



**COMPLEX AIR QUALITY SURVEYS
IN ATYRAU
AND IN THE VICINITY OF BOLASHAK OPF AREA IN ESKENE WEST**

Presenter :

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COMPLEX AIR QUALITY SURVEYS

BACKGROUND:

Complex air quality study were carried out by Republican Research Centre for Ambient Air Protection LLP (RRCAAP) in response to a request to NCOC from the community raised in 2018. The request was about the need to assess the state of the atmospheric air and the dynamics of changes in its quality.

GOALS:

Comprehensive survey of air quality in the city of Atyrau and in Eskene West in Bolashak OPF area is driven by the need to assess the current state of ground-level atmosphere and trends of air quality change.

OBJECTIVES:

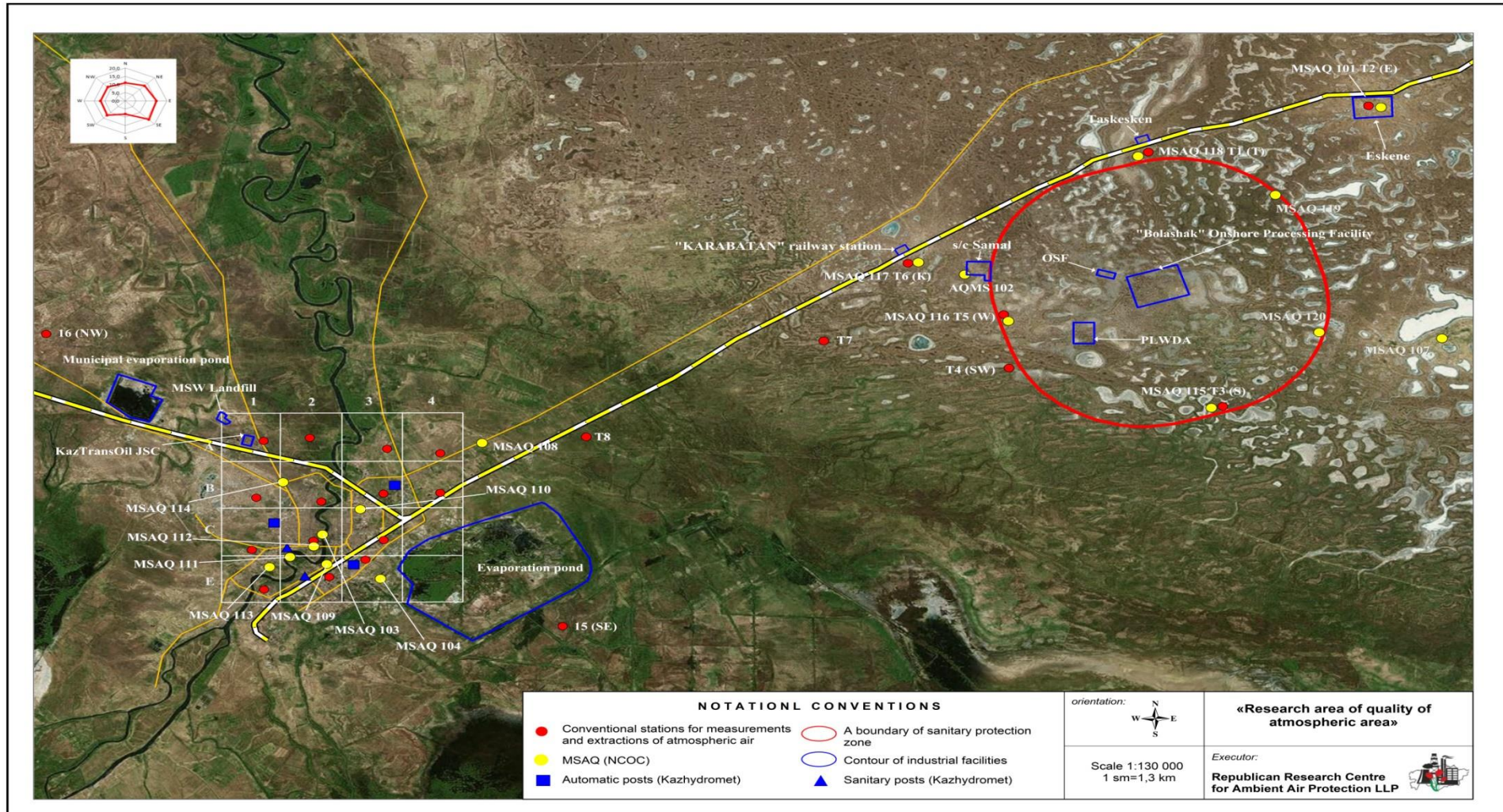
- Process, systematize, and analyse historical permitting and air quality monitoring data from NCOC, Atyrau Oblast Branch of RSE Kazhydromet, others creening studies for 2009–2021
- Conduct comprehensive air quality monitoring within Atyrau city, Bolashak OPF nearby settlements (Karabatan, Eskene, Taskesken railway stations) and at SPZ boundary
- Assess air quality trends and specifics

CONTRIBUTORS:

Al-Farabi Kazakh National University
Gidromet Ltd IPC LLP
KAZEKOANALIZ LLP.

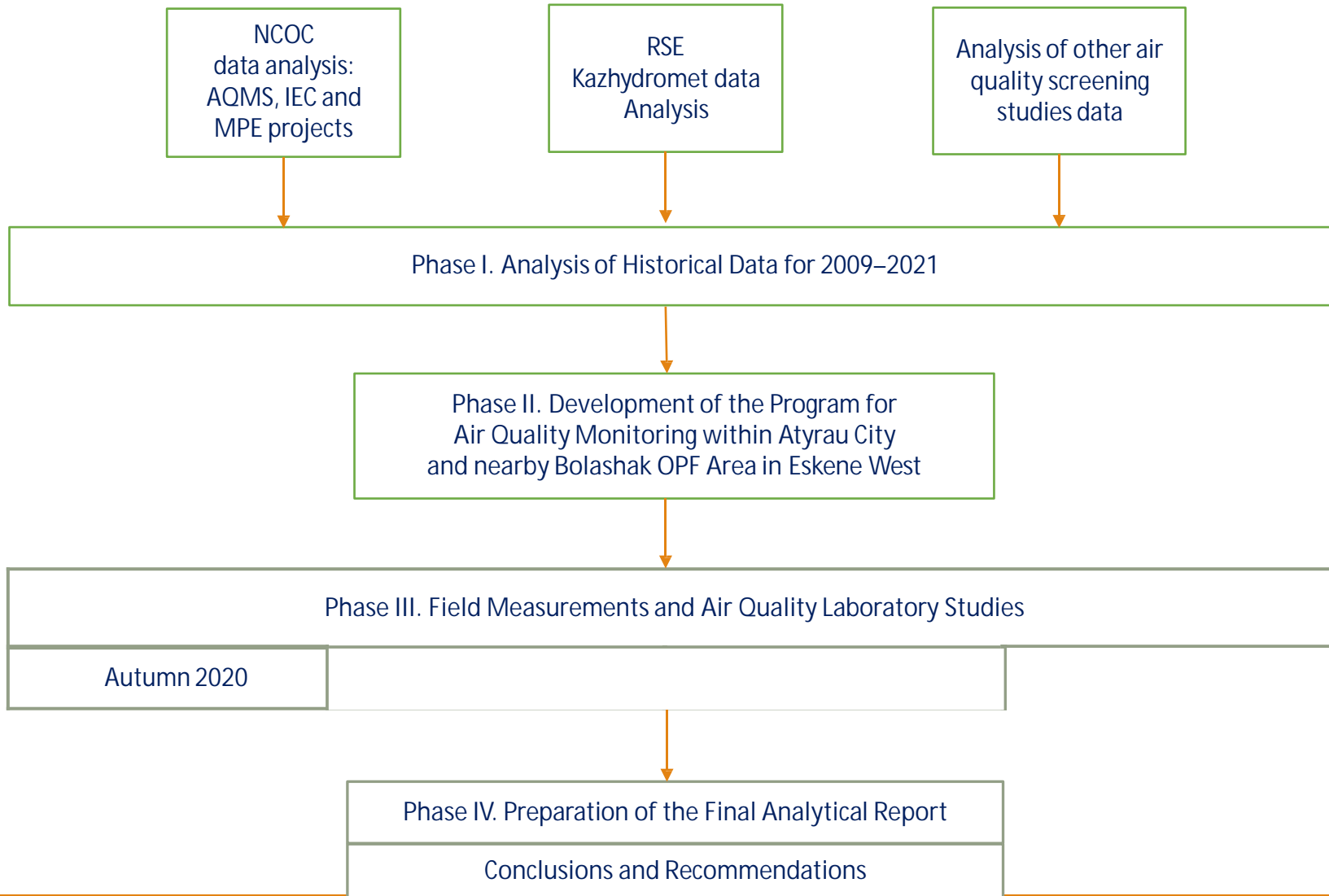


AREA OF RESEARCH OF ATMOSPHERIC AIR QUALITY





SURVEY FLOWCHART





ANALYSIS OF HISTORICAL DATA FOR 2009–2021

Monitoring data	Indicators	Number of indicators analysed
NCOC data		
Data from air quality monitoring stations (20 AQMSs)	NO ₂ , NO, SO ₂ , H ₂ S, CO in continuous (automatic) mode	> 30 000 000
Data from NCOC MPE projects	Quantitative and qualitative parameters of emissions	MPE projects for the last 5 years
Data from additional instrumental measurements of air quality in the EW area and Atyrau	NCOC Industrial Environmental Control (IEC) specifics: NO ₂ , NO, CO, SO ₂ , H ₂ S, ethylmercaptans, methylmercaptans, hydrocarbons C ₁ –C ₅ , C ₆ –C ₁₀ , C ₁₂ –C ₁₉ , methanol, elemental sulphur, Screening studies in Atyrau and EW: VOC (including benzene, xylene, toluene), PAHC, benz(a)pyrene	> 200 000
ATYRAU OBLAST BRANCH OF RSE KAZHYDROMET data		
Data from automated stations (6, 8, 9) and manual instrument stations (1, 5)	NO, NO ₂ , SO ₂ , H ₂ S, ammonia, ozone, phenol, formaldehyde as well as PM-2.5 and PM-10 suspended solids	> 2,500,000
Preliminary air pollutants' composition scanning studies in 2019	Qualitative composition of VOCs (selection within 24 hours) The quantitative composition of VOCs and PAHs (selection during the day) Determination of the maximum one-time concentration of pollutants	more than 100 pollutants more than 30 pollutants more than 40 pollutants



PHASE 1. ANALYSIS OF HISTORICAL DATA FOR 2009–2021 2019 AIR QUALITY SCREENING STUDIES RESULTS

Procedure of measurements:

Gas chromatography with mass spectrometric detector, photometric, gravimetric, atomic absorption, optronic spectrophotometric, electrochemical, semiconductor, X-ray fluorescence.

Monitoring points:

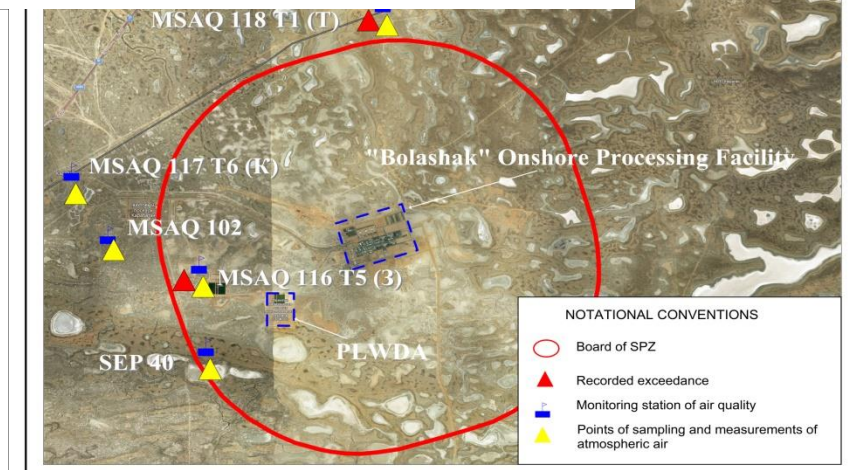
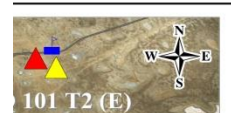
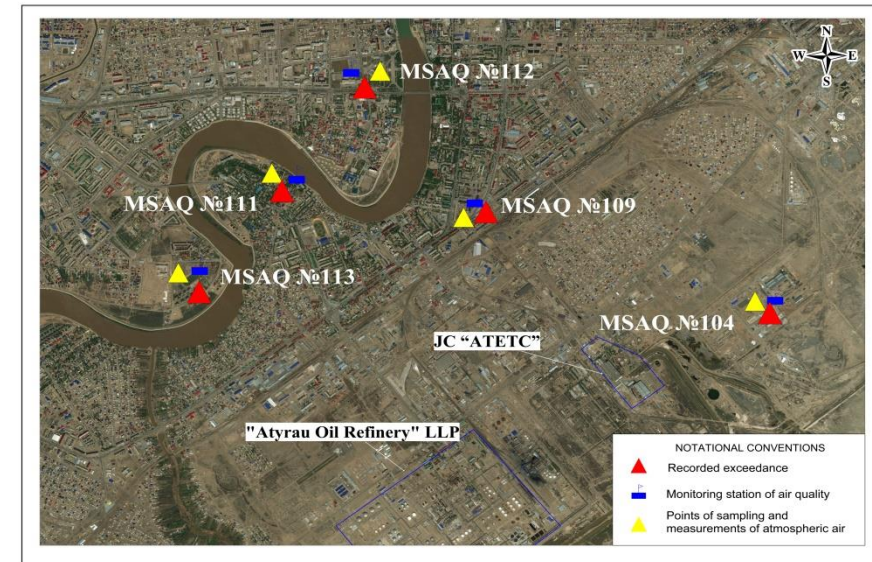
- Atyrau
 - H2S impact area: evaporation fields of Atyrau Refinery LLP, MD Avangard, MD Vostok, MD Zhilgorodok, Regional Akimat. Background: MD Nursaya
- Eskene West
 - OPF SPZ
 - Nearby settlements
 - 4 km from OPF.

Data recorded:

- >1 MPC occurrences:
 - Frequent cases: hydrogen sulfide,
 - Occasional cases: ethylbenzene, formaldehyde, suspended solids, phenol
- >100 VOCs and PAHs species (NO air quality standards are applicable)

Conclusion of screening analysis:

- >1 MPC occurrences to be considered in scoping of Phase II.
- No predominate wind direction and correlation to EW industrial activity.





PHASE 1. ANALYSIS OF HISTORICAL DATA FOR 2009–2021

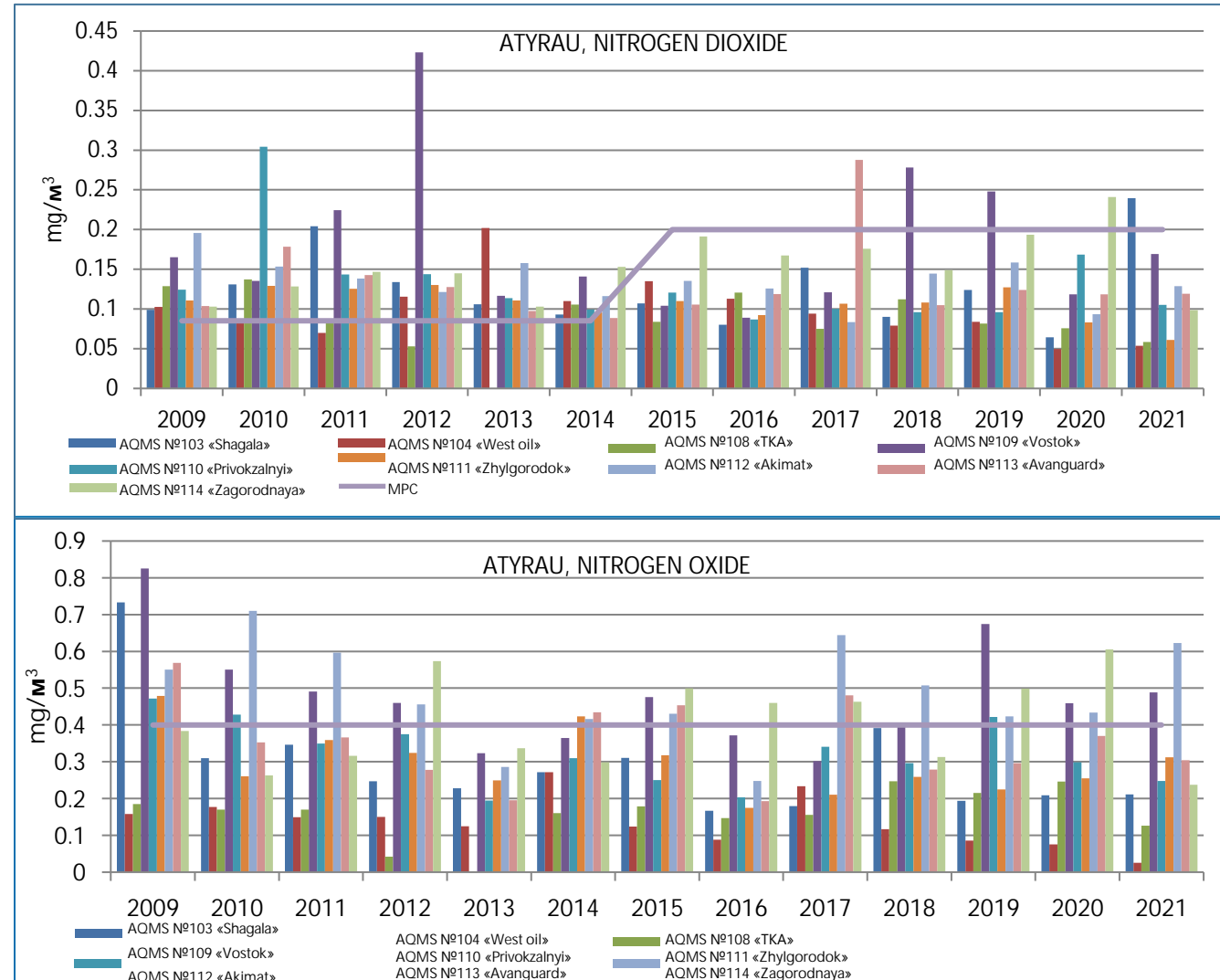
AQMS data for NO₂, NO.

Data recorded:

- >1 MPC occurrences:
 - Atyrau:
 - Nitrogen dioxide
 - Nitrogen oxide
 - EW
 - NONE

Conclusion of analysis:

- NO₂, NO concentrations in Atyrau < 1 MPC
 - spikes at AQMS 112 “Akimat”, 109 “West”, 108 “TKA” and “Zagorodnaya” in:
 - 2010-2012
 - and 2018-2021
 - spikes at AQMS 112 “Akimat”, 113 “Avangard” in 2014-2015, 2017:
- >1 MPC occurrences to be considered in scoping of Phase II.





PHASE 1. ANALYSIS OF HISTORICAL DATA FOR 2009–2021

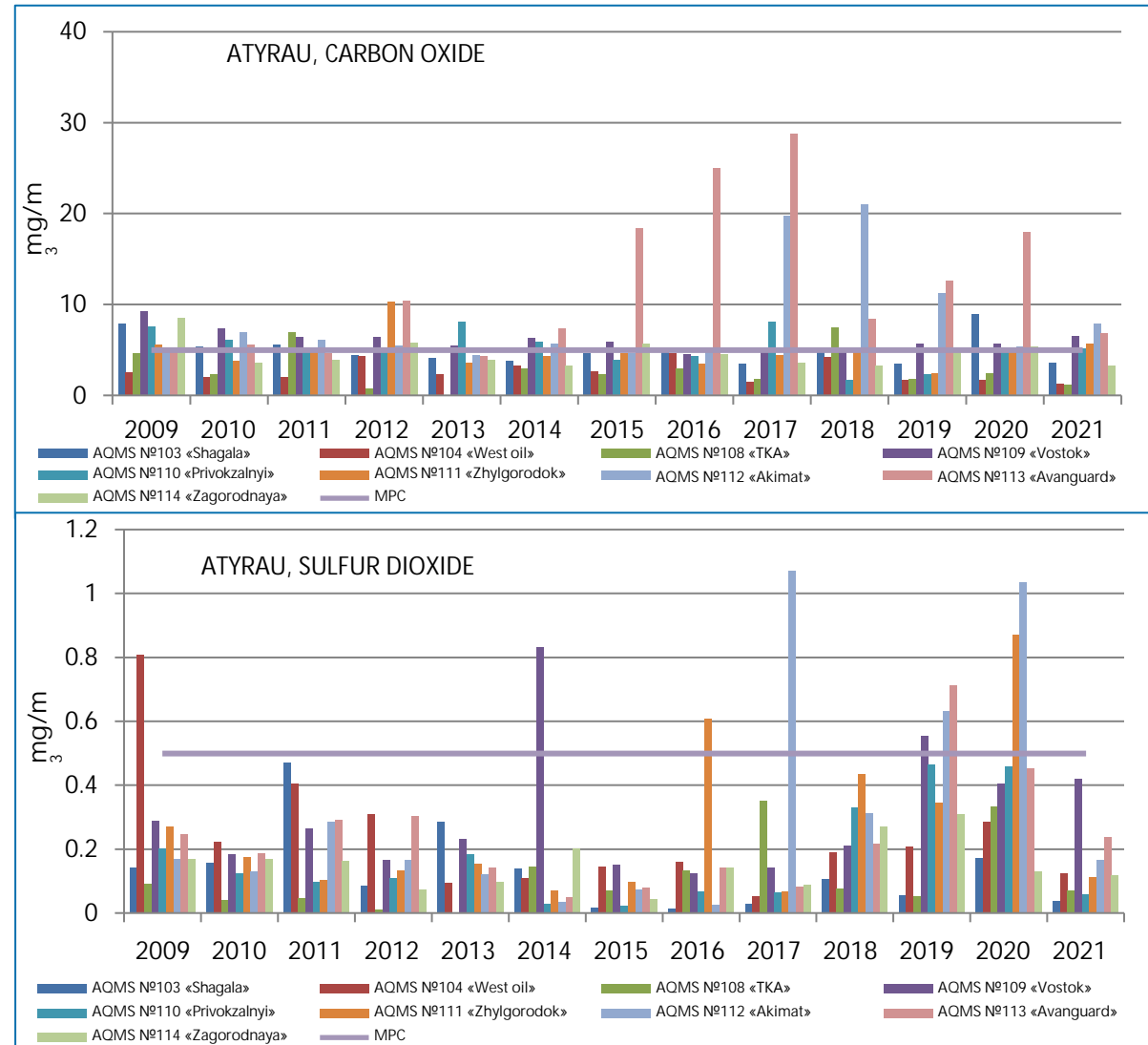
AQMS data for SO₂, CO

Data recorded:

- >1 MPC occurrences:
 - Atyrau:
 - CARBON OXIDE, SULFUR DIOXIDE
 - EW
 - NONE, SULFUR DIOXIDE (negligible)

Conclusion of analysis:

- CO concentration in Atyrau plateaued at 1 MPC
 - ~3x increase at AQMS 113 “Avangard” and 112 “Akimat” post 2014
- SO₂ concentration in Atyrau < 0.6 MPC before 2017
 - Increased level in 2018-2020
- >1 MPC occurrences to be considered in scoping of Phase II.





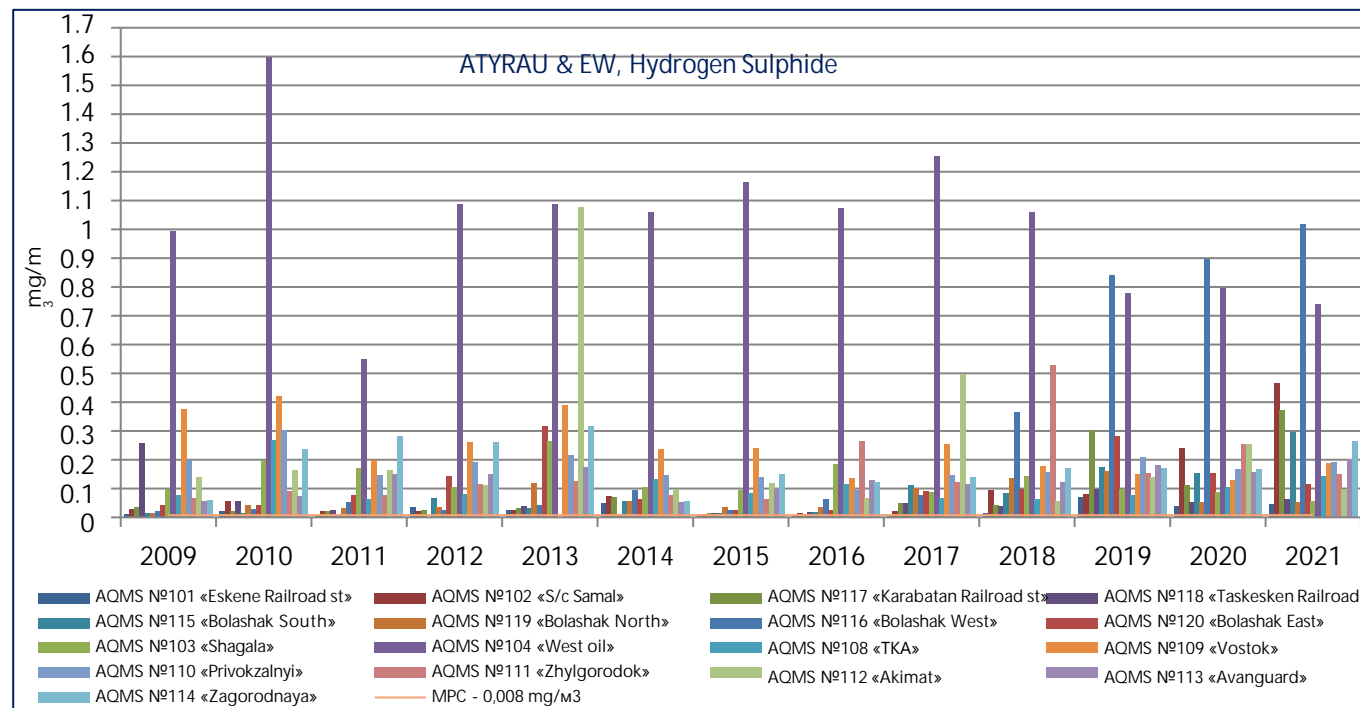
PHASE 1. ANALYSIS OF HISTORICAL DATA FOR 2009–2021 AQMS data for H2S

Data recorded:

- >1 MPC occurrences:
 - Atyrau:
 - Hydrogen Sulphide
 - EW
 - Hydrogen Sulphide

Conclusion of analysis:

- >>1 MPC occurrences is #1 priority in scoping of Phase II.
- H2S concentration in Atyrau plateaued at >>1 MPC and there is no correlation to EW ones.





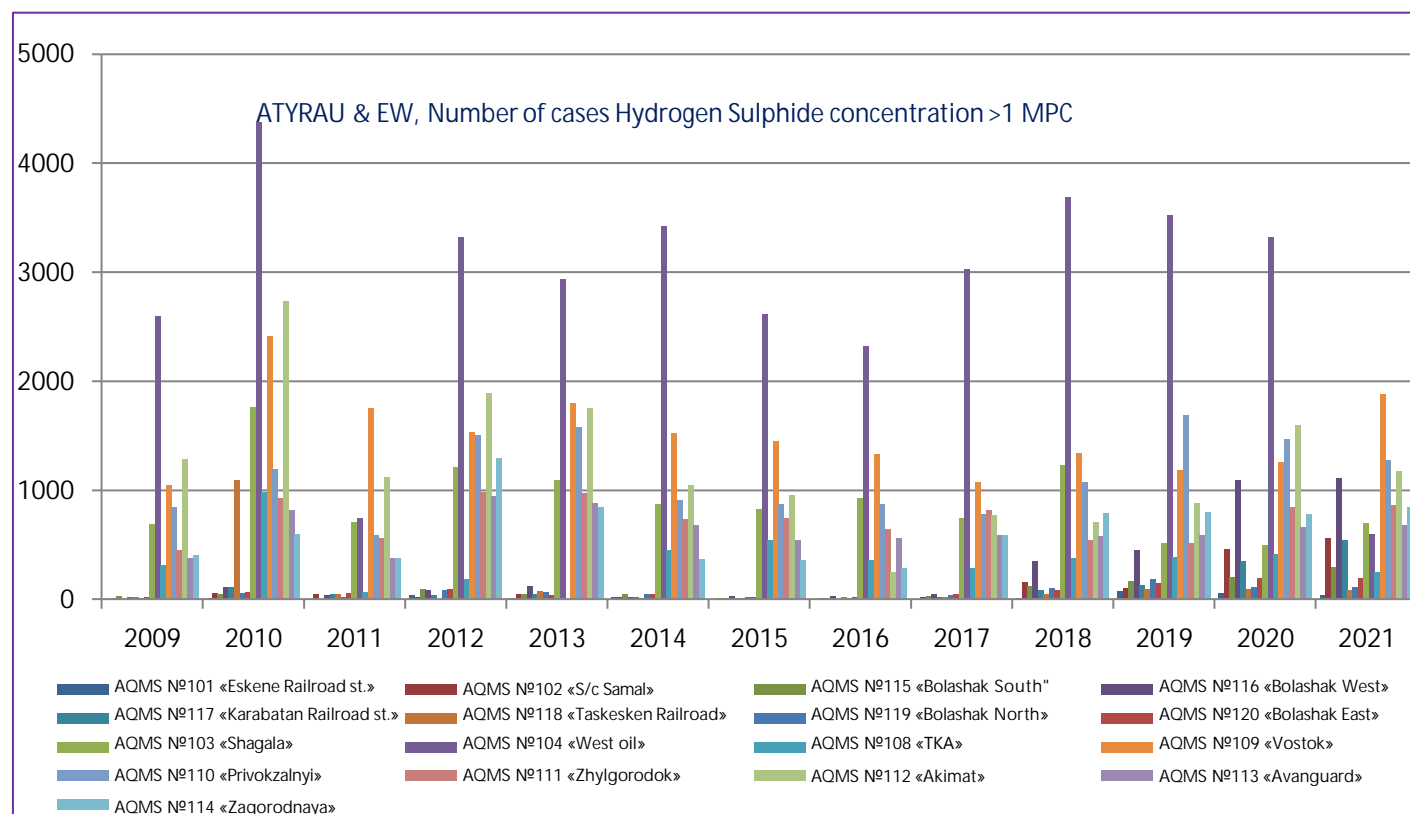
PHASE 1. ANALYSIS OF HISTORICAL DATA FOR 2009–2021 AQMS data for H2S. Number of cases above MPC level

Data recorded:

- >1 MPC occurrences:
 - Atyrau:
 - Hydrogen Sulphide (~ 6000 - 7000 cases per year in total*)
 - EW
 - Hydrogen Sulphide
 - 2009—2016: 100-200 cases in total
 - 2017—2021: 2 to 3 times lower than in Atyrau

Conclusion of analysis:

- >>1 MPC occurrences is #1 priority in scoping of Phase II.
- The number of excessive concentration cases within Atyrau plateaued and there is no correlation to EW ones.

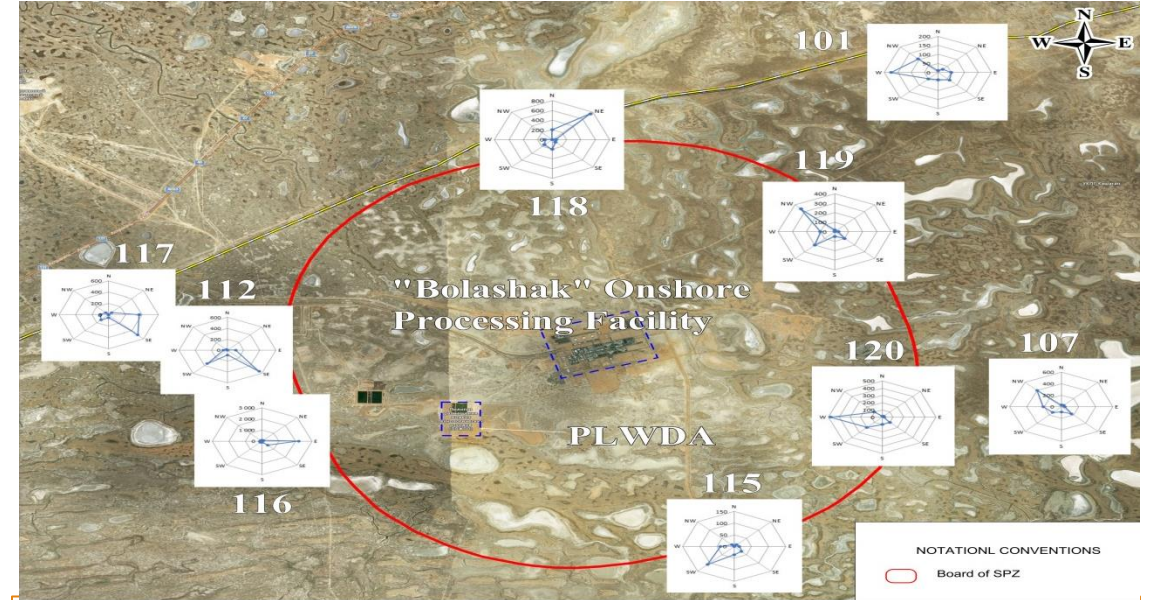
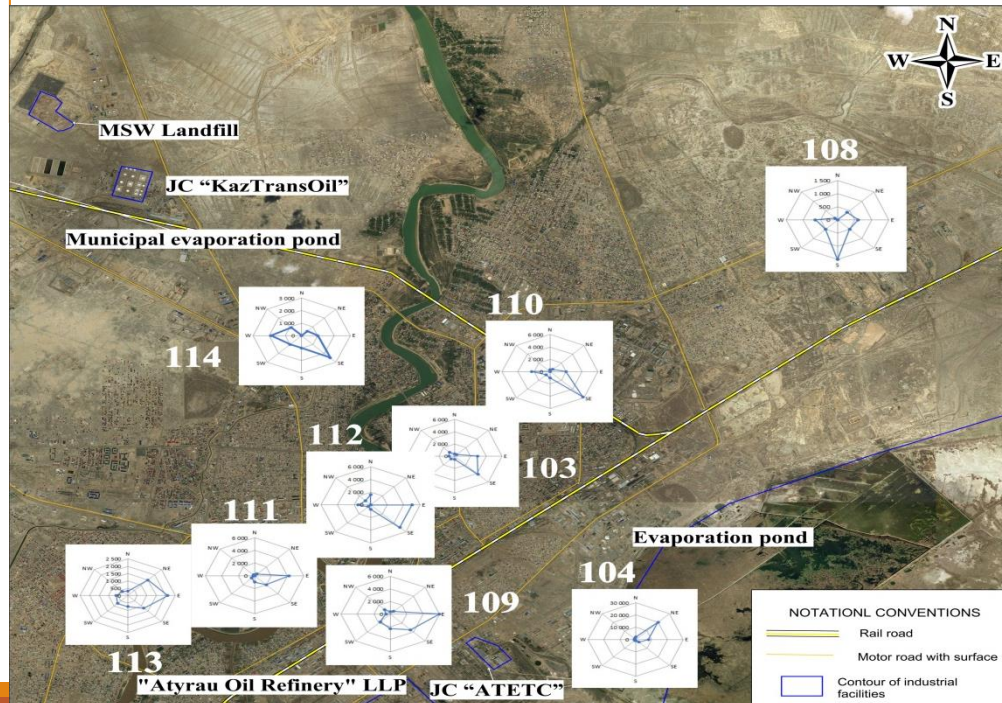




PHASE 1. ANALYSIS OF HISTORICAL DATA FOR 2009–2021 AQMS data for H2S. Distribution by time, season and wind direction

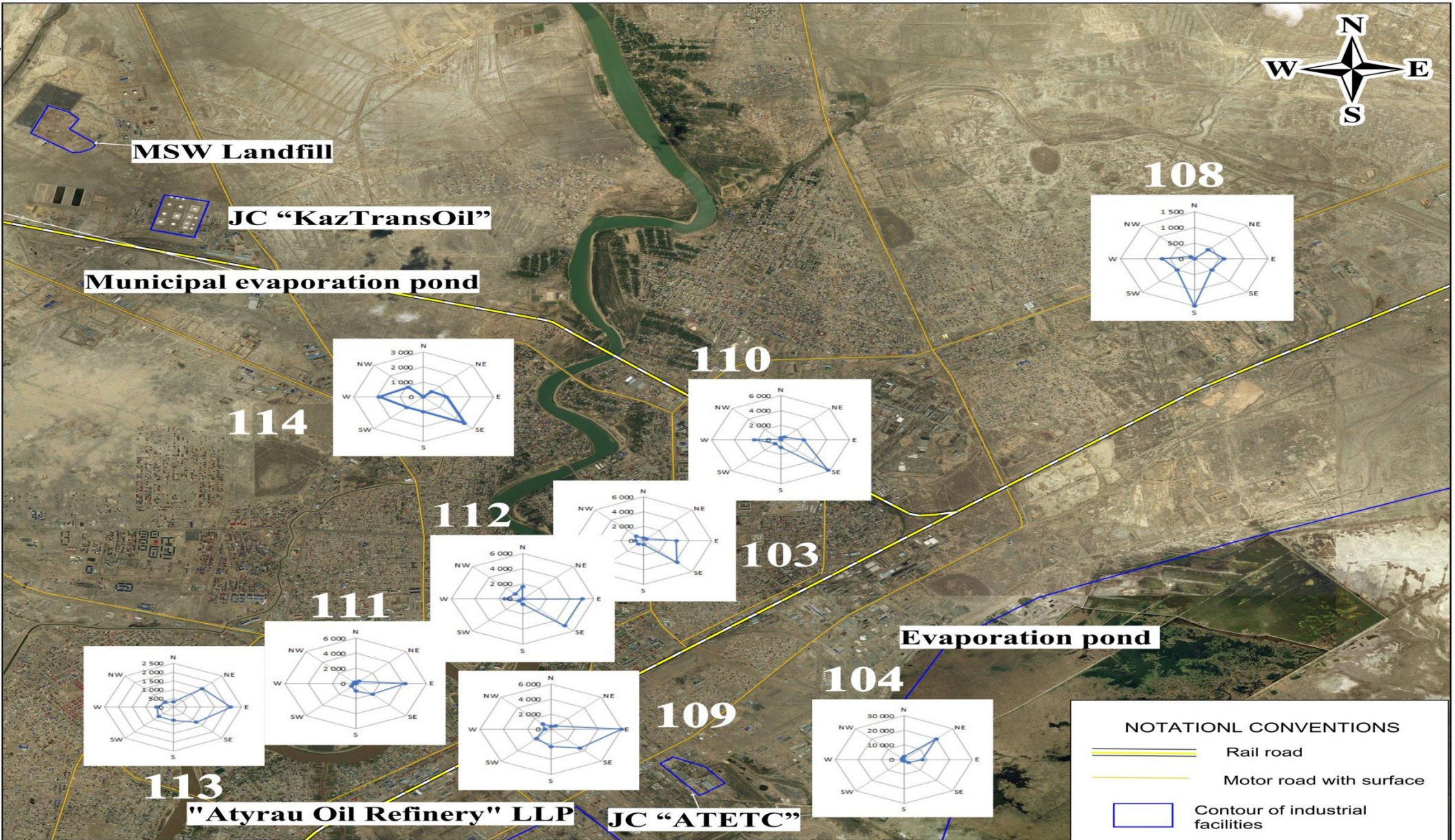
Methodology:

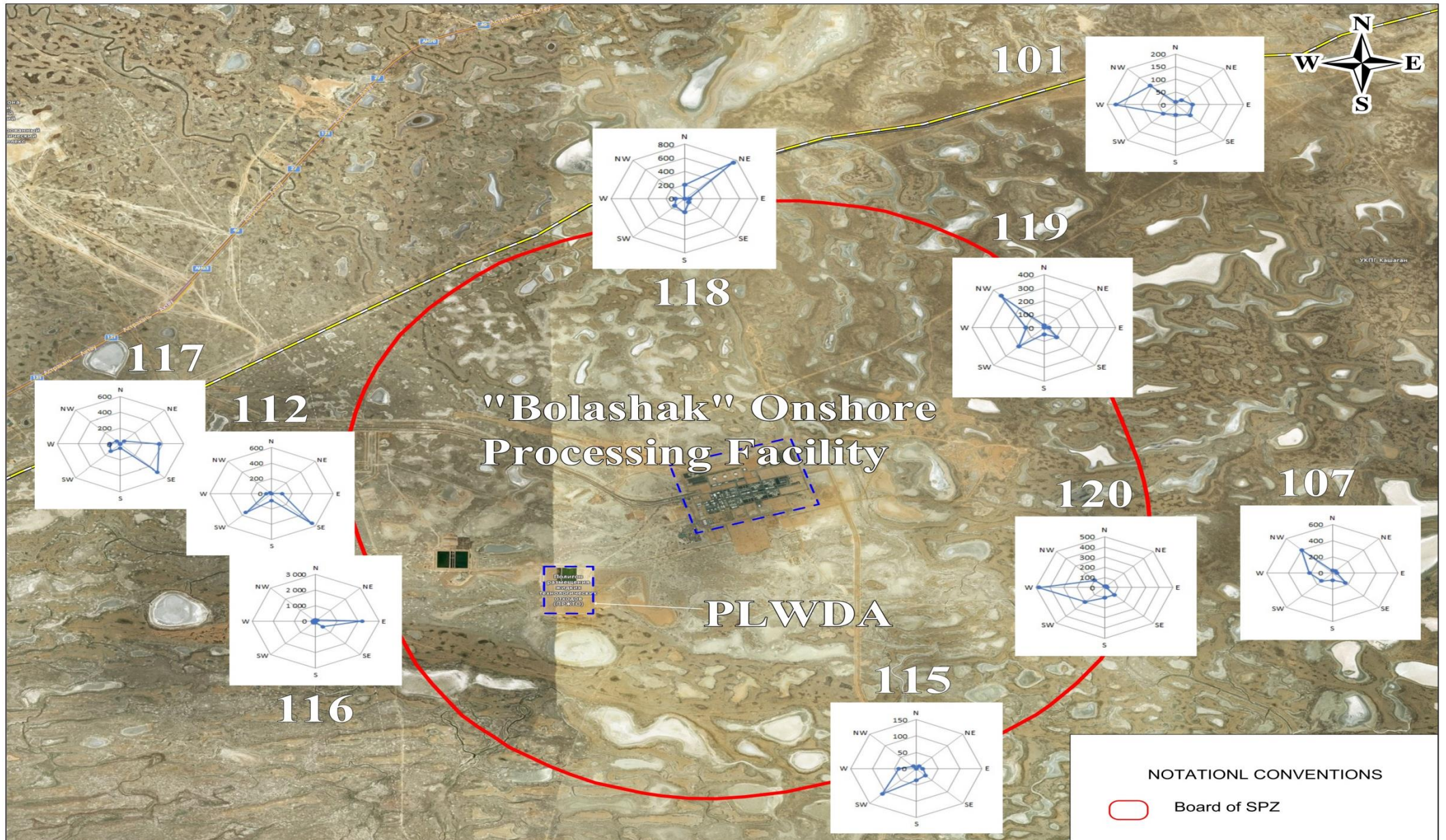
- Data representation for each AQMS:
 - 2009–2021 registered # of >1 MPC occurrences for H2S
 - distribution by the time of day
 - distribution by a year seasons
 - distribution by wind direction



Conclusion of analysis:

- distribution by the time of day
 - night and early morning hours prevail
- distribution by a year seasons
 - warm season prevail
- distribution by wind direction
 - predominate wind directions for >1 MPC H2S cases is:
 - E/SE in Atyrau
 - while Eskene West industrial facilities are located in the NE
 - NE/NW for Eskene West AQMS located close to NE SPZ border
 - ES/E/W for all other Eskene West AQMS located close to W/E SPZ border







PHASE 1. ANALYSIS OF HISTORICAL DATA FOR 2009–2021

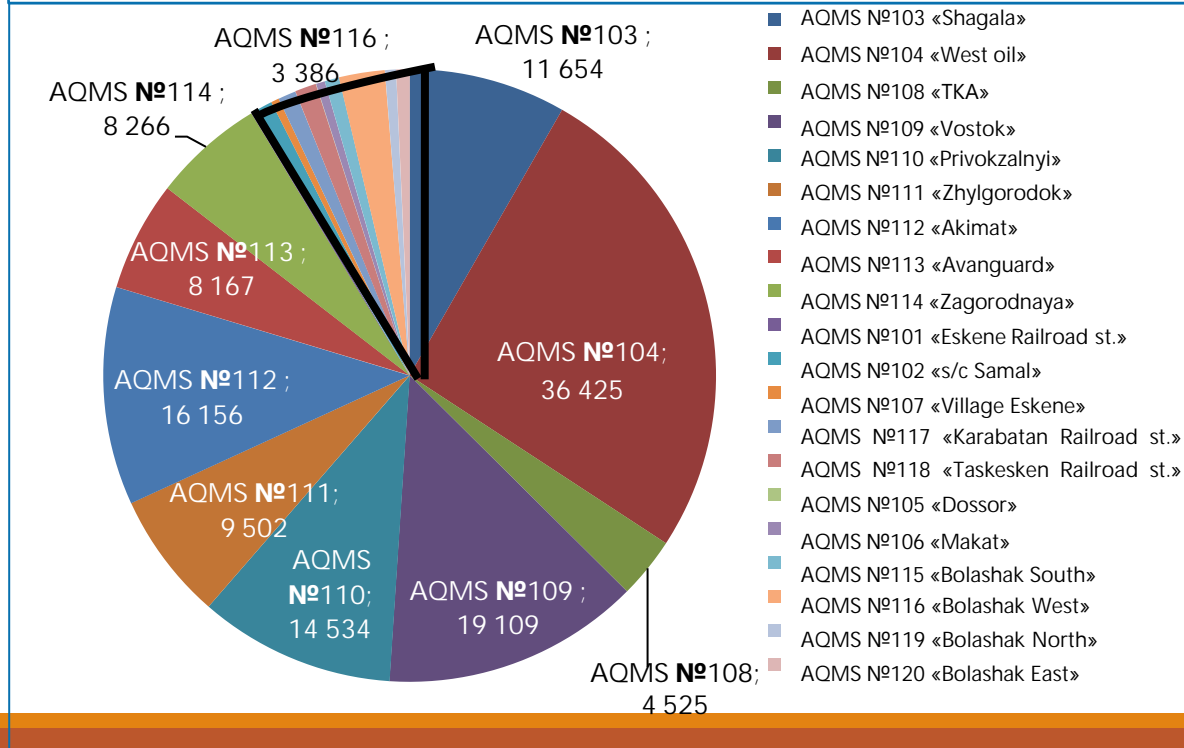
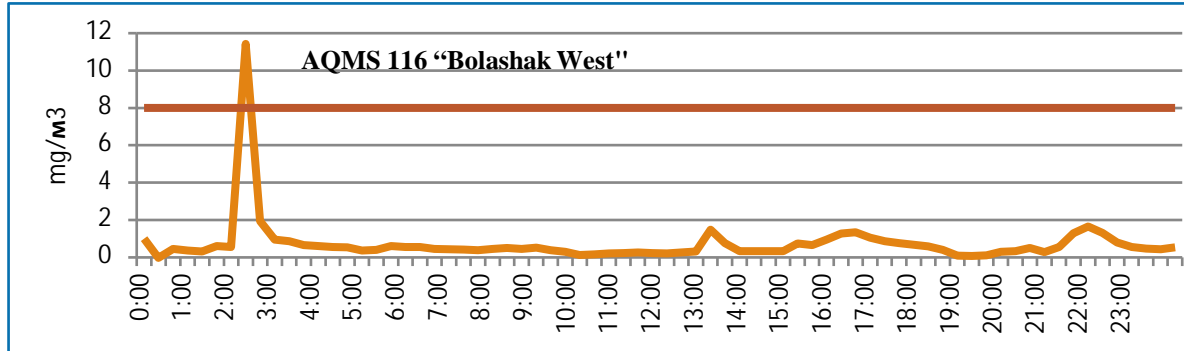
AQMS data for H₂S. Distribution by locations, duration and AQMS points

Methodology:

- Overall data representation:
 - 2009–2021 registered # of >1 MPC occurrences for H₂S
 - distribution by location
 - distribution by AQMS points
 - distribution by duration

Conclusion of analysis:

- distribution by location
 - 92% cases in Atyrau
 - 8% cases in EW
- distribution by AQMS points
 - Atyrau:
 - 25% cases at #104 “West oil”
 - 14% cases at #109 “East”
 - EW:
 - 2% cases at #116 “Bolashak West”
 - 1% cases at # 115 “Bolashak South”
- distribution by duration
 - <<5% of all AQMS records
 - withing tolerance interval of an air dispersion model





PHASE II. DEVELOPMENT OF AIR QUALITY MONITORING PROGRAM

Regulatory requirements

Statutory and regulatory enactments

- RD 52.04.186-89 Air Pollution Control Regulations
ST PK 2036-2010 Nature Protection – Emissions – Air Pollution Control Regulations
- PR RK 52.5.06-03 Environmental Monitoring Regulations – Recommended Practices for Comprehensive Surveys and Assessment of Environmental Pollution in Areas of Intensive Man-Made Impact
- GOST 17.2.3.01-86 Nature Protection –Atmosphere. Air Quality Control Regulations for Populated Areas
- GOST 17.0.0.02-79 Nature Protection (SSOP) – Metrological Assurance of Control over Contamination of Atmosphere, Surface Waters and Soil.

General

- State standard methods (GOSTs, ST RK) as well as methods of quantitative chemical analysis included in the State Register of the Uniform Measurement System (RoK SSM) are used for measurement, sampling and analysis of pollutants in atmospheric air
- Metrological assurance of the air monitoring system meets the requirements established in RoK
- Laboratory equipment used for air monitoring shall be duly calibrated
- Meteorological parameters are measured during sampling process: air temperature and humidity, atmospheric pressure, wind speed and direction, and weather conditions are also considered.



PHASE II. DEVELOPMENT OF AIR QUALITY MONITORING PROGRAM

Monitoring parameters

SELECTION CRITERIA	PARAMETERS	
<p>Phase I “Analysis of Historical Data for 2009–2021” recommendations and conclusions and the following criteria as per applicable International and Common of Independent States regulations:</p> <ul style="list-style-type: none"> ▪ Emission substances specific to Bolashak OPF operations ▪ Emission substances with a high hazard class (toxicity, carcinogenicity) ▪ Emission Substances that have a strong and unpleasant odor ▪ Emission Substances – main pollution contributors as per Bolashak OPF emission reports ▪ Emission Substances in the list of Air quality/Sanitary standards (MPC/SRLI) for the pollutants. 	<p><u>Saturated hydrocarbons:</u> Hydrocarbons C1-C5 Hydrocarbons C6-C10 Hydrocarbons C12-C19 Hydrocarbons C1-C10 Methane</p> <p><u>Unsaturated hydrocarbons:</u> Hydrocarbons C2-C5</p> <p><u>Aromatic hydrocarbons:</u> Benzene Xylene Toluene Ethyl benzene</p> <p><u>Polyaromatic hydrocarbons:</u> Acenaphthene Phenanthrene Anthracene Benz[a]pyrene</p> <p><u>Other organic compounds:</u> Formaldehyde Methanol Phenol</p>	<p><u>Heavy metals:</u> Zink Copper Lead Chromium (VI) oxide Manganese and its Compounds</p> <p><u>Mercaptans:</u> Methyl mercaptan Ethyl mercaptan Propyl mercaptan Isopropyl mercaptan Butyl mercaptan Isobutylmercaptan Tert-butyl mercaptan Sec-butyl mercaptan</p> <p><u>Oxides:</u> Nitrogen dioxide Nitrogen oxide Sulphur dioxide Carbon monoxide</p> <p><u>Other substances:</u> Hydrogen sulphide Ammonia Suspended solids Black carbon Elemental sulphur Inorganic dust: 70-20% SiO₂</p>



PHASE II. DEVELOPMENT OF AIR QUALITY MONITORING PROGRAM

Monitoring points and schedule. Atyrau

Grid : 3km x 3km

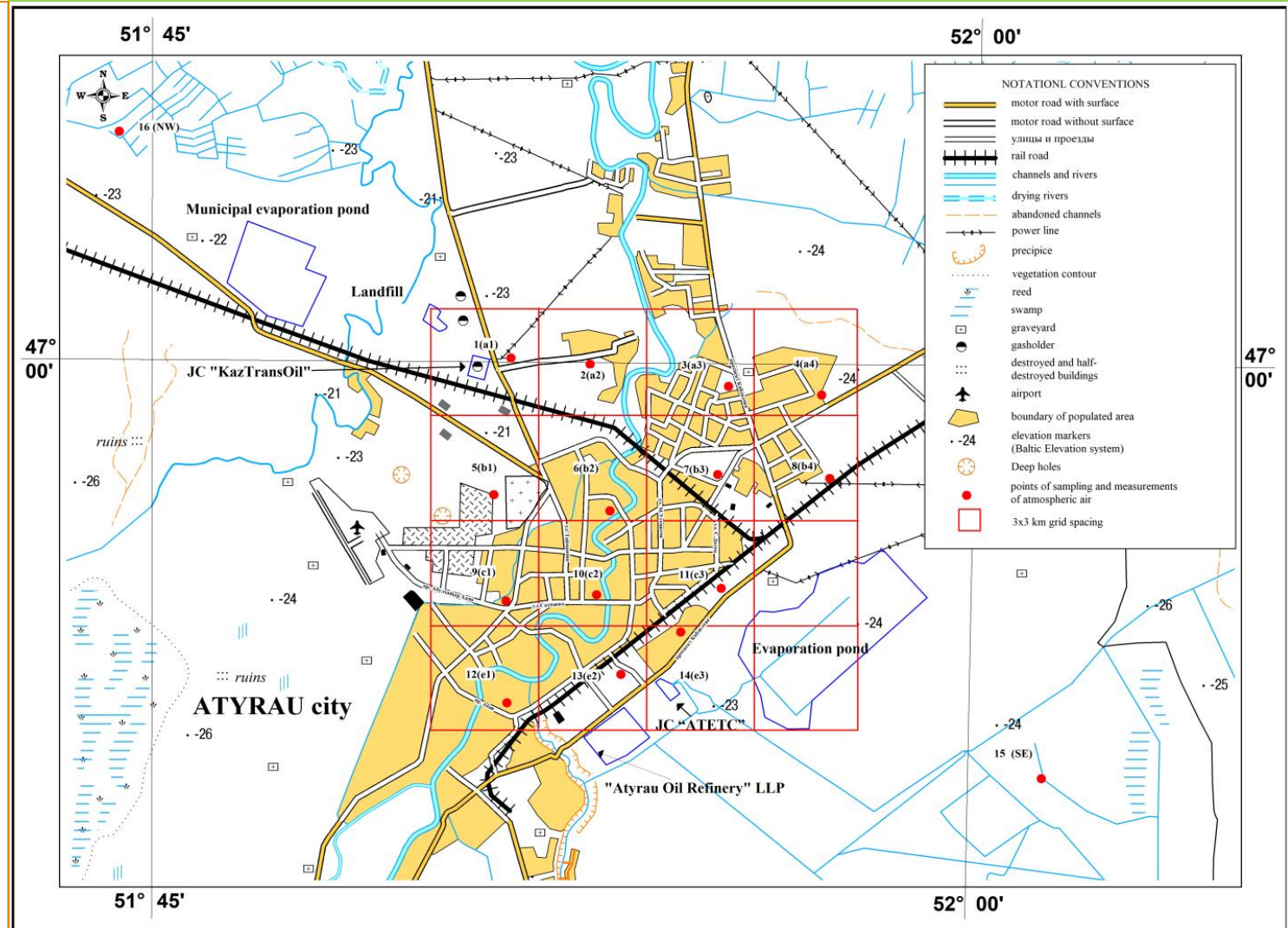
Monitoring points:
16 mobile sample stations
evenly
distributed over
squares of the city
area.

Schedule:

Full program
monitoring – 1:00,
7:00, 13:00, 19:00 hrs.

Duration:

7 days per station.





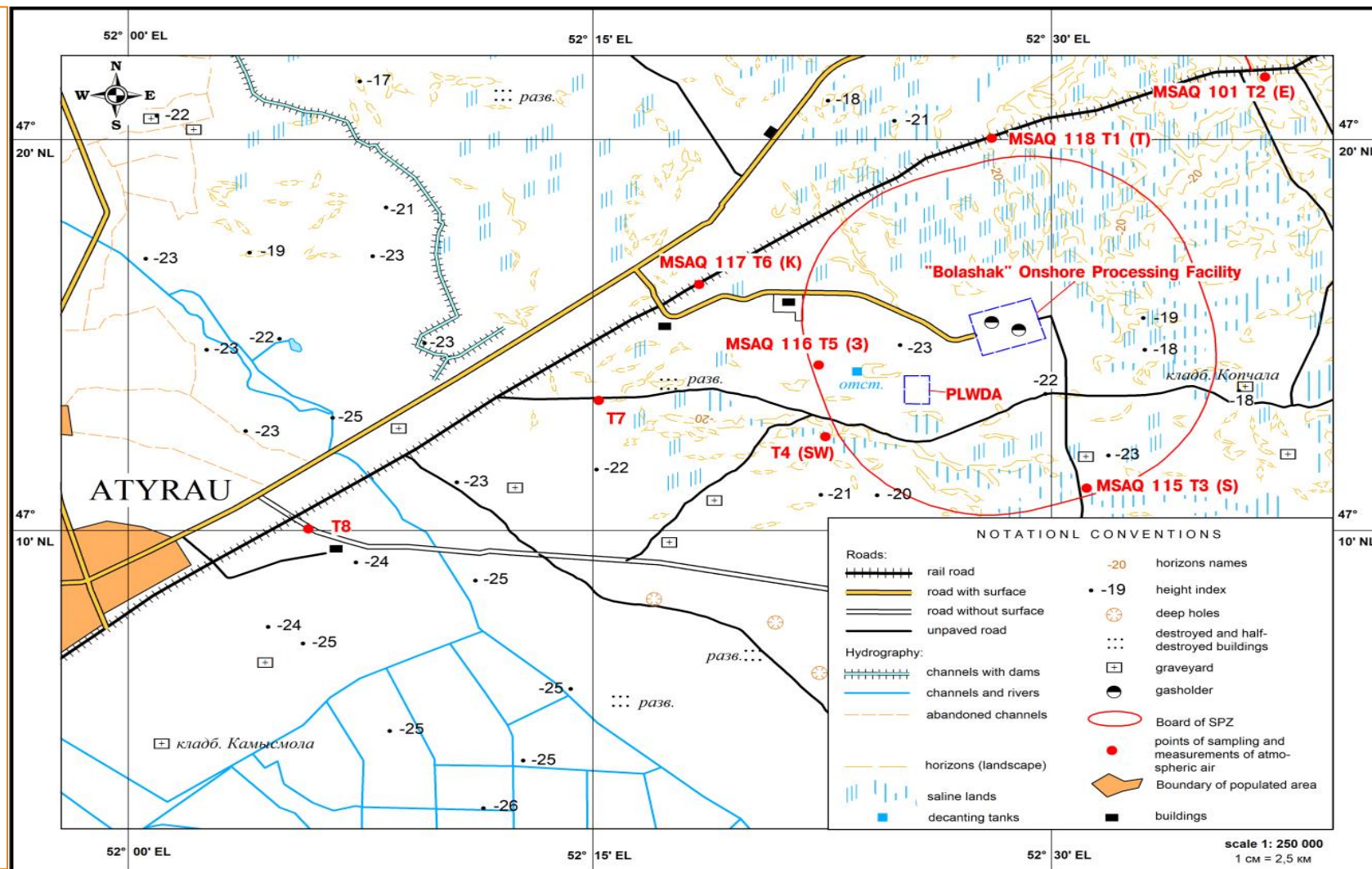
PHASE II. DEVELOPMENT OF AIR QUALITY MONITORING PROGRAM

Monitoring points and schedule. EW

Monitoring points:
Mobile sampling stations at AQMS locations at the SPZ and nearby settlements + 2 extra stations between Atyrau and OPF*

Schedule:
Full program monitoring – 1:00*, 7:00, 13:00, 19:00 hrs.

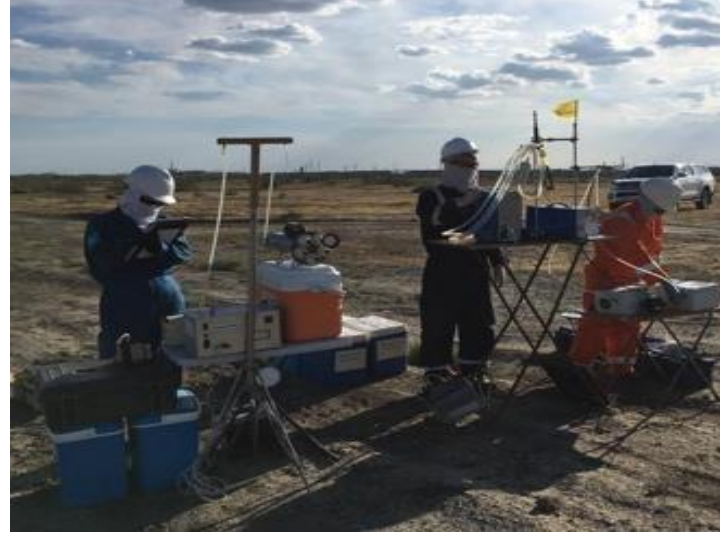
Duration:
6 days per station.



During Program approval community representatives recommended to install two additional monitoring stations between Eskene West and the city (points T7 and T8) and to shift the night-time sampling to pre-morning sampling.



Phase III. 2020–2021 Field Measurements and Air Quality Laboratory Studies FIELD PHOTO REPORT





Phase III. 2020–2021 Field Measurements and Air Quality Laboratory Studies LAB PHOTO REPORT





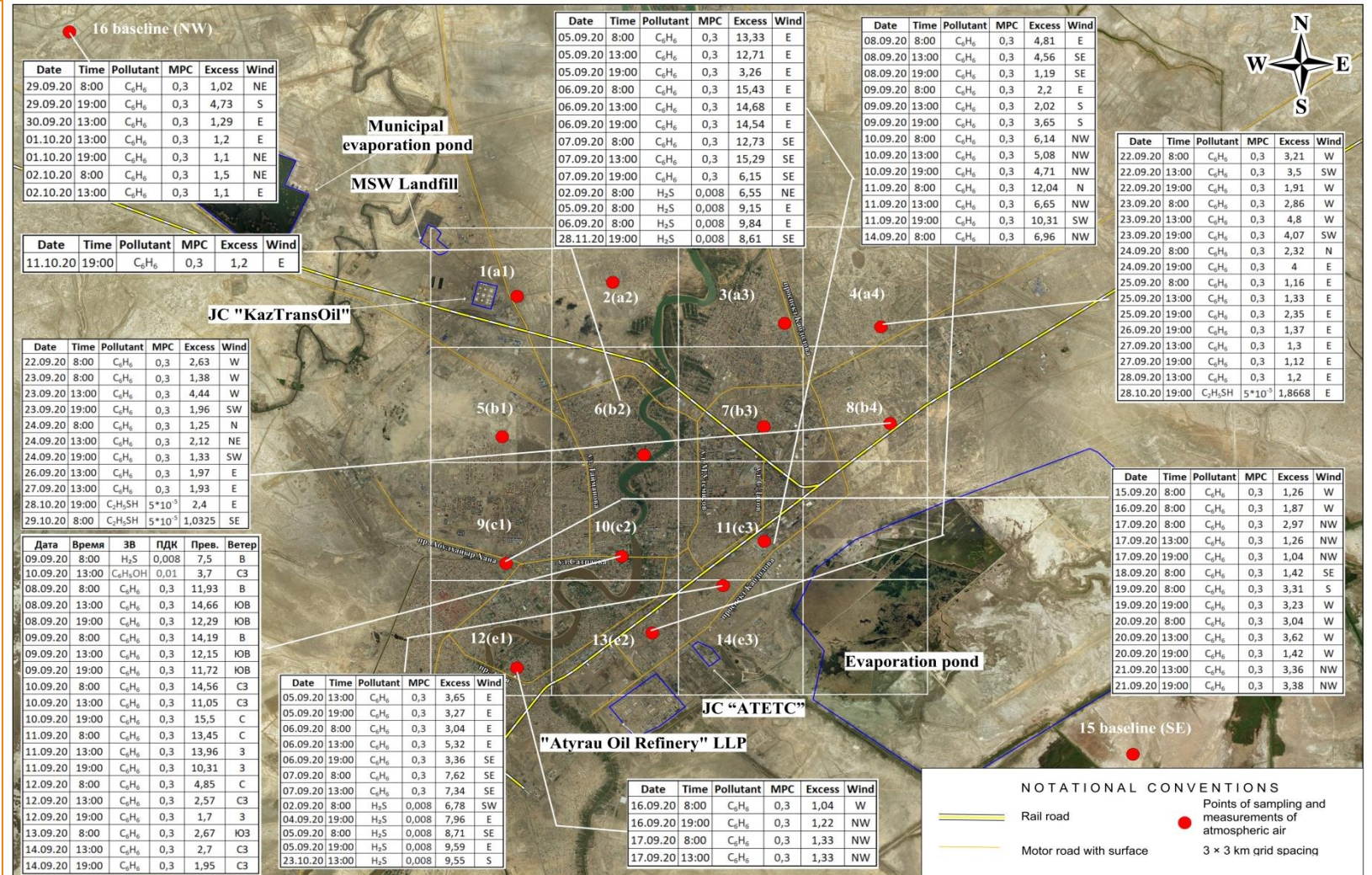
Phase III. 2020–2021 Field Measurements and Air Quality Laboratory Studies Results. Atyrau. Autumn 2020

Data recorded (Sep-Nov):

- >1 MPC occurrences:
 - Hydrogen Sulphide
 - correlate to/< AQMS data records
 - Benzene (C₆H₆)
 - Mercaptans
- All other records < 1 MPC

Conclusion of analysis:

- >1 MPC occurrences in S/SE part of Atyrau:
 - Benzene
 - No predominate wind direction (background concentration)
 - Hydrogen Sulphide, Mercaptans
 - E/SE wind
- No correlation to EW industrial activity, which is in NE.





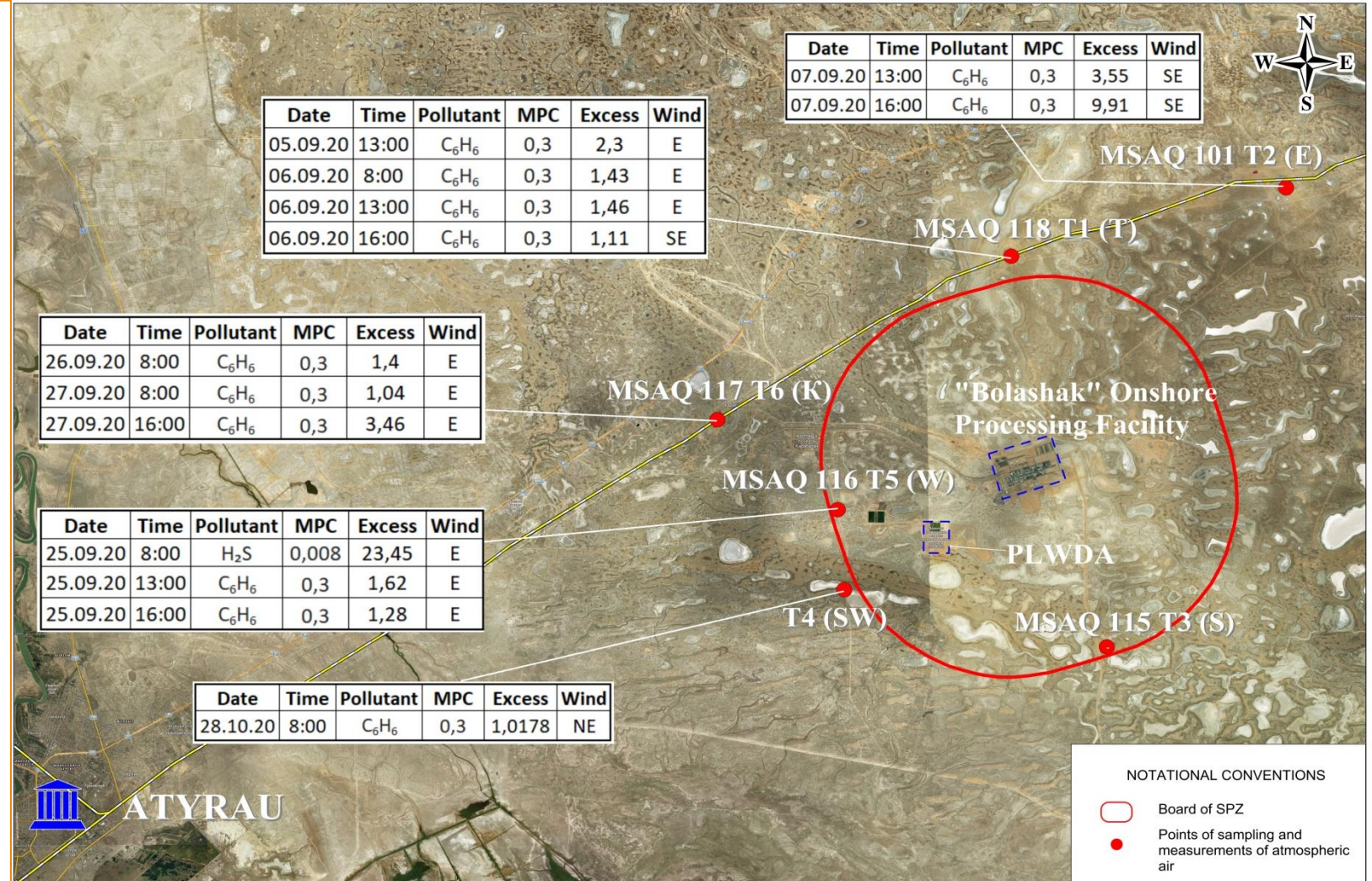
Phase III. 2020–2021 Field Measurements and Air Quality Laboratory Studies Results. EW. Autumn 2020

Data recorded (Sep):

- >1 MPC occurrences:
 - 1 for Hydrogen Sulphide
 - correlate to/< AQMS data records
 - Benzene (C₆H₆)
- All other records < 1 MPC

Conclusion of analysis:

- >1 MPC occurrences in W/N/NE part of SPZ:
 - Benzene
 - E/ES wind (windward background concentration)
 - Hydrogen Sulphide
 - E wind





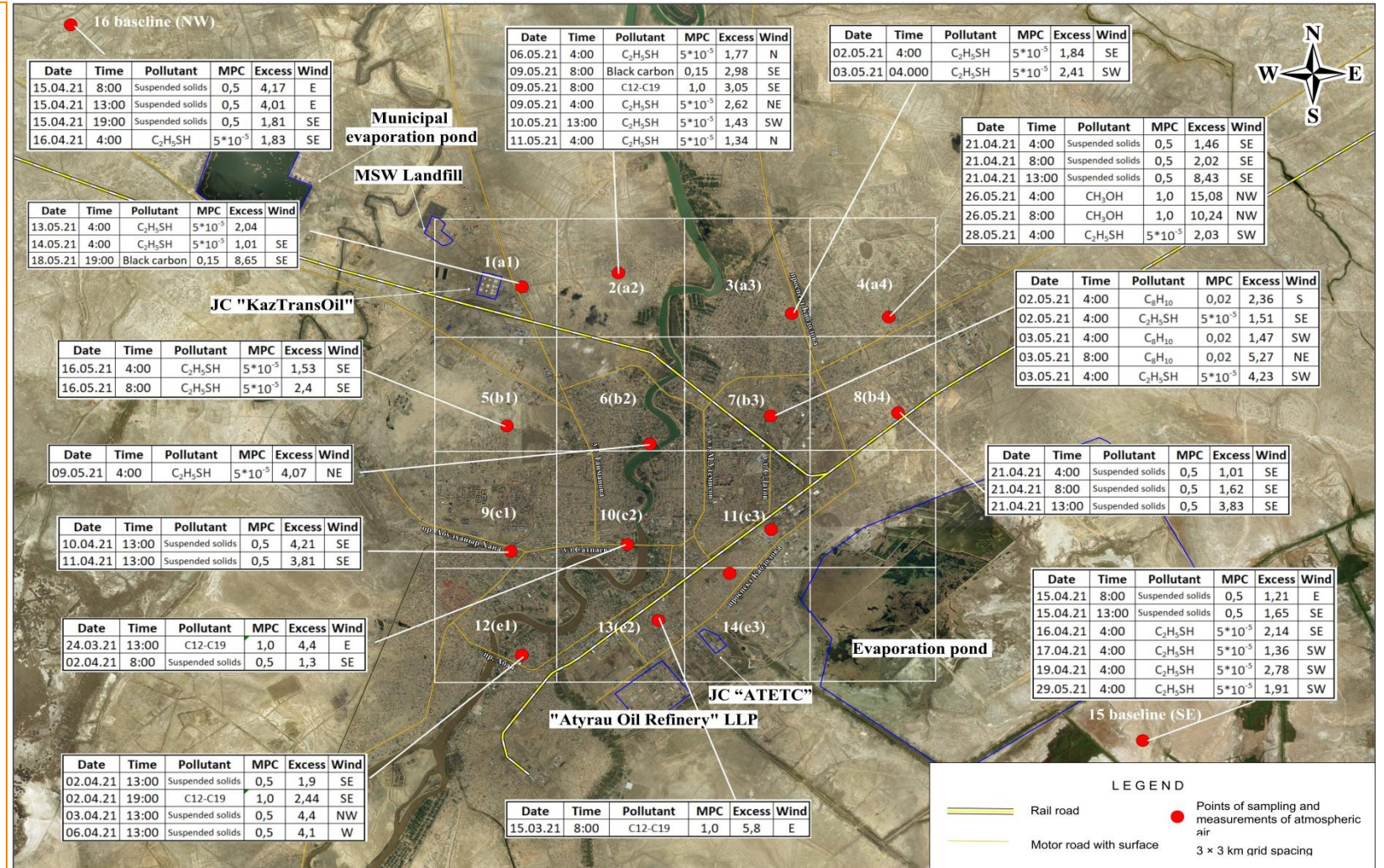
Phase III. 2020–2021 Field Measurements and Air Quality Laboratory Studies Results. Atyrau. Spring 2021

Data recorded (Apr-May):

- >1 MPC occurrences:
 - Suspended solids
 - Mercaptans
 - Methanol (CH₃OH)
 - C12-C19
- All other records < 1 MPC

Conclusion of analysis:

- >1 MPC occurrences in all parts of Atyrau:
 - SE wind
 - Methanol (CH₃OH)
 - NW wind
 - Mercaptans
 - SE/SW wind
 - C12-C19
 - SE/E wind
- No correlation to EW industrial activity, which is in NE.





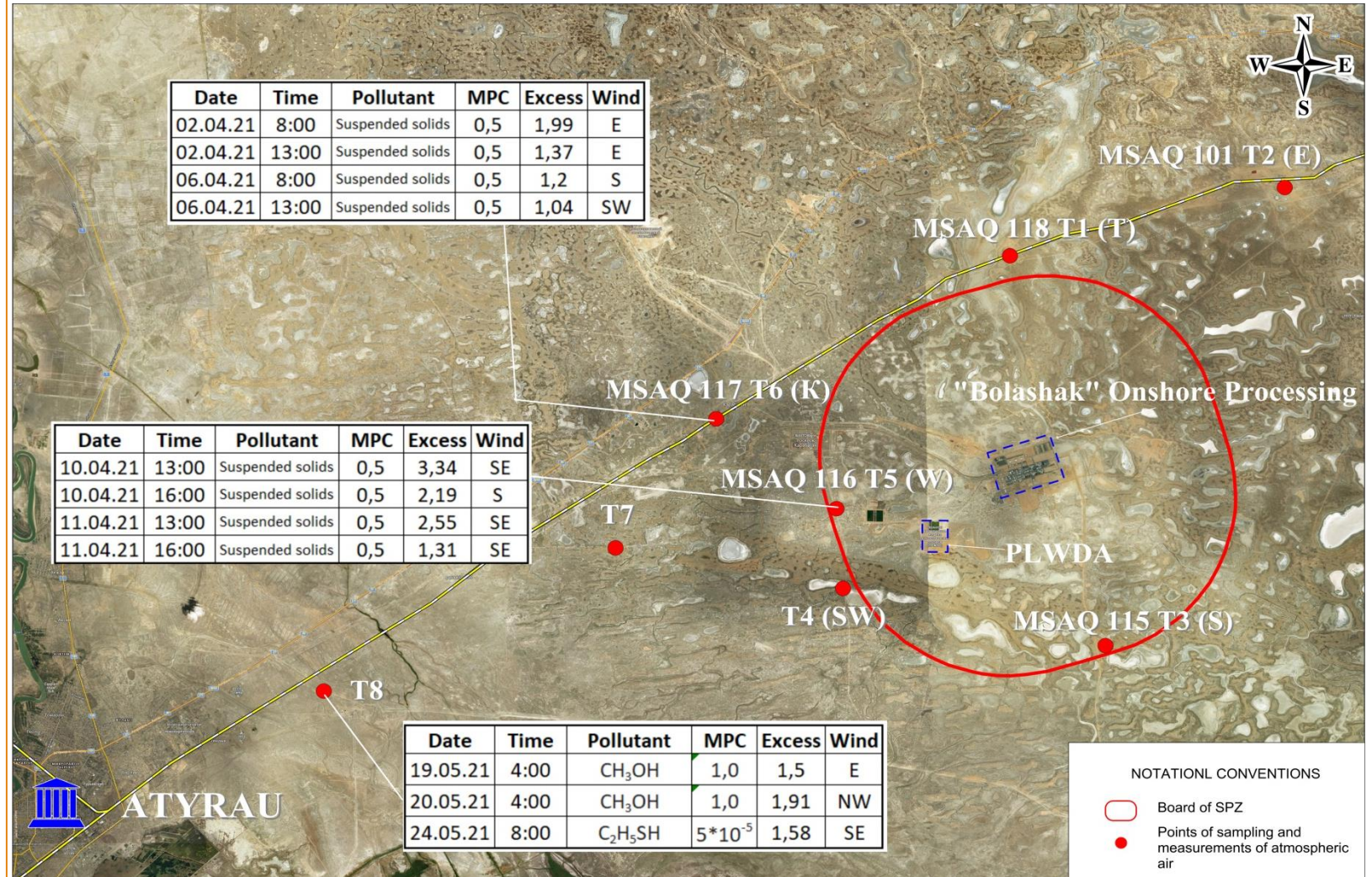
Phase III. 2020–2021 Field Measurements and Air Quality Laboratory Studies Results. EW. Spring 2021

Data recorded (Apr-May):

- >1 MPC occurrences:
 - Suspended solids
 - Mercaptans
 - Methanol (CH₃OH)
- All other records < 1 MPC

Conclusion of analysis:

- >1 MPC occurrences in W side:
 - Suspended solids and Methanol (CH₃OH)
 - No predominate wind direction (background concentration)
 - Mercaptans
 - SE wind
- No correlation to EW industrial activity, which is in NE.





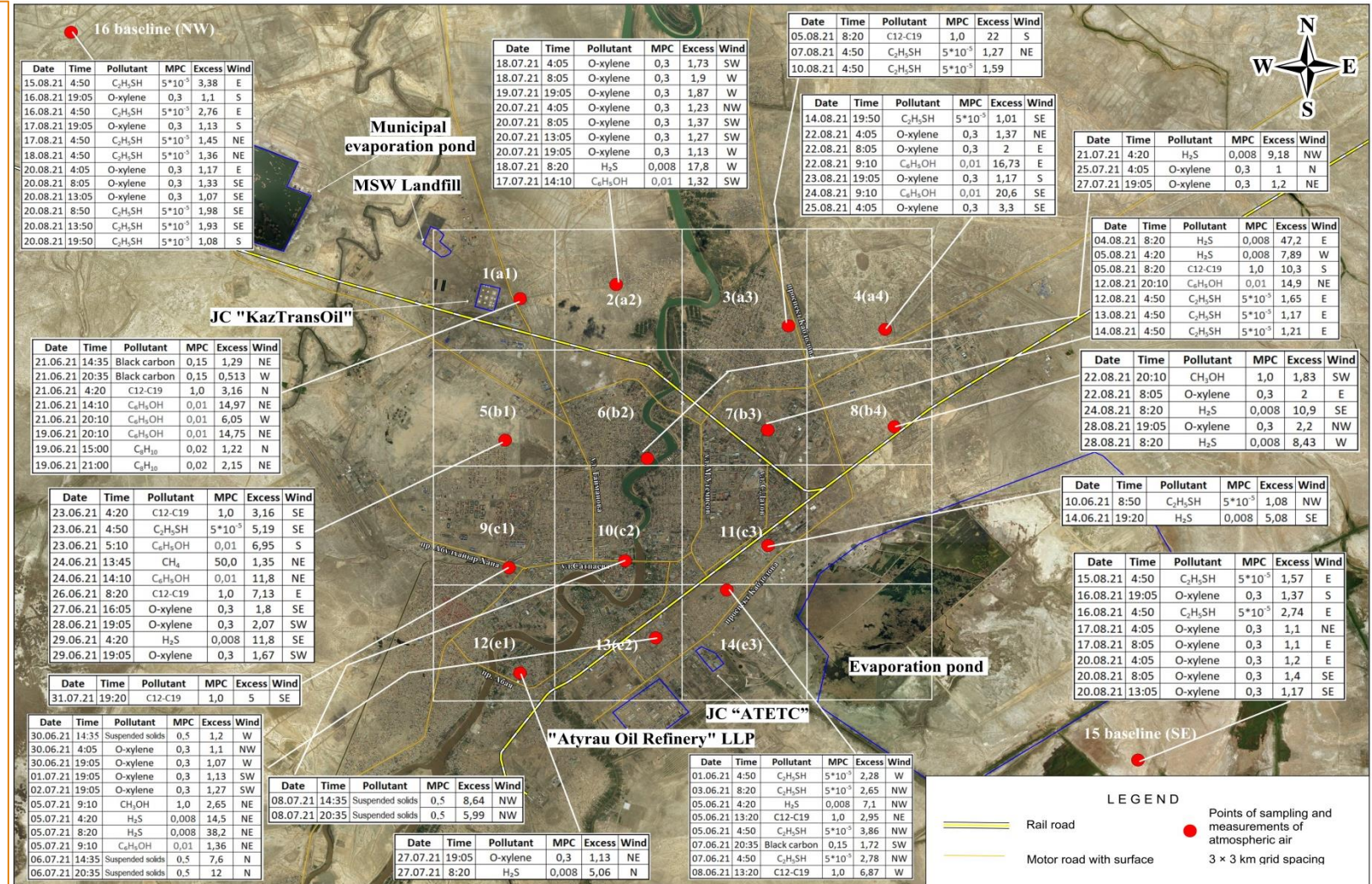
Phase III. 2020–2021 Field Measurements and Air Quality Laboratory Studies Results. Atyrau. Summer 2021

Data recorded (Jul-Aug):

- >1 MPC occurrences:
 - Hydrogen Sulphide
 - correlate to/< AQMS data records
 - Xylene
 - Suspended solids
 - Mercaptans
 - Methanol (CH₃OH)
 - Ethylbenzene (C₈H₁₀)
 - Phenol (C₆H₅OH)
 - C12-C19
- All other records < 1 MPC

Conclusion of analysis:

- >1 MPC occurrences in all parts of Atyrau:
 - Hydrogen Sulphide, Methanol, Xylene, Mercaptans, C12-C19, Phenol (C₆H₅OH), Suspended solids
 - No predominate wind direction (background concentration)
- No correlation to EW industrial activity, which is in NE.





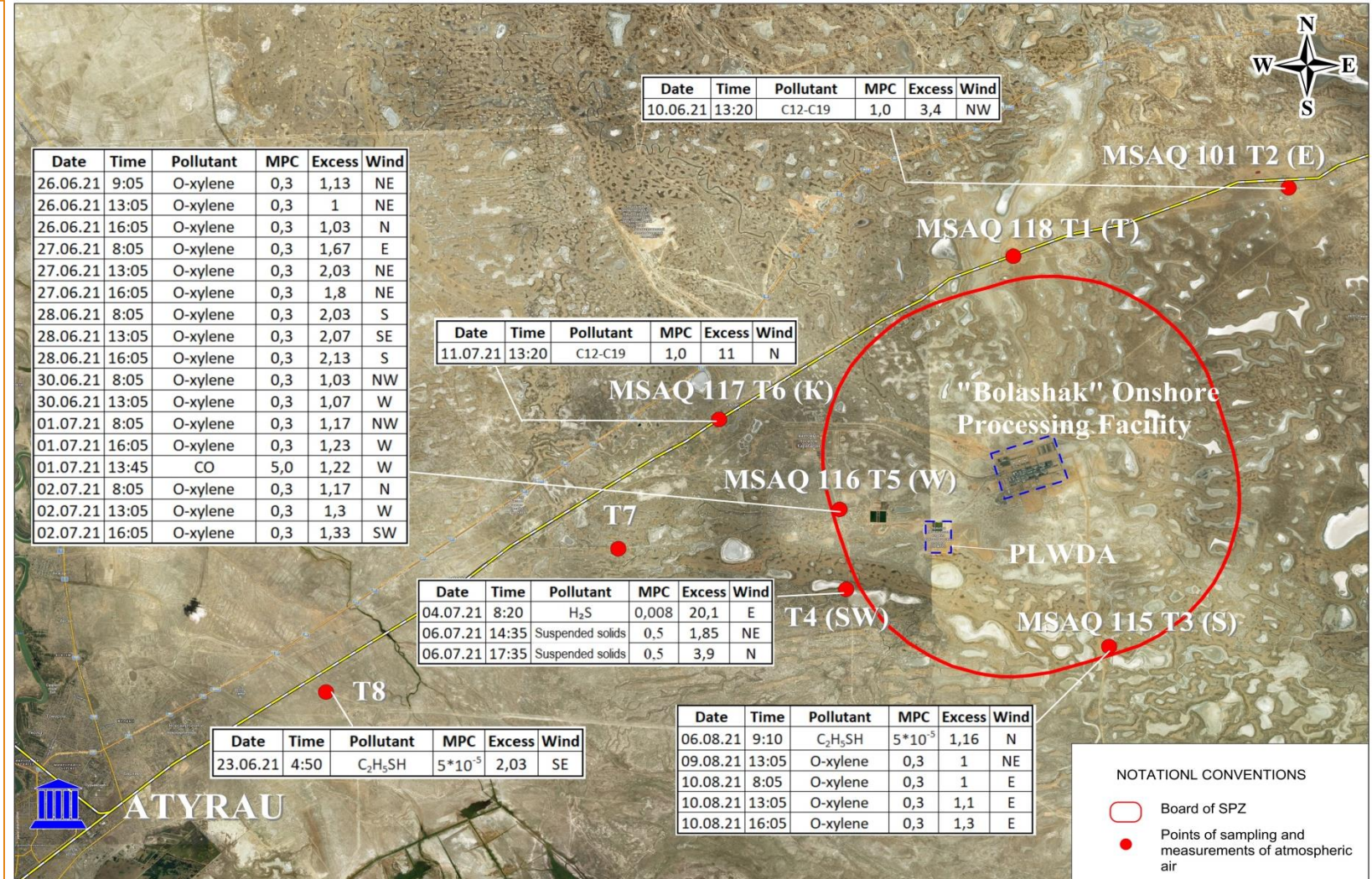
Phase III. 2020–2021 Field Measurements and Air Quality Laboratory Studies Results. EW. Summer 2021

Data recorded (Jul-Aug):

- >1 MPC occurrences:
 - Hydrogen Sulphide
 - correlate to/< AQMS data records
 - Xylene
 - Suspended solids
 - Mercaptans
 - C12-C19
- All other records < 1 MPC

Conclusion of analysis:

- >1 MPC occurrences in all parts:
 - Hydrogen Sulphide
 - SE wind
 - Suspended solids
 - N/NE wind (station on WE)
 - C12-C19
 - N/NW wind (station on N - background)
 - Xylene, Mercaptans
 - No predominate wind direction (background concentration)





Summary

- This is the first time that studies of this magnitude are being conducted in Kazakhstan covering processing data over 12 years (data from AQMS stations, NCOC MPE projects, NCOC IEC reports, data of the "Kazhydromet" in the Atyrau region and the results of other studies).
- Filed works carried out simultaneously by 3 teams in Autumn 2020, Winter – Summer 2021.
- The density of stations (manual and automatic) in Atyrau is more than 10 times higher than in any other cities (18 or one station per 6 sq. km) vs 10 stations or one station per 72 sq. km in Nur-Sultan and 6 or one station per 66 sq. km in Aktobe). It follows that a further increase in the number of monitoring stations within Atyrau city limits would be ineffective.

Results:

- Screening made at the Stage I of the study on basis of 2019 data identified excessive air quality concentration cases for hydrogen sulfide, some VOCs (ethylbenzene, formaldehyde, phenol), suspended solids, in Atyrau and Eskene West.
- Further analysis of the historical data added up Nitrogen oxides, Sulphur dioxide and Carbon monoxide cases in Atyrau to that list and revealed that:
 - AQMS data on H₂S exceedances have distribution by prevailing patterns:
 - warm season, E/SE wind in Atyrau, while Eskene West industrial facilities located in NE,
 - Short spikes in night and early morning hours (duration << 5% of total recorded AQMS operating time),
 - 92% cases in Atyrau (25% at #104 "West oil" and 14% cases at #109 "East"), 8% cases in EW (2% at #116 "Bolashak West" and 1% at # 115 "Bolashak South"),



Summary

- 2009–2021 H₂S concentration in Atyrau plateaued at >>1 MPC and there is no link found to EW cases, which are 2 to 3 times lower than in Atyrau. Moreover, baseline of H₂S exceedances at EW is leveled at 100-200 cases per year before startup of hydrocarbon operations.
 - Kashagan field Onshore facilities are ones of the complex industrial facilities in EW. NCOC maintains permitted emission standards and implements action plan to further reduce its load to air quality in EW.
- 2020–2021 Field Measurements and Air Quality Laboratory Studies at stage III have not re-confirmed Nitrogen oxides, Sulphur dioxide and Carbon monoxide exceedances and reaffirmed conclusions made for H₂S records but registered lower values for exceedances. This can be explained by the peculiarity of H₂S measuring methodology utilized at AQMSs.
- Stage III reconfirmed presence of episodic excessive air quality concentration cases for VOC (benzene, xylene, methanol, C₁₂-C₁₉), mercaptans, suspended matter at Eskene West and Atyrau and extra VOC (ethylbenzene, formaldehyde, phenol) species in Atyrau,
 - However, the study identified no prevailing patterns (predominate wind direction, ect.) attributed for those cases and further studies are required to identify the reasons/sources.



Thank you!