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INVESTIGATIONS OF CONTAMINATED SITES

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Site investigations for special waste are not new; however, recently the demand for environmental site audits has increased significantly. Real estate developers want to be able to assess their liabilities prior to land purchases; bankers want to assess the security of their loans. Consequently, more and more business decisions are being based upon the results of special waste site audits.

As the demand for auditing services has increased, so too have the requirements of a thorough site investigation. Strict sampling protocols must be followed to minimize the potential of cross-contamination of samples. On-site rapid assessment techniques, coupled with laboratory analysis of water and soil samples must be used to characterize the site soils and groundwater chemical quality. Soil profiles and the physical characteristics of the groundwater flow regime must be determined.

The liability of conducting environmental audits has grown in proportion to the increase in service demand. In response, the quality assurance and quality control of the investigation program, especially with respect to sample collection and sample analysis, must be considered paramount in importance.

The basic approach to all special waste site investigations is generally the same. However, the detail of successive investigative steps varies from site to site. Three types of site investigations are discussed to illustrate the variations in approaches, and the particular difficulties generally associated with each investigation. The examples are based upon case histories, and include:

. an investigation of fill materials of unknown origin;

. an investigation of the soils in the immediate vicinity of an underground hydrocarbon storage tank; and

. an investigation of a multi-tenant commercial/ industrial site.

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1.0 INTRODUCTION

Site investigations for special waste involve; conducting historical land use surveys, developing descriptions of the site, determining present site uses, sampling soils and groundwater, developing soil profiles and the physical characteristics of the groundwater flow regime, and analyzing samples in the field and in the laboratory for concentrations of special waste chemicals. Primarily, the investigations are designed to determine if special waste concentrations are present on a site, or if present, whether or not these concentrations warrant more detailed investigation to quantify and delineate the extent of contamination. In cases where contamination is suspected, remediation investigation work may be incorporated into the initial study program. This situation may be applied in the case of hydrocarbons which can be assessed in the field.

Recently, the demand for site investigations for special waste has increased as has the demand for detailed quantitative evaluations.

Further, the present market is making special demands on investigators. The site investigator must design a program that will with reasonable confidence accurately characterize a site; that will be reasonably priced; and that does not result in unnecessary liability to the investigator. Time constraints pose additional problems when coupled with requirements to delineate the extent of contamination during initial investigations. Each of these special demands and related problems will be discussed, and three brief case histories presented to illustrate some of the challenges associated with conducting site investigations for special waste.

2.0 WHY ARE SITE INVESTIGATIONS FOR SPECIAL WASTE COMMISSIONED

Site investigations for special wastes are commissioned to identify if property is safe for public use; to comply with municipal or government regulations; and to understand or limit development and potential liabilities of the property.

The general public is perceived as being a major force demanding greater environmental responsibility and accountability. Public awareness of environmental issues, even within the past year, has increased dramatically, and the public is displaying an unwillingness to accept health risks, real or perceived, associated with chemical pollution. Existing provincial and federal legislation, and municipal by-laws do regulate special waste; and site investigations are required in some jurisdictions for compliance. However, the existing regulations are not all-encompassing. More definitive legislation is expected in the near future in response to public pressures and the need to remediate special waste contaminated sites.

Trends in special waste legislation are illustrated by current U.S. legislation, and in particular the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). If Canadian law makers follow the U.S. lead, the future liabilities associated with contaminated sites for Canadian developers and investors could be considerable. This risk of future liability probably represents the greatest motivation for land owners, developers, and investors to have property evaluated for special waste. Individuals and companies must have a means to assess their future liability and site investigations for special waste provide such a mechanism.

2.0 THE SITE INVESTIGATION FOR SPECIAL WASTE

The basic program for a special waste site investigation includes:

- conducting a historical land use survey;
- conducting a survey of current land usage;
- reviewing site maps and geotechnical reports, if available;
- determining what future land uses are planned;
- planning and conducting a soils characterization and sampling program;
- planning and conducting a water/ groundwater characterization and sampling program;

- planning a chemical analysis program;
- evaluating the results;
- developing recommendations for remediation investigation work, or remediation if required; and
- reporting the results and recommendations.

In simple terms, the client wants to know: whether or not a property is contaminated with special waste; how extensive the contamination is, if present; what remediation options are available, and how much remediation will likely cost. A thorough site investigation should provide answers to the above questions. However, there are many ways to answer, and questions must be asked of each answer. How representative of the property soils conditions was the sampling; what was the potential of cross-contamination of samples during collection; what did the chemical analysis program focus on; how reliable is the laboratory analysis.

This ability to provide different answers create special demands or problems for the site investigator and forms the focus of this discussion. These problems are similar to those faced by geotechnical engineers conducting a foundation soils investigation; however, with special waste, an established protocol based upon years of experience and case histories does not presently exist.

3.0 SPECIAL DEMANDS AND PROBLEMS FOR INVESTIGATORS AND POSSIBLE RESPONSES

Time constraints pose special problems to site investigators for special waste. A large portion of the demand for site investigations originates from commercial real-estate agencies and real-estate developers. Land purchase options often contain subjects detailing specific option expiry dates. Planning a thorough site investigation is time consuming, especially with regard to conducting a historical land use survey. Unless detailed records of previous site activities are available in local municipal land registry offices, or in local libraries, former land owners and individuals who have worked on the property should be contacted. Responses to these type of inquires can require several days which are often not available if the site investigation is to be completed prior to the subject expiry date.

A thorough historical land use survey can be extremely valuable. Important information is often deleted from current site plans, and could include the location of buried septic fields, abandoned underground hydrocarbon storage tanks, backfilled leach or dip pits, or the location of an old bog since filled in with unknown materials. The historical land use survey allows an investigator to concentrate a part of his or her limited resources in potential problem areas. Further, the survey may indicate what type of contamination can be expected and laboratory analysis planning can be adjusted accordingly. Severe time constraints result in a tendency to reduce the scope of the historical land use survey, or even to not conduct the survey. This action can only increase the potential liability of the investigator. If the time constraint is too severe and the site is perceived to have a complex history, the commission should be declined. The only remaining option is to adjust your time commitments to accommodate this necessary task.

The scope of the site investigation for special waste as compared to the client's expectations also can create special problems for an investigator. Primarily, a site investigation is designed to determine if special waste concentrations are present on a site, or if present, whether or not these concentrations warrant more detailed investigation to quantify and delineate the extent of contamination. Upon the completion of the investigation where special waste has been identified, clients want to know the extent of the contamination, and how much the remediation will cost. The ability to provide relative answers depends on the intensity of the sampling program and the amount of money committed to chemical analysis. However, definitive answers are usually not possible, unless a potential source had been identified prior to the site investigation and targeted. Confusion over what is offered and what is expected can be eliminated prior to the acceptance of a job, as well as an unnecessary source of liability to the investigator. A letter of proposal should clearly delineate the sampling program, the objectives of the study, and the type of information which will be provided to the client.

Sampling protocol is perhaps one of the largest sources of problems in a site investigation for special waste. There are no regulations that dictate the number of auger holes that should be drilled or the number of test pits that should be excavated. Further, there are no regulations which dictate the number of samples that should be collected from a site. The number of drill holes, test pits and samples necessary for results to be reasonably representative of site conditions can best be achieved by experienced and on ongoing review of case histories.

There is an upper boundary which is established by the amount of money available for the site investigation. Large sites with complex histories of commercial or industrial activities obviously require more detailed work than small sites with no commercial or industrial history. The importance of a historical site survey is again emphasized. Yet, this upper boundary imposed by what a client is willing to spend may not be reasonable or considered sufficient if years after the survey, contamination surfaces. The investigator may be assuming unnecessary liability by allowing a client to dictate the intensity of a sampling program.

There are statistical sampling programs available, developed for environmental studies and geological evaluations, which can provide guidelines for establishing sampling intensity. Random sampling may, in some cases, be more relevant in that a relatively small volume of contaminant initially located within a small locale on the site has the potential to cause extensive contamination of the site with time. This type of situation will always be problematic. Surface drainage conditions and the groundwater flow regime can help to focus the sampling program; thus aiding in establishing sampling intensity. Theoretical approaches are useful in establishing guidelines; however, the selection of a sampling intensity should in part be dependent on site conditions. Sampling intensities are presented for the case history examples.

Cross-contamination of samples is another problem associated with sampling protocol, and creates another potential source of liability for the site investigator. Soils and water samples are being analyzed for special wastes parameters in parts per million, or parts per billion. A dirty drill rig, backhoe or even a hand sampling tool can transfer contaminates from sample to sample collected from one location, or transfer contaminants from one location to another. Cross-contamination of samples can seriously effect the interpretation of results.

The potential for cross-contamination can never be entirely removed; however, the frequency of occurrence can be considerably reduced. The procedures are simple, but in practice are often ignored because they are inconvenient. All sampling tools must be washed between sample collections in soapy water, followed by a double rinse. A double rinse ensures that soap residues are removed. Drilling and excavator equipment must be steam-cleaned prior to the site investigation, and drill stem, drill augers, sampling equipment, and backhoe buckets must be steam cleaned between sampling locations. Once equipment operators become used to the procedures involved, delays in the sampling program are minimal. The extra time is well spent. Sample analysis is very expensive, and contaminated samples not only waste clients money, but also jeopardize the site investigation validity.

After the soil and water samples have been collected; the samples are sent to a laboratory for chemical analysis. Several problems can arise in this seemingly simple step. First, a chain of custody should be established. If the samples are mis-placed by the laboratory, they are very expensive to replace. This is not an unknown occurrence. Second, at least one duplicate soil and water sample, as well as a spike or blank should be included for analysis. This procedure provides a mechanism to evaluate the quality and accuracy of the laboratory analysis. Many laboratories in Vancouver analyze a split of one sample, as well as run quality control samples. Results from the quality control samples should be requested for each site investigation. This procedure ensures that internal laboratory control is conducted on a regular basis.

The most significant problem associated with laboratory analysis, however, is deciding which samples should be analyzed and for what chemical parameter. A complete suite of chemical analysis may cost in excess of $1,000. Eight groups of parameters are listed in the British Columbia Standards for Managing Contamination at the Pacific Place Site. It is not practical to analyze for each parameter in every sample.

This problem is in many ways similar to the selection of a sampling intensity for a particular site. Site histories, and present land uses provide guidance as to which contaminants are most probable. Confirmatory analysis of other parameters on select samples is often desirable. Sample selection for hydrocarbons can be somewhat simplified through the use of an organic gas vapour analyzer. Results are qualitative unless a specific organic compound has been isolated, however, presence/ absence determinations are quite dependable as are relative concentrations. Head space above soil samples is analyzed. Metals analysis is relatively inexpensive, as is oil and grease. Both of these parameters can be applied extensively and used a indicators of special waste contamination. Lead, for instance, is found in gasoline. Samples with high lead concentrations can subsequently be tested for benzene, toluene, ethylbenzene, xylene (BTEX) and total extractable hydrocarbons. The analysis selections for the case history examples are presented.

4.0 EXAMPLES OF SITE INVESTIGATIONS FOR SPECIAL WASTE BASED ON CASE HISTORIES

Case A: Site Investigation for Special Wastes in Fill Materials

Our typical site has an area of 6000 square metres. Fill was placed on the site at least five years ago by a previous owner, and the source of the fill material was not recorded. A geotechnical soils investigation report indicates that the fill thickness varies between one-half and two metres. The fill is thicker on the southern half of the property.

Our client has an option to purchase, which expires in 30 days, and wants to know if the fill material is suitable for commercial/ residential development. The client is not concerned about the original land, because the site was never used for commercial or industrial purposes.

A work scoping document was prepared and sent to the client prior to the acceptance of this site investigation for special waste. The scope of work was limited to the fill material; however, we recommended that samples be collected from native soils immediately underlying the fill. This procedure is prudent in that should contaminants be detected in the fill, native soil samples can subsequently be analyzed to determine the extent of contaminant migration.

A telephone conversation with the land owner indicated that the site had never been used for industrial purposes. The present owner did not know where the fill material was from; however, the names of a previous owner and a local resident were provided as alternative sources of information. Further inquiries into the source of the fill were unsuccessful. Local acquisition was considered probable, due to the cost of fill transport. However, the activities in the immediate vicinity of the site did include some light industrial and commercial activities.

Planning the fill site investigation was, in this instance, not facilitated by a historical land use survey. Thus, sampling intensity had to be determined on a more theoretical basis. The property was divided into 100 square metre sampling blocks. A sampling coverage of 15 percent of the site area was considered reasonably representative, thus, nine sampling areas, each representing a 100 square metre block of land, were selected. Four sampling blocks were arbitrarily selected in the corners of the site. The remaining five blocks were randomly selected. During the field investigation, these five sampling blocks were re-located with reference to the local surface drainage pattern. The land sloped towards the south, and fill was thicker in this region. Thus, three of the five sampling blocks were positioned in this sector.

The site investigation was conducted with a back-hoe. The type and quality of the fill can be assessed with more confidence from test pits rather than bore holes; however, the potential of sample contamination is greater than with drill hole samples. One test pit was excavated in each sampling block. In each test pit, one sample was collected from a depth of 0.15 to 0.3 metres, one sample from immediately above the seepage level, and one sample from immediately below the groundwater table. If the groundwater was not encountered, these latter two samples were collected from depths of 0.6 to 0.9 metres and 1.3 to 1.6 metres respectively. One sample was collected from native soil in each excavation. Three shallow samples were extracted at a six metre radius from the test pit using a thief sampler.

The chemical analysis program was general, considering the possible sources of the fill material. Each soil sample was tested for the presence of hydrocarbons in the field using a portable organic vapour analyzer. The laboratory was requested to make composites of each shallow fill material sample collected from a sampling block. One composite was made from the fill samples extracted from depth in each test pit. Samples of native soil were stored.

Each of the 18 fill composites were analyzed for metal, sulphur and oil and grease concentrations. Two composites were analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX); and two composites were analyzed for total extractable hydrocarbons. One composite was analyzed for polycyclic aromatic hydrocarbons and one composite was analyzed for chlorinated hydrocarbons (PCB's). One sample duplicate was analyzed for metal concentrations. Individual samples were stored by the laboratory pending analytical results on the composite samples.

In this example, elevated concentrations of special waste were not found in the composite samples. If elevated concentrations were detected, recommended procedure would be to have the individual samples analyzed for the specific parameter of concern. Samples of native soil should also be analyzed to determine the probably extent of contamination. Client approval must be obtained prior to proceeding, as this extra analysis is beyond the scope of the investigation.

This site investigation example demonstrates two problems; the problem of determining sampling intensity, and the problem of determining an analysis program. The approach may vary from investigator to investigator, but the end result must be the same. The investigator must be reasonably confident that the sampling and analysis programs reasonably represent the site being investigated. The program outlined above also has a versatility, in that, should contaminates be detected, more detailed analysis can be conducted without further field sampling.

Case B: An Investigation of the Soils in the Immediate Vicinity of an Underground hydrocarbon Storage Tank

Our typical investigation involves a client who wishes to sell his property. A prospective purchaser has expressed interest in the property; however, purchase is conditional on the present owner removing the underground tank and providing a special wastes audit report on the soils in the vicinity of the tank to the prospective purchaser. Sampling access of the soils surrounding and underlying the tank will be provided by the tank removal contractor.

In this case, inquiries were made to determine the age and material of the tank. The present owner stated that the tank had been in the ground for at least ten years. It is highly probable that a tank of this age has or is leaking.

Two soil samples were collected from native soil underlying the tank. Samples were extracted from a depth of 0.3 metres into the native soil underlying the fill which surrounded the tank. Two samples were also collected from side walls of the excavation at a depth below the invert of the tank.

The groundwater level or seepage into the excavation was recorded, as well as the general condition of the extracted tank. In this case, the tank appeared to be intact. However, analysis of the free air on top of the soil samples indicated elevated hydrocarbon concentrations. The excavated fill material was replaced, but subject to removal pending laboratory confirmation of field results.

The laboratory results quantified and confirmed the field analysis for hydrocarbons. The British Columbia Ministry of Environment guidelines detailed in the B.C. Standards for Managing Contamination at the Pacific Place Site, April,1989, recommend soils remediation for the concentrations of hydrocarbons found at this site. However, this site investigation cannot delineate the vertical and lateral extent of the contaminated soil. Clients, though, want to know the extent of their problem. A drill program in this case was recommended to confirm and delineate the soil contamination.

This type of site investigation has two associated problems; sample contamination is a concern, and if contamination is indicated, not even an approximate extent of contamination is determined. Thus, the client is exposed to delays, and another field program. One possible solution is to immediately expand the excavation, should organic vapour analysis in the field indicate gross contamination with hydrocarbons. Client approval must be obtained prior to proceeding.

Case C: An Investigation of a Multi-tenant Commercial/ Industrial Site

Our typical site has an area of 24,000 square metres, and is considered prime commercial/ industrial real-estate. The prospective property purchaser and developer is experienced with industrial real-estate and wishes a thorough site investigation for special wastes. The site evaluation will be used to obtain approval for development financing. Present and past activities are known, and special waste contamination is a concern. Site activities presently include: lumber storage, auto repair, auto painting, metal fabrication, metal plating, and electrical equipment maintenance.

The site investigation itself will not be detailed in this example. The importance of this example is its size and complexity. A very thorough site investigation for special waste was conducted, and involved 30 auger holes and four piezometer installations. A detailed site history, combined with inquiries into present site activities was crucial in establishing the sampling and laboratory analysis programs. Specific investigations targets such as an underground storage tank, a septic tank, and a landfill area were isolated. Rapid assessment for hydrocarbons was conducted in the field.

The major problem associated with this investigation was a very severe time constraint. The client had a subject to purchase with a defined expiry date, and had not considered the necessity of a site investigation for special waste. Project financing, however, required a site investigation prior to approval. The initial site investigation was completed prior to the client's deadline; unfortunately, hydrocarbon contamination was found in the vicinity of the underground storage tank. The time frame did not permit further study, and a delineation of the extent of contamination was not possible. As site investigations for special waste become more of a standard procedure for the completion of land transactions, time constraint problems should be reduced. In the example provided, financing was withheld subject to a detailed delineation of the extent of the contamination. The option to purchase expired, however, before this could be completed.

5.0 CONCLUSIONS

The three case histories illustrate some of the present problems associated with site investigations of special waste in British Columbia. Developers and financial institutions presently underestimate the time required to conduct investigations; regulations are not fully developed and are subjected to change; and investigation protocols based on case histories in B.C. are still being developed.

As environmental site audits become common for all aspects of property development, it is essential that case histories are presented and investigation protocols reviewed and discussed. This process will ensure that the consulting industry can continue to provide a useful service to clients and at the same time protect itself against litigation.