"Description of the Winter Maintenance Strategy with feasible additional measures"

2011

Project reference: LIFE09 ENV/FI/000579, REDUST

Ritola Roosa
15th December 2011

Table of Contents

1 Introduction 3

2 General description 3

2.1 Street and pedestrian footpath network 3

2.2 Air quality measurements 4

3 Personnel, materials and equipment 4

3.1 Equipment 4

4 Description of the current methods 5

4.1 Winter maintenance 5

4.2 Traction control 5

4.3 Spring cleaning 6

4.3.1 Espoo 7

4.3.2 Helsinki 8

4.3.3 Vantaa 8

5 Methods to reduce street dust episodes 8

5.1 Short-term action plan 9

6 Development and implementation of a feasible winter maintenance strategy to reduce street dust emissions compared with current state 9

References 11

1 Introduction

The strategy development aims at finding the best set of practices to be used in urban areas to reduce harmful levels of respirable street dust. The strategy will describe the organisation of winter maintenance. In the strategy development in Action 4 an "optimized street dust mitigation strategy" will be developed utilizing the results of the demonstration actions. In Action 3 of the project, air quality benefits and costs of the "optimized street dust mitigation strategy" are estimated and compared with other practices (e.g. "business as usual strategy" or some lower ambition level strategy).

Implementation of the first strategy version developed during the first year of the project will start during the second winter. The strategy will be iterated during the course of the project and it can incorporate additional practices as soon as their efficiencies in reducing respirable street dust have been demonstrated.

Three cities in the Helsinki metropolitan area (Espoo, Helsinki and Vantaa) have earlier documented their current winter maintenance and spring cleaning practices. These documents include information about the available equipment and personnel for the winter/spring maintenance, as well as descriptions of the methods that eventually aim at reducing respirable street dust in springtime. The methods and equipment in different cities are in general very similar. The purpose of this paper is to collect and summarize the information from the three cities to give an overview of the current methods, and furthermore to describe an optimized street dust mitigation strategy which is developed in Action 4.

2 General description

Each city has its own characteristic street network. In this chapter, the lengths of the street networks and general descriptions are given. An overview of the air quality monitoring in the Helsinki metropolitan area is also given.

2.1 Street and pedestrian footpath network

The city of Espoo maintains altogether 825 kilometers of roadways and approximately 640 kilometers of shared-use footways.

In Helsinki there are altogether more than 1000 kilometers of roadways. Together with the pedestrian footpaths, shared-use footways, market places, squares and other areas the total maintained area is nearly 2000 hectares.

The city of Vantaa maintains altogether 1500 kilometers of roadways, shared-use footways and pedestrian footpaths, together with approximately 120 staircases of different lengths.

2.2 Air quality measurements

Helsinki Region Environmental Services Authority (HSY) is responsible for the air quality monitoring in the Helsinki metropolitan area. Altogether 11 measuring stations are located in the area in different types of environments. Several gaseous and particulate pollutants are measured. Results are updated every hour and the up-to-date information about air quality is available on the web (www.hsy.fi/en). Street dust causes high concentrations of respirable particles (PM_{10}) close to traffic areas, especially during dry spring days. The PM_{10} air quality measurements are utilized for instance to inform the public about poor air quality or daily limit value (50 µg/m3) exceedances due to street dust, to estimate the need for dust binding during acute dust episodes, to evaluate the effectiveness of dust mitigations measures and to monitor long-term annual PM_{10} trends.

3 Personnel, materials and equipment

In order to meet the requirements that are set for winter maintenance in the law, the work often has to be done outside normal working hours. Work requires flexibility. On-call duties are carried out according to an approved plan and guidelines.

Espoo has divided the street maintenance area to two; southern and northern units. Both units have 40 employees working for winter maintenance. In Vantaa the amount of personnel is approximately 60, including supervisors and subcontractors. In Helsinki there are three maintenance units: western, eastern and northern. The total number of employees is 300-400.

The amounts of material needed for traction control vary between the cities and between years. To give some reference, the latest figures (per year) from all three cities are presented.

- Espoo ca. 25 000 t gravel and 1300 t loose granular salt. The amount of calcium chloride used per year has varied from 185t (in 2009) to ca. 400 t (in 2010 and 2011).
- Helsinki ca. 30 000- 40 000 t gravel and 5000 – 10 000 t salt.
- Vantaa ca. 9500 t gravel and 2000 t salt.

3.1 Equipment

Part of the necessary maintenance equipment is owned by the cities themselves. The rest is owned by contractors and private sector operators.

Winter maintenance vehicles include trucks, tractors, wheel loaders, front-end loaders, skid loaders**,** vans and pickup cars.

Vehicles are equipped with special snow removal accessories such as snowplows, different types of blades, automatic gritters, salt spreaders and sweepers. In addition the vans and pickup trucks are equipped with tools needed for the manual work: shovels, snow scrapers and gritters as well as de-icing and sanding materials.

Vehicles that are used for sand removal and dust binding are usually trucks or tractors equipped with the needed accessories, suction sweepers and captive hydrology street cleaners.

4 Description of the current methods

In this chapter short descriptions of the current winter maintenance, traction control and street cleaning methods, from three cities are summarized.

4.1 Winter maintenance

Winter maintenance and quality assurance in Helsinki and Vantaa are in principal taken care of according to the guidelines published in *Alueurakointi, Yleinen tehtäväluettelo2003* (publication by the Association of Finnish Local and Regional Authorities). In Helsinki some supplementary guidelines are also given. However the guidelines are directive and the needed measures are always considered case by case. City of Espoo has composed a manual of its own: *Katuylläpito, Alueurakointi, Yleinen tehtäväluettelo 2011* according to which the winter maintenance and quality assurance is taken care of.

Ploughing is done when necessary, which means that snow is removed and transferred away from the street environment at the latest when the amount of snow either disturbs traffic or normal maintenance procedures, or presents a threat to surrounding vegetation. Sometimes it is also done in order to be prepared for subsequent snow fall, and to speed up the melting of snow piles in springtime.

In case of a continuous snow fall, a layer of salt or sand-and-salt-mixture is typically applied to class I and II streets, in order to facilitate the ploughing done later on.

4.2 Traction control

In the Helsinki metropolitan area streets have been classified into three groups, which also determines to some extent how traction control is conducted. Both gravel and salt ($NaCl_2$) are applied for traction control.

In driveways the traction control material is either washed and sieved sand or gravel, salt, brine or a mixture of sand and salt. The material is selected based on the location, weather, road conditions and forecasts. For the class I and II streets gravel is mainly used on the bus stops and crossroads, in case the weather does not allow the use of salt (temperatures below zero). On class III streets only traction sanding is used.
In Espoo the material used on asphalt paved streets is mainly a mixture of gravel and salt. On the streets with other type of pavements washed sand is used.

Salt or brine solution is mainly used during late winter and early spring when the removal of sand from the streets has already started. In some areas in Espoo, for example in locations where the traffic density is high, salt might be used throughout the winter. Also in Vantaa, on the streets with high traffic densities, mainly salt ($NaCl_2$) is used. When temperatures are close to zero, it is possible to keep the streets free of ice with using nothing more than salt; vehicles passing by spread the salt and break down the ice layer on the surface of the road. Meltwater evaporates efficiently from the street surface due to the traffic flow. In case the temperature is close to zero and cooling, salt is spread before sand. In case the temperature is 5-10 degrees below zero, mixture of sand and salt is applied in the busiest truck and bus routes .

Traction sand is purchased yearly based on tenders. Only washed and sieved gravel can be applied. Current requirements for the grain size of the material are 1 to 5.6 mm for driveways and 3 to 5.6 mm in pedestrian areas. Usually the material contains some salt to prevent clogging. According to the Helsinki city authorities the amount of material used with the current equipment vary between 60-110 g/m^2, depending on the weather and local conditions. Although the gravel is wet sieved material and quality control requires the supplier to provide measured grain size distributions, some leftovers of finer material are possible. Recent measured grain size distributions have contained in average 0.7 mass-% material in the sieve <63µm (min-max 0.4%-0.9%, SD 0.3). In Vantaa so-called "safety sand" (size distribution 1-6mm) is used in pedestrian areas. Safety sand differs from the conventional sanding material in that the gravel is not crushed, and thus the grains are not so sharp.

The amount of salt used varies between 5-60 g/m^2 (minimum for a dry condition, maximum for a wet, snow fall condition).The maximum grain size is 5 mm and the material is allowed to contain 5 mass-% of <125 µm material. Salt is mainly used moistened, but sometimes also as a brine solution.

4.3 Spring cleaning

Dust binder or water is used to moisten the street surfaces in order to suppress suspension of finer material during the process. Methods to mitigate the unwanted dust emissions can

also be employed before or after the spring cleaning. All three cities currently use calcium chloride ($CaCl_2$) as a dust binder, but other substances have also been tested. For example pine soap is sometimes used to decrease the surface tension of the water during street cleaning.

In case water is used, the timing of the work has to be optimized with weather conditions (sub-zero temperatures) to prevent freezing of the street surfaces. Temperatures close to zero might also cause the nozzles of the suction sweepers to freeze, and thus prevent the cleaning. During heavy rain fall it is not possible to use suction sweepers since the tanks fill up with the water. This brings variation to the timing of the spring cleanings, for example during years 2006-2010 the starting time of the spring cleanings varied between week 12/2007 to week 15/2006 in Espoo, Helsinki and Vantaa.

4.3.1 Espoo

In Espoo, cleaning begins when the road conditions allow; in case there are still wide stretches of ice on the sides of the road, it is more feasible to start the cleaning from the pedestrian areas. Due to the need of pre-moistening, the cleaning will not begin if the temperature is below zero. Occasionally $CaCl_2$ solution or pine soap is used to prevent freezing. However, since $CaCl_2$ is corrosive scrubbers suffer from the use of $CaCl_2$, and it can only be used in special equipment.

From the driveways the material is collected with suction sweepers, or with mechanical sweepers when the material has to be collected either straight to lorries or in temporary deposits. In some areas the sand is swept straight into the surrounding terrain. Additional moisturizing is used in case the machine's own sprinkling system does not bind the dust efficiently enough. Edges of the roads and other structures are washed latest when all the loose material is collected away. The work is finalized with suction sweepers and scrubbers, depending on the weather conditions and available resources.

The aim is to wash the bus stops and terminals once in the beginning of the cleaning period, and if necessary to use additional moisturizing later on before the final cleaning is done.

In Espoo the removal of the sand and gravel from the pedestrian and shared-use footways is done with mechanical sweepers and the material is collected either straight to lorries or in temporary deposits. Moisturizing is used if needed. In some areas it is possible to sweep the sand straight into the surrounding terrain. Staircases and other structures in pedestrian areas are washed manually. The cleaning of pedestrian and shared-use footways is finished with suction sweepers and scrubbers depending on the weather conditions and available resources. Sand removal from the urban green street areas is done in cooperation with the Street and Park Division, and the aim is to start the work simultaneously. This is particularly important in situations when the collected sand has to be temporarily moved from the green areas to street areas where the cleaning has already taken place.

4.3.2 Helsinki

In spring the removal of remaining sand and gravel from the streets is started as early as possible, as soon as the weather conditions allow. During spring cleaning, the gravel is removed from the street surface with mechanical brushes, after that a vacuum sweeper removes the finer material. In the final stage the surface is washed with high pressure washing. After the sand is collected, the street ought to be clean from sand/gravel, and after the high pressure washing, free from dust.

4.3.3 Vantaa

In Vantaa the first areas to be cleaned are the central pedestrian areas and shared-use footways. After that the order follows the classification of the streets. During the first weeks of the cleaning (mainly in class I and II streets), the work is done in longer shifts than usual (Mon-Thu 12 hours/day). Tunnels and some other challenging locations are cleaned during weekends and nighttime only.

Cleaning is finished with sweepers combining high pressure washing and subsequent suction, beginning from the central areas and moving forward to all mechanically swept streets and areas. It usually takes around one month before the cleaning proceeds to class III streets. The order by which the class III streets are cleaned is changed every year. The removal of the sand/gravel takes normally 6 to 8 weeks depending on the spring. Aim is to finish all cleaning by mid June.

Coarser sand is usually removed quite efficiently, but there is evidence that the finer material is only washed away by heavy rain fall. The quality assurance includes visual inspections and following the air quality index from the HSY's measuring stations.

In case of sudden changes in the weather in spring, sanding may be required in pedestrian areas after the cleaning operations have already taken place. This is not a problem in roadways, where sand can be applied only to the places where it is important (bus stops, crossroads).

Usually, after the cleaning operations have been initiated, only salt is used for traction control in each of the cities.

5 Methods to reduce street dust episodes

The main means to mitigate acute dust episodes is dust binding with calcium chloride ($CaCl_2$) solution. Dust binding is carried out year round when and if the weather and road conditions require. The need for dust binding is estimated by street maintenance personnel based on air quality monitoring results as well as on weather and air quality

forecasts. Furthermore, visual observations are utilized to obtain a view on the dryness and dustiness of different street sections.

In springtime dust binding is carried out proactively and systematically, before and during the sand removal. Sand is removed from the street environment as early as possible to prevent unnecessary accumulation of dust. Dust binding may be carried out for a selected streets or city areas. In most cases, dust binding solution is only spread on the street edges with special spreading equipments designed for the purpose. Dust binding is repeated when necessary.

Whenever old equipment is replaced or new equipment purchased, the best available technology is considered. At the same time more efficient methods and procedures are developed to enhance the current street cleaning and sand removal methods.

Cities also participate actively in studies related to street dust mitigation, and aim at utilizing the research results.

5.1 Short-term action plan

Occasionally the concentrations of air pollutants rise to an abnormally high and harmful level in the Helsinki Metropolitan Area. Regarding these air pollution episodes, local authorities have drawn up an action plan: *Short-term action plan for a sudden deterioration of air quality in the Helsinki metropolitan area* The plan includes information for the authorities; how to proceed in these types of situations to reduce resident exposure to air pollutants. The four pollutants addressed to in the plan are: respirable particles (**PM_{10})**, a cause of concern especially in the springtime due to street dust), nitrogen dioxide (**NO_2**) from traffic exhaust, fine particles (**$PM_{2,5}$**) and ozone (**O_3**).

Regarding PM_{10} particle episodes caused by street dust, the aim of the action plan procedure is (1) to speed up the mobilization of dust binding equipment to mitigate the dust problem and (2) to inform residents about the poor air quality and the means to reduce exposure. According to the plan, the Helsinki Region Environmental Services Authority (HSY) sends information to the city authorities when the daily limit value (50 $\mu g/m^3$) for PM_{10} was exceeded in previous day or if there is a clear risk of exceeding the limit value during next day. The city environmental authorities decide if it is necessary to carry out dust binding or other measures, and forward the request to the maintenance persons in charge in the concerned area.

6 Development and implementation of a feasible winter maintenance strategy to reduce street dust emissions compared with current state

In action 4 of the REDUST project the aim is to develop and implement a feasible strategy to reduce levels of respirable (PM_{10}) street dust by means of better winter

maintenance practices in urban areas in Finland. Work is based on earlier actions of the REDUST projects , which studied the reduction potential and cost estimations of the maintenance practices Testing the improved strategy includes experiments in all three cities in spring 2012.

Based on the results from Action 3, two methods were selected for the 2012 test: enhanced dust binding and intensified street cleaning with PIMU (scrubber with captive hydrology). PIMU cleaning is more efficient than traditional cleaning. However the efficiency of PIMU cleaning is dependent on the initial street dust level, and tends to be most efficient when the dust load is high For this reason, also the timing of the PIMU cleaning needs to be carefully chosen.

Three sites, one from each city were selected as test sites considering the following criteria: current methods and the need for improvement, amount of traffic, initial street dust levels, no planned construction or other factors that might interfere with the measurements. The sites and methods are presented in Table 1.

Table 1. The sites where improved measures will be tested in spring 2012.

Site	Current method 2011	Improved method 2012
Espoo: Kalevalantie & Koivu-Mankkaantie	Traditional cleaning	PIMU cleaning
Helsinki: Mannerheimintie	Traditional cleaning	PIMU cleaning
Vantaa: Talvikkitie & Talkootie	2 dust bindings (in 2011)	3 or more dust bindings

The strategy will be iterated during the course of the project. Practices might be changed or new practices incorporated as soon as their efficiencies in reducing respirable street dust have been demonstrated.

References

1. The Association of Finnish Local and Regional Authorities. 2003. *Alueurakointi. Yleinen tehtäväluettelo 2003.*

2. Espoon kaupunki, Katu- ja vihertuotanto –Liikelaitos. 2011. *Katuylläpito, Alueurakointi, Yleinen tehtäväluettelo 2011.*

3. HSY Helsinki Region Environmental Services Authority. 2010. *Short-term action plan for a sudden deterioration of air quality in the Helsinki Metropolitan Area*. Available on WWW: http://www.hsy.fi/en/regionalinfo/airquality/information/airqualitydeterioration/Pages/default.aspx

4. Kivinen, J. 2006. *Toimintamalli katupölyn ehkäisemiseksi Helsingissä 2006.*

5. Liikanen, T. 2011. *Toimintamalli katupölyn ehkäisemiseksi Espoossa 2011.*

6. Ranta, J. & Tammisto, E. 2011. *Toimintamalli katupölyn ehkäisemiseksi Vantaalla 2011.*

7. REDUST Deliverable Action3: PM_{10} dust emission and reductions estimations, 15.10.2011

8. REDUST Deliverable Action1-2. Description f the first year demonstration test, main results and conclusions. 12.8.2011