

Competence Centre 2017 - stage 1

Application title: VINNWATER

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0. INTRODUCTION

Water is a prerequisite for life. The water we are drinking today is the same water as the dinosaurs drank millions of years ago. In an urban environment, stormwater (rain and melt water) is collecting contaminants as it flows off of roads, roofs, etc. Today, this polluted stormwater is normally discharged untreated into receiving waters (e.g., lakes, rivers). Receiving waters often serve as sources for fresh water production. Accordingly, EU's Water Framework Directive (WFD) puts pressure on European countries to improve the quality of receiving waters. This, in turn, puts pressure on improving the stormwater quality before it reaches the receiving waters. Moreover, climate change, aging infrastructure, and densification of cities, lead to more flooding and its associated cost, in terms of insurance costs, human suffering, and environmental damages. Traditionally, quality aspects and volume aspects of stormwater have been looked upon separately. This has led to a large number of stormwater management solutions that have been built only to tackle one of these aspects. For instance, stormwater management solutions that are built to treat stormwater usually are constructed to manage relatively small stormwater flows. Hence, the functionality of these treatment solutions (e.g., stormwater treatment ponds, biofilters) usually is destroyed when flooded by a heavy rainfall. Accordingly, VINNWATER will conduct research on both stormwater quality and volume, first separately and then jointly, to develop pioneering, new stormwater systems, that can be customized to place specific conditions, and that can meet today's and tomorrow's challenges.



Fig. 1. Polluted stormwater runoff, and urban flooding

Companies that are in the forefront with technologies, knowledge, and methods that can treat polluted stormwater, and that can take care of stormwater volumes properly, have a huge market potential, both since the WFD has to be fulfilled by all countries within the European Union, and since the increasing costs for flooding will lead to a need for change. Hence, VINNWATER competence centre will contribute to sustainable growth.

1. EXISTING ACTIVITIES IN THE FIELD

From rain to receiving waters

One requirement of the WFD is the identification and quantification of diffuse pollution sources. Diffuse source water pollution is caused e.g., when pollutants, such as sediments, nutrients, toxic contaminants, chemicals and pathogens, from a range of dispersed urban land use activities, contaminate our waterways. Although these pollutants have originated from a specific source, the long-range transport ability and multiple sources of the pollutant make it a diffuse source of pollution. There are databases available for expected concentrations of pollutants in stormwater based on various land uses (i.e. diffuse urban runoff pollution). One of these databases is provided by the VINNWATER partner StormTac. However, these databases are undoubtedly incomplete.³⁷ The Urban Water Research Group at Luleå University of Technology (LTU) is the national centre of excellence (appointed by the Swedish Water and Wastewater Association) with regards to stormwater research. LTU has conducted a number of studies, ranging from sources of pollutants found in stormwater, to the impact of pollutants on receiving waters. Some examples:

Pathogens in stormwater were identified as one potential cause for the contaminated drinking water (*Cryptosporidium*) that led to the mass stomach sickness outbreaks in Östersund and Skellefteå. Therefore, field sites for stormwater sampling were set up by LTU in collaboration with Östersund municipality to investigate sources of pollutants, and to identify indicator bacteria in stormwater that can be used as indicators for water quality.^{38, 39, 42} The sites were selected in cooperation with the municipal partners, who also contributed with their expertise and knowledge regarding the sewer systems. The municipal partners also participated in the field studies, e.g., in the field sampling and following laboratory work and analysis. In addition, different sampling strategies and analytical procedures have been investigated by LTU at different field sites, to improve the quality of sampling results obtained from field studies.^{27, 40, 41, 66, 67} As traffic and building materials are major sources of diffuse pollution, several studies have been conducted related to this^{6, 50, 52, 60, 62, 71, 73, 80-82, 85, 87, 88, 90, 92, 93}. Please note, that in one of the studies it was found that a paint for roofing materials, which was marketed as eco-friendly, contained hazardous substances⁶.

A number of studies have also been conducted on the impact of seasonal changes and climate change on stormwater quality^{19, 26, 28-30, 55, 69, 70, 74, 75, 80, 83, 86, 89, 92, 93}. The results show that concentrations of pollution in stormwater in cold climates vary highly, among other things, since snow is gathering pollutions for a long time. The results have led to changes in the snow clearance management practices in some municipalities⁷⁰. In addition, LTU recently started a large research project, in cooperation with Ports of Stockholm, NCC, and two municipalities, on how to manage snow clearance in urban areas to minimize and control pollution loads on receiving waters.

It is important to understand where pollutants end up in the stormwater system and/or environment. This, since depending on where the pollutants end up, they

affect the environment differently, and accordingly, have to be dealt with and/or treated differently. Moreover, if sediments are deposited in the sewers, they clog the sewers which might cause severe flooding. Hence, LTU has conducted several studies on how pollutants are transported in stormwater systems^{18, 19, 33, 36, 49-52, 57, 78, 82, 84-87, 91}.

Design (e.g., biofilters with or without submerged zone), management (e.g., salt and/or sand for slipperiness control), and climatic preconditions (e.g., dry periods, rain, snow, and snowmelt) will all affect the performance of stormwater treatment solutions. Knowledge on how the design, management, and/or different climatic preconditions will affect the performance has therefore been investigated by LTU in a number of studies.^{18, 20-25, 31, 35, 56, 62-65, 77, 92, 95-97}

Climate change and/or densification of cities will in many places have impact on stormwater volumes. What impact changing stormwater volumes will have on stormwater systems, because of climate change and/or densification of cities^{7-11, 26, 43, 58, 68}, and the contribution of green infrastructure to mitigate this^{11, 58}, has been addressed in several studies.

Stormwater volumes can be managed either by the use of sewers, or through open surface stormwater infrastructure, such as permeable asphalt, stormwater ponds, biofilters, swales. In order to plan for open surface stormwater solutions, it is important to have an understanding of their infiltration capacity^{1, 3-5, 32, 34, 61, 76, 94} under different climate conditions.^{32, 34, 61}

Snow melt processes in urban runoff models has been embryonic. As melt water runoff on frozen ground is commonly occurring in cold climates, and can have severe consequences, simulation of urban snowmelt in cold climates has been explored in several research projects^{53, 54, 59, 84}.

Great investment is made in the design and installation of stormwater control measures. However, once installed, it's important to conduct accurate maintenance, to ensure the long-term functionality of the stormwater control measures. Accordingly, operations and maintenance considerations for stormwater control measures have been identified by LTU through several studies^{17, 35, 48, 51, 94}. Moreover, the long-term hydraulic function of stormwater infiltration systems has also been evaluated^{2, 5}.

Some stormwater is heavily polluted, and therefore can impact our receiving waters negatively. Therefore, the pollution content in water and sediments in stormwater facilities, and/or the impact of stormwater on receiving waters^{19, 46, 52, 56, 72, 74, 75, 79} has been studied by LTU.

The research group is conducting most of its research in close collaboration with stakeholders in the stormwater area. Since 2010, the research group is leading the national centre of excellence (appointed by the Swedish Water and Waterwater Association) Stormwater&Sewers (Dag&Nät). Within Dag&Nät, research is con-

ducted, often on site, in close collaboration with the participating municipalities (e.g., see description above on the collaboration with Östersund municipality). In the large R&I projects GreenNano and Attract, LTU is collaborating closely with a large number of companies, ranging from really small, to large, multi-national firms, as well as different divisions at municipalities, to develop goods and services based on the participating stakeholders' needs.

LTU is also active on the international arena. The research group is for instance leading the Brussels-based European Water platform's (WssTP) working group (WG) on Ecosystem services. The group is also a member of WssTP WG Urban Water Pollution, WG Managing Hydroclimatic Extremes, and WG Green Infrastructure. LTU has also been heavily involved in the process of forth bringing the Water platform. The senior researchers are often invited to speak on national and international conferences for stakeholders in the stormwater area (some examples from 2013-2015).^{12-16, 44, 45, 47, 98-100}

2. VISION AND STRATEGY

So far, stormwater management has mostly been seen as a quantity problem, i.e. focus has been on transporting water from urban areas as fast as possible to avoid flooding. However, as established in the introduction section, today's stormwater management also needs to consider stormwater content and pollution. Moreover, stormwater has to be considered as an opportunity. Accordingly:

VINNWATER's vision is to develop pioneering, research based stormwater management knowledge and solutions to minimize pollution loads on receiving waters, to minimize the risk for flooding in urban areas, and to capture the opportunities that stormwater runoff can offer.

The vice-chancellor at Luleå University of Technology has expressed support for VINNWATER, as the competence centre would be in line with, and support, at least one of the university's areas of excellence in research and innovation, i.e. attractive, built environment.

The strategy for achieving VINNWATER's vision is to bring partners from the whole value chain together, i.e. from end users, researchers, manufacturers of stormwater treatment solutions, stormwater storage solutions, sewers, consultancies, to operations and maintenance. Stakeholders representing all these areas are part of VINNWATER.

Some of VINNWATER's stakeholders are big players within the industry; these will offer stability in terms of basic funding of the competence centre. Especially the large stakeholders also have multi-national operations, which will warrant for export of goods and services developed within VINNWATER.

Moreover, one prerequisite for good collaboration is a sound understanding of what can be expected from the collaboration. All VINNWATER's stakeholders

are used to collaborate with researchers, i.e. they have a thorough understanding of the difference in time frames between research and business operations.

The collaboration with all partners of VINNWATER will be further deepened, to secure that the front end research that will be conducted is based on the stakeholders' research and development needs within the stormwater area. Obviously, this application (draft proposal) is based on needs expressed by VINNWATER's stakeholders. Nevertheless, should this draft proposal be granted, a kick-off meeting will be held, to in joint collaboration with all partners further define VINNWATER's activities for the coming 5 years.

In the long term, VINNWATER will develop pioneering, new methods and technologies, for totally new, more sustainable stormwater systems, that will replace the existing stormwater systems. However, since large parts of the existing stormwater systems will remain for many years to come, in the medium-term, VINNWATER will in parallel develop new solutions that will strengthen and improve the existing stormwater management systems.

The excellent research that is the basis for VINNWATER, will produce top-class research which will be published in the most leading and prestigious scientific journals. The research environment is also expected to be attractive in an international perspective and attract international researchers; postdocs and research assistant positions will therefore be offered to young prominent PhD's. The research topic of this proposal is of significant society relevance, and several Swedish institutions and companies are involved in the area. Since there will be a considerable need for knowledge gained from this research initiative at municipalities, authorities and companies, other career opportunities will be as researchers or experts at these institutions.

Results from VINNWATER (knowledge and methods) will be included in the courses offered by LTU. Some of the students will, after the studies, work for stakeholders within the stormwater area. Moreover, some of the students will become PhD students within the stormwater area. One of LTU's courses is offered in Norrtälje, outside of Stockholm. The target group for this course is professionals within the stormwater area, from all over Sweden.

An international reference group will be appointed to VINNWATER, to guarantee high international scientific quality in the forefront, as well as create possibilities for collaboration within H2020 and other areas. This group will also contribute in securing access to researchers that can be recruited to VINNWATER.

The vision for VINNWATER competence centre is that it is a unique, excellent research environment, that attracts both national and international researchers and businesses, and that the pioneering, new stormwater solutions, developed within VINNWATER, are implemented in society.

VINNWATER will supplement and strengthen on-going stormwater research at LTU. For instance, Dag&Nät, the centre of excellence within the stormwater and sewers area (appointed by the Swedish Water and Wastewater Association), is led by LTU. Within Dag&Nät, research is conducted in close collaboration with the participating municipalities (Sundsvall, Östersund, Umeå, Skellefteå and Luleå). Dag&Nät will offer full-scale test beds for the research-based goods and services that will be developed within VINNWATER. Unlike Dag&Nät, within VINNWATER, research will be conducted in close cooperation with stakeholders from the whole value chain, and the majority of the partners will be companies.

Another initiative with several points of contact is the research project GreenNano. GreenNano also involves several businesses, and within this project research in the front end is conducted. GreenNano, however, is a research project with much shorter time frame than VINNWATER. Accordingly, some of the results from GreenNano will be further developed within VINNWATER. However, both Dag&Nät and GreenNano cover a much wider area than VINNWATER, i.e. the research within VINNWATER is focused to excellent research in the forefront within the stormwater quality and volume area.

Just the fact that VINNWATER's project time is so much longer, compared to regular research projects, is extremely valuable for the results (and accordingly publications), as stormwater systems function differently during different climatic seasons. Moreover, operations and maintenance measures of stormwater facilities can be evaluated in the long-term, which is not possible in regular research projects.

Precipitation will always have to be handled. The densification of cities, climate change and the use increasing use of chemicals in our society, makes it increasingly important to manage stormwater in a more sustainable way than today. If we do not succeed, future generations will experience an increasing lack of potable water, and increasing costs of flooding. Accordingly, for the foreseeable future, there will be demand for improved knowledge, goods and services within the stormwater area. As VINNWATER to the major part is building upon existing networks and relationships, and since some of the stakeholders are major players in the field, there is large potential for maintaining structures and networks within the competence centre.

3. STAKEHOLDERS

The Urban Water Research Group at LTU will obviously be a part of VINNWATER. For a description on the competences LTU brings, see Section 1. Key people include Maria Viklander, Professor, Annelie Hedström, Assistant Professor, Heléne Österlund, PhD, Günther Leonhards, PhD, Anna-Maria Perttu, PhD, Godecke-Tobias Blecken, PhD and Lena Goldkuhl, PhD. Viklander, Hedström and Blecken will be on the board.

Aarsleff Rörteknik AB is part of the Aarsleff Group, Denmark's largest building and construction contractor. Rörteknik is a part of Pipe Technologies, a strongly

niched part of the Group, whose technologies are characterized by industrial construction. Own manufacturing of equipment and materials have brought forth leading technologies and flexibility in choice of technology to solve challenges within the piped technologies area. Renewal of sewer systems, and execution without the need for excavation, NoDig, is Rörteknik's main business. During the last few years, the business area on climate adaption measures has grown because of increased market demand. International internal experience is readily available and further developed for maximal spread within the Group. Aarsleff holds a leading position in Europe within the market segment excavation free sewers because of its development work and experience of many years within the area. Stefan Indahl, CEO will be on the board.

Järven Ecotech plan, design and produces complete facilities for treatment and collecting of e.g., stormwater and wastewater. The company for instance offers patented floating wall systems, as well as vortex 'air ventilators' for aeration of lakes as ponds. Key person is Emil Eriksson, Business Development Manager.

Luleå City has recently increased its investments in stormwater management, among other things, since the city has been hit by severe flooding, and a stormwater strategy has been politically pushed through. Luleå will e.g., contribute with field stations for stormwater treatment, i.e. large scale test-sites. Key person is Henrik Visser, Head of Water Department.

NCC is one of the leading construction and property development companies in the Nordic region. The Group had sales of SEK 58 billion in 2013, with approximately 18,500 employees. Stormwater is a focus area for NCC. The company both delivers services as well as goods (e.g., stormwater ponds) within the stormwater area. Recently, the company re-organized its operations, to further strengthen stormwater as a market area, as the company see this as an important future development area. Hans Säll, Senior Vice President, and Head of Business Development, NCC Infra Services, will be on the board.

Rent Dagvatten AB is a group of mainly small companies that together offer complete solutions for sustainable stormwater management and treatment. Companies in the Rent Dagvatten group include, e.g., FlexiClean AB, Uponor Infra AB, Structor Miljöteknik AB, Plastinject Watersystem AB, Skandinavia Water Engineering AB, Virdisol AB, and Constrakt AB. Key person is Erik Bick, CEO.

Stockholm City. Stockholm Water (municipally owned) is Sweden's largest water supplier. Most of the drinking water is produced using surface water from Lake Mälaren (actually, drinking water to 2,2 million Swedes is produced from Lake Mälaren's surface water). Stockholm City has recently decided to invest a lot, to protect Lake Mälaren from further pollution. Jens Fagerberg, Project Leader and Investigation Officer, and Stefan Rosengren, Head of Project Department, are key persons at Stockholm Water. Maria Svanholm, Head of the department for environmental analyses, Stockholm City, will be on the board.

StormTac, the company, offers a model software, developed and provided by StormTac. The model is based on the owner's research results (PhD). In one single model StormTac includes the interactions within the whole watershed system; runoff and base flow, pollutant transport, receiving water impacts and criteria, design of transport, pollutant treatment and flow detention facilities. StormTac is constantly further developing the model. Customers include consultancies, municipalities, etc. Key person is Thomas Larm, PhD, CEO.

Tyréns is one of Sweden's leading multi-disciplinary consultancies. The company specialises in urban planning and infrastructure solutions that promote sustainable development. Tyréns' operations are focused to six markets: Urban and Rural Planning, Buildings, Industry, Infrastructure, Climate and Environment, and Water. Tyréns will contribute with a PhD student to VINNWATER. Key persons are Birgitta Olofsson, vice CEO, Tyréns, and Karolina Berggren, PhD, Business Area Water. Olofsson will be on the board.

4. THE STRUCTURE OF THE COMPETENCE CENTRE

VINNWATER's hub will be at LTU. The organizational structure for VINNWATER comprises: a board, a coordinator, a co-coordinator, an operative leading group, and an international reference group.

The guiding principles for VINNWATER are:

Cooperation – Research must actively encourage cooperation among stakeholders, between research and practice and across geographical divides

Openness – Research must be carried out in a spirit of openness to enable conditions for collaboration among stakeholders

Relevance – Research must be consistent with the vision of VINNWATER, the priorities of its stakeholders, society needs and substantially contribute to sustainable urban development

Originality – Research must address an identified theoretical or practical gap and offer the possibility of significant progress

Quality – Research must be of high international standard

The prerequisite for the development of new methods and technologies, and further development of existing ones, is that all relevant stakeholders are involved. Research will be conducted in very close cooperation with the participating stakeholders, mainly by researchers at LTU. Those stakeholders that have research units within their organization will conduct research activities jointly with the researchers at LTU. Research will also be conducted jointly at site in participating municipalities and organizations. The stakeholders come from all over Sweden. Hence, communication platforms will be utilized to facilitate everyday communication. In addition, regular project meetings (Pulsmöten) will be held among those stakeholders that currently are working jointly on different subprojects.

The overarching goal for all research activities is to produce excellent research, of true value to VINNWATER's stakeholders, and in line with VINNWATER's vision. The stakeholders represent the whole value chain, i.e. from end users, re-

searchers, manufacturers of stormwater treatment solutions, stormwater storage solutions, sewers, consultancies, to operations and maintenance. More into detail, the stakeholders bring knowledge on e.g., materials (preliminary research findings show that type of sewer material will have an impact on treatment of stormwater), filter materials, modeling of stormwater (treatment and sources, run off), design of stormwater systems (e.g., consultancy), operations and maintenance (including sediment management).

Mobility from academia to VINN WATER’s other partners will be encouraged, e.g., that researchers are working part time in the participating companies and/or municipalities. Moreover, some of VINN WATER’s PhD students will be financed directly by industry (so called ‘industridoktorand’).

Traditionally, research within stormwater quality and stormwater volumes has been conducted separately. Within VINN WATER, researchers from both those fields will be joining forces, together with the participating stakeholders, to develop holistic stormwater management systems, i.e. stormwater systems that can manage both stormwater quality and volume for different conditions, such as soil type, pollution, site specific conditions, climate change, existing infrastructure, and condition of receiving waters.

Companies have the knowledge on market demand, municipalities have knowledge on e.g., operations and maintenance demand, consultancies design stormwater management solutions, and researchers contribute with applied front edge research of excellent quality. The involved companies will sell the goods, services and knowledge that are developed within VINN WATER. Society as a whole will benefit, as the stormwater management solutions that will be developed through VINN WATER will manage stormwater quality and volume in a much better way than today’s solutions.

5. IMPLEMENTATION AND OUTCOMES

Budget

The planned budget for VINN WATER is 108 MSEK for the first 5 years, the distribution between Vinnova, LTU and Industry/public sector are presented in Table 1. In Table 2, the distribution of the budget between the partners from industry and public sector is presented.

Table 1. Distribution of budget between Vinnova, LTU and Industry sector

	Year 1	Year 2-5	Year 6-8	Year 9-10
Vinnova	4	8	10	5
LTU	4	8	10	5
Industry/public sector.	4	8	10	5
Total	12	24	30	15

Table 2. Distribution of budget between the partners from industry and public sector

	Total	Year 1		Year 2-5		
		Cash	In-kind	Total	Cash	In-kind
Tyrens	400	200	200	900	800	100
NCC	400	200	200	800	200	600
Aarsleff	200		200	600		600
Järven	100		100	400		400
Stormtac	150		150	250		250
Kemira	50		50	200		200
Rent Dagvatten	100		100	350		350
Stockholm*	1500		1500	3000		3000
Luleå	600	400	200	1000	800	200
SVU	500	500		500	500	
Total	4000	1300	2700	8000	2300	5700

*Stockholm Miljöförvaltning och Stockholm Vatten

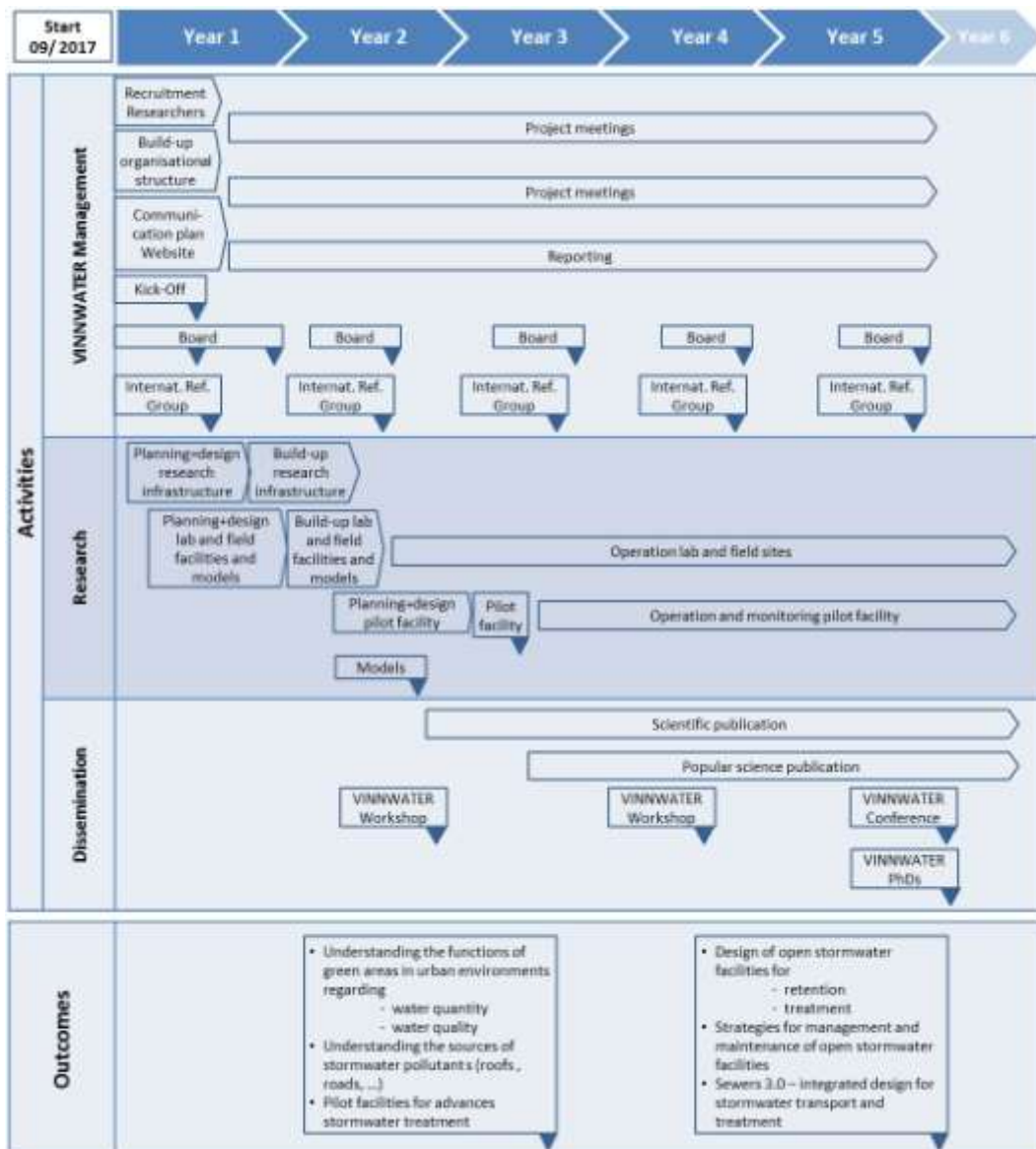


Fig. 2 Outline of Activities and Outcomes

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