Water quantity division in a rice irrigation scheme in Nickerie, Surinam

Gaining insight in physical water division in order to fine-tune its management

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Abstract

In this research the water division in the rice irrigation scheme in Nickerie (Suriname) was investigated. Farmers face problems with both oversupply of water and water scarcity. The overall objective of the study was to gain a better insight in the water distribution to the scheme. The research questions were: 1) What are the head-discharge relations of the main intakes to the Nickerie rice irrigation scheme, and; 2) How is the water distributed from the main canals to the various polders within the scheme? These questions were – partly – answered by calibrating the Nanni intake, which is the main intake to the irrigation scheme. Furthermore, longitudinal profiles were derived for two of the main irrigation canals: Van Wouw canal and HA canal.

For the intake calibration, the velocities measured with an Ott-current meter were translated into discharges – in total 48 discharge measurements – using the mid section and the mean section velocity-area methods. The mean section method was adjusted as instead of the average velocities in the two adjacent verticals, the velocities measured in only the right vertical were used as input. With the calibration of Nanni intake for the mid section method C_d-values ranges of 0.65-0.84 (average: 0.72; stDev: 0.11) for 1 gate and 0.66-0.77 (average: 0.71; StDev: 0.04) for 2 gates were obtained. The mean section method resulted in C_d-values which were 0.03 lower. For a water level difference of 0.60m this difference entailed a difference in discharge of 4% of the total discharge. The mid section method discharges and hence C_d-values are assumed to correspond best to reality, since the cross-sectional area used in this calculation covers the real cross-sectional area better than the area used for the mean section method. The ranges of water level difference which were covered for the calibration of Nanni intake during this research were 0.04-0.48m for 1 gate and 0.11-0.34m for 2 gates.

The average mid section C_d-values measured and calculated in this research are 0.22 higher than the C_d-values of the previous calibration (WLA 1980), the results appear reliable. The reliability of the previous research was already doubted by one of the researchers (Kselik) and for this research more than double the amount of discharge measurements have been executed: 22 versus 48.

For the water division, inlets along the Van Wouw canal and HA canal were mapped, canal profiles were derived by taking depth profiles and calculating canal cross-sectional areas, and by making longitudinal profiles including canal bed levels and water levels. The water division in the main irrigation canals was difficult to map as there are many inlets to the polders, with lacking information on their location and dimensions. Information on water levels in the main canals should both be collected and recorded and corresponding discharge measurements should be executed in order to be able to draw conclusions on the water division and to be able to manage and predict discharges in the Nickerie irrigation scheme in the future.

The results of this research can be used to improve the water management strategies in order to fine tune the demand and supply of irrigation water.

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1 Introduction

In the Nickerie District in the North-West of Surinam (Figure 1) rice production is the mayor economic activity (Naipal, 2005). An area of approximately 23.000 ha is under paddy rice cultivation. Over 80% of the working population of the Nickerie District is involved in rice production (Naipal, 2005). Apart from precipitation, canal irrigation is the main water supply for the rice cultivation.

This thesis contributed to the Verrijst! Project, which aimed to strengthen the rice sector in Nickerie (Mantel, 2010; Ritzema, 2010). From December 2011 – March 2012 the overarching water board of Nickerie: Overliggend Waterschap Multipurpose Corantijn Project (overarching water board Multipurpose Corantijn Project: OW-MCP) hosted this research. The Multipurpose Corantijn Project – under supervision of MCP-beheer (MCP-management) – was a project which started in 1978 and which had as main purpose to advocate two harvests per year for rice farmers in the Nickerie District. At that time this was not possible due to limited water resources. Therefore certain infrastructural measures were taken such as constructing canals and intakes in order to meet the growing irrigation water demand. Since 2007 the Federal Government changed MCP-beheer into OW-MCP and appointed OW-MCP as the official irrigation water management authority in the bevolkingspolders (inhabited polders) in Nickerie District (Venetiaan, 2007).

Figure 1: Geographical position of Suriname in South America (WorldAtlas, 2013)

The water quantity management in this irrigation scheme is subject for improvement, since farmers face water scarcity in the dry season as well as in the short rainy season (Ritzema, 2011a). To increase the water availability in these periods water is extracted from the Nanni Swamp and at the Wakay pumping station water is pumped from the Corantijn River into the Corantijn canal (Naipal, 2005). However, the pumping of water with a diesel pump from the Corantijn River into the Corantijn canal is expensive due to the pump's fuel consumption. The four pumps use approximately 100 litres of diesel per engine per hour, costing 4.60 SRD/L.

With full pump capacity this amounts to €432/hour (OW-MCP (2011) by (Witmer, 2011). Furthermore, some farmers have problems with excessive water, which hinder their agricultural practises and harm their crops, as in the long rainy season it regularly happens that rice plots are inundated for several days (Ritzema, 2011a; Naipal, 2005; Triloki, 2012).

It is not known how much water at Wakay should be pumped from the Corantijn River into the Corantijn canal and how far the gates of the main intakes of the Nickerie rice irrigation scheme should be opened to meet the irrigation water demand of the rice farmers. This problem has two sources:

- Lack of information on the quantity of water demand: Which quantity of water do farmers demand when and where?
- Lack of information on the quantity of water supply: How much time should how many pumps operate and how much time should the main intakes operate with which gate position in order to deliver the right amount of water at the right location?

It is uncertain how much fuel is needed to meet the consumption requirements of the pump engines at Wakay. Furthermore, this knowledge gap results in deficits and oversupply of irrigation water to farmers and subsequently in increased (fuel) costs for the government or yield decline for the farmers.

The overall objective of this study is to gain a better insight in the water distribution to the scheme. This research contributes towards a solution of these water quantity problems by gaining insight in irrigation water supply in order to better align it with the water demand.
A start is made to quantitatively map the flow to and in the irrigation scheme. The research questions for this research are twofold:

1. What is the head-discharge relation of the main intakes of the Nickerie rice irrigation scheme?
2. How is the water distributed from the main canals to the various polders within the scheme?

In researching the first question an intake calibration was executed for intake Nanni, which has the biggest service area in this irrigation scheme. After the background information in Chapter 2 the methodology and results of this intake calibration are given and discussed in Chapter 3.
In Chapter 4 research question 2 is elaborated. To answer this question the focus lies on researching two main irrigation canals: Van Wouw canal and HA canal. For these canals information was collected on the polders that are served by it, as well as the location of inlets along the canals. Furthermore, canal longitudinal profiles were calculated by picturing the elevation of the water levels, canal bed levels, and cross-sectional areas. In Chapter 5 the results and their reliability are summarized, and recommendations on improving the methodology and future research are given.

2 Background information

In this Chapter first the research area and its history are described. Subsequently, the interrelations in irrigation water management in this area are shortly explained, and then the physical characteristics of the water quantity affecting irrigation demand and supply are outlined.

2.1 Geographical settings and history of irrigation

The Nickerie rice irrigation scheme is divided into polders, which together cover an area of approximately 35,000ha (LVV, 2012); (Nageswhar, 2013). These rice polders are located along the left bank of the Nickerie River, and they are subdivided into the 'Westelijke polders', the 'Oostelijke polders', and the 'MCP polders'. The MCP polders are currently not under irrigation, as this area is not cultivated. The Oostelijke and Westelijke polders together cover an area of almost 23,000ha. The average plot size per farmer is 3.1ha (Ritzema, 2010).

Over the years the area under cultivation has expanded. In the past the main source for irrigation water was the Nanni Creek, which drained water from the Nanni Swamp, a swamp located south of the rice irrigation scheme. Figure 2 shows the head water supply system. As the pressure on the available water sources increased, the irrigation was enhanced by digging the Van Wouw and HA canal in the '40s (Sevenhuijsen, 1977). In the '80s additional water was pumped from the Corantijn River into the newly dug Corantijn canal to meet the irrigation water shortage (Rustwijk and Rustwijk, 1978). This pumping was and currently still is done by four pumps located at pumping station Wakay, the pumping station in the Corantijn River (Naipal, 2005). It is here where the Corantijn canal starts, and the canal prolongs in a 66km straight line in the north-east direction towards one of the main intakes for the irrigation scheme: Nanni intake. At a few locations along the Corantijn canal some pipes were constructed to drain water from Nanni Swamp into the canal. It is impossible for the water to flow in the opposite direction, since the pipes are equipped with check valves. Water from the Corantijn canal can be drained to the Corantijn River at three locations: Pand E, South Drain, and Nanni creek. All these spillways are provided with stop logs to control the water availability in the water supply system. Just upstream (150m) of where the Corantijn canal reaches the Nanni intake, the embankments of the canal were not constructed. Consequently, this part of the canal is partly in open connection to the Nanni Swamp. In the vicinity of Nanni intake the Corantijn canal bends to the East, under another name: Suriname canal. At the height of Nanni intake the Nanni creek crosses the irrigation supply canal and when the water level reaches a certain level (flexible, depending on the amount of stop logs) the water flows over a spillway: Nanni spillway. The Suriname canal forms the south border of the rice irrigation scheme, and it is the northern border of Nanni Swamp. At some locations the embankment of the Suriname canal is rather low, so with high water levels in the swamp there is an open connection between the swamp and the Suriname canal. The Suriname canal flows to two other main intakes for the rice irrigation scheme: intake Hoofd Aanvoer (Head Supply: HA) and intake Inlaat Kunstwerk Uitbreiding Groot Henar (Inlet Expansion Groot Henar: IKUGH). These two intakes are at a distance of approximately 150m from each other, and at 4.4km from Nanni intake. After intake IKUGH the Suriname canal bends towards the South-West direction, where it proceeds another 33km and reaches the Maratakka River. At their junction a dam is constructed to prevent water from the river entering the head water supply system. When the water level in the Suriname canal is high, water is spilled into the Maratakka River.

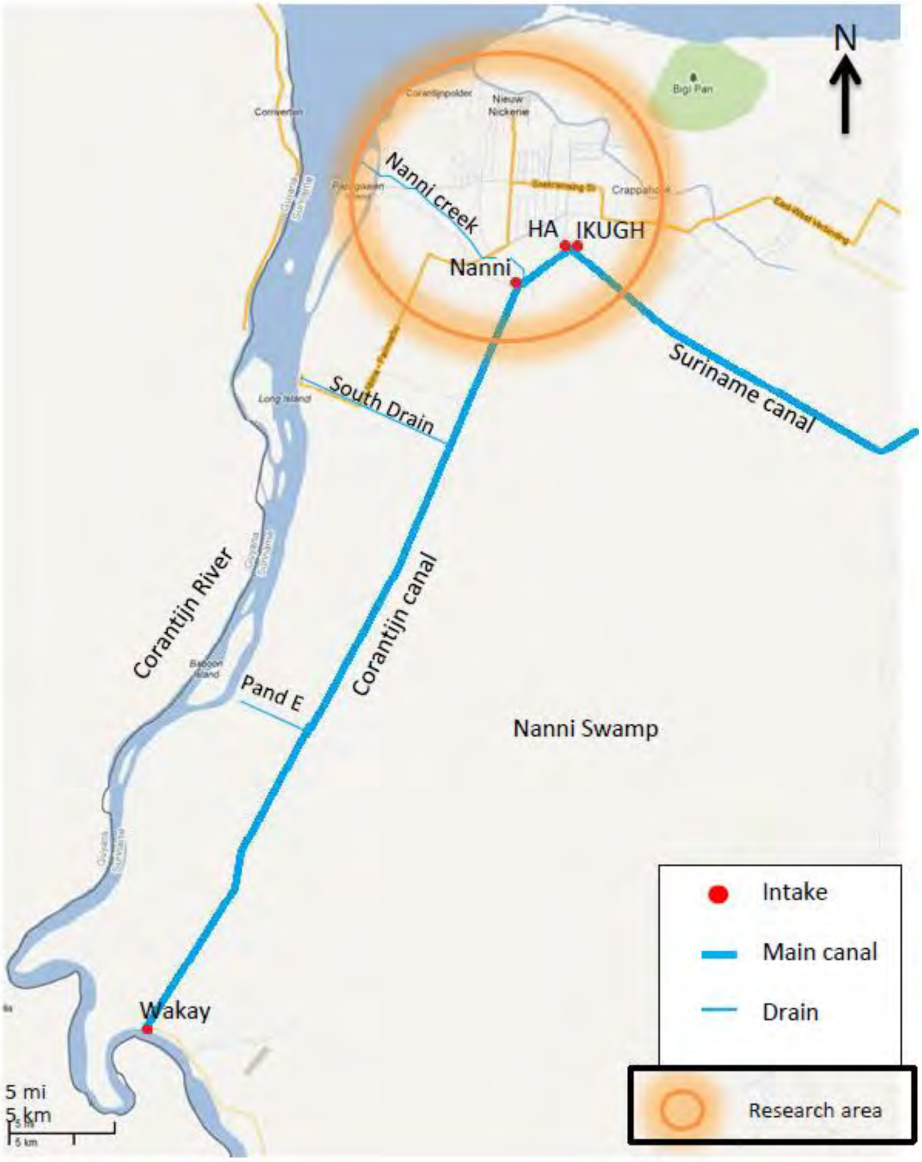

Figure 2: Head water supply system of rice irrigation scheme in Nickerie district (adjusted from Google Earth)

For this research the inputs of two water level recorders (Thalimedes instruments) were used. They are located near the Van Wouw intake (T1) in the Suriname canal, and at Driekokerpunt (T3) (**Error! Reference source ot found.**). The Thalimedes meters are owned by OW-MCP and they record the water levels automatically at an interval of 15 minutes. By the means of a SIM-card the water levels can be retrieved and send to a central computer, in this case to the employers of OW-MCP.

The three intakes for the irrigation scheme feed different canals which in their turn feed different polders with irrigation water. Nanni intake serves the Van Wouw canal, which in its turn serves some side canals. The Van Wouw canal flows approximately 13km until it reaches Clara pumping station. Here the water is divided to five different directions (Figure 3). When the water level in the Van Wouw canal is low, the water will be pumped into the division box, but most of the year the water flows into this division box by gravity. In the division box the water is divided according to a water calendar: every seven days one of the five offtakes is served with water from the Van Wouw canal (Annex A).

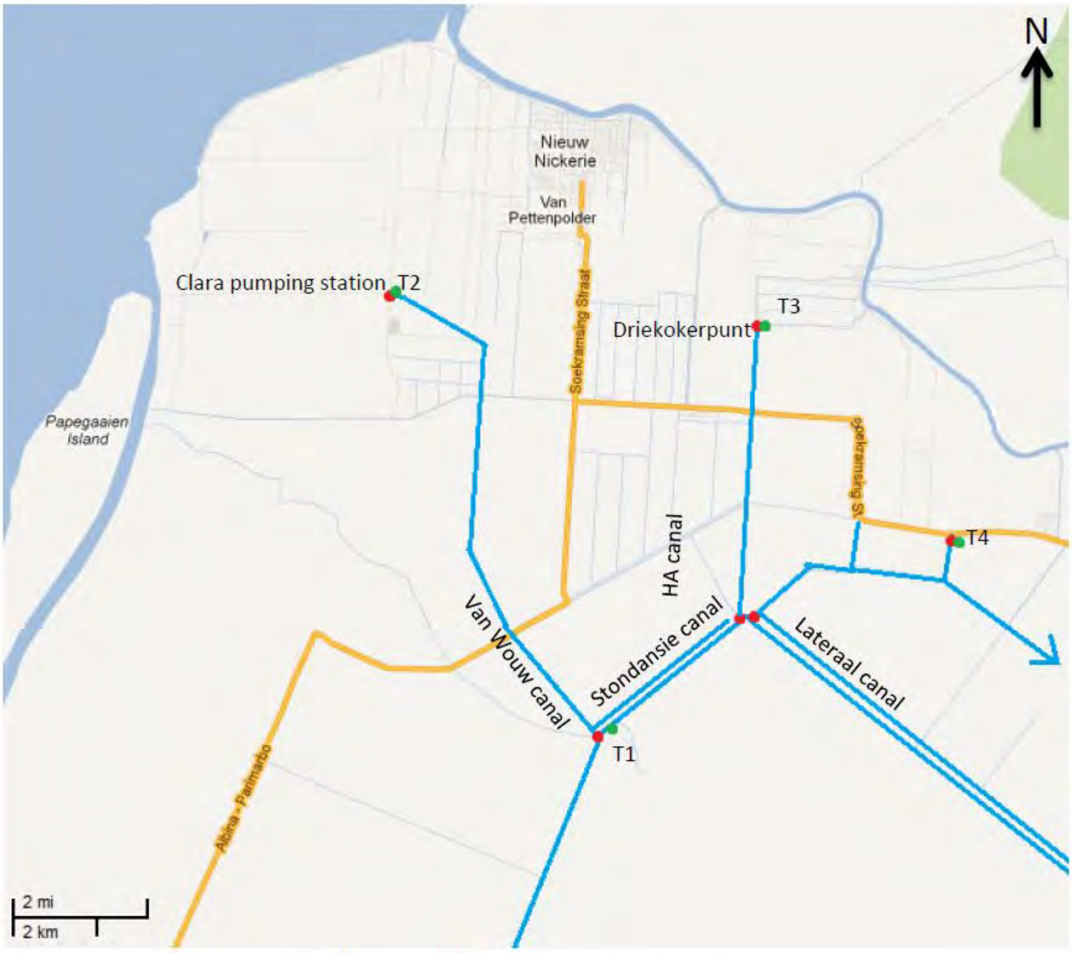

Figure 3: Clara pumping station division box. A: Picture (Witmer, 2011); B: Schematic plane view

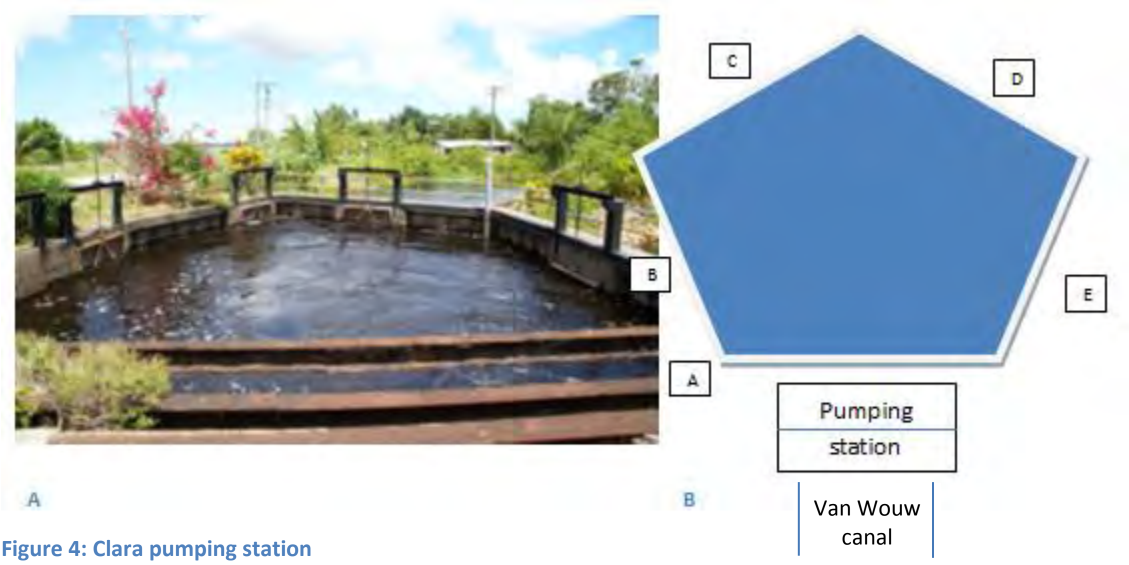

Figure 4: Clara pumping station
A= gate to Nanni polder; B= two gates to Clara polder; C= gate to Corantijn polder; D= gate to Van Drimmellen polder; E= gate to Wasima polder (Waldeck, Sidoredjo, Margharetenburg)

On the left side the Van Wouw canal serves these polders (Figure 4): Baitalli, Bruto verkaveling, Nanni polder (Bruto is part of this polder), Oemrawsing, Stalweide, and Mangli. The right side of the Van Wouw canal serves: Euro-Zuid, Euro-Noord, part of Bacoven polder, Mangli (other part), Baitalli Ons Land, and via Ons Land to Waterloo, which partly exists out of building plots and the other half is vegetable gardening. In the Euro-Zuid polder: probably in only 20 to 30% of the area is cultivated, while the remaining is forest. The Nursey and Hazard polders do not receive irrigation water. The farmers there keep livestock and cultivate dry crops for which they fetch their own irrigation water. Bruto polder directly extracts water from the Van Wouw canal. Nanni polder partly extracts water from a bypass connected to the Van Wouw canal and the level of Oemrawsing and Stalweide polder, and receives the other part of the water via Clara pumping station. For the Bacoven polder: one part receives water from the Van Wouw canal, while the other part receives water from the HA canal.

Figure 4: Polders in the Nickerie District (source: Nageswhar, 2013)

Intake HA serves the HA canal which flows 4.9km into the northern direction to Driekokerpunt, from where the water divides over several canals. To the left, HA canal supplies irrigation water to part of the Bacoven polder and expansion Paradise. And to the right it provides the following polder with irrigation water Sawmill kreek and expansions Hamptoncourt polder. After Driekokerpunt the water provides for irrigation in the Longmay and Paradise polder.

The canal flowing to the left after intake IKUGH supplies the Prins Bernhard polder, Hamptoncourt polder and Crappahoek, Boonacker, and the Groot and Klein Henar polders. The canal flowing to the right (Lateraal canal) feeds the expansion Henar 1 and 2 polders.

2.2 Water management

The roles and responsibilities of different parties which are involved in the irrigation water division are described in this section. In her MSc thesis, Pieters (Pieters, 2011) has elaborated on the exact tasks of the involved parties. In the Nickerie District the irrigation water management for the rice cultivation is executed by several parties on different levels. Water is not neutral, and in its division political decisions are involved. As resources like money, experience, and knowledge are involved, status and power relations play a considerable role in the day to day interactions in managing the water division. In this field of powers the following regional ministries play a role: the Ministry of Agriculture, Livestock and Fisheries (Landbouw, Veeteelt en Visserij: LVV); the Ministry of Public Works (Openbare Werken: OW); and the Ministry of Regional Development (Regionale Ontwikkeling: RO). Furthermore, the Federal Government, OW-MCP, the water management boards in the polders, the Hydraulic Research Division (Waterloopkundige Afdeling: WLA), the National Rice Coordinator, and the Districts Commissariat also interact in managing the irrigation water resources. These institutions have different but also overlapping responsibilities in managing the irrigation water quantity and operation and maintenance of the associated infrastructure.

Because the water management is divided amongst many institutions, the Federal Government attempts to bring the policy under one responsible party: OW-MCP. However, some parties are reluctant to release and transfer their responsibilities to OW-MCP; hence there are struggles to get the coordination of the management under one institute. Lack of trust in the capability and accountability amongst these different institutions to a high extend affect the efficiency of the water management in the Nickerie district. Roles and responsibilities are transferred to a low extend, and transparency of actions and communication to other parties is low. (Haitel, 2012)

Below a short description is given on the water management responsibilities of the different institutions in the time period of the research. This information was collected during field visits and interviews with the different institutions, and to a large extend it was adopted from Pieters (2011).

OW-MCP is responsible for the operation and maintenance of the Wakay pumping station and of the Corantijn canal with its wet infrastructure (some inlets from Nanni Swamp to the canal, and some spillways – Zuid Drain and Pand E – from the canal to the Corantijn River). As the local water boards do not function the way they are supposed to, no water fees are collected. Consequently, OW-MCP is dependent on funding from the Federal Government. The largest part of this budget is spent on fuel expenses for Wakay pumping station.

One of the main tasks of the regional representation of the Ministry of LVV is the designing of a sowing calendar, which states when which farmers should sow their plots. They also register when the farmers actually do sow their plots, since this does not necessarily correspond with the sowing calendar. LVV maintains the main infrastructure of the Nanni-polder, Euro Zuid, Euro Noord, Bruto polder, Groot Henar, and Uitbreiding Henar. LVV has the authority over operating the main intakes – Nanni, HA, and IKUGH – of the rice irrigation scheme. According to the sowing calendar, to the amount of precipitation, and to the input of farmers, they instruct the regional department of OW to either close or further open the gates of the intakes.

Hence, OW is the executing authority of operating the gates of the main intakes and Nanni spillway, meaning the wet infrastructure of the Suriname canal. A lockkeeper employed by OW is permanently settled in a house next to Nanni intake. For HA and IKUGH another lockkeeper travels up and down from the Van Petten polder, which entails that there is no permanent supervision, and consequently the operating of gates potentially could be done by dissatisfied farmers who want more or less water to reach their plots.
RO is responsible for the operation and maintenance of 15 drainage sluices.

Farmers themselves should maintain and clean irrigation and drainage canals adjacent to their plots. Often there are frictions here, since if one farmer has cleaned his irrigation canals while the neighbouring farmer did not, the water supply will still be delayed. As for the drainage aspect – often not included in the considerations – problems arise here as well. Since the water only moves as fast as the slowest link, delay in maintenance activities to clear drainage canals from grass mats and other obstacles create a smaller drainage capacity than the design drainage capacity.

Many institutions are involved in the irrigation water management in the Nickerie district. There is the legal framework of which institution has which responsibilities, and there are the corresponding and/or not corresponding analogue activities which are actually executed. Taken together, to most parties it is not clear how the irrigation water management is regulated. As some policies with regard to water quantity regulations will be disadvantageous to certain farmers, there are some examples of farmers circumventing political decisions or the lack of decisions when they do not agree. Some large farmers for instance every now and then pump water from the primary irrigation canals. This is not allowed, but in practice the rules are not enforced. As most large farmers are involved in regional or national policy, power relations are part of the explanation of this tolerance policy.

Decisions in the irrigation water management of the research area are not so much based on scientific measurements, but more on estimations which are based on experience. This is mainly due to a lack of availability of scientific background information.

2.3 Water quantity situation

2.3.1 Climate

Nickerie has a humid tropical, moist climate with annual rainfall varying from 1750mm to 2300mm with seasonal differences. Figure 5 and Figure 6 show the climate data of Nickerie. The short rainy season falls during December and January. There is also a long rainy season which takes place from April to July. The temperature generally stays the same throughout the year (Figure 5).

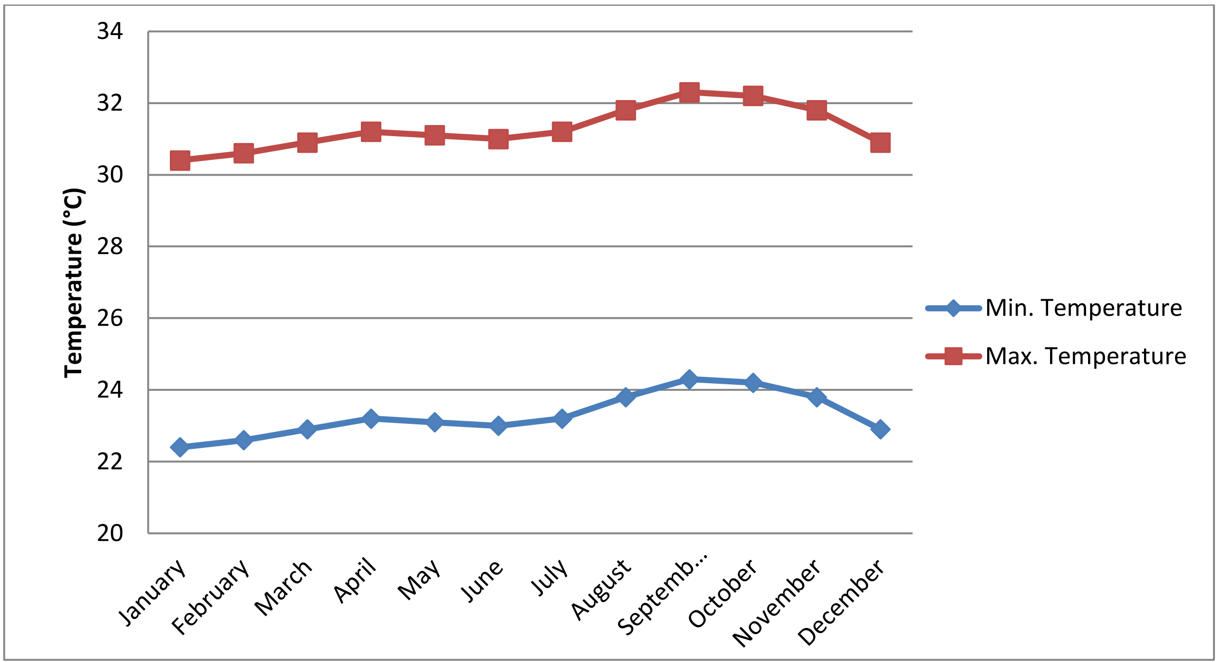

Figure 5: Average minimum and maximum temperatures in Nickerie, Suriname. Source: (FAO, 2013)

The precipitation and evapotranspiration conditions in the Nickerie District are compared in Figure 6.

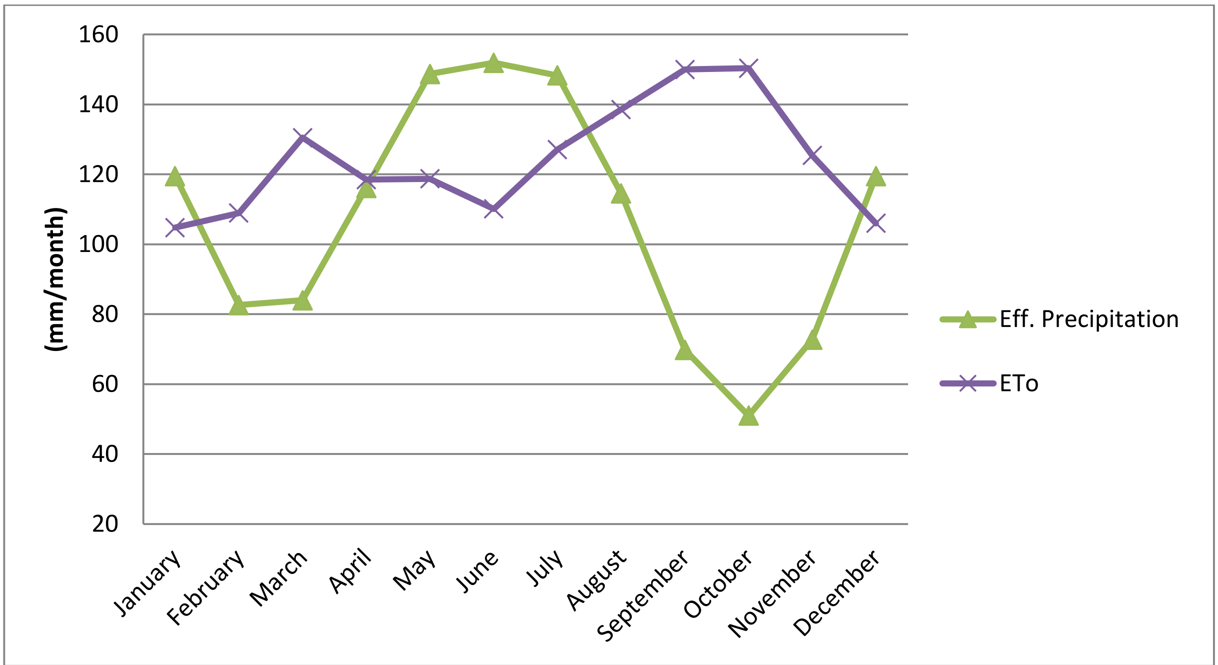

Figure 6: Precipitation and evapotranspiration (mm/month) in Nickerie, Suriname. Source: (FAO, 2013)

The evapotranspiration exceeds the water provided by effective precipitation in two seasons: from mid-February up to April and from mid-July to mid-December. Hence, to prevent crop damage and yield decrease, an additional supply of irrigation water is required in these months. However, the rainy seasons seem to shift and currently it is less predictable in which months the seasons exactly will start, and simultaneously when the dry months prevail.

2.3.2 Water demand and water supply

Apart from water for the growth development of the rice crop, the function of water for paddy cultivation is mostly to supress weed growth. Due to a favourable climate in the research area, rice can be cultivated year round. "The seeding date is determined by the availability of water, the season planning of the farmer, the availability of credit for inputs and the availability of machinery" (Wildschut, 1998 in (Witmer, 2011)). However, due to water scarcity in the dry seasons, the Ministry of LVV designs a sowing calendar every cropping season in order to accommodate tuning of water availability and demand, and hence to limit the demand for irrigation water. Therefore, the prevailing growing seasons are from April to August/September, and then again from October to March.

Furthermore, the irrigation water demand depends on additional factors like conveyance efficiency, application efficiency, irrigation efficiency, and the relative water division at locations where the water is divided over several canals or offtakes. The demand for artificial water supply for irrigation then is the total irrigation water demand – adjusted for the different efficiencies and evaporation – minus the supply by precipitation. The irrigation water is pumped from the Corantijn River at Wakay pumping station, and/or provided by Nanni Swamp. From the head water supply system the water enters the irrigation scheme at the Nanni, HA, and IKUGH intakes. OW-MCP has the policy to maintain the minimum upstream water level (swamp side) of somewhere between 2.20m+NSP (Nationaal Surinaams Peil: National Surinam reference level) and 2.40m+NSP, depending on whether precipitation is predicted or occurring already. In case farmers need more water, they can inform the Ministry of LVV, which in turn informs OW-MCP to increase its pump capacity. In times there is no need for water, the pumps do not run.

The rice cultivation in Nickerie demands approximately 26,000m^3/ha/year, which includes water for the crop growth requirements (crop water requirements: CWR), soil preparation, maintaining a water layer in the field, and over all this was accounted for seepage losses. The irrigation water demand per month is given in Table 1. Note that – as the rainy seasons shift in time – this is only an indication. The design discharge on which the design of intakes and canals was based is 1.75l/s/ha, as this is the highest discharge – occurring in November – which should be transported through the intake and be conveyed through the canals. (Ritzema, 2011b)

Table 1: Irrigation water demand per month per ha in the rice irrigation scheme in Nickerie, Suriname (Ritzema, 2011b)

Month	Activity	Water demand	
		(l/s/ha)	% of peak design discharge
January	*CWR*	0.70	40
February	*CWR*	0.46	26
March	*Harvest*	0.66	38
April	*Soil preparation*	1.09	62
May	*Soil preparation/sowing*	0.58	33
June	*Sowing*	0.28	16
July	*CWR*	0.08	5
August	*CWR*	0.04	2
September	*Harvest*	0.00	0
October	*Soil preparation*	1.15	66
November	*Soil preparation/sowing*	1.75	100
December	*Sowing*	0.95	54

It was not known how far the gates of the intakes should be opened in order to satisfy and not exceed the water demand. When there is too much water in the head water system, water is drained at Pand E, Zuid Drain and Nanni spillway. It is however not clear how much stop logs should be removed or installed to keep a safety margin: prevent flooding and have a buffer: use the head water supply system as a water reservoir to provide irrigation water at times when there is demand for it. Then there is the diversity of water demand within the irrigation scheme. When some farmers their water demands are satisfied, at the same time there will be polders which/farmers who receive either an excess of water or are supplied with too little water to meet their demand for irrigation water.

Currently, the water levels are collected, but little is done with it. Time-series of water levels are produced, and from empirical relations between flooding or complaints of farmers on water scarcity an attempt is made to gain insight in required management of operating pumps, gates of intakes, stop logs, and drainage sluices. Current guidelines on what to do with the results from the Nanni Thalimedes – located in the Suriname canal – are: keep the level above 2.20m+NSP, since below this level the farmers cannot extract water by the means of gravity, but they have to pump instead. When the level is above 3.10m+NSP OW-MCP gets anxious since the risk of flooding becomes undesirably high, and at these moments it is sincerely considered to remove some stop logs from the spillways in the head water supply system. At 3.50m+NSP the water level has reached its absolute maximum allowed level in the Suriname canal.

OW-MCP and other players in the irrigation water management sector in the Nickerie District have an interest in having a water management policy based on quantifiable data. Therefore, the next part of this thesis elaborates on an intake calibration, followed by further insight in the water division in the irrigation scheme downstream of the main intakes.

3 Intake calibration

The objective of calibrating – acquiring a head-discharge relation – the three main intakes of the rice irrigation scheme is to facilitate the water management of OW-MCP and other parties by better fine tuning of the irrigation water supply to meet the farmers' irrigation water demand. Meeting this objective can contribute to preventing problems due to deficit or oversupply of irrigation water for farmers, and could prevent extra costs for OW-MCP and the government by pumping too much water from the Corantijn River at Wakay pumping station.

In Chapter 3.1 the concepts and theories which impact a calibration are described. In Chapter 3.2 the methodology of research is outlined, addressing the choices that were made in the data collection process. The results of the calibration are shown in Chapter 3.3, and a discussion on these results can be found in Chapter 3.4.

3.1 Concepts & Theories

In Chapter 3.1.1 an elaboration on what influences a calibration is made. A calibration involves a head-discharge relation of a structure, which in its turn requires information on the parameters affecting this head and discharge. In Chapter 3.1.2 several concepts and theories are treated with regard to the calculation of discharges of water flow and the transformation of discharge data to an intake calibration is explained into detail in Chapter 3.1.2 as well.

3.1.1 Influences on discharge through structures

The geometry of a structure influences the water quantity flowing through it. Furthermore, the relative water level difference between the down- and upstream water levels – referred to as *head difference* in the rest of the report - and the gate opening affect the amount of discharge through a structure.

There are several ways to measure discharges, namely volumetric or direct methods, velocity-area methods, and tracer measurement methods. The selection of a discharge measurement method should deal with the desired frequency of measurement (single or continuous), the required accuracy of the results, the availability of persons and skills, and the costs of installation and operation. Furthermore, the availability/costs of required measurement tools and other equipment, and the availability of power supply and spare parts should be considered when selecting the most appropriate discharge measurement method. (Boiten, 2008)

For this research the limited budget and the already available equipment were decisive in selecting the velocity-area method to measure the discharges in the canal cross-sections.

3.1.2 Velocity-area method

The velocity-area method is based on the concept that discharge is the result of the multiplication of velocity and cross-sectional area:

$$Q = \bar{v} * A$$

Q = *discharge (m^3/s)*

$\bar{v}$ = *mean velocity in the cross-section (m/s)*

A = *cross-sectional area (m^2)*

Advantages of this method are the little required knowledge to execute a discharge measurement, and its wide applicability in terms of stream size and flow conditions. The method shows limited reliability in situations where either very large or very small discharges occur.

The location of the cross-section should be chosen in such a way that there are minor influences of backwater effect. A straight reach and a uniform canal bed profile are therefore preferable. The water depth has to be sufficient in order for the velocity measurement equipment to be submerged. The cross-section should be perpendicular to the main flow direction. Preferably the cross-section should be perpendicular to the prevailing wind direction. (Boiten, 2008)

For an intake calibration the cross-section should be located in such a way that it is just downstream of the intake. Appropriate locations for reliable discharge measurements should be selected based on several criteria relating to reliability and practical reasons. The discharge depends on the cross-sectional area and the velocity of the water flow. Therefore a known cross-sectional area would facilitate the ease of the discharge calculation and would increase the reliability of a measured discharge to be nearby the actual discharge. As the geometry of an intake is known – or can easily be measured – it would be convenient to locate the cross-section inside the structure. The measured discharges in the structure opening should be compared with those measured in the canal. Once these correspond to a sufficient degree, the discharge measurements can be executed in the structure opening. For practical reasons a cross-section in the intake was also preferred, as this location was assumed to have a smaller width as compared to a cross-section in the canal, and as discharge measurements therefore would be less time consuming.

The calculation of the area is based on water depth (d) (Figure 7) in so-called verticals – vertical lines identified at certain locations along the total cross-section of the canal – and the horizontal distance (b) between these verticals.

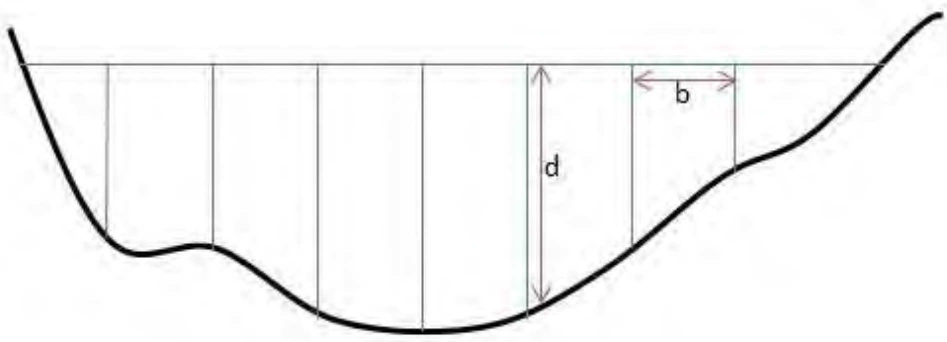

Figure 7: Cross-section canal with verticals

In order to determine the average flow velocity in a vertical, the character of the velocity distribution in vertical needs to be known. This distribution depends amongst others on whether the flow is laminar or turbulent. The Reynolds number is a turbulence indicator for the water flow (Table 2). The Reynolds number is derived with this equation:

$$Re = \frac{v * D}{\tilde{v}}$$

Re = Reynolds number)
v = *velocity (m/s)*
$\tilde{v}$ = *kinematic viscosity (m^2/s)*
D = *water depth (m)*

Table 2: Flow types according to the Reynolds number

Reynolds number	Flow type
<400	Laminar
400-800	Transitional
>800	Turbulent

In a turbulent flow the velocity distribution in a vertical is assumed to be parabolic (Figure 8). The variation of velocity distribution in a vertical is relatively strong for water ways with a rough bed as compared to water ways with smooth beds. A turbulent flow is normal in irrigation canals (Laycock, 2011). If the water flow has a turbulent nature, the average velocity in a vertical is to be found approximately at 40% of the water depth (0.4d) from the bed of the water way (Figure 8).

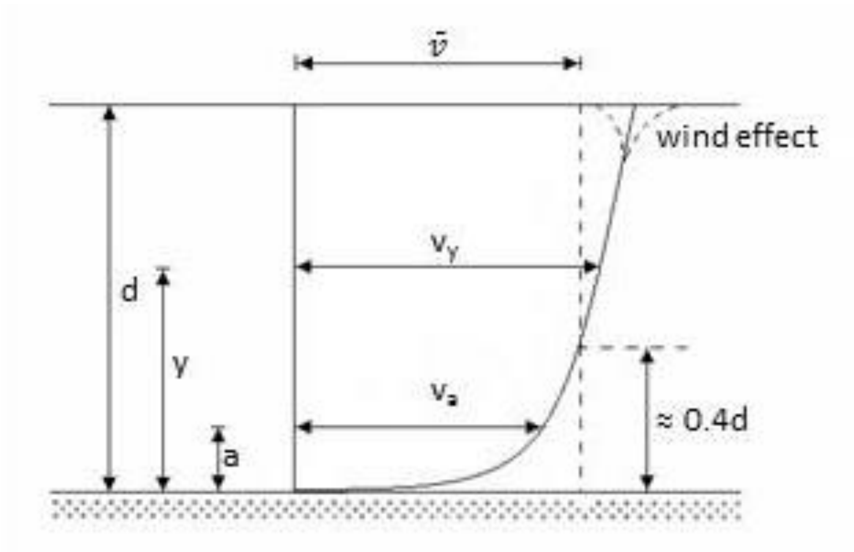

Figure 8: Velocity distribution over the water depth (adjusted from (Boiten, 2008))

As with the available equipment 'Ott Universal current meter C 31' (Figure 9) velocity measurement was a so-called point measurement, the 'one-point-method' was developed to measure at 0.4d from the bed. Table 3 shows the accuracy of measurement following a methodology of more measurement points along a vertical and their accompanied levels of accuracy. This is not a complete overview, though it shows the most frequently used methods.

Table 3: Amount of measurements in a vertical and their accuracy in deriving the mean velocity in a vertical (Boiten, 2008)

Method	Depth of measurement(s) from bed, relative to total depth	Equation of mean velocity	Recommended at water depth (m)	Standard deviation of the mean error (%)
One-point-method	0.4d	$\bar{v}_{0.4d}$	<0.25	8.2
Two-point-method	0.2d and 0.8d	$0.5(\bar{v}_{0.2d}+\bar{v}_{0.8d})$	0.25-0.50	4.9
Three-point-method	0.2d and 0.4d and 0.8d	$0.25\bar{v}_{0.2d}+0.5\bar{v}_{0.4d}+0.25\bar{v}_{0.8d}$	>0.50	4.8

In case the velocity distribution in a vertical does not have a parabolic nature, it is recommended to apply a regular equidistant spacing between the measurement points along a vertical.
Not all velocity measurement equipment calculates the velocity right away. For some equipment there are certain calibration equations to transform the output data to the flow velocity.

The measured velocities are also approximations of the specific velocity in that point. The velocities are averages due to the turbulent character of the flow. Therefore the duration of the measurements influences the reliability of the obtained data. The rule of thumb is a measurement duration of 30 to 50 seconds for water flows with a relative high velocity and 60 to 100 seconds for water flows with relative low velocity/few rotations by the propeller (Figure 9). There are no exact guidelines for the measurement time in the manual of the Ott current meter.

Figure 9: Velocity measurement instrument: Ott current meter. (Scottech, 2013)

The velocity distribution over the cross-section varies as well. In general the velocity is lower at the bed and banks of the water way, and depending on the wind direction it could be faster or slower in the middle of the water surface (Figure 10).

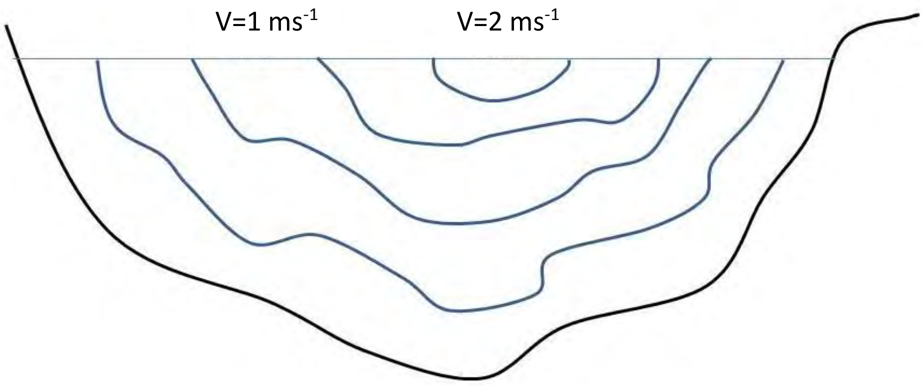

Figure 10: Example of velocity distribution in cross-section of water way

This visualizes the requirement for plural verticals along the cross-section in order to derive a reliable approximation of the total discharge passing through it. There are certain guidelines (Table 4) for the recommended amount of verticals in a cross-section.

Table 4: Recommended number of verticals in relation to cannel width (ISO, p. 80) in (Boiten, 2008)

Canal width (m)	Number of verticals
<0.5	3
0.5-1.0	4-5
1.0-3.0	5-8
3.0-6.0	8-12
>6.0	>12

These verticals can be divided by setting a fixed distance between the verticals – equidistant – with the last vertical most likely having a shorter distance to the embankment. Another way to divide the verticals over the cannel cross-section is to adjust the spacing of verticals to the bed of the water way and divide this into sections with approximately equal bed slope. The amount of verticals affects the reliability and therefore validity of the discharge measurement (Table 5).

Table 5: Relative standard deviation of error as a function of the number of verticals for the velocity-area discharge measurement method (Boiten, 2008)

Number of verticals	Relative standard deviation of error (%)	
	equidistant	Irregular
5	4.20*	7.70
6	3.70*	7.00
10	2.60	4.40
15	1.98	3.02
20	1.65	2.20
25	1.45	1.70

* Extrapolated by W. Boiten

As can be seen from this table, the relative standard deviation of error in any case is smaller for the equidistant verticals than it is for the verticals which are irregularly divided. For both methods the figures show a decreasing relative standard deviation of error with an increase in amount of verticals.

As the cross-section is now divided in segments, per segment the average velocity and area are calculated to derive partial discharges, and the summation of these partial discharges is the discharge through the total cross-section. The two methods which are common in calculating the discharge with the velocity-area method are the mid section method and the mean section method.

The calculation for the partial discharges with the mean section method is based on the following equation:

$$Q_p = \frac{\bar{v}_m + \bar{v}_{m+1}}{2} * \frac{d_m + d_{m+1}}{2} * b$$

Q_p = *partial discharge of segment (m³/s)*
$\bar{v}_m$ = *mean velocity of water flow in vertical m (m/s)*
$\bar{v}_{m+1}$ = *mean velocity of water flow in vertical adjacent (one direction) to vertical m (m/s)*
d_m = *depth of water in vertical m (m)*
d_{m+1} = *depth of water in vertical adjacent (one direction) to vertical m (m/s)*
b = *width between vertical m and the vertical m+1 (m)*

For the edge segments – bordering the embankment – the equation is somewhat different, as the relative friction is higher here than in the panels which do not touch upon the embankment:

$$Q_p = \frac{2}{3}\bar{v}_1 * \frac{1}{2}(d_0 + d_1) * b$$

The calculation for the partial discharges with the mid section method is based on this equation:

$$Q_p = \bar{v}_m * d_m * \frac{b_m + b_{m+1}}{2}$$

b_m = *width between vertical m and vertical m-1 (m)*
b_{m+1} = *width between vertical m and vertical m+1 (m)*

In Figure 11 the area considered for the partial discharge per vertical for both methods is illustrated.

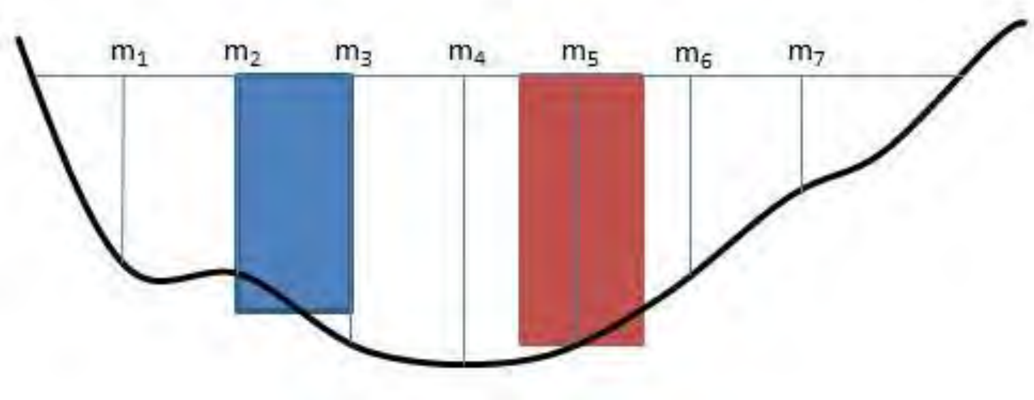

Figure 11: Area of partial discharges for mean section method (blue) and mid section method (red)

To come from discharge calculations to an intake calibration, the discharges had to be related to the gate position of the intake, the width of the opened gate(s), and the relative head difference of the downstream and upstream water level of the intake.

The following equation shows how these parameters are related:

$$Q = C_d * A * \sqrt{(2g(h_1 - h_2))}$$

Q = *discharge through intake (m³/s)*
C_d = *discharge coefficient*
A = *cross-sectional area of discharge measurement (m²)*
g = *gravity acceleration constant (m/s²)*
h_1 = *water level upstream of intake (m)*
h_2 = *water level downstream of intake (m)*

The gravitation acceleration constant 'g' for the Earth is 9.81 m/s². The water levels h_1 and h_2 should be measured from the water level to a reference point which is the same for both water levels. In this way the head difference $h_1 - h_2$ can be calculated. The discharge coefficient C_d is a coefficient to compensate for turbulence, non-uniform velocity distribution, etc. It is dependent on the type and shape of the structure. As the discharges are already measured, the C_d-factor is the only unknown parameter and hence can be calculated. Theoretically, the C_d-factor of an intake should be the same for all gate positions and head differences.

In 'Evaluatie sluisijkingen in de Nanni-Swamp 1978-1980' (Kselik, 1983) four different types of discharges are described: semi-modular and non-modular discharge both through gates which are totally open and through gates which are partially open. With semi-modular discharge the discharge does not increase with a decreasing downstream water level, and hence only depend on the upstream water level. Non-modular discharge or drowned discharge depends both on upstream and downstream water level. The equations and the situations in which they should be applied are mentioned in Table 6.

Table 6: Intake calibration equations for different types of discharge and gate positions

Discharge	Gate position	Intake calibration equation
Semi-modular	Totally open	$Q = C_d * b * h_1^{\frac{3}{2}} * \sqrt{(2g)}$
	Partly open	$Q = C_e * w * b * \sqrt{(2g * h_1)}$
Non-modular	Totally open	$Q = C_d * b * h_2 * \sqrt{(2g(h_1 - h_2))}$
	Partly open	$Q = C_d * C_v * a * b * \sqrt{(2g(h_1 - h_2))}$

b = *width of gate(s) (m)*
a *and* w = *height of gate opening under water (m)*
C_d = *discharge coefficient*
C_v = *correction coefficient to compensate for the negligence of the inflow velocity head*

The C_e-factor is calculated by multiplying the C_d-factor with the C_v-factor with contraction coefficient δ:

$$C_e = C_d * C_v * \delta$$

In general intakes are designed in such a way that the inflow velocity head is minor ($H_1 \approx h_1$) due to the submerged circumstances and therefore the C_v-factor approximates a value of 1. The contraction 'δ' affects the discharge as energy losses occur due to friction as the water is forced to change its direction while flowing through the cross-section of the intake, which generally varies from the canal cross-section.

3.2 Methodology

As the theory clarified, trade-offs had to be made before the actual discharge measurements for the intake calibrations could begin. For this intake calibration research the regional Ministry of OW granted permission and cooperation by supplying manpower for the research. Furthermore, preparations were made by researching literature (previous and similar research; intake geometry; communication with other information sources) and making the research location ready for the execution of the research. Also, preparations were taken in order to have the right equipment ready for action. Finally, a plan was designed on when and how to do measurements.

3.2.1 Information review

In 1972 W. Chin Joe (1972) already calibrated Nanni intake. Furthermore, the Hydraulic Research Division of the Ministry of Public Works executed two calibrations for Nanni intake: one in 1978 and one in 1980. It is important to take the lessons learned from those calibrations into account in this research design. Significant were the problems dealing with grass mats at the upstream side of the intake, hampering the flow through it and creating impoundment. Furthermore, there were problems related to discharge measurements for small head differences. The previous researches also provided information on the geometry. Furthermore, construction drawings were available, which also provided information on the geometry. As the information in the above mentioned sources could possibly be outdated as a consequence of weathering or due to changes or repairs in the construction of intakes, the geometry was also checked by measuring the geometry of intake Nanni, HA and IKUGH in a field visit preceding the intake calibration measurement. See Annex B on the geometry and field situation of these three main intakes.

Apart from literature sources and fieldwork, interviews were conducted with people who had contributed to the previous intake calibrations and people who knew about the field situation of the water distribution.

3.2.2 Preparation for field work

Before the field measurements could start, the field locations were prepared for the research. Suitable cross-sections for the discharge measurement had to be selected, the amount of verticals to measure and the amount of points per verticals to measure the flow velocity had to be decided upon. The velocity measurement instrument was calibrated, a field form was created, staff gauges were constructed, and the required equipment was gathered.

In order to measure a reliable flow velocity – and hence discharge measurement – the water flow should be more or less constant. No vortices and high wave formation: the streamlines should as much as possible be stable. Too high velocities however can damage the current meter. To discover this, a preliminary velocity measurement is recommended. The location of discharge measurement should be as close as possible to the intake. For an intake calibration, the discharges through the intake need to be measured. The larger the distance between the location of the cross-section and the intake, the more likely it is for the discharge to vary from the real discharge through the intake. Additionally, it would be convenient if communication with the gate operator would be possible from the location of the discharge measurement cross-section. Safety procedures for the field workers executing the research should be regarded in any case. For Nanni intake the cross-section could not be inside of the intake as the velocity of the water flowing through it was so high that the Ott current meter bended by the power of the water. Hence, the cross-section for discharge measurement could only be located in the Van Wouw canal. However, as there were vortices in the Van Wouw canal, the discharge measurement could only be done at approximately 100m downstream of the intake. A consequence of this location was the presence of an offtaking canal – Stondansie canal – just upstream of the location. To gain a complete image of the discharge through Nanni intake, this required a discharge measurement in two locations for each gate setting: one in the Van Wouw canal and one in the Stondansie canal (Figure 12).

Figure 12: Discharge measurement cross-sections for Nanni intake

As the velocity in the intake was too high, the location of the cross-section for intake HA was chosen approximately 100m downstream of the intake. Since IKUGH immediately diverges into a canal which goes both left and right, two locations for discharge measurement were selected. In Annex C the GPS-locations of the intakes, cross-sections and staff gauges are given for Nanni intake, intake HA and IKUGH, and in Annex D the depth profiles of the cross-sections for the discharge measurement locations are displayed.

As the recommended amount and division of velocity points in a vertical depend on the turbulence of the flow, an estimation of the Reynolds number was made. From a preliminary discharge measurement the velocity and water depth were measured and the kinematic viscosity of water was estimated to be $0.801 \cdot 10^{-6}$ m^2/s (Toolbox, 2013) by empirically derived figures for water at a temperature of 30°C. These approximations result in a Reynolds number far over the minimum required number for turbulence water, indicating that the water flow is turbulent. To double check the velocity-depth relation the velocity was also measured at all identified verticals at a fixed interval of 0.50m. The results can be found in Annex E.

After the cross-section location was determined, the distance between the verticals and the amount of measurements at a vertical had to be determined. This is mostly a trade-off between available time and reliability. As explained in the theory, more points in a vertical for measuring flow velocity leads to more reliable results in discharge measurement. However, execution time for the measurements was a limiting factor. This also depends on the amount of gate settings, the amount of cross-sections per gate setting, and the amount of verticals per cross-section.

Due to the limited time and as the standard deviation of mean error is only 0.1% lower for the three-point method than for the two-point method, the two-point method was selected to measure flow velocity within a vertical. For intake HA there was a smaller canal cross-section for measuring discharge, and hence there was more time to execute measurements during a field work day. It could be chosen to now measure with the three-point method, but instead a smaller interval of gate positioning was preferred since then discharges between different intakes would be more comparable. Apart from the shorter measurement time, the two-point method also has the advantage that the minimum required water depth is approximately 0.25m, whilst the three-point method a minimum water depth of 0.50m requires.

For canals with a cross-section larger than 6m the minimum recommended number of verticals is 12 (Table 4). However, a research day was limited in time due to the confined time of a working day, travel time to the field location, and the time when darkness sets in. Therefore, practically it would only be possible to space the verticals at an interval of 3m. As Table 5 showed, with the same number of verticals the equidistant spacing of verticals leads to more accurate results and hence equidistance was preferred over irregular spaced verticals.

When measuring the velocity with the Ott current meter the display shows the number of rotations made by the propeller. The Ott current meter is calibrated in order to derive the velocity from these rotations. For the particular type of Ott current meter used in this research, the calibration equations are given in Table 7.

Table 7: Calibration equations for velocity calculation with Ott current meter ((Scottech, 2013))

Equation nr#	Precondition	Equation
1	n (nr# of rotations)=< 0.90	v (m.s^{-1})= 0.2498*n+0.016
2	0.90=<n (nr# of rotations)=<9.57	v (m.s^{-1})= 0.2609*n+0.006

In order to be prepared for a discharge measurement day in the field, a whole set of equipment should be ready for take-off. See Annex F for the equipment list.

As the water flow in the irrigation canals was unsteady – not stable over time – it was important to have a fast flow of measurement. A standardized field form for intake calibration measurements was designed (Annex G) to facilitate this fast succession of measurements. The general information section contains a form with information on the location, date, gate position at arrival, weather conditions (wind power and direction, precipitation), pump activity, and head difference upstream and downstream of the intake. Profile information on canal vegetation and soil type, and information on the geometric proportions of the cross-section(s) and the (change in) water level per gate position, and a discharge measurement section containing a form where the depth from the bottom of the canal to the water level per vertical, as well as the measured rotations of the Ott current meter could be listed.

Before the discharge measurements could start, staff gauges had to be installed. Staff gauges were mounted at suitable locations both upstream and downstream of the intakes which were to be calibrated. The bars were custom tailored just for the facilitation of this research. They were installed as close as possible to the intakes and they were tuned to NSP. This stimulated easy comparison between the differences in water levels, which was required later on for the calculations. The water level should be under minimal influence of waves as a consequence of gate operation.

3.2.3 Measurement plan

The required frequency of discharge measurements for a calibration depends on a lot of different factors. More discharge measurements generally imply a higher reliability of the results. Important was that a range of differences in head upstream and downstream of the intake was covered and hence preferably the discharge measurements were executed on days with a difference in head difference. Therefore – before moving on to the discharge measurements – the head difference upstream and downstream of the intake were obtained by calling with the gate operator of the Ministry of OW (Shaamkumar Bissesar). With this information, it could be decided upon whether it was useful to measure the discharges, or – when this had already been done with a similar head difference – to pass it, and potentially go to another intake that day. The range of differences in head which preferably should be covered was not known in advance. For Nanni intake figures on the water level upstream of the intake – measured by the Thalimedes meter – were available for a number of years, and the water levels downstream were also manually recorded in notebooks. However, the reliability of the downstream water level data was questioned, as these figures turned out to be – occasionally – higher than the upstream water level. For intake HA and IKUGH there was no information on downstream water levels, and the upstream water level could only be derived from the same Thalimedes meter at Nanni intake, located 4,4km upstream of intake HA. Therefore, the best way to handle this insecurity was to just measure the head difference and decide upon a minimal required change in it in order to make a go/no go decision. As theoretically an intake calibration graph is very sensitive at small head differences (the discharge changes here relatively fast) the minimal difference was chosen to be 1cm at small differences, and going to a larger head difference this minimal required difference was increased to 5cm. Since this research was time and labour intensive, the facilitation of the research largely depended on the availability of budget for transport (both car and boat) and remuneration for labour. OW-MCP provided the availability for field work twice a week – Wednesdays and Fridays – during a time span of 2 months.

In order to determine an interval of gate openings at which discharges should be measured, the previously measured heights of the water level at the swamp side (the water will be higher on this side as compared to the Van Wouw canal side) – measured from the crest of the intake floor – were listed. The available time to measure velocities and the required time to measure these were key in this decision with time being the limiting factor. Next, red indication dots were visibly marked on the wall(s) of the intake in order to facilitate the ease of changing the gate positions once the discharge measurements had started. For Nanni intake the interval was determined to be 0.50m (Figure 13), for Intake HA it was set on 0.25m, and for IKUGH a suitable gate interval is yet to be determined.

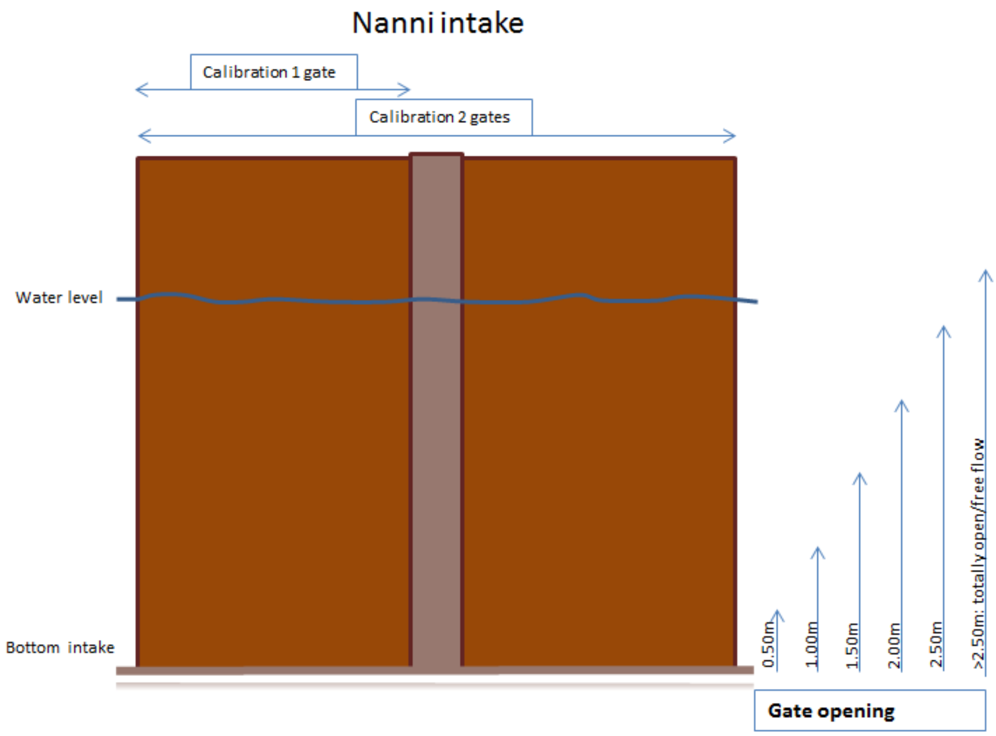

Figure 13: Gate positions for the calibration of Nanni intake

Of these three intakes intake HA is the only one with 1 gate, Nanni intake has 2 gates, and IKUGH even has 3 gates. The latter two could also be calibrated for 1 respectively 2 gate(s), leaving the remaining one(s) closed. To calibrate the intakes for multiple gates, the same methodology as for 1 gate was applied, though now opening the 2 or 3 gates at the same position.

After the gate setting was adjusted, the next discharge measurement started after approximately 5 minutes, to give the changed discharge through the intake time to arrive at the measurement cross-section and to let the water levels both upstream and downstream stabilize.

With the discharge measurements, the velocity was measured at every vertical at 20% and 80% of the water depth during 60 seconds. This time span was chosen to limit the influence of disturbances by inaccurate operation of the Ott current meter.

Before departure for a field work day, the logistics had to be arranged. A car, boat, boat trailer, and gasoline should be scheduled on the days at which manpower could also be provided. For the field work six people were convenient. There were different tasks to be divided: keeping boat in position, reading staff gauges, measuring velocities, calculating measurement depths. OW-MCP provided four men, and the remaining two were supplied by the Ministry of OW.

3.2.4 Discharge measurement

Before the measurements began, the general information section of the field form was completed. In the meantime, depending on the number of gates to be calibrated, the gate(s) were opened totally to create free flow conditions, and the other gate(s) were totally closed. The Ott current meter was assembled during this time as well. Then a rope was tied from the left to the right bank of the canal at the place where the cross-section location was determined. Next, the locations of the verticals were visualized at the rope by tying elastic bands. Thereafter the water depths at the verticals were measured in order to calculate the water depths were the velocity was going to be measured. When this had been done, the field workers took position. As the discharge measurement started, two persons – one at the upstream and one at the downstream staff gauge – listed the water level every 5 minutes. After the measurements in the Van Wouw canal were completed, the discharge in the Stondansie canal was measured. After the two measurements per gate setting had been done, the gate setting was changed to a smaller position at the closest of the 0.50m-interval. An example: water height from crest of the intake to the water level at the beginning was 2.86m. The discharges in the Van Wouw canal and Stondansie canal were measured. Following, the gate setting was changed to 2.50m, and again the discharges were measured. And so it went on with respectively the following gate settings: 2.00, 1.50, 1.00, and 0.50m (Figure 13). After the gate setting was adjusted, the water level could potentially change, and hence the measurement depths at 20% and 80% could change along. The new water levels were calculated by adding or subtracting the change in water level at the downstream staff gauge, from the water level measured at the beginning of the previous discharge measurement at that location.

3.2.5 Discharge calculation

The mid section method does not cover the entire cross-sectional area (see Chapter 3.1.2). However, as the velocities in the mean section method are calculated from an average the two adjacent verticals and as the 0-vertical and other side embankment vertical have no velocities – there is no water – these edge segments would be left out of the discharge calculation. To prevent this it was decided for this research to use an adjusted way to calculate the discharge with the mean section method: not the average velocity of two verticals would be used as input, but the velocity in only the right vertical instead. As it was not clear which method corresponded better to the real discharge, the discharges were calculated using both methods.

3.2.6 Calibration calculation

For the calibration the equations for non-modular discharge – both for totally open and partly opened gates – were used. Apart from the calculated discharges, the cross-sectional area under the gate(s) and the head difference of downstream and upstream water levels were calculated in order to calculate the discharge coefficient – C_d for totally opened gate(s) and C_d*C_v for partly opened gate(s) – for the calibration. In order to calculate the head difference for the calibration, the averages of both the upstream and downstream water levels were calculated and subtracted from each other. As the discharges through both the Van Wouw canal and the Stondansie canal were calculated, the head differences of both measurements were averaged in order to get the final head difference input for the calibration.

3.3 Results

Due to the limited time span of this research only a start was made in calibrating intake HA, and for IKUG a preliminary discharge measurement had been executed. These findings can be found in Annex H. The results of the calibration of intake Nanni are displayed in this Chapter.

3.3.1 Discharge calculation

Nanni intake has been calibrated for 1 and 2 gates. With Microsoft Excel the measured rotations were calculated to velocities and then to discharges. An example of one discharge calculation is shown in Table 8. The corresponding water levels during these discharge measurements are displayed in Table 9.

Table 8: Example of discharge calculation from velocity measurements (Van Wouw canal 16-02-2012)

Gate totally open	2.65m	n= rotations of current meter								q= partial discharge (per segment)		
		0.2d				0.8d				Mean section		
Verticals (m)	depth d (m)	0.2d (m)	n/min	n/sec	v (m/s)	0.8d (m)	n/min	n/sec	v (m/s)	v-average (m/s)	width b (m)	q (m^3/s)
0.00	0.00	0.00	-	-	-	0.00	-	-	-			
3.00	2.30	0.46	19	0.32	0.10	1.84	19	0.32	0.10	0.10	3.00	0.22
6.00	2.23	0.45	13	0.22	0.07	1.78	28	0.47	0.13	0.10	3.00	0.69
9.00	2.62	0.52	17	0.28	0.09	2.10	23	0.38	0.11	0.10	3.00	0.72
12.00	2.62	0.52	12	0.20	0.07	2.10	24	0.40	0.12	0.09	3.00	0.71
15.00	2.28	0.46	28	0.47	0.13	1.82	37	0.62	0.17	0.15	3.00	1.11
18.00	2.20	0.44	22	0.37	0.11	1.76	41	0.68	0.19	0.15	3.00	0.99
21.00	2.06	0.41	36	0.60	0.17	1.65	38	0.63	0.17	0.17	3.00	1.09
24.00	1.41	0.28	33	0.55	0.15	1.13	34	0.57	0.16	0.16	3.00	0.81
27.00	0.87	0.17	14	0.23	0.07	0.70	18	0.30	0.09	0.08	3.00	0.19
30.00	0.00	0.00	-	-	-	0.00	-	-	-	-	-	-
											Q (m^3/s)	6.53

Table 9: Water levels in Van Wouw canal and Stondansie canal during discharge measurement on 16-02-2012 with gates totally open

Van Wouw canal		Upstream	Downstream
Time (h.min)	(min)	Water level (m+NSP)	Water level (m+NSP)
start:10.17u	0	2.13	1.99
	5	2.13	1.99
	10	2.13	1.99
	15	2.13	1.99
	20	2.13	1.99
	25	2.13	1.99
	30	2.13	1.99
end: 10.52u	35	2.13	1.99
	AVERAGE	2.13	1.99
Stondansie canal			
Time (h.min)	(min)	Water level (m+NSP)	Water level (m+NSP)
start: 10.58u	0	2.13	1.99
	5	2.13	1.99
	10	2.13	1.99
	15	2.13	1.99
end: 11.19u	20	2.13	1.99
	AVERAGE	2.13	1.99

As Nanni intake directly discharges into both the Van Wouw canal and the Stondansie canal, their discharges were summed to get the total discharge through the gate(s). Figure 14 and Figure 15 show the discharges as calculated with the mid section method through respectively 1 and 2 gate(s). Annex I shows the mean and mid section method calculated discharges in tables. Figure 16 shows the differences in discharges which were calculated by the mid section method and discharges which were calculated by the mean section method.

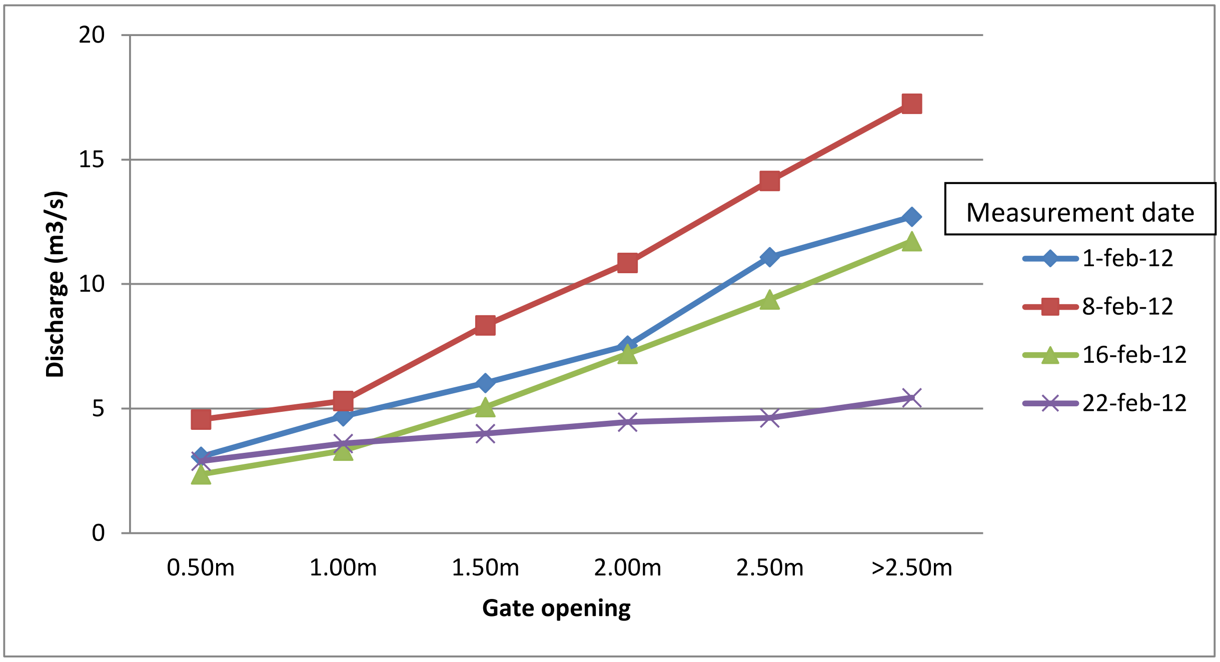

Figure 14: Measured discharges (mid section method) through 1 gate of the Nanni intake

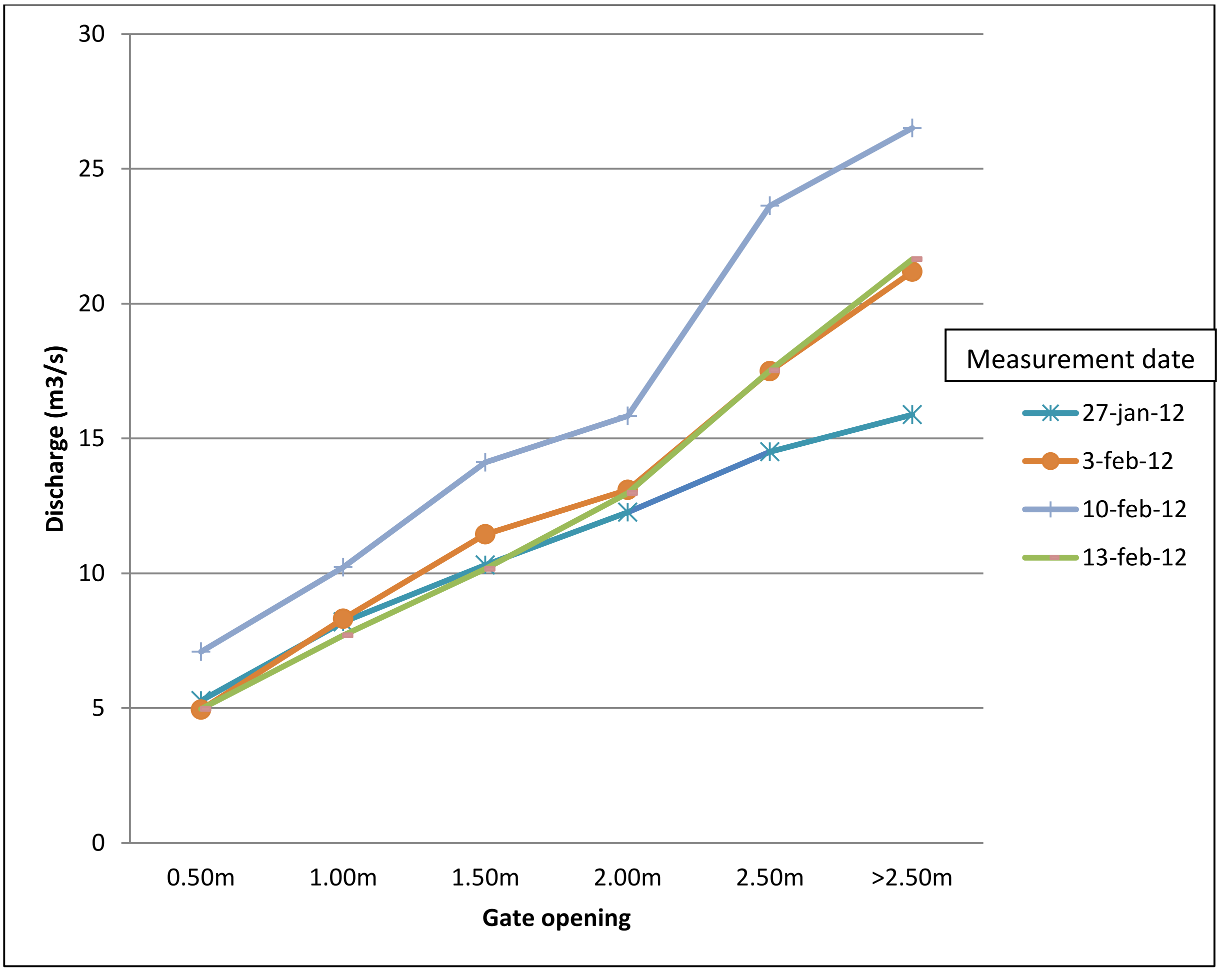

Figure 15: Measured discharges (mid section method) through 2 gates of the Nanni intake

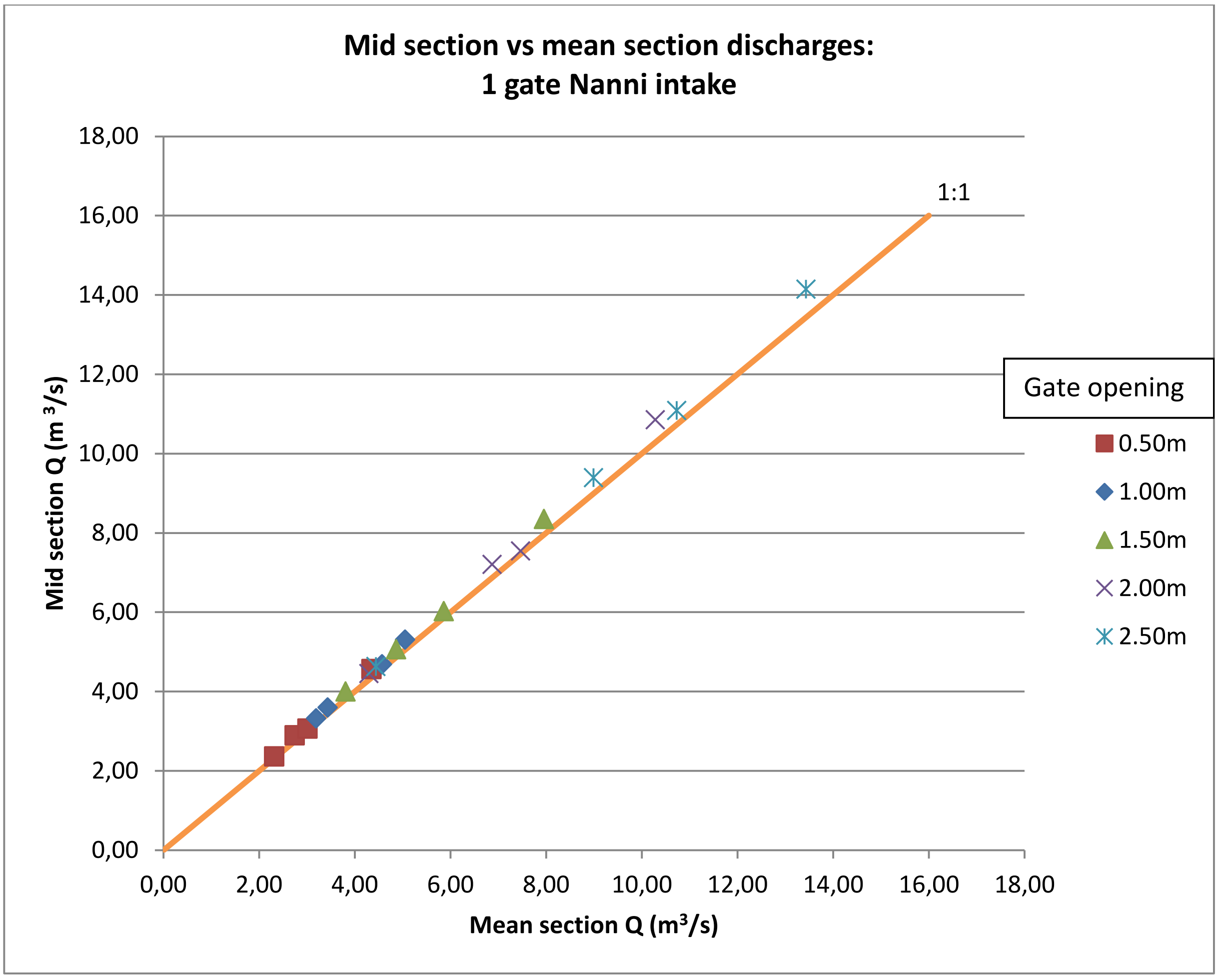

Figure 16: Discharges through 1 gate of Nanni intake as calculated by the mid section method and the mean section method

This graph is a display for the discharge through 1 gate. The graph for the discharge through 2 gates looks similar, be it with larger discharges along the axes (Annex J).

The Nash Sutcliffe efficiency coefficient is a measure for how close the calculated discharges lie to the 1:1 line of the mid section discharge and the mean section discharge.

$$N = 1 - \frac{\sum(x - y)^2}{\sum(x - \bar{x})^2}$$

The x-value being the mean section discharge and the y-value representing the mid section discharge. In this equation the x-value seems to be the true value, whilst that is not what is aimed for. Hence, the Nash Sutcliffe coefficient is also calculated by replacing the x and y-values in the equation above. The average of these coefficients represent the measure of proximity to the 1:1 line for the mid section discharge and the mean section discharge. The closer this value is to 1, the closer it is to the 1:1 line. The Nash Sutcliffe coefficients are displayed in Figure 17.

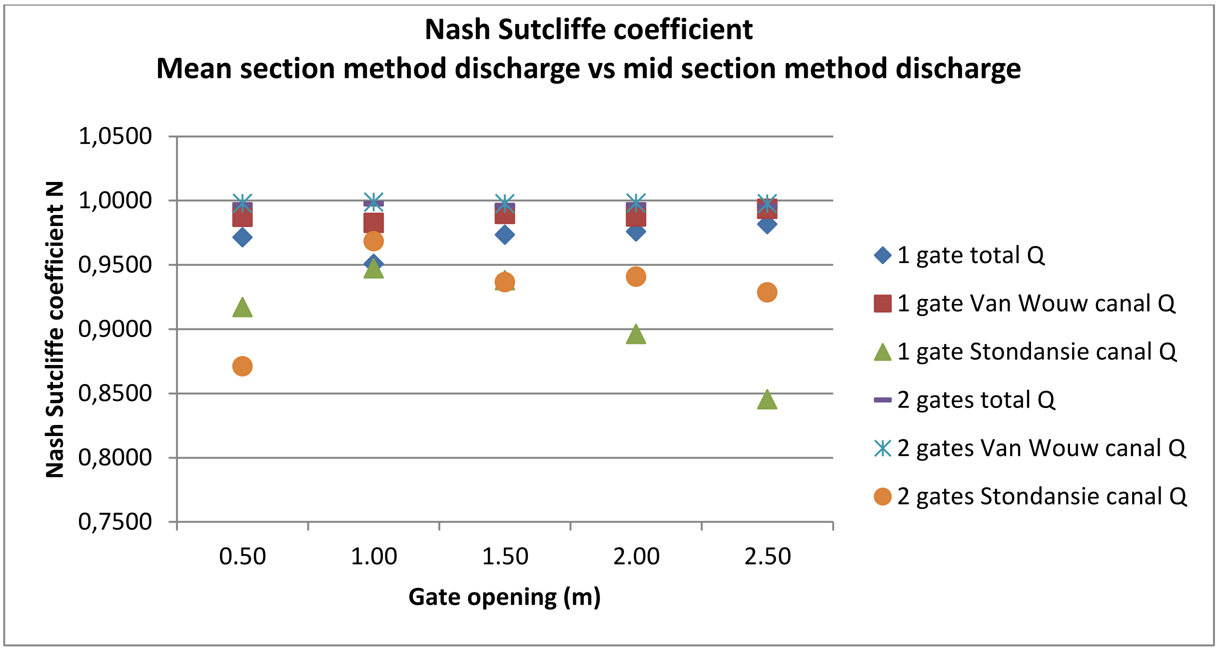

Figure 17: Nash Sutcliffe coefficients (mean and mid section method discharges) for the discharge through the Van Wouw canal and the Stondansie canal with respectively 1 and 2 open gate(s) of Nanni intake

It appears that the Nash Sutcliffe coefficients are very high for the total discharge through the Van Wouw canal and the Stondansie canal and for the discharge through only the Van Wouw canal as well. For these discharges – though now only through 1 gate – the coefficients are still rather high. The discharges through only the Stondansie canal – through either 1 or 2 gates – show considerably lower Nash Sutcliffe coefficients. An overview of the separate values is given in Annex K.

An explanation of the considerably lower Nash Sutcliffe coefficients can be found in the difference in the way the discharge is calculated by the mean section method and the mid section method (Chapter 3.1.2). As the total discharge exists of both the discharge through the Van Wouw canal and the discharge through the Stondansie canal and as these canals had different cross-sections (Figure 18) it was interesting to compare the segmental areas as how they were calculated by the mid section method and the mean section method (Table 10).

Figure 18: Cross-sectional depth profiles of Van Wouw canal and Stondansie canal near Nanni intake. 16-02-2012: Downstream water level= 1.99m+NSP

Table 10: Cross-sectional area of Van Wouw canal and Stondansie canal as calculated by the mid section method and the mean section method

SEGMENTAL AREA (m^2)						
	Van Wouw canal			Stondansie canal		
Vertical (m)	Mid	Mean	Difference(mid-mean)	Mid	Mean	Difference(mid-mean)
3.00	3.75	1.88	1.88	2.70	1.35	1.35
6.00	6.69	5.22	1.47	3.60	3.15	0.45
9.00	7.86	7.28	0.59	4.50	4.05	0.45
12.00	7.86	7.86	0.00	4.74	4.62	0.12
15.00	6.84	7.35	-0.51	5.88	5.31	0.57
18.00	6.60	6.72	-0.12	5.76	5.82	-0.06
21.00	6.18	6.39	-0.21			
24.00	4.23	5.21	-0.98			
27.00	2.61	3.42	-0.81			
SUM	52.62	51.32	1.31	27.18	24.30	2.88
Percentage (%) of average total mid and mean area						
			2.5			11.2

The largest difference occurs where the slope of the canal bed in cross-section was largest. Due to its irregular shaped cross-section the difference was higher in the Stondansie canal. For the first vertical – at 3m – the area calculated by the mean section method was twice as small as the mid section method. This difference would be cancelled when the area of the most right section would be added to the total area. Due to the absence of velocity data here this was not possible, and therefore the slope of the most right section determined the difference in area between the mid and mean section method. A higher slope would make the difference between the mid and mean sectional area bigger, with the mid section method area being the largest. With respect to this the mid area method seemed more reliable, as the coverage of area came closer to the true area, and as the velocities used in the calculated were the velocities as measured in the middle of the panel, not at the right side as was applied for the mean section method.

3.3.2 Calibration Nanni intake

Interviews have been conducted with the people who had knowledge and experience about the field situation of the Nickerie rice irrigation scheme, as well as with persons who were involved in previous calibrations of Nanni intake. A person who had contributed to the intake calibration of Nanni intake by the Hydraulic Research Division is R.A.L. Kselik. Furthermore, field workers like Puran and Surajbali had experience in previous calibrations of the specific intakes and in measuring their geometry. Professor Naipal – chair of the Climate Change and Water Resource Management group from the Anton de Kom University of Suriname – has a lot of theoretical background and practical experience in research related to both water quality and water quantity, amongst others located in Nickerie as well. All these persons were contacted and they have provided useful information for this research.

For the calibration of Nanni intake the calculated discharges were used to calculate the C_d-values. The C_v-value was equal to 1 (Chapter 3.2.1). The water levels and their differences were also required input. The measured water levels during the velocity measurements can be found in Annex L. The calibration graph for 1 gate is displayed in Figure 19 and the calibration graph for 2 gates is displayed in Figure 20. This graph mentions the R^2-values which belong to the trend lines drawn through the discharges measured at different days – and hence different heads – through the same gate setting. What is obvious from the calibration for 1 gate of the

Nanni intake is that the trend line has a better fit with increasing gate opening. For the calibration for 2 gates of the Nanni intake this effect is nearly inversed. The range of head differences covered by the calibration for these 2 gates – 0.11-0.34m – is much smaller than the head difference covered by the calibration of 1 gate: 0.04-0.48m. In Figure 19 the lowest measured discharges for gate openings of 0.50m and 1.00m deviate most from the trend lines. Therefore the R^2-values were also calculated without all the lowest measured discharges (Table 11).

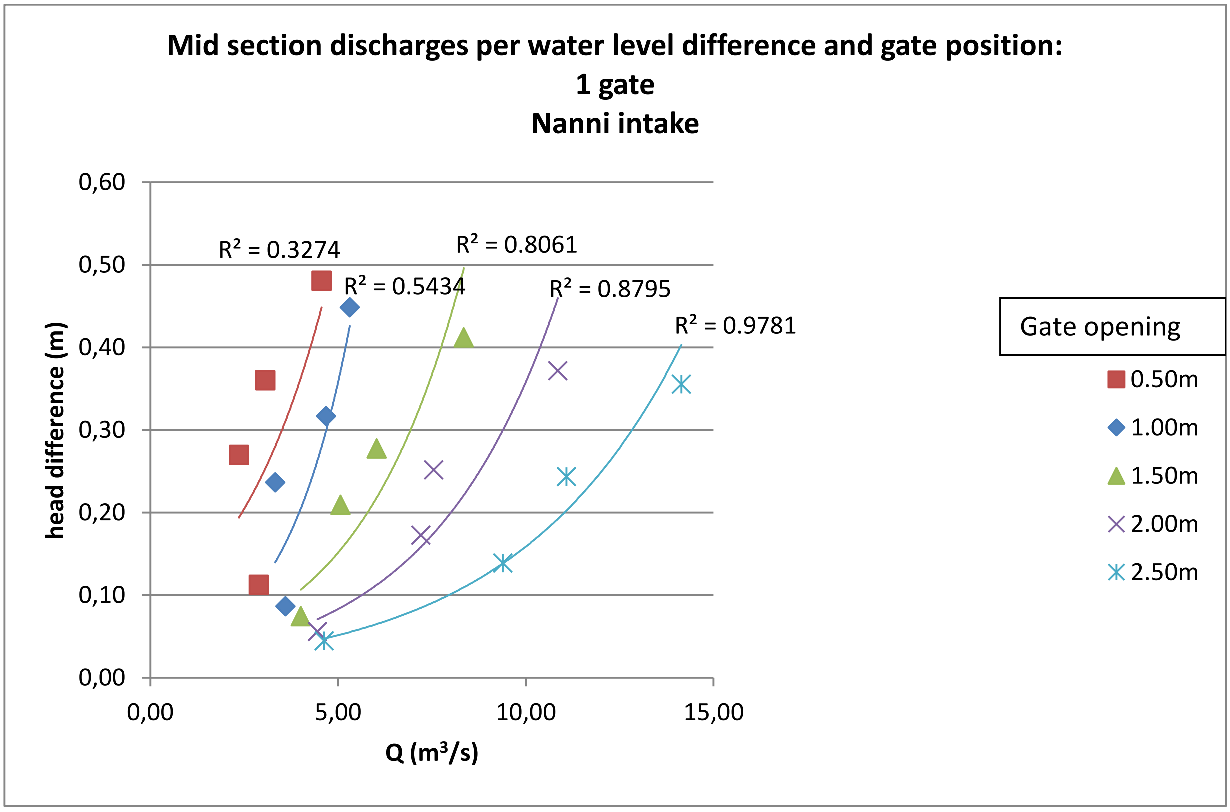

Figure 19: Measured discharges (mid section method) through 1 gate, per head difference and gate position

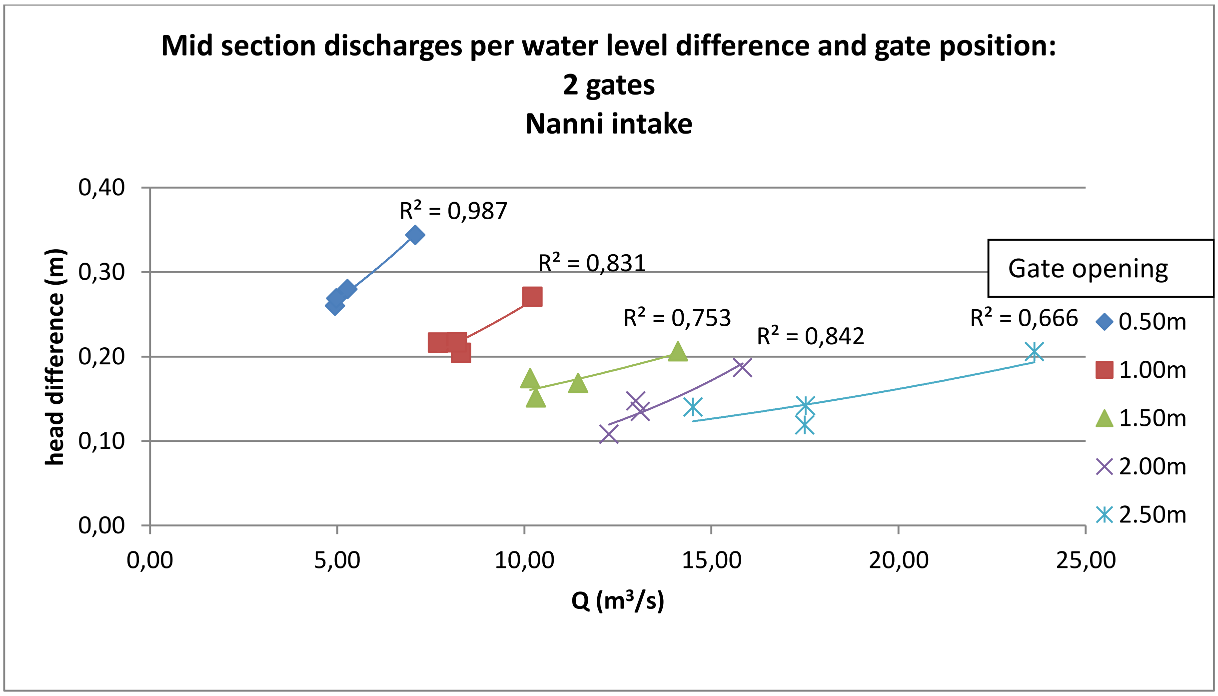

Figure 20: Measured discharges (mid section method) through 2 gates, per head difference and gate position

Table 11: Mid section method R^2-values of all discharges and of the discharges excluding the lowest measured discharge

	R^2-values			
	1 gate		2 gates	
Gate opening:	All discharges	Discharges excluding lowest discharge	All discharges	Discharges excluding lowest discharge
0.50m	0.327	0.960	0.987	1.000
1.00m	0.543	0.932	0.831	0.968
1.50m	0.806	0.981	0.753	0.787
2.00m	0.880	0.827	0.842	0.911
2.50m	0.978	0.925	0.666	0.905

For 1 gate Table 11 shows that the R^2-values are significantly higher when the lowest discharges are excluded for gate openings of 0.50m, 1.00m, and also for 1.50m. For 2.00m and 2.50m the R^2-values decrease when the lowest discharges are excluded. For 2 gates the 1.00m and 2.50m gate opening R^2-values have the highest – in comparison to the other gate openings – increase when the lowest measured discharges are excluded. Generally what can be concluded is that the calibration for 1 gate is good, with exception of small gate openings up to 1.50m with little head differences (up to approximately 0.10m). For 2 gates the differences in R^2-values are less significant and there is no causal relation in reliability of the Q-h curves and the gate openings and head differences.

Hypothetically, with the same head difference between upstream and downstream water level and the same gate opening the discharge through 2 gates should approximately double the discharge through 1 gate. To compare this, the equations of the trend lines displayed in the graphs above were used to estimate the discharges through both 1 and 2 gates at certain head differences. In order to keep extrapolation of the trend lines limited, the range of the head difference was chosen to cover 0.10-0.35m. Table 12 shows the discharges which were derived in this way, and the ratios of the discharge through 2 gates divided by the discharge through 1 gate are displayed as well.

Table 12: Trend line discharges through 1 and 2 gates on Nanni intake and the ratio of the discharge through 2 gates and through 1 gate, per gate opening and per head difference (water level difference)

Water level difference (m)	Q 2 gates	Q 1 gate	Q 2gates/Q 1gate
Gate opening: 0.50m	$y = 0.1452e^{0.1219x}$	$y = 0.079e^{0.3805x}$	
0.10	-3.06	0.62	-4.94
0.15	0.27	1.69	0.16
0.20	2.63	2.44	1.08
0.25	4.46	3.03	1.47
0.30	5.95	3.51	1.70
		Average:	**-0.11**
Gate opening: 1.00m	$y = 0.0937e^{0.1022x}$	$y = 0.0216e^{0.5612x}$	
0.10	0.64	2.73	0.23
0.15	4.60	3.45	1.33
0.20	7.42	3.97	1.87
0.25	9.60	4.36	2.20
0.30	11.39	4.69	2.43
		Average:	**1.61**
Gate opening: 1.50m	$y = 0.0869e^{0.0604x}$	$y = 0.0258e^{0.3539x}$	
0.10	2.32	3.83	0.61
0.15	9.04	4.97	1.82
0.20	13.80	5.79	2.38
0.25	17.50	6.42	2.73
0.30	20.51	6.93	2.96
		Average:	**2.10**
Gate opening: 2.00m	$y = 0.0236e^{0.1324x}$	$y = 0.0193e^{0.2919x}$	
0.10	10.91	5.64	1.94
0.15	13.97	7.02	1.99
0.20	16.14	8.01	2.02
0.25	17.83	8.77	2.03
0.30	19.20	9.40	2.04
		Average:	**2.00**
Gate opening: 2.50m	$y = 0.0604e^{0.0492x}$	$y = 0.0168e^{0.2248x}$	
0.10	10.25	7.94	1.29
0.15	18.49	9.74	1.90
0.20	24.34	11.02	2.21
0.25	28.87	12.01	2.40
0.30	32.58	12.82	2.54
		Average:	**2.07**

The ratios of the discharge through 2 gates and the discharge through 1 gate vary rather a lot. They increase with an increasing head difference. For the gate openings of in particular 0.50m and 1.00m the discharges through 2 gates appear much higher in proportion to the discharges through 1 gate. With an average ratio of 2.10, 2.00, and 2.07 the gate openings of respectively 1.50m, 2.00m, and 2.50m are closer to the theoretical relation of a ratio of 2. As the ratio of the discharges through 2 gates and the discharges through 1 gate vary considerably the C_d-values vary as well. The results of the calculated C_d-values for the mid section method and the mean section method are displayed in respectively Table 13 and Table 14. As the C_d-values theoretically should approximately be the same, it was assumed that the C_d-values are normally distributed. Therefore the average values and the standard deviations are displayed in the tables as well. A more elaborated overview of the calibration can be found in Annex K. As the essential purpose of this calibration is the provision of a graph which is simple and easy to understand so that it is feasible for employers OW-MCP and other parties involved in the irrigation water management in Nickerie, a theoretical discharge graph was developed. For this theoretical head-discharge relation the C_d-values were averaged. Table 13 and Table 14 show the average C_d-values per measurement day and per gate position. The theoretical discharge graphs (Figure 21 and Figure 22) were derived with the C_d-values as calculated with the mid section method. With these average C_d-values the results from the measurements were extrapolated to a larger range of head difference in order to predict its corresponding discharges per gate position.

Table 13: C_d-values (mid section method) of Nanni intake per date, gate position, and amount of opened gates

Mid section method												
Cd-valeus	1 gate						2 gates					
Gate position (m)	1-feb-12	8-feb-12	16-feb-12	22-feb-12	Average Cd	StDev	27-jan-12	3-feb-12	10-feb-12	13-feb-12	Average Cd	StDev
0.50m	0.77	0.99	0.68	1.30	0.94	0.27	0.75	0.73	0.91	0.72	0.78	0.09
1.00m	0.63	0.60	0.51	0.92	0.66	0.18	0.66	0.69	0.74	0.62	0.68	0.05
1.50m	0.57	0.65	0.56	0.74	0.63	0.08	0.66	0.70	0.78	0.61	0.69	0.07
2.00m	0.57	0.67	0.65	0.71	0.65	0.06	0.70	0.67	0.69	0.64	0.67	0.03
2.50m	0.68	0.71	0.76	0.66	0.70	0.04	0.58	0.76	0.78	0.70	0.71	0.09
>2.50m	0.67	0.75	0.90	0.71	0.76	0.10	0.82	0.74	0.69	0.70	0.74	0.06
Average	*0.65*	*0.73*	*0.68*	*0.84*	**0.72**	**0.12**	*0.70*	*0.71*	*0.77*	*0.66*	**0.71**	**0.06**
StDev	0.08	0.14	0.14	0.24	**0.11**		0.08	0.03	0.08	0.05	**0.04**	

Table 14: C_d-values (mean section method) of Nanni intake per date, gate position, and amount of opened gates

Mean section method												
Cd-valeus	1 gate						2 gates					
Gate position (m)	1-feb-12	8-feb-12	16-feb-12	22-feb-12	Average Cd	StDev	27-jan-12	3-feb-12	10-feb-12	13-feb-12	Average Cd	StDev
0.50m	0.75	0.94	0.67	1.23	0.90	0.25	0.73	0.72	0.85	0.69	0.75	0.07
1.00m	0.61	0.57	0.49	0.88	0.64	0.17	0.64	0.68	0.70	0.59	0.65	0.05
1.50m	0.56	0.62	0.53	0.70	0.60	0.07	0.65	0.67	0.73	0.57	0.66	0.07
2.00m	0.56	0.63	0.62	0.68	0.63	0.05	0.67	0.66	0.65	0.59	0.64	0.03
2.50m	0.65	0.68	0.73	0.63	0.67	0.04	0.55	0.74	0.73	0.66	0.67	0.09
>2.50m	0.67	0.72	0.83	0.67	0.73	0.08	0.78	0.75	0.68	0.69	0.73	0.05
Average	*0.64*	*0.70*	*0.65*	*0.80*	**0.69**	**0.11**	*0.67*	*0.70*	*0.72*	*0.63*	**0.68**	**0.06**
StDev	0.08	0.13	0.13	0.23	**0.11**		0.08	0.04	0.07	0.05	**0.04**	

The trend is that the standard deviation decreases over an increased gate opening, with the exception of a gate opening of 2.50m and gates which are totally open (>2.50m). Here the standard deviation slightly increases in comparison to a gate opening of 2.00m. This shows that the results of the discharge through a larger gate opening (at least up to 2.00m) are predictable with a higher accuracy than the discharge through smaller gate openings. This hypothetically indicates that the discharge measurement with an Ott current meter is more accurate with these higher discharges, as also appears from the smaller standard deviations with 2 gates as compared to the standard deviations of 1 gate. Note that this only is not true for a gate opening of 2.50m and higher. Also, in the gross part of the results the standard deviations for the mean section method are 0.1 below the standard deviations of the mid section method. The standard deviations for 2 gates are the same for the mid and mean section method and thus independent of the gate opening, with exception of a gate opening of 0.50m and >2.50m.

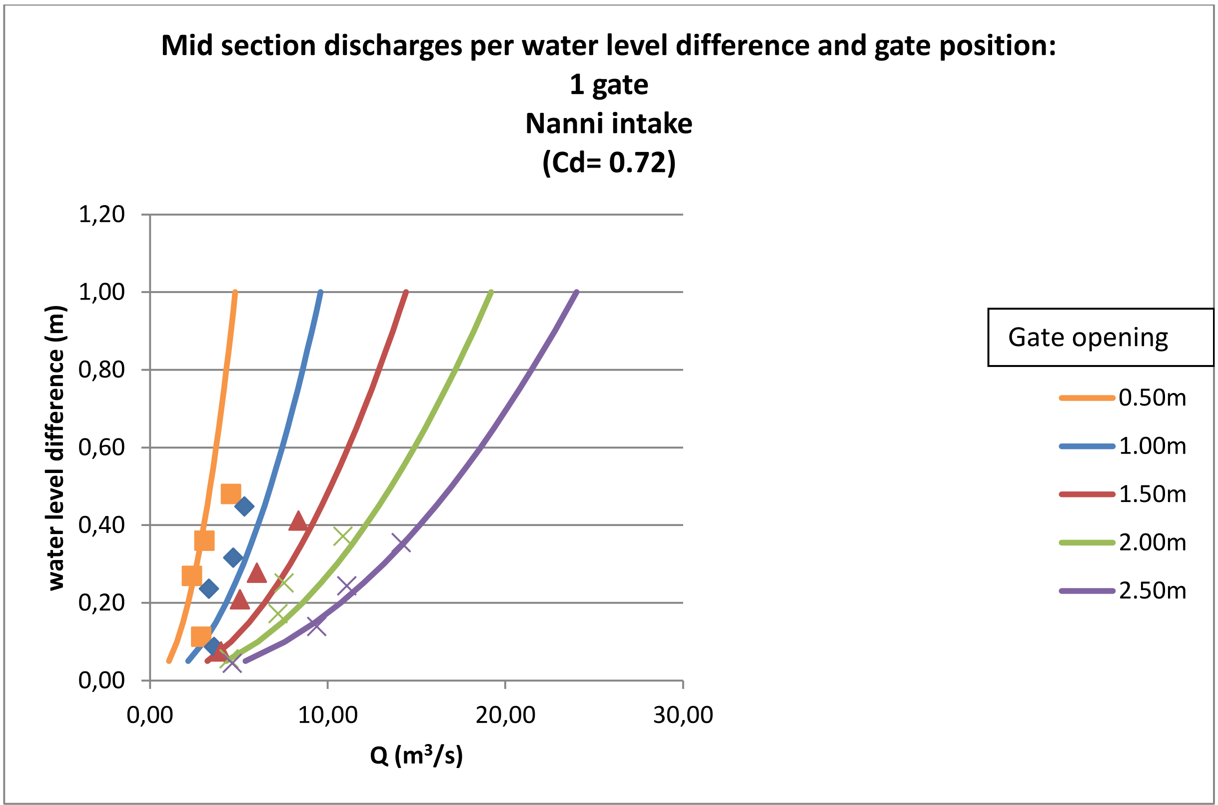

Figure 21: Theoretical calibration (mid section method) Nanni intake, 1 gate

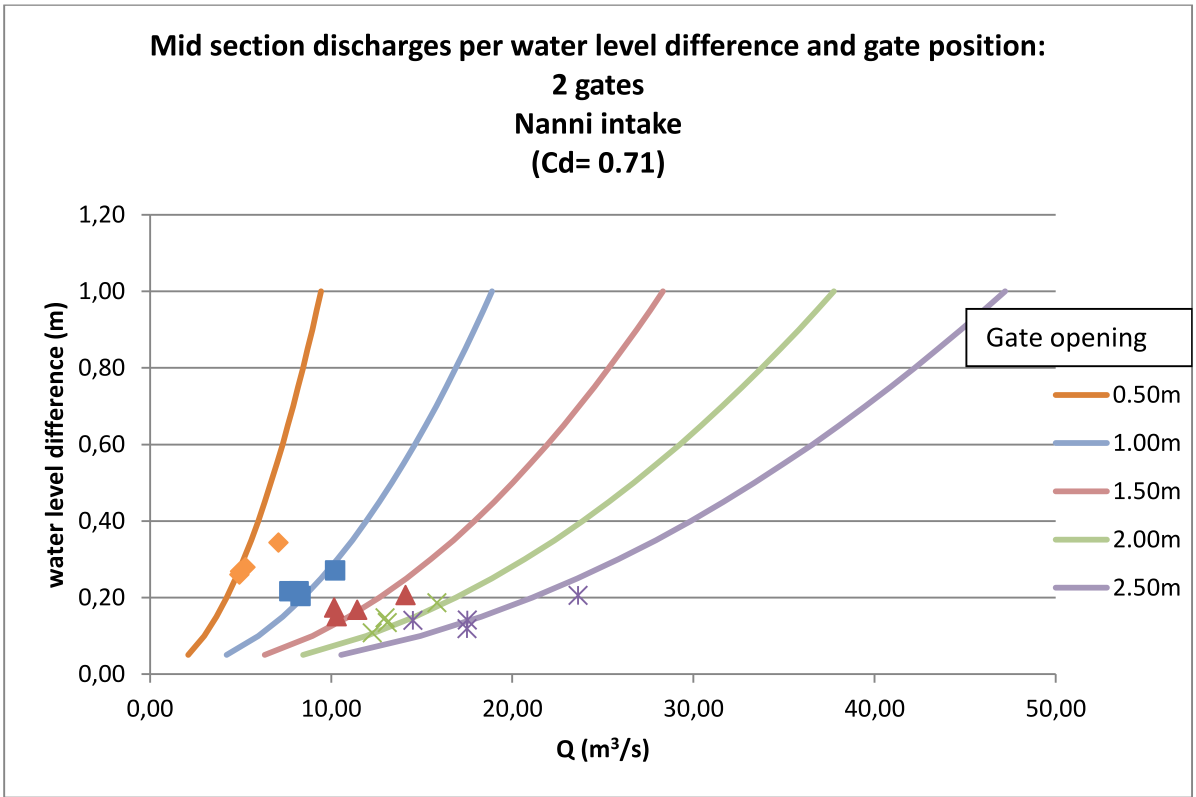

Figure 22: Theoretical calibration (mid section method) Nanni intake, 2 gates

These graphs show the measured discharges as well. Although the theoretical discharge lines seem to fit pretty well, they do not cross all these points. In Figure 23 and Figure 24 the theoretical discharges and the measured discharges are graphed against each other.

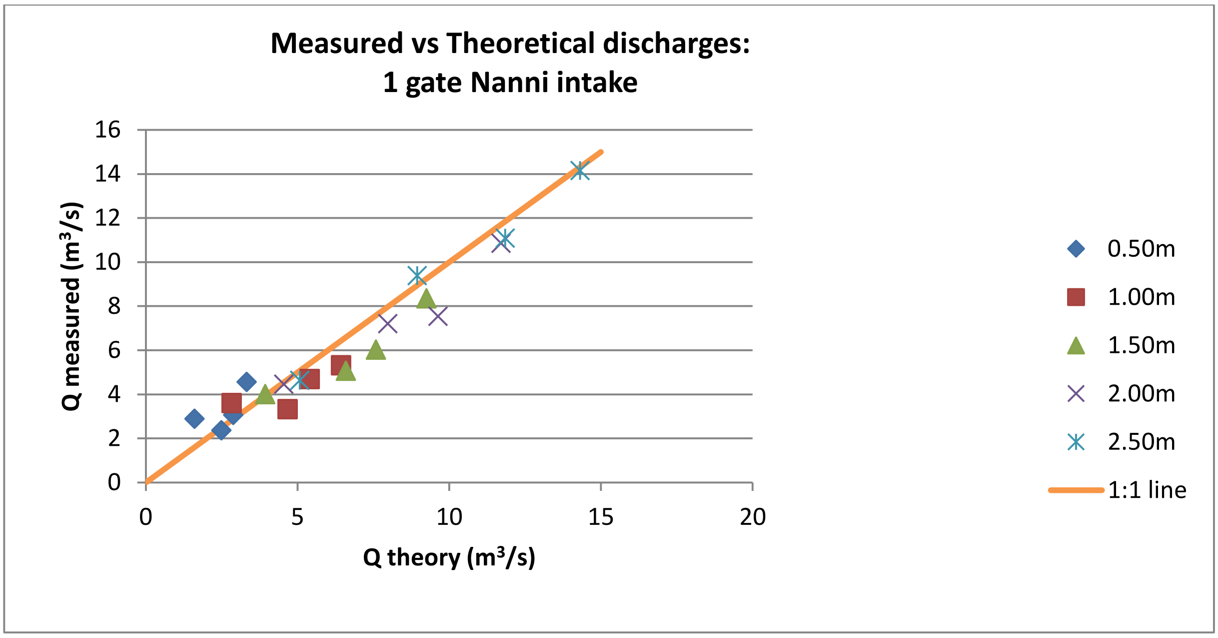

Figure 23: Measured and theoretical mid section discharges (for the same head difference) through 1 gate of Nanni intake

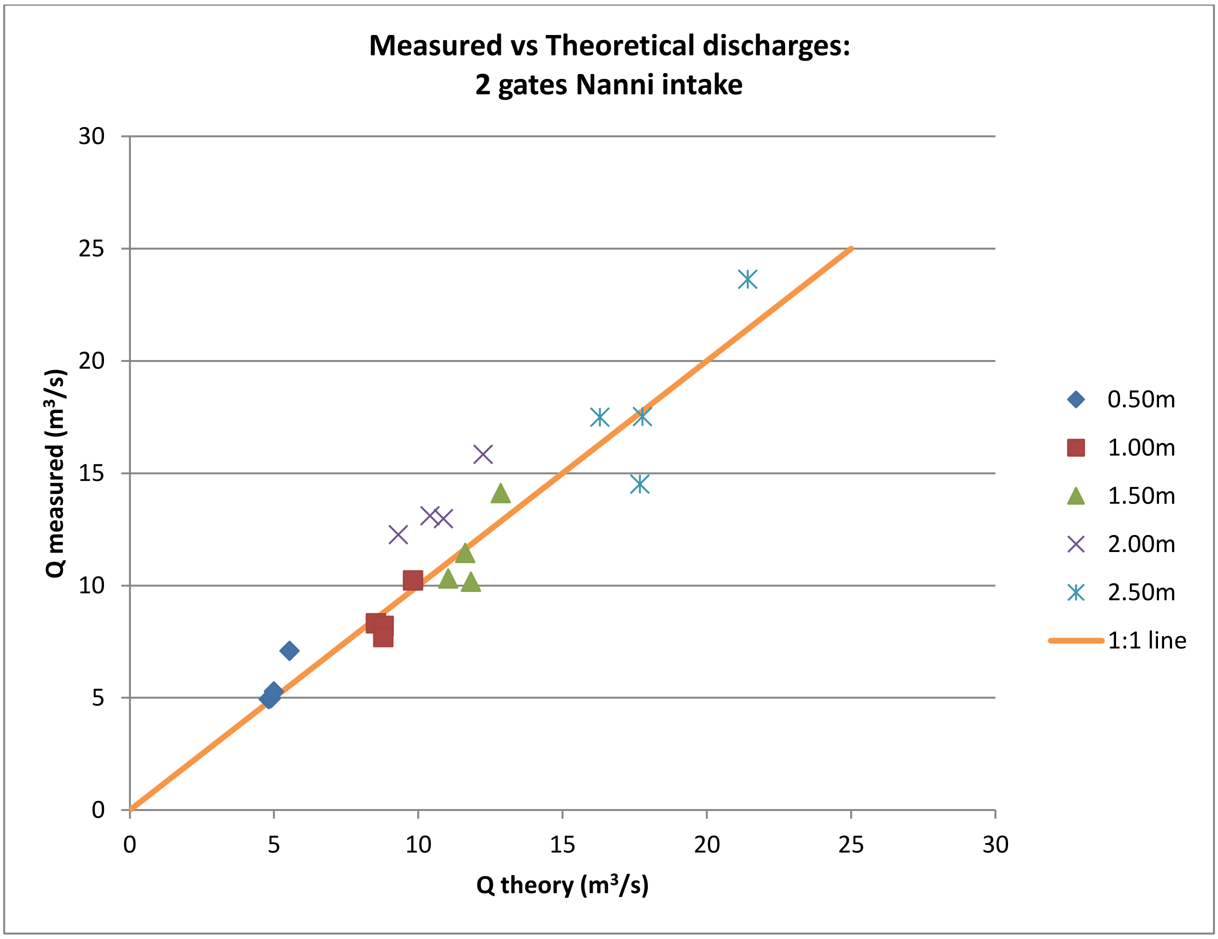

Figure 24: Measured and theoretical mid section discharges (for the same head difference) through 2 gates of Nanni intake

Both graphs show that – apart from the discharge through 0.50m gate opening for both 1 and 2 gates of Nanni intake – the theoretical discharges in general are higher than the measured discharges. Table 13 and Table 14 show that the C_d-values of the measured discharges are also are considerably higher than the average C_d-values which were used for the calculation of the theoretical discharges.

A measure of the degree to which the theoretical discharges and the measured discharges match with each other is again expressed in the Nash Sutcliffe coefficient (Figure 25). Unlike the calculation of the Nash Sutcliffe coefficient for the mean and mid section discharges, for the calculation of the Nash Sutcliffe coefficients of the measured and theoretical discharges the were not averaged, but the x-values (see Nash Sutcliffe equation) were the input for the measured discharges, and the y-values were put in as the theoretical discharges. In this way the Nash Sutcliffe coefficient is a measure to how well the measured discharges correspond with the theoretical discharges.

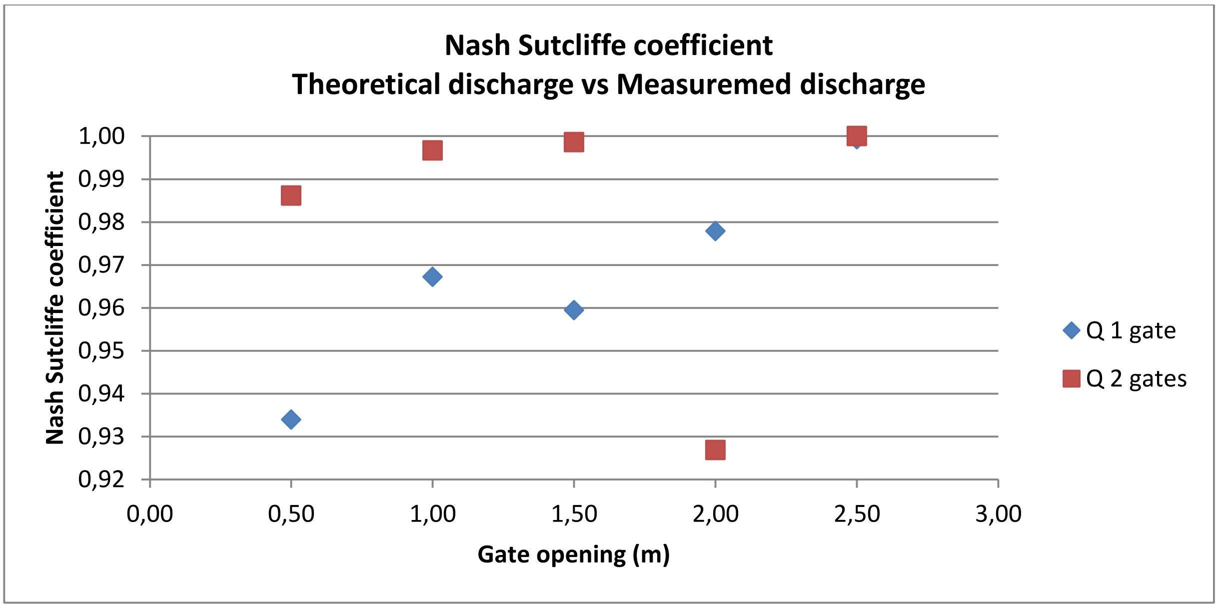

Figure 25: Nash Sutcliffe coefficients (measured and theoretical mid section discharges) for the discharges through 1 and 2 gate(s) of Nanni intake

The general trend in the Nash Sutcliffe coefficients here is that they increase with increasing gate opening. Hence, with a larger gate opening for both 1 and 2 gates of Nanni intake the discharges which can be read from Figure 21 and Figure 22 correspond better with the discharges as they were measured during this research. Furthermore, it is obvious that the theoretical discharge through 2 gates also corresponds better with the measured discharges as compared to the discharges through 1 gate. From the above it appears that with higher discharges the theoretical and the measured discharges converge to a higher degree as compared to smaller dischargers.

OW-MCP can use the following equations to calculate the discharges through respectively 1 and 2 gates of Nanni intake:

$$\boldsymbol{Q1gate} = 0.72 * 3 * gate\ opening * \sqrt{(}2 * 9.81(waterlevelupstream(m + NSP) - waterleveldownstream(m + NSP)))$$

$$\boldsymbol{Q2gates} = 0.71 * 6 * gate\ opening * \sqrt{(}2 * 9.81(waterlevelupstream(m + NSP) - waterleveldownstream(m + NSP)))$$

3.4 Discussion

The reliability of the results which were provided above is subject to ranges of inaccuracy which potentially could have occurred in several parts of the research: velocity measurement, discharge calculation, intake calibration. As these ranges of inaccuracies are multiplied with each other, the final range of insecurity is therefore relatively largest in the intake calibration, being the last step in the calculation process.

3.4.1 Discharge calculation

Location cross-sections

Because the discharge measurement cross-sections were located at a relative large distance from Nanni intake there is an increased possibility of a wrong picture of the discharge through the intake, since seepage losses could occur over a larger distance.

In the Stondansie canal the locations of the embankments – and therefore the borders of the cross-section – were difficult to determine as grass mats were connected to the embankments of the Stondansie canal. These grass mats were very firm and hence it was assumed that they would represent the embankment of the canal. However, it was not proven that no water could flow beneath it. This means that potentially there was a larger discharge than the ones which were measured. However – as due to 'embankment' friction the flow velocity could only be low – it was assumed that this would not contribute to the total discharge to a large extend.

Amount of verticals

The amount of verticals influences the degree to which the calculated area approaches the real area of the cross-section and the degree in which the measured velocity corresponds to the actual flow velocity. The recommended distance to place verticals is 0.5m in order to have a good cover of velocity distribution points and a measured cross-section area closer to the real cross-sectional area. Hence, a distance of 3m – as used in this research – will increase the range of potential inaccuracy and therefore it decreases the reliability of the results. Table 5 showed that for 6 verticals the relative standard deviation of error for 6 verticals (Stondansie) approximates 3.70, while for 10 verticals (Van Wouw canal had 9 verticals) this was 2.60%.

Velocity measurement points

The two-point method – applied in this research – has a 4.9% standard deviation of the mean error (Table 3). To investigate whether the prerequisite parabolic velocity-depth relation for the two-point method was present in the Van Wouw canal and Stondansie canal the velocities were measured in all the verticals at an interval of 0.50m. The results (Annex E) do not clearly show a parabolic trend for the Van Wouw canal and due to the limited water depth in the Stondansie canal there were only three measurement points per vertical, which did not show a clear trend at all. Also the verticals near the embankment had few measurement points due to the shallow water depth. More research should be done in order to investigate the velocity-depth relation and be able to draw significant conclusions.

In literature it is recommended to apply the one-point method in verticals were the water level is below 2.5ft (76cm) which occurred at the verticals that were closer to the embankments. In fact, some of the calculated

20% depth measurement points were determined to be positioned lower than 10cm while the lowest point for the current meter was 10cm, and hence the velocity was measured at 10cm from the canal bed here. In the discharge calculation these measured velocities were handled as being the 20% depth velocities. As the one-point methodology was not applied in this research, it could influence the measured velocity and – decrease the – reliability of the calculated discharges.

Depth measurement

In order to calculate the area of the segments, the depth was required as well. This was also susceptible to change, as the soil type of the canal bed partly existed of peat ('pegasse' in local language) through which the Ott current meter rod sometimes penetrated, and as the canal bed assumingly was wavy. By repetition of the depth measurement immediately after a first depth measurement, the difference could easily reach up to 5cm. This is especially true for the Stondansie canal, as the peat was more present here as in comparison to the Van Wouw canal, where the soil existed out of more clay. This off course has not only effect on the area per segment, but on the distribution of the velocity measurement points – defined by taking 20% and 80% of the depth of the verticals – as well. Due to time limits, the depth was measured during the first discharge measurement only. The new 20% and 80% measurement depths were specified by reading the downstream water level difference from one discharge measurement to the following. During the velocity measurements at the first field work day, the changing downstream water level was not taken into account. As the water level did not fluctuate much, it was assumed that the fixed measurement points during this first field work day only had minor influence on the total discharges through the cross-sections.

The execution of the velocity measurements themselves was also susceptible to inaccuracies. An important factor here was the limited time during a field work day. From one measurement point to the next the Ott current meter had to be changed in position quickly. A consequence was that the accuracy of Ott current meter positioning was estimated to be 1cm.

Discharge calculation: mid and mean section method

Literature is not clear on which method best suits the calculation from velocity to discharge. The results of this research show that the mid section method discharges are slightly higher than the mean section method discharges. Hypothetically, the discharges calculated by the mid section method correspond better to the actual discharge (see explanation in Chapter 3.3.1).

Air bubbles

Apart from the velocity of the water flow, the velocity measurements were also influenced by external circumstances like air bubbles which were released from the soil of the canal bed by disturbing it while positioning the Ott current meter rod. This air bubbling could affect the number of rotations by the Ott current meter since the bubbles also touched its propeller. The influence was hard to quantify, though the effect was probably limited since the bubbles touched upon both sides of the propeller. In terms of rotations it was observed and estimated that the number of rotations with bubbles could differ at most approximately 1 rotation additionally or one rotation fewer than the number of rotations without bubbles. As this phenomenon was mostly connected to the peat soil, it occurred mainly in the Stondansie canal.

Low flow velocities and wind influence

In general the flow velocity in the Stondansie canal was considerably lower than the velocity in the Van Wouw canal. With small gate opening(s) – and little head difference – this sometimes created difficulties as the number of rotations during a time span of 60s could even turn out to be 0. In situations where movement of the water was observed, the measurement was repeated once or twice. With repeated results of 0, there could potentially still be a water flow, though not sufficient to create a whole rotation of the Ott current meter propeller. According to the equation of transforming the Ott current meter rotations to velocities (Table 7) there will still be a small velocity appointed to the measurement points with 0 rotations.

Another phenomenon which was mainly observed in the Stondansie canal was the rather strong influence of the wind as the direction of the wind was perpendicular to the direction of the flow and canal. This created the practical issue of having difficulties in maintaining the boat in its position – the rope was somewhat elastic – in order to have the right location for the vertical, and also to maintain the rod of the Ott current meter here during the velocity measurement. Due to friction this wind direction could also cause the water flow to decrease its velocity, particular at the 80% depth measurement points as these points were located closer to the water surface. Also, with small gate opening(s) it was observed that it could be possible that some water flows from the Stondansie into the Van Wouw canal instead of towards the Euro-Zuid inlets. The wind could contribute to this reverse of flow direction. This was very important to discover, since the direction of the flow determines whether the calculated discharge should be added or subtracted from the discharge through the Van Wouw canal. At the 80% depth measurement points the Ott current meter was slightly visible, and it was observed that in some situations the propeller turned both clockwise and anti-clockwise though it seemed like the net direction of flow was towards the Van Wouw canal.

A small experiment was executed to test this. The Ott current meter also rotated when it was pointed with its nose in the (downstream) direction of the flow. The hypothesis for the experiment was that due to the streamlined design the Ott current meter would have most rotations with its nose directed towards the 'upstream part' (origin) of the discharge. Hence, in case the Ott current meter was turned 180°, the quantity of rotations should be highest with its nose in the upstream direction of the flow. As there were only few to no rotations, the results were not significant. As it was really difficult to discover the direction of the flow, and as then the next arguable question is for which area the water flows in this direction, it was decided to assume the water flowing in the normal direction, towards the Euro-Zuid inlets. This is something to take into account with further research and discharge measurements. It is recommended to repeat this experiment with high wind speed and small gate openings and head difference.

3.4.2 Intake calibration

In the calculation of the calibration there are some points which are subject to discussion, of which a limited data collection is an important part. Furthermore, the selected equations and the quality of their required input for the calculation are feed for discussion. A comparison with the results of this research with previously acquired results of calibrations is discussed here as well.

Previous calibrations

In Table 15 a comparison in methodologies and results of previous calibrations is provided. The C_d-value ranges of both calibrations of WLA are relatively large in comparison to the range in these values of the current research presented in this report. In the evaluation of results in the report on the calibrations of the WLA, Kselik (1983) also provided the possible explanation of inaccurate discharge measurement.

Table 15: Methods and results of calibrations of Nanni intake

	WLA 1978	**WLA 1980**	**This report**
Methodology	V-A: Ott current meter	V-A: Ott current meter	V-A: Ott current meter
Measurements per vertical	Two-point	Two-point	Two-point
Location cross-section (nr# of verticals)	Van Wouw (#17) Euro-Zuid (Stondansie) (#20)	Van Wouw (#16) Euro-Zuid (Stondansie) (#17)	Van Wouw (#10) Stondansie (#8)
Gate opening interval	0.50m	0.25m	0.50m
Number of discharge measurements	2x5 (both for 2 gates)	2x11 (11 for 1 gate; 11 for 2 gates)	8x6 (24 for 1 gate; 24 for 2 gates)
Range of Cd-values	0.40-0.76	1 gate: 0.36-0.57 2 gates: 0.35-0.94	1 gate: 0.65-0.84 2 gates: 0.66-0.77
Average Cd-values	2 gates: 0.54	1 gate: 0.44 2 gates: 0.49	1 gate: 0.72 2 gates: 0.71

The results of the current research vary greatly from the results of the previous calibrations. Part of the explanation could be that in this research in a few occasions the equations which were selected for the calibration slightly differed from the equations used in the studies mentioned above. These were the situations in which there possibly was non-modular discharge with partly opened gates (Table 6). During this research this was not clearly determined, mainly because it was forgotten to be observed. Therefore, too little information was collected for the inputs to apply the corresponding equation for this type of flow. To the advantage of the results of this research: In an interview with Kselik (2011) he indicated his doubt on the reliability of the discharge measurements which were executed in the research of the Hydraulic Research Division (WLA). Also, for the calibration described in this report many more discharge measurements were executed. Another explanation could be that C_d-values are susceptible to change over time, amongst others due to weathering processes of wetted perimeter of the intake. In a case study calibration (Lozano et al., 2009) for an irrigation system in Spain C_d-value was derived which changed with 0.1 within one year as a consequence of a gate which was substituted by a new one (with the same dimensions). "This observation reflected the sensitivity of C_d to changes in the gate structure and thus the need to check the calibration periodically or whenever changes in the structure are introduced." (Lozano et al., 2009) The higher C_d-values for the gates of Nanni intake possibly can partly be explained as consequence of weathering over the period between the current calibration and the ones of WLA, which covers a period of over 30 years. However, the average C_d-values changed from 0.49 to 0.72, which is a big difference, and it is likely there are other causes besides weathering which have influenced this change, for instance a difference in the flow regime around the intake due to for example erosion of the embankments. Furthermore, in the field it was observed that some water was seeping through the closed gates of Nanni intake. Lozano et al. (2009) investigated that in their case study research a constant contraction coefficient (C_d-value) of 0.61 – standard C_d-value used to calculate discharges if no calibration was executed – systematically underestimated the discharge through submerged gates in field conditions. Hence, a higher C_d-value is more likely to be present in field situations, and therefore it seems that the C_d-values of the current research are more likely to be valid.

Difference mid and mean section method

Due to the difference in discharges calculated by the mid section method and the mean section method, the average C_d-values for both 1 and 2 gate(s) vary 0.03. In quantifying this to theoretical discharges for example for a 2.50m gate opening of 1 gate with a head difference of 0.60m this entails a difference in discharge of 0.73m^3/s, and for the same circumstances but now for 2 open gates a difference in discharge of 1.45m^3/s is reached. For both 1 and 2 gates this is 4% of the total theoretical discharge.

Uncertainty of C_d-values

In the research of (Lozano et al.) – with relatively to this research a large dataset of water levels and discharges – they found that the uncertainty of the calibration was in the order of 5-15%, to which the uncertainty in C_d-value contributed mainly. In general they found a decreasing uncertainty with increasing gate opening. This was also found in this research (decreasing standard deviation in Table 13 and Table 14). The research of Lorenzo et al. also revealed a slightly decreasing discharge uncertainty with increasing head differences.

Water levels

For the reliability of the measured water levels the location, readability, and the decision on which head difference to insert in the equation should be taken into account. The location of the staff gauges was discussed in the methodology (Chapter 3.2.2). In the execution of the research in some circumstances – mostly at the downstream staff gauge – it appeared rather difficult to read the staff gauge as a consequence of turbulent and wavy water. Furthermore, some of the people who read the staff gauge during the velocity measurements had no previous experience with this. They were given a short tutorial, though later it appeared that some had not totally understood the procedure of reading a staff gauge. By discussing and from experience these wrong readings could be traced back to the probable water levels, though there is some insecurity in these water level data. As for both the upstream and downstream staff gauges a person was placed to do the readings, they had been asked to note both time – from the start, then every five minutes, till the end – and the corresponding water levels. When the duration of every discharge measurement was compared for upstream and downstream water level, it sometimes differed several minutes. It was assumed that the person who had noted most water levels was correct, and therefore the other ‘lacking’ water levels were supplemented by taking the last noted water levels for that staff gauge. In further research it is recommended to first do a preliminary measurement in which all future potential staff gauge readers get to practice to read the correct water levels.

Another point for discussion regarding the water level input is the time to wait for the water level to stabilize after a change in gate position. Preferably the water level should be given time to adjust before starting the next discharge measurement in order to give the discharge time to adjust at the measurement cross-sections. The importance also lies in the fact that the 20% and 80% depth velocity measurement points were calculated with reference to the difference in downstream water level from one gate position to another. However, due to limited time only 5 minutes were taken before starting the next measurements.

During one research day a gate was totally opened for the first discharge measurement. It was observed that after approximately 20 minutes the upstream water level had risen to above the gate opening. Hence, there was no free flow anymore. Possible explanations were that at arrival 2 gates were partly opened, of which one now had been closed, or the pump activity in Wakay, or less water intake of the downstream intakes from the upstream part: intake HA and IKUGH. To prevent this at the following field work days, the gates were positioned 10cm above the water level in the intake.

The head difference input for this calibration was not based upon water levels direct upstream and downstream of the intake. It was assumed that in practice this would not affect the usability of the calibration, as the same staff gauges will be used for estimating the discharges through the intake in the future. This was also the argument for assuming that it was not really bad for the research that the staff gauge was not exactly located at the location of the cross-sections where the velocities were measured.

Per gate position and discharge measurement a lot of water levels were collected. The question now was which head difference to select for use in the calibration calculations. In this research per gate position the average of the water levels for both the Van Wouw canal and the Stondansie canal were calculated and these values were averaged with each other again for both upstream and downstream water levels. And the head differences from these last two values were used in the calculation of the calibration. This means that the water levels of the measurements in the Van Wouw canal and the Stondansie canal were equal in weight: their relative share is 50% each. However, due to a smaller cross-section the discharge measurements in the Stondansie canal lasted shorter than in the discharge measurements in the Van Wouw canal. Therefore it could also have been decided that the weight of these water levels should be taken relative to their contribution in time duration. This last methodology was preferred, be it not that the duration of the discharge measurements and the collected water levels was – as explained above – not always clear set, and hence it was chosen to follow the 50%-50% methodology. In future research it is recommended to clearly record the water levels in time, so that the head difference can be inserted in the calibration calculations.

Extrapolation

As calibrations are specific to the structure which was calibrated, it cannot be extrapolated to another structure, even when this structure is of the same type. External circumstances can always vary and hence a calibration is context and time specific. During the field work days the head difference for 1 gate ranged from 0.04m to 0.48m, and for 2 gates the range was from 0.11m to 0.34m. With the calibration and the theoretical discharge this range can be extended to estimate theoretical discharges at smaller and larger head differences. However, as the C_d-values are calculated on the basis of four discharges per gate position, extrapolation of these values should be validated after doing more discharge measurements in circumstances with a head difference outside of the range on which the calibration is based currently.

4 Water division

In the study of Nienhuis (2013) the water quantity division was mapped for the Corantijn canal and partly for the Surinam canal. However, insight still has to be gained on the division of the flow within the irrigation scheme – hence, downstream of the three main intakes. The second part of this research focussed on increasing this insight by investigating the inlets to the polders and by making canal profiles for both the Van Wouw canal and HA canal.

4.1 Methodology

The main irrigation canals were topographically mapped by the means of GPS-referencing, as well as the inlets to the polders along the canals diverging from the main intakes. These inlets were also photographed and information on their geometry was obtained. Information on the dimensions of inlets was gathered by estimations, analysing drawings, and by the means of interviewing. Additional several cross-sectional depth measurements were executed in both the Van Wouw canal and in its diverging canals and in the HA canal.

During the past pumping season (Dec 2011 – Feb 2012) the water levels in the Van Wouw canal at both Nanni intake and Clara pumping station were collected. The water levels at the swamp side of Nanni intake were collected as well. Information about the pumping period at Wakay and these water levels can be found in respectively Annex K and L.

In connecting information on the elevation of the canal beds, the water levels within the canals, and the cross-sectional area on several locations in the Van Wouw canal and the HA canal, canal longitudinal profiles were derived. Information about the areas fed by the inlets was obtained by both interviewing and a literature research.

4.2 Results

This Chapter shows the results of the polder information and information on the canal profiles including cross-sectional area information and water and canal bed levels.

4.2.1 Polder and inlet information

Information on the area of the polders was derived from several sources: the Ministry of OW and the Ministry of LVV provided tables with information about the polders. The values on polder area in these tables differed for the different sources. During the period of research it was not clarified which source contained the information corresponding to the true areas. Below, one table (Table 16) is displayed, and the other tables are provided in Annex M. This Annex also contains pictures of areal drawings of certain polders.

Some calculations on plot sizes and relative area not cultivated – referring to gross and net area – were additionally executed and added to Table 16.

Table 16: Overview of polder areas (Source: adjusted from the Ministry of OW (2012a))

Polders fed by intake:	Nanni						
	HA						
	IKUGH						
Overview polders							
Ressort	**Water board area**	**Polder**	**Area (ha)**		**% area not used for cultivation**	**# plots**	**Average plot size**
			Gross	**Net**			
West	Euro-Zuid	Euro-Zuid	1309	1140	12.9	214	5.3
	Euro-Noord	Euro-Noord	1191	1035	13.1	164	6.3
	Nanni and Bruto	Nanni	1320	1062	19.5	198	5.4
		Bruto	423	358	15.4	73	4.9
		Bruto-non rice	52	39	25.0	51	0.8
	Wasima	Waldeck	140	84	40.0	120	0.7
		Sidoredjo	208	164	21.2	169	1.0
		Margarethenburg	184	104	43.5	92	1.1
	Clara	Clara	1421	1245	12.4	365	3.4
	Corantijn	Corantijn	976	747	23.5	573	1.3
	Van Drimmelen	Van Drimmelen	986	850	13.8	568	1.5
Oost I	Sawmillkreek	Sawmillkreek	280	215	23.2	90	2.4
		Boonacker	170	101	40.6	42	2.4
		Uibreiding Hamptoncourt	280	267	4.6	77	3.5
	Hamptoncourt	Hamptoncourt	876	845	3.5	480	1.8
	Paradise and Longmay	Paradise	605	570	5.8	441	1.3
		Longmay	345	308	10.7	301	1.0
Oost II	Klein Henar and Groot Henar	Klein Henar	192	142	26.0	85	1.7
		Groot Henar	2241	2100	6.3	561	3.7
	Uitbreiding Groot Henar I and II	Uibreiding Groot Henar I	1296	1080	16.7	108	10.0
		Uitbreiding Groot Henar II	793	721	9.1	67	10.8
	Middenstands	Middenstands	1742	1584	9.1	67	23.6
Totaal			**17030**	**14761**	13.3	**4906**	3.0

The added surface areas per source (Table 17) show that there is a large difference in especially the gross area – ranging from rough way 1000 to 2000 ha. Further research should reveal which source is the best.

Table 17: Different surface areas served by the main intakes, according to the Ministry of LVV and according to two different sources of the Ministry of OW

Sum area (ha)	LVV	OW1		OW2
	Net	Net	Gross	Gross?
Nanni intake	*6937*	*6828*	*8210*	*10136*
Intake HA	*1358*	*1360*	*1510*	*2415*
IKUGH	*4991*	*4989*	*5568*	*7685*

From these results it is clear that Nanni intake supplies the largest area with irrigation water. An overview – though probably incomplete – is given in Table 18, Table 19 and Figure 26. The inlets to the polders were identified in both the Van Wouw canal and the HA canal. Apart from the GPS-referenced location, the tables also provide information on which polders the inlets supply with irrigation water, and – if available – information on the dimensions of the inlets is supplied as well.

For a complete water quantity picture, the drainage of water should also be pictured. The period of research has proven to be too short for the creation of a complete picture of the water division in the main irrigation canals – including the water division downstream of Driekokerpunt, Clara pumping station, and IKUGH. The wet and dry infrastructure was not mapped there, and the spillway sluices were also not included in the overview. As this information is important for further insight in the water division of the Nickerie rice irrigation scheme, and as some of this information was collected during the research, that information is supplied in Annex O.

Table 18: Inlet information with GPS-locations in the Van Wouw canal: Nanni intake to Clara pumping station

Name	Reference nr #		Description/dimensions	Coordinates	
Van Wouw canal					
Nanni intake					
Inlets	1	Pump Baitalli		05°49.117' N	056°59.427' W
	2	Euro-Zuid inlet 1	Division box: 4 undershot gates, 1 tube in the middle. Always open	05°49.463' N	056°58.766' W
	3	Euro-Zuid inlet 2	2 undershot gates	05°50.275' N	056°57.720' W
	4	Culvert/tube	Left side. Located at Mango tree Baitallie	05°48.834' N	056°59.186' W
	5	Tube Baitallie	Left side. This was also the place where Baitally pumped	05°49.112' N	056°59.427' W
	6	Tube (plastic) Baitallie		05°49.339' N	056°59.621' W
	7	Euro-Zuid tube	Right side. Directly into rice fields. Tube diamter 0.25m	05°49.792' N	056°59.990' W
	8	Stone culvert Baitallie	Left side	05°49.805' N	057°00.017' W
	9	Culvert Baitallie	Left side. Diverging (culvert) to pumping station Baitalie	05°49.977' N	057°00.164' W
	10	Euro-Zuid tube	Right side. To drainage (also irrigation) ditch. Tube diameter 0.20m	05°50.009' N	057°00.176' W
	11	Stone culvert	Left side. Gradual adjustable gate	05°54.396' N	057°01.784' W
	12	Stone culvert to Mangli	Left side. Gradual adjustable gate. Approx. diameter 0.80m	05°53.247' N	057°00.585' W
	13	Inlet to Wadoek (Mangli and Ons land)	Right side. Opening submerged. Approx. width 2m	05°53.127' N	057°00.587' W
	14	Tube to Stalweide (Nanni polder)	Left side. Submerged. Diameter approx. 0.50/0.60m	05°53.091' N	057°00.599' W
	15	Inlet to Euro-Noord	Right side. Broken down but still operated	05°52.771' N	057°00.608' W
	16	Concrete tube (bypass to Nanni and Bruto)	Left side at Oemrawsingh. Diameter approx. 1.00/1.25m. Allways open	05°52.218' N	057°00.655' W
	17	Tube	Left side. Small tube which is always open	05°52.187' N	057°00.664' W
	18	Inlet to Euro-Noord	Right side. Broken, operated by farmers (with wooden board)	05°52.124' N	057°00.652' W
	19	Tube (pvc) to Oemrawsingh	Approx. diamter 0.25m	05°51.835' N	057°00.686' W
	20	Tube (pvc) to Oemrawsingh	Approx. diamter 0.25m	05°51.767' N	057°00.690' W
	21	Inlet to Nanni Bruto	Left side. Broken down. Approx. width 1.5m	05°51.613' N	057°00.703' W
	22	Inlet to Euro-Noord	Right side	05°51.475' N	057°00.701' W
	23	Tube (pvc) to Nanni Bruto	Left side	05°51.378' N	057°00.721' W
	24	Concrete culvert to Baitallie	Left side. Approx. width 1.25m	05°50.889' N	057°00.612' W
	25	Inlet to Euro-Noord	Right side	05°50.809' N	057°00.571' W
	26	Inlet to Baitallie	Left side. With pump station for dry times	05°50.312' N	057°00.356' W
	27	Culvert to Euro-Noord	Right side. Submerged	05°50.064' N	057°00.214' W
	28	Inlet to SBBS	Right side. Gradually adjustable	05°50.062' N	057°00.210' W
Clara pumping station division box				05°54.447' N	057°01.774' W
	30				
Depth profiles	31		Discharge measurement cross-section	05°48.805' N	056°59.157' W
	32		Discharge measurement cross-section Stondansie	05°48.777' N	056°59.082' W
	33		Depth profile measurement cross-section close to Clara p.s.	05°54.380' N	057°01.741' W
	34	Mangli canal (diverging from VWc)	Left side. Approx. 300m in lenght, 15m width. Sometimes pumping	05°54.375' N	057°01.648' W
	35		Depth profile measurement cross-section, just u.s. from second brigde	05°52.640' N	057°00.620' W
	36		Depth profile measurement cross-section, just d.s. first bridge VWc	05°50.062' N	057°00.226' W
landmark points	37		First bridge'	05°50.021' N	057°00.200' W
	38	Diverging Stondansie canal from Van Wouw canal		05°48.755' N	056°59.107' W
	39	Euro-Zuid canal 1 (diverging from Stondansie)	Left side	05°49.202' N	056°58.555' W
	40	Euro-Zuid canal 2 (diverging from Stondansie)	Left side	05°50.014' N	056°57.518' W
	41	Mangli canal (diverging from VWc)	Left side. Approx. 300m in lenght, 15m width. Sometimes pumping	05°54.375' N	057°01.648' W
	42	u.s. Clara pumping station	End VWc	05°54.433' N	057°01.773' W
Water level bars	43	d.s. of Nanni intake		05°48.747' N	056°59.122' W
	44	u.s. of Nanni intake		05°48.755' N	056°59.057' W

The red boxes refer to inlets of which pictures are available in Annex O

Table 19: Inlet information with GPS-location in the HA canal: Intake HA to Driekokerpunt

Name	Reference nr. #		Description/dimensions	Coordinates	
HA canal					
Intake HA				05°50.216' N	056°57.212' W
Inlets	45	Inlet to SBBS	Left side	05°51.755' N	056°57.145' W
	46	Euro-Zuid tube (pvc)	Left side. Tube diameter 0.30m	05°50.945' N	056°57.193' W
	47	Inlet to Sawmillkreek	Right side. To Uitbreiding Hamptoncourtpolder	05°52.923' N	056°57.055' W
	48	Inlet to Uitbreiding Paradise 3&4	Left side. Operated with wooden cover (un-off)	05°52.943' N	056°57.079' W
	49	Concrete culvert under At. Road	Just upstream (under Atthaoella road). Same dimensions as HA (2.40*1.50m)	*05°52.972' N*	*056°57.070' W*
	50	Inlet to Sawmillkreek and Boonacker	Right side. In function. Approx. width 1.25m	05°53.476' N	056°57.024' W
	51	Diversion at Driekoker	d.s. of Driekoker into two direcions: canal straight (sluice is gone), circle tube to Longmay	05°54.042' N	056°57.007' W
	52	Diversion at Driekoker	Diverging canal to Paradise. Sluice with tackle	05°54.039' N	056°56.999' W
Depth profiles	53		Discharge measurement cross-section Oostelijke Aftakking HA	05°50.245' N	056°57.223' W
	54		Depth profile measurement cross-section HA	05°52.972' N	056°57.070' W
	55		Depth profile measurement cross-section HA approx. 250m from Driekoker	05°53.924' N	056°57.015' W
Water level bars	56	u.s. of intake HA		05°50.245' N	056°57.153' W
	57	d.s. of intake HA		05°50.221' N	056°57.221' W
	58	Thalimedes Driekoker		05°54.033' N	056°57.007' W

The red boxes refer to inlets of which pictures are available in Annex O

Figure 26: Google Earth pictures with GPS-referenced locations in the Van Wouw canal (left) and HA canal (right) (derived at 05-04-2013)

From interviews (Puran, 2012; Triloki, 2012) it appeared that in dry times downstream polders in the Nanni supply area often faced water shortage. Therefore Clara pumping station was constructed in the '70s and in 2005 it was renovated. This was positive for the farmers farming in the polders downstream of Clara pumping station. However, it sometimes has negative consequences for the water availability of the polders upstream of Clara pumping station, since 'their' water is now pumped to the downstream polders. From these interviews it also appeared that the water could be used much more efficient, as in most cases the plots are not levelled since it is expensive to do so.

For above mentioned reasons and for the organizing of the maintenance and operation of intakes and inlets, irrigation canals, and drainage infrastructure, the polder management and its reorganization got increased attention. More information on this is supplied in Annex P.

4.2.2 Canal profiles VW and HA canal

With information on water levels and cross-sections, canal profiles can be derived. Figure 27 and Figure 28 show the Van Wouw canal and the HA canal and the depth profiles which were taken, with letters indicating where cross-sections were taken or where the canal changes direction.

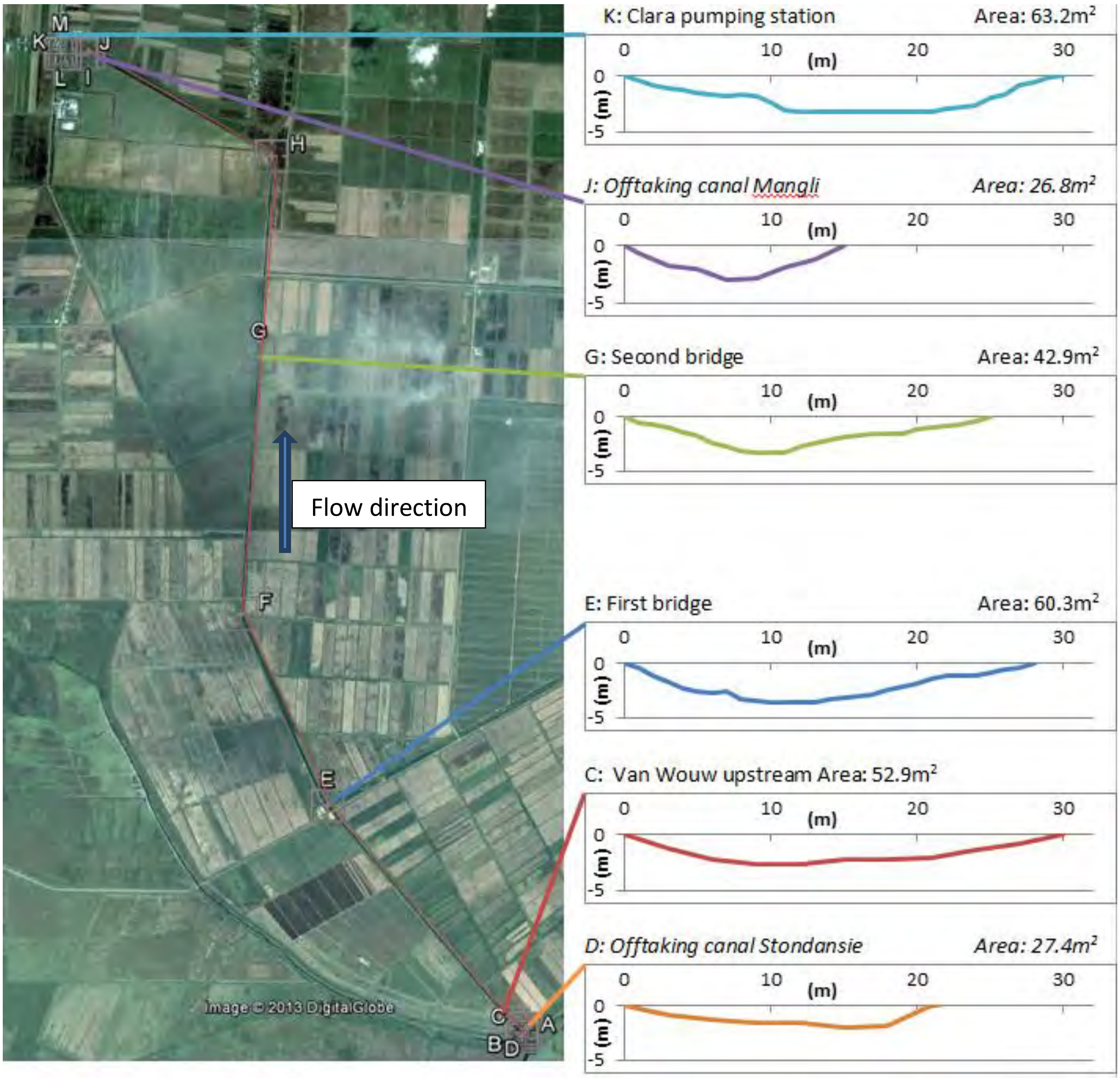

Figure 27: Google Earth picture of Van Wouw canal (left) (derived at 08-05-2013) and depth profiles of cross-sections (right). Description with letters can be found in Table 20. Cross-section J and D are offtaking canals.

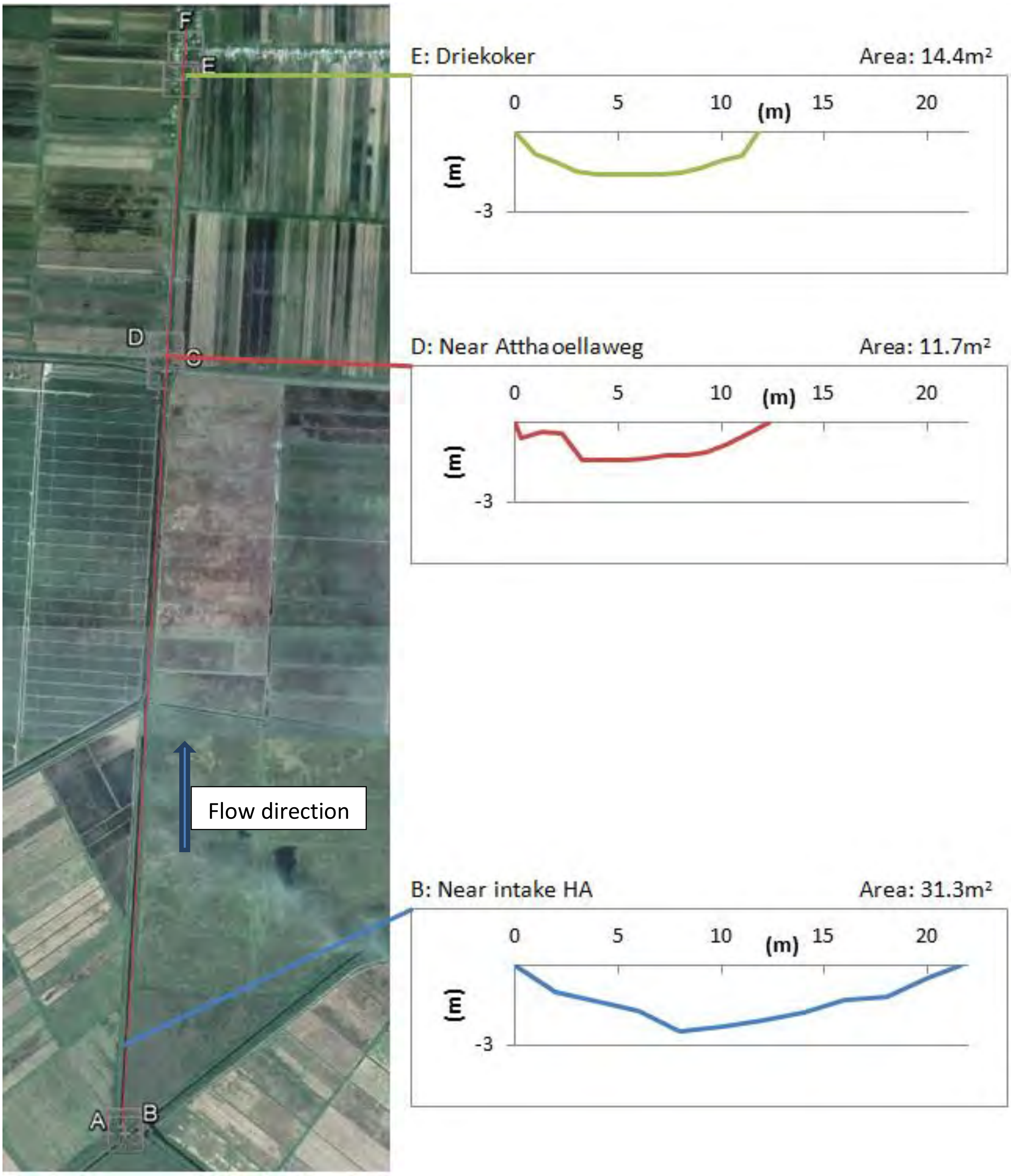

Figure 28: Google Earth picture of HA canal (left) (derived at 08-05-2013) and depth profiles of cross-sections (right). Description with letters in Table 21

In Table 20 and Table 21 the GPS-locations, descriptions, and distances are given for every letter in respectively Figure 27 and Figure 28. In Annex Q information is supplied on the GPS-locations of these cross-sections, as well as on where in the cross-sections exact the depths were measured.

Table 20: Description of letters in Van Wouw canal picture of Figure 28

Letter	GPS #	Description	Distance (m)		Cumulative distance (m)
A	43	Nanni intake	A-B:	43	
B	38	Offtaking Stondansie canal	B-C:	67	43
C	32	Discharge measurement Stondansie canal	B-D:	*128*	
D	31	Discharge measurement VWc	D-E:	3043	170
E	36	Depth profile first bridge	E-F:	2224	3214
F		Bending point VWc	F-G:	2737	5437
G	35	Depth profile second bridge	G-H:	2126	8174
H		Bending point VWc	H-I:	2243	10300
I		Bending point VWc	I-J:	80	12543
J	34	Depth profile offtaking canal Mangli	J-K:	173	12623
K	33	Depth profile VWc near Clara p.s.	K-L:	44	12796
L		Bending point VWc	L-M:	45	12840
M		End (d.s.) VWc at Clara p.s.	Total (A-M):	12885	12885

Table 21: Description of letters in HA canal picture of Figure 28

Letter	GPS	Description	Distance (m)		Cumulative distance (m)
A	57	Intake HA	A-B:	51	
B	53	Discharge measurement cross-section HA	B-C:	4906	51
C		Atthaoellaweg	C-D:	135	4957
D	54	Depth profile Atthaoellaweg	D-E:	1757	5092
E	55	Depth profile u.s. of Driekoker	E-F:	200	6849
F	58	Driekokerpunt	Total (A-F):	7048	7048

The cross-sectional flow area was calculated from the depth profiles. Table 22 shows the NSP-water levels and the date of measurement. To make a comparison of the cross-sectional areas the cross-sections preferably should have been measured at the same day. However – as this was not the case – the calculation of the cross-sectional areas was adjusted to a measured or an assumed water level at the day on which most cross-sections were measured: 02-03-2012.

Table 22: Water and canal bed levels (m+NSP) at depth profile measurement locations in the Van Wouw canal and HA canal

	Letter	water level	canal bed (maximum depth)	canal bed (average depth)	Date of measurement
VWc	C	1.99	0.03	0.72	16-2-2012
	D	1.99	-0.64	0.23	16-2-2012
	E	1.99	-1.66	-0.16	2-3-2012
	G	1.99	-1.31	0.28	2-3-2012
	J	1.99	-1.01	0.21	2-3-2012
	K	1.99	-1.29	-0.12	2-3-2012
HA	B	1.83	-0.64	0.38	23-2-1012
	D	1.69	0.27	0.74	2-3-2012
	E	1.65	0.05	0.43	2-3-2012

The red values are the adjusted water levels as they were assumed to be at the 2nd of March 2012

This was based on an assumed linear water level from the upstream to downstream end of the canal. The upstream and downstream water levels in the Van Wouw canal had been collected during the period of research (Figure 29). The values for Figure 29 were derived from water levels which were collected by employees from the Ministry of OW. These values are displayed in tabular form in Annex L.

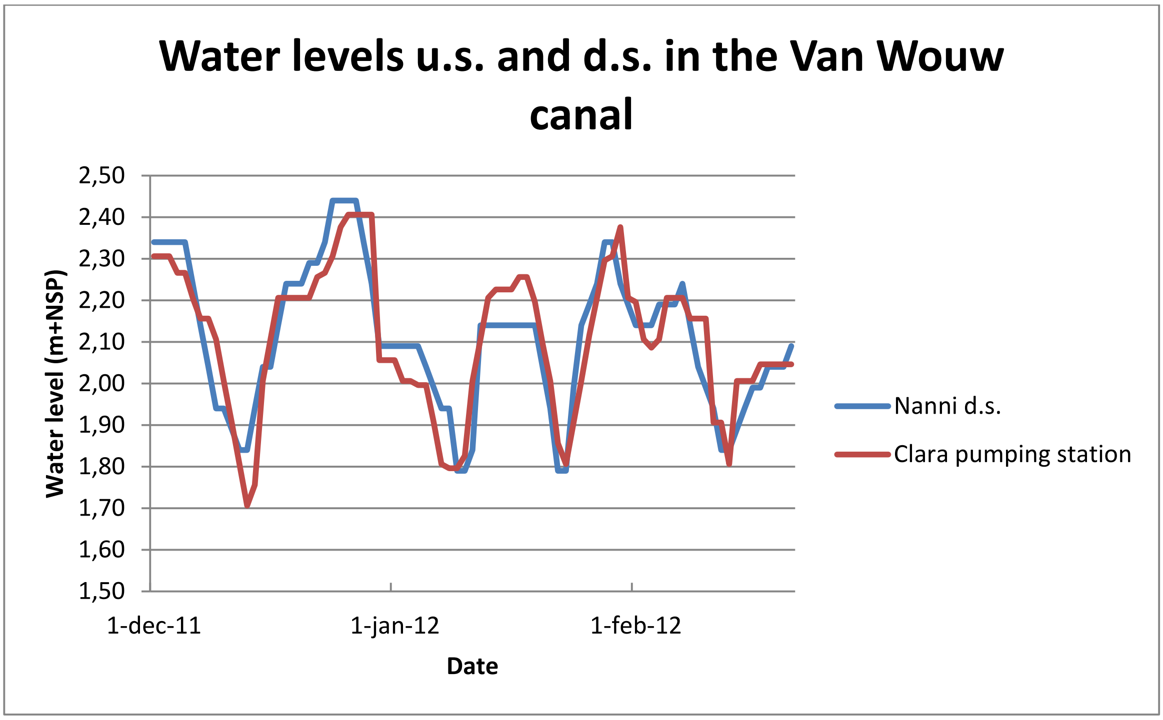

Figure 29: Water levels upstream (Nanni downstream (d.s.)) and downstream (Clara pumping station) in the Van Wouw canal (raw data from (MinisterieOpenbareWerken, 2012b) and (MinisterieOpenbareWerken, 2012c))

From this graph it is obvious that the values of the water levels should be questioned. The graph shows that at times the water level in the Van Wouw canal at Clara pumping station is higher than the water level upstream at the start of the Van Wouw canal. Apart from the occurrence of backwater effect, this theoretically is not likely to happen since the canal bed level is assumed to be lower at the downstream part of the canal than at the upstream part. Hence, the reliability of the water level data in the Van Wouw canal is questionable. According to Kalidin and Bohory (OpenbareWerken, 2012) the water level data indeed were not fully reliable, since the water level readings could potentially be not so accurate due to miss readings or even invented values. The accuracy of water levels often is with an interval of 5cm. It is unlikely that the actual water level also differed exactly 5cm every time of recording.

Despite this lack of reliability, these water levels were used since more reliable data was not available. To recalculate the assumed NSP-water levels the water levels of 16-02-2012 were compared to the water levels of 02-03-2012. According to the water levels derived by OW the water level at 16-02-2012 at Nanni intake was 1.99m+NSP. The water level at this day at Clara pumping station was 2.01m+NSP. As this goes against the laws of gravity, and as the difference is minimal, it was decided to calculate with a similar water level (1.99m+NSP) in the entire Van Wouw canal. 1.99m+NSP was favored over 2.01m+NSP since the water level registered for the calibration research at start was also 1.99m+NSP for this 16th of February. This double-measurement with the same results justified the use of this value over the water level of 2.01m+NSP measured once at the downstream end of the Van Wouw canal at Clara pumping station.

The water levels at the 2nd of March 2012 were not recorded, as the employees of the Ministry of OW missed the water levels from the 1st of March to the 5th of March 2012. It was decided to take 1.99m+NSP water level here as well and to use the same profile depths as had been measured at the 16th of February 2012. In case the real water level at the 2nd of March differed much from 1.99m+NSP this mostly would have consequences for the cross-sectional area and not so much for the general picture of the canal longitudinal profile. Per 1cm water level difference here, the cross-sectional area differs 0.30m², while a few centimeters difference in the water level has a smaller influence on the general picture of the position of the canal bed as the canal bed itself is relatively far more irregular.

For the HA canal, the water level at the most upstream part – near intake HA – was only know at the day when discharge measurements for the calibration were executed. This was at 23-02-2012, and the water level (before starting the measurements and changing the gate positions) was 1.83m+NSP. The water level at Driekokerpunt at the same time – as measured by the Thalimedes meter – was 1.76m+NSP. For the 2nd of March 2012 only the downstream water level at the Thalimedes meter at Driekokerpunt was known. This was 1.64m+NSP. Due to this lack of data, a similar water level difference between downstream and upstream water level was assumed for the 2nd of March and the 23rd of February 2012. On the 23rd of February this difference was 0.19m, and with that the assumed upstream water level of the 2nd of March at HA would be 1.64+ 0.19= 1.83m+NSP. Again – due to limited data on the water level – a linear trend was assumed in the water level difference between upstream and downstream water level. This makes the difference $2.7*10^{-5}$m/m, and the water level at point D (Table 22) then was calculated to be 1.69m+NSP.

Further water level data of the Thalimedes measurement instruments during the period of December 2011 to mid-February 2012 can be found in Annex L.

The cross-sectional areas are displayed against distance – in downstream direction – in the canal in Figure 30.

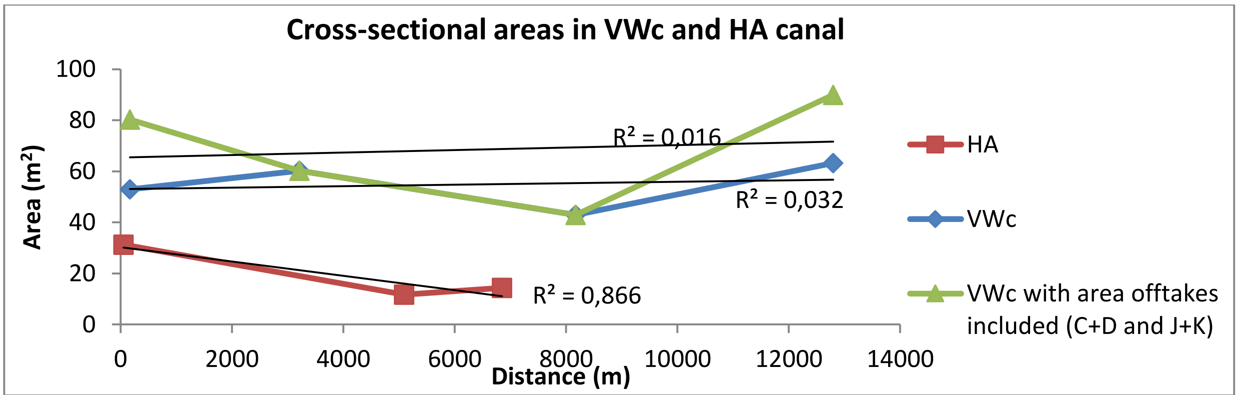

Figure 30: Cross-sectional areas in the Van Wouw canal (with and without offtaking canals) and in the HA canal. Areas were measured at the 2nd of March 2012, or an estimation was made to transform areas measured earlier to what they would be on the 2nd of March

Theoretically the area is supposed to show a descending trend of area in downstream direction, which was found to be true for the HA canal with a rather strong R^2-value: 0.866. However, the trend lines through the cross-sectional areas of the Van Wouw canal show the opposite: a positive relation of cross-sectional area while proceedings towards downstream direction. This is not a strong relation for both the Van Wouw canal cross-sectional areas and the Van Wouw canal with additionally the offtaking canal areas, with respectively R^2-values of 0.032 and 0.016. As the discharge is only likely to decrease while being conveyed through the canal and on its way being distributed to inlets to the polders (Table 18 and Figure 26), hypothetically it appears that the velocities at the beginning and the end of the canal are relatively low. Note that the calculation of the most upstream cross-sectional area could differ, as was explained as a consequence of the water level being not known here. With the data on the NSP-referenced water levels and canal bed levels (Table 22), the longitudinal profiles for both the Van Wouw canal and the HA canal were derived (Figure 31 and Figure 32). The canal bed level was obtained both by distracting the maximum water depth in a cross-section from the water level in that same cross-section, and by distracting the average water depth.

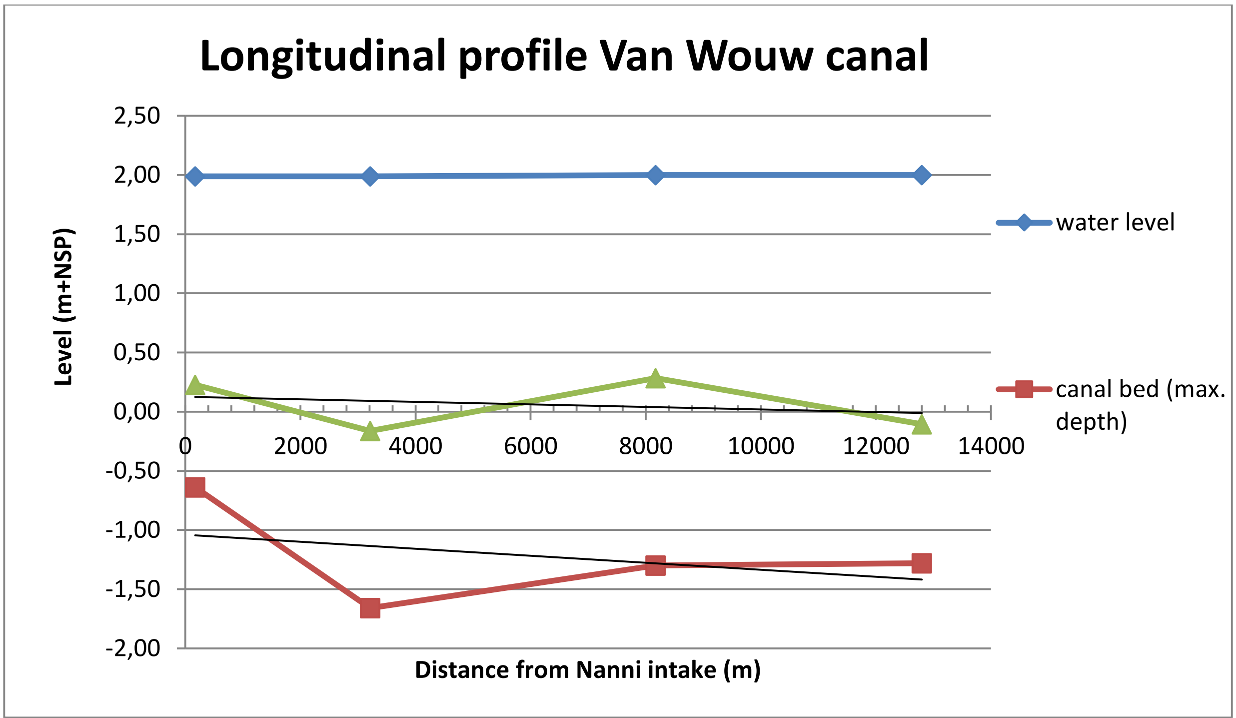

Figure 31: Canal longitudinal profile Van Wouw canal: Nanni intake to Clara pumping station

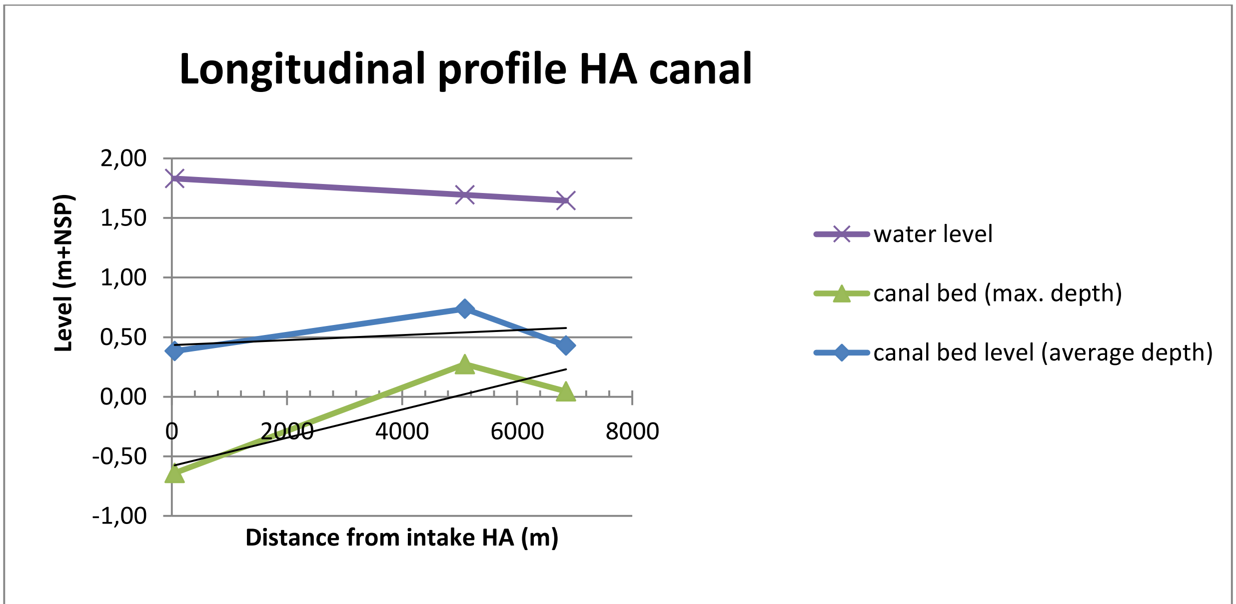

Figure 32: Canal longitudinal profile HA canal: Intake HA to Driekokerpunt

From these graphs it appears that the canal bed is not regularly descending to the downstream direction. As water flows by the law of gravity, and the flow direction is supposed to be in downstream direction, the positioning of the canal bed of in particular the HA canal is remarkable. The conclusion which can be drawn from both figures is that a lot of water is hampered in its flow downstream due to an irregular canal bed in length cross-section. At low water levels – below -1.28m+NSP for the VWc and 0.27m+NSP for the HA canal – the water potentially stagnates which increases losses through percolation through the canal bed and evaporation of the water. Note that it is possible that ponding water could also occur at even higher water levels, since these given canal bed levels are based on only limited cross-sectional data, and hence the canal bed could potentially be higher in parts of the canal where no depth profiles were taken.

4.3 Discussion

Some of the results provided in Chapter 4.2 are questionable due to the use of less reliable inputs in the calculations, whether those were obtained from third parties or due to the potential inaccuracies during the measurement procedure. Furthermore, many measurements were only executed once, and to improve the reliability it would be good to do some of the measurements at least twice or repeatedly.

First the polder areas deserved critical thoughts. In this research it was not revealed which data were most reliable. It was also not exactly clear which inlets served which polders. The inlets which were mapped in the Van Wouw canal and the HA canal were probably not comprehensive, since due to their location beneath the water level it was hard to visually distinguish them and possibly some of the inlets had been overlooked. To create a picture on the flow division from the canals into the polder ditches the level of the inlets should be known, as well as the dimensions of the inlet structures. Some of this data were derived, though again this was not a comprehensive compilation. Currently, it was therefore not possible to elaborate on the quantitative water division within these main irrigation canals, not even in a relative way.

As explained in the results of the longitudinal canal profiles, the values of the water levels in the total upstream and downstream end of the Van Wouw canal were highly questionable and most likely either miss readings or invented values – in order to supplement the missing values – were included in the data set of these water levels. As not all cross-sections were measured at the same day, the water levels had to be normalized for one date. Due to the lack of accuracy in data and lack of data on the water level differences within the canals it was difficult to decide on an assumed water level for the days that the cross-sections were measured on another day than the elected canal profile day. It is likely that the assumed linear course of the water level from upstream to downstream does not exactly correspond to the actual water levels at the cross-sections measured more in the longitudinal middle sections of the canals. With regard to the little difference in water level within one canal the general picture of how the canal beds were situated could despite of the low accuracy of the water level data still be obtained. As the cross-sections where the cross-sectional areas were derived and where the canal depths were estimated were rather limited in number, the pictures which were derived of the canal beds do not clarify the entire positioning of the canal bed. More data acquisitioning on the canal profiles would contribute to the improved image of the canal profiles.

5 Conclusion

The most important findings are summarized in this Chapter, and recommendations are done on the research methodology and on future research which can make the flow mapping more detailed, accurate, and reliable.

Summary

In this research the head-discharge relation of Nanni intake was derived. Intake HA and IKUGH were not calibrated. The ranges of head difference which were covered for the calibration of Nanni intake during this research were 0.04-0.48m for 1 gate and 0.11-0.34m for 2 gates. In the calibration of Nanni intake (Figure 19 and Figure 20) the measured discharges through 1 gate have a better fit with the calibration trend line with increasing gate opening. The calibration for 1 gate is good, with exception of small gate openings up to 1.00m (and 1.50m to a lesser extend) with little head differences up to approximately 0.10m. This trend is not present in the calibration for 2 gates. For 2 gates the calibration is also good for small gate openings and little head differences. The average C_d-values for the mid section method, which were used to create a theoretical calibration in order to predict the discharge through Nanni intake at different head differences, were 0.72 for 1 gate and 0.71 for 2 gates (Table 13). The ranges of C_d-values for the mid section method were 0.65-0.84 for 1 gate and 0.66-0.77 for 2 gates. The standard deviations of these ranges for 1 and 2 gates respectively are 0.11 and 0.04. The mean section method resulted in average C_d-values which were 0.03 lower. For a head difference of 0.60m this difference entailed a difference in discharge of 4% of the total discharge. The mid section method discharges and hence C_d-values are assumed to correspond best to reality, since the cross-sectional area used in this calculation covers the real cross-sectional area better than the area used for the mean section method. With exception of the discharge through a 0.50m gate opening for both 1 and 2 gates, the theoretical discharges in general are higher than the measured discharges. With a larger gate opening for both 1 and 2 gates of Nanni intake the discharges which can be read from Figure 22 and Figure 23 correspond better with the discharges as they were measured during this research. The theoretical discharges through 2 gates also correspond better with the measured discharges as compared to the discharges through 1 gate. With higher discharges the theoretical and the measured discharges converge to a greater extend as compared to smaller discharges.

For Nanni intake in general the results of the discharge through a larger gate opening – at least up to 2.00m – are predictable with a higher accuracy than the discharge through smaller gate openings. This hypothetically indicates that the discharge measurement with an Ott current meter is more accurate with these higher discharges, as also appears from the smaller standard deviations of the discharges through 2 gates as compared to the standard deviations of the discharges through 1 gate (Table 13 and Table 14). This is not true for a gate opening of 2.50m and higher.

OW-MCP can use the following equations to calculate the discharges through respectively 1 and 2 gates of Nanni intake:

Q1gate (m^3/s) =0.72*3m*gate opening (m)*√ (2*9.81(water level upstream (m+NSP)-water level downstream (m+NSP)))

Q2gates (m^3/s) =0.71*6m*gate opening (m)*√ (2*9.81(water level upstream (m+NSP)-water level downstream (m+NSP)))

Although the average C_d-values of this research are 0.22 higher than the C_d-values of the previous calibration (WLA 1980), the results appear reliable. The reliability of the WLA research was already doubted by one of the researchers (Kselik) and for this research more than double the amount of discharge measurements have been executed: 22 versus 48.

With the second part of this study an attempt was made to gain insight in the relative water division within the Nickerie rice irrigation scheme. Insight was gained in polder areas served per main intake, inlets along the Van Wouw canal and HA canal were mapped, and for these canals canal profiles were derived by taking depth profiles, calculating canal cross-sectional areas, and by making longitudinal profiles including canal bed levels and water levels. However, many data still is missing. The difference in polder information needs to be verified and the missing information on some inlets needs to be collected. This is also true for the canal profiles, which were partly derived from water levels that where assumed. What currently can be concluded is that the water division in the main irrigation canals is difficult to map as there are many inlets to the polders, and information on their location and dimensions need to be first collected, and in order to be able to say something on the discharge division consequently information on water levels should be collected as well.

Research methodology and recommended research

It is recommended to validate the intake calibration on Nanni intake by executing discharge measurements and checking whether it is close to the theoretical calibration graph of Figure 21 or Figure 22. Furthermore, to complete the calibration of the main intakes of the Nickerie rice irrigation scheme intake HA and IKUGH also need to be calibrated. An improvement in methodology for this calibration would be to use a smaller horizontal spacing of verticals than the spacing of 3m which was applied in this research. Due to the limited measurement time during a field day it is recommended to start very early in the morning and then experiment with decreasing this spacing to for example 2m, and if time allows even smaller.
With regard to the selection of a cross-section location for discharge measurement for intake HA attention should be paid that it should be located downstream to the occurrence of vortices, which occur to almost 200m downstream.

As explained the velocity-depth relation should be parabolic in order to justify the application of the two-points method. In this study too little research has been done to validate this. For future discharge measurements it is recommended to investigate the velocity-depth relation by measuring the velocity at all verticals with an interval of 10cm. When the relation turns out to be parabolic, the two-points method is recommended for the discharge measurements, and otherwise equidistant spacing of velocity measurement points should be applied.

Furthermore, the flow types should be observed in order to apply the correct equations for the calibration of the intakes: semi-modular or non-modular discharge.

For verticals with a water depth below 0.76m the one-point method is recommended (Chapter 3.1.2). As this was not applied in this research it is recommended to do this in future discharge measurements and then validate the calibration which is derived in this study.

Another very practical recommendation to improve the accuracy of the depth measurements is to connect a larger surface to downside of the rod of the current meter in order to measure the water depth and in order to not penetrate through the canal bed.

It would be interesting to investigate the relation between the pumping at Wakay and the water level at the upstream side of the intakes. This information stimulates better anticipation on the desired water level difference at and discharge through the intakes. Related to this, it is recommended to either have very good communication with the intake operator of the Ministry of OW who is residing next to Nanni intake in order to derive the downstream water level of the intake, or to install a Thalimedes meter in order to have this information readily available. With this information and with the – recommended – recording of the gate settings, the discharge within the upstream part of the Van Wouw canal can be recorded and connected to the water level downstream in the Van Wouw canal.

To increase insight in the water division downstream of the main intakes, information on water levels in the main canals should be collected and recorded. At the downstream location in the Van Wouw canal – at Clara pumping station – a defective staff gauge is already present, though for good measurement it is recommended to install a new staff gauge here which is related to the NSP-referenced water level. For the canals downstream of intake HA and IKUGH the water levels should also be recorded. New staff gauges have been installed, though the water levels are not collected (on a daily basis).

Furthermore, recommended research should focus on investigating the location and dimensions of the inlets to polders, and on taking more cross-sectional depth measurements in the canals during one day and preferably a larger number of cross-sections than the number of cross-sections which were measured in this research. Also the areas of the polders deserve extra attention and in order to gain insight in the scope of gravity irrigation the contour lines of polders would clarify much here. Furthermore, it would provide great insight when the discharges in the scheme would be quantified, which can be partly done by keeping record of the water levels upstream and downstream of the main intakes as well as of the gate positions of these intakes. This depends to a large extend also on the operation of inlets to the polders, pumping station(s), and drainage ways by farmers or different institutions. Therefore, it is recommended to interview the stakeholders in the water division management in order to clarify the methodology on managing the intakes and inlets. Discharge measurements further downstream in the main canals and in the offtaking canals can reveal the big picture of the water distribution to the polders.

This study contributes to an increased understanding of the physical water division. With the prolonged water quantity research in the irrigation scheme in Nickerie there is a high potential to use the results as a tool to improve the water management policy in order to fine-tune the demand and supply of irrigation water to a higher degree.

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A. Water calendar Clara pumping station

This is an example of the water division at Clara pumping station. With an indication of the dates and duration of the opening of the different gates within the Clara division box.

Waterdistributieschema Westelijke polders t.b.v. de voorjaarsinzaai 2012/najaarsoogst 2012

Inzaai periode	DATUM	VDP/SIDOREDJO/ WALDECK/ MARGENTHENBURG	COR. PLD CLARA PLD A, B EN C	NANNI PLD
Mei '12	21 mei - 27 mei '12	Open	Dicht	Open
Mei/Juni '12	28 mei - 3 juni '12	Dicht	Open	Open
Juni '12	4 juni - 10 juni '12	Open	Dicht	Open
Juni '12	11 juni - 17 juni '12	Dicht	Open	Open
Juni '11	18 juni - 24 juni '12	Open	Dicht	Open
Juni/Juli '12	25 juni - 1 juli '12	Dicht	Open	Open
Juli '12	2 juli - 8 juli '12	Open	Dicht	Open
Juli '12	9 juli - 15 juli '12	Dicht	Open	Open
Juli '12	16 juli - 22 juli '12	Open	Dicht	Open
Juli '12	23 juli - 29 juli '12	Dicht	Open	Open
Juli/Aug '12	30 juli - 5 aug '12	Open	Dicht	Open
Aug '12	6 aug - 12 aug '12	Dicht	Open	Open
Aug '12	13 aug - 19 aug '12	Open	Dicht	Open
Aug '12	20 aug - 26 aug '12	Dicht	Open	Open
Aug/Sept '12	27 aug - 2 sept '12	Open	Dicht	Open

N.B. : *Er mag slechts water gepompt worden, wanneer de desbetreffende polderinlaat dicht is en bij een waterstand lager dan het maaiveld.
*Het is de bedoeling om Nannipolder - Noord ook in het pompsysteem op te nemen.

The columns from left to right correspond to: sewing period; date; gate to VDP/SIDEOREDJO/Waldeck/Margenthenburg (in this and the following column it is mentioned whether this gate should be open or closed (=dicht); gate to Corantijn polder and Clara polder A, B, and C; gate to Nanni polder.

B. Geometry and field situation of Nanni intake, intake HA and IKUGH

1. Nanni intake

Intake description		
2 gates		
Gate width	3.00	m
Depth from concrete to bottom	4.30	m
NSP-reference pin	0.11+concrete	m
NSP-height reference pin	0.38	m
Height gates	3.63	m


Figure 33: View Nanni intake, downstream side

Figure 34: View Nanni intake, upstream side

2. Intake HA

Description		
Rectangular culvert	NSP pin 3.497	
Geometry interior	Width	2.40 m
	Height	1.50 m
	Length	15.16 m

Intake gate is somewhat slanting/skew, so that when gate is closed, probably the right side will still let water pass.



Figure 35: Intake HA downstream side

Figure 36: Intake HA, upstream side

Figure 37: Intake HA,

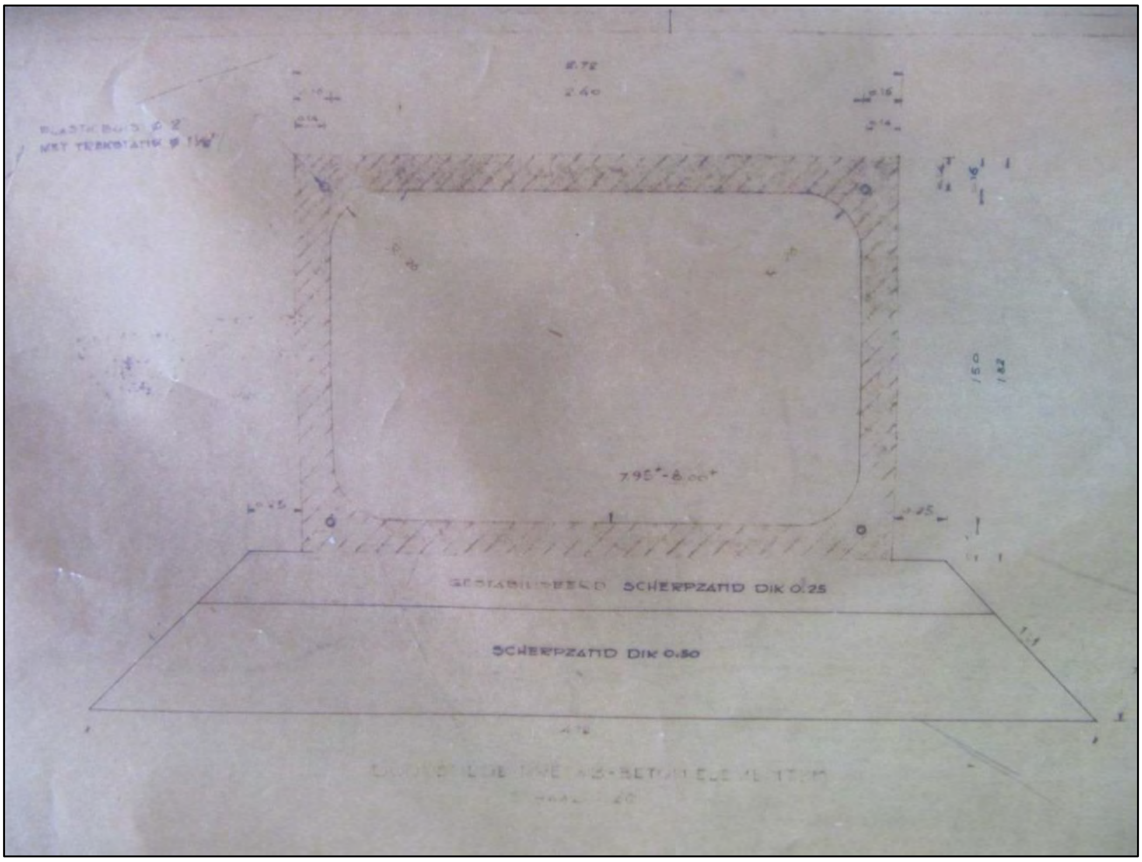


Figure 38: Construction drawing HA, front view

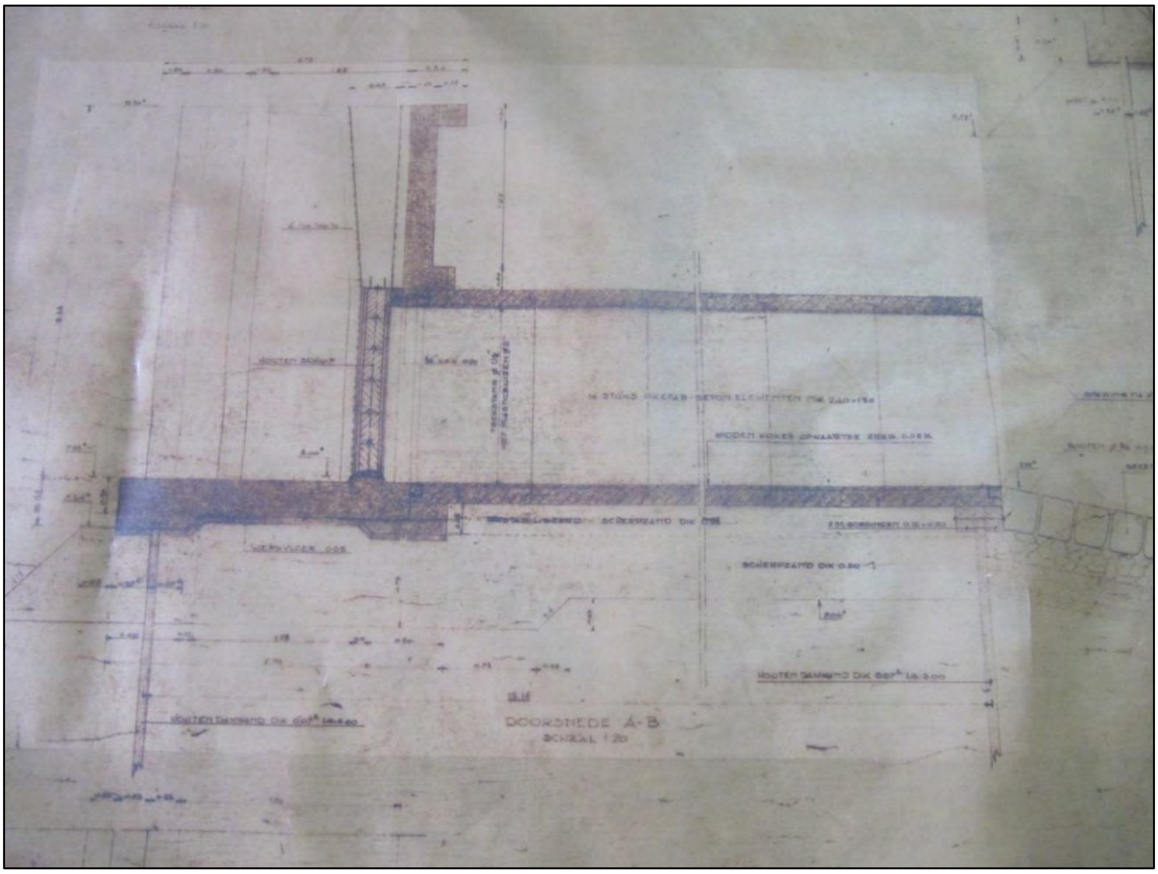


Figure 39: Construction drawing HA, side view

Intake Ha is constructed in 1966, with at the time a tackle and therefore easily operational change of gate setting. However, the tackle is broken down and now it is very hard to adjust the gate setting.

When closed, the right side of the gate of intake HA does not reach to the bottom. The distance between the bottom and the totally right side of the gate is 8cm, hence water also flows through the intake when it is 'closed'. The flow through HA is always submerged, even with a totally open gate.

The distance from the concrete to the bottom (u.s.) is 1.23m.

3. IKUGH

Intake description		
3 gates		
Width per gate	2.52	m
Depth from concrete to bottom	4.21	m
NSP-reference pin (3.902m)	0.09+concrete	m

Figure 40: Photo of the downstream side of IKUGH

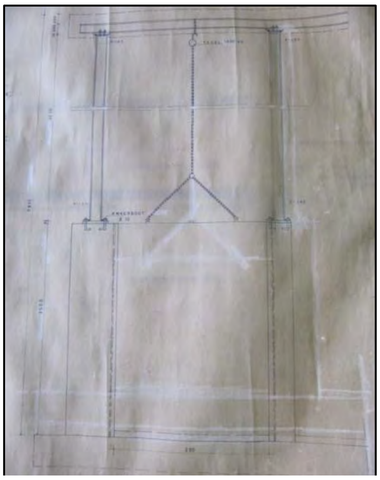


Figure 41: Construction drawing IKUGH, one gate

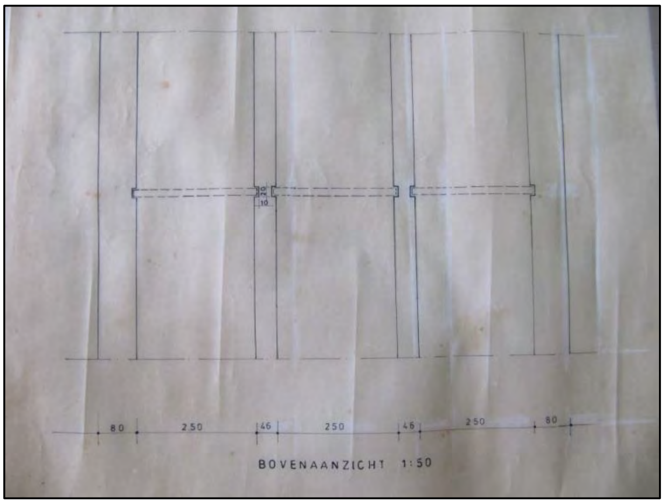


Figure 42: Construction drawing IKUGH, plan view

C. Locations of intakes, cross-sections for discharge measurement, and staff gauges

This annex displays the locations of the intakes, selected cross-sections for discharge measurement, and the locations of both upstream and downstream staff gauges.

For the intake calibrations the relative water level difference was calculated by subtracting the downstream NSP-water level from the upstream NSP-water level. These levels were read from the staff gauges which were constructed at suitable locations concerning proximity to the intakes and practicability of construction and reading. The locations of the staff gauges are visualized in the figures below.

1. Nanni intake

The coordinates for Nanni intake are: 05°48.733' N 056°59.102' W. The coordinates for the discharge measurement location in the Van Wouw canal are: 05°48.805’ N 056°59.157’ W and for the Stondansie canal these coordinates are: 05°48.784' N 056°59.087' W. And the coordinates for the staff gauges are 05°48.747' N 056°59.122' W for the downstream staff gauge and 05°48.755' N 056°59.057' W for the upstream staff gauge.

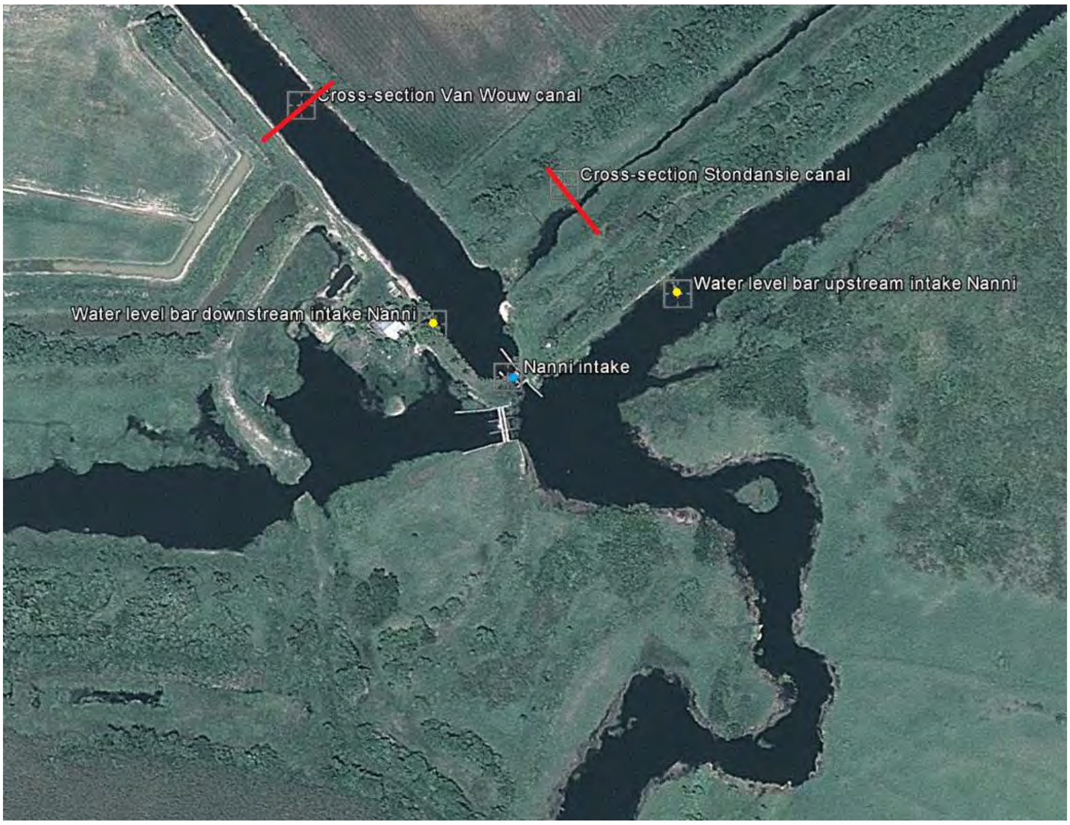


Figure 43: Google Earth picture with GPS-locations of Nanni (blue), the staff gauges (yellow) and the discharge measurement cross-sections (red). Derived at 21-03-2013

2. Intake HA and IKUGH

As intake HA and IKUGH are located in each other’s vicinity, the upstream staff gauge for the intake calibration of both intakes could be one and the same bar. During the time of research the downstream staff gauge at IKUGH had not been installed yet.

The coordinates for intake HA are: 05°50.216' N 056°57.212' W. The coordinates for the discharge measurement location in the HA canal are: 05°50.245' N 056°57.223' W. And the coordinates for the staff gauges are 05°50.221' N 056°57.221' W for the downstream staff gauge and 05°50.245' N 056°.57.153' W for the upstream staff gauge. The coordinates for the discharge measurement cross-section for the HA canal are: 05°50.245' N 056°57.223' W.

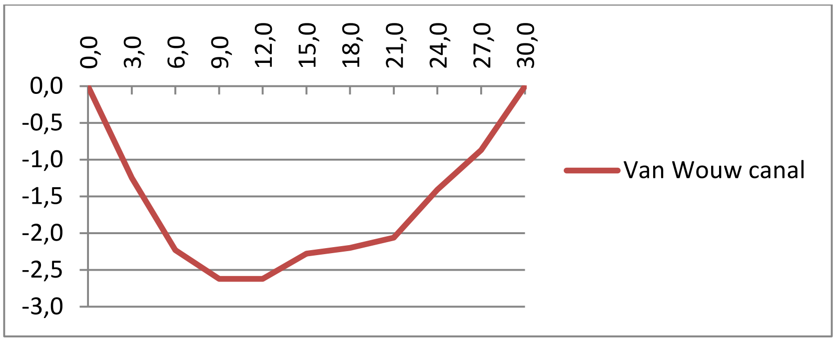
The coordinates for IKUGH are: 05°50.239' N 056°57.132' W. The discharge measurement cross-section for the left canal are: 05°50.280' N 056°57.108' W. The cross-section in the Lateraal canal was not GPS identified, though Figure 44 shows this cross-section in red as well.

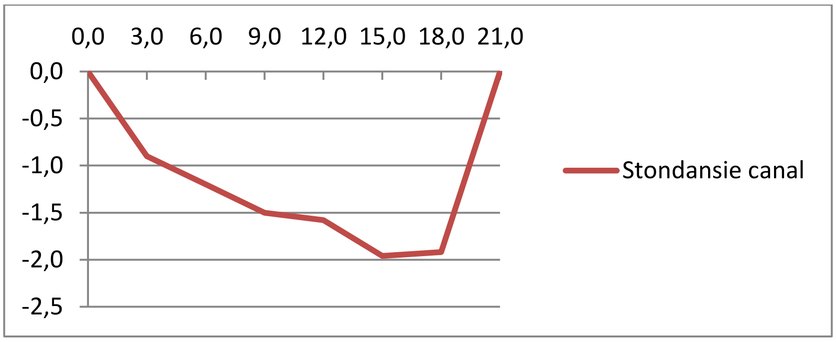
Figure 44: Google Earth picture with GPS-locations of intake HA and IKUGH (blue), the staff gauges (yellow) and the discharge measurement cross-sections (red). Derived at 21-03-2013

D. Cross-sections irrigation canals

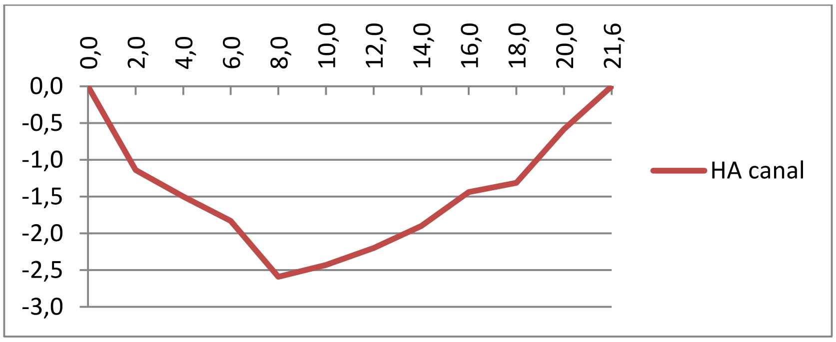
For the different calibrations the cross-sections which were selected for discharge measurement are displayed here. The units are in meters, and the x-axis at the same time displays the locations of the verticals where the depth was measured.

1. Nanni intake



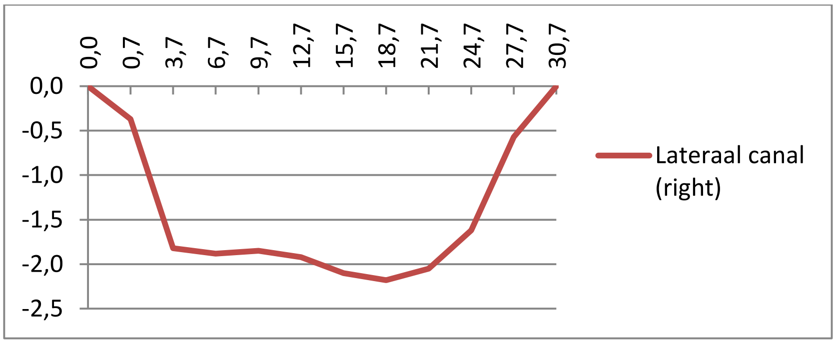


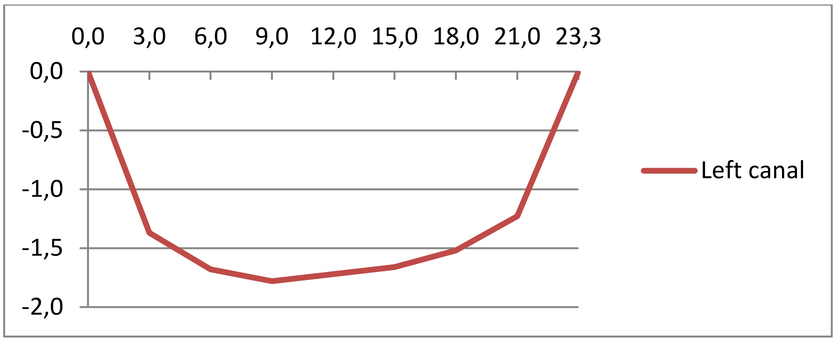
2. Intake HA



3. IKUGH

After flowing through IKUGH, the water divides into both left and right direction. Below the cross-sections at the discharge measurement locations for both the left canal and right canal are displayed.





E. Velocity-depth relations per vertical in discharge measurement cross-sections for Nanni intake

In order to check the turbulence of the water and the validity of applying the two-points method for velocity measurement and discharge measurement a velocity-depth relation was derived. The following figures show the results.

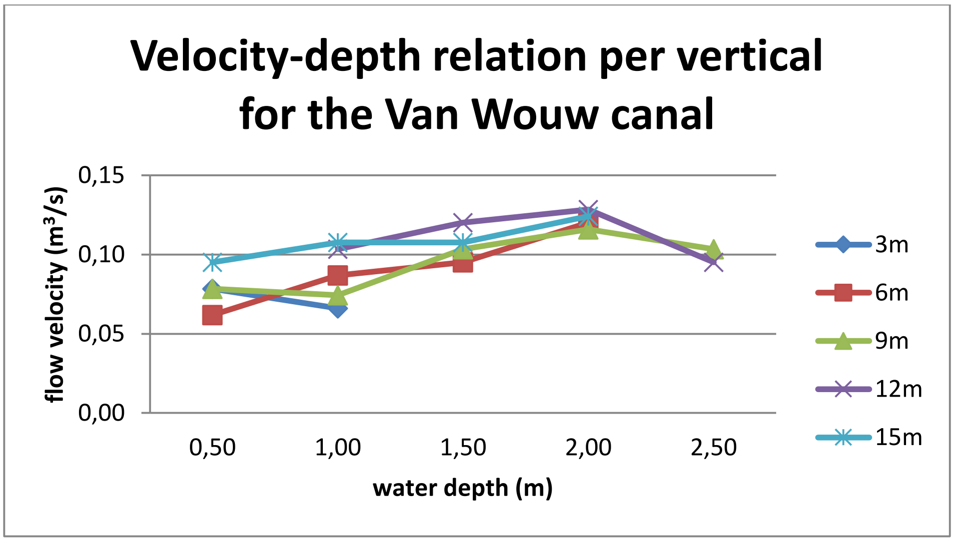


Figure 45: Velocity-depth relation, measured at the 16th of February, 2012

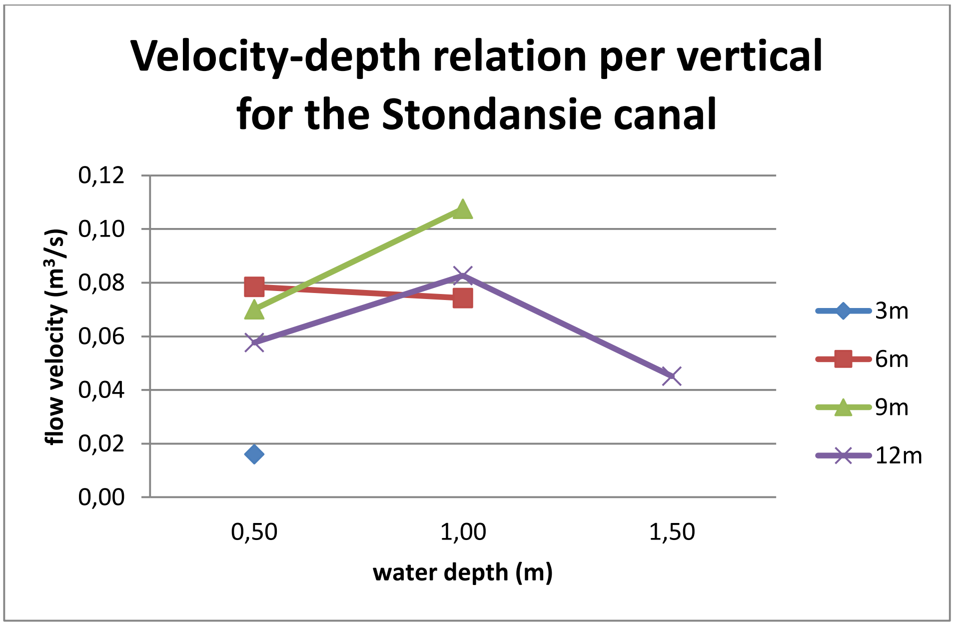


Figure 46: Velocity-depth relation, measured at the 16th of February, 2012

F. Field equipment list

For a discharge measurement field work day a check list was created on which the required equipment was listed.

Requirements:

- Universal current meter C31, OTT Z400 (version O, without display for velocity) and rods
- Boat and paddles, boat moter and gasoline
- Rope (35m)
- Measuring tape
- Notebook, standardized field form, and writing materials
- Cleaning tools in order to clean potentially present grass mats in and around the intake
- GPS-recorder
- Stopwatch
- Calculator
- Rubber bands (or other equipment) to mark the vertical locations on the rope
- Umbrella (to keep paper dry when it's raining)

Note that 2 staff gauges already have to be present, and if not, have to be constructed.

G. Standardized field form for intake calibration measurements

This standard information sheet was used with the purpose to have a quick flow in measurement and to not forget to note down important information. Point 2 and 3 were printed twice in case of measuring discharges in two cross-sections. The sheets are in Dutch, as this was the languages all field workers mastered.

1. INFORMATIE SHEET

Locatie (GPS):	
Datum:	
Ingevuld door:	
Aankomsttijd bij kunstwerk:	
Vertrektijd van kunstwerk:	

Situatie

Weer	Neerslag					
	Wind					
Schuifstand bij aankomst	Linkerschuif	Helemaal open/Helemaal dicht	Schuifstand tov bodem (m):			
	Middenschuif	Helemaal open/Helemaal dicht	Schuifstand tov bodem (m):			
	Rechterschuif	Helemaal open/Helemaal dicht	Schuifstand tov bodem (m):			
Waterstand bij aankomst	Beton-bodem sluis		Beton-waterspiegel sluis		Rode 2.5m stip-bovenkant sluis	
	Waterdiepte waterspiegel-bodem sluis:				Waterdiepte waterspiegel-bodem sluis:	

Waterextractie:

Pompen/sluizen		*aan/uit*	*hoeveel/hoever*	*tijd van begin*	*tijd van stoppen*	*Opmerkingen*
Nanni	Wakay					
	Clara					
HA	Driekokerpunt					
IKUGH:	Suluman					
	Henar					

Waterstand binnen:	
Waterstand buiten:	
Aantal schuiven waarmee geijkt zal worden:	

Notities

2. PROFIELINFORMATIE

Locatie:		
Begroeiing:	*(m)*	*Soort begroeiing*
Afstand vanaf linker oever		
Afstand vanaf rechter oever		

Bodem	
Soort bodem	
Invloed luchtbubbeling	
Opmerkingen	

Diepteprofiel en locatie vertikalen

NSP-waterstand binnen:																		
Schuifopening:				**2.5**			**2**			**1.5**			**1**			**0.5**		
Afstand van LB	**d(m)**	**0.2d**	**0.8d**	**d(m)**	**0.2d**	**0.8d**	**d(m)**	**0.2d**	**0.8d**	**d(m)**	**0.2d**	**0.8d**	**d(m)**	**0.2d**	**0.8d**	**d(m)**	**0.2d**	**0.8d**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3																		
6																		
9																		
12																		
15																		
18																		
21																		
24																		
27																		
30																		
31	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0

Observaties

3. METINGEN OTT-MOLEN

Locatie:													Referenties/opmerkingen
n													
Schuifopening			**2.5**		**2**		**1.5**		**1**		**0.5**		
Afstand van LB	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8	
0													
3													
6													
9													
12													
15													
18													
21													
24													
27													
30													
31													
Begin en einde													
Duur meting													

Opmerkingen

H. Measured velocities and calculated discharges for the intake calibrations

1. Nanni intake

a) Preliminary discharge measurement 05-01-2012

Preliminary discharge measurement Nanni intake 05-01-2012			
Duration measurement	60	s	
Depth	2.63	m	

										Mid section method			Mean S-M
	Distance verticals (m)			0.2d=	0.526m	velocity v	0.8d=	2.104m	velocity v	partial discharge			
Section/verticals	Ref. point	LB	Depth (m)	Rotations	n (1/s)	(m/s)	Rotations	n (1/s)	(m/s)	v average	b average	q (m^3/s)	
Right bank (RB)	1.20	0.00	0.00							0.00			
I	2.20	1.00	2.63	20	0.33	0.10	18	0.30	0.09	0.21	1.00	0.56	0.19
II	3.20	2.00	2.63	14	0.23	0.07	23	0.38	0.11	0.17	1.00	0.45	0.51
III	4.20	3.00	2.63	15	0.25	0.08	27	0.45	0.13	0.19	1.00	0.50	0.48
IV	5.20	4.00	2.63	27	0.45	0.13	59	0.98	0.26	0.36	1.00	0.94	0.72
V	6.20	5.00	2.63	163	2.72	0.71	144	2.40	0.63	1.67	1.00	4.40	2.67
VI	7.20	6.00	2.63	53	0.88	0.24	260	4.33	1.14	1.01	0.83	2.19	3.53
Left bank (LB)	7.85	6.65	0.00							0.00			
											Q (m^3/s)	**9.04**	**8.09**

Date measurement	1-5-2012
Date calculation	1-9-2012

Velocity equation	1	n=< 0	v= 0.2498*n+0.016	0.2498	0.016
	2	0.90=	v= 0.2609*n+0.006	0.2609	0.006

b) Discharge measurement 27-01-2012

27-01-2012	Arrival	approx. 10AM			
	Departure	7.05PM			
Pumps and water level					
Wakay	This morning (approx. 8.30AM) from 3 over to 2 pumps				
Water level Nanni Thalimede	2.3	m			
Gate positions at arrival					
Left	Totally open				
Right	Totally open				
Water depth (m)	From concrete to water level	From concrete to water level	From water level to bottom		
Downstream	4.3	1.39	2.91		
Measurements both in Van Wouw canal and in Stondansie canal					
Duration of measurement	60	s			
Situation					
Pagasse soil (peat)	Difficult to determine water depth due to soft bottom				
Wind	slight headwind from east to west				
Velocity equation OTT-mill	1	n=< 0.90	v= 0.2498*n+0.016	0.2498	0.016
	2	0.90=<n=<9.57	v= 0.2609*n+0.006	0.2609	0.006

The measured depths and the locations for the velocity measurement points at 20% and 80% are displayed in the tables below.

Cross-section Van Wouw canal				
Distance from left bank (m)	**depth (m)**	**0.2d**	**0.8d**	**Notes**
0	0.00	0.00	0.00	no vegetation Clay soil
3	1.42	0.28	1.14	Clay soil
6	2.51	0.50	2.01	Clay soil
9	2.95	0.59	2.36	Clay soil
12	2.95	0.59	2.36	Clay soil
15	2.55	0.51	2.04	Clay soil
18	2.50	0.50	2.00	Clay soil
21	2.36	0.47	1.89	Clay soil
24	1.77	0.35	1.42	Clay soil
27	1.20	0.24	0.96	Clay soil
30	0.35	0.07	0.28	Clay soil
31	0	0	0	1.60m from the bank their is vegetation growth

Cross-section Stondansie canal				
Distance from left bank (m)	**depth (m)**	**0.2d**	**0.8d**	**Notes**
0	0.00	0.00	0.00	Grassmats up to 3m from left bank
3	1.20	0.24	0.96	
6	1.15	0.23	0.92	
9	1.32	0.26	1.06	
12	1.60	0.32	1.28	
15	1.95	0.39	1.56	
18	2.28	0.46	1.82	
21	2.24	0.45	1.79	
24	2.30	0.46	1.84	
24.9	0.00	0.00	0.00	A lot of pegasse and grassmats

Following the number of rotations for each velocity measurement point are displayed for both the Van Wouw canal and the Stondansie canal.

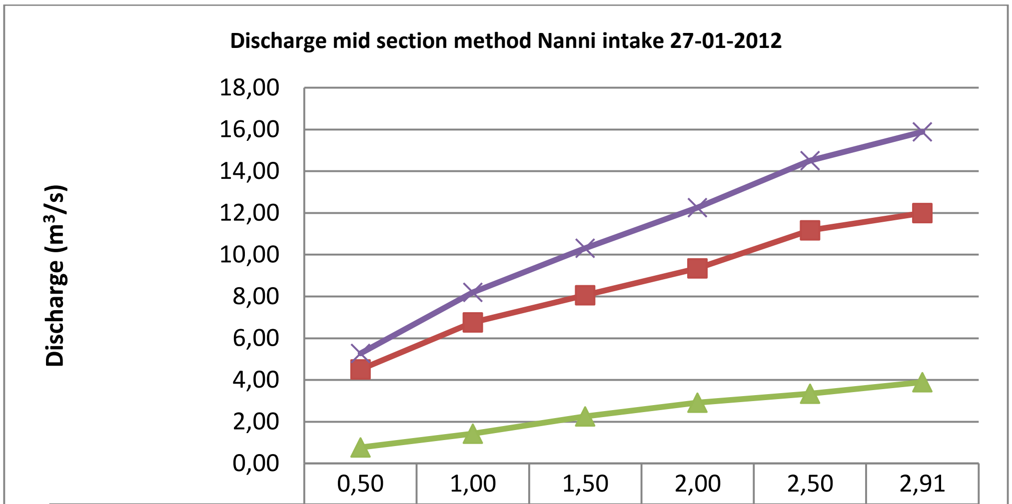
Van Wouw canal:

Gate position with respect to the bottom (m)	**2.91**		**2.50**		**2.00**		**1.50**		**1.00**		**0.50**	
Distance from left bank (m)	0.2d	0.8d	0.2d	0.8d	0.2d	0.8d	0.2d	0.8d	0.2d	0.8d	0.2d	0.8d
0												
3	25	44	42	41	31	25	20	23	12	25	15	14
6	18	48	37	49	20	37	19	22	17	25	4	11
9	39	49	45	45	24	46	13	36	10	27	6	19
12	47	54	19	53	29	44	15	31	13	29	11	19
15	50	60	46	53	24	50	34	41	24	33	12	19
18	43	50	36	54	29	43	21	39	26	27	16	20
21	42	50	36	31	26	40	33	35	31	24	16	20
24	38	39	31	28	29	34	29	31	18	22	15	19
27	23	35	31	32	24	24	25	40	19	28	15	26
30	15	11	12	10	0	8	10	8	0	0	0	0
31												
start and end measurement	11.3	12.1	13.3	14	15	15	16	16	17	17	18	18
Duration measurement	37	min	32	min	29	min	28	min	28	min	29	min

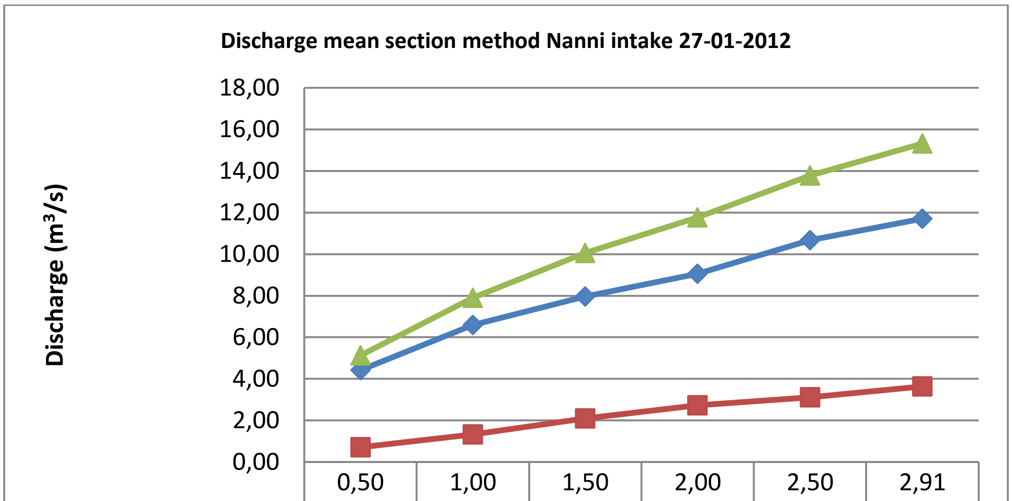
Stondansie canal:

Gate position with respect to the bottom (m)	2.91		2.50		2.00		1.50		1.00		0.50	
Distance from left bank (m)	0.2d	0.8d	0.2d	0.8d	0.2d	0.8d	0.2d	0.8d	0.2d	0.8d	0.2d	0.8d
0												
3	0	0	0	0	0	0	0	0	0	0	0	0
6	8	9	14	12	6	9	3	2	4	2	1	3
9	27	28	23	25	19	22	7	8	4	2	6	2
12	23	35	11	31	7	22	0	13	11	5	1	1
15	26	37	32	29	19	30	14	18	8	9	2	1
18	13	41	9	26	12	21	22	21	8	10	1	0
21	10	25	12	20	15	17	11	12	3	3	1	2
24	1	7	1	0	1	2	0	0	0	0	0	0
24.9												
start and end measurement	12.12	12.46	14.1	14.37	15.28	15.54	16.35	16.57	17.39	17.59	18.43	19.03
Duration measurement	34	min	27	min	26	min	22	min	20	min	20	min

With these rotations the velocities have been calculated. Following, the mid section and mean section discharges per gate position (x-axis) have been calculated from these measured velocities, and the results are displayed in the following tables and graphs.



	0,50	1,00	1,50	2,00	2,50	2,91
Van Wouw canal	4,50	6,76	8,07	9,35	11,18	11,99
Stondansie canal	0,77	1,43	2,25	2,91	3,34	3,89
Both canals	5,27	8,20	10,31	12,26	14,51	15,88



	0,50	1,00	1,50	2,00	2,50	2,91
Van Wouw canal	4,43	6,59	7,97	9,05	10,67	11,70
Stondansie canal	0,71	1,32	2,09	2,72	3,12	3,63
Both canals	5,13	7,90	10,06	11,77	13,78	15,33

c) Discharge measurement 01-02-2012

1-2-2012	Arrival	approx. 10AM			
	Departure	7.05PM			
Pumps and water level					
Wakay	Off				
Water level Nanni Thalimedes	2.47	m			
Clara	Off				
Gate positions at arrival					
Left	Totally open				
Right	Totally closed				
Water depth (m)	From concrete to water level	From concrete to water level	From water level to bottom		
Downstream	4.3	1.53	2.77		
Measurements both in Van Wouw canal and in Stondansie canal					
Duration of measurement	60	s			
Situation					
Pagasse soil (peat)	Difficult to determine water depth due to soft bottom				
Wind	slight headwind from east to west				
Precipitation	Dry, only 5 minutes slight rain				
Velocity equation OTT-mill	1	n=< 0.90	v= 0.2498*n+0.016	0.2498	0.016
	2	0.90=<n=<9.57	v= 0.2609*n+0.006	0.2609	0.006

The measured depths and the locations for the velocity measurement points at 20% and 80% are displayed in the tables below.

Van Wouw canal:

Gate position with respect to the bottom (m)	2.77			2.50			2.00			1.50			1.00			0.50				
Distance from left bank (m)	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	Notes	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	No vegetation	Clay soil
3	1.41	0.28	1.13	1.50	0.30	1.20	1.50	0.30	1.20	1.48	0.30	1.18	1.46	0.29	1.17	1.43	0.29	1.14		Clay soil
6	2.54	0.51	2.03	2.50	0.50	2.00	2.50	0.50	2.00	2.48	0.50	1.98	2.46	0.49	1.97	2.43	0.49	1.94		Clay soil
9	2.83	0.57	2.26	2.72	0.54	2.18	2.72	0.54	2.18	2.70	0.54	2.16	2.68	0.54	2.14	2.65	0.53	2.12		Clay soil
12	2.86	0.57	2.29	2.85	0.57	2.28	2.85	0.57	2.28	2.83	0.57	2.26	2.81	0.56	2.25	2.78	0.56	2.22		Clay soil
15	2.49	0.50	1.99	2.52	0.50	2.02	2.52	0.50	2.02	2.50	0.50	2.00	2.48	0.50	1.98	2.45	0.49	1.96		Clay soil
18	2.40	0.48	1.92	2.44	0.49	1.95	2.44	0.49	1.95	2.42	0.48	1.94	2.40	0.48	1.92	2.37	0.47	1.90		Clay soil
21	2.26	0.45	1.81	2.28	0.46	1.82	2.28	0.46	1.82	2.26	0.45	1.81	2.24	0.45	1.79	2.21	0.44	1.77		Clay soil
24	1.60	0.32	1.28	1.64	0.33	1.31	1.64	0.33	1.31	1.62	0.32	1.30	1.60	0.32	1.28	1.57	0.31	1.26		Clay soil
27	1.02	0.20	0.82	1.11	0.22	0.89	1.11	0.22	0.89	1.09	0.22	0.87	1.07	0.21	0.86	1.04	0.21	0.83		Clay soil
30	0.20	0.04	0.16	0.33	0.07	0.26	0.33	0.07	0.26	0.31	0.06	0.25	0.29	0.06	0.23	0.26	0.05	0.21		Clay soil
31	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	To 1.60m from right bank there is vegetation	

Stondansie canal:

Gate position (m)	2.77			2.50			2.00			1.50			1.00			0.50					
Distance from left bank (m)	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	Notes		
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Grassmats	Peat soil	Air bubbles could affect measurement
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		Peat soil	Air bubbles could affect measurement
6	1.06	0.21	0.85	1.09	0.22	0.87	1.08	0.22	0.86	1.07	0.21	0.86	1.04	0.21	0.83	1.01	0.20	0.81		Peat soil	Air bubbles could affect measurement
9	1.28	0.26	1.02	1.31	0.26	1.05	1.30	0.26	1.04	1.29	0.26	1.03	1.26	0.25	1.01	1.23	0.25	0.98		Peat soil	Air bubbles could affect measurement
12	1.63	0.33	1.30	1.66	0.33	1.33	1.65	0.33	1.32	1.64	0.33	1.31	1.61	0.32	1.29	1.58	0.32	1.26		Peat soil	Air bubbles could affect measurement
15	1.71	0.34	1.37	1.74	0.35	1.39	1.73	0.35	1.38	1.72	0.34	1.38	1.69	0.34	1.35	1.66	0.33	1.33		Peat soil	Air bubbles could affect measurement
18	1.79	0.36	1.43	1.82	0.36	1.46	1.81	0.36	1.45	1.80	0.36	1.44	1.77	0.35	1.42	1.74	0.35	1.39		Peat soil	Air bubbles could affect measurement
21	2.01	0.40	1.61	2.04	0.41	1.63	2.03	0.41	1.62	2.02	0.40	1.62	1.99	0.40	1.59	1.96	0.39	1.57		Peat soil	Air bubbles could affect measurement
24	1.55	0.31	1.24	1.58	0.32	1.26	1.57	0.31	1.26	1.56	0.31	1.25	1.53	0.31	1.22	1.50	0.30	1.20		Peat soil	Air bubbles could affect measurement
24.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1m from right bank there is pegasse		

Following the number of rotations for each velocity measurement point are displayed for both the Van Wouw canal and the Stondansie canal.

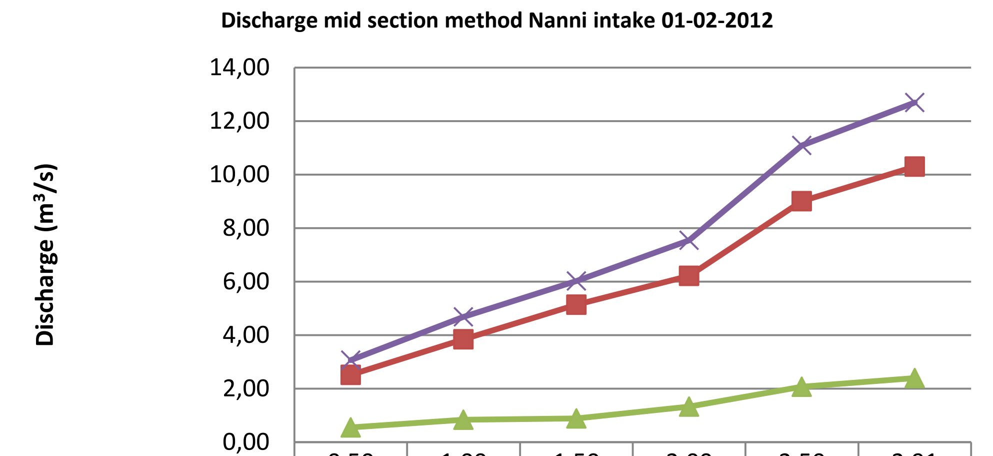
Van Wouw canal:

Number of rotations (n)												
Gate position (m)	**2.91**		**2.50**		**2.00**		**1.50**		**1.00**		**0.50**	
Distance from left bank (m)	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8
0												
3	14	22	22	33	13	13	13	15	8	9	5	5
6	25	42	20	36	9	11	10	16	6	5	1	2
9	15	34	23	32	11	16	13	20	1	15	0	8
12	24	48	17	36	18	30	10	18	10	17	3	11
15	24	46	33	41	21	32	15	21	9	17	5	11
18	31	54	33	45	27	30	25	26	16	18	9	11
21	51	67	46	45	28	30	22	19	22	20	8	13
24	54	62	36	39	23	29	15	22	12	11	8	12
27	42	55	27	25	20	27	10	18	9	9	5	5
30	13	13	8	4	2	6	4	5	0	0	0	0
31												
Start and end measurement	11.30	12.06	13.15	13.46	?	14.53	15.34	16.07	16.43	17.10	17.45	18.16
Duration measurement												

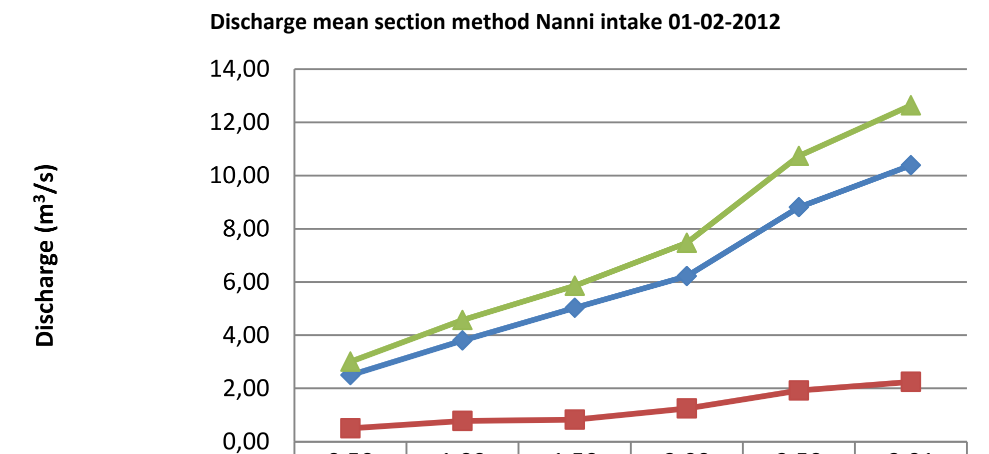
Stondansie canal:

Number of rotations (n)												
Gate position (m)	**2.91**		**2.50**		**2.00**		**1.50**		**1.00**		**0.50**	
Distance from left bank (m)	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8
0												
3	0	0	0	0	0	0	0	0	0	0	0	0
6	5	2	8	4	1	3	2	0	0	2	0	0
9	10	10	13	8	5	1	3	0	0	2	2	0
12	17	24	2	18	6	4	4	2	1	5	0	0
15	10	23	17	23	4	10	2	4	1	9	0	0
18	8	25	12	18	7	12	4	5	0	10	0	4
21	16	22	12	12	6	11	1	6	0	3	0	0
24	4	8	1	2	2	7	0	4	0	0	0	0
24.9												
Start and end measurement	12.10	12.37	14.50	14.11	14.58	15.22	16.12	16.38	17.13	17.31	18.24	18.43
Duration measurement												

Following, the mid section and mean section discharges per gate position (x-axis) have been calculated from these measured velocities, and the results are displayed in the following table and graph.



	0,50	1,00	1,50	2,00	2,50	2,91
Van Wouw canal	2,52	3,85	5,14	6,22	9,01	10,30
Stondansie canal	0,55	0,84	0,88	1,33	2,07	2,40
Both canals	3,07	4,69	6,03	7,54	11,08	12,70



	0,50	1,00	1,50	2,00	2,50	2,91
Van Wouw canal	2,50	3,79	5,03	6,22	8,80	10,39
Stondansie canal	0,51	0,78	0,83	1,25	1,93	2,25
Both canals	3,01	4,57	5,86	7,47	10,73	12,64

d) Discharge measurement 03-02-2012

3-2-2012	Arrival	9.45AM			
	Departure	5.15PM			
Pumps and water level					
Wakay	Off				
Water level Nanni Thalimedes	Not downloaded				
Clara	Not known				
Gate positions at arrival					
Left	Almost totally open				
Right	Totally closed				
Water depth (m)	From concrete to water level	From concrete to water level	From water level to bottom		
Downstream	4,3	1,57	2,73		
Measurements both in Van Wouw canal and in Stondansie canal					
Duration of measurement	60	s			
Situation					
Pagasse soil (peat)	Difficult to determine water depth due to soft bottom				
Wind	slight headwind from east to west				
Precipitation	Much				
Velocity equation OTT-mill	1	n=< 0.90	v= 0.2498*n+0.016	0,2498	0,016
	2	0.90=<n=<9.57	v= 0.2609*n+0.006	0,2609	0,006

The measured depths and the locations for the velocity measurement points at 20% and 80% are displayed in the tables below.

Van Wouw canal:

Gate position with respect to the bottom (m)	**2,69**			**2,50**			**2,00**			**1,50**			**1,00**			**0,50**				
Distance from left bank (m)	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**Notes**	
0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	No vegetation	Clay soil
3	1,53	0,31	1,22	1,59	0,32	1,27	1,59	0,32	1,27	1,57	0,31	1,26	1,57	0,31	1,26	1,54	0,31	1,23		Clay soil
6	2,45	0,49	1,96	2,51	0,50	2,01	2,51	0,50	2,01	2,49	0,50	1,99	2,49	0,50	1,99	2,46	0,49	1,97		Clay soil
9	2,80	0,56	2,24	2,86	0,57	2,29	2,86	0,57	2,29	2,84	0,57	2,27	2,84	0,57	2,27	2,81	0,56	2,25		Clay soil
12	2,84	0,57	2,27	2,90	0,58	2,32	2,90	0,58	2,32	2,88	0,58	2,30	2,88	0,58	2,30	2,85	0,57	2,28		Clay soil
15	2,47	0,49	1,98	2,53	0,51	2,02	2,53	0,51	2,02	2,51	0,50	2,01	2,51	0,50	2,01	2,48	0,50	1,98		Clay soil
18	2,40	0,48	1,92	2,46	0,49	1,97	2,46	0,49	1,97	2,44	0,49	1,95	2,44	0,49	1,95	2,41	0,48	1,93		Clay soil
21	2,21	0,44	1,77	2,27	0,45	1,82	2,27	0,45	1,82	2,25	0,45	1,80	2,25	0,45	1,80	2,22	0,44	1,78		Clay soil
24	1,50	0,30	1,20	1,56	0,31	1,25	1,56	0,31	1,25	1,54	0,31	1,23	1,54	0,31	1,23	1,51	0,30	1,21		Clay soil
27	1,08	0,22	0,86	1,14	0,23	0,91	1,14	0,23	0,91	1,12	0,22	0,90	1,12	0,22	0,90	1,09	0,22	0,87		Clay soil
29,7	0,30	0,06	0,24	0,36	0,07	0,29	0,36	0,07	0,29	0,34	0,07	0,27	0,34	0,07	0,27	0,31	0,06	0,25		Clay soil
30,4	0,00	0,00	0,00	0,00	0,00		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	To 1.60m from bank there is vegetation	

Stondansie:

Gate position with respect to the bottom (m)	**2,77**			**2,50**			**2,00**			**1,50**			**1,00**			**0,50**				
Distance from left bank (m)	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**Notes**	
0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	No vegetation	Clay soil
3	1,10	0,00	0,00	1,12	0,00	0,00	1,12	0,00	0,00	1,10	0,00	0,00	1,08	0,00	0,00	1,04	0,00	0,00		Clay soil
6	1,39	0,28	1,11	1,41	0,28	1,13	1,41	0,28	1,13	1,39	0,28	1,11	1,37	0,27	1,10	1,33	0,27	1,06		Clay soil
9	1,65	0,33	1,32	1,67	0,33	1,34	1,67	0,33	1,34	1,65	0,33	1,32	1,63	0,33	1,30	1,59	0,32	1,27		Clay soil
12	1,90	0,38	1,52	1,92	0,38	1,54	1,92	0,38	1,54	1,90	0,38	1,52	1,88	0,38	1,50	1,84	0,37	1,47		Clay soil
15	2,10	0,42	1,68	2,12	0,42	1,70	2,12	0,42	1,70	2,10	0,42	1,68	2,08	0,42	1,66	2,04	0,41	1,63		Clay soil
18	2,28	0,46	1,82	2,30	0,46	1,84	2,30	0,46	1,84	2,28	0,46	1,82	2,26	0,45	1,81	2,22	0,44	1,78		Clay soil
21	2,01	0,40	1,61	2,03	0,41	1,62	2,03	0,41	1,62	2,01	0,40	1,61	1,99	0,40	1,59	1,95	0,39	1,56		Clay soil
21,5	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00		Clay soil

Following the number of rotations for each velocity measurement point are displayed for both the Van Wouw canal and the Stondansie canal.

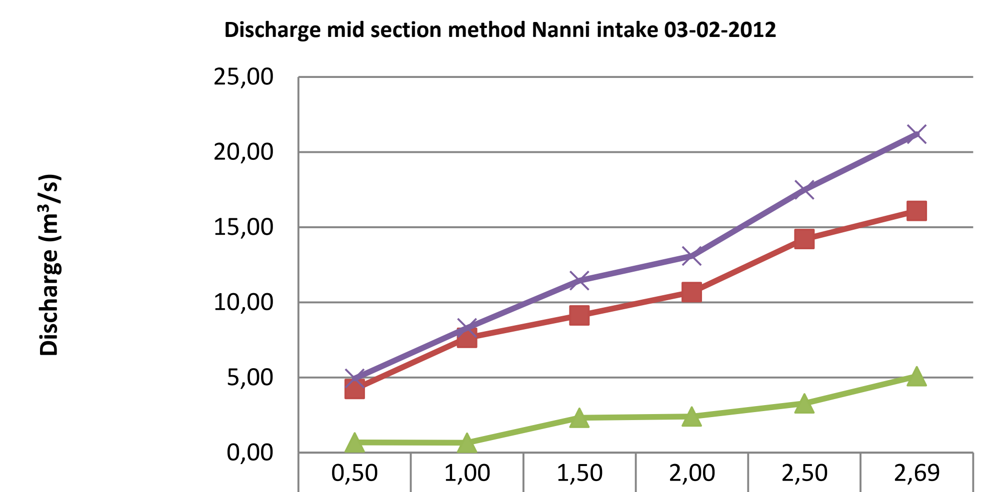
Van Wouw canal:

Number of rotations (n)												
Gate position (m)	**2.69**		**2.50**		**2.00**		**1.50**		**1.00**		**0.50**	
Distance from left bank (m)	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8
0												
3	42	62	33	50	22	34	26	30	12	23	9	8
6	50	38	33	48	25	36	27	37	16	29	2	11
9	50	70	32	58	25	40	28	38	22	32	3	21
12	54	90	42	67	34	49	25	40	21	35	15	24
15	69	85	60	66	49	56	34	37	25	32	16	20
18	51	78	57	73	31	52	39	43	33	39	11	19
21	58	68	61	64	41	48	33	42	28	33	16	17
24	72	67	62	60	34	47	24	34	26	25	9	15
27	43	58	40	37	34	43	19	26	18	32	7	14
29.7	24	24	13	21	10	17	7	8	0	7	0	0
30.4												
Start and end measurement	10.13	10.45	11.25	11.55	12.18	12.54	14.14	14.43	15.10	15.36	16.16	16.45
Duration measurement												

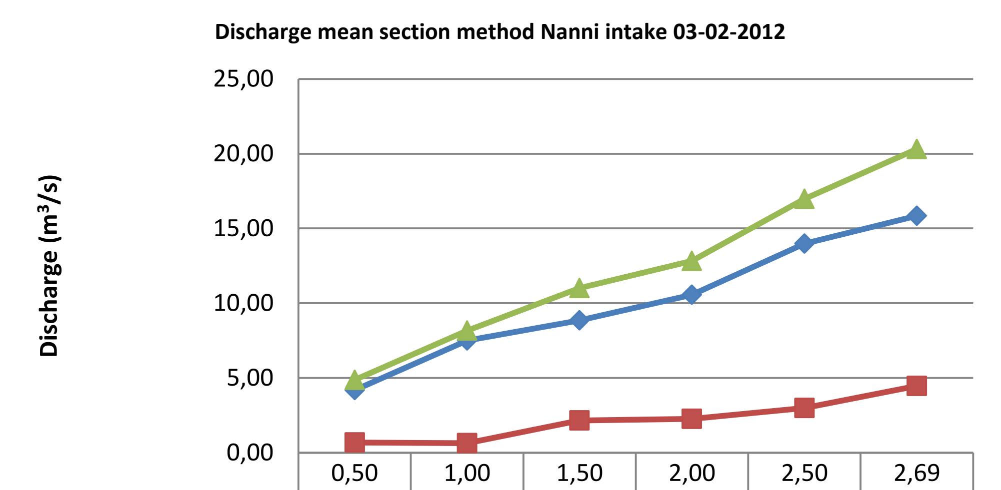
Stondansie canal:

Number of rotations (n)												
Gate position (m)	**2.69**		**2.50**		**2.00**		**1.50**		**1.00**		**0.50**	
Distance from left bank (m)	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8	0.2	0.8
0												
3	37	38	11	15	4	3	2	6	0	2	0	0
6	34	40	13	25	7	10	8	11	0	0	2	0
9	36	49	2	28	8	16	7	21	0	1	0	1
12	26	43	18	34	16	24	12	22	2	2	0	0
15	18	52	21	34	17	27	16	25	1	1	5	1
18	23	31	16	22	5	19	2	20	0	2	3	1
21	0	0	0	0	0	0	0	0	0	0	0	0
21.5	-	-	-	-	-	-	-	-	-	-	-	-
Start and end measurement	12.1	12.37	14.5	14.11	14.58	15.22	16.12	16.38	17.13	17.31	18.24	18.43
Duration measurement												

Following, the mid section and mean section discharges per gate position (x-axis) have been calculated from these measured velocities, and the results are displayed in the following table and graph.



	0,50	1,00	1,50	2,00	2,50	2,69
Van Wouw canal	4,24	7,64	9,12	10,68	14,20	16,09
Stondansie canal	0,70	0,67	2,32	2,42	3,29	5,10
Both canals	4,94	8,31	11,44	13,09	17,49	21,18



	0,50	1,00	1,50	2,00	2,50	2,69
Van Wouw canal	4,20	7,51	8,84	10,57	13,99	15,83
Stondansie canal	0,67	0,64	2,16	2,26	3,00	4,47
Both canals	4,87	8,15	11,00	12,83	16,98	20,30

e) Discharge measurement 08-02-2012

1. INFORMATIE SHEET		
Locatie (GPS):		
Datum:	41123.00	
Ingevuld door:	T. Henstra	
Aankomsttijd bij kunstwerk:	9.20u	
Vertrektijd van kunstwerk:	17.15u	

Situatie				
Weer	Neerslag	Mooi weer en warm		
	Wind			
Schuifstand bij aankomst	Linkerschuif		Schuifstand tov bode 1m	
	Rechterschuif	Helemaal dicht		
Waterstand bij aankomst	Beton-bodem sluis	Beton-waterspiegel sluis	Rode 2.5m stip-bovenkant sluis	0.25
	Waterdiepte waterspiegel-bodem sluis:		Waterdiepte waterspiegel-bodem sluis:	2.75

Waterextractie:

Pompen/sluizen		*aan/uit*	*hoeveel/hoever*
Nanni	Wakay	Uit	
	Clara	Pompen uit. Geen water verdelen waarschijnlijk	
HA	Driekokerpunt		
IKUGH:	Suluman		
	Henar		

Notities:

Waterhoogte is moeilijk af te lezen bij peillat binnen: water is onstuimig.
Officieel zou het misschien goed zijn pas te beginnen met metingen als waterpeil binnen niet meer stijgt?
Of gaat dat door tot het waterpeil binnen gelijk is geworden aan waterpeil buiten? Waarschijnlijk wel.
Practisch gezien kunnen we ook niet wachter tot het gedeeltelijk stabiel is. Geen tijd.

2. PROFIELINFORMATIE	**Kanaal 2**	
Locatie:	Stondansie kanaal	
Begroeiing:	*(m)*	*Soort begroeiing*
Afstand vanaf linker oever	0m	Gerekend dat grasmatten vergroeid zijn met oever, dus na grasmatten begint het kanaalprofiel pas
Afstand vanaf rechter oever		
Bodem		
Soort bodem	Pagasse	
Invloed luchtbubbeling	Vrij groot	Heeft waarschijnlijk wel invloed op aantal rotaties
Opmerkingen		

The measured depths and the locations for the velocity measurement points at 20% and 80% are displayed in the tables below.

Van Wouw canal:

Gate position (m)	2.75			2.50			2.00			1.50			1.00			0.50		
Distance from left bank (m)	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	1.49	0.30	1.19	1.53	0.31	1.22	1.54	0.31	1.23	1.51	0.30	1.21	1.49	0.30	1.19	1.46	0.29	1.17
6.00	2.41	0.48	1.93	2.45	0.49	1.96	2.46	0.49	1.97	2.43	0.49	1.94	2.41	0.48	1.93	2.38	0.48	1.90
9.00	2.78	0.56	2.22	2.82	0.56	2.26	2.83	0.57	2.26	2.80	0.56	2.24	2.78	0.56	2.22	2.75	0.55	2.20
12.00	2.82	0.56	2.26	2.86	0.57	2.29	2.87	0.57	2.30	2.84	0.57	2.27	2.82	0.56	2.26	2.79	0.56	2.23
15.00	2.45	0.49	1.96	2.49	0.50	1.99	2.50	0.50	2.00	2.47	0.49	1.98	2.45	0.49	1.96	2.42	0.48	1.94
18.00	2.34	0.47	1.87	2.38	0.48	1.90	2.39	0.48	1.91	2.36	0.47	1.89	2.34	0.47	1.87	2.31	0.46	1.85
21.00	2.26	0.45	1.81	2.30	0.46	1.84	2.31	0.46	1.85	2.28	0.46	1.82	2.26	0.45	1.81	2.23	0.45	1.78
24.00	1.50	0.30	1.20	1.54	0.31	1.23	1.55	0.31	1.24	1.52	0.30	1.22	1.50	0.30	1.20	1.47	0.29	1.18
27.00	1.00	0.20	0.80	1.04	0.21	0.83	1.05	0.21	0.84	1.02	0.20	0.82	1.00	0.20	0.80	0.97	0.19	0.78
30.00	0.11	0.02	0.09	0.15	0.03	0.12	0.16	0.03	0.13	0.13	0.03	0.10	0.11	0.02	0.09	0.08	0.02	0.06
30.20	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Stondansie canal:

Gate position (m)	2.75			2.50			2.00			1.50			1.00			0.50		
Distance from left bank (m)	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	1.10	0.00	0.00	1.12	0.00	0.00	1.12	0.00	0.00	1.10	0.00	0.00	1.08	0.00	0.00	1.04	0.00	0.00
6.00	1.39	0.28	1.11	1.41	0.28	1.13	1.41	0.28	1.13	1.39	0.28	1.11	1.37	0.27	1.10	1.33	0.27	1.06
9.00	1.65	0.33	1.32	1.67	0.33	1.34	1.67	0.33	1.34	1.65	0.33	1.32	1.63	0.33	1.30	1.59	0.32	1.27
12.00	1.90	0.38	1.52	1.92	0.38	1.54	1.92	0.38	1.54	1.90	0.38	1.52	1.88	0.38	1.50	1.84	0.37	1.47
15.00	2.10	0.42	1.68	2.12	0.42	1.70	2.12	0.42	1.70	2.10	0.42	1.68	2.08	0.42	1.66	2.04	0.41	1.63
18.00	2.28	0.46	1.82	2.30	0.46	1.84	2.30	0.46	1.84	2.28	0.46	1.82	2.26	0.45	1.81	2.22	0.44	1.78
21.00	2.01	0.40	1.61	2.03	0.41	1.62	2.03	0.41	1.62	2.01	0.40	1.61	1.99	0.40	1.59	1.95	0.39	1.56
21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Following the number of rotations for each velocity measurement point are displayed for both the Van Wouw canal and the Stondansie canal.

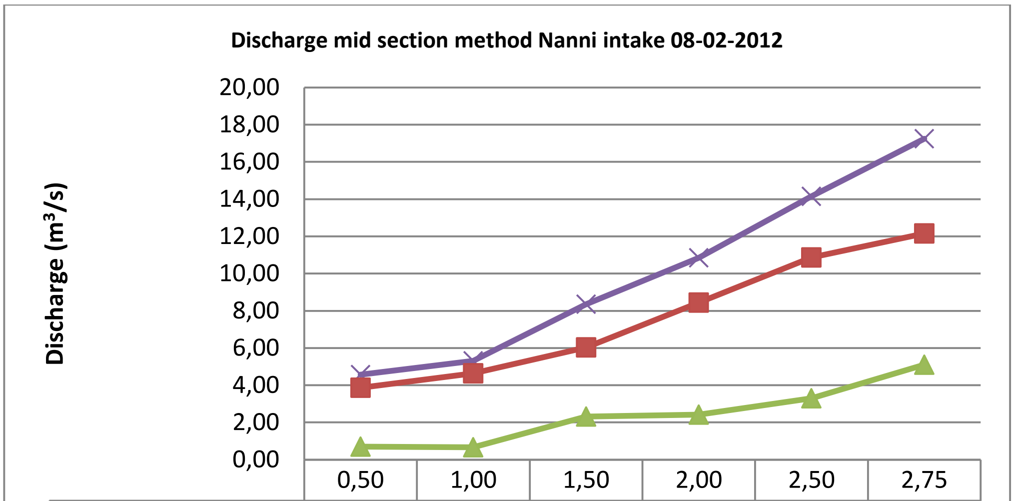
Van Wouw canal:

Number of rotations (n)												
Gate position (m)	**2.75**		**2.50**		**2.00**		**1.50**		**1.00**		**0.50**	
Distance from left bank (m)	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80
0.00												
3.00	26	27	26	28	19	28	7	17	11	13	11	7
6.00	35	44	28	38	18	34	17	22	13	12	10	13
9.00	17	41	29	46	17	34	18	21	12	15	8	12
12.00	24	47	35	44	23	41	18	24	12	18	9	13
15.00	53	63	37	50	36	47	20	29	13	21	11	15
18.00	50	70	36	49	31	37	22	30	21	24	16	19
21.00	59	69	47	59	29	39	21	27	17	20	20	15
24.00	60	67	49	53	23	31	20	28	14	18	13	15
27.00	49	69	33	51	28	31	15	17	9	11	7	8
30.00												
30.20												

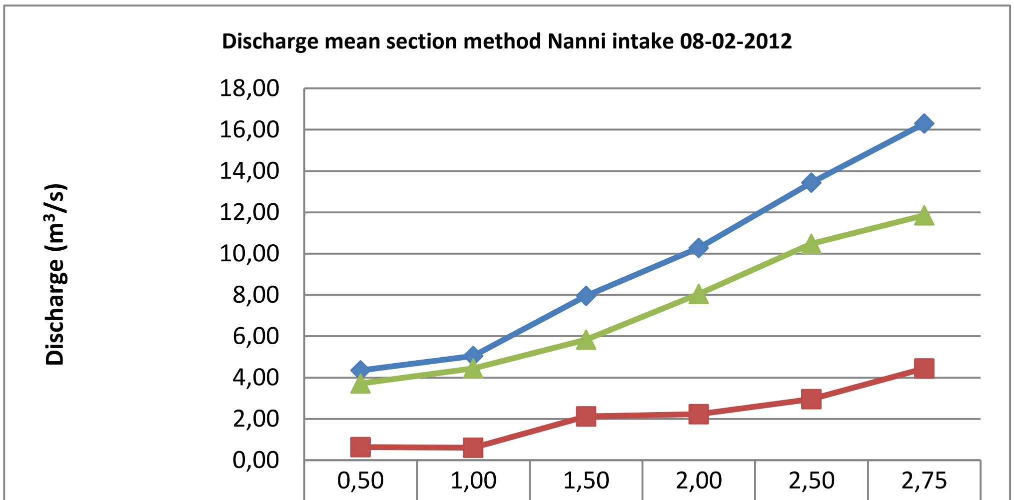
Stondansie canal:

Number of rotations (n)												
Gate position (m)	**2.75**		**2.50**		**2.00**		**1.50**		**1.00**		**0.50**	
Distance from left bank (m)	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80
0.00												
3.00	37	38	11	15	4	3	2	6	0	2	0	0
6.00	34	40	13	25	7	10	8	11	0	0	2	0
9.00	36	49	2	28	8	16	7	21	0	1	0	1
12.00	26	43	18	34	16	24	12	22	2	2	0	0
15.00	18	52	21	34	17	27	16	25	1	1	5	1
18.00	23	31	16	22	5	19	2	20	0	2	3	1
21.00	0	0	0	0	0	0	0	0	0	0	0	0
21.50	-	-	-	-	-	-	-	-	-	-	-	-

Following, the mid section and mean section discharges per gate position (x-axis) have been calculated from these measured velocities, and the results are displayed in the following table and graph.



	0,50	1,00	1,50	2,00	2,50	2,75
Both canals	4,56	5,31	8,35	10,86	14,15	17,25
Van Wouw canal	3,87	4,64	6,03	8,44	10,86	12,16
Stondansie canal	0,70	0,67	2,32	2,42	3,29	5,10



	0,50	1,00	1,50	2,00	2,50	2,75
Stondansie canal	0,64	0,61	2,13	2,23	2,96	4,44
Both canals	4,35	5,05	7,96	10,28	13,44	16,29
Van Wouw canal	3,71	4,44	5,83	8,06	10,47	11,86

f) Discharge measurement 10-02-2012

1. INFORMATIE SHEET

Locatie (GPS):	Nanni inlaat
Datum:	2-10-2012
Ingevuld door:	T. Henstra
Aankomsttijd bij kunstwerk:	10.45u
Vertrektijd van kunstwerk:	18.50u

Situatie

Weer	Neerslag	Mooi weer en warm		
	Wind	Matig		
Schuifstand bij aankomst	Linkerschuif	Klein stukje open	Schuifstand tov bodem (m):	
	Rechterschuif	Helemaal dicht		
Waterstand bij aankomst	Beton-bodem sluis	Beton-waterspiegel sluis	Rode 2.5m stip-bovenkant sluis	0.16
	Waterdiepte waterspiegel-bodem sluis:		Waterdiepte waterspiegel-bodem sluis:	2.66

Waterextractie:

Pompen/sluizen		*aan/uit*	*hoeveel/hoever*
Nanni	Wakay	Uit	
	Clara	Pompen uit. Geen water verdelen waarschijnlijk	
HA	Driekokerpunt		
IKUGH:	Suluman		
	Henar		

2. PROFIELINFORMATIE	**Kanaal 2**	
Locatie:	Stondansie kanaal	
Begroeiing:	*(m)*	*Soort begroeiing*
Afstand vanaf linker oever	0m	Gerekend dat grasmatten vergroeid zijn met oever, dus na grasmatten begint het kanaalprofiel pas
Afstand vanaf rechter oever		
Bodem		
Soort bodem	Pagasse	
Invloed luchtbubbeling	Vrij groot	Heeft waarschijnlijk wel invloed op aantal rotaties
Opmerkingen		

The measured depths and the locations for the velocity measurement points at 20% and 80% are displayed in the tables below.

Van Wouw canal:

Gate position (m)	2.66			2.50			2.00			1.50			1.00			0.50		
Distance from left bank (m)	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	1.48	0.30	1.18	1.53	0.31	1.22	1.59	0.32	1.27	1.58	0.32	1.26	1.54	0.31	1.23	1.52	0.30	1.22
6.00	2.45	0.49	1.96	2.50	0.50	2.00	2.56	0.51	2.05	2.55	0.51	2.04	2.51	0.50	2.01	2.49	0.50	1.99
9.00	2.82	0.56	2.26	2.87	0.57	2.30	2.93	0.59	2.34	2.92	0.58	2.34	2.88	0.58	2.30	2.86	0.57	2.29
12.00	2.88	0.58	2.30	2.93	0.59	2.34	2.99	0.60	2.39	2.98	0.60	2.38	2.94	0.59	2.35	2.92	0.58	2.34
15.00	2.50	0.50	2.00	2.55	0.51	2.04	2.61	0.52	2.09	2.60	0.52	2.08	2.56	0.51	2.05	2.54	0.51	2.03
18.00	2.41	0.48	1.93	2.46	0.49	1.97	2.52	0.50	2.02	2.51	0.50	2.01	2.47	0.49	1.98	2.45	0.49	1.96
21.00	2.21	0.44	1.77	2.26	0.45	1.81	2.32	0.46	1.86	2.31	0.46	1.85	2.27	0.45	1.82	2.25	0.45	1.80
24.00	1.42	0.28	1.14	1.47	0.29	1.18	1.53	0.31	1.22	1.52	0.30	1.22	1.48	0.30	1.18	1.46	0.29	1.17
27.00	1.10	0.22	0.88	1.15	0.23	0.92	1.21	0.24	0.97	1.20	0.24	0.96	1.16	0.23	0.93	1.14	0.23	0.91
30.00	0.22	0.04	0.18	0.27	0.05	0.22	0.33	0.07	0.26	0.32	0.06	0.26	0.28	0.06	0.22	0.26	0.05	0.21
30.55	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Stondansie canal:

Gate position (m)	2.66			2.50			2.00			1.50			1.00			0.50		
Distance from left bank (m)	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	0.98	0.00	0.00	1.04	0.00	0.00	1.05	0.00	0.00	1.04	0.00	0.00	1.00	0.00	0.00	0.95	0.00	0.00
6.00	1.30	0.26	1.04	1.36	0.27	1.09	1.37	0.27	1.10	1.36	0.27	1.09	1.32	0.26	1.06	1.27	0.25	1.02
9.00	1.55	0.31	1.24	1.61	0.32	1.29	1.62	0.32	1.30	1.61	0.32	1.29	1.57	0.31	1.26	1.52	0.30	1.22
12.00	1.68	0.34	1.34	1.74	0.35	1.39	1.75	0.35	1.40	1.74	0.35	1.39	1.70	0.34	1.36	1.65	0.33	1.32
15.00	2.10	0.42	1.68	2.16	0.43	1.73	2.17	0.43	1.74	2.16	0.43	1.73	2.12	0.42	1.70	2.07	0.41	1.66
18.00	2.11	0.42	1.69	2.17	0.43	1.74	2.18	0.44	1.74	2.17	0.43	1.74	2.13	0.43	1.70	2.08	0.42	1.66
21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Following the number of rotations for each velocity measurement point are displayed for both the Van Wouw canal and the Stondansie canal.

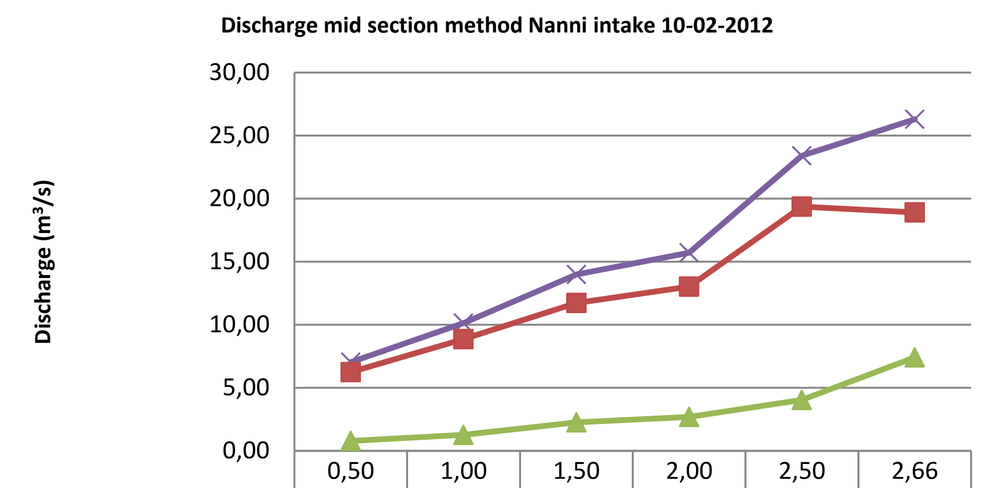
Van Wouw canal:

Number of rotations (n)												
Gate position (m)	2.66		2.50		2.00		1.50		1.00		0.50	
Distance from left bank (m)	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80
0.00												
3.00	55	78	52	62	31	36	26	37	18	15	18	16
6.00	31	86	62	85	27	40	37	48	26	24	20	24
9.00	34	53	52	80	44	51	28	46	30	39	19	21
12.00	64	89	51	86	41	60	36	56	31	42	17	24
15.00	80	94	77	95	53	61	47	56	30	39	19	27
18.00	92	98	74	101	53	64	36	52	35	37	25	27
21.00	92	67	83	98	45	55	41	49	33	42	24	28
24.00	89	91	61	80	45	59	39	53	28	35	17	18
27.00	78	77	48	43	31	38	36	30	24	25	18	18
30.00												

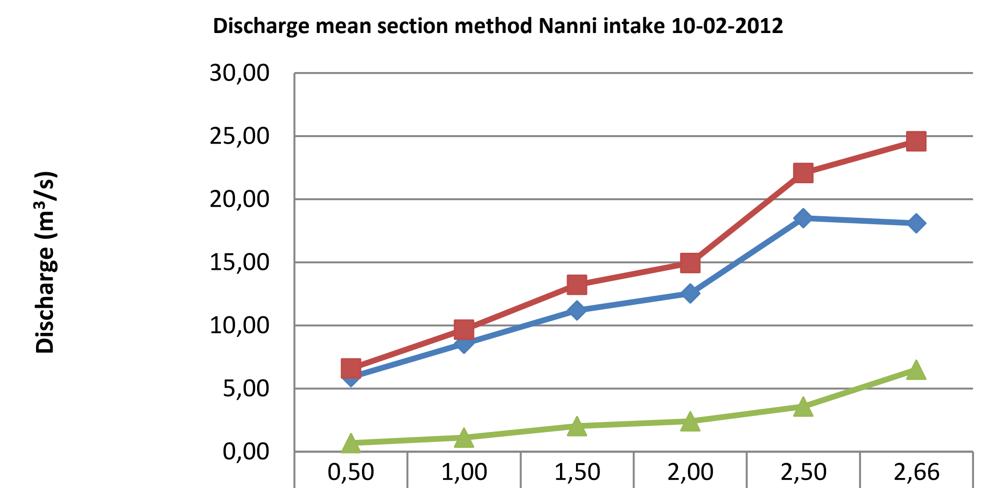
Stondansie canal:

Number of rotations (n)												
Gate position (m)	2.66		2.50		2.00		1.50		1.00		0.50	
Distance from left bank (m)	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80
0.00												
3.00	22	65	15	21	9	9	6	10	8	2	0	0
6.00	67	70	30	32	15	19	13	14	11	5	4	0
9.00	50	88	30	44	13	27	12	18	12	5	3	3
12.00	58	80	10	51	19	29	9	20	2	5	7	1
15.00	58	74	25	46	7	32	16	20	12	7	7	0
18.00	35	19	10	21	6	18	7	18	3	5	4	0
21.00	-	-	-	-	-	-	-	-	-	-	-	-
0.00	-	-	-	-	-	-	-	-	-	-	-	-

Following, the mid section and mean section discharges per gate position (x-axis) have been calculated from these measured velocities, and the results are displayed in the following table and graph.



	0,50	1,00	1,50	2,00	2,50	2,66
Both canals	7,01	10,11	13,98	15,70	23,39	26,30
Van Wouw canal	6,24	8,85	11,73	13,02	19,36	18,90
Stondansie canal	0,77	1,27	2,26	2,68	4,03	7,39



	0,50	1,00	1,50	2,00	2,50	2,66
Van Wouw canal	5,91	8,55	11,20	12,54	18,51	18,09
Stondansie canal	0,69	1,11	2,02	2,40	3,57	6,50
Both canals	6,60	9,66	13,22	14,94	22,08	24,59

g) Discharge measurement 13-02-2012

1. INFORMATIE SHEET	
Locatie (GPS):	Nanniverdeelwerk
Datum:	13 februari 2012
Ingevuld door:	Orneal Small
Aankomsttijd bij kunstwerk:	10.00 u
Vertrektijd van kunstwerk:	19.00u

Situatie					
Weer	Neerslag	zonnig, beetje motten			
	Wind	matig			
Schuifstand bij aankomst	Linkerschuif	2.5 m open		Schuifstand tov bodem (m):	1m
	Rechterschuif	0.5 m open			
Waterstand bij aankomst	Beton-bodem sluis		Beton-waterspiegel sluis	Rode 2.5m stip-bovenkant sluis	0.04
	Waterdiepte waterspiegel-bodem sluis:			Waterdiepte waterspiegel-bodem sluis:	2.54

Waterextractie:

Pompen/sluizen		*aan/uit*
Nanni	Wakay	uit
	Clara	uit
HA	Driekokerpunt	
IKUGH:	Suluman	
	Henar	

Notities:
Rechterkant van de linkersluisdeur raakt het water

2. PROFIELINFORMATIE		**Kanaal 2**	
Locatie:	Stondansie kanaal		
Begroeiing:		*(m)*	*Soort begroeiing*
Afstand vanaf linker oever		0m	Gerekend dat grasmatten vergroeid zijn met oever, dus na grasmatten begint het kanaalprofiel pas
Afstand vanaf rechter oever			
Bodem			
Soort bodem		Pegasse	
Invloed luchtbubbeling		Vrij groot	Heeft waarschijnlijk wel invloed op aantal rotaties
Opmerkingen			

The measured depths and the locations for the velocity measurement points at 20% and 80% are displayed in the tables below.

Van Wouw canal:

Gate position (m)	**2.54**			**2.50**			**2.00**			**1.50**			**1.00**			**0.50**		
Distance from left bank (m)	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	1.54	0.31	1.23	1.58	0.32	1.26	1.61	0.32	1.29	1.60	0.32	1.28	1.57	0.31	1.26	1.54	0.31	1.23
6.00	2.40	0.48	1.92	2.44	0.49	1.95	2.47	0.49	1.98	2.46	0.49	1.97	2.43	0.49	1.94	2.40	0.48	1.92
9.00	1.72	0.34	1.38	1.76	0.35	1.41	1.79	0.36	1.43	1.78	0.36	1.42	1.75	0.35	1.40	1.72	0.34	1.38
12.00	2.75	0.55	2.20	2.79	0.56	2.23	2.78	0.56	2.22	2.77	0.55	2.22	2.78	0.56	2.22	2.75	0.55	2.20
15.00	2.40	0.48	1.92	2.44	0.49	1.95	2.47	0.49	1.98	2.46	0.49	1.97	2.43	0.49	1.94	2.40	0.48	1.92
18.00	2.30	0.46	1.84	2.34	0.47	1.87	2.37	0.47	1.90	2.36	0.47	1.89	2.33	0.47	1.86	2.30	0.46	1.84
21.00	2.12	0.42	1.70	2.16	0.43	1.73	2.19	0.44	1.75	2.18	0.44	1.74	2.15	0.43	1.72	2.12	0.42	1.70
24.00	1.37	0.27	1.10	1.41	0.28	1.13	1.44	0.29	1.15	1.44	0.29	1.15	1.40	0.28	1.12	1.37	0.27	1.10
27.00	0.73	0.15	0.58	0.79	0.16	0.63	0.82	0.16	0.66	0.81	0.16	0.65	0.78	0.16	0.62	0.73	0.15	0.58
30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Stondansie canal:

Gate position (m)	2.54			2.50			2.00			1.50			1.00			0.50		
Distance from left bank (m)	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	0.90	0.00	0.00	0.92	0.00	0.00	0.94	0.00	0.00	0.93	0.00	0.00	0.90	0.00	0.00	0.86	0.00	0.00
6.00	1.18	0.24	0.94	1.21	0.24	0.97	1.22	0.24	0.98	1.21	0.24	0.96	1.18	0.24	0.94	1.14	0.23	0.91
9.00	1.50	0.30	1.20	1.53	0.31	1.22	1.54	0.31	1.23	1.53	0.31	1.22	1.50	0.30	1.20	1.46	0.29	1.16
12.00	1.58	0.32	1.26	1.61	0.32	1.29	1.62	0.32	1.30	1.61	0.32	1.28	1.58	0.32	1.26	1.54	0.31	1.23
15.00	1.96	0.39	1.57	1.99	0.40	1.59	2.00	0.40	1.60	1.99	0.40	1.59	1.96	0.39	1.56	1.91	0.38	1.52
18.00	1.92	0.38	1.54	1.95	0.39	1.56	1.96	0.39	1.57	1.94	0.39	1.55	1.92	0.38	1.53	1.88	0.38	1.50
21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Following the number of rotations for each velocity measurement point are displayed for both the Van Wouw canal and the Stondansie canal.

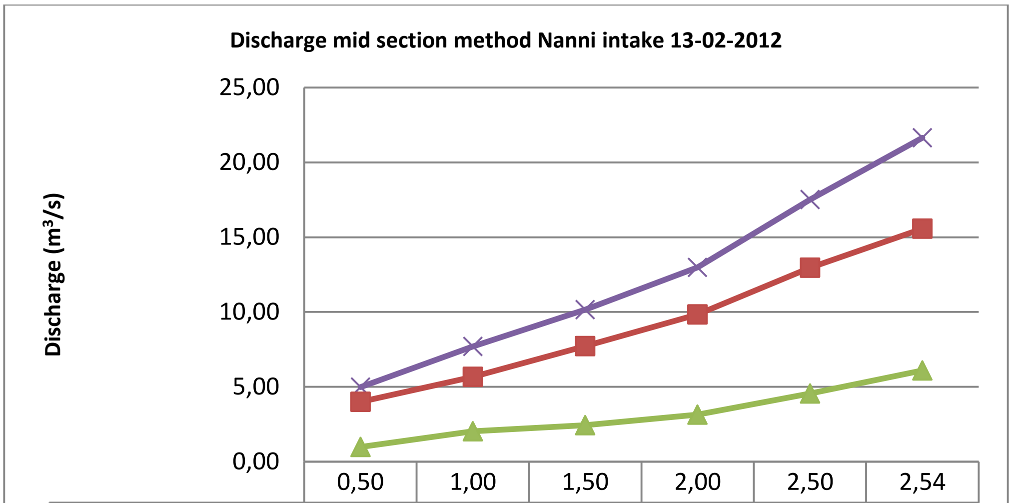
Van Wouw canal:

Number of rotations (n)												
Gate position (m)	**2.54**		**2.50**		**2.00**		**1.50**		**1.00**		**0.50**	
Distance from left bank (m)	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80
0.00												
3.00	57	51	31	57	33	42	27	29	15	13	9	14
6.00	51	50	45	49	26	44	21	28	16	19	8	15
9.00	58	69	33	52	29	44	24	31	14	20	8	15
12.00	71	83	48	76	38	52	35	41	17	32	14	15
15.00	76	88	61	69	42	34	34	43	24	25	16	22
18.00	74	79	66	57	48	51	33	34	29	32	16	16
21.00	60	53	66	54	44	42	29	33	23	26	20	21
24.00	52	60	44	53	26	48	22	28	22	23	12	12
27.00	44	41	33	51	26	30	14	19	11	11	6	11
30.00												

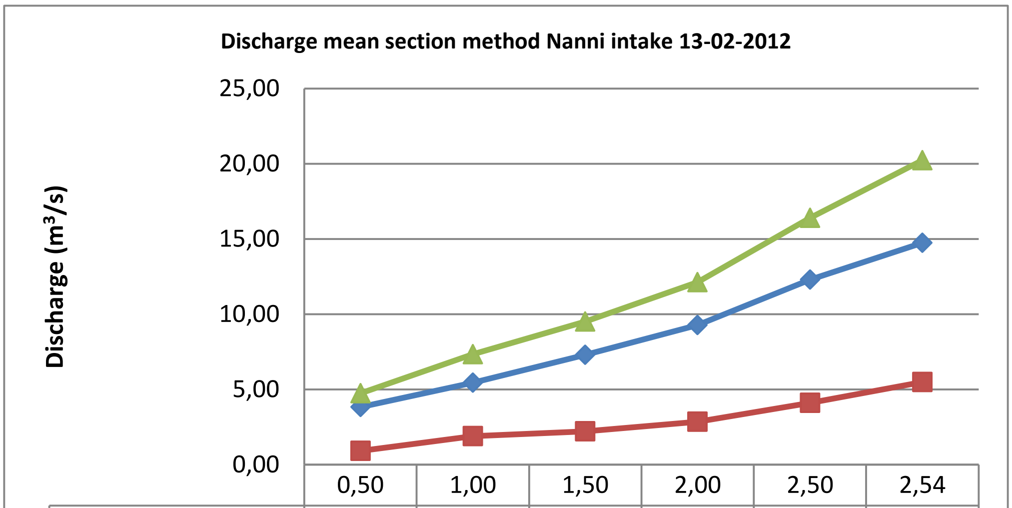
Stondansie canal:

Number of rotations (n)												
Gate position (m)	**2.54**		**2.50**		**2.00**		**1.50**		**1.00**		**0.50**	
Distance from left bank (m)	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80
0.00												
3.00	10	52	12	32	10	18	8	10	1	6	1	0
6.00	51	67	35	46	20	21	12	17	7	10	2	4
9.00	54	63	36	55	25	36	8	22	8	16	5	4
12.00	48	84	30	50	22	46	13	28	17	19	3	8
15.00	22	67	38	40	10	33	22	29	21	23	6	12
18.00	26	51	6	44	15	18	6	22	12	15	1	8
21.00	0	0	0	0	0	0	0	0	0	0	0	0
21.50	-	-	-	-	-	-	-	-	-	-	-	-

Following, the mid section and mean section discharges per gate position (x-axis) have been calculated from these measured velocities, and the results are displayed in the following table and graph.



	0,50	1,00	1,50	2,00	2,50	2,54
Both canals	4,97	7,70	10,16	12,98	17,52	21,65
Van Wouw canal	4,00	5,66	7,73	9,84	12,96	15,56
Stondansie canal	0,98	2,03	2,43	3,14	4,56	6,09



	0,50	1,00	1,50	2,00	2,50	2,54
Van Wouw canal	3,82	5,45	7,29	9,28	12,31	14,75
Both canals	4,74	7,34	9,50	12,12	16,40	20,23
Stondansie canal	0,91	1,89	2,22	2,84	4,10	5,49

h) Discharge measurement 16-02-2012

1. INFORMATIE SHEET	
Locatie (GPS):	Nanniverdeelwerk
Datum:	16 februari 2012
Ingevuld door:	Orneal Small
Aankomsttijd bij kunstwerk:	09.20 u
Vertrektijd van kunstwerk:	19.00u

Situatie					
Weer	Neerslag	Zon,bewolkt			
		Vanaf 13.00 uur regen			
	Wind	matig			
Schuifstand bij aankomst	Linkerschuif	2.0m open	Schuifstand tov bodem (m):	1m	
	Rechterschuif	0.5 m open			
Waterstand bij aankomst	Beton-bodem sluis	Beton-waterspiegel sluis	Rode 2.5m stip-bovenkant sluis		0.15
	Waterdiepte waterspiegel-bodem sluis:		Waterdiepte waterspiegel-bodem sluis:		2.65

Waterextractie:		
Pompen/sluizen		*aan/uit*
Nanni	Wakay	uit
	Clara	uit
HA	Driekokerpunt	
IKUGH:	Suluman	
	Henar	

The measured depths and the locations for the velocity measurement points at 20% and 80% are displayed in the tables below.

Van Wouw canal:

Gate position (m)	**2.65**			**2.50**			**2.00**			**1.50**			**1.00**			**0.50**		
Distance from left bank (m)	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	1.25	0.25	1.00	1.25	0.25	1.00	1.24	0.25	0.99	1.20	0.24	0.96	1.17	0.23	0.94	1.16	0.23	0.93
6.00	2.23	0.45	1.78	2.23	0.45	1.78	2.22	0.44	1.78	2.18	0.44	1.74	2.15	0.43	1.72	2.13	0.43	1.70
9.00	2.62	0.52	2.10	2.62	0.52	2.10	2.61	0.52	2.09	2.57	0.51	2.06	2.54	0.51	2.03	2.53	0.51	2.02
12.00	2.62	0.52	2.10	2.62	0.52	2.10	2.61	0.52	2.09	2.57	0.51	2.06	2.55	0.51	2.04	2.53	0.51	2.02
15.00	2.28	0.46	1.82	2.28	0.46	1.82	2.27	0.45	1.82	2.23	0.45	1.78	2.20	0.44	1.76	2.19	0.44	1.75
18.00	2.20	0.44	1.76	2.20	0.44	1.76	2.19	0.44	1.75	2.15	0.43	1.72	2.12	0.42	1.70	2.11	0.42	1.69
21.00	2.06	0.41	1.65	2.06	0.41	1.65	2.05	0.41	1.64	2.01	0.40	1.61	1.98	0.40	1.58	1.97	0.39	1.58
24.00	1.41	0.28	1.13	1.41	0.28	1.13	1.40	0.28	1.12	1.36	0.27	1.09	1.33	0.27	1.06	1.32	0.26	1.06
27.00	0.87	0.17	0.70	0.87	0.17	0.70	0.86	0.17	0.69	0.82	0.16	0.66	0.79	0.16	0.63	0.78	0.16	0.62
30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Stondansie canal:

Gate position (m)	**2.65**			**2.50**			**2.00**			**1.50**			**1.00**			**0.50**		
Distance from left bank (m)	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**	**d**	**0.2d**	**0.8d**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	0.90	0.00	0.00	0.92	0.00	0.00	0.94	0.00	0.00	0.93	0.00	0.00	0.90	0.00	0.00	0.86	0.00	0.00
6.00	1.20	0.24	0.96	1.21	0.24	0.97	1.22	0.24	0.98	1.21	0.24	0.96	1.18	0.24	0.94	1.14	0.23	0.91
9.00	1.50	0.30	1.20	1.53	0.31	1.22	1.54	0.31	1.23	1.53	0.31	1.22	1.50	0.30	1.20	1.46	0.29	1.16
12.00	1.58	0.32	1.26	1.61	0.32	1.29	1.62	0.32	1.30	1.61	0.32	1.28	1.58	0.32	1.26	1.54	0.31	1.23
15.00	1.96	0.39	1.57	1.99	0.40	1.59	2.00	0.40	1.60	1.99	0.40	1.59	1.96	0.39	1.56	1.91	0.38	1.52
18.00	1.92	0.38	1.54	1.95	0.39	1.56	1.96	0.39	1.57	1.94	0.39	1.55	1.92	0.38	1.53	1.88	0.38	1.50
21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Following the number of rotations for each velocity measurement point are displayed for both the Van Wouw canal and the Stondansie canal.

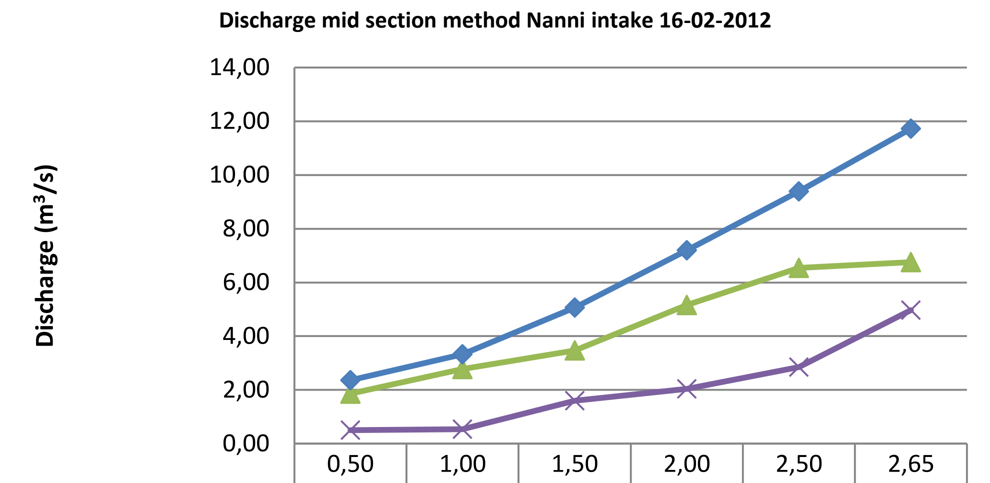
Van Wouw canal:

Number of rotations (n)												
Gate position (m)	**2.65**		**2.50**		**2.00**		**1.50**		**1.00**		**0.50**	
Distance from left bank (m)	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80
0.00												
3.00	19	19	15	14	16	15	4	6	6	7	0	0
6.00	13	28	14	21	15	19	7	13	4	10	0	6
9.00	17	23	12	26	13	22	5	15	4	9	3	5
12.00	12	24	23	21	5	27	8	18	8	15	5	11
15.00	28	37	30	37	19	26	18	18	10	16	8	7
18.00	22	41	26	42	26	28	15	18	10	13	4	7
21.00	36	38	38	43	25	26	11	18	9	13	4	6
24.00	33	34	24	35	22	21	15	8	7	10	6	7
27.00	14	18	14	21	10	11	5	6	3	6	1	3
30.00												

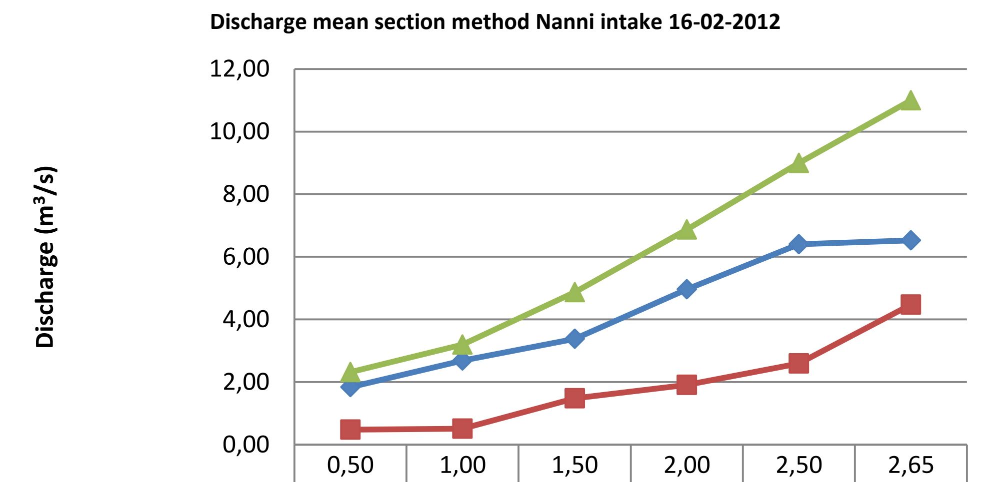
Stondansie canal:

Number of rotations (n)												
Gate position (m)	**2.65**		**2.50**		**2.00**		**1.50**		**1.00**		**0.50**	
Distance from left bank (m)	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80
0.00												
3.00	0	52	9	15	2	3	0	6	0	2	0	0
6.00	19	67	15	25	9	10	6	11	0	0	1	0
9.00	19	63	17	28	7	16	0	21	0	1	0	0
12.00	20	84	14	34	13	24	0	22	2	2	0	0
15.00	17	67	16	34	9	27	2	25	1	1	0	2
18.00	11	51	14	22	12	19	0	20	0	2	2	2
21.00	0	0	0	0	0	0	0	0	0	0	1	1
21.50	-	-	-	-	-	-	-	-	-	-	-	-

Following, the mid section and mean section discharges per gate position (x-axis) have been calculated from these measured velocities, and the results are displayed in the following table and graph.



	0,50	1,00	1,50	2,00	2,50	2,65
Van Wouw canal	1,86	2,78	3,47	5,16	6,54	6,76
Stondansie canal	0,50	0,54	1,60	2,04	2,85	4,97
Both canals	2,36	3,32	5,07	7,20	9,39	11,73



	0,50	1,00	1,50	2,00	2,50	2,65
Van Wouw canal	1,84	2,69	3,38	4,96	6,40	6,53
Stondansie canal	0,48	0,51	1,48	1,91	2,59	4,47
Both canals	2,32	3,19	4,87	6,87	8,99	11,00

i) Discharge measurement 22-02-2012

1. INFORMATIE SHEET	
Locatie (GPS):	Nanniverdeelwerk
Datum:	22-02-2011
Ingevuld door:	R Poeran
Aankomsttijd bij kunstwerk:	9.30
Vertrektijd van kunstwerk:	18.30

Situatie				
Weer	Neerslag	Bewolkt/zonnig		
	Wind	Matig		
Schuifstand bij aankomst	Linkerschuif	Helemaal open	Schuifstand tov bodem (m):	
	Rechterschuif	Open tot waterspiegel		
Waterstand bij aankomst	Beton-bodem sluis		Beton-waterspiegel sluis	0.22
	Waterdiepte waterspiegel-bodem sluis:		Waterdiepte waterspiegel-bodem sluis:	2.72

Waterextractie:

Pompen/sluizen		*aan/uit*
Nanni	Wakay	uit
	Clara	uit
HA	Driekokerpunt	
IKUGH:	Suluman	
	Henar	

Notities:
Tijdens het meten was er drijfgras aanwezig.(11.30)

2. PROFIELINFORMATIE	**Kanaal1**
Bodem	
Soort bodem	Veen,klei
Invloed luchtbubbeling	Ja
Opmerkingen	

2. PROFIELINFORMATIE	**Kanaal 2**	
Locatie:		
Begroeiing:	*(m)*	*Soort begroeiing*
Afstand vanaf linker oever	3.00	Drijfgras
Afstand vanaf rechter oever	3.00	Drijfgras
Bodem		
Soort bodem	Veen,klei	
Invloed luchtbubbeling	Ja	
Opmerkingen	Veel luchtbubbles	

The measured depths and the locations for the velocity measurement points at 20% and 80% are displayed in the tables below.

Van Wouw canal:

Gate position (m)	2.72			2.50			2.00			1.50			1.00			0.50		
Distance from left bank (m)	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	1.12	0.22	0.90	1.11	0.22	0.89	1.10	0.22	0.88	1.09	0.22	0.87	1.07	0.21	0.86	1.06	0.21	0.85
6.00	2.18	0.44	1.74	2.17	0.43	1.74	2.16	0.43	1.73	2.15	0.43	1.72	2.13	0.43	1.70	2.12	0.42	1.70
9.00	2.60	0.52	2.08	2.59	0.52	2.07	2.58	0.52	2.06	2.57	0.51	2.06	2.55	0.51	2.04	2.54	0.51	2.03
12.00	2.75	0.55	2.20	2.74	0.55	2.19	2.73	0.55	2.18	2.72	0.54	2.18	2.70	0.54	2.16	2.69	0.54	2.15
15.00	2.38	0.48	1.90	2.37	0.47	1.90	2.36	0.47	1.89	2.35	0.47	1.88	2.33	0.47	1.86	2.31	0.46	1.85
18.00	2.25	0.45	1.80	2.25	0.45	1.80	2.23	0.45	1.78	2.22	0.44	1.78	2.20	0.44	1.76	2.19	0.44	1.75
21.00	2.18	0.44	1.74	2.12	0.42	1.70	2.16	0.43	1.73	2.15	0.43	1.72	2.13	0.43	1.70	2.12	0.42	1.70
24.00	1.66	0.33	1.33	1.65	0.33	1.32	1.64	0.33	1.31	1.63	0.33	1.30	1.61	0.32	1.29	1.60	0.32	1.28
27.00	1.15	0.23	0.92	1.15	0.23	0.92	1.13	0.23	0.90	1.12	0.22	0.90	1.10	0.22	0.88	1.09	0.22	0.87
30.00	0.28	0.06	0.22	0.27	0.05	0.22	0.26	0.05	0.21	0.25	0.05	0.20	0.24	0.05	0.19	0.23	0.05	0.18

Stondansie canal:

Gate position (m)	2.72			2.50			2.00			1.50			1.00			0.50		
Distance from left bank (m)	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	1.00	0.00	0.00	1.00	0.00	0.00	0.99	0.00	0.00	0.97	0.00	0.00	0.96	0.00	0.00	0.95	0.00	0.00
6.00	1.30	0.26	1.04	1.30	0.26	1.04	1.29	0.26	1.03	1.27	0.25	1.02	1.26	0.25	1.01	1.25	0.25	1.00
9.00	1.65	0.33	1.32	1.65	0.33	1.32	1.64	0.33	1.31	1.62	0.32	1.30	1.61	0.32	1.29	1.60	0.32	1.28
12.00	1.85	0.37	1.48	1.85	0.37	1.48	1.84	0.37	1.47	1.82	0.36	1.46	1.81	0.36	1.45	1.80	0.36	1.44
15.00	1.78	0.36	1.42	1.78	0.36	1.42	1.75	0.35	1.40	1.73	0.35	1.38	1.72	0.34	1.38	1.71	0.34	1.37
18.00	1.90	0.38	1.52	1.90	0.38	1.52	1.89	0.38	1.51	1.87	0.37	1.50	1.86	0.37	1.49	1.85	0.37	1.48
21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Following the number of rotations for each velocity measurement point are displayed for both the Van Wouw canal and the Stondansie canal.

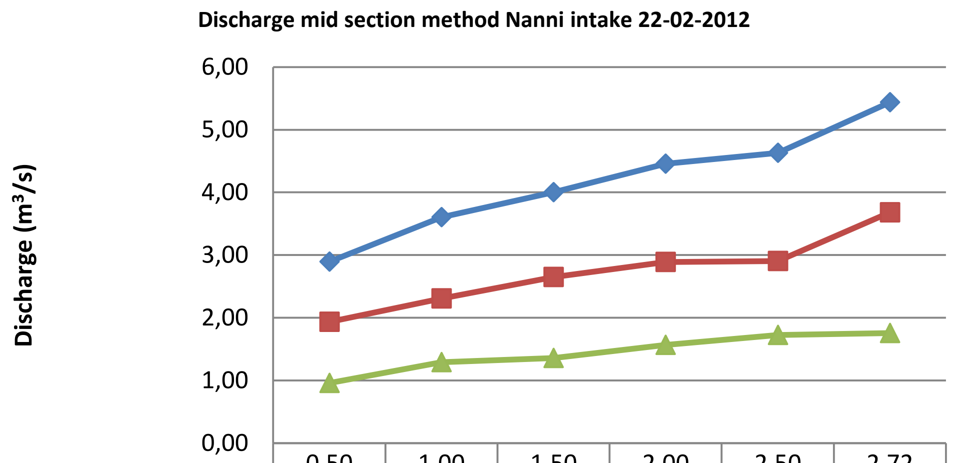
Van Wouw canal:

Number of rotations (n)												
Gate position (m)	2.72		2.50		2.00		1.50		1.00		0.50	
Distance from left bank (m)	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80
0.00												
3.00	8	5	3	1	2	0	6	2	0	2	3	1
6.00	7	12	10	10	7	6	5	7	5	6	6	2
9.00	9	10	7	9	6	9	5	9	6	10	4	3
12.00	8	14	3	5	6	13	5	15	4	10	4	5
15.00	10	13	11	12	11	15	4	12	5	11	4	6
18.00	17	19	8	14	12	14	9	14	5	10	7	8
21.00	16	19	15	11	12	11	10	11	10	8	10	9
24.00	12	17	19	7	11	7	12	1	11	0	8	0
27.00	9	11	4	7	2	2	4	1	1	1	1	0
30.00												

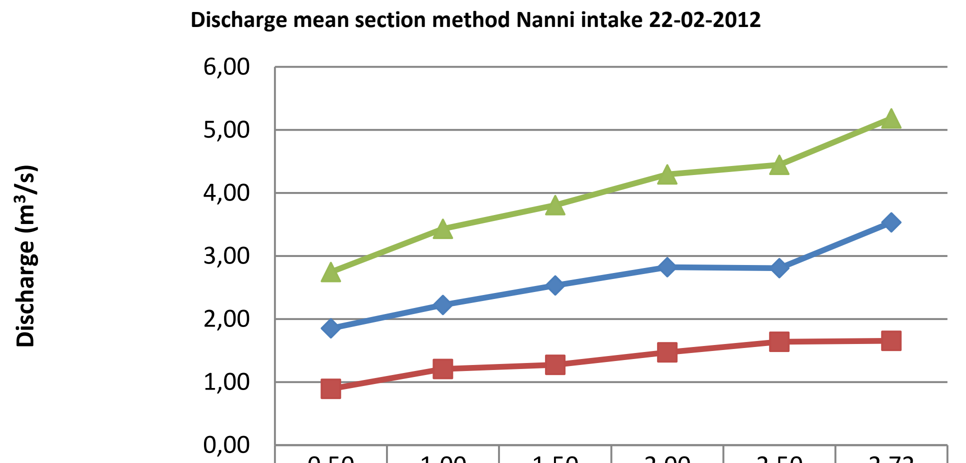
Stondansie canal:

Number of rotations (n)												
Gate position (m)	**2.72**		**2.50**		**2.00**		**1.50**		**1.00**		**0.50**	
Distance from left bank (m)	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80
0.00												
3.00	0	0	0	0	1	2	1	3	1	2	1	3
6.00	17	16	10	10	13	14	6	11	10	8	2	4
9.00	14	21	6	17	8	15	6	12	11	10	8	8
12.00	5	19	11	19	4	15	5	12	3	14	0	9
15.00	13	15	12	16	15	13	10	12	6	10	1	8
18.00	4	3	6	12	1	9	2	10	0	10	0	8
21.00	0	0	0	0	0	0	0	0	0	0	0	0
21.50	-	-	-	-	-	-	-	-	-	-	-	-

Following, the mid section and mean section discharges per gate position (x-axis) have been calculated from these measured velocities, and the results are displayed in the following table and graph.



	0,50	1,00	1,50	2,00	2,50	2,72
Van Wouw canal	1,93	2,31	2,65	2,89	2,91	3,68
Stondansie canal	0,96	1,29	1,36	1,57	1,73	1,76
Both canals	2,89	3,60	4,00	4,46	4,63	5,44



	0,50	1,00	1,50	2,00	2,50	2,72
Van Wouw canal	1,85	2,22	2,53	2,82	2,81	3,53
Stondansie canal	0,89	1,21	1,27	1,47	1,64	1,65
Both canals	2,74	3,43	3,81	4,29	4,45	5,18

2. Intake HA

a) Preliminary discharge measurement intake HA 19-01-2012

19-1-2012	Arrival	10.15AM			
	Departure	-			
Pumps and water level					
Wakay	Off	since 18-01-2012			
Gate operator:	Ramadin from the Ministry of Public Works				
Gate position at arrival					
Totally open		Still undershot			
Water depth (m)	From concrete to bottom				
upstream	3.33	m			
Duration of measurement	60	s			
Velocity equation OTT-mill	1	n=< 0.90	v= 0.2498*n+0.016	0.2498	0.016
	2	0.90=<n=<9.57	v= 0.2609*n+0.006	0.2609	0.006

Situatie	
Begroeing aan de kanten van kanaal	Links
	Rechts

The measured depths and the locations for the velocity measurement points at 20% and 80% are displayed in the table below. In these tables the velocities are already translated to discharges as well.

Gate position	1.62m														
										Mid section			**Mean section**		
Verticals (m)	**d (m)**	**0.2d (m)**	**n (0.2)**	**n(1/s)**	**v(0.2d)(m/s)**	**0.8d(m)**	**n (0.8)**	**n(1/s)**	**v (0.8d) (m/s)**	**v-gem**	**b-gem**	**q**	**b**	**q**
0.00	0.00	0.00	-	-	-	0.00	-	-	-					
2.00	1.01	0.20	20	0.33	0.10	0.81	32	0.53	0.15	0.12	2.00	0.25	2.00	0.08
4.00	1.37	0.27	30	0.50	0.14	1.10	39	0.65	0.18	0.16	2.00	0.44	2.00	0.38
6.00	1.70	0.34	33	0.55	0.15	1.36	50	0.83	0.22	0.19	2.00	0.64	2.00	0.58
8.00	2.46	0.49	28	0.47	0.13	1.97	52	0.87	0.23	0.18	2.00	0.90	2.00	0.76
10.00	2.31	0.46	23	0.38	0.11	1.85	39	0.65	0.18	0.15	2.00	0.67	2.00	0.69
12.00	2.07	0.41	35	0.58	0.16	1.66	28	0.47	0.13	0.15	2.00	0.61	2.00	0.64
14.00	1.77	0.35	21	0.35	0.10	1.42	5	0.08	0.04	0.07	2.00	0.25	2.00	0.27
16.00	1.31	0.26	6	0.10	0.04	1.05	1	0.02	0.02	0.03	2.00	0.08	2.00	0.09
18.00	1.18	0.24	4	0.07	0.03	0.94	4	0.07	0.03	0.03	2.00	0.08	2.00	0.08
20.00	0.45	0.09	0	0.00	0.02	0.36	0	0.00	0.02	0.02	1.80	0.01	2.00	0.02
21.6														
24											Q (m^3/s)	**3.93**		**3.6011**

b) Discharge measurements intake HA 23-02-2012

1. INFORMATIE SHEET	
Locatie (GPS):	H.A
Datum:	23-02-2011
Ingevuld door:	O.Small
Aankomsttijd bij kunstwerk:	10.10u
Vertrektijd van kunstwerk:	

Waterextractie:		
Pompen/sluizen		*aan/uit*
Nanni	Wakay	uit
	Clara	uit
HA	Driekokerpunt	
IKUGH:	Suluman	
	Henar	

2. PROFIELINFORMATIE	**Kanaal 1**		
Locatie: H.A			
Begroeiing:	*(m)*	*Soort begroeiing*	
Afstand vanaf linker oever	0.00	Drijfgras	
Afstand vanaf rechter oever	1.60		
Bodem			
Soort bodem	klei	Zijkanten Pegasse	
Invloed luchtbubbeling			
Opmerkingen			

2. PROFIELINFORMATIE	**Kanaal 2**		
Locatie:			
Begroeiing:	*(m)*	*Soort begroeiing*	
Afstand vanaf linker oever			
Afstand vanaf rechter oever			
Bodem			
Soort bodem			
Invloed luchtbubbeling			
Opmerkingen			

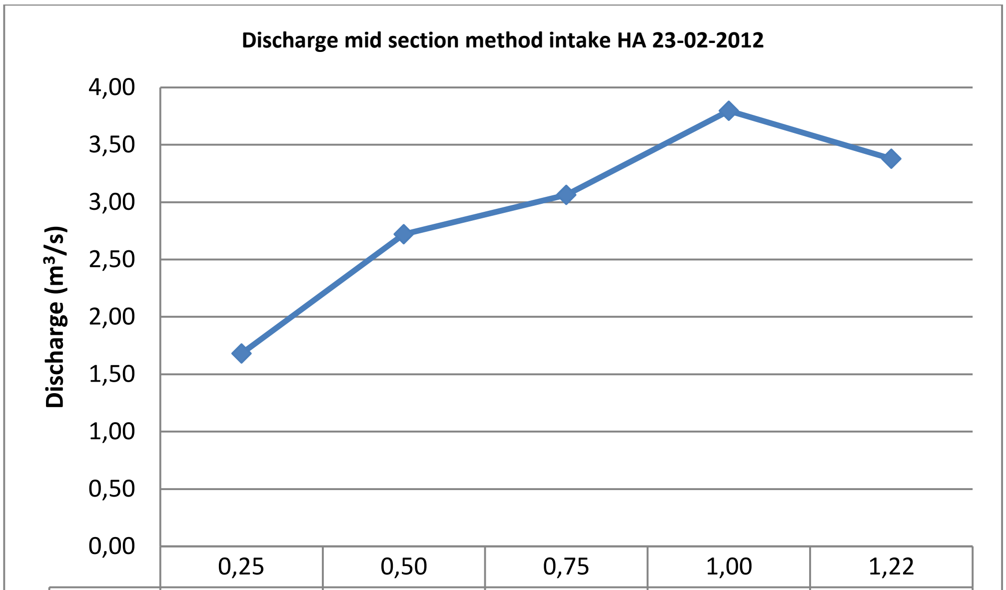
The measured depths and the locations for the velocity measurement points at 20% and 80% are displayed in the tables below.

Gate position (m)	1.22			1.00			0.75			0.50			0.25		
Distance from left bank (m)	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d	d	0.2d	0.8d
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	1.14	0.23	0.91	1.10	0.22	0.88	1.08	0.22	0.86	1.02	0.20	0.82	1.01	0.20	0.81
4.00	1.50	0.30	1.20	1.46	0.29	1.17	1.44	0.29	1.15	1.38	0.28	1.10	1.37	0.27	1.10
6.00	1.83	0.37	1.46	1.79	0.36	1.43	1.77	0.35	1.42	1.71	0.34	1.37	1.70	0.34	1.36
8.00	2.59	0.52	2.07	2.55	0.51	2.04	2.53	0.51	2.02	2.47	0.49	1.98	2.46	0.49	1.97
10.00	2.43	0.49	1.94	2.39	0.48	1.91	2.37	0.47	1.90	2.31	0.46	1.85	2.31	0.46	1.85
12.00	2.20	0.44	1.76	2.16	0.43	1.73	2.14	0.43	1.71	2.08	0.42	1.66	2.07	0.41	1.66
14.00	1.90	0.38	1.52	1.86	0.37	1.49	1.84	0.37	1.47	1.78	0.36	1.42	1.77	0.35	1.42
16.00	1.44	0.29	1.15	1.40	0.28	1.12	1.38	0.28	1.10	1.32	0.26	1.06	1.31	0.26	1.05
18.00	1.31	0.26	1.05	1.27	0.25	1.02	1.25	0.25	1.00	1.19	0.24	0.95	1.18	0.24	0.94
20.00	0.58	0.12	0.46	0.54	0.11	0.43	0.52	0.10	0.42	0.46	0.09	0.37	0.45	0.09	0.36
21.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

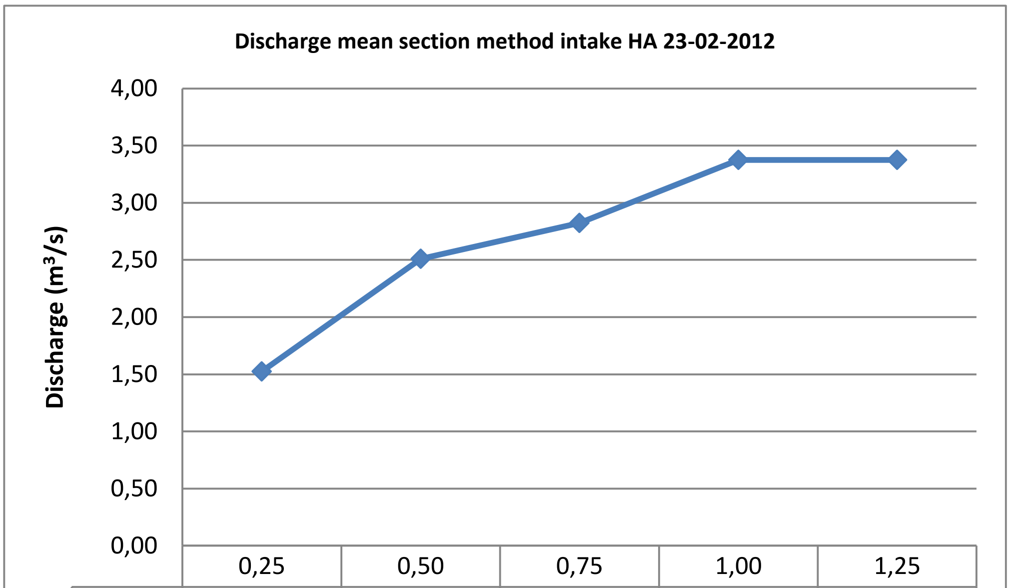
Following the number of rotations for each velocity measurement point are displayed.

Number of rotations (n)										
Gate position (m)	1.22		1.00		0.75		0.50		0.25	
Distance from left bank	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80	0.20	0.80
0.00										
2.00	8	13	25	28	7	3	0	0	2	0
4.00	27	38	27	30	25	30	47	30	21	14
6.00	37	35	51	50	38	39	51	49	25	28
8.00	54	32	44	37	33	41	42	6	21	16
10.00	31	32	33	20	31	15	21	8	17	2
12.00	13	17	25	8	28	6	15	6	2	1
14.00	12	4	9	4	3	3	13	2	2	0
16.00	10	0	1	9	4	2	0	2	0	1
18.00	4	0	0	19	0	0	0	0	0	1
20.00	1	4	0	10	0	5	0	2	0	0
21.60										

Following, the mid section and mean section discharges per gate position (x-axis) have been calculated from these measured velocities, and the results are displayed in the following table and graph.



	0,25	0,50	0,75	1,00	1,22
H.A	1,68	2,72	3,06	3,80	3,38



	0,25	0,50	0,75	1,00	1,25
H.A	1,53	2,51	2,82	3,38	3,38

3. IKGUH

Debietberekening Proefmeting IKUGH					
20-01-2012	Aankomst	9.23u			
	Vertrek				
Pompen					
Wakay	Uit				
Waterstand Nanni Thalimedes	2.05				
Suluman sluis	Gedeeltelijk open				
Weg naar Henar Thalimedes door boom geblokkeerd					
Sluisdeuren:					
Links	Open	Blijft undershot, kan niet helemaal open			
Midden	Open	Blijft undershot, kan niet helemaal open			
Rechts	Half open				
diepte van beton tot bodem		4.21			
NSP-referentiebout		0.09+beton	4.3		
Breedte sluisdeuren		2.52			
Waterdiepte (m)	Van beton tot waterspiegel	van bodem tot waterspiegel			
Instroom	1.7	2.51			
Uitstroom	1.75	2.46			
Schuifstand	Van beton tot schuif	Van schuif tot bodem			
links	2.07	2.14			
midden	1.98	2.23			
rechts	2.67	1.54			
In Lateraal kanaal (rechts)	Meetraai waar het kanaal net weer smaller wordt				
Meettijd	60	s			
Begin meting	10.10u				
Einde meting	10.56u				
Situatie					
Begroeing aan de kanten van kanaal	Links	0.7m van LB			
	Rechts	3m van RB			
Pagasse bodem (veen)	Moeilijk om diepte te bepalen door zachte bodem				
Wind	Tegenwind				

Situatie			
Begroeing aan de kanten van kanaal	Rechts	2.5m van RB	
	Links	2m van LB	
Pagasse bodem (veen)	Moeilijk om diepte te bepalen door zachte bodem		
Wind	Tegenwind		
Regen	11.45-12.00u lichte regenval		

The measured depths and the locations for the velocity measurement points at 20% and 80% are displayed in the tables below. In these tables the velocities are already translated to discharges as well.

Lateraal canal:

										Mid section			Mean section	
Distance verticals (m)	**d (m)**	**0.2d (m)**	**n**	**n(1/s)**	**v(0.2d)(m/s)**	**0.8d(m)**	**n**	**n(1/s)**	**v (0.8d) (m/s)**	**v-gem**	**b-gem**	**q**	**b**	**q**
0.00	0.00	0.00	-	-	-	0.00	-	-	-					
0.70	0.37	0.07	0	0.00	0.02	0.30	0	0.00	0.02	0.02	1.85	0.01	0.70	0.00
3.70	1.82	0.36	0	0.00	0.02	1.46	9	0.15	0.05	0.03	3.00	0.19	3.00	0.11
6.70	1.88	0.38	19	0.32	0.10	1.50	31	0.52	0.15	0.12	3.00	0.68	3.00	0.67
9.70	1.85	0.37	29	0.48	0.14	1.48	34	0.57	0.16	0.15	3.00	0.82	3.00	0.82
12.70	1.92	0.38	28	0.47	0.13	1.54	27	0.45	0.13	0.13	3.00	0.75	3.00	0.74
15.70	2.10	0.42	27	0.45	0.13	1.68	28	0.47	0.13	0.13	3.00	0.82	3.00	0.79
18.70	2.18	0.44	7	0.12	0.05	1.74	19	0.32	0.10	0.07	3.00	0.46	3.00	0.45
21.70	2.05	0.41	10	0.17	0.06	1.64	12	0.20	0.07	0.06	3.00	0.38	3.00	0.39
24.70	1.62	0.32	3	0.05	0.03	1.30	0	0.00	0.02	0.02	3.00	0.11	3.00	0.12
27.70	0.57	0.11	0	0.00	0.02	0.46	0	0.00	0.02	0.02	3.00	0.03	3.00	0.04
30.70	0.00	0.00	-	-	-	0.00	-	-	-					
											Q (m^3/s)	4.24		4.13

Left canal:

										Mid section			Mean section	
Distance verticals (m)	**d (m)**	**0.2d (m)**	**n**	**n(1/s)**	**v(0.2d)(m/s)**	**0.8d(m)**	**n**	**n(1/s)**	**v (0.8d) (m/s)**	**v-gem**	**b-gem**	**q**	**b**	**q**
0.00	0.00	0.00	-	-	-	0.00	-	-	-					
3.00	1.37	0.27	2	0.03	0.02	1.10	0	0.00	0.02	0.02	3.00	0.08	3.00	0.03
6.00	1.68	0.34	9	0.15	0.05	1.34	14	0.23	0.07	0.06	3.00	0.32	3.00	0.29
9.00	1.78	0.36	11	0.18	0.06	1.42	24	0.40	0.12	0.09	3.00	0.47	3.00	0.46
12.00	1.72	0.34	20	0.33	0.10	1.38	28	0.47	0.13	0.12	3.00	0.60	3.00	0.61
15.00	1.66	0.33	24	0.40	0.12	1.33	30	0.50	0.14	0.13	3.00	0.64	3.00	0.65
18.00	1.52	0.30	11	0.18	0.06	1.22	0	0.00	0.02	0.04	3.00	0.18	3.00	0.19
21.00	1.23	0.25	0	0.00	0.00	0.98	0	0.00	0.00	0.00	2.65	0.00	3.00	0.00
23.30	0.00	0.00	-	-	-	0.00	-	-	-					
											Q (m^3/s)	**2.29**		**2.23**

I. Discharges of Nanni intake per measurement day and gate position

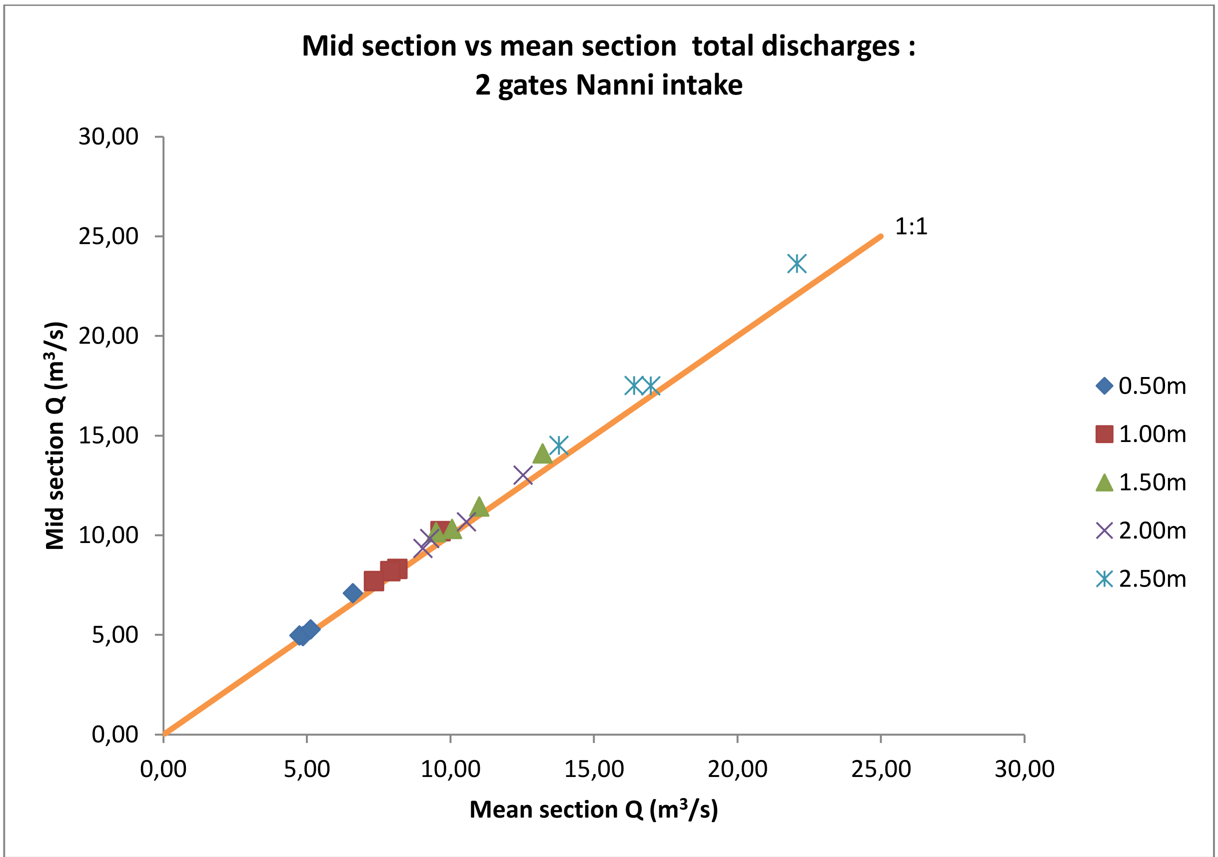
Mid section

Discharge (m^3/s)	1 sluice gate				2 sluice gates			
Gate position	*1-feb-12*	*8-feb-12*	*16-feb-12*	*22-feb-12*	*27-jan-12*	*3-feb-12*	*10-feb-12*	*13-feb-12*
0.50m	3.07	4.56	2.36	2.89	5.27	4.94	7.09	4.97
1.00m	4.69	5.31	3.32	3.60	8.20	8.31	10.22	7.70
1.50m	6.03	8.35	5.07	4.00	10.31	11.44	14.11	10.16
2.00m	7.54	10.86	7.20	4.46	12.26	13.09	15.83	12.98
2.50m	11.08	14.15	9.39	4.63	14.51	17.49	23.63	17.52
>2.50m	12.70	17.25	11.73	5.44	15.88	21.18	26.51	21.65

Mean section

Discharge (m^3/s)	1 sluice gate				2 sluice gates			
Gate position	*1-feb-12*	*8-feb-12*	*16-feb-12*	*22-feb-12*	*27-jan-12*	*3-feb-12*	*10-feb-12*	*13-feb-12*
0.50m	3.01	4.35	2.32	2.74	5.13	4.87	6.60	4.74
1.00m	4.57	5.05	3.19	3.43	7.90	8.15	9.66	7.34
1.50m	5.86	7.96	4.87	3.81	10.06	11.00	13.22	9.50
2.00m	7.47	10.28	6.87	4.29	11.77	12.83	14.94	12.12
2.50m	10.73	13.44	8.99	4.45	13.78	16.98	22.08	16.40
>2.50m	12.64	16.29	11.00	5.18	15.33	20.30	24.59	20.23

J. Nash Sutcliffe values for difference between mid and mean section discharges through 2 gates of Nanni intake



K. Nash Sutcliffe coefficients

Nash Sutcliffe N	1 gate			2 gates		
	Total discharge	Van Wouw canal	Stondansie canal	Total discharge	Van Wouw canal	Stondansie canal
0.50m	0.9714	0.9875	0.9172	0.9967	0.9978	0.8711
1.00m	0.9507	0.9825	0.9473	0.9977	0.9989	0.9686
1.50m	0.9733	0.9895	0.9380	0.9962	0.9976	0.9365
2.00m	0.9760	0.9877	0.8964	0.9966	0.9980	0.9407
2.50m	0.9818	0.9936	0.8454	0.9956	0.9976	0.9285

L. Measured water levels during the velocity measurements

For the intake calibrations the water levels were measured during the velocity discharge measurements.

In this annex these levels are mentioned per measurement day, from largest gate opening to smallest, and first for the upstream side for the Van Wouw canal as well as the Stondansie canal, and then for both of these canals for the downstream side. And for HA the water levels in the HA canal only were needed. The red marked figures are extrapolated from the figures before or after it. See discussion of explanation.

1. Nanni

a) Water levels Nanni intake 27-01-2012

Upstream:

INSTROOM

Beide schuiven geheel open (2,91 t.o.v. bodem sluis)

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.315		
	5	2.315		
	10	2.315		
	15	2.315		
	20	2.316		
	25	2.316		
	30	2.316		
	35	2.316		
	40	2.316		
	45	--		
	AVERAGE	2.316		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.316		
	5	2.317		
	10	2.317		
	15	2.317		
	20	2.317		
	25	2.317		
	30	2.317		
	35			
	AVERAGE	2.317		

Beide schuiven open tot 2.5 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.326		
	5	2.327		
	10	2.327		Orneal
	15	3.327		
	20	2.328		
	25	2.328		
	30	2.328		
	35	2.328		
	40			
	45			
	AVERAGE	2.452		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.328		
	5	2.328		
	10	2.328		
	15	2.328		Orneal
	20	2.328		
	25	2.329		
	30	2.329		
	35			
	AVERAGE	2.328		

Beide schuiven open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.339		
	5	2.340		
	10	2.340		
	15	2.342		Orneal
	20	2.345		
	25	2.345		
	30	2.345		
	35			
	40			
	45			
	AVERAGE	2.342		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.346		
	5	2.347		
	10	2.347		Orneal
	15	2.347		
	20	2.348		
	25	2.348		
	30			
	35			
	AVERAGE	2.347		

Beide schuiven open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.356		
	5	2.356		
	10	2.356		
	15	2.357		Orneal
	20	2.358		
	25	2.360		
	30	2.360		
	35			
	40			
	45			
	AVERAGE	2.358		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.360		
	5	2.361		
	10	2.364		Orneal
	15	2.365		
	20	2.365		
	25			
	30			
	35			
	AVERAGE	2.363		

Beide schuiven open tot 1.0 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.375		
	5	2.380		
	10	2.385		Orneal
	15	2.387		
	20	2.387		
	25	2.388		
	30			
	35			
	40			
	45			
	AVERAGE	2.384		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.389		
	5	2.389		
	10	2.389		Orneal
	15	2.390		
	20	2.390		
	25			
	30			
	35			
	AVERAGE	2.389		

Beide schuiven open tot 0.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.402		
	5	2.404		
	10	2.405		Orneal
	15	2.406		
	20	2.408		
	25	2.409		
	30	2.410		
	35			
	40			
	45			
	AVERAGE	2.406		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.410		
	5	2.410		Orneal
	10	2.410		
	15	2.412		
	20	2.412		
	25			
	30			
	35			
	AVERAGE	2.411		

Downstream:

			UITSTROOM		
Beide schuiven geheel open (2,91 t.o.v. bodem sluis)					
	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
		0	2.250		
		5	2.250		
		10	2.250		
		15	2.250		
		20	2.250		Dhr. Triloki
		25	2.250		
		30	2.250	Miscommunicatie bij start meeting 1	
		35	2.250		
		40	2.250		
		45	--		
		AVERAGE	2.250		
	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
		0	2.250		
		5	2.260		
		10	2.250		Dhr. Triloki
		15	2.250		
		20	2.250		
		25	2.260		
		30	2.260		
		35			
		AVERAGE	2.254		

Beide schuiven open tot 2.5 m t.o.v. sluisbodem					
	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
		0	2.250		
		5	2.250		
		10	2.250		Dhr. Triloki
		15	2.250		
		20	2.250		
		25	2.250		
		30	2.250		
		35	2.250		
		40			
		45			
		AVERAGE	2.250		
	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
		0	2.250		
		5	2.250		
		10	2.250		Dhr. Triloki
		15	2.250		
		20	2.250		
		25	2.250		
		30	2.250		
		35			
		AVERAGE	2.250		

Beide schuiven open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal

Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.240		
	5	2.240		
	10	2.240		
	15	2.240		Dhr. Triloki
	20	2.240		
	25	2.240		
	30	2.240		
	35			
	40			
	45			
	AVERAGE	2.240		

Stondansie kanaal

Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.240		
	5	2.240		
	10	2.230		Dhr. Triloki
	15	2.230		
	20	2.230		
	25	2.230		
	30			
	35			
	AVERAGE	2.233		

Beide schuiven open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal

Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.220		
	5	2.220		
	10	2.210		
	15	2.210		Dhr. Triloki
	20	2.210		
	25	2.210		
	30	2.210		
	35			
	40			
	45			
	AVERAGE	2.213		

Stondansie kanaal

Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	0	2.210		
	5	2.210		
	10	2.200		Dhr. Triloki
	15	2.200		
	20	2.200		
	25			
	30			
	35			
	AVERAGE	2.204		

		35			
		AVERAGE	2.204		

Beide schuiven open tot 1.0 t.o.v. sluisbodem					
	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
		0	2.180		
		5	2.180		
		10	2.180		Dhr. Triloki
		15	2.170		
		20	2.170		
		25	2.170		
		30			
		35			
		40			
		45			
		AVERAGE	2.175		

	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
		0	2.170		
		5	2.170		
		10	2.160		Dhr. Triloki
		15	2.160		
		20	2.160		
		25			
		30			
		35			
		AVERAGE	2.164		

Beide schuiven open tot 0.5 t.o.v. sluisbodem					
	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
		0	2.140		
		5	2.140		
		10	2.140		Dhr. Triloki
		15	2.140		
		20	2.130		
		25	2.130		
		30	2.130		
		35			
		40			
		45			
		AVERAGE	2.136		

	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
		0	2.130		
		5	2.120		
		10	2.120		Dhr. Triloki
		15	2.120		
		20	2.120		
		25			
		30			
		35			
		AVERAGE	2.122		

b) Water levels Nanni intake 01-02-2012

Upstream:

INSTROOM

Een schuif (linker) geheel open (2,77 t.o.v. bodem sluis)

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 11.30u	0	2.43		
	5	2.43		
	10	2.43		
	15	2.43		
	20	2.43		
	25	2.43		
	30	2.43		
einde: 12.05u	35	2.43		
	40			
	45			
	AVERAGE	2.43		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 12.07u	0	2.43		
	5	2.43		
	10	2.43		
	15	2.43		
	20	2.43		
	25	2.43		
einde: 12.37u	30	2.43		
	35			
	AVERAGE	2.43		

Een schuif (linker) open tot 2.5 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 13.15u	0	2.43		
	5	2.43		
	10	2.43		
	15	2.43		
	20	2.43		
	25	2.43		
einde: 13.45u	30	2.43		
	35			
	40			
	45			
	AVERAGE	2.43		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 13.50u	0	2.43		
	5	2.43		
	10	2.43		
	15	2.43		
einde: 14.10u	20	2.43		
	25	2.43		
	30			
	35			
	AVERAGE	2.43		

Een schuif (linker) open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 14.23u	0	2.43		
	5	2.43		
	10	2.43		
	15	2.43		
	20	2.43		
	25	2.43		
einde: 14.53u	30	2.43		
	35			
	40			
	45			
	AVERAGE	2.43		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 14.57u	0	2.43		
	5	2.43		
	10	2.43		
	15	2.43		
	20	2.43		
einde: 15.22u	25	2.43		
	30	2.43		
	35			
	AVERAGE	2.43		

Een schuif (linker) open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
Start: 15.38u	0	2.43		
	5	2.43		
	10	2.43		
	15	2.43		
	20	2.43		
	25	2.43		
einde: 16.06u	30	2.43		
	35			
	40			
	45			
	AVERAGE	2.43		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 16.10u	0	2.44		
	5	2.44		
	10	2.44		
	15	2.44		
einde: 16.30u	20	2.44		
	25	2.44		
	30			
	35			
	AVERAGE	2.44		

Een schuif (linker) open tot 1.0 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 16.44u	0	2.45		
	5	2.45		
	10	2.45		
	15	2.45		
	20	2.45		
einde: 17.09u	25	2.45		
	30	2.45		
	35			
	40			
	45			
	AVERAGE	2.45		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 17.13u	0	2.45		
	5	2.45		
	10	2.45		
	15	2.45		
einde:17.33u	20	2.45		
	25	2.45		
	30			
	35			
	AVERAGE	2.45		

Een schuif (linker) open tot 0.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 17.45u	0	2.45		
	5	2.45		
	10	2.45		
	15	2.45		
	20	2.45		
	25	2.45		
einde: 18.15u	30	2.45		
	35	2.45		
	40			
	45			
	AVERAGE	2.45		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 18.24u	0	2.46		
	5	2.46		
	10	2.46		
	15	2.46		
einde: 18.44u	20	2.46		
	25	2.46		
	30			
	35			
	AVERAGE	2.46		

Downstream:

UITSTROOM

Een schuif (linker) geheel open (2,77 t.o.v. bodem sluis)

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 11.30u	0	2.160		
	5	2.160		
	10	2.170		Ashwien
	15	2.170		
	20	2.170		
	25	2.170		
	30	2.170		
einde: 12.10u	35	2.170		
	40			
	45			
	AVERAGE	2.168		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 12.14u	0	2.170		
	5	2.170		
	10	2.170		Ashwien
	15	2.170		
	20	2.180		
	25	2.180		
einde: 12.48u	30	2.180		
	35			
	AVERAGE	2.174		

Een schuif (linker) open tot 2.5 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 13.20u	0	2.180		
	5	2.180		
	10	2.180		
	15	2.180		
	20	2.180		
	25	2.190		
eind: 13.54u	30	2.190		
	35			
	40			
	45			
	AVERAGE	2.183		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 13.59u	0	2.190		
	5	2.190		
	10	2.190		
	15	2.190		
	20	2.190		
	25	2.190		
einde: 14.25u	30			
	35			
	AVERAGE	2.190		

Een schuif (linker) open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 14.30u	0	2.180		
	5	2.180		
	10	2.180		
	15	2.180		
	20	2.180		
	25	2.180		
	30	2.180		
eind: 15.03u	35			
	40			
	45			
	AVERAGE	2.180		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 15.05u	0	2.180		
	5	2.180		
	10	2.180		
	15	2.180		
	20	2.180		
	25	2.170		
einde: 15.34u	29	2.170		
	30			
	AVERAGE	2.177		

Een schuif (linker) open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 15.50u	0	2.160		
	5	2.160		
	10	2.160		
	15	2.160		
	20	2.160		
	25	2.160		
	30	2.160		
einde: 16.24u	35			
	40			
	45			
	AVERAGE	2.160		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
start: 16.20 u	0	2.160		
	5	2.160		
	10	2.160		
	15	2.150		
	20	2.150		
	25	2.150		
einde: 16.46u	30			
26 min	35			
	AVERAGE	2.155		

Een schuif (linker) open tot 1.0 t.o.v. sluisbodem

	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	start: 16.50u	0	2.140		
		5	2.140		
		10	2.140		
		15	2.140		
		20	2.140		
		25	2.140		
	einde: 17.21u	30	2.130		
		35			
		40			
		45			
		AVERAGE	2.139		

	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	start: 17.20u	0	2.130		
		5	2.130		
		10	2.130		
		15	2.130		
		20	2.130		
	einde: 17.44u	25	2.120		
	22min	30			
		35			
		AVERAGE	2.128		

Een schuif (linker) open tot 0.5 t.o.v. sluisbodem

	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	start: 17.50u	0	2.110		
		5	2.110		
		10	2.110		
		15	2.110		
		20	2.100		
		25	2.100		
		30	2.100		
	einde: 18.26u	35	2.100		
	36 min	40			
		45			
		AVERAGE	2.105		

	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordlijke**
	start: 18.25u	0	2.090		
		5	2.090		
		10	2.090		
		15	2.080		
		20	2.080		
	einde: 18.50u	25	2.080		
	25 min	30			
		35			
		AVERAGE	2.085		

c) Water levels Nanni intake 03-02-2012

Upstream:

INSTROOM

Beide schuiven geheel open (2,69 t.o.v. bodem sluis)

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 10.14u	0	2.360		
	5	2.360		
	10	2.360		Bipat
	15	2.360		
	20	2.360		
	25	2.360		
einde: 10.44u	30	2.360		
		2.360		
	AVERAGE	2.360		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 10.58u	0	2.360		
	5	2.360		
	10	2.360		
	15	2.360		
einde: 11.18u	20	2.360		
	AVERAGE	2.360		

Beide schuiven open tot 2.5 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.31u	0	2.360		
	5	2.360		
	10	2.360		
	15	2.360		
	20	2.360		
einde: 11.56u	25	2.360		
	AVERAGE	2.360		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 12.05u	0	2.370		
	5	2.370		
	10	2.370		
einde: 12.20u	15	2.370		
	AVERAGE	2.370		

Beide schuiven open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 12.27u	0	2.370		
	5	2.380		
	10	2.380		
	15	2.380		
	20	2.380		
	25	2.380		
	30	2.380		
einde: 13.02u	35	2.380		
	AVERAGE	2.379		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 13.07u	0	2.390		
	5	2.390		
	10	2.390		
	15	2.390		
einde: 13.27u	20	2.390		
	AVERAGE	2.390		

Beide schuiven open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.15u	0	2.400		
	5	2.400		
	10	2.400		
	15	2.400		
	20	2.400		
	25	2.400		
einde: 14.45u	30	2.400		
	AVERAGE	2.400		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.49u	0	2.400		
	5	2.400		
	10	2.400		
einde: 15.04u	15	2.400		
		2.400		
	AVERAGE	2.400		

Beide schuiven open tot 1.0 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 15. 11u	0	2.400		
	5	2.410		
	10	2.410		
	15	2.410		
	20	2.410		
	25	2.410		
einde; 15.39u	28	2.410		
	AVERAGE	2.409		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 15.42u	0	2.410		
	5	2.410		
	10	2.410		
	15	2.410		
einde: 16.02u	20	2.410		
	AVERAGE	2.410		

Beide schuiven open tot 0.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.15u	0	2.420		
	5	2.420		
	10	2.420		
	15	2.420		
	20	2.420		
	25	2.420		
einde: 16.45u	30	2.420		
	AVERAGE	2.420		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.52u	0	2.420		
	5	2.420		
	10	2.420		
	15	2.420		
	20	2.420		
einde: 17.13u	21	2.420		
	AVERAGE	2.420		

Downstream:

UITSTROOM

Beide schuiven geheel open (2,69 t.o.v. bodem sluis)

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 10.21u	0	2.180		
	5	2.180		
	10	2.180		Natha
	15	2.200		
	20	2.210		
	25	2.220		
	30	2.210		
eind: 10.53u	32	2.220		
32 min				
	AVERAGE	2.200		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.05u	0	2.230		
	5	2.230		
	10	2.230		
	15	2.230		Natha
eind: 11.24u	20	2.240		
19 min				
	AVERAGE	2.232		

Beide schuiven open tot 2.5 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.38u	0	2.240		
	5	2.240		
	10	2.250		Natha
	15	2.240		
	20	2.240		
einde: 12.03u	25	2.240		
25 min				
	AVERAGE	2.242		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 12.13u	0	2.250		
	5	2.250		
	10	2.250		Natha
einde: 12.28u	15	2.250		
	AVERAGE	2.250		

Beide schuiven open tot 2.0 m t.o.v. sluisbodem

	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 12.34u	0	2.250		
		5	2.250		
		10	2.240		Natha
		15	2.250		
		20	2.250		
		25	2.250		
	einde: 13.04u	30	2.250		
			2.250		
		AVERAGE	2.249		

	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 13.14u	0	2.250		
		5	2.250		
		10	2.250		Natha
		15	2.250		
	einde: 13.34u	20	2.250		
		AVERAGE	2.250		

Beide schuiven open tot 1.5 t.o.v. sluisbodem

	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 14.22u	0	2.240		
		5	2.240		
		10	2.230		Natha
		15	2.230		
		20	2.230		
		25	2.230		
	einde: 14.51u	30	2.230		
		AVERAGE	2.233		

	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 14.57u	0	2.230		
		5	2.230		Natha
		10	2.230		
		15	2.230		
	einde: 15.13u	20	2.230		
		AVERAGE	2.230		

Beide schuiven open tot 1.0 t.o.v. sluisbodem					
	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 15.18u	0	2.210		
		5	2.210		Natha
		10	2.210		
		15	2.210		
		20	2.210		
		25	2.210		
	einde: 15.46u	26	2.210		
		AVERAGE	2.210		

	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 15.49u	0	2.200		
		5	2.200		Natha
		10	2.200		
		15	2.200		
	einde: 16.09u	20	2.200		
		AVERAGE	2.200		

Beide schuiven open tot 0.5 t.o.v. sluisbodem					
	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 16.22u	0	2.170		
		5	2.170		Natha
		10	2.170		
		15	2.170		
		20	2.170		
		25	2.170		
	einde: 16.52u	30	2.170		
		AVERAGE	2.170		

	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 17.00u	0	2.150		
		5	2.150		Natha
		10	2.150		
		15	2.150		
	einde: 17.20u	20	2.150		
			2.150		
		AVERAGE	2.150		

d) Water levels Nanni intake 08-02-2012

Upstream:

INSTROOM

Een schuif (linker) geheel open (2,75 t.o.v. bodem sluis)

Van Wouw kanaal

Meting	Tijd (min)	Waterstand (m NSP)	Opmerking	Verantwoordelijke
start: 10.12u	0	2.560		
	5	2.560		
	10	2.560		
	15	2.560		
	20	2.560		
	25	2.560		
einde:10.42u	30	2.560		
	AVERAGE	2.560		

Stondansie kanaal

Meting	Tijd (min)	Waterstand (m NSP)	Opmerking	Verantwoordelijke
start: 10.42u	0	2.560		
	5	2.560		
	10	2.560		
	15	2.560		
einde: 11.02u	20	2.560		
	AVERAGE	2.560		

Een schuif (linker) open tot 2.5 m t.o.v. sluisbodem

Van Wouw kanaal

Meting	Tijd (min)	Waterstand (m NSP)	Opmerking	Verantwoordelijke
start: 11.10u	0	2.560		
	5	2.560		
	10	2.560		
	15	2.560		
	20	2.560		
	25	2.560		
einde: 11.40	30	2.560		
	AVERAGE	2.560		

Stondansie kanaal

Meting	Tijd (min)	Waterstand (m NSP)	Opmerking	Verantwoordelijke
start: 11.42u	0	2.560		
	5	2.560		
	10	2.560		
	15	2.560		
einde: 12.00u	18	2.560		
	AVERAGE	2.560		

Een schuif (linker) open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 12.10u	0	2.570		
	5	2.570		
	10	2.570		
	15	2.570		
	20	2.570		
einde: 12.35u	25	2.570		
		2.570		
	AVERAGE	2.570		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 12.40u	0	2.570		
	5	2.570		
	10	2.570		
	15	2.570		
eind: 12.58u	18	2.570		
	AVERAGE	2.570		

Een schuif (linker) open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start:13.52u	0	2.580		
	5	2.580		
	10	2.580		
	15	2.580		
	20	2.580		
	25	2.580		
eind: 14.19u	27	2.580		
	AVERAGE	2.580		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.22u	0	2.580		
	5	2.580		
	10	2.580		
	15	2.580		
	20	2.580		
einde: 14.46u	24	2.580		
	AVERAGE	2.580		

Een schuif (linker) open tot 1.0 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.54u	0	2.585		
	5	2.585		
	10	2.585		
	15	2.587		
	20	2.587		
	25	2.589		
	30	2.589		
einde: 15.28u	34	2.589		
		2.587		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start:15.32u	0	2.590		
	5	2.590		
	10	2.590		
	15	2.590		
	20	2.590		
eind: 15.57u	25	2.590		
	AVERAGE	2.590		

Een schuif (linker) open tot 0.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.05u	0	2.590		
	5	2.590		Bhulai
	10	2.590		
	15	2.590		
	20	2.590		
einde: 16.30u	25	2.590		
		2.590		
	AVERAGE	2.590		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.35u	0	2.590		
	5	2.590		
	10	2.590		
	15	2.590		
	20	2.590		
einde: 17.00u	25	2.590		
	30	2.590		
	35			
	AVERAGE	2.590		

Downstream:

			UITSTROOM		
Een schuif geheel open (2,75 t.o.v. bodem sluis)					
	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 10.11u	0	2.160		
		5	2.160		
		10	2.165		Orneal Small
		15	2.170		
		20	2.180		
		25	2.185		
	einde: 10.38u	26	2.185		
		AVERAGE	2.172		
	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 10.41u	0	2.185		
		5	2.185		
		10	2.190		
		15	2.190		
	einde: 11.01	20	2.200		
		AVERAGE	2.190		
Eeen schuif open tot 2.5 m t.o.v. sluisbodem					
	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 11.09u	0	2.200		
		5	2.190		
		10	2.200		
		15	2.205		
		20	2.205		
		25	2.205		
	einde: 11.36u	27	2.205		
		AVERAGE	2.201		
	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 11.41u	0	2.205		
		5	2.205		
		10	2.210		
		15	2.210		
	einde: 11.59u	18	2.210		
		AVERAGE	2.208		

Een schuif open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal					
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 12.07u	0	2.200		
	5	2.190		
	10	2.190		
	15	2.195		
	20	2.200		
	25	2.200		
einde: 12.35u	28	2.200		
	AVERAGE	2.196		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 12.38u	0	2.200		
	5	2.200		
	10	2.200		
	15	2.200		
einde: 12.57u	19	2.200		
	AVERAGE	2.200		

Een schuif open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 13.53u	0	2.170	waterpeil fluctueert tussen	
	5	2.170	2.16 en 2.17	Rewien Nageswar
	10	2.170		
	15	2.170		
	20	2.170		
	25	2.170		
einde: 14.22u	29	2.170		
	AVERAGE	2.170		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.24u	0	2.170	waterpeil fluctueert tussen	
	5	2.165	2.16 en 2.17	vanwege golven
	10	2.170		Rewien Nageswar
	15	2.170		
	20	2.160		
einde: 14.48u	24	2.160		
	AVERAGE	2.166		

Een schuif open tot 1.0 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.56u	0	2.150		
	5	2.150		
	10	2.150		
	15	2.150		Rewien Nageswar
	20	2.140		
	25	2.140		
einde: 15.25u	29	2.140		
		2.140		
	AVERAGE	2.145		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 15.34u	0	2.140		
	5	2.140		Rewien Nageswar
	10	2.140		
	15	2.130		
	20	2.130		
einde: 15.59u	25	2.130		
	AVERAGE	2.135		

Een schuif open tot 0.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.03u	0	2.120		
	5	2.120		
	10	2.120		Orneal Small
	15	2.120		
	20	2.110		
	25	2.110		
einde:16.30u	27	2.110		
	AVERAGE	2.116		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.35u	0	2.110		
	5	2.105		
	10	2.105		Orneal Small
	15	2.100		
	20	2.100		
	25	2.100		
einde: 17.03u	28	2.100		
	AVERAGE	2.103		

e) Water levels Nanni intake 10-02-2012

Upstream:

INSTROOM

Beide schuiven geheel open (2,66 t.o.v. bodem sluis)

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 10.51u	0	2.45		
	5	2.45		Poeran
	10	2.45		
	15	2.45		
	20	2.45		
	25	2.45		
einde: 11.21u	30	2.45		
	AVERAGE	2.45		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.23u	0	2.45		
	5	2.44		
	10	2.44		
	15	2.44		
	20	2.44		
einde: 11.46u	23	2.44		
		2.44		
	AVERAGE	2.441428571		

Beide schuiven open tot 2.5 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.56u	0	2.44		
	5	2.44		
	10	2.44		
	15	2.44		
	20	2.44		
	25	2.44		
	30	2.44		
einde: 12.29u	33	2.44		
	AVERAGE	2.44		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 12.38	0	2.44		
	5	2.44		
	10	2.44		
	15	2.44		
	20	2.44		
einde: 13.00u	22	2.44		
		2.44		
	AVERAGE	2.44		

Beide schuiven open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 13.41u	0	2.44		
	5	2.44		
	10	2.44		
	15	2.45		
	20	2.45		
	25	2.45		
einde: 14.11u	30	2.45		
		2.45		
	AVERAGE	2.45		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.16u	0	2.45		
	5	2.45		
	10	2.45		
	15	2.45		
	20	2.45		
einde: 14.38u	22	2.45		
	AVERAGE	2.45		

Beide schuiven open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.53u	0	2.46		
	5	2.46		
	10	2.46		
	15	2.46		
	20	2.46		
	25	2.46		
einde: 15.23u	30	2.46		
		2.46		
	AVERAGE	2.46		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 15.26u	0	2.46		
	5	2.46		
	10	2.46		
	15	2.46		
	20	2.46		
einde: 15.50u	24	2.46		
	AVERAGE	2.46		

Beide schuiven open tot 1.0 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.23u	0	2.48		
	5	2.48		
	10	2.48		
	15	2.48		
	20	2.48		
	25	2.48		
	30	2.48		
einde: 16.55	32	2.48		
	AVERAGE	2.48		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 17.04u	0	2.48		
	5	2.48		
	10	2.48		
	15	2.48		
	20	2.48		
einde: 17.27u	23	2.48		
	AVERAGE	2.48		

Beide schuiven open tot 0.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 17.36u	0	2.50		
	5	2.50		
	10	2.50		
	15	2.50		
	20	2.50		
	25	2.50		
	30	2.50		
einde: 18.07u	31	2.50		
	AVERAGE	2.50		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 18.11u	0	2.50		
	5	2.50		
	10	2.50		
	15	2.50		
einde: 18.28u	17	2.50		
	AVERAGE	2.50		

Downstream:

UITSTROOM

Beide schuiven open tot (2.66 m t.o.v. sluisbodem)

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 10.50u	0	2.160		
	5	2.160		
	10	2.170		
	15	2.170		
	20	2.180		
	25	2.180		
einde: 11.20u	30	2.180		
	AVERAGE	2.171		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.20u	0	2.190		
	5	2.200		
	10	2.200		
	15	2.210		
	20	2.210		
einde: 11.4?u	?	2.210		
		2.210		
	AVERAGE	2.204		

Beide schuiven open tot 2.5 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.50u	0	2.210		
	5	2.200		
	10	2.200		
	15	2.200		
	20	2.200		
	25	2.200		
einde 12.20u	30	2.200		
		2.200		
	AVERAGE	2.201		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start 12.20u	0	2.250		
	5	2.270		
	10	2.270		
	15	2.270		
	20	2.270		
	25	2.270		
einde: 12.48	28	2.270		
	AVERAGE	2.267		

Beide schuiven open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 13.52u	0	2.270		
	5	2.270		
	10	2.260		
	15	2.260		
	20	2.260		
	25	2.260		
einde: 14.27u	26	2.260		
		2.260		
	AVERAGE	2.263		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.28u	0	2.260		
	5	2.260		
	10	2.260		
	15	2.260		
	20	2.260		
einde: 14.48	23	2.260		
	AVERAGE	2.260		

Beide schuiven open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 15.03u	0	2.260		
	5	2.260		
	10	2.250		
	15	2.250		
	20	2.250		
	25	2.250		
	30	2.250		
einde: 15.36u	33	2.250		
	AVERAGE	2.253		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 15.37u	0	2.250		
	5	2.250		
	10	2.250		
	15	2.260		
	20	2.260		
einde: 16.01u	25	2.260		
	AVERAGE	2.255		

Beide schuiven open tot 1.0 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start:16.34u	0	2.220		
	5	2.220		
	10	2.220		
	15	2.210		
	20	2.210		
	25	2.210		
	30	2.210		
einde: 17.07u	33	2.210		
	AVERAGE	2.214		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 17.15u	0	2.210		
	5	2.210		
	10	2.210		
	15	2.200		
	20	2.200		
einde: 17.40u	25	2.200		
	AVERAGE	2.205		

Beide schuiven open tot 0.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
Start: 17.45u	0	2.170		
	5	2.170		
	10	2.170		
	15	2.160		
	20	2.160		
einde: 18.15u	25	2.160		
		2.160		
		2.160		
	AVERAGE	2.164		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 18.20u	0	2.160		
	5	2.150		
	10	2.150		
	15	2.140		
einde: 18.37u	17	2.140		
	AVERAGE	2.148		

f) Water levels Nanni intake 13-02-2012

Upstream:

INSTROOM

Beide schuiven geheel open (2,60 t.o.v. bodem sluis)

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.02u	0	2.295		
	5	2.295		
	10	2.290		Bhulai
	15	2.290		
	20	2.285		
einde:11.26u	24	2.285		
	AVERAGE	2.290		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.28u	0	2.285		
	5	2.285		
	10	2.285		
	15	2.285		
einde: 11.47u	19	2.285		
	AVERAGE	2.285		

Beide schuiven open tot 2.5 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.57u	0	2.285		
	5	2.285		
	10	2.285		
	15	2.285		
	20	2.285		
	25	2.285		
einde: 12.26u	29	2.285		
	AVERAGE	2.285		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 12.36u	0	2.285		
	5	2.285		
	10	2.285		
einde: 12.51u	15	2.285		
	AVERAGE	2.285		

Beide schuiven open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 13.40u	0	2.300		
	5	2.300		
	10	2.300		
	15	2.300		
	20	2.300		
	25	2.300		
einde: 14.10u	30	2.300		
	AVERAGE	2.300		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.16u	0	2.300		
	5	2.300		
	10	2.300		
	15	2.300		
einde: 14.36u	20	2.300		
	AVERAGE	2.300		

Beide schuiven open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.51u	0	2.305		
	5	2.305		
	10	2.305		
	15	2.305		
	20	2.305		
	25	2.305		
einde: 15.21u	30	2.305		
	AVERAGE	2.305		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 15.28u	0	2.305		
	5	2.305		
	10	2.305		
	15	2.305		
einde: 15.48u	20	2.305		
	AVERAGE	2.305		

Beide schuiven open tot 1.0 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.15u	0	2.315		
	5	2.315		
	10	2.315		
	15	2.315		
	20	2.315		
	25	2.315		
einde: 16.43u	28	2.315		
	AVERAGE	2.315		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.50u	0	2.315		
	5	2.315		
	10	2.315		
	15	2.315		
einde: 17.10	20	2.315		
	AVERAGE	2.315		

Beide schuiven open tot 0.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start:17.23u	0	2.325		
	5	2.325		
	10	2.325		
	15	2.325		
	20	2.325		
	25	2.325		
einde: 17.50u	27	2.325		
	AVERAGE	2.325		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 18.04u	0	2.325		
	5	2.325		
	10	2.325		
	15	2.325		
einde: 18.24u	20	2.325		
	AVERAGE	2.325		

Downstream:

			UITSTROOM		
Beide schuiven geheel open (2,60 t.o.v. bodem sluis)					
	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 10.54u	0	2.080		
		5	2.090		P. Surajbali
		10	2.090		
		15	2.100		
		20	2.110		
	einde: 11.17u	25	2.110		
		AVERAGE	2.097		

	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 11.20u	0	2.110		
		5	2.110		P. Surajbali
		10	2.120		
		15	2.120		
	einde: 11.39u	20	2.120		
		AVERAGE	2.116		

Beide schuiven open tot 2.5 m t.o.v. sluisbodem					
	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 11.50u	0	2.120		
		5	2.120		P. Surajbali
		10	2.130		
		15	2.130		
		20	2.140		
	einde: 11.15u	25	2.140		
			2.140		
		AVERAGE	2.131		

	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 12.30u	0	2.150		
		5	2.150		P. Surajbali
		10	2.160		
	einde: 12.45u	15	2.160		
		AVERAGE	2.155		

Beide schuiven open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 13.41u	0	2.150		
	5	2.150		Tetje Henstra
	10	2.150		
	15	2.150		
	20	2.150		
	25	2.150		
einde: 14.11u	30	2.150		
	AVERAGE	2.150		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.20u	0	2.155		
	5	2.155		
	10	2.155		Tetje Henstra
	15	2.155		
einde: 14.40u	20	2.155		
	AVERAGE	2.155		

Beide schuiven open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.51u	0	2.140		
	5	2.140		
	10	2.135		Tetje Henstra
	15	2.135		
	20	2.135		
	25	2.135		
einde: 15.21u	30	2.135		
	AVERAGE	2.136		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 15.28u	0	2.135		
	5	2.135		Tetje Henstra
	10	2.135		
	15	2.135		
einde: 15.47u	19	2.135		
	AVERAGE	2.135		

Beide schuiven open tot 1.0 t.o.v. sluisbodem

	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 16.15u	0	2.110		
		5	2.110		Tetje Henstra
		10	2.110		
		15	2.110		
		20	2.105		
	einde: 16.40u	25	2.105		
			2.105		
		AVERAGE	2.108		

	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 16.50u	0	2.105		
		5	2.100		Tetje Henstra
		10	2.100		
		15	2.095		
	einde: 17.10u	20	2.095		
		AVERAGE	2.099		

Beide schuiven open tot 0.5 t.o.v. sluisbodem

	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 17.22u	0	2.075		
		5	2.075		Tetje Henstra
		10	2.075		
		15	2.070		
		20	2.070		
	einde: 17.47u	25	2.065		
			2.065		
		AVERAGE	2.071		

	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 18.04u	0	2.060		
		5	2.055		Tetje Henstra
		10	2.050		
		15	2.050		
	einde: 18.24u	20	2.045		
		AVERAGE	2.052		

g) Water levels Nanni intake 16-02-2012

Upstream:

		INSTROOM			
Een schuif geheel open (2,65 t.o.v. bodem sluis)					
	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start:10.17u	0	2.130		
		5	2.130		N. Bipat
		10	2.130		
		15	2.130		
		20	2.130		
		25	2.130		
		30	2.130		
	einde: 10.52u	35	2.130		
		AVERAGE	2.130		
	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 10.58u	0	2.130		
		5	2.130		
		10	2.130		
		15	2.130		
	einde: 11.19u	20	2.130		
			2.130		
		AVERAGE	2.130		
Eeen schuif open tot 2.5 m t.o.v. sluisbodem					
	Van Wouw kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 11.31u	0	2.130		
		5	2.130		
		10	2.130		
		15	2.130		
		20	2.130		
		25	2.130		
	einde: 12.01u	30	2.130		
		AVERAGE	2.130		
	Stondansie kanaal				
	Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
	start: 12.06u	0	2.130		
		5	2.130		
		10	2.130		
		15	2.130		
	einde:12.26u	20	2.130		
		AVERAGE	2.130		

Een schuif open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 13.12u	0	2.140		
	5	2.140		
	10	2.140		
	15	2.140		
	20	2.140		
	25	2.140		
	30	2.140		
einde: 13.47u	35	2.140		
	AVERAGE	2.140		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start:13.50u	0	2.140		
	5	2.140		
	10	2.140		
	15	2.140		
einde: 14.10u	20	2.140		
	AVERAGE	2.140		

Een schuif open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 15.25u	0	2.140		
	5	2.140		
	10	2.140		
	15	2.140		
	20	2.140		
	25	2.140		
einde: 15.55u	30	2.140		
	AVERAGE	2.140		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.05u	0	2.140		
	5	2.140		
	10	2.140		
	15	2.140		
eind: 16.25u	20	2.140		
	25	2.140		
	AVERAGE	2.140		

Een schuif open tot 1.0 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.36u	0	2.145		
	5	2.145		
	10	2.145		
	15	2.145		
	20	2.145		
einde: 17.01u	25	2.145		
	AVERAGE	2.145		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 17.10u	0	2.145		
	5	2.145		
	10	2.145		
	15	2.145		
einde: 17.30u	20	2.145		
		2.145		
		2.145		
	AVERAGE	2.145		

Een schuif open tot 0.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 17.39u	0	2.145		
	5	2.145		
	10	2.145		
	15	2.145		
	20	2.145		
eind: 18.04u	25	2.145		
	AVERAGE	2.145		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 18.12u	0	2.150		
	5	2.150		
	10	2.150		
	15	2.150		
eind: 18.28u	16	2.150		
	AVERAGE	2.150		

Downstream:

UITSTROOM

Een schuif geheel open (2,65 t.o.v. bodem sluis)

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 10.17u	0	1.990		
	5	1.990		
	10	1.990		
	15	1.990		
	20	1.990		
	25	1.990		
	30	1.990		
einde: 10.51u	34	1.990		
	AVERAGE	1.990		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 10.58u	0	1.990		
	5	1.990		
	10	1.990		
	15	1.990		
	20	1.990		
einde: 11.19u	21	1.990		
	AVERAGE	1.990		

Eeen schuif open tot 2.5 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.31u	0	1.990		
	5	1.990		
	10	1.990		
	15	1.990		
	20	1.990		
	25	1.990		
einde:	29	1.990		
	AVERAGE	1.990		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 12.05u	0	1.990		
	5	1.995		
	10	1.995		
	15	1.990		
einde:	20	1.990		
	AVERAGE	1.992		

Een schuif open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 13.12u	0	1.975		
	5	1.975		
	10	1.970		
	15	1.970		
	20	1.970		
	25	1.970		
	30	1.965		
	35	1.965		
	40			
	AVERAGE	1.970		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 13.51u	0	1.965		
	5	1.965		
	10	1.965		
	15	1.965		
	20	1.965		
	AVERAGE	1.965		

Een schuif open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 15.27u	0	1.940		
	5	1.940		R. Nageswar
	10	1.940		
	15	1.930		
	20	1.930		
	25	1.930		
einde: 15.57	30	1.930		
	AVERAGE	1.934		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.07u	0	1.930		
	5	1.930		
	10	1.930		
	15	1.930		
	20	1.920		
einde: 16.28u	25	1.920		
	AVERAGE	1.927		

Een schuif open tot 1.0 t.o.v. sluisbodem

Van Wouw kanaal

Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.38u	0	1.920		
	5	1.920		
	10	1.920		
	15	1.920		
	20	1.910		
einde: 17.03u	25	1.910		
	AVERAGE	1.917		

Stondansie kanaal

Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 17.12u	0	1.900		
	5	1.900		
	10	1.900		
	15	1.900		
	20	1.900		
	25	1.900		
einde: 17.32u	30	1.900		
	35			
	AVERAGE	1.900		

Een schuif open tot 0.5 t.o.v. sluisbodem

Van Wouw kanaal

Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 17.38u	0	1.890		
	5	1.880		
	10	1.880		Orneal Small
	15	1.880		
	20	1.880		
einde: 18.03u	25	1.880		
	AVERAGE	1.882		

Stondansie kanaal

Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 18.10u	0	1.880		
	5	1.880		
	10	1.870		
	15	1.870		
einde: 18.28u	18	1.870		
	AVERAGE	1.874		

h) Water levels Nanni intake 22-02-2012

Upstream:

INSTROOM

Een schuif geheel open (2,72 t.o.v. bodem sluis)

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 10.26u	0	2.096		
	5	2.096		
	10	2.096		
	15	2.096		
	20	2.096		
	25	2.096		
	30	2.096		
Einde: 10.58u	32	2.096		
	AVERAGE	2.096		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.05u	0	2.096		
	5	2.096		
	10	2.096		
	15	2.096		
	20	2.096		
einde : 11.29u	23	2.096		
	AVERAGE	2.096		

Een schuif open tot 2.5 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.43u	0	2.095		
	5	2.095		
	10	2.095		
	15	2.095		
	20	2.095		
	25	2.095		
	30	2.095		
einde: 12.12u	31	2.095		
	AVERAGE	2.095		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 12.19u	0	2.095		
	5	2.095		
	10	2.094		Ashwien
	15	2.094		
	20	2.094		
einde: 12.40u	22	2.094		
	AVERAGE	2.094		

Een schuif open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 13.33u	0	2.094		
	5	2.094		Orneal Small
	10	2.094		
	15	2.094		
	20	2.094		
	25	2.094		
einde: 14.00u	27	2.094		
	AVERAGE	2.094		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.05u	0	2.094		
	5	2.094		
	10	2.095		
	15	2.095		
	20	2.095		
14.27u	22	2.095		
	AVERAGE	2.095		

Een schuif open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.40u	0	2.095		
	5	2.095		
	10	2.095		
	15	2.095		
	20	2.095		
	25	2.095		
einde: 15.07u	27	2.095		
	AVERAGE	2.095		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 15.20u	0	2.097		
	5	2.097		
	10	2.097		
	15	2.097		
einde: 15.38u	18	2.097		
	AVERAGE	2.097		

Een schuif open tot 1.0 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 15.50u	0	2.098		
	5	2.098		
	10	2.098		
	15	2.098		
	20	2.098		
	25	2.099		
einde: 16.16u	26	2.099		
	AVERAGE	2.098		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.20u	0	2.099		
	5	2.099		
	10	2.099		
	15	2.099		
einde: 16.40u	20	2.100		
	AVERAGE	2.099		

Een schuif open tot 0.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 17.18u	0	2.105		
	5	2.105		
	10	2.105		
	15	2.105		
	20	2.105		
einde: 17.43u	25	2.105		
	AVERAGE	2.105		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 17.50u	0	2.110		
	5	2.112		
	10	2.114		
	15	2.116		
einde: 18.08u	18	2.117		
	AVERAGE	2.114		

Downstream:

UITSTROOM

Een schuif geheel open (2,72 t.o.v. bodem sluis)

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 10.26u	0	2.050		
	5	2.050		Ashwien
	10	2.050		
	15	2.050		
	20	2.050		
	25	2.050		
	30	2.050		
einde: 10.58u	32	2.050		
	AVERAGE	2.050		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.05u	0	2.050		
	5	2.050		
	10	2.050		
	15	2.050		
	20	2.050		
einde: 11.29u	23	2.050		
	AVERAGE	2.050		

Een schuif open tot 2.5 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 11.43u	0	2.050		
	5	2.050		
	10	2.050		
	15	2.050		
	20	2.050		
	25	2.050		
	30	2.050		
einde: 12.12u	31	2.050		
	AVERAGE	2.050		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 12.19u	0	2.050		
	5	2.050		
	10	2.050		
	15	2.050		
	20	2.050		
einde: 12.40u	22	2.050		
	AVERAGE	2.050		

Een schuif open tot 2.0 m t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 13.33u	0	2.040		
	5	2.040		
	10	2.040		Orneal Small
	15	2.040		
	20	2.040		
	25	2.040		
einde: 14.00u	27	2.040		
	AVERAGE	2.040		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start:14.05u	0	2.040		
	5	2.040		
	10	2.040		
	15	2.040		
	20	2.030		
einde: 14.27u	22	2.030		
	AVERAGE	2.037		

Een schuif open tot 1.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 14.40u	0	2.030		
	5	2.030		
	10	2.020		
	15	2.020		
	20	2.020		
	25	2.020		
eind: 15.07u	27	2.020		
	AVERAGE	2.023		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 15.20u	0	2.020		
	5	2.020		
	10	2.020		
	15	2.020		
eind: 15.38u	18	2.020		
	AVERAGE	2.020		

Een schuif open tot 1.0 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 15.50u	0	2.020		
	5	2.020		
	10	2.020		
	15	2.010		
	20	2.010		
	25	2.010		
eind: 16.16u	26	2.010		
	AVERAGE	2.014		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 16.20u	0	2.010		
	5	2.010		
	10	2.010		
	15	2.010		
eind: 16.40u	20	2.010		
	AVERAGE	2.010		

Een schuif open tot 0.5 t.o.v. sluisbodem

Van Wouw kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 17.18u	0	2.000		
	5	2.000		
	10	2.000		
	15	2.000		
	20	2.000		
eind: 17.43u	25	2.000		
	AVERAGE	2.000		

Stondansie kanaal				
Meting	**Tijd (min)**	**Waterstand (m NSP)**	**Opmerking**	**Verantwoordelijke**
start: 17.50u	0	2.000		
	5	2.000		
	10	1.990		
	15	1.990		
eind: 18.08u	18	1.990		
	AVERAGE	1.994		

2. Intake HA

a) Water level intake HA 23-02-2012

Upstream:

INSTROOM

Een schuif open tot 0,25m t.o.v. bodem sluis

Meting	Tijd (min)	Waterstand (m NSP)	Opmerking	Verantwoordelijke
start: 11.30	0	2.269		
	5	2.269		
	10	2.269		
	15	2.269		
	20	2.269		
	25	2.269		
	30	2.269		
	35	2.269		
einde: 12.07	37	2.269		

Een schuif open tot 0,50m t.o.v. bodem sluis

Meting	Tijd (min)	Waterstand (m NSP)	Opmerking	Verantwoordelijke
start: 12.18u	0	2.264		
	5	2.262		
	10	2.260		
	15	2.257		
	20	2.256		
	25	2.255		
	30	2.254		
einde: 12.52u	34	2.253		

Een schuif open tot 0,75m t.o.v. bodem sluis

Meting	Tijd (min)	Waterstand (m NSP)	Opmerking	Verantwoordelijke
start: 13.45u	0	2.254		
	5	2.254		
	10	2.254		
	15	2.254		
	20	2.254		
	25	2.254		
	30	2.254		
einde: 14.20u	35	2.254		

Een schuif open tot 1,00m t.o.v. bodem sluis

Meting	Tijd (min)	Waterstand (m NSP)	Opmerking	Verantwoordelijke
start: 14.38u	0	2.244		
	5	2.244		
	10	2.244		
	15	2.244		
	20	2.244		
	25	2.244		
	30	2.244		
einde: 15.13u	35	2.244		

Een schuif open tot 1,22m t.o.v. bodem sluis (maximale stand,geheel open)

Meting	Tijd (min)	Waterstand (m NSP)	Opmerking	Verantwoordelijke
start: 15.27u	0	2.244		
	5	2.244		
	10	2.244		
	15	2.244		
	20	2.244		
	25	2.244		
	30	2.244		
einde: 16.02u	35	2.244		

Downstream:

			UITSTROOM		
Een schuif open tot 0,25m t.o.v. bodem sluis					

Meting	Tijd (min)	Waterstand (m NSP)	Opmerking	Verantwoordelijke
start: 11.32u	0	1.950		
	5	1.940		
	10	1.940		
	15	1.940		
	20	1.940		
	25	1.940		
	30	1.940		
	35	1.940		
einde: 12.10u	38	1.940		

Een schuif open tot 0,50m t.o.v. bodem sluis

Meting	Tijd (min)	Waterstand (m NSP)	Opmerking	Verantwoordelijke
start: 12.21u	0	1.960		
	5	1.960		
	10	1.960		
	15	1.960		
	20	1.960		
	25	1.970		
	30	1.970		
einde: 12.56u	35	1.975		

Een schuif open tot 0,75m t.o.v. bodem sluis

Meting	Tijd (min)	Waterstand (m NSP)	Opmerking	Verantwoordelijke
start: 13.49u	0	2.020		
	5	2.020		
	10	2.020		
	15	2.020		
	20	2.030		
	25	2.030		
	30	2.030		
einde: 14.24u	35	2.040		

Een schuif open tot 1,00m t.o.v. bodem sluis

Meting	Tijd (min)	Waterstand (m NSP)	Opmerking	Verantwoordelijke
	0	2.060		
	5	2.060		
	10	2.060		
	15	2.060		
	20	2.065		
	25	2.070		
	30	2.070		
	34	2.075		

Een schuif open tot 1,22m t.o.v. bodem sluis (maximale stand,geheel open)

Meting	Tijd (min)	Waterstand (m NSP)	Opmerking	Verantwoordelijke
	0	2.085		
	5	2.090		
	10	2.090		
	15	2.095		
	20	2.095		
	25	2.095		
	30	2.095		
	34	2.095		

M. Calculations for the calibration

Only Nanni intake has been calibrated during the time of research. In the tables below the inputs and calculated figures are shown which were required to derive the C_d-values for the intake calibration. The first table shows the results for the calibration of 1 intake gate, and the second table shows the results of calibrating the 2 gates of Nanni intake.

Date	# Measurement	Mid section Discharge (m^3/s)	Mean section	Gate position (m)	Downstream water level (m)	Upstream water level (m)	Water level difference	Mid section Cd	Mean section Cd
2-1-2012	1	3.07	3.01	**0.50**	2.10	2.46	0.36	0.77	0.75
	2	4.69	4.57	**1.00**	2.13	2.45	0.32	0.63	0.61
	3	6.03	5.86	**1.50**	2.16	2.44	0.28	0.57	0.56
	4	7.54	7.47	**2.00**	2.18	2.43	0.25	0.57	0.56
	5	11.08	10.73	**2.50**	2.19	2.43	0.24	0.68	0.65
	6	12.70	12.64	**2.77**	2.17	2.43	0.26	0.67	0.67
							Average	0.65	0.64
8-2-2012	1	4.56	4.35	**0.50**	2.11	2.59	0.48	0.99	0.94
	2	5.31	5.05	**1.00**	2.14	2.59	0.45	0.60	0.57
	3	8.35	7.96	**1.50**	2.17	2.58	0.41	0.65	0.62
	4	10.86	10.28	**2.00**	2.20	2.57	0.37	0.67	0.63
	5	14.15	13.44	**2.50**	2.20	2.56	0.36	0.71	0.68
	6	17.25	16.29	**2.75**	2.18	2.56	0.38	0.75	0.72
							Average	0.73	0.70
16-2-2012	1	2.36	2.32	**0.50**	1.88	2.15	0.27	0.68	0.67
	2	3.32	3.19	**1.00**	1.91	2.15	0.24	0.51	0.49
	3	5.07	4.87	**1.50**	1.93	2.14	0.21	0.56	0.53
	4	7.20	6.87	**2.00**	1.97	2.14	0.17	0.65	0.62
	5	9.39	8.99	**2.50**	1.99	2.13	0.14	0.76	0.73
	6	11.73	11.00	**2.65**	1.99	2.13	0.14	0.90	0.83
							Average	0.68	0.65
22-2-2012	1	2.89	2.74	**0.50**	2.00	2.11	0.11	1.30	1.23
	2	3.60	3.43	**1.00**	2.01	2.10	0.09	0.92	0.88
	3	4.00	3.81	**1.50**	2.02	2.10	0.07	0.74	0.70
	4	4.46	4.29	**2.00**	2.04	2.09	0.06	0.71	0.68
	5	4.63	4.45	**2.50**	2.05	2.09	0.04	0.66	0.63
	6	5.44	5.18	**2.72**	2.05	2.10	0.05	0.71	0.67
							Average	0.84	0.80

		Mid section	Mean section					Mid section	Mean section
Date	# Measurement	Discharge (m^3/s)		Gate position (m)	Downstream water level (m)	Upstream water level (m)	Water level difference	Cd	Cd
27-1-2012	1	5.27	5.13	**0.50**	2.13	2.41	0.28	0.75	0.73
	2	8.20	7.90	**1.00**	2.17	2.39	0.22	0.66	0.64
	3	10.31	10.06	**1.50**	2.21	2.36	0.15	0.66	0.65
	4	12.26	11.77	**2.00**	2.24	2.34	0.11	0.70	0.67
	5	14.51	13.78	**2.50**	2.25	2.39	0.14	0.58	0.55
	6	15.88	15.33	**2.91**	2.25	2.32	0.06	0.82	0.78
							Average	0.70	0.67
3-2-2012	1	4.94	4.87	**0.50**	2.16	2.42	0.26	0.73	0.72
	2	8.31	8.15	**1.00**	2.21	2.41	0.20	0.69	0.68
	3	11.44	11.00	**1.50**	2.23	2.40	0.17	0.70	0.67
	4	13.09	12.83	**2.00**	2.25	2.38	0.14	0.67	0.66
	5	17.49	16.98	**2.50**	2.25	2.37	0.12	0.76	0.74
	6	21.18	20.30	**2.69**	2.22	2.36	0.14	0.74	0.75
							Average	0.71	0.70
10-2-2012	1	7.09	6.60	**0.50**	2.16	2.50	0.34	0.91	0.85
	2	10.22	9.66	**1.00**	2.21	2.48	0.27	0.74	0.70
	3	14.11	13.22	**1.50**	2.25	2.46	0.21	0.78	0.73
	4	15.83	14.94	**2.00**	2.26	2.45	0.19	0.69	0.65
	5	23.63	22.08	**2.50**	2.23	2.44	0.21	0.78	0.73
	6	26.51	24.59	**2.66**	2.19	2.45	0.26	0.69	0.68
							Average	0.77	0.72
13-2-2012	1	4.97	4.74	**0.50**	2.06	2.33	0.27	0.72	0.69
	2	7.70	7.34	**1.00**	2.10	2.32	0.22	0.62	0.59
	3	10.16	9.50	**1.50**	2.14	2.31	0.17	0.61	0.57
	4	12.98	12.12	**2.00**	2.15	2.30	0.15	0.64	0.59
	5	17.52	16.40	**2.50**	2.14	2.29	0.14	0.70	0.66
	6	21.65	20.23	**2.60**	2.11	2.29	0.18	0.70	0.69
				2.54/2.73			Total average	0.66	0.63

K. Information on Wakay pumping period November 2011-February 2012

The following information is on the Wakay pumping season from November 2011 to February 2012. During the period of research this was the pumping season (August, 2012). As it is in Dutch, the author – T. Henstra – can be contacted for translation.

Bedrijfsgegevens Wakay Motoren en Pompen
Periode: November 2011 - Februari 2012

Bedrijfsgegevens	Motor 1	Motor 2	Motor 3	Motor 4	Totaal	Opmerkingen
Toerental (rpm)	-	710	712	711		
Draaiuren	-	803.00	876.00	1,039.25	2,718.25	
Dieselverbruik (gem per uur)	-	100	102	101		
Dieselverbruik (Totaal)	-	80,300.00	89,352.00	104,964.25	274,616.25	
Volume gepompte water (m3)		21,681,000.00	23,652,000.00	28,059,750.00	73,392,750.00	

Beginvoorraad op 31 oktober 2011 (ltrs.)	95,200.00
Mahespalsingh levering I op december 2011	100,000.00
Mahespalsingh levering II op december 2011	50,000.00
Mahespalsingh Levering III op december 2012	50,000.00
Brandstofverbruik generatoren 31 oct 2011 - 31 jan 2012 (100 ltrs/dag)	(15,100.00)
Verbruik Motoren in deze periode	(274,616.25)
Saldo	5,483.75
Voorraadverschillen (afleesfouten + hoeveelheid in brandstofleidingen)	2,750.00
Saldo gecorrigeerd	2,733.75
Eindvoorraad opgenomen 31 februari 2012 (ltrs.)	2,900.00

Datum	Gepompte dagen (+/-)				Machinist	Gepompte uren			
	Motor 2	Motor 3	Motor 4			Motor 2	Motor 3	Motor 4	Totaal
31-okt-10	-	-	+	+	RP;MS	-	-	2.00	2.00
21-nov-10	+	+	-	+	SP;JA	11.00	11.00	-	22.00
22-nov-10	+	+	-	+	SP;JA	24.00	24.00	-	48.00
23-nov-10	+	+	-	+	RP;MS	24.00	24.00	-	48.00
24-nov-10	+	+	+	+	RP;MS	24.00	24.00	3.25	51.25
25-nov-10	+	+	+	+	RP;MS	24.00	24.00	8.00	56.00
26-nov-10	+	+	+	+	RP;MS	13.00	24.00	24.00	61.00
27-nov-10	-	+	+	+	RP;MS	-	24.00	24.00	48.00
28-nov-10	-	+	+	+	RP;MS	-	24.00	24.00	48.00
29-nov-10	+	+	+	+	RP;MS	0.75	24.00	24.00	48.75
30-nov-10	-	+	+	+	RP;MS	-	24.00	24.00	48.00
1-dec-10	-	+	+	+	RP;MS	-	24.00	24.00	48.00
2-dec-10	-	+	+	+	RP;MS	-	24.00	24.00	48.00
3-dec-10	-	+	+	+	RP;MS	-	24.00	24.00	48.00
4-dec-10	-	+	+	+	RP;MS	-	24.00	24.00	48.00
5-dec-10	-	+	+	+	RP;MS	-	9.00	24.00	33.00
6-dec-10	-	-	+	+	P;MS/SP;J.	-	-	24.00	24.00
7-dec-10	-	-	+	+	SP;JA	-	-	24.00	24.00
8-dec-10	-	-	+	+	SP;JA	-	-	24.00	24.00
9-dec-10	-	-	+	+	SP;JA	-	-	23.50	23.50
10-dec-10	-	-	+	+	SP;JA	-	-	3.75	3.75
11-dec-10	-	-	-	-		-	-	-	-
12-dec-10	-	-	-	-		-	-	-	-
13-dec-10	+	+	+	+	SP;JA	8.50	8.25	8.25	25.00
14-dec-10	+	+	+	+	SP;JA	24.00	24.00	24.00	72.00
15-dec-10	+	+	+	+	SP;JA	24.00	24.00	24.00	72.00
16-dec-10	+	+	+	+	SP;JA	24.00	10.25	24.00	58.25
17-dec-10	+	-	+	+	SP;JA	24.00	-	24.00	48.00
18-dec-10	+	-	+	+	SP;JA	24.00	-	24.00	48.00
19-dec-10	+	-	+	+	SP;JA	24.00	-	24.00	48.00
20-dec-10	+	-	+	+	P;JA/RP;M	24.00	-	24.00	48.00
21-dec-10	+	-	+	+	RP;MS	24.00	-	24.00	48.00
22-dec-10	+	-	+	+	RP;MS	24.00	-	24.00	48.00
23-dec-10	+	-	+	+	RP;MS	24.00	-	24.00	48.00
24-dec-10	+	-	+	+	RP;MS	24.00	-	24.00	48.00
25-dec-10	+	-	+	+	RP;MS	24.00	-	24.00	48.00
26-dec-10	+	+	+	+	RP;MS	24.00	8.25	24.00	56.25
27-dec-10	+	+	+	+	RP;MS	24.00	24.00	24.00	72.00
28-dec-10	+	+	+	+	RP;MS	24.00	24.00	24.00	72.00
29-dec-10	+	+	+	+	RP;MS	24.00	24.00	24.00	72.00
30-dec-10	+	+	+	+	RP;MS	8.00	24.00	8.00	40.00
31-dec-10	-	+	-	-	RP;MS	-	16.00	-	16.00
1-jan-11	-	-	-	-		-	-	-	-
2-jan-11	-	-	-	-		-	-	-	-
3-jan-11	-	-	-	-		-	-	-	-
4-jan-11	-	-	-	-		-	-	-	-
5-jan-11	-	-	-	-		-	-	-	-
6-jan-11	-	-	-	-		-	-	-	-
7-jan-11	-	-	-	-		-	-	-	-
8-jan-11	-	-	-	-		-	-	-	-
9-jan-11	-	-	-	-		-	-	-	-
10-jan-11	+	+	+	+	SP;JA	9.50	9.50	9.25	28.25
11-jan-11	+	+	+	+	SP;JA	24.00	24.00	24.00	72.00
12-jan-11	+	+	+	+	SP;JA	24.00	24.00	24.00	72.00
13-jan-11	+	+	+	+	SP;JA	24.00	24.00	24.00	72.00
14-jan-11	+	+	+	+	SP;JA	24.00	24.00	24.00	72.00
15-jan-11	+	+	+	+	SP;JA	24.00	24.00	24.00	72.00
16-jan-11	+	+	+	+	SP;JA	9.50	24.00	24.00	57.50
17-jan-11	-	+	+	+	P;JA/RP;M	-	24.00	24.00	48.00
18-jan-11	-	+	+	+	RP;MS	-	8.75	8.50	17.25
19-jan-11	-	-	-	-	RP;MS	-	-	-	-
20-jan-11	-	-	-	-	RP;MS	-	-	-	-
21-jan-11	-	-	-	-	RP;MS	-	-	-	-
22-jan-11	+	+	-	+	RP;MS	6.75	6.75	-	13.50
23-jan-11	+	+	-	+	RP;MS	24.00	24.00	-	48.00
24-jan-11	+	+	+	+	RP;MS	24.00	24.00	15.50	63.50
25-jan-11	+	+	+	+	RP;MS	24.00	24.00	24.00	72.00
26-jan-11	+	+	+	+	RP;MS	24.00	24.00	24.00	72.00
27-jan-11	+	+	+	+	RP;MS	24.00	24.00	9.00	57.00

L. Water level information

The thalimedes water level measurement instruments provide a great quantity of information on the water levels at the locations where they are positioned. It should be possible to derive these water levels digitally over a distance within the reach of the signal from the sim-card which is installed in it. However, many of the measurement instruments have defects and are therefore not functioning to their full potential. Currently the state of the instruments are as given in this table:

Thalimedes	Functioning sim-card	Manual download (MD)	Notes
Nanni	x		
Henar	x		
Clara division box		x	MD failed
Driekokerpunt		x	
Camisa creek			No signal
Wakay			No signal > removed

The raw water level data which is displayed in the graph in the body text is given below. The table shows values which were derived from the Ministry of OW. At Clara pumping station an employee of the Ministry of OW took the water level readings at 7AM every morning.

	Water levels			
NSP-correction	3.74		0.394	
	Nanni d.s.		**Clara pumping station**	
Date	*inside sluice*	*NSP*	*d.s in VWc*	*NSP*
1-dec-11	1.40	2.34	2.70	2.31
2-dec-11	1.40	2.34	2.70	2.31
3-dec-11	1.40	2.34	2.70	2.31
4-dec-11	1.40	2.34	2.66	2.27
5-dec-11	1.40	2.34	2.66	2.27
6-dec-11	1.50	2.24	2.60	2.21
7-dec-11	1.60	2.14	2.55	2.16
8-dec-11	1.70	2.04	2.55	2.16
9-dec-11	1.80	1.94	2.50	2.11
10-dec-11	1.80	1.94	2.40	2.01
11-dec-11	1.85	1.89	2.30	1.91
12-dec-11	1.90	1.84	2.20	1.81
13-dec-11	1.90	1.84	2.10	1.71
14-dec-11	1.80	1.94	2.15	1.76
15-dec-11	1.70	2.04	2.40	2.01
16-dec-11	1.70	2.04	2.50	2.11
17-dec-11	1.60	2.14	2.60	2.21
18-dec-11	1.50	2.24	2.60	2.21
19-dec-11	1.50	2.24	2.60	2.21
20-dec-11	1.50	2.24	2.60	2.21
21-dec-11	1.45	2.29	2.60	2.21
22-dec-11	1.45	2.29	2.65	2.26
23-dec-11	1.40	2.34	2.66	2.27
24-dec-11	1.30	2.44	2.70	2.31
25-dec-11	1.30	2.44	2.77	2.38
26-dec-11	1.30	2.44	2.80	2.41
27-dec-11	1.30	2.44	2.80	2.41
28-dec-11	1.40	2.34	2.80	2.41
29-dec-11	1.50	2.24	2.80	2.41
30-dec-11	1.65	2.09	2.45	2.06
31-dec-11	1.65	2.09	2.45	2.06
1-jan-12	1.65	2.09	2.45	2.06
2-jan-12	1.65	2.09	2.40	2.01
3-jan-12	1.65	2.09	2.40	2.01
4-jan-12	1.65	2.09	2.39	2.00
5-jan-12	1.70	2.04	2.39	2.00
6-jan-12	1.75	1.99	2.30	1.91
7-jan-12	1.80	1.94	2.20	1.81
8-jan-12	1.80	1.94	2.19	1.80
9-jan-12	1.95	1.79	2.19	1.80
10-jan-12	1.95	1.79	2.22	1.83
11-jan-12	1.90	1.84	2.40	2.01
12-jan-12	1.60	2.14	2.50	2.11
13-jan-12	1.60	2.14	2.60	2.21
14-jan-12	1.60	2.14	2.62	2.23
15-jan-12	1.60	2.14	2.62	2.23
16-jan-12	1.60	2.14	2.62	2.23
17-jan-12	1.60	2.14	2.65	2.26
18-jan-12	1.60	2.14	2.65	2.26
19-jan-12	1.60	2.14	2.59	2.20
20-jan-12	1.70	2.04	2.49	2.10
21-jan-12	1.80	1.94	2.40	2.01
22-jan-12	1.95	1.79	2.25	1.86
23-jan-12	1.95	1.79	2.20	1.81
24-jan-12	1.75	1.99	2.30	1.91
25-jan-12	1.60	2.14	2.40	2.01
26-jan-12	1.55	2.19	2.51	2.12
27-jan-12	1.50	2.24	2.60	2.21
28-jan-12	1.40	2.34	2.69	2.30
29-jan-12	1.40	2.34	2.70	2.31
30-jan-12	1.50	2.24	2.77	2.38
31-jan-12	1.55	2.19	2.60	2.21
1-feb-12	1.60	2.14	2.59	2.20
2-feb-12	1.60	2.14	2.50	2.11
3-feb-12	1.60	2.14	2.48	2.09
4-feb-12	1.55	2.19	2.50	2.11
5-feb-12	1.55	2.19	2.60	2.21
6-feb-12	1.55	2.19	2.60	2.21
7-feb-12	1.50	2.24	2.60	2.21
8-feb-12	1.60	2.14	2.55	2.16
9-feb-12	1.70	2.04	2.55	2.16
10-feb-12	1.75	1.99	2.55	2.16
11-feb-12	1.80	1.94	2.30	1.91
12-feb-12	1.90	1.84	2.30	1.91
13-feb-12	1.90	1.84	2.20	1.81
14-feb-12	1.85	1.89	2.40	2.01
15-feb-12	1.80	1.94	2.40	2.01

Tetje Henstra:
MCP NSP pin: 3.77m>pin is 11 cm above concrete> concrete is 3.66m+NSP. OW measures from concrete but has NSP-reference of 3.74m.

As seen in the intake calibration part: to know how much water flows through an inlet depends on the opening, and the water levels. Therefore a picture has been created from the water levels during the period of research for the different Thalimedes measurement instruments (Figure 47).

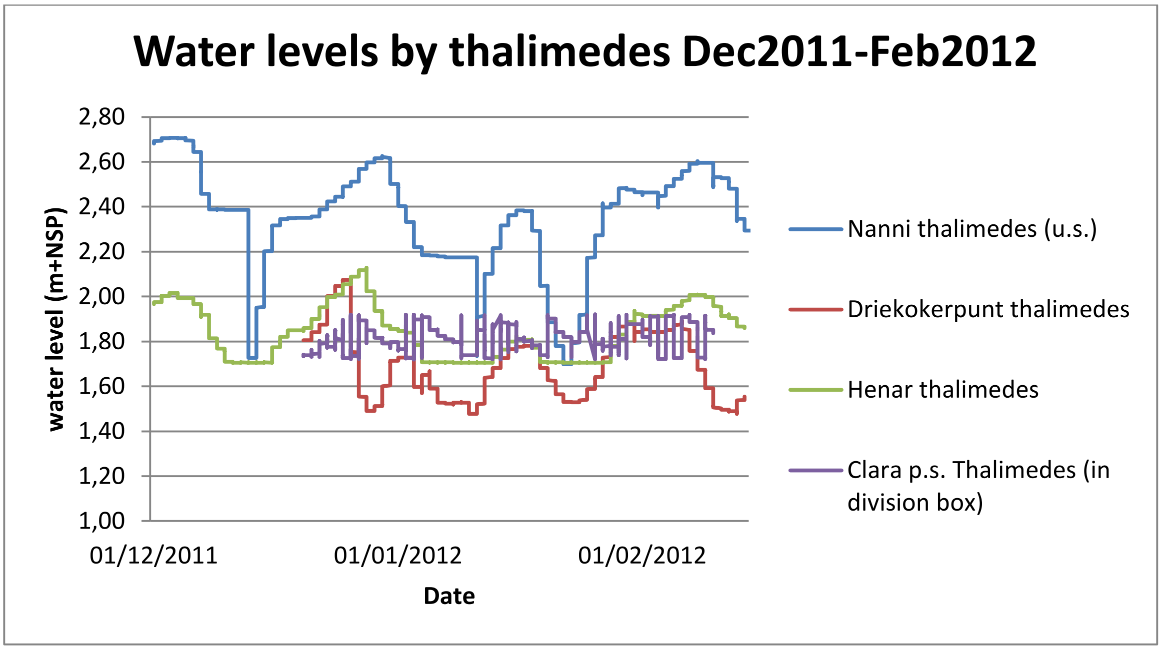


Figure 47: Water levels as measured by the Thalimedes measurement instruments (raw data from (Small, 2012))

M. Polder information

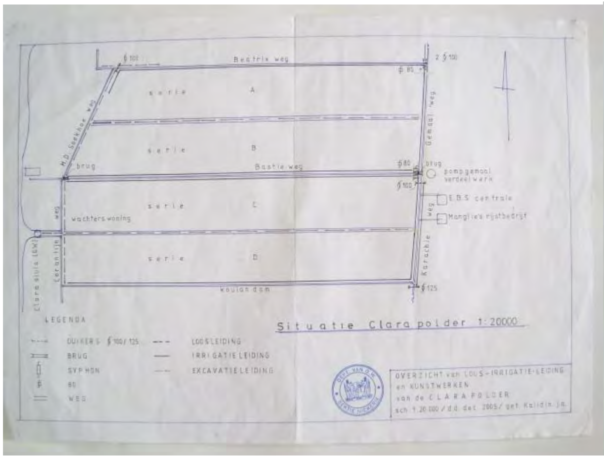
In this annex information on polder area, plot sizes, etc. is supplied. Both the Ministry of OW and LVV provided figures on the sizes of different polders. The first table (left) was obtained from (MinisterieOpenbareWerken, 2012a) and the second table (right) was obtained from (LVV, 2012). The figures in the table from OW most likely indicate the net area of the polders. As explained, the different tables not only show different polder sizes, but also contain this information on different polders. As during the time of research it was not clarified which information is correct, this annex shows – additional to the body text – the rest of the information which was derived for the polders and their sizes.
Drawing of different polders are displayed in the second part of this annex.

OW2		
POLDER	AREA (m2)	AREA (ha)
Europolder Noord	13463557	1346
Hamptoncourtpolder	12637988	1264
S.B.B.S. N.V	5517624	552
Brutopolder	5296751	530
Koningin Juliuanpolder	6969676	697
Sawmillkreekpolder	2630657	263
Manglie	4483975	448
Uitbreiding Hamptoncourtpolder	2827763	283
Stalweide	2220810	222
Klein Henarpolder	2415964	242
Tewarie	825781	83
Paradijs	3933283	393
Ons Land	8451031	845
Longmay	4390894	439
Van Pettenpolder	3012162	301
Uitbreiding Paradijs	4848767	485
Clarapolder	14518912	1452
Hazard	1572587	157
Van Drimmelenpolder	10958275	1096
Manglie	6698443	670
Prins Bernard Polder	10883558	1088
Uitbreiding Groot Henarpolder	22268709	2227
Nursery	3187093	319
Groot Henar Polder	26751157	2675
Nieuw Nickerie	1411504	141
Waterloo	8050203	805
Magretenburg	2354290	235
Waldeck	1537600	154
Sidoredjo	2286530	229
Stalweide (Corantijnpolder)	4638091	464
Madhar	1280201	128
Corantijnpolder	9711291	971
Natuurgebied	1200240	120
Boonackerpolder	1896304	190
Nannipolder	14740246	1474
Totaal		22987.192

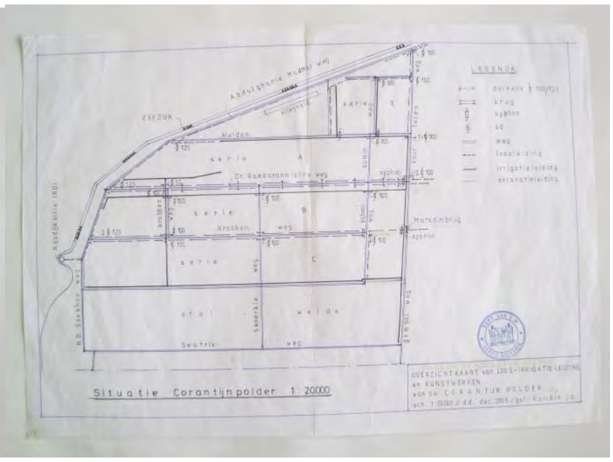
LVV	Net	Average	# plots
Polders	**area (ha)**	**plot size (ha)**	
Sidoredjo	164	1,0	169
Margarethenburg	104	1,1	92
Waldeck	84	0,7	120
Van Drimmelen	850	1,5	568
Corantijn	747	1,3	573
Clara	1366	3,4	365
Hamptoncourt	847	1,7	493
Sawmillkreek	480	2,8	169
Paradise/Bacovendam	570	1,3	439
Boonacker	101	2,4	42
Longmay	308	0,98	314
Klein-Henar	142	1,8	78
Groot-Henar	2100	4,0	520
Europolder-Zuid	1140	5,3	214
Europolder-Noord	1035	6,3	164
Nanni	1062	5,5	194
Bruto	385	5,7	68
Uitbr. Groothenar I	1080	10,0	108
Uitbr. Groothenar II	721	11,3	64
Totaal:	**13286**		**4754**

Drawings of the polders are supplied below. These drawings were derived from (MinisterieOpenbareWerken, 2005).

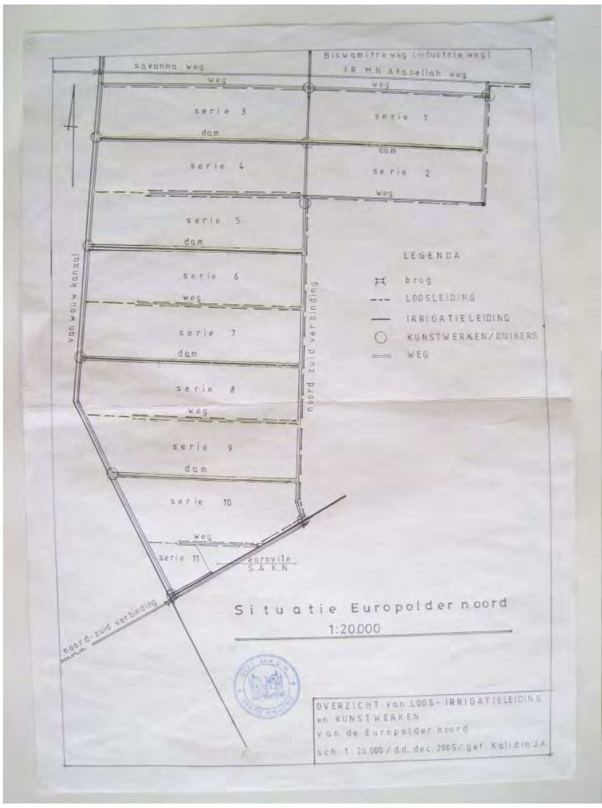
Clara polder:



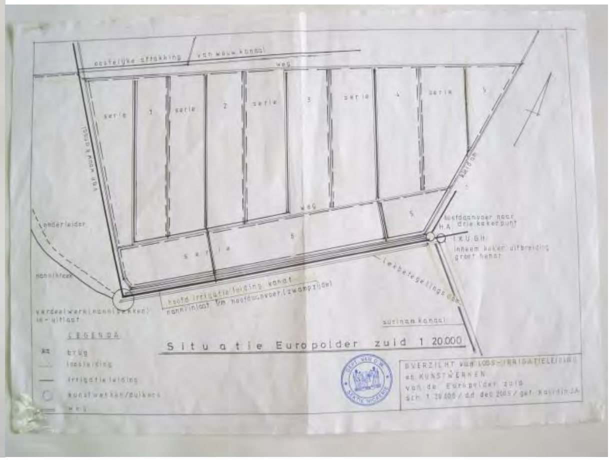
Corantijn polder:



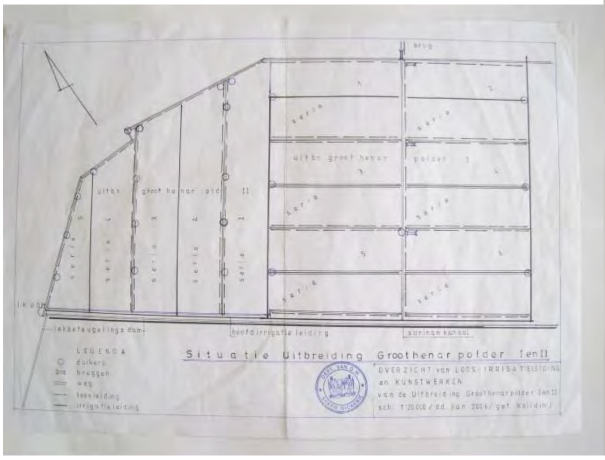
Euro-Noord polder:



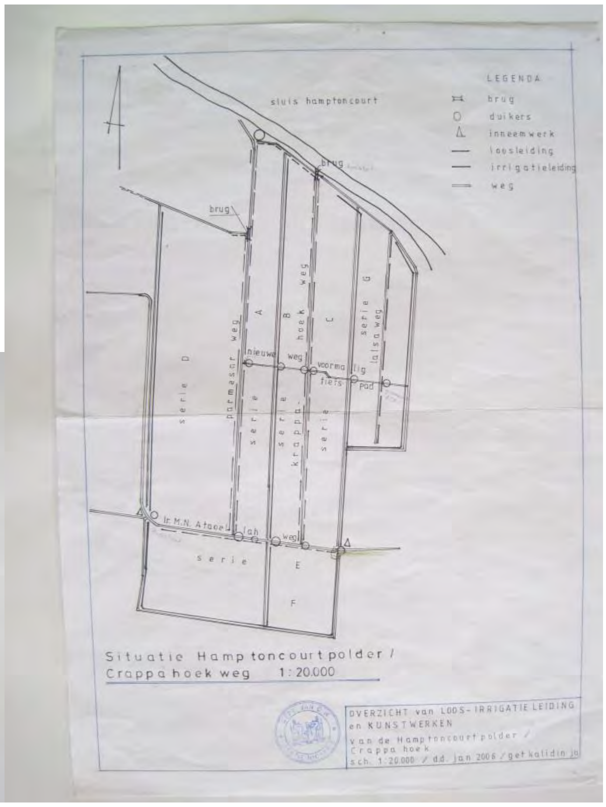
Euro-Zuid polder:



Groot Henar polder:

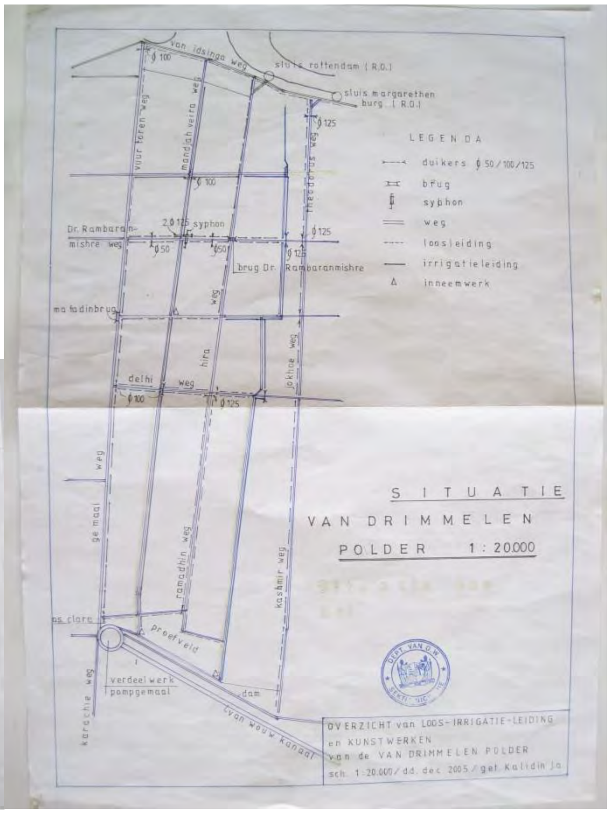


Hamptoncourt polder:



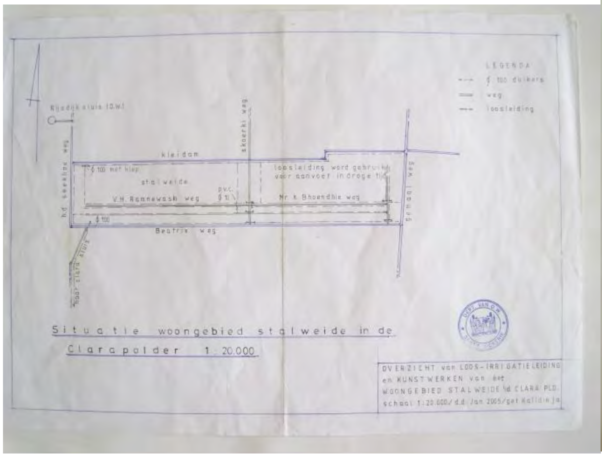
Nanni and Bruto polder:

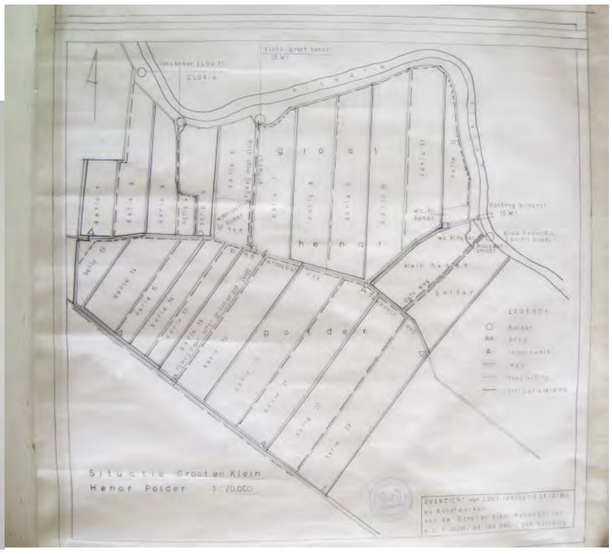
Van Drimmelen polder:



Living area Stalweide polder:

Groot Henar and Klein Henar:





N. Pictures of inlets and offtaking canals

For several inlets and canals pictures were taken. This annex shows these pictures with a reference number. This reference number refers to the numbers noted in Table 18 and 19.

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O. Information on drainage sluices

In the rainy season farmers experienced nuisance of too much water, due to for example blocked drainage canals. When the water was stagnant for approximately 3 weeks the harvest of rice had failed. This happened in the Corantijn polder and the inhabited areas (where people excavate soil to level up their houses, so in the rainy season water collects in the area where soil was removed). In the inhabited areas the drainage canals were dirty as well since there was contamination, and a lot of water hyacinth and grass mats counteract a smooth flow of the water. The polders which were located more downstream in the irrigation scheme were disposed to a higher probability of flooding, as the drainage discharge lacks sufficiency in wet times.

The information in the tables below was derived from (Triloki and Angoelal, 2012). The first table is on all drainage sluices in the irrigation scheme, with the drainage area mentioned per sluice. The second table displays the drainage sluices under supervision of the Ministry of Public Works. In this table information on the dimensions of the gates and the type of operation is included. The figure shows the location of the sluices.

Name of drainage sluice	**Drainage area (ha)**
Nanni sluice:	5066.00
Clara sluice:	1366.03
Rijsdijck sluice:	1024.38
Sluice Post Rotterdam:	1509.46
Sluice Margarethenburg:	513.44
Sluice Van Petten polder:	381.4
Sluice Nieuw – Nickerie:	147.25 (+ pump Nw – Nickerie).
Sluice Waterloo:	616.00
Sluice Nurserij:	1066.00
Sluice Ontw. Bacoven pld:	722.44 (Hazardsluis)
Sluice Longmay:	35.40
Sluice Boldewijn:	66.60
Sluice longmay:	113.42
Sluice Paradise: Dubbel	1st= 110.53; 2nd= 202.6
Sluice Sawmillkreek:	236.10
Sluice Boonakker pld:	171.60
Sluice Hamtoncourt polder:	2371.60
Sluice Krappahoek tot kreek:	135.97
Sluice Henar:	165.44
Sluice Groot Henar:	4255.30
Sluice Klein Henar:	206.70

Nr. #	**Sluice Name**	**Amount of gates**	**Dimensions**	**Notes and type of operation**
01	Nanni spillway	Stop logs	3 openings	
04	Nanni sluice	4 gates	4.40m x 3.00m	Automatic flap gates
05	Clara sluice	3 gates	2.00m x 3.65m	Automatic flap gates
06	Waterloo sluice	2 gates	2.00m x 3.65m	Automatic flap gates
07	Uitwaterings sluice Bacovenpolder	4 gates	3.15m x 3.80m	4 tackles (5 ton)
08	Hamtoncourt sluice	3 gates	2.00m x 3.65m	3 tackles (5 ton)
09	Groot Henar sluice	4 gates	4.40m x 3.00m	4 tackles (5 ton)

The drainage sluices in the figure below are indicated with the red dots ranging from North West to North East.

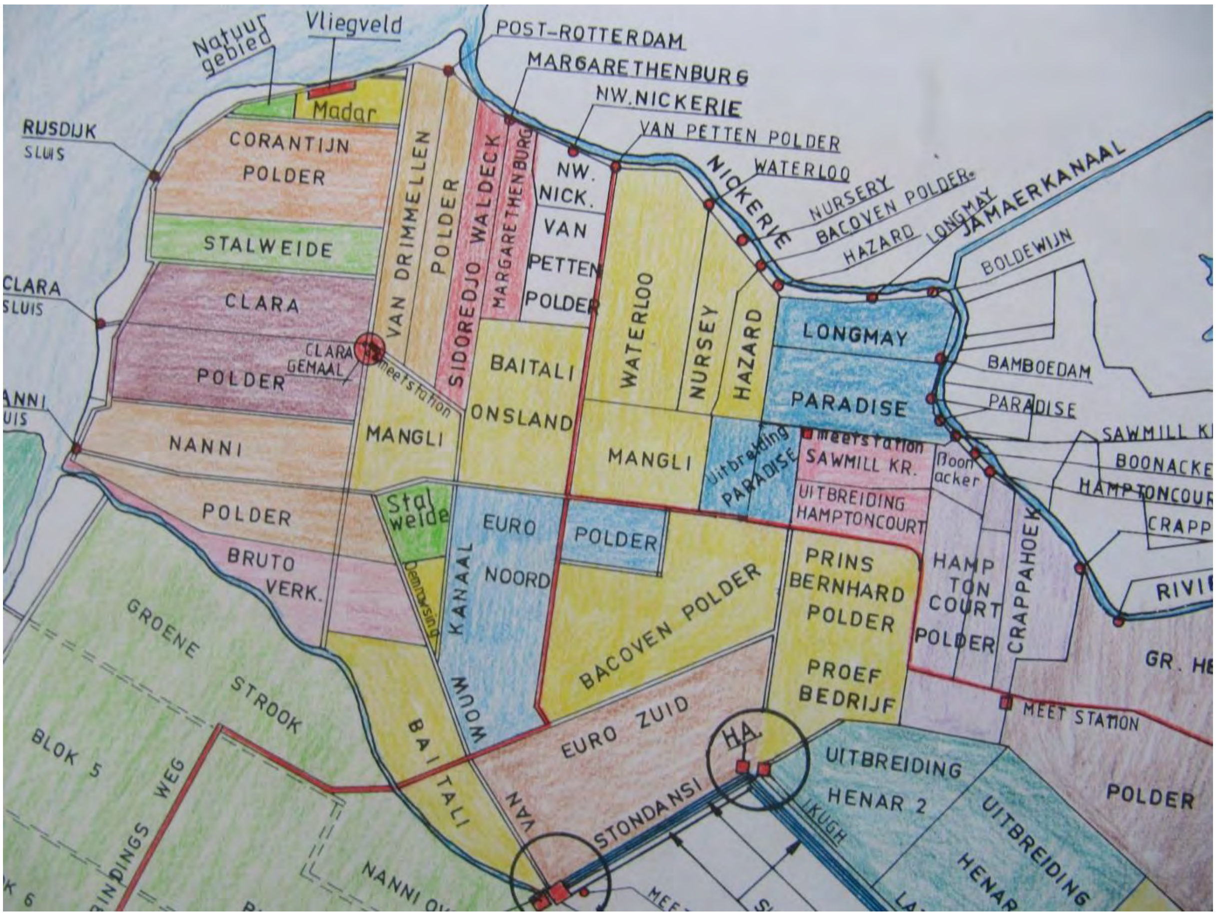


Figure: Polder drawing Nickerie rice district (Nageswhar, 2013)

P. Polder management and water boards

The polder management is organized by different parties in different polders. An – incomplete – overview follows:

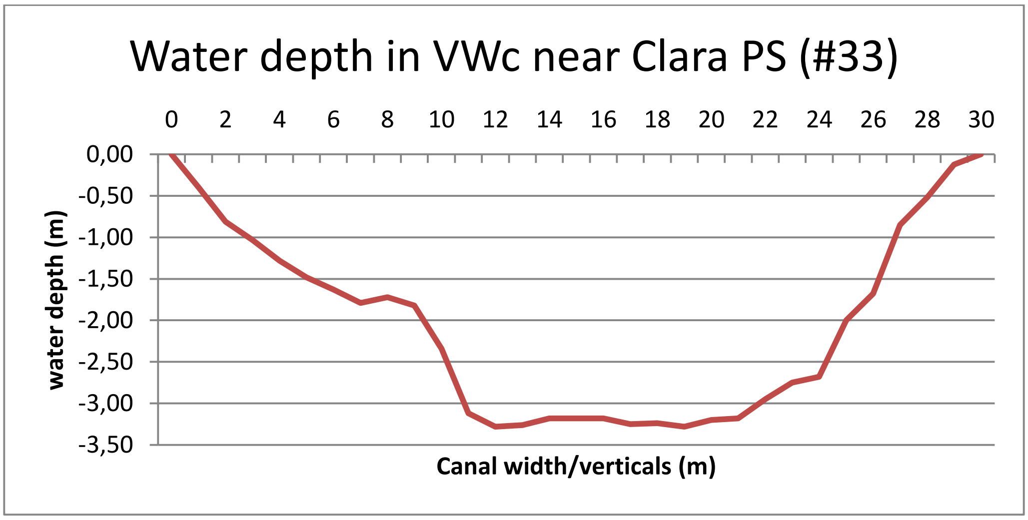
- Mangli and Baitalli and Oemrawsing – large scale farmers - take care of the maintenance and operation of their land and canals themselves.
- The Euro polders are the responsibility of the Ministry of LVV.
- In Stalweide the water board is responsible, though this board directly falls under the responsibility of the Ministry of RO.

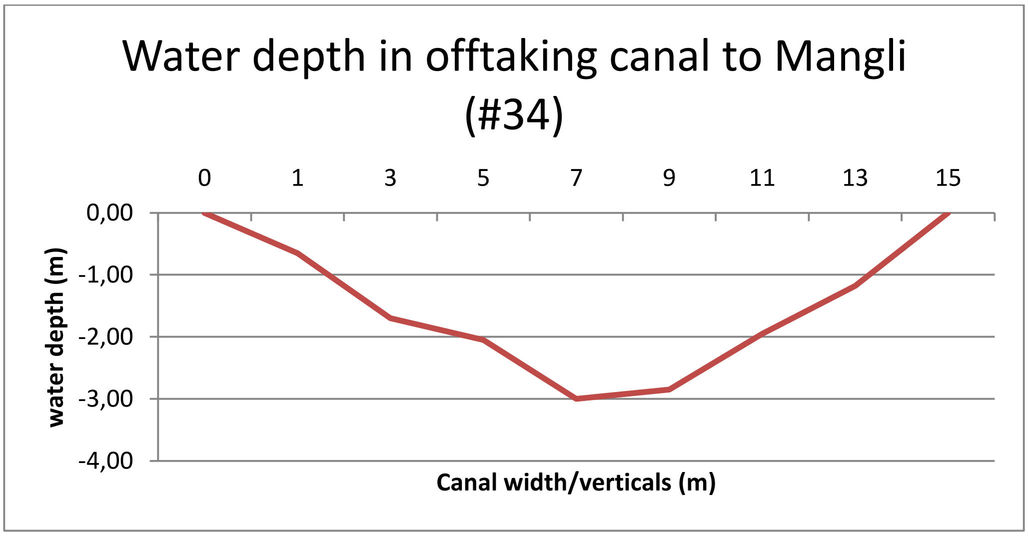
Some polders (e.g. Euro-Noord and part of Groot Henar) had problems with water supply and drainage, since their canals are not clean from vegetation. In most polders this is the responsibility of the farmers themselves. As the operation and maintenance of inlets and canals does not always run fluently, the policy in the Nickerie district focused on creating water boards with a 'keur' stating which preconditions and changes of the water system are legal. In 2013 there were elections in order to appoint candidates for the boards. For some polders – Nanni and Bruto polder, Euro-Zuid polder, and Wasima polder – no candidates were available and so the

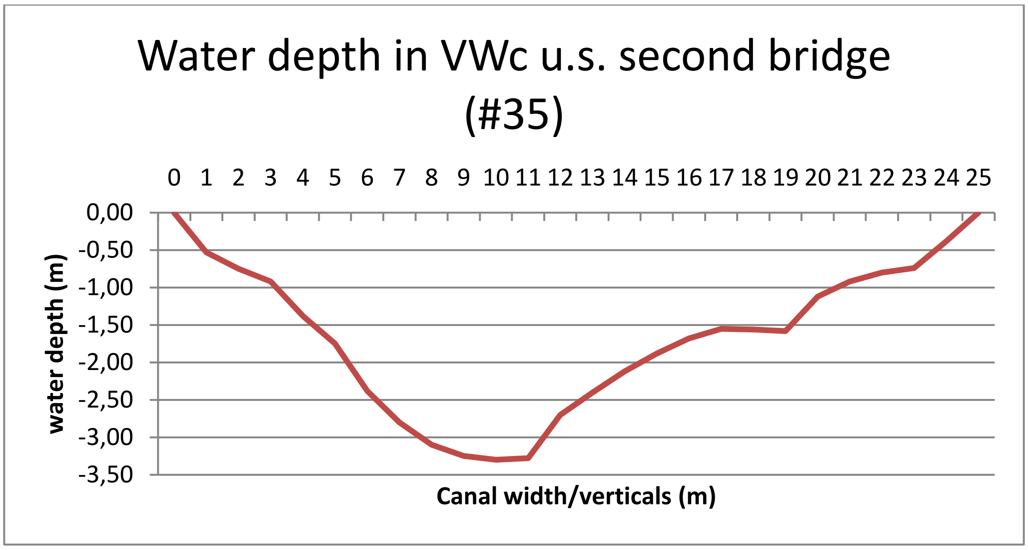
Ministry of RO will appoint their boards for a period of 6 months. Other polders already had boards, though currently the Districts Commissioner has to install these boards before they are officially recognized. At this moment the dry and wet infrastructure of some polders are rehabilitated by the government (LVV) in order to transfer the management to the water boards. The power of enforcing the 'keur' lacks in most water boards still. The positions in the water boards are taken by elected voluntary persons, and due to a lack of time and power water boards are therefore often non-active.

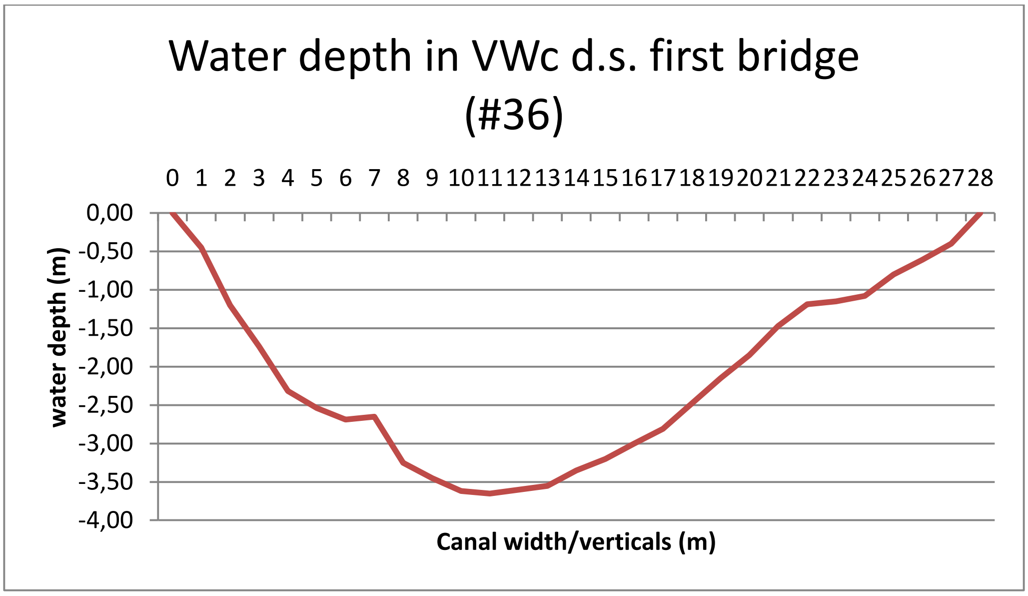
Q. Depth profiles main irrigation canals and offtaking canal

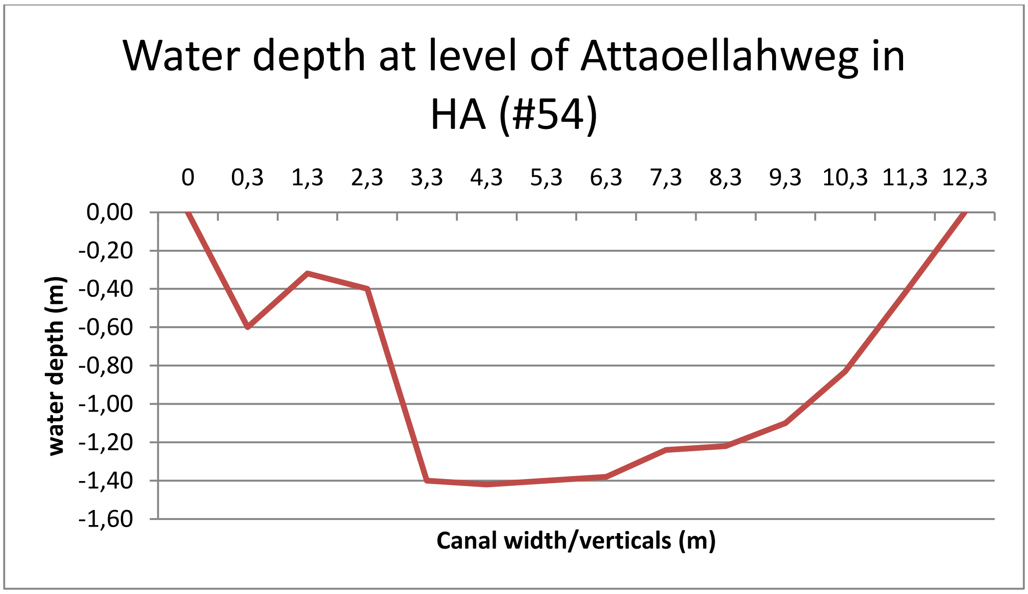
This annex shows the measured depth profiles taken at different locations in cross-sections of the Van Wouw canal and the HA canal. The numbers mentioned in the titles of these graphs refer to the reference numbers in table 18 and 19 of the main report. The numbers on the x-axis refer to the location where the depth measurements were taken. Note that for the first two graphs (#33 and #34) the depth was only measured every 2 meters, while for the cross-sections displayed below those the depth was measured every meter.

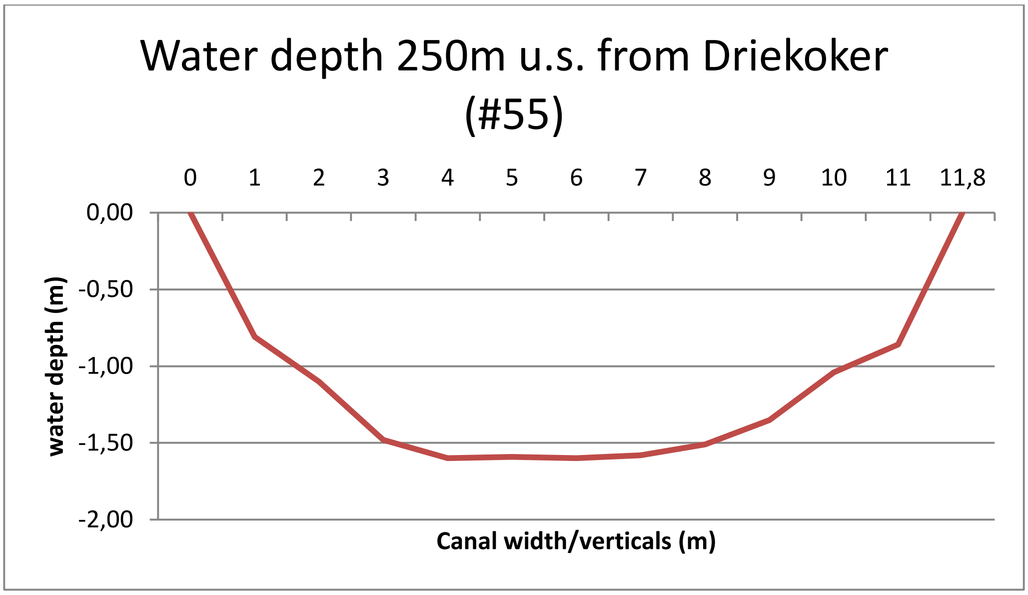





Water depth in VWc u.s. second bridge (#35)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
0,00
-0,50
-1,00
-1,50
-2,00
-2,50
-3,00
-3,50
water depth (m)
Canal width/verticals (m)


Water depth in VWc d.s. first bridge (#36)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
0,00
-0,50
-1,00
-1,50
-2,00
-2,50
-3,00
-3,50
-4,00
water depth (m)
Canal width/verticals (m)


Water depth at level of Attaoellahweg in HA (#54)
0 0,3 1,3 2,3 3,3 4,3 5,3 6,3 7,3 8,3 9,3 10,3 11,3 12,3
0,00
-0,20
-0,40
-0,60
-0,80
-1,00
-1,20
-1,40
-1,60
water depth (m)
Canal width/verticals (m)


Water depth 250m u.s. from Driekoker (#55)
0
1
2
3
4
5
6
7
8
9
10
11
11,8
0,00
-0,50
-1,00
-1,50
-2,00
water depth (m)
Canal width/verticals (m)