

Report on Hydrogeological Impacts
Caused by Aggregate Washing
at the Teedon Pit near Waverly, Ontario

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1) Background

I am a hydrogeologist, and I have worked as an environmental consultant for 27 years (2 years for a larger firm in Germany, and 25 years independently in Canada). I am a specialist in water resource and contamination issues, and have dealt with many such issues over the course of my consulting career including numerous aggregate-related issues. I have done high-profile work for the Ministry of the Environment and I have given testimony as an expert witness on hydrogeological issues before various boards, including the Environmental Review Tribunal, the Environmental Assessment Board, the Joint Board, the Canadian Nuclear Safety Commission, the Ontario Municipal Board and the Niagara Escarpment Commission. A copy of my Curriculum Vitae is available upon request.

I have been retained by Bonnie Pauze and Jake Pigeon to investigate and prepare a report on the hydrogeological impacts (if any) of aggregate washing and other activities at a nearby aggregate pit known as the Teedon Pit, which is owned by Cedarhurst Quarries and Crushing Limited (hereafter referred to as “Cedarhurst”). This report outlines my findings, conclusions and recommendations. In preparing this Report, I have reviewed the documents which are listed as references in **Appendix 1**.

The main focus of my report is an August 2015 document prepared for Cedarhurst entitled “Assessment of Local Well Water Quality Complaints” (hereafter referred to as the “Complaints Assessment Report”). The Complaints Assessment Report was commissioned by Cedarhurst in response to numerous complaints about the off-site impacts of aggregate washing and other activities at the Teedon Pit, and was prepared by Alpha Environmental Services Inc (AES).

2) Introduction

a) The Teedon Pit and its Aggregate Washing Operations

Cedarhurst operates a Class A (Above the Water Table) aggregate pit called the Teedon Pit on Part of Lots 79 and 80, Concession 1 WPR, Township of Tiny, County of Simcoe. The Teedon Pit is situated on an 85.39 hectare property, of which 76.89 hectares are licensed for extraction.

There is a market for washed aggregate from the Teedon Pit. Cedarhurst applied to the MOECC and in April 2008 obtained a Permit to Take Water (PTTW) allowing the company to pump up to 5.2 million liters/day of water from a specially constructed pond for aggregate washing. Aggregate washing commenced in 2009, but Cedarhurst soon found that the pond did not provide sufficient water for its aggregate washing, and subsequently applied to the MOECC for a major revision to its PTTW.

An amended PTTW was issued in July 2010. Under the terms of that amended PTTW in the event that natural processes are not adequate to fill the pond then Cedarhurst can “top up” the pond by pumping up to 1.6 million liters/day of water from a production well (PW1-09) which is situated at the east end of the property.

Aggregate washing commenced in 2009 and has continued on an intermittent basis since then. An important aspect of understanding the nature and extent of the potential off-site impacts of Cedarhurst's aggregate washing activities is getting an understanding of the volumes of water which have been pumped by Cedarhurst.

A summary of the volumes of water pumped by Cedarhurst is provided in Table 4 of the Complaints Assessment Report. Unfortunately there are significant problems with the data provided in Table 4, which include the following:

- the monthly pumping data in Table 4 are presented in 3 different sets of units (US gallons, Imperial gallons, and liters) making it very difficult to compare and understand the relative amounts being pumped;
- the daily volumes which Table 4 indicates were pumped from PW1-09 in 2010 do not add up to the annual total for PW1-09, meaning there is a mistake in the data being presented;
- Condition 4.1 of the PTTW requires water volumes pumped from the pond and PW1-09 to be metered, and Table 4 shows flows for the years 2009-2014. Table 4 is presented in the report as being based on meter readings, but Cedarhurst's representative (Mr. Campbell) has confirmed that in much of 2009 at least there were no meters in use at the pit. It is therefore unclear what the actual basis is for the volumes shown in Table 4.

The annual amounts of water pumped by Cedarhurst in each year since 2009 (based on the data from Table 4) are provided below in **Table 1** of this report.

Table 1 - Water Pumped by Cedarhurst for Aggregate Washing at the Teedon Pit

<u>Year</u>	<u>Water Pumped from Wash Pond</u>	<u>Water Pumped from PW1-09 to Pond</u>
2009	174,431,841 liters	none
2010	none	19,175,443 liters
2011	33,823,772 liters	14, 203,674 liters
2012	51,338,692 liters	34, 749,459 liters
2013	55,388,579 liters	18, 183,554 liters
2014	none	none

c) Off-site Impacts and my Clients' Concerns

There have been complaints of impacts of aggregate washing at the Teedon Pit on groundwater levels (causing flooding) and/or on groundwater quality (causing silt contamination of well water) from at least 4 households including my clients.

My clients (Bonnie Pauze and Jake Pigeon) have lived at their present location on Marshall Road about 1.4 km downgradient from the Teedon Pit since 1993. They have 2 wells on their property, which until 2009 provided excellent quality water supplies.

Since the construction of the wash pond and the commencement of aggregate washing at the Teedon Pit (in 2009), they have suffered very negative impacts to the quality of water being delivered by their 2 wells caused by high levels of suspended solids (silt) in the well water.

d) The Nature of my Retainer

I was asked by my clients to investigate and provide my professional opinion regarding the following questions:

- whether activities at the Teedon Pit (in particular the aggregate washing operations) could have affected off-site groundwater levels and groundwater quality;
- whether any such effects could have caused the observed impacts on my clients' property;
- whether the Cedarhurst hydrogeological investigations and monitoring programs have been adequate to protect local groundwater resources (including local domestic well water supplies) and to investigate off-site impacts of the aggregate washing operations;
- whether Cedarhurst has complied with the Terms and Conditions of its Permit to Take Water (PTTW), and whether the PTTW is adequate to protect local groundwater resources.

This Report is intended to provide my detailed response to these questions.

3) General Site Description

a) Topography

The Teedon Pit is situated in the Simcoe Uplands region of southern Ontario (Chapman and Putnam, 1984). It is sited on the flanks of a massive hill of ice-contact deposits (mainly stratified to substratified sands and gravels, with some incorporated silty till deposits) which extends southward and covers an area of at least 6 square km west of the village of Waverly.

The original ground surface generally sloped downward to the east, north, and west from the area of the Cedarhurst property - though the excavations for the gravel pit have now altered the original topography.

The ground surface on the highest parts of the Cedarhurst property has an elevation of over 300 meters above sea level (masl) to the west of the current pit, with the ground surface falling away quite steeply from there (more than 50 meters) to the west and north and sloping away somewhat more gently in an irregular fashion to the east through the area of the pit toward the property entrance on Darby Road.

b) Drainage

The Cedarhurst property is very well drained due to the sand and gravel nature of the subsurface, with no permanent drainage features. A source water pond and settling ponds have been excavated for the aggregate washing operation. On the date of my site tour on July 7, 2015 the settling pond area was dry and water levels in the source water pond (referred to as the “wash pond” in the Cedarhurst documentation) were low.

Based on my observations during my site tour it appeared that currently the runoff from the eastern part of the pit was being diverted to the north (around the wash pond), flowing down a deeply eroded gully into the unnamed intermittent water course which drains northeast from the center of the Cedarhurst property.

c) Geology

The bedrock beneath the area is the Bobcaygeon Formation, a limestone bedrock. It is found deep beneath the ground surface, covered by very thick overburden deposits. None of the local wells on which information is available extend to the bedrock, and it is of no further interest in this matter.

Overlying the bedrock are the very thick overburden deposits found in what is referred to by Chapman and Putnam (1984) as the Simcoe Uplands region of southern Ontario. The Simcoe Uplands consist of broad rolling till plains and moraines, overlain or interstratified locally with ice-contact deposits.

The Teedon Pit is sited on the flanks of a massive hill of ice-contact deposits (mainly stratified to substratified sands and gravels, with some incorporated silty till deposits). The sands and gravels are being mined in the Teedon Pit.

Figure 14 of the August 2015 report entitled “Assessment of Local Well Water Quality Complaints” (hereafter referred to as the “Complaints Assessment Report”) is a not-to-scale drawing which nonetheless gives a sense of the massive hill of sand and gravel which is being mined in the pit. The notch in the hill marks the area where aggregate is being mined.

There is no question that the local geology is very complex - with almost every borehole log and cross-section through the area of the Teedon Pit and the surrounding properties presenting a different picture regarding the nature and composition of the overburden deposits in the area of the pit.

Certainly there is a lot of sand and gravel present, but there are also repeated references to finer grained deposits which are interlayered with the sand/gravel in places which are simplistically referred to in the Complaints Assessment Report as “clay”. In reality there will be some combination of fine grained materials in the silt and/or clay sized soil classification groups, which would more accurately be referred to as “silt and/or clay”.

The existing pit provides an excellent cross-sectional view of the upper portions of the hill’s geology in the various exposed faces in the extraction area. During my site tour of the pit on July 7, 2015 I saw extensive sand and gravel deposits. I did not see any clay. There were some places where finer grained materials were present but these materials generally had the consistency of silt (ie. finer than sand, but not as fine as clay). I am not aware of any soils testing having been done by Cedarhurst to try to determine the size of particles which are present in the fine-grained deposits at the pit.

Overall, the complexity of the local geology is such that facile interpretations will risk entirely missing the mark in terms of providing an understanding of how groundwater will move in this extraordinary environment. This has been a problem for Cedarhurst’s hydrogeologists, who have provided conflicting interpretations of the site’s hydrogeology - none of which are what I would consider to be an accurate description of the nature of groundwater movement in the area.

d) North Arrows and Scale Bars

For some reason, the figures presented in the Complaints Assessment Report are generally missing north arrows and scale bars.

A basic aspect of any complete map or air photo is an arrow showing which direction is north, to allow the viewer of the map to understand the orientation of the features shown on the map. The Complaints Assessment Report also does not adhere to the convention which is sometimes used in the absence of north arrows, of presenting maps such that “up” on the map is due north. This makes it challenging to read the report and try to determine what is being talked about with respect to various figures which are presented in the report.

The lack of scale bars likewise makes it challenging to use the maps and air photos, or to estimate distances between the features shown on them.

4) Hydrogeological Site Investigation

a) Introduction

In order for Cedarhurst to properly assess the off-site impacts of their aggregate washing operation, the starting point must be a detailed understanding of the site hydrogeology. The work which has been done in this regard by AES for Cedarhurst is assembled and documented in the Complaints Assessment Report.

In my professional opinion the hydrogeological information provided in the Complaints Assessment Report is inadequate to allow for a proper assessment of the impacts of the aggregate washing activities at the Teedon Pit. The following items (which are necessary to allow for a proper assessment of impacts) have not been provided in the Complaints Assessment Report:

- A detailed history of activities at the Teedon Pit which could have affected groundwater levels and/or groundwater quality.
- Records of water levels in the source water pond (also known as the “wash pond”) which is used to supply the Teedon Pit’s aggregate washing operation, and in wells in nearby test pits.
- A history of all complaints of well interference (impacts on well water levels or water quality) which have been made to the MOECC and/or Cedarhurst from the surrounding area starting in 2009, including full details of the particular concern(s) of each household.
- If any complaints have been resolved, then a clear statement of the nature of the resolution should be provided.
- A baseline account from each household at which well interference is alleged to have occurred regarding their pre-washing (ie. pre-2009) well water levels and well water quality.
- A clear description of the geological materials in which the wash pond is situated, based on an analysis of the available information from all nearby boreholes and test pits.
- A coherent site conceptual model which would account for the inexplicably large water losses from the wash pond during aggregate washing operations. This should include a detailed estimate of the magnitude of water losses from the aggregate washing process.
- Information from a network of monitoring wells which meet the following criteria:
 - 1) hydraulically connected to the shallow aquifer beneath the wash pond;
 - 2) situated between the wash pond and the affected households (and therefore useful for assessing the impacts of aggregate washing at the pit on downgradient groundwater supplies);
 - 3) a clear differentiation of monitoring wells, based on which aquifer unit(s) they are monitoring;
 - 4) measurements of groundwater levels and tests of groundwater quality done at a time of aggregate washing for all wells being used to interpret the effects of aggregate washing on the groundwater flow system.

I will discuss each of these issues in turn below.

b) Site Investigation Concern #1 - Detailed History of Activities at the Teedon Pit

A history of all events at the Teedon Pit which could have contributed to the complaints by local residents has not been provided.

The complaints regarding the Teedon Pit pertain to impacts on groundwater levels and impacts on well water quality.

The first step in assessing those complaints should have been the development of a history of events at the pit which had the potential to cause such effects. The Complaints Assessment Report simply provides records of dates on which pumping is said to have occurred at the pit, but nothing else. In my opinion, this is not adequate.

The complaints by local residents pertain to flooding due to high groundwater levels, and water quality impacts caused by siltation of their wells. The following activities could have contributed to the flooding and/or the off-site water contamination by suspended silt/clay particles:

- the excavation of the wash pond;
- the redirection of stormwater flows from the wider pit area into the wash pond;
- the redirection of some storm flows past the wash pond and into the normally dry valley north of the wash pond.

c) Site Investigation Concern #2 - No Water Level Records for Wash Pond or Nearby Wells

The most likely source of the off-site impacts being reported by neighbours of the site is leakage of silt/clay-laden washwater from the wash pond. No records of water levels in the pond or in wells installed in adjacent test pits (which could be used to determine rates and impacts of leakage) are available.

The original conceptual model for the site (provided in a 2007 Report by Waterloo Geoscience Consultants, or WGC) was that the wash pond would provide all of the water needed for aggregate washing, and that it would be replenished through a combination of rainfall, stormwater runoff, and groundwater inflows.

In order to confirm that the pond was functioning as designed, Condition 4.3 of the original April 18, 2008 Permit to Take Water (PTTW) required daily measurements of water levels in the wash pond and wells in nearby test pits TP1 through TP4. Such measurements should have been taken throughout 2009.

I have requested that these records be made available, but have been told by a Cedarhurst representative (Mr. Ross Campbell) that there are no measurements available because they “could not be located”.

When the PTTW was amended in July 2010, the requirement to measure water levels in the wash pond and the wells in nearby test pits was dropped from the PTTW.

I consider this to be significant error on the part of the MOECC, as it has made it very difficult to accurately estimate rates of leakage and assess nearby impacts of leakage from the pond during the 2011 to 2013 period in which there were heavy off-site impacts being reported by neighbours of the site.

d) Site Investigation Concern #3 - No Record of Complaints to Cedarhurst and MOECC

It seems bizarre that in a report intended to investigate complaints from neighbours about well interference, that there is no record in the report of the details of those complaints.

All that is provided in the Complaints Assessment Report are highly sanitized and abbreviated descriptions of the neighbours' concerns. For example the following statement is provided on page 40 of the report:

"The common water quality complaint of the 4 concerned residents including: (1) Pigeons, (2) Andersons, (3) Irvines, and (4) Towers was silt in their well waters."

This is inadequate. It appears that no attempt has been made to document the actual complaint(s) from each household, or to provide the details in the report. I know that historically there have been complaints from other households in the vicinity of the Teedon Pit, and that the complaints from the various households have involved some combination of flooding due to unusually high groundwater levels and water quality impacts caused by high silt levels in the wells.

I do not have direct knowledge of the complaints of others, but in the case of my clients I know that complaints were made as follows:

- 1) The pit was visited in person by Mr. Pigeon with a follow-up contact by phone in the summer of 2010. In response Mr. Rick Geary said *"he would make note of it but they had not washed any gravel this year"*.
- 2) Cedarhurst was contacted again by phone on August 5, 2011 by Ms. Pauze, who spoke with Mr. Geary expressing her frustrations and concerns due to excessive silt in her well and damage to pumps and machines in her home. Mr. Geary indicated *"it was not his problem and they are not having an impact on our wells"*. A visit from an employee was promised for the following day, but no one came.
- 3) After the promised visit by a Cedarhurst employee failed to occur on August 6, 2011 Ms. Pauze phoned and left a voicemail message that evening - with no response from Cedarhurst.

Condition 5.1 of both the original Permit to take Water (PTTW) and the amended PTTW are identical and state the following:

"The Permit Holder shall immediately notify the local District Office of any complaint arising from the taking of water authorized under this Permit and shall report any action which has been taken or is proposed with regard to such a complaint.."

e) Site Investigation Concern #4 - No Record of Resolution of Complaints

In a report which is intended to report on an investigation of complaints of well interference, all complaints should be listed including complaints which have since been resolved.

Based on the information available to me I believe that in addition to the 4 households listed as having current complaints in the Complaints Assessment Report (Pauze/Pigeon, Andersons, Irvines, and Towers) there were previously complaints from other households featuring concerns about abnormally high groundwater levels and/or silty well water.

I am assuming that since the additional households are not featured in the Complaints Assessment Report that their complaints have been resolved in one way or another. But for completeness' sake both the details of the original complaints and the nature of the resolution need to be provided.

f) Site Investigation Concern #5 - No Account of Prior Water Levels and Water Quality

The focus of the Complaints Assessment Report is the issue of silt levels in domestic wells, which neighbours of the site believe are related to aggregate washing activities at the site. A key aspect to any such issue is the question of how water quality has evolved over time, but no information is provided in this regard in the Complaints Assessment Report.

In order for Cedarhurst to properly assess the off-site impacts of their aggregate washing operation, the starting point should be a firm and thorough understanding of the prior "baseline" hydrogeological conditions in the Teedon Pit area and its surroundings. Unfortunately, there was no meaningful work done by Cedarhurst to establish off-site baseline conditions prior to the commencement of pumping and aggregate washing at the pit in 2009.

Conveniently for Cedarhurst, there was no PTTW requirement from the MOECC for baseline monitoring of water quality (or water levels) at any of the wells of the households with complaints.

I am not able to speak to the situation of the other families, but my clients are very clear about the fact that prior to the commencement of aggregate washing in 2009 that they enjoyed excellent quality well water. This is supported through anecdotal accounts from friends and neighbours, which can be provided upon request.

To help substantiate the excellent pre-2009 water quality, it is interesting to note that testing of levels of metals (major ions and trace metals) of my clients' well was done in the context of broader testing being done for a scientific paper related to the Site 41 issue (Shotyk et al, 2010). That testing confirmed very low levels of all metals tested, and excellent quality water. The scientist who did the testing (Dr. William Shotyk of the University of Heidelberg) can also attest to the excellent quality of the water at the time of testing.

Beginning in 2009, the quality of water in my clients' 2 wells deteriorated dramatically due to contamination by excessive levels of silt and/or clay in the well water. There were also significant fluctuations in groundwater levels, first a decline and then some major occurrences of flooding. This all coincided with the commencement of aggregate washing operations at the Teedon Pit.

A letter of complaint documenting my clients' experiences of silt impacts on their wells was filed with the MOECC this year, and is reproduced in **Appendix 2** of this report.

It should be noted that Cedarhurst failed to test my clients' wells in any of the years when aggregate washing was occurring and impacts were at their peak. The obvious time to have tested my clients' water would have been in 2011, when they complained directly to Cedarhurst - however the Company failed to respond to the complaints or to do any testing, or to pass the complaints on to the MOECC.

My understanding based on conversations with my clients is that now (in 2015) the water quality in their wells is the best that it has been since prior to the commencement of aggregate washing in 2009. The testing of water quality in residential wells in the summer of 2015 occurred about 2 years after the last washing of aggregate at the Teedon Pit, and as such should not be considered in any way reflective of impacts which were being experienced by local residents at the time when aggregate washing was occurring.

The testing of their wells which was done this summer by Cedarhurst, while useful in establishing current conditions is entirely useless in terms of providing any assessment of conditions when impacts were at their peak a few years ago. This statement is likewise applicable to the testing of other residents' wells which was also done by Cedarhurst this summer.

In summary, Cedarhurst and the MOECC failed to do any baseline testing of water quality in wells of the households which have filed complaints about the impacts of aggregate washing. Likewise there was no ongoing testing which could have provided information on well water quality at the time of peak impacts in 2009-2013. Given the absence of baseline or peak impact testing, the only source of information about baseline and impacted conditions are the residents themselves. I recommend that formal Affidavits regarding pre-2009 and 2009-2013 well water quality be prepared by affected residents.

g) Site Investigation Concern #6 - Lack of Clear Description of Geology in Wash Pond Area

Given that the complainants are clear in their expressions of concern that Cedarhurst's aggregate washing activities have negatively affected their properties and wells, it would appear that a key aspect of an investigation of local hydrogeology would be aimed at developing a clear description of the geology in the immediate area of the wash pond, based on nearby test pits records. This has not been done in the Complaints Assessment Report.

Unfortunately there is no legible map in the Complaints Assessment Report which shows the locations of the nearest test pits to the wash pond area.

To assist in this regard, I have taken a map of the test pit from a 2007 Report by Cedarhurst's previous consultants (which has a scale on it) and blown it up by 160% - it is included in this report as **Figure 1**. What **Figure 1** shows is that there were 6 test pits within the immediate area of the wash pond (ie. within about 50 meters of its location).

The test pits in the immediate area of the Cedarhurst aggregate washing operations are listed below, together with a record of the geological materials found in each test pit and their moisture levels.

Test Pit TP1 - ground elevation 262.17 masl

0 to 0.45 meters below ground surface (mbgs)

0.45 to 2.3 mbgs

2.3 to 3.7 mbgs

black silty FINE SAND

brown silty FINE SAND - moist

grey silty FINE SAND - saturated

Test Pit TP2 - ground elevation 259.96 masl

0 to 0.45 mbgs

0.45 to 1.25 mbgs

1.25 to 1.5 mbgs

1.5 to 2.9 mbgs

2.9 to 3.2 mbgs

black silty FINE SAND

brown silty FINE SAND - moist

brown gravelly SAND - saturated

grey silty FINE SAND - saturated

grey silty FINE SAND, some gravel
(compact TILL)

Test Pit TP3 - ground elevation 262.37 masl

0 to 0.4 mbgs

0.4 to 1.65 mbgs

1.65 to 3.6 mbgs

3.6 to 4.05 mbgs

dark grey/red brown silty FINE SAND

brown silty FINE SAND - moist

grey silty FINE SAND - saturated

grey silty FINE SAND, laminated, compact,
- wet

Test Pit TP4 - ground elevation 264.51 masl

0 to 0.55 mbgs

0.55 to 2.8 mbgs

2.8 to 4.4 mbgs

4.4 to 4.75 mbgs

brown gravelly MEDIUM-COARSE SAND

brown silty FINE SAND - moist

grey silty FINE SAND - saturated

grey silty FINE SAND, laminated, compact,
- wet

Test Pit GI-07-03-01 - ground elevation 261 masl

0 to 1.1 mmbgs

1.1 to 2.3 mbgs

2.3 to 5.5 mbgs

clayey SILT to SILT

silty FINE SAND to FINE SAND - damp

SILT to clayey SILT - saturated to wet

Test Pit GI-07-03-02 - ground elevation 266.6 masl

0 to 1.3 meters below ground surface (mbgs)

1.3 to 3.0 mbgs

3.0 to 5.0 mbgs

coarse silty SAND with stones

medium to fine SAND

silty fine SAND to SILT - saturated

clay content increasing with depth, saturated

Please note that the actual logs for the above test pits can be found in Appendix B of the 2007 WGC Report. What is clear from the test pit logs is that in the immediate area within which the wash pond is now situated, that the geological materials which were found were mainly silty sand, with some gravel or stones in some areas and a little clay in others. The geological materials are certainly not identical from one test pit to another - but they tend to be similar and are generally classified as silty fine sand.

This needs to be compared to what is stated about the geological materials in the area of the wash pond by the author of the Complaints Assessment Report, who in correspondence with me stated the following:

“The pond was constructed during winter and remained dry until spring with the observed base of the pond being clay.”

and also

“The wash pond was constructed on an impermeable clay base that prevents leakage.”

I do not find these statements to be credible, given the information available from the logs of test pits which were constructed in the immediate area of the wash pond. None of the test pit logs indicate that the main geological material encountered was clay - even though that is all that is mentioned by the author of the Complaints Assessment Report in his correspondence.

It should be noted that in his interpretation of the test pit logs TP1 - TP4 in the area of the wash pond Cedarhurst's previous consultant who is the author of the 2007 WGC Report stated that:

“Local stratigraphy as indicated by the test pits, shows a uniform layer of silty fine sand overlying compact silty sand that has been interpreted as a till.”

Geology of Deeper Overburden Materials

All of the above discussion has focussed on the geology of the immediate near surface soils within which the wash pond is situated. It is also worth looking at what is known about the deeper geology of the broad area between the wash pond and my clients' wells.

It turns out that there are very few certainties when it comes to the deeper geology of this broader area. The overall scenario (a massive hill of sand and gravel, with some interlayering of till) is clear enough - but the picture which emerges when one considers the available information is that very little is known about exactly what might be there. For whatever reason, the information presented in the Complaints Assessment Report is mainly focussed on the front of the Cedarhurst property at Darby Road.

The map on Figure 2 of the Complaints Assessment Report shows that there are 4 wells on the west side of wash pond in the area between the pond and Marshall Road (the road on which the wells of my clients and several other families with complaints are situated):

Well # 7054134

Well # 5716439

Well #5716440

Well #7124729

Well #7054134 is apparently situated near the northwest corner of the wash pond. It is an anomaly, in that the well log shows 5 feet of sand followed by 55 feet (or 16.8 meters) of clay. The big hill of ice-contact deposits on which the Teedon Pit is situated is known to be mainly sand and gravel, with some interdeposition of finer grained (till) materials. A well log suggesting 5 feet (1.5 meters) of sand underlain by 55 feet (or 16.8 m) of “clay” stretches the bounds of credibility, and is evidence of the risk of relying entirely on MOE well logs for information about local geology.

Well #5716439 is situated a few hundred meters further west from the wash pond (along the northern Cedarhurst property line), and to sum up the borehole log it simply shows 140 feet (or 42.7 meters) of interlayered fine gravel with some sand.

Well #5716440 is situated a little further west of Well 5716439, and was likewise drilled to a depth of 140 feet (42.7 m). The well log likewise shows the entire length of the borehole to be composed of interlayered fine gravel or gravel with some sand.

Well #7124729 is situated on the north side of the west boundary of the Cedarhurst property, closest to Marshall Road. The well is 220 feet (67 m) deep. The first 160 feet (48.8 m) were drilled through gravel and sand, and most of the rest of the well was drilled through sand. There is a layer of silt with fine sand in the depth interval 180-189 feet (54.9 to 57.6 meters) below ground surface.

For three of these wells the results are pretty much what one would expect - the hill which is being mined in the Teedon Pit is a major deposit of sand and gravel, and these deposits are widespread and extend outward toward Marshall Road. As indicated above I have serious doubts about the veracity of the details of the drill log for Well 7054134, and would urge Cedarhurst and/or the MOECC to further check their available records for this well. I note that the Eastings and Northings information on the well log for Well #7054134 (in Table 1 of the Complaints Assessment Report) is not consistent with the information in the Well Summary Table (in Table 2 of the Complaints Assessment Report), which also raises questions about the actual location of the well.

In Summary

The location of the wash pond on the Cedarhurst property is clear from air photos - it is situated about 1/3 of the way into the property from the site entrance on Darby Road.

The geology in the area of the wash pond is not (as the author of the Complaints Assessment Report has suggested) an impermeable clay - rather it is a complex mix of sand and gravel deposits, with interlayered gravel silt till in some places. This complex geology is not going to be impermeable to groundwater movement, in fact it will tend to be highly permeable in places.

As will be discussed in subsequent sections of this report, groundwater flow in such a complex mix of geological materials will be complex and unpredictable - and quite rapid in places.

h) Site Investigation Concern #7 - Lack of Clear Hydrogeological Conceptual Model

A major shortcoming of the Complaints Assessment Report is the lack of a clear hydrogeological conceptual model for the area of the wash pond. In this regard the report is rather confusing, in that it first recaps the findings from earlier studies done for Cedarhurst (each of which was based on a different view of the site hydrogeology) before providing an update with the author's current interpretation.

I will try to summarize the prior conceptual models which have been put forward on behalf of Cedarhurst:

i) 2007 WGC Conceptual Model

The 2007 WGC Report (which is found in Appendix D of the Complaints Assessment Report) was prepared in support of the application for a PTTW which would allow Cedarhurst to wash aggregate, and to take the water needed for such washing from a specially constructed "wash pond" on site.

The conceptual model for the 2007 WGC Report was that the wash pond was situated squarely within the water-bearing aquifer on-site, with the water table more or less at the ground surface. It was thought that any water losses from the aggregate washing operation would be made good by a combination of precipitation, runoff, and inflowing groundwater from the aquifer - and detailed calculations were provided in support of this model.

The 2007 WGC Report was the basis for the original Permit to Take Water (PTTW) which the MOECC issued April 18, 2008 and which permitted the removal of up to 5.2 million liters/day of water from the wash pond for the purposes of aggregate washing.

ii) 2010 AES Conceptual Model

By 2010 it was clear that there were problems with the WGC conceptual model. In particular, much less water than expected was available from the wash pond - even though it had been made 2 to 3 times larger than had been originally proposed by WGC.

Cedarhurst had a new consultant by this point (Alpha Environmental Services Inc., or AES) and AES put together a report dated April 2010 (which is found in Appendix H of the Complaints Assessment Report) in support of a new application for an amended PTTW. The amended PTTW, if approved, would allow the wash pond to be "topped up" with water from a newly drilled well (PW1-09) near the site entrance.

In response to MOE questions regarding the PTTW application, AES provided calculations on page 11 of a July 30, 2009 letter to the MOECC showing that water losses from the pond were much higher than had been expected - in the range of 47.5% of the wash water used, compared to an "industry standard" of 10%. Clearly a very considerable amount of water was being lost from the pond, and the conceptual model which had been the basis for the original PTTW was flawed.

AES put forward 2 hypotheses for the water losses (on page 11 of their July 30, 2009 letter):

- a) an underestimate of the amount being pumped, because the required flow meter had not yet been installed.
- b) “an immature return groundwater flow system for the wash water that has drained from the washed aggregate which will be rectified with time and additional aggregate washing”.

Hypothesis b) is interestingly worded. I take this to mean that the author figured that water was leaking from the settling ponds and/or wash pond into the groundwater flow system, but that once enough silt-laden water had been run through the system it would eventually “mature” and plug up any leaks with silt.

In any event, the AES simply left it at that and Cedarhurst requested MOECC approval of the proposal to “top up” the wash pond with water from PW1-09. Even though there were clearly major problems with the WGC conceptual model which had been the basis for the original approval, the MOECC ultimately approved the AES proposal with an amended PTTW dated July 23, 2010.

I firmly believe that the MOECC’s issuance of this PTTW approval was a mistake. I think that both the MOECC and Cedarhurst needed to ask the question “*Where is the water being lost from the aggregate washing operation going?*”, before putting in place a scheme that would allow massive additional inputs of water to the aggregate washing operation. That question should have been clearly articulated by the MOECC, and the MOECC should have insisted on a detailed and plausible answer which could be incorporated into a revised conceptual model before issuing the amended PTTW.

The MOECC made what I believe were further mistakes in issuing the amended PTTW:

- it dropped the requirement for daily measurements of wash pond water levels (making it difficult to accurately determine losses of water from the aggregate washing operation) and it dropped the requirement for measuring water levels in wells in nearby test pits TP1 - TP4;
- it did not require precautionary monitoring of well water levels and well water quality in a representative number of homes around the Teedon Pit, despite the pit’s location upgradient of numerous homes and the known massive water losses from the aggregate washing operation;
- it did not require monitoring wells which were hydraulically connected to the shallow aquifer beneath the wash pond to be installed around the wash pond in order to monitor the effects of the aggregate washing operation on the surrounding groundwater flow system.

In essence after the issuance of the amended PTTW both Cedarhurst and the MOECC were left “flying blind”, with no appropriately situated monitoring wells in place which could be used to help assess the well interference complaints coming from my clients (and other complainants) and with no conceptual model which could provide an explanation for the massive losses of water from the aggregate washing operation.

iii) 2015 AES Conceptual Model

Following complaints from my clients and other households around the Teedon Pit, AES was asked by Cedarhurst to investigate - and the findings of that investigation are provided in the Complaints Assessment Report.

One important aspect of the Complaints Assessment Report is that it has effectively abandoned the 2007 WGC conceptual model. The new AES interpretation of site hydrogeology is presented in the Complaints Assessment Report, but there are also several places in the Complaints Assessment Report where the author indicates his disagreement with the prior WGC conceptual model including page 21 (in the first and fifth paragraphs) and page 22 (paragraph 3).

The AES conceptual model is alluded to in numerous places in the Complaints Assessment Report, however the report is confusing because it also presents the highlights of prior reports prepared by AES and WCG - so I will try to paraphrase what I understand is being presented.

My understanding of the new AES conceptual model (based on the discussion in Section 2.5.3) is that AES is indicating that the wash pond is situated on a clay base (with a bottom elevation of 257 masl) and that groundwater levels in that clay base are “perched” above the actual water table of the underlying aquifer (which is indicated on page 20 to have a potentiometric level of about 254.8 masl).

This is one area where I am in agreement with AES - that is, I also believe that the wash pond and shallow groundwater levels in the surrounding soils are “perched” above the underlying groundwater table. The implication of this area of agreement between myself and AES is that any “perched” pond is by definition one which is losing water - the only question is the rate at which water is being lost. The Complaints Assessment Report does not identify or try to answer this question, even though it is at the heart of matter being considered.

I should note that I disagree with AES, in that I do not believe that the wash pond and the associated settling ponds are situated in “impermeable clay”. I believe that these ponds are situated in leaky soils, which may or may not be predominantly clay-based in places but which also have “windows” composed of much coarser grained materials which facilitate downward leakage of wash water into the underlying aquifer which is hydraulically connected to the wells of my clients and other complainants.

In other areas, AES seem to be adopting aspects of the prior WGC conceptual model for the site - including the bizarre assertion that there is a “flow divide” through the middle of the Cedarhurst property, and that because of the presence of this flow divide it is not possible for activities on the east side of the property to affect groundwater resources on the other (west) side of the flow divide including the area where my clients live. Nothing could be further from the truth.

Groundwater flow systems are nothing if not dynamic, and flow divides can instantaneously shift if there are sudden new inputs - such as massive leakage of silt/clay-laden wash water from settling and/or wash ponds which are being “topped up” by pumping from a distant well.

iv) My Conceptual Model

In the above discussion of the 2015 AES conceptual model I have begun referring to the details of my conceptual model for the Teedon Pit, and in particular the hydrogeological effects of its aggregate washing operations.

The full details of my conceptual model (based on my understanding of the local hydrogeology, and the aggregate washing operations at the Teedon Pit) follow below:

The Teedon Pit is situated on the northern edge of a very large hill (6 square km) of gravel and sand. This hill is a groundwater recharge area, meaning that it is a place where rainfall enters the ground and recharges the regional groundwater flow system.

Groundwater flow directions are generally outward from the hill to the surrounding lower lands, with specific flow directions dependent on local variations in hydraulic gradients and permeabilities of the geologic materials.

There are numerous residential and farm properties downgradient of the Teedon Pit which are 100% reliant upon groundwater for their well water supplies. All of the complainants' properties are situated downgradient of the Teedon Pit and its aggregate washing operations - that is, there is a hydraulic potential which would allow for groundwater flow from the Teedon Pit to any of the complainants' wells.

Actual pathways for downgradient groundwater movement from the Teedon Pit towards the wells of individual complainants would be very difficult to determine - even in the best of circumstances (if there were an adequate network of monitoring wells between the Teedon Pit and the complainants' properties). As will be discussed below, none of the monitoring wells installed by Cedarhurst are appropriate for assessing potential impacts of Cedarhurst's aggregate washing operations on any of the complainants' wells.

Mapping of groundwater level measurements obtained from various wells prior to 2009 has been interpreted by Cedarhurst's consultants (WGC and AES) to indicate that there is a flow divide running through the Cedarhurst property in a north-south direction, such that "*water users west of the divide will not be affected by the aggregate washing operation on the Teedon site*" (AES, 2015). This is a fundamental misunderstanding of the dynamic nature of groundwater flow. Mapping of groundwater levels measured prior to 2009 (ie. before the wash pond and settling ponds were constructed) is not applicable to what was happening in the groundwater flow system during periods of aggregate washing in 2009 and in subsequent years.

Aggregate washing operations began at the Teedon Pit in 2009, and occurred in the years 2009, 2011, 2012, and 2013. In 2009 the water for aggregate washing is said to have come entirely from the wash pond, which is fed by precipitation and by runoff of snowmelt and stormwater from the larger area of the Teedon Pit (which is directed to the pond). Starting in 2011 there was an additional source of water for the aggregate washing, namely water which was pumped into the wash pond from well PW1-09.

There were very significant water losses from the aggregate washing operations at the Teedon Pit. These water losses were estimated at 47.5% by AES (based on wash pond water levels measured in July 2009), as discussed on page 15 of [this](#) report. Cedurhurst claims it has lost all of the subsequent 2009 pond water measurements it was required to make under the original 2008 PTTW for the site, and the MOECC dropped the requirement for measuring pond water levels from the amended 2010 PTTW for the site. As a result, we are left with the estimate of 47.5% water losses from the aggregate washing operation, which is much higher than the “industry standard” of 10% losses.

It is my position that the difference of 37.5% represents water losses caused by leakage of silt-laden wash water into the underlying groundwater flow system at times of aggregate washing. I believe that such leakage is occurring through one or more “windows” which allow rapid downward flow of silt-laden wash water into the underlying groundwater flow system. When aggregate washing is occurring, volumes of one million liters/day or more of wash water are moving through the system with potential leakage losses which average around 500,000 liters/day.

There will be both short-term and long-term effects resulting from these massive inputs of leaking wash water to the underlying groundwater from system.

The short-term effects of the leakage of massive amounts of silt-laden wash water will include the following:

- The leakage of on the order of 500,000 liters/day of wash water will quickly and massively raise hydraulic heads in the underlying groundwater flow system.
- During periods of aggregate washing the area of the wash pond and settling ponds will become the high point in the local groundwater flow system - with outward movement in all downgradient directions from there.
- The quick rise in hydraulic heads will be transmitted rapidly through the groundwater flow system, and will lead to similarly rapid rises in off-site groundwater levels with the magnitude of the rise dependent on distance from the wash pond area and on the degree of hydraulic connection between the wash pond area and the specific off-site location.
- This may lead to anomalous episodes of surface flooding if off-site groundwater levels rise above the ground surface, and it may also lead to problematic rises in water levels in domestic wells.

The long-term effects of the leakage of massive amounts of silt/clay-laden wash water will include the following:

- Each day of aggregate washing will cause a slug of silt-laden wash water to leak into the underlying groundwater flow system, and that silt/clay-contaminated groundwater will be moving downgradient from the area of the wash pond.

- The preferred directions of flow will in part depend on the unpredictable position of higher-permeability pathways, but will also tend to be toward low points in the downgradient groundwater flow system (ie. wells).
- Plumes of silt/clay-contamination will be emanating outward from the area of the wash pond in an unpredictable fashion, due to the intermittent nature of the aggregate washing operations and to the fact that initially preferred flow channels may “plug up” over time with fine-grained materials.
- The greatest amounts of silt/clay contamination will be moving in the highest hydraulic conductivity features.
- It is not possible to precisely estimate rates of contaminant movement because of the absence of suitable monitoring wells (discussed in more detail below), but based on the very coarse nature of some of the local gravel deposits peak flow rates ranging from 10s of meters per day to over 100 meters per day seem possible.
- The estimate of groundwater flow rates (presented in Figure 26 of the Complaint Assessment Report) which suggests that it would take groundwater over 1,000 years to travel from the Teedon Pit to Marshall Road is utterly implausible, and based on a very sloppy assumption that hydraulic conductivity throughout the groundwater flow system would be 3.5×10^{-7} m/s (ie. that the geological deposits all along the flow path would be silt). In the predominantly sand/gravel aquifer which is present flow rates would of course be very much more rapid.
- The effects of dispersion and attenuation of the silt plume in the downgradient groundwater flow system will cause silt levels to remain elevated long after aggregate washing operations have ceased, although in the absence of renewed washing activities silt levels should be steadily decreasing with time.

i) Site Investigation Concern #8 - Problems with Monitoring Well Network

The monitoring well network which is being relied upon in the Complaints Assessment Report is not adequate for the task to which it is being applied.

The Cedarhurst monitoring well network is shown on Figure 2 of the Complaints Assessment Report, which I have reproduced and included in this report - also as Figure 2.

The Complaints Assessment Report is supposed to be investigating neighbours' complaints that aggregate washing at the Teedon Pit has caused off-site impacts on groundwater quality (silty wells) and groundwater levels (localized flooding).

It follows that the monitoring well network being used to investigate such off-site impacts should be hydraulically connected to the shallow aquifer beneath the wash pond, and should be situated downgradient of the wash pond - between the wash pond and the domestic wells which are subject of the complaints. The Cedarhurst monitoring well network fails on both counts.

Firstly, Cedarhurst has failed to install monitoring wells which are hydraulically connected to the shallow aquifer unit which the wash pond and settling ponds are leaking into.

There is only one monitoring well which is situated close enough to the wash pond and which is completed shallow enough that it might be useful for monitoring groundwater impacts of aggregate washing activities - namely well MW1 (aka Well #7054134). Unfortunately this well has been completed in a fine grained deposit whose composition is described as “clay”. The hydrograph for MW1 confirms that the well is not hydraulically connected to the underlying groundwater flow system which is receiving leakage from the Cedarhurst aggregate washing operations.

Secondly, aside from MW1 there are no wells situated between the wash pond area and Marshall Road where one group of complainants (including my clients and the Towers) are situated. Likewise there are no monitoring wells situated between the wash pond and the east end of the Stamp Sideroad where the other complainants (Irvines and Andersons) are situated.

The lack of suitable monitoring wells means that any impact assessment by Cedarhurst is sure to find no impacts, given that there is no possibility of finding impacts (even if they are occurring) with the existing well network.

I should note that the map cited in the Complaints Assessment Report as showing a “flow divide” running through the Cedarhurst property (Figure 9 of the 2007 WGC Report) is not based on current information from any monitoring wells in the area of interest. It was produced in 2007, 2 years before the commencement of aggregate washing activities at the Teedon Pit. The wells shown on the figure are also all situated far to the west of the wash pond. The figure is therefore utterly useless for the purpose of assessing local groundwater flow directions or impacts of aggregate washing at the Teedon Pit on surrounding domestic wells.

5) Impact Assessment

a) Introduction

Despite my best efforts, I could find no evidence in the Complaints Assessment Report of any assessment of potential impacts from Cedarhurst’s aggregate washing operations, even though the complainants are unanimous in their belief that the impacts on their wells have been caused by Cedarhurst’s aggregate washing.

Instead, the Complaints Assessment Report puts forward the bizarre hypothesis that the observed off-site impacts consisting of silt contamination and/or flooding (due to abnormally high groundwater levels) in wells at several different locations were due in all cases to poor well construction - even though the complainants were clear in stating that all wells had been working properly prior to the commencement of aggregate washing at the Teedon Pit.

Instead of putting forward such an implausible hypothesis, it would have been good if a thorough impact assessment had been carried out.

b) Components of a Thorough Impact Assessment

A thorough impact assessment should have included the following components:

- An estimate of the likely composition of the silt-contaminated wash water resulting from Cedarhurst's aggregate washing operations.
- An estimate of the daily losses of wash water from Cedarhurst's aggregate washing operations at the Teedon Pit.
- Installation of a monitoring well network with wells situated between the wash pond and the homes of the complainants, which could be used to investigate the groundwater flow system in the area of concern.
- Monthly measurements of water levels in these wells, as well as grain size analyses and tests of hydraulic conductivity in the wells - with the goal of obtaining data which could be used to develop reasonably accurate estimates of groundwater flow rates between the Teedon Pit and the homes of the complainants.
- Consideration of the feasibility of conducting a combined pumping and tracer test, to confirm whether or not there is a hydraulic connection and flow path between the groundwater flow system beneath the wash pond and the wells of the complainants.
- A request for each household to provide an account of baseline conditions (pre-washing), peak impacts conditions (in years when washing was being carried out), and current conditions (after 2 years of no washing).

None of the above components of a thorough impact assessment were carried out.

c) The "Impact Assessment" in the Complaints Assessment Report

The Complaints Assessment Report presents a considerable amount of information (much of it a recitation of outdated information from earlier reports), very little of which is really relevant to the issue at hand - namely the complaints about off-site impacts of aggregate washing.

No attempt was made in the Complaints Assessment Report to estimate the likely composition of the wash water, to estimate the daily losses of silt-laden water from Cedarhurst's aggregate washing operations, or to try to develop hypotheses regarding where the lost water might be going.

Despite the fact that the existing monitoring well network is useless for investigation of the impacts of aggregate washing, no new wells were installed.

Much is made in the Complaints Assessment Report of the purported presence of a groundwater divide on the Cedarhurst property, even though it is based on mapping of pre-2009 water levels in a series of wells far outside and to the west of the area of interest. The presentation of the supposed flow divide as a rationale for the Complaints Assessment Report's conclusion that the wash pond could not have affected wells along Marshall Road is considered incorrect.

As soon as aggregate washing with its massive water losses commenced, the aquifer beneath the wash pond and settling ponds would have become the high point in the groundwater flow system - and any flow divide will have shifted to directly beneath the wash pond, with outward groundwater flow carrying silt contamination in all downgradient directions from there.

My Initial Thoughts Regarding the Assessment of Impacts

Wash Water Quality

In the absence of renewed aggregate washing at the Teedon Pit, it is not possible to establish an accurate estimate of the levels of silt/clay contamination in the wash water since no sampling was done when aggregate washing was occurring. However the wash water will have been very high in levels of total suspended solids and turbidity, due to the presence of silt and clay particles in the water. Please note that I have often simply referred to these silt and clay particles as "silt" in this report (as shorthand for any tiny particles finer grained than sand) - and I would request this is how these references to "silt" should be interpreted.

The wash water would look "muddy" to the eye, and if poured in a glass and left to stand there would be some settling out of residue at the bottom of a glass. Most problematic for off-site well owners would be the finer grained silt or clay particles in the wash water - that is, those that wouldn't settle out quickly and thus could be carried off-site in the groundwater flow system.

Wash Water Leakage into the Groundwater System

Unfortunately it is not possible to develop accurate estimates of wash water losses in the absence of pond water level measurements. While the original 2008 PTTW required water levels to be measured and records to be kept, Cedarhurst claims that these records (for 2009) now "can not be located". In 2010 the MOECC issued an amended PTTW, which no longer required measurements of pond water levels to be taken. The outcome of this poor decision is an inability to accurately estimate water losses from the aggregate washing operations.

An estimate of water losses of 47.5% (vs. an "industry standard" of 10%) was provided by AES in a July 30, 2009 letter to Mr. Christopher Munro (MOECC). This is the only and thus the best available estimate (based on pond water levels) of the percentage of water losses from Cedarhurst's aggregate washing operation.

A very rough check on this figure of 47.5% water loss can be obtained by comparing the annual volumes of water pumped from the wash pond (for aggregate washing) in 2011, 2012, and 2013 with the volumes of “top up” water pumped into the wash pond from PW1-09.

Table 1 on page 3 of this report provides the annual totals of water pumped from the wash pond for aggregate washing, and of water pumped from PW1-09 to top up the wash pond. Comparing these figures shows the following:

In 2011, about 33.8 million liters of water were pumped from the wash pond and about 14.2 million liters were pumped from PW1-09 to top up the wash pond - the relative percentage of top up water to wash water is 42%.

In 2012, about 51.3 million liters of water were pumped from the wash pond and about 34.7 million liters were pumped from PW1-09 to top up the wash pond - the relative percentage of top up water to wash water is about 68%.

In 2013, about 55.4 million liters of water were pumped from the wash pond and about 18.2 million liters were pumped from PW1-09 to top up the wash pond - the relative percentage of top up water to wash water is about 33%.

Averaging the figures for the 3 years, we come up with an average percentage of about 47.7% which is very close to the original AES estimate of water losses. It should be noted that these estimates are not conservative - there is a sizeable “water surplus” in this part of Ontario, meaning that any pond with an impermeable base will accumulate water on an annual basis. The Cedarhurst wash operation is losing all of the annual water surplus for the wash pond PLUS any runoff from the west side of the pit PLUS the top up water being pumped from PW1-09.

Overall water losses from the Cedarhurst aggregate washing operations will be in excess of 50% of every liter pumped - on peak days these are losses of about 1,000,000 L/day (or 11 L/second). This should be a red flag for both Cedarhurst and the MOECC - these water losses are not reasonable, and they will be causing offsite impacts in areas downgradient of the Teedon Pit.

The onus is on the MOECC in particular to respond to the complaints of off-site well interference and to the documented massive losses of silt-laden water from the Cedarhurst aggregate washing operation in a proactive and precautionary manner.

Monitoring Well Network

In my professional opinion, the existing Cedarhurst monitoring well network is all but useless for monitoring the off-site impacts of aggregate washing operations at the Teedon Pit. If Cedarhurst wishes to continue washing aggregate, either the wash system needs to be upgraded (so that it is truly “closed loop”) or upgrades to the monitoring network will be necessary.

Several properties in the area are owned by other aggregate companies, so one way to augment the existing monitoring network may be to seek permission to use other companies’ wells.

The alternative is for Cedarhurst to drill numerous new wells itself. Locations along the road allowance of the Stamp Sideroad between the wash pond and the complainants' homes would be an obvious place for installation of new monitoring wells. For any such new wells the boreholes should be logged by a qualified hydrogeologist, and monthly measurements of water levels as well as grain size analyses and tests of hydraulic conductivity should be carried out.

Pumping/Tracer Testing

If Cedarhurst wishes to continue to operate a leaky aggregate washing operation (which I would advise against), then any such operation should not be at the expense of local residents.

If Cedarhurst wishes to continue with its existing aggregate washing system, then the MOECC should first of all require the installation of an appropriate monitoring well network (with a sufficient number of wells situated between the Cedarhurst aggregate washing operations and the homes of complainants), and then should require that a pumping test be carried out to try to simulate the effects of Cedarhurst's aggregate washing on the downgradient groundwater flow system.

The details of such a pumping test should include the following:

- water should be pumped from PW1-09 at the maximum permitted rate for a period of 5 days;
- at the same time, as much water as is available should be pumped from the wash pond to the settling ponds;
- water levels in the wash pond and settling ponds should be monitored twice daily (before pumping starts in the morning, and after pumping ends in the evening);
- volumes pumped to the wash pond from PW1-09 should be measured by meter daily;
- regular measurements of water levels should be carried out in a network of appropriate off-site monitoring wells (discussed in the previous section) and residents' wells, starting 24 hours before the start of the pumping test and continuing for 72 hours after the test;
- well water samples should also start to be taken before the test, with water quality sampling (for conductivity, TDS, TSS, and turbidity) continuing over the medium term throughout the test and after the conclusion of pumping.

Consideration could also be given to introducing a unique (non-toxic) tracer to the wash pond, to try to track actual flow paths of water from the wash pond through the downgradient groundwater flow system. Downgradient water quality testing for the tracer in the monitoring well network as well as in selected residents' wells could prove extraordinarily helpful in ascertaining where exactly the water leaking from the aggregate washing operations at the Teedon Pit is going.

Residents' Accounts of Aggregate Washing Impacts

The Complaints Assessment Report has failed to actually document the complaints which it is said to be investigating. I would think that this should have been the starting point of the whole exercise, and would urge the MOECC to develop a comprehensive overview of complaints.

The MOECC should request each household to provide an account of baseline conditions (pre-washing), peak impacts conditions (in years when washing was being carried out), and current conditions (after 2 years of no washing).

6) Discussion of Go-forward Options for Addressing the Complaints

I do not consider the current approach to handling the complaints of off-site well interference from the Cedarhurst aggregate washing operations (which seems to consist of denying that any problem exists) to be reasonable or sustainable.

More than 50% of every liter being pumped during Cedarhurst's aggregate washing operations is being "lost", and that water is going somewhere. The complaints from neighbours of the site appear to confirm that at least some of the lost silt-laden wash water is causing silt contamination of their wells and/or flooding of their properties.

I see at least 5 main options which Cedarhurst and the MOECC could consider as means of addressing Cedarhurst's massive wash water losses and the residents' complaints:

- 1) In recognition of the fact that the wash operations are losing (ie. discharging) on the order of 500,000 liters per day of silty wash water (with peak losses of up to 1 million liters/day), the MOECC could require Cedarhurst to apply for an Environmental Compliance Approval which would quantify and regulate discharges from the site and provide for appropriate monitoring (from an appropriate monitoring well network) and contingency plans to ensure that there are no unacceptable off-site impacts going forward. This would include a pumping test (and possible tracer test) as described above.
- 2) Alternatively the MOECC could request that Cedarhurst implement a true "closed loop" wash operation, with impermeable settling ponds and an impermeable wash pond. This would require all ponds to be lined with an impermeable liner, to be connected by pipe, to not have overflow or outflow facilities, and would require ongoing measurements of pond water levels and nearby groundwater levels to confirm that no leakage was occurring. Inputs of "top up water" for a closed loop system would be strictly monitored, and restricted to a maximum of the industry standard 10% of the water being pumped for aggregate washing.
- 3) Cedarhurst could voluntarily surrender its PTTW, and/or provide binding assurances that it will no longer wash aggregate at its Teedon Pit.
- 4) Alternatively, the MOECC could order a stop to all aggregate washing at the Teedon Pit until all complaints of off-site impacts caused by the aggregate washing have been addressed to the satisfaction of the complainants.
- 5) Cedarhurst could provide alternative water supplies to each affected residence at its expense - in this context the most effective way of doing so would likely be to drill deeper wells into formations unaffected by the aggregate washing.

What would not be reasonable or desirable from my perspective would be a continuation of the status quo, which would be a recipe for continued off-site impacts and needless conflict between residents and Cedarhurst and the MOECC. I sincerely encourage both the MOECC and Cedarhurst to carefully consider the contributions that their respective past actions and inactions have made to the current uncomfortable situation.

Neither the MOECC nor Cedarhurst should be surprised that local residents are going to significant lengths to protect themselves in this matter - it is quite understandable given their dependence on their well water supplies.

I sincerely hope that the MOECC and/or Cedarhurst decide to do the right thing, and take action to improve the current situation. If not, then remedies available to my clients and the other complainants include complaints made directly to the Environmental Commissioner of Ontario and/or the Minister of the Environment. Civil suits are also a possibility. Finally, the amended PTTW expires in 2018 - and filing a request for leave to appeal any renewal of the PTTW is yet another possible course of action if the off-site impact issues have not been satisfactorily addressed by then.

However it would be vastly preferable for this matter to be dealt with in a proactive and precautionary manner. All parties are fortunate that this is not an insoluble problem - the state of the science is adequate to appropriately deal with this matter once Cedarhurst and/or the MOECC decide to do so.

I strongly recommend that no further aggregate washing activities be carried out at the Teedon Pit for the time being, and that Cedarhurst and the MOECC carefully consider the 5 go-forward options which I have presented.

In a meeting with the MOECC and Mr. Campbell, I was asked what it was that my clients are seeking? My understanding is that what they are seeking is restoration of the excellent quality well water which they enjoyed prior to 2009. I believe that all 5 of the go-forward options will lead to this outcome.

In the meantime, there are past losses and expenses suffered by my clients (and perhaps by the other complainants) which appear to have been caused by Cedarhurst's aggregate washing activities from 2009-2013. I would urge Cedarhurst to meet with each affected household with a goal of reaching agreement on how to make good those losses and expenses.

7) Conclusions

Following careful review and consideration of the documents listed in **Appendix 1** of this Report, I have reached the following conclusions regarding the off-site impacts of aggregate washing at the Cedarhurst Teedon Pit:

1) In my professional opinion, the aggregate washing operations at the Teedon Pit are not sustainable given the massive water losses of 50% or more from the wash operations. Leakage of silt-laden wash water into the environment at rates averaging about 500,000 liters per day (ie. about 6 L/second) with peak losses of up to about 1,000,000 liters/day occurred at this site on a regular basis during aggregate washing in 2009 - 2013.

2) It appears that there have been off-site impacts caused by the leakage of silt-laden wash water from the Cedarhurst property, including anomalously high groundwater levels (causing local flooding) and well interference due to the uptake of silty groundwater in local residents' wells.

While there is not conclusive evidence to confirm these impacts (due to the failure by Cedarhurst and the MOECC to collect evidence in response to complaints made when aggregate washing was occurring), the impacts cited by at least 4 separate households around the site are entirely consistent with what would be expected as a result of the massive leakage of silt-laden wash water from the Cedarhurst property.

3) The Complaints Assessment Report has not done a good job of assessing the impacts of the aggregate washing, and should not be relied up by the MOECC in developing a response to the complaints of off-site well interference due to silt contamination of neighbours' wells.

4) Major shortcomings of the information presented in the Complaints Assessment Report include the following:

- the hydrogeological investigation which was the basis for the report did not commence until almost 2 years after the last occurrence of aggregate washing;
- the existing monitoring well network which is being relied upon in the report is utterly inadequate for assessing the off-site impacts of Cedarhurst's aggregate washing operations;
- no attempt has been made to account for the massive water losses from the Cedarhurst operation, or to develop a hypothesis about where the lost silty wash water is going;
- the report is missing key information including wash pond water levels, water levels in wells in nearby test pits, actual meter readings of water being pumped, records of complaints, accounts of baseline well water quality and well water quality at times of peak aggregate washing, and a compilation of detailed information about the geology of the area of the wash pond.

5) The testing of water quality in residential wells in the summer of 2015 occurred about 2 years after the last washing of aggregate at the Teedon Pit, and as such is not in any way reflective of peak impacts which were being experienced by local residents in 2009 through 2013.

6) The hydrogeological conceptual model for the site which is presented in the Complaints Assessment Report is inconsistent with the available information about the site hydrogeology, and does not explain what is happening to the massive volumes of silty wash water being lost from the Cedarhurst aggregate washing operations.

7) The Complaints Assessment Report's conclusion that there is a "flow divide" on the Cedarhurst property which prevents wash pond impacts on homes on Marshall Road is based on a pre-washing (2007) map of water levels measured in off-site wells outside of the area of interest, and thus is considered incorrect.

At times of aggregate washing with the massive water attendant losses, the leakage of about 500,000 liters per day of wash water (with much higher peak water losses) will have caused the aquifer beneath the wash pond and settling ponds to become the high point in the groundwater flow system - and any flow divide will have shifted to directly beneath the wash pond, with outward groundwater flow carrying silt contamination in all downgradient directions from there.

8) The aggregate washing will have had both short-term and long-term effects on the off-site groundwater flow system. The short-term effects would be likely to include anomalous and sudden rises in groundwater levels (which may cause flooding) and silt contamination of wells. The long-term effects would include slowly subsiding silt levels in the shallow aquifer system which has received the leakage from the wash pond and settling ponds. If there is no further aggregate washing, then eventually pre-washing water quality will be re-established.

9) To date the MOECC has not done a good job of overseeing the aggregate washing operations at the Teedon Pit, and has failed to protect the off-site environment and neighbours of the site from the impacts of the leakage of huge volumes of wash water from the Cedarhurst property.

In particular the MOECC failed to recognize that the site conceptual model which was the basis for the original 2008 Permit to Take Water (PTTW) was incorrect, and before issuing the amended 2010 PTTW failed to consider the fate of the massive volumes of silty wash water leaking from the Cedarhurst settling/wash ponds into the underlying groundwater flow system.

10) All parties are fortunate that this is not an insoluble problem - the state of the science is adequate to appropriately deal with this matter once Cedarhurst and/or the MOECC decide to do so. There are a number of reasonable and feasible go-forward options for dealing with the off-site impacts of aggregate washing at the Teedon Pit which are presented in **Section 6** of this report.

8) Recommendations

Recommendation #1

In my professional opinion there is potentially a contravention of Conditions 4.2 and 4.3 of the April 18, 2008 Permit to Take Water, which should be investigated by the MOECC.

These conditions required Cedarhurst to measure and record:

- static water levels in monitoring well MW1 and accessible test pit standpipes;
- wash pond water levels.

Recommendation 2

- a) Based on the available information I believe that Cedarhurst failed to comply with Condition 5.1 of its PTTW with regard to complaints made by my clients (Bonnie Pauze and Jake Pigeon). These contraventions of Condition 5.1 of Cedarhurst's Permit to Take Water for the Teedon Pit should be investigated by the MOECC.
- b) I also recommend that the MOECC should carefully investigate the history of other complaints which may have been made to Cedarhurst and/or the MOECC by other neighbours of the Teedon Pit.

Recommendation 3

- a) The MOECC should contact Cedarhurst and Tiny Township (and conduct a thorough search of internal files), and seek to obtain copies of all complaints received relating to potential impacts of the aggregate washing at the Teedon Pit on local groundwater levels and/or well water quality (in particular silt contamination). This should include complaints which are now considered to be resolved.
- b) The MOECC should compile the full record of all complaints, and make it available to Cedarhurst, the Township, and interested members of the public.
- c) Cedarhurst and the MOECC failed to do any baseline testing of water quality in wells of the residents who have filed complaints about the impacts of aggregate washing. Given the absence of baseline testing, the only sources of information about baseline conditions are the residents themselves. I recommend that formal Affidavits regarding pre-2009 well water quality be sought from the affected residents by the MOECC.
- d) As part of this process, the MOECC should also request that each household provide an account of conditions at times of peak impacts (in years when washing was being carried out) compared to current conditions (after 2 years of no washing).
- e) Please note that I have recommended that the MOECC do the above recommended work, because of Cedarhurst's consultants failure to do so.

Recommendation 4

Numerous additional monitoring wells situated between the Teedon Pit wash pond and downgradient receptors are required if Cedarhurst wishes to carry out a credible hydrogeological impact assessment of its aggregate washing activities.

Locations along the road allowance of the Stamp Sideroad between the wash pond and the complainants' homes would be an obvious place for installation of new monitoring wells. For any such new wells the boreholes should be logged by a qualified hydrogeologist, and monthly measurements of water levels as well as grain size analyses and tests of hydraulic conductivity should be carried out.

Recommendation 5

If Cedarhurst wishes to continue with its existing aggregate washing system, then the MOECC should first of all require the installation of an appropriate monitoring well network (with a sufficient number of wells situated between the Cedarhurst aggregate washing operations and the homes of complainants), and then should require that a pumping test be carried out to try to simulate the effects of Cedarhurst's aggregate washing on the downgradient groundwater flow system.

The details of such a pumping test should include the following:

- water should be pumped from PW1-09 at the maximum permitted rate for a 5 day period;
- at the same time, as much water as is available should be pumped from the wash pond to the settling ponds;
- water levels in the wash pond and settling ponds should be monitored twice daily (before pumping starts in the morning, and after pumping ends in the evening);
- volumes pumped to the wash pond from PW1-09 should be measured by meter daily;
- regular measurements of water levels should be carried out in a network of appropriate off-site monitoring wells (discussed in the previous section) and residents' wells, starting 24 hours before the start of the pumping test and continuing for 72 hours after the test;
- well water samples should also start to be taken before the test, with water quality sampling (for conductivity, TDS, TSS, and turbidity) continuing over the medium term throughout the test and after the conclusion of pumping.

Recommendation 6

A series of 5 go-forward options for addressing residents' complaints (of local flooding caused by high groundwater levels and/or silt contamination of their wells) are presented in Section 6 of this report. I strongly recommend that no further aggregate washing activities be carried out at the Teedon Pit for the time being, and that Cedarhurst and the MOECC carefully consider the 5 go-forward options which I have presented.

In the meantime, there are past losses and expenses suffered by my clients (and perhaps by the other complainants) which have likely been caused by Cedarhurst's aggregate washing activities from 2009-2013. I would urge Cedarhurst to meet with each affected household with a goal of reaching agreement on how to make good those losses and expenses.

9) Signature and Professional Stamp

This report has been prepared in its entirety by Wilf Ruland (P. Geo.). It is based on my honest conviction and my knowledge of the matters discussed herein following careful consideration and review of the documents in the Reference List in **Appendix 1** of this Report.

This review has been prepared exclusively for the use of my clients, Bonnie Pauze and Jake Pigeon.

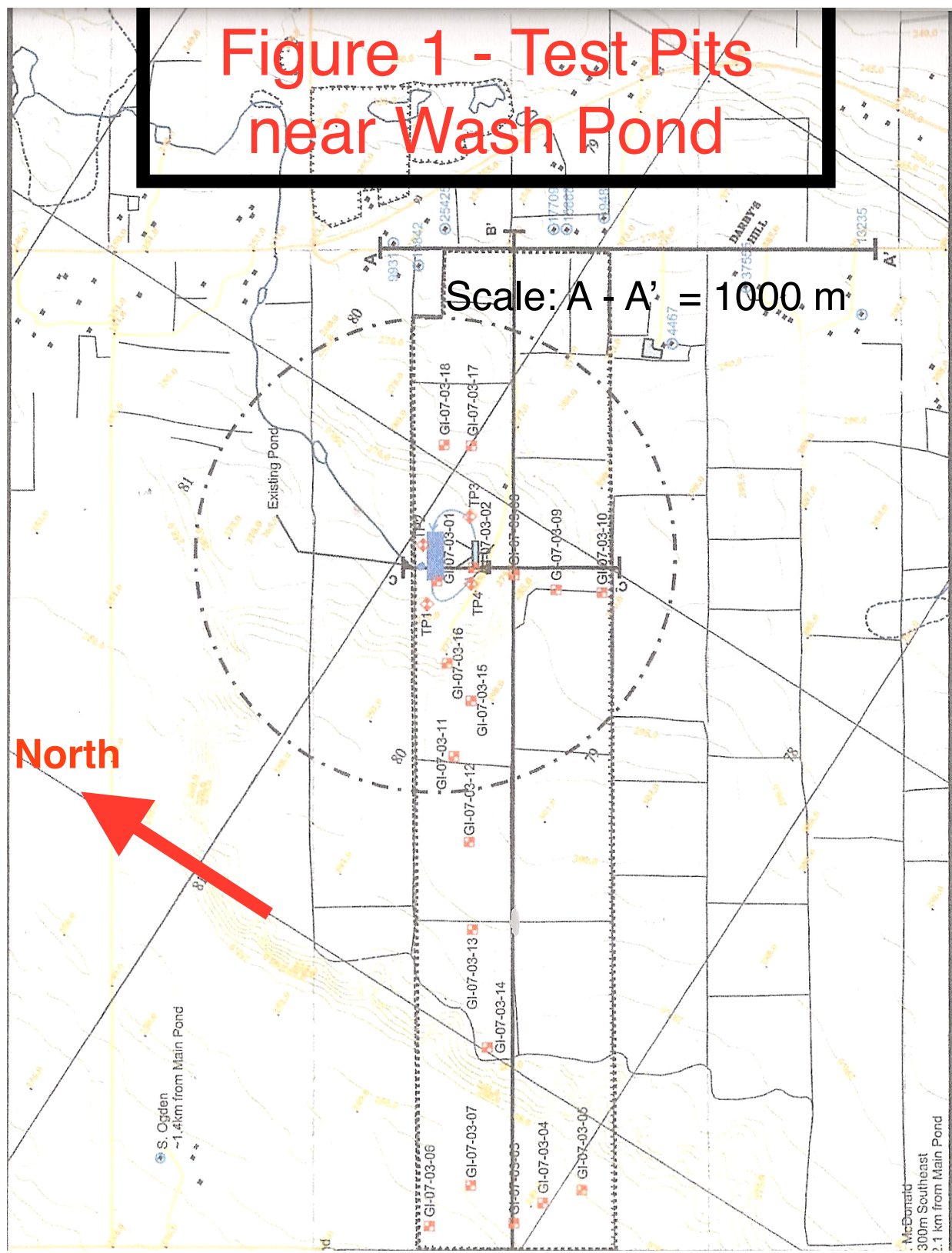
Signed on the 20th of October, 2015



W. Ruland

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Local Well Locations		
Date: July 2015	Project: AES 15-08	Figure 2
Drawn: FRC	Scale: NTS	

Appendix 1

List of Documentation Reviewed or Referenced

The following list includes most of the key documentation which has been reviewed or referenced in the course of preparing this Report.

Alpha Environmental Services Inc. August 2015. Assessment of Local Well Water Quality Complaints.

Alpha Environmental Services Inc. April 2010. Aggregate Wash Water Supplementary Supply Pumping Test Results.

Alpha Environmental Services Inc. June 30, 2009. Letter to Mr. Christopher Munro, MOECC.

Chapman and Putnam (1984). The Physiography of Southern Ontario.

Domenico, P.A. and Schwartz, F.W. 1998. Physical and Chemical Hydrogeology.

Freeze, R.A. and Cherry, J.A. 1979. Groundwater.

Skelton Brumwell & Associates, February 1993. The ARA Site Plans, including the following sheets:

Drawing 1 - Existing Features

Drawing 2 - Operational Plan

Drawing 3 - Progressive and Final Rehabilitation Plan

Drawing 4 - Cross-Sections

Ontario Ministry of Natural Resources (MNR), January 2010. Rules and Regulations; under The Aggregate Resources Act. Available on the MNR website.

Ontario Ministry of the Environment, April 18, 2008. Permit to Take Water No. 0503-7D4PX7.

Ontario Ministry of the Environment and Climate Change; July 23, 2010. Amended Permit to Take Water No. 4317-87CNZN.

Shotyk, W. et al, 2010. Trace Elements in Recent Groundwater of an Artesian Flow System.

Waterloo Geoscience Consultants Inc. May 17, 2007. Hydrogeological Investigation to Support an Application for a Permit to Take Water, proposed Wash Plant, Teedon Pit.

Appendix 2

E-mailed Complaint

from Bonnie Pauze and Jake Pigeon.

Sent to MOECC on February 24, 2015.

Follow up Email from our telephone conversation of Feb 9/2015 regarding the Beamish Waverley pit (Cedarhurst Quarries)

We are making a formal complaint to the Ministry of the Environment regarding the existing Beamish Pit in Waverley ON.. (Cedarhurst Quarries and Crushing LTD). We are experiencing an adverse impact and the following neighbours are also experiencing an adverse impact.

- **Peter and Jenny Anderson**
- **Kim Tower**
- **Glenn and Janet Irvine**
- **Bonita and Rick Haggart**
- **David Barkey**
- **Rick Lang**

We have lived at 1189 Marshal Rd. since 1993.

We have two artesian wells that are essential to our existence and to our farming operation.

The quality ,quantity and clarity of our water was excellent. This was validated through extensive testing which was done by a world renown hydro geologist during the site 41 conflict. This was Dr.Bill Shotyk University of Heidelberg as Professor and Director of the Institute of Enviromental Geochemistry.

It was the spring of 2009 when there were the initial changes to our two flows .The quantity of water significantly diminished.

In June, July, August and September 2009 we had silt in our water in both flows. The water was no longer clear. It was muddy and we could no longer drink it.

In 2009, the well which is south of us, overflowed. This well belonged to our neighbor MR. Steve Ogden. Also, and in addition to this, water started to flood the ditches on Marshall Rd to such a point that the Township of Tiny had to place a culvert across Stamp Side Road to divert the excess water.

The only changed activity was the development and mining of Cedarhurst Quarry off of Darby Rd. in Tiny Township

In the winter of 2009, the amount of silt in our water diminished.

In the spring 2010 the silt returned to both artesian wells. At this point I started to collect water samples.

Summer 2010 my husband visits the Pit on Darby road and speaks to a pit worker who says they wash gravel. He calls [705 325 7447](tel:7053257447) he speaks to Rick who said he would make a note of it but they had not washed any gravel this year.

Summer 2010 called the township and complained to By law

Sept 2010 Silt continues.

Replaced two washing machine due to silt destroying the pumps.

Pressure tank needed to be replaced

Water pump all needed replacement due to the silt

October 2010 cleaned holding area for water. It had buckets of silt .

The Intake was covered

We bought a water filtration system with .005 filters

January 2011 hot water tank cleaned for two pails of silt Hydro Bill 700 dollars

And we Replaced two toilets damaged by silt

June 2011 silt increases in both wells

Dr. Bill Shotyk University of Heidelberg as Professor and Director of the Institute of Environmental Geochemistry, was called and he retested our water.

July 2011 replaced hot water tank

Flushed our hot water heating system and replaced radiators.

Aug 5/2011 lots of silt in both flows

I called Rick at Beamish expressing my frustration and concerns. He said he would send a man to have a look the following day but didn't feel it's his problem and they that are not having an impact on our wells. No study was done to confirm whether or not they were having an impact.

I waited all day no one appeared .

Aug 6 /2011 I called back to Beamish and left voice mail. No one returned my call.

On Aug 2011 I called the township bylaw who said they would call us when there would be a public mtg.

Spring 2012. silt in our water cleaned well reservoir

replaced another washing machine.

Pump in Jacuzzi plugged with silt

Waiting for mtg .

2013 silt in both flows

2014 received notification from Tiny Township of Beamishes request to expand and the public meeting January 26/2015.

Outcome of the Mtg. Tiny Township agrees to put Zoning approval on hold due to a lack of information and concerns addressing the issues.

Ad hoc information

**Our neighbor Steve Ogden had adverse effects with Beamish regarding his water and had reported it to the MOE ,MNR, County of Simcoe, and the Township of Tiny with no positive outcome or cumulative impact study implemented
He decided to sell his property and it was purchased by Sarjeant's Paving Company.
How coincidental?**

Our concerns are also with Sarjeant's NEW developments where they have clear cut approximately 40 acres of old growth maples and they have permit to remove 2 million tonnes of aggregate per year. We are very concerned how this will further impact our aquifer. This area is over the very recharge zone which is referred to in Jagger Hims calibrated model report which was completed for the county of Simcoe.

Do they have a water taking permit?

Has a cumulative impact study been completed involving a three kilometer radius of this site?

At present Beamish Pit ,Cedar Hurst Quarry Pit, and the Sidhorpe Pit have a permit to remove 600 thousand tonnes per year and can remove 1.2 million liters' of water from the aquifer daily. This is the very aquifer that is identified in the Jagger Report, Hydro Geologist consultation, which indicates that the Waverley uplands are a recharge zone and need to be protected.

In Conclusion:

It is our understanding that when a water taking permit has been issued by the Ministry of Environment, it is the responsibility of the permit holder to address any complaints and/or concerns and the district office shall immediately be notified. Has this been done by the permit holder?

There has been a permanent adverse effect and a negative impact to our water supply since they commenced mining the Waverley Uplands.

This area has been investigated in the past. Site 41 was stopped with prudent judgement to protect the precious aquifer. There is substantial investigation and

documentation that would support our request for a cumulative impact study before any further mining occurs in this very water sensitive area.

Looking forward to your response to our concerns.

Bonnie Pauze and Jake Pigeon

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