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8 July 2009

Gary Bedford
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Dear Gary

Marfell Park Sampling Plan

1.0 Introduction

This sets out the proposed sampling plan to assess the risks to users of Marfell Park from possible dioxin contamination.

The background to the project is that the park is located on a former municipal landfill in which hazardous wastes may have been buried between the early 1950s and 1970s. The landfill was closed in 1976 and subsequently was developed into the park, which has a children's playground, skateboard park, BMX track and two former sports field areas that now have casual use.

Recent laying of stormwater pipes in the northern part of the park, in the vicinity of the playground, encountered some crushed drums with a small amount of chemical residue about 2 m below the surface. Laboratory testing of the waste and surrounding soil by Taranaki Regional Council (TRC) revealed trichlorophenol (TCP), tetrachlorobenzene (TCB) and dioxin contamination (2,3,7,8-TCDD) within the waste. Small concentrations of some other organic pesticide compounds (including the organophosphate insecticide dichlofenthion) were also detected but these are not of concern at the concentrations found.

The crushed drums and a large amount of surrounding soil (about 210 m^3) were removed to secure disposal at Colson Road landfill and the excavation backfilled with clean imported soil.

The discovery of the chemical residues has raised concerns within the community that there could be general dioxin and other contamination within the landfill and that this contamination could also be affecting the surface of the park. Park users are concerned that they or their children might be exposed to such contamination in their day-to-day use of the park.

2.0 Site description and history

The following description has been derived from information provided by New Plymouth District Council (NPDC) and TRC staff, the New Plymouth BMX Club, local residents and a site walkover on 19 June 2009.

The park (see attached figure) has an area in excess of 6 ha and is formed on top of a landfill which filled a south to north trending gully on three levels. The depth of fill is unknown, but judging by the current topography is perhaps 20 m or more deep in the deepest parts of the upper two levels of the park. If so, the volume of landfill is expected to be at least several hundred thousand cubic metres. The park is bounded by the remnants of the gully walls which slope steeply up to Marfell School and residential properties on Endeavour Street to the west and residential properties on Cook Street to the east.

The top level of the park has an area of about 3.3 ha and the intermediate level has an area of about 1 ha. Combined, these two areas make up the majority of the park but perhaps the least intensively used. Both are grassed areas originally developed as sports fields but no longer used for that purpose. The sports fields were developed jointly in 1977/78 by the then New Plymouth City Council and the Education Department for use by the adjacent Marfell School and as rugby fields by a local club. The landfill material was capped with imported soil and perimeter surface drains installed. Not surprisingly, the fields were a maintenance problem due to settlement and the council routinely imported truckloads of soil every year to deal with hollows that developed. The school ceased using the playing fields, except occasionally, from the mid-1980s, following a drop in the school roll.

The park was converted to soccer pitches in 1991 and was also used for softball. The park was upgraded in 1995 for the then New Plymouth United Football Club but the club went out of existence and the upgraded park was not used for organised sport from that point on. The clubrooms fell into disrepair and were demolished last year.

The middle and upper levels of the park now have a slightly undulating surface as a result of further settlement and are unsuitable for sports use. They are used in a casual way by local residents and as a thoroughfare, including by children going to and from school. The local school seldom uses the park except for “clean up Marfell” events each term. The most regular users of the upper part of the park are probably skate boarders, who use a skate park at the southern end of the park. The skate park is constructed of concrete on slightly higher natural ground. Being on natural ground the skate park presents no particular risk from soil contaminants.

The lower level of the park is very roughly triangular, narrowing towards the main entranceway off Grenville Street, and has an area of about 1.6 ha. A further entrance is up a grassed slope off Cook Street. The lower level is occupied, south to north, by a BMX track immediately below the terrace face of the intermediate level of the park, a carpark for the BMX track, a grassed area on which is located a children’s playground, and a sealed accessway past the playground to the carpark.

While the main landfill is reported to be south of the BMX track (starting at the terrace face immediately south of the BMX track), BMX club members report that there is waste material at shallow depth below the lowest parts of the track. The majority of the BMX track has been built up with at least 1 m and typically several metres of imported fill to create the undulating gravel-surfaced track itself and grassed areas in between.

Waste was also encountered in the recently excavated stormwater pipe trench from immediately south of the carpark to about halfway to where the trench intersects the entrance road. This would put the northern extent of the waste roughly at the southern extremity of the playground, roughly being a line from the swings to the east and a small “round about” near the entrance road to the west. Land to the north, including further play equipment, probably does not have waste material under it. It can be assumed that waste extends under the gravel-surfaced carpark. Somewhat speculatively, the waste under the lower part of the park is probably shallow, a few metres at most, thinning towards the north, and possibly represents waste that was buried towards the end of the landfill’s life.

Some information exists with respect to the amount of soil cover over the waste. Soil borings carried out by NPDC over the upper two levels in April 1995, possibly associated with planning the 1995 playing field upgrade, show cover depths of between about 600 mm and 1 m. Waste is located perhaps as little as 200 or 300 mm below the lowest parts of the BMX track, but is otherwise a metre or more down, while photographs of the excavation for the stormwater pipe suggest waste at depth of as little as 200 or 300 mm but more typically 500 mm. The final profile after the completion of the stormwater work is expected to cover the waste by at least 500 mm.

The landfill produces leachate. Prior to the late 1990s leachate was able to discharge to the stormwater system. A leachate drain at the toe of the landfill now discharges to the council wastewater system. The old stormwater pipe in the vicinity of the playground is in poor condition and could be subject to infiltration of leachate. However, the replacement stormwater pipe should have little if any infiltration of leachate. Both the old and new stormwater pipes, which also convey road runoff, discharge to the Mangaotuku Stream a few hundred metres away. The discharge point for the new pipe is orange-stained from iron oxide. Iron-oxide staining was also observed in a nearby roadside gutter which runs permanently from iron-rich groundwater seepage unrelated to the landfill.

3.0 Currently perceived risk to park users from soil contamination

The landfill waste will contain a variety of heavy metal and naturally formed and man-made organic contaminants of varying toxicities. The landfilled material will be typical of a municipal “dump” of its era, when fewer controls were exercised over disposal of hazardous waste. It will contain a variety of both hazardous and benign material from households and industry of the time. It is probable there is a variety of industrial waste in drums of which waste from former agrichemical manufacturing no doubt forms a part. There is no known record of the waste and therefore it is not possible to ascertain what waste might exist in the landfill.

The waste can only create a risk to people or environmental receptors if toxic components are able to come into contact with these receptors, that is, if exposure can occur. The contaminants of concern from the stormwater excavation, and the landfill in general, are non-volatile and generally not mobile in soil or water, as they tend to bind strongly to soil and have low solubility. This is particularly true of dioxins. In that case, for a risk to occur there must be direct contact between the contaminant and the receptors. People are receptors of greatest concern in this case, particularly children.

All of us ingest small amounts of soil as part of our day-to-day activities, typically through hand to mouth contact with dirty hands. Children ingest more soil than adults because children generally have more hand to mouth contact than adults. The combination of more soil ingested and lower body weight makes children more vulnerable to exposure to contaminated soil than adults.

Unless the contaminants are at such high concentrations as to cause an immediate or “acute” risk of poisoning, risk from soil contaminants occurs as a result of prolonged exposure over months and years. This is known as chronic exposure. The soil concentrations that can be tolerated depend on the duration and frequency of exposure and the toxicity of the contaminant. Occasional or limited exposure to even relatively high concentrations of contaminants typically presents no particular risk. This would be the situation for a person walking across a park. Conversely, contaminants in a residential property present a much higher risk, and therefore much lower concentrations can be tolerated, as residents are typically exposed every day, may have direct contact through bare soil in gardens and may also grow vegetables in contaminated soil. A playground presents a risk intermediate between these two scenarios, with perhaps up to daily exposure for short periods of time, but little if any contact with bare soil unless conditions are wet and muddy.

Using typical exposure parameters, and using residential exposure as the benchmark, people participating in a contact sport such as rugby on a contaminated sport field could tolerate (be safe with) about four to 20 times the contaminant concentrations that would be safe in a residential situation, depending on the particular contaminant, a child playing in a playground about ten to 100 times the residential concentrations and a child walking in a park much more than 100 times the residential concentrations. In calculating such concentrations conservative assumptions are used that over-estimate the risk.

There is a very large range of contaminant toxicities. These range from the very highly toxic dioxins to the low toxicity of some heavy metals (e.g. copper) and many man-made organic compounds. The safe concentrations in soil for a highly toxic substance will be much lower than for a substance with low toxicity. For example, the safe concentration for the organophosphate insecticide found in some of the playground excavation samples is about 100,000 to a million times higher than the safe concentration for dioxin.

The high concentrations of dioxin and some chlorophenols found in the drum residues were unsafe if this material had been at the surface. Such high concentrations were not unsafe when buried 2 m deep. The 2 m of soil and landfill materials over the top of the residues were a barrier to exposure for any users of the park. The particular chemicals will not get to the surface of their own accord as they have a low to very low mobility in soil due to a combination of generally low volatility and solubility and a tendency to bind strongly to soil. Dioxin is particularly immobile. The drum residues would have to have been physically moved to the surface to become a risk. This is true of many of the persistent contaminants still found in landfills after many years.

The fact that the residues were exposed during the excavation created a risk. This risk was dealt with by removing the residues and crushed drums and a large amount of soil around the crushed drums. The remaining residues in the vicinity of the excavation have been reburied and are no longer a risk.

There may be similar chemical residues elsewhere under the park. If such residues are adequately buried then no particular risk is presented to users of the park. The minimum the waste is buried is the depth of the soil capping layer. Most waste (and therefore most hazardous waste) is buried much deeper and presents a lower risk than the same material buried immediately below the capping layer. A capping layer of 0.6 – 1 m is a sufficient barrier to hazardous material for the upper levels of the park, particularly given the limited use of these areas of the park. A capping layer of more than this would have been better in the early days of the park, as settlement can create hazards from rigid items (e.g. pieces of wood, car bodies) sticking up through the cap as the waste around the items settles. The likelihood of this happening now is much reduced as much of the potential settlement will have occurred over the more than 30 years since the landfill was closed.

Cover of as little as 200 – 300 mm is only marginally sufficient in areas where the park is more intensively used. Such a barrier in combination with grass cover is a sufficient barrier if left intact, but a thin cap is more likely to be disturbed during park development and maintenance activities or even a child deciding to dig a hole. A thicker cap is desirable.

Isolated areas of contaminants brought to or exposed at the surface do not present as great a risk as large areas of contamination. This is because people move around and are exposed to many places. Unless a contaminant occurs at very high concentrations (a hotspot) to make that particular location a risk even for occasional exposure, we are generally interested in average concentrations over an area (e.g. a playing field. However, where an area is more intensively used (e.g. a playground) hotspots are of greater concern as they are more likely to be encountered by a playground user.

Hotspots could be created if excavation activity brought some concentrated contamination to the surface. Obvious activities that involve excavation are construction of building foundations, excavation of trenches and excavation of post holes (e.g. for play equipment). The latter involves such small amounts of soil that a large risk is unlikely, particularly if grass then provides a barrier to direct contact with soil.

In summary, the risks from soil contaminants over most of the park are low. The general expectation is that there will be minimal if any contamination of surface soil over the park. A potentially greater risk exists where the soil cover is thin and the park is more frequently used (e.g. the playground). However, the risks are not so high that people need to avoid using the playground. It is prudent, however, to discourage children from digging or playing in bare soil until such time as the contaminant status of the soil is better quantified.

4.0 Proposed sampling

It is proposed to sample soil in various locations in the park to determine whether the soil contains concentrations in excess of soil concentration guidelines. The overall aim of the sampling is to confirm or otherwise that there is a minimal level of contamination in surface soils and therefore a minimal risk to users of the park. If contaminant levels are excessive, then a subsidiary aim is to determine ways of managing the risk. Assessing the risk will be achieved by:

1. Determining the thickness of landfill cover over the park, as a means of assessing the likelihood of waste being exposed at the surface at the particular locations.

2. Sampling surface soil for laboratory analysis of chemical contaminants to assess the current risk. The focus will be on the dioxin 2,3,7,8-TCDD, but a variety of other typical landfill contaminants will also be assessed.

3. Sampling soil from the surface of the waste material in selected locations to assess whether the waste most likely to be exposed in future (i.e. the waste immediately under the cover) has significant contaminant concentrations, as a measure of the potential future risk if excavation were to occur. There is no information on the nature of the waste under each of these areas other than that it is expected to be typical municipal waste of its era (1950s to 1970s). It is therefore assumed that the waste under each area is similar, and that sampling the waste in one location will be representative of the waste in other locations.

The investigation is to be carried out at a screening level, that is, at a sufficient level of detail to provide reasonable confidence that compliance with soil guideline values will mean that further investigation is not required. Non-compliance with soil guideline values does not necessarily mean a risks exists, rather that further investigation is required to assess whether a non-compliance represents an isolated situation requiring some form of local management or a more general situation.

The investigation is not aimed at finding hotspot locations within the waste. It can be assumed that there will be high concentrations of various contaminants from place to place. Given the considerable depth of landfilled material, such hotpots will, on average, be at some depth within the landfill mass. Attempting to find such locations under the cover is beyond the scope of this investigation as an impractically high density of sampling would be required. Using geophysical investigation methods (e.g. ground penetrating radar) is not useful in such cases as, inevitably, a large number (thousands) of potential targets will be identified, the great majority of which will be buried items of no particular interest.

It is appropriate to divide the park into areas of similar use, and hence exposure (exposure areas), with a different sampling density and pattern in each area. The areas are:

- the former sports field areas on the intermediate and upper park levels
- the BMX track
- the children's playground
- local areas where excavation is known to have been carried out, including the recent stormwater pipe excavation, a stormwater pipe installed to the east of the BMX track and any other areas of significant excavation that come to light before the commencement of sampling.

Analysis for dioxins is expensive, typically of the order of \$1000 - \$2000 per sample, depending on whether a screening test or a full profile is required. Other analyses add additional cost. Because of the large cost, a composite sampling approach will be adopted. Using composite samples loses information on concentration variability, but it is a valid approach when average concentrations are being sought.

Sampling will be carried out using normal environmental sampling protocols, in general accordance with the Ministry for the Environment's *Contaminated Land Management Guideline No. 5: Site Investigation*. Clean sampling techniques detailed in MfE's *Health and Environmental Guidelines for Selected Timber Treatment Chemicals* will be employed to avoid cross-contamination. Samples will be submitted to IANZ accredited laboratories.

Sampling can be observed by a community representative if desired, but otherwise members of the public will be requested to remain at an appropriate distance for reasons of safety and to avoid the possibility of sample cross-contamination.

4.1 Sampling the sports fields

There are no particular targets to be sampled in the former sports field areas. The intent is to find average concentrations over the complete area.

The lower sports field is roughly rectangular, which would lend itself to grid sampling, but the upper sports field is an irregular area. It is therefore proposed to carry out stratified random sampling, consisting of six equal areas from which four randomly located samples will be collected. This will result in 24 sample locations, or one sample per approximately 1800 m^2 for the roughly 4.3 ha of the sports fields. This is equivalent to a grid of approximately 40 m, which is reasonable for a park area.

As average contaminant concentrations are of interest over this area, samples will be analysed as composites. The composites will consist of equal-weight sub-samples randomly selected from each of the six areas in turn, resulting in four composites each consisting of six samples.

Surface samples will be collected from the top 75 mm of soil using core samplers, after removing the surface grass. The turf will then be removed and a machine auger used to excavate down to the surface of the waste material. Excavated material will be deposited on a plastic sheet surrounding the hole to prevent contamination of the surface. A core sampler will then be used to recover a soil sample from the bottom of the hole. The hole will then be backfilled and the turf replaced. Surplus soil will be disposed of to landfill.

The composites will be prepared in the laboratory. The individual samples will be retained to enable these to be analysed if necessary.

4.2 BMX track sampling

The BMX track area will be sampled on a judgemental basis, that is, locations will be selected on the basis of judgement that they will either having a higher probability of being contaminated or that the location is more intensively used, that is, exposure is potentially greater for the location.

The majority of the BMX track is built up from imported fill. However, the low points of the track are reported to be close to the surface of the waste (within 200 – 300 mm). The low points are therefore more likely to be contaminated than other areas. Soil below the track itself will not be sampled as the track is constructed from compacted limestone with a fine gravel surface, which is difficult to repair. The track surface provides a good barrier to contact with soil. Instead, samples will be taken off to the side of the track, using a hand-auger to bore down to the appropriate level as required.

Grassed areas between and surrounding the track are likely to be used by track officials, competitors and spectators, and therefore present areas of greater potential exposure than other areas. The soil under the grassed areas is reported to be imported and therefore should not be contaminated, however, 75 mm deep core samples will be taken at a number of locations to confirm this.

Samples of the surface of the waste will not be taken as waste samples from the sports fields are expected to be representative of the BMX track area. However, the hand auger will be used to check the depth to the waste.

It is expected that three to five samples will be collected from each of the low-point areas and grassed areas. Two composites will be analysed.

4.3 Playground sampling

The playground area consists of the playground itself and the formerly grassed area between the playground and the BMX track carpark. The formerly grassed area is where the drum residues were found and is currently a fenced-off construction zone associated with the stormwater pipe installation.

The ground investigation will consist of two components; assessing the depth of soil cover to waste and taking soil samples for laboratory analysis. The two components will be carried out separately.

Investigation of the depth of cover will be carried out by advancing hand auger holes down to the surface of the waste at 8 – 10 m centres on four east-west transects spaced along the length of the area. The auger holes are expected to be up to 1 m deep.

The objective of soil sampling in this area is to determine whether contaminants exist at the surface of both undisturbed and disturbed ground and whether contaminants exist in deeper soil in the location of the "drum excavation". Soil sampling will be carried out as a mixture of judgemental and random sampling as follows:

- surface soil close to each item of play equipment (but avoiding taking samples immediately adjacent to support posts and the like so as to avoid effects from leaching of timber treatment chemicals or weed spraying chemicals that might have been applied close to play equipment), and two other randomly selected samples from grassed areas between the play equipment, on the basis that children are most likely to be exposed to soil close to the play equipment. There are four items of play equipment. A single composite of six will be analysed.
- surface soil at six equally spaced intervals along the new stormwater pipe trench from a point roughly in the centre of the playground to 10 m short of the stormwater manhole location.
- surface soil samples at six randomly selected locations across the surface of the "drum excavation", the samples to be analysed as a composite
- samples taken at 1m depth at the same locations within the drum excavation, again analysed as a composite.

4.4 Excavation area sampling

Apart from the new stormwater pipe, which is to be sampled as part of the playground sampling, only one other area of significant excavation is known to have penetrated the waste. This was to the east of the BMX track, where, according to BMX club members, a stormwater pipe was laid some years ago.

It is proposed to sample surface soil along the alignment of the pipe. The assistance of a club member will be required to identify the location. The part of the pipe alignment now covered with a metre or two of imported soil will be avoided. Otherwise, samples will be collected at equally spaced intervals to make up a five or six-part composite.

While the particular location is not expected to contribute significantly to a park user's exposure to surface soil, sampling the location will give a measure of the likelihood of future excavation unwittingly bringing significant contamination to the surface.

4.5 Laboratory analysis

Concern has been expressed within the community about organic pesticides (particularly organochlorines and organophosphates) and dioxins. In addition, common contaminants in landfill material are heavy metals and polycyclic aromatic hydrocarbons (PAHs). It therefore proposed to target these groups of contaminants using standard analytical suites. In addition, a small number of samples from the vicinity of the playground and "drum excavation" will be analysed for acid herbicides, including 2,4,5-T.

In the interests of economy it is proposed to carry out a TCDD/TCDF screen rather than a full dioxin congener profile. Examination of soil samples collected by PDP from the Paritutu area in 2002 shows that TCDD typically makes up 70 – 90 % of the total dioxin (expressed in terms of toxic equivalence - TEQ). This is typical of dioxins associated with 2,4,5-T manufacture. A TCDD/TCDF screen therefore provides a good estimate of the TEQ for such a source. However, dioxins from other sources are not necessarily dominated by TCDD.

Open burning of waste at landfills can generate dioxins. It is probable open burning occurred when the landfill was operating. It is not possible to predict what the dioxin congener profile from waste burning might be, except in very general terms, but TCDD may not be dominant. If the TCDD/TCDF screen returns significant concentrations, the sample with the highest concentration will be subjected to the full congener analysis in order to determine whether TCDD is in fact dominant.

5.0 Risk assessment

The risk to park users will be assessed by comparing the laboratory results with soil guideline values. Soil guideline values are derived for a small set of generic land use scenarios, typically residential, industrial and, for some common contaminants, recreational use.

New Zealand has only a small number of generic guidelines for the most common contaminants encountered. New Zealand-derived guidelines do not exist for many of the contaminants to be analysed for in this investigation, or the New Zealand values are out of date and should not be used. In these cases similarly calculated values from overseas must be used. This is in accordance with the recommendations of MfE's Contaminated Land Management Guideline No. 2. The United States has guideline values (the US Environmental Protection Agency's Regional Soil Screening Levels) for a wide range of contaminants. These are derived similarly to New Zealand guidelines. Thus, where New Zealand guidelines do not exist, United States guidelines will be referred to.

The United States does not have guidelines for recreational use. The closest scenario is the residential scenario. This is more conservative than recreational exposure but provides an initial conservative screening. If the sampling results comply with residential soil guideline values then it can be safely concluded that the results would also comply with park use guidelines if they existed. If a laboratory result does not comply with a residential guideline then a recreational guideline will be derived for the particular contaminant using the soil guideline derivation procedures recently developed for MfE[1].

Dioxin presents a particular problem as the existing New Zealand guideline is out of date because in 2002 the Ministry of Health (MoH) adopted a maximum monthly intake value somewhat lower than previously used. The US soil guideline value is also not appropriate because its toxicological basis is different from the MoH recommendation.

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[1] Proffitt G, Cavanagh J E, Court J and Ellis H. *Development of a National Methodology for Risk-Based Human Health Soil Guideline Values for Contaminated Land Assessment*, Proceedings, New Zealand Waste Management Institute Annual Conference, Blenheim, November 2008

Accordingly, a site-specific guideline for TCDD will be derived using the MoH intake recommendation and exposure parameters specific to the park. This will be based on exposure parameters from the new MfE derivation methodology.

6.0 Reporting

A report will be prepared describing the investigation and presenting the results. Diagrams will be prepared showing the sample locations and depth of landfill cover. The risk to park users, if any, will be assessed for each subsection of the park.

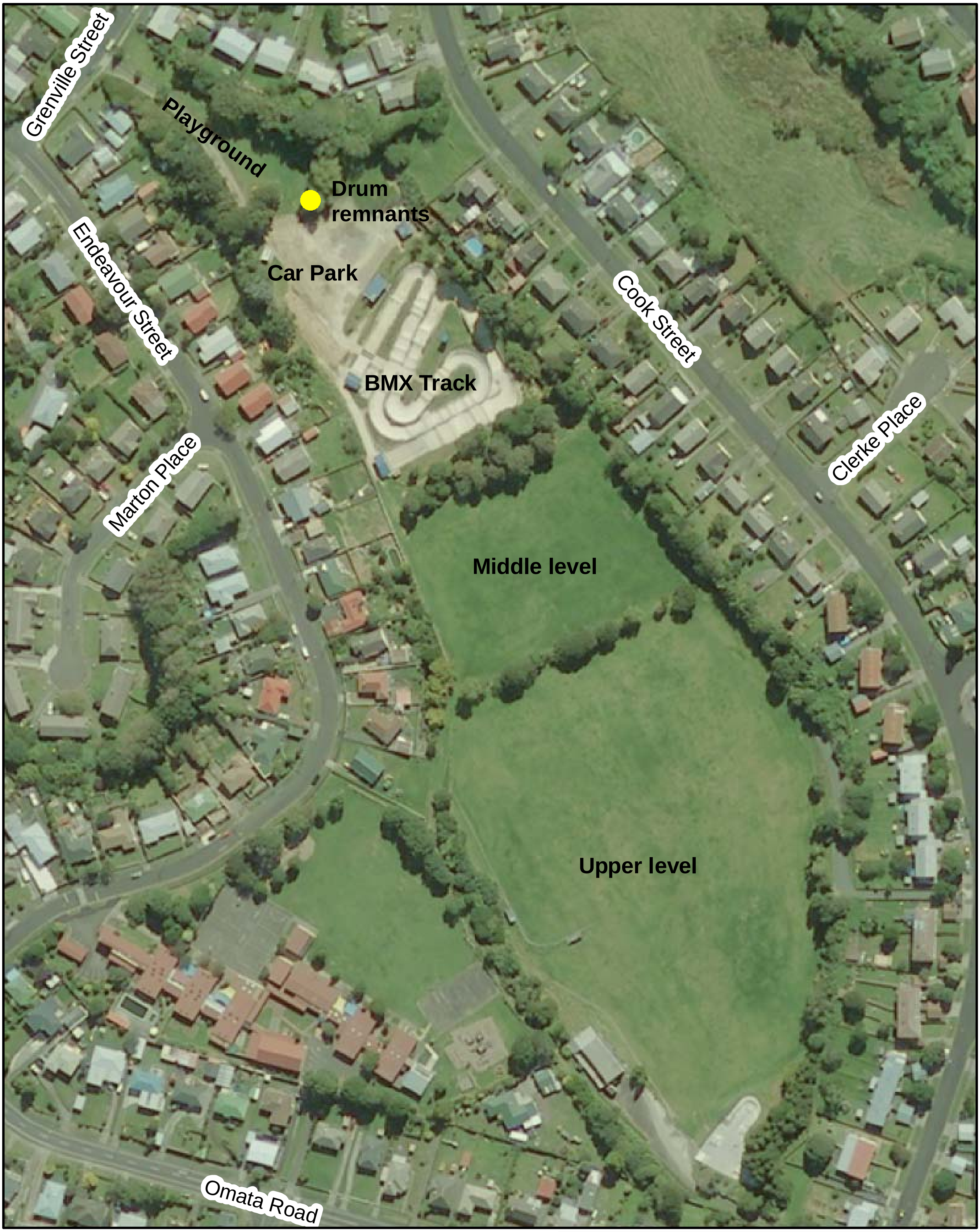
I trust this sampling plan meets you requirements. Please contact me if you require further information.

Yours sincerely

PATTLE DELAMORE PARTNERS LIMITED

Graeme Proffitt

Marfell Park



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DATE:30 June 2009