

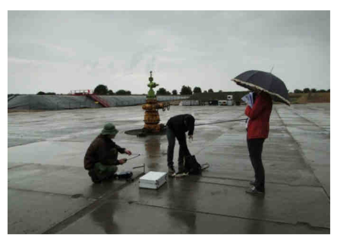

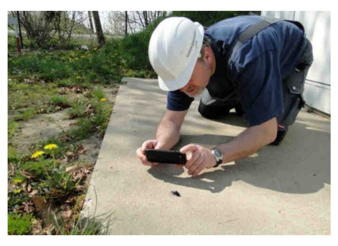

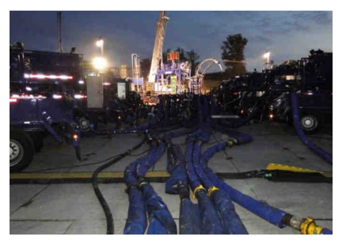


"Baseline and monitoring data assessment of surface, groundwater, and soil" is one of M4 Shale Gas Project work packages. The main objective is to recommend optimum monitoring approach for water and soil, both quantitative and qualitative, taking into account the entire water cycle and in particular the need to reuse. Review of the state-of-the art of European soil and water monitoring systems and its sufficiency/ shortcomings for shale gas development impact assessment has been already performed within the project. Further research will focus on scientific studies related to shale gas environmental impacts, which is crucial when it comes to deriving a set of monitoring parameters and recommending best practices for monitoring of the actual impact of shale gas activities on surface water, groundwater and soils. Sampling is a base issue for environmental studies and assessments. There are numerous instructions and best practices including different approaches for different purposes of sampling, covering different topics, from field protocols and sample identification to transport options. In terms of shale gas development many additional circumstances should be taken into consideration compared to already operating monitoring networks.

M4ShaleGas
Measuring, Monitoring, Mitigating, Managing the Environmental Impact of Shale Gas

Strategies of water, soil, and waste sampling in environmental studies related to shale gas operations

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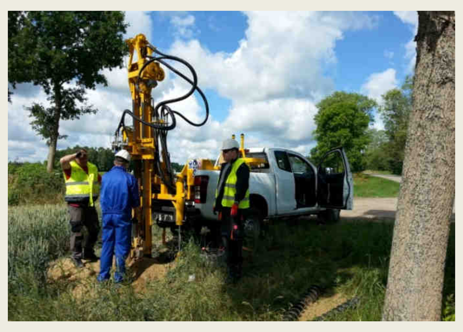
SURFACE AND GROUNDWATER

Different types of water sampling points

The inventory of monitoring points includes: drilled wells, hand-dug water wells, springs, drainage wells, piezometers, rivers, strings, lakes, artificial reservoirs, and also drilling site drainage network, like belt ditches, drains and drain tanks. Sampling points selection is preceded by following actions:

- review of geological and hydrogeological conditions in the region;
- field identification of hydrological and hydrogeological objects;
- object evaluation [accessibility, physical condition, current use, representativeness, potential impact from any local sources of pollution].





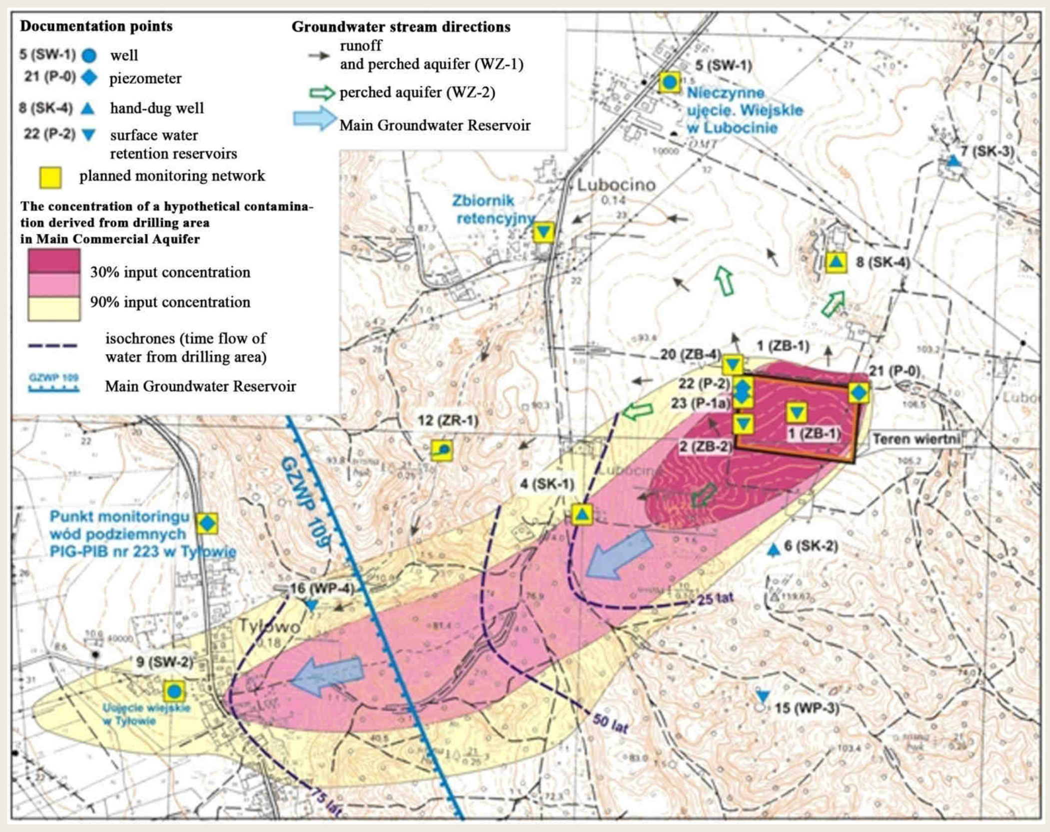

Hydrodynamic modeling

A digital model of groundwater flow takes into account the entire groundwater system:

- perched aquifers,
- main commercial aquifers,
- secondary commercial aquifers,
- main groundwater reservoir.

Direction and velocity of potential pollution migration depend on hydrodynamics in each water-bearing stratum. The water quality observation network and sampling schedule need to be adjusted to particular condition in each groundwater layer.

Detailed, local and validated model of fresh water zone enables the proper observations planning for all plumes of well defined source location. Usually there is not sufficient information on possible migration pathways along natural or induced faults or fractures.



Source: FINAL REPORT ON DELIVERY OF RESEARCH ACTIVITIES AT TEST SITE 1- LUBOCINO, in Polish only, unpublished, Directorate General for Environmental Protection, Warsaw, 2015

Ground and surface water sampling

Process monitoring must be consistent with operations conducted on a well pad. Baseline status has to be established before launch of well pad construction and at this stage all other possible pollution sources must be identified. For future references it is important to know what kind of operations and chemical substances are applied during drilling and completion. All accidentals spills should be reported and immediately recovered under well-pad emergency procedures. Further monitoring of environmental consequences need to be set up when justified. Such investigative, short-term monitoring refers to spill character and local conditions. Further long-term monitoring of possible changes due to unrecognized upward migration of fluids must ensure sampling schedule with reference to regional conditions and scope of parameters character of expected contamination .The scope of monitored parameter must be chosen with reference to the expected tracers.

Source: THE ENVIRONMENT AND SHALE GAS EXPLORATION RESULTS OF STUDIES ON THE SOIL-WATER ENVIRONMENT, AMBIENT AIR, ACOUSTIC CLIMATE, PROCESS FLUIDS AND WASTES, Directorate General for Environmental Protection, Warsaw, 2015

Operation stage	Test site						
	Lubocino	Stare Miasto	Syczyn	Wysin	Zawada	Łebień	Gapowo
Initial status (before drill site development)				ROUND I	ROUND I		
As-found status (drill site in operation)	ROUND I	ROUND I					ROUND I
As-found status (horizontal leg drilling)	ROUND II		ROUND I				
Horizontal leg drilling completed			ROUND II		ROUND II		
Prior to hydraulic fracturing stimulation			ROUND III			ROUND I	
During hydraulic fracturing stimulation						ROUND II	
On completion of Operator's activity	ROUND III		ROUND IV		ROUND III	ROUND III	
After 1–2 years of hydraulic fracturing stimulation		ROUND IV	ROUND V		ROUND IV	ROUND IV	

SOIL

Soils survey has two main aims. One is to monitor possible loss in soil fertility due to mechanical disturbances and weathering and surface runoff

The other is the possible contamination caused by accidental spills and overflows. Assessment of fertility loss must be conducted based on comparison of initial samples with measurements made in reference points while stored in heaps. The frequency of sampling depends on local soil and atmospheric conditions. Because of possible sub-soil compaction influencing future crop productivity agrotechnical treatment shall be employed. In case of accidental spills properly designed check-up round of measurements need to be conducted.

In case of any unwanted migration stray gases will be the first to reach the land surface. Soil gas analysis can be an early warning tool. However baseline is needed for comparison and due to seasonal changes it should be established by more than one sampling round. In close vicinity of defined source of possible contamination, like well-head or abandon well-bore a network shall be established. In case of any increased values obtained, sampling for isotope as a hydrocarbon's source indicator is essential.

FLOWBACK

There is many options how to sample flowback. The most essential factor determining sampling is its purpose. To determine the original flowback characteristics in order to be aware what kind of contaminations plumes might be expected the sample must be taken as close to the well head as possible. Normally the first such place is a chock manifold. Such sample is usually of high temperature and may contain significant amounts of free or dissolved gas, which requires a special handling. From waste management perspective, samples ought to be taken from liquid waste tank, after degassing at separators. Time and frequency of sampling must be determined by further way of handling, like reuse, treatment technology or disposal methods.


WELL HEAD


COARSE SEPARATOR


SAND CATCHER


MANIFOLD


SEPARATOR


TANK