ECOH
Environmental Consulting
Occupational Health

ASBESTOS INVESTIGATION AND REMEDIAL OPTIONS ANALYSIS

KYMORE VILLAGE, MADHYA PRADESH, INDIA

Submitted to:
Mr. Krishnendu Mukherjee

Submitted by:
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ECOH Project No.: 16452

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EXECUTIVE SUMMARY

ECOH was requested Mr. Krishnendu Mukherjee to complete a preliminary visual assessment of reported asbestos contamination issues facing 7000 – 8000 local residents of Kymore and Kalhara (subject sites), and to provide a preliminary remedial options analysis. Historical asbestos product manufacturing operations in the subject area have reportedly created asbestos soil contamination issues within certain areas in the villages of Kymore and Kalhara. ECOH was specifically asked to look at asbestos contamination issues associated with the former operation of the existing Everest Industries that is currently operating at the site. Reportedly, asbestos-containing waste debris was historically disposed outside the Everest Industries site in the surrounding fields, including the period between 1996 and 1997 when the facilities were operated by Etex (the former owner). Asbestos waste debris was also placed in a hazardous waste landfill located in the village of Kalhara, when the plant was being operated by the former owners. The concern is that the asbestos debris in both areas is currently exposed at surface, and is continuously being disturbed by the local residents, mobilizing the fibers allowing them to be inhaled. Inhalation of asbestos fibers can pose a long term health hazard, and has been directly linked to several types of respiratory illness, collectively referred to as "asbestos disease".

ECOH developed an investigative methodology that was sufficient in detail to allow us to visually identify exposed areas of asbestos debris and provide baseline data to develop a preliminary remedial options analysis.

Results of ECOH's investigation have concluded that Chrysotile asbestos contamination ranging in concentration from 2% to 70% are pervasive throughout the surficial soils in the areas identified south of Everest Industries in the Kymore village area and in the hazardous landfill area in Kalhara. It was visually identified in playing fields, residential yards within the village, agricultural fields, and was also identified to the north of Tilak Chowk Road in a naturalized area. The fact that the identified asbestos contamination is exposed at surface allows it to be continuously disturbed by local residents, mobilizing the fibers, creating an immediate inhalation health hazard to the local residents.

Based on our visual assessment of the asbestos-containing materials, we estimate that the areal extent of surficial asbestos contamination is approximately 562,500 m2 in the Kymore Village area and 3,905 m2 in the Kalhara landfill area.

Based on the current asbestos hazards identified during ECOH's site inspections and testing, ECOH recommends the following:

1. Undertake additional subsurface investigation of both soils and ground water on the subject site to determine the lateral and vertical extent of asbestos contamination in the subsurface. This information is critical to determine the feasibility of the proposed remedial options, and define the proposed scope.

2. Undertake a site specific quantitative health risk assessment of the local residents who interact with the subject sites to determine their likely asbestos exposure from a human health perspective, determine the exposure pathways, and how to control the exposure.

3. Investigate the feasibility of the proposed remedial options in greater detail, (Option #1, Source Excavation and Off-site Removal or contaminated soils, and Option #2 Capping of Existing Contamination), and determine the most appropriate remedial option that should be implemented at the subject sites to mitigate the asbestos contamination issue.

Preliminary budget estimates of Capital Costs necessary for implementing the proposed remedial options are:

- Option #1 – Excavation of 1.0m of soil and Off-Site Disposal – Approximately $88,000,000.00 (US dollars), and
- Option #2 – Cap Barrier with 0.3m of excavation and off-site disposal – Approximately $52,000,000.00 (US dollars).

Other remedial options may be feasible to mitigate the asbestos contamination issues, but additional investigations will be required before these other options can be fully vetted to determine applicability to the subject site.

This executive summary provides a brief overview of the study findings. It is not intended to substitute for the complete report, nor does it discuss specific issues documented in the report. The executive summary should not be used as a substitute to reading the complete report.

1. ACKNOWLEDGEMENTS

ECOH would like to express its thanks to the Kymore Activists who provided accommodation for the ECOH team while in the Kymore region, logistical ground support, and historical background on the asbestos issues at the site. The activists' hospitality and assistance were appreciated and instrumental in allowing ECOH to complete its objectives in a timely and efficient manner.

2. INTRODUCTION AND OBJECTIVE

ECOH Management Inc. (**ECOH**) is pleased to provide the following preliminary remedial options analysis (ROA) for the inferred Asbestos contaminated areas located within the villages of Kymore and Kalhara, India (herein referred to as the Sites). Both villages are located within the central state of Madhya Pradesh, India. Refer to **Figure 1** for the geographical location of the Site.

The objective of the ROA is to provide remedial strategies and/or risk management options for the areas contaminated with asbestos waste debris from historical and current manufacturing practices, along with associated costs and estimated remediation timelines. It should be noted that this is a preliminary ROA for the areas where visual evidence of asbestos waste dumping was observed, and does not include areas outside of the visually impacted areas.

As part of the ROA, two (2) main remedial options for the contaminated areas were selected for review and discussion. These options included;

1. Excavation and Off-site removal, and
2. Cap material in place.

Each option is assessed with respect to applicability, limitations, time and cost. As part of the ROA the following tasks were completed:

- Site reconnaissance to visually identify asbestos impacted areas,
- A review of available analytical data collected from the Site,
- The development of a series of site plans showing areal extent of visually identified asbestos contamination, and
- An analysis of the two (2) selected remedial/risk management options.

The following outlines ECOH's methodology utilized during our investigation, the results of our investigation, a discussion regarding our findings, and the proposed remedial options that can be implemented at the subject site.

3. BACKGROUND

In the fall of 2015, ECOH was approached by Mr. Krishnendu Mukherjee regarding providing an opinion on the asbestos contamination issues facing 7000-8000 local residents of Kymore and Kalhara (subject sites). Historical asbestos product manufacturing operations in the subject area have reportedly created asbestos soil contamination issues within certain areas in the villages of

Kymore and Kalhara. ECOH was specifically asked to look at asbestos contamination issues associated with the former operations of the Everest Industries that is currently operating at the site. Reportedly, asbestos containing waste debris was historically disposed outside the Everest Industries site in the surrounding fields, including the period between 1996 and 1997 when the facilities were operated by Etex, the former facility owner. Asbestos waste debris was also placed in a hazardous waste landfill located in the village of Kalhara, when the plant was being operated by the former owners. The concern is that the asbestos debris in both areas is currently exposed at surface, and is continuously being disturbed, mobilizing the fibers and allowing them to be inhaled. Inhalation of asbestos fibers can pose a long term health hazard, and has been directly linked to several types of Asbestos Disease, namely: Asbestosis, Lung Cancer, Pleural Effusion and Mesothelioma. A description of several of the known asbestos related diseases is discussed in Attachment A.

"Asbestos" is a generic term applied collectively to a genus of naturally occurring fibrous hydrate silicates, each possessing various properties that are appealing for various uses in manufacturing and construction industries. This genus of mineral is further delineated into two groups based on their mineralogical characteristics: *serpentines ("snake-like") and amphiboles ("needle-like")*. Minerals in each of these groups are either fibrous (presence of long, thin fibers that are easily separated) also known as asbestiform or non-fibrous non-asbestiform. There are almost thirty (30) varieties of asbestos minerals, however there are only six (6) that were utilized in commercial applications namely *chrysotile, amosite, crocidolite, anthophyllite, tremolite and actinolite.* Of these, chrysotile is the most widely used on a commercial basis and belongs to the serpentine group. The other varieties of asbestos belong to the amphibole group.

Manufactured Asbestos-containing materials (ACM's) are generally classified as either Friable (pulverized to dust by moderate hand pressure when dry) or Non-friable (hard materials, fibers bound and difficult to pulverize without the use of power tools).

- ***Asbestos-cement (A/C) Products***

The most common use of asbestos in terms of total mass incorporated was as a reinforcing agent in cement products. Asbestos-reinforced cement is strong, durable, rigid and resistant to both fire and weather. Utilizing a process similar to papermaking, Portland cement, water and asbestos are mixed to form a slurry from which end products can be fabricated. The asbestos fiber content of A/C products can vary significantly but is usually between 10 and 20 percent.

Asbestos-cement sheet is produced in four basic forms: flat sheet, corrugated sheet, siding shingles and roofing shingles. The main use of A/C sheeting is for the roofing and cladding of buildings. Other uses have been ceiling tiles, decorative paneling, electrical insulation and laboratory tabletops. Asbestos-cement pipe is used for water supply, sewage, irrigation, drainage applications, the transport of corrosive chemical fluids, and electric and telephone conduits. Asbestos cement products are still in production in many parts of the world. Non-asbestos substitute cement products are now available for most asbestos cement products. Reportedly, these were the products that were manufactured in the region and are currently being manufactured by Everest Industries.

4. METHODOLOGY

ECOH's assessment of the reported asbestos contamination within the subject sites was undertaken using a standard problem solving technique used in such projects that included the following steps:

1. Historical Review
2. Site Investigation
3. Results and Discussion
4. Development of Remedial Options

In keeping with the project objectives, our methodology was designed to be a visual identification of asbestos and ACM areas sufficient in detail to provide adequate data to carry out a preliminary remedial options analysis. Our methodology was not designed to be an exhaustive sub-surface study of the lateral and vertical extent of asbestos contamination. As asbestos and asbestos containing materials (asbestos debris) are relatively easily recognized by a trained professional, only the asbestos debris visible at surface has been identified within this report. Additional subsurface investigations will be required to accurately assess the extent of asbestos contamination within the subsurface soils.

4.1 Historical Review including Aerial Photo Review

Prior to undertaking any site investigation work, ECOH reviewed all readily available historical information that was provided by Mr. Mukherjee, in an attempt to determine the types of asbestos that may have been disposed, and possible locations of disposed material. ECOH also searched public domain maps and aerial photographs of the subject sites and developed site maps showing the areas where disposal was believed to have taken place. These maps have formed the base for the various site plans and figures that have been attached to this report.

4.2 Site Investigation

The site investigation included walk through of the subject sites as identified by the historical review, aerial photographs and local activists who accompanied the ECOH team, and collection of surface soil samples.

The ECOH team made up of John Lewis – the Principal Investigator, Mark Lai – Experienced Asbestos Surveyor, and Om Malik – A certified Industrial Hygienist, attended the site between February 18 and 21, and visually inspected the areas where historical dumping was reported to have occurred. This visual inspection, coupled with historical information provided by the local activists, allowed ECOH to map the areas where asbestos was observed at surface or within 10cm of surface, and record on site plans for the subject site (Figures 2, 3, and 4). ECOH also collected GPS coordinates of the impacted areas to allow for relatively accurate mapping.

Visual assessment indicates that asbestos containing debris is pervasive throughout the surficial soils. It was visually identified in playing fields, residential yards within the village, agricultural fields, and was also identified to the north of Tilak Chowk Road in a naturalized area.

Approximately sixteen (16) surficial soil samples were collected during this site visit and sent to an independent laboratory in the United States for asbestos analysis. An issue with the sample preparation at the laboratory compromised the integrity of these samples and allowed for cross-contamination of the samples. As a result, no analysis of these soil samples was undertaken.

Two (2) members of ECOH returned to the site from May 2 – 5, 2016 to re-collect the soil samples. A total of sixteen (16) surficial soil samples were collected from the previous sampled locations. All samples were discrete soil samples collected at surface (0.0m – 0.1m below surface). All samples were collected from the visually impacted areas with the exception of one sample being collected as a background sample approximately 2 km west of the subject site outside of the town limits (GPS-WP49), utilizing hand sampling methods. Locations of the soil samples are presented on the attached Figures 3 and 4. The collected samples were placed directly in laboratory supplied sample bags; a formal chain of custody was established for shipment to the laboratory (A copy of this chain of custody is attached in Attachment B); and submitted to EMSL Analytical Inc. laboratories in Cinnaminson, New Jersey, USA for asbestos analysis by US EPA 600/R-93/116 Method for Polarized Light Microscopy (PLM) method of analysis. EMSL is a NVLAP accredited asbestos laboratory.

4.3 Results and Discussion

4.3.1 Results

Collected samples generally consisted of visible debris and soils from areas where there was significant visible evidence of asbestos contamination. Results of laboratory analysis are provided in Table 1 and the certificates of Analyses are presented in Attachment B. This Table shows the sample ID, Sample description and approximate location, type and concentration of Asbestos in the sample.

Table 1

Sample ID	Sample Description/Location	Asbestos Concentration
WP-6	Field Debris	3% Chrysotile
WP-7	Field Debris	15% Chrysotile
WP-8	Field Debris	15% Chrysotile
WP-13	Debris	20% Chrysotile

Sample ID	Sample Description/Location	Asbestos Concentration
WP-15	Private Yard	15% Chrysotile
WP-16	Debris, side of road adjacent to residential area	3% Chrysotile
WP-20	Agricultural Field – debris on path	2% Chrysotile
WP-21	Agricultural Field – debris off path	2% Chrysotile
WP-28	Debris by Quarry – hazardous landfill	70% Chrysotile
WP-32	Debris by Quarry – hazardous landfill	25% Chrysotile
WP-40	Debris by Quarry – hazardous landfill	70% Chrysotile
WP-43	Debris from field adjacent to residential area	15% Chrysotile
WP-44	Debris by path and field	2% Chrysotile
WP-45	North of Tilak Chowk Road – debris in field	12% Chrysotile
WP-47	Debris at Perimeter	None detected
WP-49	Random sample by road approx. 2km west of Kymore (background)	None detected

All samples, with the exception of two (2), had Chrysotile asbestos ranging in concentrations from 2% – 70%. The two samples that did not contain any asbestos were samples WP-47 which is a soil sample located on the western perimeter of the visually identified impact zone in the Kymore village area, and sample WP-49 which is the background sample collected approximately 2 km outside the Kymore.

These analytical results confirm that the visually identified ACM debris in playing fields, residential yards within the village, agricultural fields, naturalized areas (e.g. north of Tilak Chowk

Road) etc. is indeed asbestos contamination. It can therefore be concluded that asbestos containing debris is pervasive throughout the surficial soils. A photographic log of evidence of surficial asbestos contamination is presented in Attachment C.

Based on our visual assessment and the analytical results, we estimate that the areal extent of surficial asbestos contamination is approximately 562,500 m2 in the Kymore Village area and 3,900 m2 in the Kalhara landfill area.

4.3.2 Discussion

Based on our observations and mapping of the asbestos contaminated sites, the areas of surficial asbestos contamination are extensive with significant Asbestos concentrations. The fact that the identified asbestos contamination is exposed at surface allows it to be continuously disturbed by 7000 – 8000 local residents, mobilizing the asbestos fibers thus creating a major exposure pathway (inhalation) for the residents. There is probably asbestos debris located in the sub-surface, but as long as it remains buried and undisturbed, it does not pose an immediate inhalation health hazard to the local residents. However, the presence of asbestos and ACM in public places such as school play grounds, backyards of residents, sidewalks etc. and with the possibility and high probability of mobilization and disturbance, the risk of exposure to cause adverse health effects to the population at large is judged to be significant. Considering that asbestos is a known cancer causing substance, the present situation poses an immediate health hazard to the local inhabitants, and should be addressed immediately.

ECOH recommends that the focus for dealing with the asbestos contamination should be the development of sound remedial strategy that prevents the mobilization of the fibers.

5. REMEDIAL OPTIONS ANALYSIS

At present we have only identified surficial asbestos hazards that were visible during our site visits, but we do not know the extent of asbestos in the sub-surface or if there is any impact to the ground water. For a detailed analyses of various remediation options it may be necessary as part of any final remedial strategy to accurately assess the areal and vertical extents of the asbestos debris and determine if there is any impact to local ground water. However, for controlling the immediate exposure hazard which is the surficial asbestos contamination in the areas identified south and west of Everest Industries and in the immediate vicinity of the hazardous landfill near Kalhara, ECOH proposes two (2) remediation options to prevent the mobilization of the asbestos fibers at surface:

1. Excavation and off-site removal of Asbestos contaminated soil (Dig and Dump), and
2. Capping the contaminated areas to prevent fiber mobilization.

In our opinion these remediation options are the most practical solutions for eliminating the asbestos inhalation hazard that is of concern to the local residents.

In developing these options, we considered the following:

- Primary objective of the remediation option;
- Future construction restrictions;
- Advantages;
- Disadvantages; and
- Estimated costs.

The remedial options are discussed in detail in the following sub-sections. Furthermore, a Class D cost estimate for each of the two (2) remedial options is presented within the Remedial Options Analysis Summary Table provided in **Attachment D**.

5.1 Option 1: Excavation and Off-Site Removal of asbestos contaminated soil (Dig and Dump)

This option includes excavation and off-site removal of all visually identified asbestos contaminated surficial soils to a depth of approximately 1.0m below existing grade. This option assumes that the asbestos contaminated soil will be disposed of at a suitable, hazardous materials landfill facility within the region. However, if there is no suitable hazardous waste landfill within the region, additional investigative work and the construction of a suitable receiving facility may be necessary. Fees associated with the construction of a hazardous waste receiving facility have not been factored into the analysis of this remedial option.

The proposed remediation would consist of the following steps:

a. Removal of existing trees, temporary structures, and any temporary site services located within the work areas;
b. Excavation of surficial contaminated material to a depth of approximately 1.0m below surface within the Kymore village area and Kalhara landfill area;
c. Supply and placement of non-contaminated granular backfill material to a depth of 0.3m – 1.0m below ground surface. All backfilled material is to be compacted to 85% proctor density to prevent soil subsidence; (Note: Proctor density is measured by the Proctor compaction **test** which is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become most dense and achieve its maximum dry density)
d. Supply and placement of a landscape textile to provide the top-soil a medium to adhere to;
e. Supply and placement of locally sourced, non-contaminated top-soil material from surface to approximately 0.3m below surface:
f. Replace any removed site services, temporary structures, etc.;
g. Hydro seeding of backfilled areas with a local grass mix to allow grass to seed backfilled areas;
h. Design and installation of storm water management system in the excavated areas, to prevent erosion of remediated areas during rain events;

i. Development of landscaping plan to promote growth of trees, bushes and local grass covers. Installation and maintaining a vegetative cover on the backfilled area is critical to control erosion and maintain slope stability of remediated areas;
j. Paving of roads within the work area; and
k. Development of on-going asbestos management program to address maintenance of excavated areas, and discuss acceptable activities within the backfilled areas.

Estimates of Extent of contaminated area, Volume and weight of soil to be removed and backfill

Location	Dimensions (m)	Volume (m^3)	Weight (mt)[1]
Kymore Village Area	750 x 750 x 1.0	562,500	1,012,500
Kalhara Landfill Area	71 x 55 x 1.0	3,905	7,029
	Total	**566,405**	**1,019,529**

[1] 1.8 mt/m^3 multiplier applied
[2] (m) = metres; (m^3) = cubic metres; (mt) = metric tonnes

Advantages:

- Removal of upper 1.0m of contaminated soils and filling it with uncontaminated soils will reduce the chance of asbestos contamination working its way to surface during normal day to day use.
- Easier to fix cap during construction as there would be only earth work and no geomembrane to repair.
- Good public perception.
- No change to existing grade.

Disadvantages:

- Significant capital cost.
- High degree of site disruption.

Future Construction Restrictions – Once the area has been excavated and backfilled, any sub-grade excavation or construction activities should be minimized. If there is to be any excavation below surface for any reason, then asbestos contaminant control procedures should be implemented and the capped area should be reinstated.

Assumptions

a. Asbestos contaminated soils can be disposed of at a regional approved receiving facility.
b. Non-contaminated fill material and top-soil can be sourced locally.

Costs

The total estimated capital cost for implementation of this option is $88,000,000.00 (US dollars). This cost does not include any associated engineering or consulting fees, soil sampling costs, or additional subsurface investigation costs that may be required during this proposed construction program. These costs also do not include any long-term monitoring / maintenance programs that will probably be needed to ensure that the cap remains intact.

5.2 Option 2: Cap Barrier with Partial Excavation (Capping the contaminated areas to prevent fiber mobilization)

The fill cap barrier and partial excavation envisages excavation of the upper 30 cm of soil over the identified asbestos contaminated areas (Kymore village and Kalhara), and the placement of 1.0m of clean fill material over the excavated areas raising the grading by almost 0.6m.

The proposed remediation program would consist of the following steps:

a. Removal of existing trees, temporary structures, and any temporary site services located within the work areas;
b. Excavation of surficial contaminated material to a depth of approximately 0.3m below surface within the Kymore village area and Kalhara landfill area;
c. Supply and placement of a porous geo-membrane at the base of the excavated areas;
d. Supply and placement of non-contaminated granular backfill material atop the geo-membrane to 0.3m above existing grade. All backfilled material is to be compacted to 85% proctor density to prevent soil subsidence;
e. Supply and placement of a landscape textile atop the backfilled granular material prior to placement of top-soil to provide medium for the top-soil to adhere to;
f. Supply and placement of a 0.3m thick locally sourced, non-contaminated top-soil material atop the landscape fabric;
g. Replace any removed site services, temporary structures, etc.;
h. Hydro seeding of backfilled areas with a local grass mix to allow grass to seed backfilled areas;
i. Design and installation of storm water management system in the excavated areas, to prevent erosion of remediated areas during rain events;
j. Development of landscaping plan to promote growth of trees, bushes and local grass covers. Installation and maintaining a vegetative cover on the backfilled area is critical to control erosion and maintain slope stability of remediated areas;
k. Paving of roads within the work area; and
l. Development of on-going asbestos management program to address maintenance of excavated areas, and discuss acceptable activities within the backfilled areas.

Soil Volume Estimates

Location	Dimensions (m)	Volume (m^3)	Weight (mt)[1]
Kymore Village Area	750 x 750 x 0.3	168,750	303,750
Kalhara Landfill Area	71 x 55 x 0.3	1,172	2,109
Total		**4,806**	**8,651**

[1] 1.8 mt/m^3 multiplier applied
[2] (m) = metres; (m^3) = cubic metres; (mt) = metric tonnes

This option includes partial excavation of contaminated soils and placement of 1.0m earth cap with a geomembrane. This option will reduce the volume of soils excavated and removed from the site, and will significantly reduce the probability of surficial asbestos to be mobilized and create asbestos fiber inhalation risk for the residents. However, this option may not be feasible as proposed, because of the proposed grading change (i.e. raising by 0.6m the surrounding land area). A cut and fill survey at the design stage will confirm if this option is feasible or if additional excavation will be required.

Advantages:

- Significant reduction in volume of contaminated soils to be removed.
- Significantly lower capital costs to implement.
- May be less intrusive for local residents, and existing site services.

Disadvantages:

- Limited contaminant removal. There is a greater chance that day to day usage will cause subsurface asbestos to become exposed to surface.
- More difficult to repair geomembrane liner during construction activities than an earth barrier.
- Significant change in existing grade by raising surrounding areas by 0.6m above current levels. This could pose significant storm water drainage issues and require enhanced storm water management and possible water management at local buildings.
- On-going maintenance program is required to ensure that the barrier does not get damaged and if it does, it needs to be repaired.

Future Construction Restrictions – In the event that sub-grade construction activities are proposed within the footprint of the capped area it must be ensured that the integrity of the cap is maintained and/or reinstated if disturbed. Any impacted soil from below the cap which is excavated must be managed appropriately (e.g. disposed of at an approved facility).

Assumptions

a. Asbestos contaminated soils can be disposed of at a regional approved receiving facility

b. Non-contaminated fill material and top-soil can be sourced locally

Costs

The total estimated capital cost for implementation of this option is $52,000,000.00 (US dollars). This cost does not include any associated engineering fees, soil sampling costs, or additional subsurface investigation costs that may be required during this proposed construction program. These costs also do not include any long-term monitoring / maintenance programs that will need to be implemented to ensure that the cap remains intact.

6. CONCLUSIONS

Extensive areas within Kymore village and the Kalhara landfill have surficial soil contaminated with asbestos. This asbestos contamination is currently creating an inhalation hazard to the local residents who come into contact with and/or disturb the soils. Based on the current asbestos hazards identified during ECOH's site inspections and testing, ECOH recommends the following:

1. Undertake additional subsurface investigation of both soils and ground water on the subject site to determine the lateral and vertical extent of asbestos contamination in the subsurface. This information is critical to determine the feasibility of the proposed remedial options, and define the proposed scope.
2. Undertake a site specific quantitative health risk assessment of the local residents who interact with the subject sites to determine their likely asbestos exposure from a human health perspective, determine the exposure pathways, and how to control the exposure.
3. Investigate the feasibility of the proposed remedial options in greater detail, and determine the most appropriate remedial option that should be implemented at the subject sites to mitigate the asbestos contamination issue.

Other remedial options may be feasible to mitigate the asbestos contamination issues, but additional investigations will be required before these other options can be fully vetted to determine applicability to the subject site.

7. STATEMENT OF LIMITATIONS

The report completed by **ECOH** concerning the remedial options analysis for the asbestos contamination within the Kymore village and Kalhara landfill area, is limited to the specific scope of work for which **ECOH** was authorized to undertake, and is based solely on information generated as a result of the specific scope of work developed by ECOH and submitted to Mr. Mukherjee. This report provides a description of work completed at the Site, sampling and analytical methodology and the analytical results obtained through the sampling activities. It is **ECOH**'s professional opinion that the level of detail carried out during the investigation programs at the Site and the remedial options analysis presented herein is appropriate to meet the study objectives. However, there is no warranty, expressed or implied, that the investigation conducted at the Site has uncovered all potential environmental liabilities associated with the Site. In addition, **ECOH** cannot guarantee the completeness or accuracy of information supplied by a third party. It should also be noted that any investigation regarding the presence of contamination on the Site is based on interpretation of conditions determined at specific sampling locations, and conditions may vary between sampling locations.

This report was prepared by **ECOH** for the purposes of Mr. Mukherjee. The material in it reflects **ECOH**'s professional interpretation of information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. **ECOH** accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. Should additional information become available that suggests other environmental issues of concern beyond that described in this report, **ECOH** retains the right to review this information and modify conclusions and recommendations presented in this report accordingly.

We trust that this report provides you with the information that you require at this time. Should you require additional information or have any questions regarding this submission please do not hesitate to contact the undersigned.

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Prepared by:	Reviewed by:
Mr. John Lewis, B.Sc., CET **Principal**	**Dr. Om Malik, PhD., P.Eng., CIH** **Principal**

FIGURES

Image Source: This map has been compiled from Google Maps and other sources and is not to scale.

N	Figure 1	Geographical Location of Site	LOCATION: Kymore & Kalhara, India	PROJECT NUMBER: 16452 CAD FILE: FIG1 P16452 India Geographical	DATE: April 2016 SCALE: Not To Scale	DRW BY: CB CHK BY: LD

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Visually Identified Asbestos Debris	Figure 2	Site Location Map	LOCATION: Kymore & Kalhara, India	PROJECT NUMBER: 16452	DATE: April 2016	DRW BY: CB	ECOH Environmental Consulting Occupational Health
				CAD FILE: FIG2 P16452 Kalhara Site Location	SCALE: Not To Scale	CHK BY: LD	

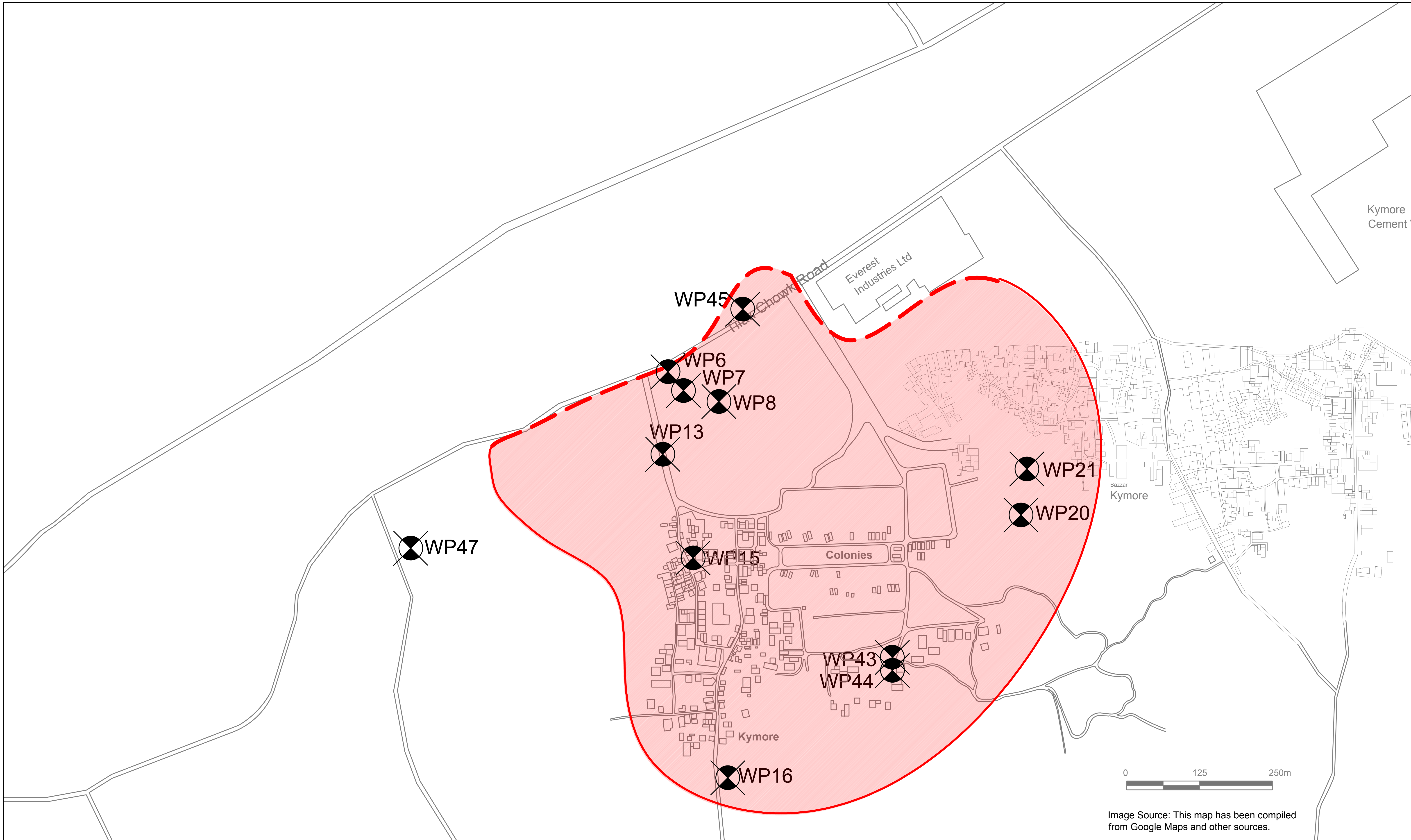

Image Source: This map has been compiled from Google Maps and other sources.

Soil Sample Location	Visually Identified Asbestos Debris; Inferred Boundary of Visually Identified Asbestos	Figure 3	Kymore Site Location Map	**LOCATION:** Kymore, India	**PROJECT NUMBER:** 16452	**DATE:** April 2016	**DRW BY:** CB
					CAD FILE: FIG3 P16452 Kymore Site Map	**SCALE:** As Noted	**CHK BY:** LD

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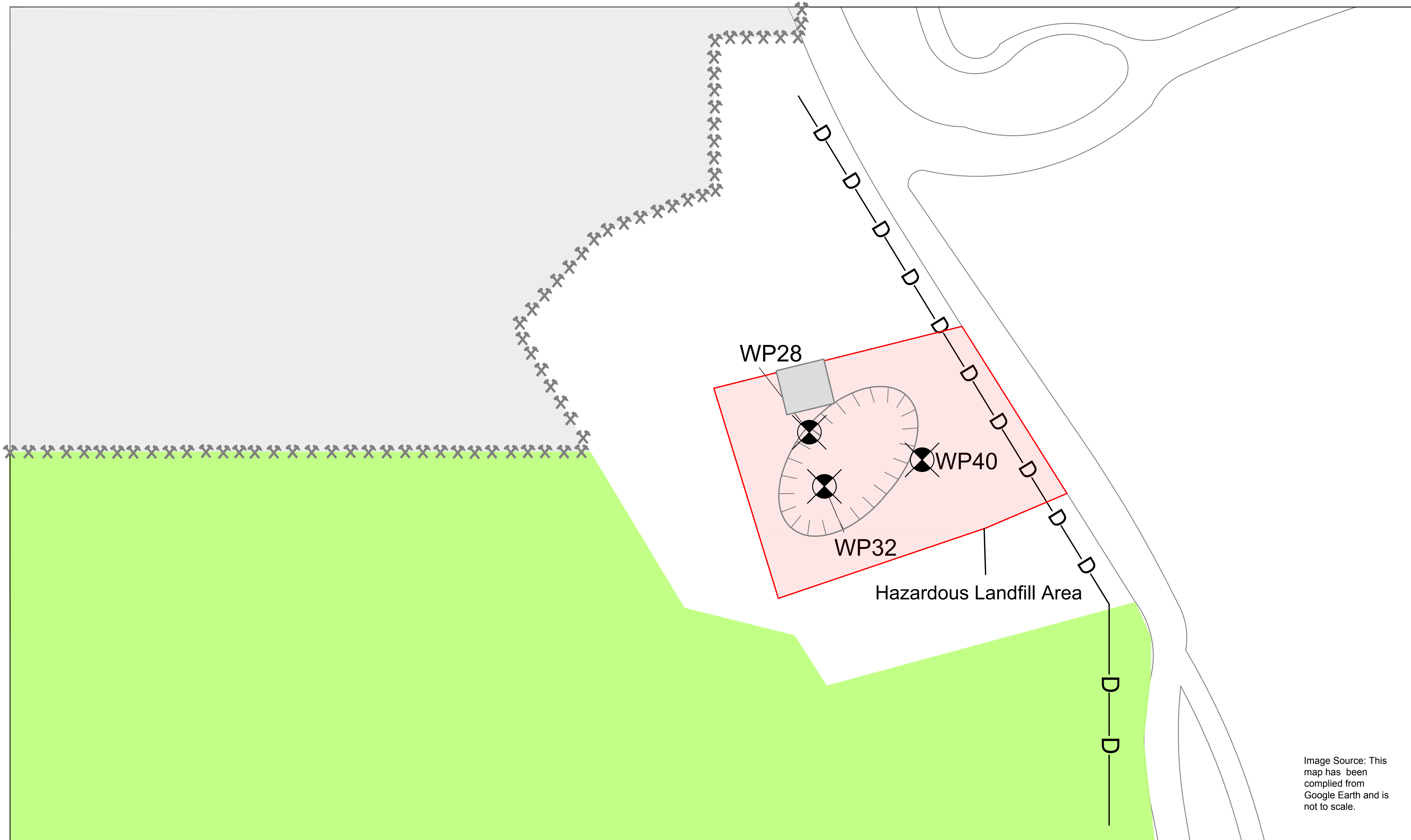

Legend: Agricultural; Visually Identified Asbestos Debris; Concrete Pad; Quarry; Slope; —D—D Ditch; Soil Sample Location; N

Figure 4

Hazardous Landfill Site Location Map

LOCATION:	PROJECT NUMBER: 16452	DATE: April 2016	DRW BY: CB
Kalhara, India	CAD FILE: FIG5 P16452 Maps	SCALE: Not To Scale	CHK BY: LD

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Attachment A

Asbestos Health Effects

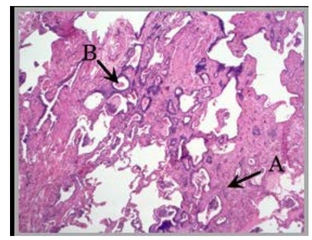
ATTACHMENT A

ASBESTOS HEALTH EFFECTS

ASBESTOS-RELATED ILLNESSES

There are essentially four main illnesses that manifest themselves in individuals that are exposed to asbestos over a prolonged period of time. These illnesses are debilitating and often result in extremely compromised lifestyles and even death:

ASBESTOSIS: Asbestosis is characterized by a fibrosis (scarring) of the lung tissue, which makes breathing difficult. The most prominent symptom of this disorder is breathlessness. Early detection of asbestosis is possible by x-ray examination and lung functioning testing. However, the disease is irreversible and will continue to progress even after exposure to asbestos has been discontinued. Rarely does asbestosis result in death, however this disease seriously compromises life expectancy as a result of deaths from related illnesses.



MESOTHELIOMA: This is a rare cancer arising from the cells of the pleura (lining of the chest cavity and lungs) and peritoneum (lining of the abdominal cavity). A long latency period, usually at least 15 years and sometimes more than 40 years characterizes the development of mesothelioma. There is no effective treatment for mesothelioma. A large portion of mesothelioma patients die within a year of diagnosis and few survive longer than five years. Although asbestos was once thought to be responsible for all mesothelioma, other causes have now been identified. Still, the chance of getting mesothelioma in the absence of asbestos exposure is considered to be extremely remote.

PLEURAL EFFUSION:

During the first 20 years after initial exposure to asbestos, the most common physical finding is pleural effusion. This is the collection of fluid between the linings of the lung and chest wall. The fluid production may be benign or represent a disease process such as cancer. Often asymptomatic, an individual with a pleural effusion may experience chest pain worsened by breathing or coughing. Difficulty breathing may also be experienced. Pleural thickening generally develops in individuals with effusions and this represents the result of persistent pleural irritation by asbestos fibers.

LUNG CANCER

Unlike asbestosis and mesothelioma, lung cancer is not associated only with asbestos exposure. Furthermore, there is no basic difference between lung cancers caused by asbestos versus other causes. In general, the risk of getting lung cancer increases with the extent of asbestos exposure, in terms of both intensity and duration. This risk is also greatly exacerbated by smoking. Most asbestos workers who develop lung cancer are smokers. The prognosis for persons diagnosed with lung cancer is poor. Only about one in twenty survives longer than five years after it is diagnosed.

OTHER ASBESTOS-RELATED CANCERS:

The relationship between asbestos exposure and asbestosis, mesothelioma, pleural effusion, and lung cancer has been clearly established and is beyond argument. Several other cancers have also been associated with inhalation of asbestos. Although the evidence is not as good as for the diseases discussed above, these cancers should be noted. They are as follows:

- Gastrointestinal cancer (esophagus, stomach, colon, and rectum)
- Cancer of the larynx

OTHER ASBESTOS-RELATED CONDITIONS

A number of less serious effects have been associated with asbestos exposure. They are as follows:

- Pleural plaques
- Asbestos bodies
- Asbestos warts

Pleural plaques are areas of scarring of the pleural surfaces. In general, they are not associated with any functional abnormality and are merely an indicator of asbestos exposure. Occasionally, these conditions become so pervasive in an individual's system that they result in restricted lung function. Asbestos bodies also termed "ferruginous bodies", result when asbestos fibers become coated with a substance containing protein and iron. The asbestos bodies are not harmful and, like pleural plaques, serve as evidence of asbestos exposure. Asbestos warts are harmless skin growths that occur when asbestos fibers penetrate the skin.

ATTACHMENT B

Analytical Chain of Custody and Certificates of Analysis

EMSL Analytical, Inc.
200 Route 130 North Cinnaminson, NJ 08077
Tel/Fax: (800) 220-3675 / (856) 786-5974
http://www.EMSL.com / cinnasblab@EMSL.com

EMSL Order: 041612880
Customer ID: ECOH45
Customer PO:
Project ID:

Attention: John Lewis
ECOH Management, Inc.
75 Courtneypark Drive West
Unit 1
Mississauga, ON L5W 0E3
Project: 16452

Phone: (905) 795-2800
Fax: (905) 795-2870
Received Date: 05/13/2016 9:30 AM
Analysis Date: 05/18/2016
Collected Date: 04/05/2016

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
GPS-WP6 *041612880-0001*	Field - Debris	Brown/Gray/White Fibrous Heterogeneous	20% Cellulose	77% Non-fibrous (Other)	3% Chrysotile
GPS-WP7 *041612880-0002*	Field - Debris	Gray Fibrous Heterogeneous		85% Non-fibrous (Other)	15% Chrysotile
GPS-WP8 *041612880-0003*	Field - Debris	Gray Non-Fibrous Heterogeneous		85% Non-fibrous (Other)	15% Chrysotile
GPS-WP13 *041612880-0004*	Debris	Gray/White/Black Fibrous Heterogeneous		80% Non-fibrous (Other)	20% Chrysotile
GPS-WP15 *041612880-0005*	Private Yard	Brown/Gray Fibrous Heterogeneous	15% Cellulose	70% Non-fibrous (Other)	15% Chrysotile
GPS-WP16 *041612880-0006*	Side Of Road - Adj To Residential Area - Debris	Brown/Gray/Black Fibrous Heterogeneous	15% Cellulose 20% Min. Wool	62% Non-fibrous (Other)	3% Chrysotile
GPS-WP20 *041612880-0007*	Agricultural Field - Debris On Path	Gray Fibrous Homogeneous	2% Cellulose 5% Glass	91% Non-fibrous (Other)	2% Chrysotile
GPS-WP21 *041612880-0008*	Agricultural Field - Debris On Path	Brown/Gray Fibrous Heterogeneous	5% Cellulose	93% Non-fibrous (Other)	2% Chrysotile
GPS-WP28 *041612880-0009*	By Quarry - Debris	Gray Fibrous Homogeneous		30% Non-fibrous (Other)	70% Chrysotile
GPS-WP32 *041612880-0010*	By Quarry - Debris	Gray Fibrous Homogeneous		75% Non-fibrous (Other)	25% Chrysotile
GPS-WP40 *041612880-0011*	By Quarry - Debris	White Fibrous Homogeneous		30% Non-fibrous (Other)	70% Chrysotile
GPS-WP43 *041612880-0012*	Field Adj To Residential Area - Debris	Brown/Gray/White Fibrous Heterogeneous	10% Cellulose	75% Non-fibrous (Other)	15% Chrysotile
GPS-WP44 *041612880-0013*	By Path And Field - Debris	Brown/Gray Fibrous Heterogeneous	10% Cellulose	88% Non-fibrous (Other)	2% Chrysotile
GPS-WP45 *041612880-0014*	North Of Main Road - In Field - Debris	Gray Fibrous Homogeneous		88% Non-fibrous (Other)	12% Chrysotile
GPS-WP47 *041612880-0015*	At Perimeter - Debris	Brown/Gray Fibrous Heterogeneous	5% Cellulose	95% Non-fibrous (Other)	None Detected
GPS-WP49 *041612880-0016*	By Road West Of Town - Random Sample	Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

Initial Report From: 05/18/2016 13:09:20

EMSL Analytical, Inc.
200 Route 130 North Cinnaminson, NJ 08077
Tel/Fax: (800) 220-3675 / (856) 786-5974
http://www.EMSL.com / cinnasblab@EMSL.com

EMSL Order: 041612880
Customer ID: ECOH45
Customer PO:
Project ID:

Analyst(s)
William Nguyen (16)

Benjamin Ellis, Laboratory Manager
or Other Approved Signatory

Initial Report From: 05/18/2016 13:09:20

EMSL CANADA, INC.
LABORATORY • PRODUCTS • TRAINING

Asbestos Chain of Custody

EMSL Order Number *(Lab Use Only)*

041612880

EMSL CANADA, INC.
2756 SLOUGH STREET
MISSISSAUGA, ON L4T 1G3
PHONE: (289) 997-4602
FAX: (289) 997-4609

Company : ECOH	**EMSL-Bill to:** ☒ Same ☐ Different If Bill to is Different note instructions in Comments**
Street: 75 Cournteypark Drive West, Unit 1	*Third Party Billing requires written authorization from third party*
City: Mississauga — **State/Province: Ontario**	**Zip/Postal Code: L5E 0EW** — **Country: Canada**
Report To (Name): John Lewis	**Fax #: 905-795-2870**
Telephone #: 905-795-2800	**Email Address: jlewis@ecoh.ca**
Project Name/Number: 16452	
Please Provide Results: ☐ Fax ☒ Email — **Purchase Order:**	**U.S. State Samples Taken:**

Turnaround Time (TAT) Options* – Please Check

☐ 3 Hour ☐ 6 Hour ☐ 24 Hour ☐ 48 Hour ☐ 72 Hour ☐ 96 Hour ☒ 1 Week ☐ 2 Week

*For TEM Air 3 hours through 6 hours, please call ahead to schedule *There is a premium charge for 3 Hour TEM AHERA or EPA Level II TAT. You will be asked to sign an authorization form for this service. Analysis completed in accordance with EMSL's Terms and Conditions located in the Analytical Price Guide

PCM - Air
- ☐ NIOSH 7400
- ☐ w/ OSHA 8hr. TWA

PLM - Bulk (reporting limit)
- ☒ PLM EPA 600/R-93/116 (<1%)
- ☐ PLM EPA NOB (<1%)
- Point Count
- ☐ 400 (<0.25%) ☐ 1000 (<0.1%)
- Point Count w/Gravimetric
- ☐ 400 (<0.25%) ☐ 1000 (<0.1%)
- ☐ NYS 198.1 (friable in NY)
- ☐ NYS 198.6 NOB (non-friable-NY)
- ☐ NIOSH 9002 (<1%)

TEM – Air ☐ **4-4.5hr TAT (AHERA only)**
- ☐ AHERA 40 CFR, Part 763
- ☐ NIOSH 7402
- ☐ EPA Level II
- ☐ ISO 10312

TEM - Bulk
- ☐ TEM EPA NOB
- ☐ NYS NOB 198.4 (non-friable-NY)
- ☐ Chatfield SOP
- ☐ TEM Mass Analysis-EPA 600 sec. 2.5

TEM – Water: EPA 100.2
- Fibers >10µm ☐ Waste ☐ Drinking
- All Fiber Sizes ☐ Waste ☐ Drinking

TEM- Dust
- ☐ Microvac - ASTM D 5755
- ☐ Wipe - ASTM D6480
- ☐ Carpet Sonication (EPA 600/J-93/167)

Soil/Rock/Vermiculite
- ☐ PLM CARB 435 - A (0.25% sensitivity)
- ☐ PLM CARB 435 - B (0.1% sensitivity)
- ☐ TEM CARB 435 - B (0.1% sensitivity)
- ☐ TEM CARB 435 - C (0.01% sensitivity)
- ☒ EPA Protocol (Semi-Quantitative)
- ☐ EPA Protocol (Quantitative)

Other:
- ☐

☒ **Check For Positive Stop – Clearly Identify Homogenous Group** — **Filter Pore Size (Air Samples):** ☐ 0.8µm ☐ 0.45µm

Samplers Name: Mark Lai — **Samplers Signature:** [signature]

Sample #	Sample Description	Volume/Area (Air) HA # (Bulk)	Date/Time Sampled
GPS - WP6	Field Debris		4/5/16
GPS - WP7	Field Debris		4/5/16
GPS - WP8	Field Debris		4/5/16
GPS - WP13	Debris		4/5/16
GPS - WP15	Private Yard		4/5/16
GPS - WP16	Debris - Side of road - adjacent to residential area		4/5/16
GPS - WP20	Agricultural Field - debris on path		4/5/16
GPS - WP21	Agricultural Field - debris off path		4/5/16

Client Sample # (s): - **Total # of Samples:** 16

Relinquished (Client): Mark Lai **Date:** May 10, 2016 **Time:** 10:00am

Received (Lab): VC - FP **Date:** 5-13-16 **Time:** 9:30

Comments/Special Instructions:

EMSL CANADA, INC.
LABORATORY • PRODUCTS • TRAINING

Asbestos Chain of Custody

EMSL Order Number *(Lab Use Only)*.

041612880

2EMSL CANADA, INC.
2756 SLOUGH STREET
MISSISSAUGA, ON L4T 1G3
PHONE (289) 997-4602
FAX: (289) 997-4609

Additional Pages of the Chain of Custody are only necessary if needed for additional sample information

Sample #	Sample Description	Volume/Area (Air) HA # (Bulk)	Date/Time Sampled
GPS - WP28	Debris by quarry		3/5/16
GPS - WP32	Debris by quarry		3/5/16
GPS - WP40	Debris by quarry		3/5/16
GPS - WP43	Debris from Field adajacent to residential area		4/5/16
GPS - WP44	Debris by path and field		4/5/16
GPS - WP45	North of main road, debris in field		4/5/16
GPS - WP47	Debris at perimeter		4/5/16
GPS - WP49	Random sample by road west of town		4/5/16

RECEIVED EMSL CINNAMINSON, NJ 16 MAY 13 AM 10:59

***Comments/Special Instructions:**

Page ____ of ____ pages

Attachment C

Photographic Log

Client Name: Mr. Mukherjee	**Site Location: Kymore / Kalhara, India**	**ECOH Project No.: 16452**

Photo No. 1.

Date:

February 2016

Description:

Friable Asbestos debris at surface near residences.

Photo No. 2.

Date:

February 2016

Description:

Friable asbestos debris at surface between residences in Kymore village.

Client Name: Mr. Mukherjee	Site Location: Kymore / Kalhara, India	ECOH Project No.: 16452

Photo No. 3.

Date:

February 2016

Description:

Surficial Asbestos Debris in hazardous waste landfill

Photo No. 4.

Date:

February 2016

Description:

Surficial Debris in fields near residences.

Client Name: Mr. Mukherjee	Site Location: Kymore / Kalhara, India	ECOH Project No.: 16452

Photo No. 5.	
Date:	
February 2016	
Description:	
Poorly covered friable asbestos waste debris in landfill area.	

Photo No. 6.	
Date: **February 2016**	
Description: **Houses in Kymore (colonies) constructed with asbestos roofs, and partial walls. Asbestos in poor condition with signs of degradation.**	

Attachment D

Remedial Options Analysis Summary

ATTACHMENT D - REMEDIAL OPTIONS ANALYSIS SUMMARY TABLE

Criteria	Option 1 Excavate and Remove Upper 1m of Impacted Soils (Dig and Dump)	Option 2 Cap Barrier - 1.0m Soil Cap Barrier with 0.3m excavation
Soil Disposal Volume (m^3)	- 562,500 m3 - Kymore Village, - 3,905 m3 - Kalhara landfill	- 562,500 m3 - Kymore Village, - 3,905 m3 - Kalhara landfill
Excavation/Soil Removal Details	- approx. 750m x 750m = 562,500 m2 areal extent, Kymore village area - approx. 71m x 55m = 3,905m2 areal extent at Kalhara landfill	- approx. 750m x 750m = 562,500 m2 areal extent, Kymore village area - approx. 71m x 55m = 3,905m2 areal extent at Kalhara landfill
Future Construction Restrictions	Yes	Yes
Advantages	-removing the upper 1.0m of contaminated soils - no cap maintenance required - minimal long term monitoring required - good public perception	- significantly less capital cost - no source excavation or removal of existing infrastructure - less intrusive to local residents
Disadvantages	- significant capital cost - future construction limitations -high degree of site disruption - will require removal of trees, site infrastructure (within the upper 1.0m)	- limited source removal - future construction limitations - annual maintenance costs and monitoring requirements in perpetuity -
Contamination Source Removal	Yes	Limited
Degree of Site Disruption	Highest	High
Estimated Time for Implementation	6 months	6 months
Timing of Implementation	Year-round	Year-round
Long Term Monitoring Requirements	Routine inspection of backfilled material to ensure no digging or erosion	Routine inspection of backfilled material to ensure no digging or erosion
Cap Maintenance Requirements	None required	Yes – Annual inspections and repairs
Capital Costs	$87,135,000.00 (kymore village) $838,865.00 (kalhara landfill)	$51,341,900.00 (kymore village) $638,865.00 (kalhara landfill)
Long Term Maintenance Costs[1]	$50,000.00 (per year)	$200,000.00 (per year)
Total Estimated Cost +/- (Class D)	$88,000,000.00	$52,000,000.00

Notes: