



CITY OF BERGEN

Welcome to Bergen!





CITY OF BERGEN

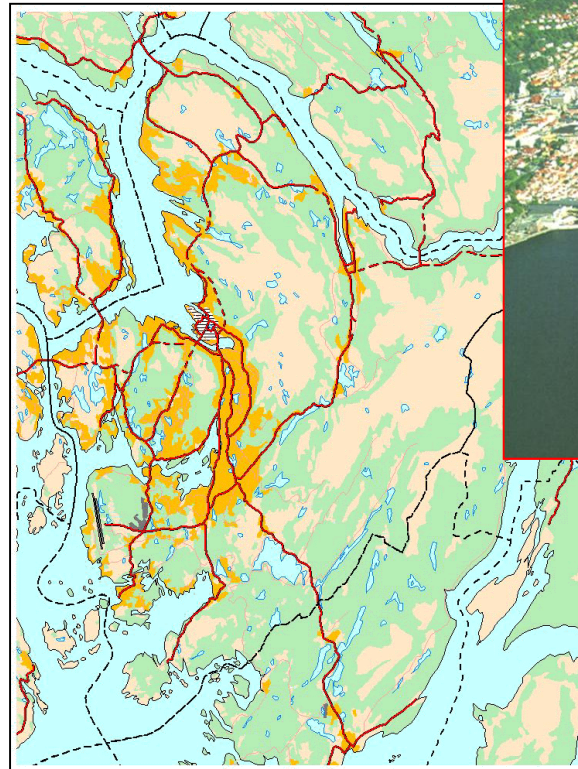
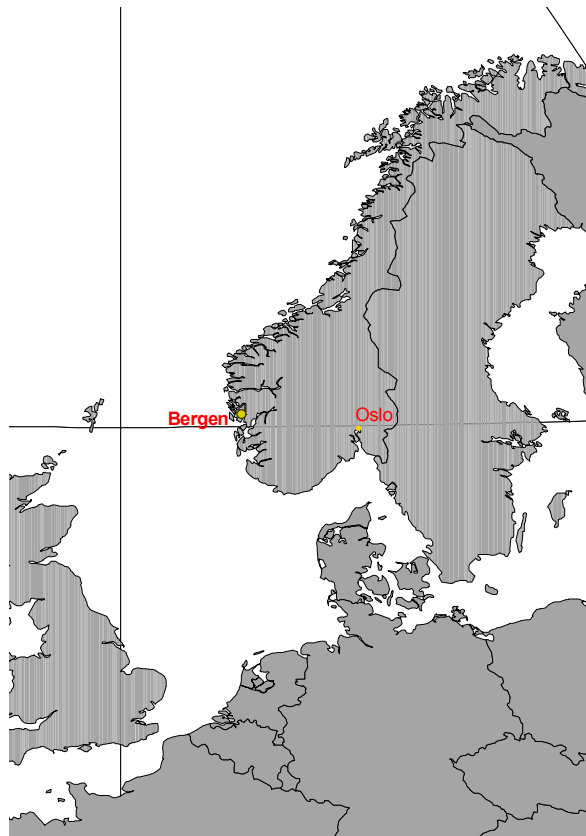
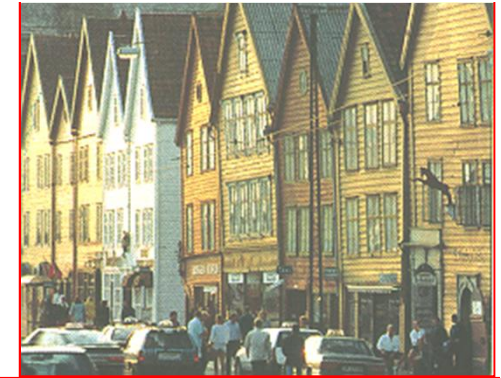
City of Bergen,

founded 1070 a.C.

Area 450 km²

Population 275 000

Yearly precipitation:
2250 mm



Ivar Kalland,
Advisor
Bergen Water &
Sewerage Agency



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Bergen





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This is Bergen... in a sunny day....



Vann- og avløpsetat



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Vågen – the heart of Bergen



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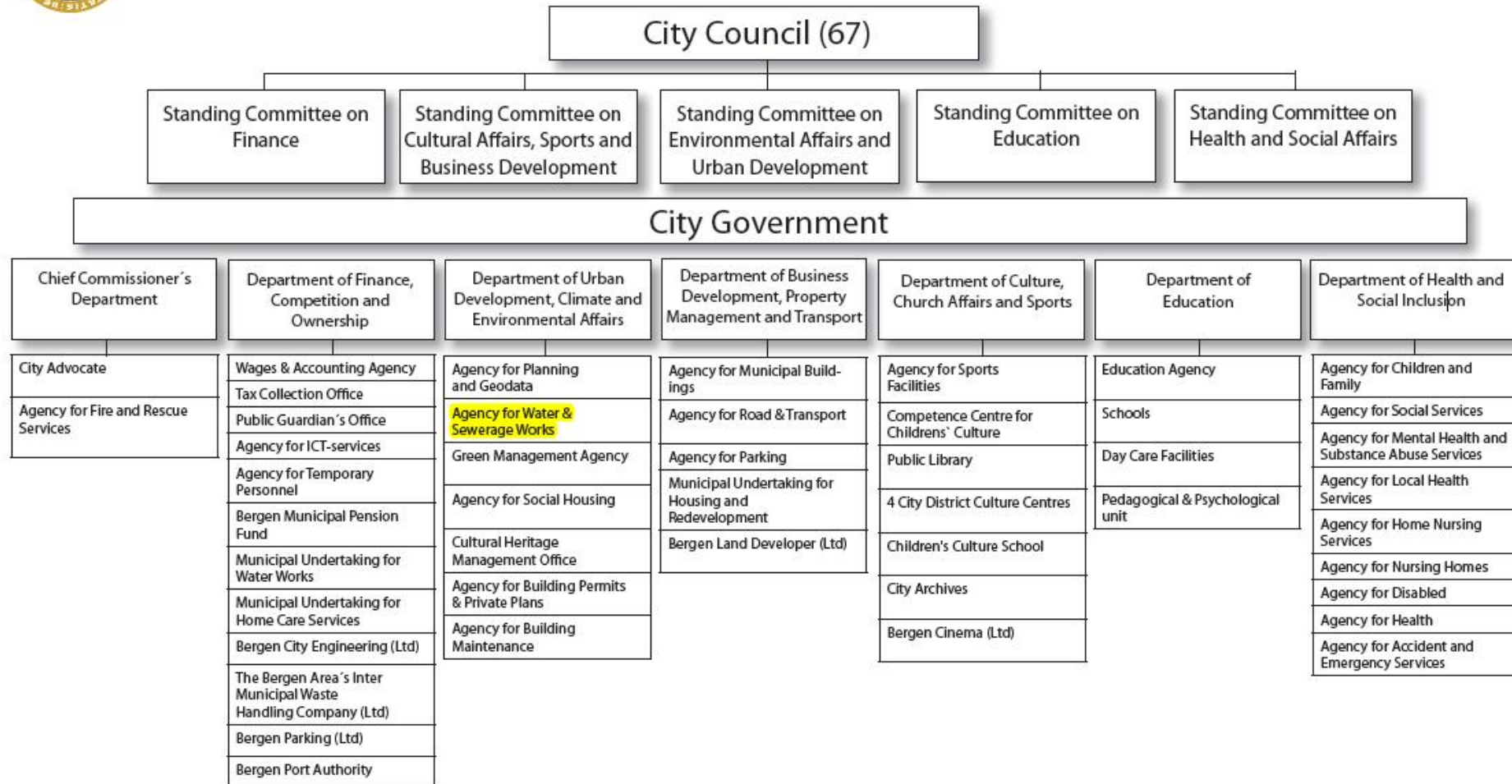


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City of Bergen



Oppdatert august 2011

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Storm water Management in Bergen!

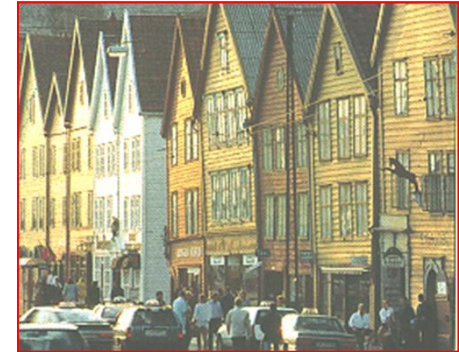




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Bergen

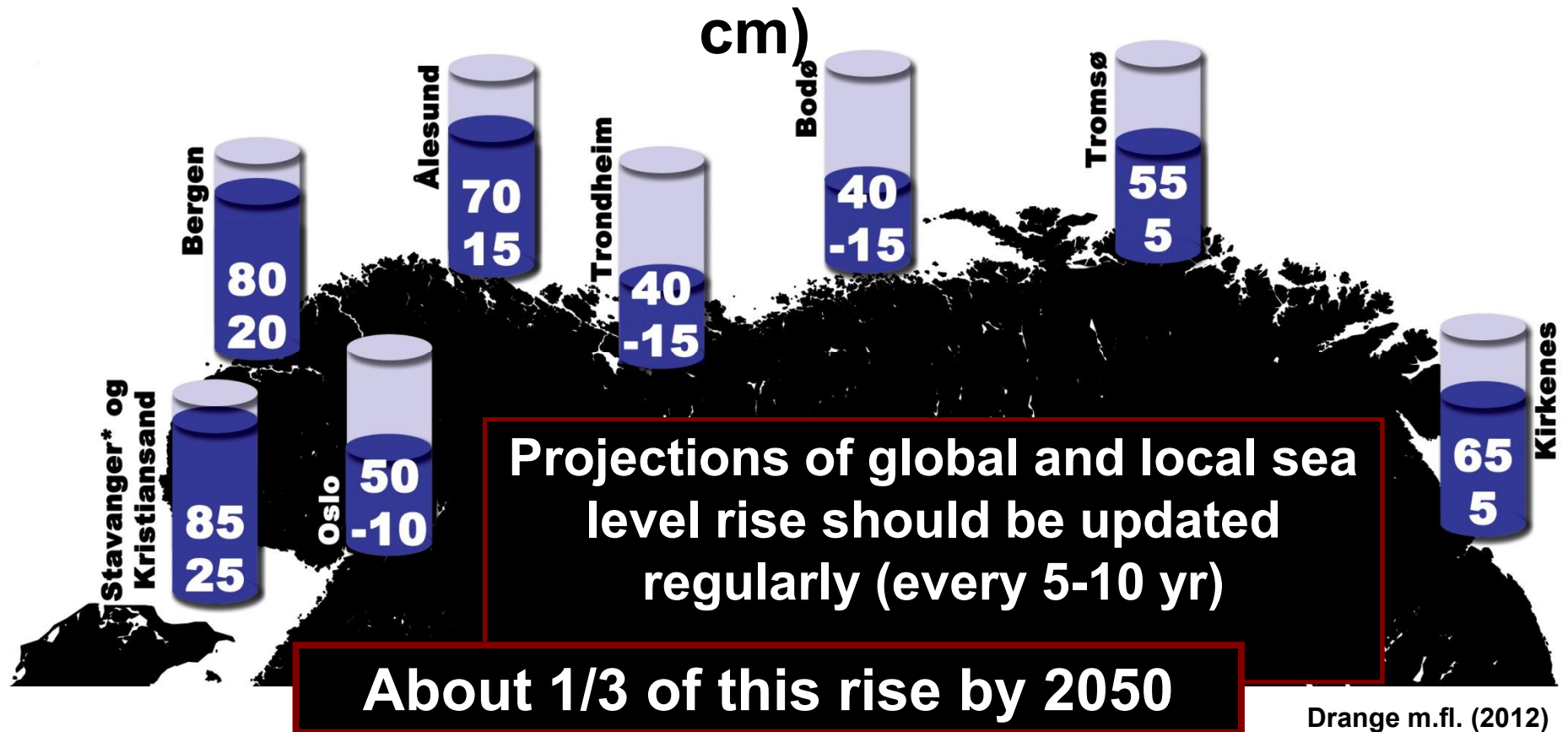
The most rainy city in Europe!

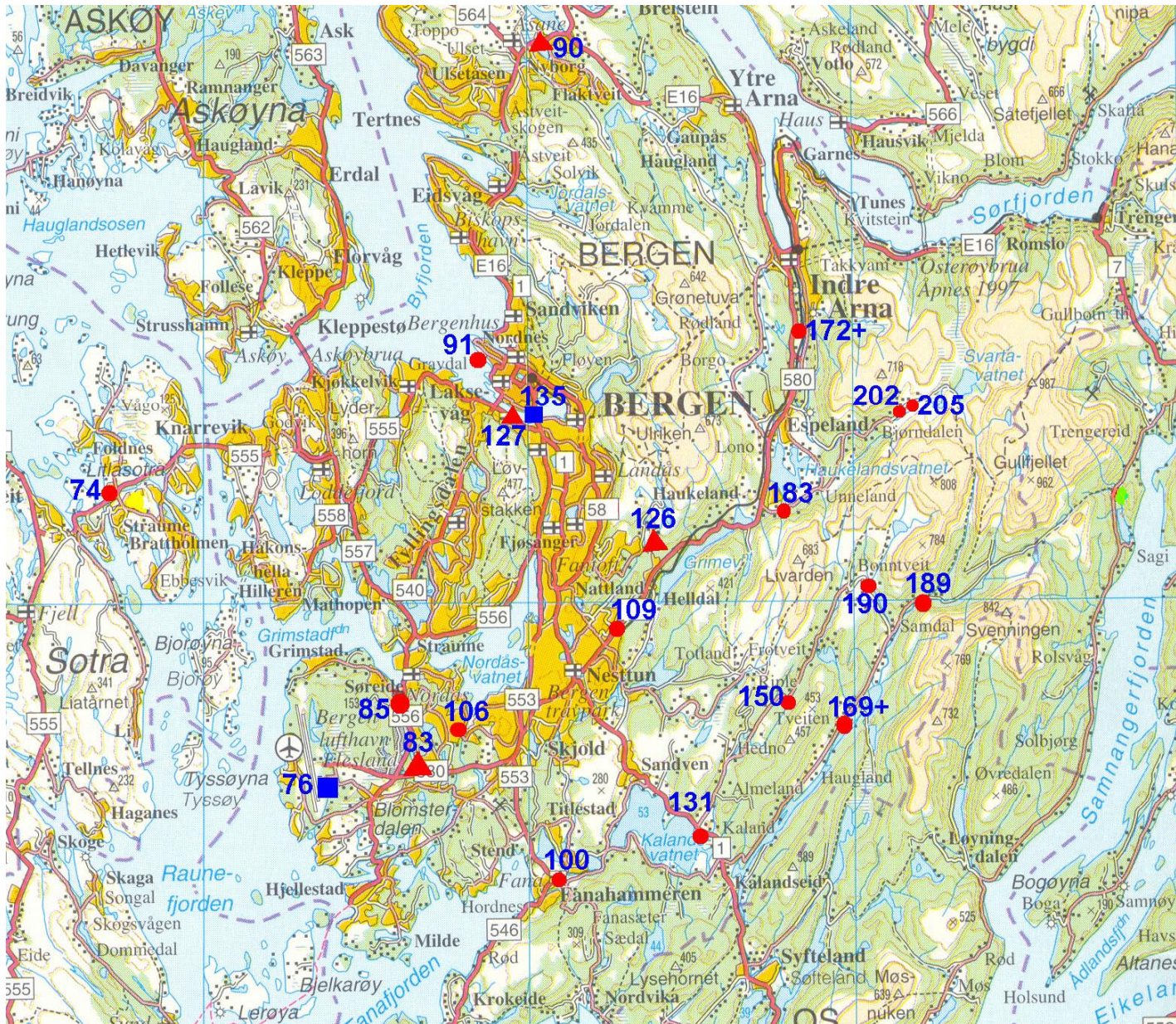


- The City has a long tradition in surface water management.
- The City has managed this rather well so far, but existing water systems are about to reach their limit of capacity, and many systems will have problems in the future due to climate change
 - Increasing amount of precipitation (especially in autumn and winter)
 - Increasing intensity of the rainfall (summer rain)
 - Problems with flooding (Nestun watercourse, Damsgård and more)
- Sea Level will rise
 - Overflow from the sewer systems will increase
 - Bryggen will be flooded more often
- We need to take into account Climate change in planning, operation and maintenance and risk, vulnerability and preparedness planning
 - What we construct today shall be functioning in the coming 100 years

Estimated sea level rise (cm) along the coast of Norway, next 100 years (66% probability)

(corresponding to a global sea level rise of 50-110 cm)





Observerte nedbørmengder i Bergens-området.
Periode: 24 timer, 13. nov kl. 1900 - 14. nov kl. 1900 i 2005.

- Værstasjoner til Meteorologisk instiutt (Bergen-Florida og Flesland).
- Uoffisielle nedbørmålere satt ut av Storm Weather Center (15 stk)
- ▲ 4 automatiske nedbørmålere - Bergen kommune, Vann- og avløpsetaten





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Masterplan for the city of Bergen

- Bergen shall have water and sewage systems that are robust and which can adapt to future population growth and Climate change including sea level rise and more heavy precipitation.

Bergen shall be prepared to handle unexpected incidents.

Adaptation to Climate Change shall be taken into account in the overall city planning

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How Bergen work regarding adaptation to Climate change

- **Storm water management**
 - Requirement for Storm water plan for all area plans at early stage
 - A demand which is specified in the City masterplan (areaplan)

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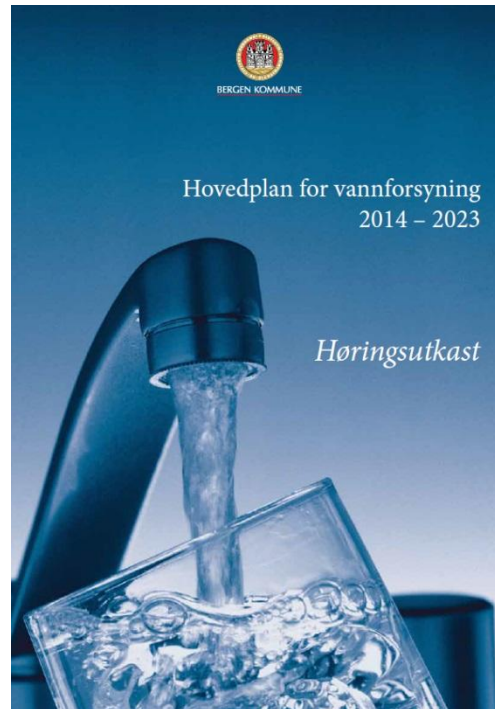


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The city of Bergen

Masterplans for Water Supply and Sewerage Works 2014-2023

www.bergenvann.no



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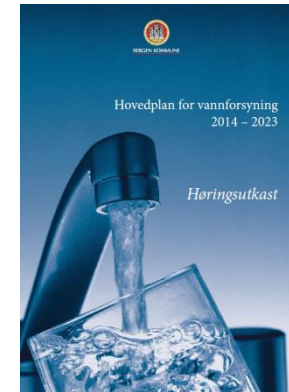


BERGEN KOMMUNE

Water in the Modern City

1. chapter in Bergen Masterplans

- **The Modern City handle its water resources in a good way**
- **The Modern City sets high standards of safety and service**
- **In the Modern City people want to live at the Waterfront**
- **In the Modern City rainwater is given time and space**
- **The Modern City coordinate its development of infrastructure**
 - In the Modern City cooperation and ability to common solutions are the key to success.
- **The Modern City is robust in aspects of unexpected occurrences and climate change.**





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Our vision-
Clean water
to the People
and the Fjords

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The Agency is certified according to NS-EN ISO 9001:2008 and NS-EN ISO 14001:2004.

Management System Certificate

To certify conformity with // Godkjent overensstemmelse med the Management System Requirements of // Styringsystemkravene i henhold til


NS-EN ISO 9001:2008



BERGEN KOMMUNE

Manufacturing/supplying following products/services: for produksjon/leveranse av følgende produkter/tjenester:

Ansvar for byens vannforsyning og avløpshåndtering





Vann- og avløpsetaten
Fjesangerveien 68, 5068 Bergen

Certificate No // Sertifikat nr.: **777**

First issued // Utstedt første gang: 2009-06-02
Valid until // Gyldig til: 2012-06-02
Issued // Utstedt: 2009-06-03
Audit: Annual // Oppfølging: Årlig

Arne Sjøelstad
Managing Director // Daglig leder


Siri Mathiesen
Lead Auditor // Revisjonsleder

Management System Certificate

To certify conformity with // Godkjent overensstemmelse med the Management System Requirements of // Styringsystemkravene i henhold til


NS-EN ISO 14001:2004



BERGEN KOMMUNE

Manufacturing/supplying following products/services: for produksjon/leveranse av følgende produkter/tjenester:

Ansvar for byens vannforsyning og avløpshåndtering





Vann- og avløpsetaten
Fjesangerveien 68, 5068 Bergen

Certificate No // Sertifikat nr.: **990**

First issued // Utstedt første gang: 2011-04-08
Valid until // Gyldig til: 2014-04-08
Issued // Utstedt: 2011-04-08
Audit: Annual // Oppfølging: Årlig

Arne Sjøelstad
Managing Director // Daglig leder

Andreas Nordoy
Lead Auditor // Revisjonsleder

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Adaptation to Climate Change



- **Climate change**
 - We have to take climate change into account in practical planning and design
 - Influences both water supply and drainage
 - Water in the city - robust drainage systems - floodways
 - Sustainable Urban Drainage Systems (SUDS)
 - The blue-green concept
 - Safe handling of storm water and flooding situations
 - Risk management and flood plans
 - Better systems for financing storm water systems (SUDS) is needed

Adaptation to Climate change – water in focus.



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Vann- og avløpsetaten • Fjøsangerveien 68 • Pb. 7700 • 5020 Bergen • www.bergenvann.no

Examples on different flooding



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15.11.2013 -
A «50-year-rainfall»
(duration 3-4 hours)

NOT WANTED SITUATIONS!



Flooding - Odda 29.10.14, BT



FØR FLOMMEN: På dette bildet kan man tydelig se tre av husene som ble tatt av flommen. Det fjerde huset (Hjello 6, som kan skimtes i nedre del av bildet) er det samme huset som er borte på bildet øverst. FOTO: TERJE LÆGREID / GRAFIKK: ERLEND LANGELAND HAUGEN



ETTER FLOMMEN: Der elven var på sitt smaleste har den gravd seg bred. I den prosessen forsvant fire hus og store mengder jordmasser. FOTO: RUNE SÆVIG / GRAFIKK: HEIDI GROTTLE



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Guidelines for Surface Water Management in the city of Bergen



[http\\www.bergenvann.no](http://www.bergenvann.no)

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The Interreg IVB
North Sea Region
Programme

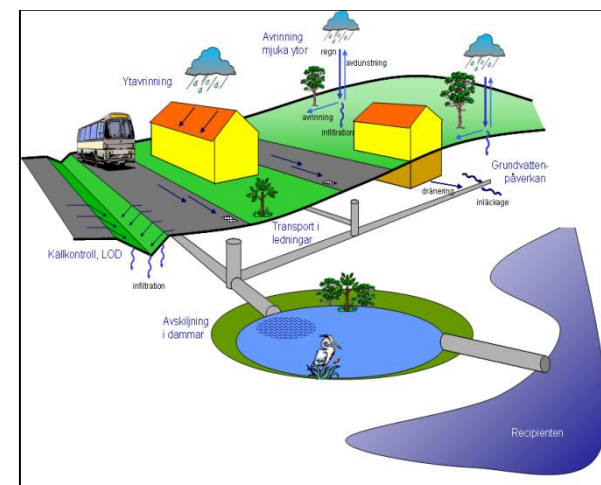


Dealing with water planning and Urban planning

- Water in the City
 - *Water planners, urban planners and gardeners should talk more together.*
 - *Green-Blue Network for urban planners, landscape architects, gardeners and water engineers is established in March 2011*
 - *Storm water should be considered a positive element and make the city more beautiful.*
 - *Clean Storm water is a valued resource and should be used as a positive element in urban planning.*



Sustainable management of surface water.



- Safety of citizens (life, health, economy)
- Avoid flooding and ensure that flood water is diverted into designated areas (temporary flood routes) away from buildings so they cause minimal damage.
- Ensure that flood risk areas are not developed
- Ensure the best possible water quality for surface water
- Reduce the overflow from the waste water system.
- Protect the vegetation areas within urban areas
- Make good use of the existing waterways in the design of new urban areas. Avoid replacing streams with pipes.
- Good planning can avoid disasters

Managing **adaptive** responses

to changing **flood risk**



programme	Interreg IVB Northsea
duration	2009 - 2012
project partners	15
budget	5.2 M EUR
EC-contribution	2.5 M EUR
coordinator	City of Dordrecht

Consortium

- City of Dordrecht
- Waterboard Hollandse Delta
- Rijkswaterstaat
- Provincie Zuid-Holland
- UNESCO-IHE
- Ministry V & W
- Dura Vermeer

- Sheffield City Council
- University of Sheffield, PWG
- Rotherham City Council

- City of Hannover
- Leibniz University of Hannover
- Hannover Region
- TU Hamburg-Harburg

- City of Bergen
- Bergen Region

Goals of the project

Enable widespread implementation of local adaptive

Approach

1 Stimulate cooperation: Intensive, multi-disciplinary cooperation between all levels of the

Results

1 Flood risk management plans at city-wide level and

- » Duration: 2009 – 2012
- » 15 partners
 - 5 city partners
 - 4 regional or national public partners
 - 5 research institutes
 - 1 private partner
- » Total budget: 5,2 M Euro



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Bergen Learning and Action Alliance and cooperating organisations

- **City of Bergen**

- Agency for Planning and Geodata - Bergen City
- Agency for Landscape Design and Agriculture – Bergen City
- Agency for Water and Sewerage works

- **Bjerknes Centre for Climate Research – University of Bergen**

- **Governor's office of Hordaland region (County Governor)**

- **Hordaland County Council**

- **Association of Municipalities Bergen Region**

- **Regional Climate Panel**

- **The Norwegian Water Resources and Energy Directorate (NVE)**

- **Department of Justice and Police**

- **Directorate for Civil Protection and Emergency Planning**

- **Cities of the future – national project on how to meet climate change**

- **NORADAPT – project concerning climate change and social effects**

- **Nansen Centre (Project on Sea level rise)**

- **Friends of the Nesttun Water Course**

- **Stakeholders**

MAR

<http://www.mare-portal.eu>

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The Interreg IVB
North Sea Region
Programme





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Regional Climate Panel

- Decided that the panel will be extended with mayors from the rest of the county
- Establishing a regional climate network with professionals from the municipalities – lead by the county





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Other activities linked to MARE

Cities of the Future – national program initiated by Ministry of Environment

How to organize planning to avoid future problems caused by climate change

Knowledge development – Flood Risk Management Plans

Cooperation with other national and international projects

Noradapt – what will be the impact of climate change in the communities and how to prepare adaptive responses

BaltCICA, SKINT

Project on Rising Sea Level (Bjerknes and Nansen Centre – UiB)

MARE

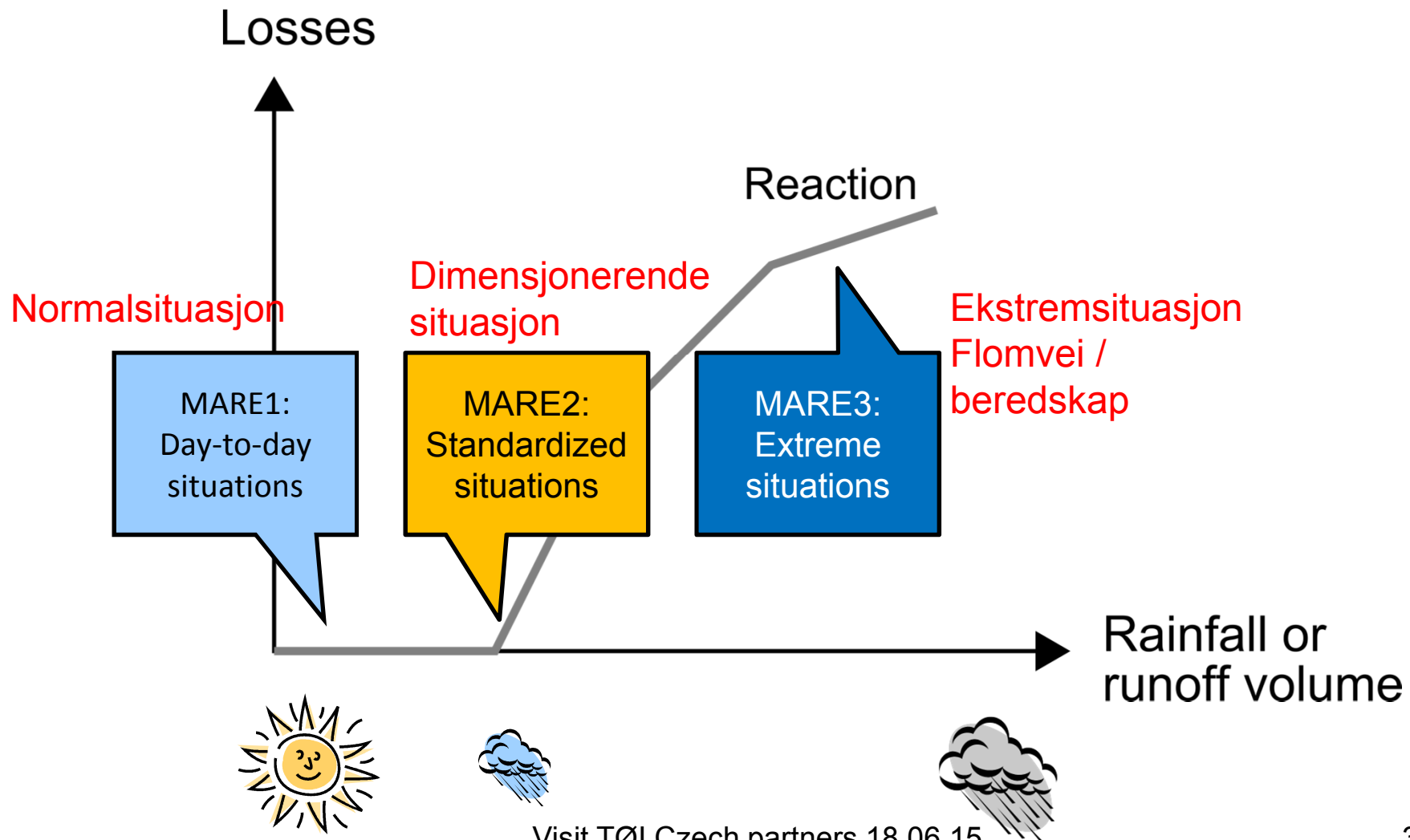
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MARE - Climate Proofing Toolbox



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Hannover – Kronsberg area



MARK

visit for Czech partners 16.06.15
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Programme





BERGEN KOMMUNE

Dordrecht okt.-10



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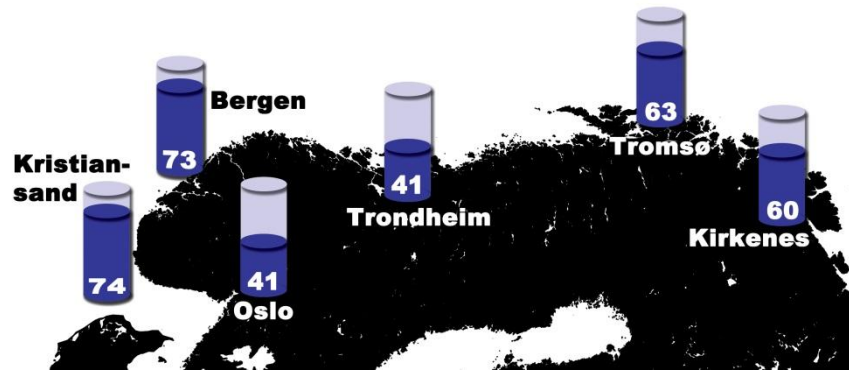


Vastra Hamnen Malmö - Sweden



Bergen

Climate Proofing Toolbox



Sea Level rise 2000 - 2100





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Guidelines for operation of Nesttun Watercourse

Rutine for overvåking av Nesttunvassdraget.

Ansvar for å følge med langtidsvarsel nedbør: **VA-etaten**
 Ansvar for rensk og beredskap: **VA + Samferdsel.**
 Ansvar for kommunens totale beredskap: **Etat for samfunnssikkerhet og beredskap**

Fra	Varsel Døgnnedbør	Ansvar	Kontaktes	Mål
DNMI	50 - 70 mm	VA Vaktentral	Ingeniørvakt Hopsfossen	Varsle / Forberede Rengjøre overvannssystem Åpne sluser Myrdalsvatnet
	70 - 100 mm	Ingeniørvakt	Adm. byvakt Hopsfossen Nesttun sentrum	Høyne beredskap Åpne sluser Hop
	100 – 130 mm	Adm Byvakt	Brannvesen Brannvesen + sivilforsvar	Overvåkning Flompakke klargjøres
	Mer enn 130 mm	Adm byvakt Vakhavende byråd	Krisestab	Forsterke innsats
	Mer enn 150 mm	Adm byvakt	Kriseledelse	Varsle publikum - media



Utarbeidet av: VA-etaten og Etat for samfunnssikkerhet og beredskap

Godkjent av: MS/MM

Dato: 12.10.07

Sist revidert:

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Calculation of surface water quantities

- Maximum flow from an area is to be calculated
 - Catchment area and Run-off factor
 - Which rain-duration gives maximum flow (concentration time)
 - Knowledge of rain statistics
 - Recurrence interval
- We can not know today exactly how rainfall will change or will be in the future.
- Intensity Duration Frequency curves needs to be adjusted – West Precip.

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The Interreg IVB
North Sea Region
Programme





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Level of safety in water handling.

- Nesttun Water Course – flood tunnel
- Bryggen – how to deal with sea level rise
 - It is proposed to set a limit of minimum 2,5 m above sea level for constructions which are sensitive to water
- Acceptable targets or limits are normally to be considered specially for each case
 - risk and vulnerability analysis.
- Different measures have already partly been done and some increase of flood impacts are already assessed

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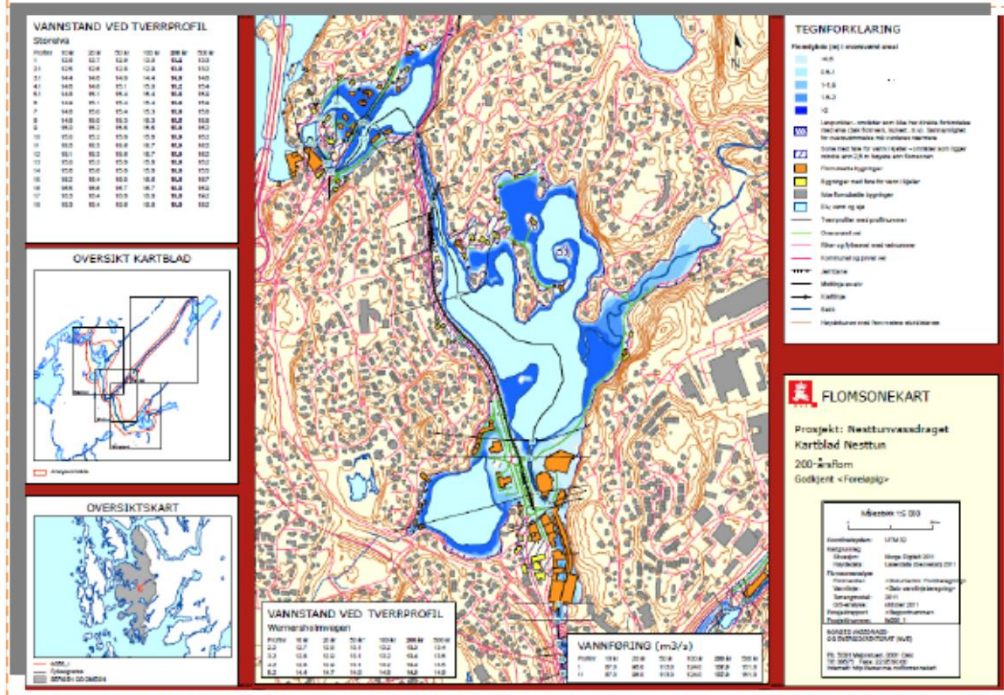
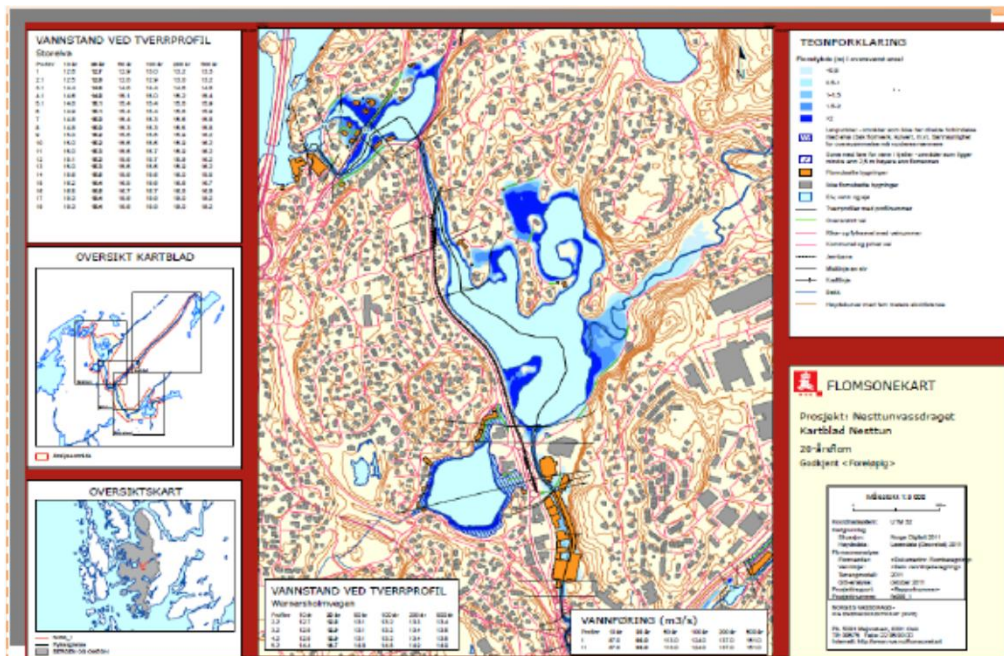


Calculated flood zones Nesttun

Flood zone maps Nesttun

20 years flooding

200 years flooding





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Climate Adaptation Mainstreaming through Innovation

Transformation project Damsgårdsundet

- How to secure good water quality in the Puddefjord
- Needed action to manage storm water and meet climate change

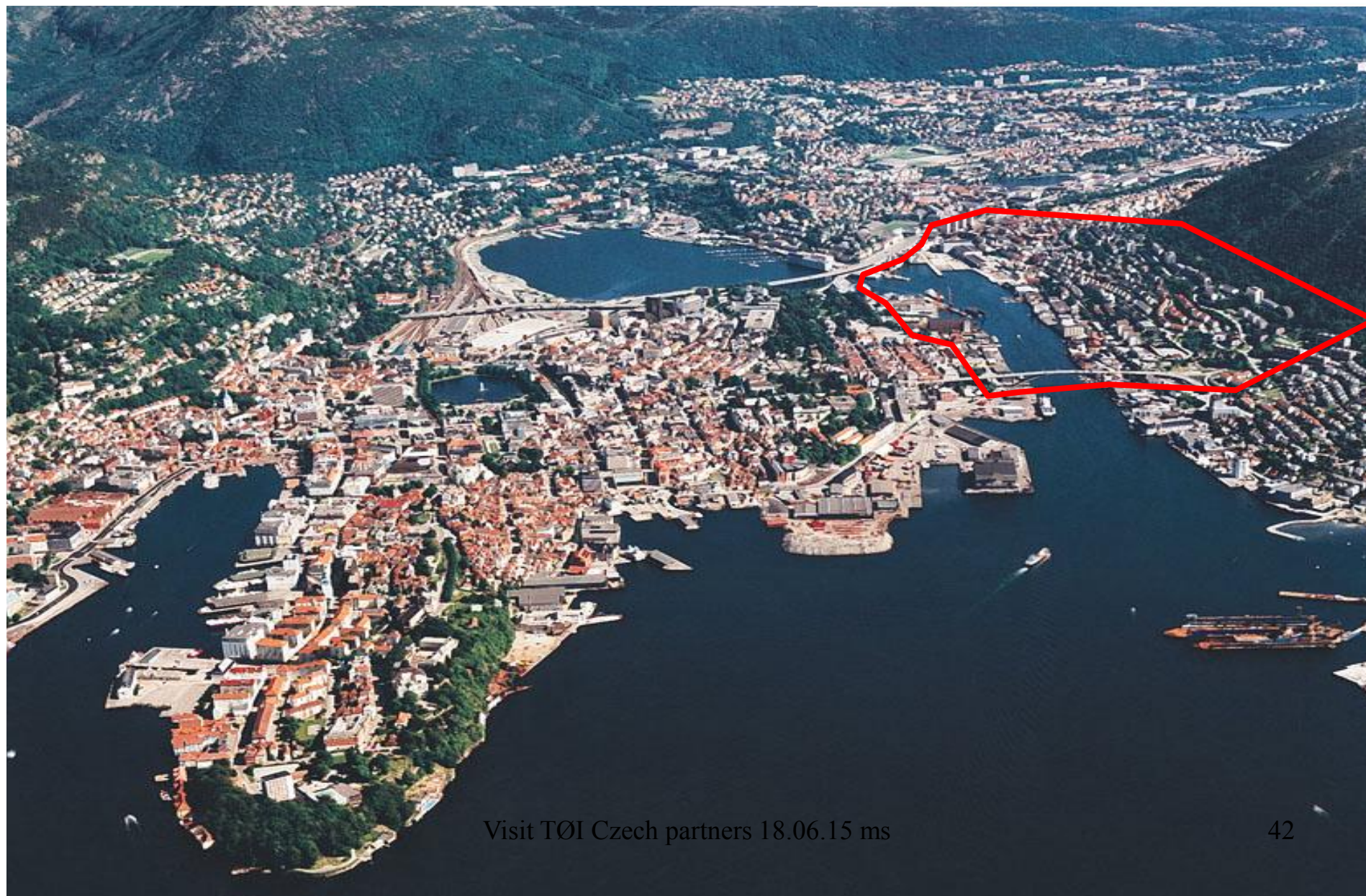


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North Sea Region
Programme

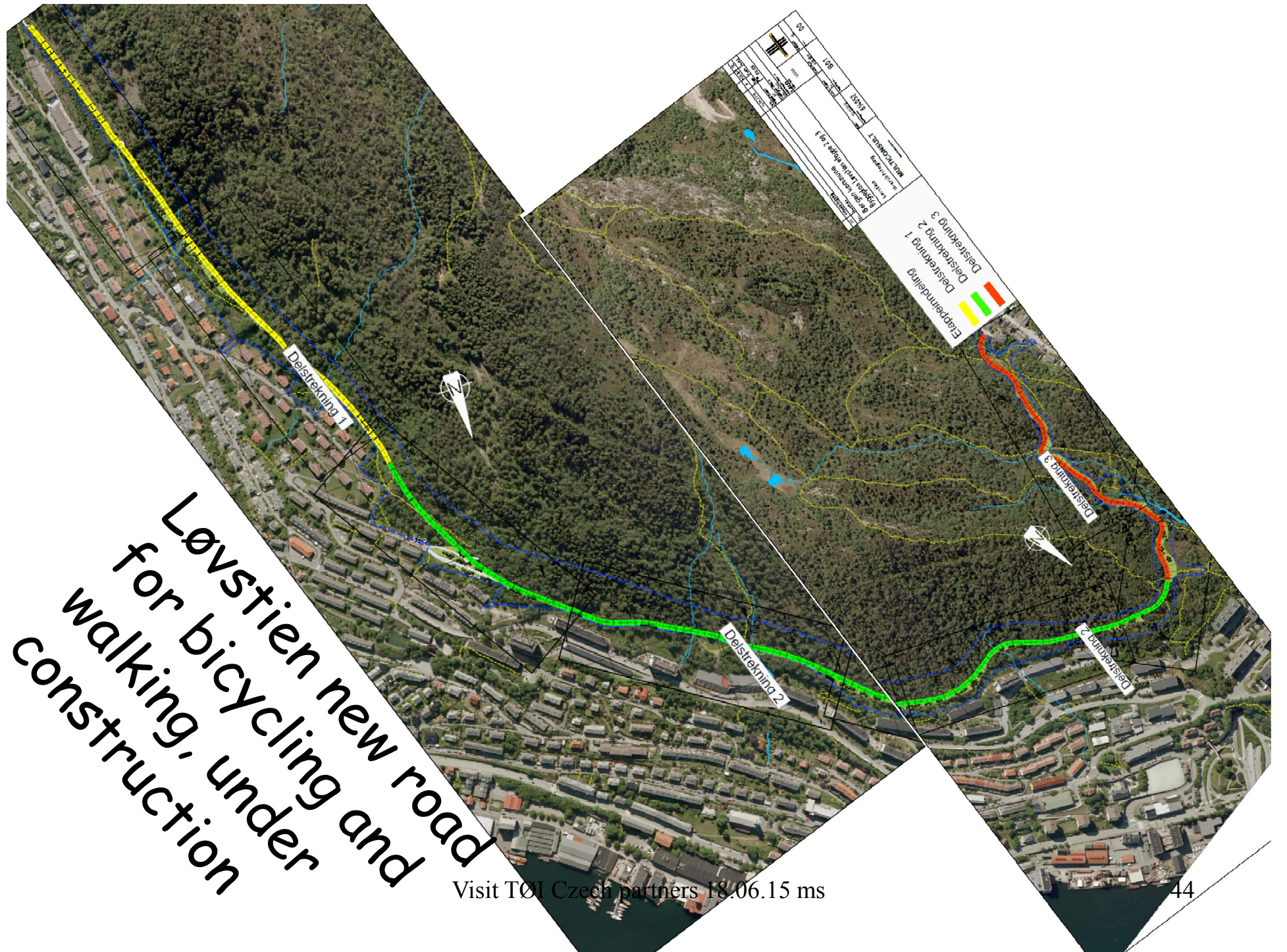


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New housing areas at the west side

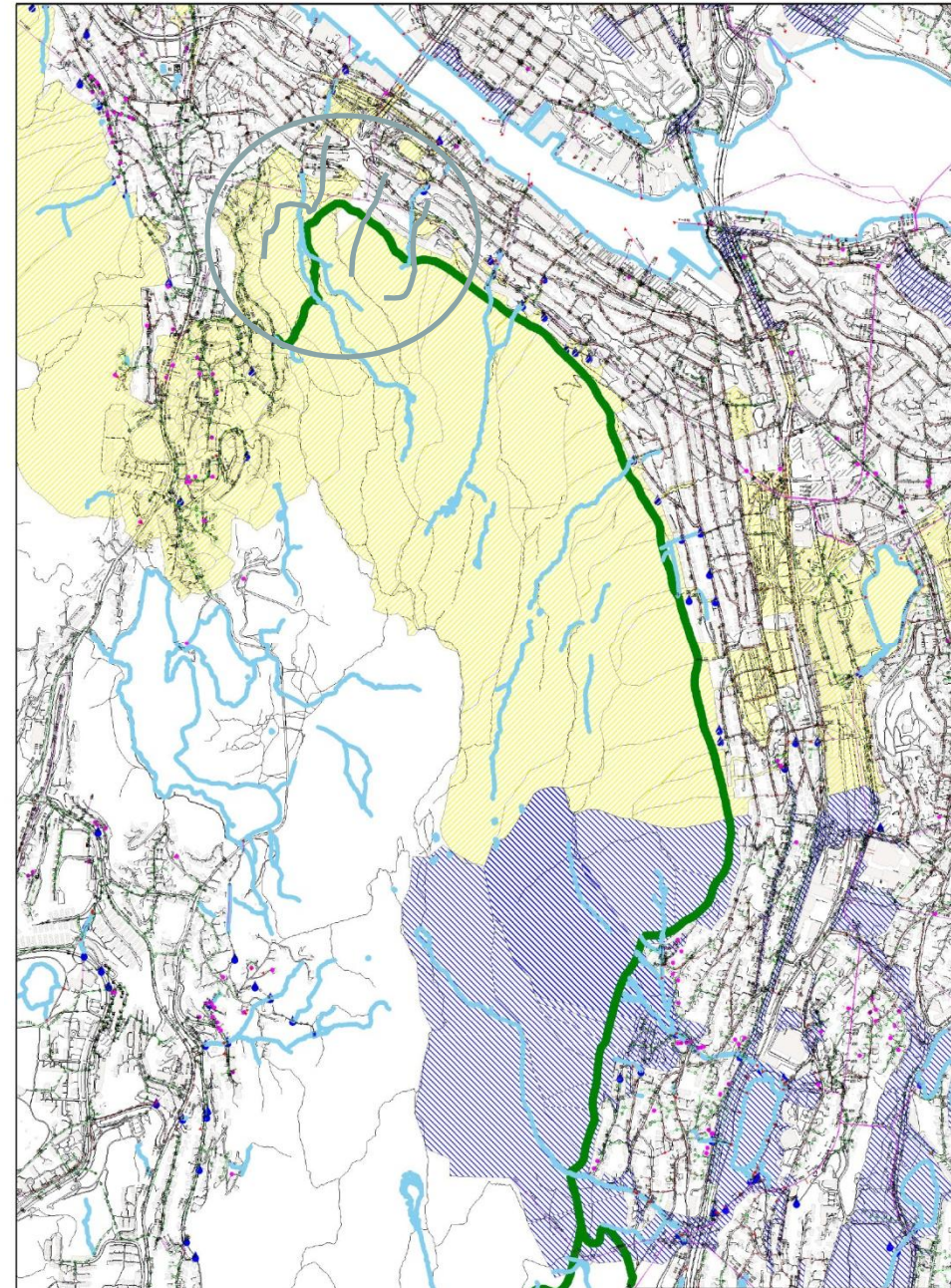


Løvstien new road
for bicycling and
walking, under
construction

We have to construct a new storm water system and separate the storm water from the sewage water.

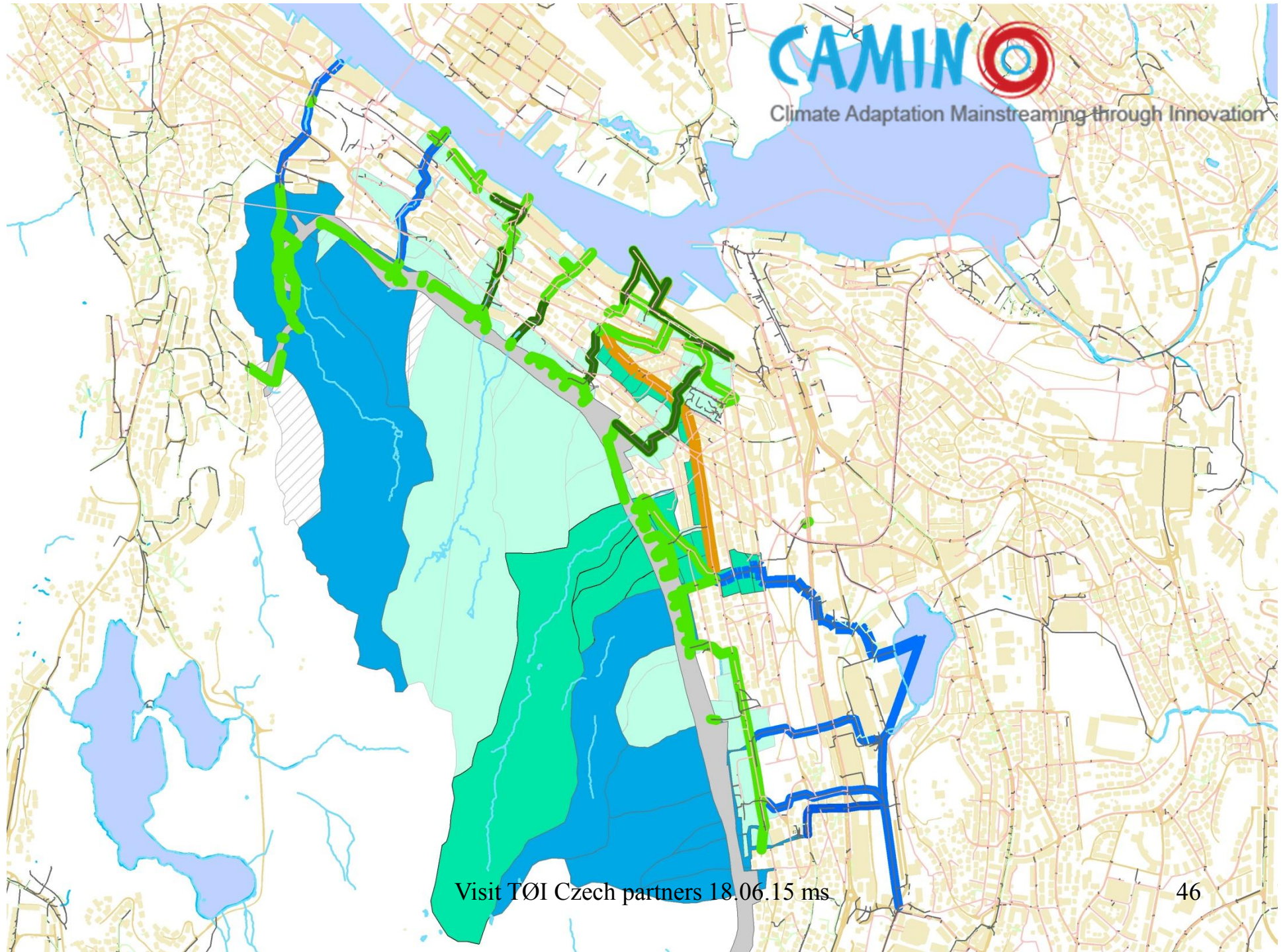
We have to design and build new flooding routes for the storm water.

Escape routes for the really heavy rain situations





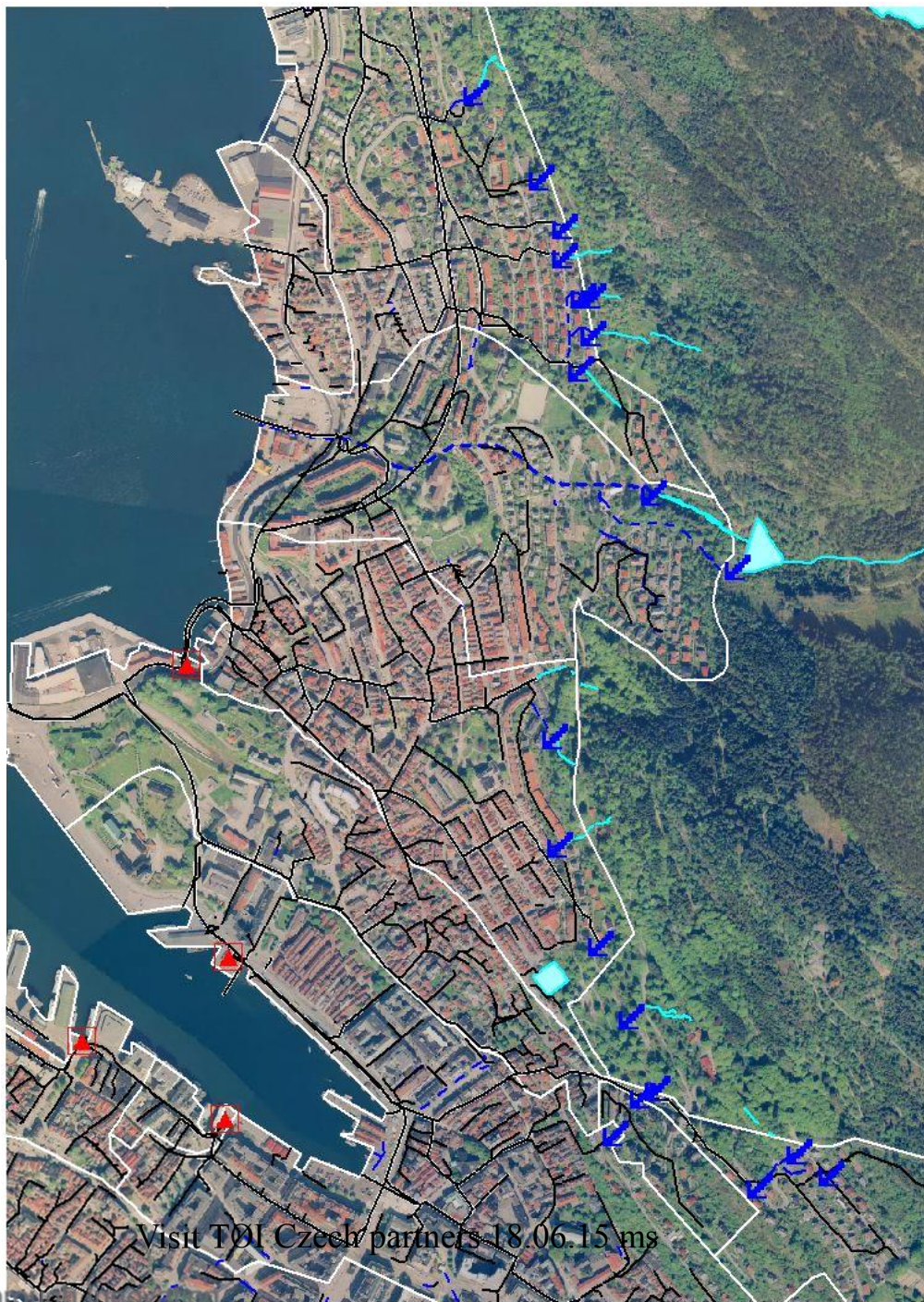
Climate Adaptation Mainstreaming through Innovation



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Bergen- Sandviken area

Separating
surface water
and sewage in
Sandviken



Climate Adaptation Mainstreaming the Us...

Reopening of a small river i Bergen – Laksevåg – opened 23.10.14

BYEN



NYE DÅSE Lange allveier under opparbeidning av den gamle, 300 meter lange, som er nå er bygget opp. I tillegg har fyll som vil bli bygget på grunn. Etter påfølgende 10 år vil det bli et utvidet avløpsnett og utløpskanal til å reise vannet. (Foto: Sverre Holm)



BYDELSPARK Den gamle allveier og utløpskanal, som er nå er bygget opp, vil bli bygget opp. Etter påfølgende 10 år vil det bli et utvidet avløpsnett og utløpskanal til å reise vannet. (Foto: Sverre Holm)



NYE DÅSE En liten oase i byen. Den gamle allveier og utløpskanal, som er nå er bygget opp, vil bli bygget opp. Etter påfølgende 10 år vil det bli et utvidet avløpsnett og utløpskanal til å reise vannet. (Foto: Sverre Holm)



NYE DÅSE Fylt for å avløse, bygging av utløpskanal. Den gamle allveier og utløpskanal, som er nå er bygget opp, vil bli bygget opp. Etter påfølgende 10 år vil det bli et utvidet avløpsnett og utløpskanal til å reise vannet. (Foto: Sverre Holm)



BYDELSPARK # Håstelnsparken begynner å ta form. I dag åpner den første av parkens tre byggetrinn.

En liten oase på Laksevåg

Bydelsparken # Håstelnsparken begynner å ta form. I dag åpner den første av parkens tre byggetrinn. Den gamle allveier og utløpskanal, som er nå er bygget opp, vil bli bygget opp. Etter påfølgende 10 år vil det bli et utvidet avløpsnett og utløpskanal til å reise vannet. (Foto: Sverre Holm)

BYDELSPARK Den gamle allveier og utløpskanal, som er nå er bygget opp, vil bli bygget opp. Etter påfølgende 10 år vil det bli et utvidet avløpsnett og utløpskanal til å reise vannet. (Foto: Sverre Holm)

BYDELSPARK Den gamle allveier og utløpskanal, som er nå er bygget opp, vil bli bygget opp. Etter påfølgende 10 år vil det bli et utvidet avløpsnett og utløpskanal til å reise vannet. (Foto: Sverre Holm)

BYDELSPARK Den gamle allveier og utløpskanal, som er nå er bygget opp, vil bli bygget opp. Etter påfølgende 10 år vil det bli et utvidet avløpsnett og utløpskanal til å reise vannet. (Foto: Sverre Holm)



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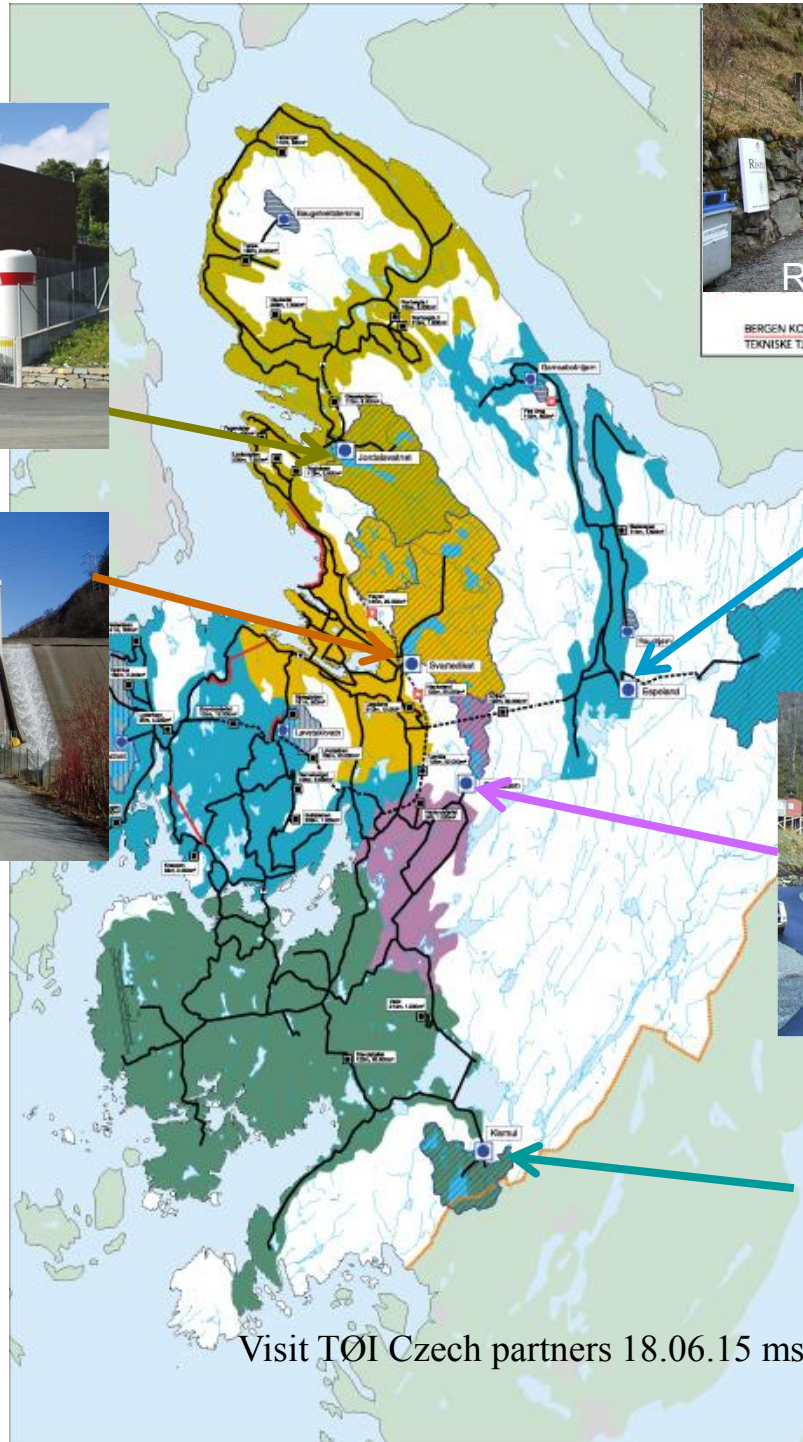
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Jordalsvatnet vba



Svartediket vba



Risnæs vba

BERGEN KOMMUNE
TEKNISKE TJENESTER



Gullfjellet vba



Sædalen vba



Kismul vba

Bergen water treatment plants



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Water Supply

- Bergen has a robust and well designed system
 - Long term planning through the last 25 years
 - Continuous supply of safe and good quality water
 - Safety and contingency
- The distribution system is the main challenge
 - Renewal of pipelines
 - Reduction of leakage (both on public and private pipelines)
- We need to increase reservoir capacity and safeguard catchment areas
- Energy optimization
 - Reduce use of energy
 - Hydroelectric power from the water work

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Risk and Vulnerability Analysis

- Increased focus on safety and preparedness from the water source to the tap. (ROS-analyser)
 - Catchment area (restrictions, supervision etc.)
 - Water treatment
 - Coordination of supply from treatment plants
 - Pipeline renewal
 - Good and well documented procedures for operation and control
- Quality Management, ISO-9001 certification

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Pipe burst on the oldest water main in use - from 1865



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Thank you for your attention!



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Budgets for the Water sector in Bergen

- Total turnover 2014:
 - **729 mill NOK = 91 mill euro**
-
- Investments and renewal of water and wastewater mains

	– Yearly investments	Renewal of pipes
– 2011	182 mill kr	100 mill kr
– 2012	463 mill kr 55 mill euro	120 mill kr 12 mill euro
– 2013	503 mill kr 60 mill euro	189 mill kr 14,5 mill euro
– 2014	767 mill kr 92 mill euro	186 mill kr 22,5 mill euro

- Water and waste water taxes (2014)_{(120 m² flat):} NOK: 5169,-

- **622 euro**

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Water price 2013

Lowest: 3.110 kr/år

Average: 7.263 kr/år

Highest: 16.471kr/år

Norwegian Benchmarking
«Bedre VA»

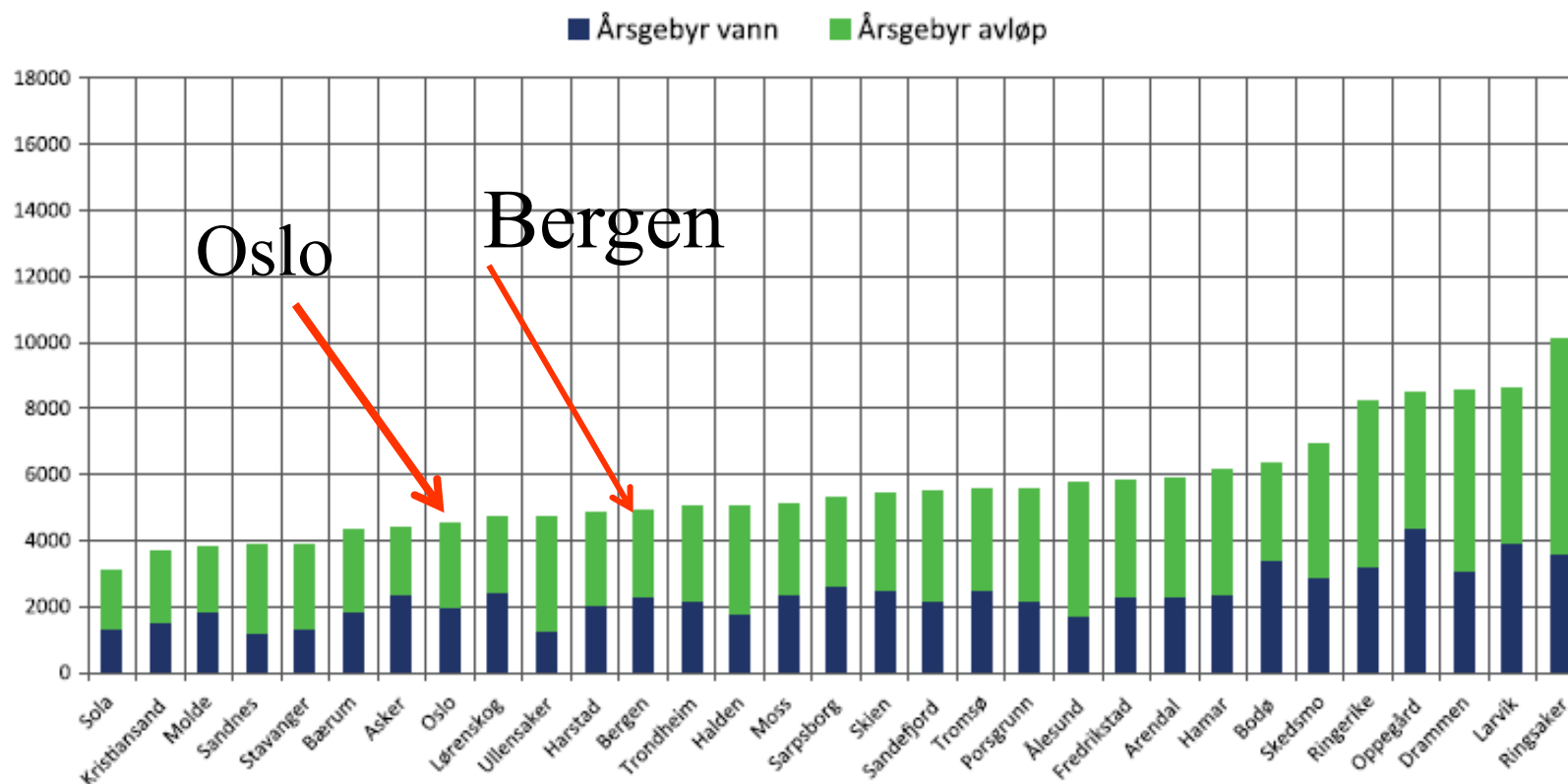
Tilstandsvurdering av kommunale
vann- og avløpstjenester

Prisen til abonnentene

Årsgebyr for vann og avløp for en standard bolig i 2013 - kr/år inkl. mva

for kommuner der > 20 000 innbyggere er tilknyttet tjenesten

Kommunenes gebyrsatser for 2013 er korrigert iht. selvkostdekning og inkl.





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WATER SUPPLY IN BERGEN

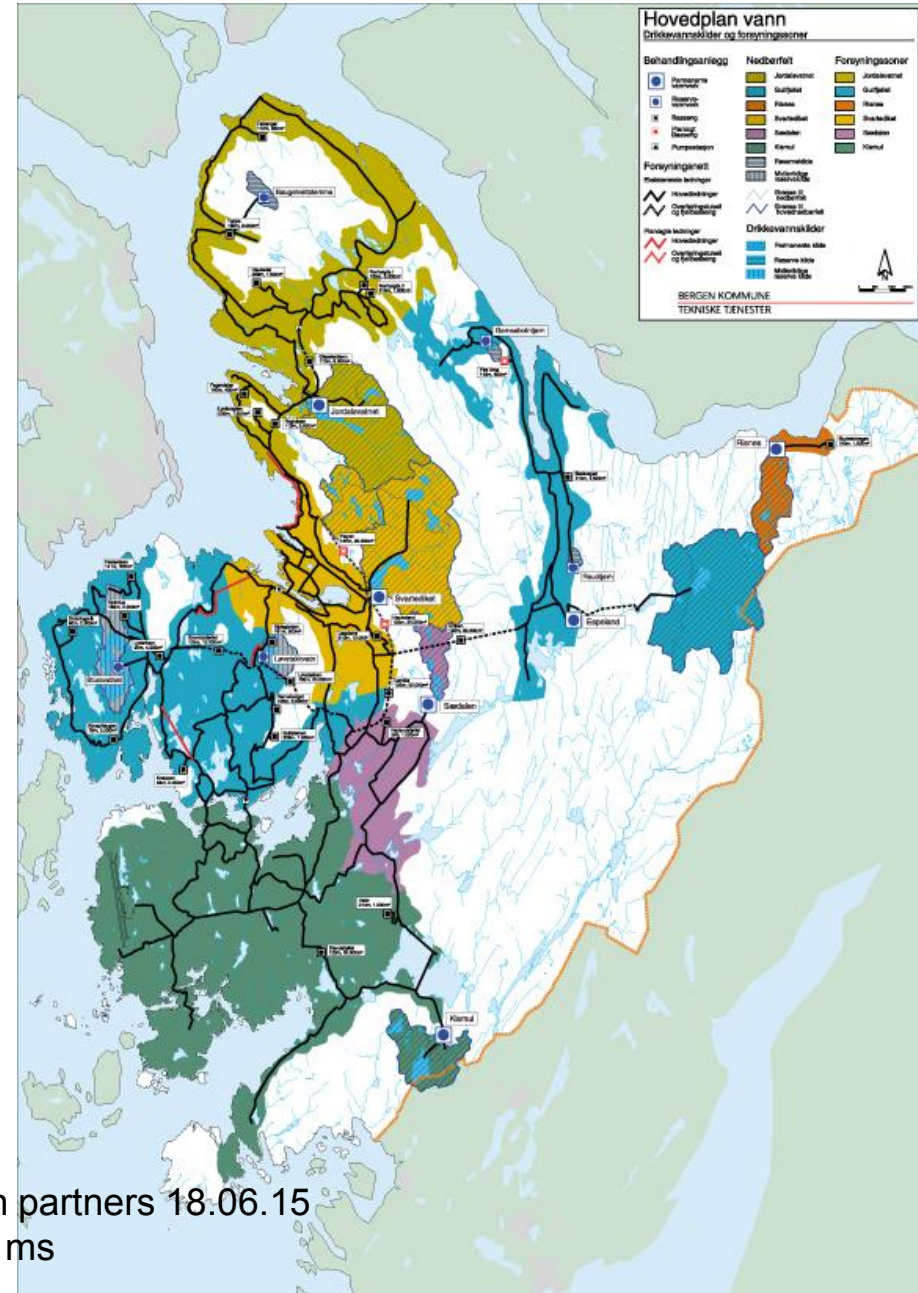
The water supply system consists of:

- 6 water treatment plants
- 61 dams (subject to regulations from the Norwegian Water Resources and Energy Directorate, NVE. Many of the dams are no longer used for water supply)
- 36 water basins (250.000m³)
- 920 km pipelines
- 90 pump stations
- 8.500 manholes
- 35.000 valves (distribution system)

Replacement costs are estimated to be approx. 12 billion NOK (1,5 billion EUR)

Annual water production:
35,8 million m³ (2013)

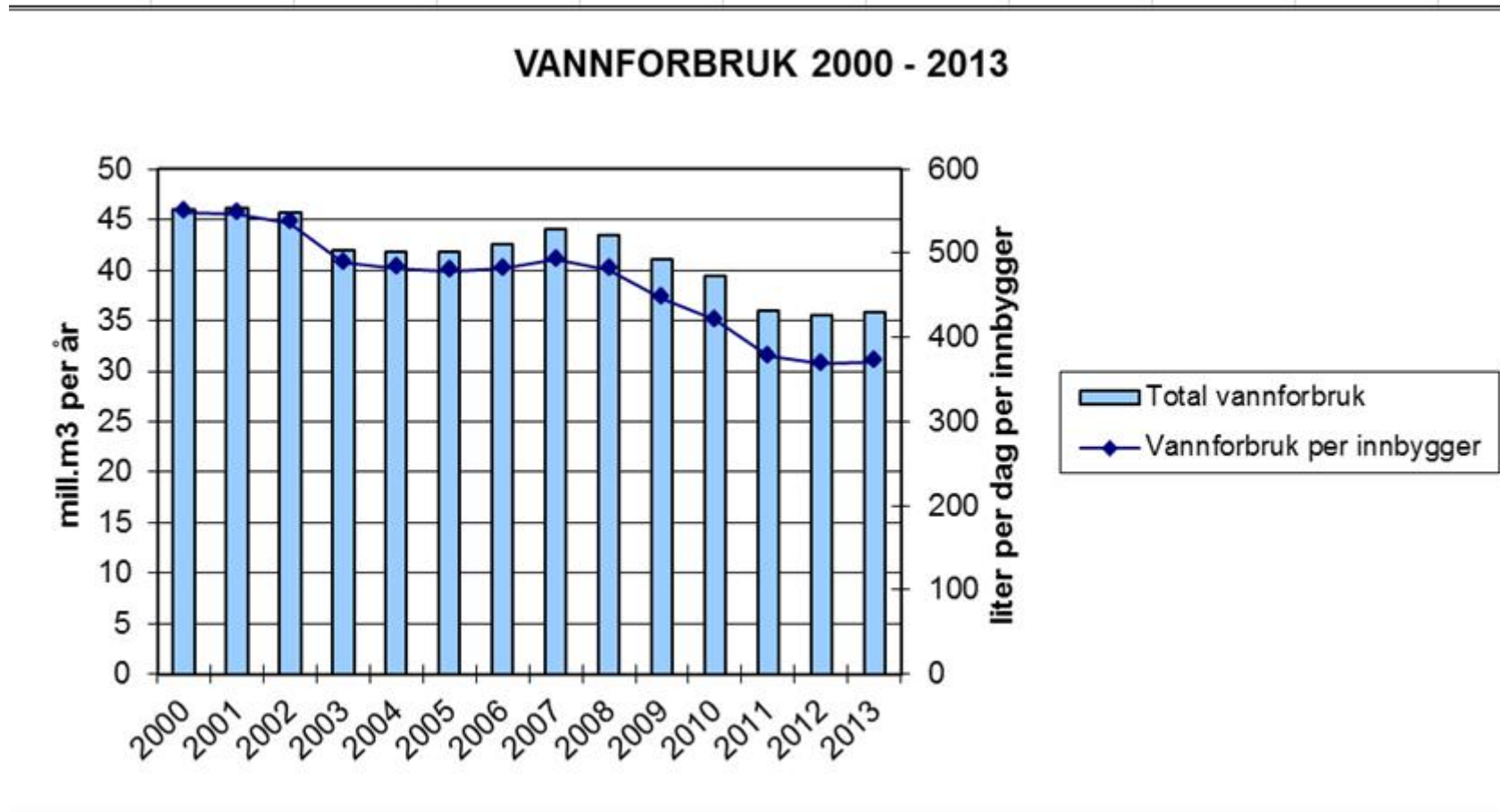
Approx. 97% of the city's 270.000 inhabitants are served



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Water consumption in Bergen



New dam Svartavatnet Golden Mountain



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New dam Svartavatnet Golden Mountain



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THE SEWERAGE SYSTEM IN BERGEN

The sewerage system consists of:

6 major waste water treatment plants

14 minor waste water treatment plants

850 km sewer pipelines

360 km surface water pipelines

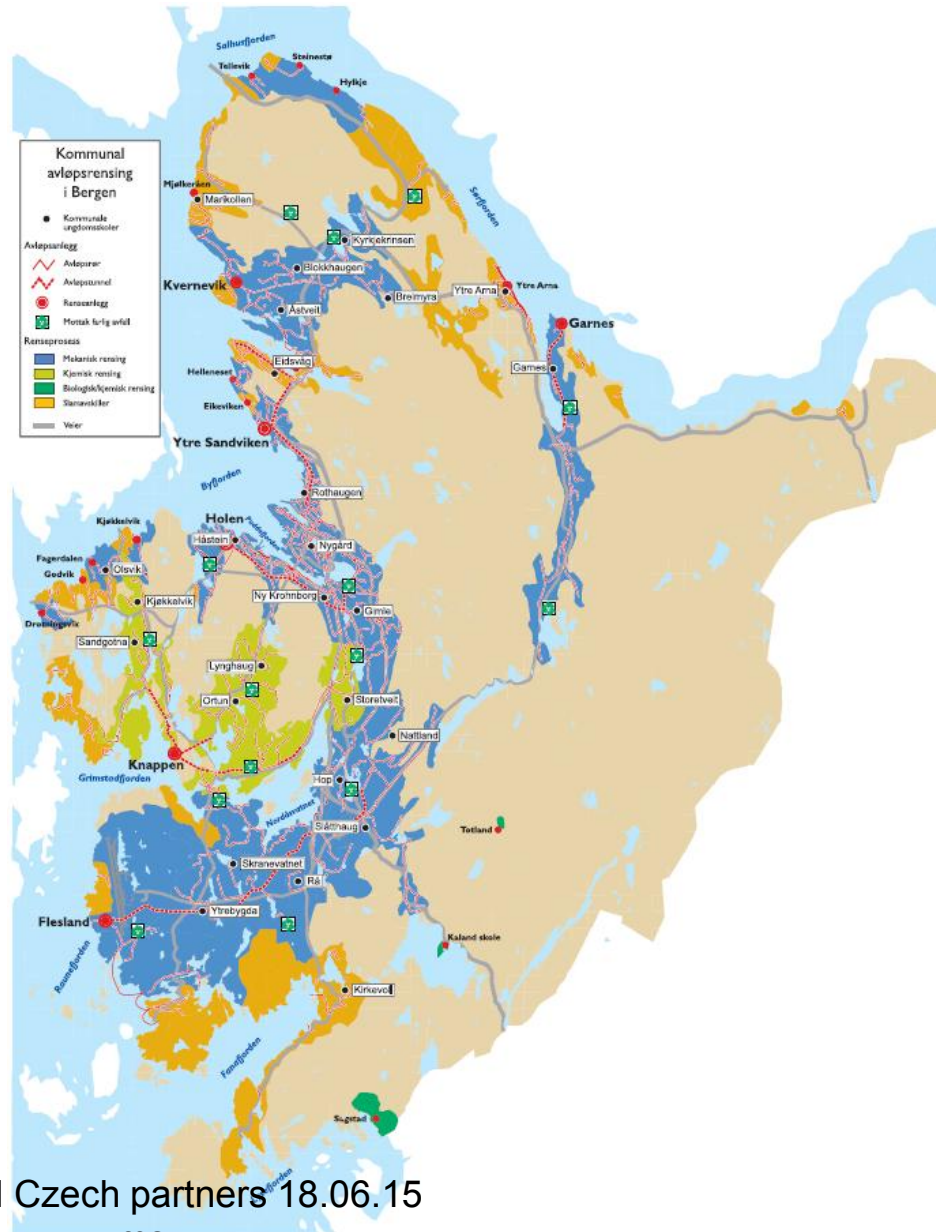
160 pump stations.

24000 sewer manholes

8000 surface water manholes

Replacement costs are estimated to be approx. 15 billion NOK (1,5 billion EUR)

Approx. 90% of the city's 270.000 inhabitants are connected.



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CITY OF BERGEN

Bergen

The fjord city and the city between 7 mountains

- Bergen is surrounded by fjords
- The landscape rises to steep hills up to the mountains
- The landscape is rocky with quite limited space for the city to expand
- Especially in the city centre, and the local city centres of Bergen
- When planning the water systems – especially the waste water treatment plants – open space for construction is quite limited – and would rise several conflicts.
- Therefore we have concluded it to be a technical and economical good solution to build the treatment plants into the mountains – as you will see later on today.
- The city is satisfied with this solution



Upgrading of four WWTP

- Invest at least 1500 millions NOK (180 mill euro)
- Chemical and biological treatment
- The WWTP must be finished in 2014/2016.
- EU-directive 91/271 wastewater treatment in urban areas
- Must build the plants at the same time.

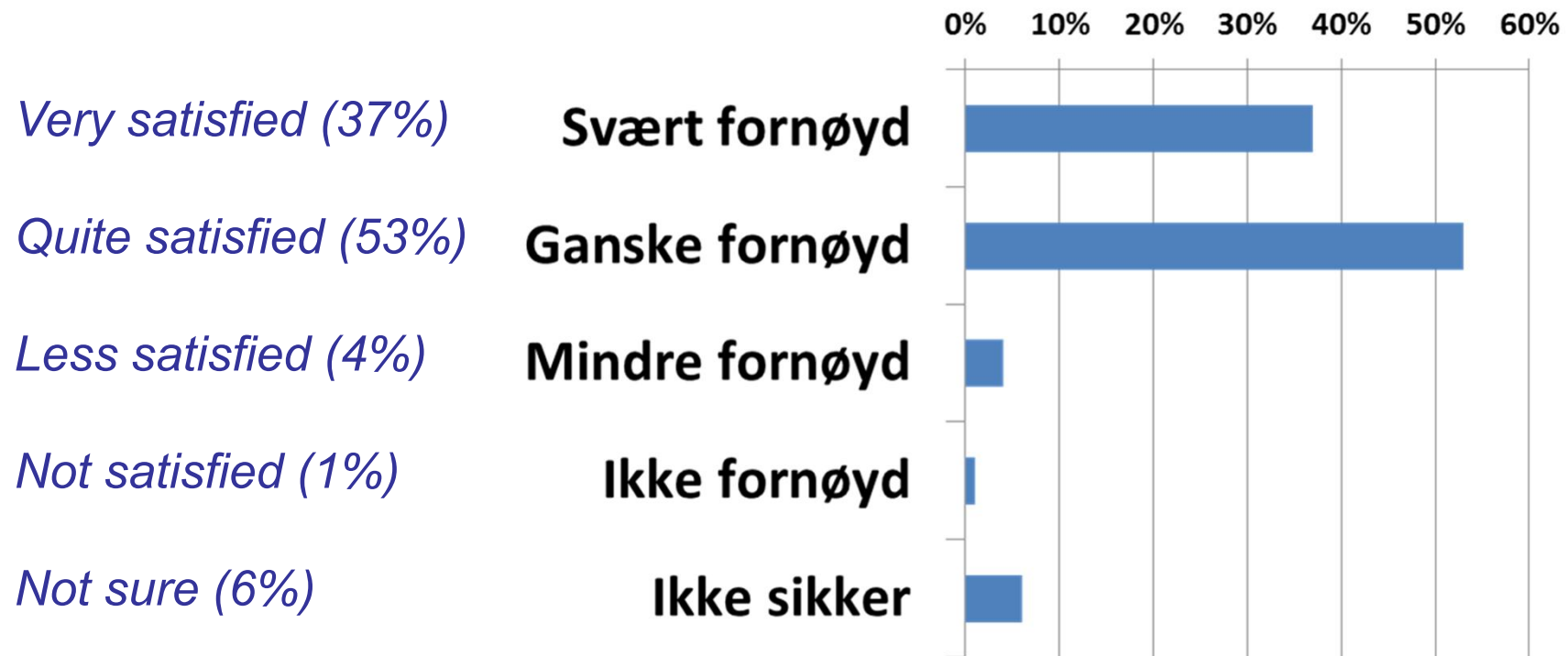


CITY OF BERGEN

Customer Satisfaction 2012

Yearly customer survey.

How satisfied are you with the services provided by the Agency?



Organization of the Water sector in Bergen

- **The sector is owned by the municipalities of Bergen City and is mainly operated by two organisations (Bestiller – utfører konsept)**
- **Agency for Water and Sewerage Works (80 employes) which have :**
 - The daily municipal undertaking of the water and wastewater sector
 - Is responsible for the results of the sector towards the public and the political leadership.
- **Duties:**
 - Strategic and long term planning
 - Renewal and investments in infrastructure and ordering operation and maintenance
 - Local authorities, Customer services and management
- **Municipal Undertaking for Water Works (140 employes)**
 - Operation and maintenance of the public water and wastewater systems is cared out by the Municipal Undertaking for Water Works on contract from the Agency for Water and Sewerage Works
 - Operation and maintenance of the public water systems in a neighbour community Os (from September 2014)

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Water and Sewage system in Norway, source Norsk Vann

- 43.900 km public water mains
 - Average age 33 years
 - Yearly degree of renewal 0,6%
 - >30% leakage
- 51.000 km public sewer lines
 - 55% sewage, 15% mixed, 30% storm water
 - Average age 37 years
 - Yearly degree of renewal 0,44% (156 km)
 - Construction of new pipelines: 407 km
 - 67 sewage blockages pr 1000 km pipeline
- 180.000 km private service pipes (approximately)

