

Regional Disposal of Sewage Sludge Using the Example of the Canton of Zurich – Thermal Sewage Treatment Plant Zurich-Werdhoelzli –

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1. Current situation in the Canton of Zurich

The Canton of Zurich is the most populous canton in Switzerland. The approximately 1.4 million inhabitants generate 250 million cubic metres of wastewater every year. The wastewater is cleaned in 104 public sewage plants. Some of the sewage plants are operated by the communes while the others are operated by regional associations.

The wastewater treatment process generates 100,000 tonnes of fouled, drained sewage sludge per year.

In the past, a large proportion of this was used as fertiliser in the agricultural sector. Since 1st October 2006, however, the use of sewage sludge for agriculture has been banned in Switzerland. Following a risk assessment, it was decided at the time that the medium-term damage caused to the soil by the pollutants in the sewage sludge was greater than the benefits that could be expected from using sewage sludge as a fertiliser. Today, sewage sludge is considered to be municipal waste. In accordance with Swiss legislation, the cantons are required to develop a waste management plan. The needs, capacities and waste management sites must be identified and constantly updated. Furthermore, collection areas must be established for the waste from the public wastewater treatment and the efficient operation of the waste management facilities guaranteed.

As early as 2003, the Zurich cantonal government stipulated the objectives of sewage sludge disposal within the new framework. On the basis of ecological and economic criteria, particular importance was attached to waste management safety. For disposal purposes, the drained sewage sludge from all sewage treatment plants in the canton was directed to the following processing and waste management facilities:

- 4 waste incineration plants involving the co-incineration of the sludge with refuse,
- 2 dedicated sludge incineration plants,
- 3 sludge drying plants with the subsequent incineration of the granulated material in cement works.

can subsequently be recovered. This requirement is also included in Swiss legislation. It is incorporated in the revised Technical Ordinance on Waste to take effect in the coming years.

- Energy use
Optimum use must be made of the renewable energy contained in the sewage sludge, irrespective of the treatment location.
- Waste management costs
Future waste management operations in sewage treatment plants must be conducted efficiently, at marketable prices.
- Waste management safety
Waste management safety must be guaranteed at all times with regard to cantonal sewage sludge.

With a view to developing the concept, AWEL set up a planning group which played an active role in the planning process through interviews, workshops and meetings. The group consisted of representatives of AWEL and of all previous processing and waste management facilities, as well as an external project manager. In a stepwise process, the current status was identified, options were clarified, alternative solutions were developed and the principles of the decision-making were formulated.

The results produced by the planning group gave rise to the following implementation decisions:

- The Canton of Zurich will adopt a dedicated sewage sludge incineration solution. This will allow the phosphorous present in the waste to be concentrated in the ash, thereby facilitating subsequent recovery.
- For the necessary capacity of 100,000 tonnes of drained sewage sludge per year, a single, central sewage sludge processing facility will be built. By building a single large-scale processing facility instead of two smaller processing plants, a more reasonable waste management price can be ensured.
- The cantonal government will allocate all sewage sludge from the Canton of Zurich to the central processing facility. This will ensure that the facility is used to capacity.
- The owner of the land on which the sewage sludge processing facility will be built will finance, build and operate the facility.
- Cost transparency concerning the sewage treatment plants supplying the sewage sludge must be guaranteed by the operator of the facility.

3. Choice of location for the central sewage sludge processing facility

Once the decision had been taken concerning the concept, four organising entities with a total of five locations indicated their interest in building the central sewage sludge processing facility.

- Entsorgung und Recycling Zürich (ERZ), with the Hagenholz Zurich refuse heating plant and the Werdhoelzli Zurich sewage treatment plant;
- Kehrichtverwertung Züricher Oberland (KEZO), with the Hinwil waste incineration plant;

- Interkommunale Anstalt Limeco, with the Dietikon refuse heating plant; and
- The City of Winterthur, with the Hard Winterthur sewage treatment plant.

Each entity conducted a feasibility study for its designated location(s). This study closely examined how the sewage sludge could be processed in a dedicated incineration facility and how such a facility could best be incorporated in the existing infrastructure. To ensure the comparability of the studies, the procedural concepts for all locations were set identically, the general conditions defined precisely and the structure of the dossier was standardised.

The locations were assessed by a project team comprising officials, representatives of all the organising entities concerned and representatives of the previous sewage sludge processors. The assessment criteria were stipulated by the planning group before the studies were conducted.

- Operating efficiency (50 %)
Estimated processing costs per tonne of drained sewage sludge including energy revenue, operating material costs, ash disposal costs, etc.
- Energy use (10 %)
Absolute value of the energy used annually in the proposed location concept.
- Carbon footprint (15 %)
Emission of or reduction in greenhouse gases, expressed as CO₂ equivalent per tonne of sewage sludge disposed of
- Transport use (15 %)
Annual tonne kilometres and truck hours generated by the delivery of the drained sewage sludge from the entire canton to the waste management facility.
- Reserve space (10 %)
Availability of the estimated area necessary for (a) a subsequent, directly adjacent ash processing facility for phosphorous recovery and (b) the seamless replacement of the sewage sludge processing facility once it has reached the end of its service life.

With regard to the key criterion of operating efficiency, the studies demonstrated a difference of only a few francs per tonne of sewage sludge. Although the planning precision was identical for all locations, a clear ranking was nevertheless identified for this criterion. The main differences concerned the ecological criteria. Energy use and CO₂ reduction were largest when the location already had an energy use infrastructure which could be used. As expected with regard to transport, the locations at the outer limits of the canton performed poorly. The decisive element here was the proximity of the site to the main supply of sewage sludge.

The overall assessment of the location comparison provided the following results.

In the main assessment, with the criteria weighting shown above, the Werdhoelzli Zurich sewage treatment plant offered the best performance. To check the results, a sensitivity analysis was conducted. This involved changing the weighting of the criteria so that the ecological criteria were given a higher weighting than efficiency. It also involved conducting an analysis whereby all the criteria were given the same 20 % weighting. In both cases, the ranking of the locations remained unchanged with only the differences between the sites changing.

Table 1: Overall assessment of the location comparison

Location	Main assessment	Sensitivity analysis	
		Ecology before price	All equal at 20 %
Werdhoelzli sewage treatment plant	91	82	86
Location B	86	73	78
Location C	75	63	69
Location D	58	39	49
Location E	35	0	8

The main advantages of the Werdhoelzli sewage treatment plant are:

- The waste heat generated by the sludge incineration process can be used in the sewage treatment plant. Consequently, the biogas previously used as an energy transfer medium is no longer required and can be processed and fed into the domestic gas network.
- The Werdhoelzli sewage treatment plant processes approximately one third of the entire volume of sewage sludge generated by the canton. This volume therefore requires no transport.
- The area has good reserves of space for a future facility for recovering the phosphorous contained in the sewage sludge ash.
- The vapour wastewater from the sludge pre-drying procedure can be processed in the existing return water treatment plant.
- A shift work organisation already exists at the sewage treatment plant. It will be possible to incorporate the operations of the new facility in the existing organisation.

In June 2010, based on the location assessment, the Building Department of the Canton of Zurich, together with the organising entities responsible for sewage sludge disposal at that time, selected the Werdhoelzli Zürich sewage treatment plant as the location for the new, central sewage sludge processing facility. In September 2010, the City of Zurich decided that it would build the facility, subject to the approval of the loan by the voting population.

4. The Werdhoelzli sewage sludge processing facility project

In November 2010, Entsorgung + Recycling Zürich began work on the project planning for the central sewage sludge processing facility at the Werdhoelzli sewage treatment plant.

The project will be operated within the ERZ project organisation with the Werdhoelzli sewage treatment plant divisional manager as principal of the project and an internal project leader. An engineering firm will be commissioned to act as the planner. A particular feature of this project is its canton-wide significance. A steering committee and support group ensure that the overriding goals of the project are achieved. The technical support group, consisting of representatives of the cantonal authorities and the operators of the previous waste management facilities, ensures compliance with the technical conditions and targets. It also guarantees the flow of information to the authorities of the previous organising entities. The political steering committee, including representatives of the canton and the political managers of the previous organising entities, represents the interests of the communities and approves the loan for the selected offer.

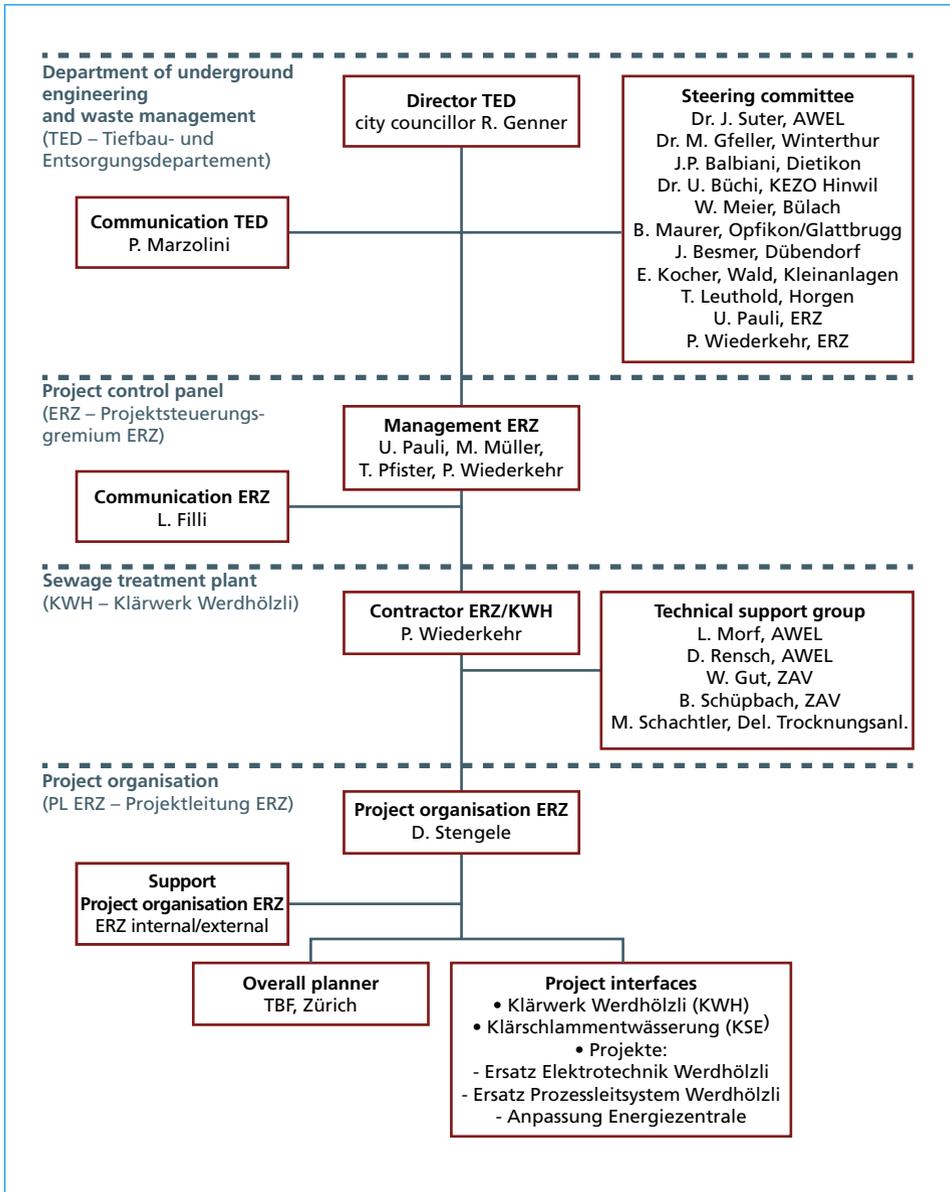


Figure 2: Project organisation for the sewage sludge processing facility in the project planning phase

The sewage sludge processing facility will be built within the framework of an EPC contract. The site planning and drafting of the tender documents lasted from November 2010 to June 2011. The call for tenders was issued on 8th July 2011. In total, the project schedule covers seven years.

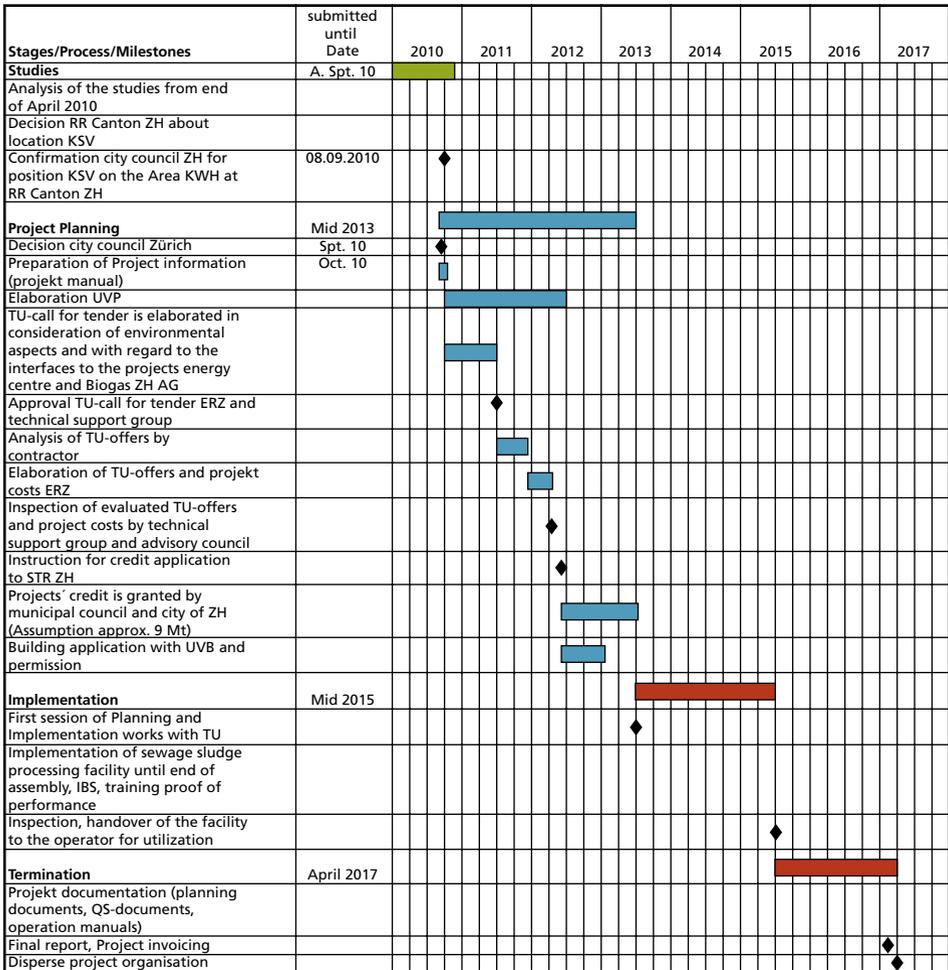


Figure 3: Schedule for the sewage sludge processing facility project

The sewage sludge processing facility is based on a dedicated incineration concept in order to ensure maximum recovery of phosphorous in the future. Furthermore, the sewage sludge processing facility should ensure long-term efficient sewage sludge disposal. Scheduled to begin commercial operations in July 2015, the sewage sludge processing plant, which is to be planned and built as a turnkey facility by the EPC contractor, must handle 100,000 tonnes of fouled and drained sewage sludge annually with an average dried matter content of 30 %, representing 30,000 tonnes of dried matter per year.

The EPC contractor call for tenders is designed as a functional call for tenders. It leaves the EPC contractor certain liberties and room for manoeuvre to submit what it believes to be an optimised building and systems design within the specified planning perimeter. The following overriding general requirements must be taken into consideration:

- maximum phosphorous recoverability and therefore,
- dedicated incineration in a fluidised bed furnace,

- optimum and efficient energy utilisation,
- a high level of operational safety.

The sewage sludge processing facility consists of the following main components and/or process steps:

- transfer of sludge from the Werdhoelzli sewage treatment plant,
- delivery of sludge by truck from the other sewage treatment plants in the Canton of Zurich,
- temporary storage of the drained sewage sludge,
- pre-drying of the drained sewage sludge with vapour condensation,
- incineration of the drained sewage sludge and recovery of the heat generated in a boiler plant,
- energy use, including the generation of electricity depending on the process,
- multi-level flue gas cleaning, including residue treatment with as high a level as possible of particulate collection for separate phosphorous recovery,
- auxiliary facilities.

The sewage sludge processing facility will operate automatically 24 hours a day throughout the entire year except during necessary maintenance and inspection operations. Supervision personnel will be on hand, although the concept provides for the construction of facilities which can be operated without supervision (automatic operations).

The following facilities must be provided for the operating personnel of the new sewage sludge processing plant:

- Sampling points for extracting drained and/or dried sewage sludge (one after every silo, one at every delivery point, one after every drying chamber and one directly before the fluidised bed furnace).
- The residue from the wastewater treatment (filter cakes) will be collected in basins (prevent formation of dust and ensure dry location). A silo with lorry terminal must be planned for the residue from the alternative fabric filter.
- An on-site sewage sludge processing facility control room consisting of two operator stations each with two screens, one screen for all video surveillance, a network-capable computer workstation with a screen, space for a conference table for 10 people and filing cabinets for all documentation. The room must be fitted with windows facing outside and another window overlooking the delivery point.
- A storeroom in which all wearing parts and strategic spare parts for the sewage sludge processing plant can be stored (with space reserves of at least 20 % and a minimum floor area of 100 m²). The storeroom will be fitted with the necessary equipment such as shelves and hoisting devices and space must also be provided for a workbench.

The EPC contractor will construct a turnkey, fully-functional and licensable complex for the processing of drained sewage sludge based on a sewage sludge incineration plant. The location for the plant is an unused area behind the sewage sludge drainage unit of the Werdhoelzli sewage treatment plant in Zurich.



Figure 4: Overview of the Werdhoelzli sewage treatment plant

The work of the EPC contractor encompasses all services necessary for the construction of the sewage sludge processing plant, including the main groups:

- Concepts and detailed studies,
- Project-related quality management,
- Implementation planning,
- Preparatory work for implementing the project,
- Excavation work,
- Underground and above-ground construction,
- Mechanical and/or procedural systems,
- Electrical systems,
- Instrumentation and control systems,
- HVACR systems,
- Fixtures,
- Exterior maintenance work,
- Access to the existing adjacent sewage sludge drainage plant with extension of the sewage sludge advisory bodies and their structural environment and connection between the sewage sludge drainage plant and the sewage sludge processing plant by means of walkway,
- Site management (general and specialist site management, installation management, coordination),
- Start-up, tests and inspections,
- Training and briefing the operating personnel,
- Efficiency statement and operating test,
- Construction documents and operating manuals,
- Rectification of faults and guarantee,
- Additional building costs of the EPC contractor such as models, reprography, insurances, fees, charges for certifications and authorisations.

The closing date for the submission of tenders is 25th November 2011. The tenders will then be assessed and the tender for the construction of the sewage sludge processing plant will be awarded to the winning EPC contractor. In the City of Zurich, loans totalling more than 20 million francs must be approved by referendum. The political approval process lasts about one year. Consequently, the contract between Entsorgung + Recycling Zürich and the successful EPC contractor will be signed sometime in mid-2013.

In addition to the actual building project, an accompanying project concerning the optimisation of all logistics processes will also be implemented. The aim of this is to ensure the trouble-free delivery of the sewage sludge from the sewage treatment plants in the Zurich area to the new sewage sludge processing plant and a balancing of transport costs between the plants situated nearby and those located further afield.

5. Summary

In the Canton of Zurich, approximately 100,000 tonnes of drained sewage sludge from 104 sewage treatment plants are currently burned in 9 waste management facilities. The methods used include co-incineration in waste incineration plants, dedicated incineration and drying with subsequent incineration in a cement works. From the middle of 2015, all sewage sludge will be treated in a new, central sewage sludge processing facility. This new plant will be based on a dedicated incineration concept with a fluidised bed incineration system. This will enable the phosphorous to be concentrated in the ash so that it can subsequently be recovered. Furthermore, it will allow optimum use to be made of the energy content of the sludge while reducing waste management costs.

As a result of site competition, the new sewage sludge processing facility will be built on the Zurich Werdhoelzli sewage treatment plant site. In July 2011, Entsorgung + Recycling Zürich issued a call for tenders as an EPC contract for the construction of the sewage sludge processing facility. The plant is scheduled to begin operations in mid-2015.

6. Literature

- [1] Klärschlammagenda 2009, Baudirektion Kanton Zürich, Dezember 2009 (http://www.awel.zh.ch/internet/audirektion/awel/de/abfall_rohstoffe_altlasten/abfall/siedlungsabfaelle/klaerschlam.html)
- [2] Klärschlammagenda 2010, Baudirektion Kanton Zürich, Dezember 2010 (http://www.awel.zh.ch/internet/audirektion/awel/de/abfall_rohstoffe_altlasten/abfall/siedlungsabfaelle/klaerschlam.html)
- [3] Regierungsratsbeschluss 1784 Gewässerschutz (Klärschlamm-Entsorgungsplan), Regierungsrat Kanton Zürich, Dezember 2003
- [4] Regierungsratsbeschluss 572 Gewässerschutz (Umsetzung Klärschlamm-Entsorgungsplan), Regierungsrat Kanton Zürich, April 2007
- [5] Planung der Klärschlamm Entsorgung im Kanton Zürich 2007-2020, Baudirektion Kanton Zürich, Oktober 2007

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