Guide for soil pollution assessments in existing day-care centers and playgrounds

Soil contamination in day-care centers and playgrounds
NGU Report 2007.030
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Guide for soil pollution assessments in existing
day-care centers and playgrounds
On the 28\textsuperscript{th} of November 2006, the Ministry of Environment in Norway passed the "Action plan for the remediation of polluted soil in day-care centers and playgrounds".

The first step of the "Action plan" involves the initiation of soil pollution assessments in all day-care centers in the 10 largest cities and 5 major industrial areas within the end of 2008. In day-care centers where unacceptable pollution is discovered, soil remediation is to be completed within the summer of 2010.

Limits for acceptable concentrations of pollutants are prepared by the Norwegian Institute of Public Health (Alexander, 2006).

Norwegian Pollution Control Authority (SFT) engaged Geological Survey of Norway (NGU) to prepare guides on how to perform environmental soil studies and report soil pollution in existing and future day-care centers and playgrounds. SFT requests that the methodology (field work, chemical analyses and reporting) described in this guide must be used in each and all of the day-care centers and playgrounds.

The present guide describes how to investigate soil pollution in existing day-care centers and playgrounds and is translated from the Norwegian version (TA 2260-2007).
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PREFACE

Geological Survey of Norway (NGU) was engaged by the Norwegian Pollution Control Authority (SFT) to establish a system for quality assurance upon environmental investigations of soil in day-care centers and playgrounds.

The project consisted of the following parts:

1. Prepare a guide for geochemical investigations of soil pollution (soil assessments) in existing day-care centers and playgrounds (TA-2260/2007)
2. Prepare a guide for geochemical investigation of soil pollution (soil assessments) in new day-care centers (TA-2261/2007)
3. Prepare a template for reporting the soil pollution in day-care centers and playgrounds (TA-2262/2007)
4. Prepare a guide for geochemical investigation of soil pollution (soil assessments) in day-care centers and playgrounds in industrial areas. Addition to TA-2260/2007 (existing day-care centers) and TA-2261/2007 (new day-care centers) (TA-2263/2007)
5. Quality assurance/Quality control of investigation reports covered by the Action plan from the Ministry of Environment.

Revision 15.08.2007:
Based on the experiences from the various assessments so far, and with an adjustment made in regards to "Green" day-care centers, a few modifications to the original manuscript have been made:

- Description of sample packing: If one laboratory performs the analyses for both elements and organic pollutants, it will be sufficient with one single sample of 0.5 kg on each sampling site. This sample must be collected and stored in a RILSAN plastic bag.
- Definition of green day-care centers: Green day-care centers include only those growing their own vegetables and berries, not fruit.
- Clarification; all explicitly stated requirements for chemical analysis must be followed.

Revision 13.06.2008:
Based on the experiences from the various assessments so far, and to update the content of the guide in accordance with updated and safe guideline concentrations, a few modifications to the original document have been made:

- The definition of private day-care centers is included in chapter 1 of the guide.
- Table 1: The safe guideline concentration for PAH_{16} in soil will not be changed to 4 mg/kg as previously assumed, but will remain unchanged (2 mg/kg). The quality criterion for PAH_{16} in soil for green day-care centers is 2 mg/kg.
- Table 2: Updated safe guideline concentrations have been established, and the values for cadmium, chromium, zinc, and PAH_{16} have been altered.
Table 3: The concentration criteria for the content of pollutants in soil to be delivered to day-care centers and playgrounds have been changed according to the new safe guideline concentrations set by SFT. In addition, separate guideline concentrations for chromium and nickel in the Trondheim area have been established because of naturally high background concentrations.

Revision 13.10.2008

- A footnote is added to table 1 to clarify when chromium (VI) is to be determined in the soil samples.
- Data for copper has been inserted in tables 2 and 3.

Revision 22.09.2009

- The chapter 2 of Regulations relating to pollution control (Pollution regulations) was changed on the 1st of July 2009. The terms new, updated or established safe guideline concentrations are therefore changed to safe guideline concentrations.
1. INTRODUCTION

In its Soria Moria declaration, the Norwegian Government announced an action plan to provide a pollutant free environment for children by performing soil remediation in day-care centers, playgrounds and schools. Mapping projects on soil pollution performed in Oslo, Bergen, Trondheim, and Tromsø have disclosed high concentrations of a range of pollutants in the play areas of several day-care centers and playgrounds. The Government wants to reduce the environmental health risk to children, and provide parents with a genuine confidence that their children will be exposed to no harmful pollutants in the play areas of day-care centers and playgrounds.

As a follow up to the Soria Moria declaration, the Ministry of Environment passed the "Action plan for the remediation of polluted soil in day-care centers and playgrounds" on November 28th 2006. The first step of this "Action plan" was a thorough assessment of the surface soil pollution in all day-care centers in the 10 largest cities and 5 major industrial areas in Norway within the end of 2008. If any unacceptable contamination is discovered, an environmental remediation of the soil in the given day-care center must be performed within the summer of 2010.

The guideline concentrations for pollutants that are considered safe is prepared by the Norwegian Institute for Public Health and published in "Quality criteria for soil in day-care centers, playgrounds, and schools, based on health risk assessments" (Alexander, 2006).

Norwegian Pollution Control Authority (SFT) and Geological Survey of Norway (NGU) have initiated a project on quality assurance of the upcoming investigations and soil pollution assessments in day-care centers and playgrounds. The guide that you're now reading describes the various processes during such an assessment of soil pollution.

SFT requires all existing day-care centers and playgrounds to perform the environmental assessments according to the methodology (field work and chemical analyses) presented here in this guide. A separate guide has been prepared for the soil pollution assessments of day-care centers and playground in industrial areas (TA-2263/2007).

To confine the extent of the "Action plan"-project to outdoor play areas, so that the benefits of the assessments and remediation are in proportion to the actual cost, it has been decided that private day-care centers with 8-10 children (double group) are comprised by the "Action plan" whereas those with 4-5 children (single group) are not. Private day-care centers often have their outdoor play areas in private property gardens, and are often established only for a short period of time. Those with a double group are, however, usually more permanent than those with a single group. An evaluation should be made in each case whether or not the actual day-care center should be regarded as a "normal" or "green" day-care center.
We call on the specific municipal authorities to initiate close collaborations with both the public and private day-care centers upon start-up (ordering) and completion of the environmental assessments.

2. WHAT KIND OF SOIL MAY YOU FIND IN DAY-CARE CENTERS AND PLAYGROUNDS?

In day-care centers and playgrounds there are several types of materials in the ground:

1. Pristine soil on the property
2. Delivered soil for landscaping
3. Delivered sand for sandboxes and sandpits
4. Delivered garden soil for planting and cultivation

2.1 Pristine soil on the property

The ground in urban day-care centers often consists of so called *urban soil*, which may be of local origin or transported to the given property as a filling compound (excavation masses). This kind of soil has been used and reused several times, and for that reason often has a high content of man-made waste such as bricks, concrete fragments, plaster, paint, and pieces of asphalt.

In areas where the vegetation has been worn down it is often possible to see that the soil contain this kind of waste (figure 1). The urban soil may contain high concentrations of lead (Pb) and polycyclic aromatic hydrocarbons (PAHs). It is important to note that the soil may be severely contaminated even if no such waste fragments are visible.

In younger, suburban, areas the dominating soil type is often the pristine, natural soil. Natural soil usually contains lower concentrations of pollutants than the urban soil.
Figure 1 Urban soil with a high content of man-made particles such as bricks, asphalt, and paint.
2.2 Delivered soil for landscaping

Soil for landscaping can origin from excess excavation materials within the given property or delivered from other areas. In several studies, these kinds of soils contain moderate to strongly polluted urban soil.

![Image of landscaping examples](image1)

*Figure 2* Four examples of artificial landscape characteristics within daycare centers. All these heaps contain polluted urban soil.

2.3 Delivered sand for sandboxes and sandpits

The sand in sandboxes is usually delivered from a local sand pit. In principle, this sand is clean and will contain low concentrations of pollutants. However, high concentration of arsenic may occur where the sand lies adjacent or in contact with CCA (copper-, chromium- and arsenic-) impregnated wood. These kinds of materials are often used for playground equipment such as swings, and as enclosure around sandboxes (see figure 3). Increased contents of metals and PAHs are often caused by mixing of sand with the underlying, original soil (urban soil).
2.4 Delivered garden soil for planting and cultivation
Delivered soil for planting and cultivation may be urban soil with added organic material. In several studies, high concentrations of metals and organic pollutants have been discovered in these kinds of soils.

Figure 3 Delivered sand in a sandbox area.

Figure 4 Delivered soil for planting and cultivation
3. PLANNING AND PREPARATIONS

The local authorities (municipality) will in each case (assessment) provide the executive consultants with complete lists of addresses for all day-care centers within their jurisdiction. In addition, the municipality must provide detailed, digital maps of the properties. The following GIS data layers are recommended where available: buildings, roads/streets, property boundaries/fences, contour lines, and playground equipment. An air photo of the area may also be useful.

The consultant performing the environmental soil assessment in each day-care center or playground will need the following equipment:

- Printed map (preferably M 1:1000 or M 1:500) to bring to the field
- A field form (to write all notes)
- A paint-free metal garden shovel
- Black, permanent, water-resistant marker to write on the outside of the sample packing
- Appropriate sample packing materials for soil samples going to determination of organic pollutants (e.g. RILSAN plastic bags)
- Appropriate sample packing materials for soil samples going to determination of chemical elements (arsenic, heavy metals), such as "Craft" paper bags, or white plastic boxes with a lid. This is applicable where two different laboratories will perform the organic and inorganic chemical analyses, respectively.
- Appropriate cases (preferably plastic boxes) to ship the samples to the laboratory/storage.
- Digital photo camera
- An appropriate sample numbering system, to be able to identify a single day-care center, its identification number and its soil samples. Example: The day-care center called "Rainbow forest" has the number 18 in the original list provided by the municipality. The 10 soil samples from this day-care center should receive separate sample identification, e.g. like this: 18_1, 18_2, 18_3, 18_4, 18_5, 18_6, 18_7, 18_8, 18_9 and 18_10.

All field equipment used for the collection of soil samples must be clean and paint-free. The packing materials (bags) must under no circumstances contain metals that may contaminate the soil sample.
4. SAMPLING

4.1 The choice of sampling locality
Sampling should include original soil, soil used for landscaping, and soil used for planting and cultivation. Sand in sandboxes should normally not be included, except where this kind of material totally dominates the given area. Preferably, the actual sample collection point should be where the vegetation has been worn, and where bare soil is exposed. These are areas where the children will come in direct contact with the soil (see figures 5-7).

Figure 5 The vegetation has been worn down close to the slide.

Figure 6 Intense play activity has worn the vegetation down. Children may be exposed to contaminated soil.
Figure 7 Pile/heap of soil where the vegetation is worn down.

4.2 Sampling and the number of samples

Samples from 10 individual localities inside each day-care center or playground must be collected. If the outdoor area in a specific day-care center is especially large, more samples should be collected accordingly. In "green" day-care centers (see chapter 5.2) an additional 5 samples of the actual garden soil (where vegetables/berries are grown) must be collected.

Surface soil (0-2 cm depth) is to be collected from all localities. Examples of localities are shown in figures 5-7. From each of the 10 localities, two (2) individual samples must be collected, each of about 300 grams (0.3 kg). The sample for arsenic and metal determination must be collected in "Craft" paper bags or white plastic boxes with a lid. The sample for organic pollutants (PAHs, PCBs) must be collected in RILSAN plastic bags. If one laboratory is performing both metal- and organic pollutant analyses, one single sample of about 500 grams (0.5 kg) collected in a RILSAN plastic bag will be sufficient. Sample number must be written outside the sample packing material with a black, permanent, and water-resistant marker.

In every second day-care center or playground, a duplicate sample must be collected at the 5th locality (see figure 8). The duplicate sample should receive the identification 5D (example: 18_5 and 18_5D, from day-care center number 18 as mentioned in chapter 3). The duplicate sample will be a part of the routines for quality assurance during the project. A duplicate must be collected for both inorganic (arsenic, heavy metals) and organic pollutants (PAHs, PCBs).
4.3 Field observations

When performing the collection of soil samples, notes should be taken on what type of materials exist on each locality, including the percentage of mixed-in sand in the soil sample. These notes must be filled in a field form (see figure 9). An example of such a field form may be downloaded from the Norwegian Pollution Control Authority (www.sft.no).
**Figure 9** Example of a field form for one day-care center.
Figure 10 Example of a crude field map with notes based on a digital map provided by the municipality or city authority.
CCA-impregnated or creosote wood must be noted on the field form where applicable (see figures 9-11). Greenish, wooden poles older than 2002, are very often of the CCA-kind. This information is very useful upon remediation of the area.

In addition, the total area used for growing vegetables/berries must be written on the field form. For these day-care centers, the number of children attending the day-care center must also be noted (see chapter 5). This is to classify the day-care center as "normal" or "green" (see chapter 5.2).

Each sample location must be marked on the detailed field map (figure 10) and notes should be written on the field form (figure 9) during sample collection. Playground equipment (swings, sandboxes...), soil heaps/piles, and sandy areas should also be marked on the field map. Each sample location must later on be digitalized by GIS (e.g. in ArcMap) for exact coordinates in the report. The original field maps and field forms must be stored safely, and a copy of these should be sent to the ones responsible for future remediation. This is to ensure that any remediation would take place in the right areas of the day-care center. Overview pictures of the sample area will provide good information about the area in the report. Common practice (legislation) is that no children must be identified or recognized in the pictures.

Figure 11 CCA-impregnated wood is used to confine the sandbox around the swing.
4.4 Digitalization

Digital aerial photo of the area is often very useful for digitalizing the specific sample locations, especially in areas where digital maps are of poor quality or totally absent. In addition it will be easier to localize playground equipment. Using ArcGIS, each sample location may be digitalized on the geo-referenced map. The chemical analytical results must be generated in a map showing all sample locations with concentrations above the action level (which induces remediation) in one single group of symbols.

5. “NORMAL” AND “GREEN” DAY-CARE CENTERS

5.1 Normal day-care centers

The most probable exposure route in “normal” day-care centers will be oral intake, respiration of gas/dust, and dermal contact (skin absorption). Other routes of exposure, such as intake of groundwater as drinking water, or vegetables/berries grown on the property are not included in the definition of a “normal” day-care center. The concentrations of pollutants in soil that are regarded safe (with a safety margin) are presented in table 1. Quality criteria for other relevant substances in industrial areas are provided in the additional guide for assessments of soil pollution in day-care centers and playgrounds in industrial areas (TA-2263/2007).

5.2 “Green” day-care centers

In “green” day-care centers vegetables and/or berries are grown on the property and eaten by the people attending/working there. Intake of such food will lead to stricter criteria for what are regarded acceptable concentrations of pollutants in the soil compared to “normal” day-care centers. The updated, acceptable concentrations include PAH16, benzo(a)pyrene, and PCB7 (table 1). The new criteria apply only to the specific areas of the day-care center where vegetables/berries are grown. A day-care center is defined as “green” by SFT if the growing/cultivation area exceeds 0.5 m² for each child attending that particular day-care center.

5.3 Drinking water from a local well

If relevant, it must be stated whether or not the day-care center uses groundwater from a local well. If YES, samples of the water coming out of the faucets must be collected and analyzed, and the results must be compared with the guidelines regulated in the drinking water act (National or EU regulation).
Table 1. Quality criteria for soil in day-care centers, playgrounds, and schools (Alexander, 2006).

<table>
<thead>
<tr>
<th>Substance (mg/kg)</th>
<th>Normal day-care center</th>
<th>Green day-care center</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Substances with the same criteria for normal and green day-care centers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arsenic (As)</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Chromium $^{6+}$ (Cr VI)</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>135</td>
<td>135</td>
</tr>
<tr>
<td><strong>Substances with stricter criteria for green day-care centers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>$^{2}$PAH$_{16}$</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>$^{3}$PCB$_{7}$</td>
<td>0.5</td>
<td>0.01</td>
</tr>
</tbody>
</table>

$^{1}$See chapter 6.4 for when the content of Cr$^{6+}$ must be determined
$^{2}$PAH=Polycyclic aromatic hydrocarbons
$^{3}$PCB=Polychlorinated biphenyls

Quality criteria for other relevant substances in industrial areas are provided in the additional guide for assessments of soil pollution in day-care centers and playgrounds in industrial areas (TA-2263/2007).

6. CHEMICAL ANALYSES

The collected soil samples must be sent to the laboratory(-ies) performing the sample preparation and chemical analyses. The analytical methods are defined precisely to ensure reliable and comparable results. Note that industrial areas have a different analytical program, see TA-2263/2007. The specified analytical methods are definite.

6.1 Arsenic and metals

Samples going to arsenic- and metal determination must be digested/decomposed according to Norwegian Standard NS 4770 (using 7 N nitric acid (HNO$_3$) in autoclave or microwave oven). The chemical content of arsenic (As), lead (Pb), cadmium (Cd), chromium (Cr), and nickel (Ni) must be determined using ICP-AES. Mercury (Hg) must be determined using cold-vapor atomic absorption spectrometry (AAS) technique.
6.2 Polycyclic aromatic hydrocarbons (PAHs)

The digestion and determination of PAHs must be performed according to Nordtest 1143-93. Determination must be performed using GC-MS. Results for the 16 standard PAHs (PAH_{16}) must be reported.

6.3 Polychlorinated biphenyls

The digestion and determination of PCBs must be performed according to Nordtest 1143-93. Detection is to be performed using GC-MS. Results for the 7 Dutch PCB congeners (IUPAC 28, 52, 101, 118, 138, 153, and 180) must be reported.

6.4 When do we need to determine chromium?

Chromium (VI) might be especially harmful for humans. The natural content of chromium in soil varies over relatively short distances (Ottesen et al., 2000). If a strong correlation exists between the chromium and nickel content in the soil samples (r > 80) it will be a strong indication that the major chromium source is the natural local soil and bedrock. This correlation might be visualized with the use of XY-diagrams, with plots of the nickel content on one axis, and the content of chromium on the other.

![Figure 12](image)

*Figure 12* XY-diagram showing the concentrations of chromium and nickel, indicating a natural source for chromium.

If the content of chromium correlates with other metals, such as zinc, cadmium, lead, or arsenic, which is unusual in natural materials, it will be a strong indication that there is an anthropogenic source for chromium (Rose et al., 1979). A correlation coefficient of r > 80 indicates such a covariation. Figure 13 shows two examples where the left diagram indicates no correlation between chromium and zinc (indicating a natural source for Cr), whereas the right diagram illustrates a relatively strong correlation (anthropogenic source).
Figure 13  The XY-diagram on the left indicate no covariation between chromium and zinc, which indicates a natural source for Cr. The diagram on the right, however, shows a selection of samples where chromium and zinc seem to correlate, which may be an indication of an anthropogenic source for Cr. Consequently, this may represent a strong possibility for high concentrations of Cr (VI).

If a correlation between Cr and other metals than Ni is determined, the content of chromium (VI) must be determined analytically if the total-Cr concentration exceeds natural levels in the actual area. In Norway, a specific set of rules has been established based on thorough data on the natural variation of concentrations in soil. For some of the cities, where the natural content of Cr in soil and bedrock is low, it is mandatory to determine the Cr (VI) concentration if the total-Cr concentration exceeds 50 mg/kg. For a selection of cities, especially in the northern part of Norway where the natural background concentrations of Cr are higher, the total-Cr concentration may be 100 mg/kg before the content of Cr (VI) is determined. One city decided on their own to set the total-Cr limit to 40 mg/kg. All soil samples above this limit induce the determination of Cr (VI).

7. QUALITY CONTROL

The duplicates, described in chapter 4.2, constitute a major part of the quality control procedure. They are used to control the reproducibility of sampling and chemical analyses. If the number of duplicates in a soil sampling batch exceeds 10, an XY-diagram showing the two “sister” samples must be constructed. Figure 14 is an example showing two XY-diagrams (B(a)P and Pb) for duplicate soil samples in the Oslo project in Norway. They both show satisfactory results. If large variances are discovered, these must be explained or tested.
NGU have prepared a large collection of soil samples with known concentrations of arsenic, heavy metals, PAHs, and PCBs (field standards, control samples). These control samples must be inserted among the actual field samples for each assessment project. This is another major part of the quality control. Every project (municipality, consultant agency) will upon start-up receive a certain number of control soil samples from NGU to be placed randomly in the sample batch going to chemical analyses. The analytical results for the control samples and the actual soil samples in the given project must be sent to NGU as soon as they are ready from the laboratory. NGU will confirm the results of the standard/control samples, and if any large deviations are discovered, NGU will contact the executive consultant and/or the responsible municipality directly.

8. REPORTING
The results from the soil assessment project must be assembled in a report. For larger cities, one report for each city district may be more convenient. The guide TA-2262/2007 from SFT provides a detailed template for a satisfactory report.

9. DATABASE
A digital database file must be prepared and delivered with the written report (MS Word or pdf) along with all the analytical results to NGU (e-mail: miljolaget@ngu.no). The data will be a part of the national geochemistry database. The database file should contain information such as the ID for the single soil samples, name and address for every day-care center/playground, coordinates for the soil sample locations, information from the field form, and all analytical results (heavy metals, PAHs, PCBs). Attachment 2 in the guide TA-2262/2007 from SFT provides an example of the structure of such a database file.
10. DOCUMENTATION REQUIREMENTS FOR DELIVERED SOIL TO DAY-CARE CENTERS

Each municipality (or city authority) responsible for the soil assessment projects and subsequent remediation, construction, or changes on any given property, will normally sign contracts with a contracting/construction firm to execute proper action. Documentation requirements on the chemical content of the new, delivered soil to the actual day-care center will therefore be handed to the executive contractors directly. They need to have valid contracts with collaborating soil suppliers.

The ones responsible for soil remediation must document that the new soil meets the requirements of the safe guideline concentrations for all pollutants given by the SFT (see table 2). Delivered (soil) masses to the day-care centers or playground cannot contain pieces of waste (e.g. bricks, wood chips, plastic, asphalt, wires, concrete, glass, etc.).

Documentation of clean soil from soil suppliers may result from:

- 10 single soil samples directly from the soil producer/supplier 4 times each year
- 1 composite sample for each 20 m³ of delivered soil

This is described more closely in 10.1 and 10.2.

Table 2. Safe guideline concentrations

<table>
<thead>
<tr>
<th>Substance</th>
<th>Safe guideline concentrations (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic (As)</td>
<td>8</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>60</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>1.5</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>50</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>100</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>1</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>60</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>200</td>
</tr>
<tr>
<td>PAH₁₆</td>
<td>2</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>0.1</td>
</tr>
<tr>
<td>PCB₁₅</td>
<td>0.01</td>
</tr>
</tbody>
</table>

10.1 Soil sampling from soil suppliers delivering masses to a large number of day-care centers

10 single soil samples (each of about 0.5 kg) of the product ready for delivery must be collected 4 times each year by an independent consultant. The samples must be collected from random locations in the soil, packed in RILSAN plastic bags, and sent to an accredited...
laboratory. The content of arsenic, lead, cadmium, copper, chromium, mercury, nickel, zinc, PAH\textsubscript{16} and PCB\textsubscript{7} must be determined by the same methods as soil samples from the environmental assessment in day-care centers and playgrounds.

The average result of the chemical analyses must be below or equal to the safe guideline concentrations set by the SFT (table 2) for the soil to be delivered to the day-care center or playground. One single soil sample may exceed the safe guideline concentration by no more than 50\%. The demands and requirements for delivered new soil to day-care centers and playgrounds are summed up in table 3.

### Table 3. Required chemical content of pollutants in soil ready for delivery to day-care centers and playgrounds.

<table>
<thead>
<tr>
<th>Substance (mg/kg)</th>
<th>Average (arithmetic) of 10 single samples</th>
<th>Maximum concentration in single samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic (As)</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>1.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Chromium (Cr)\textsuperscript{1}</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Nickel (Ni)\textsuperscript{1}</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>PAH\textsubscript{16}</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Benzo(a)pyrene</td>
<td>0.1</td>
<td>0.15</td>
</tr>
<tr>
<td>PCB\textsubscript{7}</td>
<td>0.01</td>
<td>0.015</td>
</tr>
</tbody>
</table>

\textsuperscript{1}The natural background concentrations of chromium and nickel in Trondheim have been documented to exceed 100 mg/kg for Cr and 75 mg/kg for Ni. This might be used as an average for soil to be delivered within this specific area. Maximum concentration in a single soil sample from the Trondheim area may not exceed 150 mg/kg for Cr and 112 mg/kg for nickel to be delivered to a day-care center.

### 10.2 Soil sampling from soil suppliers delivering masses to a limited number of day-care centers

A composite sample of each 20 m\textsuperscript{3} produced soil is collected. The composite sample must be comprised of 5 single samples (each of 0.3 kg) from the 20 m\textsuperscript{3} collected by an independent consultant or city authority (responsible for the assessment). The sample(s) must be sent to a chemical laboratory at once. Samples must be collected from produced soil, be packed in RILSAN plastic bags, and sent to an accredited laboratory. The content of arsenic, lead, cadmium, copper, chromium, mercury, nickel, zinc, PAH\textsubscript{16} and PCB\textsubscript{7} must be determined by the same methods as soil samples from the environmental assessment in day-care centers and playgrounds.
11. HOW MAY WE PREVENT FUTURE CONTAMINATION?

Below are a series of important steps in order to preserve clean (contaminant free) soil inside the day-care centers and playgrounds.

- Only clean soil must be delivered
  By “clean soil” we mean soil/sand that is documented to satisfy the requirements of safe guideline concentrations set by the SFT (table 2).

- Be specifically aware during renovation
  Buildings may contain a large number of pollutants in high concentrations (e.g. in paint, plaster). During renovation of buildings it is important to avoid the dispersion of fragments/waste to the nearby soil. Consider appropriate timing for renovation, cover the soil in play areas and consider vacuuming.

- Use pollutant free equipment in play areas

- CCA-impregnated wood in playground equipment (e.g. swings) and around sandboxes must be removed
  Remaining, untreated CCA-impregnated wood in swings and fences may be active sources of arsenic in a play environment. To prevent further contamination from such sources the need for oil treatment every second year is a minimum requirement. All CCA-wood must be removed when possible, and replaced by pollutant free alternatives.

- Be aware during new landscaping in the day-care center
  The soil assessments presented in this guide are first and foremost for surface soil (0-2 cm). Studies have shown that the soil might be more polluted as you dig deeper down. Caution should be made upon excavation/landscaping within the day-care centers, e.g. when installing new outdoor play equipment. Soil from deeper parts of the soil must not become surface soil after excavation unless it is documented pollutant free. Contaminated soil in excess (e.g. after excavation) must be delivered to a proper waste facility (landfill).

- Identify the potential contamination sources if the soil is proven polluted
  It is important that the consultant performing the soil assessments are trying to identify possible contamination sources within the day-care center or playground. Active contamination sources may, unless removed, lead to further soil pollution after some time, and any remediation may have a short-term effect.

12. REFERENCES


TA-2260/2007: Veileder for undersøkelse av jordforurensning i eksisterende barnehager og lekeplasser (Guide for soil pollution assessments in existing day-care centers and playgrounds). The Norwegian version of this guide.

TA-2261/2007: Veileder for undersøkelse av jordforurensning i nye barnehager (Guide for investigation of soil pollution in new day-care centers)

TA-2262/2007: Mal for rapportering fra undersøkelse av jordforurensning i barnehager og på lekeplasser. (Template for reporting soil pollution in day-care centers and playgrounds)

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Om SFT

Statens forurensningstilsyn (SFT) er et direktorat under Miljøverndepartementet med 300 ansatte på Helsfyr i Oslo. SFT arbeider for en forurensningsfri framtid Vi iverksetter forurensningstilsyn og er veiviser, vokter og forvalter for et bedre miljø.

SFTs hovedoppgaver er å:
- overvåke og informere om miljøets tilstand og utvikling
- utover myndighet og føre tilsyn etter forurensningsloven, produktkontrollloven og klimakvoteloven
- styre og veilede fylkesmennenes miljøvernavdelinger innen SFTs ansvarsområder
- gi råd til Miljøverndepartementet og tydeliggjøre behovet i sektorene for økt miljøinnsats
- delta i det internasjonale miljøvernsamarbeidet og utviklingssamarbeidet på miljøområdet

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