MSc Water Technology
(joint degree)

Wageningen University
University of Twente
University of Groningen

January 2013

Limited initial accreditation

Panel report

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1 Executive summary

The Accreditation Organization of the Netherlands and Flanders (NVAO) received a request for an initial accreditation procedure, including programme documents, regarding a proposed Master of Science Water Technology (joint degree) of the University of Groningen, University of Twente and Wageningen University . NVAO convened an expert panel, which studied the information available and discussed the proposed programme with representatives of the institutions and the programme during a site visit. The expert panel has assessed the joint degree following the NVAO limited initial accreditation framework. In addition to this, the panel has adhered to the *Protocol for Dutch Applications for Initial Accreditation leading to a Joint Degree.* In its assessment of the framework's standard 2, the panel has additionally adhered to the *Protocol on master degree programme length*.

The following considerations have played an important role in the panel's assessment.

The MSc Water Technology (120 ECTS) is scheduled to start in September 2013. It is a collaborative initiative of the three universities mentioned above, with education being provided in Leeuwarden. Programme length is based on, and has been compared to, other European master programmes in the field of water engineering and technology and is necessary to be eligible for a PhD position.

The master is built, since 2008, on experience of the tracks Water Technology of the accredited MSc programmes Biotechnology of the Wageningen University and Chemical Engineering of the University of Twente and the University of Groningen. Aim of the master is to create a bridge between science and engineering applications, providing students with a broad scope of knowledge in the key applications of water treatment technology. The content of the curriculum is strongly connected to the objective of the *Technologisch Top Instituut Watertechnologie Wetsus* research programme to develop and to design innovative and sustainable water technologies.

Based on the available information and the discussions during the site visit the panel considers, that the applicants of the MSc Water Technology have succeeded sufficiently to formulate the intended general and specific learning outcomes and competences. It exhibits an adequate academic level, meets (inter)national standards and there is a neat balance between knowledge, learning, attitude and skills. Initially the panel had some concern about the relatively limited content in the learning outcomes of the pillars '*Business'* and '*Society'*. The representatives of the three universities, however, could explain this by emphasizing that the pillar *Research* is the central subject of the programme. The joint degree Water Technology is first of all an academic master.

Research is, for a considerable part, demand driven and determined by the water (technology) sector. 'Society' and 'Business' are covered within the electives and the research of sustainable water technology. Throughout the curriculum professional aspects are continuously raised in assignments and cases. Students can apply their knowledge, experience and skills during the internship and the *Business Case Design Project*. During the site visit members of the professional field acknowledged these aspects. They were very positive and had good experiences with students during their internships. "They work hard, are motivated and driven, entrepreneurial and rapidly address new problems or territories".

The different backgrounds and qualifications of incoming (inter)national students necessitate introductions in the courses of the first year, in order to equalize differences in knowledge and academic skills. To prevent unnecessary failures and delays, all students, prior to admission, are carefully screened and strictly selected. The panel appreciates these actions, but believes that this (growing) target group can and will benefit from additional support. For instance, a summer course could be offered in preparation for the master. The space thus created in the programme could then be used to provide more depth to the professional side of water technology. Management and teachers responded positively to this suggestion and will investigate its realization.

The panel judges the assessment system as sufficient. It is largely based on the system of Wageningen University and is transparent and adequately applied. A few issues, however, deserve more focus. Regarding the membership of the committees the panel wants to remind the management that they must be aware of a 'mixing' of responsibilities or a conflict of interest. The panel also believes that improvements can be made in quality assurance to achieve better results with the theses. Members of the professional field mentioned that reporting and communication skills should be given more attention.

Based on financial details of the application report and discussions and assurances during the site visit, the panel is convinced that the cooperating universities of the joint degree can sufficiently guarantee students to complete the entire curriculum of the master Water Technology. The master, however, is subsidized considerably by scholarships and financial support of the province of Fryslân and Wetsus. This support will not be provided indefinitely, so, according to the panel, this necessitates an active PR campaign and recruitment by the management in which the unique selling points of the master Water Technology should be emphasized: for instance the strong link with the research of Wetsus and the professional field and the emphasis on chemical process technology.

In summary, the panel considers that although a number of remarks and suggestions have been made, these should be interpreted as recommendations for further improvement. The panel is confident that the three universities can and will improve these adequately in the near future. All four standards have been assessed by the panel as satisfactory.

Given these considerations, the panel advises NVAO to take a positive decision regarding the quality of the proposed programme MSc Water Technology at University of Groningen / University of Twente / Wageningen University.

With a view to registration in CROHO, the panel advises for the programme to be allocated to the "Technology" field of study.

The Hague, 28 January 2013

On behalf of the Initial Accreditation panel convened to assess wo-ma Water Technology at University of Groningen / University of Twente / Wageningen University,

Prof. dr. ir. L.C. Rietveld
(chair)

Drs. H.J.M.M. Tubbing
(secretary)

2 Introduction

2.1 The procedure

NVAO received a request for a limited initial accreditation procedure including programme documents regarding a proposed wo-ma Water Technology (joint degree). The request was received on15 June 2012 from the University of Groningen / University of Twente / Wageningen University.

An initial accreditation procedure is required when a recognized institution wants to offer a programme and award a recognized bachelor or master's degree. To a certain extent, initial accreditation demands a different approach to the accreditation procedure for programmes already being offered. Initial accreditation is in fact an *ex ante* assessment of a programme, and a programme becomes subject to the normal accreditation procedures once initial accreditation has been granted.

NVAO convened an international panel of experts. The panel consisted of:
Chair:
- Prof. dr. ir. Rietveld

Members:
- Prof. emeritus dr. ir. W. Verstraete
- Ir. M. van Eekeren

Student member:
- J.E. Schijf BSc

On behalf of the NVAO, drs. F. Mulder and drs. H.J.M.M. Tubbing were responsible for the process-coordination and the drafting of the experts' report, respectively.

This composition reflects the expertise deemed necessary by NVAO. (Annex 1: Composition of the panel). All the panel members signed a statement of independence and confidentiality.

The panel has based its assessment on the standards and criteria described in the NVAO Limited Initial Accreditation Framework (Stcrt. 2010, nr 21523).

The following procedure was undertaken. The panel members studied the programme documents (Annex 3: Documents reviewed) regarding the proposed programme. Their first impressions were sent to the process coordinator of NVAO, in order to outline these remarks within the accreditation framework and detect the items to be clarified during the site visit.

Based on its first findings, the panel organised a preparatory meeting on 31 October 2012. The site visit took place on 20 December 2012 on the premises of Wetsus, Leeuwarden (Annex 2: Schedule of the site visit).

Unfortunately, ir. M.van Eekeren had to cancel the site visit on account of illness. In consultation with the applicant institutions, the panel chair, and the Board of NVAO, it was decided to go ahead with the site visit without him. In the stages preceding the site visit, Van Eekeren fully participated in the panel's activities. Following the site visit, he has read the draft report and his comments are included in the final report.

The panel formulated its preliminary assessments per standard immediately after the site visit. These are based on the findings of the site visit, and built on the assessment of the programme documents.

On 11 January 2013, the draft version of this report was finalized, taking into account the available information and relevant findings of the assessment. Where necessary the panel corrected and amended the report. The panel finalized the report on 28 January 2013.

2.2 Panel report

The first chapter of this report is the executive summary, while the current chapter is the introduction.

The third chapter provides a description of the programme including its position within the University of Groningen / University of Twente / Wageningen University and within the higher education system of the Netherlands.

The panel presents its assessments in the fourth chapter. The programme is assessed by assessing the standards in the Limited Initial Accreditation Framework. For each standard the panel presents an outline of its findings, considerations, and a conclusion.

The *outline of the findings* are the objective facts as found by the panel in the programme documents, in the additional documents and during the site visit. The panel's *considerations* are the panel's subjective evaluations regarding these findings and the importance of each. The *considerations* presented by the panel logically lead to a concluding assessment.

The panel concludes the report with a table containing an overview of its assessments per standard.

3 Description of the programme

3.1 Overview

Country	The Netherlands
Institution	University of Groningen / University of Twente / Wageningen University
Programme	Master of Science Water Technology (joint degree)
Level	master
Orientation	academic (wo)
Degree	Master of Science
Location(s)	Leeuwarden
Mode of study	2 years fulltime (120 ECTS)
Field of study	Technology

3.2 Profile of the institutions

The joint degree Water Technology is a collaborative initiative of Wageningen University , University Twente and University of Groningen with education being provided in Leeuwarden (information dossier page 10-12).

Wageningen University is part of Wageningen UR (University & Research centre) with the mission: “To explore the potential of nature to improve the quality of life”. The Wageningen University connects fundamental scientific theory with practice, to find solutions for real life problems in the domain of healthy food and living environment. Wageningen University comprises just one faculty: Agricultural and Environmental Sciences. Education is organized in the Education Institute which is responsible for the content and quality of the study programs. The Corporate director Education, Research & Innovation of this institute is member of the Executive Committee Joint Degree Water Technology. The Programme Committee joint degree Water Technology is represented by a professor of the faculty, who also is involved in the study programme.

University Twente combines technology with social, business and behavioral sciences, based on the conviction that the most interesting and relevant innovations will take place at the cutting edges of these fields. The master programme Chemical Engineering and the joint degree Water Technology will be part of the faculty Science & Technology. The Dean of the faculty is member of the Executive Committee Joint Degree Water Technology. The program director of Chemical Engineering, who is responsible for the policy, planning, execution, quality and innovation of the programme, is a member of the Programme Committee joint degree Water Technology, and consults (un)invited the programme director of the joint degree Water Technology.

The University of Groningen has a distinct research profile and works on those societal problems where high quality research can make significant contributions. These themes – Healthy Ageing, Energy and Sustainable Society – fit in with both national and European societal priorities. The master programme Chemical Engineering and the joint degree Water Technology are part of the Faculty Mathematics and Natural Sciences. A member of the Board of the faculty, responsible for educational affairs, is member of the Executive Committee Joint Degree Water Technology. The Programme Committee joint degree Water

Technology is represented by a professor of the faculty, who also is involved in the study programme.

3.3 Profile of the programme

The default study duration of a MSc programme is one year (60 ECTS). The wo-ma Water Technology however is a two year programme of 120 ECTS and instruction in English. Programme length is based on a comparison with other European master programmes in the field of water engineering and technology and necessary to be eligible for a PhD position (information dossier page 21). The master is built on experience of the collaborating universities with the track Water Technology of the accredited MSc programmes Biotechnology of the Wageningen University and Chemical Engineering of the University of Twente and the University of Groningen.

The expert panel has assessed the joint degree following the NVAO limited initial accreditation framework. In addition to this, the panel has adhered to the *Protocol for Dutch Applications for Initial Accreditation leading to a Joint Degree.*

According to applicants the intention is to create a separate MSc programme with a *joint degree* instead of continuing the study programme as a track. This benefits the distinguishability of the study programme and the flexibility to adopt the programme more to the developments on the labor market. It will serve also as a bridge between science and engineering applications, providing students with a broad scope of knowledge in the key applications of water treatment technology. With regard to the 'joint degree' of the master, the panel has established that the participating universities cooperate well and that each of them contributes experienced researchers and teachers. The positioning as a joint programme consequently has an added value with regard to the students.

The content of the curriculum is strongly connected to the objective of the *Technologisch Top Instituut Watertechnologie Wetsus* (TTIW Wetsus) research programme to develop and to design innovative and sustainable water technologies. The joint degree MSc Water Technology is scheduled to start in September 2013.
No other institution of higher education in the Netherlands offers a programme with a similar profile (information dossier page 4, 18 en 20-21).

The first year of the programme starts with the compulsory course Global Water Cycle. At the same time students choose 15 credits (three courses) out of 20 credits (four courses). These courses together provide in-depth disciplinary and multidisciplinary insights into the fields of chemical engineering and biotechnology, based on mathematics, chemistry, physics and microbiology (information dossier page 18 and Appendix 3a of that dossier). They form the basis with respect to content of the wo-master and align the programme with the prior knowledge of students with different backgrounds. A selection of domain questions will be approached from the perspective of key-disciplines. Coherence between the different courses is ensured by the integration of disciplinary knowledge and engineering applications (technologies) of the individual courses.

After this initial period the programme continues with five compulsory courses:
1. Chemical Reactor Design
2. Colloid Chemistry
3. Multi-component mass transfer in membrane processes
4. Bioreactor Design
5. Biological Water Treatment and recovery technology

These courses provide advanced knowledge and applications in water technology. At the end of the first year an internship (15 EC) offers students the opportunity to work at an academic level in a company, in the Netherlands or abroad, engaged in water technology.

The second year is spent on a Business Case Design Project: a research-oriented design of a water process supported by simulations (10 EC), an elective part of two courses at the universities involved (10-12 EC), and the master thesis (38-40 EC).

New programme for the institution
The Master of Science Water Technology is new to the three cooperating universities but, as mentioned above, is built on experience of the tracks Water Technology of MSc programmes Biotechnology of the Wageningen University and Chemical Engineering of the University of Twente and the University of Groningen.

Credits
The length of the programme is 120 ECTS.

4 Assessment per standard

This chapter presents the evaluation by the assessment panel of the four standards. The panel has reproduced the criteria for each standard. For each standard the panel presents (1) a brief outline of its findings based on the programme documents and on documents provided by the institution and the site visit, (2) the considerations the panel has taken into account and (3) the conclusion of the panel.

4.1 Intended learning outcomes (standard 1)

The intended learning outcomes of the programme have been concretized with regard to content, level and orientation; they meet international requirements.

Outline of findings
According to the information dossier (page 5) breakthrough technological developments are required in the field of water treatment technology to enable the export ambitions of the water sector and to solve global threats and challenges in society. The objectives of the joint degree Water Technology are therefore to gain knowledge, skills and academic attitude at such a level that graduates have the competences for professional, autonomous practice and/or can successfully continue their academic education in scientific research or process engineering in sustainable water technology and related fields (information dossier page 13).
The curriculum includes engineering application of basic sciences such as chemistry, physics, biology and mathematics in order to design, analyze and control chemical, physical and biological water processes, including the mitigation of (potential) hazards associated with these processes. Biological and chemical conversion (science) is combined with separation technologies, sophisticated technological systems and new/improved materials (technology).

The programme is based on the 3TU Academic Competences (Meijer's criteria). The relation with Dublin Descriptors is as follows (information dossier page 14-15 and appendix 1b of that dossier):

Dublin Descriptors	3TU Academic Competences
Knowledge and understanding	1. Competent in one or more discipline
Applying knowledge and understanding	2. Competent in doing research 3. Competent in designing
Making judgments	4. Intellectual skills
Communication	5. Competent in co-operating and communicating
Learning skills	6. Scientific approach
(Additional)	7. Takes account of the temporal and social context

Based on these competences 13 learning outcomes are formulated:
- seven in the domain of water technology (competences 1, 2 and 3);
- four with regard to academic skills (competences 4, 5, 6);
- two account for the temporal and social context (competence 7).

The relation between these general learning outcomes and the different courses of the study programme is clarified by means of a matrix (appendix 1c of the information dossier). More specific learning outcomes of the courses are also described in appendix 3b.

The Water Technology programme is mainly based on the combined knowledge from the underlying engineering programmes in Biotechnology and Chemical Engineering. No subject-specific framework for water (process) technology exists. Therefore the subject-specific reference framework of Chemical Engineering defined by QANU (Scheikunde, QANU 2007) is used as reference. The objectives and general final qualifications for (inter)national (Bio)Chemical Engineering programmes (information dossier page 16 and appendix 1a of that dossier) are taken into account too. The joint degree programme prepares for new scientific developments of the Research Institute of Water Technology, Wetsus.

The applicants emphasize the fact that the joint degree Water Technology is an academic master, as opposed to a professional study programme, which is also reflected in the intended learning objectives. There is a strong interaction between education and research (information dossier page 17). Graduates will possess a considerable degree of independence, being able to deal with fairly complicated and new issues in the domain, both as an academic professional and as a researcher/designer.

Considerations
Before the site visit the panel requested more information about why the 'pillars' *Business* and *Society* are relatively underrepresented in programme and learning outcomes, while in the application dossier (p. 5) they seem to have been given such prominent places. In their reply before and during the site visit the applicants stressed the fact that the pillar *Research* is in fact the central subject of programme and learning outcomes. It has a strong link with the research programme of the research institute Wetsus in which companies and the professional field cooperate. The research is for a considerable part demand driven and determined by the water (technology) sector. According to the Steering Committee this cooperation has important added value for both the research and the educational side of the master and marks the difference with other similar master studies. The programme, therefore, is focused on the relevance of scientific research in the domain of sustainable water technology ('society' and 'business') and tries to find technological solutions for social issues ('society') and issues which the water sector ('business') faces. Within the programme, the course *Global Water Cycle* and the *Business Case Design Project* present context and global social issues and outline the possibilities / limitations of technologies in different countries (cultures). Students can also choose more 'business' and 'society' within the electives.

The above explanations and arguments helped the panel to a better understanding of purpose and content of the master. In that light the panel judges that the joint degree MSc Water Technology has succeeded sufficiently to formulate the intended general and specific learning outcomes and competences. They are largely based on the experience, since 2008, of the three universities with the Water Technology tracks of the MSc programmes Biotechnology (Wageningen University) and Chemical Engineering (University of Twente and University of Groningen). Therefore a lot of development has already taken place during the last four years. Competences and learning outcomes exhibit sufficient academic level and there is a neat balance between knowledge, learning, attitude, and skills. They also possess enough content, level and orientation to meet (inter)national standards such

as the above mentioned Dublin Descriptors and 3TU Academic Competences. Literature and topicality are thereby consistent with the qualifications frameworks of (Bio)Chemical Engineering. During the site visit, members of the professional field shared enthusiasm about and appreciation of the graduates of the water technology tracks whom they employ. They emphasized the knowledge components and that first of all a thorough academic and scientific education is preferred. Further *professional* training will often take place in the first years of employment.

Based on the information in the application report and the observations during the site visit the panel concludes, that the joint degree MSc Water Technology has been orientated (as far as possible) sufficiently on the professional domain, market and the working field. The intended learning outcomes fit into the Dutch and international qualifications frameworks and the requirements currently set by the professional field.

Conclusion
The panel assesses standard 1 'Intended learning outcomes' as satisfactory.

4.2 Teaching-learning environment (standard 2)

The curriculum, staff and programme-specific services and facilities enable incoming students to achieve the intended learning outcomes

Outline of findings
The structure of the programme aims to provide a common basis for all students (see also section 3.3, Profile of the programme). The curriculum allows students, advised by their study advisor, to broaden or deepen their knowledge in a specific area by offering (restricted and free) choices (information dossier page 19). The choice of the programme must be sealed with a contract. An extensive outline of the curriculum of the first and second year and its components are given in appendix 3a and 3b of the information dossier. Teaching and learning methods are based on problem-orientation and active learning during assignments, cases, the writing of essays, excursions, literature study, presenting results, interactive classes and group work. They will provide students with knowledge and skills which enable them to develop a multidisciplinary orientation (information dossier page 19). Individual feedback and the opportunity to practice at various moments also enable students to develop their skills. Scientific and professional experts from different Dutch and preferably also European knowledge institutes and companies will be involved in the programme. Graduates will have good national or international career prospects in business and research (PhD).

According to the information dossier (page 20-21) the duration of the programme of 120 ECTS is the accepted standard in the international field (see also section 3.3). Cohesion between the different courses will be achieved by the first introductory course (*Global water cycle)* which will give the 'why' and 'how' of the programme and in which technologies are presented within the societal context of their application. Each of the subsequent courses starts with an introductory lecture too, and includes examples of additional techniques from other tracks to stress the added value of multidisciplinary knowledge and problem solving.

Lectures and practical courses are developed by academic staff of the three universities and taught on the basis of personal scientific expertise. All academic staff involved in the core

courses of the joint degree has a PhD degree. Most lecturers are active in research and involved in the Water Technology research programme of the TTIW in which 16 national and international know-how institutes participate. Scholars and company participants from Wetsus will be invited as guest lecturers on a regular basis. Staff members of TTIW who participate in teaching must obtain the University Teacher Qualification (BKO = Basiskwalificatie Onderwijs).
Based on a yearly intake of 30 students the total teaching staff is 4.15 fte and the staff-student ratio 13.75 (information dossier page 21- 22).

Students will be registered at all three universities and can use all facilities, for instance (digital) libraries and databases. They will spend most of the time, however, in Leeuwarden. . Wetsus and its research facilities are located in this institute which provides different-sized classrooms and study corners, extensive laboratories, a reprographic centre, restaurant facilities, library, multi-media centre and computer facilities. The building has an auditorium and state-of-the-art video-conferencing facilities.
Information about the study programme, courses, digital study materials and schedules can be found in the Programme Guide Water Technology and on the website www.wetsusacademy.nl. Housing for international students will be organised by the Wetsus Academy in cooperation with a local partner and the local government (information dossier page 23).

Support and guidance of students, like an introduction week, study planning, general meetings and individual advice, are being organized by a special programme team of a programme director, a study advisor and a secretary in Leeuwarden. At the start of the programme all students receive a programme guide with (practical) information. All universities also have their own Students Service Centre with facilities such as a Dean's office and Student Health Services.

The admission requirements are such that most students will have a BSc Biotechnology, BSc Chemical Engineering or BSc Environmental Engineering. Representatives of the cooperating universities will be members of the admission committee. Requirements include a relevant BSc-degree, a grade point average of at least 70% of the maximum scale and fluency in English both written and spoken. In the near future, bachelors that do not qualify for direct admission will be able to attend a linkage programme (Dutch: doorstroomminor) of 30 credits during the final year of their study programme (informative dossier page 24) .

Considerations
In its assessment of this standard, the panel has additionally adhered to the *Protocol on master degree programme length*. Based on the explanations during the site visit, the four year experience with the tracks and the comparison with other European master programmes, the panel judges that an extended programme for the master Water Technology is indeed necessary to achieve the intended level. The content of the programme, however, can use some extra depth with respect to the professional 'business' side (see also below).

The panel appreciated the fact that the programme offers a wide range of distinctive courses but also wondered whether some of them had enough 'depth' to gain a real master level. Especially in the first year there are courses, for instance Global Water Cycle and Mathematical principles, which seem to offer a kind of 'bachelor' introduction to the science and practice of water technology. During the site visit, teachers and members of the

curriculum committee acknowledged this impression, but at the same time assured the panel that after a relatively short introduction period all students obtain the same 'master level' within each course. They explained the need for a short but thorough introduction within the four compulsory courses of the first year in order to equalize differences in knowledge and academic skills, by pointing to the different backgrounds and qualifications of incoming students. To prevent unnecessary failures and delays, all (inter)national students, prior to admission, are carefully screened and strictly selected and must possess at least a relevant BSc-degree. The experience of past years has shown that such an equal level among students is actually achieved. If needed, students are given extra support. After that, theory and skills are offered at master level, so in the end true master qualifications can be, and are, achieved effectively. In general, students pass their exams and seven have already acquired a position as PhD. Depending on their knowledge, students must follow one or more subjects or will have the opportunity to dedicate themselves to one of the disciplines or to develop certain skills. Based on experience, in consultation with the teachers, this concept will continually be optimized to challenge and motivate all students. Students confirmed this explanation by pointing out that some of the introductions represented familiar terrain and were easy to follow, but others meant intensive studying. They have much appreciation for the guidance and supervision of teachers and lecturers: "They are always available to help." None of them perceived the ‘introductions’ as a major problem.

The panel had also some concern about the relatively little attention in the curriculum given to business and entrepreneurship (see also section 4.1). The panel believes that true professionals in water technology can fulfill an important role in society. The applicants, however, were able to reduce this concern to a large extent by stressing that throughout the curriculum professional aspects were continuously raised in assignments and cases. In particular, students can apply their knowledge, experience and skills in a company under the guidance of a professional during the internship. Students also mentioned the internship as an important period to learn the “where and how”. The *Business Case Design Project* provides business and social aspects of sustainable water technology. During *Global Water Cycle*, students can visit various companies and guest speakers are invited. During the thesis a relationship exists with the professional field as companies are involved in the research of Wetsus. In various meetings students may come into contact with their professionals. Members of the professional field were positive too and shared good experiences with students during their internships. “They work hard, are motivated and driven, entrepreneurial and rapidly address new problems or territories (for instance drinking water or blue energy). According to them Wetsus provides a typical demand-driven research program.

With regard to the number of students the panel asked itself whether the quality of the master could be maintained in a larger group of students. The variable background and the extensive influx of foreign students, necessitate additional guidance and effort of teachers and coaches (for instance individual pathways). The cooperating universities will need to facilitate those aspects and make investments. For instance, a summer course could be organized in preparation for the master for those (inter)national students who are qualified, but can use some extra support and training. When asked during the site visit, students agreed with this suggestion. Typical 'heavy' subjects as *Mathematical Principles*, *Physical Chemistry in Water Technology*, *Multi-component mass transfer in membrane processes* and perhaps an *English refresher course* could be offered. The space thus created in the master could then be used to provide more depth, attention and time to laboratory practicals

and to the professional, occupational side of water technology (see also above and section 4.1). Management and teachers also reacted positive and said they would investigate how it could be organized.

Taking the above points of consideration and attention into account, the panel is nevertheless convinced of the 'overall' educational quality of the master Water Technology which will enable students to achieve the intended learning outcomes sufficiently. This opinion is based on the written information in the information dossier, the additional documentation and study materials provided before the site visit (answers to questions, books, exams etc.), and the discussions with students and academic staff. The didactic concept of problem-based and (inter)active learning, the still small study groups and different methods of practical and theoretical training (self study, assignments, projects, cases, group work, essays, excursions, literature study, thesis, presenting results etc.) provide for a stimulating educational environment and a solid interaction with research. Students agree with each other that the teachers are always available and willing to help. The facilities are sufficient and the careful monitoring and guidance by the academic and administrative staff support the learning process. Within the different courses of the programme the academic competences and general and specific learning outcomes are sufficiently and demonstrably translated.

Conclusion
The panel assesses standard 2 ‘Teaching-learning environment’ as satisfactory.

4.3 Assessment (standard 3)

The programme has an adequate assessment system in place.

Outline of findings
The three cooperating universities are jointly responsible for the final examinations as well as the coordination and organization of the interim examinations. Therefore the master will have its own Examining Board with representatives of the three universities involved. A representative not directly connected to the universities will be part of the Examining Board too. They will provide guidelines and indications to ensure that assessment of a course is valid, reliable and transparent. Also, the Examining Board will visit the chair groups involved on a regular basis to verify the quality of assessment of courses (information dossier page 25 and appendix 4b of that dossier).

Every course concludes with a test of the student’s knowledge, insight and skills in line with learning outcomes and teaching methods. The course guides explain how a course is organized, and how students are expected to participate. The assessment strategy (Dutch: toetsplan) informs about how and when a learning outcome is assessed, who is involved in assessing the students, and how the final mark will be determined.

Generally, lectures will be assessed by written or oral exams with open answer questions. A report, essay, presentation or design assignment can be part of the total assessment. The reliability of assessment for open answer questions and assignments will be embodied in model answers, assessment criteria or rubrics. The *Business Case Design Project* will include the personal performance and functioning during the project, the report, the presentation of the results, and the final discussion. Regarding the internship and the thesis

the assessment forms of the Wageningen University will be used. The chair groups involved will use the assessment form designed for Wageningen University as a whole. The thesis form assesses general research competences (30-60%), the quality of the thesis report (30-60%), the colloquium (5%), and the final oral examination (5%). The assessment will be carried out by the supervisor and the chair group examiner (information dossier page 26 and appendix 3b of that dossier).

Considerations
The panel had the opportunity, prior to the site visit, to study additional information and documentation (study books, practical guides, exams, theses etc.) of the track Water Technology. Evaluation forms could be evaluated too. In general, the panel judges the level sufficient to good and the different assessments as adequate. The discussions during the site visit with management, students, and teachers demonstrated clearly that, during the interactive lectures, workshops and practices, students were assessed continuously on careful preparation and active participation. The varied individual and group assessments, case studies, discussions and presentations, assignments, skills, essays, examinations (models and examples), and thesis guarantee the achievement of learning outcomes of the required master level sufficiently. At the oral presentation and defense of the thesis at least one person will be present from another department. The assessment system is largely based on Wageningen University's and is transparent and adequately applied. In case of disagreement, students can complain and have the right to appeal. The system will be regularly tested against the requirements of the occupational field by the Examination Committee and the members of the Professional Field Committee.

In addition to this positive evaluation of the assessment system the panel feels compelled to mention some issues that deserve more focus and critical consideration:
- The joint degree programme must be aware of a 'mixing' of responsibilities or a conflict of interest. The Programme Director, for instance, is a member of the Executive Committee, and is the programme's Study Advisor.
- Examiners, as far as possible, should be independent of Wetsus to prevent undesirable influencing of the assessment procedures.
- In general, the quality of theses is sufficient (and sometimes even good), but the panel believes that improvements can be made to achieve better results.
- The panel missed assessments halfway during the courses.
- Members of the working field mentioned that reporting and communication skills should be given more attention during the master, since graduates often experience difficulties in that area.

In summary, it can be stated that the assessment system sufficiently reflects the learning outcomes of the MSc Water Technology. The panel is convinced that the cooperating universities can and will improve the above mentioned aspects in the immediate future adequately.

Conclusion
The panel assesses standard 3 'Assessment' as satisfactory.

4.4 Graduation guarantee and financial provisions (standard 4)

The institution guarantees students that they can complete the entire curriculum and makes sufficient financial provisions available.

Outline of findings
The three universities have a joint responsibility for the funding of the joint degree Water Technology and guarantee that the first three student cohorts can complete the programme in full (information dossier page 27 and the cooperation agreement, appendix 8, article 15 of that dossier).

The financial provisions are arranged in the cooperation agreement (appendix 8, article 14 and page 27 of the information dossier). To finance the programme an intake of at least 30 students per year has to be achieved. Tuition fees and governmental funding based on number of registered students and on graduation have been taken into account as revenues. Existing fixed costs, such as costs for housing, libraries, student-administration, ICT, general marketing through flyers and website, and overhead are not attributed to the joint degree in the period 2012-2015. A steady-state situation is expected for the first time in 2015. The TTIW and the province of Fryslân allocate financial provisions to bear this deficit till 2015.

Considerations
The panel notes that the joint degree Water Technology is subsidized considerably by scholarships and financial support of the province of Fryslân and the TTIW. During the site visit, however, it was made clear that this support would not be provided indefinitely and within a few years will be phased out. For instance, Wetsus can stop financing and facilitating the master due to poor economic conditions of its own. Therefore, the cooperating universities are forced to attract enough students in the years ahead to be able to proceed independently. The management has indicated that such a break-even point can be achieved by 30 students in 2015. The panel, however, wondered whether such a scenario is feasible. To date, the inflow into the tracks doesn't exceed 15 students per year. According to the panel this necessitates an active PR campaign and recruitment by the universities. In such a campaign the unique selling points of the master Water Technology, should be emphasized, since similar, somewhat broader, MSc programmes already exist in the Netherlands. For instance the strong link with the research of Wetsus and the professional field and the emphasis on (bio)chemical process technology. If the programme succeeds in attracting 30 students annually then, concomitantly, there must be attention and care to ensure the availability of adequate job opportunities.

With regard to the above mentioned necessary intensive recruitment the panel also asked whether there isn't a 'conflict of interest' between the financial interest of a sufficiently large influx and the strict use of qualitative selection criteria. The Admissions Committee, however, was very clear about this and emphasized that the selection process will be maintained strictly and consistently. Candidates who do not comply will not be accepted. Significant experience with the tracks has already led to further tightening of the selection criteria. Study results play an important role in this consideration too, as a large percentage of failures will harm the image of the master. Quality is therefore decisive not quantity.

Another question of the panel concerned the fact that the electives of the second year largely take place at the participating universities (Groningen, Enschede, Wageningen). As a result, aren't students, whose residence is mostly Leeuwarden, burdened with a time-consuming travel program? The representatives of the joint degree argued that a temporary mobility to follow electives applied to other students in the Netherlands as well. The curriculum is adjusted in such a way that no conflict occurs in the study schedule. During the site visit international students remarked that distance influenced their choice of electives, because traveling is *expensive*. That's why Groningen is often the preferred university. This surprised the panel, but if that is an important motive, the cooperating universities could consider a travel allowance to make Wageningen and Enschede more attractive for students.

Based on the financial details of the application report and the discussions and assurances during the site visit, the panel is convinced that the cooperating universities can sufficiently guarantee students to complete the entire curriculum of the master Water Technology. The panel is also confident that, when required, the universities will make sufficient financial resources available to further enhance the quality of the master and support students with their study. No additional investment will be needed regarding facilities, because the master will make use of the existing ones of Van Hall Larenstein in Leeuwarden and those of Groningen, Wageningen and Enschede.

Conclusion
The panel assesses standard 4 'Graduation guarantee and financial provisions' as satisfactory.

5 Overview of the assessments

The panel presents its assessments per standard, as outlined in chapter 4, in the following table.

Standard	Assessment
1 Intended learning outcomes	Satisfactory
2 Teaching-learning environment	Satisfactory
3 Assessment	Satisfactory
4 Graduation guarantee and financial provisions	Satisfactory
Conclusion	Satisfactory

Annex 1: Composition of the panel

Chair:
Prof. Dr. Ir. L.C. Rietveld
Member:
Prof. Emeritus dr. Ir. W. Verstraete
Member:
Ir. M. Van Eekeren
Student member:
J.E. Schijf BSc

Drs. F. Mulder, process coordinator NVAO
Drs. H.J.M.M. Tubbing, secretary

Annex 2: Schedule of the site visit

The panel undertook a site visit on 20 December 2012 as part of the external assessment procedure regarding the wo-master Water Technology on the premises of Wetsus, Leeuwarden.

Agenda:

08.30-08.45 h **arrival, welcome**

08.45-09.30 h **conversation with students**
- Oane Galama (cohort 2008, Wageningen University, PhD at Wetsus)
- Alexandra Florea (cohort 2010, University of Twente, working atj Voltea)
- Roxana Nicolae (cohort 2010, Wageningen University, looking for a job in the Netherlands)
- Raul Mastan (cohort 2011, Wageningen University, tweedejaars student)

09.30-09.45 h **internal consultation panel**

09.45-10.30 h **conversation with members of the professional field**

- Eric Roesink (professional field committee)
- Niels Groot (Dow Chemcials)
- Bert van der Wal (Voltea)
- Doeke Schippers (Vitens)
- Rob Heim (Paques)
- Paul Hagemeijer (Shell)

10.30-10.45 h **internal consultation panel**

10.45-11.30 h **conversation with lecturers / programme committee**
- De heer Huub Rijnaarts
- De heer Marc van der Maarel
- De heer Ben Betlem
- De heer Caroline Plugge (Water Microbiology - Wageningen University)
- De heer Nieck Benes (Multicomponent Mass Transfer in membrane – processes - University of Twente)
- De heer Francesco Picchioni (Colloid chemistry/ Physical Chemistry – University of Groningen)

11.30-11.45 h **internal consultation panel**

11.45-12.15 h **conversation with the admission committee**
- Mevrouw Sonja Isken (programme director Biotechnology Wageningen University)
- De heer Rik Akse (programme coordinator Chemical Engineering University of Twente)
- Ton Broekhuis (professor product technology - University of Groningen)

12.15-13.30 h **guided tour and lunch (private)**

13.30-14.00 h **conversation with the exam committee**

- De heer Gert Jan Euverink (chair - University of Groningen)
- De heer Hardy Temmink (secretary - Wageningen University)
- Mevrouw Nelleke van Dorenmalen (study advisor - Wageningen University)

14.00-14.15 h **internal consultation panel**

14.15-15.00 h **conversation with the steering committee**

- Dr.ir. A.F. Groen, Corporate Director Education, Research & Innovation Wageningen University
- Prof. dr. G. van der Steenhoven, Dean of the Faculty Science & Technology University of Twente
- Prof. dr. P.J.M. van Haastert, Member Board Faculty Mathematics & Natural Sciences University of Groningen
- Prof. dr.ir. C.J.N. Buisman, Executive Board Wetsus
- Prof. dr. F. Zwarts, Professor Director University Campus Fryslân
- Ir. P.H.A. van Dorenmalen, Programme Director Joint Degree

15.00-16.30 h **internal consultation panel**

16.30-17.00 h **feed back**

- Mevrouw Nelleke van Dorenmalen (study advisor - Wageningen University)
- De heer Gert Jan Euverink (chair - University of Groningen)

Annex 3: Documents reviewed **(see also annex 4)**

Programme documents presented by the institution

- Information dossier for the limited initial accreditation MSc Water Technology (joint degree, with eight appendices).
- Email of 26 November 2012: Answers to the written questions from the panel (with three appendices).

Documents made available during the site visit

- Course guides
- Handouts lectures
- Handouts process dynamics
- Handouts exercises and results/answers
- Practical guides
- Exams cohort 2010-2012
    - Overview results
    - Written exams
- Exams cohort 2011-2013
    - Overview results
    - Written exams
- Textbooks
- Theses

Annex 4: Documentation courses MSc Water Technology

Global Water Cycle

Handouts lectures
1. Introduction
2. Water in Global Perspective
3. Waste water treatment
4. Drinking water 1
5. Drinking water 2
6. Micropollutants
7. Health and hygiene related to sanitation
8. Water reuse
9. New sanitation concepts

Handouts guest lectures
1. Wireless UV-LEDs for disinfection/oxidation - Johannes Kuipers (Wetsus)
2. Desalination technologies -Luewton L F Agostinho (Wetsus)
3. Bio-electrochemical systems - Tom Sleutels (Wetsus)
4. Drinking water production in the Netherlands - Peter Maas (WLN)
5. Characteristics, treatment and reuse of human excreta - Mariska Ronteltap (Unesco-IHE)

Additional literature
1. Kujawa-Roeleveld K & Zeeman G (2006) Anaerobic treatment in decentralized and source-separation-based sanitation concepts. Reviews in Environmental Science and Bio/Technology (2006) 5:115-139.
2. Hermann BG, Kroeze C & Jawjit W (2006) Assessing environmental performance by combining life cycle assessment, multi-criteria analysis and environmental performance indicators. Journal of Cleaner Production 15 (2007) 1787-1796.
3. Vinneras Björn, Nordin Annika, Niwagaba, Charles & Nyberg Karin (2008) Inactivation of bacteria and viruses in human urine depending on temperature and dilution rate. Water Research 42 (2008) 4067-4074.
4. Kirchmann H & Pettersson S (1995) Human urine – Chemical composition and fertilizer use efficiency. Fertilizer Research 40: 149-154, 1995.
5. Publication of the World Business Council for Sustainable Development - Facts and trends – Water (version 2).
6. Richter Anna, Gensch Robert, Jönsson Håkan, Stenström Thor-Axel & Dagerskog Linus (2010) Practical guidance on the Use of Urine in Crop Production. Stockholm Environment Institute, EcoSanRes Series 2010-1.
7. Winker Marina (2010) Are pharmaceutical residues a problem for urine reuse in agriculture? German Technical Cooperation (GTZ) on IWA Conference (Girona) Spain 19-20 April 2010.

Recommended literature
1. Gray NF Water Technology, an introduction for environmental scientists and engineers. 3rd ed. Elsevier Ltd.
2. Metcalf & Eddy Inc., Wastewater Engineering, treatment and reuse. 4th ed. McGraw-Hill Education – Europe.

Mathematical Principles in Water technology

Handouts lectures
1. Reference sheet
2. Schedule of topics related to the mandatory literature
3. Measles in London – model simulation
4. Derivation of the equation of motion of a pendulum
5. Falling objects by SF Ellermeyer (2003)
6. First order differential equations: techniques and (some different) models
7. Complex numbers and solutions to DE's
8. Process Dynamics 1 - systems theory: basics
9. Introduction MATLAB
10. Matlab – the very short tutorial

Mandatory literature
1. Stewart, J, Calculus, Early Transcendentals. 6th ed., Cengage Learning Services.
2. Lay DC, Linear Algebra and its applications. 3rd ed., Pearson Education.

Transport phenomena in Water technology

Handouts
1. Transport Phenomena part I
2. Transport Phenomena part II
3. Exercises and answers transport phenomena
4. Process Dynamics 2 - systems theory: continued

Mandatory literature
1. Beek, WJ Muttzall KMK et al. Transport Phenomena. 2nd ed. John Wiley & Sons Ltd.

Physical Chemistry

Handouts lectures
1. Introduction
2. Kinetics
3. Thermodynamics
4. Rate Laws
5. Thermodynamic relationships involving the equilibrium constant
6. Collection and Analysis of Rate Data
7. Reaction Mechanisms, Pathways, Bioreactions, and Bioreactors

Water Microbiology

Handouts lectures
1. Overview topics book Brock Biology of Microorganisms
2. Introduction

3. Basic principles of microbiology
4. Cell structure and function in bacteria and archaea
5. Nutrition, Culture and Metabolism of Microorganisms
6. Microbial growth
7. Energy generation & metabolism
8. Environmental Factors
9. Biofilm formation in aquatic environments
10. Methods in microbial ecology
11. Practical guide

Mandatory literature
1. Madigan M, Martinko J et al. Brocks Biology of Microorganisms. 13th global ed. Pearson Education Inc.

Colloid Chemistry

Handouts lectures
1. What are colloids?
2. Interaction forces
3. Interfacial Phenomena
4. Colloids
5. Adsorption at the G-L interface
6. Monolayers and LB films
7. Membranes, osmotic pressure, Donnan equilibrium
8. Solid surfaces and adsorption
9. Liquid o solid interfaces colloids
10. Electrokinetics
11. Bio-colloids and Water technology
12. Answers to exercises book Barnes & Gentle

Mandatory literature
1. Barnes GT & Gentle IR, Interfacial science, an introduction. 1st ed., Oxford.

Chemical Reactor Design

Handouts lectures
1. General tips
2. Overall balances in multi-phase,
3. multi-component systems
4. Total mass balance, and
5. component mass balance
6. Ideal homogeneous reactors
7. Networks of model reactors to
simulate real reactors and plant
8. Selectivity, yield. Conversion
9. Heat balance
10. Two-phase reactors
11. Exercises and answers
12. Process Dynamics 3 - Linearization of systems

Mandatory literature
Reader Chemical Reactor Design – lecture notes

Multi-component mass transfer in membranes processes

Handouts lectures
1. General introduction to Maxwell-Stefan
2. Matlab instruction
3. Membrane technology: a versatile tool for water purification (and sustainable energy production)
4. Reverse Osmosis
5. Solid matrices
6. Properties of polymers
7. Diffusion in polymers
8. Dialysis and gas separation
9. Pervaporation and reverse osmosis
10. Electrolysis and electrodialysis
11. Ion exchange
12. Gas permeation
13. In porous catalysts
14. In adsorbents
15. Utrafiltration

Mandatory literature
1. Wesselingh JA & Krishna R, Mass transfer in Multicomponent Mixtures. 1st ed. 200-2006, VSSD.

Recommended literature
1. Baker RW, Membrane Technology and Applications. 2nd ed. 2004, John Wiley and Sons Ltd.

Bioreactor Design

Handouts lectures
1. Bio-reaction kinetics and exercises
2. Stoichiometry and exercises
3. Microbial aggregates in bioreactors and exercises
4. Gas exchange and exercises
5. Photo-bioreactors and exercises
6. Cell retention and exercises

Mandatory literature
Reader Bioreactor Design for Water technology

Biological Water Treatment and recovery technology

Handouts lectures
1. Course guide
2. Waste water characteristics
3. Principles of biological processes
4. Systems with biomass retention
5. Nitrogen
6. Phosphorus
7. Anaerobic conversions
8. Process conditions
9. Anaerobic reactors
10. Anaerobic reactor design
11. Microbiology of anaerobic digestion
12. Sulphur cycle
13. Biocrystallisation
14. Gibbs Free Energy & Microbial Growth
15. Gibbs Free Energy & Microbial Yield
16. Problems with answers from Metcalf & Eddy
17. Exercises and answers for anaerobic water treatment

Additional literature
1. Sulfide removal processes
2. Sulfate reduction for inorganic waste and process water treatment
3. Amend Jan P & Shock Everett L (2001) Energetics of overall metabolic reactions of thermophilic and hyperthermophilic Archaea and Bacteria. FEMS Microbiology Reviews 25 (2001) 175-243.
4. Angement Largus T, Karim Khursheed, Al-Dahhan Muthanna H, Wrenn Brian A & Domiguez-Espinosa Rosa (2004) Production of bioenergy and biochemicals from industrial and agricultural wastewater. TRENDS in Biotechnology Vol. 22 No. 9 (September 2004) 477-531.

Mandatory literature
1. Metcalf & Eddy Inc., Wastewater Engineering, treatment and reuse. 4th ed. McGraw-Hill Education – Europe.

Business Case Design Project

Handouts lectures
1. Course guide
2. Microsoft Office Visio
3. Introduction in desalination
4. Short course about Membrane Filtration and Desalination
5. Cradle to Cradle
6. Patents – nuisance or opportunity?
7. Speaking in public
8. Process Dynamics 4 – parameter estimation

Additional literature

1. Cordon Jennifer, Intellectual Property 26. Industrial Microbiology and Biotechnology: 309-320.
2. Raven HW, Module Patents
3. Heerkens Gary R (2007) Project Management – 24 lessons to help you master any project. McGraw-Hill Publishing company.

Recommended literature

1. Wesselingh, J.A., Kiil, S. et al., Design & Development of biological, chemical, food and pharmaceutical products, 2nd ed. 2008, John Wiley and Sons, Ltd..
2. Metcalf & Eddy Inc., Water Reuse: Issues, Technologies, and Applications, 1st ed. 2006, McGraw-Hill.
3. Crittenden J.C., Hand, D.W. et al., Water Treatment: Principles and Design, 3rd ed. 2012, MWH.
4. Seider, W.D., Seader J.D. et al., Product and Process Design Principles: synthesis, analysis and design, 3rd ed. 2009, John Wiley and Sons Inc.
5. Douglas J.M., Conceptual Design of Chemical Processes, 1st ed. 1988, McGraw-Hill.
6. Hoekstra, A.Y. and Chapagain, A.K., Globalization of water, sharing the Planet's Freshwater Resources, 1st ed. 2008, Blackwell Publishing.

Annex 5: List of abbreviations

ba	bachelor
ECTS	European Credit Transfer System
hbo	hoger beroepsonderwijs
ma	master
NVAO	Nederlands-Vlaamse Accreditatieorganisatie
TTIW	Technologisch Top Instituut Watertechnologie Wetsus
wo	wetenschappelijk onderwijs

The panel report has been ordered by NVAO for the initial accreditation of the programme Master of science Water Technology (joint degree) of the University of Groningen, University of Twente and Wageningen University.

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