

RoeVac® Vacuum Sewer Systems

Part 3:

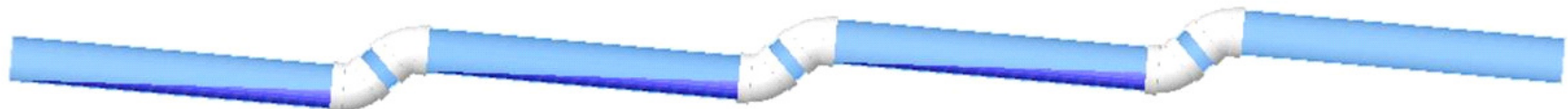
Design Aspects, Components and Feasibility Aspects



Our Technology – Design Aspects

General design aspects

- Vacuum Sewer Systems are designed similar to gravity sewer networks under consideration of its advantages
- Vacuum Sewer Systems collect waste water from individual buildings and transport the collected waste water to a central vacuum station
- A saw-tooth profile has to be considered for the pipe profile
- No manholes are required



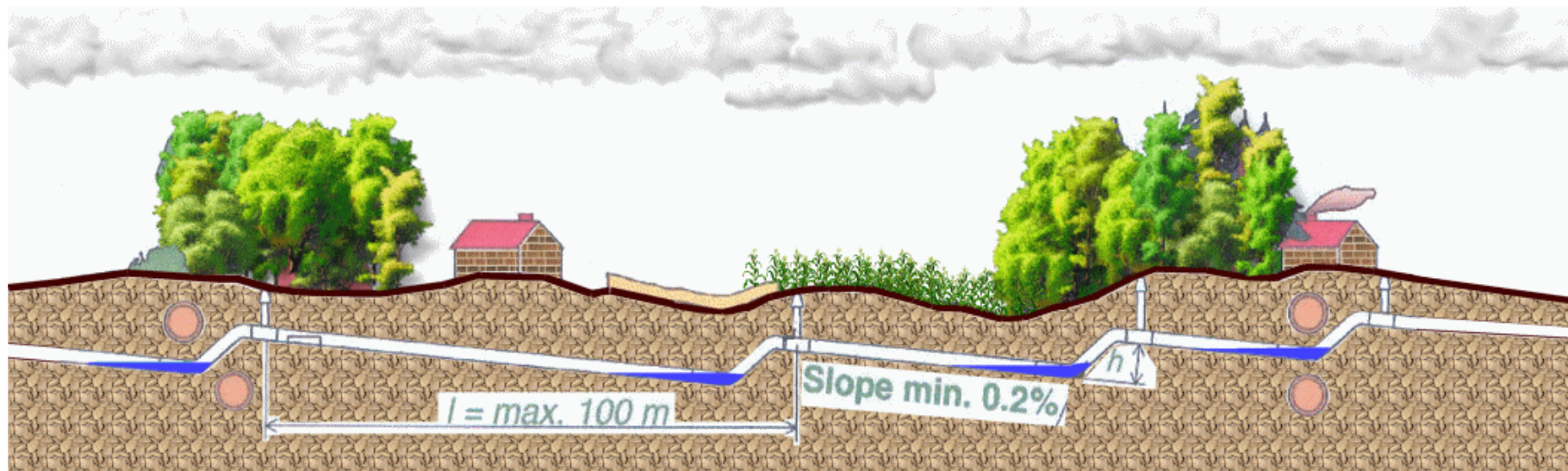
Our Technology – Design Aspects

The saw-tooth profile

- Air based transport of sewage
- A sawtooth profile will create small water pockets at lift low points
- Air-stream and turbulences will transport sewage water when vacuum valves open

Advantages

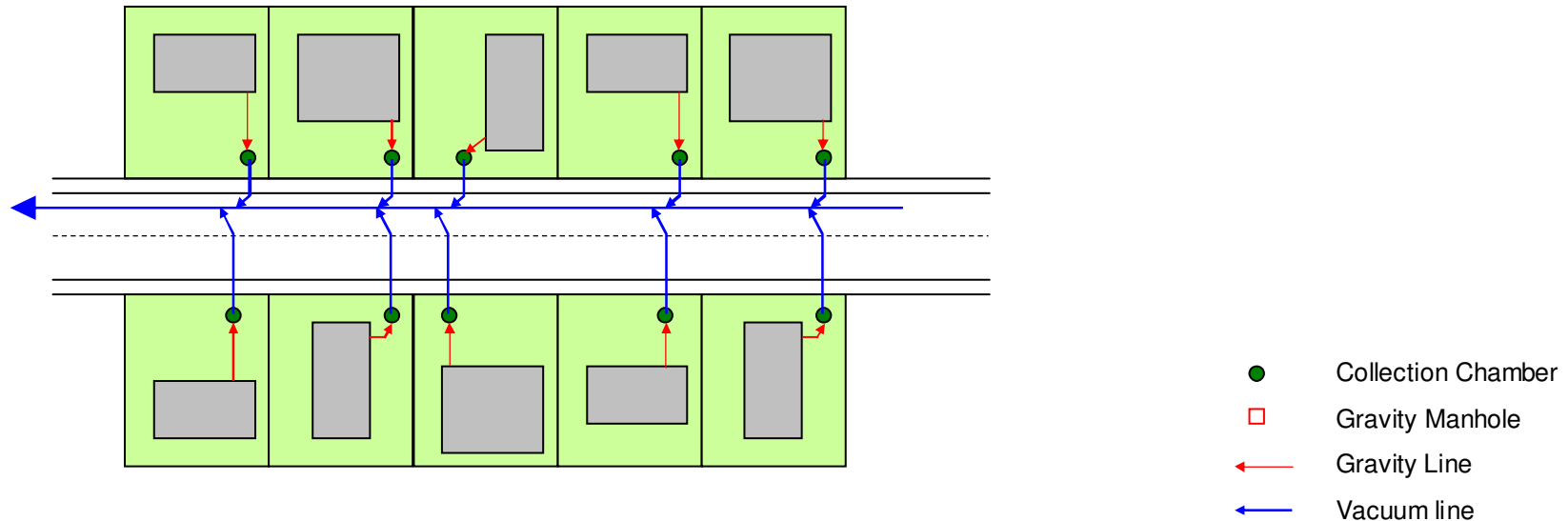
- Constant aeration of sewage water
- High velocities, no sedimentation
- Shallow pipes



Our Technology – Design Aspects

One Collection Chamber per Household

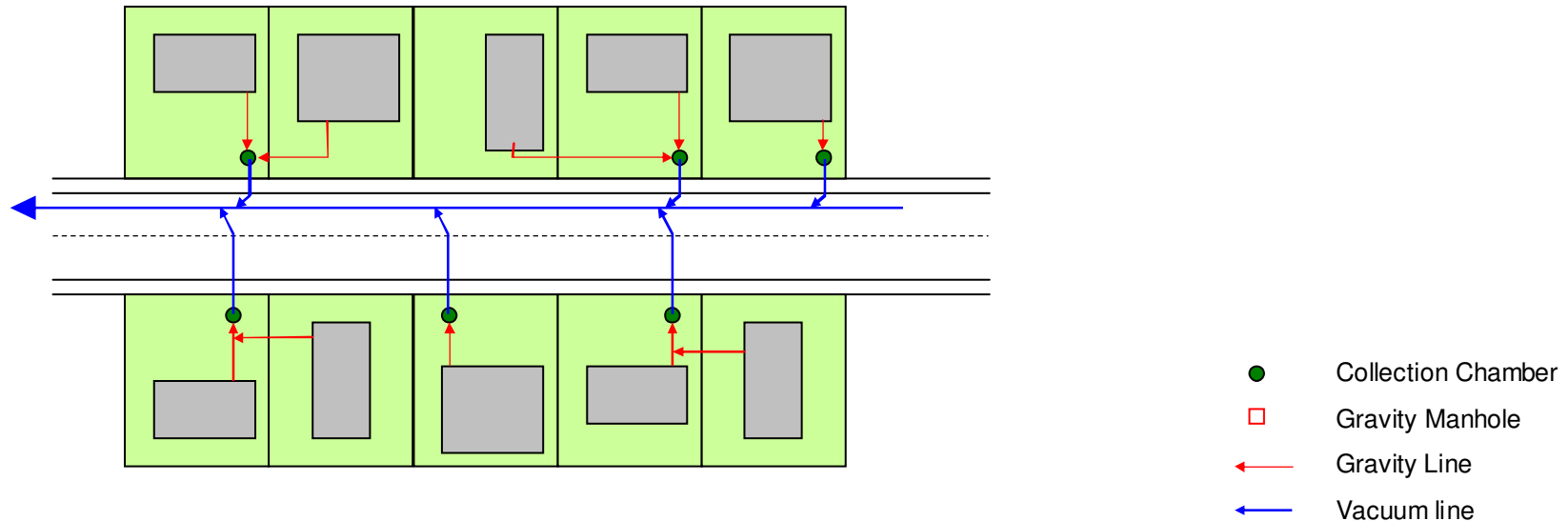
- Each house: one collection chamber
- Clear responsibility principle – Highest redundancy
- Best solution: sufficient air-liquid ratio



Our Technology – Design Aspects

2-4 Collection Chamber per Household

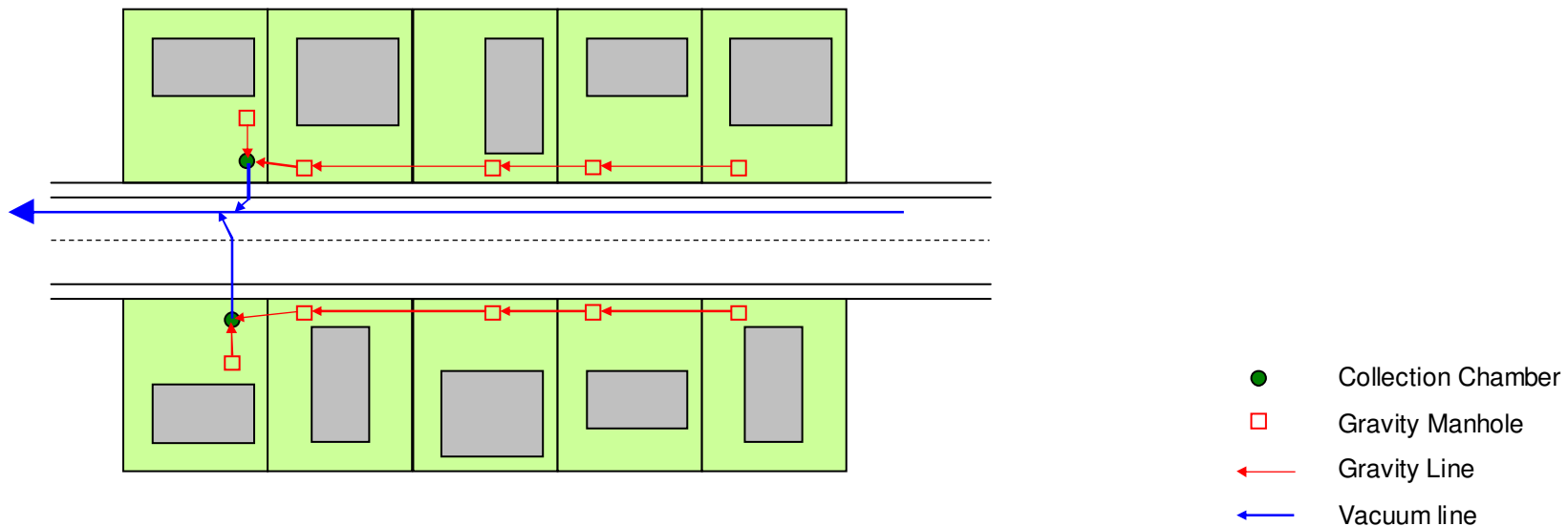
- Most economic solution for the location of the collection chambers
- No clear responsibility for the collection chamber
- Acceptable solution: air-liquid-ratio is sufficient



Our Technology – Design Aspects

More than 4 Collection Chamber per Household

- Large gravity connection lines necessary: higher investment costs
- Not clear responsibility for each collection chamber
- High wastewater quantities, but few inlets: problem for air-liquid-ratio
- Each vacuum valve has a high wear and tear: Maintenance costs
- High infiltration risk along gravity pipes



Our Technology – Design Aspects

Design parameters

- Roediger Vacuum uses **standard design parameters for sewage systems** to dimension pipe networks and vacuum station
 - Daily flows per capita (usually 200-280 l/d•PE)
 - Peak factor (usually 3-4)
 - Air-to-liquid-ratio ALR (usually 5-10)
- Vacuum sewer systems allow using comparable low design flows per capita as any infiltration water can be terminated
- Our system will be adopted to any local design guides and requirements

Our Technology – Design Aspects

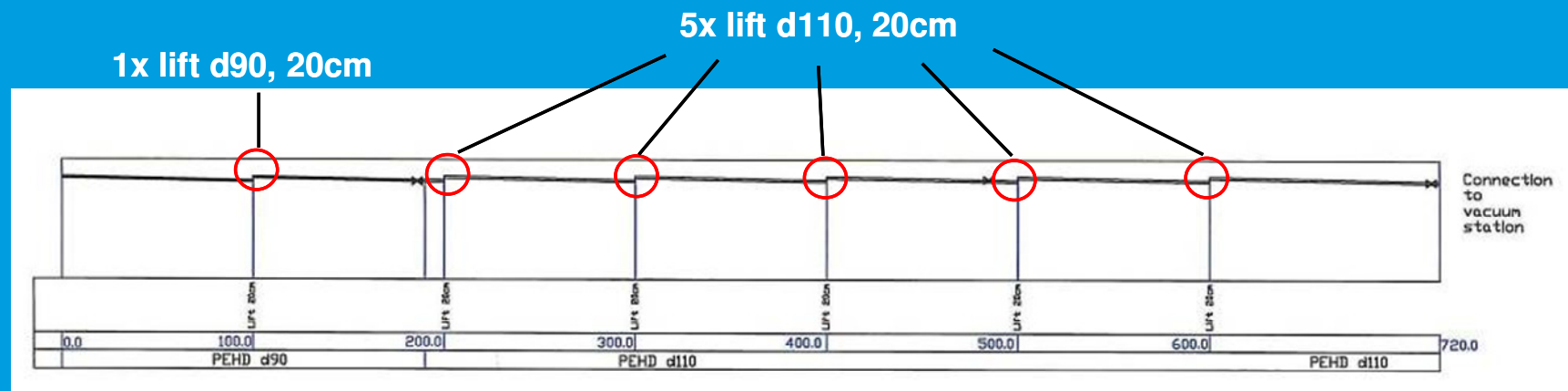
Vacuum sewer systems have hydrostatic limitations

- The number of lifts within a saw-tooth profile (total head) is limited
- The following formula applies
 - The total hydrostatic lift height within a vacuum line may not exceed 4.0 m
 - $\sum h = \sum (H-D) \leq 4.0\text{m}$
 - h = hydrostatic lift height
 - H = lift height
 - D = internal diameter of the pipe
- This results in
 - **maximum 4 km long vacuum lines** in flat areas
 - **or a maximum catchment diameter of 8 km** around the central vacuum station

Our Technology – Design Aspects

Hydro-static calculations

Example A: vacuum line in flat terrain



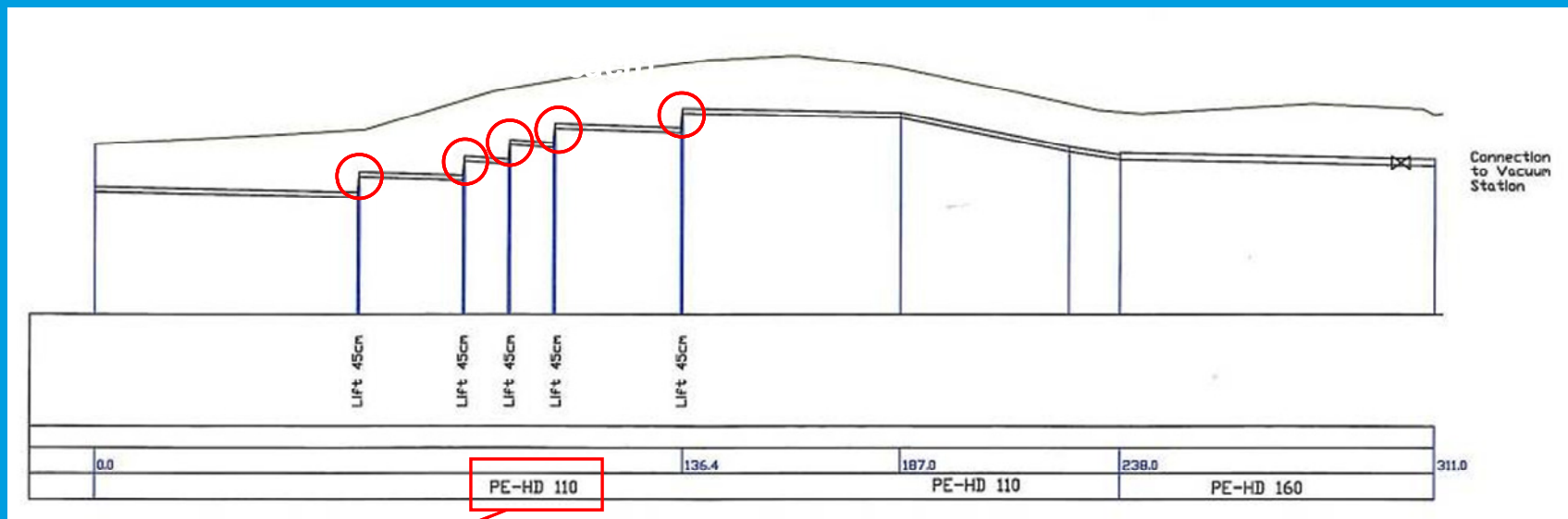
Hydro-static losses: 1 lift x (0,20 – 0,0736) +
 5 lifts x (0,20m - 0,09m) = **0,7 m** < 4,0 m

Status of line: OK

Our Technology – Design Aspects

Hydro-static calculations

Example B: vacuum line in rising terrain



Internal diameter of pipe PE-HD 110 SDR 11: 90mm

Hydro-static losses: $5 \text{ lifts} \times (0,45\text{m} - 0,09\text{m}) = 1,8 \text{ m} < 4,0 \text{ m}$
 Status of line: OK

Our Technology – Design Aspects

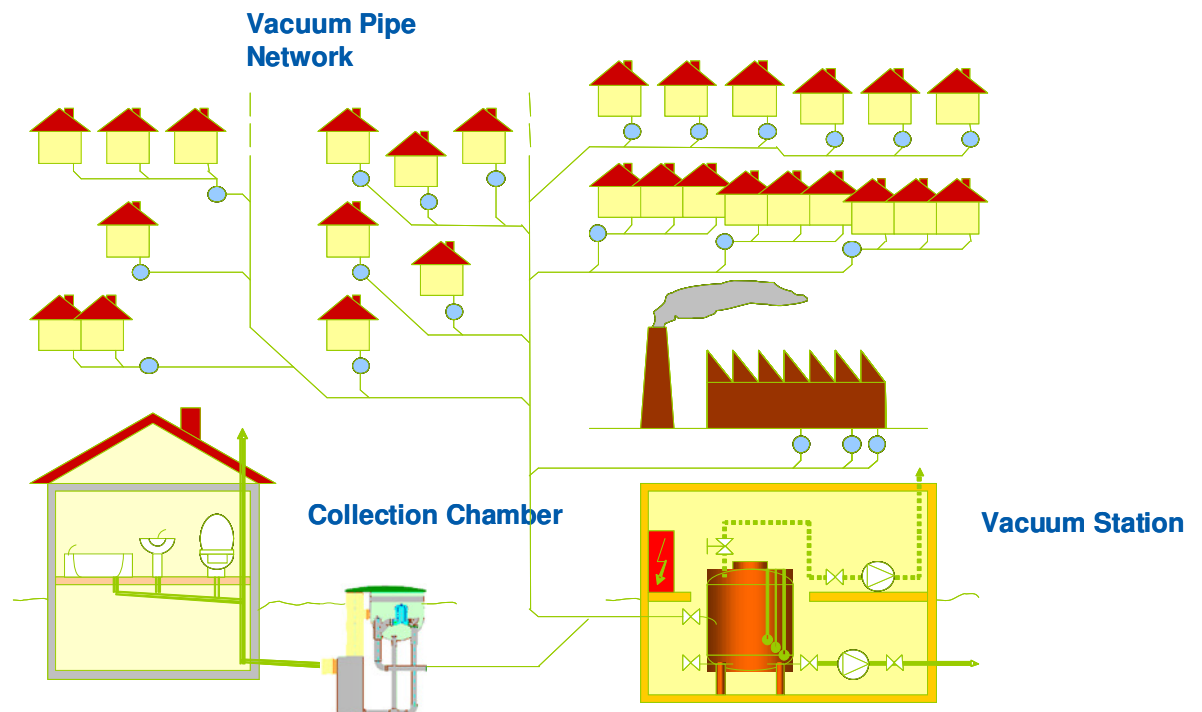
Vacuum sewer systems have “hydraulic limitations”

- The flow capacity of a vacuum sewer pipes is hydraulically limited due to air-stream based transport of sewage
- Vacuum sewer systems become less competitive the higher the population density gets
(Our cost saving factor is the network)
- High flows will require parallel vacuum sewer pipes and comparable huge vacuum stations

So basically the “hydraulic limitation” is an economic limitation

Components of Vacuum Sewer Systems

- Vacuum sewer systems contain of 3 main components
 - Central vacuum station
 - Collection chambers (with valves)
 - Vacuum pipe network



Our Products – The collection chambers

- Roediger Vacuum provides **pre-manufactured** collection chambers
- Collection chambers for **different load conditions**: pedestrian load, traffic load or special applications such as water villas
- Roediger Vacuum collection chambers are **durable, light weight, easy to install** and very maintenance friendly

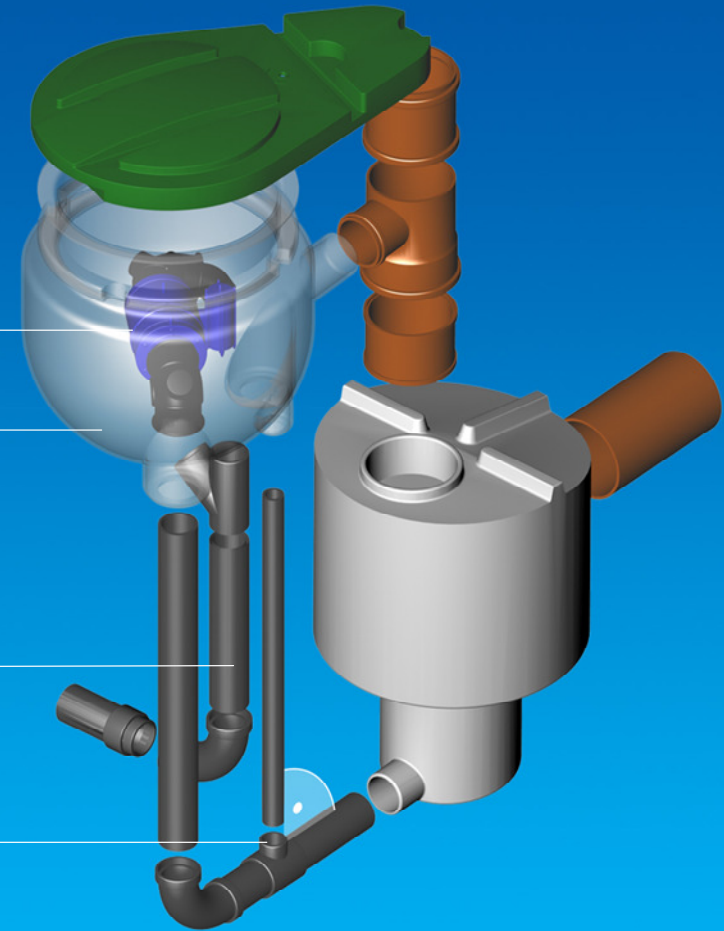
Our Products – The collection chambers

Separation between the vacuum valve unit
and the waste water sump

Chamber body made of infiltration proof PE
Patented system

Flexible installation depths

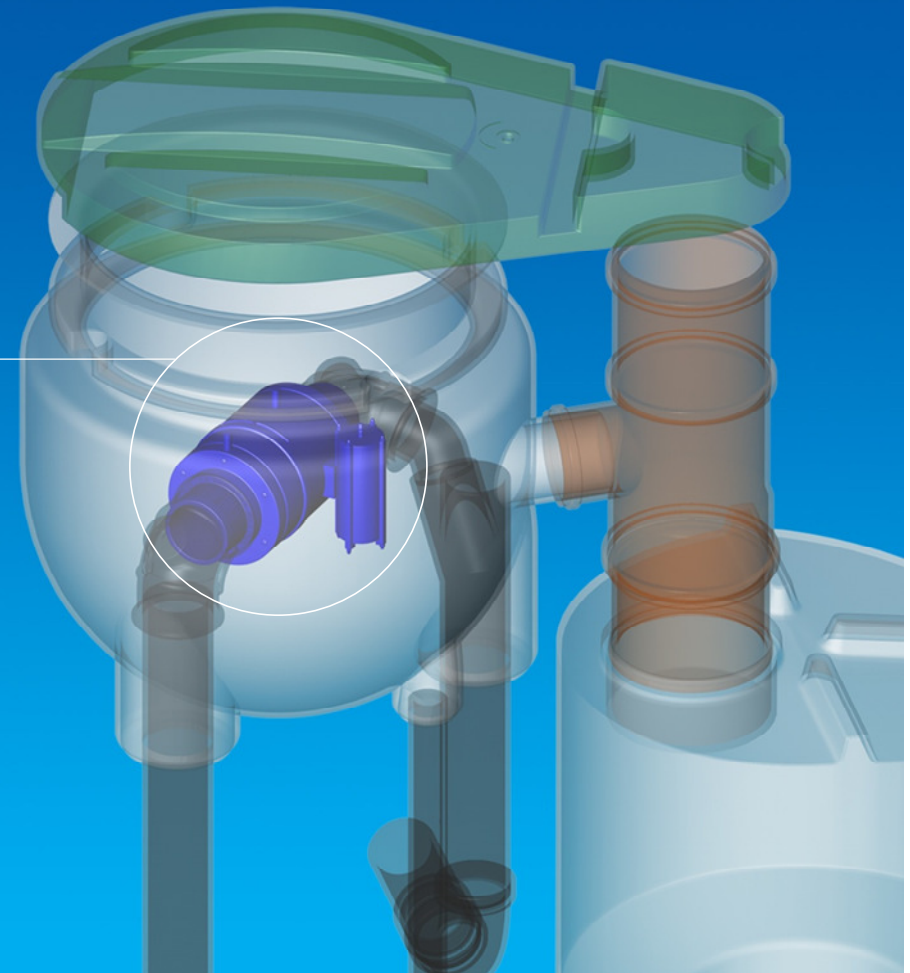
Self-cleaning sensor pipe,
due to 90° connection with suction pipe



Our Products – The collection chambers

Vacuum Valve Unit:

- Service-friendly
- Reliable and long lasting materials
- Fully-opening membrane valve
- Advanced technology controller
- No power supply required



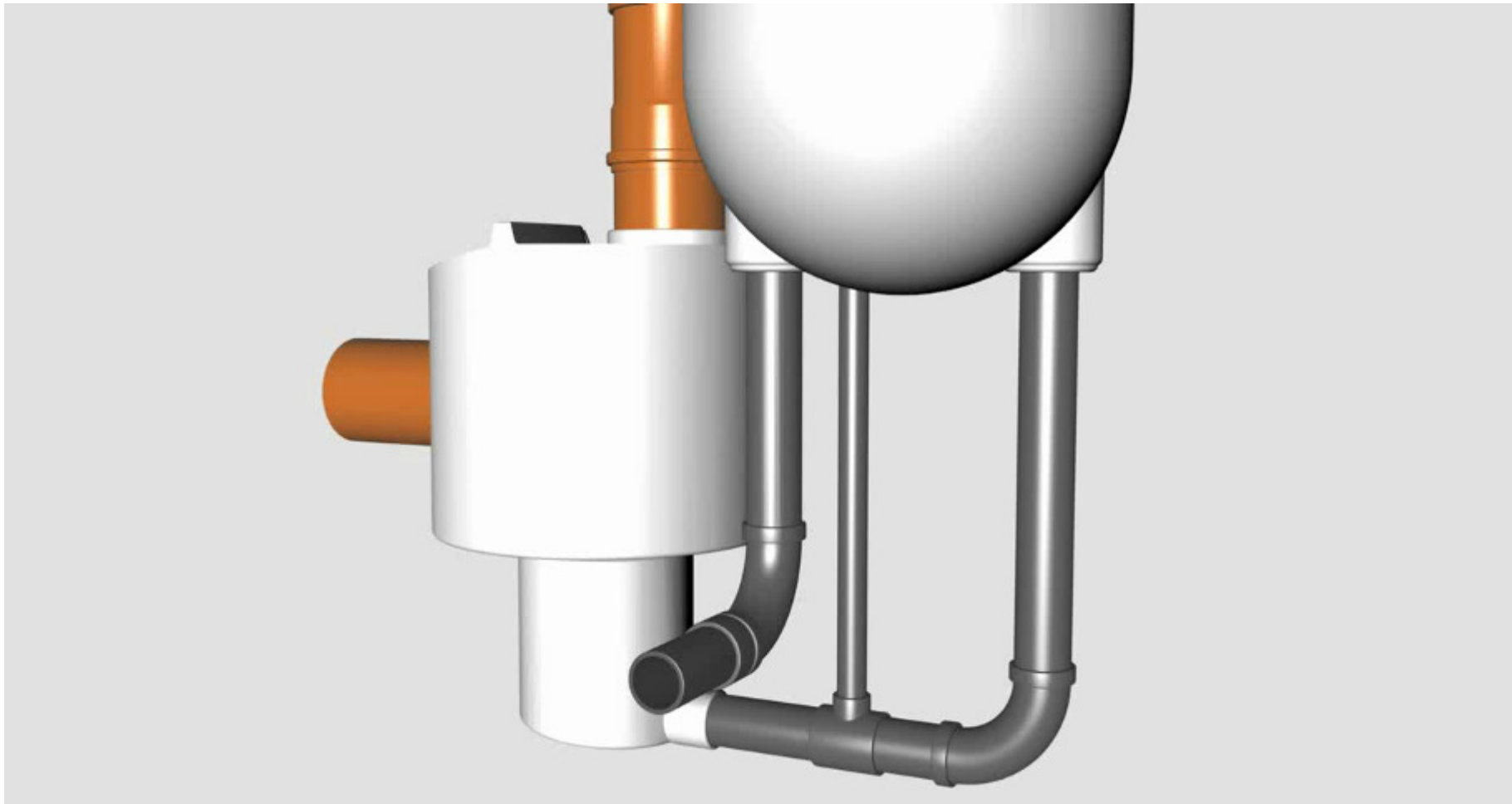
Our Products – The collection chambers

■ VCC Components



Our Products – The collection chambers

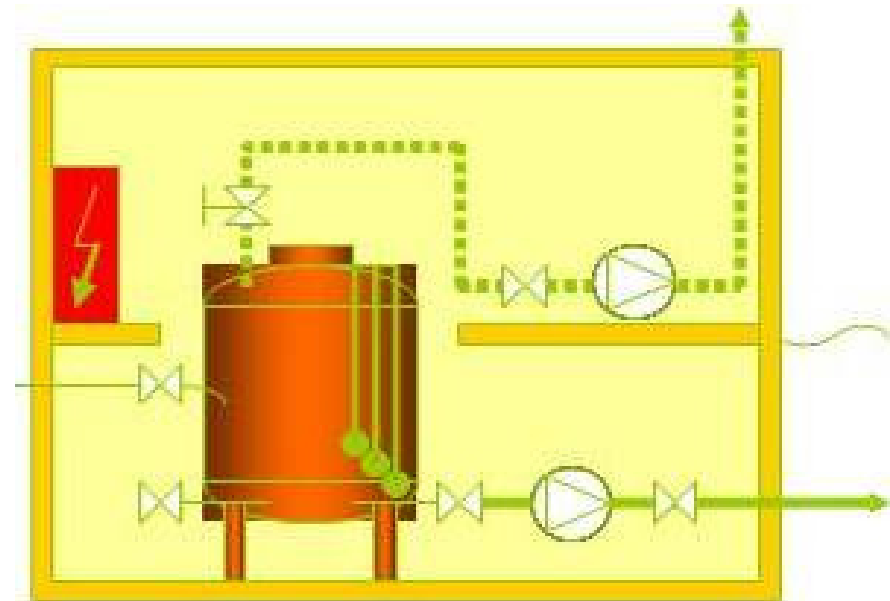
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Our Products – The vacuum station

- Only source with energy consumption
- Central point for maintenance and operation

- Main components
 - Vacuum pumps
 - Vacuum tank
 - Discharge pumps
 - Motor control centre (MCC)



Our Products – The vacuum station

- Typical arrangement of 3 x 15 KW vacuum pumps
- Suction capacity sufficient for approx. 2.000 - 2.500 PE



Our Products – The vacuum station

- A typical 25m³ vacuum tank during construction of the vacuum station



Our Products – The vacuum station

- Different vacuum station buildings



Our Products – The vacuum station

- Different vacuum station buildings



Our Products – The vacuum station

- Typical MCC for vacuum stations



VDE German Standard



BS Standard form 3b

Feasibility and Cost Aspects

What does it cost?

- Costs vary depending of network size and project specifications
- The cost saving factor is the network itself, so a minimum project size is required to be competitive
- Vacuum sewer systems can achieve up to 25-40% costs savings compared to gravity sewer systems considering all aspects of construction

Again!

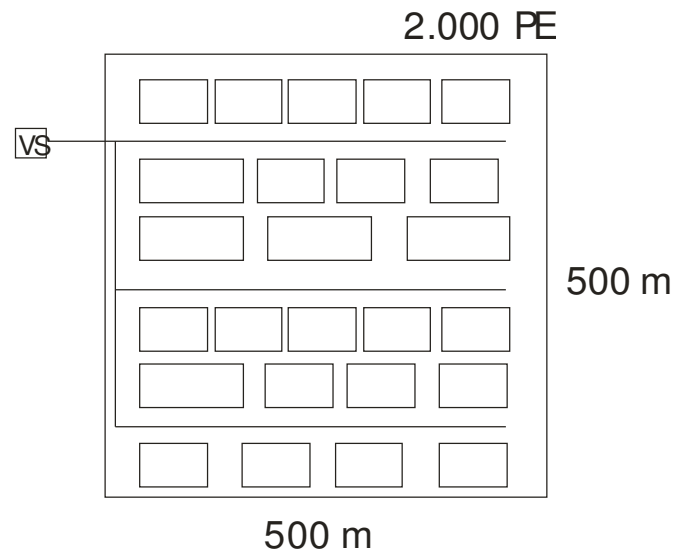
- Vacuum sewer system do not require manholes
 - Trenching is limited to average 1.2 - 1.5m depth
 - No interim pumping station for large networks in flat terrain
 - Central M&E and central odour control
- 

Case studies

Example A: High dense, compact area

■ Characteristic

- Small and compact area → Short pipe network, shallow
- Apartment blocks, high rise → High flows
- Straight roads → Few manholes required



Case studies

Example A: High dense, compact area

■ Vacuum costs:

Pipes:	2.000 m x 50 €/m	=	100.000 €
Collection chambers:	100 CC x 2.000 €	=	200.000 €
Vacuum station:		=	200.000 €
Total:			500.000 €

■ Gravity costs:

Pipes:	2.000 m x 100 €/m	=	200.000 €
Manholes:	40 x 300 €	=	15.000 €
Pump station:	1 x 50.000 €	=	50.000 €
Total:			275.000 €

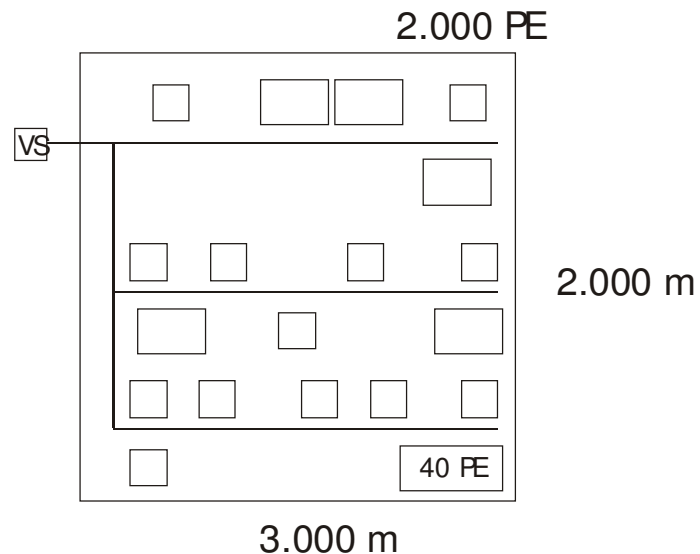
Note: Actual costs are depending on local prices, contractors, soils, etc.

Case studies

Example B: Low dense, wide area

■ Characteristic

- Wide area, non symmetric development → Long pipe network
- Villas, town houses → Little flows spread over the area
- Winding roads, not symmetric → Lots of branch connections



Case studies

Example B: Low dense, wide area

■ Vacuum costs:

Pipes:	10.000 m x 50 €/m	=	500.000 €
Collection chambers:	130 CC x 2.000 €	=	260.000 €
Vacuum station:		=	200.000 €
Total:			960.000 €

- 30 %

■ Gravity costs:

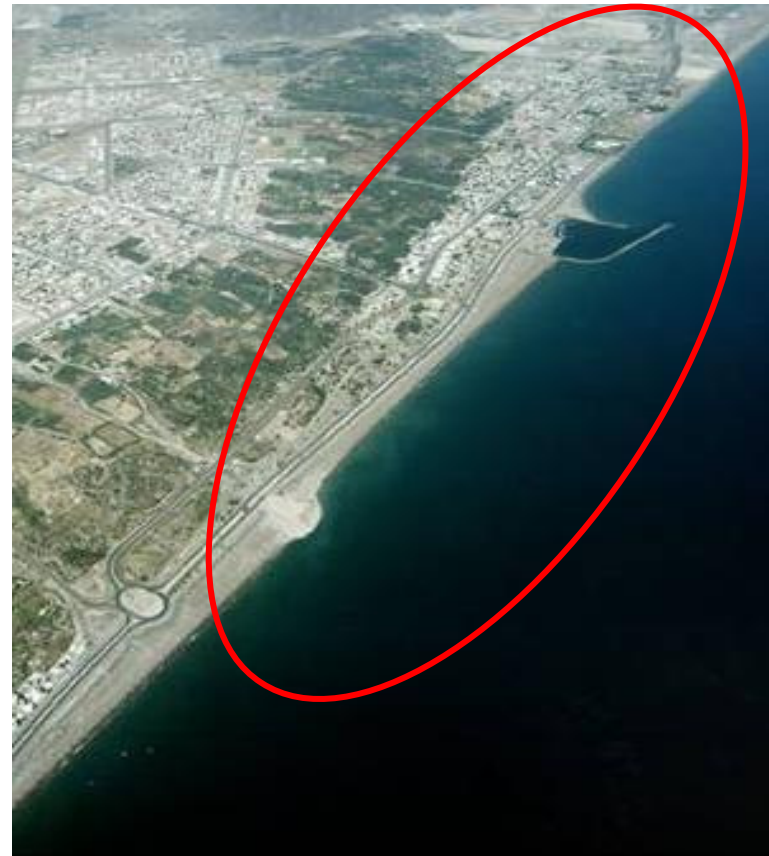
Pipes:	10.000 m x 100 €/m	=	1.000.000 €
Manholes:	200 x 300 €	=	60.000 €
Pump station:	4 x 50.000 €	=	2000.000 €
Total:			1.260.000 €

Note: Actual costs are depending on local prices, contractors, soils, etc.

Case studies

Real case study Middle East

- Project perfectly suitable for a vacuum sewer system
 - Flat terrain, no natural slopes
 - Sandy, unstable soils
 - Coastal area with high ground water table
 - Long stretched development with a long pipe network
 - Low dense with only 7.500 PE



Case studies

Vacuum sewer lines (S&I)	500.000 €
Inspections pipes and division valves (S&I)	40.000 €
Collection chambers (S&I) (350 nos. G75 3")	700.000 €
Vacuum station (S&I)	350.000 €
Customs and transport costs	90.000 €
TOTAL approx.	1.680.000 €

S&I: Supply & Installation / Length of the lines: 18000 meter

Case studies

Gravity Sewer Lines (S&I)	1.600.000 €
Manholes (S&I)	1.000.000 €
5 pumping stations (civil + M&E) (estimated S&I)	180.000 €
Odour control unit for manholes and pump stations	50.000 €
TOTAL approx.	2.830.000 €

S&I: Supply & Installation / Length of the lines: 18000 meter

Operation and maintenance

Every sewer system requires operation and maintenance!

- Vacuum sewer systems require operation and maintenance, too!
- Maintenance works to be done mainly at the central vacuum station
- Little maintenance for the collection chambers and valves
- No maintenance for the pipe network

The myth: Gravity sewer systems are maintenance free!

The truth: A whole industry is built up for gravity sewer maintenance!



Operation and maintenance

Vacuum sewer system

Labour

- Regular check of vacuum station
- Annual check-up of collection chambers
- Odour control only at vacuum station (tight system)

Replacement/repair

- Lubricants and filters for vacuum pumps
- Valve parts (few pieces, membranes)

Gravity sewer systems

Labour

- Regular check of manholes
- Pipeline inspection, CCTV inspections
- Cleaning of sedimentations, slime and debris (jetting with high-pressure)
- Flushing of lines
- Odour control along the whole network (open system)

Replacement/repair

- Oil for lifting station pumps
- Manhole/Sewer rehabilitation



Operation and maintenance

Vacuum sewer system

Electricity consumption

- Electricity consumption of vacuum station (approx. 10-20 kWh per capita and year)
- Only one central power supply at vacuum station

Cleaning the system

- Self cleaning due to high velocities

Sewage treatment

- Only waste water, no surface or ground water
- Constant aerated waste water
- No illegal connections possible; closed system

Gravity sewer systems

Electricity consumption

- Electricity consumption of lift- and pump stations
- Power supply for each and every pump and lift station

Cleaning the system

- H₂S deodorization
- Cleaning of pipes and manholes

Sewage treatment

- Waste, surface and ground water due to infiltration
- Aged and septic wastewater, major solids
- Illegal (storm water) connections



Operation and maintenance

Vacuum sewer system

Operation Safety

- No risks for operators at all
- No direct contact with waste water
- No open wet wells
- No manholes
- Less septic gases such as H_2S

Gravity sewer systems

Operation Safety

Atmospheric hazards in confined spaces:

- Low oxygen conditions
- Significant hydrogen sulphide (H_2S)
- Explosive concentrations of methane

Physical hazards with confined space entry

- Falling objects into manholes and wet well
- Ladders, high platforms

Biological hazards:

- Germs, diseases, viruses
- Pathogenic organisms
- Insects, animals
- Bad smell along the lines and manholes

