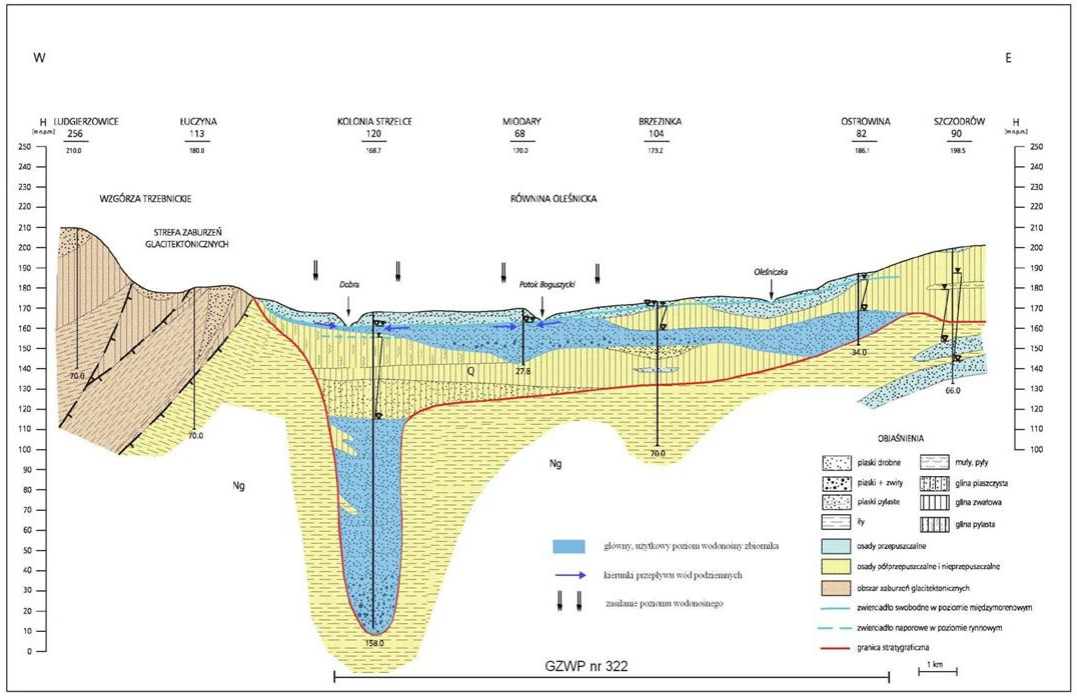
High groundwater resources as a supplementary source of water supply –Wrocław City

Prof. Stanisław Staśko



Uniwersytet Wrocławski

High groundwater resources as a supplementary source of water supply –Wrocław City

- Water in big City
- Groundwater resources in Poland
- Existing water supply, quality and cost- case study of Wrocław City
- New findings – groundwater resources in Wrocław City vicinity
- New idea, proposal, solution , advantages and cost
- Summary

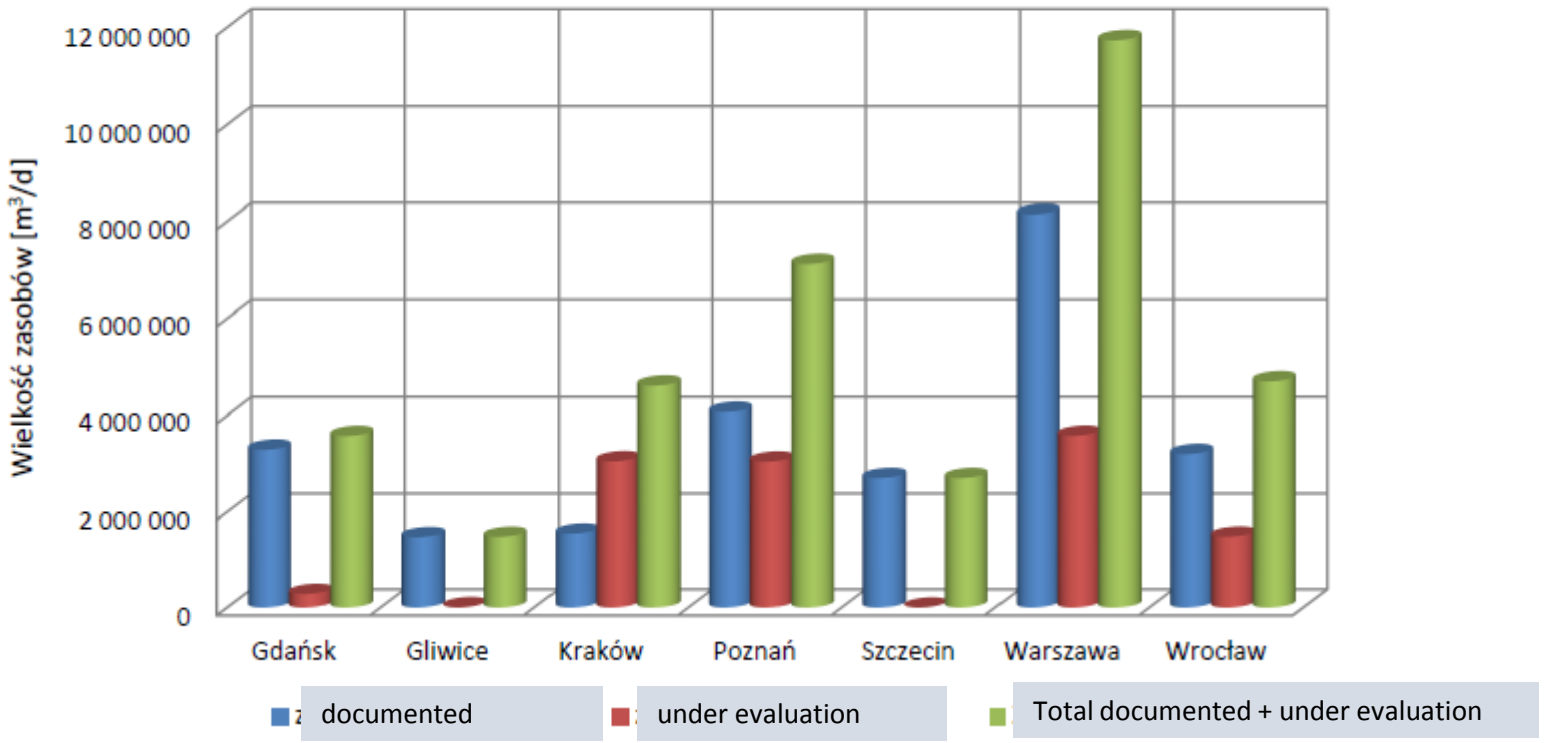
- Over **72% of world population is located in urban area and according to prognosis in 2050 year it will be >80 %** (Eurostat, 2016)

- In Poland over **20 mln people is leaving in cities when around 20% is located in** 16 bigest cities including **Wrocław City** (GUS, 2017)

http://www.crresearch.com/the-re-urbanization-of-america

Big City and infrastructure –roads, electricity, gas, water supply and sewage system, surface water
Increasing demand and pressure on limited land surface

Groundwater resources Poland



Total available groundwater resources in Poland 35,9 million m^3/d, when 24.5 million m^3/d disposable

Wrocław region – 4.2 million m^3/d

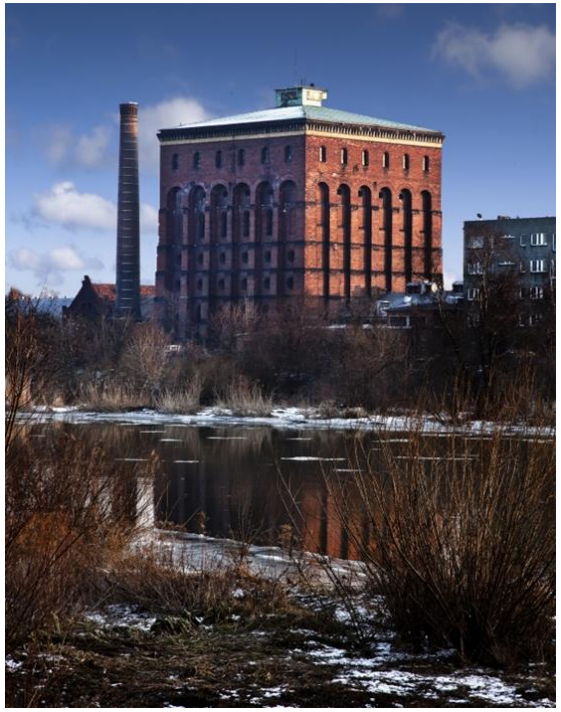
Groundwater exploitation in Wrocław region -16.3 % of total

Woznicka 2017, Polish Geological Institute

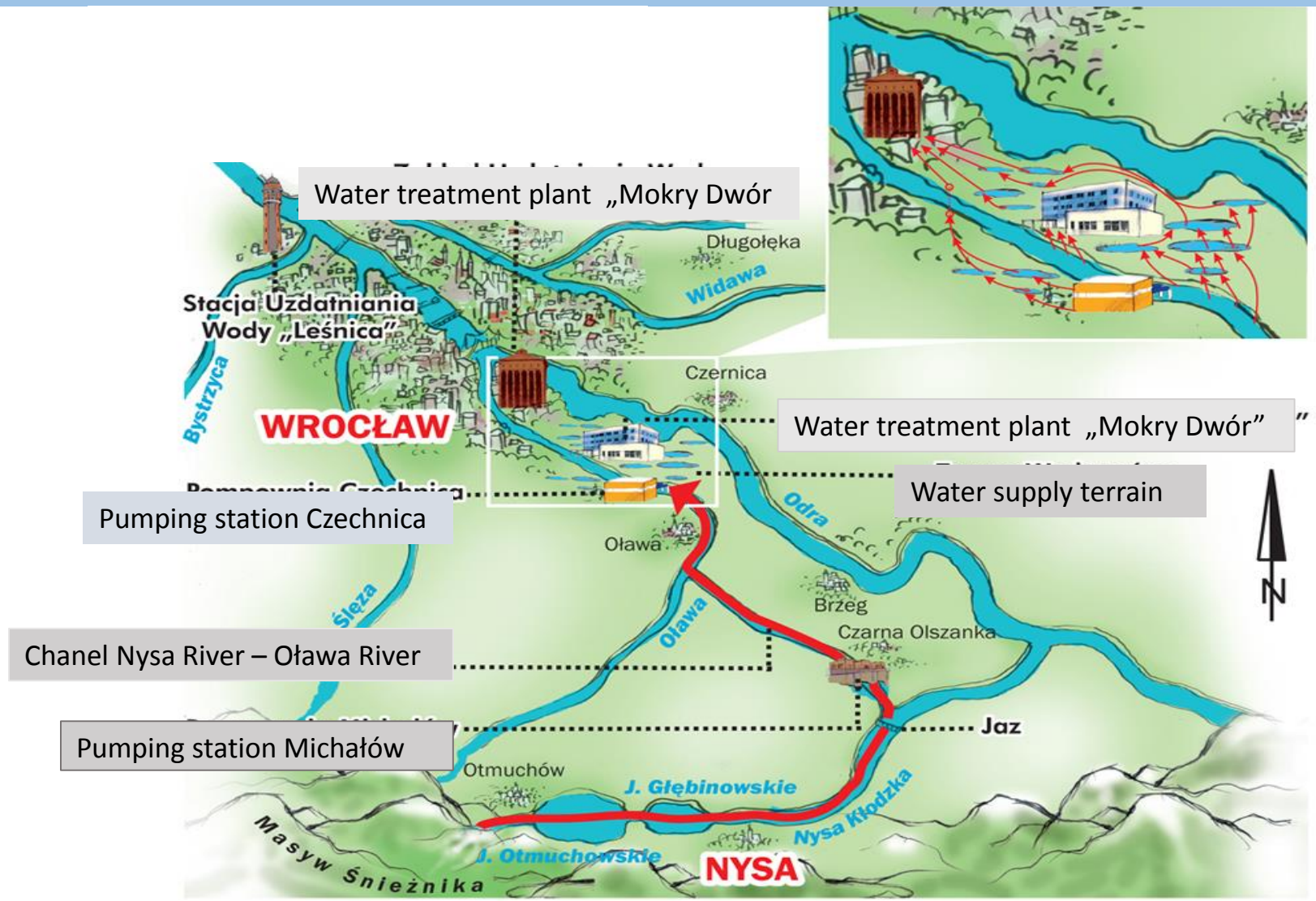
Short history of water supply Wroclaw City

- 1386 year – Big Water Wheel supply water from Odra River
- 1871 year Water Treatment Plant Na Grobli – surface water

- 1905 r. groundwater intake by inż. Adolf Thiem in Oława river valley construction of 313 wells and expected exploitation 40 000 m^3/d
- High Fe and Mn concentration
- Artificial recharge by ponds
- After 1945 year the water intake has been reconstructed nad modified and produce 110 000 -150 00 m^3/d



Water supply system Wrocław City base on surface water and artificial recharge – infiltration by ponds



Wrocław City water supply system

Area -1026 ha (60 % out of the City)

54 infiltration ponds ,

Over 488 shallow wells,

Two water treatment plants

According to Municipal Water Supply (MPWiK) Wrocław

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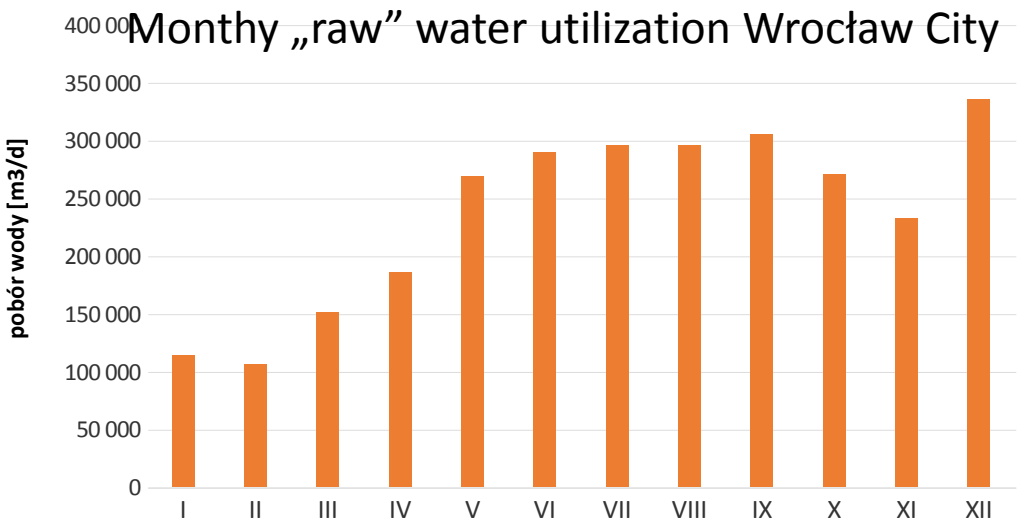
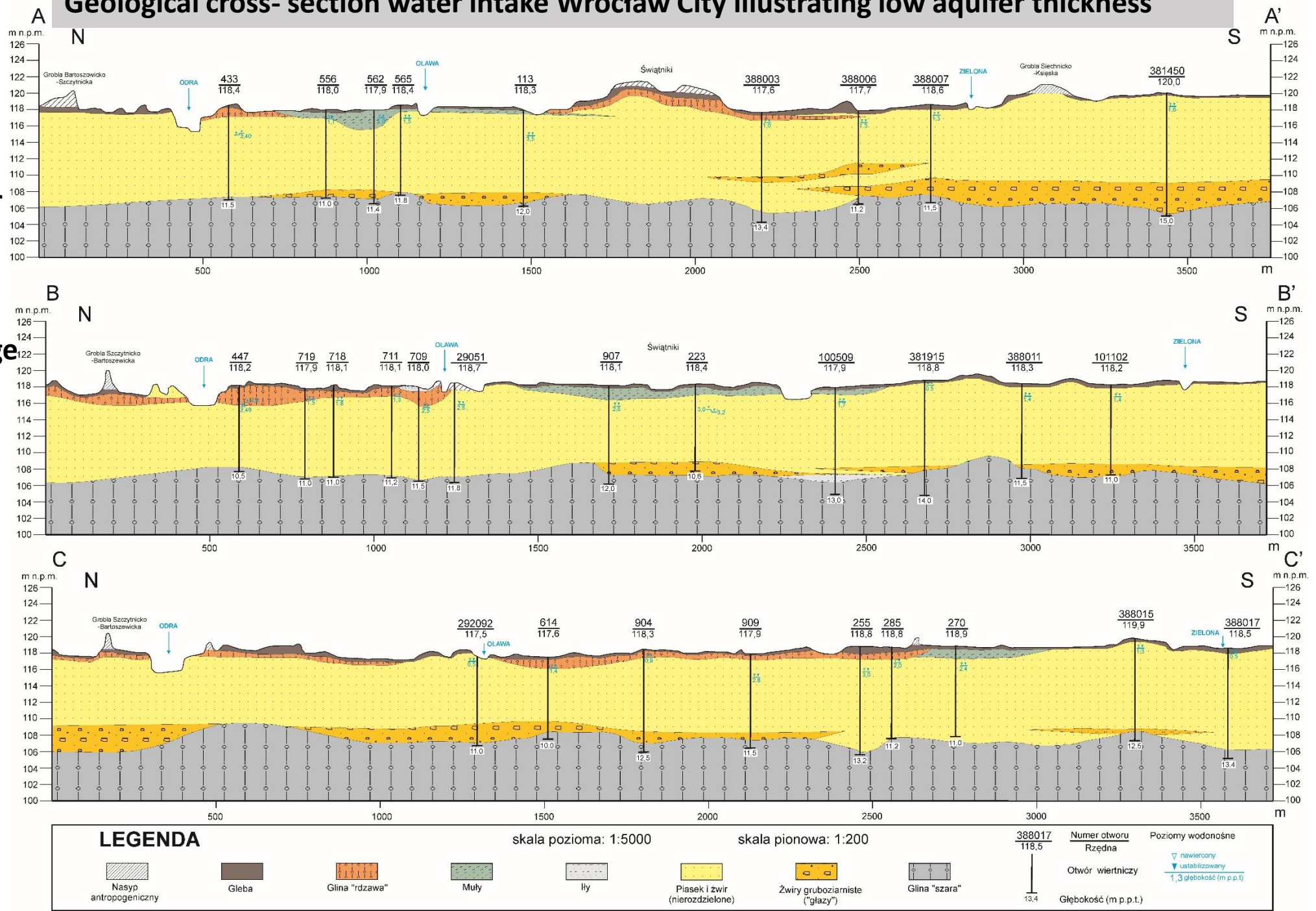
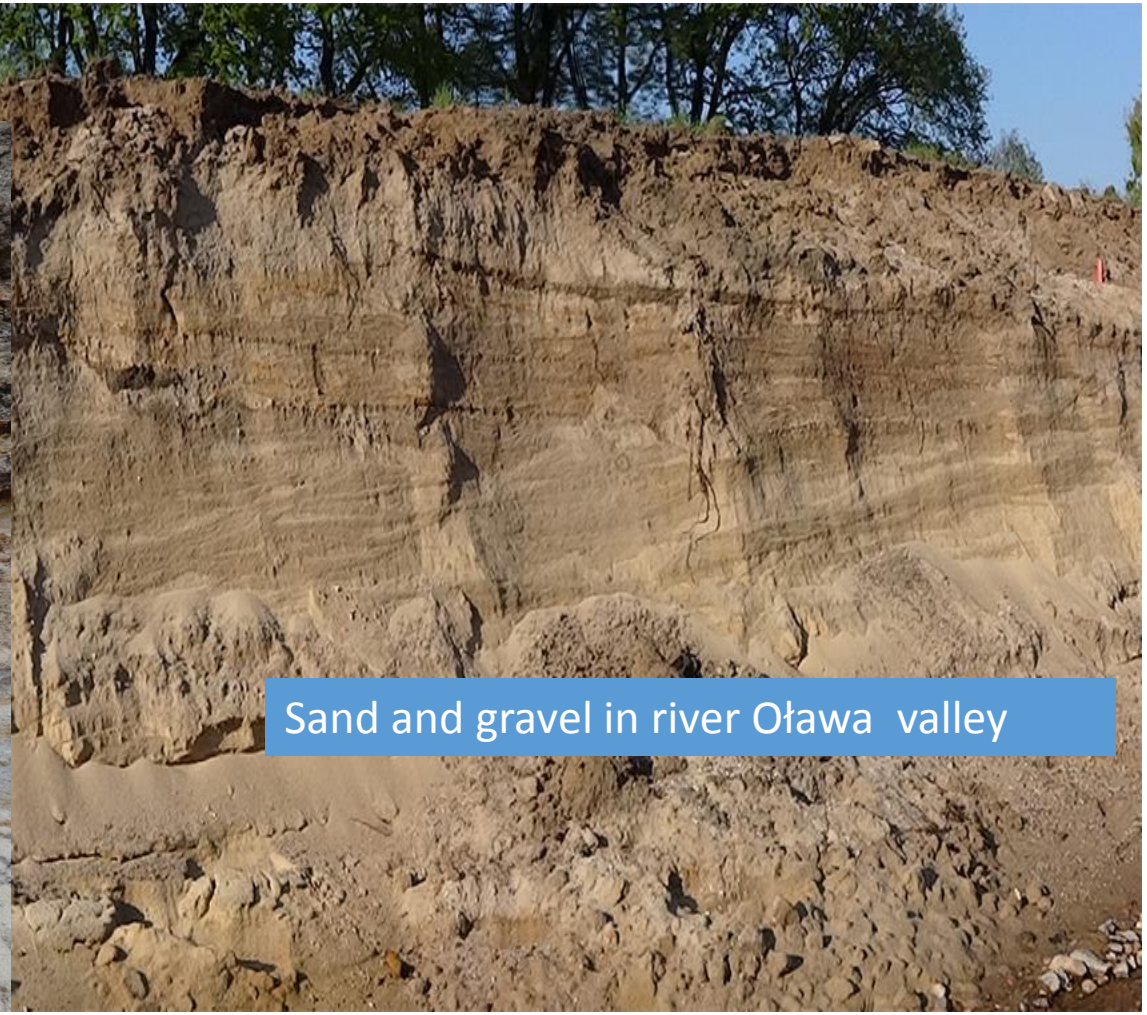


Geological cross- section water intake Wrocław City illustrating low aquifer thickness

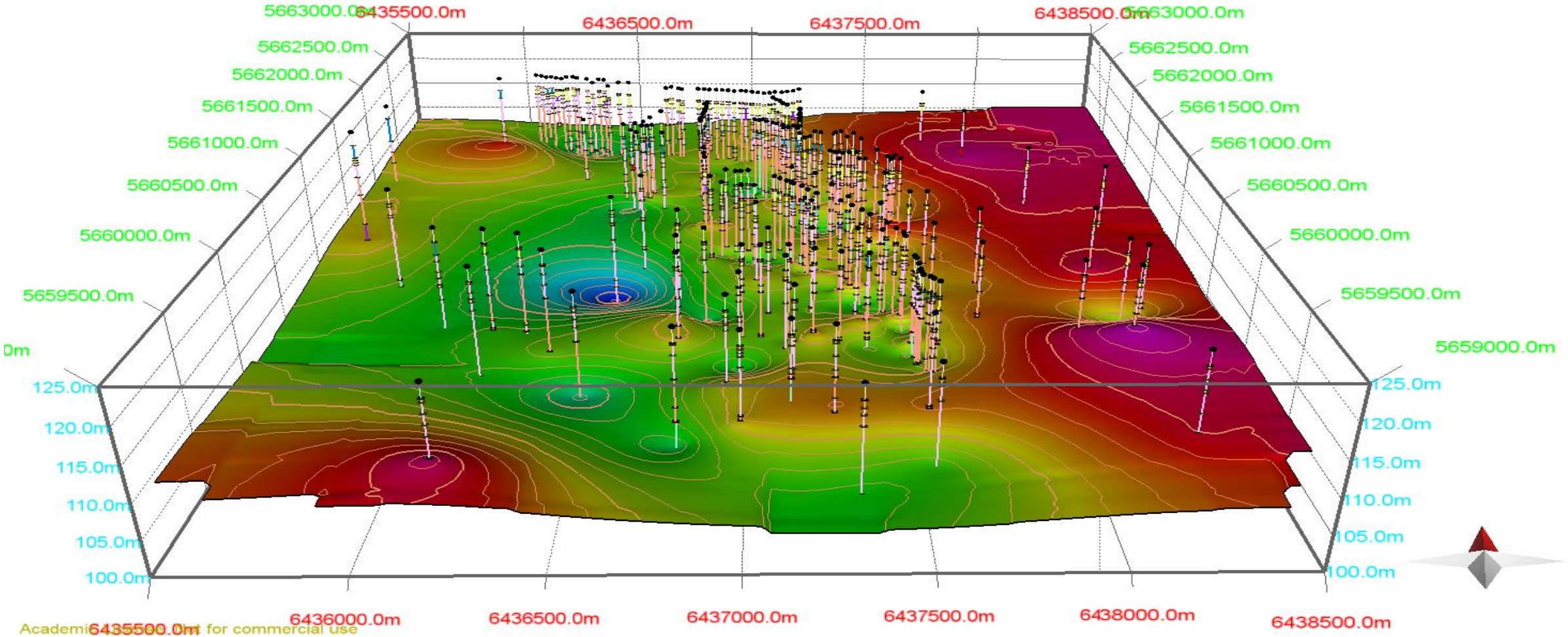
Infiltration water intake
Sand and gravel thickness water bearing unit range form 6.4-8.2 m (Świątniki)





After Wojewoda et al 2015

Detailed geological study and research on the water intake terrain Wrocław City



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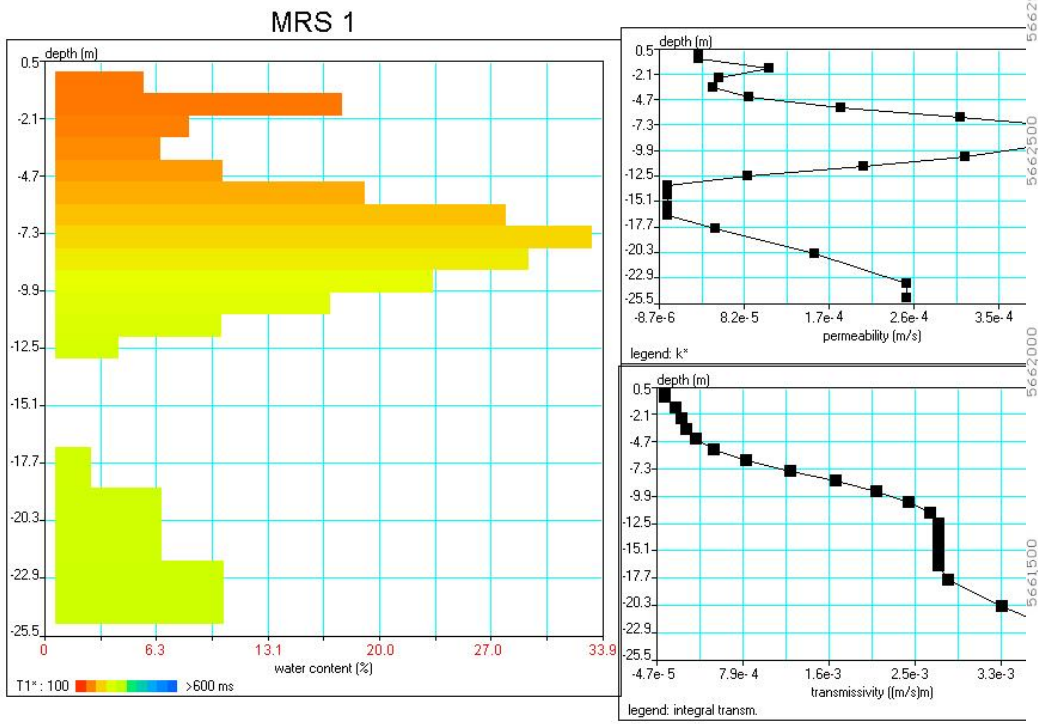


Magnetic resonance sounding (MRS) and numerical modeling showed that 35 000-65 000 m^3/d could be pumped from infiltration part of water intake (30-50 % water demand).

Geological and hydrogeological survey, magnetic resonance sounding (MRS) and numerical modeling showed that 35 000-65 000 m^3/d could be pumped from infiltration part of water intake (30-50 % water demand).

The rest (85 000 m^3/d -55 000 m^3/d) of total average amount 120 000 m^3/d has been treated by Mokry Dwór Plant based on surface water of Oława and Nysa Kłodzka river .

Five processes has been used to utilized and meet required water quality standards

Big City means
Increasing demand and pressure on limited land surface

Let us consider

Reverse solution dispersed sources on surrounding terrains

Geological survey in late70- and 80 –thies XX century discovered high groundwater aquifers near Wrocław City

In the vicinity of Wrocław City three Major Groundwater Basin (MGB) has been recognized and documented: MGB 319 Środa Śląska, MGB 322 Oleśnica and MGB 320 Wrocław

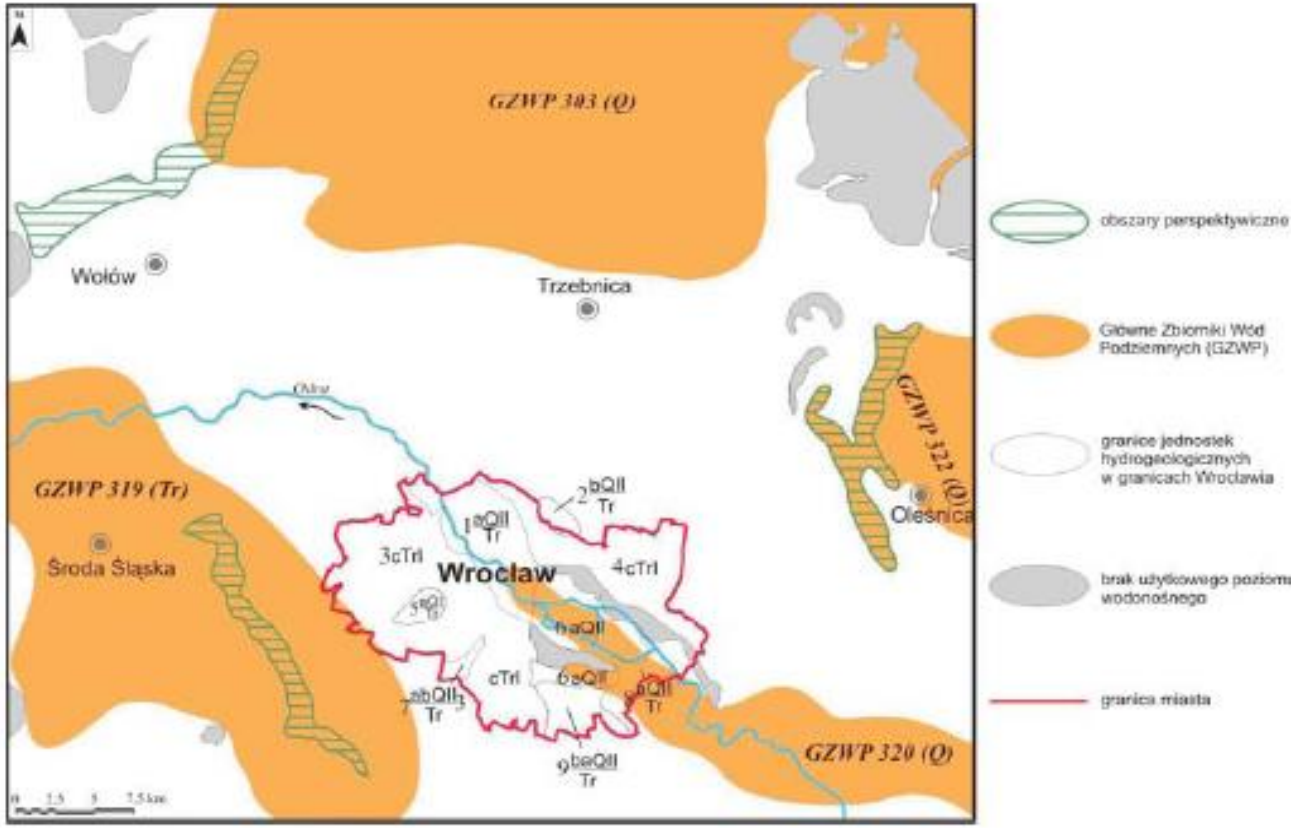
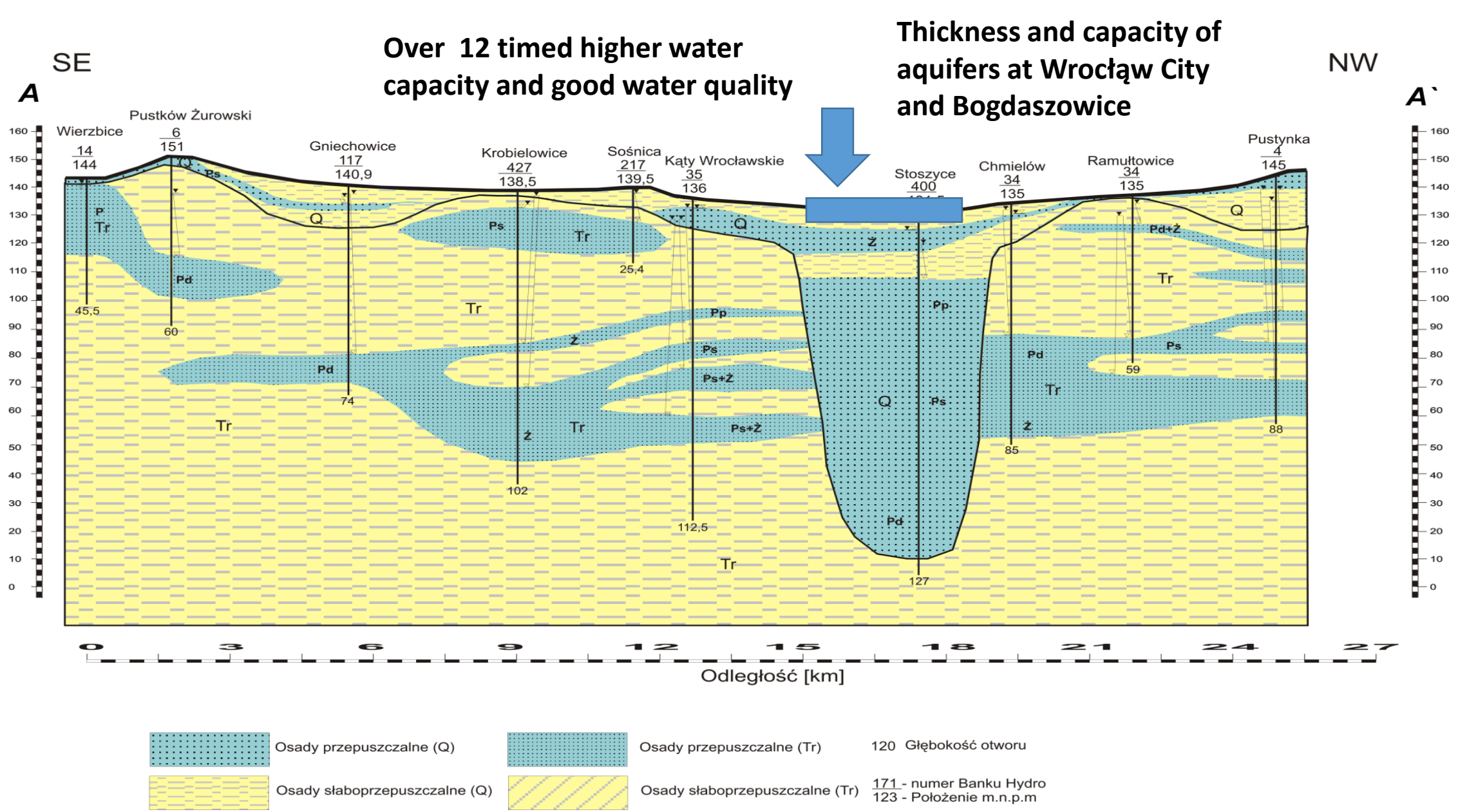


Fig. 5. Mapa warunków hydrogeologicznych w rejonie Wrocławia

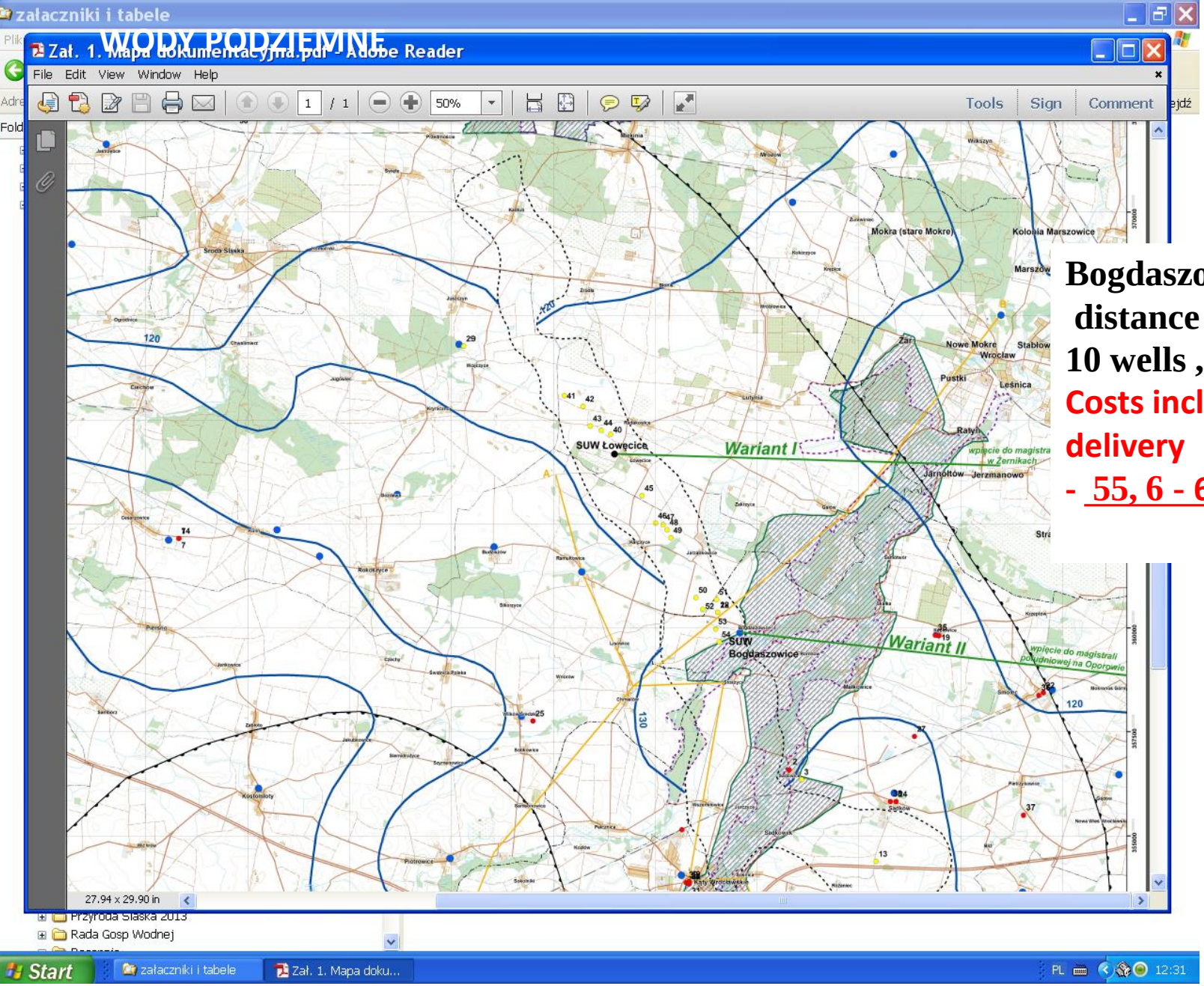
Major Groundwater Basin near Wrocław City

After Sobol i inni 2009, PIG



Hydrogeological cross-section illustrating high groundwater resources and depth to 120 m --Bogdaszowice buried valley

WODY PODZIEMNE



Bogdaszowice groundwater intake - 20 000 m^3/day,
distance from the City – 10 km,
10 wells , water treatnment plant , piplines

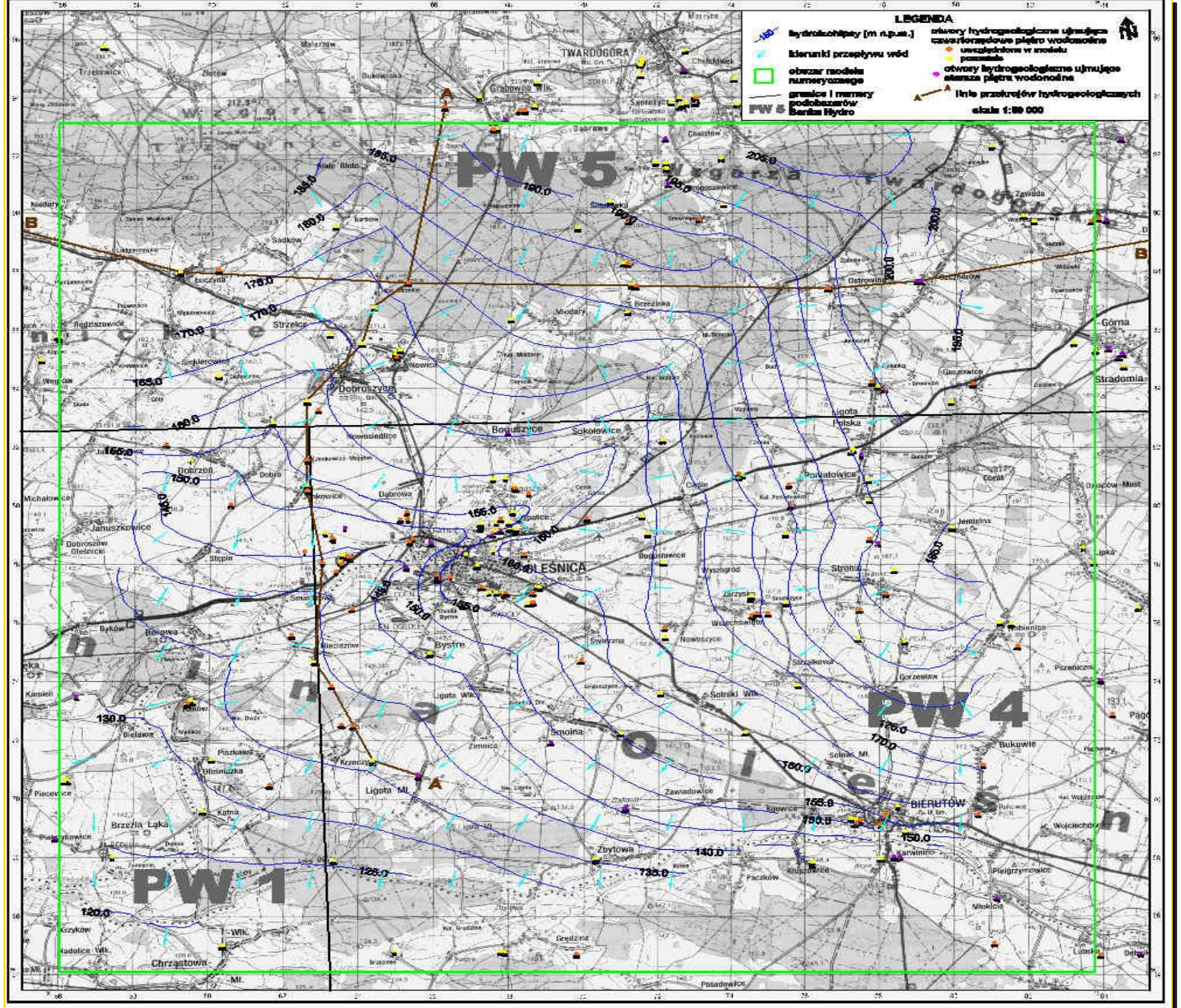
Costs including construction , water treatmnt and delivery

- 55, 6 - 64, 16 mln PLN or 13-15 milions Euro.

Groundwater chemical compsition – Bogdaszowice case study

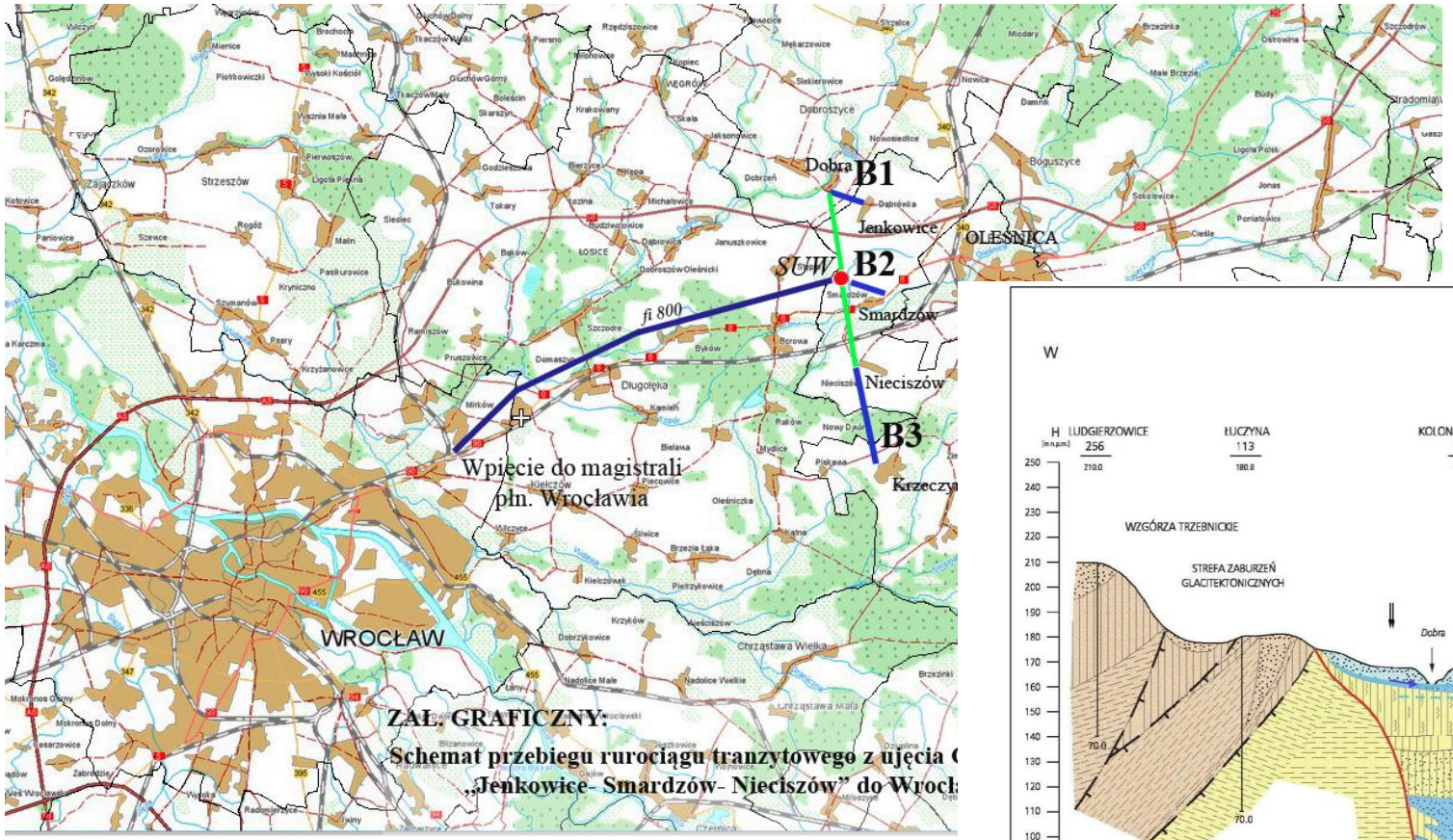
Wskaźnik	Jednostka	N	Średnia	Mediana	Minimum	Maksimum
pH	-	41	7,31	7,30	7,00	8,60
Mineralizacja og.	mg/l	39	437	381	289	800
PEW	µS/cm	26	618	677	288	1245
Mętność	NTU	18	3,2	1,8	0,0	25,0
Barwa	mgPt/l	18	11,1	10,0	3,0	20,0
Og. węgiel org.	mg/l	18	1,47	1,30	0,30	3,20
Temperatura	•C	11	11	11	10	13
Tlen rozp.	mg/l	5	6,02	5,56	2,40	9,96
Twardość og.	$mgCaCO_3/l$	5	266	225	214	422
HCO_3^-	mg/l	38	227,1	222,7	183,0	305,0
SO_4^{2-}	mg/l	38	68,14	39,75	7,04	222,00
Cl^-	mg/l	40	29,83	15,87	3,13	346,00
NO_2^-	mg/l	42	0,019	0,010	0,000	0,226
NO_3^-	mg/l	42	2,313	0,266	0,000	53,700
NH_4^+	mg/l	39	0,165	0,077	0,012	1,290
HPO_4^{3-}	mg/l	37	0,674	0,535	0,030	3,720
F^-	mg/l	34	0,2222	0,2000	0,0000	0,6800
SiO_2	mg/l	3	14,7	15,4	12,7	16,0
Ca^{2+}	mg/l	39	92,54	81,60	39,98	164,00
Mg^{2+}	mg/l	40	11,59	11,78	4,06	23,10
Na^+	mg/l	40	10,13	8,58	5,00	20,70
K^+	mg/l	40	2,29	2,20	0,50	6,94
Fe og.	mg/l	41	1,427	1,400	0,010	3,991
Mn	mg/l	40	0,238	0,181	0,000	0,552
Zn	mg/l	23	0,0981	0,0200	0,0001	0,8700
Cr	mg/l	10	0,0058	0,0045	0,0004	0,0100
Cu	mg/l	25	0,0068	0,0050	0,0005	0,0420
Pb	mg/l	25	0,0100	0,0100	0,0001	0,0500
Sr	mg/l	3	0,1987	0,1075	0,1075	0,3810
Ba	mg/l	14	0,1066	0,1008	0,0500	0,2100
Al	mg/l	22	0,0386	0,0360	0,0009	0,1000

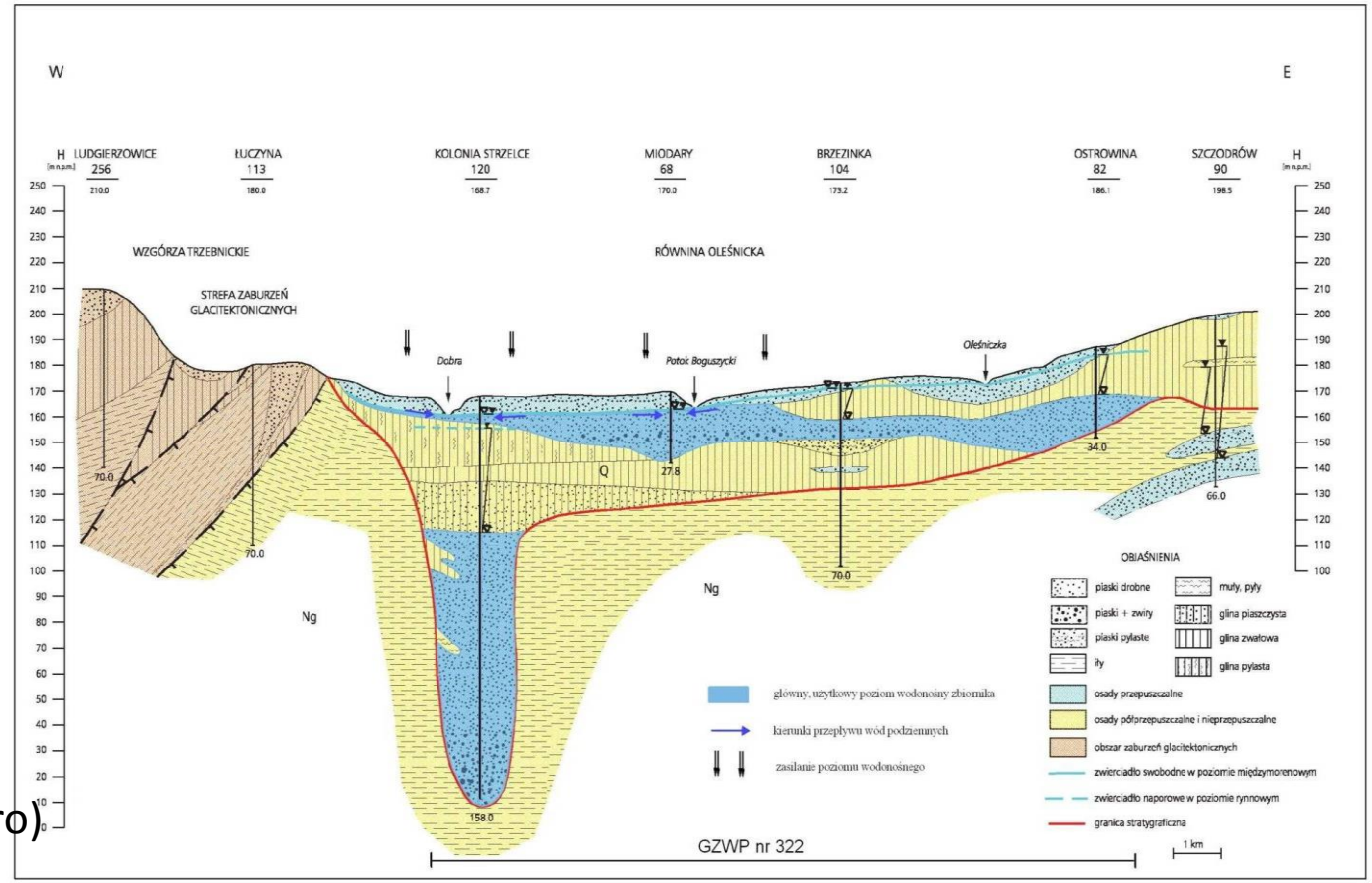
Groundwater modeling results proves high water resources and quality – Oleśnica case study.



TYTUŁ ZADANIA	Analiza aktualnego stanu rozpoznania warunków hydrogeologicznych regionu wrocławskiego oraz wytypowanie zbiorników wód podziemnych i struktur wodonośnych dla alternatywnego zaopatrzenia w wodę miasta Wrocławia
GŁÓWNY WYKONAWCA	Uniwersytet Wrocławski, Instytut Nauk Geologicznych
	Mapa dokumentacyjna struktury wodonośnej rejonu GZWP nr 322 "Oleśnica"

Burried valley Oleśnica – Nieciszów, MGB 322 – distance from the City 12 km





Groundwater resources available -36 000 m^3/d
Cost of water treatment plant and water delivery
to the City -around 146 million PL zł (35 millions Euro)

Why groundwater ?

- Well recognized and available in short distance for the Wrocław City
- High quality and stable chemical composition
- Naturaly protected
- Low vulnerability to pollution from land surface
- Low cost of exploitation and treatment in comparison with surface water

Summary

Existing over 100 years water supply system for the Wrocław City with artificial recharge cover huge area in the city and vicinity.

It base on surface water and infiltration part by ponds and it is expensive and vulnerable to flood and pollution.

Progress in geological survey in late70- and 80 –thies XX century and discovery of high groundwater resources in aquifers near Wrocław City brings new option.

Base on documented groundwater resources of high quality it is recommended to include groundwater as a supplementary source of drinking water.