RESEARCH REVIEW

CIVIL ENGINEERING

UNIVERSITY OF TWENTE

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REPORT ON THE RESEARCH REVIEW OF THE DEPARTMENT OF CIVIL ENGINEERING OF THE UNIVERSITY OF TWENTE

1. PREFACE BY COMMITTEE CHAIR

The University of Twente has been engaged in Civil Engineering (CE) research for the past 30 years. During the last decade the research was primarily carried out by four research groups: Construction Management & Engineering (CME), Marine and Fluvial Systems (MFS), Centre for Transport Studies (CTS), and Water Management (WM). In 2016 the four groups merged to become the Department of Civil Engineering and a year later the groups were relocated closer together on one floor of the same campus building. The department is relatively small in size with an average of 10.5 fte tenured staff and a total research capacity of 44.1 fte (including PhD students). The Department of Civil Engineering is one of two academic CE departments in the Netherlands, the other (much larger) department being at Delft University of Technology. In 2012, all CE research in the Netherlands was simultaneously assessed by one international committee. In 2018, the Executive Board of the University of Twente preferred a stand-alone assessment of the CE department as it had evolved over recent years.

In accordance with the Standard Evaluation Protocol (SEP) 2015–2021 for research reviews in the Netherlands, a committee was formed consisting of leading experts in the four research areas, coming from universities in the Netherlands, the United Kingdom, and the United States of America. The committee was asked to assess the quality, the relevance to society and the viability of the scientific research, as well as to provide comments and suggestions on the strategic targets and the extent to which the department is equipped to achieve these targets. In addition, a qualitative review of the PhD training programme, research integrity policy, and diversity was part of the committee's assignment, as reflected in this report.

Triggered by the considerable challenges that society is facing (climate change adaptation, energy transition, increasing risks of water scarcity and flooding, continued urbanisation, shifts in mobility and modes of transport, the push for a circular economy) the vision of the department is that Civil Engineering has a key role to play in coping with these challenges. The mission of the department is to develop, apply and disseminate knowledge and novel solutions contributing to achieving a sustainable, efficient, safe and resilient society. This mission closely connects to the 'high tech human touch' focus of the University of Twente as a whole. In a joint and open process three cross-cutting research themes were selected by the department: (i) sustainability; (ii) efficiency; (iii) safety and resilience; and elaborated into joint research programmes.

The committee greatly appreciated the kind cooperation, in-depth discussions and open and frank attitude of university officials, faculty, staff and students alike.
The support from QANU is also greatly appreciated.

Prof. dr. ir. A.E. Mynett
Chair

2. THE REVIEW COMMITTEE AND THE PROCEDURES

2.1. Scope of the review

The review committee has been asked to perform a review of research conducted by the department of Civil Engineering at the University of Twente. The review includes the Construction Management and Engineering (CME) group, the Marine and Fluvial Systems (MFS) group, Water Management (WM) group and the Centre for Transport Studies (CTS).

In accordance with the Standard Evaluation Protocol (SEP) 2015 – 2021 for research reviews in the Netherlands, the committee was asked to assess the quality, the relevance to society and the viability of the scientific research as well as the strategic targets and the extent to which the unit (i.e. the department of Civil Engineering) is equipped to achieve these targets. Furthermore, a qualitative review of the PhD training programme, research integrity policy and diversity was part of the committee's assignment.

2.2. Composition of the committee

The composition of the committee was as follows:

- Prof. A.E. (Arthur) Mynett, emeritus professor in Hydraulic Engineering, UNESCO-IHE & Delft University of Technology [chair];
- Prof. N. (Nicholas) Dodd, Professor of Coastal Dynamics, Faculty of Engineering at the University of Nottingham (United Kingdom);
- Prof. S.L. (Susan) Handy, department of Environmental Science and Policy at the University of California at Davis (United States of America);
- Prof. J. (Jennifer) Whyte, department of Civil and Environmental Engineering at Imperial College London (United Kingdom).

The committee was supported by dr. B. (Barbara) van Balen, who acted as secretary on behalf of QANU.

2.3. Independence

All members of the committee signed a statement of independence to guarantee an unbiased and independent assessment of the quality of the department of Civil Engineering at the University of Twente. Personal or professional relationships between committee members and the research unit under review were reported and discussed amongst the committee members at the start of the site visit (25-26 June 2018). The committee concluded that no specific risk in terms of bias or undue influence existed and that all members were sufficiently independent.

2.4. Data provided to the committee

The committee received the self-evaluation report from the unit under review, including all the information required by the SEP.

The committee also received the following documents:

- the Terms of Reference;
- the SEP 2015-2021;
- lists of publications, consisting of five key publications per group.

2.5. Procedures followed by the committee

The committee proceeded in accordance with the SEP protocol. Prior to the first meeting, all committee members independently formulated a preliminary assessment based on the written information that was sent in advance. All committee members prepared the assessment of the

department and sent their preliminary assessments to the QANU secretary of the committee. These preliminary assessments were further enhanced by the committee members after the site visit in order to establish the final assessment of the department. Due to personal circumstances Prof. Handy could not be present during the site visit, but the committee had contact by email and the assessment of the committee is also based on the evaluation by Prof. Handy.

The final review is based on both the documentation provided by the Department of Civil Engineering and the information gathered during the interviews with management and representatives of the research unit during the site visit. The site visit took place on 25 and 26 June 2018 in Enschede (see the schedule in Appendix 2).

Preceding the interviews, the committee was briefed by QANU about research reviews according to the SEP. It also discussed the preliminary assessments and decided upon a number of comments and questions. The committee also agreed upon procedural matters and aspects of the review. After the interviews on Monday 26 June the committee discussed its preliminary findings and comments in order to allow the chair to present the preliminary findings to the department and other interested university members (including the dean and the rector) in the late afternoon and to provide the QANU secretary with argumentation to draft a first version of the review report.

The draft report by committee and secretary was presented to the Department of Civil Engineering for factual corrections and comments. In close consultation with the chair and other committee members, the comments were reviewed to draft the final report. The final report was presented to the Board of the University and to the management of the research unit.

The committee used the criteria and categories of the Standard Evaluation Protocol 2015-2021 (SEP). For more information see Appendix 1.

3. ASSESSMENT OF THE DEPARTMENT OF CIVIL ENGINEERING

3.1. Introduction

The University of Twente has been engaged in Civil Engineering (CE) research for the past 30 years. In the last decade Civil Engineering research was organised in four research groups: Construction Management & Engineering, Marine and Fluvial Systems, Centre for Transport Studies, and Water Management. In 2016 the four groups that execute the educational programme of Civil Engineering merged to become the Department of Civil Engineering. The new department identified similarities between the four groups and their original research trajectories. Four crossover themes were selected: sustainability, efficiency, safety and resilience. In 2017, the four original groups were re-allocated physically to the same floor in the building.

The Department of Civil Engineering is one of two academic CE departments in the Netherlands. The only other department is located at Delft University of Technology. In 2012, all CE research in the Netherlands was simultaneously assessed by one international committee. This time, the Executive Board of the University of Twente chose to apply for a stand-alone assessment. The department is relatively small in size with an average of 10.5 fte tenured staff and a total capacity of 44.1 fte (including PhD students). An overview of the capacity is included in Appendix 3.

3.2. Profile, strategy and management of the department

The department's research is characterised as interdisciplinary and explorative. It considers the physical, human and policy context of civil engineering systems, as well as the management of such systems. Society is facing great challenges by a combination of climate change, energy transition, increasing risks of water scarcity and flooding, continued urbanisation, shifts in mobility and modes of transport and the push for a circular economy. In the vision of the department the Civil Engineering discipline has a key role in coping with these challenges. The mission of the department is to develop, apply and disseminate knowledge and novel solutions in the domain of civil engineering contributing to a sustainable, efficient, safe and resilient society. This mission closely connects to the 'high tech human touch' focus of the University of Twente. The cross-cutting themes of sustainability, efficiency, safety and resilience are visible in the research programmes of the four research groups.

The mission of the Construction Management & Engineering (CM&E) group is to reduce (the effects of) fragmentation in the infrastructure life cycle and construction project delivery. The group studies, develops and teaches new process approaches, methods & technologies to enhance integration and innovation for the infrastructure life cycle and integrated project delivery. The group uses a design-oriented approach, in close cooperation with practice, with emphasis on the integration of disciplines. The objective of the group is to improve the performance of construction industry by:

- High quality research – fundamental as well as applied – in the spirit of engaged scholarship;
- Deepening the understanding of the dynamics of change and innovation in the industry by studying construction processes and value chains at the level of the stakeholders;
- Developing effective and innovative solutions to the problems of managing construction processes and the life cycle of infrastructures.

The Marine and Fluvial Systems (MFS) group studies marine and fluvial systems from an engineering point of view. It creates and uses physical knowledge to help interventions in these water systems to get a desired (sustainable, safety with respect to floods) state. The group's overall aim and strategy is building with nature. The group examines how the building with nature principle can help to cope with climate change impacts. The group studies river management and floodplain rehabilitation, sustainable ecological design of sand nourishments, and sustainable dredging offshore. The group explores how to improve decision-making efficiency in water-management. In regard to safety and resilience it studies dikes with multiple functions, coastline security, and the role and use of mangroves in flood protection, and investigates the long-term interactions between beach-dune

dynamics and the built environment at the land-sea interface. In addition, the group undertakes fundamental research into dynamics of natural and engineered coastal systems.

Research at the Centre for Transport Studies (CTS) concerns the design of smart transport systems for Medium/Low Urbanized Regions to contribute to a sustainable, safe, resilient and inclusive society. The group uses ICT technology to monitor both travel demand and accessibility for all modal transport systems. Therefore, the group needs a good understanding of underlying processes, for instance: which factors are actually motivating travel demand and driving behaviour; how does demand influence supply and vice versa; and how can individual travel patterns best be influenced. Research activities by this group require advanced ICT methodologies for data fusion, data analytics and human-machine interaction, and ICT technologies that are able to measure the motivation for travellers making certain choices.

The Water Management (WM) group aims to advance the understanding of the natural and socio-economic processes behind water scarcity, flooding and pollution. Its research has a strong interdisciplinary character that takes from and contributes to the natural, technical, social and policy sciences. The group studies water productivity in crop, livestock and energy production. It investigates water use at local as well as at global level. Furthermore, it studies and evaluates techniques and policies to reduce water use and scarcity and analyses the causes of water scarcity, droughts and floods.

3.3. Research quality

Since the department was only recently established, most of the research results in the assessment period should be accredited to the individual research groups. As a whole, the CE department has core strengths in construction engineering and management, marine, water and transport - all areas of civil engineering that are of particular relevance in the Netherlands. The committee noticed during the site visit that fruitful connections between the groups are growing. During the site visit, their representatives presented several co-operative projects and project ideas, such as infrastructure and power locks, sustainability and energy and 'sponge cities'. The committee wholeheartedly encourages the further development of these ideas. The committee appreciated the interdisciplinary approach and the cross-cutting themes (sustainability, efficiency, safety, resilience) around which to organize collaborations. It was clear to the committee how each group in the department responds to these cross-cutting themes and during the site visit it was further illustrated how these groups are starting to collaborate on research across themes.

The department has a strong international profile in the research areas of particular strength, which enables the desired linking of natural, social, policy and engineering sciences. The relatively small CE faculty has produced an impressive quantity of research that has received international recognition. All four groups in the department have a strong national and international profile, and many publish in well-ranked journals. The department has some star performers but the quantity and quality of research is consistently very good across the four research groups.

The Construction Management and Engineering group is one of a few top research groups in the world. Its research is of high quality and scientific relevance. The group shows an increasing focus on refereed articles rather than conference papers and it performs well in winning grants for research. The group is recognized worldwide as a leading construction management group. The committee would recommend promoting the work of this group more and thinks it would be useful to explore if there are ways to craft the significance of the research and to promote top papers to increase the citation rates.

The Marine and Fluvial Studies group has established an outstanding international research profile. In particular, there are two world leading areas, one long established and another more recently developed: (1) understanding the natural morphodynamics of bed forms of the continental shelf (e.g., sand waves and sand banks), and the effects of human interventions; and (2) understanding

and modelling the effect of biota on evolution of bed forms on the continental shelf and coast. The research quality is excellent, as evidenced by numerous publications in top journals. The understanding of bed-forms of the continental shelf and their evolution is primarily a result of the research at Twente. Furthermore, the present knowledge of sand behaviour under oscillatory flow is also significantly due to work at Twente. Similarly, the academic reputation of the group is very high. This can be seen in the number of international collaborations the group has been involved in, both of Twente researchers visiting other groups and vice versa. It can also be seen from the amount of funding the group has brought in, and from the involvement in a large number of prestigious boards and committees. The high quality of the research of this group is also underpinned by the prestigious awards and research grants received. It is remarkably successful in bringing in research money, publishing, and outreach activities.

The Centre for Transport Studies has unquestionably made important contributions to the field of travel behaviour research and to the development of accessibility measures to inform transport policy. The Mobility Panel for the Netherlands is a unique resource for travel behaviour researchers not just in the Netherlands but around the world. The relatively small faculty has produced an impressive quantity of research that has received international recognition. The group is working on interesting projects such as working on traffic data with the use of mobile phones. Its focus adheres to the University Twente slogan 'high tech and human touch'. The committee has the impression that the group could do more to connect with the other groups in the department in particular with the Construction Engineering and Management group regarding 'smart cities'.

The Water Management group has a very impressive academic track record. The group has a clear and coherent vision that includes the connection to the other research areas in the CE department. The group is world leading in its research area. It is, in particular, visible internationally and in some respects complementary to the Marine and Fluvial Studies group. The committee was impressed that a relatively small group achieved such a big worldwide impact. In particular the work on the water footprint assessment and the Water Footprint Network is internationally highly visible and recognized as outstanding. The committee appreciates that the group continuously innovates its focus and research. The new direction of the research on the water-food nexus is very promising. The committee noticed that the group attracts a lot of staff but that there is a high turnover, indicating that the researchers and graduates are well sought after. The fact that graduates are going to renowned organisations like the World Bank is further proof of its success.

The department obviously has research programmes and researchers that are world leading and most influential in their particular field, but across the board the committee assesses the quality of research of the four research groups as very good.

3.4. Relevance to society

The committee has seen a lot of evidence that the research of the Civil Engineering Department has significant impact in informing policy and practice in the Netherlands. The four themes – sustainability, efficiency, safety, and resilience – clearly motivate the department's research programme. Across all four groups, researchers have produced knowledge and developed tools that help to improve practice in both the private and public sectors with respect to these issues. The self-evaluation report includes many examples of the successful implementation of the department's products.

The information in the self-evaluation report, as well as the additional information presented during the site visit, show the strong relevance of the department's work to society and the ability of the research teams to engage with society and ensure impact through trained graduates, spin-offs, outreach activities, as well as through the collaborations with, and uptake and use of research outputs in, public and private sectors. All groups make a strong effort to publicise their work and the impact of their work for a broad general audience. The committee has strong evidence that the department delivers high quality PhD graduates. The graduates are highly sought after and take positions in

various public and private organisations like Rijkswaterstaat, Deltares, Arcadis and international NGO's, where they use their knowledge and expertise for innovation and development targeted at sustainability, efficiency, safety and resilience in society.

The committee appreciates the focus of the CE&M group on infrastructure. It gives the group strong leads to policy makers in The Netherlands. During the site visit the group showed how it uses the university campus as a living lab. The committee finds that this is a very efficient and practical solution and a good way to involve students in projects.

The work being undertaken by MFS is very relevant to society. For instance, in the Rivercare project the expertise on morphodynamics of the group is being put to practical use, as is the work done on understanding the effect of biota (vegetation) on fluids (rivers). MFS is making a very significant effort to publicise their work to a more general audience. The group has also made significant efforts to access and make their research available to the wide public through newspapers, professional journals, science cafés and the internet. Furthermore, connections with industrial partners and the wider academic community are very strong. A number of members of staff within MFS have joint appointments and are also connected to governmental organisations like Rijkswaterstaat or knowledge institutes like Deltares. The group described its lab policy to the committee, which was impressive and innovative in how it allows the group to make use of renowned lab facilities all over the world in collaborative projects.

The research activities of the CTS group are very relevant for the transport and mobility area. Although the group does not explicitly target (disadvantaged) economic, social, or cultural groups, the outcomes of the research at least indirectly benefits them. The research facilities in terms of equipment for the group are modest but the group also makes good use of the living lab in and around the university campus.

The societal impact of the research activities of the Water Management group is impressive. For instance, the water foot print indicator is increasingly used by policy makers and academic institutions to assess water usage and stimulate increased efficiency The group has a high profile, making the University of Twente visible to a larger public, both nationally and internationally.

The committee assesses the relevance to society of the Department Civil Engineering as very good. The department makes obvious and great, in some cases outstanding, contributions to society.

3.5. Viability

In its self-evaluation report the department describes the four CE groups to be operating in domains and contexts that differ in opportunities and resources. MFS and WM operate in a domain where the Netherlands has an internationally acknowledged strong and rich scientific tradition. This is supported by well-developed infrastructure and domain-designated research funding. The domain of transport studies has become more volatile and more interdisciplinary: due to the increasing attention to autonomous driving, TS is now just one of many disciplines in this domain. Compared to 'water', the Dutch knowledge infrastructure and funding in the Transport Studies domain is more scattered and less coherent. In the Construction Management domain, the knowledge infrastructure and funding are virtually absent. As a consequence, to secure viability, CME follows a close-to-practice approach and pushes to convert this approach to stronger scientific excellence. All groups have a strong national basis and international visibility and outreach.

The representatives of the department reported during the site visit that developing a department is a slow process. The committee, however, thinks that a lot has been achieved already. The four groups are making considerable efforts to collaborate and are looking for joint ways forward. Furthermore, the CE department has been re-located to occupy the same physical space on one floor of the Horst building. The committee sees this as a very good development and has noticed that this generates more synergy, closer contact lines and more awareness of the possibilities to work

together. However, more can be done. The PhD students very much appreciated meeting each other and learning about their respective projects during the poster session organised for the committee. They suggested having regular meetings in which they all present their work to each other. A common coffee room and common coffee times could further support the steps already taken by the department to build an interdisciplinary and stimulating community.

The committee learnt during the site visit that the recruitment policy is aimed at attracting staff on cross-connecting subjects for the whole department of civil engineering. Vacancies and new positions are discussed within the department, and not necessarily filled by a candidate with the same expertise as the one who left. The department emphasizes the interdisciplinary approach and uniqueness of civil engineering in its hiring policy. The committee appreciates this policy and finds this cooperation and openness within the department very positive. The committee has seen that over the last two years a lot of effort has been put into building a department out of four independent groups, and is impressed by the achievements.

The CE Department seems to be on solid ground with respect to funding, given a steady stream of research funding from various sources. The department has the ambition to grow but at a steady pace. The committee has established that the relatively small number of research staff was very productive and had an enormous impact. It, however, underlines that the department needs more mass and a sufficient basis of tenured staff to be able to maintain the position it has achieved and to continue participating in the subsidy schemes and attracting second and third tier money projects. Developing innovative and new interdisciplinary projects needs significant investments before they can be realised. It could be a wise investment by the University of Twente to provide seed money for these initiatives.

The research programme of the CE department is well connected to the themes defined in the Dutch National Science Agenda. It seems that the researchers have a good eye for the societal challenges and what they can contribute to the big questions of this decade. The researchers are quite strategic in identifying areas to make the best use of their strengths. The committee however recommends establishing an advisory board for the department with members from industry and public and societal organisations, which can help the department to set the agenda for the future.

The committee concludes that the viability of the department is good. The department is well equipped for the future and makes responsible strategic decisions. The chosen priorities in research and the process through which the priorities are determined will sufficiently support the department to sustain and foster its viability in the long term. The committee appreciates the chosen strategy for talent management, in particular the process of determining vacancies and is confident that this will support the viability of the department.

3.6. PhD programmes

The CE department actively participates in the management of relevant national research schools, such as the research school on transport and logistics, TRAIL; the national environmental research school, SENSE; and the research school on fluid dynamics, the JM Burgers Centre. Since 1 January 2014, all PhD students participate in the Twente Graduate School (TGS). As a result, uniform procedures and rules now apply for all PhD students. These involve:

- Central registration of all PhD students;
- Clear go/no-go moment in the first year followed by a formal appointment of the promoter;
- Digital Training and Supervision Plan;
- Forecast and dropout registration.

There is a central Civil Engineering Discipline Board that meets monthly to assess the qualifiers for the PhD trajectory. The qualifier aims to determine a conclusive assessment as to whether or not to proceed with the remainder of the PhD project. A Training and Supervision Plan is obligatory for all categories of PhD candidates. In principle, the educational programme for the PhD Students amounts

to 30 ECs (European Credits). The committee remarks that the success rates of the PhD students can be improved. Only 50% of the students enrolled finish their project within 6 years. The department mentioned several reasons why students take longer or discontinue their project, and this resembles the common pattern in the Netherlands. The department is aware of the completion rates and is taking measures to improve them. As mentioned, the committee is impressed by the quality of the PhD graduates and received evidence of their good job opportunities on the international job market. Furthermore, the committee spoke with a selection of PhD students who all were very satisfied with their training and supervision. They specifically mentioned the open-door policy of their supervisors, which allows them to ask for feedback and advice about their progress at any given time.

During the meeting with the PhD Students it became clear to students as well as the committee that it would be a good idea to organise meetings in which the PhD Students present their work to each other more often. The poster session was very informative for the PhD students to learn from each other and to identify common interests and good practices. The training and courses offered by the Twente Graduate School as well as by the national research schools are appreciated and sufficient; the only subject that could perhaps be added is 'data science'.

3.7. Research integrity

The CE Department adheres to university-wide policies and procedures for scientific integrity. The committee ascertained that the university has a well-developed integrity policy and that the graduate school offers courses on the subject. The committee also verified that the PhD students are very aware of the subject. Furthermore, one of the professors of the department actively participates in the university-wide committee concerning research integrity.

3.8. Diversity

The issue of staff diversity was not explicitly covered in the self-evaluation report, but it was discussed during the site visit. Gender diversity in staff is growing but still can be improved. The international and cultural diversity can also be improved. Furthermore, it was surprising to the committee that there is a relatively low number of female masters students, given the performance of successful female staff members and the department policy to further increase the number of female staff in the future. The committee suggests gathering detailed statistics about who (gender, and cultural and national background) applies to the master degree programmes, PhD positions, and staff vacancies, and develop an open recruitment policy to avoid individual bias. It particularly recommends developing a policy on where and how to recruit future staff to ensure a wider diversity in applicants.

3.9. Conclusions

The committee felt very honoured and pleased to be invited to assess the Civil Engineering Department of the University of Twente. During the site visit it met with a very friendly and open community. In the view of the committee the department has very many merits. It has excellent research groups and some star performers. Its overall performance is very good. The CE department is relatively young but has already developed into a real department where co-operation between the groups is stimulated and facilitated. Staff and PhD's all seem happy with their working environment. The department has an adequate research integrity policy and PhD training programme. Although the staff composition shows increasing gender diversity, more could be done to achieve overall diversity amongst the staff.

The committee considers the quality of the research of the Civil Engineering Department as a whole as very good. The department's research can be characterised as interdisciplinary and explorative. It considers the physical, human and policy context of civil engineering systems, as well as the management of such systems. Since the department was only recently established, most of the

research results in the assessment period should be accredited to the individual research groups. However, the committee noticed during the site visit that fruitful connections between groups are growing. The committee wholeheartedly encourages further development of these connections. The relatively small CE faculty has produced an impressive quantity of research that has received international recognition. All four groups in the department have a strong national and international profile, and many publish in well-ranked journals. The department clearly has some excellent star performers that are world leading and most influential in their particular field. But the quantity and quality of research is consistently very good across the four research groups.

Regarding relevance to society the committee considers the department to be very good in view of the evidence provided that the research of the Civil Engineering Department has a significant impact on policy makers, public opinion and practice in the Netherlands. Across all four groups, researchers have produced knowledge and developed tools that help improve practice in both the private and public sector. The self-evaluation report contains many examples of the successful implementation of research outcomes and in some cases outstanding contributions to society. Graduates are highly sought after and have often taken up important positions in various public and private organisations, both nationally and internationally (e.g. World Bank).

The committee concludes that the viability of the department is good. The department is well equipped for the future and makes responsible strategic decisions. The chosen priorities in research topics and the process through which priorities are determined will sufficiently support the department to sustain and foster its viability in the long term. The committee appreciates the chosen strategy for talent management, in particular the process of identifying preferred profiles for vacancies, and is confident that this will support the viability of the department.

3.10. Overview of the quantitative assessment of the research unit

After having assessed the research quality, relevance to society and viability, and comparing that to the developments and standard in the field of Civil Engineering, the committee comes to the following quantitative assessments:

Research quality:	very good
Relevance to society:	very good
Viability:	good

4. RECOMMENDATIONS

The committee underlines that the department needs a sufficient basis of tenured staff to be able to maintain the position it has acquired and to continue in participating in the subsidy schemes and attracting second and third tier money projects.

The committee recommends establishing an advisory board for the Department with members from industry and public and societal organisations, who can help the Department to set the agenda for the future.

The committee suggests that the department gathers detailed statistics about who (gender, and cultural and national background) applies to both the master's degree programmes, PhD positions, and staff vacancies and develops an open recruitment policy to avoid individual bias. It particularly recommends developing a policy on where and how to recruit future staff to ensure a wider diversity in applicants.

The committee recommends the department to enhance promoting the work of the Construction Management & Engineering group. It would be useful to investigate if there are ways to craft the significance of the research and to promote top papers to increase the citation rates.

The committee recommends that the Centre for Transport Studies invests in connecting with the other groups in the department, in particular with the CE&M group in regard to smart cities.

The committee recommends organising monthly meetings where PhD students of all groups are present to discuss their work (i.e. to an audience of others within the department as a whole, not just their research group).

A common coffee room and common coffee times could support the steps taken by the department to build an interdisciplinary and stimulating community.

APPENDICES

APPENDIX 1: THE SEP CRITERIA AND CATEGORIES

There are three criteria that have to be assessed:

- Research quality:
  - Level of excellence in the international field;
  - Quality and Scientific relevance of research;
  - Contribution to body of scientific knowledge;
  - Academic reputation;
  - Scale of the unit's research results (scientific publications, instruments and infrastructure developed and other contributions).

- Relevance to society:
  - quality, scale and relevance of contributions targeting specific economic, social or cultural target groups;
  - advisory reports for policy;
  - contributions to public debates.

The point is to assess contributions in areas that the research unit has itself designated as target areas.

- Viability:
  - the strategy that the research unit intends to pursue in the years ahead and the extent to which it is capable of meeting its targets in research and society during this period;
  - the governance and leadership skills of the research unit's management.

Category	Meaning	Research quality	Relevance to society	Viability
1	World leading/excellent	The unit has been shown to be one of the most influential research groups in the world in its particular field.	The unit makes an outstanding contribution to society	The unit is excellently equipped for the future
2	Very good	The unit conducts very good, internationally recognised research	The unit makes a very good contribution to society	The unit is very well equipped for the future
3	Good	The unit conducts good research	The unit makes a good contribution to society	The unit makes responsible strategic decisions and is therefore well equipped for the future
4	Unsatisfactory	The unit does not achieve satisfactory results in its field	The unit does not make a satisfactory contribution to society	The unit is not adequately equipped for the future

APPENDIX 2: PROGRAMME OF THE SITE VISIT

Sunday 24 June 2018 Location De Broeierd Meeting room 15-12 h		
15.30- 17.00 h	Welcome and meeting (committee in private)	Mrs A.M. (Anne-Marie) Klijnstra
17.00- 17.30 h	Meeting with the Dean	Prof dr G.P.M.R. (Geert) Dewulf, Dean of the Faculty of ET
17.30-- 19.15 h	Drinks and diner with sub programme leaders or in private if preferred, restaurant	Prof dr G.P.M.R. Dewulf, Dean of the Faculty ET Prof dr S.J.M.H. (Suzanne) Hulscher (MFS) Prof dr ir E.C. van Berkum (Head of Department CE&M/ CTS) Prof dr ir A.G. (André) Dorée (CME)

Monday 25 June 2018 Location Horst building in Centre: Z-203		
08.30- 09.00 h	Informal welcome and preparation committee in private	Prof dr G.P.M.R. Dewulf, Dean of the Faculty ET Prof dr ir E.C. van Berkum (Head of Department CE&M/ CTS) Mrs A.M. (Anne-Marie) Klijnstra
09.00- 9.30 h	Board of the University/ Faculty	Prof.dr. T.T.M. (Thom) Palstra (Rector magnifucus UT) Prof dr G.P.M.R. (Geert) Dewulf (Dean of the Faculty ET)
9.30- 10.15 h	Department CE	Prof dr G.P.M.R. (Geert) Dewulf (Dean of the Faculty ET) Prof dr ir E.C. (Eric) van Berkum (Head of Department CE&M) Prof dr S.J.M.H. (Suzanne) Hulscher, Chair Discipline Council CE&M
10.30- 11.10 h	Sub programme: Construction Management & Engineering	Prof dr ir. A.G. Dorée (Programme leader) / Prof dr ir J.I.M. (Joop) Halman
11.25- 12.05 h	Sub programme: Marine and Fluvial Systems	Prof dr S.J.M.H. (Suzanne) Hulscher (programme leader) / Prof.dr K.M. (Kathelijne) Wijnberg
12.20- 13.20 h	Lunch with PhD students (poster session) T-1300	CME: Zaharah allah Bhukhs, Koos Johannes CTS: Oscar Eikenbroek, I Gusti Ayu Andani WM: Bunyod Holmatov, Charlotte Verburg MFS**:** Anouk Bomers, Pim Willemsen
13.20- 14.00 h	Sub programme: Centre for transport studies	Prof dr ir E.C. (Eric) van Berkum (programme leader) / Prof dr ing K.T. (Karst) Geurs
14.15- 14.55 h	Sub programme: Water Management	Prof dr ir A.Y. (Arjen) Hoekstra (programme leader) /Dr M.S. (Maarten) Krol
15.10- 15.40 h	Tour of the facilities	Dr.ir. F.(Farid) Vahdadtihaki /dr. Ir A.P. van den Beukel
15.40- 17.30 h	Committee review of the visit (private)	
17.30- 18.00 h	Feedback to faculty / drinks	All

18.30 h	Diner in De Broeierd (committee in private)	

Tuesday 26 June 2018 De Broeierd Meetingroom (9-13 h)		
08.00- 11.00 h	Writing of draft report	

APPENDIX 3: QUANTITATIVE DATA

Financial resources per group

Construction Management and Engineering (CME) group

	2009	2010	2011	2012	2013	2014	2015	2016	2017		Avg.
	k€	k€	k€	k€	k€	k€	k€	k€	k€	k€	%
Direct funding (1)	2102	1688	1695	1447	1443	1702	1685	1658	2303	1747	61
Research grants (2)	0	24	109	153	225	172	117	117	112	114	4
. Contract research	1351	1769	944	1007	1163	668	549	615	566	959	
. Indirect funding	7	14	0	0	0	12	37	45	71	21	
Contract research & indirect funding (3)	1358	1783	944	1007	1163	680	585	660	637	980	34
Total funding	**3460**	**3495**	**2748**	**2607**	**2831**	**2554**	**2387**	**2435**	**3052**	**2841**	**100**
Expenditure:	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**%**
Personnel costs	2327	2199	2380	2067	2250	2184	2089	1766	1810	2119	75
. Indirect funding	7	14	0	0	0	12	37	45	71	21	
. Personnel costs	2320	2185	2380	2067	2250	2172	2052	1721	1739	2098	
Housing costs	238	242	289	264	274	226	223	219	127	234	8
Other costs	439	406	493	258	585	593	241	573	620	468	17
Total expenditure	**3004**	**2847**	**3162**	**2590**	**3109**	**3003**	**2553**	**2559**	**2557**	**2820**	**100**

Marine and Fluvial Systems (MFS) group

	2009	2010	2011	2012	2013	2014	2015	2016	2017		Avg.
	k€	k€	k€	k€	k€	k€	k€	k€	k€	k€	%
Direct funding (1)	1008	857	799	795	733	749	819	1044	1013	869	57
Research grants (2)	163	249	138	307	412	436	581	751	803	427	28
. Contract research	378	69	178	219	139	74	81	58	82	142	
. Indirect funding	71	30	83	134	135	125	78	79	20	84	
Contract research & indirect funding (3)	449	99	261	354	274	200	159	137	101	226	15
Total funding	**1620**	**1205**	**1198**	**1456**	**1419**	**1385**	**1559**	**1932**	**1917**	**1521**	**100**
Expenditure:	k€	k€	k€	k€	k€	k€	k€	k€	k€	k€	%
Personnel costs	1246	978	1116	1197	1062	1071	1249	1473	1498	1210	78
. Indirect funding	71	30	83	134	135	125	78	79	20	84	
. Personnel costs	1175	948	1033	1063	927	946	1170	1394	1478	1126	
Housing costs	108	103	94	103	103	98	94	97	88	99	6
Other costs	147	149	140	208	306	331	255	314	310	240	16
Total expenditure	**1501**	**1230**	**1350**	**1508**	**1471**	**1500**	**1598**	**1884**	**1896**	**1549**	**100**

Water Management (WM) group

	2009	2010	2011	2012	2013	2014	2015	2016	2017		Avg.
	k€	k€	k€	k€	k€	k€	k€	k€	k€	k€	%
Direct funding (1)	677	706	552	557	629	638	645	765	757	658	56
Research grants (2)	0	0	0	11	10	104	133	105	107	52	4
. Contract research	277	461	434	469	445	342	295	214	260	355	
. Indirect funding	10	35	185	192	179	171	75	90	74	112	
Contract research & indirect funding (3)	287	496	618	661	624	513	370	304	333	467	40
Total funding	**964**	**1202**	**1170**	**1229**	**1263**	**1256**	**1148**	**1174**	**1197**	**1178**	**100**
Expenditure:	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**%**
Personnel costs	815	970	975	987	958	987	926	824	876	924	77
. Indirect funding	10	35	185	192	179	171	75	90	74	112	
. Personnel costs	804	935	790	795	779	816	851	734	802	812	
Housing costs	74	83	84	108	118	111	105	73	57	90	8
Other costs	222	139	114	107	235	273	180	227	208	189	16
Total expenditure	**1111**	**1193**	**1172**	**1202**	**1311**	**1370**	**1210**	**1124**	**1141**	**1204**	**100**

Centre for Transport Studies (CTS)

	2009	2010	2011	2012	2013	2014	2015	2016	2017		Avg.
	k€	k€	k€	k€	k€	k€	k€	k€	k€	k€	%
Direct funding (1)	1094	724	711	477	676	750	754	687	764	738	56
Research grants (2)	0	39	43	158	320	157	95	170	305	143	11
. Contract research	380	383	772	392	370	189	251	323	449	390	
. Indirect funding	19	18	25	55	4	55	115	92	86	52	
Contract research & indirect funding (3)	400	401	797	446	374	244	366	415	535	442	33
Total funding	**1494**	**1164**	**1551**	**1082**	**1370**	**1152**	**1215**	**1272**	**1605**	**1323**	**100**
Expenditure:	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**k€**	**%**
Personnel costs	898	1004	958	904	823	855	903	891	1152	932	73
. Indirect funding	19	18	25	55	4	55	115	92	86	52	
. Personnel costs	879	986	933	849	820	801	788	799	1066	880	
Housing costs	65	61	76	81	74	60	59	67	73	68	5
Other costs	339	166	165	197	337	314	174	337	394	269	21
Total expenditure	**1301**	**1231**	**1199**	**1182**	**1234**	**1230**	**1136**	**1295**	**1619**	**1270**	**100**

Staff overview

Category	2011	2012	2013	2014	2015	2016	2017	Avg.
Tenured staff								
CME	3.99	4.91	4.64	4.53	3.99	4.56	4.6	4.5
CTS	1.45	1.29	1.43	1.77	1.81	1.79	1.76	1.6
MFS	2.52	2.17	2.19	2.09	2.46	3.02	2.98	2.5
WM	1.97	1.69	1.87	1.93	1.87	2.14	2.2	2.0
Sum	9.93	10.06	10.13	10.32	10.13	11.51	11.54	10.5
Non tenured staff								
CME	0.7	1.49	1.52	1.17	2.8	2.19	1.3	1.6
CTS	1.55	2.02	2.18	1.68	1.21	2.4	2.09	1.9
MFS	1.64	1.16	1.57	1.76	1.73	2.18	2.33	1.8
WM	0.97	2.32	2.4	3.18	1.8	1.35	1.91	2.0
Sum	4.86	6.99	7.67	7.79	7.54	8.12	7.63	7.2
PhD students								
CME	14.84	12.05	11.56	8.61	5.55	4.61	4.42	8.8
CTS	4.77	4.88	4.95	3.83	5.23	5.16	7.02	5.1
MFS	5.37	7.9	6.58	5.33	8.05	10.95	10.38	7.8
WM	4.84	3.98	4.07	4.34	4.37	4.57	6.3	4.6
Sum	29.82	28.81	27.16	22.11	23.2	25.29	28.12	26.4
Other								
CME	0	0.17	0	0	0	0	0	0.0
CTS	0.05	0	0	0	0	0	0	0.0
MFS	0	0	0	0	0	0	0	0.0
WM	0	0	0	0	0	0	0	0.0
Sum	0.05	0.17	0	0	0	0	0	0.0
SUM	44.66	46.03	44.96	40.22	40.87	44.92	47.29	44.1

Output per group

Construction Management and Engineering (CME) group

SEP output CME type	2011	2012	2013	2014	2015	2016	2017
Book	1					1	
Refereed article	25	23	19	28	31	31	20
Non-refereed article	5	1			2	1	
Book chapter	4	4	3	1	3	3	
PhD thesis		3	3	2	6	3	
Conference paper	46	68	32	31	12	26	18
Professional publication	11	11	12	9	6	6	9
Publications aimed at the general public	1	3	6		1		1
Other research output	9	6	3	1		2	1
Total	102	119	78	72	61	73	49

Marine and Fluvial Systems (MFS) group

SEP output type	2011	2012	2013	2014	2015	2016	2017
Book						2	
Refereed article	23	9	24	17	16	33	23
Non-refereed article					1		
Book chapter	1	1	5		2	2	5
PhD thesis	2	3	2	3	2	4	
Conference paper	19	23	16	15	20	10	9
Professional publication	5	8	7	4	1	5	8
Publications aimed at the general public		2		1			
Other research output	12	12	21	31	17	39	48
Total	62	58	75	71	59	95	93

Water Management (WM) group

SEP output type	2011	2012	2013	2014	2015	2016	2017
Book	2	1	2				
Refereed article	21	35	25	34	31	25	35
Non-refereed article	3	5	2	1	1	1	
Book chapter	2	6	5	4	8	2	5
PhD thesis	2	1	1	3	4	3	1
Conference paper	16	14	7	3	5		
Professional publication	8	9	7	3		1	
Publications aimed at the general public				2	4	1	
Other research output	1	1	5	6	3	7	14
Total	55	72	54	56	56	40	55

Centre for Transport Studies (CTS)

SEP output type	2011	2012	2013	2014	2015	2016	2017
Book			1			1	
Refereed article	9	8	10	15	20	11	10
Non-refereed article	5	2		3	3	2	
Book chapter	2		7		2	3	
PhD thesis	3	3		3	2		1
Conference paper	28	35	24	17	14	11	8
Professional publication	3	9	5	1		1	1
Publications aimed at the general public				1		1	1
Other research output	1	2	3	3	1	1	3
Total	51	59	50	43	42	31	24