



LIFE06/ENV/IT/255

A.S.A.P.

Actions for Systemic Aquifer Protection

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ASAP Protocol – Step # 2 (draft)

Actions for Systemic Aquifer Protection - Implementation and demonstration of a Protocol to scale down groundwater vulnerability to pollution due to overexploitation

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Professionals and Scholars

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(i) Thanks

- 5 Without the co-financing of the European Community LIFE Program it has not been possible to start the generalization and validation job of the ASAP project approach for its diffusion and re-use.

The team availability of external monitoring has been a jewel help.

- 10 This job has been possible thanks to the availability and collaboration of all the ASAP Project Team.

The active share, availability, professional quality of all the involved subjects have allowed to start the editing of the ASAP protocol, of which this document represents the first section in draft.

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(iii) Purpose of the document

This document is the draft version of the A.S.A.P. Protocol **second** step.

20 The proposed model uses the protocol that Acque Ingegneria - in collaboration
with the project A.S.A.P. partners - has introduced in the LIFE project "A.S.A.P.
Actions for Systemic Aquifer Protection", contract LIFE06/ENV/IT/255, that the
European Community has co-financed in 2006 and dedicated to the interventions
which can reduce the pressure on the aquifers, particularly through the hidden
25 losses search.

The project has a total value of about 2,5 million of Euros, it begun in 2006 it has
an approximate 36 month duration.

Major information about the project are available in the web sites

30 http://ec.europa.eu/environment/life/infoproducts/lifeenvcompilation_06.pdf and in
the project development to the URL portal <http://www.klink.it/gate/asap>.

The A.S.A.P. project Actions for Systemic Aquifer Protection consists on the put
in work and demonstration of a Protocol to reduce the stratum vulnerability to the
pollution caused by the great exploitation.

35 Among the project objectives, in an ample perspective at community level, there
is the availability of a protocol, of drive lines and of a demonstrative site to the
aquifers protection, the demolition of the capitation levels, the distribution
systems of drinkable water in normal conditions optimization.

The A.S.A.P. Protocol documentation has been planned in three steps
(correspondents to other three phases / task of the work plan) in order to allow its
40 verification in the field.

The three principal steps of the protocol are:

- acquisition of the system knowledge on which they intervene;
- **net optimization and collecting demolition;**
- definition and progressive approach to the optimal management level
45 (enough least collecting).

Every documented step is compiled in draft form and it is putted in circulation
between the project partners to the verifications, criticisms and suggestions.

50 The version obtained in this way is translated and putted at disposal in the
project web site and it is presented to the examination by the community of the
interested operators; nevertheless, it remains open until the document
completion in all its three parts and to the final validation.

(iv) Warnings

55 **1.** 1.The authors of this document have tried, where it was possible, to use a
comprehensible language for readers of different origins and users with
different finalities, avoiding, where it was possible, the use of specific or
sector terms; nevertheless, some technical aspects have necessarily
asked for a sector language.

2. 1.This document is in "draft" version. At the moment of its release as
deliverable, it is circulating among the project partners for the harvest of

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suggestions, criticisms, contributions, before to be submitted to the partial validation. Therefore, its use in field should be postponed to the moment in which the whole protocol was available, *complete in all its parts and validated*.

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1 INTRODUCTION OF THE METHODOLOGICAL ASPECTS

The final objective of the A.S.A.P. protocol is the pressure reduction on the aquifer (and in general on the water reserves from which collecting are effected).

The pillars on which it is founded are the losses reduction and the optimal pressures management.

After the losses control of the losses (about which it was discussed in the Draft I) the second fundamental passage is tied therefore to the pressures.

65 1.1 PRESSURE CONTROL

In order to manage the net pressure in the way to reduce the losses and the effect of the greatest consequent hydraulic loads to the reparations it is necessary to have specific automatic valves; these valves are organs which dissipate the energy maintaining constant the energy value of valley.

70 The project can become an instrument to allow the manager to reduce / maintain the loss levels reached with the initial search.

1.2 PRESSURE OPTIMIZATION

An optimization turns to the pressures increase and with the purpose to pursue better service levels for the users could solicit in not bearable way the nets, 75 which present all the uneasiness related to their ancientness (danger bursts, bad estate of the joints and the valves, etc.). A not suitable optimization of the pressures could bring to not adequacy situations in comparison to the minimum service levels or it could provoke some local unbalances of pressure produced by the reparation of a local water loss with consequent increase of the other small 80 losses set in the proximities of the cured one.

The pressure reduction interventions will mainly be assembled in the night time hours when because of a collecting reductions, it can be found the natural raising of the internal load of the distribution nets. To such purpose it has been proposed the use of automatic control valves with prevailing function of pressure regulation 85 of valley through two pilots (pilot of low pressure for the night time hours, pilot of high pressure for the diurnal hours) with least nominal diameters DN 50.

1.3 REGULATION PERIODS

High and low pressure periods will be selected only after the instant course analysis of the sector or district checked by the valve.

90 The electronic system of electro valves management at the pilots disposition will be programmable through computers with many low pressure daily cycles of and/ or weekly conditions.

In order to favour the best possible service to the users it will be imposed a different operation to the valve for the days of Saturday and Sunday, when it is 95 verified a translation in the required time in comparison to the other days of the week.

In general it is foresees the following low pressure cycle:

- LMMGV low pressure from 06:45 to 23:00
- SD low pressure from 07:30 to 23:30

100 1.4 VALVES REMOTE CONTROL

Such as general principle, for every valve it will be proposed the pilots tele control and tele command for the management of the served nets pressure level, or the pressure measure of mountain, of valley and of the course in transit. A specific page of the tele control will have to be realized for every installed valve and it will have to control both the hydraulic variables and the operation conditions of the control devices:

The minimum number of variables that have to be kept under control are:

1. The mountain pressure
2. The valley pressure
- 110 3. The course
4. Alimentation system current
5. Buffer batteries tension
6. Peripheral functioning state

1.5 SYSTEM ALIMENTATION

115 In absence of electric supply it is advisable the use of pressure jumps produced by the valve, for the production of the necessary energy to the functioning of the peripherals in low tension and of the measure instruments (translators, course measurers, etc.). With this purpose they exist specific turbines, which are realized and patented by ACQING, which have to be inserted in parallel to the automatic valves.

120 In alternative the valves are predisposed with some 12 V batteries, which allow to activate the high and low pressure cycles through solenoids bi stables on low tension.

125 However, this function is used only in the initial starting phase and it has to be replaced with a system that uses direct current electro-valves.

1.6 VALVES INSTALLATION

The automatic control valves installation in the internal part of the distribution nets, will be realized possibly out of earth, in a devoted lodging in bricks masonry or metallic material, always maintaining possible the manual derivation of courses in transit bypass through an help reduction gear or a fuse regulation valve for possible maintenances or ache operations of the principal valve.

In order to guarantee the best safety conditions they have to be avoided installations in the internal part of grits buried in favour of constructions in masonry out of earth.

135 The connection carpentry of the valve to the pipelines will have to be realized in metallic material and if it was possible in steel inox AISI 304 with a minimum thickness of 3 mm.

In order to avoid valves movement phenomena they have to be provided some devices of automatic awry and to valley of the valve.

140 1.7 CONTROL DEVICES PURCHASE

In order to proceed correctly to the control devices purchase it is fundamental to declare to the valve supplier the valve supposed fields of work and particularly at the moment of the purchase it is required:

- the maximum course;
- 145 ● the minimum course;
- the high and low valley pressure;
- the high and low mountain pressure;
- the function that it has to absolve.

1.8 AUTOMATIC VALVES REGULATION

150 The first valves regulation is manual and it is effected by an operator who acts through a grapevine without end that manages the pressure to maintain on valley.

The second one happens through a connection by cable that is established among the computer, on which it will have to be installed the management
155 software and the electronics on board of the valve and of the consequent planning that establishes the activation times.

The operations have to be shared with the management responsible, who will have to modify the loads in the contour of its own net without limiting the costumers service.

160 During the initial optimization phase they can be found some problems related to the water quality (muddying), this can be caused by temporal bewilderments among the activation of competing valves in the same sector.

In these cases in the internal part of the net they are verified some flow inversions which are not due to a real users requirement but only to a wrong
165 distribution of the loads to the contour (too much high on one side and too low on the other side in the same moment), this last effect has been motive for pressures recalibration. The pressures of the contour regulation produces some situations in the net that are predictable with the model with an accuracy of the order of some meter of water column, but they are also measurable with
170 precision directly in the net.

Therefore, the regulation phase has to be effected measuring contemporarily the pressure in the points where normally it is manifested with the lowest levels or in the zones from which they reach the calls for insufficient pressure.

The best hours for the valves regulation, in the diurnal values, are those around
175 the hours of great consumption (08:20, 14:20, 20:30) in these moments it is useful to effect a regulation with more operators displaced on the valve and on the net and both endowed with pressure measurer.

The operator placed on the valve can know in this way in real time the pressure value produced by the valve to the planned regulation.

180 When the regulation in the diurnal hours has been effected, it is convenient to position some pressure recorders to value also the value that is determined in the net in consequence of the night time pressure cycle produced by the valve and automatically activated by the electronic centreline on board of this.

With this operation the connected risks to the attainment of the minimum service level are reduced.

In those cases in which the valve installation was realized at the same time of the acquisition system the consumption monitoring and the benefits in term of smaller consumptions, deriving by the losses reparation and/or valves regulation it will be made automatically and recorded by the company tele control.

While in the cases in which the monitoring remote postings were installed subsequently to the valves, these will have to be monitored through course at ultrasound and pressure instruments, seated in all the sector points of feeding of alimentation.

1.9 TECHNOLOGY EMPLOYED FOR THE LOSSES SEARCH

It is known that a loss originates some vibrations that are manifested with a noise which is originated by the fluid passage, to high speed, through some small pipe openings or by state imperfections. During the energy pressure transformation into sonorous energy a quota part is longitudinally transmitted through the pipeline, while a part is radially disperses from the escape point through the surrounding ground until to come in surface. Exploiting this loss characteristic they will be adopted search techniques and systems which are found on the noise listening and the relative analysis. This particularity is exploited for the losses search and in the actuality it guarantees the maximum result.

1.10 INTERACTION WITH OTHER NET SERVICES

Considering the hidden character of the losses it is fundamental to investigate also on the other net services. So that some investigations are necessary and determining contemplated in the other net services canalizations which in the greatest part of the cases "they receive", at despite, the hidden losses. It is the very known case of the sewerages that, in many cases, pick up a great part of the water losses and whose evidence is very known to the purification plants managers that, also in crisis periods, have to purify courses of non justifiable entity and not unload in sewerage of only black or mixed waters.

1.11 DIRECT INSPECTION OF THE SEWERAGES

At such purpose an "ancient" search technique will be also used, it foresees the visual investigation inside the sewerages until the use of a special camera ("periscope"). This technique has effectively interrupted a bad way to work that consists on the direct sewerages inspection under conditions of scarce safety for the operators.

The periscope is endowed with a telescopic auction and of a camera with a powerful zoom to which is combined a source of high brightness that allows to monitor the sewerage hollow and conducts where they are often infiltrated and they show the hidden losses.

The greatest frequency of the sewerage grits compared to the aqueduct one increases the possibility to acquire visual information on the loss and eventually to record some film.

The inspection will be limited only to the parts on mountain and on valley of the sewerage grits, for a linear line of about 80 meters, or until the visible zone thanks to the directional illumination and to the camera zoom.

1.12 PRE-LOCALIZATION

230 The search protocol foresees an initial pre-location activity effected through devices that recognize the loss noise and they give an approximate location, to which it follows the phase of real punctual individualization.

Such devices have the same present technology on geophones board but they also perform a statistic noise verification discriminating the noises leading from those with a frequency and constancy typical of the loss noise.

1.12.1 Pre-localization point of strenght

Their point of strength is constituted by the fact that they wake up again and they perform only the analysis during the night time hours, when the noises leading weaken and the hidden losses ones are amplified. Consequently, the searches with geophone can be avoided on the high-density traffic roads.

Generally, their high sensibility allows to perceive also the smallest losses, for this reason it is really advisable to repeat the investigation also after the losses reparation individualized with the first search.

1.12.2 Pre-localizations positioning

245 The positioning of these devices, of redoubts dimension, can directly be made also inside of counter users vain or in the manoeuvre net small rooms.

The pre-localizations position have to be supported by a cartography with a non inferior to 1:10000 scale on which they have to be annotated the pre-localization code and position (for example street and civic number).

250 The medium distance between two pre-localizations, with which this investigation is effected, and of about 100-150 ms with an increase to 50-80 ms in the case of pipelines made in plastic material.

1.13 TEAM TYPE FOR LOSSES SEARCH

Every team type will preferably be composed by two specialized technicians and as minimum it will be gifted by the following instrumentation and a mediums:

45 noise analysers (pre-localizations)

- 2 correlators
- 2 geophones
- 2 computers
- 260 ● 1 periscope 1 search chiusini 1 search services
- specific software for the measures, measures points and losses filing
- 2 digital cameras
- 1 equipped van

1.14 SPECIFIC INSTRUMENTS FOR THE LOSSES SEARCH

265 The use of this or that instrument is essentially joined to the knowledge degree that we have about the problem. In the more unfavourable case they are not known the pipeline material and diameter, the pipeline position and the other net services position.

1.14.1 The geophone

270 Therefore, in these cases, even if the preceding monitoring activity has regarded
only a precise search field, the search will actually be conducted with good part
of the anticipated instruments in order to reach the classical punctual
individualization with geophone. In practice, basing on the noise recording and
analyses effected in pre-established night time hours, such instruments succeed
275 in rapid times in furnishing the indication of the loss presence in the examined
zone. In the cases of little wide surfaces search and in all those cases in which it
is made necessary a great precision in the individualization of the point of
escape, the search techniques to use are those classical with acoustic methods
through the correlator and the geophone use.

280 In the case of the geophone it is determining the noise interpretation that the
operator effects continuatively through the direct listening in bonnet.

The experience plays in this case an essential role and therefore with the
geophone the human component is enough determining to the goals of the
success.

285 1.14.2 The correlator

Instead, in the correlator case the physical interpretation is directly made by the
software that analyzes the acquisition time of two sensors and it appraises the
difference comparing it to the conduct length. In this way the correlator can give
the correspondent noise position that is propagated to the two sensors. After this
290 phase it is surely necessary the second search phase with geophone which
guarantees the maximum precision compared to all the present instrument on
the market

In this case the human component is inferior even if it is not negligible.

1.15 DISTURB NOISE

295 Being the losses individualization essentially based on the noise transmission it is
evident that some activities, such as the search with geophone, were to be
developed primarily during the first morning hours or in particular cases during
the night time hours. It is common to have to work on high-density traffic roads,
or in the immediate proximities of such productive activities, particularly noisy,
300 that is not possible to interrupt. In these cases it is preferable to use the pre-
localization in massive way.

The correlator use or the losses infer one, analyzing the noise according to
specific frequencies, can also work in presence of the typical noises leading
diurnal, even if the analyses effected in the night time hours are more reliable.

305 1.16 SYSTEM TUNING

The mathematical modelling and the following setting effected considering the
initial state, allows the planning of the first interventions to effect and the
evaluation of the system answers in the possible sceneries.

310 The useful methods to the water losses reduction which have an impact at brief
and medium term on the recoverable water volume are both the hidden losses
reparation, and the regulation modulated in the pressure time which has to
maintain unchanged the minimum level service value in the critical points.

The whole of these activities involves a substantial change both geometrical and of the hydraulic net behaviour and the consequent progressive re-movement
315 between the initial model and the effective state.

In fact, with the losses reduction and with the pressure regulation they intervene both on the spatial consumptions distribution in a sector and consequently on the courses circulation, and on the introduced water quantity making inappropriate the pattern used in the model previously set.

320 Consideration that the calibration effected minimizing the discard between the measured datum and the calculated one doesn't furnish an univocal combination of the system variables values (roughness and spatial question dislocation) but only one of them, because of many of the incoming data don't coincide in number with the unknown ones, it is necessary a new recalibration phase, which
325 furnishes a new roughness and question distribution combination that makes the model valid.

In this phase the cartography and the model can usefully be adjourned thanks to the information that will be acquired with the losses reparation or when it is discovered and it can be measured the conduct real diameter, the internal
330 roughness and it can be valuated the constituent material.

Therefore, a second course and pressure net measurement campaign is necessary with the purpose to value the operation variations brought to the system by the interventions, in comparison to the preceding state.

Obviously, the single district data analysis has to return a generalized water
335 consumption diminution, in particular way of the minimum night time value (Minimum night flow, QMNF) and the level service congruity with the objective of the effected interventions.

The elements which have to be inserted in the hydraulic model are the new request pattern discredited on a hourly interval of 5 minutes that allows us not to
340 eliminate the consumption limits and if we perform the PDA analysis making reference to the water losses, the new K_j coefficients of each knot calculated basing on the minimum night time analysis of the night time consumption.

The calibration is performed through a trial and error procedure, punctually comparing the course and pressure data measured in specific net points with
345 those furnished by the model until the optimization of the same.

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