



Summary review

January 2017

IMPROVE LIFE13 ENV/ES/000263



Coordinated by
idæ^a CSIC







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1. ACTIVITIES FOLLOW-UP

The following summary report covers IMPROVE LIFE13 ENV/ES/000263 activities from **01/10/2016 to 31/12/2016**.

Activities were launched on time and the project progresses according to the proposed timetable. Actions A and B1 have been completed. The main tasks initiated or accomplished at each action in progress were as follows:

- **Action B2** “Testing mitigation measures and development of mitigation strategies”. This action is still in progress and is planned to finish on 30th June 2017, therefore the dates for completion of the deliverables for this action have consequently been extended.

During the period described in this report measurements progressed at Poble Sec station (L3) from 14th September to 11th October. Tests aimed to investigate the effects on air quality linked to the addition of ballast to tunnel, and were designed following the methodology previously performed at Palau Reial and Maria Cristina stations in summer 2015. Accordingly, two different methods were compared: 1) addition of ballast under normal conditions (ballast +water), and 2) addition of ballast using a commercial available anti-resuspension polymer (ballast +water +dust suppressant). Each method was applied at a different side of the tunnel. Instruments were moved from one platform to the opposite one, following the schedule of the tunnel works. The sampling periods included days under normal conditions and days affected by works (comprising adding and levelling ballast). The analysis of the results is now in progress, combining this campaign with that performed at Palau Reial and Maria Cristina. Information on the kilometric points where works were carried out each night is being compiled.

The effect of air purifiers manufactured by two different companies (PurAir and GINSA) was compared against the air quality under normal conditions in the platform of Palau Reial station (L3). This campaign will complete and validate the results previously obtained in the station of Tarragona (L3) in February-May 2016, which pointed to an efficient performance of PurAir purifiers. Palau Reial was selected due to the higher concentrations of air pollutants recorded in this station in 2015, compared to the rest of the stations included in the IMPROVE project. Measurements were carried out from 11th October to 10th November 2016. Each purifier was tested during one week periods, always preceded and followed by one week under standard conditions. Additionally, in order to account for the inter day variability of air conditions at platforms, measurements were simultaneously carried out at the adjacent station of Maria Cristina (L3) from 12th to 28th October, maintaining standard conditions all the period along. This was considered the best proxy to quantify the impact of air purifiers on air quality, as certain homogeneity of air conditions can be assumed within L3, according to previous sampling campaigns. To further characterize the effect of the PURAIR purifiers, measurements were also carried out aiming to assess how the effectiveness varies with the distance. During these tests, a portable automatic PM monitor was used to measure in 8 different positions,

approximately equidistant, along the platform; the first measurement being located at the air quality sampling site, at one end of the platform. For comparisons, the same measurements were carried out once under normal conditions and once under the effect of the purifiers' performance.

All the campaigns involve the deployment of several equipments at one end of the platform of the selected stations fulfilling all the necessary safety conditions. The monitoring equipment includes a high volume PM_{2.5} sampler (for daily sampling particulate matter below 2.5 microns), passive samplers for NO₂ monitoring, and automatic equipments registering continuously concentration levels of i) PM in 3 sizes (1, 2.5 and 10 microns); ii) particle number concentrations in 16 size ranges; and iii) CO, CO₂, temperature and relative humidity every 5 minutes.

Complete chemical analyses of all the PM_{2.5} samples collected by the high volume sampler at all the platforms studied were planned. The objective is to determine the variations in chemical composition driven by the influence of the different activities performed and situations tested. The chemical analyses include:

A) Determination of major and trace elements. To this end, a quarter of each filter is acid digested and the resulting solution is subsequently chemically analysed by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES: IRIS Advantage TJA Solutions, THERMO) and Mass Spectrometry (ICP-MS: X Series II, THERMO).

B) Determination of major ions (nitrate, sulfate, chloride and ammonium). To this end a quarter of each filter is water leached with de-ionized water to extract the soluble fraction. The solution obtained is analysed by ion chromatography and by selective electrode.

C) Determination of Total Carbon (TC). This analysis is performed by an elemental analyser using a portion of each filter.

D) Determination of molecular organic species in a selection of the samples. A subset of samples is selected to perform these extra analyses. The subset of samples is selected so that it is representative of the entire set. Hence, the average PM_{2.5} concentration of the subset of samples is similar to the average PM_{2.5} concentration of the entire set. Moreover, the different situations (renewal works activities, ventilation settings, etc) are represented by the subset of samples. Concentrations of molecular organic species are determined after extraction by methanol/dichloromethane (1:1 v/v), derivation of esters to TMS-esters and subsequently detection and quantification in a gas-chromatograph coupled to a mass-spectrometer (GC-MS) in full-scan mode.

Up to December 2016, the gravimetric analyses to determine the PM_{2.5} concentrations have been carried out for all the collected PM_{2.5} samples, which add 436 samples. These samples are subsequently used to perform the chemical analysis. Up to December 2016, a total of 163 samples had been completely chemically analysed (71 samples from Sagrera station, 44 samples from Palau Reial station, 27 from Maria Cristina station and 21 from Tarragona station). Moreover, 33 samples from Santa Coloma station, 46 samples from Joanic station, 16 samples from Sant Ildefons station, 71 samples from Tarragona station, and 27 samples from Collblanc station have been chemically analysed completely except for the ion chromatography analyses. Additionally, 30 samples from Collblanc station have

been analyzed for ICP-AES, ICP-MS and ammonium (while the TC analyses are to be done). During the specific period for the present report (October to December 2016), gravimetric analyses to determine the PM_{2.5} concentration have been carried out for 22 samples from Poble Sec station and 28 samples from Palau Reial station. Additionally, during this specific period, 32 samples from Tarragona have been analyzed for ICP-MS, 27 samples from Collblanc have been analyzed for ICP-AES, ICP-MS, ammonium and TC, and other 30 samples from Collblanc station have been analyzed for ICP-AES, ICP-MS and ammonium. The selection for the subset of samples to be analysed for organic molecular species is under progress.

Regarding the indicators of progress of actions B1 and B2, the construction of a database detailing the concentrations of chemical tracers for pollutant sources in subway systems and the impact of each of them on air quality is in progress as still PM samples are being collected at the moment. Furthermore a report overviewing and comparing the full impacts on air quality of each of the selected parameters is in progress until all samples are analysed.

- **Action C1** “Effectiveness of the project actions”. This action focuses on the evaluation of the policy effectiveness of the project’s actions, but also following the requirement from the European Commission (letter 22/07/2016) the action includes also now the evaluation and monitoring of the project impact. This Midterm report sent to the European Commission on December 2016 will be sent also to the nominated external committee formed by five international air pollution experts on January 2017, together with a series of questions designed to allow judgement of the success of the project so far. This will be requested to be returned to the project coordinator (T. Moreno) by the end of March 2017.
- **Action C2** “Assessment of the socio-economic impact of the project”. This action started on July 2016. An on-line questionnaire about different aspects of IMPROVE is being developed and will be launched in the project webpage in January 2017. This follows the questionnaire carried out by TMB the previous year, and aims to gather more detailed data on the opinions/knowledge of subway passengers by asking the follow ten questions:
 - ✓ Q1. Your Age
 - ✓ Q2. City where you live/work (and use public transportation)
 - ✓ Q3. How often do you think about air quality? < Often / occasionally / never >
 - ✓ Q4. Do you think you breathe clean air in the city? < Yes / no >
 - ✓ Q5. The World Health Organisation has proved that breathing poor quality air can reduce your life expectancy. Did you know this? < Yes / no >
 - ✓ Q6. Which means of transport do you use more often in the city? < bicycle / subway / bus / tram / motorbike / car >
 - ✓ Q7. In your opinion, which of the above means of transport are best for city air quality?
 - ✓ Q8. What is your opinion on the subway air quality? < good / ok / poor >

- ✓ Q9. Where do you believe the air is cleaner? <on the platform/inside the train>
 - ✓ Q10. Do you think subway air quality could be improved? If so, how?
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- **Action D1** “A Project website designed as a tool to raise the profile of the project and improve the dissemination of its activities”. The web site of IMPROVE LIFE (<http://improve-life.eu>) was launched in December 2014 and is updated in a 2-week basis. Main updates during this period have been on reports, scientific publications and conference presentations of the project, activities and results. A visitor’s counter has been added to have a more detailed knowledge of the web views. The page has had an average of 1000 hits per week during December (similar to previous months).

 - **Action D2** “LIFE+ Information board will be on displayed describing the project at the locations where it is implemented, at strategic places accessible and visible to the public”. LIFE+ Information boards are on display since January 2015 describing the project at the locations where it is implemented, at strategic places accessible and visible to the public. By September 2016 hard information boards on the project have been placed at Sagrera, Palau Reial, Maria Cristina, Tarragona, Santa Coloma, Joanic, Saint Ildefons, Collblanc and Poble Sec stations where measurements have been performed. Panels are also permanently displayed in IDAEA-CSIC (Palau Reial) and TMB (Santa Eulalia) main offices. As previously, no vandalism problems have occurred during the July-September period.



Action D2. Informative panel in the entrance area of subway stations where measurements have been performed and in CSIC and TMB main offices.



- **Action D3** “Dissemination of project results”. During this period the following activities to disseminate IMPROVE LIFE results have been carried out:

- ✓ Two informative **videos**, of 10 (to be shown in the web page) and 20 (to be shared with other subway systems) minutes explaining the aims of the IMPROVE LIFE project are in preparation. The script has been translated into three languages (English, Spanish and Catalan) and is being edited at the moment. Final result is aimed to be available in the next trimester.
- ✓ **Scientific international publications** on the project results in SCI journals acknowledging the LIFE+ financial support during this period:

Moreno, T., Kelly, F., Dunster, C., Oliete, A., Martins, V., Minguillon, MC., Amato, F., Capdevila, M., de Miguel, E., Querol, X. Oxidative potential of subway PM2.5. Atmospheric Environment (in press)

Triadó-Margarit, X., Veillette, M., Duchaine, C., Talbot, M., Amato, F., Minguillón, M. C., Martins, V., de Miguel, E., Casamayor, E. O. and Moreno, T. Bioaerosols in the Barcelona subway system. Indoor Air. doi: 10.1111/ina.12343 (in press)

Moreno, T., X. Querol, V. Martins, M. C. Minguillón, C. Reche, LH. Ku, HR. Eun, K. Ahn, M. Capdevila and E. de Miguel, Formation and alteration of airborne particles in the subway environment. Environ. Sci.: Processes Impacts, DOI: 10.1039/C6EM00576D. (in press).

- **Action E1** “Project Management and Audit”. The next report to be delivered was the Midterm report that was submitted by 27th of December 2016.

- **Action E2** “Monitoring of the project progress according to indicators defined by the managing team”. Three-month summary reviews, as the present one, are being prepared since the beginning of the project and published in the web page. Regular meetings every month of all partners to discuss developments, problems and progress of the project have been hold (more frequently than initially programmed), including:

- ✓ Discussion on Midterm report. 30th November CSIC: Teresa Moreno; TMB: Eladio de Miguel, Marta Capdevila, Sonia Centelles.
- ✓ Discussion on dust suppressant campaign preliminary results. 22nd December CSIC: Teresa Moreno, Cristina Reche; TMB: Marta Capdevila, Sonia Centelles, David Gómez.

A Gantt chart for the whole lifecycle of the IMPROVE LIFE project is shown below. Action B1 has been extended 3 months until September 2016, as chemical results were not finished by June due to the large number of samples. Similarly B2 will benefit from an extension until June 2017, due to both i) mechanical problems with the equipment necessary to add ballast to the rail tracks, and ii) an over-optimistic originally proposed date by which to finish the monitoring campaigns (09/2016). These adjustments to the deadlines will give more time for the deliverable associated with action B2 (Elaboration of a technical guide for mitigation measures), which will be one of the most important results of the project. The modification of



the duration of both Implementation Actions was discussed and agreed with the LIFE Monitoring Team (NEEMO) during their visit last June 2016. Accordingly Action D4 (Layman report) will start in January 2017, instead of July 2016, a modification also approved by the Monitoring Team. Finally the one-day workshop with other European Projects, which was scheduled to take place before 30/06/2015, has been moved to May 2017, when the results of IMPROVE LIFE are further advanced.

- **Action E3** “Networking with other European projects (including LIFE+)”. A list of related projects is continuously updated in the project web page. During these three months IMPROVE LIFE has had meeting with:
 - ✓ Network activities are programmed to increase during the last half of the project, mainly in 2017. On 3-6th of July 2017 the coordinator of the project is organizing an **international conference** in Barcelona (<http://www.ricta2017.org/>) during which there will be presentations on the IMPROVE results (3rd July), and one day (4th July) dedicated to Air Quality while Commuting, including metro systems, with the participation of about 100 participants including researchers, and national, regional and European stakeholders. Confirmed speakers for this day from other LIFE+ projects and the European Union include Alfredo Sánchez (Project Manager for Transport for the European Environment Agency), Jesús Miguel Santamaría (Universidad de Navarra, coordinator of LIFE+ RESPIRA) and Xavier Querol (CSIC, coordinator of LIFE+ AIRUSE), Moniek Zuurbier (Regional Public Health Services Gelderland-Midden), Francisco Ferreira (Universidade Nova de Lisboa) and Soon-Bark Kwon (an international expert on subway air quality from Univ Sci and Technology, Korea).
 - ✓ A 1-day workshop with other European Projects was originally scheduled to take place before 30/06/2015, however as the project has progressed it has become clear to us that it would be more logical to organise this workshop when a full set of results of IMPROVE LIFE are available for discussion. With this in mind we are co-organising with AIRUSE (LIFE11/ENV/ES/584) an **Air Quality Platform Meeting** to be hold in Barcelona next 23-24 May 2017, to which other LIFE projects will be invited.



IMPROVE TIME-TABLE

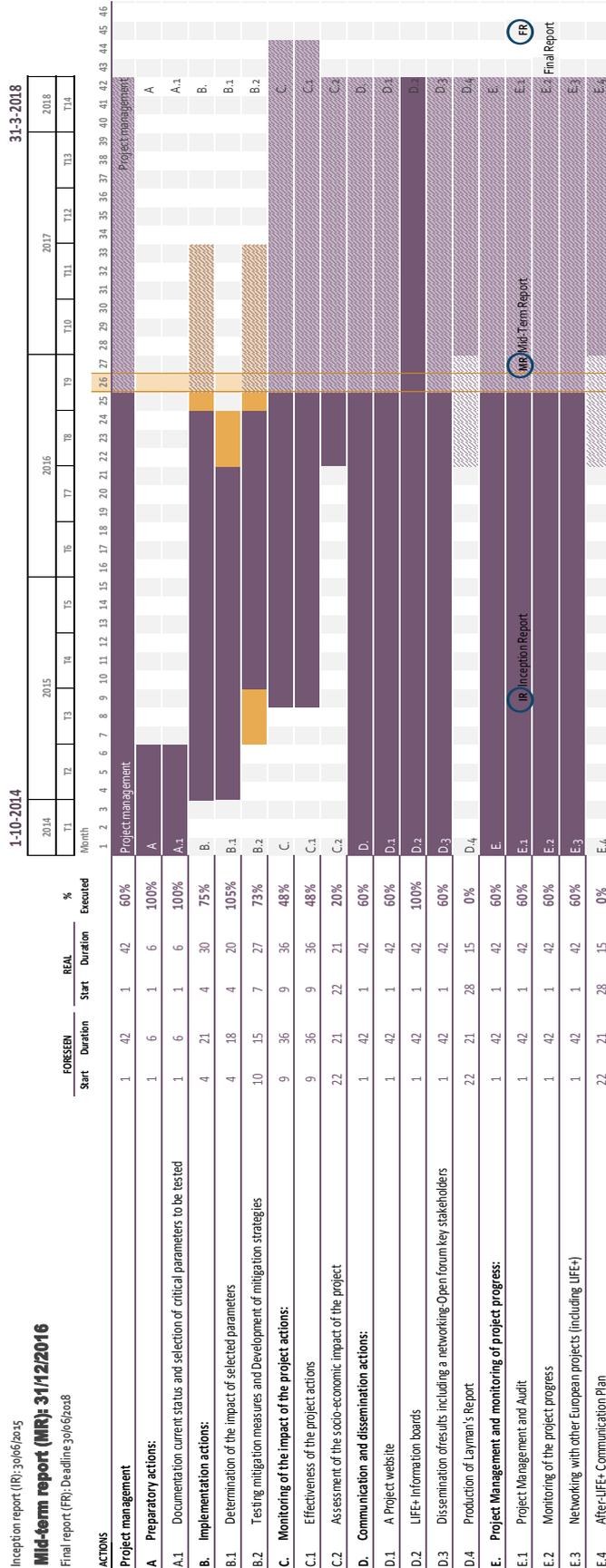
Inception report (IR): 30/06/2015

Mid-term report (MR): 31/12/2016

Final report (FR): Deadline 30/06/2018

Update by month 26

Foresen Foresen
 Real Real
 % executed % executed
 Delay /Ahead of schedule Delay /Ahead of schedule
 Real (més allà del plan) Real (més allà del plan)



Action E2. Progress of the project and the planned actions.



2. LIST OF THE PROJECT'S OUTCOMES DURING THE PERIOD

ACTION	DATE	TITLE
2.1. IMPROVE LIFE publications		
D3		Moreno, T., Kelly, F., Dunster, C., Oliete, A., Martins, V., Minguillon, MC., Amato, F., Capdebila, M., de Miguel, E., Querol, X. Oxidative potential of subway PM2.5. Atmospheric Environment (in press)
D3		Triadó-Margarit, X., Veillette, M., Duchaine, C., Talbot, M., Amato, F., Minguillón, M. C., Martins, V., de Miguel, E., Casamayor, E. O. and Moreno, T. Bioaerosols in the Barcelona subway system. Indoor Air. doi: 10.1111/ina.12343 (in press)
D3		Moreno, T., X. Querol, V. Martins, M. C. Minguillón, C. Reche, LH. Ku, HR. Eun, K. Ahn, M. Capdevila and E. de Miguel, Formation and alteration of airborne particles in the subway environment. Environ. Sci.: Processes Impacts, DOI: 10.1039/C6EM00576D. (in press).
2.2. IMPROVE LIFE reports		
E1	29/12/2016	Midterm Report
E2	31/12/2016	Summary review
2.3. IMPROVE LIFE other dissemination materials		
D1	31/12/2016	Project website (updated)



3. DISSEMINATION ACTIVITIES DURING THIS PERIOD

ACTION	DATE	TITLE
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3.1. IMPROVE LIFE events

3.2. IMPROVE LIFE presentations in other events

3.3. IMPROVE LIFE networking with other projects

D3	12/2016	Publication of web page for the international conference RICTA co-organised by IMRPOVE to be hold in Barcelona (http://www.ricta2017.org/) during which there will be presentations on the IMPROVE results (3rd July), and one day (4th July) dedicated to Air Quality while Commuting, including metro systems, with the participation of about 100 participants including researchers, and national, regional and European stakeholders. Confirmed speakers for this day from other LIFE+ projects and the European Union include Alfredo Sánchez (Project Manager for Transport for the European Environment Agency), Jesús Miguel Santamaría (Universidad de Navarra, coordinator of LIFE+ RESPIRA) and Xavier Querol (CSIC, coordinator of LIFE+ AIRUSE), Moniek Zuurbier (Regional Public Health Services Gelderland-Midden), Francisco Ferreira (Universidade Nova de Lisboa) and Soon-Bark Kwon (an international expert on subway air quality from Univ Sci and Technology, Korea).
D3	12/2016	Elaboration of an agenda for a 1-day Air Quality Platform Meeting with other European Projects co-organised with AIRUSE (LIFE11/ENV/ES/584) an to be hold in Barcelona next 23-24 May 2017, to which other LIFE projects will be invited.

4. DELIVERABLES AND MILESTONES CHECK-UP (31/12/2016)

(Shown in green those already completed, and in yellow those in progress)

START	ACTIVITIES FOLLOW-UP	OUTCOMES available on-line at:	DEADLINE
A. PREPARATORY ACTIONS			
A1 Documentation of current status and selection of critical parameters to be tested			31-march-15
1-oct-14	Construction of 1 historical database of studies examining the methods used to identify and resolve the contribution of aerosol emission sources and their major results	Deliverable 2 Historical source contribution	31-jan-15
	Elaboration of 1 list of the main parameters identified to be considered in all studies	Deliverable 4 Parameters to test	31-march-15
	Prioritisation of air pollution sources in subway systems	Milestone D Main Air Pollution sources	31-jan-15
B. IMPLEMENTATION ACTIONS			
B1 Determination of the impact of selected parameters			30-jun-16
1-jan-15	Organisation and coordination of a campaign program	Campaigns calendar	15-dic-14
	Presentation of Technical reports on the advance of:	Report 1 Campaigns	30-apr-15
	- sampling campaigns works		
	air conditioning in trains (series 2 & 3K)	Report 2 Campaigns	31-oct-15
	ventilation		
	air conditioning (series 5K)		
	rail change		
	brake pads		
	ventilation	Report 3 Campaigns	31-mar-16
	graphite pantograph		
	- chemical analysis inorganic PAH in PM filters NO2 samples		
	- results of the chemical analyses	Milestone G Impact of main air pollution source	31-dic-15
	- statistical analysis,		
	- results of source apportionment		
	Determination of the impact of main air pollution sources	Milestone H Main pollution tracers	31-dic-15
	Identification of the main pollutant tracers	Database 2 Chemical tracers concentration	31-mar-16
	Construction of 1 database with concentrations of chemical tracers for pollutant sources in subway systems and the impact of each of them on air quality	Milestone K Characterisation emission sources	30-jun-16
	Characterisation of the emission sources	Deliverable 8 Report sources contribution	30-sep-16
	Report on the overviewing and comparing the full impacts on air quality of each of the selected parameters		



START	ACTIVITIES FOLLOW-UP	OUTCOMES available on-line at:	DEADLINE
B2. Testing mitigation measures and Development of mitigation strategies			30-sep-16
1-abr-15	Organisation and coordination of a campaign program	Campaigns calendar	1-dic-14
	Presentation of Technical reports on the advance of:	Report 1 Campaigns	30-apr-15
	- testing mitigation measures and estimated benefit in metro ambient air quality		
	ballast with water	Report 2 Campaigns	31-oct-15
	air conditioning in trains (series 2 & 3K)		
	ballast with dust suppressant		
	ventilation		
	air conditioning (series 5K)	Report 3 Campaigns	31-mar-16
	brake pads		
	ventilation		
	graphite pantograph		
	Proposal of measures for air pollution emission reduction	Milestone I Propose mitigation measures	31-may-16
	Testing of mitigation measures for emission sources	Milestone J Test mitigation measures	31-may-16
	Evaluation of mitigation measures (B2)	Milestone L Evaluate mitigation measures	30-jun-17
	Report on the results of mitigation measures in subway systems	Deliverable 9 Report Mitigation measures	30-jun-17
	Preparation of 1Technical Guidance documentation, identifying and comparing effective strategies for reducing the impact of each selected emission source.	Deliverable 10 Technical guide mitigation measures	30-june-17
C. MONITORING ACTIONS			
C1 Effectiveness of the project actions.			31-mar-18
1-abr-15	Definition of (Management Team) a list of parameters/ indicators to assess the impact of the project including:	List 2 Impact indicators	30-jun-17
	- initial situation regarding PM levels and sources (Action A1), (completed)		
	- identification of air pollution sources during the campaigns (Action B1), (completed)		
	- contribution of each of the emission sources identified (in progress)		
	Nomination of an external committee to evaluate the progress of the project after 2 years	Commitment of members	30-jun-15
	Elaboration of 1 Quality plan for the political effectiveness of the project	Deliverable 12 Report policy effectiveness	31-dic-17
	Monitor of the impact of the project	Milestone P Monitor the impact of the project	31-mar-18

START	ACTIVITIES FOLLOW-UP	OUTCOMES available on-line at:	DEADLINE
C2 Assessment of the socio-economic impact of the project.			31-mar-18
1-jul-16	Monitor of the awareness of the problem (annually <i>not every 6 months</i>) with a questionnaire to public:	Deliverable 11 Questionnaires for public	31-dic-17
	- Number of people participating.		
	Incentive other metro systems, or local authorities to apply measures proposed by IMPROVE	List 3 Replicated measures	31-mar-18
	Assessment of the socio-economic effect	Milestone M Assess Socio-economic effect	31-dic-17
	Report on the socio-economic impact of the project	Deliverable 18 Report Socio-economic Impact	31-mar-18
D. COMMUNICATION AND DISSEMINATION ACTIONS			
D1 A Project website.			31-mar-18
1-oct-14	Design and maintenance of the project website	Deliverable 1 Project website	31-dic-14
	Monitor of the number of visitors.	6 Summary reviews	31-mar-18
D2 LIFE+ Information boards.			31-mar-18
1-oct-14	Preparation and placing of 10-15 information boards	Deliverable 3 Information boards	31-jan-15
	Maintenance of boards in the metro facilities	13 Summary reviews	31-mar-18
D3 Dissemination of project results			31-mar-18
1-oct-14	Design and elaboration of 300 leaflets.	Deliverable 7 Informative leaflets	30-jun-16
	Publication of articles (4-6) in local/national press (quantification of their readership), during actions B1 & B2 and at beginning/end of project	Deliverable 15 Articles in general/trade press	31-mar-18
	Submission of 6 technical papers/presentations in international journals/conferences	Deliverable 13 Publications journals/conferences	31-mar-18
	Organisation of 1 open-forum Stakeholders (around 80 people) private and public sector	Milestone E Organize open-forum	30-jun-15
	Publication of the forum's outcomes on the project's web site.	Deliverable 5 Minutes of the open Forum	30-sep-15
	Organisation of 1 international conference (200 people) with researchers, governmental institutions, public transport assoc. and public.	Deliverable 17 Proceedings of the conference	31-mar-18
D4 Production of Layman's Report.			31-mar-18
1-jul-16	Production and dissemination of 2.000 copies to the stakeholders	Deliverable 16 Layman's Report	31-mar-18



START	ACTIVITIES FOLLOW-UP	OUTCOMES available on-line at:	DEADLINE
E. MANAGEMENT ACTIONS			
E1 Project Management and Audit.			31-mar-18
1-oct-14	Nomination of the Project Management Team	Milestone A Project management team	31-oct-14
	Elaboration of the Quality assurance plan	Milestone C Quality assurance plan	30-nov-14
	Submission of the Inception Report	Inception Report	30-jun-15
	Submission of the Mid-term Report	Mid-term Report	31-dic-16
	Submission of the Final Report	Final Report	30-jun-18
E2 Monitoring of the project progress.			31-mar-18
1-oct-14	Revision the progress of the project, according to its indicators.	Milestone B Indicators of Progress	30-nov-14
	Meeting between partners	Deliverable 19 Summary reviews	31-mar-18
	Implementation of corrective recommendations after each meeting if necessary		
E3 Networking with other European projects (including LIFE+).			31-mar-18
1-oct-14	Organisation of 1 expert group workshop	Deliverable 6 Minutes of the expert's workshop	30-sep-15
	Organisation of 1 workshop with other European projects	Milestone F Workshop with LIFE+ projects	23/24-may-17
	Participation in other LIFE+ project's meetings	Presentations of IMPROVE	31-mar-18
E4 After-LIFE+ Communication Plan.			31-mar-18
1-jul-16	Preparation of the After-Life communication plan	Deliverable 14 After-Life communication plan	31-mar-18