ONTARIO SOCIETY OF PROFESSIONAL ENGINEERS

GTSWCA since 1957

RESIDENTIAL AND CIVIL CONSTRUCTION ALLIANCE OF ONTARIO
RCCAO Constructing Ontario's Future

Excess Soil Management:

Ontario is Wasting a Precious Resource

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ABOUT

OSPE

The Ontario Society of Professional Engineers (OSPE) is the voice of the engineering profession in Ontario. We represent the entire engineering community, including engineers, engineering professionals, graduates, and students who work or will work in several of the most strategic sectors of Ontario's economy.

OSPE elevates the profile of the profession by advocating with governments, offering valued member services and providing opportunities for ongoing learning, networking and community building.

OSPE was formed in 2000 after members of Professional Engineers Ontario (PEO) voted to separate regulatory and advocacy functions into two distinct organizations.

GTSWCA

The Greater Toronto Sewer and Watermain Contractors Association (GTSWCA) was established in 1957 and represents the most qualified sewer and watermain construction contractors in Southern Ontario. Our motto is "Clean Water is our future."

The GTSWCA currently serves approximately 200 member companies including contractors, suppliers, manufacturers and other industry stakeholders. Our goals extend far beyond lobbying for increased funding. Our areas of expertise include: harmonious labour relations; water, wastewater and stormwater systems management and legislation; the environment; health and safety; security and theft prevention; mutually beneficial contract terms; innovation and engineering; and many other issues relevant to the sewer and watermain construction industry. We are the voice for the sewer and watermain sector of construction.

RCCAO

The Residential and Civil Construction Alliance of Ontario (RCCAO) is an alliance composed of management and labour groups that represents a wide spectrum of the province's construction industry. RCCAO's goal is to work in cooperation with governments and related stakeholders to offer realistic solutions to a variety of challenges facing the construction industry, and which also have wider societal benefits.

Our motto is "Constructing Ontario's Future," because together we build the homes, roads, watermains and much more. This infrastructure is of critical importance to the residents and businesses of Ontario. We have always taken pride in the quality of work that goes into building our communities and aim to collectively accomplish even greater things to meet the demands of a growing population.

EXECUTIVE SUMMARY

The Ontario Society of Professional Engineers (OSPE), the Greater Toronto Sewer and Watermain Construction Association (GTSWCA) and the Residential and Civil Construction Alliance of Ontario (RCCAO) have partnered to prepare a study on excess soil management to ensure sustainable practices are considered through the design and construction of Ontario's infrastructure projects.

Building on the Ministry of the Environment and Climate Change (MOECC)'s *Management of Excess Soil – A Guide for Best Management Practices* (the Guide) that encourages adoption of best management practices (BMPs), a survey of excess soil management was issued to industry practitioners. A total of 24 surveys were completed.

As environmental stewards, professional engineers and construction professionals should promote BMPs to conserve natural resources such as soil during the development of various infrastructure and construction projects.

KEY RECOMMENDATIONS

1. Excess soils generated from projects in Ontario should be treated as a resource, not a waste.
2. Reducing the transport of soils that can be re-used or recycled makes economic and environmental sense.
3. A model by-law should be created to promote the use of the Guide on infrastructure projects.
4. Industry should collect data to highlight opportunities for both government and businesses to prioritize the handling of excess soil.
5. Responsibility and onus should be placed on the Qualified Person (QP), and QP regulators need to be involved in ensuring QPs have the proper qualifications.

KEY FINDINGS

While acknowledging that the data generated from the survey results would be more robust if the sample size was larger, information about 24 projects when treated as case studies nonetheless provides valid current examples of the management of excess soil in Ontario. The descriptions provided by analyzing survey results demonstrate that huge amounts of soil are being disposed of as waste and are transported over great cumulative distances while emitting significant amounts of greenhouse gases (GHG).

Key highlights of the analysis include the following:

1. Projects surveyed range from under $1 million to over $50 million, with a total value of more than $330 million.
2. On average, handling and disposal of excess soil represents 14% of total project value; for all 24 projects, this represents costs of $46 million.
3. Over 75% of projects reported more than 100 one-way trips to dispose of excess soil, averaging almost 65 kilometres.
4. Combined one-way travel distances to dispose of soil totalled more than 200,000 km – more than 25 times the length of the Trans-Canada Highway.
5. Importing virgin soil and/or granular materials resulted in an additional 115,000 km of haulage.
6. Using target emission rate calculations from Environment Canada and the United States. Environmental Protection Agency (U.S. EPA), all 24 projects are estimated to have released over 300 tonnes of CO_2 into the environment.
7. Average savings would be 13% (or almost $1.8 million) for each project if excavated soil had been reused; for all 24 projects, this would generate a savings of almost $43 million.
8. Projects that reported using the Guide experienced an average of 9% in cost savings; for all 24 projects this would represent a total of almost $30 million in savings.

Nine per cent of the $160 billion in infrastructure investment commitments made by the Ontario government over 12 years equates to over $14 billion. Savings from using the Guide for beneficial reuse of excess soil could be redirected towards other government and social priorities.

Excess Soil Management:
Ontario is Wasting a Precious Resource

BACKGROUND

Most Ontarians are familiar with major infrastructure projects, from roadwork construction in rural areas to development of high rise condominiums and the upgrading of buried utilities in cities, and recognize that a great deal of soil is excavated for such projects. But does the general public realize that enormous amounts of excavated soil is disposed of as waste, and in the process, increases costs and greenhouse gas (GHG) emissions that burden the economy and environment? Indeed, the Residential and Civil Construction Alliance of Ontario (RCCAO) estimates that 20 to 25 million cubic metres of excess soil is generated from these excavations each year in Ontario (Manahan 2015).

The purpose of this report is to use current examples to demonstrate that a huge amount of soil is unnecessarily considered a "waste" rather than being re-used. The disposal of this excess construction soil contributes to GHG emissions from transport vehicles, adds to the wear and tear of roads, and increases traffic congestion – all of which increases costs that are ultimately paid by taxpayers.

Fortunately, the Government of Ontario recognizes the value in addressing this issue. An Ontario Government (2014) document, *Management of Excess Soil – A Guide for Best Management Practices* (the Guide) offers guidance on improving the disposition of excess soil, and a Proposed Soil Management Policy Framework was released in 2016 (Ontario Government 2016). It is our hope that the analysis outlined in this document will encourage widespread adoption of the Guide.

Many excess soil best practices are modeled on the successful work done in the United Kingdom by Contaminated Land: Applications in Real Environments (CL:AIRE), which provides objective, scientifically robust sustainable remediation approaches involving a strong focus on excess soil management and its beneficial reuse. As an independent, not-for-profit organization, CL:AIRE works with and supports the UK government's regulatory framework by developing industry voluntary codes of practice. Their *Definition of Waste: Development Industry Code of Practice* (DoW CoP) and supporting training tools, professional certification process and soil matching registry have significantly encouraged the cost effective beneficial reuse of excess soil while reducing environmental and safety concerns associated with the trucking and land filling of soil.

In 2014, CL:AIRE conducted a research project on the use of their DoW CoP. The resulting report confirmed that since 2011, of the 118 projects audited approximately 2,000,000 m^3 of material was reused resulting in significant reductions in journey miles driven to landfills, replacement material required, fossil fuels consumption and pollutant GHG emissions (CL:AIRE 2014).

JUSTIFICATION

As environmental stewards, engineers and other site professionals working on infrastructure in Ontario should consider and advance best management practices (BMPs) to conserve natural resources such as soil during the development of various infrastructure projects. Proper planning should apply sustainable practices that consider the economic, environmental, and societal impacts or benefits through the design, construction, and operation of infrastructure projects. Together, the Ontario Society of Professional Engineers (OSPE), Greater Toronto Sewer and Watermain Contractors' Association (GTSWCA) and RCCAO joined forces to look into soil management practices in Ontario. These organizations represent a significant proportion of the designers, developers and builders of Ontario's infrastructure and are well suited to address soil management issues.

OSPE, GTSWCA, and RCCAO have taken the principles espoused in the Guide to form a survey given to companies asking for information on their soil management practices. Data analysis was subsequently conducted to determine whether there is widespread removal of excess soil from major projects, primarily municipal infrastructure projects. The goal is to demonstrate to industry and governments, especially at the municipal level, that treating soil as a resource and re-using or recycling it makes economic and environmental sense. This report outlines survey findings and presents recommendations to establish better soil management practices. Soil should be considered a resource, not a waste.

PARTNER STAKEHOLDERS

In addition to the aforementioned associations, many organizations and companies stand to benefit from the survey report of soil management practices. Engineering and related private companies will benefit as well as members of associations such as Consulting Engineers of Ontario (CEO), Professional Engineers Ontario (PEO), the Ontario Association of Certified Engineering Technicians and Technologists (OACETT) and the Association of Professional Geoscientists of Ontario (APGO). Industry bodies such as the Construction and Design Alliance of Ontario (CDAO), the Ontario Environment Industry Association (ONEIA), the Ontario Home Builders' Association (OHBA), the Ontario General Contractors Association (OGCA), the Ontario Road Builders' Association (ORBA) and the Residential Construction Council of Ontario (RESCON) will also benefit and likely share findings with their members. Many government ministries also have a vested interest in improving excess soil management practices as well as municipalities and regional conservation authorities.

ISSUES

There are many specific issues associated with disposing of excess soil. A few considerations include:

- Extra costs on many infrastructure projects:
  - Extra costs in trucking soil
  - Costs for disposal
  - Costs for replacement soil (bedding, backfill & cover)

- Environmental impacts:
  - Use of landfill space and soil (both finite resources)
  - Air emissions from increased truck traffic – GHG/particulates/incomplete combustion products/other (dust generated by the soil loads as well as by the traffic passing over degradable surfaces)
  - Noise pollution and highway congestion from truck traffic
  - Wear on road surfaces by heavy truck traffic
  - Depletion of fossil fuels that power the trucks – diesel
  - Dependence on oil-consuming vehicles

- Other concerns:
  - Increased costs for infrastructure projects/reduced capacity for other municipal services
  - Uncertainties about using soil BMPs – the default is an ultra-cautious approach to avoid municipal liabilities – meaning treating soil as waste and dumping it at a landfill site
  - Potential Ministry of the Environment and Climate Change (MOECC) enforcement typically triggers a due diligence approach to avoid prosecutions
  - Participation of inadequately qualified people involved in this industry results in poor overall outcomes and a need for more training of Qualified Persons (QPs)
  - Geotechnical suitability of soil for re-use; this is a design decision by the geotechnical engineer of record for each project

SURVEY FINDINGS

In August 2015 OSPE, GTSWCA and RCCAO designed a survey to evaluate examples of excess soil management practices and determine the volume of soil being moved, their associated costs and the amount of GHG emissions that result from current practices. The goal was to demonstrate to industry and government, especially municipalities, that following best soil management practices makes economic and environmental sense.

To generate data and metrics associated with current excess soil management practices on construction sites, OSPE, GTSWCA and RCCAO distributed the survey in August 2015 and again in January 2016 to their respective members. A total of 24 surveys were completed, although almost an equal number of additional respondents started the survey but did not finish. The software storing the survey did not allow viewing of incomplete surveys. Although 24 is a relatively small sample group, these submissions provide valuable information on current soil management practices in Ontario. They are treated as case studies and thus findings are snapshots based solely on descriptions of survey answers.

General descriptions of responses are set forth below. The survey questionnaire is listed in Appendix A.

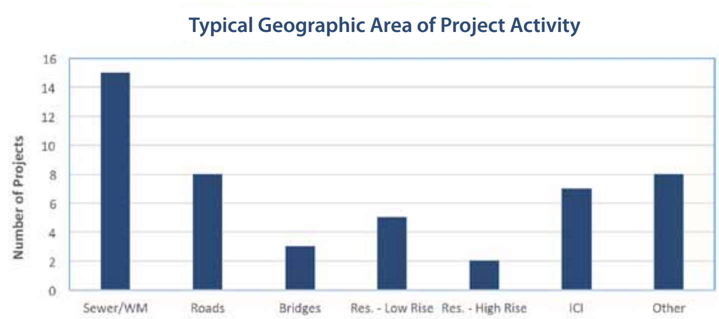
Question 1: Type of Company/Organization – (choose the best fit)

At 50%, most submissions were from earthworks contractors, followed closely by consultants at 33%.

Question 2: Typical Projects – (answer all that apply)

Most respondents worked on sewer/watermain projects at 30%, followed by roads, 'other', and ICI (Industrial, Commercial and Institutional note that Res. is Residential).

FIGURE 1



Note that respondents were not limited to one answer and could list all types of projects they work on.

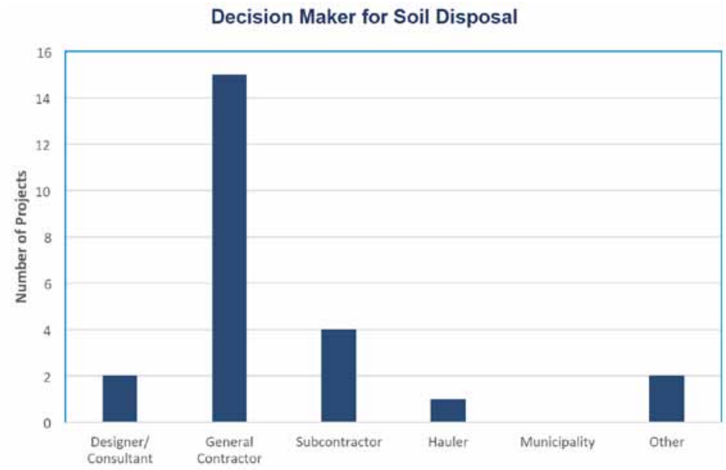
Question 3: Typical Geographic Area of Project Activity

All except one respondent worked in the GTHA with five also working in the east and four in both the southwest and north.

Question 4: Who makes the environment/business project decision on the location for final disposition of excess soil?

Fully 80% of respondents indicated the general contractor or subcontractor made this decision (note: general contractors often select receiving sites with input from the consultant).

FIGURE 2

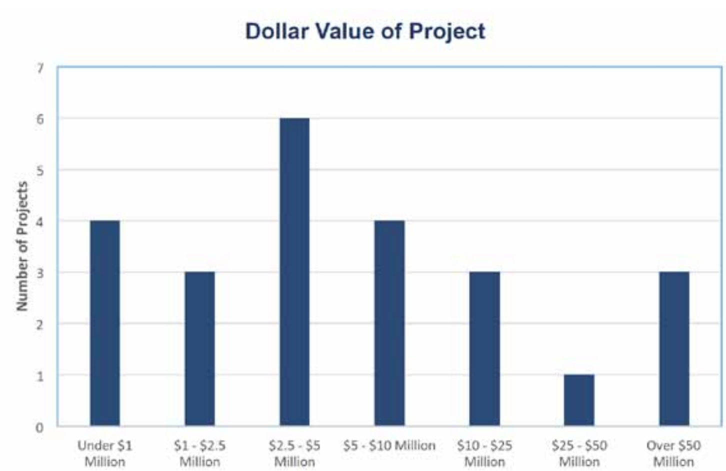


The following questions are about specific projects since August 2014. Respondents were asked to report on their most recent project in the past year.

Question 5: What was the approximate dollar value of the project?

There was a range of answers to this question with most projects valued at between \$2.5 and \$5 million. Answers are useful as they are cross-referenced with other answers to demonstrate if the value of the project is associated with other soil management variables. To estimate the total value of all projects, midpoints of value ranges are used (i.e. \$7.5 million is the midpoint of the \$5 million to \$10 million range) along with \$750,000 for projects less than \$1 million and \$60 million for projects over \$50 million. Using this method, the total overall value of all 24 projects is estimated at \$330,750,000.

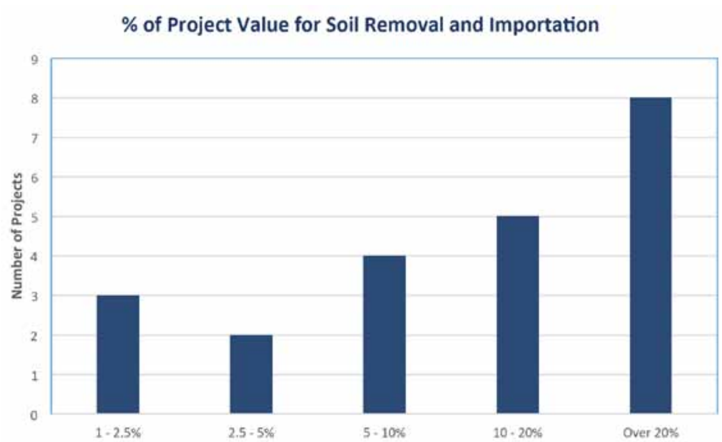
FIGURE 3



Question 6: What percentage of the project value was represented by the cost of soil removal and soil importation?

A trend emerges from this snapshot indicating soil transport represents a relatively significant proportion of the costs of a project. At almost 60%, most projects incurred costs of over 10% of total project value for soil removal, with over one third of projects requiring more than 20% of project costs for the handling and disposal of soil.

FIGURE 4



When cross-referenced with the total value of the project, the eight projects in which more than 20% of the total cost went towards soil removal and importation were from projects valued up to $10 million. Four of those projects were valued at under $1 million, one at between $1 and $2.5 million, two at between $2.5 and $5 million and one project between $5 and $10 million. This means, for projects over $1 million, the costs of soil removal/importation would be between $200,000 and $2 million. For one of the projects valued at over $50 million, the respondent indicated soil removal/importation costs represented 2.5-5% of the project value. This means if the project was valued at $50 million and spent 5% of soil transport costs, the cost would be $2.5 million (note that likely costs involved in these cases include disposal costs at landfill as well as transport).

Using midpoint values for ranges of per cent soil costs and project values as outlined in Question 5, it is estimated that removal and importation of soil represents 14% of total project value. Using the estimated total value of all 24 projects, this means that more than $46 million was incurred to remove and import soil for the 24 projects.

The following questions are about soil disposal.

Question 7: What was the distance travelled (1 way) for soil disposal?

Almost all projects, at 92% (22 out of 24), involved one-way travel of between 10 and 100 kilometres to dispose of soil with slightly more projects in the 10-50 kilometre range. Using midpoints in each distance range as the average (i.e. 30 kilometres is the midpoint between the range of 10-50 kilometres) the average project travel distance for all projects is just over 60 kilometres one way.

Question 8: What was the typical round trip travel time related to this function?

All respondents reported that return travel time was between one and six hours. This response correlates well with distances noted in Question 7.

Question 9: How many trips were required to complete disposal work in a dual-axle vehicle? (Skip if dual-axle wasn't used).

Most of the projects, at 67% (8 out of 12) using dual-axle vehicles for soil disposal made more than 100 trips for this function. Of those, half (4 out of 8) travelled between 50 and 100 kilometres one way to dispose soil. At over 100 trips, this means distances of at least 5,000 kilometres and potentially 10,000 kilometres. For one project, this equates to more than 100 one way trips at 200+ kilometres. This means that at least 20,000 kilometres were travelled using a dual-axle vehicle to dispose of soil.

Question 10: How many trips were required to complete disposal work in a tri-axle vehicle? (Skip if tri-axle wasn't used).

At 80% (17 out of 21), even more projects used tri-axle trucks making 100 or more trips to dispose of soil. Of those, 16 projects necessitated driving between 10 and 100 kilometres one way. This represents between 1,000 and 10,000 kilometres travelled. For one project, the distance to transport excess soil was between 100 and 200 kilometres, meaning between 10,000 and 20,000 kilometres were travelled.

Question 11: How many trips were required to complete disposal work with a truck and trailer? (Skip if a truck-trailer combination wasn't used).

Most projects, at 75% (six out of eight), utilizing a truck and trailer for soil disposal made more than 100 trips for this function. All six projects required travel between 10 and 100 kilometres, with travel from four projects measuring between 50 and 100 kilometres to dispose of soil. Given the size of the loaded trailers, the 1,000 to 10,000 kilometres driven for these six projects represents significant travel costs and GHG emission impacts.

Questions 9 – 11: Total Distances and CO_2 Emissions.

For each of the 24 projects, the number of trips were categorized by vehicle type and then cross referenced with the range of distance travelled to dispose of soil. Midpoints between number of trips and range of distance were used to determine estimated total distance travelled by all 24 projects. For example, three projects used a dual axle vehicle and required between one and 10 trips to dispose of soil, travelling between 10 and 50 kilometres. Thus, the midpoint of trips required is 5.5 ((1+10)/2) and the midpoint of distance travelled is 30 ((10+50)/2). The total estimated distance travelled is thus 495 kilometres (3 projects*5.5 trips*30 kilometres).

Using these estimates, the total for all 24 projects required over 200,000 kilometres of truck travel to dispose of soil. To put this into perspective, the Trans Canada Highway is 7,821 kilometres long, meaning truck traffic from these 24 projects would have travelled the highway an equivalent of more than 25 times. Return travel distances were not recorded, although it is appropriate to speculate upwards of 400,000 kilometres could have been driven to and from the project site to dispose of soil.

For estimation of total amounts of CO_2 emissions generated from trips required to dispose of excess soil, two regulations were consulted:

- Government of Canada: Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations (SOR/2013-24)
- Government of Ontario: O. Reg. 413/05 Vehicle weights and dimensions — for safe, productive and infrastructure-friendly vehicles

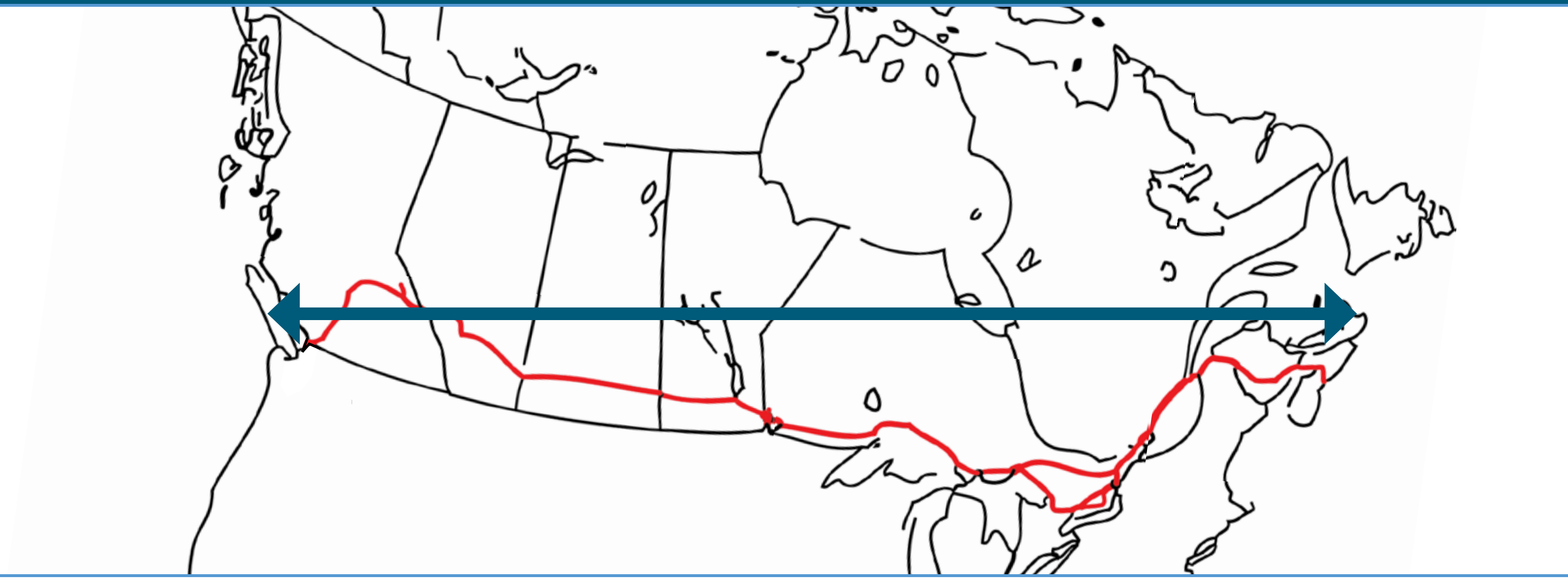
Based on United States Environmental Protection Agency (U.S. EPA) standards, SOR/2013-24 provides formulas to calculate CO_2 emission targets. For this report, 2014 emission targets were used. O. Reg. 413/05 provides specifications for different types of vehicles to determine gross vehicle weight rating that is specified as the maximum design loaded weight of a vehicle.

Formulas from SOR/2013-24 were used to determine standard CO_2 emission targets on typical dual axle, tri axle and trailer vehicles, maximum load weights of which were determined from O. Reg. 413/05. Standards used are for model year 2014 trucks as it is assumed most trucks were older than this. Final figures therefore reflect the amount of emissions that should be the target for model year 2014 vehicles, not necessarily what was actually emitted as earlier model years would most likely emit more CO_2 than those from 2014. Calculations were factored into trips made by truck traffic from the 24 projects to dispose of soil, based on vehicle type and distance travelled.

The outcome of calculations produced an estimated target figure of over 340,000 kilograms, or 340 tonnes, of CO_2 being emitted by truck traffic from the 24 projects travelling one-way to dispose of excess soil. As this number is a target, it is likely that more than 340 tonnes were actually emitted.

Please note that it is recognized that GHG calculations are a new/developing area and CO_2 calculations are not an exact science. Every effort has been made in this report to reproduce factual base calculations based on assumptions of vehicle type, distance travelled, etc. The authors would appreciate any constructive, science-based feedback on the accuracy and methodology used in our calculations of CO_2 emissions.

Soil disposal from 24 projects travelled the equivalent of more than 25 times the distance of the trans-Canada highway while emitting more than 300 Tonnes of CO_2!



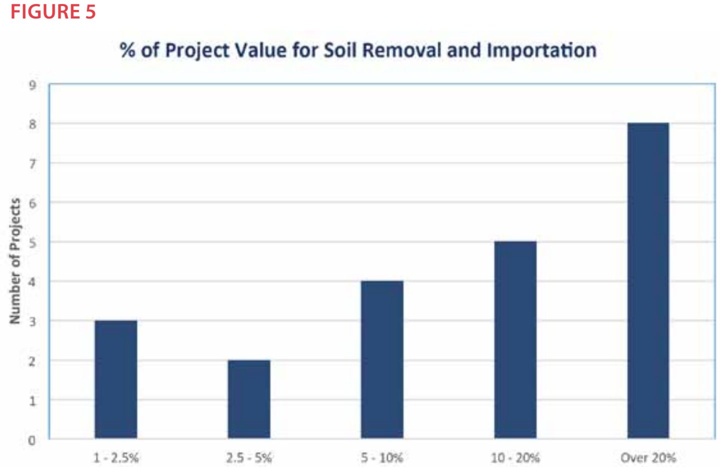
Question 12: What percentage of this material was considered to have unsuitable engineering characteristics for re-use on site (e.g. compatibility, moisture content, deleterious materials, etc.)?

We elected not to analyze the answers to this question as our review of the wording determined it was ambiguous. We were not able to determine from the responses whether respondents may have included contaminated soil as part of this answer. This was not the intent of this question.

Question 13: How much of the disposed soil was taken to a licensed waste disposal site?

While relatively evenly divided, more projects resulted in transporting over 50% of excavated soil to landfill.

FIGURE 5



Given that licensed waste disposal sites are landfills, this indicates that over half of the projects (13 out of 24) managed soil as a waste material, rather than as a resource (those with over 25% of the soil taken to landfill). Conversely, just over 45% (11 out of 24) of the projects appeared to treat soil as a resource (those with less than 25% of soil disposed of in this manner).

The value of projects was not a factor in the percentage of soil taken or not taken to landfill. However, eight of the projects reporting over 50% of soil disposed of at landfills represent the highest proportion of project costs in terms of percentage of the value of project (10% to over 20% of total project cost for soil disposal).

Significantly, of the 12 projects reporting over 50% of disposed soil to landfill, over 100 trips were reported using dual axle vehicles in five of these projects, over 100 trips were reported using tri- axle vehicles in seven of these projects, and for one project, more than 100 trips were made using trailer loads for soil disposal. This represents a large volume of soil being transported for disposal as a waste and lost as a resource. Of the 13 times that over 100 trips were required, one project identified travel distances greater than 200 kilometres in a dual-axle vehicle to the disposal site, two identified travel distances between 50 and 100 kilometres in a tri-axle vehicle as well as the project that reported more than 100 trips using truck and trailer transport. This means that a large volume of soil was transported between 5,000 and 20,000 kilometres to be disposed of as a waste material rather than a resource.

It is insightful to look more closely, as a case study, at the one project that utilized a truck and trailer transport method, and required over 100 trips to transport excess soil for disposal. This particular project was linear and over one kilometre in length and reported that both dual-axle vehicles and truck/trailers were used for 100+ trips to dispose of soil between 50 and 100 kilometres away. The project was valued at over $50 million with soil disposal representing 2.5 to 5% of total project value. In terms of costs, using 2.5% as representing soil disposal costs, a minimum of $1.25 million was spent on taking soil to landfill. Furthermore, over 50% of the soil was disposed of in landfill and less that 10% in either a recycling facility or like-quality soil facility. This means that at least 90% of the 200+ trips taken in both dual-axle truck/trailers were to a landfill(s).

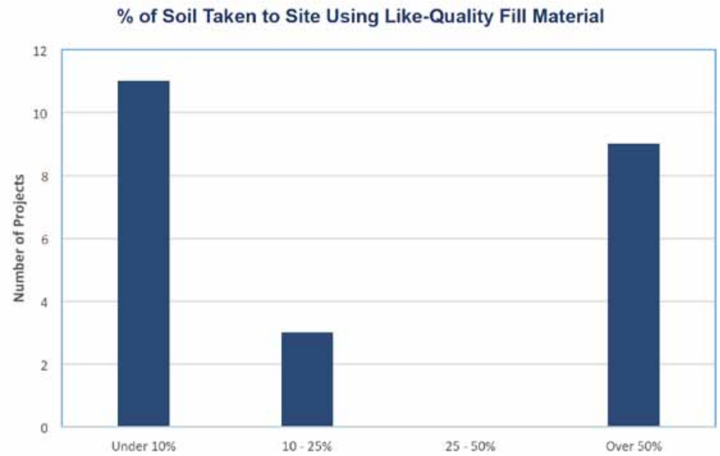
Question 14: How much of the disposed soil was taken to a recycling facility?

Most responses (17 out of 19) reported that under 10% of disposed soil was taken to a recycling facility. However, one project transported between 25-50% of soil and one project took over 50% of soil to a recycling facility. The project recycling 50% of soil was a linear project over one kilometre in length and the value of the project was over $50 million, yet soil disposal only represented 1-2.5% of the total project value. While worthy that this project recycled soil, the same project also reported taking the other 50% of disposed soil to landfill.

Question 15: How much of the disposed soil was taken to another site looking for like-quality fill material?

This outcome represents a beneficial reuse of soil and indicates that the Guide was followed. More than one third of projects (nine out of 23) managed excess soil in this manner. However, almost 50% of respondents reported under 10% of soil was taken to this type of site, with the remainder of respondents (three) identifying that 10 to 25% of excess soil was transported for beneficial reuse.

FIGURE 6



Of the more than one third of projects that managed soil in this beneficial manner, three projects reported transport using dual-axle vehicles, eight projects used tri-axle vehicles and three projects used truck and trailer combinations. All but one of these required 100 or more trips and all were between 10 and 100 kilometres of one way travel. While part of a beneficial soil management practice, this nonetheless means that between 1,000 and 10,000 kilometres one way were driven to manage excess soils.

The following questions are about imported soil materials.

Question 16: What was the travel distance (1 way) for imported soil?

There were no projects where travel distance was less than 10 kilometres, and 55% (10 out of 18) were between 10 and 50 kilometres. Almost 40% (seven out of 18) identified travel distances between 50 and 100 kilometres, and one over 100 kilometres.

Question 17: What was the typical round trip travel time (including traffic) related to these functions?

Results again are similar to those referring to soil disposal and consistent with the responses to the preceding question, with over 70% needing between one and three hours of round trip travel time, and 20% reporting three to six hours (one project was under one hour).

Question 18: What was the travel distance (1 way) for granular fill?

Again, most projects identified between 10 and 100 kilometres with the majority (14 of 19) traveling less than 50 kilometres.

Question 19: What was the typical round trip travel time (including traffic) related to these functions?

The majority of projects (15 of 18) were in the range of one to three hours.

Question 20: How many trips were required to complete the soil and granular fill importing?

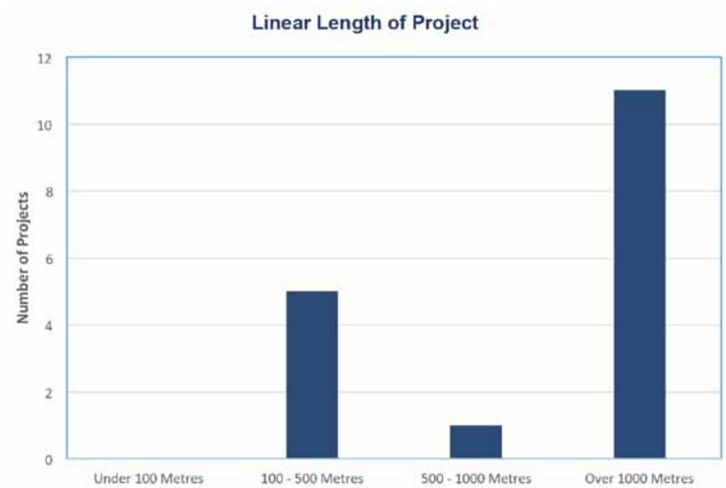
The majority of projects, at over 70% (14 of 19), required over 100 trips. All projects required between 10 and 100+ kilometres, meaning total mileage ranged from 1,000 to 10,000+ kilometres of travel for each of the 19 projects reporting. Because the 19 projects reported number of trips for combined importing of soil and granular, further breakdown of distance travelled for each event of soil and granular importation cannot be calculated.

A majority of the 14 projects (nine or 62%) that required over 100 trips to import soil/granular indicated that if soil could have been re-used, they would have achieved at least a 10% savings for both disposal and importation of soil in terms of overall project value. When cross-referenced to the 14 projects reported overall value, that would translate to a savings of over $12.5 million.

The following questions are about the project in general.

Question 21: If your project represents linear infrastructure (roads/sewers/water) what is the total linear length of the project?

FIGURE 7



Of 17 linear projects, 65% (11 of 17) were over one kilometre in linear length. Of those, 45% (5 of 11) had more than half of the project's excess soil taken to landfill for disposal and thus treated as a waste and not a resource. The 11 projects necessitated over 100 trips to dispose of soil on 17 different occasions using a variety of vehicle types. Each trip required between 10 and 100 kilometres of travel, representing between 1,000 and 10,000+ kilometres of driving to waste disposal (landfill) sites. These are summarized in more detail:

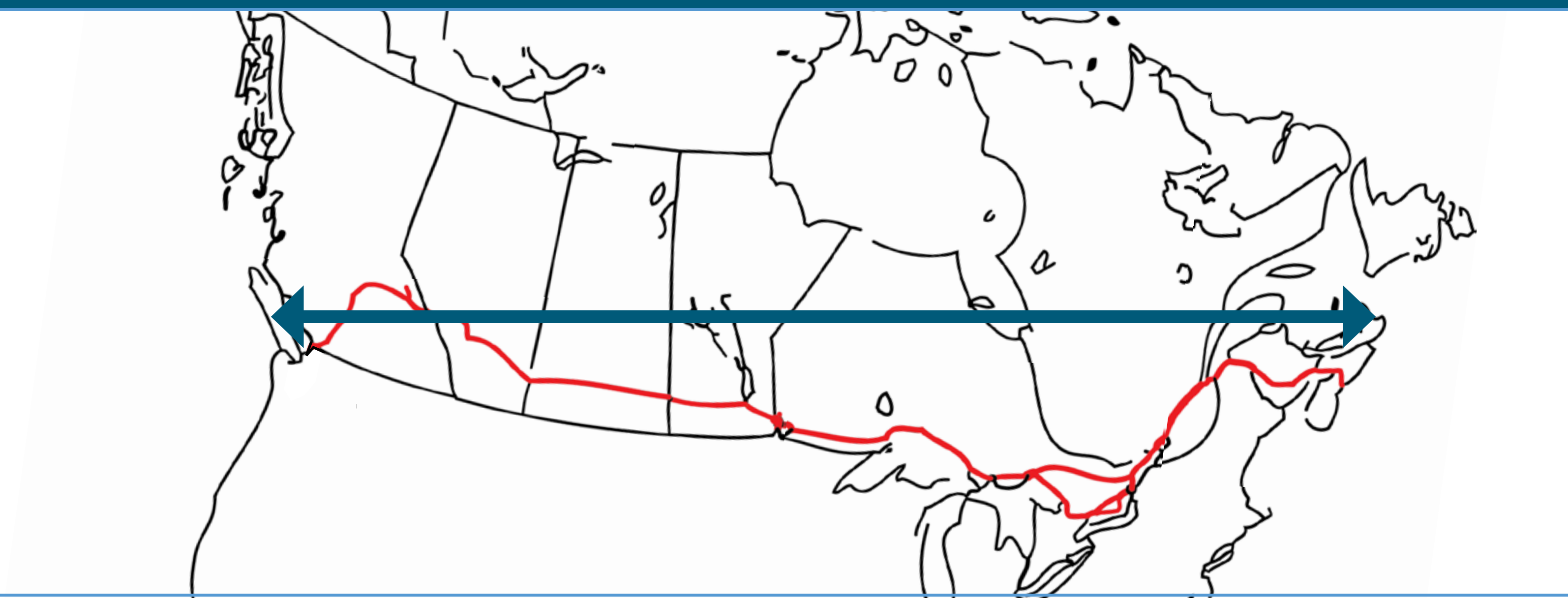
- Dual Axle Trips: four projects reported average travel of 75 km one way for soil disposal
- Tri Axle Trips: four projects reported average travel of 25 km, four an average of 75 km and one travelled 150 km one way
- Truck & Trailer Trips: four projects reported average travel of 75 km

Using the above metrics, it is estimated that more than 300 tonnes of excess soil was transported 115,000 kilometres to be disposed of, primarily in landfill, for those linear projects over one kilometre in length and requiring more than 100 trips to dispose of soil.

Soil for the GTA area is assumed to consist of clay and have an average weight of 2,000 kg/m³

- Dual: Volume = 7 m^3; Total Weight Soil Only Tonnes/ Vehicle = 14
- Tri: Volume = 9 m^3 ; Total Weight Soil Only Tonnes/ Vehicle = 18
- Trailer: Volume = 15 m^3 ; Total Weight Soil Only Tonnes/ Vehicle = 30

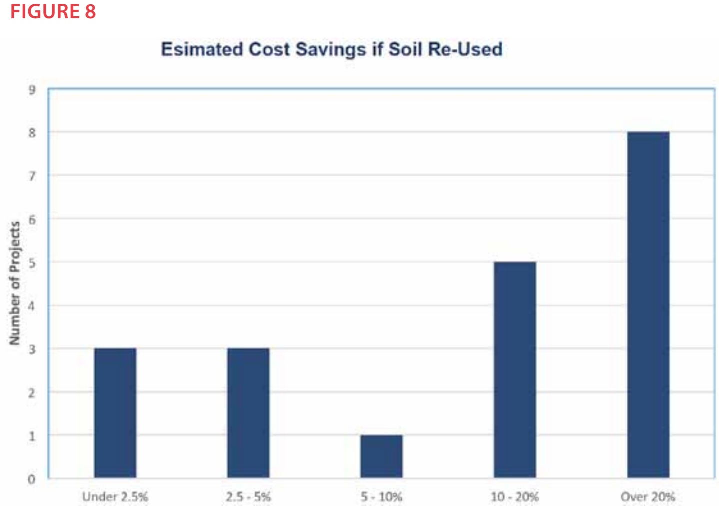
11 linear projects over one kilometre in length and requiring more than 100 trips to dispose of soil resulted in the transport of more than 300 tonnes of excess soil over 15 times the length of the trans Canada highway – 115,000 Km



Question 22: What would be the estimated cost savings have been to the project if all soils (with suitable engineering qualities) could have been re-used on the project (no off-site disposal required and complementary granular importation)?

Answers to this question demonstrate a significant cost savings could be achieved by reusing excess soil on-site.

FIGURE 8



Looking at the 20 respondents answering Question 22, estimates of cost savings if soil could have been re-used can be derived by taking the average values of the projects multiplied by the average of the range of percentage savings (i.e. 15% was used for the 10% - 20% range). For projects valued at less than $1 million, $750,000 was used, and those valued at greater than $50 million, a value of $60 million was used. Where respondents identified "over 20%" savings, a savings of 25% was used. (Note that even if re-used, there are costs involved. It is hoped that there are environmental benefits associated with those costs.)

Based on these assumptions, the average savings was reported as 13% for each of the 20 projects if excavated soil had been reused. When cross-referenced with total value of all 24 projects, an average of almost $1.8 million per project was reported. Applying a cost savings of 13% to the total value of all projects, if soil could be re-used as a resource it could have saved as much as $43 million across all 24 projects.

The following questions are about the use of the soil BMP document, ***Management of Excess Soil – A Guide for Best Management Practices.***

Question 23: Was a soil management plan as recommended by the Guide prepared for the project?

About one third of respondents reported, yes, a plan was prepared. Out of the respondents using a plan, five out of seven sent less than 10% of excess soil to landfill – a positive sign that soil was not wasted in these projects. One of these projects took over 50% of soil to a recycling facility, and three of the projects took over 50% of soil to a like-quality facility.

Question 24: If so, what additional project costs were incurred on account of this plan?

Six of the seven projects that used a plan reported on costs incurred with having the plan. Four reported over $10,000 in costs with one each for between $1,000-$5,000 and $5,000-$10,000, respectively.

Question 25: If you implemented a BMP approach and if there was a cost savings, what was the percentage cost savings?

Four of ten projects that said they used the Guide and reported percentage cost savings at less than 2.5%, with two reporting 2.5-5%. Of note, two of the projects stating a cost savings of less than 2.5% were valued at more than $50 million, thus representing more than $1.2 million in savings. One project using the Guide and saving between 2.5-5% is valued at more than $50 million, thus saving between $1.25 and $2,5 million or more. Two projects reported savings of between 10% and 20%, one of which was valued between $5 and $10 million, thus potentially saving up to $2 million. A further two projects reported savings over 20% although neither was valued at more than $5 million, meaning a maximum savings of $1 million.

Overall, projects that reported using the Guide experienced an average saving of 9% in costs. For the 10 projects reporting using the Guide, the overall average cost savings was almost $700,000. If all 24 projects used the Guide and could achieve 9% in cost savings, almost $30 million could have been saved.

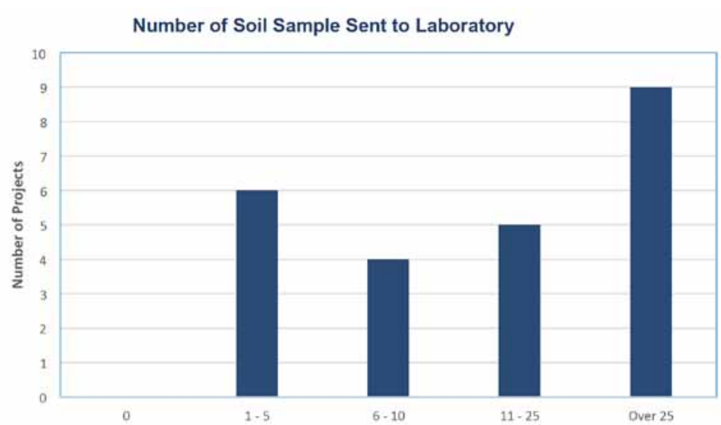
Question 26: Was a soil management plan requested by any receiving site before accepting soil materials from the project?

There was almost an even split to this question with 10 respondents reporting yes and 12 no. Of the 10 affirmative responses, only three projects took more than 50% of disposed soil to landfill and six projects took less than 10% of soil to landfill, indicating a management plan may have encouraged less waste. Furthermore, four of the 10 projects took more than 50% of excess soil to a like-quality site. This is in contrast to the 12 projects reporting a management plan was not requested whereby seven of the 12 projects reported taking more than 50% of excess soil to landfill.

Question 27: How many soil samples were collected for submittal to an analytical testing laboratory to determine the chemical characteristics of the soil?

A majority of respondents reported that more than 25 soil samples were collected with numbers evenly split between each category.

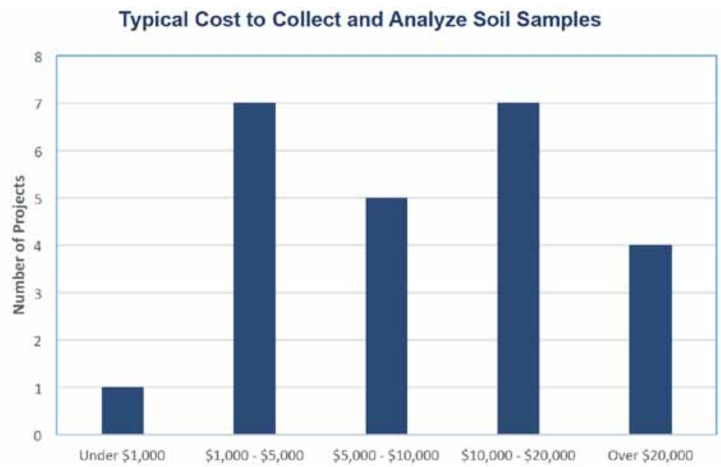
FIGURE 9



Question 28: What was the cost (or typically the cost) of sample collection and analysis for a project of this size?

Sample collection costs are relatively expensive according to respondents.

FIGURE 10



Of the four respondents reporting more than $20,000 in costs, three were from projects valued at over $50 million.

Question 29: Was this sampling conducted as part of a Phase 2 ESA?

Seven, or 30%, of the respondents reported sampling as part of a Phase 2 ESA. Of those seven, five reported transporting more than 50% of excess soil to landfill. Two of the seven took more than 50% of soil to like-quality sites.

Question 30: Was this sampling conducted as part of a Soil Management Plan?

Respondents were relatively split on this with 10 (43%) reporting yes and 13 (57%) reporting no regarding whether the sampling was conducted as part of a Soil Management Plan.

Question 31: Was this sampling conducted as part of another purpose? If so, please specify.

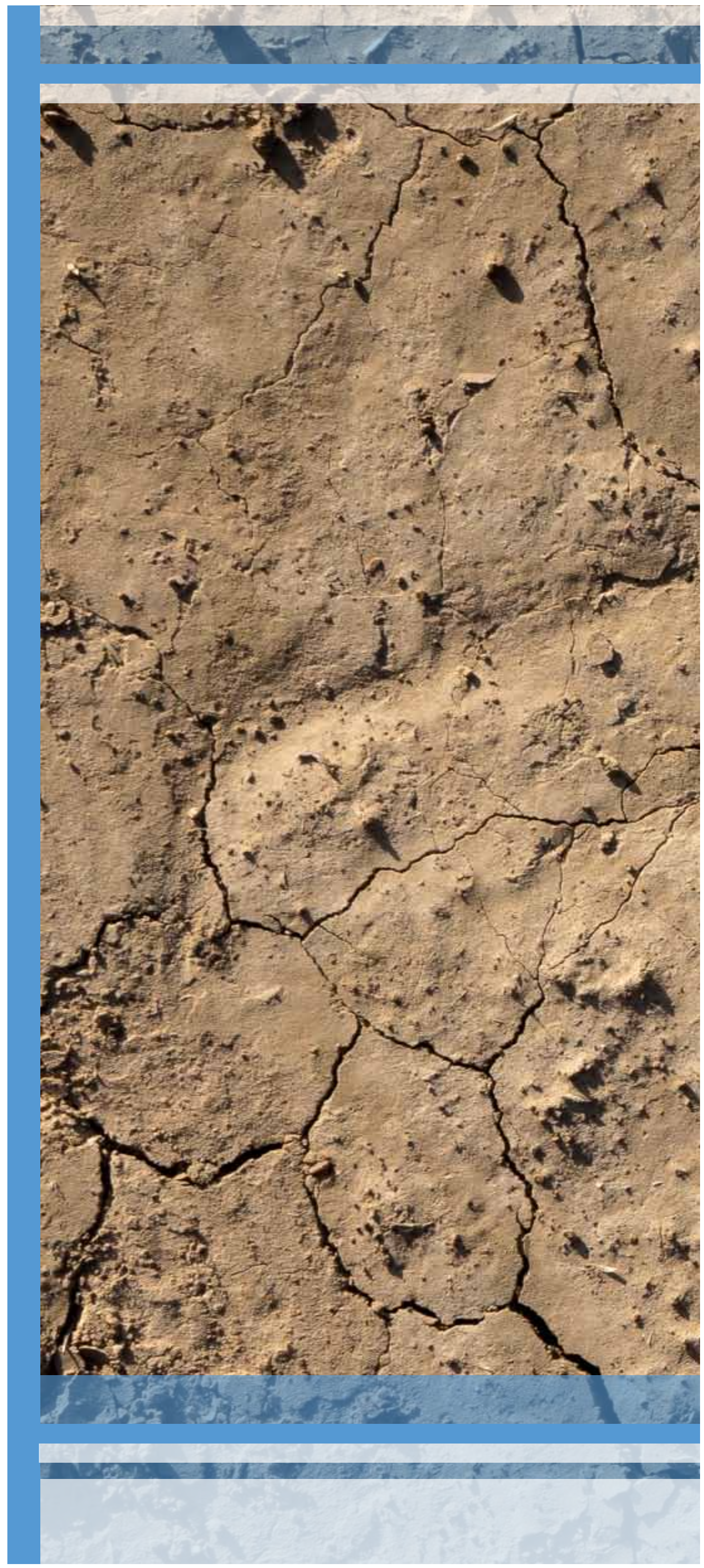
Most responses indicated that sampling was conducted to determine options for receiving sites capable of accepting excess soil (soil disposal options).

Question 32: Who carried the cost for this?

Most respondents, at 70%, indicated the owner/client carried the costs, with 25% specifying the earthworks contractor and one reporting a third party.

Question 33: Are there any additional considerations we should take into account?

Respondents provided fulsome and detailed observations. To maintain confidentiality, they are not listed here, but are incorporated in further discussion in other sections of this report. Overall comments reflect an understanding of the Guide directions and their benefits.



SUMMARY AND RECOMMENDATIONS

While acknowledging that the data generated from the survey results would be more robust if the sample size was larger, information from these 24 projects, when treated as case studies, nonetheless provides valid current examples of the management of excess soil in Ontario. The descriptions provided from analyzing survey results demonstrate that huge amounts of soil are being disposed of as waste and over great cumulative distances while emitting significant amounts of GHGs.

Key highlights of the analysis include the following:

- Surveyed projects in Ontario ranged from less than $1 million to more than $50 million and were cumulatively valued at more than $330 million
- On average, handling and disposal of excess soil represents 14% of total project value; for all 24 projects, this represents costs of $46 million
- Over 75% of projects resulted in more than 100 one-way trips averaging almost 65 kilometres to dispose of excess soil
- Combined one-way travel distances to dispose of soil totalled more than 200,000 km – more than 25 times the length of the Trans-Canada highway
- Importing virgin soil and/or granular materials resulted in an additional 115,000 km of haulage
- Using target emission rate calculations from Environment Canada and based on U.S. EPA, all 24 projects are estimated to have released more than 300 tonnes of CO_2 into the environment
- Average savings would be 13% (or almost $1.8 million) for each project if excavated soil had been reused; for all 24 projects, this would generate a savings of almost $43 million
- Projects that reported using the Guide experienced an average of 9% in cost savings; for all 24 projects this would represent a total of almost $30 million in savings

Based both on survey results and expertise of the practitioners from the consortium organizations that conducted the survey, five major recommendations are derived from this study.

1. **Excess soil generated from projects in Ontario should be treated as a resource, not a waste.**

   While perhaps apparent, a mindset seems to exist among people managing soil that it is easier (and less risky) to dispose of soil as a waste rather than institute mechanisms to reuse or recycle it. This is reflected in the 24 case studies which indicate more than 50% of soil is disposed of in landfill in a majority of projects.

   One way to ensure more soil is treated as a resource is to put more onus on the source site or property owners (including municipalities), meaning there should be more front end soil reuse planning by developers. The proposed Excess Soil Management Policy Framework (the Framework) by the Ontario government indeed reflects this.

2. **Reducing the transport of soil that can be re-used or recycled makes economic and environmental sense.**

   The 24 projects clearly show that decreasing the amount of soil that is disposed of translates to lower expenses and fewer GHG emissions. Even with a small sample size, the fact that most projects required over 100 trips to dispose of soil is staggering. The metric demonstrating that the Trans-Canada highway was driven more than the equivalent of 25 times to dispose of soil by just these few projects indicates that any decrease in the distance or amount of transport needed could achieve cost savings and environmental benefits.

   One mechanism to save on costs as well as to incent adoption of the Guide is to employ soil banking, whereby soil is stored and then beneficially re-used at a later date. In a Golder Associates report submitted to the Region of Waterloo, the City of Guelph saved approximately $900,000 by stockpiling soil for a period of three years before using it in the construction of an expressway interchange (Golder 2013).

3. **A model by-law should be created to promote the use of the Guide on infrastructure projects.**

   An effective way to institute the Guide for excess soil management is for municipalities to adopt a consistent set of by-laws to assist in the management of excess soil. The Framework acknowledges this and recognizes that municipal site alteration by-laws could benefit from additional guidance to promote better oversight. Municipalities need to widely adopt model by-laws from other jurisdictions. Ontario needs to guide and ensure that by-laws are consistent throughout the province as well as being transparent and enforceable. A useful excess soil by-law tool was released in September 2016 and can be accessed at http://www.excesssoil.com/.

   Municipalities will need incentives to promote the use of the Guide if regulations governing them are not mandatory. One incentive is cost savings that can be achieved by instituting the Guide for excess soil management. As the survey indicates, a 9% savings could be attained in the 24 projects surveyed which translated to almost $30 million in savings. For a municipality, 9% savings is significant.

4. **Industry should collect data to highlight opportunities for both government and businesses to prioritize the handling of excess soil.**

   Better tracking and record keeping is necessary to properly manage excess soil. Indeed, in reality there is no centralized repository of soil movement and disposal, let alone quantitative data on volume, disposal, destination and other characteristics of excess soil movement.

   An efficient way that municipalities and industry can work together to monitor soil management practices and achieve greater soil re-use or recycling is to establish a virtual soil banking system. This system would integrate information at a relatively low cost through a GIS-linked database. As stated in the Golder report mentioned above:

   > In the event that consistent or frequent requirements for storage or treatment are identified through the operation of a virtual banking system, this information could form the basis for establishing and locating fixed facilities. In such a scenario, it is anticipated that the electronic tracking infrastructure that would be developed through a virtual banking system could be scaled to allow for tracking of soil from the point of origin, through the treatment or storage facility, and to the final site of placement, meeting one of the key principles and best practices of sustainable soil management (Golder 2013:72).

5. **Responsibility and onus should be placed on the QP. QP regulators need to be involved in ensuring QPs have the proper qualifications.**

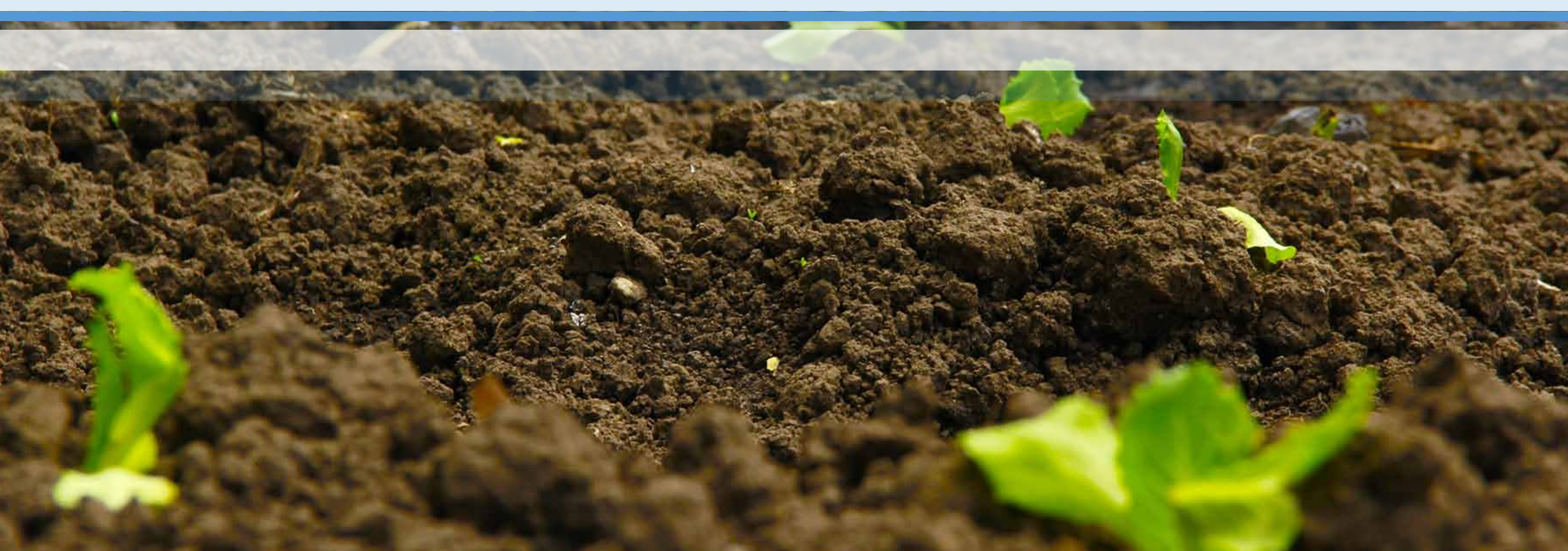
OSPE, as one of the three survey partners, represents individual QPs (while Professional Engineers Ontario (PEO) and Association of Professional Geoscientists of Ontario (APGO) regulate them). As such, OSPE is well placed to provide insight and quality assurance in terms of establishing and defining the competencies of QPs. The Framework must ensure that QPs are indeed qualified and guided by key points:

- Work must be undertaken by qualified and licensed individuals.
- Licensing bodies should be held accountable for their respective members being fully qualified to conduct this work, and develop transparent methods for demonstrating these qualifications to the public.
- Government and the public should be able to rely on this work being completed competently.

In summary, key government and industry players are already well aware of the troubling amounts of excess soil that is being wasted in Ontario. As well, these individuals realize there are cost savings and environmental benefits when the Guide is used. The survey analysis in this report provides evidence using current examples and actual metrics associated with excess soil removal to support these observations.

Looking forward, the implementation of the Guide requires more than encouragement and incentives to be successful. The province should take action to establish a regulatory framework to protect soil as a natural resource; a decision that will benefit both the economy and the environment. To encourage this outcome, OSPE, RCCAO, and GTSWCA will distribute these key messages (supported by the survey findings) to as broad an audience as possible, and continue to work with all levels of government to increase the awareness and understanding of proper excess soil management.

Lastly, with reference to the reported 9% savings if the Guide was used by the 24 projects surveyed, consider that 9% of Ontario's $160 billion in infrastructure investment commitments over 12 years equates to over $14 billion. Savings from using the Guide could be redirected towards other government and social priorities.



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APPENDIX A: SURVEY QUESTIONNAIRE

Question 1: Type of Company/Organization – (choose the best fit)

Earthworks Contracting	12	50%
Design Engineer or Geotechncial Engineer	1	4%
Consulting Engineer	8	33%
Project Management or Contract Admin	1	4%
Trucking Company	0	0%
Upper/Lower Tier Municipality	0	0%
Other	2	8%
	24	**100%**

Question 2: Typical Projects – (answer all that apply)

Sewer/water main	15	31%
Road work	8	17%
Bridge work	3	6%
Residential - low rise	5	10%
Residential - high rise	2	4%
ICI	7	15%
Other	8	17%
	48	**100%**

Question 3: Typical Geographic Area of Project Activity

GTA/GTHA	23	62%
Southwest	4	11%
East	5	14%
North	4	11%
Other	1	3%
	37	**100%**

Question 4: Who makes the environment/business project decision on the location for final disposition of excess soil?

Designer/Consulting Engineer	2	8%
General Contractor	15	63%
Subcontractor	4	17%
Hauler	1	4%
Municipality	0	0%
Other	2	8%
	24	**100%**

Question 5: What was the approximate dollar value of the project?

Under $1 Million	4	17%
$1 - $2.5 Million	3	13%
$2.5 - $5 Million	6	25%
$5 - $10 Million	4	17%
$10 - $25 Million	3	13%
$25 - $50 Million	1	4%
Over $50 Million	3	13%
	24	**100%**

Question 6: What percentage of the project value was represented by the cost of soil removal and soil importation?

1 - 2.5%	3	14%
2.5 - 5%	2	9%
5 - 10%	4	18%
10 - 20%	5	23%
Over 20%	8	36%
	22	**100%**

Question 7: What was the distance travelled (1 way) for soil disposal?

1 - 10 Kms	0	0%
10 - 50 Kms	13	54%
50 - 100 Kms	9	38%
100 - 200 Kms	1	4%
Over 200 Kms	1	4%
	24	**100%**

Question 8: What was the typical round trip travel time related to this function?

1 - 3 Hrs	16	67%
3 - 6 Hrs	8	33%
6 - 8 Hrs	0	0%
8 - 10 Hrs	0	0%
Over 10 Hrs	0	0%
	24	**100%**

Question 9: How many trips were required to complete disposal work in a dual-axle vehicle? (Skip if dual-axle wasn't used).

1 - 10	3	25%
10 - 25	0	0%
25 - 50	0	0%
50 - 75	1	8%
75 - 100	0	0%
100+	8	67%
	12	**100%**

Question 10: How many trips were required to complete disposal work in a tri-axle vehicle? (Skip if tri-axle wasn't used).

1 - 10	1	5%
10 - 25	1	5%
25 - 50	1	5%
50 - 75	1	5%
75 - 100	0	0%
100+	17	81%
	21	**100%**

Question 11: How many trips were required to complete disposal work with a truck and trailer? (Skip if a truck-trailer combination wasn't used).

1 - 10	0	0%
10 - 25	2	25%
25 - 50	0	0%
50 - 75	0	0%
75 - 100	0	0%
100+	6	75%
	8	**100%**

Question 12: What percentage of this material was considered to have unsuitable engineering characteristics for re-use on site (e.g. compatibility, moisture content, deleterious materials, etc.)?

Under 10%	5	21%
10 - 25%	3	13%
25 - 50%	8	33%
Over 50%	8	33%
	24	**100%**

Question 13: How much of the disposed soil was taken to a licensed waste disposal site?

Under 10%	10	42%
10 - 25%	1	4%
25 - 50%	1	4%
Over 50%	12	50%
	24	**100%**

Question 14: How much of the disposed soil was taken to a recycling facility?

Under 10%	17	89%
10 - 25%	0	0%
25 - 50%	1	5%
Over 50%	1	5%
	19	**100%**

Question 15: How much of the disposed soil was taken to another site looking for like-quality fill material?

Under 10%	11	48%
10 - 25%	3	13%
25 - 50%	0	0%
Over 50%	9	39%
	23	**100%**

Question 16: What was the travel distance (1 way) for imported soil?

Under 10 Kms	0	0%
10 - 50 Kms	10	56%
50 - 100 Kms	7	39%
Over 100 Kms	1	6%
	18	**100%**

Question 17: What was the typical round trip travel time (including traffic) related to these functions?

Under 1 Hr	1	5%
1 - 3 Hrs	14	74%
3 - 6 Hrs	4	21%
6 - 8 Hrs	0	0%
Over 8 Hrs	0	0%
	19	**100%**

Question 18: What was the travel distance (1 way) for granular fill?

Under 10 Kms	1	5%
10 - 50 Kms	13	68%
50 - 100 Kms	4	21%
Over 100 Kms	1	5%
	19	**100%**

Question 19: What was the typical round trip travel time (including traffic) related to these functions?

Under 1 Hr	0	0%
1 - 3 Hrs	15	83%
3 - 6 Hrs	3	17%
6 - 8 Hrs	0	0%
Over 8 Hrs	0	0%
	18	**100%**

Question 20: How many trips were required to complete the soil and granular fill importing?

1 - 10	0	0%
10 - 25	3	16%
25 - 50	1	5%
50 - 75	0	0%
75 - 100	1	5%
100+	14	74%
	19	**100%**

Question 21: If your project represents linear infrastructure (roads/sewers/water) what is the total linear length of the project?

Under 100 Metres	0	0%
100 - 500 Metres	5	29%
500 - 1000 Metres	1	6%
Over 1000 Metres	11	65%
	17	**100%**

Question 22: What would be the estimated cost savings have been to the project if all soils (with suitable engineering qualities) could have been re-used on the project (no off-site disposal required and complementary granular importation)?

Under 2.5%	3	15%
2.5 - 5%	3	15%
5 - 10%	1	5%
10 - 20%	5	25%
Over 20%	8	40%
	20	**100%**

Question 23: Was a soil management plan as recommended by the Guide prepared for the project?

Yes	7	29%
No	17	71%
	24	**100%**

Question 24: If so, what additional project costs were incurred on account of this plan?

Under $1,000	1	10%
$1,000 - $5,000	1	10%
$5,000 - $10,000	2	20%
Over $10,000	6	60%
	10	**100%**

Question 25: If you implemented a BMP approach and if there was a cost savings, what was the percentage cost savings?

Under 2.5%	4	40%
2.5 - 5%	2	20%
5 - 10%	0	0%
10 - 20%	2	20%
Over 20%	2	20%
	10	**100%**

Question 26: Was a soil management plan requested by any receiving site before accepting soil materials from the project?

Yes	10	45%
No	12	55%
	22	**100%**

Question 27: How many soil samples were collected for submittal to an analytical testing laboratory to determine the chemical characteristics of the soil?

0	0	0%
1 - 5	6	25%
6 - 10	4	17%
11 - 25	5	21%
Over 25	9	38%
	24	**100%**

Question 28: What was the cost (or typically the cost) of sample collection and analysis for a project of this size?

Under $1,000	1	4%
$1,000 - $5,000	7	29%
$5,000 - $10,000	5	21%
$10,000 - $20,000	7	29%
Over $20,000	4	17%
	24	**100%**

Question 29: Was this sampling conducted as part of a Phase 2 ESA?

Yes	7	29%
No	17	71%
	24	**100%**

Question 30: Was this sampling conducted as part of a Soil Management Plan?

Yes	10	42%
No	14	58%
	24	**100%**

Question 31: Was this sampling conducted as part of another purpose? If so, please specify.

Question 32: Who carried the cost for this?

Earthworks Contractor	6	25%
Owner/client	17	71%
Third Party	1	4%
	24	**100%**

Question 33: Are there any additional considerations we should take into account?

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