,935,607	$942,507,377	$1,605,159,010
Labour Income	Direct	$63,629,202	$50,484,688	$190,819,132	$304,933,022
	Indirect	$44,015,379	$42,718,332	$131,445,036	$218,178,747
	Induced	$85,981,077	$74,445,884	$257,408,408	$417,835,369
	Total	$193,625,657	$167,648,905	$579,672,576	$940,947,138
FTE Jobs	Direct	1,403	833	3,369	5,605
	Indirect	828	825	2,351	4,004
	Induced	1,787	1,548	5,351	8,686
	Total	4,019	3,205	11,071	18,295
Gross Output	Direct	$269,516,781	$278,277,742	$720,905,477	$1,268,700,000
	Indirect	$170,927,656	$129,690,897	$414,181,359	$714,799,912
	Induced	$247,225,006	$214,057,383	$740,137,221	$1,201,419,610
	Total	$687,669,443	$622,026,022	$1,875,224,057	$3,184,919,521

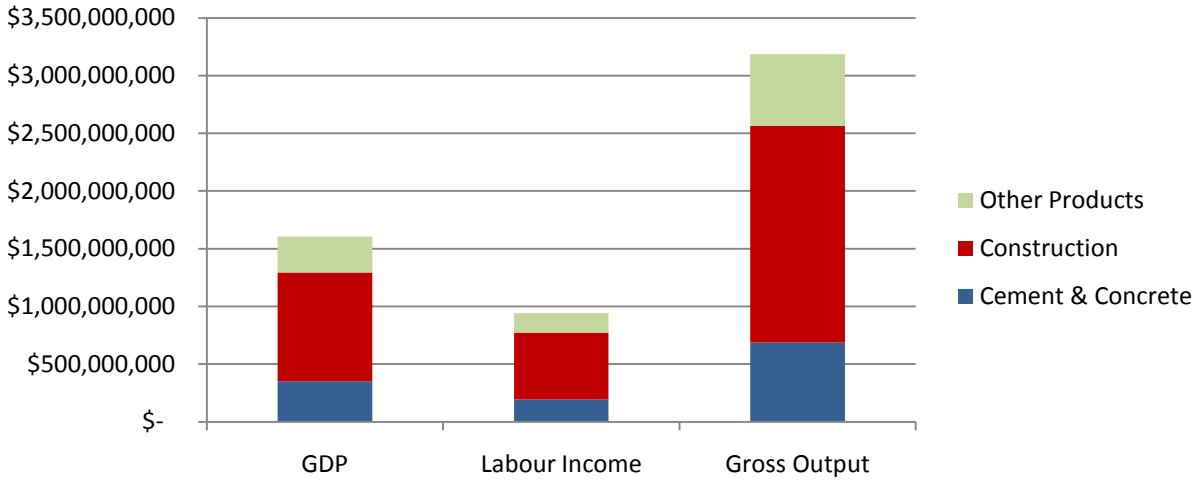
Source: AECOM, 2009

Figure 2-8 FTE Job Outputs to Aggregates Consumption in Downstream Industry Categories



Source: AECOM, 2009

Figure 2-9 Economic Outputs of Aggregate Consumption in Downstream Industry Categories



Source: AECOM, 2009

Aggregate Enabled Industries

The Provincial GDP contribution of the entire cement and concrete, other aggregate products and construction industry sectors addressed in this report exceeds $22 billion. These industries account for labour income of $12.7 billion and they create 246,000 jobs. The total gross output of these sectors sums to $44.7 billion.

In terms of job creation other aggregate sector products lead the way with 111,000 jobs (45% of total) followed by construction with 88,000 jobs (36% of total) and then cement and concrete products with 46,000 jobs (19% of total).

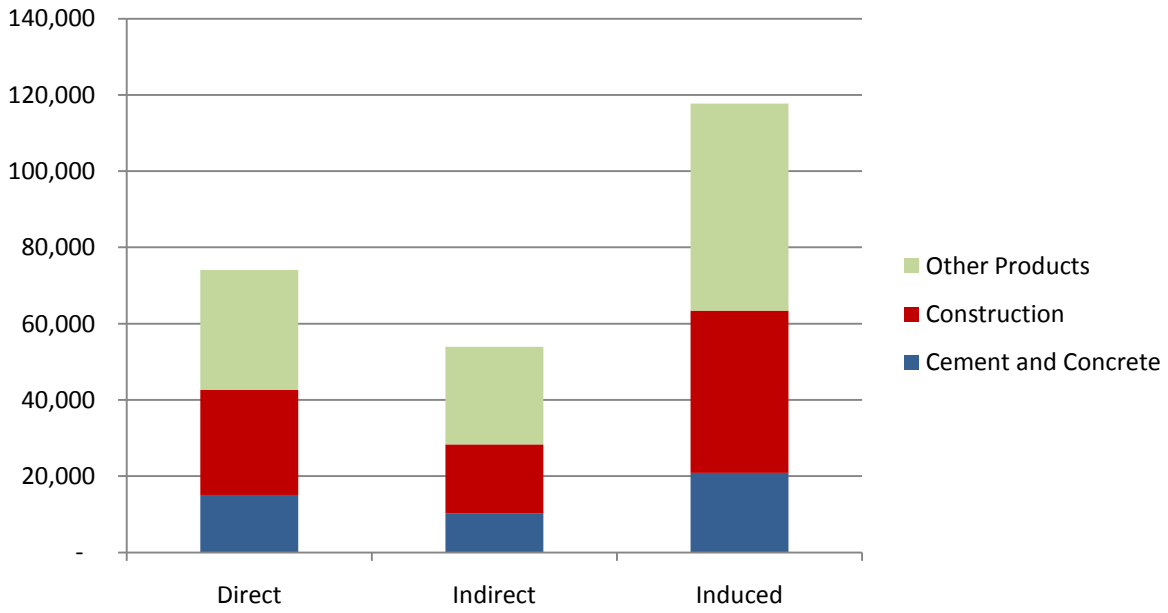
Table 2-16 presents the economic outputs of the downstream industry sectors. Figures 2-10 and 2-11 illustrate the dimensions of these outputs.

Table 2-16 Economic Outputs of Downstream Industry Sectors

		Cement and Concrete Total	Other Products Total	Construction Total	Sum of Downstream Sectors
GDP	Direct	$1,341,300,000	$3,576,800,000	$2,235,500,000	$7,153,600,000
	Indirect	$1,118,507,540	$2,530,784,187	$1,512,281,071	$5,161,572,799
	Induced	$1,730,926,857	$4,512,195,921	$3,528,240,137	$9,771,362,914
	Total	$4,190,734,397	$10,619,780,108	$7,276,021,208	$22,086,535,713
Labour Income	Direct	$711,086,351	$1,906,677,346	$1,552,449,232	$4,170,212,928
	Indirect	$545,017,841	$1,367,746,519	$1,007,934,650	$2,920,699,010
	Induced	$1,003,312,846	$2,615,445,079	$2,045,105,857	$5,663,863,782
	Total	$2,259,417,038	$5,889,868,945	$4,605,489,738	$12,754,775,721
FTE Jobs	Direct	15,071	31,480	27,532	74,083
	Indirect	10,301	25,558	18,047	53,905
	Induced	20,858	54,373	42,516	117,747
	Total	46,230	111,410	88,095	245,735
Gross Output	Direct	$3,298,840,344	$9,910,959,746	$5,441,094,146	$18,650,894,236
	Indirect	$2,128,824,815	$4,536,135,041	$3,118,473,766	$9,783,433,621
	Induced	$2,884,867,627	$7,520,299,245	$5,880,378,890	$16,285,545,762
	Total	$8,312,532,785	$21,967,394,032	$14,439,946,802	$44,719,873,619

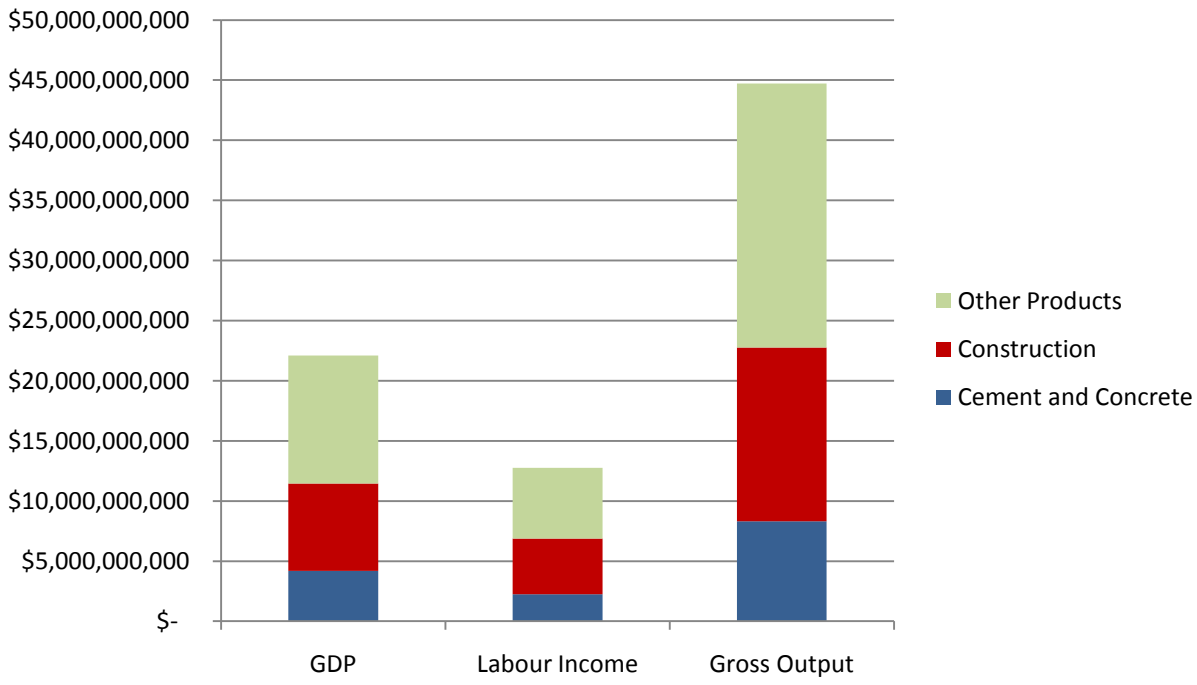
Source: AECOM, 2009

Figure 2-10 Jobs Created by Downstream Industry Categories



Source: AECOM, 2009

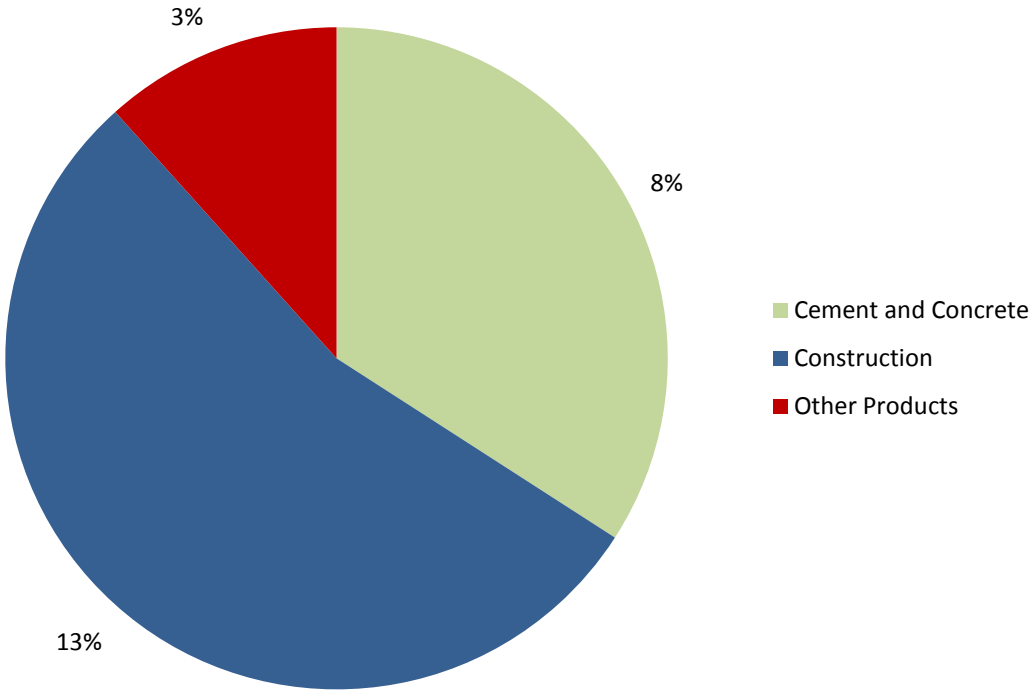
Figure 2-11 Economic Outputs from Downstream Industry Categories



Source: AECOM, 2009

In Figure 2-12 the proportion of economic outputs within these industry sectors attributable to aggregate inputs are summarized in percentage terms. Aggregate inputs accounts for approximately 8% of the economic output in the cement and concrete category, 3% in the other products category and roughly 12% in the construction category. For all three categories combined the contribution is in the order of 7%. These statistics underscore the observation that aggregate is an important ingredient for many downstream industry sectors. Although in many circumstances, not the main ingredient, it is certainly a critical one that enables and underpins the economic viability of these industry sectors.

Figure 2-12 Contributions of Aggregate to Overall Economic Output of Downstream Industry Sectors



Source: AECOM, 2009

2.2 Case Studies

For a more in depth analysis, a short list of infrastructure projects was derived to select five case studies. This list was comprised of the 25 infrastructure projects in the Province of Ontario with the largest cost or value between 2005 and 2009. To be included in the list of projects considered for case studies, projects needed to be under construction in the identified period or have had achieved financial close. Table 2-17 describes the shortlist of 25 case studies and the following map indicates where they were located in the province. These are illustrated on Figure 2-13.

Table 2-17 Top 25 Infrastructure Projects in the Province of Ontario 2005 - 2009

Project	Project Type	Location	Value	Portland Cement Region
1. Bruce A Nuclear Generating Station Restart	Energy	Kincardine	$5,250,000,000	3
2. Pier F at Lester B. Pearson International Airport	Transportation/Public Transit	Toronto	$4,500,000,000	4
3. Spadina Subway Extension	Transportation/Public Transit	Toronto	$2,630,000,000	4
4. Niagara Tunnel Project	Energy	Niagara Falls	$985,000,000	2
5. **Portlands Energy Centre**	Energy	Toronto	$730,000,000	4
6. Woodstock General Hospital	Hospitals/Health Care	Woodstock	$685,000,000	1
7. Greenfield Energy	Energy	Sarnia	$675,000,000	1
8. New Data Centre Project	Public Buildings/Government Offices	West of Toronto	$650,000,000	4
9. Bruce to Milton Power Line	Energy	Toronto	$600,000,000	4
10. Toronto Power Line	Energy	Toronto	$600,000,000	4
11. North Bay Regional Health Centre	Hospitals/Health Care	North Bay	$552,000,000	7
12. William Osler Health Centre	Hospitals/Health Care	Brampton, Etobicoke, Georgetown	$550,000,000	4
13. Wolfe Island Wind Project	Energy	Wolfe Island	$450,000,000	5
14. Sault Area Hospital	Hospitals/Health Care	Sault Ste. Marie	$408,000,000	8
15. Durham Consolidated Courthouse	Justice	Oshawa	$334,000,000	4
16. Union Station Signaling Contract	Transportation/Public Transit	Toronto	$300,000,000	4
17. Highway 401 Expansion	Transportation/Public Transit	Greater Toronto Area	$285,000,000	4
18. Melancthon II Wind Farm	Energy	Shelburne	$265,000,000	3
19. Henderson General Hospital Redevelopment	Hospitals/Health Care	Hamilton	$259,200,000	2
20. Art Gallery of Ontario	Social	Toronto	$254,000,000	4
21. Bluewater Health	Hospitals/Health Care	Sarnia	$214,000,000	1
22. London Health Sciences Centre North Toronto	Hospitals/Health Care	London	$212,000,000	1
23. Royal Ontario Museum	Social	Toronto	$211,000,000	4
24. Peterborough Regional Health Centre	Hospitals/Health Care	Peterborough	$197,000,000	5
25. Hospital Montfort	Hospitals/Health Care	Ottawa	$177,400,000	6

Sault Area Hospital
(Hospitals/Health Care)
Sault Ste. Marie
$408 Million

North Bay Regional Health Centre
(Hospitals/Health Care)
North Bay
$552 Million

Hopital Montfort
(Hospitals/Health Care)
Ottawa
$177.4 Million

Quebec

Ontario

Georgian Bay

Lake Huron

LEGEND

Capital Projects within the Greater Toronto Area

Transportation:
Pier F at Lester B. Pearson Airport = $4.5 Billion
Spadina Subway Expansion = $2.63 Billion
Union Station Signalling Contract = $300 Million
Highway 401 Expansion = $285 Million

Energy:
Portlands Energy Centre = $730 Million
Bruce to Milton Power Line = $600 Million
Toronto Power Line = $600 Million

Social:
Royal Ontario Museum = $211 Million
Art Gallery of Ontario = $254 Million

Bruce A Nuclear Generating Station Restart (Energy)
Kincardine
$5.25 Billion

Melancthon II Wind Farm
Energy
Shelburne
$265 Million

Peterborough Regional Health Centre
(Hospitals/Health Care)
Peterborough
$197 Million

Wolfe Island Wind Project (Energy)
Wolfe Island
$450 Million

William Osler Health Centre
(Hospitals/Health Care)
Brampton, Etobicoke, Georgetown
$550 Million

New Data Centre Project
(Public Buildings/Government)
West of Toronto
$650 Million

Lake Ontario

Durham Consolidated Courthouse (Justice)
Oshawa
$334 Million

Refer to Legend for Projects within the Greater Toronto Area

USA

Bluewater Health
(Hospitals/Health Care)
Sarnia
$214 Million

Greenfield Energy (Energy)
Sarnia
$675 Million

Henderson General Hospital
(Hospitals/Health Care)
Hamilton
$259.2 Million

Niagara Tunnel Project (Energy)
Niagara Falls
$985 Million

Lake Erie

London Health Sciences
(Hospitals/Health Care)
London
$212 Million

Woodstock General Hospital
(Hospitals/Health Care)
Woodstock
$685 Million

USA

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W E
S

Kilometers
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Basemapping from Ontario Ministry of Natural Resources Orthophotography:

25 Large Infrastructure Projects in Ontario

December 2009
Project 60119329

AECOM

Figure 2-13

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Of the projects on the short list the vast majority of them were energy and hospital/healthcare projects. Almost half of these projects were located in the GTA.

Table 2-18 Top 25 Infrastructure Projects in the Province of Ontario by Project Type

Project Type	Number of Projects	Combined Value
Energy	8	$9,555,000,000
Transportation	4	$7,715,000,000
Hospitals	9	$3,254,600,000
Public Buildings/Government	1	$650,000,000
Justice	1	$334,000,000
Social	1	$465,000,000

Table 2-19 Top 25 Infrastructure Projects in Province of Ontario by CPCA Geographic Area

Portland Cement Region	Number of Projects	Combined Value
Area 1 Southwest	4	$1,786,000,000
Area 2 Peninsula	2	$1,244,200,000
Area 3 West Central	2	$5,515,000,000
Area 4 GTA	12	$11,644,000,000
Area 5 East Central	2	$647,000,000
Area 6 East	1	$177,400,000
Area 7 Northeast	1	$552,000,000
Area 8 Northwest	1	$408,000,000

The following five case studies were selected for further analysis (Table 2-20). These case studies were selected through a qualitative assessment to find projects that would be aggregate intensive, represent a wide range in project sizes, project types, and cover a wide geographic area (Figure 2-14). The five case studies represent the three project types most prevalent (transportation, energy and healthcare) in the largest projects in Ontario between 2005 and 2009.

Table 2-20 Five Infrastructure Projects Selected for Case Study

Project	Project Type	Location	Project Value	Portland Cement Region	Tonnes of Aggregate Used
Spadina Subway Extension	Transportation/Public Transit	Toronto	$2,630,000,000	4	982,573
Niagara Tunnel Project	Energy	Niagara Falls	$985,000,000	2	632,000
Woodstock General Hospital	Hospitals/Health Care	Woodstock	$685,000,000	1	93,540
North Bay Regional Health Centre	Hospitals/Health Care	North Bay	$552,000,000	7	136,188
Wolfe Island Wind Project	Energy	Wolfe Island	$450,000,000	5	88,329

Quebec

Ontario

Georgian Bay

Lake Huron

Lake Ontario

Lake Erie

USA

North Bay Regional Health Centre
North Bay, Ontario
$552 Million

Spadina Subway Extension
Toronto, Ontario
$2.63 Billion

Wolfe Island Wind Project
Wolfe Island, Ontario
$450 Million

Woodstock General Hospital
Woodstock, Ontario
$685 Million

Niagara Tunnel Project
Niagara Falls, Ontario
$985 Million

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Kilometers
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Basemapping from Ontario Ministry of Natural Resources Orthophotography:

5 Case Studies In Ontario

December 2009
Project 60119329

AECOM

Figure 2-14

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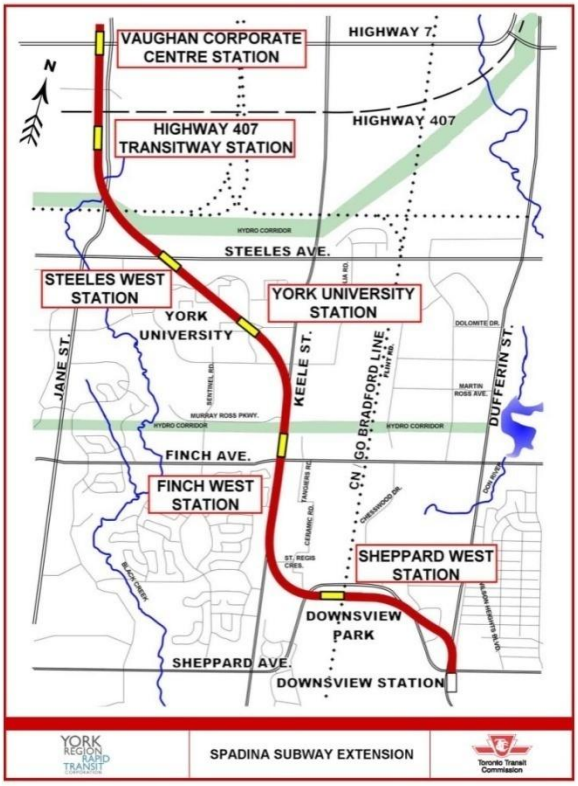
2.2.1.1 Spadina Subway Extension

Figure 2-15 Map of Spadina Subway Extension



Source: TTC, 2009

Project:	Spadina Subway Extension
Project Type:	Transportation
Project Location:	Toronto, Ontario – Portland Cement Area 4 GTA
Project Description:	• Expansion of the Toronto Transit Commission (TTC) subway network into the Region of York. • The addition of 8.6 kilometres of new subway line to the existing Spadina subway line. • The creation of 6 new TTC stations.
Size of Project:	$2.63 billion
Aggregates used:	980,000 tonnes of aggregate to be used
Economic Benefits:	• Will support an average of 7,500 jobs a year in Ontario through the 6 years of construction, through direct, indirect and induced economic impacts. • 91 of these jobs will be directly related to the economic value add

from aggregates.

- Will result in the creation of $2.2 billion of labour income throughout the project life.
- $87 million of worker salaries will be directly related to the aggregate input to the project.
- Will contribute $3.4 billion to the province of Ontario's gross domestic product.
- The value added by the aggregates used in this project will be worth $42 million to the province of Ontario, 1.22% of the total value created by the project.

Other Benefits:

- Project creates a major transit funnel between the Region of York, the City of Brampton, the City of Barrie, and Toronto.
- Project will help reduce commute times.
- Project will alleviate growth pressures on the Oakridge Moraine.
- Project will spur sustainable growth in accordance with Ontario's Places to Grow legislation.

2.2.1.2 Niagara Tunnel Project

Figure 2-16 Drill Used on Niagara Tunnel Project

Source: Panoramio, 2009

Project:	Niagara Tunnel Project
Project Type:	Energy
Project Location:	Niagara, Ontario – Portland Cement Area 2 Peninsula
Project Description:	• Third tunnel project in Niagara falls. • One of the largest tunnels built in North America. • The tunnel will add an additional 500 cubic metres per second through the Sir Adam Beck Power Group generating stations.
Size of Project:	$985 million
Aggregates used:	632,000 tonnes of aggregate used
Economic Benefits:	• Will support e14,000 fulltime equivalent (FTE) years of employment in Ontario throughout the project life through direct, indirect and induced economic impacts. • 623 of FTE years of employment will be directly associated with the value added from aggregates. • Will result in the creation of $755 million of labour income throughout the project life. • $33 million of worker salaries will be directly related to the aggregate input to the project. • Will contribute $1.3 billion to the province of Ontario's gross

domestic product.

- The value added by the aggregates used in this project will be worth $59 million to the province of Ontario.
- 4.43% of the total value created by the project is related to the aggregate input.

Other Benefits:

- Project will produce an additional 580 megawatts of electricity.
- This will increase the power produced by the Adam Beck Power Group by 28%.
- The Tunnel Project will generate 1,600 Gigawatt hours of sustainable hydro-electricity annually.

2.2.1.3 Woodstock General Hospital

Figure 2-17 New Woodstock General Hospital

Source: Delta Elevator, 2009

Project:	Woodstock General Hospital
Project Type:	Hospital/Healthcare
Project Location:	Woodstock, Ontario – Portland Cement Area 1 Southwest
Project Description:	• New three story state-of-the-art replacement for the existing community hospital • Approximately 350,000 square foot building on a 25 acre greenfield site • New hospital will support a number of new regional healthcare programs
Size of Project:	$685 million
Aggregates used:	94,000 tonnes of aggregate used
Economic Benefits:	• Will support an 14,000 fulltime equivalent (FTE) years of employment in Ontario throughout the project life through direct,

	indirect and induced economic impacts. • 36 of FTE years of employment will be directly associated with the value added from aggregates. • Will result in the creation of $707 million of labour income throughout the project life. • $1.8 million of worker salaries will be directly related to the aggregate input to the project. • Will contribute $1.0 billion to the province of Ontario's gross domestic product. • The value added by the aggregates used in this project will be worth $2.7 million to the province of Ontario. • 0.26% of the total value created by the project is related to the aggregate input.
Other Benefits	• Creation of a 22-bed inpatient rehabilitation program. • Creation of 12 critical care beds, and 33 complex continuing care beds. • Development of a state-of-the-art diagnostic imaging capability. • Will have the ability to offer surgical services with 5 operating rooms. • Development of a new maternal/child/women's health unit with 14 beds, and 5 birthing rooms. • Creation of new mental health beds.

2.2.1.4 North Bay Regional Health Centre

Figure 2-18 North Bay Regional Health Center (Under Construction)

Source: Northeast Mental Health Center, 2009

Project:	North Bay Regional Health Centre
Project Type:	Hospital/Healthcare
Project Location:	North Bay, Ontario – Portland Cement Area 7 Northeast
Project Description:	• New facilities for North Bay General Hospital and the Northeast Mental Health Centre. • The North Bay General Hospital will be housed in a new three-story building. • The Northeast Mental Health Center will be based in a village-like mental health centre.
Size of Project:	$552 million
Aggregates used:	136,000 tonnes of aggregate used
Economic Benefits:	• Will support 11,000 fulltime equivalent (FTE) years of employment in Ontario throughout the project life through direct, indirect and induced economic impacts. • 67 of FTE years of employment will be directly associated with the value added from aggregates.

- Will result in the creation of $570 million of labour income throughout the project life.
- $3.4 million of worker salaries will be directly related to the aggregate input to the project.
- Will contribute $839.8 million to the province of Ontario's gross domestic product.
- The value added by the aggregates used in this project will be worth $5.1 million to the province of Ontario.
- 0.60% of the total value created by the project is related to the aggregate input.

Other Benefits:

- Accommodation of 57,000 emergency room patients per year through the creation of a larger emergency department with 32 treatment stretchers.
- Capacity to treat 63,000 ambulatory care patients in a new ambulatory care centre.
- Addition of 275 acute care beds.
- Creation of 52 forensic psychiatry beds.
- Creation of 61 specialized mental health beds.

2.2.1.5 Wolfe Island Wind Project

Figure 2-19 Wolfe Island Wind Project in Spring

Source: Wikipedia, 2009

Project:	Wolfe Island Wind Farm Project
Project Type:	Energy
Project Location:	County of Frontenac, Ontario – Portland Cement Area 5 East Central
Project Description:	• Creation of a 197.8-megawatt wind plant on Wolfe Island
Size of Project:	$450 million
Aggregates used:	88,000 tonnes of aggregate used
Economic Benefits:	• Will support 6,400 fulltime equivalent (FTE) years of employment in Ontario throughout the project life through direct, indirect and induced economic impacts. • 671 of FTE years of employment will be directly associated with

	the value added from aggregates. • Will result in the creation of $345 million of labour income throughout the project life. • $3.5 million of worker salaries will be directly related to the aggregate input of the project. • Will contribute $605.1 million to the province of Ontario's gross domestic product. • The value added by the aggregates used in this project will be worth $3.9 million to the province of Ontario. • 0.64% of the total value created by the project is related to the aggregate input.
Other Benefits	• Development of Canada's second largest wind project. • Increased the Township of Frontenac Island's green energy resources. • Forecast to generate 594 Gigawatt hours of renewable energy annually. • Royalties, taxes, and amenities agreement for the host community.

2.3 Social Value

This section summarizes the results of the social value component of this study, including the Public Attitude Research (telephone survey) and the content analyses. The results of the Public Attitude Research are presented in the subsequent sections and the results of the content analyses are presented in the final subsection, 2.2.5 – Costs.

2.3.1 Perceived Direct Experience (PDE)

2.3.1.1 Assessment of Perceived Direct Experience (PDE)

It was hypothesized that the social value of aggregates and aggregate extraction may differ depending upon whether people have direct experience with the aggregate industry. To this end, the telephone survey sought to establish respondents' perceived direct experience with a pit or quarry and whether a member of their household was employed by the aggregate or a related industry (for example, construction).

Respondents were asked if they lived near a pit or quarry, and also if they lived near an aggregate transportation route. As seen in Table 2-21, one-third of the respondents (33%) identified themselves as living near a pit or quarry, and one-quarter (25%) indicated that they live near a transportation route.

Table 2-21 Contact with the Aggregate Industry

	Pit or Quarry Near Their Home		Home Near Transportation Route	
	%	*N*	%	*N*
Yes	33	*(473)*	25	(355)
No	61	*(860)*	67	(945)
Don't know	6	*(88)*	8	(120)
n	*100*	*(1420)*	*100*	*(1420)*

Note: Percentages may not sum to 100% due to rounding
Source: Intellipulse, 2009

Similarly, respondents were also asked if they or someone else in their household was employed by the aggregate or a related industry. As can be seen in Table 2-22, very few respondents were, or had someone in their household, employed by the aggregate industry or related industries such as road or building construction. Those who responded affirmatively were asked how that person was employed. The types of occupations that were identified included: working at a pit or quarry and employment in the mining, construction and transportation industries.

Table 2-22 Way in Which a Household Member is Employed in the Aggregate Industry

	%	*n*
Employed in the Industry:		
Yes	3	*(41)*
No	97	*(1375)*
n	*100*	*(1417)*
Yes - In what way:		
Construction - general	18	(8)
Road construction	17	(7)
Gravel/pit quarry	16	(7)
Home construction/ contractor	11	(5)
Heavy equipment operator/ crush stone	9	(4)
Business owner	8	(3)
Miner/aggregate company	5	(2)
Mechanic	3	(1)
Truck driver	3	(1)
Other	23	(9)
Don't know/refused	4	(2)
Total # of respondents		*(41)*

Note: Percentages may sum to more than 100% as more than one response was accepted.
Source: Intellipulse, 2009

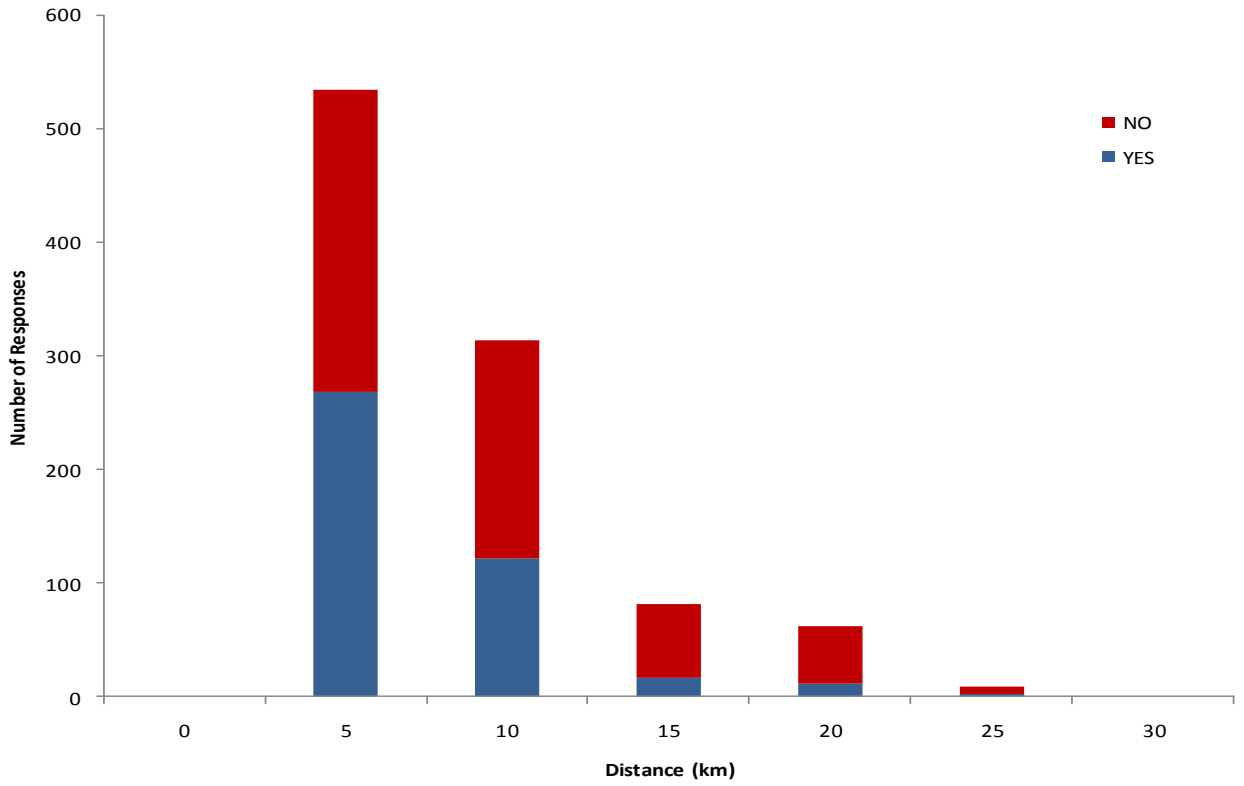
On the basis of these responses, those that answered "yes" to these two questions were considered to have a *Perceived Direct Experience* (PDE) with the aggregate industry. That is, those respondents that answered "yes" in Tables 2-21 or 2-22 are stated to have a PDE with the aggregate industry. However, because so few respondents stated that there was a relationship of employment with the aggregate industry, only physical proximity to a pit, quarry, or aggregate transportation route were used to group respondents according to PDE and used in analyses.

2.3.1.2 Subjectivity in Perceived Direct Experience (PDE)

It was also thought that a person's PDE with the aggregate industry would be largely subjective, in that some people would state that they live in close proximity to a pit or quarry and do not, and conversely, others would state that they do not live near a pit or quarry, but in fact do. In order to test whether or not respondents had a PDE, respondent's location (determined by their postal code and if that was not available, their Forward Sortation Area (FSA)) was cross referenced against actual locations of pits or

quarries, as obtained in a data file from the MNR (2009)[2]. These data were used to compare individual estimates of proximity to a pit or quarry[3] to the actual distances of the individual's location to an existing pit or quarry, as defined by the MNR (2009) data file. Figure 2-18 summarizes this comparison.

Figure 2-20 Comparison of Perceived and Actual Proximity to a Pit or Quarry



Source: AECOM, 2009 based on MNR, 2009

Figure 2-18 depicts two groups of respondents: those that said they do live near a pit or quarry and those that said that they do not live near a pit or quarry. Visually, though it appears that as distance from a pit or quarry increases, more respondents are likely to say that they do not live near a pit or quarry, there is no statistically significant difference between the actual distances these two groups of respondents. Respondents that replied "yes", statistically, do not actually live closer to a pit or quarry than those respondents that replied "no". These results confirmed that the perceived distance to a pit or quarry is

[2] *It should be noted that the data file of existing pits or quarries was not 100% complete, though the MNR gave a rough estimate of 85% completion and accuracy for that data file.*

[3] *Note that only "Yes" or "No" responses were used and "I don't know" was not considered for this part of the analysis.*

largely subjective, and that overall, this perception does not vary based on how close or far respondents live from a pit or quarry. The MNR (2009) data file and the survey data indicated that 53% of the respondents live within 5 km of a pit or quarry and none of the respondents live further than 25 km from a pit or quarry.

Figures 2-21 to 2-28 depict responses for perceived proximity to a pit or quarry, grouped by FSA[4]. Each map illustrates a different Portland Cement Region. Each FSA is represented by a small pie chart, illustrating the proportion of respondents in that FSA that stated they did or did not live near a pit or quarry. The locations of existing pits and quarries are indicated in these figures as well. The same variation illustrated in Figure 2-18 is also indicated in these maps.

[4] *Note that Figure 2-22, Area 4, aggregates several FSA's in the City of Toronto for ease of viewing.*

Lake Huron

Lake Ontario

Lake Erie

Essex

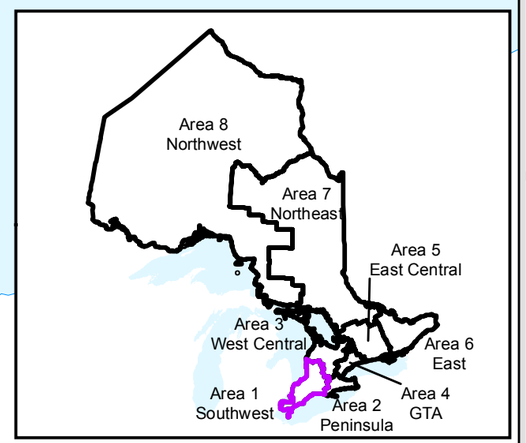
Legend

- Quarry/Pit
- CPCA Geographic Area
- Municipal Division

Number of Responses

- 1
- 5
- 11

- Yes
- No



Basemapping from Ontario Ministry of Natural Resources

N
W
E
S

Kilometers

0 5 10 20 30 40

1:1,000,000

UTM Zone 17N, NAD 83

Grouped by FSA Location

Respondents' Perceived Distance to a Pit or Quarry Area 1 (Southwest)

December 2009
Project 60119329

AECOM

Figure 2-21

Map Document: (N:\projects\0-aecom\112870\2009\FinalGISSpatialMXDs\ReportMXDs\112870Response1_Area1.mxd)
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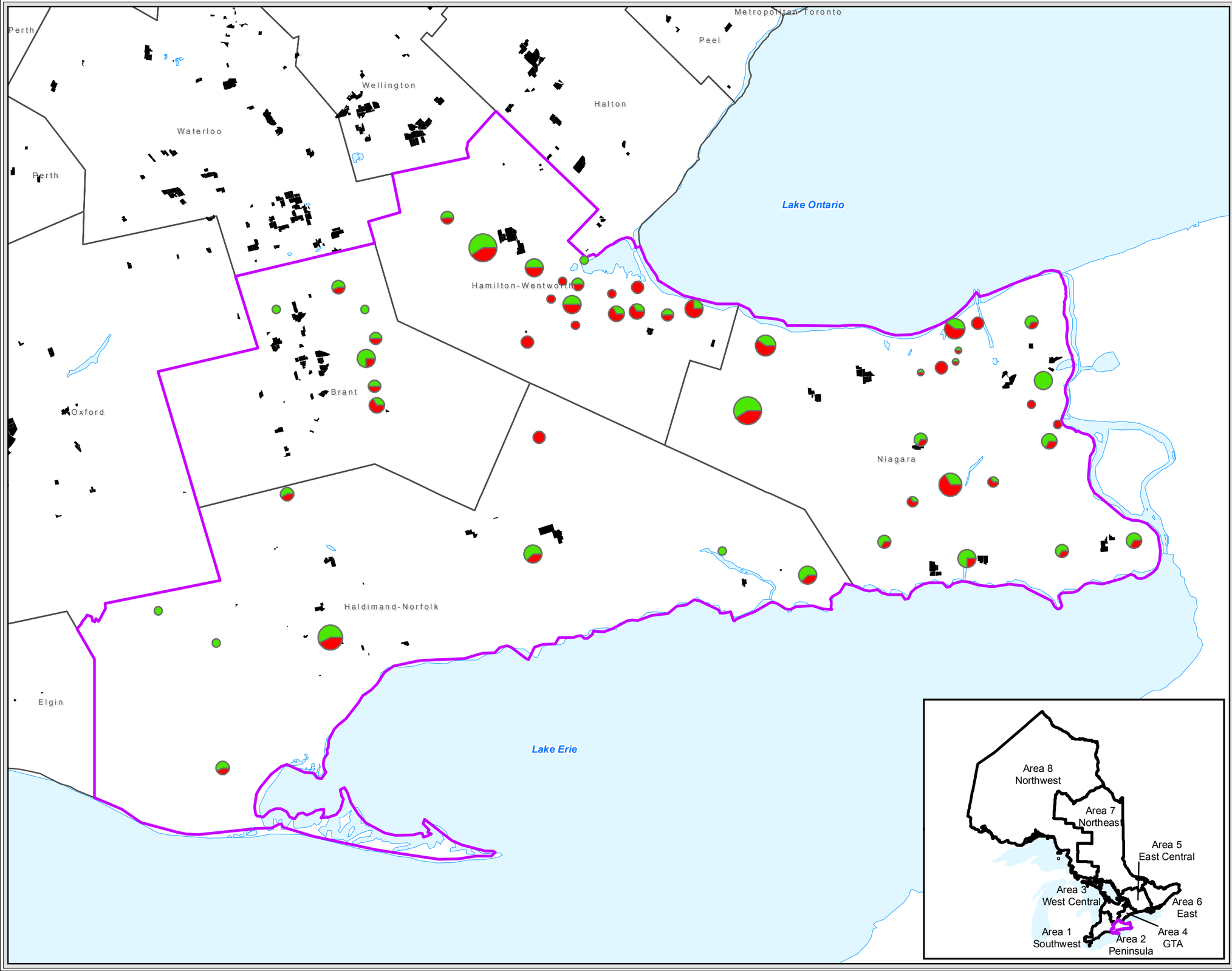

Legend

- Quarry/Pit
- Portland Cement Geographic Areas
- Municipal Division

Number of Responses

- 1
- 4
- 9
- Yes
- No

Basemapping from Ontario Ministry of Natural Resources

N W E S

Kilometers

0 2.5 5 10 15 20

1:500,000

UTM Zone 17N, NAD 83

Grouped by FSA Location

Respondents' Perceived Distance to a Pit or Quarry Area 2 (Peninsula)

December 2009
Project 60119329

AECOM

Figure 2-22

Map Document: (N:\projects\0-aecom\112870\2009\Final\GIS\Spatial\MXDs\Report\MXDs\112870Response1_Area2.mxd)
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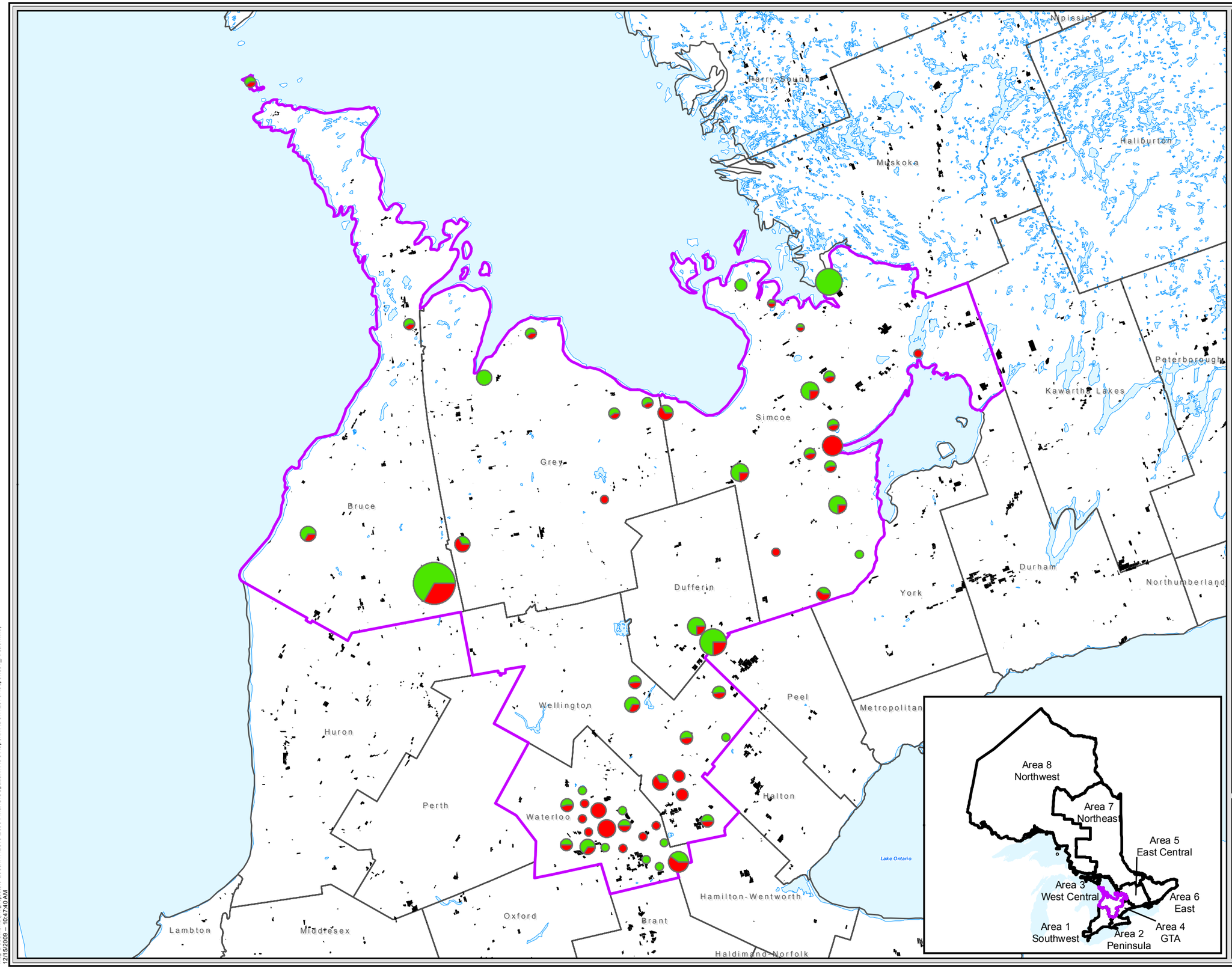

Legend

- Quarry/Pit
- CPCA Geographic Area
- Municipal Division

Number of Responses

- 1
- 8
- 18

- Yes
- No

Basemapping from Ontario Ministry of Natural Resources

N
W E
S

Kilometers

0 5 10 20 30 40

1:1,000,000

UTM Zone 17N, NAD 83

Grouped by FSA Location

Respondents' Perceived Distance to a Pit or Quarry Area 3 (West Central)

December 2009
Project 60119329

AECOM

Figure 2-23

Map Document: (N:\projects\0-aecom\117287012009\Final\GIS\SpatialMXDs\ReportMXDs\117287OResponse1_Area3.mxd)
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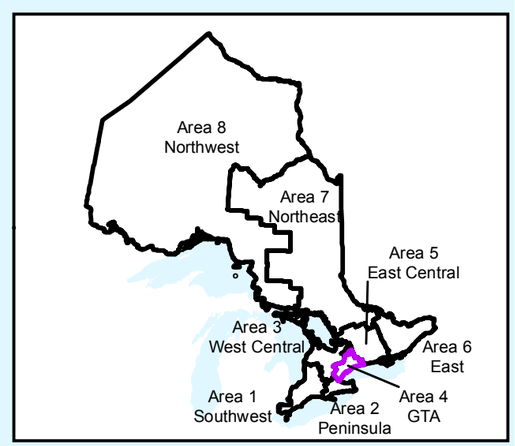
Grey
Simcoe
Dufferin
Kawartha Lakes
York
Durham
Peterborough
Wellington
Peel
Northumberland
Metropolitan Toronto
Halton
Hamilton-Wentworth
Lake Ontario
Brant

Legend

- Quarry/Pit
- CPCA Geographic Area
- Municipal Division

Number of Responses

- 1
- 6
- 30
- Yes
- No



Basemapping from Ontario Ministry of Natural Resources

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Kilometers
0 2.5 5 10 15 20

1:500,000

UTM Zone 17N, NAD 83

Grouped by FSA Location

Respondents' Perceived Distance to a Pit or Quarry Area 4 (GTA)

December 2009
Project 60119329

AECOM

Figure 2-24

Map Document: (N:\projects\0-aecom\112870\2009\Final\GIS\Spatial\MXDs\Report\MXDs\112870Response1_Area4.mxd)
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Nipissing
Parry Sound
Renfrew
Ottawa-Carlton
Haliburton
Muskoka
Lanark
Hastings
Frontenac
Leeds & Grenville
Peterborough
Kawartha Lakes
Simcoe
Lennox & Addington
Northumberland
Durham
Dufferin
York
Prince Edward
Peel
Metropolitan Toronto
Wellington
Halton
Hamilton-Wentworth
Lake Ontario
Niagara

Area 8
Northwest
Area 7
Northeast
Area 5
East Central
Area 3
West Central
Area 6
East
Area 1
Southwest
Area 2
Peninsula
Area 4
GTA

Legend

Quarry/Pit
CPCA Geographic Area
Municipal Division

Number of Responses

1
6
12

Yes
No

Basemapping from Ontario Ministry of Natural Resources

N
W E
S

Kilometers
0 5 10 20 30 40

1:1,000,000
UTM Zone 17N, NAD 83

Grouped by FSA Location

Respondents' Perceived Distance to a Pit or Quarry Area 5 (East Central)

December 2009
Project 60119329

AECOM

Figure 2-25

Map Document: (N:\projects\0-aecom\112870\2009\Final\GIS\Spatial\MXDs\Report\MXDs\112870Response1_Area5.mxd)
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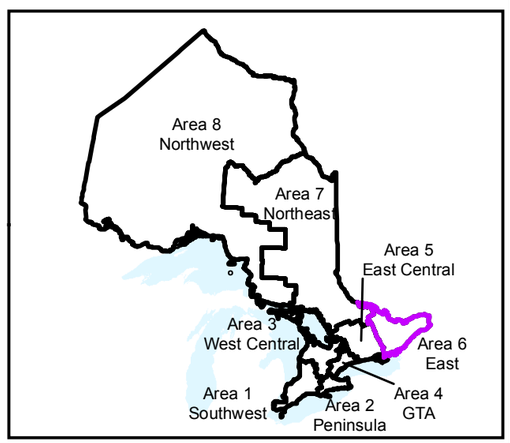
Nipissing
Renfrew
Prescott & Russell
Ottawa-Carlton
Stormont Dundas & Glengarry
Haliburton
Lanark
Hastings
Frontenac
Leeds & Grenville
Peterborough
Lennox & Addington
Kawartha Lakes
Northumberland
Prince Edward
Durham

Legend

- Quarry/Pit
- CPCA Geographic Area
- Municipal Division

Number of Responses

- 1
- 3
- 7
- Yes
- No



Basemapping from Ontario Ministry of Natural Resources

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Kilometers

0 5 10 20 30 40

1:1,000,000

UTM Zone 17N, NAD 83

Grouped by FSA Location

Respondents' Perceived Distance to a Pit or Quarry Area 6 (East)

December 2009
Project 60119329

AECOM

Figure 2-26

Map Document: (N:\projects\0-aecom\112870\2009\FinalGISSpatialMXDs\ReportMXDs\112870Response1_Area6.mxd)
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Kenora

Cochrane

Thunder Bay

Algoma

Sudbury

Timiskaming

Sudbury Region

Nipissing

Manitoulin

Parry Sound

Renfrew

Haliburton

Hastings

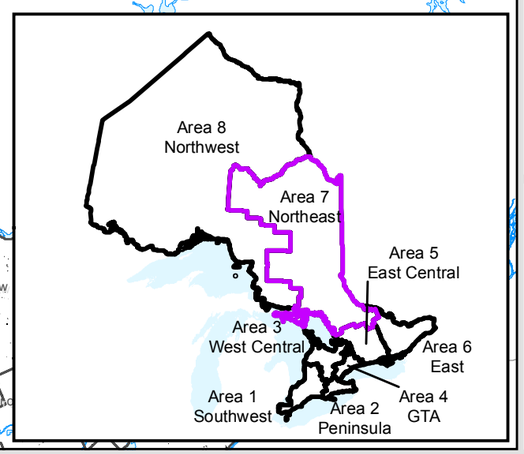
Lennox & Addington

Bruce

Muskoka

Kawartha Lakes

Peterborough



Legend

- Quarry/Pit
- CPCA Geographic Area
- Municipal Division

Number of Responses

- 1
- 6
- 13

- Yes
- No

Basemapping from Ontario Ministry of Natural Resources

N W E S

Kilometers

0 16 32 64 96 128

1:3,250,000

UTM Zone 17N, NAD 83

Grouped by FSA Location

Respondents' Perceived Distance to a Pit or Quarry Area 7 (Northeast)

December 2009
Project 60119329

AECOM

Figure 2-27

Map Document: (N:\projects\0-aecom\112870\2009\FinalGIS\SpatialMXDs\ReportMXDs\112870Response1_Area7.mxd)
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Kenora
Thunder Bay
Rainy River
Cochrane
Algoma
Sudbury
Timiskaming
Sudbury Region
Parry Sound
Muskoka

Legend

- Quarry/Pit
- CPCA Geographic Area
- Municipal Division

Number of Responses

1
7
15

Yes
No

Basemapping from Ontario Ministry of Natural Resources

N
W
E
S

Kilometers

0 25 50 100 150 200

1:5,000,000

UTM Zone 17N, NAD 83

Grouped by FSA Location

Respondents' Perceived Distance to a Pit or Quarry Area 8 (Northwest)

December 2009
Project 60119329

AECOM

Figure 2-28

Map Document: (N:\projects\0-aecom\11287\0\2009\Final\GIS\Spatial\MXDs\ReportMXDs\11287\0Response1_Area8.mxd)
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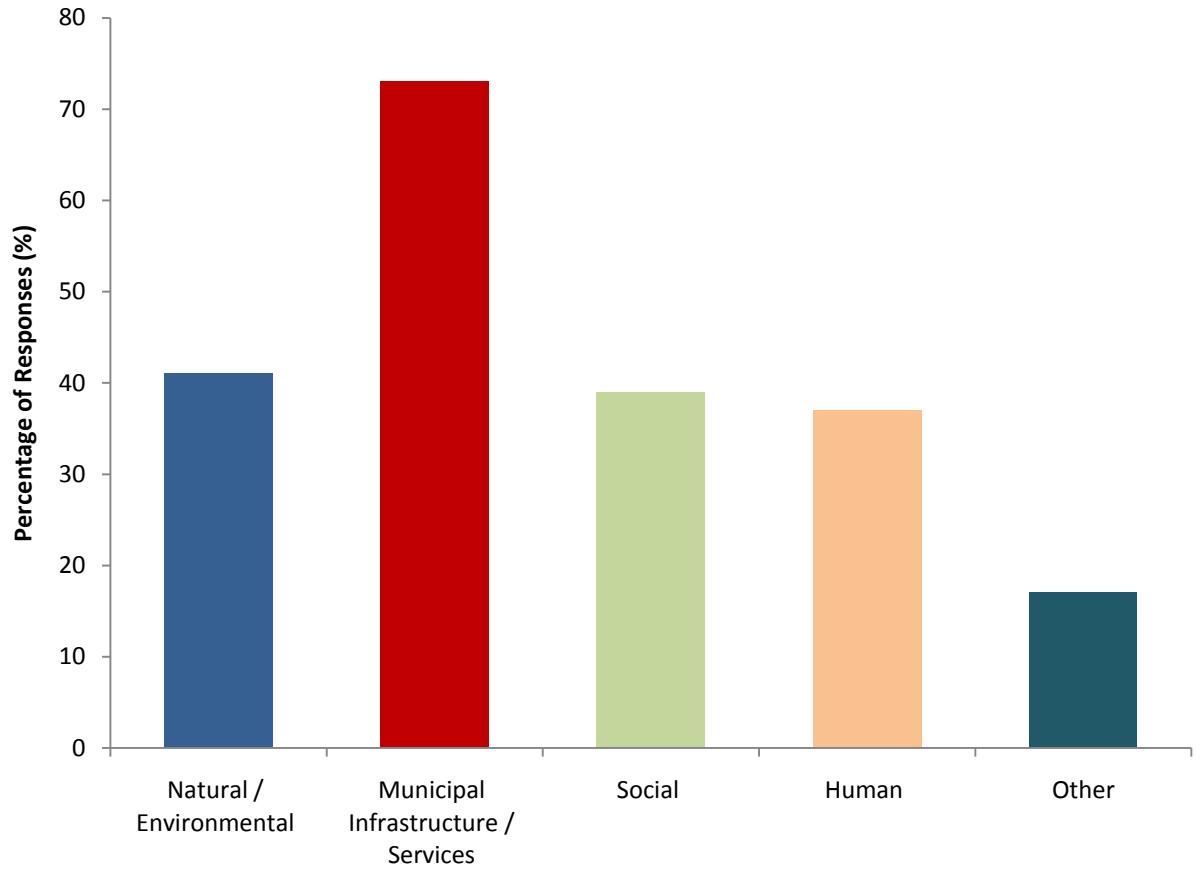
2.3.2 Community-Well Being

In order to understand the Ontario public's social values, respondents were asked to list the three most important things that they value about their community. A range of answers were given and grouped according to five overall themes. Figure 2-27 displays the proportion of responses, by major theme, and Table 2-23 summarizes the detailed types of responses and their proportions, by major theme.

Figure 2-29 Respondents' Community Values, by Major Theme



Note: Percentages sum to more then 100%, since up to three responses were accepted

Source: Intellipulse, 2009

Table 2-23 Respondents' Community Values, Detailed Summary

	%	*N*
Municipal Infrastructure/Services Aspects:	**73**	
Parks/trails	19	*(264)*
Cleanliness/up keep of community	10	*(141)*
Municipal services-garbage, social services, taxes, library etc.	8	*(111)*
Water quality/clean water	7	*(93)*
Recreational/community center	7	*(101)*
Infrastructure/highways/roads	6	*(90)*
Public/transportation	6	*(83)*
Education/access to schools	5	*(75)*
Good healthcare/services/EMS, doctors etc.	5	*(69)*
Nature/Environment Aspects:	**41**	
Green space/trees/wildlife	20	*(290)*
Clean/fresh air/no pollution	14	*(197)*
Accessibility to lakes	7	*(95)*
Social Aspects:	**39**	
Quite neighbourhood/privacy	16	*(229)*
Community/friendly neighbours	13	*(185)*
Sense of community/ involvement/ multiculturalism/diversity	6	*(86)*
Family/family oriented community	4	*(63)*
Human Aspects:	**23**	
Public safety/personal security	14	*(198)*
Access to local amenities/ shopping/ entertainment	13	*(178)*
Small town/village feel	5	*(76)*
Location-proximity to work/city/others	3	*(43)*
Job/employment	2	*(35)*
Other:		
Road safety/noise/no heavy trucks	1	*(15)*
Other	11	*(143)*
Don't know/refused	4	*(51)*
None/No other issues	1	*(55)*
Total # of respondents		*(1420)*

Note: Percentages sum to more than 100% as more than one response was accepted.
Source: Intellipulse, 2009

These responses indicate the most important community attributes that are "top-of-mind" to respondents were municipal and infrastructure services including parks and trails (19%), cleanliness of the community (10%) and municipal services (8%).

Respondents were asked to rank the relative importance of development and infrastructure projects, including highways, railways, energy facilities and airports as well as residential, commercial and industrial buildings, against the three values previously stated as important to their community's well-being. Respondents were asked which of their stated values were more or less important than development and infrastructure projects. It should be noted that some respondents had already stated values related to development an infrastructure projects. The results indicate that:

- 30% of respondents said that none of their previously stated values were more important that development and infrastructure projects, or that development and infrastructure projects were ranked above the three most important things that affect their community well-being.
- 72%[5] of the respondents said development and infrastructure projects were less important than all of their previously stated values, or that development and infrastructure project were ranked least important of the things that affect their community well-being. This indicates that for this 72% of respondents, development and infrastructure projects are not as important as other things with perceived social benefits (such as cleanliness of their community, clean air, or proximity to the workplace).

In summary, respondents did not consider development and infrastructure projects highly among the things that they value about their community and the things that contribute to their community's well-being.

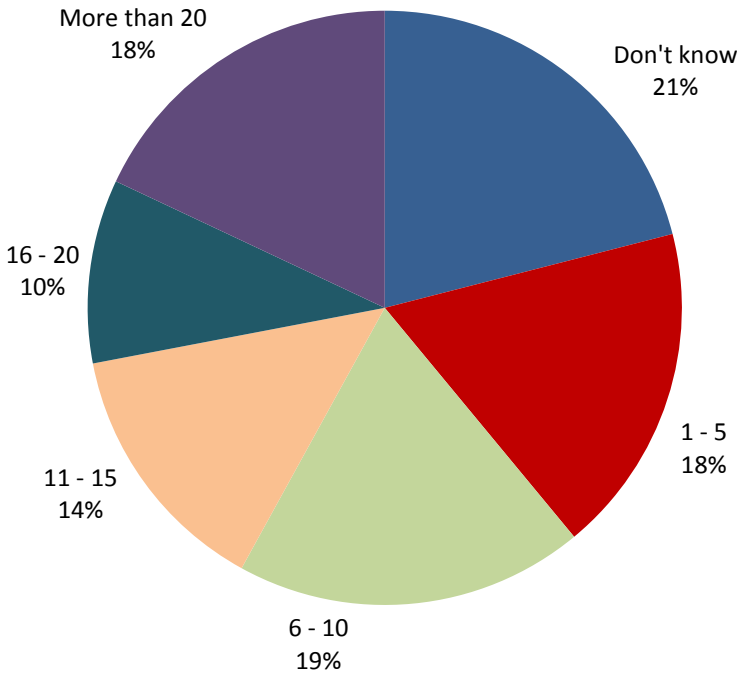
2.3.3 Knowledge of the Aggregate Industry

As demonstrated by the economic analysis, the aggregate industry is one of many important industries to the Ontario Province; however it was hypothesized that it may not be one that the Ontario public is very familiar with. To test this hypothesis, respondents were asked several questions about the industry (i.e., the amount of aggregates use in the province, where aggregates are extracted from and how they are transported). The results indicate that there is a relationship between Ontarians social values of aggregates and their familiarity with the aggregate industry. While this study did not investigate the nature of this relationship in detail, the study results shed light onto the public's general knowledge of this industry.

[5] *Note that percentages sum to more than 100%, since some respondents may have said "none" to both questions.*

According to the Ontario Stone Sand and Gravel Association (OSSGA, 2009) Ontarians consumed, on average, 14 tonnes of aggregates per person per year. Figure 2-29 demonstrates that only 14% of respondents could accurately estimate the amount of aggregate consumed by Ontarians. Most other respondents either could not provide an estimate at all (21%), or severely overestimated (18%) or underestimated (18%) the amount of aggregates consumed by Ontarians.

Figure 2-30 Respondents' Estimate of Tonnes of Aggregates Consumed Per Person, Per Year in Ontario



Source: Intellipulse, 2009

Respondents were also asked where they thought aggregates were being extracted in Ontario (i.e. the general location of pits or quarries). Table 2-24 summarizes these responses.

Table 2-24 Respondents' Perception of Aggregate Extraction Sites

	%	*n*
Within 25 km of where you live	49	*(698)*
Within 100 km of where you live	38	*(535)*
In Northern Ontario	30	*(423)*
In Southern Ontario	22	*(318)*
Outside of Ontario	13	*(186)*
Don't know/not sure	8	*(107)*
Total # of respondents		*(1420)*

Note: Percentages sum to more than 100% as more than one response was accepted.
Source: Intellipulse, 2009

These results indicate that nearly 50% of the respondents thought that pits are located within 25 km of where they live, while MNR (2009) data indicates that all of the respondents (100%) do in fact live within 25 km of an aggregate pit or quarry.

Finally, respondents were asked to rank three modes of transportation used to transport aggregate resources, in order of frequency of use. These were sea, rail and road transport. Table 2-25 summarizes these responses.

Table 2-25 Ranking of Modes to Transport Aggregates

Transport type:	Rank:	%	*n*
Truck	1	75	*(1060)*
	2	13	*(181)*
	3	13	*(178)*
Rail	1	18	*(263)*
	2	58	*(817)*
	3	24	*(341)*
Sea or Lake	1	7	*(97)*
	2	30	*(422)*
	3	63	*(901)*
Total			*(1420)*

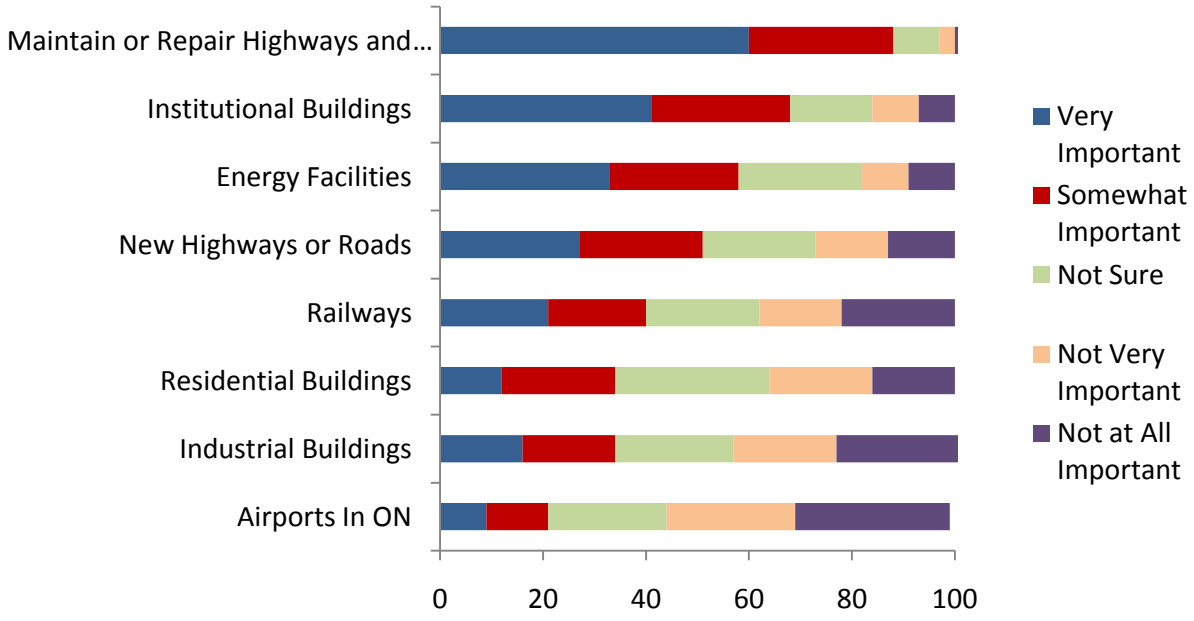
Note: Percentages may not sum to 100% due to rounding. 1 is the most commonly used transportation mode, 3 the least.
Source: Intellipulse, 2009

These results indicate that most respondents are aware that truck transport is most frequently used to transport aggregates. In summary, it can be concluded that respondents are not very familiar with the aggregate industry. Although their awareness of transport methods is largely accurate, their knowledge of the locations of pits and quarries and the amounts of aggregates used per person, per year is much less accurate.

2.3.4 Benefits

The social benefits of aggregate resources were also investigated. As previously mentioned, 72% of respondents considered development and infrastructure projects as being less important than other important things or attributes that contribute to their community's well-being. However, when asked to rate the importance of various types of development and infrastructure projects, some were considered more important than others. These responses are summarized in Figure 2-31.

Figure 2-31 Importance of Various Development and Infrastructure Projects



Source: Intellipulse, 2009

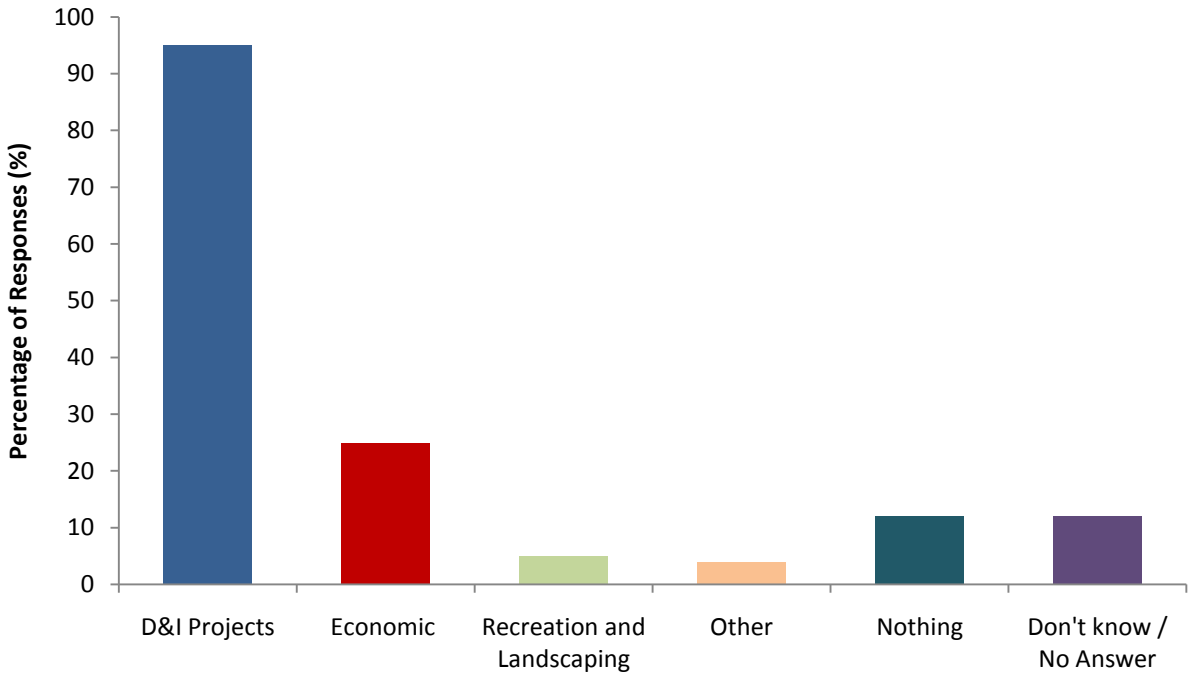
These results indicate that among the various development and infrastructure projects, maintaining or repairing highways or roads, building new institutional buildings, new energy facilities and new highways or roads were considered the most important and have the greatest social value.

The results also indicated that if the necessary resources (including aggregates) were not available for these projects, then approximately half of the respondents would consider themselves or their communities as being negatively affected.

In summary, while 72% of the respondents may have ranked development and infrastructure projects as less important than the top three things that they value about their community, approximately 50% of the respondents view some types of development and infrastructure projects as important.

Respondents were also asked to state the three main benefits of aggregate extraction in open ended responses. A wide range of answers were given, and these were grouped into 6 main themes. Figure 2-32 summarizes these overall themes and Table 2-26 summarizes these responses in more detail.

Figure 2-32 Social Benefits of Aggregate Extraction



Source: Intellipulse, 2009

Note: Percentages sum to more than 100% because more than one response was accepted

Table 2-26 Main Social Benefits of Stone, Sand & Gravel Extraction

	%	*n*
Infrastructure & Development Projects:	**95**	
Provision of materials/construction of buildings/homes	36	*(513)*
Improve infrastructure/better roads/highways/railway	35	*(498)*
Availability of materials/local	9	*(129)*
Use of raw materials/natural resources	7	*(93)*
Need it/necessary	4	*(61)*
Cheap materials/resources	2	*(32)*
Improve/development of the community	2	*(23)*
Economic Benefits:	**25**	
Job creation/employment	18	*(250)*
Economic development	5	*(66)*
Industrial growth/support the local/regional industry	2	*(23)*
Recreation/Landscaping Projects:	**5**	
Landscaping/beaches	3	*(38)*
Can create lakes/drainage	2	*(23)*
Other	4	*(60)*
Other - Negative:	**12**	
None	8	*(109)*
Negative impact	4	*(58)*
Don't know/refused	12	*(168)*
Total # or respondents		*(1420)*

Note: Percentages sum to more than 100% as more than one response was accepted. 0% indicates less than 0.5%.
Source: Intellipulse, 2009

Table 2-26 indicates that 95% of the respondents view the value of aggregates in relation to its uses in development and infrastructure projects. These respondents view it as necessary for construction and infrastructure improvements. 25% of the respondents stated that aggregate extraction had related economic benefits, such as job creation and input to economic development and 12% of the respondents stated that there were no positive or social benefits of aggregate extraction

In summary, the respondents view many types of development and infrastructure projects as important to them, and they view the main benefits of aggregate extraction in relation to these development and infrastructure projects and in relation to the economic impacts of the industry.

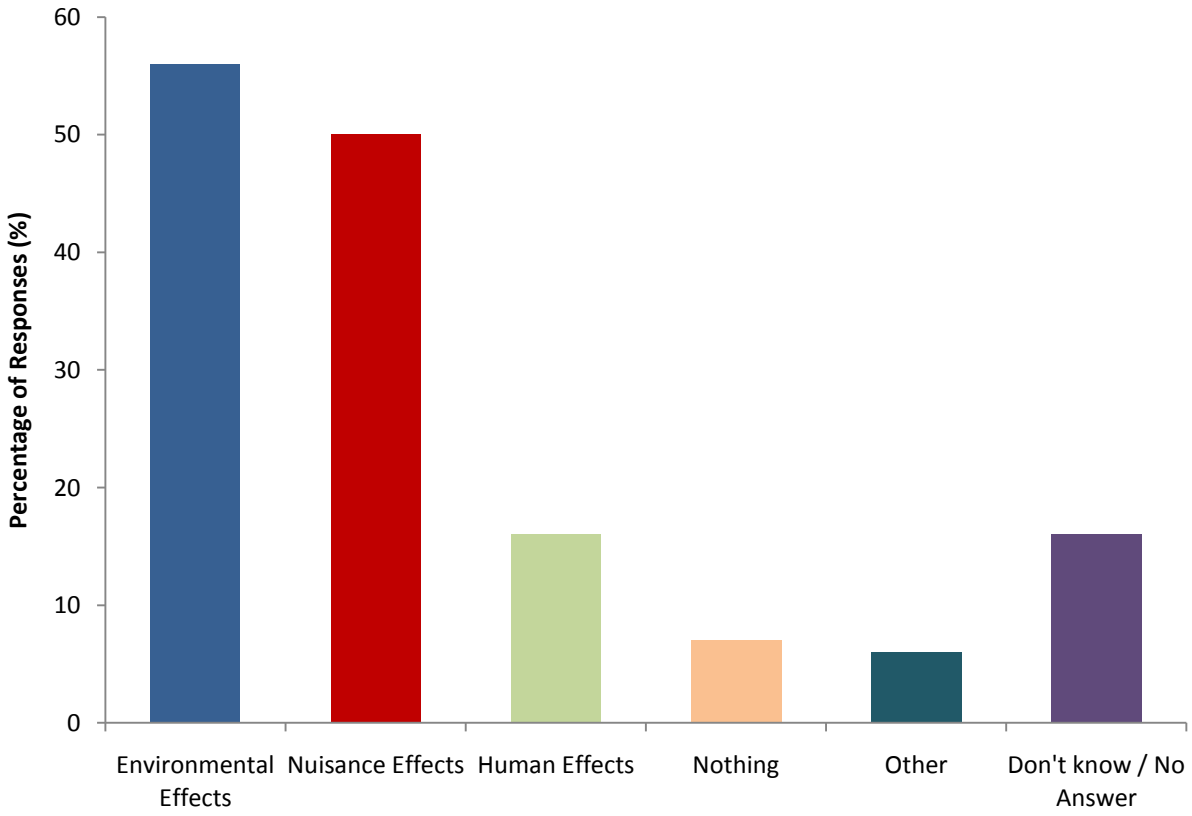
2.3.5 Costs

The views of Ontarians regarding the social costs of aggregates were determined from the telephone questionnaire and also through content analyses of public comments related to aggregate sites and licence applications. These results are presented here separately.

2.3.5.1 Results of the Telephone Survey

Respondents were a asked to state the three main costs of aggregate extraction in open ended responses. A wide range of answers were given, and these were grouped into 6 main themes. Figure 2-33 summarizes these overall themes and Table 2-27 summarizes these responses in more detail.

Figure 2-33 Main Social Costs of Aggregate Extraction



Note: Percentages sum to more than 100% since more than one response was accepted

Source: Intellipulse, 2009

Table 2-27 Social Costs of Stone, Sand & Gravel Extraction

	%	*n*
Environmental Effect:	**56**	
Holes/pits/left behind/no rehabilitation	13	*(181)*
Water tables are exposed/contaminate water	9	*(130)*
Destruction of the natural environment	9	*(126)*
Disruption of wild life/animal habitat	7	*(105)*
Eroding of earth/digging up land	6	*(87)*
Blasting/destroying non-renewable resources	4	*(63)*
Destroys agricultural/topsoil	3	*(49)*
Removal of trees/forestry/greenery	3	*(42)*
Disruption of the ecosystem	2	*(31)*
Changes the climate/global warming	0	*(7)*
Nuisance Effect:	**50**	
Dust/sand/dirt	11	*(158)*
Noise from trucks/machinery	11	*(157)*
Heavy/trucks/damages the road	8	*(116)*
Disruption of scenery/an eye sore	8	*(114)*
Trucks create traffic on the road	5	*(64)*
Damages the surrounding communities/ residential areas	5	*(68)*
Trucks throw stones/gravel damaging other vehicles	2	*(30)*
Human Effect:	**16**	
Pollution/poor air quality affecting human health	13	*(179)*
Health risks for workers/residents	3	*(48)*
Nothing/none	**7**	*(104)*
Other	**6**	*(87)*
Don't know/refused	**16**	*(230)*
Total # of respondents		*(1420)*

Note: Percentages sum to more than 100% as more than one response was accepted. O% indicates less than .5%.
Source: Intellipulse, 2009

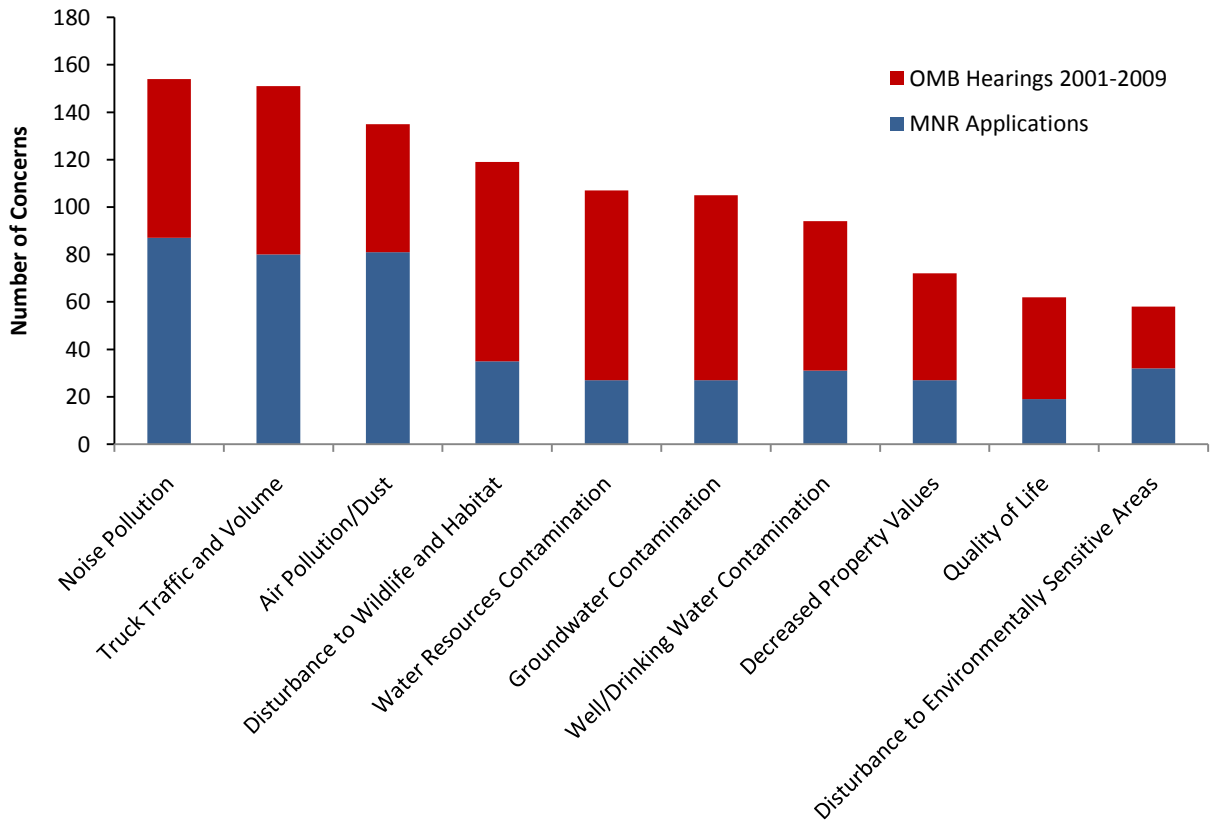
These results indicate that 56% of the respondents said that environmental effects were the main social cost of aggregate extraction. This includes a lack of site rehabilitation, water contamination and a destruction of habitat. Half (50%) of the respondents stated nuisance effects as a social cost of aggregate extraction, including dust and noise nuisance effects and 7% of the respondents said that there were no social costs of aggregate extraction.

2.3.5.2 Results of the Content Analyses of MNR and OMB Data

Public comments from MNR site licence applications and from OMB hearings (2001-2009) were reviewed and coded according to common themes. For the former, the most recent 31 site licence applications were provided to AECOM by the MNR and public comments were reviewed from these 31 files. Of those 31, 14 site licences contained public comments. All comments were reviewed and coded according to major recurrent themes. Members of the public expressed numerous concerns regarding the development and operation of proposed pits and quarries.

The OMB hearing data were retrieved from the OMB website, under a general search for "aggregate". Records were screened for relevance, yielding 76 records. Each of these were coded and numerated using the same major themes as the MNR site licence applications. In some cases, new themes were created as the types of public comments differed slightly between the MNR and the OMB data. The top three concerns for the OMB hearing data were in relation to groundwater contamination, water resources contamination and traffic/truck volume. Figure 2-32 summarizes the results of the content analyses, for the OMB and MNR data. It should be noted that only the top 10 most frequent results are noted in this figure.

Figure 2-34 Ten most Frequent Public Comments Regarding Aggregate Applications or Operations



Source: AECOM, 2009

There is a wide range of types of public complaints regarding aggregate operations and licence applications. These indicate the types of social costs associated with aggregate extraction. From a combination of the MNR and OMB data, it is clear that the three most frequently reported public complaints are regarding noise pollution, truck traffic and volume and air pollution and dust.

The MNR site licence applications also detailed proposed or actual resolutions to the public complaints. For many of the proposed development projects, the proponents held meetings in order to address the public concerns. Issues were addressed and communicated thorough letters and telephone calls between the proponent and members of the public. Comments were also addressed through letters, describing mitigation measures that will be put in place in order to minimize the social and environmental impacts. In some cases, attempts were made to address public concerns through a

reduction of the licenced area and creation of a greater buffer area between the licenced pit/quarry and the residential development, removing a haul road through an Environmentally Sensitive Area (ESA) and inclusion of additional noise monitoring of dust deposition around the perimeter of the Environmentally Sensitive Areas (ESA). In many cases, public concerns and proposed monitoring measures were implemented to the site plans of the proposed quarry developments and mitigation measures were included as well.

2.3.5.3 Results from the NEC Case Files

The Niagara Escarpment Commission (NEC) provided AECOM with a sample of case files, which included public comments, letters, and summaries for cases related to aggregate operations, dating back to 2001. The files were reviewed in order to understand key and recurring themes. This is not a representative sample of all of the aggregate licence applications on the Niagara Escarpment, but rather a sample of approximately 9 cases. Therefore, conclusions about the public comments from the NEC case files cannot be drawn from this small sample. However, they do highlight some (but not all) of the recurrent themes. These were:

- Environmental - relating to the use and enjoyment of the local area and the intrinsic value of nature and the surrounding environment.
- Economic – relating to impacts on economic opportunities
- Social – relating to noise, nuisance and community character issues.

A small proportion of the comments were related to the benefits of aggregate extraction in the Niagara Escarpment. These were grouped into two themes, which were:

- Social Benefits - relating to infrastructure and access to services
- Economic Benefits - relating to employment and expenditures

The majority of the comments received in support of a new quarry operation or expansion were made by local business owners or affiliates whose business would be positively affected. Overall, from these nine case files, the concerns with negative impacts were much more common than the comments that documented potential positive benefits.

2.3.6 PDE Influence on Social Values of Aggregates

Perceived Direct Experience (PDE) was one of the variables used in cross-tabular analyses. Respondents who reported that they live near a pit or quarry or near a truck transportation route formulated groups of respondents that were stated to have a PDE with the aggregate industry. Those respondents that stated they or someone in their household was employed by the aggregate or a related industry were not included as a group of respondents with a PDE since the number of respondents in this category was too low to conduct any statistical analyses.

Cross tabular analyses were run for all groups with a PDE for every question in the telephone survey. This section summarizes all of the statistically significant results, by PDE.

2.3.6.1 Respondents that Live near a Pit or Quarry

- Less likely to name parks and trails as important things they value about their community (14%).
- More likely to say they live within 25km of a pit or quarry (76%).
- More likely to rank truck transportation higher as a mode of aggregate transportation (82%).
- More likely to name nuisance effects as a social cost of aggregate extraction (61%).

2.3.6.2 Respondents that Live near an Aggregate Truck Transportation Route

- More likely to say they live within 25km of a pit or quarry (72%).
- More likely to rank truck transportation higher as the main mode of aggregate transportation (82%).
- More likely to state economic aspects as a social benefit of aggregate extraction (33%).

2.3.6.3 Respondents that do not live near a Pit or Quarry

- More likely to highly rank rail transportation higher as a mode of aggregate transportation (21%).

2.3.6.4 Respondents that do not live near an Aggregate Truck Transportation Route

- More likely to highly rank rail transportation higher as a mode of aggregate transportation (21%).

In summary, respondents that live near a pit or quarry were more likely to name nuisance effects as a social cost of aggregate extraction. However, respondents that live near an aggregate truck transportation route were more likely to state that the economic aspects of aggregate extraction as a social benefit.

2.3.7 Geographical Variation in Social Values of Aggregates

The samples for the telephone survey were drawn from the eight Portland Cement Regions of Ontario (Figure 1-1). Table 2-29 summarizes the sample sizes within each of the eight regions. The sample yielded overall results with an accuracy of +/- 2.6%, 19 out of 20 times, for all of Ontario.

Geographical location was another grouping used in cross tabular analysis for each question of the survey. This section presents all statistically significant difference, by CPCA geographic area.

2.3.7.1 Area 1 – Southwest

- More likely to name parks/trails as important aspects of their community (22%).
- More likely to rank sea transport first in terms of modes of aggregate transportation used (13%).

2.3.7.2 Area 2 – Peninsula

- More likely to state that pits and quarries are located within 25 km of where they live (71%).

2.3.7.3 Area 3 - West Central

- More likely to state that pits are quarries are located within 25 km of where they live (73%).
- More likely to rank truck transport highest in terms of modes of aggregate transportation used (86%).
- More likely to state nuisance effects as a social cost of extraction (69%).

2.3.7.4 Area 4 – GTA

- More likely to name parks/trails as important aspects of their community (22%).
- More likely to rate building new institutional buildings as high in importance (47%).
- More likely to state that pits and quarries are located in Northern Ontario (36%).

- More likely to rank rail transport higher in terms of modes of aggregate transportation used (25%).
- Less likely to say they live near a pit or quarry (18%).
- Least likely to state that pits and quarries are located within 25 km of where they live (30%).

2.3.7.5 Area 5 - East Central

- More likely to say they live near a pit or quarry (58%).
- More likely to state that pits and quarries are located within 25 km of where they live (65%).
- More likely to rank truck transport higher in terms of modes of aggregate transportation used (87%).
- Less likely to name parks/trails as important aspects of their community (7%).

2.3.7.6 Area 6 – East

- More likely to state that pits and quarries are located within 25 km of where they live (64%).
- More likely to state that D&I Projects and improvements to infrastructure are a benefit of aggregate extraction (45%).

2.3.7.7 Area 7 – Northeast

- More likely to say they live near a pit or quarry (58%).
- More likely to rate building new highways or roads as high in importance (47%).
- More likely to rate building new residential buildings as high in importance (17%).
- More likely to rate building new airports as high in importance (16%).
- More likely to state that pits are quarries are located within 25 km of where they live (68%).
- More likely to state that pits are quarries are located in Northern Ontario (34%).
- More likely to state that D&I Projects and improvements to infrastructure are a benefit of aggregate extraction (40%).

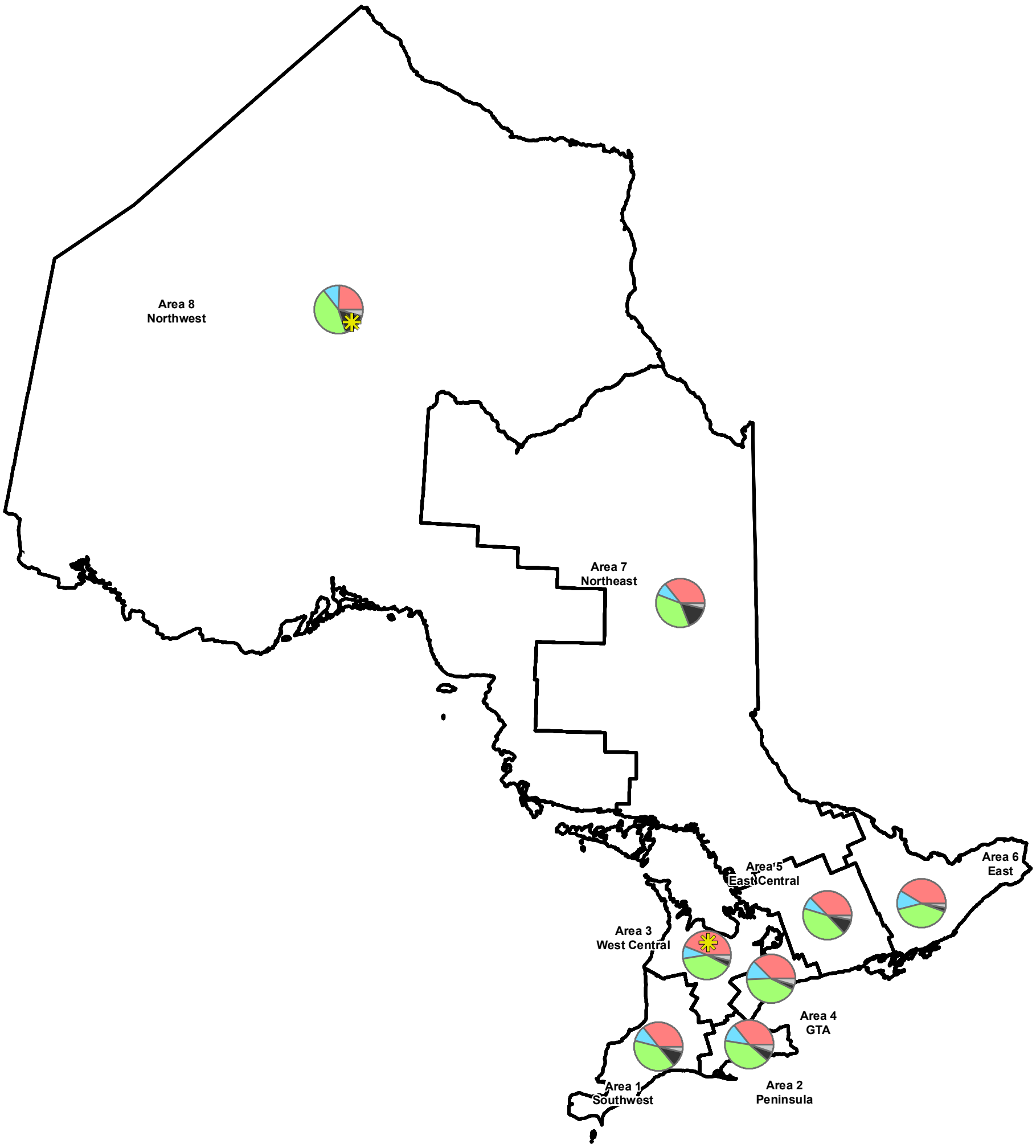
2.3.7.8 Area 8 - Northwest

- More likely to say that nature/environmental aspects are more important that D&I projects (13%).
- More likely to rate building new highways or roads as high in importance (51%).
- More likely to rate building new residential buildings as high in importance (18%).
- More likely to rate building new industrial buildings as high in importance (34%).
- More likely to rate building new airports as high in importance (18%).
- More likely to state that pits and quarries are located within 25 km of where they live (65%).
- More likely to state that pits and quarries are located in Northern Ontario (40%).
- More likely to state that there are no social costs of extraction (20%).
- Less likely to name parks/trails as important aspects of their community (5%).

Two of the more critical questions of the survey addressed the social costs and benefits of aggregate extraction. These results were tabulated by geographic area and are illustrated in Figures 2-35 and 2-36. Those responses with significant differences are noted with an asterisk.

Based on the findings from the geographical variation study we can infer from the results that respondents who live in an urban such as Area 4 – GTA, rate parks and trails as an important aspect of their community. Also, respondents from Area 4 - GTA highlighted new institutional buildings as important. Based on these responses we can infer that respondents do not rate development and infrastructure projects, with the exception of institutional buildings, as high importance.

Respondents from Area 3 – West Central are more likely to link social costs such as nuisance effects with aggregate extraction. Respondents who live in the far northeast and northwest areas of the Portland Cement Regions such as Area 7 and 8 are most likely to name development and infrastructure projects as a benefit of aggregate extraction. It is interesting to note that residents in the Northwest, Area 8, are more likely to say there are no social costs of aggregate extraction.



Basemapping from Ontario Ministry of Natural Resources

N
W E
S

Kilometers
0 50 100 200 300 400

1:6,500,000

UTM Zone 17N, NAD 83

Legend

- Nuisance Effect
- Human Effect
- Environmental
- No Social Cost
- Other
- CPCA Geographic Areas
- Statistically Significant

Perceived Scocial Costs of Aggregate Extraction by CPCA Geographic Area

December 2009
Project 60119329

AECOM

Figure 2-35

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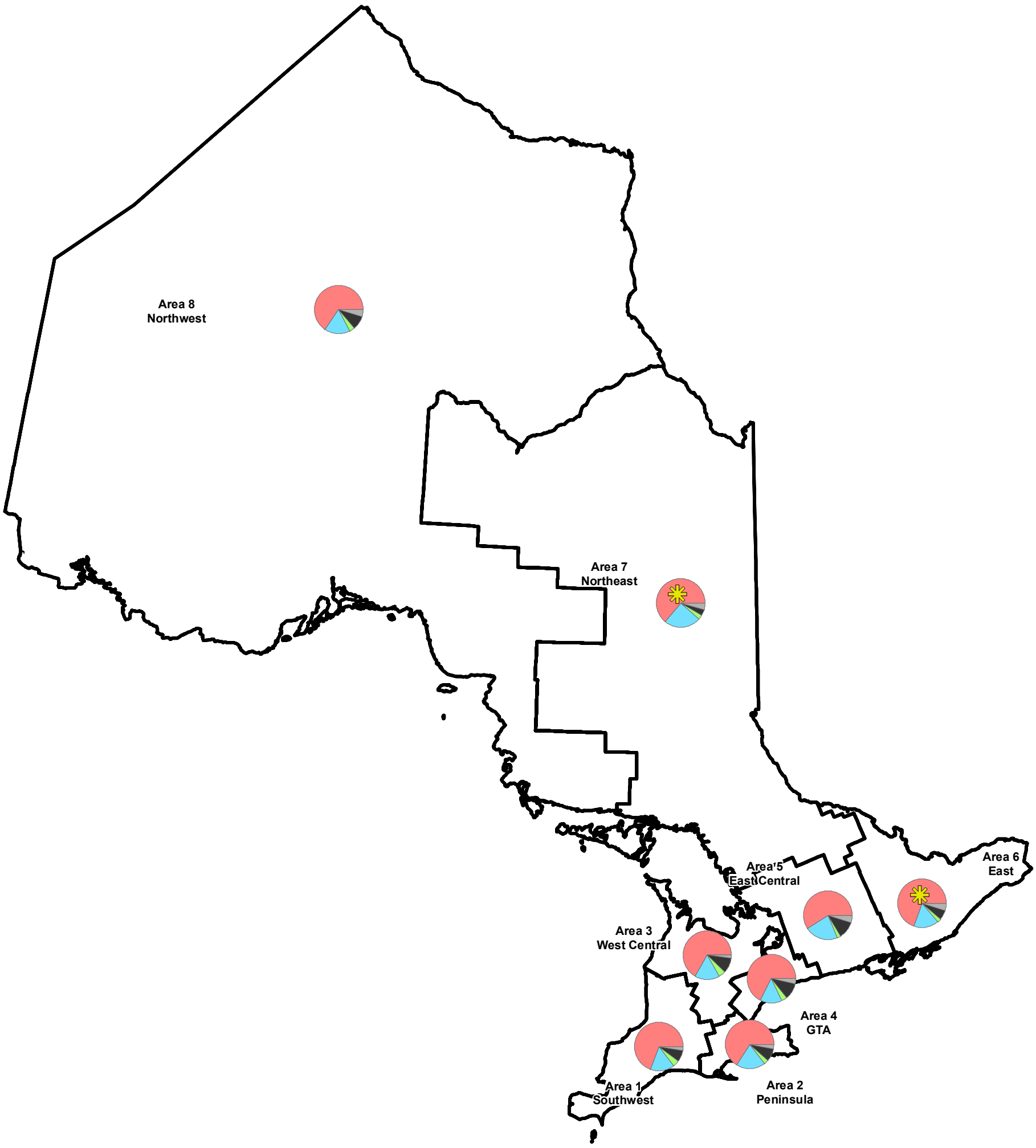

Basemapping from Ontario Ministry of Natural Resources

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Kilometers
0 50 100 200 300 400

1:6,500,000

UTM Zone 17N, NAD 83

Legend

- Infastructure & Development
- Economic
- Recreational/Landscape
- No Social Benefit
- Other
- CPCA Geographic Areas
- Statistically Significant

Perceived Scocial Benefits of Aggregate Extraction by CPCA Geographic Area

December 2009
Project 60119329

AECOM

Figure 2-36

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2.4 Environmental Benefits

An ecosystem is a dynamic complex of plant, animal and microorganism communities and the nonliving environment interacting as one functional unit providing services necessary for life (MA, 2005). Ecosystem services are benefits that people obtain from ecosystems and, which is categorized into four types by the Millennium Ecosystem Assessment (MA, 2005). These include:

- Provisioning Services
  - Products obtained from ecosystems (e.g. food and fuel)
- Regulating Services
  - Benefits obtained from regulation of ecosystems processes (e.g. water purification)
- Cultural Services
  - Nonmaterial benefits from ecosystem (e.g. recreation and ecotourism)
- Supporting Services
  - Services necessary for the production of all other ecosystem services (e.g. soil formation, nutrient cycling)

These ecosystem services are constantly changing due to climate, disturbance regimes and time (age of the ecosystem). Human disturbance has the greatest capacity for creating change to an ecosystem and its services in the shortest amount of time. Human modification of the environment can result in changes to the availability and efficiency of ecosystem services which will create an impact to human health and welfare and natural ecosystems. Identification of ecosystem services provides a tool that provides language to aid our understanding of these complex systems, facilitates management actions to maintain them, and provides an opportunity to apply economic models to evaluate these services in order to better quantify their importance to social and economic systems. The mining of aggregates often results in major alterations to the landscape. While extraction activities creates change to the ecosystem services provided by the overlying land uses, the aggregates themselves can be used in processes that create ecosystem value, and rehabilitation plans may ultimately replace the services removed. For example, a licence that initially provided services associated with forest and agriculture may transition through meadow and transform into services associated with lakes and meadows as a result of the identified rehabilitation plan.

Since we do not directly pay for ecosystem services it is difficult to assign a dollar value for their loss. We tend to take their benefits for granted. In the past 50 years humans have changed the Earth's ecosystems more rapidly and extensively than in any other period in human history (MA, 2005). This is a result of increased population which leads to more development which requires more resources and therefore more change to the landscape. There are indications that we no longer have the natural resources to replace forests, once thought to be renewable due to the effects of acid rain leaching essential nutrients from the

soil. Statistics Canada (2009c) has shown an average population increase of 1.1% in Ontario from 2004 to 2008 which correlates with the consumption of more and more aggregates (Stats Can, 2009c).

The *Ontario Aggregate Resources Act* (ARA*) and Regulation 244/97*, defines aggregates as gravel, sand, clay, earth, shale, stone, limestone, dolostone, sandstone, marble, granite, rock or other prescribed material (ARA, 1990). Aggregates constitute the largest, by tonnage, nonfuel mineral commodities currently inventoried in North America (Poulin *et al.,* 1994). They are used to build and maintain our houses, offices, roads, schools and hospitals; provide a firm foundation for railways, used to construct factories, warehouses and shops and can protect us against flooding (BGS, 2008).

Aggregate production is one of the most important mining industries in the world; annual worldwide aggregate production totals about 16.5 billion tonnes, or more than $70 billion (Langer *et al*., 2004). Aggregates are necessary in today's society because they are used to build and maintain a variety of urban, suburban and rural infrastructures such as buildings, roadways, water storage, filtration and delivery systems, wastewater collection and treatment systems (BGS, 2008; Langer *et al*., 2004).

In the province of Ontario, the demand for aggregate is ever increasing due to the affluent construction industry which requires more and more aggregate for production. In 2007 Ontario produced approximately 181 million tonnes of stone, sand and gravel (including recycling), with a large proportion of this going to construction (TOARC, 2009). The construction of a new road can consume over 15,000 tonnes of aggregate per kilometre for a local two-lane highway, and up to 48,000 tonnes for each kilometre of a six-lane asphalt freeway, not to mention the tonnage of aggregate used to rehabilitate and maintain Ontario's current provincial highway network (Environmental Commissioner of Ontario, 2002-2003). The Ontario Sand, Stone and Gravel Association (2009) predict that the consumption of aggregate in Ontario will total approximately 4 billion tonnes in the next 25 years.

Aggregates directly provide some of the supporting, provisioning, regulating and cultural services that directly affect people. The following sections provide a breakdown of the contribution of products of aggregate extraction to create ecosystem services.

2.4.1 Use and Environmental Benefit of Aggregate Matrix

Aggregates are used for a wide range of purposes. For the purposes of this paper, the identification of the ecosystem services provided by the rock, stone, gravel, etc. was confined to the first order or primary uses. The rehabilitation of a pit or quarry to a golf course was identified as a primary spatial benefit, but the health and recreation benefits (secondary or indirect benefits) associated with the use of the golf course could not be attributed to the aggregate extraction directly.

A matrix that details the nature of the aggregate, the use and the environmental benefit accrued expressed as ecosystem service, is provided in Appendix B and summarized in the following section. It is divided into two main sections: Processes to which aggregates contribute and Spatial - the places that are created as a consequence of extraction activities.

A wide range of aggregates are used in **processes** that provide an environmental benefit and include:

- Landscape Restoration and/or Rehabilitation;
- Water Quality Treatment;
- Removal of Anthropogenic Pollutants;
- Uses in Mines;
- Landfills and Waste Disposals; and
- Maintenance of Biodiversity.

The **Spatial** categories include services where the extraction itself contributes ecosystem services as a consequence of the ultimate rehabilitation of extraction sites and where aggregates are used for the creation of fixed structures. These include construction and rehabilitation uses and post-quarry operations.

2.4.2 Processes

2.4.2.1 Landscape Restoration and/or Rehabilitation

Historically, humans have altered the natural landscape through agricultural activities, settlement and commercialization, in ignorance of the effect on environmental sustainability. The science of ecological restoration is built on the recognition that some of these effects can be reversed and/or controlled. The strategic use of aggregates is a key tool in rehabilitation of damaged landscapes, leading to the reaction of regulating, cultural and preserving ecosystem services.

Wetland and River/Stream Restoration

Wetland and river/stream restoration use aggregates (stone, gravel or boulders) to promote habitat creation and to prevent erosion and the associated negative effects. Erosion can cause a negative impact on the local environment by contaminating waterways from soil fertilizers and pesticides; increasing the risk of flooding; reducing the stability of river banks, reducing the ability of banks to support plant growth which

decreases biodiversity; and increases the loss of nutrients, soil organic matter and soil biota. Boulders, rocks and stone can be used for restoring diminished habitat for a variety of smaller creatures, such as crayfish, invertebrates and a variety of fish. Animals take advantage of holes and crevices within these aggregates as shelter from predators while providing more habitat niches leading to increased biodiversity. In addition, habitat connectivity can be promoted by using aggregates for building wildlife overpasses, underpasses and other connectivity structures to help maintain corridors for animals from one natural area to another.

In addition to enhancements for wildlife, both terrestrial and aquatic, enhancement of human recreation and tourism facilities (e.g. paths and arenas) often occur in association with landscape restoration. These benefits are important aesthetically and improve connectivity among neighbourhoods.

Ecosystem services identified include:

Regulating Services
- Water quality
- Water quantity
- Natural Hazard Control

Cultural Services
- Aesthetics
- Recreation and Tourism

Preserving Services
- Biodiversity
- Connectivity

Agricultural Land (soil aggregate stability)

Aggregates are used in agricultural practices through the incorporation of different types of material into the soils to change the structure and water holding capacity. Sand is essential for good drainage and clay holds water, nutrients and minerals in the soil; both necessary for good crop production. Soils can serve as a filter to prevent pollutants from contaminating groundwater (Hairston *et a*l. 2001). In turn crop production leads to many supporting ecosystem services.

Ecosystem services identified include:

Supporting Services
- Soil formation
- Nutrient Cycling
- Water Cycling

Regulating Services

- Pollution Treatment
- Natural Hazard Control (wind)

2.4.2.2 Water Quality Treatment

Clean water is necessary for all living things. Aggregates are involved in the process of filtering and purifying contaminated water both in nature, and in human made procedures.

Sewage Treatment

Aggregates are used to filter water during sewage treatment to physically remove solid contaminants from sewage. In addition, sewage treatment facilities, and fixtures are comprised of aggregates. By being involved in the sewage treatment process, aggregates aid in improving water quality and controlling the spread of disease through the purification process.

Ecosystem services identified include:

Supporting Services

- Water Cycling

Regulating Services

- Water Quality
- Waste Treatment
- Disease Control

Stormwater Control

Stormwater management systems are part of the strategy to control runoff from impervious surfaces that historically would have been absorbed by vegetation and soil, with the objective of reducing export of sediments and sources of pollution to watersheds. Stormwater controls, such as stormwater management ponds, French drains, bioswales and infiltration gardens are created and maintained using aggregates. These features provide additional storage capacity for waterways to control peak flows for flood control, mitigating erosion impacts, water quality control for water quality impacts and control of suspended soils and additional nutrients in waterways. By controlling flooding, aesthetics of the surrounding environment are maintained since it is not damaged during heavy precipitation events. Stormwater control ponds in some cases provide opportunities for recreation and tourism (OSSGA 2006). These can be passive recreational opportunities such as bird watching, trail walking, and irrigation of golf courses (Rain City of Lincoln 2006); or direct recreation such as skating, boating and fishing (City of Saskatoon 2009; South Carolina Department of Health 2007). The Adopt-A-Pond program in association

with the Toronto Zoo, has established many stormwater control ponds in the GTA including the large stormwater control pond in Millikin Park, Scarborough located at Steels Avenue and McCowan Road, which is used for fishing and non-motorized boating in the summers as well as the trail systems year round (Toronto Zoo 2009).

Ecosystem services identified include:

Supporting Services
- Nutrient Cycling
- Water Cycling

Regulating Services
- Water Quality
- Water Quantity
- Pest Control (-)
- Natural Hazard Control

Cultural Services
- Aesthetics (both +/-)
- Sense of place
- Recreation and Tourism

2.4.2.3 Removal of Anthropogenic Pollutants

Some aggregates can be used to remove certain environmental pollutants; reducing the amount of stress that humans put on the environment. The most prevalent aggregate used for chemical pollutant removal is limestone because of its reactive nature with acidic contaminants.

Flue Gas Desulfurization

Limestone or lime is used for removing sulfur dioxide produced from exhaust flue gases caused by burning coal or oil, thereby cleaning the air and reducing associated pollution. This process reduces the amount of sulfur dioxide in the natural environment (air and water) contributing a variety of regulating ecosystem services (Schnelle & Brown, 2001).

Ecosystem services identified include:

Supporting Services
- Nutrient Cycling

Regulating Services
- Air Quality
- Climate Regulation

- Water Quality
- Pollution Treatment

Acid Neutralization

Limestone is also used to neutralize acidic waste and/or water caused by industrial process. Limestone (lime) has properties making it a preferred acid neutralizer; properties such as heavy, low in volume, easy to handle, easy to clarify and it is a low cost reagent in terms of neutralizing value (National Lime Association, 2000).

Ecosystem services identified include:

Supporting Services
- Nutrient Cycling

Regulating Services
- Air Quality (+/-)
- Climate Regulation (-)
- Water Quality
- Waste Treatment
- Pollution Treatment

2.4.2.4 Use in Mine Sites

Aggregates are used as a base to create new habitat for completed mining projects (SSGR, 2009).

Mine reclamation (backfill, land cover)

Like aggregate pit and quarry operations, mines are subject to rehabilitation programs. Unlike aggregate operations however, mine sites are often contaminated with the by-products of extraction and smelting, therefore the reclamation often includes using aggregates for the chemical as well as the physical rehabilitation restoring the ecological and physical integrity of the site and surrounding landscapes.

Ecosystem services identified include:

Supporting Services
- Soil Formation
- Nutrient Cycling
- Water Cycling

Regulating Services

- Water Quality
- Water Quantity
- Natural Hazard Control

Cultural Services

- Recreation and Tourism

Coal Mine Dusting to Prevent Explosions

Due to limestone's chemical composition it can be used to prevent explosions during the coal mining process. If an explosion occurs the limestone dust mixes with the coal dust inhibiting flame propagation by acting as a thermal inhibitor (Man & Teacoach, 2009).

Ecosystem services identified include:

Cultural Services

- Health and Safety

2.4.2.5 Landfills and Waste Disposal

It is important to localize anthropogenic waste so the impact to the environment is contained in a smaller area. Leachate from landfills can contain a variety of contaminats such as toxic metals, organics, high concentrations of ammonia, and pathogenic microorganisms. The leachate collection layer is comprised of washed drain gravel or crushed glass cullet and is used to drain leachate into holding tanks for treatment (NIST, 1997). Like leachate collection, aggregates are used in a similar manner to collect gas and reduce its movement throughout and out of the landfill site. Gas is collected by way of gravel filled trenches which allow upward movement of gas, which is collected and later burned off (NIST, 1997).

Aggregates, namely clay, sand and crushed stone, are used to cover landfills preventing leachate formation. Depending on the strategy for long term management of the site, landfills are covered with clay to decrease the amount of precipitation entering the site and becoming contaminated, or in some cases, covered with sands to allow infiltration which compresses the refuse and increases the life span of the landfill (e.g., Keele Valley Landfill, City of Vaughan). In this case, the leachate from the landfill must be collected and treated, a process which also relies on aggregates as part of the process. Limestone aggregate is used in the treatment of leachate to neutralize its acidity, helping to promote water and air quality.

Ecosystem services identified include:

For Leachate Collection

Supporting Services
- Water Cycling

Regulating Services
- Water Quality
- Pollution Treatment
- Disease Control

For Gas Collection

Provisioning Services
- Fuel/Energy

Regulating Services
- Air Quality
- Climate Regulation
- Pollution Treatment

For Cover and Protection

Regulating Services
- Water Quality
- Disease Control
- Natural Hazard Control

Cultural Services
- Health and Safety

For Leachate pH Adjustment

Regulating Services
- Air Quality
- Water Quality

2.4.2.6 Maintenance of Biodiversity

Provision of artificial disturbance regimes

Human activities have created waves of landscape scale disturbances, but never before have natural disturbance regimes been as controlled due to suppression of fire, control of flooding, and construction that resists the effects of severe wind. Since the 1950s the landscape of Ontario has been recovering from widespread deforestation and shifting toward extensive urbanization and away from agriculture as more and more farmers move to the cities. As landscapes stabilize and disturbance regimes (fire, wind) are controlled, habitats that are created by disturbance are declining. Grassland species are among the rarest in the landscape, and those associated with intermediate disturbance regimes, such as species that are disturbance dependant (Golden-winged Warbler; Prairie Cinquefoil; Olympia Marblewing). Aggregate production provides a controlled activity that can target the sequential restoration of habitats for disturbance-dependant species with the goal of maintaining native biodiversity.

Ecosystem services identified include:

Preserving Services

- Biodiversity
- Connectivity
- What we do not yet know

2.4.3 Spatial Benefits of Aggregate Extraction

2.4.3.1 Construction

Construction provides a direct benefit to society as it creates human infrastructure. The majority of the ecosystem services provided for direct construction (e.g. buildings, roads, etc) are cultural services, since they provide a direct influence on society and economic returns. The purpose of some of the built infrastructure directly benefits the environment (i.e. incinerators and recycling facilities).

Dams decrease erosion and associated negative impacts, aid in the use of water supply for sustainable energy by controlling flow; provide recreational uses by way of increasing flow of river for associated activities (e.g. white water sports); and allow access to created lakes and hydraulic power.

Other general benefits of construction include: roads and bridges that increase the availability of goods transported; shorelines/navigation channels prevent erosion and deterioration of the natural habitat; and during construction aggregates can prevent contamination of runoff into local water ways by redirecting flow.

Ecosystem services identified include:

Road and Highway maintenance and repair

Cultural Services
- Social Relations
- Commerce
- Recreation and Tourism

Road and Highway new construction

Cultural Services
- Social Relations
- Commerce
- Recreation and Tourism

Preserving Services
- Biodiversity (-)
- Connectivity (-)

Houses

Cultural Services
- Cultural Diversity
- Spiritual and religious values, Inspiration
- Education
- Aesthetics
- Social Relations
- Sense of Place
- Cultural Heritage
- Recreation and Tourism

Institutional Buildings

Cultural Services
- Cultural Diversity
- Spiritual and religious values, Inspiration
- Education
- Aesthetics
- Social Relations
- Sense of Place
- Cultural Heritage
- Commerce
- Recreation and Tourism

Airports

Cultural Services
- Cultural Diversity
- Social relations
- Cultural Heritage
- Commerce
- Recreation and Tourism

Preserving Services
- Biodiversity (-)

Incinerators/Recycling Facilities

Regulating Services
- Air Quality (-/+)
- Waste Treatment (-/+)
- Disease Control

Cultural Services
- Commerce

Dams

Supporting Services
- Water Cycling

Provisioning Services
- Fuel/Energy

Regulating Services
- Water Quantity
- Natural Hazard Control (+/-)

Cultural Services
- Recreation and tourism

Preserving Services
- Connectivity (-)

Dams, Reservoirs and Water Supply

Supporting Services
- Water Cycling

Provisioning Services
- Fuel/Energy

Regulating Services
- Water Quantity
- Natural Hazard Control (+/-)

Cultural Services
- Recreation and Tourism

Preserving Services
- Biodiversity (+/-)
- Connectivity (-)

Roadways/Bridges

Cultural Services
- Social Relations
- Commerce
- Recreation and Tourism

Preserving Services
- Biodiversity (-)
- Connectivity (-)

Shorelines/Navigation Channels

Regulating Services
- Natural Hazard Control

Construction Site (exits and runoff control)

Regulating Services
- Water Quality
- Water Quantity
- Natural Hazard Control

2.4.3.2 Rehabilitation Uses Post-Quarry Operations

The Aggregates Resources Act requires that the quarries be restored to appropriate end uses that range from restoration of natural habitat (terrestrial, aquatic) through provision of sites for recreation, education, agriculture and/or residential/commercial/industrial development. The 31 MNR aggregate site licences were examined and the following services were provided by the existing conditions (before extraction) and rehabilitation (subsequent to extraction) plans:

Licences - Existing conditions

Supporting Services
- Soil Formation
- Photosynthesis
- Primary Production
- Nutrient Cycling
- Water Cycling

Provisioning Services
- Food
- Genetic Resources

Regulating Services
- Air Quality
- Climate Regulation
- Water Quality
- Water Quantity
- Pollination

Cultural Services
- Depend on the site (Spiritual and religious values inspiration, aesthetics, cultural heritage)

Preserving Services
- Biodiversity

Rehabilitation- subsequent to extraction

Supporting Services
- Soil Formation
- Photosynthesis
- Primary Production
- Nutrient Cycling
- Water Cycling

Provisioning Services
- Food
- Genetic Resources

Regulating Services
- Air Quality

- Climate Regulation
- Water Quality
- Water Quantity
- Pollination

Cultural Services

- Depend on the site (Spiritual and religious values inspiration, aesthetics, cultural heritage)

Preserving Services

- Biodiversity

Post Rehabilitation Uses

As conveyed above aggregates provide various ecosystems services; moreover the sites in which they were mined also provide eco-services subsequent to the completion of the rehabilitation phase. Aggregate extraction sites can be rehabilitated to productive land uses such as:

- Arboreta
- Earth Science Study Sites
- Gardens (e.g., Royal Botanical Gardens in Burlington, ON)
- Development: residential, commercial, industrial
- Parks
- Resorts
- Golf courses
- Landfills
- Zoos
- Lakes and beaches
- Wildlife habitat: alvars; wetlands, especially fens due to unique groundwater conditions

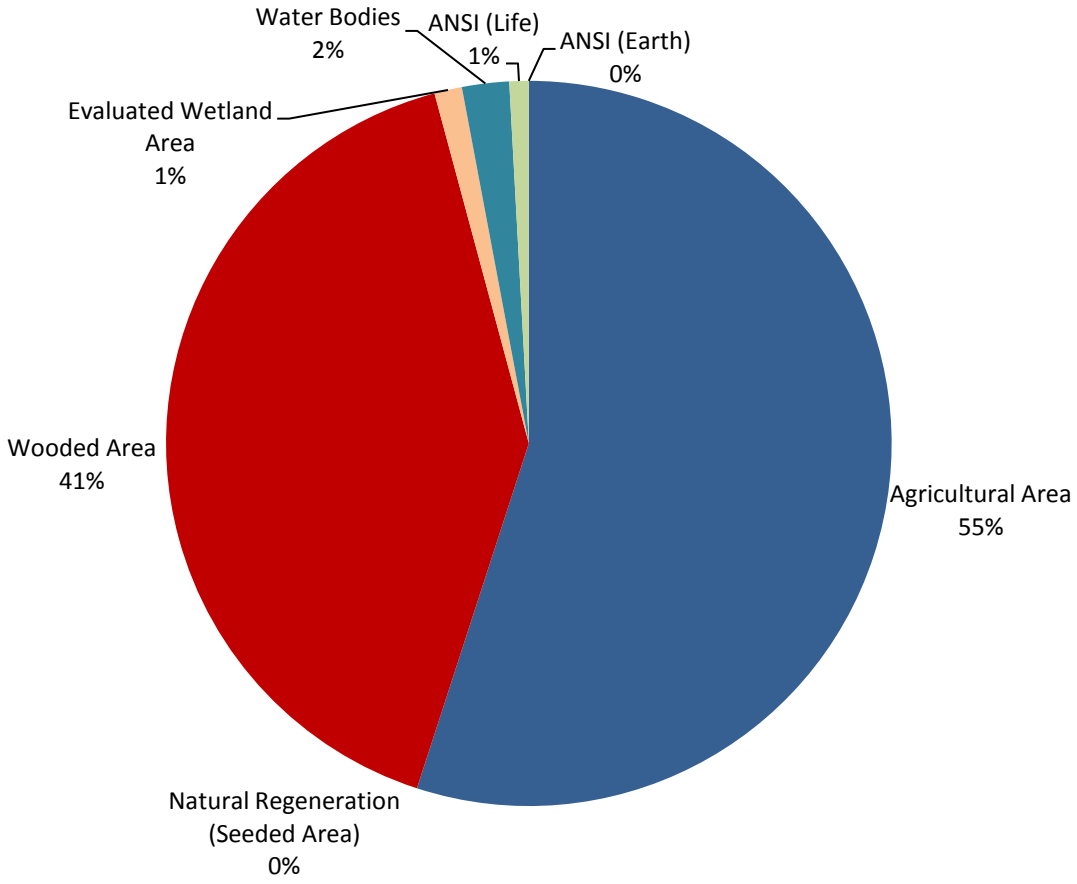
2.5 Environmental Impacts of Aggregate Extraction

Section 1.3.4 provides the methodology that was used to calculate the area of existing land uses on the most recent 31 approved aggregate licences based on the associated natural heritage reporting and comparison to relevant GIS data layers. The long term outcomes anticipated as a result of the progressive implementation of rehabilitation plans were calculated in order to compare the nature and magnitude of the change. Ecosystem services associated with pre and post extraction activities were assigned qualitatively. Assignment of dollar values to the services was beyond the scope of this project.

On average 69% of the licenced area was extracted for aggregates, while the remaining 31% was protected as watercourses, ANSIs, significant woodlands and significant wetlands and buffers to the site and/or features. The licenced area corresponds to the

limit of ownership of the sites, whereas the extraction limits are interior to this area, and defined by the constraints of the site.

Figure 2-37 Relative area of natural heritage features before extraction

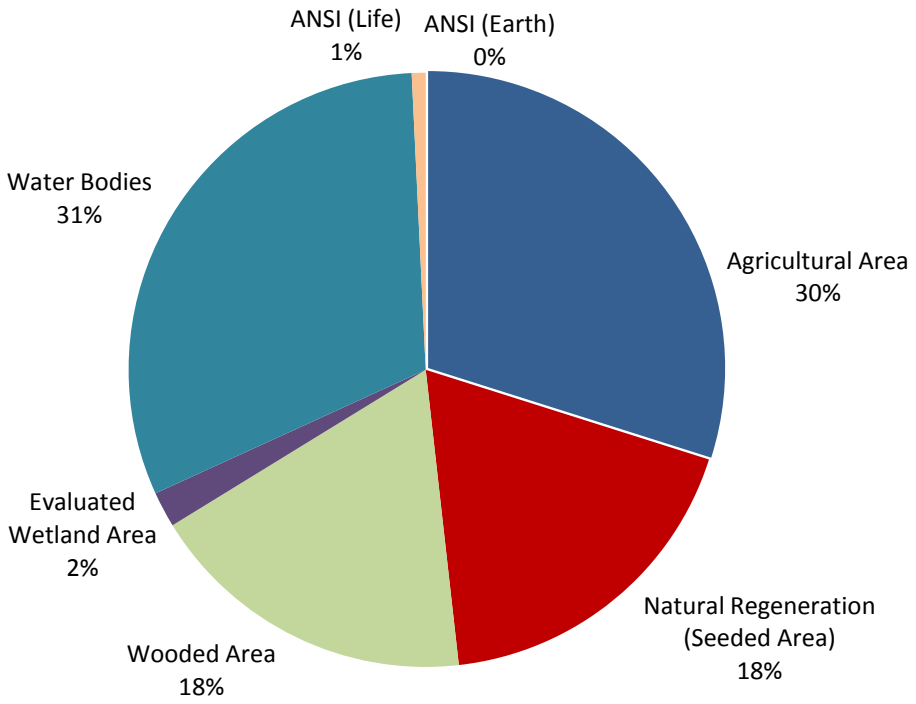


Source: AECOM, 2009

Of the 31 licences analyzed, most of the extracted area was comprised of agriculture (38% of the licenced area; 55% of the extraction limit area). Of the agricultural lands removed during extraction, 62% was returned to agricultural use while 38% were seeded and left to naturally regenerate. The natural regeneration offset the loss of agricultural land at approximately a 1:1 ratio (160 ha agriculture removed: 170 ha seeded area regenerated) (Table 2-28).

The wooded areas within the licenced areas were not significant in the context of the Provincial Policy Statement and the majority were less than 10 ha in size. Of these wooded areas, approximately half were removed and not rehabilitated directly to their former state, but rather converted to some other form of natural area. There was a net loss of 50% of the pre-extraction woodlands.

Figure 2-38 Relative area of natural heritage features after extraction



Source: AECOM, 2009

Water bodies are defined by a body of water large enough to provide potential habitat for aquatic life (pond, lake, etc). The total area of water bodies increased approximately 18 times their original amount from 17 ha to 285 ha (Table 2-28). This statistic is likely inflated as a comparison of the vegetation reported in the natural heritage reports was frequently identified as "wetland", but the corresponding NRVIS data interpreted the communities as "water bodies".

A small net increase of evaluated wetlands (none were provincially significant) was observed (net increase of 8 ha). Only one Life Science Area of Natural and Scientific Interest (ANSI) was situated in the licenced area, but was left undisturbed throughout the extraction, likely due to the requirements under the ARA legislation (Table 2-28).

Once quarrying was complete, the total licenced areas were rehabilitated into the following areas:

- 36% lakes (converted from agriculture)
- 28% in ecological restoration (natural rehab/woodlands/wetlands)
- 35% agriculture

The following discrepancies were observed during the analysis of the 31 licenced areas:

- Some licences leave slopes un-rehabilitated
- Two licences do not account for rehabilitation areas on drawings or natural heritage reports
- NRVIS data variable (lakes = wetlands for many licences)
- Errors in GIS measurements but not significant at this scale

Table 2-28 Environmental Changes of Licenced Areas

Extraction Limits	Before	Interim Condition	Rehabilitation Condition	Net Change
Licence Boundary Area	1170	-	-	-
Extraction Limit Area	811	-	-	-
Agricultural Area	446	0	277	-169
Natural Regeneration (Seeded Area)	0	0	170	170
Wooded Area	331	125	42	-164
Evaluated Wetland Area	10	9	9	8
Water Bodies	17	14	288	285
ANSI (Life)	7	7	0	0
ANSI (Earth)	0	0	0	0

The Canada Land Inventory (CLI) agriculture classes represent the potential of soil for the production of field crops (Agriculture and Agri-Food Canada 2008). The analysis of the licences concluded that approximately 50% of the lands within the licence boundaries were in classes four to seven, which are deemed lower quality for crop utilization. The other 50% broke down into 47.63% of classes one to three, and the remaining 2.37% as class zero, which represents organic soils and is not placed in a capability class. The specific definitions of each class are found in the Glossary. See Tables 2-29 and 2-30 for specific areas.

Table 2-29 Licenced Area Classed under the Canada Land Inventory for Agricultural Use

Class	Licence Boundary (ha)	Extraction Limit (ha)	Total (ha)
0	18	10	28
1	32	104	135
2	116	223	339
3	22	62	83
4	23	21	44
5	12	9	21
6	111	325	436
7	26	57	83
Total	360	811	1,170

Source: AECOM, 2009

Table 2-30 Percentage of Licenced Area Classed under the Canada Land Inventory for Agricultural Use

Class	Licence Boundary (%)	Extraction Limit (%)	Total (%)
0	5	1	2
1	9	13	12
2	33	27	29
3	6	8	7
4	6	3	4
5	3	1	2
6	31	40	37
7	7	7	7
Total	100	100	100

Source: AECOM, 2009

2.6 Environmental Costs

By definition, ecosystem services analysis is designed to evaluate the benefits accrued from natural heritage features and functions. However,"values" are highly subjective, and ecosystems are highly connected and non-judgemental. Therefore, while it is possible to list the environmental benefits enjoyed as a result of ecosystem services and their associated societal and economic benefits, there are also equal and opposite effects that can be interpreted as costs, at least in some circles.

It should be recognized that natural heritage provides a cohort of services that do and do not benefit human ecosystems. Reductions in some of these services can create a negative impact on human ecosystems (e.g. erosion, water quality, carbon storage), while increases can create positive impacts. The following highlights some of the primary ecosystem services that are negatively affected by the use of aggregate for human development and activity.

Extraction of limestones and dolostones triggers a release of carbon dioxide upon exposure to the atmosphere and precipitation. Carbon dioxide is one of the principle greenhouse gases that has been identified as a contributor to global change, including warming effects.

2.6.1 Processes

2.6.1.1 Stormwater Control

Contrary to the benefits provided by stormwater control ponds some become breeding grounds for mosquitoes and other pests. Mosquitoes may carry West Nile Virus that has affected not only humans but some bird cohorts (Science Daily, 2009). It should be noted that an increase in human pests will correlate to a foraging benefit for other organisms therefore the service is not all negative. These ponds can be developed to create a pleasing atmosphere but some are ill maintained and may become contaminated, aesthetically unpleasant, or they may represent a safety threat.

- Regulating Services
  - Pest Control (-)
- Cultural Services
  - Aesthetics (both +/-)
  - Health and Safety

2.6.1.2 Removal of Anthropogenic Pollutants

Some aggregates can be used to remove certain environmental pollutants but at the same time can create bi-products that are not environmentally friendly. The most prevalent aggregate for chemical pollutant removal is limestone because of its reactive nature with acidic contaminants.

Acid Neutralization

Although limestone stone is often used to remove acidic properties from water or leachate the process of limestone acid neutralization produces carbon dioxide (a greenhouse gas) as a bi-product and this contributes to climate change.

Regulating Services

- Air Quality (+/-)
- Climate Regulation (-)

2.6.2 Spatial Costs of Aggregate Extraction

2.6.2.1 Construction

The structures created with aggregates do not in themselves provide ecosystem impacts until they are located and/or managed in a manner that provides consequences. To credit aggregates with these "costs" is to speculate about secondary or indirect effects. However, as the structures with obvious benefits have been listed above, it is reasonable to discuss the possible downside of investing in these structures without an analysis of the ecosystem services that may be affected.

Although humans find roads an indispensible necessity for today's society, the indiscriminate construction of new roads, highways, dams or bridges, made possible by relatively inexpensive aggregates, can cause negative effects to the surrounding environment. New roadways may dissect natural areas into fragments decreasing the amount of connectivity and total area of a habitat thereby creating a negative impact to biodiversity. Edges are generally good habitat for invasive and non-native species where they outcompete native species, many of which have more specialized habitat requirements. Bisecting habitats with new roads is likely one of the most significant impacts created on natural areas often affecting significant species within an area because the habitat no longer suits their needs.

Dams, although beneficial on a variety of fronts from energy production to irrigation planning and food production, also create significant negative impacts. The barrier effect alone to the migration of fish accounts for the loss of whole populations for example, the

American Eel (Environment Canada, 2009; MacGregor, 2009). This disturbance of the natural flow regimes also can create changes to spawning and nursery habitat through changes in water depths and temperature. Pulse events (sudden release of excess water) can dislodge eggs and fry as well as in-stream food sources. This concern is expressed in the research by the Ontario Water Resources into Best Management Practices for management of Sturgeon in streams where there are hydro installations within the range of this fish due to the implications of the Endangered Species Act. Sturgeon is only one of a long list of aquatic species that could be affected.

Airports decrease the biodiversity of the neighbourhood in which they are situated due to the complete change in landscape for the airport to be safe from an operations perspective (e.g. no trees, no birds or mammals to be present in aircraft area; many chemicals are present due to maintenance of vehicles and aircrafts, de-icing and anti-icing procedures, etc.). The airport campus becomes a biodiversity "black hole".

Although incinerators and recycling facilities aid in reducing waste that ends up in landfills, the processes they use emit bi-products that can have negative effects on the environment (e.g. carbon dioxide, sulfur dioxide, heavy metals, etc.) if scrubbers and other methods to control emissions are not implemented or well maintained.

Road and Highway new construction

Preserving Services
- Biodiversity (-)
- Connectivity (-)

Airports

Preserving Services
- Biodiversity (-)

Incinerators/Recycling Facilities

Regulating Services
- Air Quality (-/+)
- Waste Treatment (-/+)

Dams, Reservoirs and Water Supply

Regulating Services
- Natural Hazard Control (+/-)

Preserving Services
- Connectivity (-)

Dams, Reservoirs and Water Supply

Regulating Services

- Natural Hazard Control (+/-)

Preserving Services

- Biodiversity (+/-)
- Connectivity (-)

2.6.2.2 Agriculture

The analysis of the 31 most recent licence approvals indicates that agricultural land composed over half of the excavated area (446 ha total; 55%). Of that, almost half (48%) was Prime Agricultural land. The rehabilitation plans anticipate that 277 ha will be returned to production (38%), however the capability of that land is not classified. One of the measureable costs of aggregate extraction appears to be the loss of agricultural land that does not discriminate between Prime and non-prime areas.

There was a concern that the losses of agricultural land would be underevaluated if the resources currently forested were not included in the loss. In this study, the loss in forested area is offset by the regenerating areas. The occurrence of forest proves to be a better land use for soil conservation than agricultural uses.

3. Major Study Findings and Recommendations

3.1 State of the Aggregate Resource in Ontario

3.1.1 Economic Analysis – Upstream and Downstream Flows

This study sought to understand a range of economic impacts of aggregates, both in the upstream and downstream flows. In 2007, aggregate production in the Province of Ontario inclusive of recycling and export was in the order of 181,000,000 tonnes and new production totalled almost 164,000,000 tonnes. The primary areas of new production were CPCA geographic areas 4 and 3, the GTA and West Central respectively. The economic value of this production was approximately $1.3 billion.

The aggregate industry generates both upstream and downstream effects in the provincial economy. The upstream effects include spending by the aggregate industry on its industry supply chain and the industry itself. In 2007, taking into account direct, indirect and induced effects the sector generates approximately:

- $1.6 billion of GDP
- $827 million of labour income
- 17,000 fulltime jobs
- $2.9 billion of gross output
- $78 million in taxes

In terms of material, stone and sand and gravel production are each responsible for approximately 45% of the economic outputs generated by the aggregate sector. Other materials are responsible for about 10% of the economic outputs. CPCA geographic Areas 3, 4 and 6 collectively account for approximately 54% of the economic outputs of the aggregate sector in the Province.

The downstream economic effects include economic impacts in sectors that purchase goods and services from a subject sector where initial production spending took place. The 2007 aggregate production volumes were tracked downstream to 16 end use sectors. These sectors were subsequently grouped into three categories:

- Cement and Concrete
- Other Products
- Construction

Approximately 21% of the provincial aggregate production by value flows to industries in the cement and concrete category and 57% to various forms of construction. The remaining 22% is destined for a suite of industry sectors in the other products category. The economic output attributable to aggregate production in the downstream sectors is:

- $1.6 billion of GDP
- $940 million of labour income
- 18,300 fulltime jobs
- $3.2 billion of gross output

In terms of industry categories, the majority of the value add (GDP) falls to construction (59%), The cement and concrete category accounts for 22% and the other products category 19%. The downstream industry categories and sectors referred to in this study generate the following economic outputs.

- $22 billion of GDP
- $13 billion of labour income
- 245,000 fulltime jobs
- $44.7 billion of gross output

In terms of the industry categories themselves, the contribution of aggregates to the overall economic outputs are roughly:

- Cement and concrete 8%
- Other products 3%
- Construction 13%

For all the categories combined, the contribution of aggregates to total economic output is in the order of 7%.

This paper concluded that aggregate plays an important role in the Ontario economy. Although it is a low price commodity, its use is in a very high volume. It is a 1.3 billion industry that through direct, indirect and induced means creates approximately 16,000 jobs in the provincial economy.

Aggregate moves to a wide variety of end users and it is an essential ingredient in the industry sectors associated with construction and manufacturing. Although it is not the dominate input in most sectors in terms of value, it is nevertheless an essential input and one for which there is no obvious substitute at the present time.

3.1.2 Case Studies

Through the assessment of the value of aggregates in 5 case studies selected from Ontario's major infrastructure projects we can conclude that the value of aggregates in infrastructure projects is a relatively small component of the total project. The following table indicates the value of aggregates as a percentage of the total project value for the selected case studies.

Table 3-1 Value of Aggregates as a Percentage of Total Project Value for the Selected Case Studies

Project	Aggregate / Project
Spadina Subway Extension	1.22%
Niagara Tunnel Project	4.43%
Woodstock General Hospital	0.26%
North Bay Regional Health Centre	0.60%
Wolfe Island Wind Project	0.64%

For each of the 5 case studies examined, all of the projects had a readily available local source of aggregate to be used in the project. Our assessment of case studies found aggregates to be an enabler of major infrastructure projects. Although the value of aggregates is a relatively small component of project value, it is a product that does not have many readily available substitutes and without aggregates available it is unclear how these major projects would proceed.

3.1.3 Social Value

The social costs and benefits of aggregate extraction were assessed through the telephone survey results, the content analyses of the OMB and MNR data, and also through the qualitative assessment of the case files from the NEC. From the telephone survey the following conclusions were made for the following areas of interest.

In terms of knowledge of the aggregate industry, there was no significant difference of actual distance to a pit or quarry between the two groups of respondents (those that said they do and those that said they do not live near a pit or quarry). The base knowledge seems to be varied and it can be concluded that respondents are not very familiar with the aggregate industry. This lack of familiarity indicates that the aggregate industry is not top

of mind for a statistically significant representation of the Ontario population and there are opportunities to build awareness and education amongst the public.

From the perspective of community well-being, respondents in general do not rank development and infrastructure projects highly among the other things that they value about their community and the things that contribute to their community's well-being. However, over half of the respondents did rank that certain types of development and infrastructure projects such as road and highway repair and maintenance, building new institutional buildings, new energy facilities and new highways and roads as "Somewhat Important" or "Very Important." Based on further questions to assess the benefits of aggregates, it was found that these specific projects, maintaining or repairing highways or roads, building new institutional buildings, energy facilities and new highways or roads were valuable to respondents and offered the greatest level of benefit. Respondents noted that the main benefits of these projects are the positive economic impacts associated with the aggregate industry such as job creation. This information shows that when respondents from the survey were asked to compare the attributes to their community that were valuable to them against infrastructure and development projects the data was not consistent. This leads us to conclude that respondents did not seem willing to trade the most important things that their value about their community for development and infrastructure projects.

The survey instrument focused several questions on assessing the social costs associated with the aggregate industry. Respondents perceived the main costs were the environmental effects such as lack of site rehabilitation, water contamination, and a destruction of habitat. Nuisance effects were also rated fairly high amongst respondents.

As a result of the Content Analyses from a combination of the MNR, OMB and NEC data, there was a wide range of types of public complaints regarding aggregate operations and licence applications. From an analysis of the MNR and OMB data, it is clear that the three most frequently reported public complaints are regarding noise pollution, truck traffic and volume and air pollution and dust. Likewise, the themes found in the NEC data were reflective of both the MNR and OMB data.

Respondents who reported that they live near a pit or quarry or near a truck transportation route formulated groups of respondents that were stated to have a *Perceived Direct Experience* (PDE). In our cross tabular analysis on whether a PDE has an influence on the Social Value of aggregates, we were able to infer the main costs and benefits from this group of respondents. Respondents that live near a pit or quarry were more likely to name nuisance effects as a social cost of aggregate extraction. However, respondents that live near an aggregate truck transportation route were more likely to state that the economic aspects of aggregate extraction as a social benefit.

Based on the findings from the geographical variation study, we can conclude that respondents who live in an urban area such as Area 4 - GTA rate parks and trails as an important aspect of their community. Also, respondents from Area 4 - GTA highlighted new institutional buildings as important. Based on these responses we can infer that respondents do not rate development and infrastructure projects, with the exception of institutional buildings, as high importance.

Respondents living in Area 7 and 8 overwhelmingly rated development and infrastructure projects as high importance and were more likely to state that there were no social costs of extraction. We can infer from this information that respondents living further away from urban centers recognize the benefits from aggregate extraction and are less likely to name parks and trails as important aspects of their community. Finally, the only geographical area to link social costs such as nuisance effects with regards to aggregate extraction were respondents from Area 3 – West Central.

When comparing the different approach to data collection we can make varied inferences. For example, From the Content Analysis findings it can be concluded that while the main concerns of aggregate extraction are nuisance effects, it should be noted that this comes from a sample that represents a vocal minority who are directly affected by the aggregates industry. However, when surveying a more statistical significant representation of the Ontario population, environmental impacts emerge as the main costs to aggregate extraction.

3.1.4 Environmental Value

This analysis qualitatively identified both the positive and negative aspects of ecosystem services provided by aggregates and their extraction. Reductions in some of these services can create a negative impact on human ecosystems (e.g. erosion, water quality, carbon storage), while increases can create positive impacts. Further analysis could identify trade-offs, and the ability to maximize net benefits.

The analyzed eco-services provided by aggregates were all of the first order. Secondary benefits and costs exist but they are very difficult to define and opinions on how they should be quantified vary. The environmental aggregates value matrix was broken down into the two categories of *Processes* in which the products of aggregate extraction are used and *Spatial,* where the extraction itself contributes ecosystem services as a consequence of the ultimate rehabilitation of extraction sites and the aggregates are used for the creation of fixed structures. Under the *Processes* heading the majority of the ecosystem services were categorized as “regulating”, in that they control processes that create an environmental benefit. This can be explained by the fact that the practices/procedures that are used by Landscape Rehabilitation; Water Quality Treatment; Removal of Anthropogenic Pollutants; Uses in Mines; Landfills and Waste Disposals; and Maintenance of Biodiversity are used to regulate ecosystem processes. The majority of the ecosystem services provided under the *Spatial* headings were cultural. The reason for

this is two-fold: the use of aggregate as the main source of building materials, and the rehabilitation of sites for culturally important functions that lead to secondary benefits. Aggregates have a large influence on human culture because it provides structures that reflect societal values.

The bulk of the negative effects of aggregates on eco-services fall to either regulating (likely due to the associated bi-products of aggregate processing) and/or preserving services (likely due to the permanent human impact that buildings, roads, dams, etc have on the developed landscape).

The 31 analysed licences were those of the most recent approvals, and it was established that these licences were subject to the most restrictive environmental controls. The fact that these sites were largely agricultural and environmental features were almost entirely preserved indicates that the legislation with respect to natural environment is having an effect on the outcomes. A small amount of good quality habitat was affected due to quarrying, and if it was affected, rehabilitation efforts usually replaced it.

The same perhaps cannot be said for the preservation of agricultural land, which the PPS also seeks to protect. Via this analysis, half of the agricultural resources are transformed. Within the licenced boundaries 50% of the lands extracted were of lower quality soils for crop utilization (agricultural classes four to seven, according to the CLI). However, 48% of the agricultural lands were of the classes one to three, which are good to high quality soils for crop utilization: Prime Agricultural Lands. Agricultural land is important for producing a wide range of products including food (nutrition), and energy and its consumption, for alternative purposes, particularly in the case of high quality land needs to be carefully considered.

The net shift in land use via the aggregate extraction process was from terrestrial to lake habitats, with a 50% net reduction in agricultural lands.

3.1.5 The Value of Aggregates in Ontario

This paper concludes that aggregate demand in the province of Ontario will continue to escalate and that this demand will be spurred on three fronts:

- by a growing population and concomitant need for new infrastructure and buildings
- the need to maintain existing infrastructure and buildings
- growth in the manufacturing economy and ongoing need for aggregate inputs

The key areas of demand for aggregate are in southern Ontario particularly around built-up areas. To-date, aggregate has been sourced in close proximity to these areas, keeping transportation costs and distances minimal. However, going forward as local sources are used up and development pressures expand in southern Ontario, there will be pressures to bring aggregate from further afield this will have cost implications. The industry should

optimize recycling to help offset the demand for new aggregate materials and balance the cost of supply.

Aggregate is not an inexhaustible commodity in southern Ontario and it needs to be responsibly husbanded. The vast majority of people are not significantly affected by aggregate extraction however people in close proximity to extraction areas and living along haul routes are. In addition, if transportation distances increase as resources are extracted further from their final destinations, a larger number of people will be affected by the transportation of aggregate resources.

At the moment there is no readily apparent substitute for aggregate it is an essential input for many parts of the Provincial economy. Therefore, it is imperative that efforts be sought to maximise the associated benefits and minimise costs.

3.2 Recommendations

3.2.1 Economic Analysis – Upstream and Downstream Flows

This economic analysis required the use of some assumptions to manage data gaps in available aggregate flow and pricing information. There is a need for better cooperation and transparency of data between the Ministry and the Industry. It is recommended that the Ministry, Industry Groups, and individual producers work together in a way to communicate primary data so that the flow of material may be better monitored, while still protecting confidentiality and proprietary information. To effectively manage this resource it is essential that strong data banks be constructed and maintained.

Some areas for future economic study include:

- Understanding the flow of aggregates to end users and the actual value of materials flowing need to be part of a future data assembly and management process;
- Understanding the supply cost implications of bringing aggregate from further afield;
- Understanding the implications (sensitivities) of raised aggregate costs to end users;
- End user surveys to collect primary information on significance of aggregate to construction and production processes;
- A quantitative analysis of the environmental costs and benefits of aggregate;
- Lifecycle cost analysis of pits and quarries from inception through after use; and
- Understanding the cost implications of using more recycled material and aggregate substitutes.

3.2.2 Case Studies

In order to better understand the role and impact of aggregates to major infrastructure projects, we recommend that future case studies be undertaken to look at the indirect use of aggregates on major infrastructure projects. We also recommend that MNR periodically surveys large infrastructure projects to understand quantities of aggregate used on a project, sources of aggregate and value of aggregate used.

3.2.3 Social Value

After our study, it is clear that there is some conflict between the cost and benefits society places on the aggregate industry. It is fairly clear that most of the respondents in our survey placed value on the built environment that which comes from aggregates but when faced with the idea of aggregate *extraction*, respondents clearly associate a number of social costs with this activity. However, respondents also recognize the positive economic impact that aggregate extraction and the use of aggregate materials has on job creation.

Based on this assessment it is our recommendation to conduct a more in-depth analysis to determine the net benefits or net costs specifically associated with aggregate *extraction*. In furthering our Content Analysis, we recommend a more direct analysis of community groups that are directly affected by aggregate operations including residents that live on or near major haul routes and residents that live near a pit or quarry. As seen in our assessment many of these residents raised their concerns to such bodies as the OMB, MNR and NEC but in order to obtain more in-depth information we would recommend a continuation of interviews and focus groups.

It would be beneficial to do more in-depth cross-tabular analysis with the existing telephone survey data, to locate case studies of major pits and quarries (or also the 31 recent MNR site licence applications) in Ontario and test if proximity to these sites affects respondents' views on the social costs and benefits of aggregates.

It is also necessary to gauge the level of benefits and costs experienced by aggregate operators. Again, interviews with the businesses that are operating and applying for aggregate licences as well as business that are indirectly connected to the industry will help to determine some of the net benefits and costs.

3.2.4 Environmental Value

The environmental value section of this study has highlighted a number of important environmental contributions of aggregate use however the relative contribution to values and costs are speculative. The quantification of these contributions is outside of the scope of this study, however undertaking the application of economic models to designate dollar values would improve not only the magnitude of contributions from the various features

and functions, but would also provide a tool to better correlate the natural environment values with societal and economic factors.

The environmental cost of transportation increases the negative impact on the environment and should be studied further to understand how to reduce this cost and to deal with the paradox that the constant, predictable need for aggregates conflicts with the community's desire that mining operations are conducted far from its boundaries (Poulin *et al.* 1994).

There is a further need to research changes in the landscape due to extraction and rehabilitation of aggregates, which in turn change species composition in the area, and how that affects the ecosystem.

The valuation of aggregate use and the environment would likely benefit from a cradle to grave analysis, which would not only analyze primary uses, but also secondary, transportation impacts, mining impacts, etc.

Studies on the affect of quarrying on the soil overburden should be conducted to determine the impact of extraction on the soil quality of the site to assess if it does or does not result in less fertile land after rehabilitation.

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Appendix A

Intellipulse Report and Telephone Questionnaire

Ministry of Natural Resources
Social Value of the Aggregate Industry
To the Ontario Public

August 2009

Prepared for:
AECOM

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1 RESEARCH OVERVIEW AND KEY FINDINGS

1.1 RESEARCH OBJECTIVES

AECOM was contracted by the Ministry of Natural Resources (MNR) to examine the Value of Aggregates, as part of a larger body of work entitled, the State of the Aggregate Resources in Ontario Study (SAROS). The Value of Aggregates Study examined the social, economic, and ecological values of aggregates (i.e. stone, sand and gravel) in Ontario. AECOM retained IntelliPulse Inc. to undertake a public opinion survey on the social values associated with the aggregate industry. In Ontario, aggregates are used to repair and maintain the current infrastructure and as the province's population increases; to expand current and build new infrastructure and development projects. It was anticipated that Ontarians would have various opinions regarding the social costs and benefits related to the aggregate industry and that the public's knowledge of the aggregate industry could vary widely.

The overall purpose of this study was to determine the social value placed by the public on the aggregate component of Ontario's development and infrastructure needs and to gain some understanding of the public's knowledge of the aggregate industry. The specific objectives of this study were to gather data regarding:

- The relative importance of development and infrastructure projects to things the public value about their community that contribute to quality of life;
- The importance assigned to various types of new development and infrastructure projects in relation to their community's well-being;
- Knowledge of the Ontario aggregate industry; and
- Public opinion regarding the social costs and benefits of aggregate extraction.

IntelliPulse is pleased to present the results of this survey of social values of the aggregate industry among the Ontario public. The following sections provide the frequency responses to each question. Crosstabular analysis was undertaken to examine whether there are significant differences by three categories. The first, **Geography**, defines respondents by their location within one of the eight Portland Cement Association Geographic Areas (see Appendix 6.4 for figure). The second, **Demographic Characteristics**, defines respondents by their stated age as grouped into one of 6 age categories and by their gender, as identified by the interviewer. The third, **Perceived Direct Experiences (PDE)**, defines respondents by the perceived geographical proximity of a stone, sand or gravel pit or quarry to their home or a perceived geographical proximity of their home to a stone, sand or gravel transportation route. Significant differences are noted in the text.

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1.2 STUDY AREAS AND APPROACH

In order to fulfill these research objectives a questionnaire was developed by AECOM for telephone administration, a copy of which is included in the Technical Appendix Section 6.3. IntelliPulse Inc. developed a sample design within the eight Portland Cement Regions to achieve a target level of confidence in the information collected.

The findings provided in this report are based on a random sample of Ontario residents. A total of 1420 interviews were conducted. A sample of this size yields results that are accurate within ±2.6%, 19 out of 20 times.

A disproportional provincial sample allocation was developed in order to have a sufficient sample size in each of the eight Portland Cement Association geographic areas to examine whether there are significant differences in responses by area. A minimum of 150 interviews were allocated per area to achieve a minimum accuracy level of ±8.1%, 19 out of 20 times. The geographic area samples were weighted to ensure proportional representation for reporting the total Ontario results. The weighting procedure is presented in the Technical Appendix. The following table summarizes the geographic area sample sizes and their respective confidence intervals.

Table 1.2 Ontario Sample Allocation

Geographic Area	Sample		Confidence Interval, ±19 / 20 times
	Actual	Weighted	
Area 1 – Southwest	153	161	8.1
Area 2 - Peninsula	153	136	8.1
Area 3 - West Central	153	154	8.1
Area 4 - GTA	354	651	5.3
Area 5 - East Central	151	57	8.1
Area 6 - East	152	169	8.1
Area 7 - Northeast	154	51	8.1
Area 8 - Northwest	150	41	8.1
Ontario Total	**1,420**	**1,420**	**2.6**

The telephone survey was administered by The Logit Group Inc. (Toronto, Ontario) under the direct supervision of IntelliPulse Inc. and AECOM. A pre-test was conducted on July 28, 2009. Interviewing dates were July 28 to August 6, 2009. The survey's average duration was 15 minutes.

1.3 KEY FINDINGS

Contact with the industry

- A core group of respondents reported some perceived direct experience with various aspect of the aggregate industry. One-third of the respondents (33%) claimed to live near a stone, sand and

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gravel pit or quarry, and one-quarter (25%) claimed to live near a stone, sand and gravel transportation route. Three percent (3%) reported that they themselves or someone in their household was employed in the aggregate or an associated industry (i.e. road or building construction).

Values attributed to their community

- A variety of things were valued in the respondents' community that contribute to their quality of life. When asked to name up to three things, the most frequently reported were those related to municipal infrastructure/services (73%) including parks and trails, and cleanliness and up-keep of the community.

- Respondents were asked to rate the importance of development and infrastructure projects relative to other valued things in their community that contribute to quality of life:

  - 30% of respondents indicated that there are no other things in their communities that were more important than development and infrastructure projects. 29% stated that nature and the environment were more important. 21% name social aspects of their community and 20% name municipal characteristics as being more important. 17% name the human aspects (i.e. public safety/personal security, small town/village feel).

  - 72% of respondents stated that development and infrastructure projects were less important than the three things they value about their community. The remaining 28% of respondents stated that natural/environmental aspects, municipal infrastructure and services aspects and social aspects were less important than infrastructure and development projects.

Contributors to Community Well-being

- Respondents were asked about the importance of eight types of development and infrastructure projects in respect to their contribution to community well-being. Of these, the highest rated in importance was maintaining or repairing existing highways or roads (60% "very important").

- Fewer than half rated the remaining projects as "very important". However, more than half the respondents rated building new institutional buildings (68% "very" and "somewhat" important), new energy facilities (57%) and new highways or roads (51%) as important.

- Fewer than half the respondents stated it is important to build new railways (40%), new residential buildings (34%), and new industrial buildings (34%).

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- The least important type of project is building new airports in Ontario. Approximately 21% stated that building new airports was important to their community's well-being.

Knowledge

- Despite a core group of respondents that stated they were geographically located near an aggregate pit or quarry or located near an aggregate transportation route, respondents appeared to have limited knowledge about the aggregate industry. For example, there was no common understanding on the amount of stone, sand and gravel consumed per person each year. Roughly 10% to 20% of respondents provided each of the 5 answer categories or stated "don't know".

- When asked to rank modes used to transport these aggregate resources, 75% ranked trucking as the most commonly used, 58% ranked rail as second, and 63% ranked sea or lake transport as third.

Social Costs and Benefits

- Respondents identified a variety of social costs related to stone, sand and gravel extraction. 56% identified "Environmental Effects" including the remaining pits, exposure of the water table, and disruption to nature; 50% named "Nuisance Effects" such as dust, and noise or damage from truck; and 16% volunteered "Human Effects" such as the impact on air quality affecting human health.

- In terms of social benefits, almost everyone (95%) identified "Infrastructure and Development Projects" including materials used in construction and improvements to roads; 25% named "Economic Benefits" such as job creation; and 5% named "Recreation / Landscaping Projects" such as creating beaches and lakes.

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2 ENGAGEMENT WITH THE AGGREGATES INDUSTRY

At the outset of the survey, respondents were asked whether they reside near a stone, sand and gravel quarry or a transportation route, and whether they or anyone in their household is employed in the aggregate or related industry (such as construction). These questions helped to set a potential for Perceived Direct Experiences (PDE) with the aggregate industry that may have an influence on respondents' answer to other questions.

As can be seen in Table 2-1, one-third of the respondents (33%) claimed to live near a stone, sand and gravel pit or quarry, and one-quarter (25%) claimed to live near a stone, sand and gravel transportation route.

Table 2-1: Contact with the Aggregate Industry

	Pit or Quarry Near Their Home		Home Near Transportation Route	
	%	*N*	%	*N*
Yes	33	*(473)*	25	(355)
No	61	*(860)*	67	(945)
Don't know	6	*(88)*	8	(120)
n	*100*	*(1420)*	*100*	*(1420)*

Note: Percentages may not sum to 100% due to rounding.
Q1, 2

As is to be expected, there was a relationship between these two industry contact questions. Half of the respondents (53%) who lived near a quarry also claimed to live near a transportation route; one-in-ten respondents (11%) who stated they do not live near a quarry claimed to live near a stone, sand and gravel transportation route. In total, 24% of all respondents claimed to live near a quarry or a transportation route. PDE refers to residents that either said that they lived near a pit or quarry or near to a transportation route.

In terms of statistically significant differences by respondent characteristics:

GEOGRAPHY

- Respondents in Areas 5 East Central (58%) and 7 Northeast (58%) were more like to say they live near a pit or quarry, and Area 4 GTA (18%) respondents are least likely.

DEMOGRAPHIC CHARACTERISTICS

- Men (37%) and older respondents (45 to 54 years of age, 38%) were more likely to say they lived near a quarry or pit. Men (29%) and older respondents (55 to 64 years of age, 30%) were more likely to say they lived near a stone, sand and gravel transportation route.

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As can be seen in Table 2-2, very few respondents were themselves or have someone in their household employed by the aggregate industry or related industries such as road or building construction. Those who were employed in the industry were asked "In what way is that person employed in the aggregate industry?" The types of occupations are listed in the second portion of Table 2-2. A variety of occupations are named, although each category has few respondents.

Table 2-2: Way in Which a Household Member is Employed in the Aggregate Industry

	%	*n*
Employed in the Industry:		
Yes	3	*(41)*
No	97	*(1375)*
n	*100*	*(1417)*
Yes - In what way:		
Construction - general	18	(8)
Road construction	17	(7)
Gravel/pit quarry	16	(7)
Home construction/ contractor	11	(5)
Heavy equipment operator/ crush stone	9	(4)
Business owner	8	(3)
Miner/aggregate company	5	(2)
Mechanic	3	(1)
Truck driver	3	(1)
Other	23	(9)
Don't know/refused	4	(2)
Total # of respondents		*(41)*

Note: Percentages for q4 sum to more than 100% as more than one response was accepted. Base: Household member works in the industry in Q3. Q3, 4

There are too few respondents who themselves or a household member is employed in the aggregate industry to examine responses by geographic area or demographic characteristics. Due to the low number of respondents in this category, these respondents were not considered as part of the PDE characteristics.

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3 COMMUNITY WELL-BEING

3.1 WHAT PEOPLE VALUE ABOUT THEIR COMMUNITY

Prior to a discussion about the value of aggregates to Ontario the survey asked, "There are many things that people value about their community that contribute to their quality of life. In your opinion, what are some of the things that you value?"

A variety of volunteered responses were obtained, and for simplicity they have been grouped into four main categories. As can be seen in Table 3.1 (next page), a number of values were identified, summarized as follows:

- Municipal Infrastructure/Services Aspects - Almost three-quarters of the respondents (73%) valued various aspects of living in their municipality. The most frequent mentions were parks/trails (19%) and the cleanliness and up-keep of their community (10%). Notably, 6% mentioned infrastructure projects including highways and roads. The remaining values are named by fewer than 10% of respondents each.

- Natural/Environmental Aspects - Four-in-ten respondents (41%) mentioned green space/trees/wildlife (20%), clean, fresh air/no pollution (14%) or access to lakes (7%).

- Social Aspects - One-third of the respondents (39%) also volunteered a social characteristic contributing to quality of life. The most frequent mentions were quiet neighbourhood (16%) and community / friendly neighbours (13%).

- Human Aspects - One-third of the respondents (37%) mentioned a human aspect that they value, including public or personal security (14%) and access to amenities (13%).

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Table 3.1: Value About Their Community

	%	*N*
Municipal Infrastructure/Services Aspects:	**73**	
Parks/trails	19	*(264)*
Cleanliness/up keep of community	10	*(141)*
Municipal services-garbage, social services, taxes, library etc.	8	*(111)*
Water quality/clean water	7	*(93)*
Recreational/community center	7	*(101)*
Infrastructure/highways/roads	6	*(90)*
Public/transportation	6	*(83)*
Education/access to schools	5	*(75)*
Good healthcare/services/EMS, doctors etc.	5	*(69)*
Nature/Environment Aspects:	**41**	
Green space/trees/wildlife	20	*(290)*
Clean/fresh air/no pollution	14	*(197)*
Accessibility to lakes	7	*(95)*
Social Aspects:	**39**	
Quite neighbourhood/privacy	16	*(229)*
Community/friendly neighbours	13	*(185)*
Sense of community/ involvement/ multiculturalism/diversity	6	*(86)*
Family/family oriented community	4	*(63)*
Human Aspects:	**37**	
Public safety/personal security	14	*(198)*
Access to local amenities/ shopping/ entertainment	13	*(178)*
Small town/village feel	5	*(76)*
Location-proximity to work/city/others	3	*(43)*
Job/employment	2	*(35)*
Other:		
Road safety/noise/no heavy trucks	1	*(15)*
Other	11	*(143)*
Don't know/refused	4	*(51)*
None/No other issues	1	*(55)*
Total # of respondents		*(1420)*

Note: Percentages sum to more than 100% as more than one response was accepted. Q5

For the most part the things that people valued about their community were similar across the geographic areas, demographic characteristics, and PDE. The following respondent segments are significantly different in what they value from the average:

GEOGRAPHY

- Respondents in Areas 1 Southwest (22%) and 4 GTA (22%) named parks/trails. This value was less likely to be named by respondents in Areas 5 East Central (7%) and 8 Northwest (5%).

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- Green space was more likely to be named by respondents in Area 8 Northeast (30%) and least likely in Area 7 Northeast (14%).

- Respondents in Area 8 Northeast were more likely to name Nature Environment Aspects (52%).

DEMOGRAPHIC CHARACTERISTICS

- Older respondents (65 years of age or older, 16%) were more likely to name clean/fresh air/no pollution, and overall were more likely to name Natural Environment Aspects (44%). Respondents under 25 years of age were more likely to state "no other".

- Women (22%) and younger respondents (25 to 34 years of age, 34%) were more likely to name parks/trails.

PDE

- Parks and trails were less likely to be named by respondents who claimed live near a quarry or pit (14%).

3.2 RELATIVE IMPORTANCE OF THEIR VALUES

To gauge the relative importance of the things valued about their community, respondents were asked which of the things they named was more important and which was less important than development and infrastructure projects that happen in their community.

Table 3.2-1 (next page) presents the things respondents valued **more** than development or infrastructure projects. By way of a summary:

- Notably, 30% of respondents considered Municipal Infrastructure / Services Aspects to be most important to their community well-being – more important than any other aspect.

- Of the remaining respondents, 21% stated that Nature and Environment was more important than development or infrastructure projects.

- Approximately 19% of respondents named Social Aspects of their community. Slightly fewer (17%) name the Human Aspects that they value most.

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Table 3.2-1: Values Stated as More Important Than Development or Infrastructure Projects

	%	*N*
None	30	*(419)*
Municipal Infrastructure/Services Aspects:	**30**	
Parks/trails	8	*(109)*
Cleanliness/up keep of community	5	*(70)*
Water quality/clean water	3	*(48)*
Education/access to schools	3	*(37)*
Municipal services-garbage, social services, taxes, library etc.	3	*(44)*
Recreational/community center	2	*(32)*
Good healthcare/services/EMS, doctors etc.	2	*(37)*
Public/transportation	2	*(28)*
Infrastructure/highways/roads	2	*(26)*
Nature/Environment Aspects:	**21**	
Green space/trees/wildlife	11	*(155)*
Clean/fresh air/no pollution	7	*(107)*
Accessibility to lakes	3	*(38)*
Social Aspects:	**19**	
Quite neighbourhood/privacy	8	*(114)*
Community/friendly neighbours	5	*(67)*
Family/family oriented community	3	*(39)*
Sense of community/ involvement/ multiculturalism/diversity	3	*(38)*
Human Aspects:	**17**	
Public safety/personal security	8	*(108)*
Access to local amenities/ shopping/entertainment	5	*(68)*
Small town/village feel	2	*(27)*
Location-proximity to work/city/others	1	*(17)*
Job/employment	1	*(11)*
Other:		
Road safety/noise/no heavy trucks	1	*(9)*
Other:	4	*(55)*
Don't know/refused	1	*(12)*
Total # of respondents		*(1420)*

Note: Percentages sum to more than 100% as more than one response was accepted. O% indicates less than .5%. Q6

There were only two significant difference by respondent characteristics in volunteered values more important than development or infrastructure projects:

GEOGRAPHY

- Area 8 Northwest respondents (31%) were more likely to mention Nature / Environment Aspects.

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DEMOGRAPHIC CHARACTERISTICS

- Women (18%) were more likely to name Human Aspects.

The findings in Table 3.2-2 summarize the values stated as **less** important than development or infrastructure. 72% of respondents stated that development and infrastructure projects were less important than the things they stated contribute to their community well-being. 11% or fewer stated that Municipal Infrastructure/Services, Nature / Environment, Social, or Human aspects were less important that development or infrastructure projects.

Table 3.2-2: Values Stated as Less Important Than Development or Infrastructure Projects

	%	*n*
None	72	*(1020)*
Municipal Infrastructure/Services Aspects:	**11**	
Parks/trails	3	*(41)*
Cleanliness/up keep of community	2	*(22)*
Infrastructure/highways/roads	2	*(22)*
Municipal services-garbage, social services, taxes, library etc.	1	*(20)*
Public/transportation	1	*(12)*
Water quality/clean water	1	*(11)*
Recreational/community center	1	*(18)*
Education/access to schools	0	*(6)*
Good healthcare/services/EMS, doctors etc.	0	*(5)*
Social Aspects:	**6**	
Quite neighbourhood/privacy	2	*(38)*
Community/friendly neighbours	2	*(32)*
Sense of community/ involvement/ multiculturalism/ diversity	1	*(15)*
Family/family oriented community	1	*(7)*
Human Aspects:	**5**	
Access to local amenities/ shopping/ entertainment	3	*(40)*
Small town/village feel	1	*(20)*
Public safety/personal security	1	*(17)*
Job/employment	0	*(6)*
Location-proximity to work/city/others	0	*(6)*
Nature/Environment Aspects:	**4**	
Green space/trees/wildlife	2	*(35)*
Accessibility to lakes	1	*(20)*
Clean/fresh air/no pollution	1	*(13)*
Other:		
Road safety/noise/no heavy trucks	0	*(1)*
Other	1	*(26)*
Don't know/refused	1	*(9)*
Total # of respondents		*(1420)*

Note: Percentages sum to more than 100% as more than one response was accepted. O% indicates less than .5%. Q7

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There were no significant differences in each response category by geographic area, demographic characteristics, or PDE either on their own or grouped, other than the response "none":

DEMOGRAPHIC CHARACTERISTICS

- Older respondents (65 years of age or older) were more likely to say "none" (i.e. that development and infrastructure projects were less important than the other things they value about their community well-being) (78%).

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4 DEVELOPMENT AND INFRASTRUCTURE PROJECT NEEDS

4.1 CONTRIBUTION OF PROJECTS TO COMMUNITY WELL-BEING

Respondents were asked to rate the importance of some types of development and infrastructure projects with respect to their contribution to their community's well-being. There were clear demarcations as to which types of projects the public believed to be more and less important to community well-being By way of summarizing the findings in Figure 4.1:

- The most important type of project was maintaining or repairing existing highways or roads. Not only did 88% of the respondents state that this type of project was important, but 60% stated it was "very important".

- Approximately 68% of respondents stated that building new institutional buildings (such as schools or hospitals) was important, with 41% stating "very important".

- Approximately half of the respondents stated that building new energy facilities (57%) and new highways or roads (51%) was important. Notably, almost as many volunteered that they were "not sure" how important these projects were or stated they were "somewhat" important.

- Fewer than half the respondents (40%) stated it is important to build new railways.

- There was little agreement among respondents about the importance new railways given the similar proportions of respondents distributed across all answer categories.

- One-third of respondents stated that building new residential buildings (34%) and new industrial buildings (such as factories or repair shops) (34%) was important.

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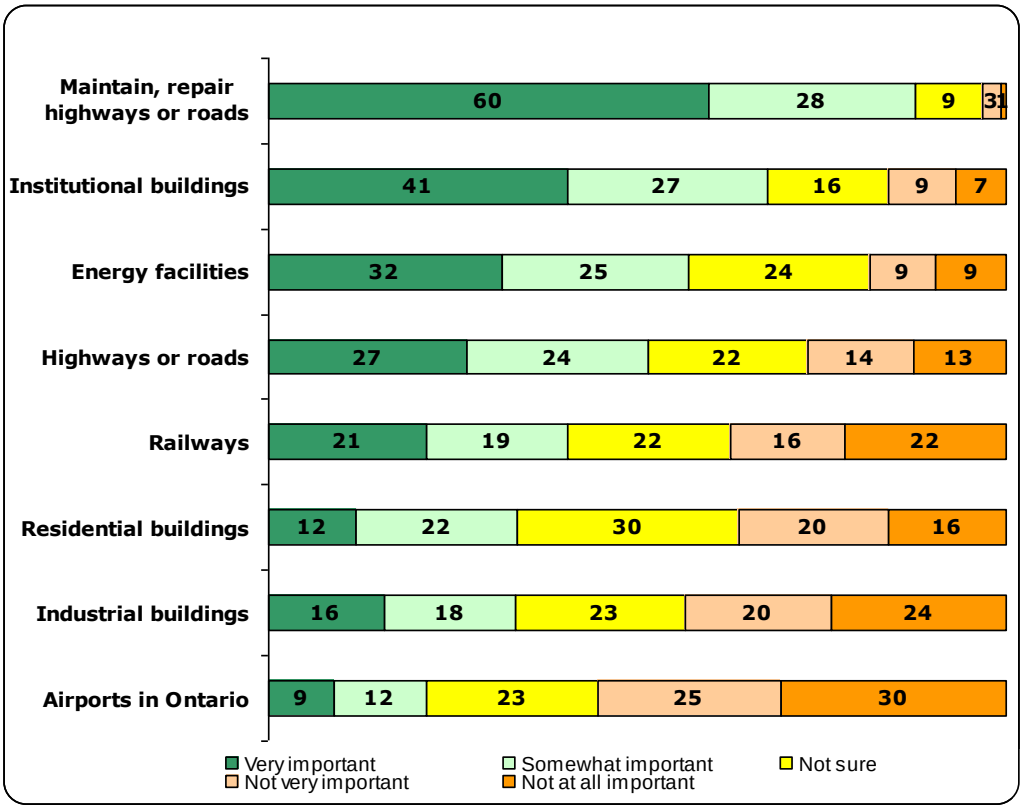
Figure 4.1: Importance of Various Development and Infrastructure Projects
(% of respondents)



- A higher proportion of respondents stated building new residential buildings (36%) and new industrial buildings (44%) were not important.

- The least important type of project was building new airports in Ontario. Less than one-quarter (21%) stated it was important to their community's well-being while 55% stated it is not important.

There are several project types where segments of respondents are more likely than the average to state that a development or infrastructure project is important:

GEOGRAPHY

- Building new institutional buildings – was rated higher in importance among respondents in Area 4 GTA (47%).

- Building new highways or road – was rated higher in importance in Areas 7 Northeast (47%) and 8 Northwest (51%).

- Building new residential buildings – was rated higher in importance in Areas 7 Northeast (17%) and 8 Northwest (18%).

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- Building new industrial buildings – was rated higher in importance in Area 8 Northwest (34%).

- Building new airports – was rated higher in importance in Areas 7 Northeast (16%) and 8 Northwest (18%).

DEMOGRAPHIC CHARACTERISTICS

- Maintaining or repairing existing highways or roads – was rated higher in importance by older respondents (65 years of age or older, 68% "very important").

- Building new energy facilities – was rated higher in importance by men (36%).

- Building new highways or road – was rated higher in importance by men (30%).

- Building new railways - was rated higher in importance by older respondents (65 years of age or older, 31%).

- Building new industrial buildings – was rated higher in importance by men (19%), and respondents who are older (55 years of age or older, 21%).

4.2 KNOWLEDGE ABOUT THE AGGREGATE INDUSTRY

Several questions were asked to gauge the public's knowledge about the aggregate industry. First, respondents were asked "If you have to guess how many tonnes of stone, sand and gravel do you think are consumed per person each year?"

As can be seen in Figure 4.2, the range of responses was similar across most of the answer categories. It should be noted that according to the Ontario Stone, Sand and Gravel Association (OSSGA, 2009) the average Ontarian uses 14 tonnes of aggregate per year.

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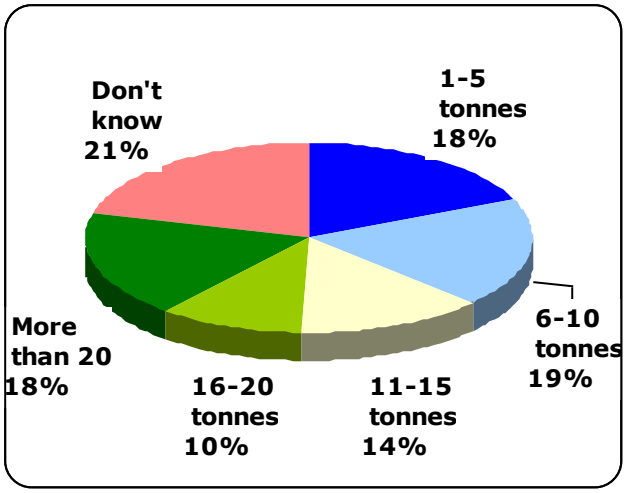
Figure 4.2: Amount of Stone, Sand and Gravel Consumed per Person Each Year
(% of respondents)



Moreover, there were no significant differences by geographic area, PDE, and by almost all demographic characteristics. The one exception is based on gender:

DEMOGRAPHIC CHARACTERISTICS

- Men (22%) were more likely than women (14%) to state each person consumes more than 20 tonnes each year and hence overestimate the amounts of aggregates used.

These findings suggest that respondents did not understand the amount of aggregates consumer per person each year.

Respondents were then asked "Where do you think the pits and quarries used to extract stone, sand and gravel resources are located?" As can be seen in Table 4.2-1, approximately 50% of the respondents stated that the pits and quarries were located within 25 km of where they live. 38% state within 100 km, 30% in Northern Ontario, and 22% in Southern Ontario.

Table 4.2-1: Location of Pits & Quarried to Extract Stone, Sand and Gravel

	%	*n*
Within 25 km of where you live	49	*(698)*
Within 100 km of where you live	38	*(535)*
In Northern Ontario	30	*(423)*
In Southern Ontario	22	*(318)*
Outside of Ontario	13	*(186)*
Don't know/not sure	8	*(107)*
Total # of respondents		*(1420)*

Note: Percentages sum to more than 100% as more than one response was accepted. Q17

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In terms of significant differences in responses by respondent characteristics:

GEOGRAPHY

- Respondents in Areas 3 West Central (73%), 2 Peninsula (71%), 7 Northeast (68%), 8 Northwest (65%), 5 East Central (65%), and 6 East (64%) were more likely to state within 25 km of where they live. Area 4 GTA (30%) was least likely to provide this response.

- Northern Ontario was more likely to be named in Areas 8 Northwest (40%), 4 GTA (36%) and 7 Northeast (34%).

DEMOGRAPHIC CHARACTERISTICS

- Men (52%) and older respondents (45 years of age or more, 59%), were more likely to state within 25 km of where they live.

- Northern Ontario was more likely to be named by women (33%).

- Women (11%) and respondents with a household income of less than $20,000 (19%) were more likely to state "don't know".

PDE

- Respondents who claimed to have a pit or quarry where they lived (76%) or had a transportation route near them (72%) were more likely to say they live within 25 km of a pit or quarry.

Respondents were asked then to rank order three modes of transporting stone, sand and gravel resources from the pits and quarries to where they are needed. Table 4.2-2 presents the ranking distribution for each mode. Findings indicate that:

- Three-quarters of the respondents (75%) mentioned truck as the most commonly used form of transportation.

- Rail was the second most commonly used transportation mode with over half giving it a 2 ranking (58%).

- The least commonly used mode was sea or lake transport, although one-third rate it first or second (37%).

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Table 4.2-2: Ranking of Modes to Transport Aggregates

		%	*n*
Transport type:	**Rank:**		
Truck	1	75	*(1060)*
	2	13	*(181)*
	3	13	*(178)*
Rail	1	18	*(263)*
	2	58	*(817)*
	3	24	*(341)*
Sea or Lake	1	7	*(97)*
	2	30	*(422)*
	3	63	*(901)*
Total			*(1420)*

Note: Percentages may not sum to 100% due to rounding. 1 is the most commonly used transportation mode, 3 the least. Q18

In terms of significant differences in answers by respondent characteristics:

GEOGRAPHY

- Truck transport was more likely to be ranked higher in Areas 5 East Central (87%) and 3 West Central (86% provide a 1 ranking).
- Rail transport received a higher ranking than the average by Area 4 GTA respondents (25%).
- Sea or lake transport was ranking higher among respondents in Area 1 Southwest (13% rate it as first).

DEMOGRAPHIC CHARACTERISTICS

- Truck transport was more likely to be ranked higher by older respondents (65 years of age or older, 80%).
- Rail transport received a higher ranking than the average among younger respondents (under 25 years of age, 35% rate it as first), and women (21%).

PDE

- Truck transport was more likely to be ranked higher by those who said they lived near a pit or quarry (82%) or transportation route (82%).
- Rail transport received a higher ranking than the average by those who said they did not live near a pit or quarry (21%) or a transportation route (21%).

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5 SOCIAL COSTS AND BENEFITS OF AGGREGATE EXTRACTION

5.1 SOCIAL COSTS

Respondents were asked to identify what they considered to be the most adverse or negative effects of stone, sand and gravel extraction. As can be seen in Table 5.1, respondents identified a variety of negative effects, with fewer than 15% volunteering each response category. The highest single response was "don't know" (16%). When responses were grouped, 56% mentioned Environmental Effect, and 50% named Nuisance Effect.

Table 5.1: Social Costs of Stone, Sand & Gravel Extraction

	%	*n*
Environmental Effect:	**56**	
Holes/pits/left behind/no rehabilitation	13	*(181)*
Water tables are exposed/contaminate water	9	*(130)*
Destruction of the natural environment	9	*(126)*
Disruption of wild life/animal habitat	7	*(105)*
Eroding of earth/digging up land	6	*(87)*
Blasting/destroying non-renewable resources	4	*(63)*
Destroys agricultural/topsoil	3	*(49)*
Removal of trees/forestry/greenery	3	*(42)*
Disruption of the ecosystem	2	*(31)*
Changes the climate/global warming	0	*(7)*
Nuisance Effect:	**50**	
Dust/sand/dirt	11	*(158)*
Noise from trucks/machinery	11	*(157)*
Heavy/trucks/damages the road	8	*(116)*
Disruption of scenery/an eye sore	8	*(114)*
Trucks create traffic on the road	5	*(64)*
Damages the surrounding communities/ residential areas	5	*(68)*
Trucks throw stones/gravel damaging other vehicles	2	*(30)*
Human Effect:	**16**	
Pollution/poor air quality affecting human health	13	*(179)*
Health risks for workers/residents	3	*(48)*
Nothing/none	**7**	*(104)*
Other	**6**	*(87)*
Don't know/refused	**16**	*(230)*
Total # of respondents		*(1420)*

Note: Percentages sum to more than 100% as more than one response was accepted. O% indicates less than .5%. Q19

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There were differences in responses to the grouped categories by respondent characteristics:

GEOGRAPHY

- Area 8 Northeast was more likely to state "nothing" (20%).
- Area 3 West Central was more likely to name Nuisance Effect (69%).

DEMOGRAPHIC CHARACTERISTICS

- Younger respondents (under 25 years of age, 27%) and women (19%) were more likely to name Human Effects.
- Men (64%) and those 45 to 54 years of age (65%) were more likely to name Environmental Effects.
- Seniors 65 or more were more likely to state "nothing) (14%).

PDE

- Respondents who claimed to live near a stone, sand and gravel pit were more likely to name Nuisance Effect (61%).

5.2 Social Benefits

Respondents were asked to identify what they considered to be the main benefits or positive effects of stone, sand and gravel extraction. As can be seen in Table 5.2 (next page), over two-third of the respondents identified the provision of materials for construction of buildings and homes (36%) and improving the provinces infrastructure including road, highways and railways (35%). Almost 2-in-10 named job creation and employment (18%). Less than 10% named each of the remaining positive effects. Overall, 95% named some element of Infrastructure and Development Projects.

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Table 5.2: Main Social Benefits of Stone, Sand & Gravel Extraction

	%	*n*
Infrastructure & Development Projects:	**95**	
Provision of materials/construction of buildings/homes	36	*(513)*
Improve infrastructure/better roads/highways/railway	35	*(498)*
Availability of materials/local	9	*(129)*
Use of raw materials/natural resources	7	*(93)*
Need it/necessary	4	*(61)*
Cheap materials/resources	2	*(32)*
Improve/development of the community	2	*(23)*
Economic Benefits:	**25**	
Job creation/employment	18	*(250)*
Economic development	5	*(66)*
Industrial growth/support the local/regional industry	2	*(23)*
Recreation/Landscaping Projects:	**5**	
Landscaping/beaches	3	*(38)*
Can create lakes/drainage	2	*(23)*
Other	4	*(60)*
Other - Negative:	**12**	
None	8	*(109)*
Negative impact	4	*(58)*
Don't know/refused	12	*(168)*
Total # or respondents		*(1420)*

Note: Percentages sum to more than 100% as more than one response was accepted. O% indicates less than .5%. Q20

In terms of differences in responses by answers:

GEOGRAPHY

- Respondents in Areas 7 Northeast (40%) and 6 East (45%) are more likely to name improvements to the infrastructure.

DEMOGRAPHIC CHARACTERISTICS

- Men (21%) are more likely than women (14%) to name job creation. Men (28%) are also more likely to name the overall category of Economic Benefits than women (20%).

- Men (40%) are more likely than women (32%) to name materials for construction. Overall, men (100%) are more likely to name Infrastructure and Development Projects than women (88%).

- Older respondents (65 years of age or older, 40%) are more likely to name improvements to the infrastructure.

- Respondents with a lower household income (under $20,000, 20%) are more likely to reply that there are no benefits.

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PDE

- Respondents who claimed to live near a stone, sand and gravel transportation route were more likely to name Economic Benefits (33%).

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6 TECHNICAL APPENDIX

6.1 SURVEY OVERVIEW

The survey was undertaken by telephone among a random sample of residents in Ontario who are 18 years of age and older; the sample was split between men and women. Interviews were conducted from July 28 to August 6, 2009, and the average length was 15 minutes.

For this study IntelliPulse established a sample requirement such that each of the 8 Portland Cement Association Geographic Areas had a minimum confidence interval of ±8.1%, 19 times out of 20. This resulted in a disproportional sample allocation by area as presented in Table 6.1. The confidence interval for the area samples of approximately 150 interviews is ±8.1%, Area 4 GTA is ±5.3%, and the weighted Ontario sample is ±2.6%.

Table 6.1: Sample Allocation by Area

	Population Count	% of Population	Proportional Sample Allocation	Interviews	Weight
Area 1 - SouthWest	1,374,304	0.113	161	153	1.0517
Area 2 - Peninsula	1,164,891	0.096	136	153	0.8914
Area 3 - West Central	1,312,946	0.108	154	153	1.0047
Area 4 - GTA	5,555,912	0.458	651	354	1.8376
Area 5 - East Central	486,189	0.040	57	151	0.3770
Area 6 - East	1,447,655	0.119	169	152	1.1151
Area 7 - Northeast	433,783	0.036	51	154	0.3298
Area 8 - Northwest	352,507	0.029	41	150	0.2751
Grand Total	**12,128,187**	**1**	**1,420**	**1,420**	

6.2 RESPONDENT PROFILE

At the conclusion of the survey respondents were assured of confidentiality and asked several questions about their personal and family characteristics. As is evident throughout this report, these characteristics were important in the analysis of the study results.

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As can be seen in Table 6.2:

- A mix of age groups is represented in the sample. The smallest cohorts are under 25 years of age and 25 to 34.
- The largest single household income category is $100,000 or more.
- By the nature of the sample selection, respondents are split by gender.

Table 6.2: Demographic Profile of Respondents

		%	*n*
Age	Under 25 years of age	6	*(83)*
	25 - 34	12	*(173)*
	35 - 44	18	*(253)*
	45 - 54	24	*(332)*
	55 - 64	20	*(283)*
	65 years of age or older	20	*(280)*
	Total	*100*	*(1404)*
Total household income	Under $20,000	8	*(83)*
	$20,000 - $39,999	13	*(132)*
	$40,000 - $59,999	18	*(178)*
	$60,000 - $79,999	17	*(167)*
	$80,000 - $99,999	13	*(129)*
	$100,000 or more	30	*(298)*
	Total	*100*	*(987)*
Gender	Male	50	*(708)*
	Female	50	*(712)*
	Total	*100*	*(1420)*

Note: Percentages may not sum to 100% due to rounding. Q21-23

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6.3 QUESTIONNAIRE

Part 1 – Introductory Script and Participant Information

Hello, I'm _____ of IntelliPulse Research, a national survey research firm. We're talking to people today on behalf of the Ontario Ministry of Natural Resources about resources like stone, sand and gravel in Ontario and how the management of these resources may affect you and your community. We are not selling anything, and your responses are confidential to IntelliPulse. This survey should take less than 15 minutes of your time.

A. Are you 18 years of age or older and an Ontario resident?

Yes (SKIP TO C) 1
No 2
WATCH FOR GENDER QUOTAS 50/50

B. IF NO ASK: May I please speak to someone in the household who is?

Yes REPEAT INTRODUCTION 1
No, not available, ASK; What would be a good time to call back? RECORD 2
Date: _____ Time: _____

IF NECESSARY: This survey is registered with the Marketing Research and Intelligence Association who can confirm that it is a legitimate market research survey. Their number is 1-800-xxxxx and the identification Number of the study is .

C. Have I reached you at your home telephone number, that is (READ TELEPHONE NUMBER)?

No (THANK AND TERMINATE, RECORD INCIDENCE) 1
Yes (CONTINUE) 2

1. Is there a stone, sand and gravel pit or quarry near where you live?

Yes 1
No 2
Don't know / Not sure (volunteered) 3

2. Do you live near a stone, sand and gravel transportation route?

Yes 1
No 2
Don't know / Not sure (volunteered) 3

3. Are you or someone in your household, employed by the aggregate industry (that is a company which extracts stone, sand or gravel) or related-industries such as road or building construction?

Yes (CONTINUE).....1
No (SKIP TO Q5) 2
Don't know / Not sure (volunteered) (SKIP TO Q5).....3

4. In what way is that person employed in the aggregate industry?

_____

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Part 2 – Community Well-Being

Thank you. Now I'm going to ask your some questions about the things that you value in your community.

5. There are many things that people value about their communities that contribute to their quality of life. In your opinion, what are some of the things that you value? (Accept up to three responses) And what else do you value? And what else?

    a)
    b)
    c)

Thank you for your ideas. This survey is trying to understand how the people of Ontario value stone, sand and gravel resources in the context of community well-being. These resources are used for development and infrastructure projects such as highways, railways, energy facilities and airports, as well as residential, industrial, and commercial buildings.

6. Now thinking back to the things that you value about your community, which you previously stated [*remind participant of responses from Q5*], which of those, if any, are **more** important than development or infrastructure projects that happen in your community? SELECT ALL THAT APPLY…ACCEPT UP TO 3 MENTIONS

    None (Volunteered) 1

    a)
    b)
    c)

7. Which of those values you named, if any, are **less** important than development or infrastructure projects that happen in your community? SELECT ALL THAT APPLY…DO NOT READ THOSE SELECTED IN Q6

    None (Volunteered) 1

    a)
    b)
    c)

Part 3 – Social Attitudes towards Different Types of Development and Infrastructure Projects

Next, I am going to name some types of development and infrastructure projects, and I'd like you to rate their importance in relation to your community's well-being. Using a scale of 1 to 5, a score of 5 is **very** important, and 1 is **not at all** important. ROTATE Q8 – 15 REPEAT SCALE FOR EVERY OTHER QUESTION

8. Building new highways or roads

    Not at all important 1
    Not very important 2
    Not sure (Volunteered) 3
    Somewhat important 4
    Very important 5

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9. Maintaining or repairing existing highways or roads

Not at all important 1
Not very important 2
Not sure (Volunteered) 3
Somewhat important 4
Very important 5

10. Building new railways

Not at all important 1
Not very important 2
Not sure (Volunteered) 3
Somewhat important 4
Very important 5

11. Building new energy facilities

Not at all important 1
Not very important 2
Not sure (Volunteered) 3
Somewhat important 4
Very important 5

12. Building new airports in Ontario

Not at all important 1
Not very important 2
Not sure (Volunteered) 3
Somewhat important 4
Very important 5

13. Building new residential buildings

Not at all important 1
Not very important 2
Not sure (Volunteered) 3
Somewhat important 4
Very important 5

14. Building new industrial buildings (such as factories or repair shops)

Not at all important 1
Not very important 2
Not sure (Volunteered) 3
Somewhat important 4
Very important 5

15. Building new institutional buildings (such as schools or hospitals)

Not at all important 1
Not very important 2
Not sure (Volunteered) 3
Somewhat important 4
Very important 5

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Part 4 – Respondent Knowledge about Inputs into Infrastructure Projects

Thank you for your answers. There are many requirements for these types of development and infrastructure projects to occur. These include skilled labour, raw materials, and public demand.

16. In Ontario, if you had to guess how many tonnes of stone, sand and gravel do you think are consumed per person, each year? READ RESPONSE CODES

    1-5 tonnes per person 1
    6-10 tonners per person 2
    11-15 tonnes per person 3
    16-20 tonnes per person 4
    More than 20 tonnes per person 5
    Don't know (Volunteered).....6

17. Where do you think the pits and quarries used to extract stone, sand and gravel resources are located? Please state all that apply. READ RESPONSE CODES. IF NEEDED: Extraction refers to removing the stone, sand or gravel out of the earth.

    Within 25 km of where you live.....1
    Within 100 km of where you live.....2
    In Northern Ontario 3
    In Southern Ontario 4
    Outside of Ontario.....5
    Don't know/not sure (volunteered).....6

18. Stone, sand and gravel resources need to be transported from the pits and quarries where they are extracted, to where they are needed. Please rank the following modes used to transport these resources where 1 is the **most** commonly used mode of transportation and 3 is the **least** commonly used. READ ALL THREE … Which one is the most commonly used? Which one is second most common? Last leaves (READ LAST ONE) as the least commonly used.

Mode	Ranking (response)
A. Rail Transport	
B. Sea or Lake Transport	
C. Truck Transport	

Part 5 – Social Costs and Benefits of Aggregate Extraction

19. What do you think are the most adverse or negative effects of stone, sand and gravel extraction? These can be at a local or regional scale. ACCEPT UP TO 3 RESPONSES. Is there another adverse or negative effect? Any other effect?

    a)
    b)
    c)

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20. What do you think are the main benefits or positive effects of stone, sand and gravel extraction? These can be at a local or regional scale. ACCEPT UP TO 3 RESPONSES. Is there another benefit or positive effect? Any other effect?

a)
b)
c)

Part 6 – Respondent Information

Thank you for your answers. Now I am going to ask you some demographic questions to help our analysis. Your responses will be grouped with those of other respondents. Please be assured your responses are confidential to IntelliPulse only.

21. What is your age please? Are you …?

Under 25 years of age 1
25 - 34 2
35 - 44 3
45 - 54 4
55 - 64 5
65 years of age or older 6

22. What is your total household income, before taxes from all sources for all members of your household? Is it …

Under $20,000 1
$20,000 - $39,999 2
$40,000 - $59,999 3
$60,000 - $79,999 4
$80,000 - $99,999 5
$100,000 or more 6

23. Gender (By Observation)

Male 1
Female 2

24. What is your postal code?

a)

25. Date of interview (RECORD)

a)

Thank you for your time today. Your answers are important to the future planning of resources in Ontario. Do you have any questions or comments?

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6.4 PORTLAND CEMENT GEOGRAPHIC AREAS

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6.5 QUALITY ASSURANCE

The procedures used for this social values study are standard procedures used in public affairs and sociological research. They conform to the Marketing Research and Intelligence Association standards (MRIA). As part of the standards, the survey was registered with the MRIA; the project leader (Ms. Margaret Buhlman) and the Field Director (Mr. Sam Pisani) are members of the Marketing Research and Intelligence Association and abide by its standards for conducting the research (www.mria-arim.ca).

The sampling and drawing of telephone numbers was undertaken by The Logit Group. The Logit Group imported the sample into the CATI programming that contained the questionnaire. The Logit Group then undertook all CATI programming of the questionnaire, interviewing, coding, and production of the SPSS data file.

The backbone of the research infrastructure at The Logit Group is a fully monitored 70 station CATI facility located in Toronto, Ontario. It is equipped with the state-of-the-art *Voxco Interviewing* CATI platform. Voxco's CATI platform integrates sample management, quota and call-back management, interviewing and real-time on-screen monitoring. As well, the set-up allows for interviewers to be directly monitored by supervisors at all times.

Remote monitoring is a standard feature of the quality assurance protocols employed for this study, allowing clients (i.e., AECOM) direct access to both on-going interviews, as well as supervisors for constant feedback. Ms. Margaret Buhlman (IntelliPulse Inc.) monitored each interviewer on the first night. AECOM monitored the survey on the same evening.

Several management procedures were taken to ensure quality. These included:

- *Interviewers* - Only experienced interviewers who were fully fluent in English were assigned to the study.

- *Briefing* - Prior to 'live' interviewing the interviewers were trained and briefed by the Logit Group supervisor. The session included a question-by-question review, role-playing, and the opportunity to ask questions. Interviewers who were new to the project after this time undertook the interviewer training.

- *Ensuring Response Rates* – Based on experience with a wide range of public attitude research surveys, there is a general downward trend in response rates. Consequently, constant attention was placed on methods to ensure the highest response rates possible. Extensive interviewer training was used to help to reduce refusal rates and increase response rates, including teaching interviewers the necessary, although often overlooked "soft skills" needed to engage respondents at the outset of the interview.

  As well, multiple call attempts were made to records, and spread across different days and times, to ensure the highest possible "connect rate" on

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randomly selected records. Requests by respondents for appointments or call-backs at more convenient times were respected. All our contact records made provision for follow-up calls and appointments with respondents. Response rates are presented in Technical Appendix 6.5.

- *Ensuring the quality of CATI screens* –The correct and accurate programming of a questionnaire into CATI is one of the first, and one of the most fundamental aspects of overall quality management – ensuring that all questions are programmed accurately, including streaming and skip patterns, valid ranges and fields, and correct interviewer instructions are presented. All programming was undertaken by The Logit Group's lead programmer.

  To ensure the highest quality level possible, the following steps were undertaken:

  – The programmed CATI questionnaire was tested first by the programmer, and then independently by the Project Manager and a senior supervisor to ensure that the questionnaire logic and answer choices are correct.

  – Next, a CATI simulation was performed, whereby randomly generated "dummy data" was written to a test file. The data processing department also checked for inconsistencies in base totals and logic within the test data file itself.

  Interviewing – The Ontario Ministry of Natural Resources was identified as the sponsor of the survey. The time frame for the survey was kept long (July 28 to August 8, 2009) in order to make the best use of the sample and to retain a small cadre of interviewers.

  Quality of data accuracy - On-site supervision was provided on a regular basis. One supervisor was on duty for every 10 interviewers. Supervisory staff monitored 30% of all contacts, using a DEES-based voice and data-monitoring unit (exceeding MIRA's 10% requirement). The unit combined standard audio monitoring of the interview with remote monitoring of CATI workstation screen. In this way, supervisors did not only hear responses, they also ensured that they had been correctly recorded.

  In addition to the monitoring, a further 15% of all completed interviews were validated via a call-back methodology. Respondents were randomly selected from the pool of recently completed interviews. Selected respondents were contacted within 24 hours of the original interview and the survey restarted at a random point. If no inconsistencies were encountered, the validation consisted of only a few questions. If unusual changes were noted, the interview would have been re-conducted in its entirety or removed from the dataset.

  The available audio-based monitoring system allowed AECOM, regardless of location, to remotely monitor the study in progress.

  To ensure the highest level of data accuracy, a "confirmation-based" procedure to its CATI platform was utilized. This meant that after

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entering a response during an interview, interviewers saw a "Response Confirmation Screen" that quickly ensured that they recorded the appropriate response. This screen was not read to the respondent, but rather it was used as an internal phone room check to ensure that any mis-keyed responses by interviewers were caught quickly, without impeding the actual flow of the interview at all.

- *Open-end coding* - Code lists and verbatim responses were provided to IntelliPulse for review and modification. The code list/verbatim processes were as follows.

  - undertaking a preliminary coding of the responses based on 50% of the completed questionnaires.
  - Supplying code lists (Word) and verbatims (Excel) to IntelliPulse electronically.
  - review of the code list and the verbatims for each question, and highlighting changes and additions so that The Logit Group could use the changes as a guide to complete the coding.
  - Once code lists were revised by IntelliPulse, code lists and all coding were revised to reflect any applicable revisions. Any additional codes after the approval list were provided to IntelliPulse for acceptance.

- Sample Weighting –It is standard survey research procedure when dealing with a disproportional sample selection, where some areas are over-represented in the sample, and others are under-represented to have a sufficient sample size for area analysis, to weight the data into their proportion proportions for reporting results for the entire area. Technical Appendix 6.1 provides a detailed description of the sample selection by Geographic Area and the weighting procedures.

- *SPSS data file* - Fully documented data file in labelled SPSS format was sent electronically to IntelliPulse. SPSS was used to produce the frequencies for the tables. All questions were crosstabulated against the demographic questions, and by area. The chi-square statistic and correlation statistics (Person's r, and Gamma) were used to determine whether there is a correlation between survey responses and demographic questions. Significant differences are noted in the report.

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6.6 RECORD OF CALL

Table 6.6: Record of Call

Total	**26315**
No Answer	5908
Busy	500
Answering machine	4708
Callback	2503
Fax/modem	342
Not In Service	236
Business / Not Residential	115
Operator intercept	3360
Language Barrier	525
Quota full	122
Line answered	1084
Default value	1
No one is available for duration of survey	208
Call back later to finish the survey	82
NOT HOME PHONE	40
Household Refusal	1489
Respondent Refusal	3511
Refusal (Mid-survey)	153
Local / Long Distance Autodialer Error	8
COMPLETED	**1420**

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Appendix B

Use and Environmental Benefit of Aggregate Matrix

			Supporting Services → to produce other services					**Provisioning Services** → Products ecosystems provide				**Regulating Services** → Regulate ecosystem processes									**Cultural Services** → Links to human activity									**Preserving Services** → intrinsic values		
Aggregate Use	**Type of Aggregate**	**Benefit/Ecosystem service**	Soil formation	Photosynthesis	Primary Production	Nutrient cycling	Water cycling	Food	Fiber	Fuel/Energy	Genetic resources	Air quality	Climate regulation	Water quality	Water quantity	Waste treatment	Pollution Treatment	Disease control	Pest control	Pollination	Natural hazard control (e.g., erosion)	Cultural diversity	Health and Safety	Spiritual and religious values, Inspiration	Education	Aesthetics	Social relations	Sense of place	Cultural heritage	Commerce	Recreation and tourism	Biodiversity	Connectivity	What we do not know yet
Processes																																	
Human Land Use Change		Humans alter the environment to suit their needs, but also restore natural environments susceptible to natural hazards.																															
Wetland and River/Stream Restoration	riverrun stone; rip-rap (stone); armour stone	Prevent erosion and negative effects associated with it (e.g. contamination to surrounding habitat, decreased biodiversity), promote habitat creation and riparian corridor restoration												X	X						X					X					X	X	X	
Agricultural Land (soil aggregate stability)	clay, sand	Sand essential for good drainage and clay holds nutrients and minerals in the soil; both necessary for good crop production. In turn crop production leads to many supporting ecosystem services	X	?	?	X	X										x				X - wind												
Water Quality Treatment		Clean water necessary for all living things. For example, water filtration provides clean drinking water and healthy aquatic and terrestrial habitat.																															
Sewage Treatment	clay, sand, crushed stone	Aids in the physical removal of contaminants from sewage					X							X		X		X															
Stormwater Control	All	Part of the environmental water cycle, cleaning water naturally (no human influence)				X	X							X	X				O		X					X O		X			X		
Removal of Anthropogenic Pollutants		Reduce the amount of stress that humans put on the environment.																															
Flue Gas Desulfurization	Limestone	Used for removing sulfur dioxide produced from exhaust flue gases cause by burning coal or oil, thereby cleaning the air and reducing associated pollution. Reduces the amount of sulfur dioxide in natural environment (air and water).				X						X	X	X				X															
Acid Neutralization	Limestone	Industrial processes causing acidification of water can be neutralized by limestone (aggregate) thereby making the water safe and useable				X						X O	O	X		X	X																
Use in Mine Sites		Used as a base to create new habitat for completed mining projects; e.g. habitat, soils																															
Mine reclamation (backfill, land cover)	sand, crushed concrete	creates a different landscape type (flat, hilly, etc)	X			X	X							X	X						X										X		
Coal Mine Dusting to Prevent Explosions	non-combustible limestone	Limestone aggregate mixed with coal dust to prevent flame propagation by acting as a thermal inhibitor																				X											
Landfills and Waste Disposal		Important to localize human waste so environment less likely to be impacted by pollution/garbage.																															
Leachate Collection	crushed glass cullet, stone	Drainage media in landfill leachate					X							X			X	X															
Gas Collection	crushed glass cullet, stone	Drainage media in gas collection								X		X	X				X																
Cover and Protection	clay, sand, crushed stone	Used to prevent leachate formation												X				X			X	X											
Leachate pH Adjustment	limestone	Neutralize leachate										X		X																			
Maintenance of Biodiversity																																	
Provision of artificial disturbance regimes	All	As landscapes stabilize and disturbance regimes (fire, wind) are controlled, species that are disturbance dependant (Golden-winged Warbler; Prairie Cinquefoil; Olympia Marblewing) may be negatively affected by loss of habitat. Aggregate production provides a controlled activity that can target the sequential restoration of habitats for disturbance-dependant species.																														X	X	X
Spatial																																	
Construction	Concrete and Asphalt	Provides a direct benefit to society as it creates human infrastructure as we know it.																															
Road and Highway maintenance and repair	All	Transportation																									X			X	X		
Road and Highway new construction	Glass; Rubber additives	Transportation																									X			X	X	O	O
Houses	All	Social																				X		X	X	X	X	X	X	X	X		
Institutional Buildings	All	Social																				X		X	X	X	X	X	X	X	X		
Airports	All	Social																				X					X			X	X	O	
Incinerators/Recycling Facilities	All	Social - Reduce human waste										X O				X O		X												X			
Dams	concrete; sand; gravel	Decrease erosion and negative impacts associated with it; aids in the use of water supply for sustainable energy by controlling flow; recreational use by way of increasing flow of river for associated activities (e.g. white water sports)					X			X					X							X O									X		O	
Dams, Reservoirs and Water Supply	All	Allow access to water and hydraulic power					X			X					X							X O									X	X O	O	
Roadways/Bridges	sand, gravel, asphalt, concrete	Increase availability of goods transported																										X			X	X	O	O
Shorelines/Navigation Channels	concrete, rip/rap; armour stone	Prevent shoreline erosion and deterioration																				X												
Construction Site (exits and runoff control)	concrete; sand; gravel	Prevent contaminated runoff into local waterways												X	X							X												
MNR Licences	All	Aggregates Resources Act requires that the quarries be restored to appropriate end uses that range from restoration of natural habitat (terrestrial, aquatic) through provision of sites for recreation, education, agriculture and/or residential/commercial/industrial development.																			Gardens				Arboreta; Earth Science Study Sites; Schools	Gardens		Residential development		Industrial/commercial development	Parks, resorts; golf courses; zoos; lakes & beaches	Wildlife Habitat; alvars		X
Licences - existing conditions			X	X	X	X	X	X			X	X	X	X	X						X	?			?		?			?		X		
Rehabilitation		Post Quarry Operations	X	X	X	X	X	X			X	X	X	X	X						X	?			?		?			?		X		

X - benefit
O - Not a benefit