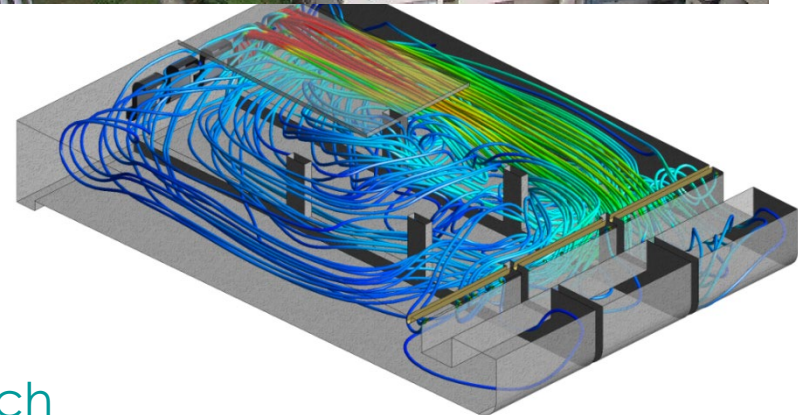




Urban Hydrology class: Technical solutions



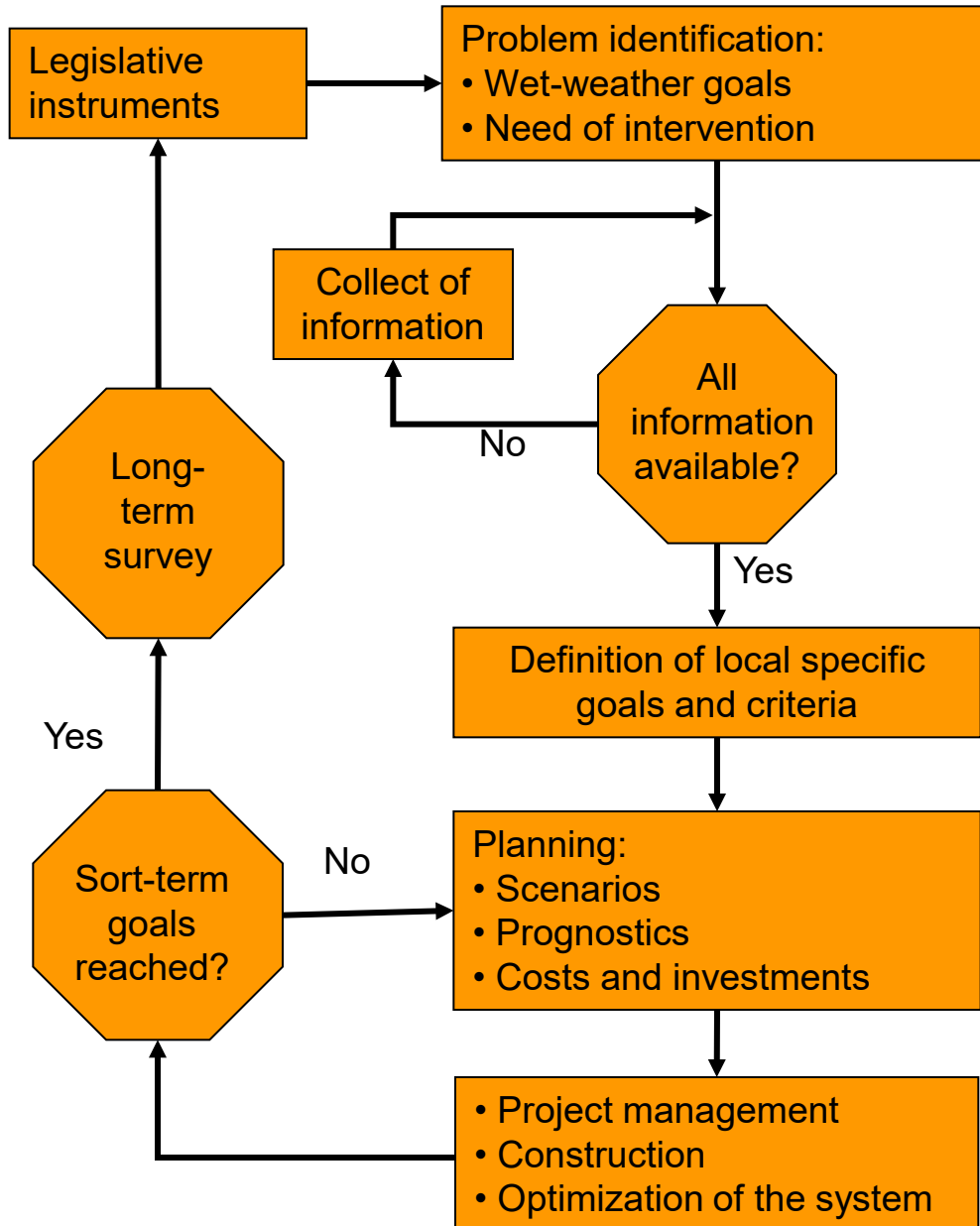
Luca Rossi

luca.rossi@epfl.ch

Goals of the course



- To know the main technical solutions to solve problems in urban hydrology
- To be able to select solutions for dedicated purposes



Once a problem is identified or expected in future scenarios, technical solution must be considered...



... But which one ?

Table of content

- Selection of technical solutions
- At-source solution
 - For contaminants
 - To limit runoff
- Solution in the sewer network
- Solution at the WWTP
- Solution in the receiving waters
- Some conclusions...



Introduction



Basic questions :

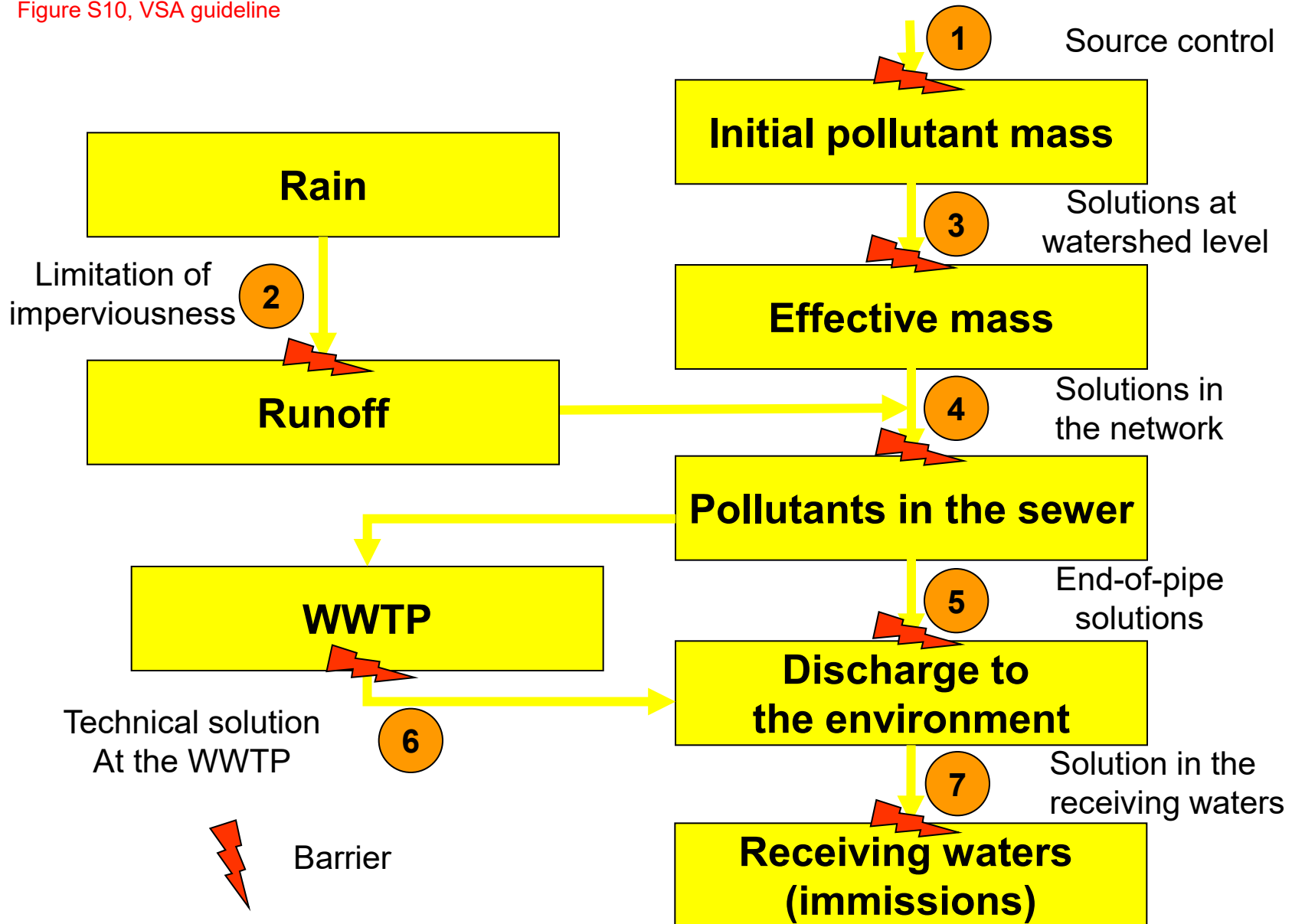
- Do we have criteria to select a technical solutions ?
- How to estimate the different solutions ?
- Structural or non-structural solutions ?
- Visible /invisible solutions ?
- Mono- or multiple functions ?



Introduction: catalogue of solution



Figure S10, VSA guideline



Introduction: selection of solution, set-up of priorities



1. Optimization of system performance in existing structures
2. Solutions for reducing runoff volume
infiltration and retention
3. Technical solutions on the catchment
cleaning of streets, polluted water retention ...
4. Operational measures in the sewer network
regular maintenance of manholes and CSOs, "flush-gates"
5. Maximal flow to the wastewater treatment plant
6. Stormwater treatment
Performance optimization of existing system
7. Technical operations in the receiving waters
shadow banks, renaturation...

Introduction: selection of solution, criteria



Criteria for the selection of technical solutions

- Substances involved, yield, costs, maintenance...
- Processes involved: need of specialized equipment or personal?

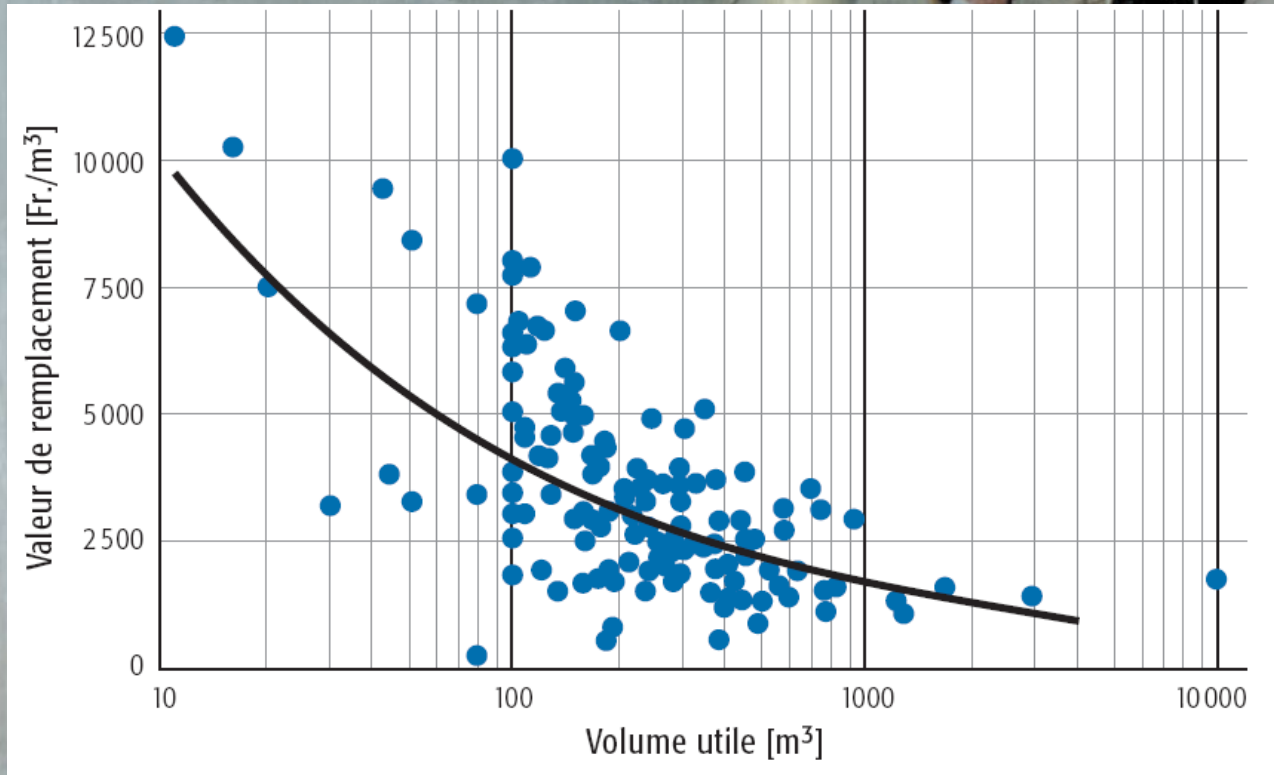
Need of a metric to evaluate different scenarios

- Units: kg, kg/an, m³ /an, % In-Out, % Effects...
- kg / m² ?

How to compare the costs?

- $\text{Frs/kg}_{\text{MES}}$, $\text{Frs/kg}_{\text{Ptot}}$?
- Costs = Investments + Maintenance + Renewal
- Extrapolation from other studies are difficult !

Introduction: selection of solution, criteria



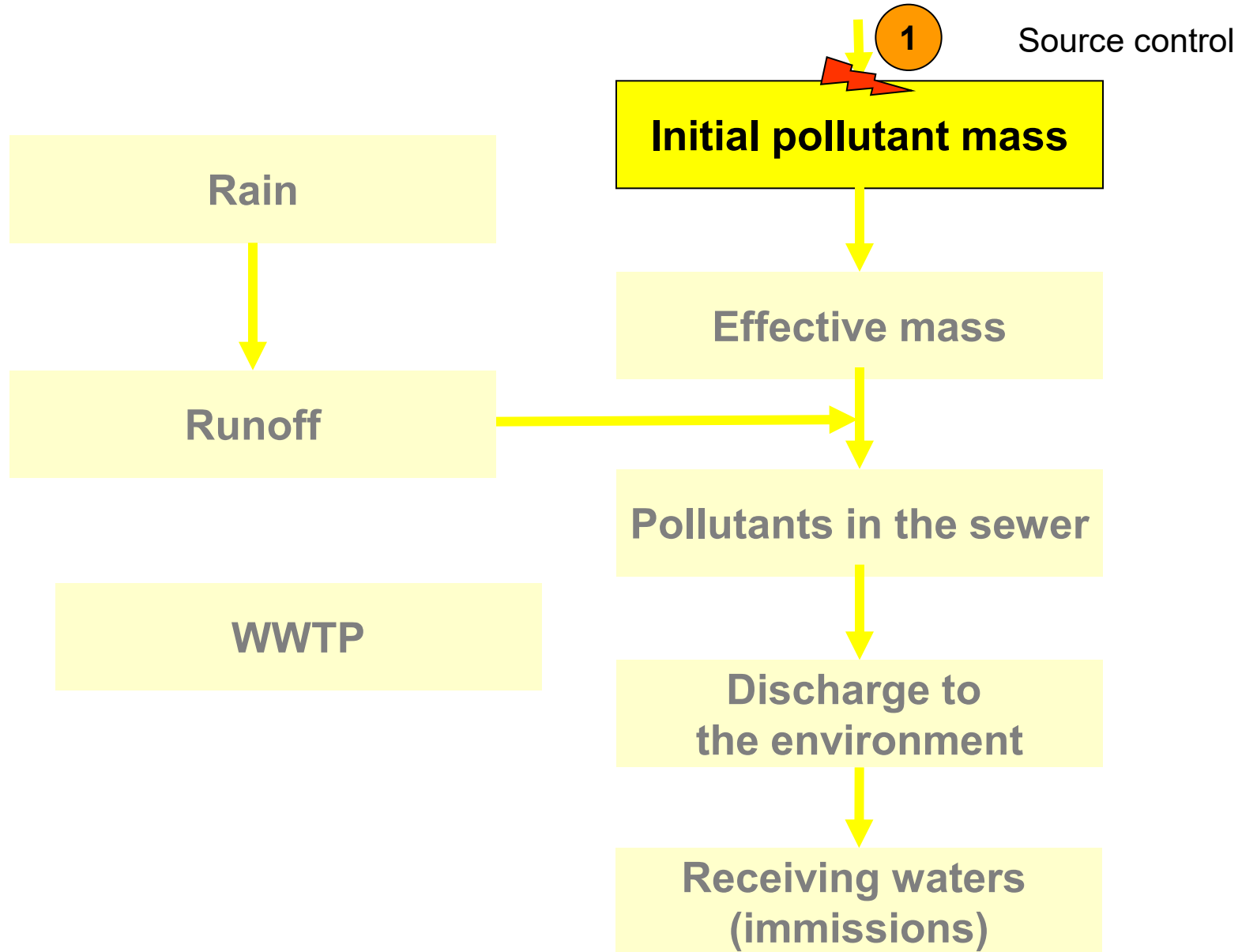
See course « Economical aspects »

Table of content

- Selection of technical solutions
- **At-source solution**
 - For contaminants
 - To limit runoff
- Solution in the sewer network
- Solution at the WWTP
- Solution in the receiving waters
- Costs and maintenance
- Some conclusions...



At-source control



At-source control

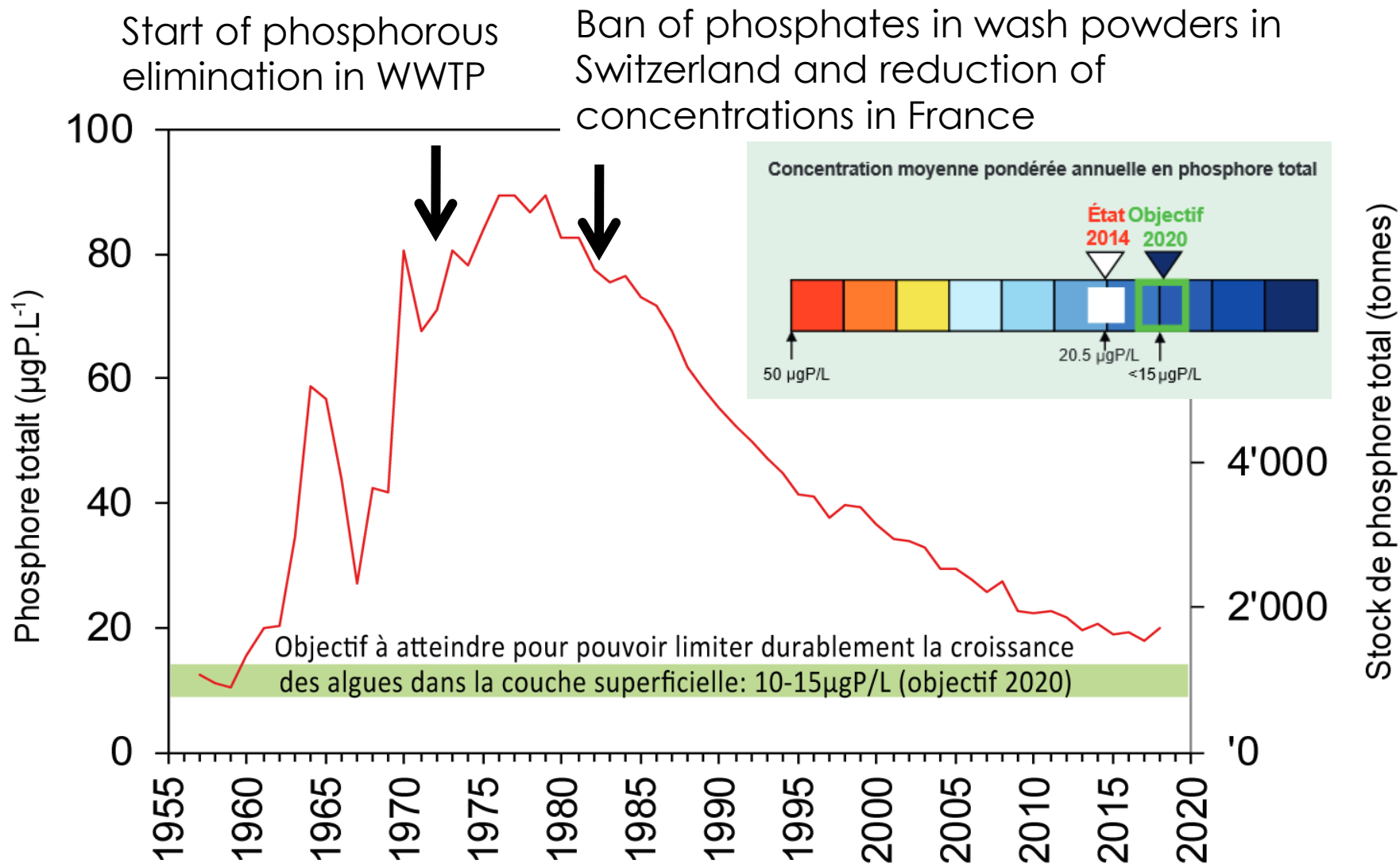


Definition: actions taken to limit or ban the entry of substances in the sewer system

- Different possibilities:
 - Ban
 - Substitution
 - Moderate usage
- Non-structural solution
 - Very efficient solution (up to 100%...)
 - Political decision
 - Costs ?
 - Substitution products ?

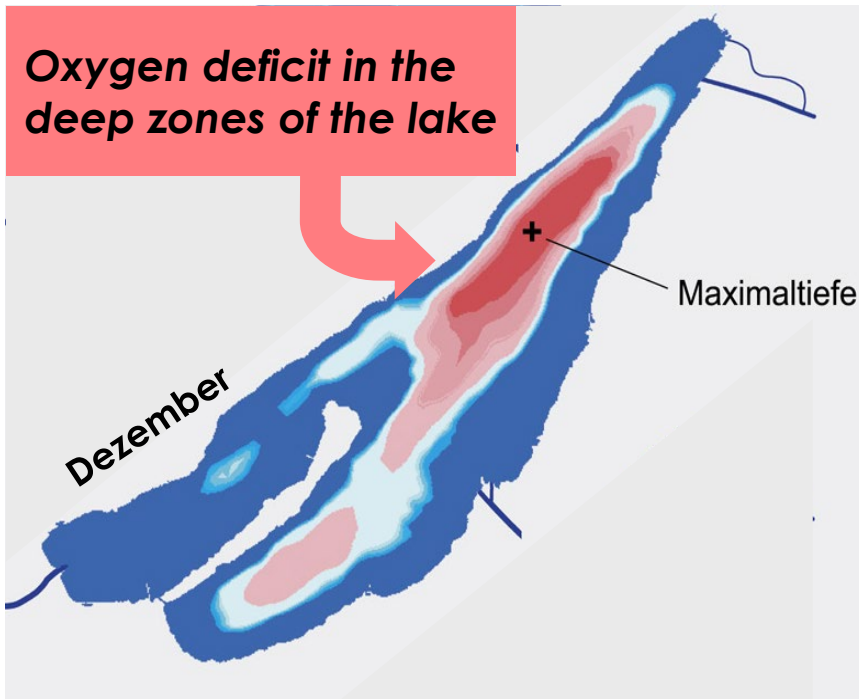


At-source control: phosphorous



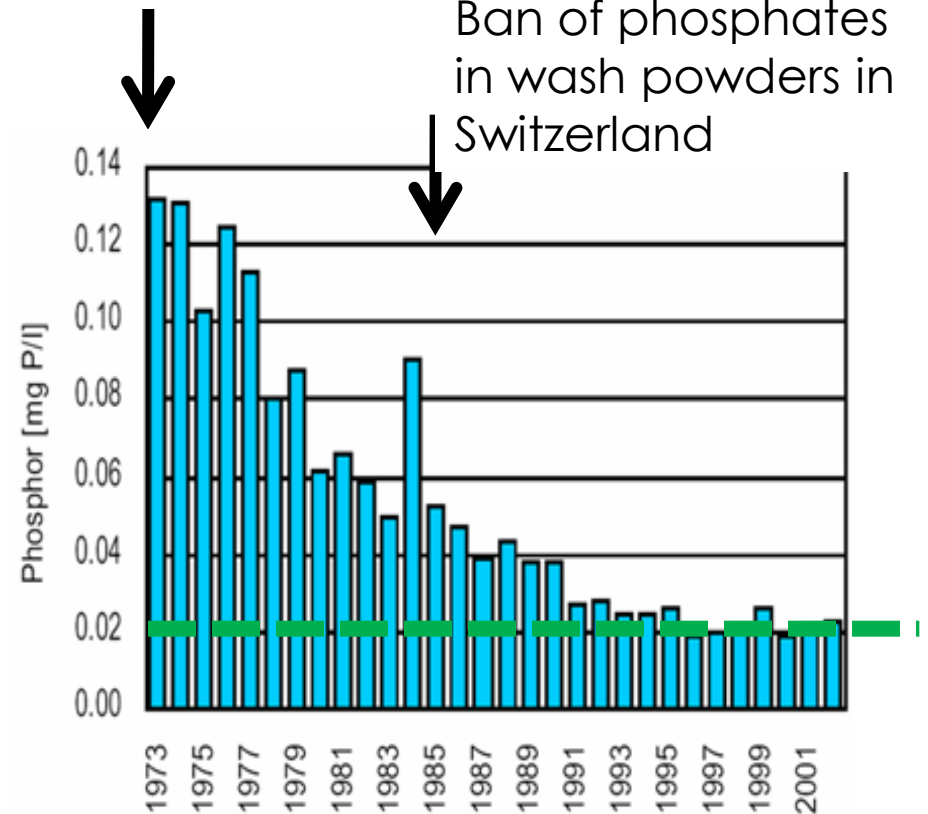
Source: CIPEL 2011, Résultat plan d'action 2011-2020

At-source control: phosphorous



Start of phosphorous elimination in WWTP

Ban of phosphates in wash powders in Switzerland



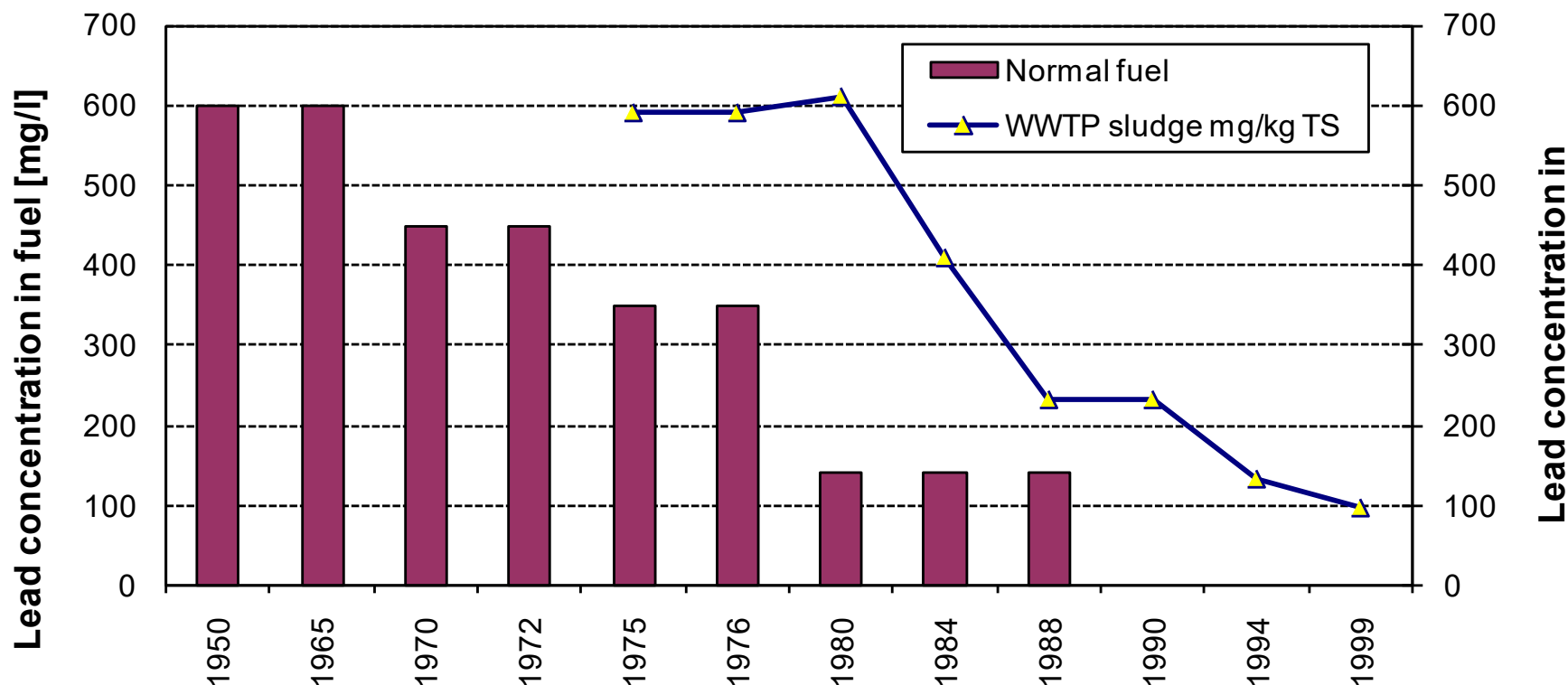
Goal: to avoid algae development in the upper layer of the lake



At-source control: lead in fuel



Substitution product : MTBE ?



Source: Schlöpfer et al. 1996, Külling et al. 2001

At-source control: selection of pharmaceuticals



- First step: to avoid the most dangerous substances in the environment
- Classification of pharmaceuticals of function of their risk for the environment, example in Sweden: www.janusinfo.se/environment
- At European level, Eco-label



http://ec.europa.eu/environment/ecolabel/index_en.htm



SANTÉ DE DEMAIN

5 mars 2025

Santé-environnement. Intégrer la question environnementale dans les choix thérapeutiques

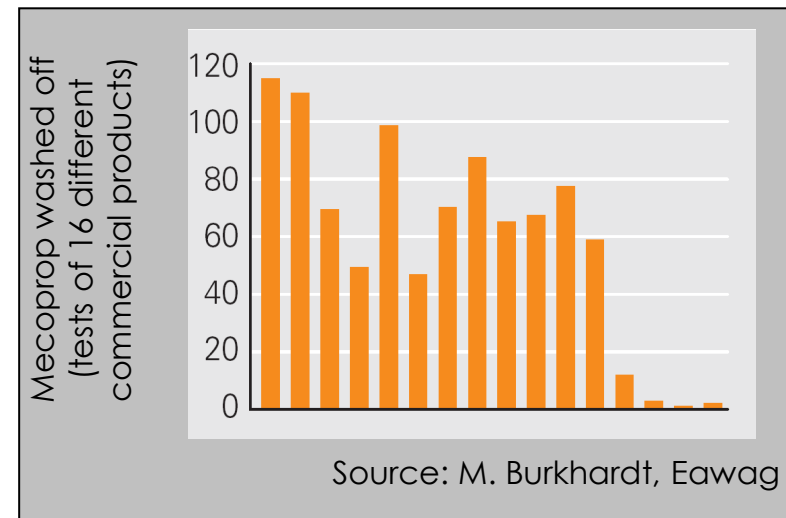
Tiphaine Charmillot , Marie Méan , Omar Kherad , Nathalie Chèvre , Nicolas Senn ,
Sylvain De Lucia 

DOI: 10.53738/REVMED.2025.21.908.460

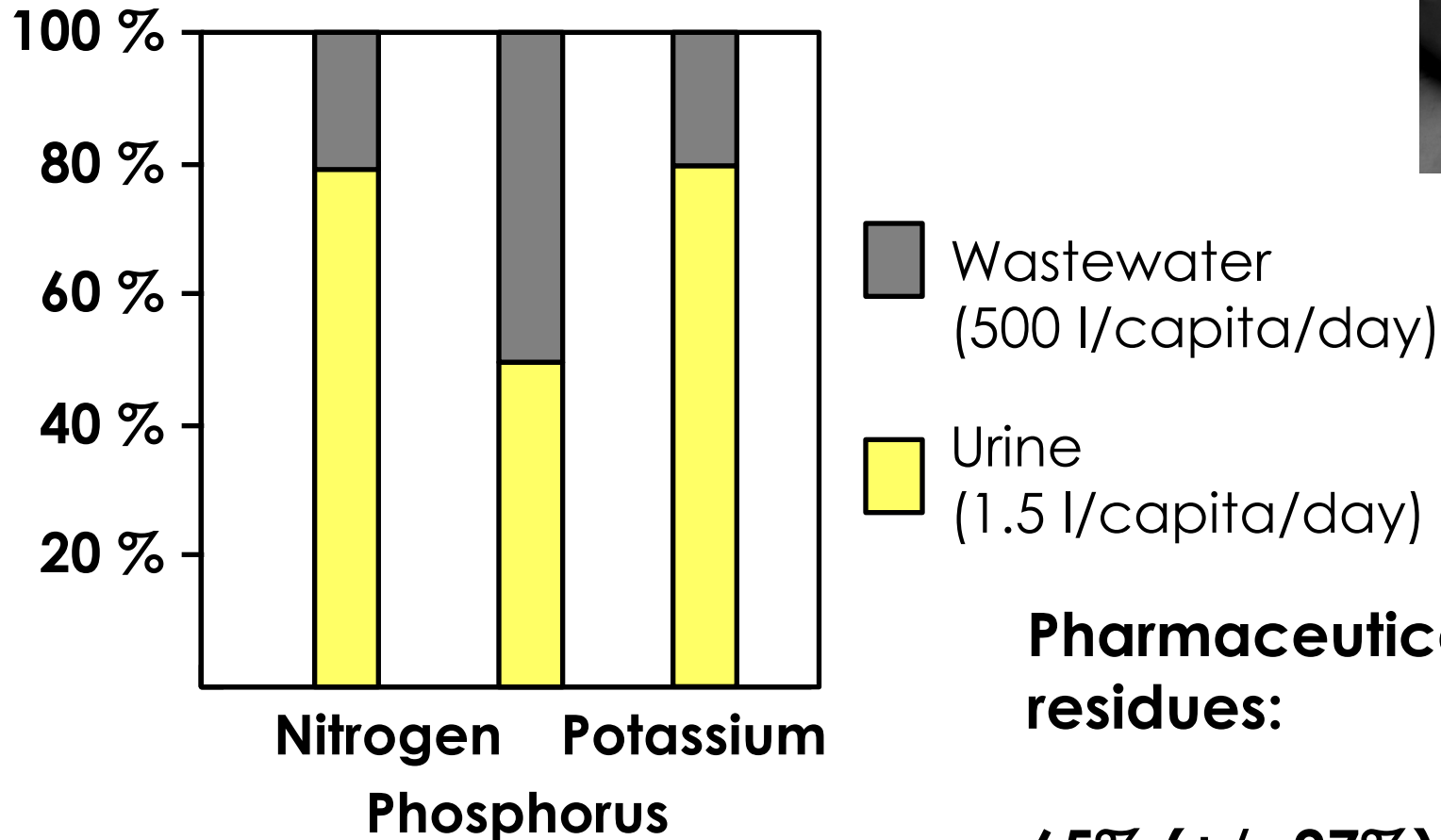
At-source control: pesticides in stormwater



- Goal of anti-root products:
to avoid perforation of bituminous sheets
- To be active, the product should be in the water phase
- Elution tests of commercial products:
large differences in the results
- Goals for the industry:
to limit the use of this substance
- Collaborative discussions, still on-going
- Identical approach with biocides in paints: encapsulation of active substance



At-source control: The NoMix concept



Pharmaceuticals residues:

**65% (+/- 27%)
excreted in urine**

At-source control: The NoMix concept

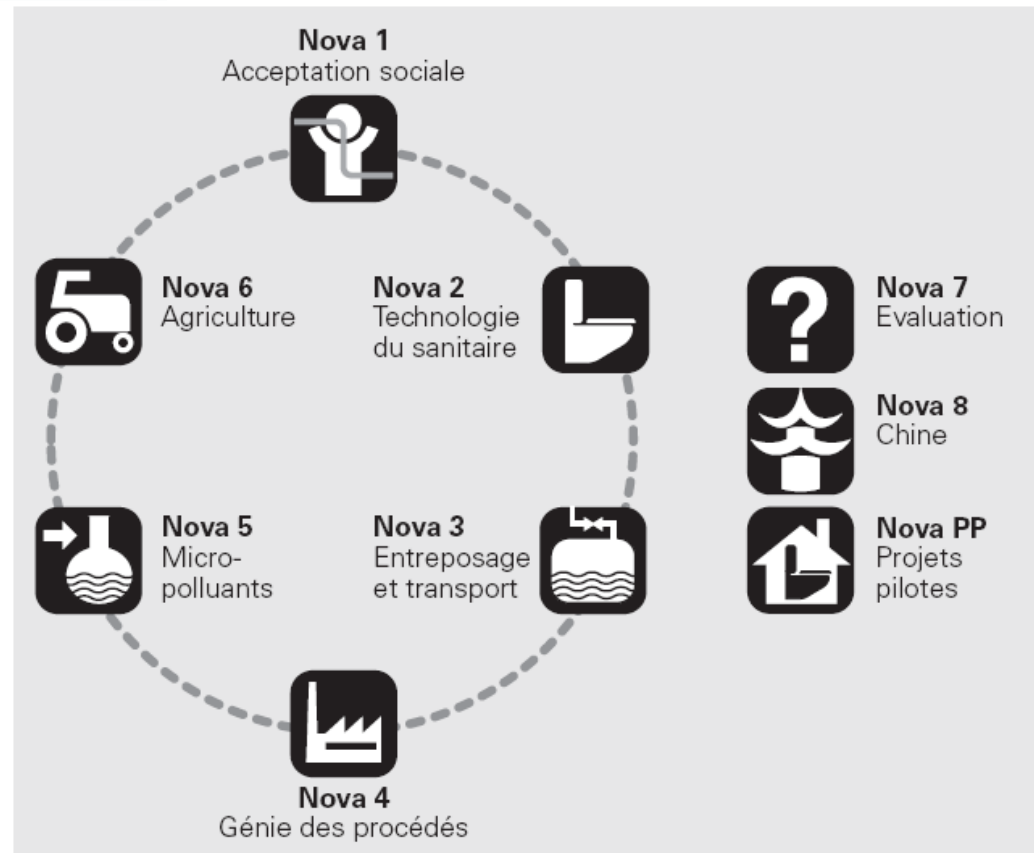


- Research program from 2000
- 8 different workpackages, covering nutrients cycle
- Pilot projects and researches on-going

www.novaquatis.eawag.ch/index_EN

Direction of the project: T. Larsen, J. Lienert

<https://vuna.ch/>



At-source control: The NoMix concept



Geneva: [Pitribon](#)

At-source control: The NoMix concept

Acceptation of the technology



- Enquiry (1750 answers):
 - 72%: a good idea
 - 80%: NoMix equal to conventional toilets
 - 86%: would agree to move in an apartment equipped with NoMix toilets
- Identified problems :
 - Sitting position
 - Children utilization
 - Cleaning
 - Maintenance (blockage)

Sociological context is very important for such kind of solutions !



New design: [Laufen Save!](#)

At-source control: some conclusions



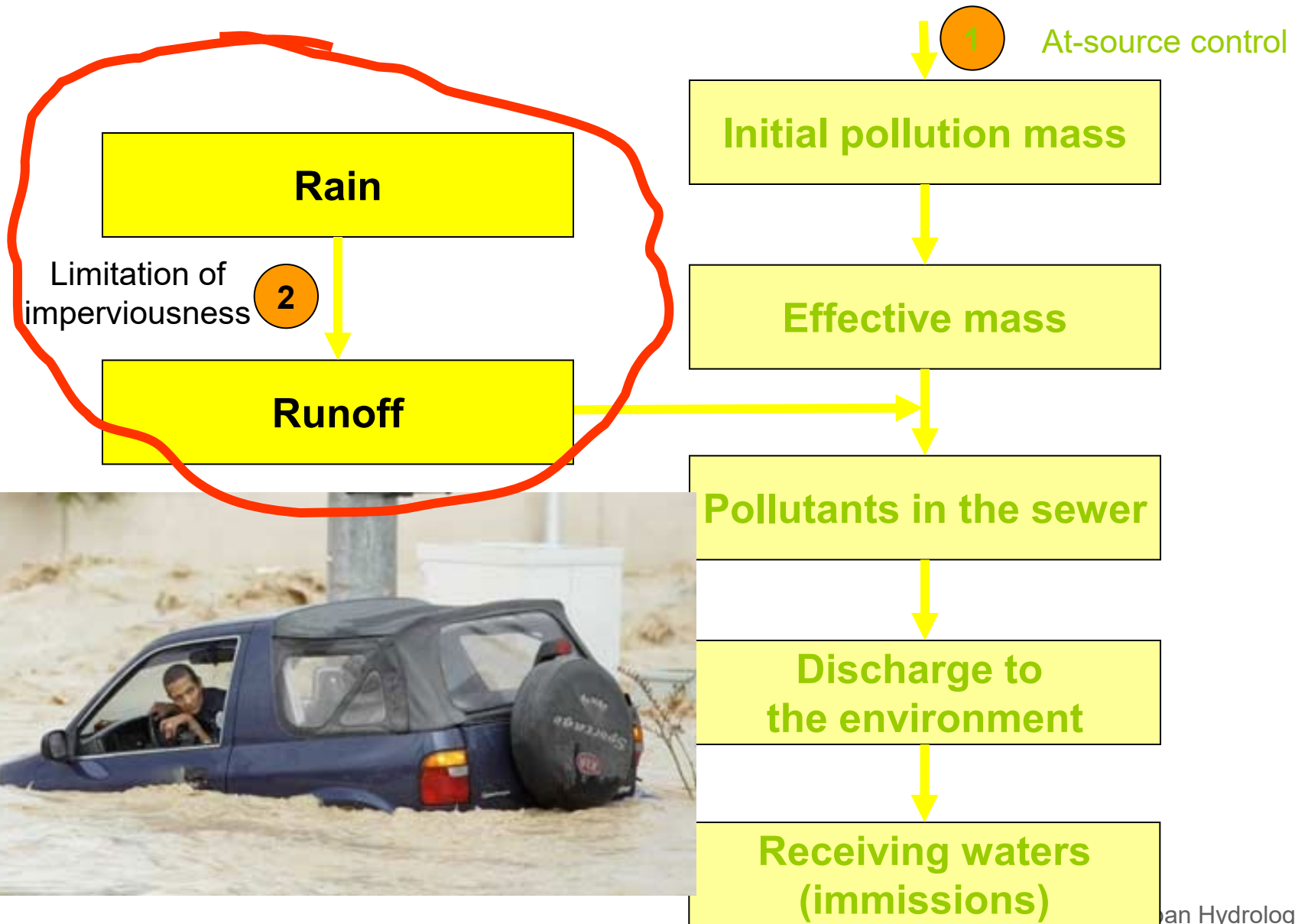
- Definition: actions taken to limit or ban the entry substances in the sewer system
- Could be a very efficient solution
- Stakeholders: different levels of action
 - Producers: to optimize the product and its usage
 - Consumers: selection of products
 - Authorities: to influence the selection of products
- Knowledge on products composition
- Technical solutions: multiplication of individual systems!
 - Controls ? Maintenance ?



All substances consumed will end up in the receiving waters !



At-source control: runoff control

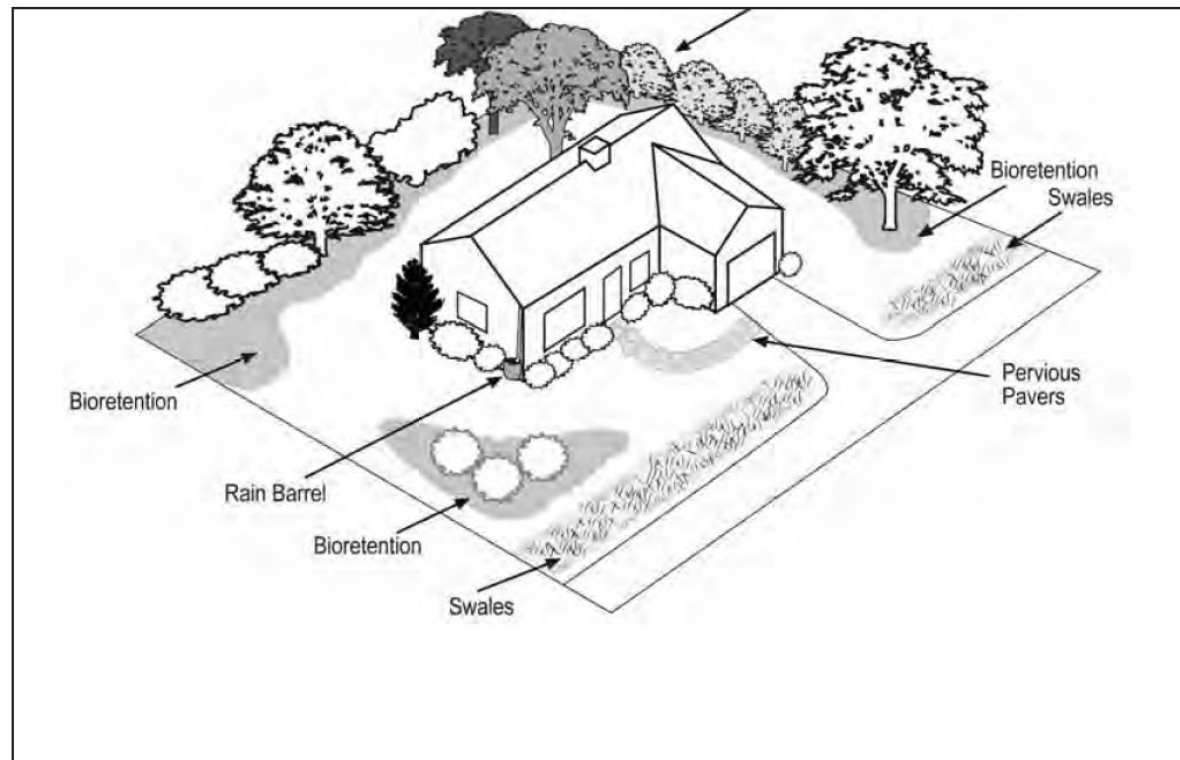


At-source control: runoff control



- On-site detention / infiltration of rainwater
- Pay attention to the contamination of water (cf legislation course)
- For infiltration, see PGEE and groundwater conditions
- **Global goal: to not exceed ca. 30% imperviousness**

KBOB
publication in
VSA guidelines!



At-source control: runoff control



KBOB
publication in
VSA guidelines

Also available
[here](#)

KBOB

Koordinationskonferenz der Bau- und Liegenschaftsorgane der öffentlichen Bauherren
Conférence de coordination des services de la construction et des immeubles des maîtres d'ouvrage publics KBOB

Verband Schweizer Abwasser- und Gewässerschutzfachleute
Associazione suisse dei professionisti della protezione delle acque
Associazione svizzera dei professionisti della protezione delle acque
Swiss Water Association



EMPFEHLUNG • RECOMMANDATION • EMPFEHLUNG • RECOMMANDATION • EMPFEHLUNG • RECOMMANDATION • EMPFEHLUNG

Nachhaltiges Bauen • Construction Durable • Nachhaltiges Bauen • Construction Durable • Nachhaltiges Bauen • Construction Durable • Nachhaltiges Bauen

Infiltration et rétention des eaux pluviales en milieu bâti

2019/1

Saviez-vous que...

- ... vous pouvez contribuer à une utilisation durable des eaux souterraines par l'aménagement des surfaces et l'infiltration des eaux pluviales?
- ... l'infiltration des eaux pluviales à travers une couche d'humus protège les eaux souterraines et les cours d'eau des polluants tout en bouclant le cycle hydrologique naturel?
- ... vous pouvez ainsi désengorger les canalisations et limiter, voire empêcher les inondations dans les zones résidentielles?
- ... vous pouvez influencer positivement le microclimat grâce à l'infiltration des eaux pluviales et, ainsi, contribuer à la réduction des îlots de chaleur et de la sécheresse en milieu bâti?

Contexte

En Suisse, la législation impose que **les eaux non polluées soient évacuées par infiltration**. Au niveau des communes, la nécessité et les modalités d'une infiltration sont définies pour chaque bien-fonds dans le plan général d'évacuation des eaux (PGEE). Lorsqu'une infiltration n'est pas possible ou ne l'est que de façon restreinte, il convient d'aménager une solution de rejet dans les eaux de surface.

La mise en œuvre des dispositions est réglementée par la **directive «Gestion des eaux urbaines par temps de pluie» (VSA, 2019)**. Cette directive fournit des outils pour déterminer si des eaux peuvent être considérées comme non polluées et, ainsi, être infiltrées. La présente recommandation illustre, à l'aide d'exemples de bonnes pratiques, les consignes de la directive VSA en matière d'évacuation des eaux de biens-fonds.



Illustration 1: Exemple d'un bassin d'infiltration bien intégré dans l'aménagement du quartier

At-source control: runoff control



Recommandation
KBOB:
Infiltration et rétention
des eaux pluviales en
milieu bâti

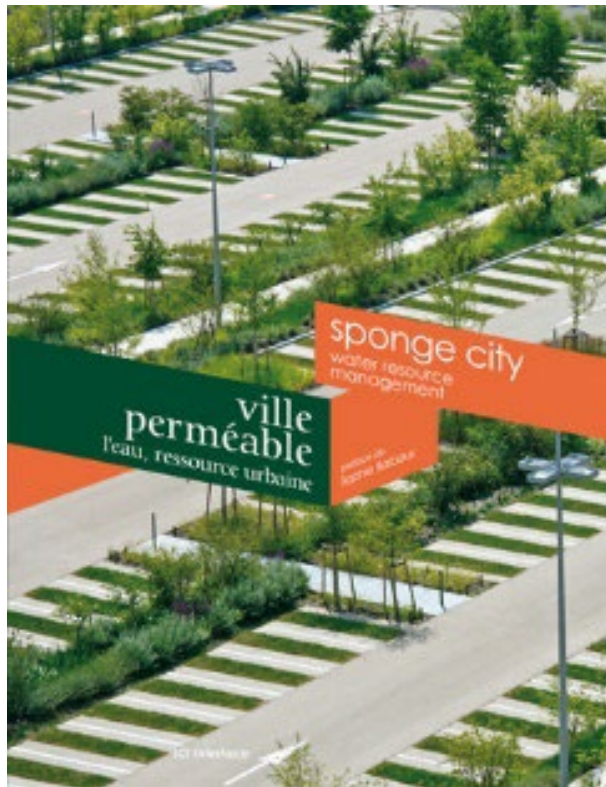
Directive VSA



At-source control: runoff control



« Sponge cities » concept



ISBN 978-2-916977-35-5

<http://www.vegetalcity.net/>
(Luc Schuiten)

At-source control: runoff control



www.bloomberg.com/news/articles/2017-08-18/berlin-is-becoming-a-sponge-city



Berlin is Becoming a Sponge City

Rummelsburg
Berlin

At-source control: runoff control



«Eau de pluie dans l'espace urbain»

Swiss federal office of the environment

Fig. 85 : À Roskilde, le canal alimentant le bassin de rétention sert aussi de skatepark



Fig. 86 : Bassin de rétention aménagé comme un lac proche de l'état naturel



Fig. 87 : Bord de la place avec bordure de 3 cm de haut



Fig. 88 : La Vulkanplatz, un espace multifonctions



2022 | Connaissance de l'environnement

Climat

Eau de pluie dans l'espace urbain

Fortes précipitations et gestion des eaux pluviales dans le contexte d'un développement urbain adapté aux changements climatiques



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Office fédéral de l'environnement OFEV

Office fédéral du développement territorial ARE

At-source control: runoff control

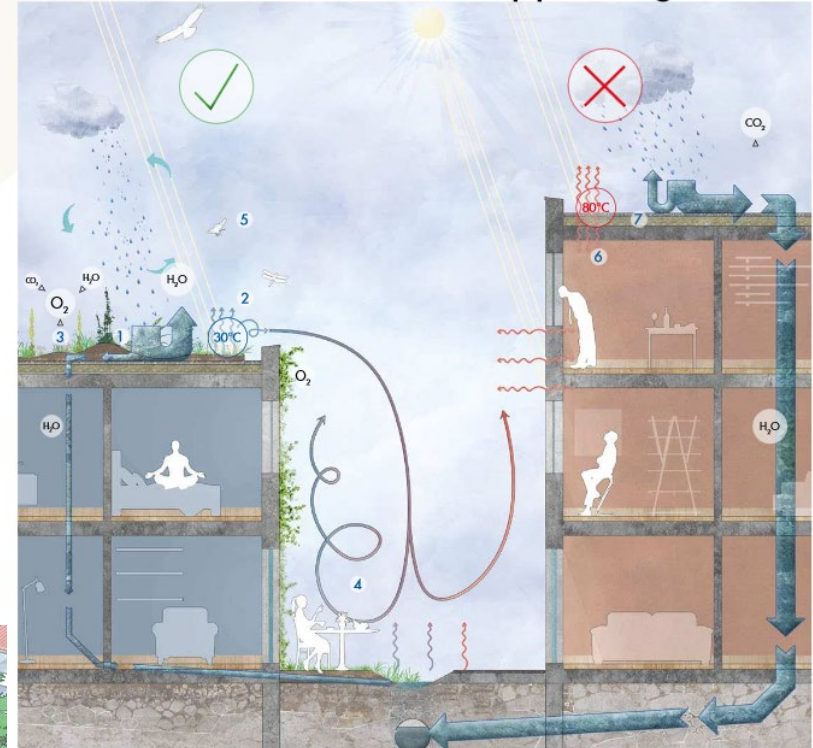
Sion Example



Précipitations: -10 mm



Le rôle vertueux des enveloppes végétales



11 GUIDE DES AMÉNAGEMENTS EXTÉRIEURS SUR FONDS PRIVÉS DE LA VILLE DE SION

www.sion.ch/acclimatation

At-source control: runoff control

Geneva Example



Office cantonal de l'eau
Service de la planification de l'eau

Eau en Ville

Gestion des eaux pluviales :
vers un changement de
pratiques ?



Version 1.0 – Avril 2020



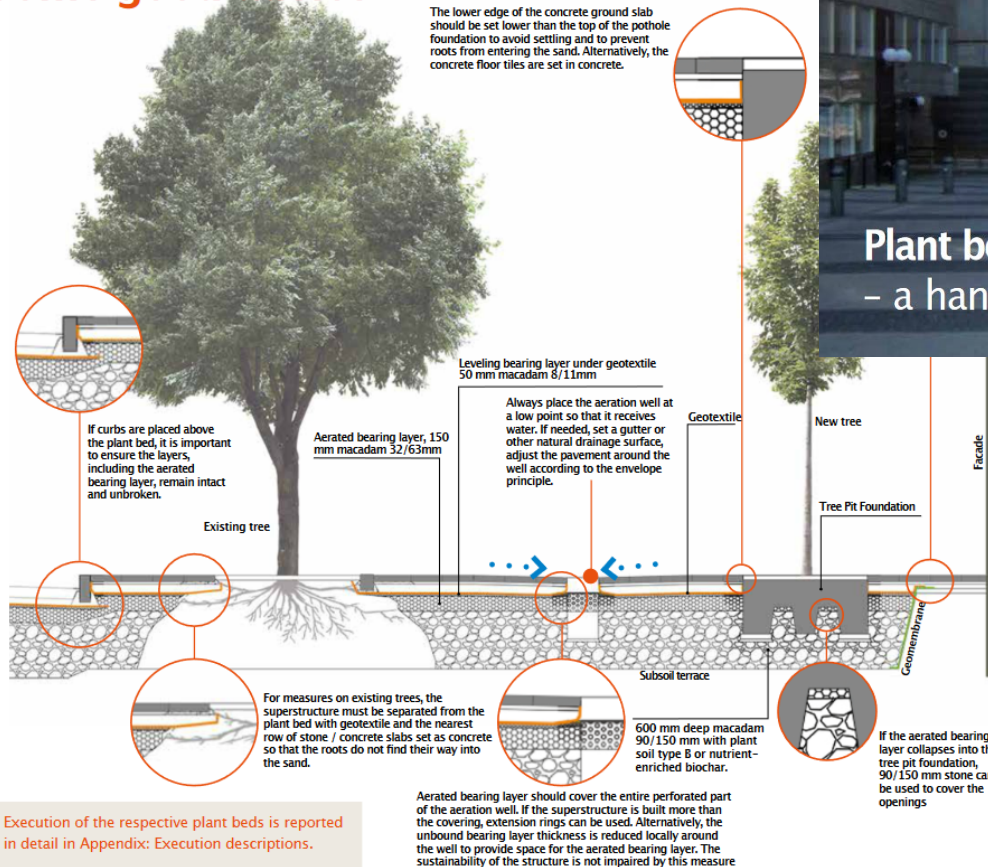
REPUBLIQUE
ET CANTON
DE GENEVE

POST TENEBRAS LUX

<https://www.ge.ch/eau-ville-changement-pratiques-applications>

URBAN PLANT BEDS

Some good advice



Plant beds in Stockholm city – a handbook 2017

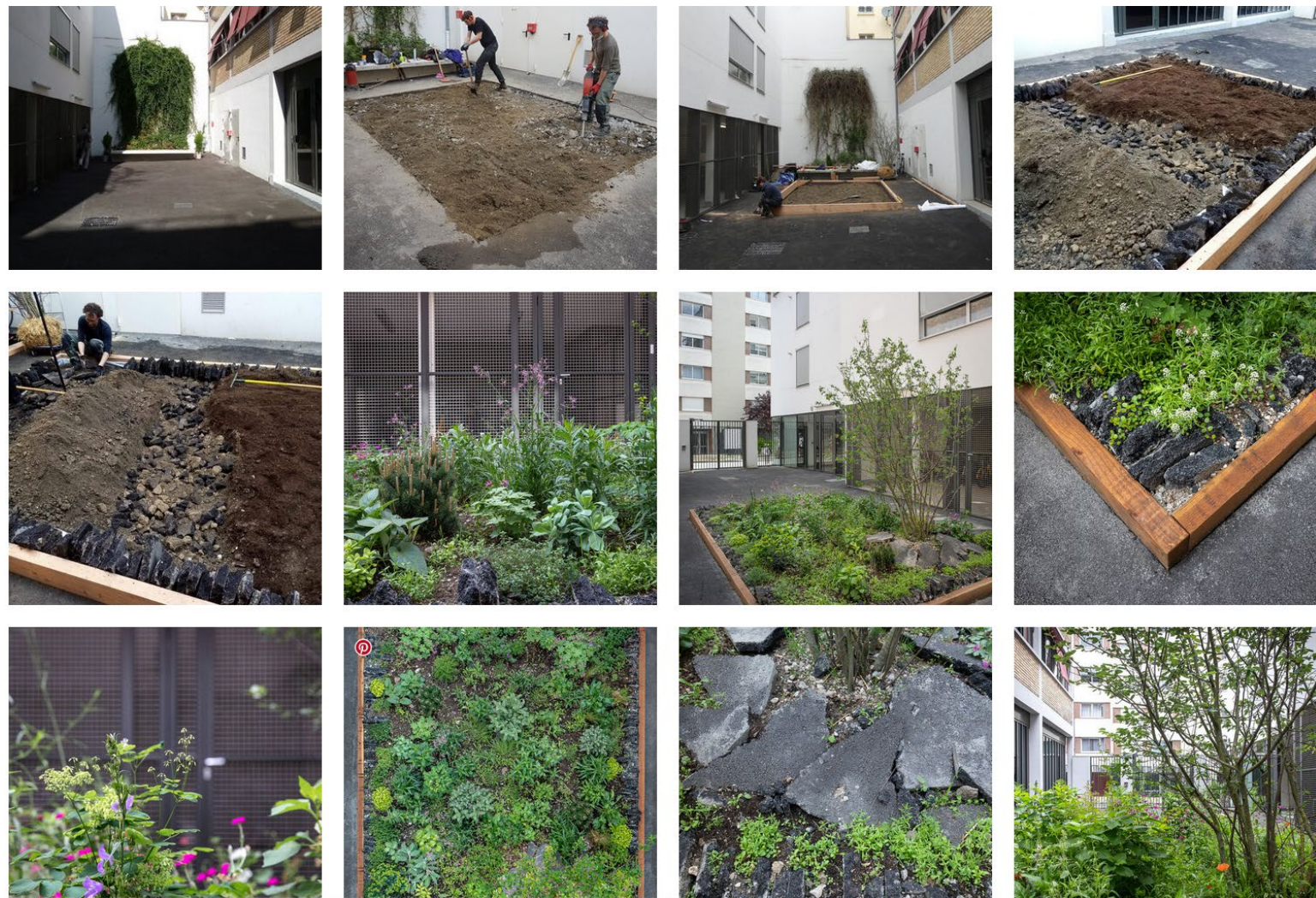
stockholm.se/trad

http://www.biochar.info/docs/urban/Planting_beds_in_Stockholm_2017.pdf

« Asphalt jungle »



www.wagon-landscaping.fr/



At-source control: runoff control



Solutions also developed in Switzerland !

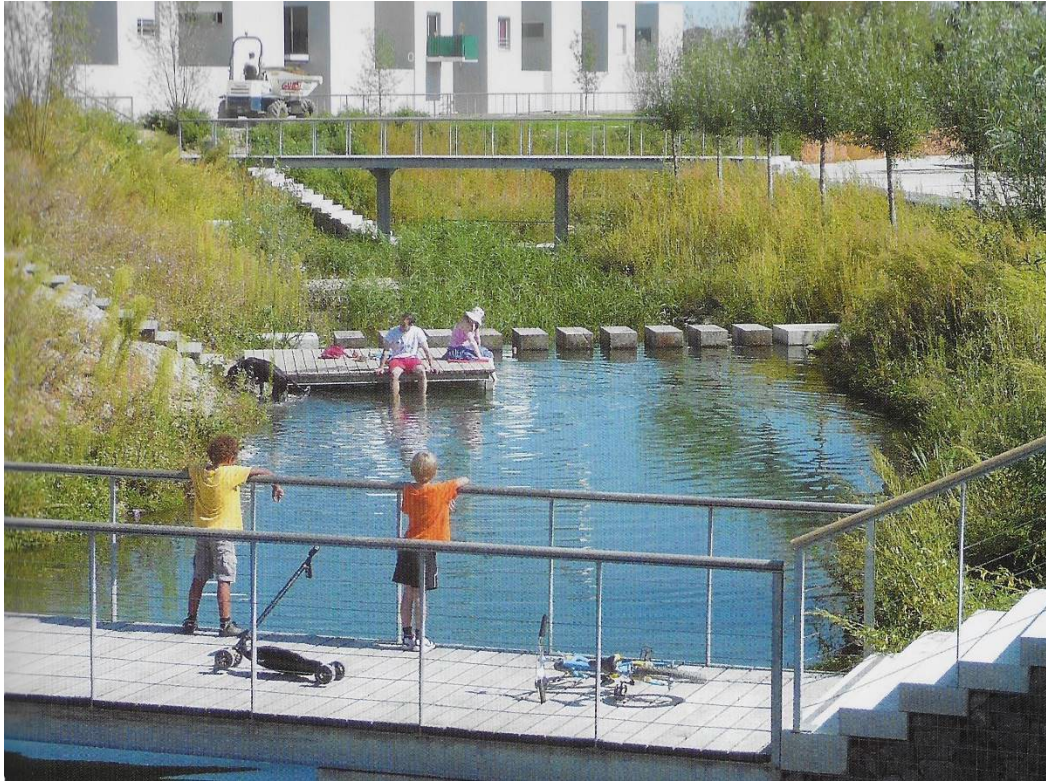
Fribourg example



bluefactory



At-source control: runoff control



Ecoquartier de Bottière-Chênaie, Nantes, France, 2008-2018



ZAC des Cents Arpents, Bussy-Saint-Georges, France, 2013



At-source control: runoff control



Espace public du Zénith, Strasbourg, France, 2008, 30 ha

At-source control: runoff control



Grand-jardin Ampère, Massy, France, 2013

Faubourg des Prés-Devant, Châlon-sur-Saône, France, 2013

At-source control: runoff control



Parco Casarico Sorengo

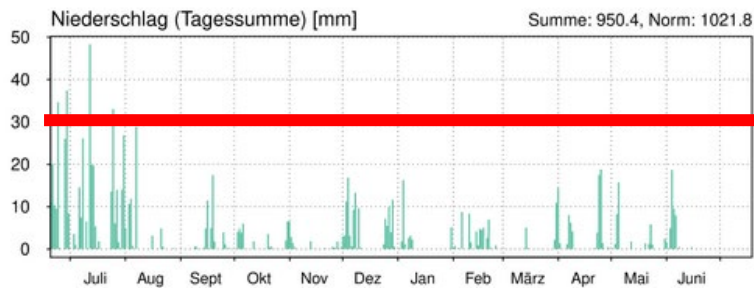


At-source control: runoff control



Flood area - Vulkanplatz in Zürich Altstetten

- The space can hold up to 3 cm before overflowing
- About 80% of rainfall events are less than 30 mm – they can be managed in a decentralised manner and not dumped into the sewers.





At-source control: roof runoff control



WestView Condominium, Nashville

<http://www.dreiseitl.net>

<http://www.dreiseitl.com/en/portfolio>

URBANISME

Lausanne veut favoriser le retour de la nature en ville

Par Alain Détraz . Mis à jour le 15.03.2012 14 Commentaires

Recommander 3

La Municipalité lausannoise veut une ville plus verte. A commencer par les toitures plates, dont elle encouragera la végétalisation.



Florence Germond entend inciter les propriétaires à verdifier les nouvelles toitures plates, comme la ville l'a fait sur la bibliothèque d'Entre-Bois.

Image: Samuel Fromhold

24heures 250^{ans}



Source: Nathalie Baumann, ZHAW
Séminaire ARPEA « Renaturer nos Villes », 2017



At-source control: roof runoff control

Punggol Roof Garden, Singapore

www.greenroofs.com/projects/punggol-roof-garden/



At-source control: runoff control

Green roofs

Positive points

- Reduction of stormwater
- Positive impact on CO₂
- Insulation of buildings
- Cooling effects in cities
- Biodiversity
- Landscape

Negative points

- Risk of water infiltration
- Costs, especially on existing buildings
- Structural constraints

At-source control: runoff control



Chemin des roches, Lausanne

SIA SN 564 312

Begrünung von Dächern

www.greeninfrastructureconsultancy.ch



Halles sud de Baulieu, Lausanne

<http://webapps.lausanne.ch/ressources/diapos/nature/nature-et-vous-diapo/toitures-vegetalisees/slides/P1030017-2.html>

Urban Hydrology, 17.05.2025

VÉGÉTATION INTENSIVE

VÉGÉTATION EXTENSIVE

Toiture-jardin légère

Toiture végétalisée

Végétation

Substrat

Couche filtrante

Couche de drainage

Couche de protection

mécanique; Etanchéité

Isolation thermique

Pare-vapeur

Support et pente

008

Türbinenplatz

Zurich, Suisse, 2003

Aménagement d'une place au cœur de l'ancien site industriel de Sulzer-Escher Wyss

Maître d'ouvrage : Sulzer Immobilien, Winterthour

Concours sur invitation : 2000, 1^{er} prix

Projet : 2000-2001

Réalisation : 2002-2003

En collaboration avec :

Tobias Eugster, architecte, Zurich

Les Eclairagistes Associés, Lyon

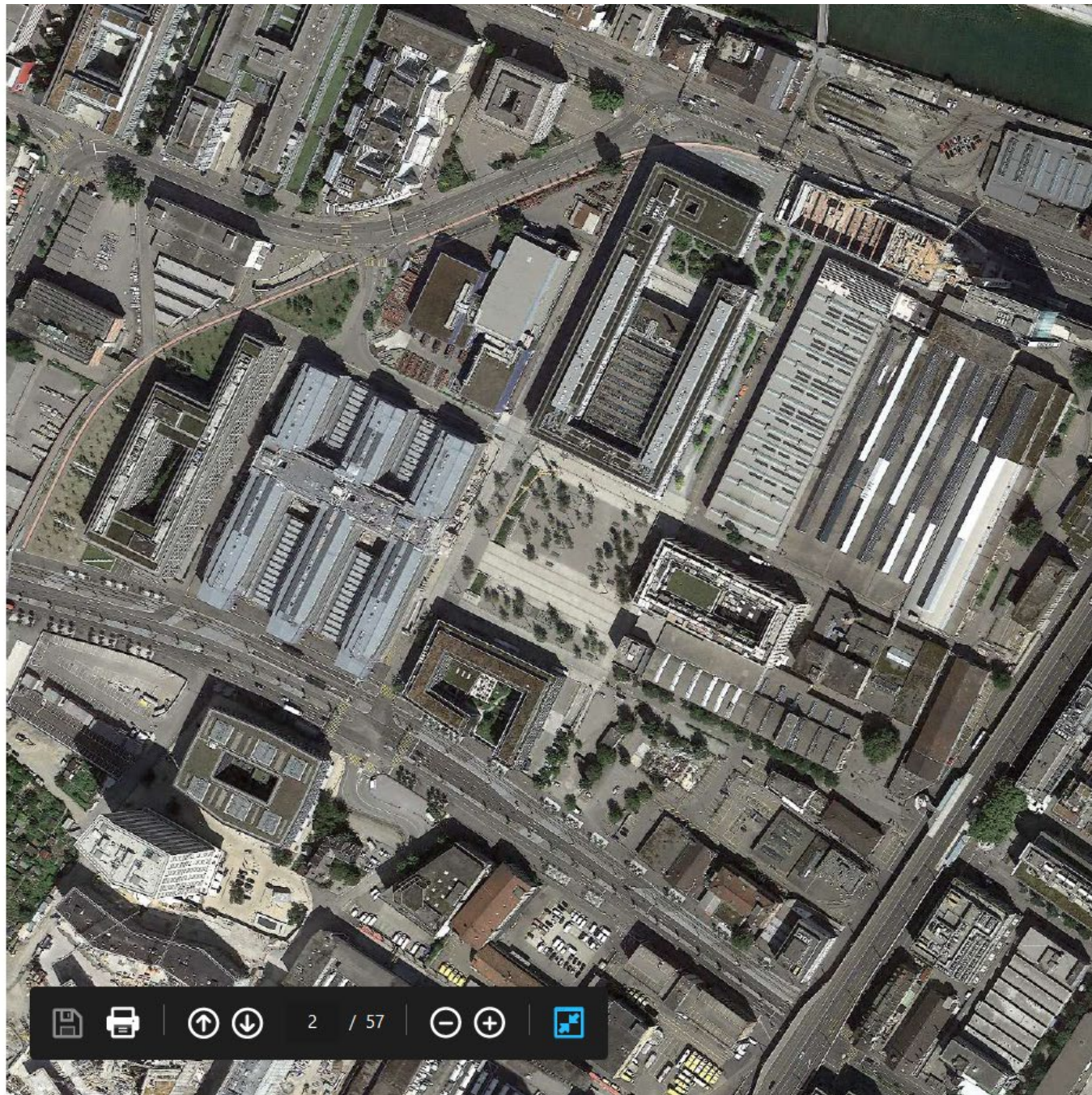
Ingénieur civil : Flückiger + Bosshard, Zurich

Ingénieur civil : Passera & M. Pedretti, Zurich

Ingénieur électricité : Suselectra Ing., Bâle

Nomination au "Auszeichnung für gute Bauten der Stadt Zürich 2002-2005"

Distinction "Die Besten 2004", catégorie paysage (prix Hochparterre)



2

/ 57





At-source control: runoff control



Parking with important
mouvements during the day



Pervious pavement



Porous pavement:

- with / without infiltration, detention
- Reduction of noise
- Cleaning effect for pollutants
- Security
- Costs
- Special maintenance



At-source control: runoff control



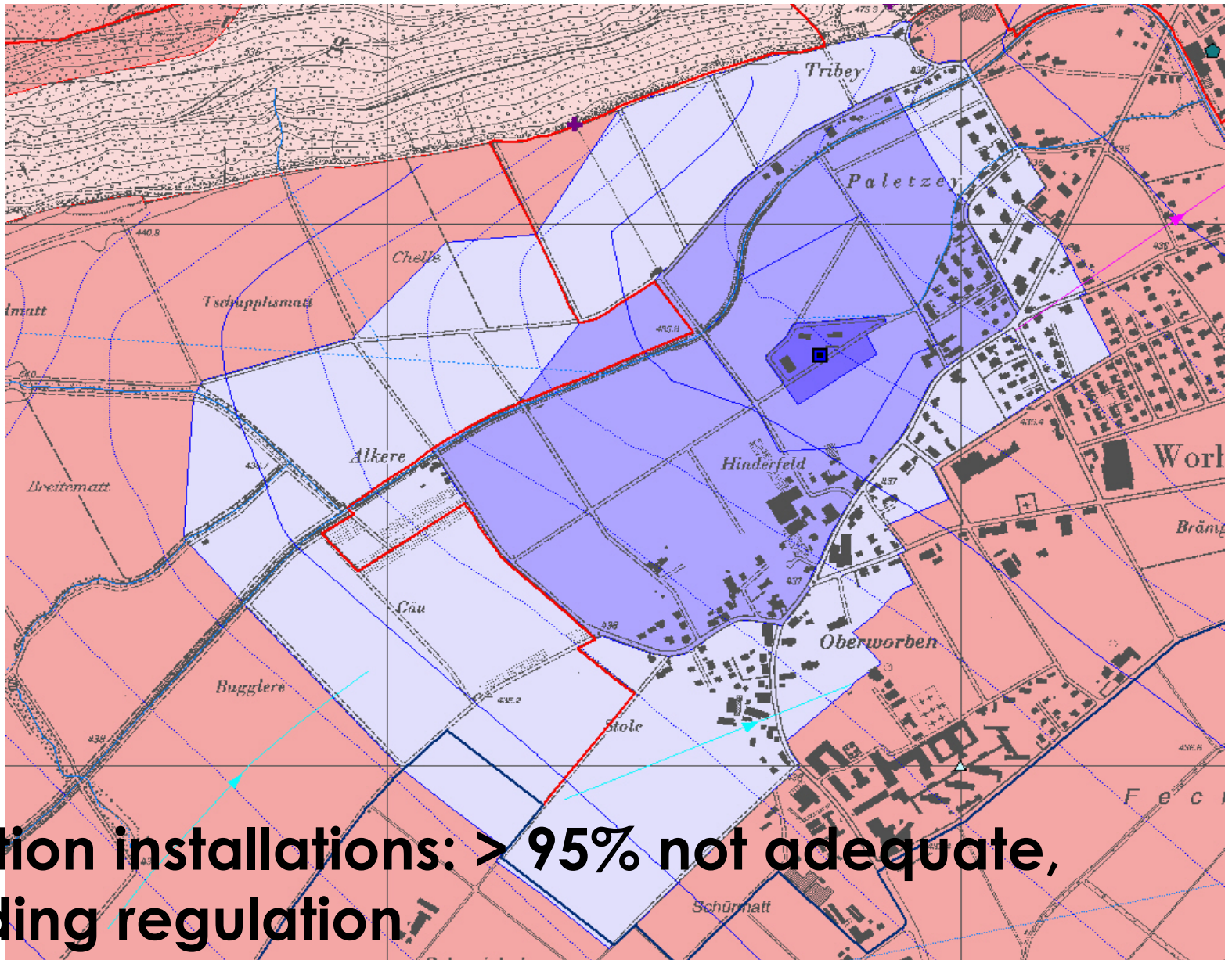
In situ controls: a priori the ideas are good, in practice they don't follow the Cantonal / Federal guidelines !



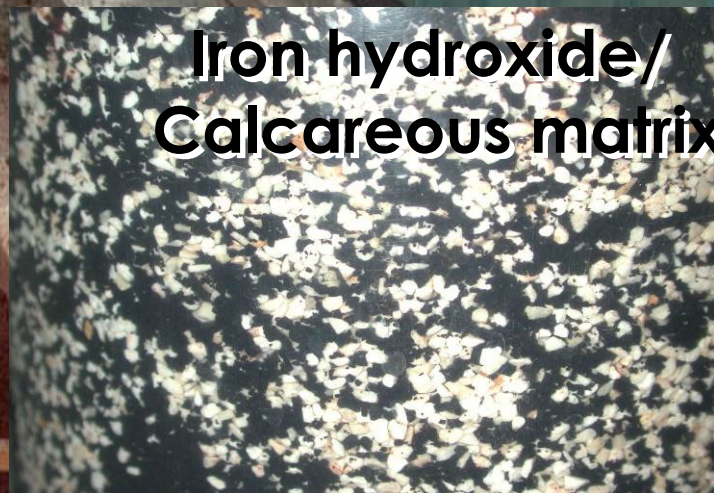
Source: « *Expériences avec les installations d'infiltration* », M. Stämpfli / J.-P. Clément, OPED, BE



WWTP Worben



**Infiltration installations: > 95% not adequate,
regarding regulation**



**Iron hydroxide/
Calcareous matrix**

Infiltration: pay
attention to water
contamination

New regulation on
adsorbers in
Switzerland

At-source water quality control for infiltration

The VSA guidelines defines requirements for treatment of stormwater:

- In case of infiltration
- With or without floor passage (= adsorption systems)

Infiltration							
Secteur de protection des eaux A _u , S1–S3, S _h , S _m , üB selon carte de protection des eaux	Passage à travers le sol (structure selon module DA, chap. 1.3)	Type de surface à drainer					
		Toitures et façades			Places et surfaces de circulation		
		Classe de pollution des eaux de ruissellement					
		selon tableau B6			selon tableaux B7+B8		
		faible	moyenne	élevée	faible	moyenne	élevée
Sol filtrant Installations d'adsorption	avec	+	+	+ ²	+	+	+ ²
	sans	+	+	B ^{élevé}	B ^{standard} ³	B ^{standard}	B ^{élevé}
	avec	+	+	+ ²	+	+	+ ²
	sans	+	B ^{standard} ¹	B ^{élevé}	B ^{standard} ⁴	B ^{standard}	B ^{élevé}



Legende	
+	Déversement admissible
B _{standard}	Déversement admissible avec traitement dans une installation du niveau d'exigences «standard» ou «élevé»
B _{élevé}	Déversement admissible avec traitement dans une installation du niveau d'exigences «élevé»

At-source water quality control for infiltration

How to reach the defined level of treatment for infiltration of contaminated stormwater runoff ?

Exigence	Degrés d'efficacité exigés			
	Charge hydraulique	MES	Métaux (cuivre, zinc)	Pesticides (Mecoprop, Diuron)
Standard	≥ 90%	≥ 80%	≥ 70%	≥ 70%
Élevé	≥ 90%	≥ 90%	≥ 90%	≥ 90%
Réduit*	≥ 90%	≥ 70%	—	—

* Ce niveau d'exigences n'est admissible que pour des eaux de chaussée non mélangée et uniquement dans certains cas (voir T
C'est pourquoi seules les exigences de la norme SN 640 361 ont été reprises.

Technical guidelines : test and validation
of manufactured solutions

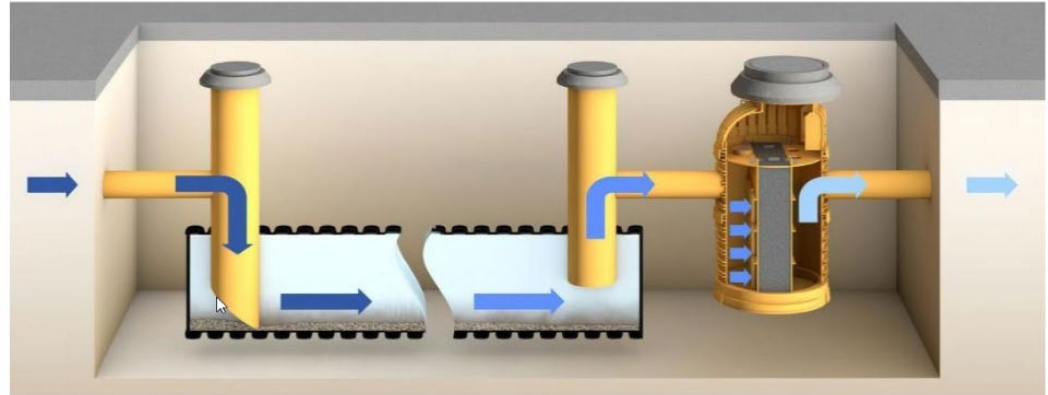
<https://vsa.ch/fr/fachbereiche-cc/assainissement-urbain/temps-de-pluie/adsorption/>



At-source water quality control for infiltration



ACO StormClean



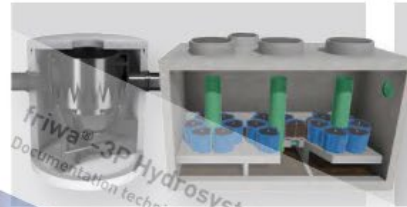
ACO RAUSIKKO HydroClean Pro CH



mall
umweltsysteme

FRIWA - 3P HYDROSYSTÈME

CREABETON

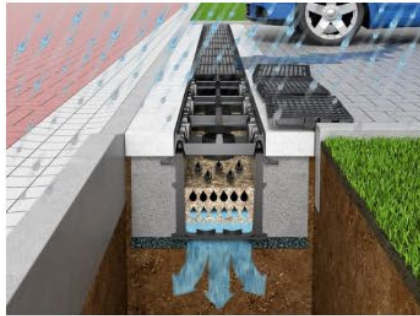


At-source water quality control for infiltration

D-Rainclean-Substrat



D-Rainclean Bassin d'infiltration
(Installation d'essai dans le cadre
du contrôle VSA)



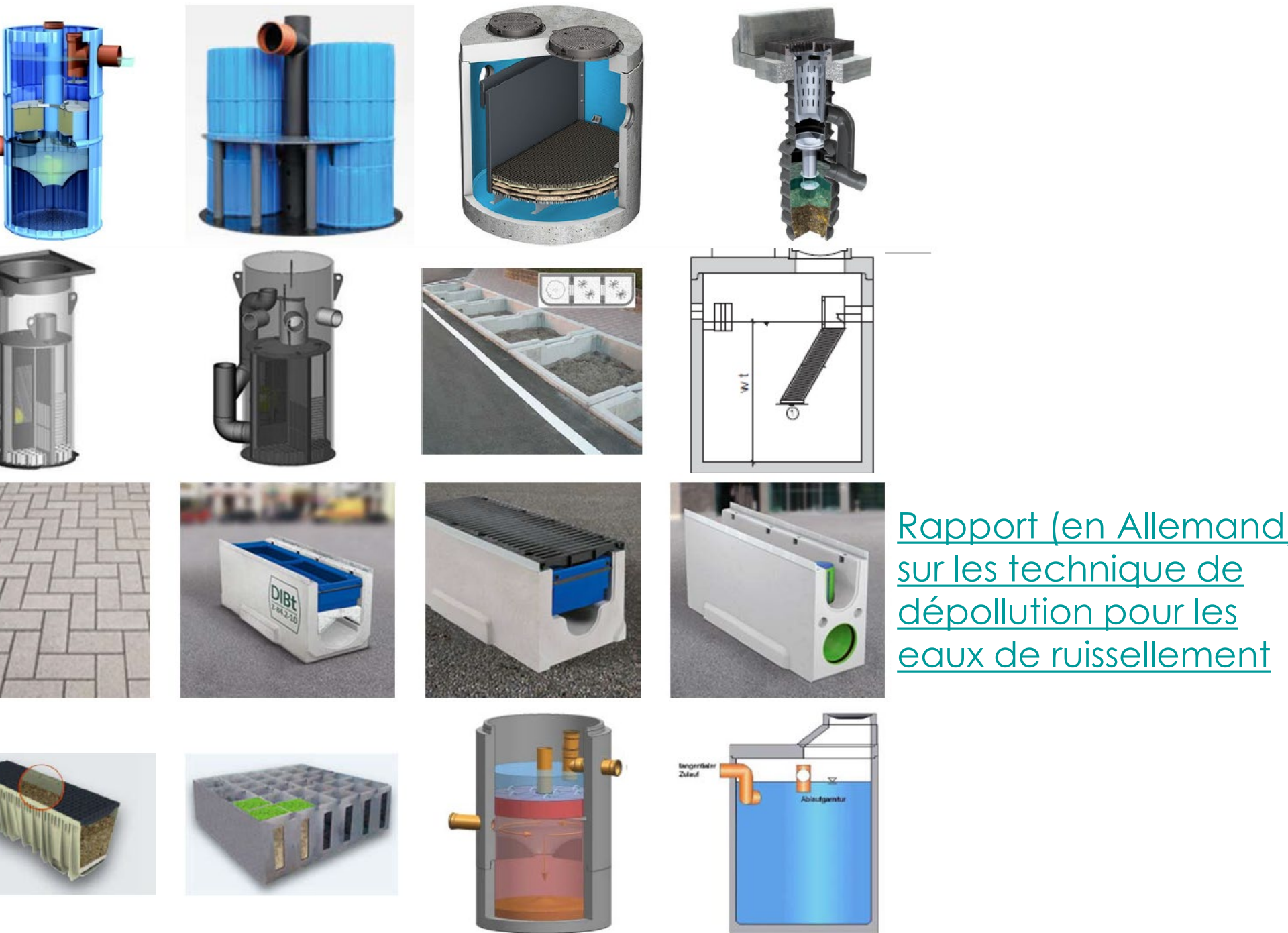
D-Rainclean Box



Funke Kunststoffe

D-Rainclean Cuvette de filtre





Rapport (en Allemand sur les technique de dépollution pour les eaux de ruissellement

At-source control: runoff control



At-source control: runoff control



plate-forme d'information ville éponge // sponge-city.info
pour une gestion de l'eau adaptée au climat en milieu urbain

DE FR

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[BONS EXEMPLES](#)

[OUTILS](#)

[ÉVÉNEMENTS & FORMATIONS](#)

[NOTRE RÉSEAU](#)

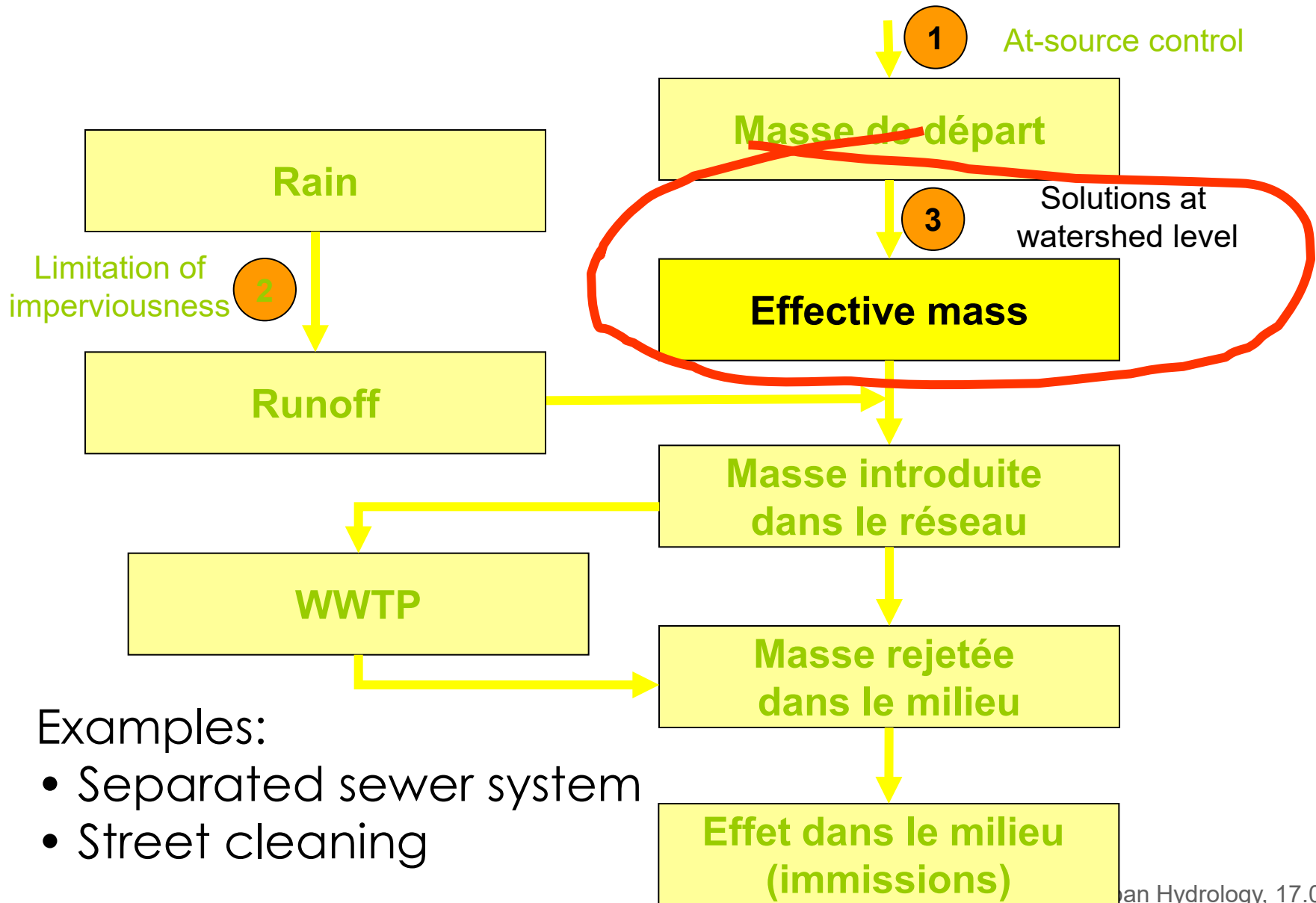


**Biotope avec fonction de retenue d'eau en cas de pluies intenses
dans le Parco Casarico**

**AVEC LE CONCEPT VILLE ÉPONGE VERS UN
ESPACE URBAIN DE QUALITÉ ET ADAPTÉ AU
CLIMAT**

<https://sponge-city.info/>

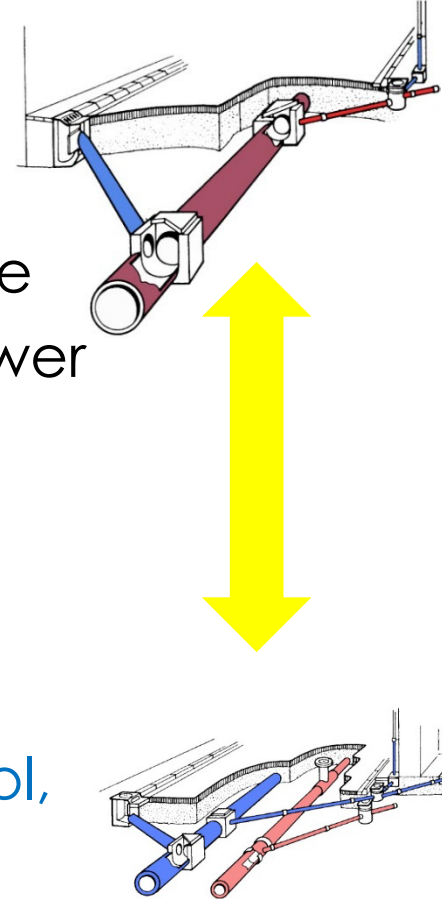
Solutions at watershed level





Solutions at watershed level: Separated or combined sewer systems ?

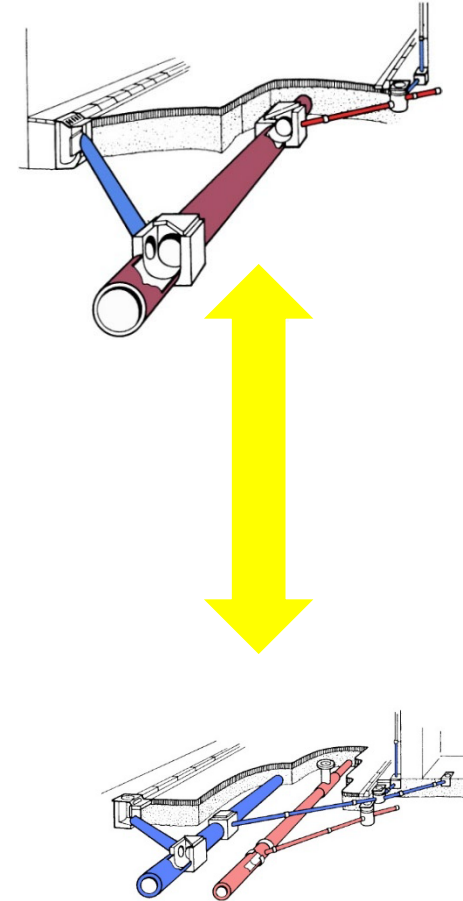
- Module E VSA guidelines
- This answer is linked with the characteristics of the receiving waters, the watershed, the existing sewer system...
- Use the criteria and the evaluation matrix to evaluate the situation
- « *Turbo combined system* » (système modifié):
optimization of existing network (real time control, storage capacities of the sewer network...)





Solutions at watershed level: Separated or combined sewer systems ?

Critère	Propriétés		Pondération
	1 point	3 points	
Topographie	Plat, faible pente ou contre-pente (évacuation vers la STEP à l'aide d'une station de pompage)	Pente suffisante (évacuation vers la STEP par écoulement gravitaire possible)	1
Situation des eaux réceptrices	Proches du bassin versant	Assez éloignées du bassin versant	3
Densité des constructions	Faible densité des constructions (p. ex. zone de maisons individuelles)	Grande densité des constructions (p. ex. centre ville)	2
Place dans le coffre de route	Amplement suffisante	Peu de place	1
Infrastructures existantes			
• Système d'évacuation des eaux	Système séparatif	Système unitaire	3
• Gestion des eaux unitaires	Inexistant ou ne satisfait pas aux exigences selon l'examen de l'admissibilité pour le déversement d'eaux unitaires (voir module de base)	Existe et satisfait aux exigences selon l'examen de l'admissibilité pour le déversement d'eaux unitaires (voir module de base)	3
• STEP	Faible capacité de tampon hydraulique	Grande capacité de tampon hydraulique, réserves, éventuel traitement des eaux unitaires à la STEP possible	1



Somme des points ≤ 32 : tendance au système séparatif

Somme des points ≥ 40 : tendance au système unitaire

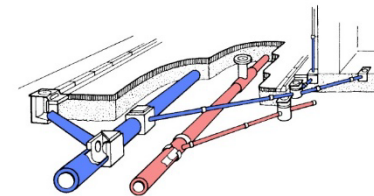
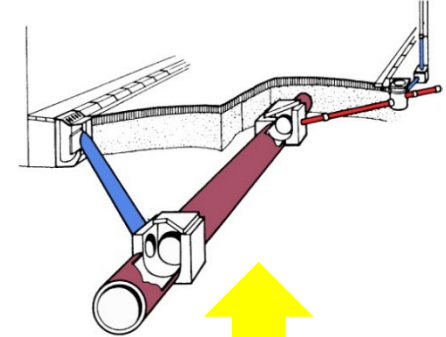


Solutions at watershed level: Separated or combined sewer systems ?

Exemple d'application (proche de Bâle)



Kriterium	Punkte	Gewichtung	Produkt	Bemerkung
Topographie	1	1	1	plat
Lage des Gewässers	1	3	3	Proche de la rivière
Dichte der Bebauung	3	2	6	Conditions urbaines
Platz im Strassenkörper	3	1	3	Très peu de place disponible sous la route
Bestehendes Entwässerungssystem	3	3	9	Unitaire, certains rejets sont traités
Bestehende Mischabwasserbehandlung	2	3	6	Traitement des eaux mixtes à la STEP Acheminement long, lieux de baignade
ARA	2	1	2	capacité-tampon moyenne de la STEP
Fremdwasser	3	2	6	< 10% d'ECP
Behandlungsbedürftiges Regenabwasser	3	2	6	Industrie, beaucoup de trafic
		Summe:	42	Tendance à l'unitaire



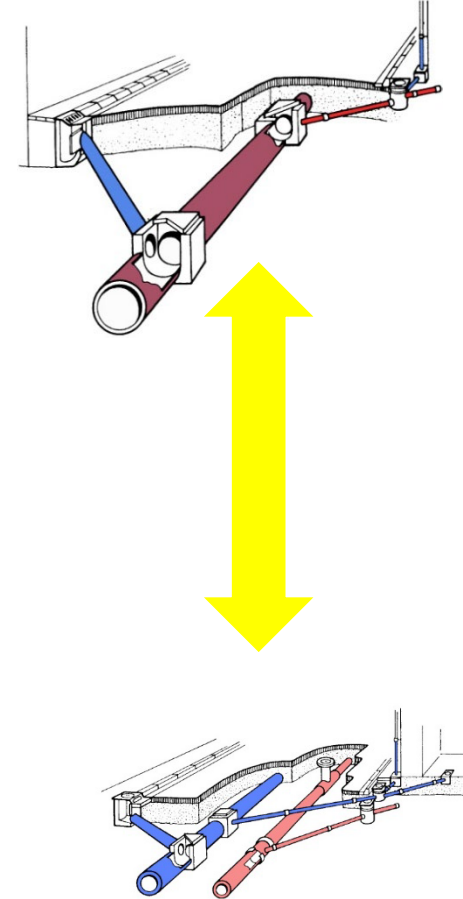
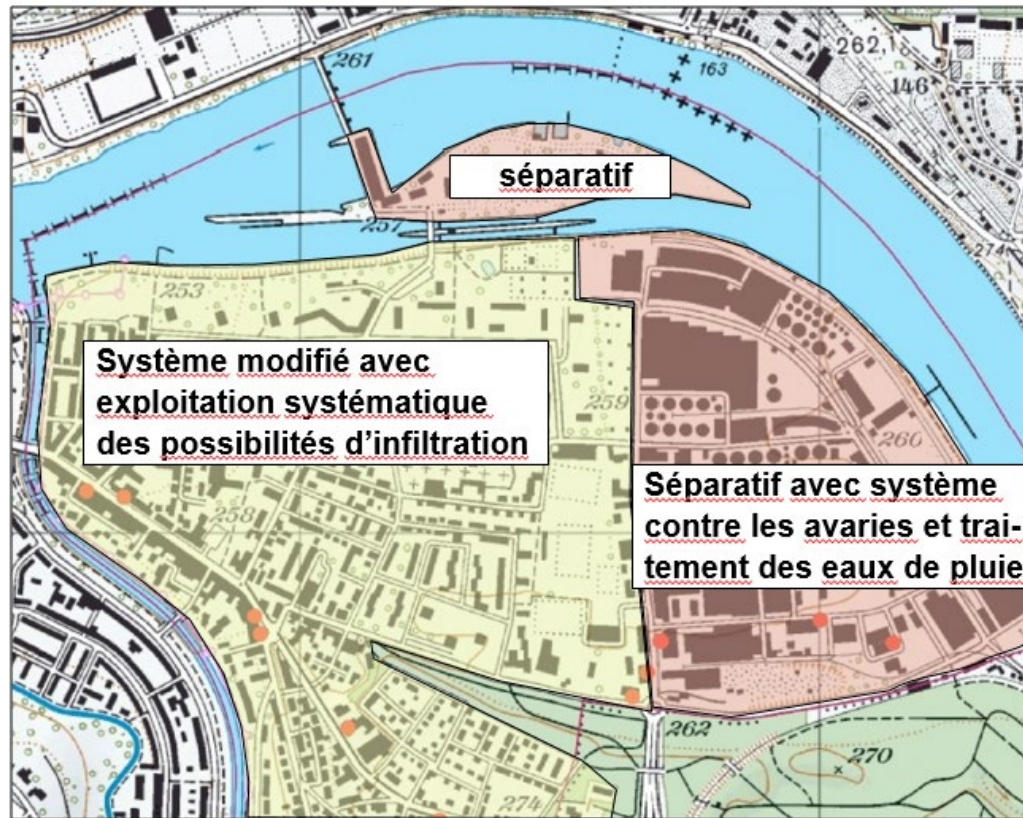
La méthode est à utiliser avec **discernement**.

Elle peut être **adaptée** en fonction des situations rencontrées.



Solutions at watershed level: Separated or combined sewer systems ?

Conclusions pratiques dans cet exemple



Solutions at watershed level:

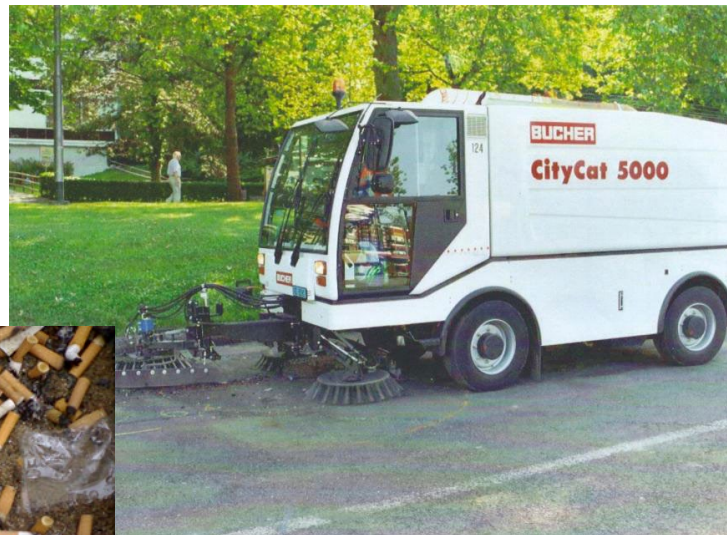
Street cleaning



Cleaning with
aspersions/vaccum

Main goal: littering

Lifespan in the environment: 12 years



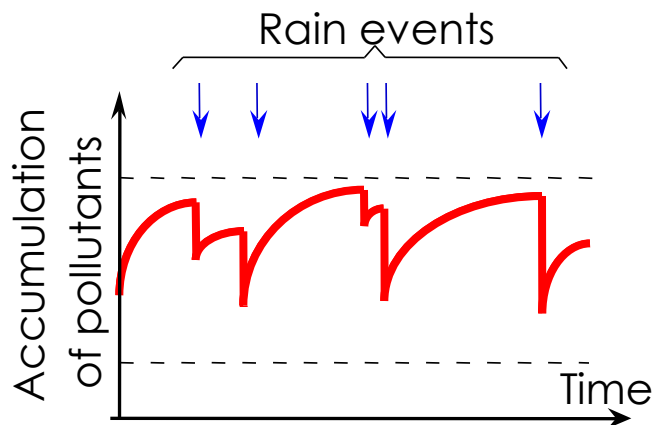
Geneva: 1.5 Mio / day



<https://vsa.ch/fr/M%C3%A9diath%C3%A8que/vsa-ecobox/>

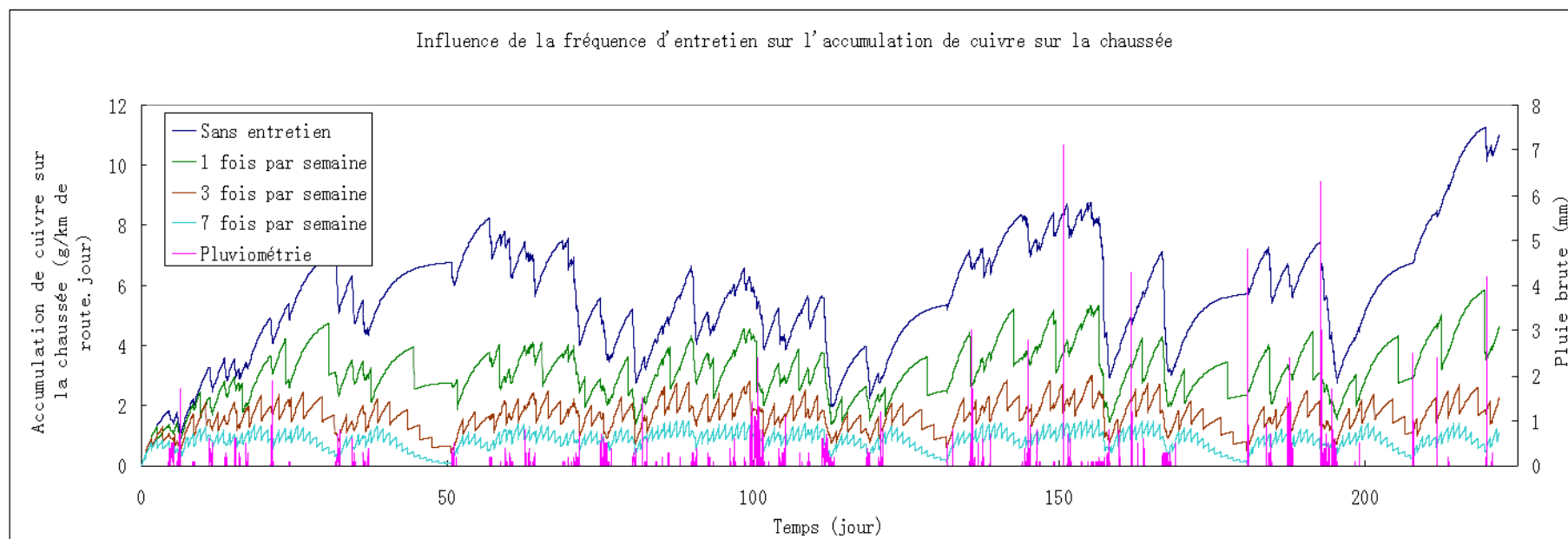
Solutions at watershed level:

Street cleaning



Street cleaning in Lausanne:
66 Frs/m/year (90% salaries)

Optimal frequency: 3 -7 /week



Source: Juliana León et Qingxia Zhong, Design Project 2009

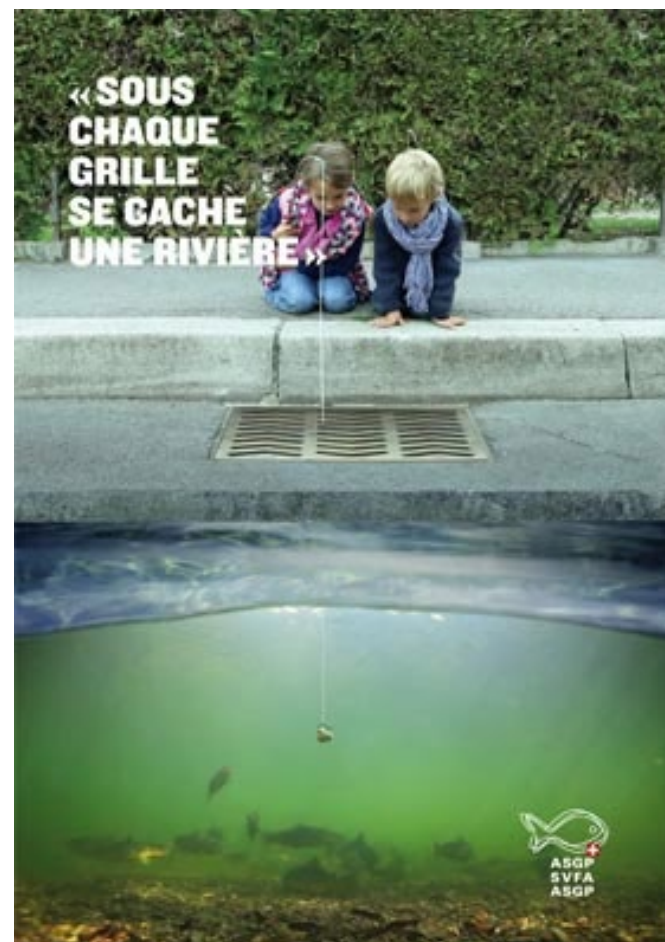
Solutions at watershed level: Public information



www.vsa.ch



www.vonroll-hydro.ch



www.aquava.ch/
Association Suisse
des Garde-Pêche (ASGP)

Solutions at watershed level:

Other solutions



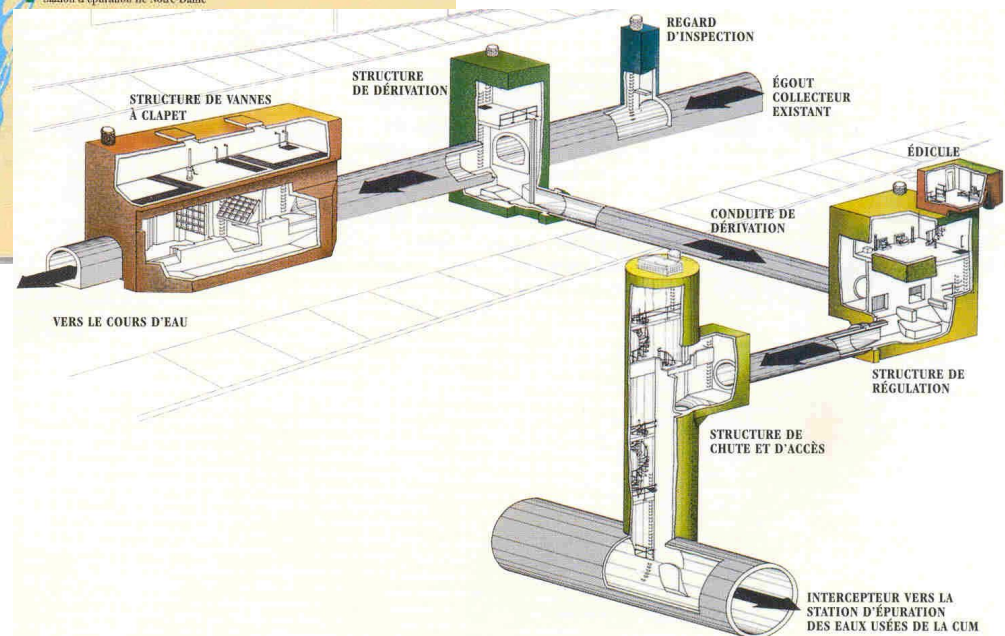
- Wastewater detention
 - studies in Lausanne /Baden /Geneva...:
interesting solution for micropollutants in hospitals
- Pre-treatment of industrial wastewater
 - Mandatory or not
 - Auto-control
- RTC (Real Time Control)
 - Coordination (WWTP, industries, city managers...)
 - Take into account „Worst-Case“ scenario
 - Example: CUM Montreal, NoMix technology, RTC for sewer systems in Lausanne...

Solutions at watershed level:

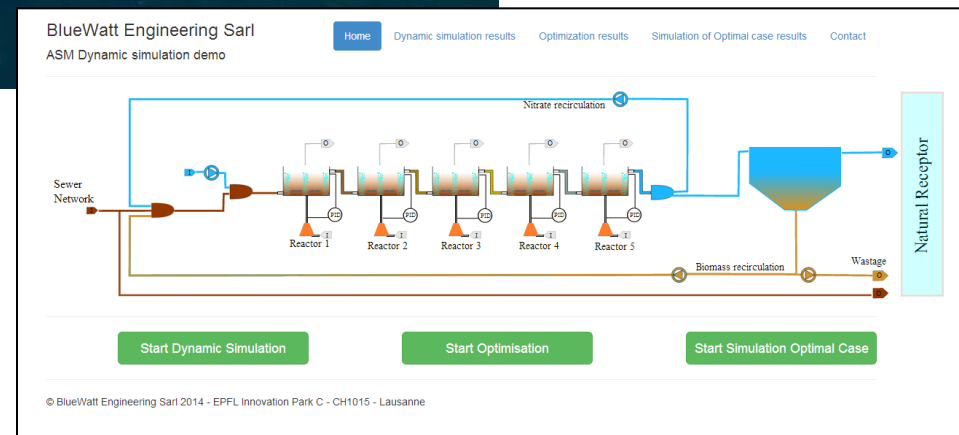
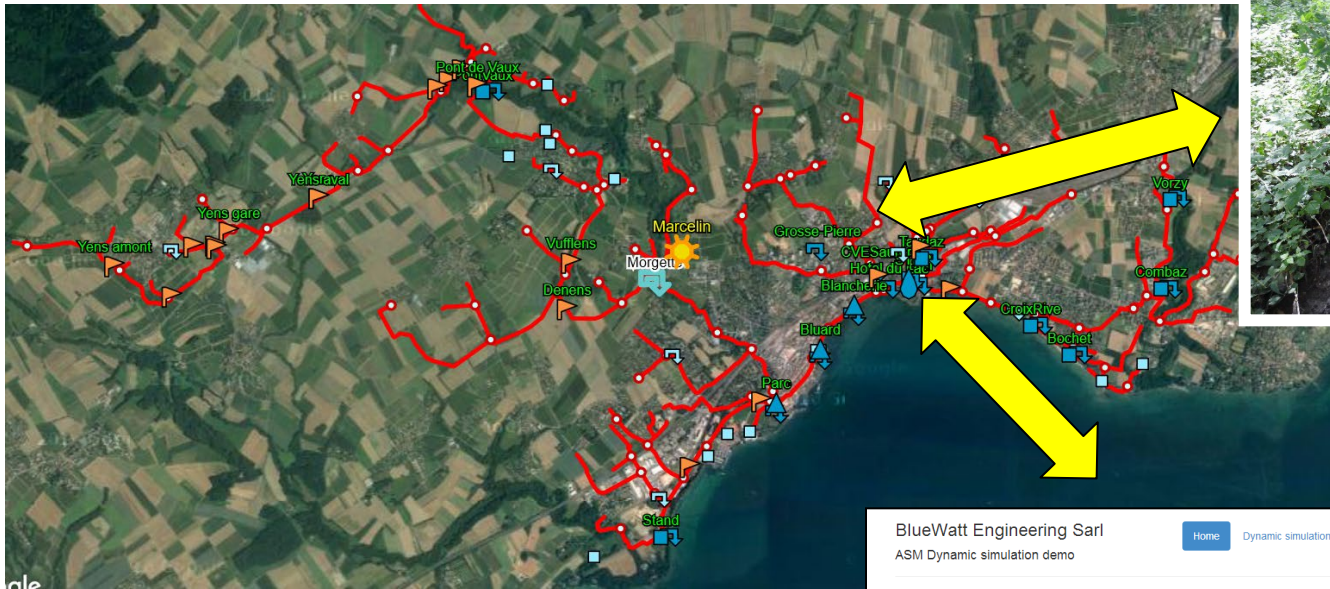
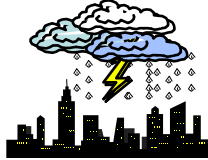
Real time control



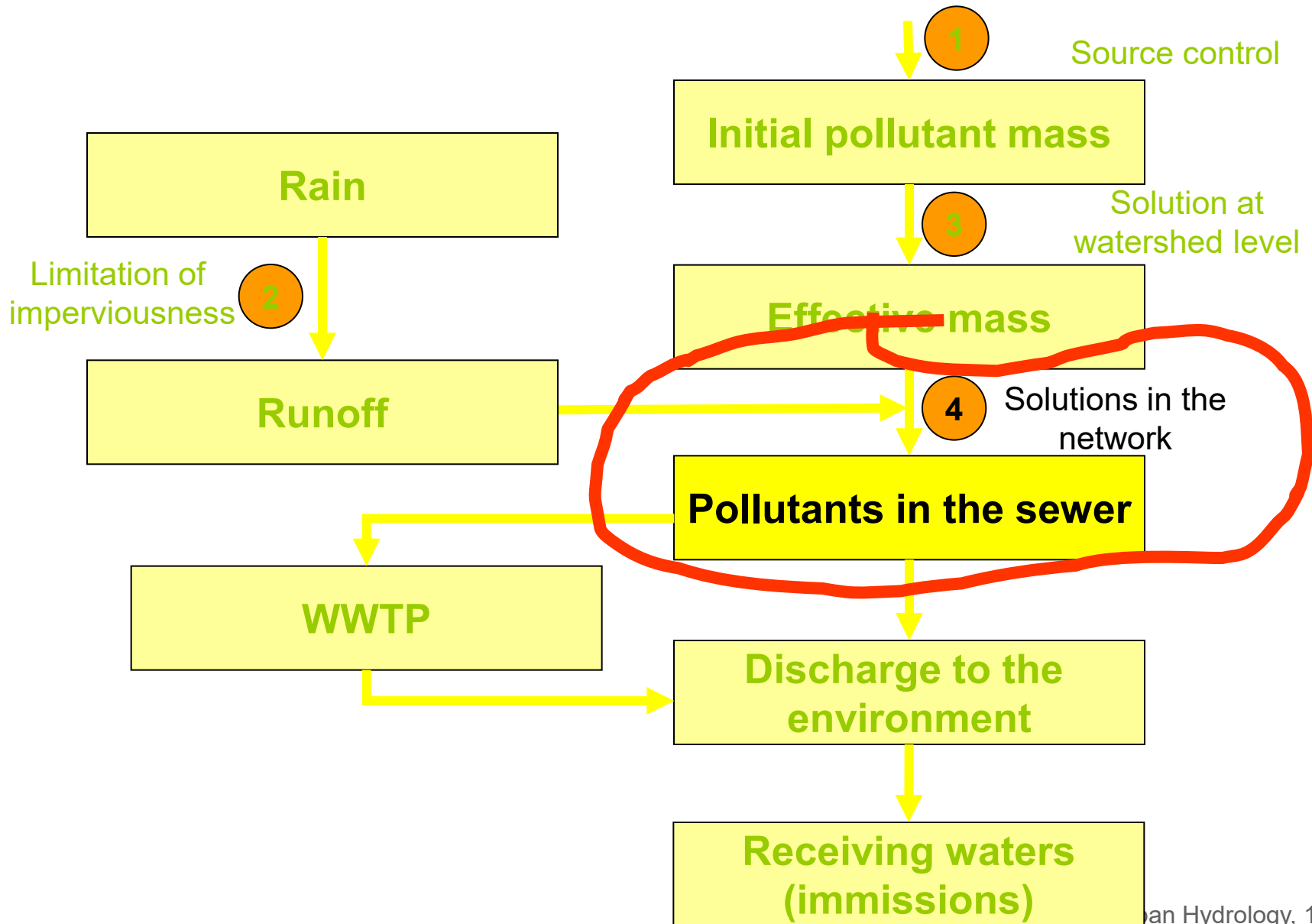
Example of the interceptors system for the CUM (Communauté urbaine de Montréal)



Solutions at watershed level: Real time control



Solutions in the network

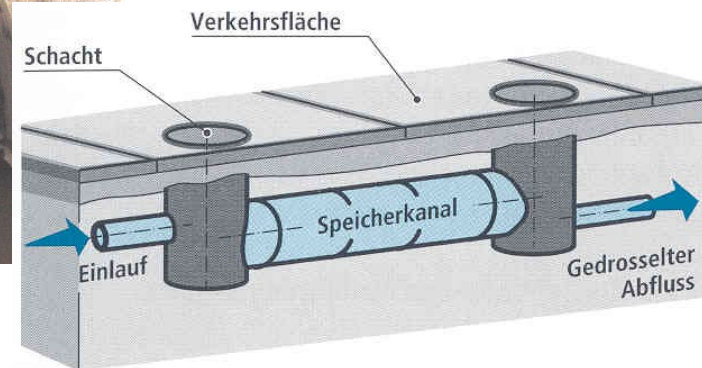
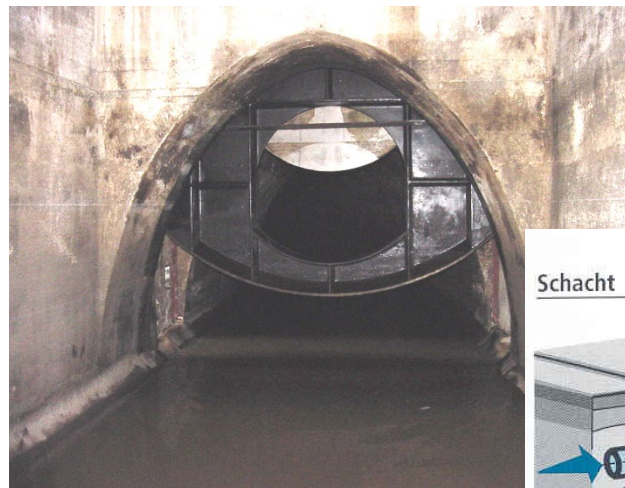


Solutions in the network



Different solutions, as for example:

- Manhole
- „Flush Gates“
- Sediment trap
- On-line detention
- ...



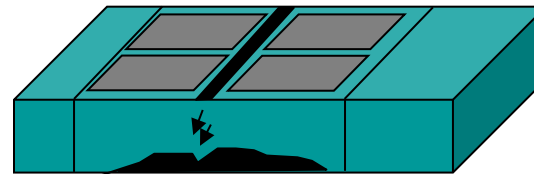
Solutions in the network: sediment trap



ERZ
Entsorgung +
Recycling Zürich

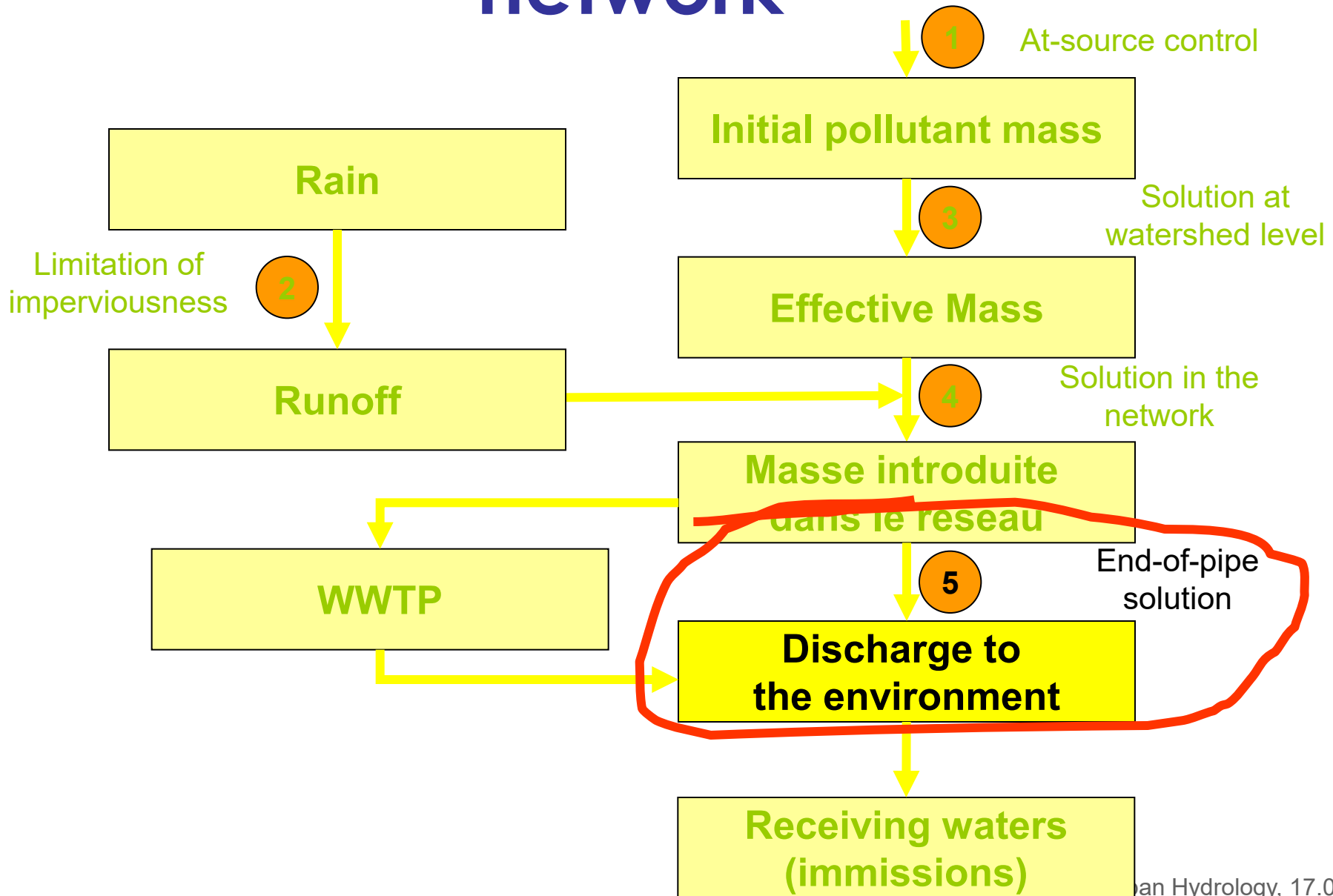


Volume: 37.5 m³



See also Capelard in Lausanne!

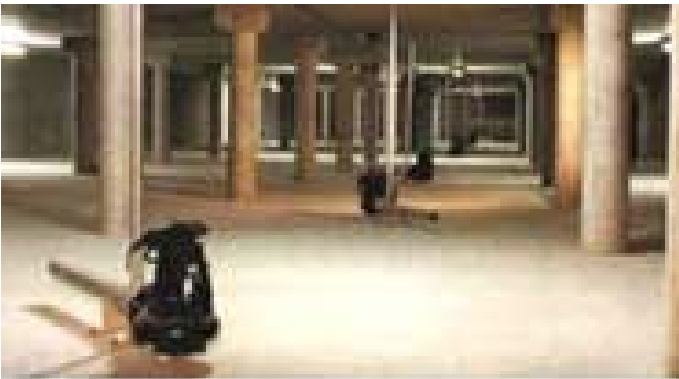
Solutions at the end of the network



Solutions at the end of the network



- Detention and settling systems
- Special solutions (lamellar, vortex, adjunction of chemicals...)
- Screening

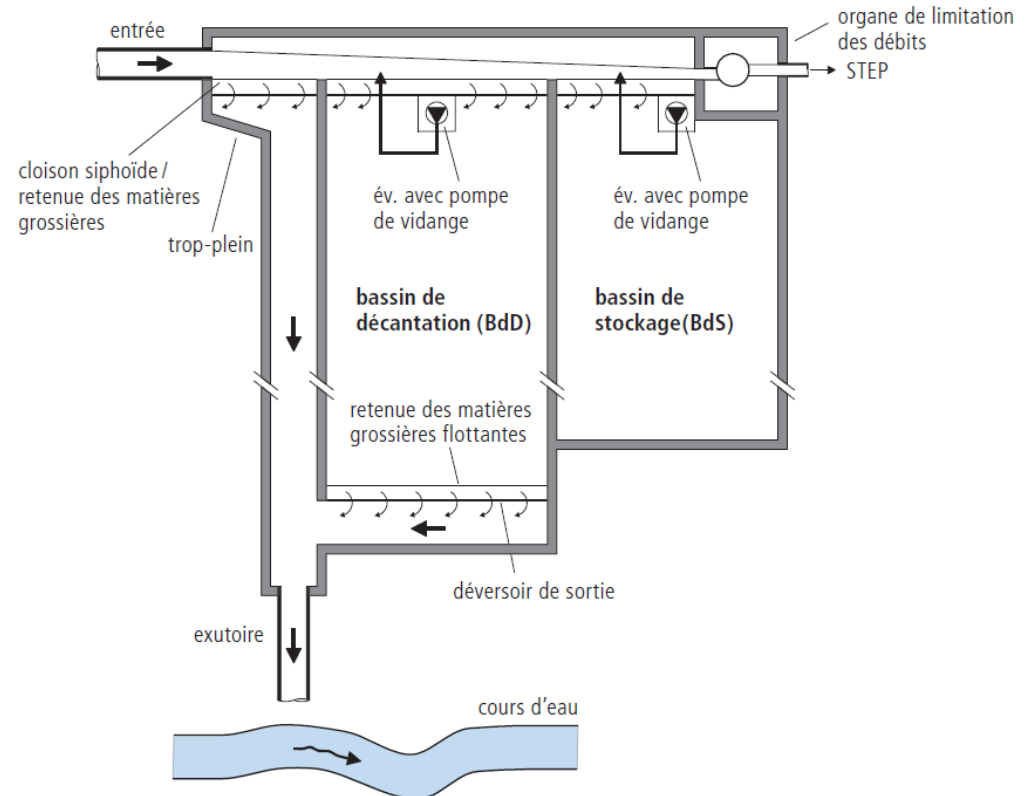
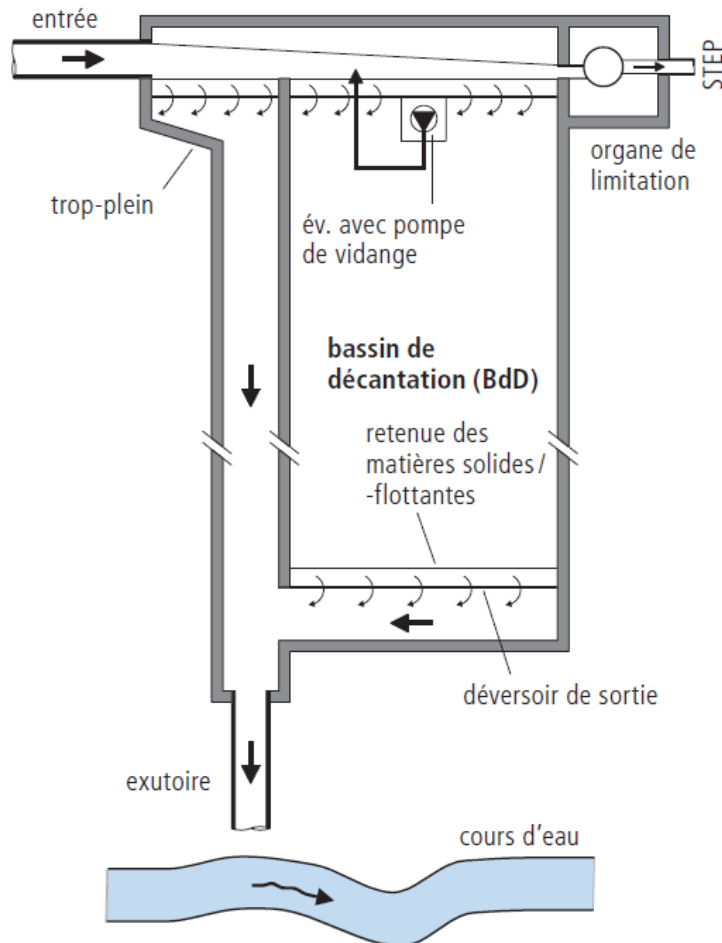


Solutions at the end of the network



- Detention and settling systems

Figure 7.5: Représentation schématique d'un bassin de décantation en parallèle avec év. un trop-plein de sécurité en amont.



Directive pluviale, module DB

Solutions at the end of the network

- Different solutions, mainly underground
- Old principle (Swiss German: one detention pond after each CSO...)
- Detention volume: the volume in the network itself is usually not considered
- Real efficiency of detention pond for TSS removal ?



Solutions at the end of the network: Efficiency of detention ponds



$$EFF = 1.0 - \left[1.0 + \frac{V_s}{n \cdot (Q/A)} \right]^{-n}$$

EFF: Yield / efficiency

Vs: Settling velocity of particles ($\text{m} \cdot \text{s}^{-1}$)

Q : Max. flowrate to the pond ($\text{m}^3 \cdot \text{s}^{-1}$)

A : Effective settling surface (m^2)

n : Turbulence and short-circuit factor (-)

Real efficiency of detention
pond for TSS removal ?
From -20% to 100%...

New tool: REBEKA-DIM



*Study of sedimentation processes in
detention ponds [Torres A, INSA Lyon, 2007]*

Solutions at the end of the network: Multi-functional solutions

Detention ponds
with different
structures



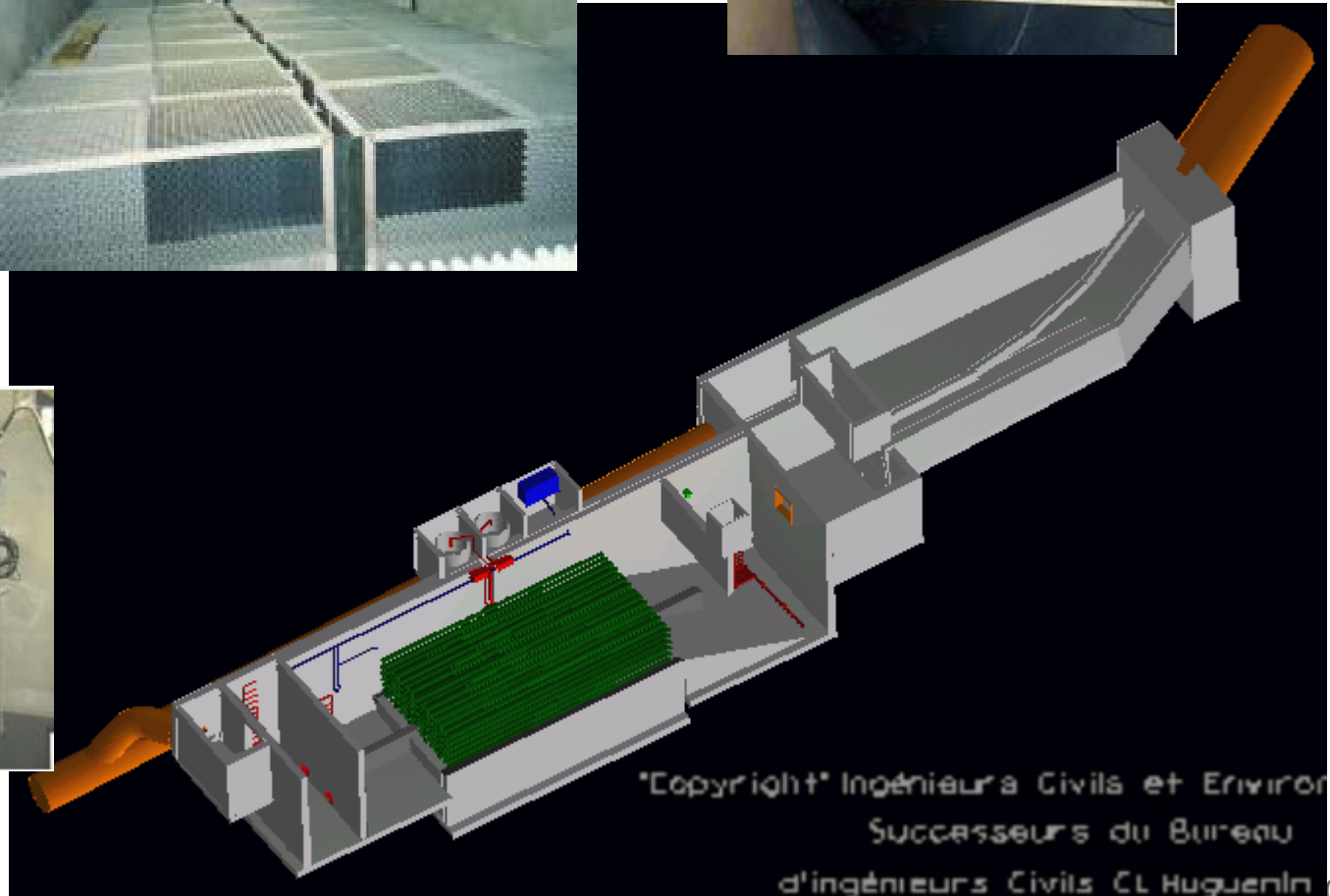
Solutions at the end of the network: Lamellar separator



Example in
Canton Geneva
(Frontenex),
Study made at
EPFL

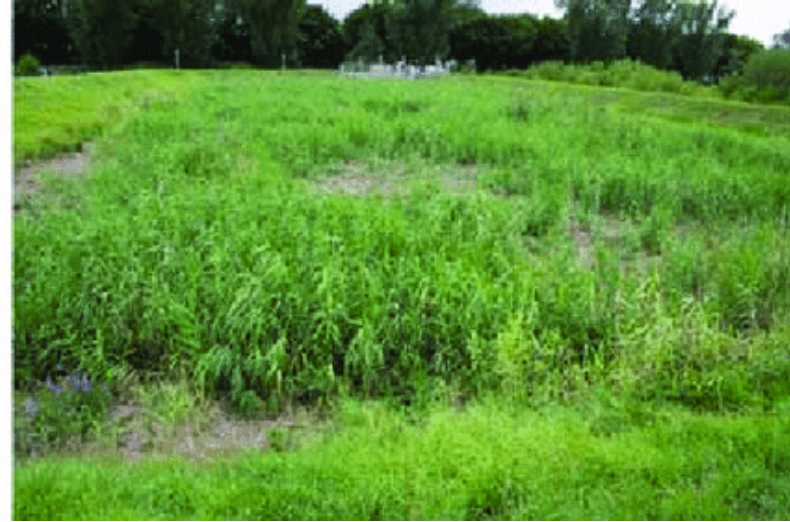


Mainly for
treatment of
stormwater.
Compact
solutions.

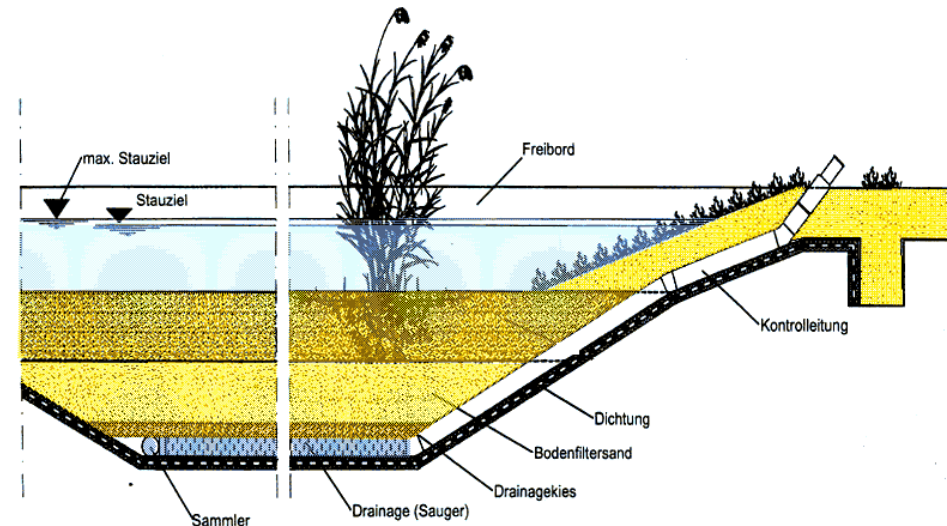


"Copyright" Ingénieurs Civils et Environnement
Successeurs du Bureau
d'ingénieurs Civils CL Huguenin

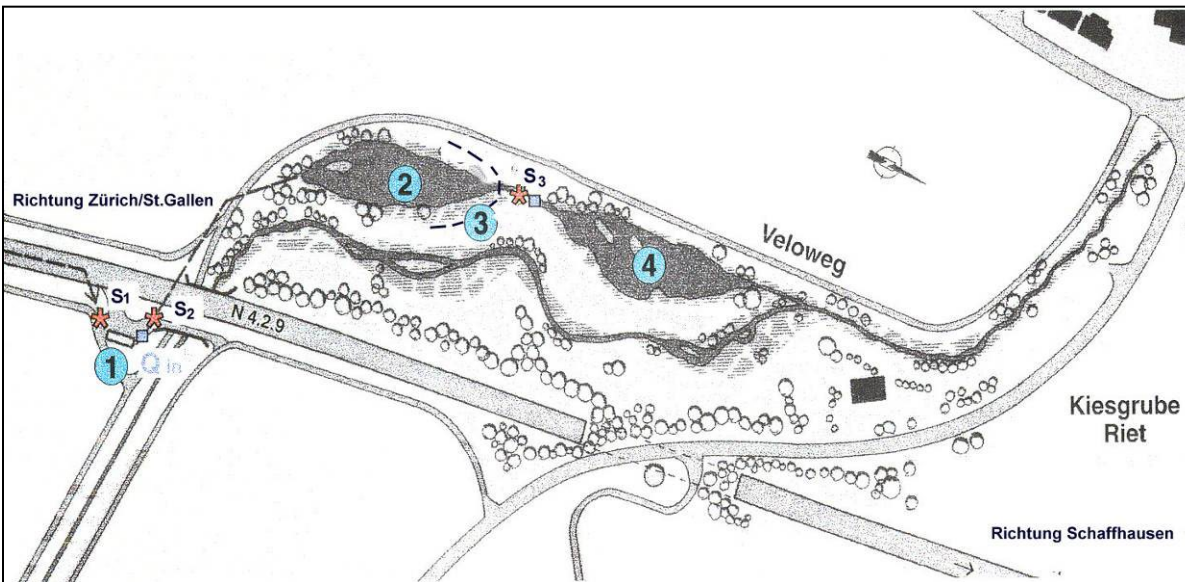
Solutions at the end of the network: Constructed wetlands



- Technology adapted for CSOs and stormwater
- Interesting landscape management possibilities in urban areas

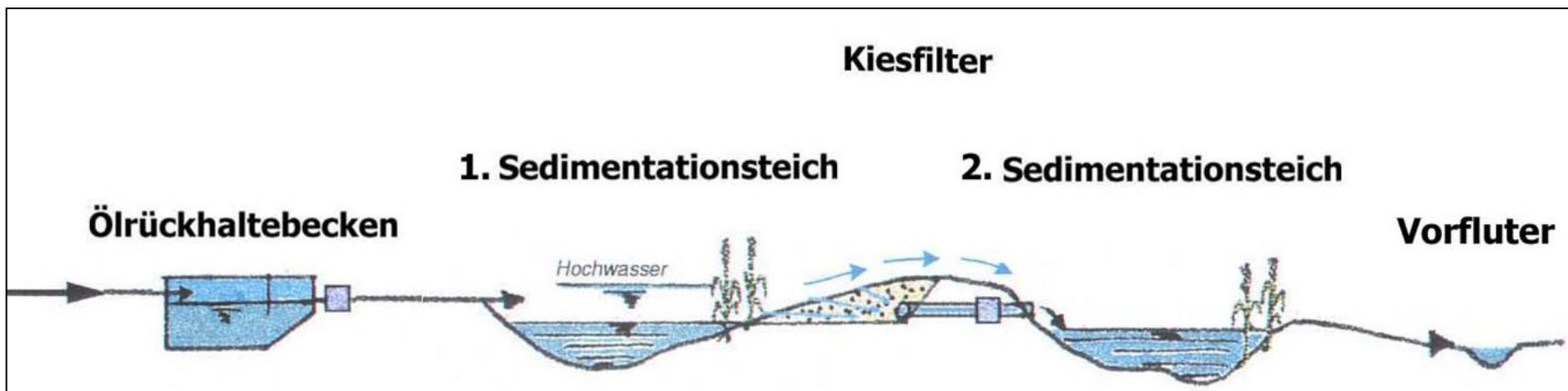


Solutions at the end of the network: Constructed wetlands



Installation
„Krebsbachknie“ for a
Highway:

Yield: 60 % bis > 90%
Costs after 4 years:
1500 Frs/ha_{road}
2 m³ Sludge/ha_{road}*y



Solutions at the end of the network: Constructed wetlands



Multi usage treatment systems: stormwater treatment coupled with recreational areas

Solutions at the end of the network: Screening of debris



Cf Capelard in Lausanne!



= indicator of wastewater discharge

Integrated solutions



Location: Böblingen/ Sindelfingen – Germany

Project: Former Airfield Böblingen/ Sindelfingen

Architects: AP Plan Mory, Osterwalder, Vielmo, H. Kienle - Stuttgart

Commercial Development Project (90 ha)

Zero runoff settlement

- Decentralised storm water management
- Rainwater harvesting, treatment and reuse
- Harvesting of street runoff, treatment and reuse in a lake, 4,2 ha



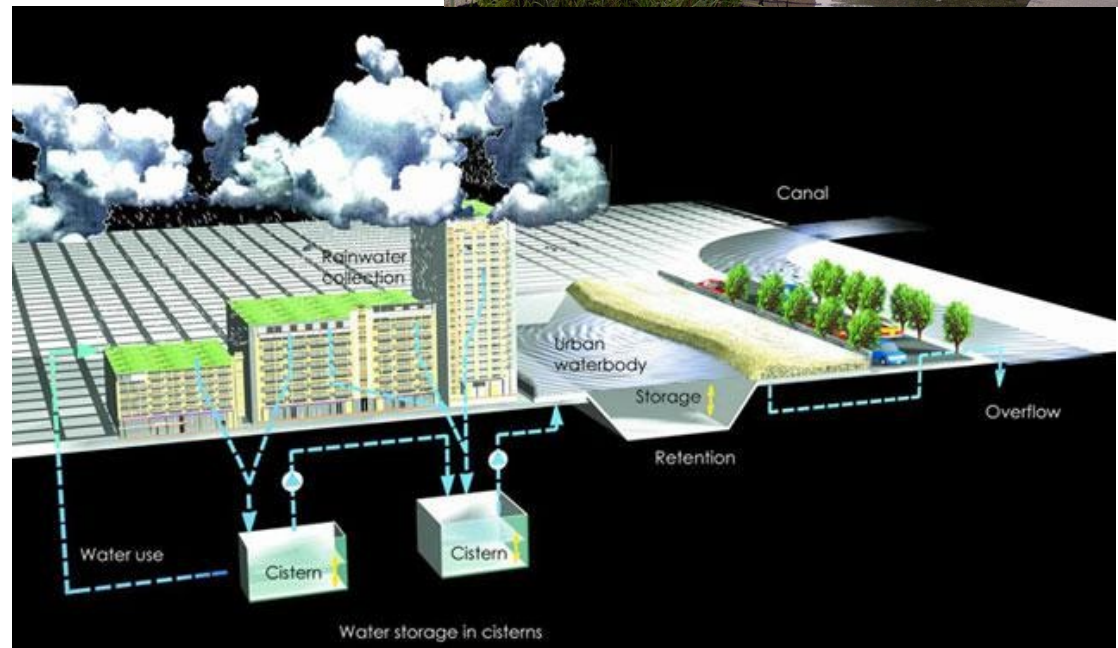
Integrated solutions: example Böblingen/ Sindelfingen



Integrated solutions



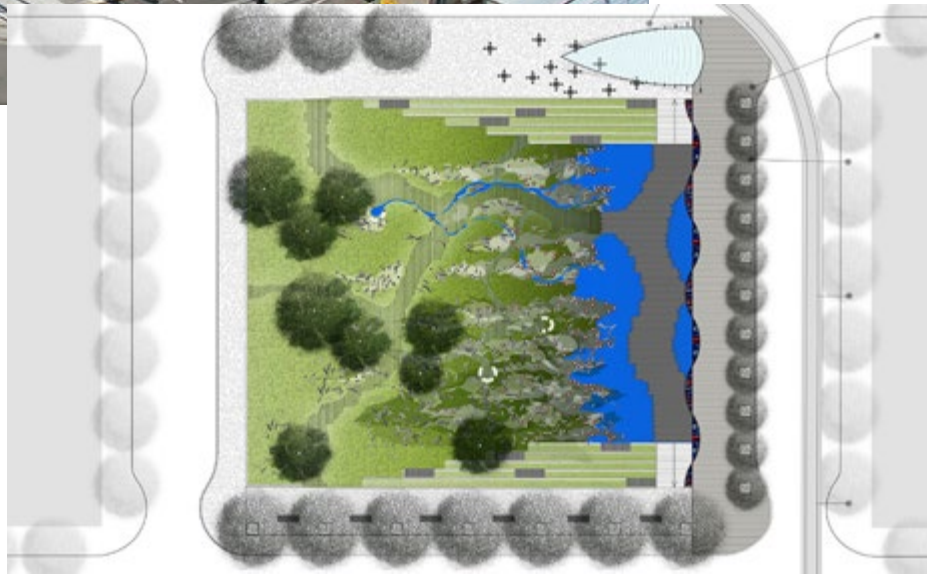
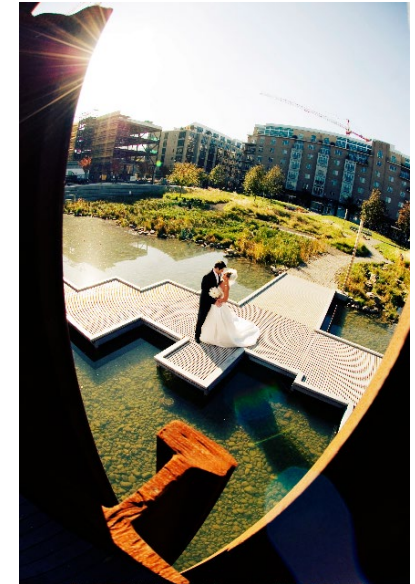
Location: Potsdamer Plaza - Berlin



Integrated solutions



Location: Tanner Springs-Park, Portland, USA





082

Y-Parc

Yverdon, Suisse, 2009-12

Principes de gestion des eaux, aménagement paysager et des espaces publics d'une zone d'activité

Maître d'ouvrage : Copropriété du PST (Ville d'Yverdon-les-Bains, ECA, Etat de Vaud)

Projet : 2008-2010

Réalisation : 2009-2012

En collaboration avec :

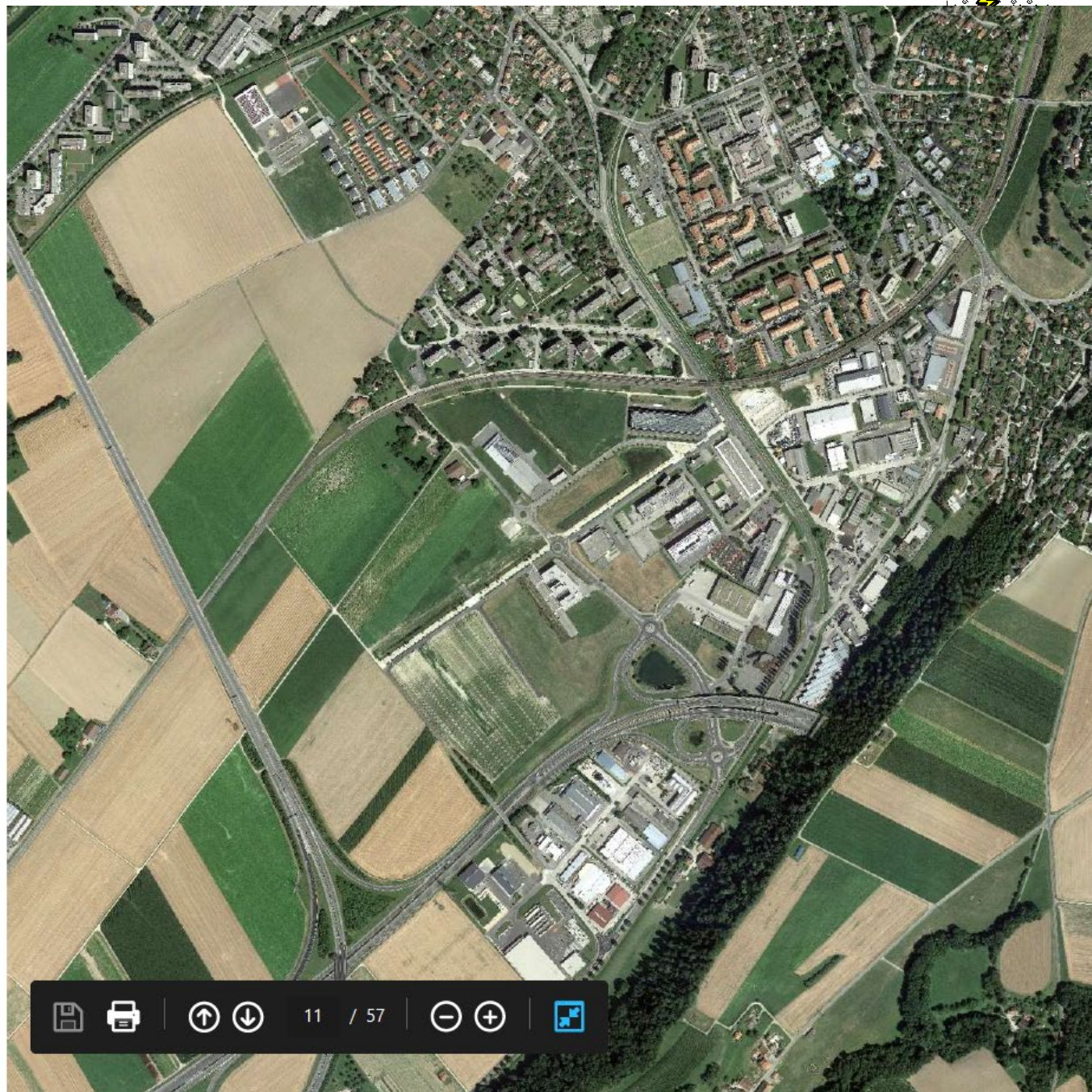
Fischer Montavon + associés, urbaniste,
Yverdon

Ingénieur civil : Perret-Gentil & Rey, Yverdon

Ingénieur env., 1^{re} étape : RWB, Yverdon

Ingénieur env., 2^e+3^e étapes : Biol Conseil,
Lausanne

Distinction du Flâneur d'or 2014 (prix Mobilité piétonne Suisse)



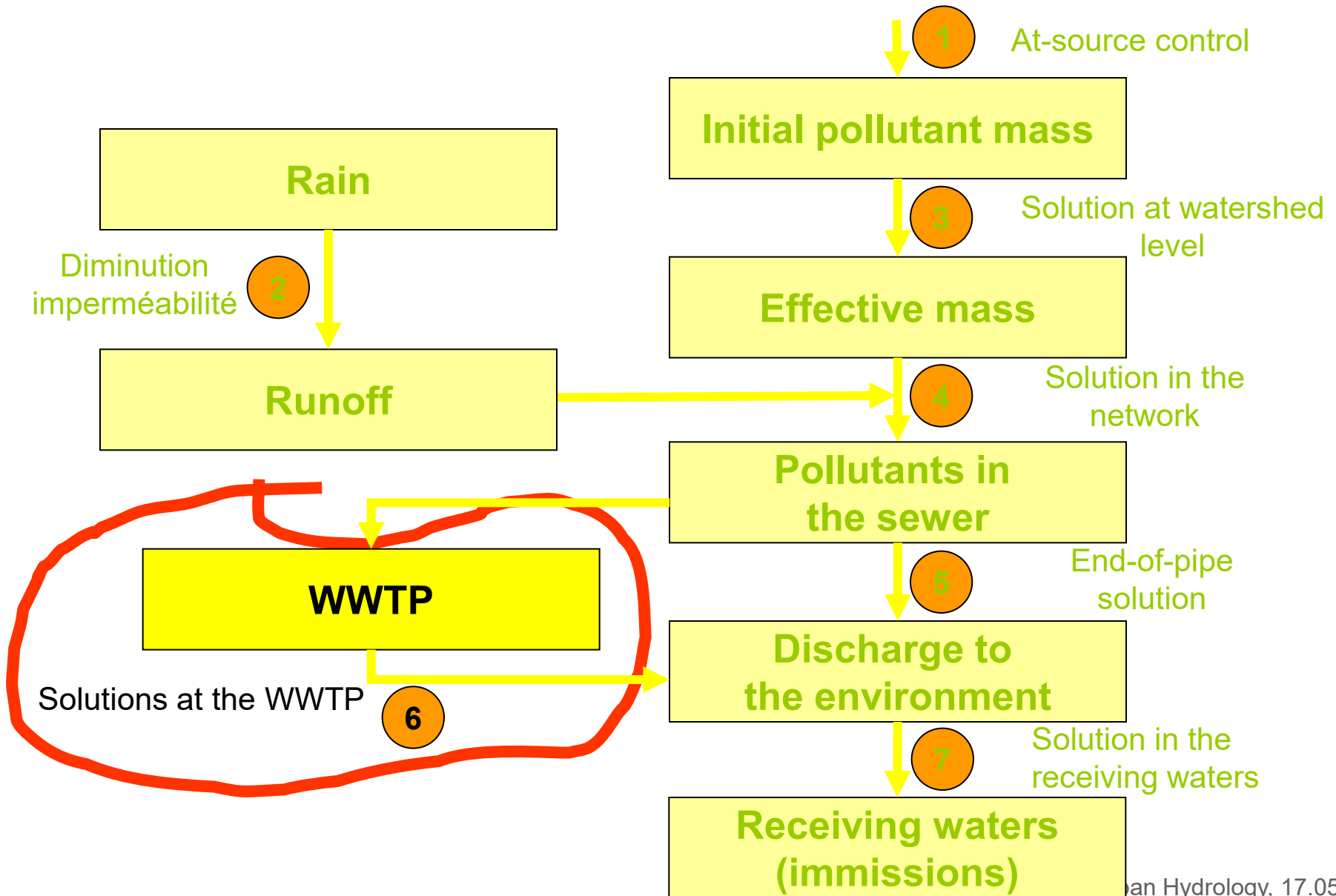
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Solutions at the WWTP



Solutions at the WWTP



- Lack of integrated approach: www.gire.ch
sewer system + WWTP + receiving waters
- Mainly three different treatment steps in WWTP:
pre-treatment, settling, biological treatment
- During rain events, the biological treatment is the
limitation step (overflow needed to protect the biology)
- “Dogma” for WWTP: max. $2 Q_{TS}$ (dry-weather flow)
- Depending on the technology, higher flowrate could be
considered, but generates higher costs of treatment

Source:  WABAG



SBR



MBR

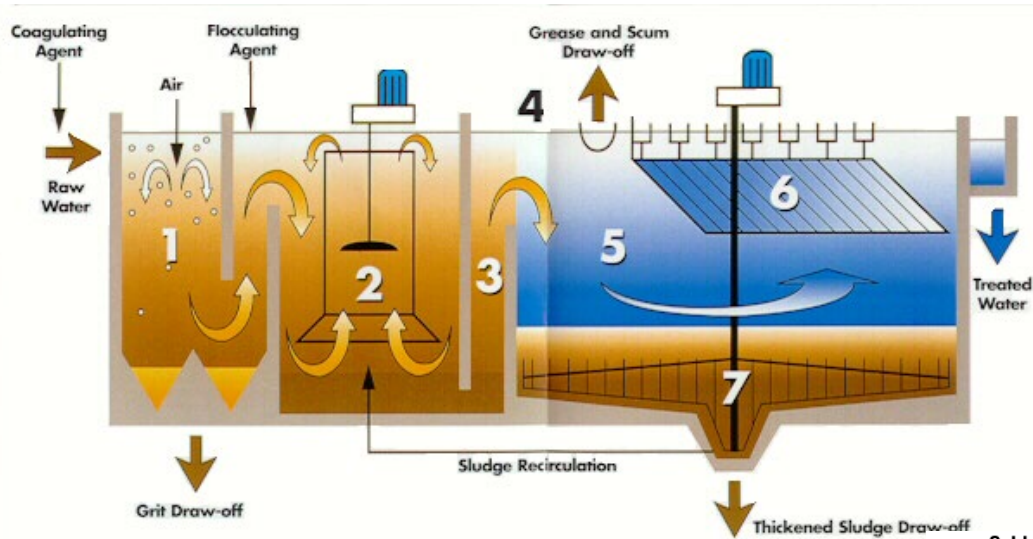
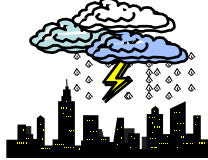


Biofiltre



Lit fluidisé

Solutions at the WWTP: compact solutions



Compact solutions, can be used during dry-weather to enhance the treatment of wastewater

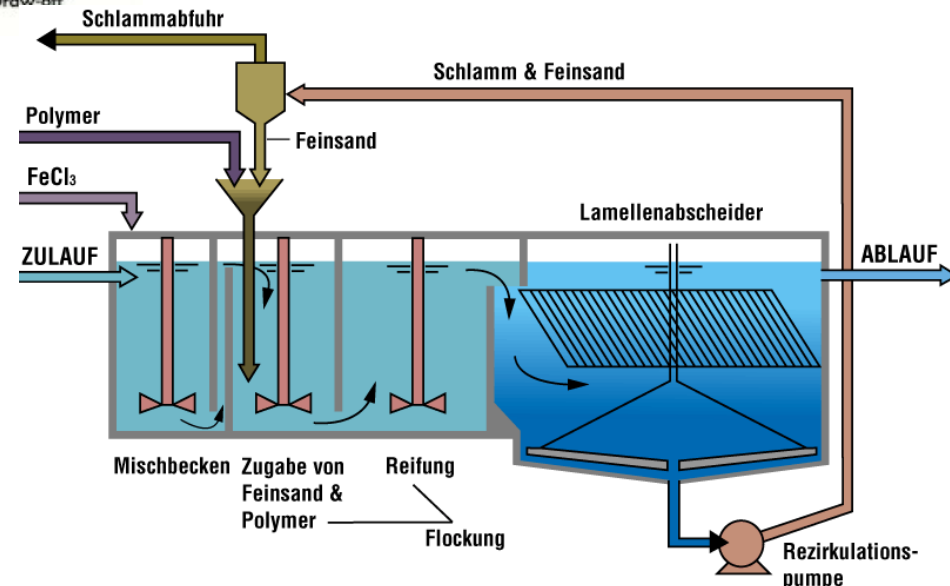


ACTIFLO

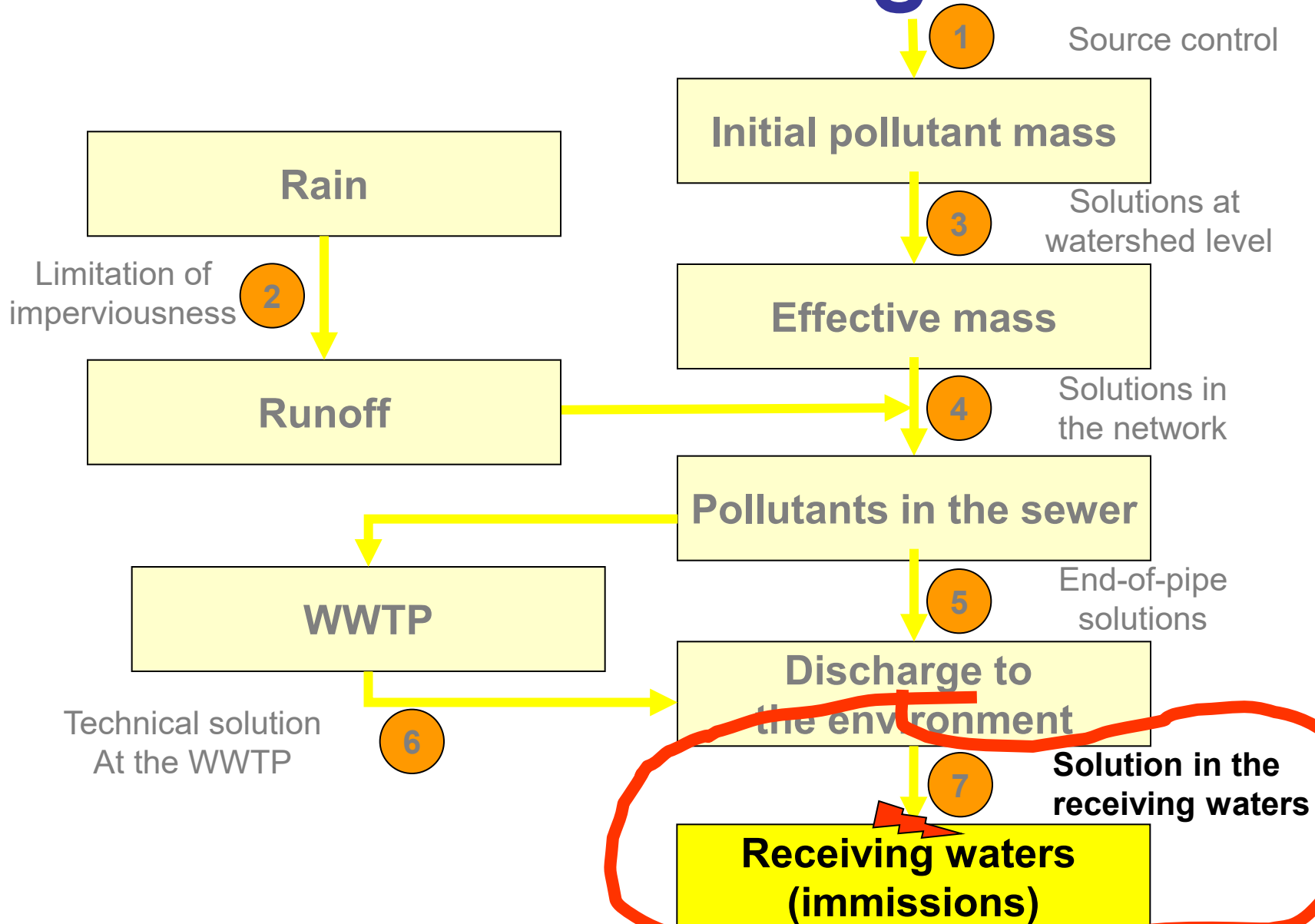
<http://www.veoliawater.com/>

DENSADEG (Degrémont)

<http://www.enquip.com/CSO-SSO.htm>

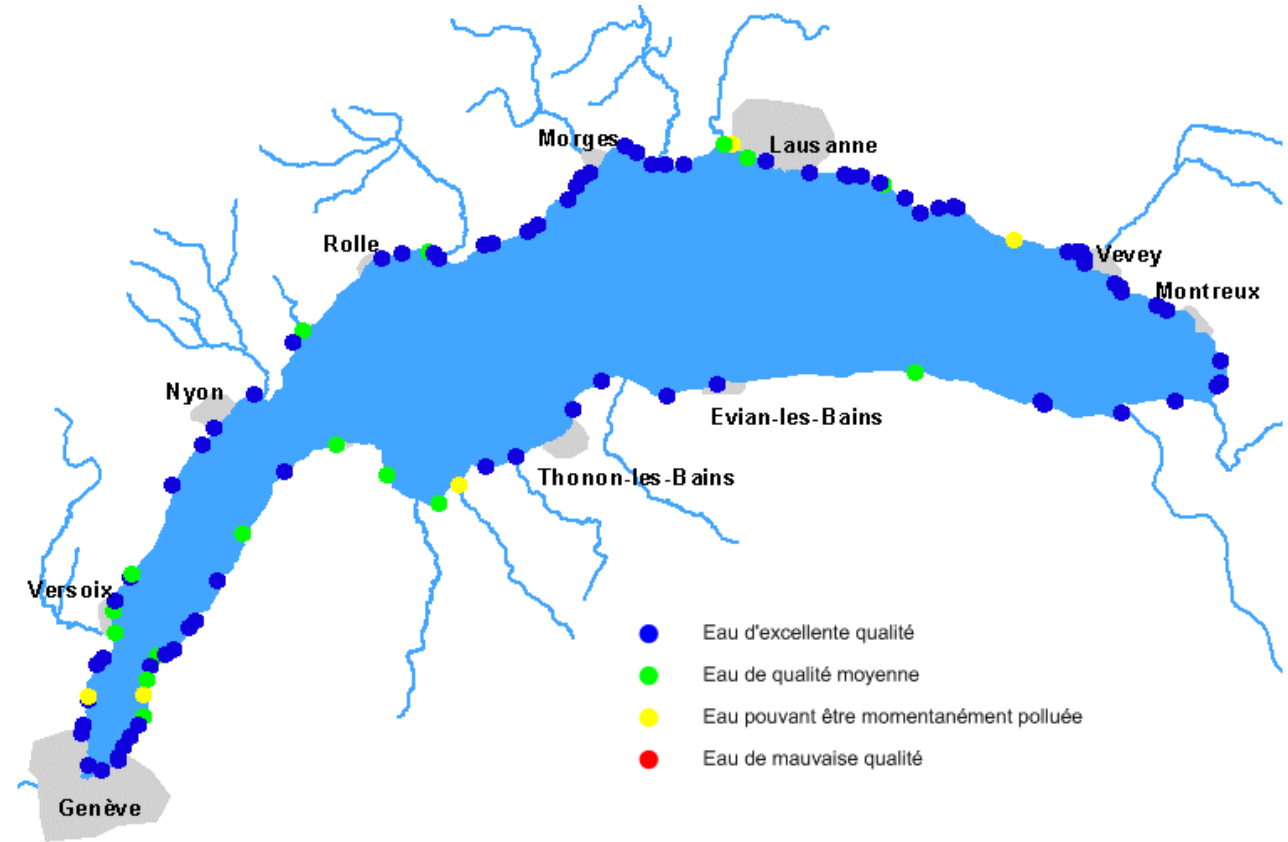


Solutions in receiving waters



Solutions in receiving waters

Non-structural solution: public information

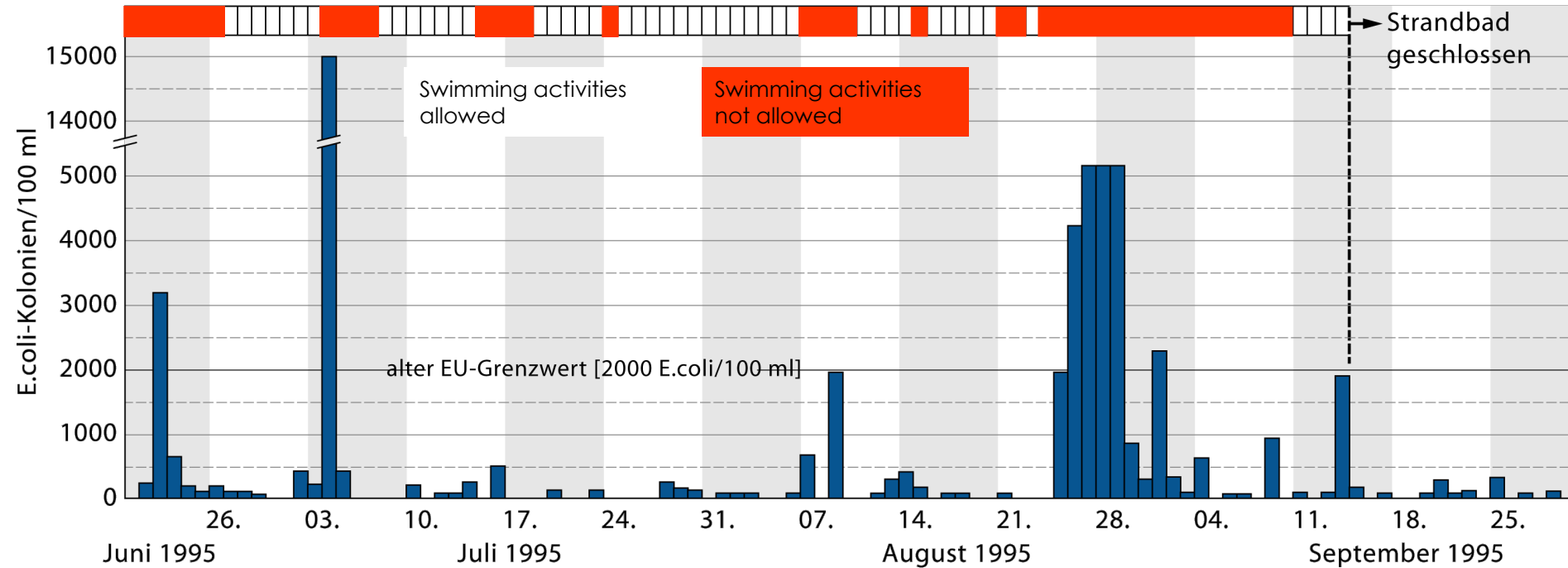


Solutions in receiving waters

Non-structural solution: public information



Example of „Real-Time-Control“ for *E.Coli* (Langenargen, Bodensee)



No swimming activities:

- During CSOs discharges
- Critical flowrate exceeded in a river (Schussen) near the beach



Solutions in receiving waters

Structural solution: morphological changes



- Changes in the morphology of the receiving waters
- Revitalization of rivers
- Set-up of flooding areas
- Shadow of riverbank

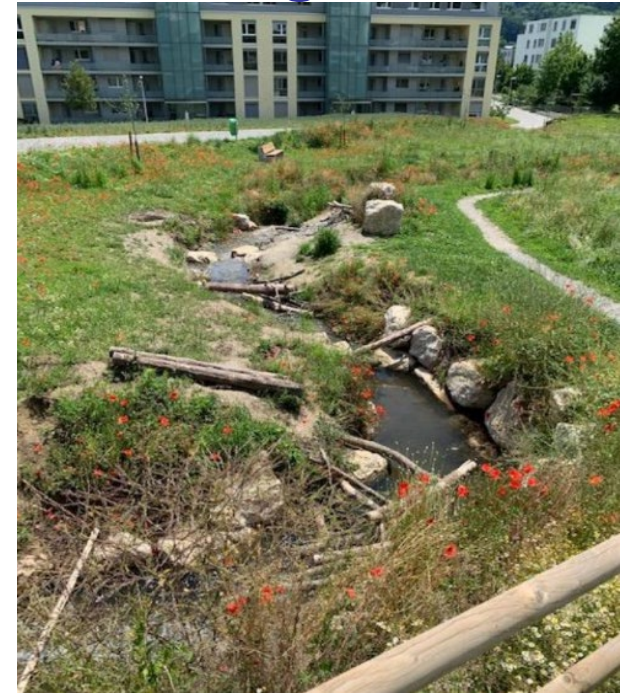


Solutions in receiving waters

Structural solution: morphological changes



Fruehlibach



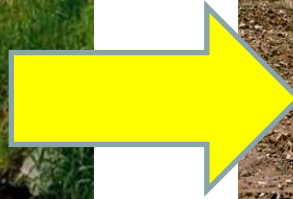
Obersiggingerbach



Furtbach Wallisellen

Solutions in receiving waters

Structural solution: morphological changes



Example of Urtenen River, Canton BE (source: VOKOS)

Solutions in receiving waters: Aire, Geneva



Solutions in receiving waters: Aire, Geneva



Solutions in receiving waters: Aire, Geneva



Solutions in receiving waters: Aire, Geneva



Solutions in receiving waters: Aire, Geneva



Solutions in receiving waters: Aire, Geneva





Solutions in receiving waters

City of Meyrin (Geneva area), Lac des Vernes

Dry weather:

- volume of the lake: 20,500 m³
- Surface area : 1.9 ha
- Maximum depth: 1.9 m



Wet-weather (protection of the river Nant d'Avril :

- Useful retention volume: 27,500 m³
- Total lake volume: 48,000 m³
- Surface area of the lake: 2.5 ha
- Maximum depth: 3 m
- Maximum water level variation: 1.10 m



Solutions in receiving waters

City of Meyrin (Geneva area), Lac des Vernes



Construire un lac pour la ville et la nature

- Une opportunité pour sensibiliser la population aux enjeux environnementaux



- L'accès à la surface de l'eau



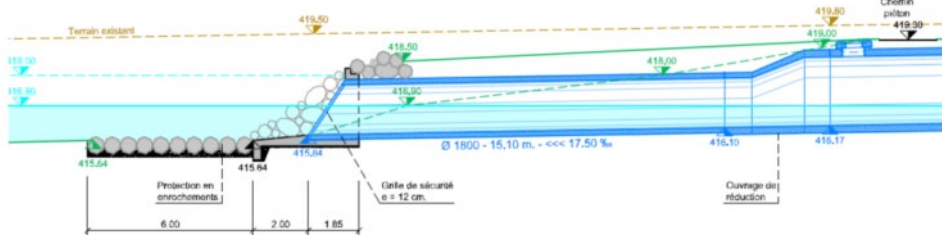
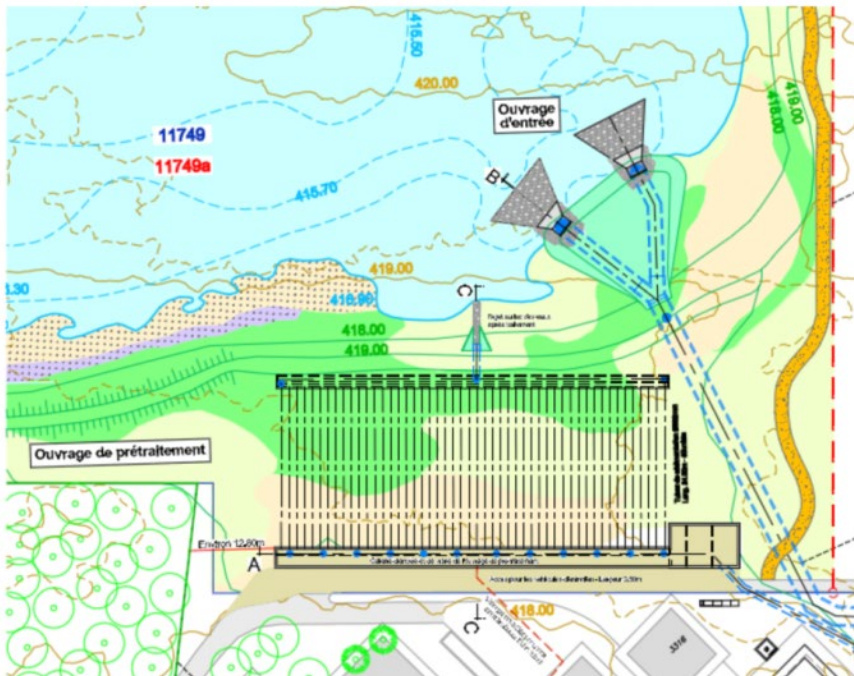


Solutions in receiving waters

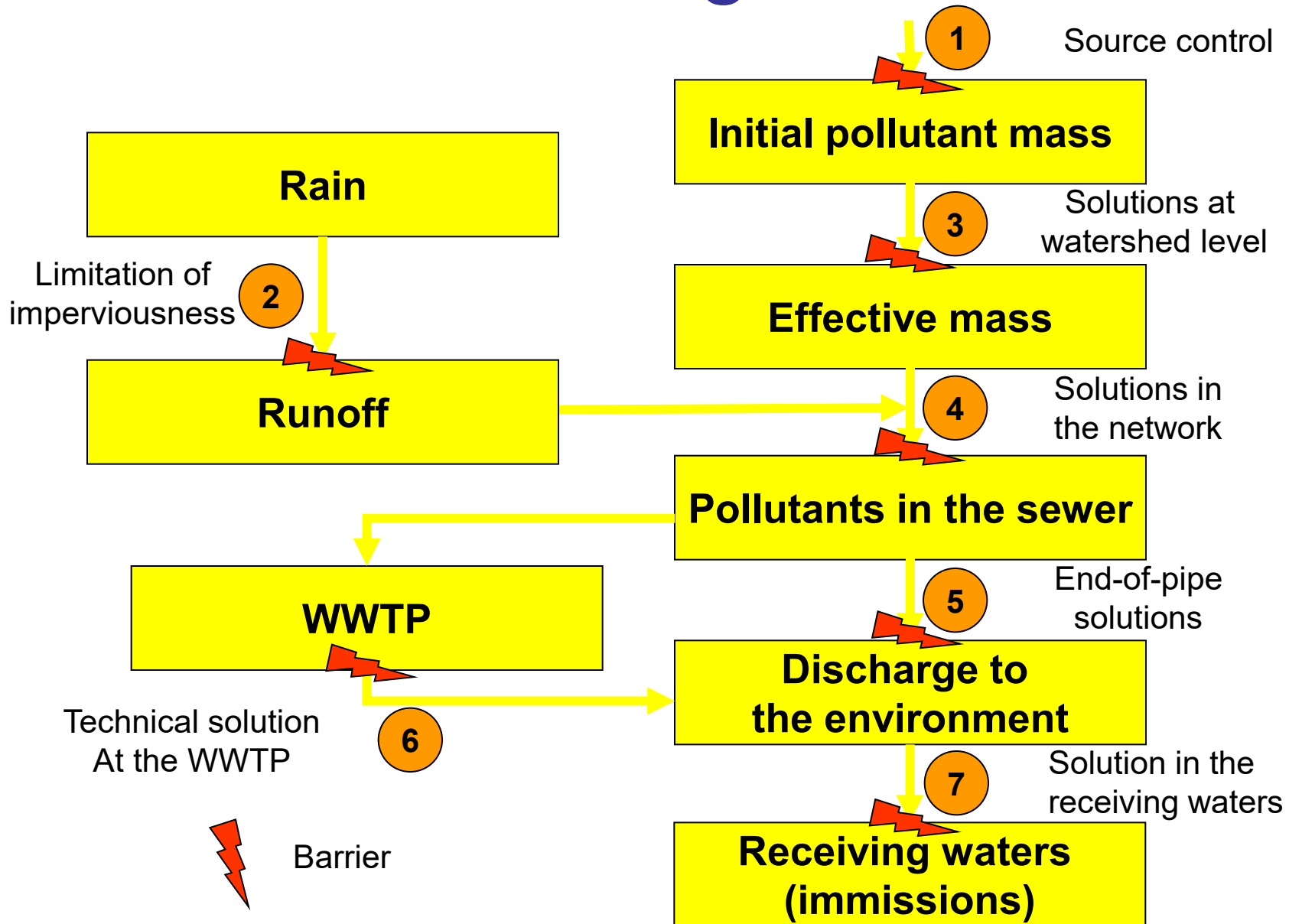
City of Meyrin (Geneva area), Lac des Vernes

Ouvrage d'entrée à l'aval du système de prétraitement

Système de prétraitement « SEDI-Pipe »



Conclusion: catalogue of solution



Conclusion: catalogue of solution



- The need of intervention, the goals, must be clearly identified
- Numerous technical solutions can be selected
- Solutions must be adapted to local conditions
- Try to find solutions near the source of the problem
- Security of the installation for the population !
- Social: public education, sensibilization, participation : very important step!
- Controls and surveys of the solutions must be planed since the beginning of the project ...
and also the money for these investigations!
- Document your realizations !
(Aqua & Gaz, ARPEA, internet...)

**To combine architecture, urban hydrology,
landscape, social aspects, art, urban
design, environmental technology :**
A typical challenge for ENAC engineers !

