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Assessment of lake - groundwater interactions at a dredge lake by means of environmental isotopes and hydrochemical analyses



Diplomarbeit unter der Leitung von Prof. Dr. M. Weiler Freiburg im Breisgau, Dezember 2010

Institut für Hydrologie Albert-Ludwigs Universität Freiburg im Breisgau

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Ehrenwörtliche Erklärung

Hiermit erkläre ich, dass ich die Arbeit selbstständig und nur unter Verwendung der hier angegebenen Hilfsmittel angefertigt habe.

Freiburg, den 06. Dezember 2010

Katrin Kley

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List of abbreviations

D-Excess	Deuterium Excess
DOC	Dissolved organic carbon
EC	Electric conductivity
EDTA	Ethylenediaminetetraacetic acid
e.g.	For example
Fe	Iron
GW	Groundwater
GWML	Global Meteoric Water Line
GWout	In mm/a outflow from a lake into the groundwater
Inflow	In mm/a inflow into the lake
LMWL	Local Meteoric Water Line
MIA	Marginal inflow area
Mn	Manganese
MOA	Marginal outflow area
NDP	New deepest point
ODP	Old deepest point
SMOW	Standard Mean Ocean Water
VSMOW	Vienna Standard Mean Ocean Water
WS-CRDS	Wavelength-Scanned Cavity Ring-Down Spectroscopy

List of variables

Isotope fractionation factor
Separation
Secchi depth
Depth of the end of euphotic zone
Isotope ratio of lake water in late autumn after circulation
Isotope ratio of the lake water in spring after circulation
Averaged isotope ratio of the lake water
Isotopic composition of the total discharge
Isotope ratio of the upgradient groundwater
Isotopic composition of the downgradient groundwater metering
Isotope ratio of the endmembers
Enrichment factor

EP	Average yearly evaporation in mm/a			
f	The fraction of water remaining in the reservoir			
h	Relative humidity			
Κ	Compensation level			
KS _{4.3}	Acid capacity up to pH 4.3			
KS _{8.2}	Acid capacity up to pH 8.2			
m	Slope			
m a.s.l.	Metres above sea level			
Ν	More abundant isotope			
N _i	Less abundant isotope			
Р	Average yearly Precipitation in mm/a			
Q	Volumetric flow rate			
Q_{inflow}	Inflow rate into the lake			
Q _{out}	Outflow rate off the lake			
$Q_{GWinflow}$	Groundwater inflow into the lake			
Q _T	Total discharge			
Q _{1,2}	Discharges of the endmember.			
R_0	Initial ratio			
\mathbb{R}^2	Coefficient of determination			
t	Time			
τ	Turnover time or mean transit time			
V	Volume			
V _{lake}	Lake volume			
$\mathbf{X}_{\mathrm{inflow}}$	Fraction of inflow water in a lake			
X_{LW}	Fraction of lake water in the groundwater			

List of units

Litres per second		
Metres		
Milligrams per litre		
Milliequivalents per litre		
Microgram per litre		

Summary

The dredge lake "Schlosssee Salem" and the interaction with its adjacent groundwater field are reviewed in this thesis. Nowadays, the lake is used as a recreational and leisure area. A dredge lake is an exposure of the aquifer and affects the upgradient and downgradient groundwater largely. At the western wing of the lake, the aquifer outcrops. Therefore, this part of the "Schlosssee Salem" is less connected to the groundwater field. The eastern wing instead, is very well connected with the groundwater field. The measuring program includes the parameters electric conductivity, temperature, oxygen content, pH values, radon level, main ions and other nutrients and stable isotopes ratios.

The stable isotopes ratios were used in a mixing analysis calculating the groundwater inflow and the fraction of lake water in downgradient observation wells. The groundwater inflow is determined to 29.5 l/s. An overflow pipe of the spring "Schapbuch" contributes 7.5 l/s to the groundwater inflow, additionally. The groundwater outflow is estimated over the water budget of the lake to 37.8 l/s. The results, for the fraction of lake water in the downgradient groundwater, are not reliable.

The mean transit time is about ten to eleven month. The "Schlosssee Salem" is stratified over summer. Measurements of electric conductivity, temperature, stable isotopes ratios and radon levels indicate that the groundwater prefers to sink or rise to the thermocline. The mean transit time is calculated with the volume of the lake and the groundwater inflow. Therefore, the mean transit time could be shorter than calculated due to the smaller involved volume of the thermocline.

Hydrochemistry analyses and considerations reinforce the statement that the dredge lake acts as a nutrient trap. Especially the mineralisation is higher in upgradient groundwater then in the downgradient groundwater. The oxygen content in downgradient groundwater is low.

Zusammenfassung

In der folgenden Studie wird der Schlosssee Salem behandelt und seine Wechselwirkungen mit dem angeschlossen Grundwassersystem. Der Schlosssee Salem ist ein dimiktischer Baggersee. Heutzutage wird der See als Freizeit- und Naherholungsgebiet genutzt. Ein Baggersee ist eine Freilegung des Grundwasserleiters. Dies führt zu einer starken Beeinflussung des ober- und unterstromigen Grundwassers. Am westlichen Flügel des Sees streicht der Kiesaquifer aus. Dieser Teil des Schlosssees ist weniger mit dem Grundwasserfeld verbunden. Der östlichen Flügel ist jedoch sehr gut an das Grundwasser angeschlossen.

Das Messprogramm beinhaltete die Parameter elektrische Leitfähigkeit, Temperatur, Sauerstoffgehalt, pH Wert, Radonaktivität, Hauptionen und -nährstoffe und stabile Isotopengehalte.

Der Grundwasserzufluss in den See wurde berechnet mit Hilfe einer Mischungsrechnung, sowie auch den Anteil des Seewassers im unterstromigen Grundwasser. Eingehende Parameter waren die stabilen Isotopengehalte. Der Grundwasserzufluss wurde bestimmt zu 29,5 l/s. Hinzu kommt noch das Wasser der Schapbuchquelle, die tagsüber in den See geleitet wird mit 7,5 l/s. Der Grundwasserabfluss (37,8 l/s) wurde über eine Wasserbilanz ermittelt. Leider sind die Ergebnisse der Seewasseranteilsrechnung im Grundwasser nicht sehr glaubwürdig.

Die mittlere Verweilzeit wurde über den Grundwasserzufluss und des Volumen des Sees auf zehn bis elf Monate bestimmt. Der Schlosssee Salem ist als dimiktischer See geschichtet im Sommer. Elektrische Leitfähigkeits-, Temperatur- und stabile Isotopenmessungen weisen darauf hin, dass das einfließende Grundwasser in das Metalimnion steigt oder sinkt. Deshalb könnte die mittlere Verweilzeit kürzer sein, da mit dem Metalimnion ein kleineres Volumen beteiligt ist.

Hydrochemische Analysen und Annahmen bekräftigen die Aussage, dass ein Baggersee als Nährstofffalle wirkt. Besonders die Mineralisation ist um einiges höher im oberstromigen Grundwasser als im unterstromigen Grundwasser. Außerdem ist der Sauerstoffgehalt im abstromigen Grundwasser sehr gering.

1 Introduction

1.1 General introduction

In the last decades a growing demand for constructing material leads to an increasing excavation of gravel and sands. At many sites the excavation is continued below the water table of shallow Quaternary aquifers. As a side effect a lot of dredge lakes have been created, especially in the Rhine valley and in the foothills of the Alps. Nowadays, the new created artificial lakes are used as recreational areas, inclusive bathing or angling (Kluge et al., 2007).

The creation of a dredge lake affects the surrounding groundwater field and the ecosystem whereby hydraulic, hydrological, hydrogeological and hydrochemical conditions are altered. The effects are more often negative than positive (Armbruster & Kohm, 1977). The exposure of the shallow aquifer and the usage of the dredge lake often have a negative effect on the adjacent groundwater which gets highly vulnerable to pollution (Yehdegho & Probst, 2001).

In the majority of cases, dredge lakes act as flow-through-lakes with short mean transit times (Yehdegho et al., 1997). The lake and its evolution are dominantly controlled by the groundwater since dredge lakes usually have no surface inflow and outflow. Therefore, future eutrophication is also mainly controlled by the nutrient loads of the groundwater (Kluge et al., 2007). The lake bed is sealed gradually by organic and inorganic sediments, and thus the mean transit time increases with time (Yehdegho et al., 1997).

Frequently great groundwater resources are present in the regions of Quaternary gravel aquifers, and they are very important for the water supply. With the creation of a dredge lake, a change in the water supply zones could be necessary (Stichler et al., 2008).

Consequently, dredge lake – groundwater interactions are often study objects in the literature with a focus on water and nutrient budgets studies, including investigations of

mean transit times, future eutrophication and to minimization and on the effects on groundwater and water supply (Stichler et al., 2008).

1.2 Objectives and approaches

The groundwater - lake interactions at the dredge lake "Schlosssee Salem" will be reviewed in this thesis. It is situated in southern Germany near to the Lake Constance. Several expertises were undertaken around and about the "Schlosssee Salem".

In the 1990ies, hydrogeological and isotope-hydrologic expertises were made. The issues were about delimitation and assessment of the water protection zones around several springs and deep wells of drinking water supply, as for the spring "Schapbuchquelle" and the deep well "TB Stefansfeld", also with regard to the "Schlosssee Salem" influence. Furthermore, the direct influence of precipitation on the groundwater was examined as well as an influence of infiltrating water of the small river "Deggenhauser Aach" on the "Schapbuchquelle", which is close to the spring. The final report of the Geologisches Landesamt Baden-Württemberg (1994) summarized the different expertises.

In 2009 two expertises were made concerning an increasing accumulation of mud in the Schlosssee, the suspicion of deteriorated water quality for bathing and an enhanced plant growth. Surveys were commissioned by the municipality of Salem to HYDRO-DATA (2009) and Planstatt Senner (2010). The research program considered the following points:

- Investigation of the geological and hydrogeological structures like expansion; limitation of gravel deposits and aquifer,
- Determination of the hydraulic connection between the "Schlosssee Salem" and the adjacent groundwater field,
- Estimation of the groundwater inflow, outflow and mean transit time for a limnologic assessment,
- Limnologic issues like source of the accumulation of mud, the reason of the increased plant growth and the today's condition of the lake,
- Possible remedial actions.

HYDRO-DATA (2009) researched the geological/hydrogeological parts. The aim of this thesis is to continue their measurements and refining their results if possible.

The objectives of this thesis concern the study of the dredge lake - groundwater interactions. The aims are precisely:

- Refining the estimation of groundwater inflow, outflow and mean transit time,
- Establishing a water balance of the "Schlosssee Salem",
- Determination of groundwater inflow and outflow areas of the "Schlosssee Salem",
- Discovering of the hydrochemical influences of the groundwater on the "Schlosssee Salem" and vice versa.

The estimation of groundwater inflow was made by HYDRO-DATA by means of hydraulic and isotopic investigations. Bertleff et al. (2001) modified a mixing analysis for the purpose of a calculation of the groundwater inflow for dredge lakes. Therefore, the isotopic composition of the groundwater and the lake water in November and the following March is needed. HYDRO-DATA could only collect samples between February and November 2009 because of the given time for the expertise. Therefore, the stable isotope ratio of the lake water in March was taken one year too early. In this thesis the mixing analysis over stable isotope data is refined.

The mean transit time is calculated over the groundwater inflow and the volume of the lake. The groundwater outflow was estimated as the remainder term of the water balance of the lake.

In the expertise of HYDRO-DATA (2009) the hydraulic connection of the dredge lake and its adjacent groundwater field was determined. This is taken into account for the identification of main inflow or outflow areas. Furthermore, the performance of a radon measurement is considered for detecting groundwater inflow.

In spring and in late summer, samples of upgradient, downgradient groundwater and lake water were taken for hydrochemical analyses.

Moreover, electric conductivity, temperature, oxygen content and pH values were measured monthly.

2 Theoretical background

2.1 Characteristics and effects of dredge lakes

An artificial dredge lake is an exposure of the groundwater. The lake and the groundwater are in a complex interrelation. Usually no surface inflow or outflow exist, a dredge lake is only feed by groundwater. The rate of in- and outflowing groundwater depends on the hydraulic parameters of the involved aquifer, the gradient of the groundwater table, and the degree of sealing of the lake bed. The sealing is determined by the morphology of the dredge lake and its age. The older the lake gets, the more the permeability of the lake bed decreases, and so does the inflow and outflow rates. The lake provides less resistance for throughflow. Hence, the flow paths prefer to go through the lake and the inflow catchment is wider than the width of the lake (Figure 2.1).



Figure 2.1: Schematic hydraulic conditions surrounding a dredge lake, modified after Bertleff et al. (2001).

Dredge lakes are dominated by groundwater and usually without surface inflow and outflow, and so could be equated with the lake type "north hemispheric groundwater dominated seepage lakes". The opposite of seepage lakes are "surface water dominated drainage lakes". Typically seepage lakes are older than 8000 years. They could be used as objects of long term studies (Boos & Strohm, 1996).

Krabbenhoft et al. (1994) suggest that the classification of groundwater-lake systems in seepage and drainage lakes is not appropriate. It is recommended to assign them into types according to the distribution of the hydraulic heads of the adjacent groundwater field:

- Recharge systems, where the lake level is higher than the surrounding water table.
- Discharge systems, where the lake level is lower than the surrounding water table.
- Flow-through systems, where the lake gains water from the groundwater system in some parts and loses water to the groundwater system in other parts.

Most dredge lakes would be assigned to the "Flow-through-systems".

2.2 Stratification and circulation of dimictic lakes

A dimictic lake in temperate climate is stratified in summer and winter and circulates in spring and autumn. Stratification is a result of the temperature distribution in the lakes.

The heat balance of lakes is mainly controlled by the heat absorption and heat emission from or to the atmosphere and the heat distribution in the water body of the lakes. Radiation energy to the lake surface is absorbed and transformed into heat energy. Heat losses to the atmosphere are affected by emission, evaporation and heat transmission to the atmosphere. Due to the low thermal conductivity of water, heat is distributed into deeper lake layers almost entirely by transportation of heated water. In a dimictic lake in the temperate climate zone, wind is the motor for the transportation of the heated surface water. However, this effect is limited by the differences in water density, caused by different water temperatures (Lampert & Sommer, 1993; Schwoerbel & Brendelberger, 2005).

At the water-atmosphere boundary layer, wind creates a water flow along the lake surface through friction. At the shore, the flow is redirected into the depth, where it changes the direction. The stronger the wind, the deeper the mixing depth gets. However, the higher the surface temperatures, the lesser deep the warm water can get because of density differences.

In spring the whole water body is in circulation. The wind brings the heated surface water in deeper layers. The more the water gets heated in summer, the lesser deep zones the water can reach, because the heated water has a lesser density. Therefore, the mixing in summer is limited to a warm, relatively homogeneous surface layer called the epilimnion. The hypolimnion is the deepest layer in the lake, in which the water with the greatest density, mostly around 4°C, may be found. Between the epilimnion and the hypolimnion, the thermocline develops. This is a layer with a steep temperature gradient. Hence, it includes the greatest variations in density (Lampert & Sommer, 1993). The thermocline not only inhibits the heat exchange between the epilimnion and the hypolimnion, but also the mass transfer in general. For example, oxygen containing water from the surface cannot reach the hypolimnion, where the oxygen storage is soon consumed by oxygen depleting processes (Mader et al., 2004).

With the cooling of the lake surface in late autumn, the summer stratification ends. Cooler surface water can reach deeper layers with the help of the wind again. The whole lake circulates once the water is cooled down to 4°C. When the temperature of the surface water gets colder than 4°C, it is less dense than the deeper lake water with 4°C. The winter stratification arises (Figure 2.2). In spring, the lake surface gets heated again. Before the summer stratification starts to develop again, the whole water body can circulate once more (Schwoerbel & Brendelberger, 2005).



Figure 2.2: Stratification and circulation of a dimictic lake modified after Mader et al. (2004).

In less deep lakes, like for example, the Mindelsee in Radolfzell at the Lake Constance, with a lake depth of 13.5 m, heated water can reach the deepest zone before the beginning of summer stratification due to strong winds. As a result, the temperature in the hypolimnion is around $6 - 8^{\circ}$ C during summer, and the autumn circulation of the whole lake starts, when the overall temperature of the lake water again reaches 6-8°C (Schwoerbel & Brendelberger, 2005).

2.3 Hydrochemistry of dredge lakes and their groundwater

The chemical character of groundwater depends on many factors. Primarily, infiltrating precipitation and surface waters contain substances of geogenic and anthropogenic origin. Once in the underground, the water reacts with the soil air and the contacted rocks. Typically the overall mineralization increases during this processes (Grimm-Strele et al., 1994).

When groundwater enters a dredge lake, the general conditions change from a closed to an open system. Thereby, the water surface is in contact with the atmosphere and is exposed to solar radiation (Bertleff et al., 2001).

The most important reactions concerning the chemical contents in groundwater in a gravel exploitation region, are those of the lime-carbonic acid balance. Percolating water, on its passage through the unsaturated zone, solve CO_2 out of the soil air, which is enriched in comparison to the atmosphere. The pH value declines and the water achieves a higher potential for solving lime. The solubility of CO_2 depends on the temperature, it is higher at lower temperatures (Bertleff et al., 2001).

$$H_2 0 + C O_2(g) \leftrightarrow H_2 C O_3 \tag{1}$$

$$H_2CO_3 \leftrightarrow HCO_3^- + H^+ \tag{2}$$

$$HCO_3^- \leftrightarrow CO_3^{2-} + H^+ \tag{3}$$

The dissolution of carbonate is the most important reaction in carbonate containing rocks, whereby the content of calcium-, magnesium- and hydrogen carbonate ions rises in the groundwater, and consequentially so does the total hardness of the water (Bertleff et al., 2001).

$$CaCO_3 + H^+ \leftrightarrow Ca^{2+} + HCO_3^- \tag{4}$$

$$CaMg(CO_3)_2 + 2H^+ \leftrightarrow Ca^{2+} + Mg^{2+} + 2HCO_3^-$$
 (5)

As the groundwater enters the lake, a reverse reaction could start. In that case CO_2 can outgas over the lake surface into the atmosphere. Due to the loss of CO_2 the pH value rise again and causes a shift the lime-carbonic acid balance. The water can get oversaturated with carbonates and calcite precipitates chemically. The result is a decrease in the concentration of calcium and hydrogen carbonate, to some extend magnesium and in consequence the total hardness (Bertleff et al., 2001).

High hydrogen carbonate contents over 61 mg/l signify a high buffering capacity. Lakes with a high buffering capacity can handle higher nutrient loads, especially phosphorus, which is precipitated chemically together with the hydrogen carbonate (Boos, 2004).

The groundwater character is altered by flowing through a dredge lake, but not only because of the lime-carbonic acid balance (Boos & Strohm, 1999). The most important aspects including the lime-carbonic acid balance, are reported below.

In a dredge lake the groundwater is exposed to the overlying stratum, without any protection. Substances can get into the water directly over precipitation, dry deposition and surface inflow, and additionally by the usage of the lake, like bathing. A positive effect of the exposure is the reduction of substances, outwashed from agriculturally used soil, such as phosphate and nitrate. Because of degradation and transformation processes the direct input is not a matter of concern (Bertleff et al., 2001).

Temperature and gases are exchanged between the dredge lake and the atmosphere via the water surface. Regarding to the temperature, the lake water has a much higher variation over time than the groundwater. In the downgradient groundwater field, the temperature effect of the lake is no longer evident from a distance of 200 m onward. Besides temperature, gases are exchanged with the atmosphere via the lake surface in both directions. Visible in all lakes, is an intake of oxygen into the lake water, which is called physical ventilation. In summer, the intake is limited to the epilimnion but during circulation in spring and late autumn all regions in the lake profit from it. If the inflowing groundwater is of a reductive chemical composition, it changes to an oxydising one in the lake. In that case CO_2 is set free, and the lime-carbonic acid balance gets shifted (Bertleff et al., 2001).

If a dredge lake is an exposure of two usually separated groundwater storeys, the waters of the aquifers are mixed during the lake's circulation phase which can be detected downgradient (Bertleff et al., 2001).

As mentioned before the groundwater comes into an altered environment by entering the lake. Thereby, substances in water can become fixed by chemical precipitation and can be sedimented to the lake bed. If the aquifer provides a reductive environment, the aerobe conditions of the lake induce iron and manganese to chemical precipitation by transforming Fe(II) and Mn(II) compounds to Fe(III) and Mn(IV) compounds which are hardly soluble. The decrease of manganese and iron is measurable in the downgradient groundwater even in greater distance to the lake (Bertleff et al., 2001). Iron oxidation follows the equation:

$$0_2 + 4 Fe^{2+} + 6 H_2 0 \to 4 FeOOH + 8 H^+$$
(6)

The loss of CO_2 at the lake surface and the biological activity leads in an oversaturation of carbonates in the lake water. This leads to chemical precipitation of carbonates and a decrease of the concentration of calcium, hydrogen carbonate, to some extent magnesium, total hardness and in the consequence electric conductivity (Bertleff et al., 2001).

In the outflow zones, CO_2 is released by degradation of organic matter, while O_2 is consumed for the reaction. In addition, outflowed groundwater gets in contact with rocks and become more mineralised again, but the upgradient mineralisation state is not reached within at least 500 metres (Bertleff et al., 2001).

Another fixation of solutes in the lake takes place via biological activity. CO_2 and biological relevant elements like phosphorus and nitrogen are incorporated in the biomass, and hence, their concentrations decrease. In abundance of diatoms, the concentration of silicic acid decreases, too (Bertleff et al., 2001).

Nitrate and sulphate may get degraded through denitrification or sulphate reduction in a reductive milieu such as in the hypolimnion and lake sediments (Bertleff et al., 2001). The equations for denitrification and sulphate reduction are stated below:

$$5 CH_2 O + 4 NO_3^- + 4H^+ \to 5 CO_2(g) + 2 N_2(g) + 7 H_2 O$$
(7)

$$2 CH_2 O + SO_4^{2-} + H^+ \to HS^- + 2 H_2 O + 2 CO_2(g)$$
(8)

Formations of new compounds occur at altered environmental conditions or biological activity. For example, under reductive conditions ammonium could be build out of

nitrate, and hydrogen sulphide out of sulphate. Ammonium, by the way, can only be found in low concentration in a lake because it is sorptive in an anaerobe milieu and tends to oxidise in an aerobe environment (Bertleff et al., 2001). The equation for ammonifiation is:

$$2 CH_2 O + NO_3^- + 2 H^+ \to NH_4^+ + 2 CO_2(g) + H_2 O \tag{9}$$

Substances, which were previously fixed in the lake, could get remobilised by passing out of the lake. Furthermore, reoxidation of substances is possible due to circulation of the lake in spring and late autumn. Under reductive conditions, previously chemically precipitated substances could be released again into the water such as iron and manganese (Boos & Strohm, 1999). The iron(III) reduction equation is:

$$CH_2O + 8H^+ + 4Fe(OH)_3 \rightarrow 4Fe^{2+} + 11H_2O + CO_2(g)$$
 (10)

Outflowing lake water changes the milieu in the downgradient aquifer. The most important influences are temperature, a changing in the redox conditions and a shift in the lime-carbonate acid balance. Thereby, iron and manganese could be released again or sulphidic minerals could oxidise. The effects of the change in the milieu are difficult to separate from remobilisation effects. However, the change of the environment is limited to the vicinity of the lake, and after a distance of 100-200 metres the upgradient conditions are re-established (Bertleff et al., 2001). Nitrification, sulphide oxidation and denitrification through sulphide are stated in the following equations:

$$3 O_2 + 2 NH_4^+ \rightarrow 2 NO_3^- + 8 H^+$$
 (11)

$$2 O_2 + HS^- \to SO_4^{2-} + H^+ \tag{12}$$

$$5 HS^{-} + 8 NO_{3}^{-} + 3 H^{+} \rightarrow 4 N_{2}(g) + 5 SO_{4}^{2-} + 4 H_{2}O$$
(13)

For further information about nutrient sources, pollution paths, reactions in upgradient and downgradient aquifer and within a dredge lake Boos & Strohm (1999) is recommend.

Secchi depth

The secchi depth is a measuring unit for the transparency of the water, which depends strongly on e.g. the seasonal variable plankton content in the water (Schwoerbel, 1994). Furthermore, it characterized 18-24% of the light intensity directly under the lake surface. The euphotic zone is the zone, where sufficient photosynthesis is possible. It ends, when only 1% of the surface light intensity is left. Between the secchi depth D_{sd} and the end of euphotic zone D_{eu} depth, thre is the aproximate relationship:

$$D_{ey} \approx 5 \cdot \sqrt{D_{sd}} \tag{14}$$

In addition, the secchi depth can be used to calculate the compensation level K (Boos, 2004). This is the depth, down to which water plants can still be found:

$$K = 1.7 \cdot D_{sd} \tag{15}$$

In dredge lakes where the gravel excavation has stopped, the secchi depth is primarily determined by the density of algae. A considerable reduction of the secchi depth during the vegetation period indicate a high biological activity and nutrient load (Boos, 2004).

2.4 Isotopes

Isotopes of a certain element are nuclides with the same number of protons and electrons but with a different number of neutrons and thus a different atomic weight. Environmental isotopes are isotopes which are present in the natural environment, regardless of whether they are a result of natural processes or they are anthropogenic introduced (Rozanski et al., 2001). In many cases isotopes are unstable or radioactive and have a certain probability of decay. Stable isotopes do not decay. In this thesis, only the stable isotopes of the elements of the water molecule and the radioactive isotope ²²²Rn are considered.

2.4.1 Water isotopes

The isotopes ¹H, ²H (deuterium), ¹⁶O, ¹⁷O, ¹⁸O are stable isotopes. Water molecules species with these isotopes have the advantage of a conservative behaviour as a tracer. The abundance of the stable isotopes of the elements of the water molecule, O and H, is listed in Table 2.1 (Clark & Fritz, 1997).

 Table 2.1: The abundance in percent of the stable isotopes of the element of the water molecule (Clark & Fritz, 1997).

Isotope	¹ H	² H	¹⁶ O	¹⁷ 0	¹⁸ O
Abundance [%]	99.985	0.015	99.76	0.04	0.20

The ratio R is the abundance of the less abundant isotope species N_i divided by the more abundant isotope N (Leibundgut et al., 2009):

$$R = \frac{N_i}{N} \tag{16}$$

The common international standard for measuring ${}^{18}\text{O}/{}^{16}\text{O}$ and ${}^{2}\text{H}/{}^{1}\text{H}$ ratios is the Vienna Standard Mean Ocean Water (VSMOW). The ratios of VSMOW are specified in Baertschi (1976) and Hageman et al. (1970) both cited in Leibundgut et al. (2009):

$$R_{^{18}O/^{16}O} = \left(\frac{^{^{18}O}}{^{^{16}O}}\right)_{VSMOW} = (2005.2 \pm 0.45) \cdot 10^{-6}$$
(17)

$$R_{{}^{2}H/{}^{1}H} = \left(\frac{{}^{2}H}{{}^{1}H}\right)_{VSMOW} = (155.76 \pm 0.05) \cdot 10^{-6}$$
(18)

For a better handling, the ratio of a sample is referred to a standard, in this case VSMOW, and given in per mill (Leibundgut et al., 2009):

$$\delta = \frac{R_{Sample} - R_{Standard}}{R_{Standard}} \cdot 1000 \left[\%_0 Standard\right]$$
(19)

Only the water molecule species ${}^{1}\text{H}_{2}{}^{16}\text{O}$, ${}^{1}\text{H}_{2}{}^{18}\text{O}$, ${}^{2}\text{H}^{1}\text{H}^{16}\text{O}$ are relevant, because other species have too little abundance to measure them accurately (Rozanski et al., 2001).

Isotope fractionation

A water molecule with a heavier isotope, for example an isotopically heavier H-atom $({}^{2}H^{1}H^{16}O)$, has a higher atomic mass than the isotopically lighter common water molecule $({}^{1}H_{2}{}^{16}O)$. The molecule species have different reaction rates in any thermodynamic reaction, as well as different vapour pressures and melting points. This leads to a disproportionate concentration of one isotope compared the other after a thermodynamic reaction (Clark & Fritz, 1997). The fractionation factor α expresses this disproportion as the division of the ratio of the reactant and the ratio of the product (Clark & Fritz, 1997):

$$\alpha = \frac{R_{reactant}}{R_{product}} \tag{20}$$

For example after a phase change from water to vapour:

$$\alpha^{18}O_{water-vapour} = \frac{\binom{^{18}O/^{16}O}_{water}}{\binom{^{18}O/^{16}O}_{vapour}}$$
(21)

A fractionation at equilibrium conditions is reversible. Majoube (1971, cited in Leibundgut et al., 2009) found that the fractionation factor α for equilibrium conditions can be determined by an equation of the following type:

$$10^3 \cdot \ln \alpha_{A \leftrightarrow B} = 10^6 a / T_K^2 + 10^3 b / T_K + c \tag{22}$$

 T_K is the temperature in Kelvin. In Clark & Fritz (1997) the values for the parameters a, b and c are documented, and other values for $10^3 \ln \alpha$ are listed for different temperatures from other authors.

The enrichment factor ε expresses the disproportion in the isotope content of two compounds in ∞ notation (Clark & Fritz, 1997):

$$\varepsilon_{X-Y} = \left(\frac{R_X}{R_Y} - 1\right) \cdot 1000 = (\alpha - 1) \cdot 1000 \,[\%_0] \tag{23}$$

If $\varepsilon > 0$ or respectively $\alpha > 1$, an enrichment has occurred, and a depletion has happened when $\varepsilon < 0$ or $\alpha < 1$ (Rozanski et al., 2001).

The separation is the isotopic difference between two compounds involved in an isotopic fractionation reaction (Clark & Fritz, 1997):

$$\Delta_{X-Y} = \delta_X - \delta_Y \tag{24}$$

$$\alpha_{X-Y} = \frac{1 + \frac{\delta_X}{1000}}{1 + \frac{\delta_Y}{1000}} = \frac{1000 + \delta_X}{1000 + \delta_Y}$$
(25)

There are three kinds of fractionation processes in a thermodynamic reaction: physiochemical reactions at equilibrium, kinetic conditions due to higher binding energies, and fractionation by molecular diffusion due to the slightly less mobility of heavier species (Clark & Fritz, 1997). Isotopic fractionation can be a result of phase changes like, evaporation, condensation, freezing sublimation, and melting as well as some chemical reactions (Leibundgut et al., 2009).

A kinetic fractionation, for example, takes place during evaporation, when the water vapour is removed or added, or at a sudden change in temperature. No reverse reaction is possible (Clark & Fritz, 1997). Usually kinetic fractionation is stronger than fractionation in isotope equilibrium.

One kind of kinetic fractionation is the Rayleigh distillation process. Here, the reactant is removed continuously, as it occurs, for example, in clouds during precipitation events or evaporation. The isotopic ratio R is a function of the initial ratio R_0 , the fraction of water remaining in the reservoir f and the fractionation factor α (Leibundgut et al., 2009):

$$R = R_0 \cdot f^{(\alpha - 1)} \tag{26}$$

Overall, heavier species diffuse and react slower, they need higher temperatures or, more precisely, more energy for melting and vaporisation. The heavier isotope species are enriched in the condensed phase or in the remaining liquid phase. In reverse, they are depleted in the vaporised phase. The effect of this fractionation decreases with higher temperatures.
The fractionation of isotopes induces effects in the ratio of isotopes in precipitation (Clark & Fritz, 1997).

On a global scale, the dependence of 18 O on the monthly average surface air temperature is (Yurtsever & Gat, 1981):

$$\delta^{18}O = (0.338 \pm 0.028)T_{monthly} - 11.99 \left[\% VSMOW\right]$$
(27)

For annual averaged surface air temperatures Dansgaard (1964) found the following relationship:

$$\delta^{18}O = 0.695 T_{annual} - 13.6 \left[\% SMOW\right]$$
(28)

$$\delta^2 H = 5.6 T_{annual} - 100 [\% SMOW]$$
⁽²⁹⁾

The temperature predominantly controls the partitioning of the isotopes. The resulting effects on the precipitation are described in Dansgaard (1964) and Clark & Fritz (1997):

- Latitude effect: Depletion of the heavier isotopes with increasing latitude,
- Continental effect: Depletion of the heavier isotopes with increasing distance from the coast,
- Altitude effect: Depletion of the heavier isotopes with increasing altitude,
- Seasonal effect: Isotopically depleted in winter and isotopically enriched in summer,
- Amount effect: Depletion of the heavier isotopes with increasing amount of a precipitation event.

The latitude and continental effects are relevant on a global scale. The altitude, seasonal and amount effect play a role on a regional scale (Clark & Fritz, 1997).

Global Meteoric Water Line

Craig (1961) studied the relationship between deuterium and ¹⁸O concentrations on a global scale. He found out that the concentration of deuterium and ¹⁸O in fresh waters, for which evaporation is not a dominant factor like precipitation, correlate very strong along a straight linear line – the Global Meteoric Water Line (GMWL). It can be described by the following equation:

$$\delta^2 H = 8 \cdot \delta^{18} O + 10 \left[\% SMOW\right] \tag{30}$$

The GMWL is determined in reference to the Standard Mean Ocean Water (SMOW) and matches with most continental stations in humid regions (Leibundgut et al., 2009). Isotopically depleted waters are associated with cold regions and enriched waters with warm regions. The meteoric relationship results from fractionation during the

condensation of the vapour mass. Rayleigh distillation during rainout accounts for partitioning between warm and cold regions (Clark & Fritz, 1997).

The molecular species of water ${}^{1}\text{H}_{2}{}^{18}\text{O}$ and ${}^{2}\text{H}{}^{1}\text{H}{}^{16}\text{O}$ have different vapour pressures. This leads to disproportional enrichments in the water phase during evaporation under equilibrium conditions, in which the enrichment for ${}^{2}\text{H}$ is about eight times greater than for ${}^{18}\text{O}$ (Clark & Fritz, 1997).

The y-axis intercept of this graph is called deuterium excess (d-excess). It is calculated for any precipitation sample by:

$$D - Excess = \delta^2 H - 8 \cdot \delta^{18} 0 \tag{31}$$

The d-excess depends on the relative humidity, wind speed and sea surface temperature during primary evaporation, and it is a good indicator for the meteorological conditions in the source region (Clark & Fritz, 1997). The d-excess of about 10 ‰ is caused by an average relative humidity of 85 % over the ocean during evaporation.

It can be useful to determine a local meteoric water line (LMWL) when studying a certain region, especially islands or coastal areas (Leibundgut et al., 2009). The slope and the d-excess are affected by local climatic factors such as the origin of the vapour mass, secondary evaporation during rainfall and the seasonality of precipitation (Clark & Fritz, 1997).

Evaporation line

At open water surfaces, especially in a closed basin, the evaporation causes additional fractionation effects. The heavier isotope species are enriched in the remaining liquid phase and the δ^{18} O / δ^{2} H relationship changes. The enriched waters also lie on a line in a δ^{18} O / δ^{2} H relationship graph, although the slope differs from the GMWL. This line with lower slope is called evaporation line (EP line). The isotope relation of the original water is identifiable as the intersection of the GMWL and the evaporation line (Kendall & Caldwell, 1998).

The lower gradient of the evaporation lines depend largely on the relative humidity (Gonfiantini, 1986). The lower the relative humidity, the more the slope differs from 8. At a relative humidity 50 % the slope is about 4.5 (Figure 2.3).



Figure 2.3: The change of slope of the δ^2 H- δ^{18} O relationship with different relative humidities (Gonfiantini, 1986).

Furthermore, the slope is caused by the equilibrium and kinetic fractionations, which are both depending on the temperature and the boundary conditions (Rozanski et al., 2001).

Further information about the evaporation line, such as its evolution or calculation can e.g. be found in Clark & Fritz (1997) or Gat (1996).

Lake water in summer undergoes evaporation and the described additional fractionation at the lake surface and so the $\delta^{18}O/\delta^2H$ ratios of the remaining water plot along the evaporation line (Clark & Fritz, 1997).

The isotopically enriched residual lake surface waters can be used to determine the water balance of a lake, especially the inflow and the evaporation fluxes, to examine the mixing in the lake and as a tracer for the influence of the lake water in the adjacent groundwater (Krabbenhoft et al., 1994).

The downgradient outflowing lake water is enriched in heavy isotopes due to evaporation, and for this reason can be regarded as labelled. It can be traced in the downgradient groundwater, the mixing with uninfluenced groundwater can be determined quantitative, the flow direction can be tracked and even the flow velocity can be estimated because of the seasonal variations in lake water (Bertleff et al., 2001).

2.4.2 Endmember mixing analysis

Two waters with distinct isotopic compositions mix conservatively. As a result, the isotopic composition of the mixture lies in between the endmembers' compositions. They can be treated like others chemical component in a mixing analysis (Kendall & Caldwell, 1998). When, for example, two discharging water flows merge, the resulting discharge is their sum:

$$Q_T = Q_1 + Q_2 \tag{32}$$

Whereby Q_T is the resulting combined total discharge, Q_1 and Q_2 are the discharges of the endmembers. The isotopic compositions of the involved discharges can be computed in similar manner. (Kendall & Caldwell, 1998):

$$\delta_T Q_T = \delta_1 Q_1 + \delta_2 Q_2 \tag{33}$$

Whereby $\delta_{T, 1, 2}$ is the corresponding isotope ratio of the constituents, either $\delta^{18}O$ or $\delta^{2}H$.

The fraction of the discharge Q_1 of the combined flow can then be determined (Kendall & Caldwell, 1998):

$$Q_1/Q_T = (\delta_T - \delta_2)/(\delta_1 - \delta_2) \tag{34}$$

The endmember mixing calculations can be adopted to all systems with mass flux (Maloszewski & Zuber, 1982).

Groundwater inflow and outflow

For a dimictic lake, the equation can be adopted to estimate the fraction of inflow water X_{inflow} into the lake (Bertleff et al., 2001), and $\delta^2 H$ or $\delta^{18} O$ ratios can be used as tracers:

$$X_{inflow} = (\delta_{lake \ spring} - \delta_{lake \ autumn}) / (\delta_{GW} - \delta_{lake \ autumn})$$
(35)

Hereby, $\delta_{lake spring}$ is the lake water in spring after circulation, which can be corrected by the amount and isotopic composition of the fallen precipitation, $\delta_{lake autumn}$ is the isotope ratio of lake water in late autumn after circulation and δ_{GW} is the isotopically lighter water of the upgradient groundwater. The inflow rate Q_{inflow} can afterwards be calculated by the formula (Bertleff et al., 2001):

$$Q_{inflow} = (V_{lake} \cdot X_{inflow})/t \tag{36}$$

Whereby t is the time in seconds, between the measurements of the lake water in autumn and in spring.

Obviously these formulae average the flows over half a year, and for the summer half year the flow could differ.

The outflow into the groundwater GW can be estimated over an average lake water budget (Winter, 1995):

$$GW_{out} = P + Inflow - EP \tag{37}$$

Whereby P is the average yearly precipitation, EP the yearly evaporation, Inflow the yearly inflow, all parameters are in the unit mm/a.

The calculated GW_{out} value can then be converted into the outflow rate Q_{out} in 1/s.

Lake water fraction in downgradient observation wells

The fraction of lake water in downgradient groundwater can be also estimated by an endmember mixing analysis:

$$X_{LW} = (\delta_{Sample} - \delta_{GW}) / (\delta_{Lake \, water} - \delta_{GW}) \tag{38}$$

Whereby X_{LW} is the fraction of lake water in the groundwater, δ_{Sample} is the isotopic composition of the downgradient groundwater measuring point, δ_{GW} is the isotopic composition of the upgradient uninfluenced groundwater and $\delta_{Lake water}$ is the averaged isotope ratio of the lake water.

2.4.3 Radon

In almost all soils and rocks, traces of naturally occurring uranium and radium deposits can be found. Radon-222 is part of the uranium-238 decay chain (Figure 2.4), with a half-life of 3.82 days. Radon is a gas and can dissolve in groundwater. Dissolved radon gas in water outgases by contact with air. It cannot be found in significant concentrations in surface waters (RAD7 RAD H2O, Radon in Water Accessory, Owner's Manual, 2009). Therefore it is a good tracer for measuring and monitoring the movement of ground water into lake near the shore (Kluge et al., 2007).



Figure 2.4: Radon-222 decay chain (RAD7 Radon Detector User Manual, 2009).

When radon-222 decays to polonium-218 it releases an α particle with an energy of 5.49 MeV Polonium-218 has a half-life of 3.05 minutes and decays to lead-214 by releasing an α particle with an energy of 6.00 MeV. Lead-214 decays to bismuth-214, which decays to polonium-214. Both are β emitters with half-lives of 26.8 and 19.8 minutes. Polonium-214 has only a half-life of 164 microseconds and decays with α radiation of 7.69 MeV to the relatively stable lead-210 (half-life: 22.3 years). The used device RAD7, for measuring the radon level, can only detect α particles. Thus the β decays are not the subject of interest (RAD7 Radon Detector User Manual, 2009).

The radon levels were analysed with the emphasis more on a qualitative than a quantitative evaluation. By using the radon levels, not the amount of inflow at one point should have been examined, but the areas of more groundwater flow into the lake should have been detected, in order to compare these results with the information derived from the isotope contents.

2.5 Mean transit time

The mean transit time, or turnover time, τ for a hydrological system in steady state describes, how much time the water molecules stay in the system before leaving through outflow or evaporation. The mean transit time is defined as: (Maloszewski & Zuber, 1982):

$$\tau = V/Q \tag{39}$$

Whereby V is the Volume of mobile water and Q is the volumetric flow rate through the system. Steady state requires that the volume V is constant.

In the case of a lake, the mean transit time can be expressed as (Bertleff et al., 2001):

$$\tau = V_{lake} / Q_{inflow} \tag{40}$$

Whereby Q_{inflow} is the inflow rate into and V_{lake} is the lake volume.

2.6 Dredge lakes and applicable methods in literature

In the last decades a lot of research was done concerning dredge lakes. Dredge lakes could be assigned to seepage lakes or flow-through lakes. Methods applied to natural lakes can be used for dredge lakes, too. Thereby, the methods get often simpler, because dredge lakes have usually no surface inflow or outflow.

Armbruster & Kohm (1977) and Kohm (1980) examined the influence of dredge lakes on the adjacent groundwater field and on the evaporation. Thereby, different positions in the groundwater field and different sealings of the lake bed are considered.

At dredge lakes, the main issue is the groundwater inflow. Lee (1977) described a method to estimate directly the inflow of groundwater by means of seepage meters. However, it needs a large effort, and a flow net of seepage meters are still point measurements. The spatial and temporal variability of seepage is high due to heterogeneous deposits, transpiration from near-shore vegetation and the not uniform redirecting of groundwater flow paths (Winter, 1995). Lee (1977) found out that the water collected with the seepage meters in the lake was similar to the groundwater from wells at the same flow paths relating to the water chemistry. The seepage velocity decreases in an exponential fashion with distance from the shore and he assumed that shallow groundwater was discharged near the shore and deeper groundwater farther away from the lake's edge.

As a result of isotopic fractionation during evaporation, residual surface waters are isotopically enriched. This can be used to determine the water balance of a lake, especially the inflow and the evaporation fluxes, Furthermore, stable isotopes can be used to examine the mixing in a lake and as a tracer for the influence of the lake water in the adjacent groundwater (Krabbenhoft et al., 1994). The isotope methods are widely applied to lake-groundwater interaction issues. Moser & Rauert (1980), Gonfiantini (1986) Rozanski et al. (2001) and Froehlich et al. (2005) explain the basic theory and compile several application at different study sites.

Zimmermann (1978) applied a stable isotope balance method to dredge lakes. The method calculates the evaporation rate, the groundwater inflow and outflow. In some lakes the gravel excavation stopped just a few years before. Therefore, the new dredge

lakes were not in isotope equilibrium. In a deep dredge lake with small groundwater inflow it could take up to 15 years until isotope equilibrium is reached.

The most difficult step in the isotope mass balance equation is the determination of the isotopic content of evaporating moisture, which cannot be measured directly (Zuber, 1983).

Krabbenhoft et al. (1994) compile several methods for establishing the groundwater inflow into a lake:

- The stable isotope mass balance method for groundwater-lake systems in hydrological and isotopic steady state (Krabbenhoft et al., 1990),
- The index lake method for estimating the groundwater inflow over a already examined lake in the vicinity with similar settings,
- An application of isotopic methods to non-steady-state groundwater-lake systems
- The solute tracer mass balance method which cannot be used by higher calcite or gypsum content.

Wollschläger et al. (2007) used a groundwater model to determine recharge and discharge areas around a dredge lake in the Upper Rhine valley. Additionally, the results of the model were verified and improved by δ^{18} O and SF₆ measurements. Furthermore, δ^{18} O and SF₆ was used to determine the flow direction in the vicinity of the lake. However, the model could be improved by taking the results of the environmental isotopes analysis into account.

The radon content in groundwater is much higher than in surface waters. Thus radon-222 is used as tracer to detect and quantify groundwater inflow into lakes. Kluge (2007) used radon-222 in a dredge lake of the Rhine valley. By means of measuring the vertical and horizontal radon distribution in the lake, the groundwater inflow rate was calculated. Furthermore, the spatial variability of groundwater inflow was examined. Due to the low radon content in the lake, they took water samples of 12 l but with a simple and low cost method.

Krabbenhoft & Webster (1995) established for relatively shallow continually mixed seepage lake a solute mass balance with calcium to determine the groundwater in- and outflow. The lake was over a period hydraulically mounded and had no groundwater inflow in that time and in which it underwent acidification. Water samples were taken also of pore water from the lake bed and piezometers near the shore. With stable isotopes measurement some assumption concerning the flow direction and its reversal were proved. The groundwater inflow shows a great temporal and spatial variation.

A small dredge lake in southern Austria was a highly examined study object. Yehdegho et al. (1997) applied the isotope mass balance the lake to establish the water balance. Dredge lakes changes the hydrogeochemical and biochemical settings. Therefore, the influence on the hydrochemistry of groundwater was examined at the same lake and at another Austrian dredge lake (Yehdegho & Probst, 2000). Furthermore a chemical mass budget was established (Yehdegho & Probst, 2001). Mainly a decrease of Ca^{2+} and HCO_3^- was found.

The hydrochemistry of dredge lakes with regard to pollution paths and possible reactions is compiled in Boos & Strohm (1996; 1999).

LAWA (2003) developed a guideline for an initial assessment of dredge lakes. Therefore, trophic criteria take into account. Total phosphorus, secchi depth, chlorophyll α and phytoplankton are the considered parameters.

Wrobel (1980) realised that dredge lakes influence the downgradient groundwater in a way, which could concern the water supply. The influence can be altered by a change in the shape of a dredge lake and in its position in regard of the groundwater slope. Stichler et al. (2008) examined the influence of a dredge lake on a pumping well for water supply. They combined a two-dimensional water flow model with stable isotope data for delimitating the capture zone.

Bertleff et al. (2001) examine the interaction of dredge lakes with the adjacent groundwater field. Eight dredge lakes were chosen for further investigation. Most of them are situated in the Rhine Valley. The aim of the study was to identify qualitative and quantitative changes in the groundwater and to establish the most influencing factors. The investigation included measurement of electric conductivity, temperature, oxygen content, pH and hydrochemical parameters such as main ions and hydrogen carbonate over a time period of approximately two years. Furthermore, stable isotope ratios were also measured to calculate the fraction of groundwater in the dredge lake, the mean transit time and the fraction of lake water in downgradient groundwater. The examined dredge lakes showed no permanent negative effects on the downgradient groundwater. In the vicinity of the lakes, the oxygen concentrations are low and the temperature rises. The dredge lakes cumulate substances and improve partly the groundwater quality.

3 Study area

3.1 Overview and geological background

Salem is about six kilometres off the northern shore of the Lake of Constance in southern Germany in the foothills of the Alps. The dimictic dredge lake "Schlosssee Salem" and its adjacent groundwater field will be reviewed.



Figure 3.1: Position of the Schlosssee Salem in the region of the Lake of Constance inclusive the relief (Google Maps, 2010).

The Salem basin is finger-shaped and radiate from the main basin of the Lake of Constance in north-north west direction. Nowadays, the lowland of the Salem basin ranges in the altitude between 430 and 445 m above sea level. The region around Salem was completely glaciated during the last ice ages in the Quaternary, and the whole

region is highly affected by the last Würm glaciation and its retreat. Ground and terminal moraines and other glacial forms were created such as the Lake of Constance. In the Salemer-Frickinger basin a big glacier tongue remained during the retreat. An ice-dammed lake was formed in front of the ice. Gradually, the glacier tongue retreated and a lot of gravel was deposited (Erb, 1986) alternating with clays and sands (Geologisches Landesamt Baden-Württemberg, 1994). The quaternary aggradation is underlain by molasse rocks. In short, the region around the Schlosssee Salem is situated in fluvioglacial deposits, gravels and sands, chronological out of the Würm glaciation (Erb, 1986; Regierungspräsidium Freiburg).

Between 1962 and 1975 gravel excavation took place in the area of Schlosssee Salem (LUBW, 2008). At the western part of the today's lake, the former gravel excavation was limited by solid clay. So the aquifer outcrops at the western shore (HYDRO-DATA, 2009). The approximate location of the edge of the aquifer is marked in Figure 3.2.

The renaturation and recultivation of the lake and its surrounding area had been finished in 1984, which transformed the Schlosssee Salem to an area for recreational activities including angling and public swimming (LUBW, 2008). The western wing of the Schlosssee is primarily for bathing inclusive vast leisure areas at the west-southern shore while the eastern shore is reserved predominantly for hobby fishing.

In north-south direction the maximum length of the lake is about 575 m and in east-west direction about 450 m with an overall area of 17.5 hectares excluding the two small islands. The volume is determined by "Ingenieur Büro Trenkle" (HYDRO-DATA, 2009) to circa one million cubic metres with a maximum depth of 16.5 to 17 metres depending on the water level. The calculated average depth is about 5.71 m according to volume and area. During the measuring campaign in 2010 the lake water level was around 433.30 m above sea level. The lake level fluctuates between 50 - 100 cm within a year with a minimum in winter and a maximum in summer.



Figure 3.2: Area of the Schlosssee Salem with the roughly location of the edge of the aquifer (Google Maps, 2010).

The Schlosssee Salem is in the well field management zone (water protection zone III) of the "TB Stefansfeld", which is about 180 metres away from the eastern shore (LUBW, 2008).

There is a deep well on the peninsula of the Schlosssee Salem. In the bathing season the water is pumped to the swimming area at the west- southern shore to operate a fountain. In addition, the sports ground nearby gets irrigated by this water and the excess water flows back into the lake over drainage pipes.

At the northern shore the water of the spring Schapbuch ("Schapbuchquelle") is discharged into the lake during the day time with an average yield of 15.1 l/s (Geologisches Landesamt Baden-Württemberg, 1994) in a depth of 20 - 40 centimetres. During the night the water is used to fill the central water tank of the deep well Neufrach. Averaged over a whole day, the discharge into the lake is about 7.5 l/s.

A dump is in the vicinity of the groundwater metering point P33 in northern direction. In the 1990ies there was a freight railway between P37 and "TB Stefansfeld".

Hydrogeology

The region in the Alpine foothills holds fluvioglacial gravel and sands and unconsolidated rock aquifers with high yield containing mostly Ca-HCO₃ waters (Regierungspräsidium Freiburg).

In the central part of the Salem basin there is a gravel aquifer with a maximum thickness of 24 m and a width of one kilometre. At "TB Stefansfeld", formerly known as "TB Hardtwald", the aquifer is 14 - 15 metres thick (Geologisches Landesamt Baden-Württemberg, 1994). The major direction of the groundwater flow is from North to South. The central basin is fed by groundwater out of a northern and a smaller north-eastern channel. In the north-eastern one the "Deggenhauser Aach" is running (Geologisches Landesamt Baden-Württemberg, 1994). The groundwater of the northern channel flows mainly into the "Schlosssee Salem". In the 1990ies the water of "TB Stefansfeld" was found to be a mixture of groundwater of the north-eastern channel and the lake water. The groundwater in the central basin at "TB Stefansfeld" is unconfined whereas more southerly there are a few areas with confined groundwater (Geologisches Landesamt Baden-Württemberg, 1994).



Figure 3.3: Overview of important groundwater metering points (Google Maps, 2010).

Soil

In the area around the Schlosssee Salem, the soil type of para-brown earths predominates. The substrate is carbonate containing rubble and terrace sands. As the vertical infiltration is dominant, the soils yield nearly no surface runoff (Regierungspräsidium Freiburg).

3.2 Climate and precipitation data

The climate is humid temperate with more rain in summer than in winter. Frickingen has got a small weather station, run by "Landwirtschaftliches Technologiezentrum Augustenberg - Außenstelle Stuttgart" (LTZ, 2010) which is about five kilometres away from the Schlosssee Salem. The exact geographical position is 47.81304 N and 9.27507 E at the altitude of 470 m above the sea level. Frickingen is situated in the same basin like Salem, and the weather station of Frickingen is only about 35 metres higher as the Schlosssee Salem. Therefore, the data from this small station is assumed to be more conferrable to Salem than interpolated data from the remoter precipitation stations of the "Deutscher Wetterdienst" in Überlingen, Markdorf and Heiligenberg, of which the latter is located on a mountain(DWD, 2010). Frickingen is highlighted yellow in Figure 3.1. The daily precipitation and temperature during the measuring campaigns is listed in the Appendix B.4.

Unfortunately, no long term data exists for the station in Frickingen,. The mean annual temperature is 9.0°C averaged from the years of 1995/96 and 1999 to 2009. The mean annual precipitation is 880 mm averaged from the years of 1995 to 2009, whereby the year 1998 is lacking. The maximum annual precipitation occurred in 2000 (1157.4 mm/a) and the minimum befalled in 2003 (532 mm/a). In comparison with the long term data from 1961-1990 of Überlingen (DWD, 2010) with a mean annual temperature of 8.7°C and an average annual precipitation of 904 mm/a, and with the long term precipitation data of Markdorf with an average annual precipitation of 976 mm/a, the values of Frickingen are acceptable.

At a lake with an open water surface, the evaporation equates the potential evaporation. Using an estimation for evaporation of dredge lakes in the Alpine foothills by Lübbe (1977), the annual evaporation of the lake amounts about 650 mm/a.

3.3 Results of former studies and expertises around the Schlosssee Salem

The LUBW (2008) keeps a land register including general information and measured physical and chemical parameter. The measurements at the Schlosssee Salem took place in spring 1997, 2000, 2003 and in the end of summer 1999. In spring 1997 and 2000 only samples from the surface at the shore were examined. The result was an overall assessment of the limnological quality for the time period of 1994 to 2006. However, the eutrophication potential was rated as low, the biological production was determined as moderate and the oxygen relations were adverse (LUBW, 2008).

In 2009 two expertises were commissioned by the municipality of Salem to HYDRO-DATA (2009) and Planstatt Senner (2010). The issues of the surveys have been mentioned before. Some remedial actions have been started in 2010.

The report of the Geologisches Landesamt Baden-Württemberg (1994) summarized different expertises. It was found, that the bank filtrate of the "Deggenhauser Aach" has no influence on the "Schapbuchquelle", and that the electric conductivity hydrograph shows only minor variations, which may be correlated with precipitation events (Geologisches Landesamt Baden-Württemberg, 1994).

In the report of Geologisches Landesamt Baden-Württemberg (1994) the tritium content at sites around the Schlosssee Salem were measured. By assuming an extensive groundwater recharge, the mean residence time and the fraction of water younger than 50 days or younger than six months were calculated with the exponential model for groundwater recharge (Table 3.1).

Measuring point	Mean residence time	Fraction younger than 50 days	Fraction younger than six months
	[years]	[%]	[%]
Schapbuchquelle	6.5	2	7.5
Deggenhauser Aach	2	6.5	22
P33	4	3.5	12
P34	5	2.5	9.5
TB Stefansfeld	7.5	2	6.5
P37	7	2	7
Schlosssee	5	2.5	9.5
P36	5.5	2.5	8.5
P12/75	4	3.5	12
TB Neufrach	6.5	2	7.5

 Table 3.1: Mean residence times and fractions of young water of selected waters (Geologisches Landesamt Baden-Württemberg, 1994).

The gradient of the north-eastern channel is much steeper than that of the northern channel. In the area of the "TB Stefansfeld" the flow direction is difficult to establish. The reason is the lake, which impounds water, raises the water level and the flow prefers to go through the lake. These facts are intensified due to the artificial inflow of the "Schapbuchquelle" and more and more sealing of the lake bed over time. The study of the Geologisches Landesamt Baden-Württemberg (1994) concluded that the "TB Stefansfeld" was a mixture of the groundwater from the north-eastern channel and the lake water at least during the measuring campaign in the 1990ies. A contribution of the northern channel could not be proved.

During their investigation the lake water flowed out of the lake in southern and southeastern direction and was detectable in the groundwater of "TB Stefansfeld", "TB Neufrach", P36 and P12/75 (Geologisches Landesamt Baden-Württemberg, 1994). Endmembers for mixing analyses were the lake water in spring and the groundwater of P35 (Table 3.2). P35, which is not on the map in Figure 3.3, was chosen because of its isotopic composition and not because of its location.

Measuring point	δ ¹⁸ Ο	Fraction
	[‰ VSMOW]	[%]
Lake water	-8.49	-
P35	-10.33	-
TB Stefansfeld	-10.01	15±10
P36	-9.25	60±10
P12	-9.85	25±10
TB Neufrach	-9.93	20±10

 Table 3.2: Fraction of lake water in the downgradient groundwater metering points (Geologisches Landesamt Baden-Württemberg, 1994).

4 Methodology

4.1 Field work

4.1.1 Measuring points

The groundwater and lake measuring points were chosen after advice from HYDRO-DATA, Radolfzell, Germany. The measuring schedule contains three upgradient, three downgradient groundwater measuring points and one point with variable behaviour. Moreover, two deep points of the lake were examined, another one at the lake's edge, a small wooden pier, and later in June two more points were added (Figure 4.1).

The exact coordinates of the measuring points, altitude of the gauge's upper edge, length of the filter section of the observation wells, water levels during the measuring campaign 2010 may be found the Appendix B.1.



Figure 4.1: Location of the measuring points (Google Maps, 2010).

Upgradient measuring points

The observation well P33 is located close to a dump between trees at a broad street. P34 lies on private ground just before a garden fence. Behind the fence, a meadow extend, which was cut twice between March and August. P2/09 is located near the north-western shore of the lake on a small mound in a meadow. The Schapbuch spring ("Schapbuchquelle"), supplied by water of the north-eastern groundwater channel, is situated in the greatest measure distance to the lake. Half of the day the water of the Schapbuch spring feeds the Schlosssee Salem as an overflow with about 7.5 l/s. The deep well Stefansfeld ("TB Stefansfeld") is set up in the area of P37 and P36, close to a former railway track. In some expert's report the "TB Stefansfeld" is called "TB Hardtwald".

P37 lies near the eastern shore at a larger street and a forest and shows a variable behaviour concerning the flow direction.

Downgradient measuring points

The observation well P1/09 is located in the area of the public bath at the south-western end of the lake. It is influenced mainly by lake water. P36 is found near the south-eastern end of the lake. The forest around this place was felled before the first measuring in March. Later on the area was reforested. In the observation well a lot of material was swimming, mainly remains of rotten roots. P12/75 is located south-eastern of P36 besides a small street between apple tree plantations.

Measuring points on and at the lake

Usually samples are collected at the deepest point of a lake. In 2009 the deepest point of Schlosssee Salem was thought to be at the western wing. Later on by further depth measurements, it became obvious that the deepest point is more in the eastern wing. For the sake of continuity, measurements were performed at both places now called "Old deepest point" (ODP) and "New deepest point" (NDP). In June two more points of measurements were added: The "Marginal inflow area" (MIA) is situated close to the north-eastern shore with a depth of ten metres and the "Marginal outflow area" (MOA) is at the southern end of the eastern wing with a depth of about seven meters. Groundwater contour graphs of the expertise of HYDRO-DATA (2009) refer to the main inflow and outflow width. The point MIA was chosen by boating along the north eastern shore and watching the change of the electric conductivity (EC). At the point MIA the EC showed variations. Another location at the lake is a small wooden pier at the eastern shore (Pier1) where a few years ago a gauging pipe with a gauge board was installed.

4.1.2 Organisation of sampling

Every week from April to August the town janitor Mr. Petz and the district water master Mr. Tressel took water retain samples of the "Schapbuchquelle", "TB Stefansfeld", the downgradient point P1/09 and the lake water at Pier1for a later measurement of the electric conductivity and the stable isotope content. The vials were stored in a relatively cool room without direct sunlight exposure until they were picked up for the monthly analysis.

At the end of every month, water from the seven observation wells, the points on the lake and Pier1 were sampled. At the groundwater metering points first the depth to water was determined and then a profile of electric conductivity and temperature was recorded. Afterwards, a water sample with the bailer was taken for the isotope analysis and for determining the pH and oxygen content. In March the water of every groundwater sampling point was pumped out for at least fifteen minutes to activate the aquifer and to achieve a water sample which was useable for the hydrochemical analysis. In August the water of P33 and P12/75 was not pumped out, because it was not needed for the hydrochemical analysis. In addition, in March and August 2010 two samples for the isotope analysis were taken, one was pumped and the other one was scooped for comparing the stable isotope content.

At the lake sample points ODP and NDP first a profile of electric conductivity and temperature was taken. Afterwards a small case pump pumped water out of every lake depth metre. This water was analysed for pH and oxygen content and along samples for the isotope analysis were taken. At MIA and MOA an electric conductivity and temperature profile was taken. Samples for the isotope analysis were taken, too, but no pH and oxygen content was determined. In July several depths of MIA and NDP were picked out for the radon analysis. In August Radon sampling took place along a line between the shore and the point MIA. Along this line the depth to the ground 2, 4, 6, 8 and 10 metres were looked for and these points were called G2, G4, G6, G8 and G10. The water sample for these points was always taken one meter over the ground in the depth of 1, 3, 5, 7 and 9 meters. The point G10 is therefore the same measuring point of MIA in 9 metres lake depth.

4.1.3 The field equipment

Bottles:

For the isotopes' analysis water was sampled in 100 ml PE bottles. For the hydrochemistry analysis two plastic bottles with a volume of 500 or rather 1000 ml

were chosen. For the total phosphorus analysis extra 100 ml PE bottles were cleaned with dishwashing detergent containing no phosphorus. The bottles for the isotope and hydrochemical analysis were cooled down as soon as possible. Measuring the radon content requires extra bottles which are enclosed with the radon meter. The 40 ml and 250 ml glass bottles were filled under water to avoid outgassing. All radon samples were measured within 33 hours.

Electric contact gauge:

At twenty-four groundwater metering points in March 2010 and at twenty-two in August 2010 the depth to water was measured via an electrical contact gauge to achieve a groundwater contour graph by means of ArcGIS. Unfortunately, a lot of groundwater metering points have been destroyed between the measurements. Furthermore every month the depth to water was measured in the seven groundwater metering points.

WTW Multi 350i and WTW Cond 197i:

The WTW Multisonde 350i was used for measuring the electric conductivity, pH, oxygen content and temperature of water. It came to operation on the lake and at the groundwater measuring points. The WTW Cond 197i was used for depth profiles of electric conductivity and temperature on the lake and at the groundwater measuring points. The meter is a very robust gadget inclusive a 100 metre cable.

Before their monthly use the devices were calibrated. The accuracy is about +/-0.004 for the pH value, +/-0.5 % for the electric conductivity and +/-0.5 % for the oxygen content (WTW, 2010). Both WTW meters compensate the electric conductivity to the temperature of 25°C with a non linear function.

Case pump:

Lake water from different depths was obtained by the use of a small pump in a case. The including flexible tube is labelled metre by metre, it has a water filter and a weight at the end (Figure 4.2).



Figure 4.2: Case pump with flexible tube.

Submersible pump and bailer:

A submersible pump was used to get the water samples from the groundwater metering points in March and August. The water was pumped fifteen to twenty minutes until the electric conductivity and the temperature were stable. The water had to be pumped in March and August because of the hydrochemistry analysis. In all other month the water was scooped out of the groundwater metering points by means of a bailer working after the principle of a Ruttner water sampler (Schwoerbel, 1994). When it moves downward, the water flows through the vessel. When, however, the bailer is pulled upwards, a ball closes the vessel at the top so that no water from other upper depths could get in. Still this water is only a mixture of different depths and it contains water which was standing in the pipe for a longer time. In one groundwater metering point the pipe was too slim for the bailer (P12/75). At another point (P36) the bailer was plugged with root remains. In both cases another simpler bailer came to use. This bailer was just a small short pipe with an open top. Several comparison specimens were taken in March and August to see the difference between scooped and pumped water in regard to the measured parameters.

Diver:

Two Diver data loggers were lowered in P34 (upgradient) in the depth of ten meters and P1/09 (downgradient) in the depth of fifteen meters. At these chosen depths no changes in the electric conductivity could be observed. I assume that this part is really flowed through by groundwater. The CTD-Diver data loggers measured temperature und electric conductivity half-hourly.

Diver data loggers are small with a diameter of 22 mm, a length of 26 cm and 300 g weight. They include a sensor, the memory and an internal battery with a lifetime of 8-10 years in a non-rusting steel casing. The measuring chamber and the pressure sensor are made of ceramic. The electric conductivity sensor is platinum on a ceramic carrier with four electrodes (Eijkelkamp Agrisearch Equipment, 2003).

The accuracy of the measured parameters is for the electric conductivity value about 1 % of the measured value, for temperature about 0.1° C and for the water level about 0.1 %.

Odyssey:

At Pier1 at the lake's s shore a gauge pipe has been built. In this pipe an Odyssey data logger was installed to measure the water level of the lake during the time of the measuring campaign 2010. The Odyssey capacitance water level probe is a kind of capacitor (Technical handbook for Odyssey data logger, 2009). It consists of a Teflon-covered measuring element in form of a cable with a counterweight at the bottom. The

measuring element forms one conducting plate of the capacitor and its Teflon cover forms the insulator. The second conducting plate is the water. By a rising or a sinking water level, the area of water that is in contact with the Teflon increases and decreases simultaneously. Therefore, the value of the capacitance is directly proportional to the height of the water in contact with the Teflon. The counterweight is also used as an earthing contact with the water.

Before use, the Odyssey data logger was calibrated in a bucket. The Odyssey data logger was lowered in the pipe at Pier1 by a string. Over the time the measured value shift a little bit from the real value. Hence, the measured values were adjusted for one centimetre for the first twenty days and from then on for two centimetres.

Secchi disk:

A home-made secchi disk was used to determine the secchi depth (Schwoerbel, 1994). The secchi disk is black/white with a diameter of 25 cm. The disk is lowered into the water. The secchi depth is called the depth in which the contour of the disk can no longer be seen by eye. It is not a very accurate measurement method but it is cheap and easily transportable.

4.2 Laboratory measurements

All laboratory measurements were performed in the laboratory of the Institute of Hydrology at the Albert-Ludwigs-University in Freiburg.

4.2.1 Picarro

The analysis of the stable isotopes δ^{18} O and δ^{2} H were conducted with the instrument "Picarro 1102-i", which is based on Wavelength-Scanned Cavity Ring-Down Spectroscopy (WS-CRDS). This device scans the absorption lines of ${}^{1}\text{H}_{2}{}^{16}\text{O}$, ${}^{1}\text{H}_{2}{}^{18}\text{O}$, ${}^{2}\text{H}{}^{1}\text{H}{}^{16}\text{O}$ (Picarro, 2008). Every H₂O molecule species has a unique near-infrared absorption line. At sub-atmospheric pressure the absorption lines are sharp and well resolved, each at a characteristic wavelength representing a particular molecule species. For the measurement, a laser beam enters a cavity including three mirrors and the gaseous sample. The laser light quickly fills the cavity. When the signal to the photodetector reaches a threshold level, the laser is turned off. The light in the cavity continues to bounce between the mirrors. The light intensity inside the cavity decays in

an exponential fashion. This decay is measured by the photodetector in real time (Crosson, 2008).

 δ^{18} O and δ^{2} H were measured simultaneously. The precision of the Picarro is 0.1 ‰ for δ^{18} O and 0.5 ‰ for δ^{2} H according to the manufacturer (Picarro, 2008)

4.2.2 Radon

In the end of July 2010 the two points NDP and MIA were examined for radon activity. At MIA a sample was taken in metre steps. At NDP samples were only taken from in depths of interest. In the end of August 2010, G2, G4, G6, G8, G10 and additionally the groundwater measuring point P34 were sampled. Simultaneously, a sample for stable isotopes measurement was taken to compare it to radon level.

The radioactivity of radon was measured with the device "RAD7" from the company Durridge Co with the accessory "RADH₂O" including bottles. The RAD7 is an α -Counter with a special detector which is calibrated for detection of ²²²Rn. The half-life of the ²²²Rn is only 3.82 days. Thus, the samples were measured as soon as possible. But even when the radon level is measured within hours a decay correction is necessary. The decay correction factor is given by the formula:

Decay Correction Factor =
$$e^{(T_h/132.4)}$$
 (41)

whereby the time T_h is in hours. When the sample is sealed and stored properly and measured within 24 hours the corrected result is almost as accurate as that of a sample which was measured directly after sampling (RAD7 RAD H2O, Radon in Water Accessory, Owner's Manual, 2009).

Before a measurement, the humidity in the RAD7 and in the connected closed air loop has to be lowered and it must be free of radon. Usually, 7 % relative humidity could be achieved by pumping fresh air in with is dried before with a connected desiccant column. Between the measurements, the device has to be purged with fresh dry air to make it radon free and dry again. This procedure takes about 20 minutes (RAD7 RAD H2O, Radon in Water Accessory, Owner's Manual, 2009).

For the RAD7 device, a lot of different adjustments are possible. At the first measurement in the end of July 2010, two types of bottles were used, one type with 40 ml and one type with 250 ml capacity. In the end of August only the bottles with 250 ml capacity were used. The capacity of the bottles can be specified in the RAD7 menu point "Setup - Mode".

In July recommended adjustments of the manual were used. In this adjustment the measuring cycle is five minutes with four repetitions (menu point "recycle") and the pump is on "Grap" which means that the pump is only on in the first five minutes to aerate the sample and to deliver the radon out of the water into the closed loop and RAD7. After the five minutes aeration of the sample, the radon meter waits five minutes more waiting the polonium 218 to approach equilibrium. Thereafter, RAD7 counts five minutes the α particle and repeat the counting four times. In the end, a summary with the calculated radon level, expressed in Bq/m³, will be printed.

In August 2010 only 250 ml bottles were used because of the low radon content in the lake water samples. The cycle was set from five minutes to thirty minutes for the same reason. The humidity got very high in the RAD7 during the measurement in July thus the pump was put on Auto. That means an initial pumping air for aeration for four minutes and then every time the humidity reaches 10 % (RAD7 Radon Detector User Manual, 2009).

The accuracy is easily affected by sample taking and then amounts from ± 10 % to ± 20 % (RAD7 RAD H2O, Radon in Water Accessory, Owner's Manual, 2009).

4.2.3 Hydrochemistry

Ion chromatography

The ion chromatography or ion exchange chromatography is a technique for separation and detection of anions and cations.

A solid stationary phase (the separating column, ion exchanger) and a liquid mobile phase (the eluent, an aqueous buffer) are necessary. Cations and anions could not be measured simultaneously, because a different eluent is necessary. The sample ions displace the eluent ions at the column temporary. They will be held back by the fixed loadings of the column before the eluent ions displace the sample ions again resulting in equilibrium. By having a different affinity to the solid phase, the ions get separated. The determination of the ions is performed by the detection of conductivity.

The analysis of the main ions has been carried out with the ion chromatograph Dionex DX 500 of the Institute of Hydrology in Freiburg. Measured cations were sodium ions (Na^+) , potassium ions (K^+) , magnesium ions (Mg^{2+}) , calcium ions (Ca^{2+}) and measured anions were chloride (Cl^-) , nitrate (NO^{3-}) , sulphate $(SO4^{2-})$. A sample volume of 2 x 5 ml was needed which was filtered with a 45 nm filter first. Two standard solutions one for cations and one for anions were also measured to obtain a calibration line.

Total phosphorus

When estimating the total phosphorus, the total phosphate as PO_4^{3-} must be determined first. The applied method is after the technical regulation DEV EN ISO 6878:2004.

To determine the total phosphate content, the solute organic and the particular phosphorus fraction must be solubilised with sulphuric acid and potassium persulphat. Then all the phosphorus is present as orthophosphate which build with ammonium molybdate in an acid environment a phosphorus molybdate complex. Adding a reducing agent like ascorbic acid leads to Phosphorus molybdenum blue. The intensity of the colour can be measured. The used wavelengths are 700 and 880 nm.

First of all the standard solutions for the calibration line were chosen according to the expected total phosphate content. The standard solutions were mixed from the stock solution Merck 1.09870 Titrisol 1000 mg PO_4^{3-} per litre.

40 ml of a sample are pipetted in a 100 ml volumetric flask. 1 ml 4.5 molar H_2SO_4 (sulphuric acid) and 8 ml oversaturated $K_2S_2O_8$ solution (5%, potassium persulphate) were added. The same procedure is applied to the standards as well, which were filled afterwards with distilled water to 50 ml, so that in the volumetric flask is an comparable amount of liquid like in the flask with the samples. The samples were autoclaved by 120°C for 30 minutes. After cooling down, 4 ml acid ammonium molybdate solution (Vogler reagent) and 1 ml ascorbic acid solution (10%) were added. The sample gets blue depending on the phosphate content. All samples and standards were put in a 50 ml glass cuvette. The extinction is measured against water in a spectral photometer with a wavelength of 700 and 880 nm. The extinction of the standards gives the calibration line.

The total phosphorus can be calculyted after the total phosphate is determined by averaging over the results of the different wavelengths. The value of the total phosphate is multiplied with 0.3261 because of the molar mass of phosphorus in phosphate.

Total hardness

The total hardness of water is the sum of the hardness producing ions (alkaline earth metal ions), mainly Ca^{2+} and Mg^{2+} . A method to determine the total hardness is the complexometric titration. Thereby the metal ions are transformed by complex formatting substances which can be visualised with a metal indicator by building a complex with the metal ions, too.

First the metal indicator is added to the sample. The alkaline earth metal ions in the sample build a complex with the metal indicator of a light red colour. Afterwards a much stronger complex formatting substance is added, it is ethylenediaminetetraacetic

acid (EDTA). EDTA displaces the metal indicator and builds itself a complex with a Ca^{2+} or Mg^{2+} ion. The more EDTA is added, the more metal indicators gets free again. One EDTA anion binds one Ca^{2+} or Mg^{2+} ion. When all metal ions are bound by EDTA, the entire metal indicator is set free and without the ion it has got a different colour, green. The changing point from light red to green is arrived, when every Ca^{2+} or Mg^{2+} ion is in a complex with one EDTA anion.

For determination of the total hardness 100 ml of a sample are pipetted in a 250 ml Erlenmeyer flask. 1-2 ml ammoniac solution (25%) is added after an indicator buffer tablet is dissolved in the sample water. With a 0.05M EDTA- solution the sample will be titrated at pH 10 until the first shades of green appear and all red has disappeared (Schwoerbel, 1994).

1 ml Titriplex B solution (0.05 M EDTA) equates to 10 mg/l CaO or 1°dH (German hardness) or 0.18 mmol (eq)/l alkaline earth metal ions.

In general surface water is softer than groundwater. In regions with lots of limestone the water is very hard.

Hydro carbonate

Carbonic dioxide, carbonic acid and its anions display a complicated equilibrium system. Therefore, the analysis is not as definite as the analyses of other water substances. Acids and bases are the most important factors influencing the equilibrium system by forcing the compounds to transform. The end points of the transformation processes are characterized by specific pH values. In the analysis the compounds are titrated with acids or bases until one of the end points is reached (Kölle, 2010).

At a pH of 8.2 almost only hydrogen carbonate ions (HCO₃⁻) exists in the water and at a pH of 4.3 almost only solute carbon dioxide (CO₂) exists (Figure 4.3). The end points are called acid capacities. The hydrogen carbonate content can be determined by titrating the water sample with hydrochloric acid up to the acid capacity 4.3 (KS_{4.3}). The carbonate content (CO₃²⁻) is calculated by titrating the solution also with hydrochloric acid up to the acid capacity 8.2 (KS_{8.2}). Different indicators are used for KS_{8.2} and KS_{4.3} (Kölle, 2010).



Figure 4.3: Relation between pH and the relative proportions of inorganic carbon species in solution (Wetzel, 2001).

To determine the hydro carbonate content of a 100 ml water sample, it is titrated with a 0.1 M hydrochloric acid after adding 2-3 drops methyl orange. H^+ -ions are added with the hydrochloric acid which are bound by HCO_3^- ions. Thereby the pH value decreases to 4.3. At this point the carbonic acid is nearly completly dissociated in CO_2 and H_2O . At pH 4.3 the colour changes from yellow to light red. The determination of the carbonate content is alike, but the indicator is phenolphthalein and the pH value decreases to 8.2 while the colour changes from light rose to colourless (Kölle, 2010).

Calculation of the hydrogen carbonate and carbonate content:

If
$$KS_{8,2}=0$$
 and $KS_{4,3}>0$: $HCO_3^{-} [mmol(eq)/l] = KS_{4,3}$ (42)
If $2*KS_{8,2}: $HCO_3^{-} [mmol(eq)/l] = KS_{4,3} - 2*KS_{8,2}$ (43)
 $CO_3^{2-} [mmol(eq)/l] = 2*KS_{8,2}$ (44)
1 mmol(eq)/l $HCO_3^{-} = 61.02 \text{ mg/l}$ (45)
1 mmol(eq)/l $CO_3^{2-} = 30.01 \text{ mg/l}$ (46)$

Carbonate exists in fresh water predominantly as calcium hydro carbonate (Schwoerbel,

Iron

1994)

The iron content was measured by an "Iron Cell Test" of the Firma Merck No 114549. This test can measure solute bivalent and trivalent iron and fresh colloidal iron (III) hydroxide.

Foremost the iron ions are reduced to iron (II) by ascorbic acid. Then thioglycolate is added as a buffer. In this medium the iron (II) ions react with a triazine derivative to a complex. This complex is red-violet and can be measured photometrically. The used photometer was "Spectroquant Nova 60". The measuring range is from 0.05 to 4.00

mg/l Fe. The test was expired in November 2008. In August 2010 only ten reaction cells were left, so not all the 13 samples could be measured. The samples were preserved with nitric acid 65% (1 ml nitric acid per 1 l of water sample).

4.3 ArcGIS

A groundwater contour map is made by means of the geo information system software ArcGIS. The groundwater and lake level measurements on the 25th/26th of March and 20th/21st of August 2010 are the data basis for this purpose. The projected coordinate system is "Germany Zone 3" based on the geographic coordinate system "Deutsches Hauptdreiecksnetz". The altitude data was interpolated to a surface with the tool "Spatial Analyst-Interpolation-Kriging". Within the options, the Kriging method "Ordinary" with a "Exponential" semivariogram model was chosen. The contours were made by the tool Spatial Analyst-Surface-Contours with a distance to each other of 25 cm and a base of 433 m above sea level. Afterwards the contours were manual smoothed at one's own discretion.

The surface of the "Schlosssee Salem" was also calculated with the help of ArcGIS.

5Results

5.1 Groundwater and lake level measurements

During the measuring campaign in 2010 the groundwater levels of the observed seven groundwater measuring points and the lake level were determined monthly. In addition, at the 25th/26th of March and 20th/21st of August 2010 the groundwater levels of several surrounding observation wells were also measured. The lake level was monitored continuously by an Odyssey Capacitance Water Level Probe. The installed Diver at P1/09 and P34 did not work because of operating errors. This type of Diver is probably designed for a maximum water depth of nine metres. Unfortunately in P1/09 the water column over the Diver was about ten metres.

The monthly changes in groundwater and lake levels (Pier1) are shown in Figure 5.1. The highest water levels can be observed at the upgradient observation wells P33 and P2/09 and the lowest levels at the downgradient groundwater measuring points P1/09 and P12/75. The groundwater levels of P34 and P37 are almost equal to the lake levels. The level of P36 is only about ten centimetres lower as the lake level. In the end of June 2010, P2/09, P1/09 and P12/75 feature a higher level increase than the other points.



Figure 5.1: Groundwater levels during the measuring campaign 2010.

The precise lake level and its relation to the daily precipitation is demonstrated in Figure 5.2. During the measuring campaign the lake level first decreases about ten centimetres until mid of June. Then the lake level suddenly rises for eight centimetres within one day. Afterwards it continues to rise. The starting lake level in March was 433.31 m, the minimum in June was 433.19 m and the maximum level was found in August with 433.40 m above sea level. The last measuring in the end of August of 433.39 m above sea level was not much lower than the maximum level.



Figure 5.2: Lake levels and precipitation between March and August 2010.



Figure 5.3: Groundwater contour diagram; March 2010 contours in white and August 2010 contours in lilac; distance between isolines 25 centimetres; aquifer's edge in black, main in- and outflow width in red; elements adopted from HYDRO-DATA (2009).

The groundwater levels in March and August 2010 are illustrated in the groundwater contour diagram in Figure 5.3. The groundwater contours of March are dashed dotted in white and the contours of August are in lilac. The distance between the isolines is 25 cm. The most northern contour stands for 436.25 m and the most southern for 431.75 m above sea level. Additionally, the aquifer's edge and the main in- and outflow width are drawn within the graph adopted from the expertise of HYDRO-DATA (2009). The

groundwater level distribution is very akin in the two months. At the western wing the groundwater is impounded in the north and enhanced in the south. At the eastern shore there is an area with the same range of water levels as is found in the lake.

5.2 Physicochemical parameters

5.2.1 Introduction

The electric conductivity (EC) and the temperature were both measured with the device WTW Cond 197 in monthly intervals at seven groundwater measuring points (P1/09, P2/09, P12/75, P33, P34, P36, P37) and in the lake points "New deepest point" (NDP), "Old deepest point" (ODP), "Marginal inflow area" (MIA) and "Marginal outflow area" (MOA). The graphs of the data of the data logger "Diver" are situated in the Appendix A.1 and A.2. Oxygen content and the pH value were determined by means of the Multi 350i. Unfortunately there are for groundwater only reliable values of both parameters in March and August when the water was pumped. Oxygen content and pH profiles of the lake points were always measured around midday.

5.2.2 Electric conductivity

Figure 5.4 and Figure 5.5 illustrate monthly EC profiles between March and August 2010 at the point NDP. In March almost the same EC is found in all depths. In the first four meters counting from the lake surface, the EC it decreases every month. Looking at a single month, the EC values show no variation in the upper zone. The lowest EC values can be found in the upper metres in August (about 470 μ S/cm) and the highest in March (about 640 μ S/cm). From the lake depth five metres on, the EC increases very strong. In the end of April and May a peak of 680 μ S/cm is seen at five metres and in the end of June only a small peak of 650 μ S/cm at six metres whereas in the end of July and August 2010 the peak migrate to nine metres with EC values of about 700 μ S/cm and 680 μ S/cm. In the deepest zone of the lake the EC values are in the range of those measured in March. This zone is found from April to June 2010 in seven to eight metres and in July in twelve metres depth. The highest EC values were measured in the deepest five metres in August.


Figure 5.4: Electric conductivity profiles at "New deepest point" in 2010.



Figure 5.5: Contour graph of electric conductivity at "New deepest point" on the lake over the time and lake depth.

Figure 5.6 depicts monthly EC profiles at ODP. The EC values of the end of April are missing. The characteristics of the EC profiles at NDP are not so concise at ODP. The development of an upper and a deeper zone is also visible. The peaks of high electric conductivities misalign in May from five to six metres. The EC peaks at nine metres at NDP in July and in August 2010 are absent at ODP. In August higher EC values are measured in the deeper metres.



Figure 5.6: Electric conductivity profiles at "Old deepest point" in 2010.

The EC profiles of MIA and MOA from the end of June until August are shown in Figure 5.7 (a and b). Like at NDP, an upper zone, with peaks in June in six metres and in July and August in nine metres, are also identifiable. MOA has only a lake depth of seven metres but down to this depth, the EC values of MIA and MOA are alike.



Figure 5.7a, b: Electric conductivity profiles at "Marginal inflow area" (a) and "Marginal outflow area" (b) in 2010.

In Figure 5.8 the EC profiles of all sampling points and all months of the measuring campaign in 2010 are illustrated. The lake values are averaged for a combined profile. The upgradient groundwater measuring points P34 and P2/09 and the points P37 and P12/75 show the highest EC values with about 800 μ S/cm. In all month P37

demonstrated lower EC values in the upper metres. The small blue crosses on the lefthand of Figure 5.8 represent the EC of P33 with values about 400 μ S/cm. The EC profile of P33 is lower than that of the other upgradient groundwater measuring points and even lower than the lake values. The EC values of P36 are between the values of the upgradient observation wells P2/09 and P34 and the lake water. Moreover, P36 has got the widest range in EC values between 700 and 800 μ S/cm. P1/09's EC values are between those of the upper zone and the deepest zone of the lake and amount about 600 μ S/cm.



Figure 5.8: Monthly electric conductivity profiles of groundwater measuring points and of lake water between March and August 2010.

Figure 5.9 illustrates the EC of the groundwater measuring points as a function of time. In addition, the precipitation is drawn within the figure.

The monthly EC value of a measuring point is taken from the EC profile. It is the value at the middle of the filter section or at the middle between the water surface in the pipe and the end of the filter section. For P2/09 with a very short profile, the value of the deepest measuring metre was chosen, because these values were closer to those obtained by pumping. The EC values of the P33 profile in March are lower than those achieved by pumping. The pumped EC value in March is 657 μ S/cm and the value in the middle of the profile is 400 μ S/cm. In Figure 5.9 the upgradient groundwater measuring points are coloured in blue, the downgradient observation wells (P1/09 and P36) in orange, P37 besides the lake in lilac and the farthest downgradient point P12/75 in green.

Except of P33 and "Schapbuchquelle" the upgradient groundwater measuring points, P37 and P12/75, achieve higher EC values. P33 has got the lowest values and the "Schapbuchquelle" and the downgradient points, P36 and P1/09, lie in the middle range.



Figure 5.9: Electric conductivity of groundwater measuring points as a function of time.

The EC profiles of all groundwater measuring points are shown in graphs in the Appendix A.1, as well as the graphs of all the measuring points in monthly intervals.

5.2.3 Temperature

The temperature profiles of NDP are illustrated in Figure 5.10 and as contour graph in Figure 5.11. From the first measurement in March 2010, temperature increases from the surface on. This increase is found mainly at the lake's surface. At the ground the temperature rises only between a quarter to one degree per month. In every month the middle zone, where the temperature strongly decreases with the lake depth, gets wider and the gradient larger. In August the temperature between two and six metres was lower than in July. The monthly maximum at NDP at the surface increases from 10.3°C in March to 24.1°C in August. Otherwise, the monthly minimum occurs in the deepest zone with a rise from 4.5°C in March to 7.6°C in August.



Figure 5.10: Temperature profiles at "New deepest point" in 2010.



Figure 5.11: Contour graph of temperature at the "New deepest point" on the lake over the time and lake depth.

In Figure 5.12 (a and b) the temperature with the lake depth of MIA and MOA is shown. There are practically no differences between the two points or NDP or ODP.



Figure 5.12a, b: Temperature profiles at "Marginal inflow area" (a) and "Marginal outflow area" (b) in 2010.

All temperature profiles of the measuring campaign in 2010 are compiled in the Figure 5.13. Except those of P1/09 and P37, all groundwater temperatures are in the range of 9.5 to 11°C. The temperature of P1/09 and P37 is higher and P1/09 and P36 exhibit the widest variations. As mentioned above, the temperature of the lake profiles increases. The lake can be divided in an upper, a gradient and a deeper zone. The temperature of

the groundwater is in the same range as the temperature in the gradient zone. Except of March, when the lake water is colder in all depths than in the groundwater.

The temperature profiles of all groundwater measuring points are illustrated in the Appendix A.2 as well as the graphs of all measuring points in monthly intervals.





The temperature values of the groundwater measuring points in Figure 5.14 are obtained in the same way as the EC values of Figure 5.9 from the same depth. They are illustrated as a function of time. The warmest water flows through P37 (about 13.5° C), followed by P1/09 (about 13° C), whereas the coldest water flow through P36 (about 10° C). The upgradient measuring points are in the colder range with around 11° C. Apart from P12/75 and P33, the temperatures in the groundwater measuring points behave quite similar over the time of the measuring campaigns in 2009 and 2010 with a minimum in spring or summer. Unfortunately, the data of the winter are lacking. A maximum in winter could occur but it is not definite. The temperature data of P33 and P12/75 exists only from March to August 2010. During this time period the temperature does not change essentially and demonstrates a small maximum in early summer. The highest amplitudes exist in P2/09, P1/09 and P37, whereas the temperature changes of P34 and P36 are smoother. Because of the minimums and the steepness of the curves, P2/09 and P1/09 can be clustered as well as P34 and P36. P37 shows a large amplitude but a late minimum value, fitting better to P34 and P36.



Figure 5.14: Temperature of groundwater measuring points as a function of time.

5.2.4 Oxygen content and pH values

The oxygen content and pH values of the groundwater metering points are only reliable when the water is pumped. This was the case at the $25^{\text{th}}/26^{\text{th}}$ of March and 20^{th} of August. The data are listed in Table 5.1.

Measuring point	Oxygen	content	рН		
	[mg/l]		[-]		
	March	August	March	August	
P33	2.4	-	7.2	-	
P34	7.3	7.2	7.4	7.1	
P2/09	3.5	2.5	7.0	7.1	
P37	4.8	2.4	6.4	7.2	
P1/09	0.7	0.0	7.3	7.4	
P36	2.4	0.8	7.2	7.2	
P12/75	4.8	-	7.4	-	

 Table 5.1: Oxygen content and pH values of the groundwater metering points in March and August 2010.

The oxygen content of the groundwater in March is in the range of 0.7 and 7.3 mg/l and in August between 0.0 and 7.2 mg/l, whereat the upgradient observation wells present a higher content than the downgradient ones. The highest oxygen is found in P34 and the lowest in P1/09. The pH values in March are in the range of 6.4 and 7.4 and in August between 7.1 and 7.4. The pH values show no difference between upgradient and downgradient points.

Concerning the lake, the data of oxygen content and pH at the end of July at NDP are missing, because of device failure. Furthermore, no data of the oxygen content at ODP in the end of April exists. Figure 5.15 and Figure 5.16 picture the oxygen content at NDP and ODP as a contour graph. Both graphs show that the oxygen content decreases from spring to summer. The oxygen content at ODP is relatively higher. From March to June the highest values are around six meters below the lake's surface. In August the highest content is found in four metres. Both lake points demonstrate an absolute maximum of about 17 mg/l in a lake depth of six to seven metres.

At NDP (Figure 5.15) no oxygen is found at lake depths below nine metres from the end of June. The values at ODP (Figure 5.16) in these depths are low but oxygen can be found until July 2010.



Figure 5.15: Contour graph of oxygen content at the "New deepest point" over the time and lake depth.



Figure 5.16: Contour graph of oxygen content at the "Old deepest point" over the time and lake depth.

Figure 5.17 and Figure 5.18 illustrate the pH values at NDP and ODP as contour graphs. The highest pH values of 8.4 and 8.5 are found in the end of April at a depth of around seven metres below the lake surface with 8.4 and at NDP just under the surface in August. In March the overall pH value is 8.1 and in August it is in the range of 7.5 and 8.5.



Figure 5.17: Contour graph of pH values at the "New deepest point" over the time and lake depth.



Figure 5.18: Contour graph of pH values at the "Old deepest point" over the time and lake depth.

5.3 Sensory parameters

5.3.1 Secchi depth

The secchi depth was identified in March in 4 m depth and in August in 2.5 m. The end of the euphotic zone D_{eu} and the compensation level K can be calculated with the Formulas (14) and (15). The results are presented in Table 5.2.

Month	Secchi depth	D _{eu}	К
Month	[m]	[m]	[m]
End of March	4.0	10	7.9
End of August	2.4	7.7	4.1

Table 5.2: Secchi depth, resulting euphotic zone depth and compensation level.

5.3.2 Sensory impressions – Smell and colour

Sensory impressions could give additional hints e.g. when looking for an explanation of an odd values.

The water at:

- P33 was milky with auburn flocculation from June on,
- P2/09 was milky from June on,
- P34 was milky in May, July and August, and in additional, with sandy sediments in May,
- P37 was milky in April, July and August,
- P1/09 was milky with a touch of auburn; the clay seal is perhaps damaged,
- P36 in March after 10 min of pumping still smells a little bit like rotten eggs, which points towards H_2S , and it was yellowich to brownisch with sands; P36 was full of rotten roots when taken the bailer,
- P12/75 was milky and partly with sediment, because of an anthill, which was build over the underground pipe.

In the measuring campaign of 2009 something block the pipe of P36 at 4-5 metres, so that no deeper measurement have been taken

The lake water was very clear in March. From April to July, the lake water had a light touch of blue-green. In August the colour had changed to a flashy green. Lake water colour impressions can be found in the Appendix C.

5.4 Isotopes

5.4.1 Introduction

Stable isotope data were collected in monthly intervals between March and August 2010 at the groundwater measuring points (P1/09, P2/09, P33, P34, P36, P37) and at several points of the lake (NDP, ODP, MIA, MOA, Pier1). Furthermore, weekly retain samples of "Schapbuchquelle", "TB Stefansfeld", P1/09 and Pier1 were taken by the

water district master Mr. Tressel and by Mr. Petz from the municipal of Salem. In addition, stable isotope data of 2009 could be taken from the expertise of HYDRO-DATA (2009). In March and August some of the samples were taken by a submersible pump in addition to a bailer. In all other months only the bailer was applied for sampling water.

5.4.2 Stable isotopes in groundwater

In March all groundwater samples were pumped out. In addition, at P1/09 and P37 samples were taken with a bailer. In August the water samples of P1/09, P2/09, P34, P36 and P37 were first scooped and then pumped out. The scooped water was taken out of the filter section in the observation well where the electric conductivity and the temperature did not change anymore. It was assumed, that new water of the aquifer flows through this part all time, if the pipe is not damaged or the filter section sealed, and that there would not be a noticeable evaporation effects in the depths. The values of the two samples of March were very close together so it was thought, the assumption could be right (Figure 5.19). In August the stable isotope content of scooped and pumped samples vary, especially in P37.

Probably, all samples should have been pumped especially those of P37. This was judged not to be appropriate, especially for the weekly retain samples of P1/09 because of the spent time and efforts of Mr. Petz.



Figure 5.19: Comparison of the stable isotope content of scooped and pumped-out water samples in March and August 2010.

In the next figures (Figure 5.20 to Figure 5.26) only the stable isotope ratios of the scooped water samples were taken into account for a better comparison of the monthly or weekly samples. The stable isotopes values of the 2009 and the 2010 measuring campaigns are drawn in Figure 5.20 and Figure 5.21. The precipitation during this time is also added. Figure 5.22 and Figure 5.23 include the same data zoomed on the campaign of 2010.

The upgradient or uninfluenced groundwater measuring points are presented in blue. Except of P33, the values are relatively constant. P33's water, instead, is isotopically lighter and more variable. The downgradient observation wells are illustrated in orange. They are more enriched in isotopes than the upgradient groundwater. P37, besides the lake, and P12/75, in a greater distance from the lake, have special colours due to their variable behaviour. The values of P37 are in lilac in the graphs. P37's behaviour in the summers 2009 and 2010 is different. In 2009 the water of P37 gets isotopically heavier from July on. In 2010 it depletes from the end of April on. Values of P12/75 (green) are only on hand for the 2010 campaign. In June 2010 P12/75's water enriches more than 1 % in δ^{18} O and more than 10 % in δ^{2} H.









Figure 5.22: $\delta^{18}O$ ratios in groundwater samples in 2010.



Figure 5.23: δ^2 H ratios in groundwater samples and 2010.

5.4.3 Stable isotopes in weekly retain samples of groundwater and lake water

In the 2010 measuring campaign, weekly samples were taken of the upgradient or uninfluenced waters of "Schapbuchquelle" and "TB Stefansfeld", of the lake surface water at Pier1 and of the downgradient observation well P1/09. Even data of 2009 are available. Due to the higher resolution and the different kinds of observed water it is worth to have a closer look at the data.



Figure 5.24: δ¹⁸O ratios of Schapbuchquelle, TB Stefansfeld, Pier1 and P1/09 of the measuring campaigns in 2009 and 2010.

In Figure 5.24 the δ^{18} O ratios of the water samples of the measuring campaign in 2009 and 2010 are depicted. In both years the lake surface water of Pier1 becomes strongly enriched in ¹⁸O isotopes. Before May the water of P1/09 is isotopically heavier than the Pier1 water. It also enriches during the summer but not so strongly as in P1/09. The groundwater of "Schapbuchquelle" and "TB Stefansfeld" is isotopically lighter than the lake water and the downgradient water.

Figure 5.25 shows the stable isotope contents of the measuring campaign of 2010 and the amount of daily rain. At the 17./18.06.2010 a heavy and long rain of more than 23 hours took place. After this event especially the Pier1, water depleted and even in the groundwater a small negative peak can be seen.



Figure 5.25: δ^{18} O ratios of the weekly retain samples of Schapbuchquelle, TB Stefansfeld, Pier1 and P1/09 of the measuring campaign in 2010.

In Figure 5.26 the deuterium excess of the four observation points is presented. The error bars are calculated over the accuracy errors of the δ^{18} O and δ^{2} H measurement. In 2009 no trend is recognisable. In 2010 the waters of all points show a lower Deuterium Excess. In all four observed points the water gets a little bit heavier.



Figure 5.26: Deuterium Excess of the water samples of Schapbuchquelle, TB Stefansfeld, Pier1 and P1/09 of the measuring campaigns in 2009/10.

5.4.4 Stable isotopes in lake water

In Figure 5.27 to Figure 5.32 the δ^{18} O ratios of the 2010 measuring campaign are illustrated in monthly intervals. If 2009 data of approximately the same month exist, they are added to the monthly graphs.

In the end of March (Figure 5.27) the δ^{18} O ratio is alike from top to bottom within the measurement error.

In the end of April (Figure 5.28) the lake water is slightly enriched in the first four metres top down. An isotopically lighter peak exists at five metres. Data of ODP are nonexistent.

In the end of May (Figure 5.29) the isotopically lighter peaks migrate down to six metres. The first four metres down from the lake surface are more enriched than in April. The enrichment of the upper lake metres gets monthly more extreme in summer (Figure 5.29 to Figure 5.32).

In the end of June (Figure 5.30) MIA and MOA get measured for the first time. The peak of isotopically lighter values is more complex in June. At NDP a double peak is in six and nine metres. In ODP the only clear peak is at six metres.

In the end of July (Figure 5.31) the first four metres are strongly enriched. Between four and six metres a very steep depletion occurs. The isotopically lighter peak is in NDP at the lake depth of nine metres. In August the measuring points G2 to G8 are added. At a specific lake depth almost no variations at the different lake measuring points are noticeable. Three layers could be identified: the well mixed and enriched upper layer to four metres, the middle layer with a steep gradient between four and seven metres and the deepest layer, which shows again fewer variations. Isotopically lighter peaks are not very distinct. The peak for NDP is in about 10 metres. In August 2009 the upper layer was even more enriched in heavy isotopes than in 2010.



Figure 5.27: δ^{18} O ratios in the lake in the end of March.







Figure 5.29: $\delta^{18}O$ ratios in the lake in the end of May.







Figure 5.31: δ^{18} O ratios in the lake in the end of July.



Figure 5.32: δ^{18} O ratios in the lake in the end of August.

In Figure 5.33 the stable isotope data of lake points of the 2009 measuring campaign are pictured. The stable isotope profile of March and November 2009 during the circulation are noteworthy. At both times no bigger variations in the ratio are apparent. Just the averaged value of November with -8.22 ‰ VSMOW is more enriched than the value of March with -8.96 ‰ VSMOW.



Figure 5.33: δ^{18} O ratios in lake water of the measuring campaign of 2009.

Figure 5.34 and Figure 5.36 show the progress of the δ^{18} O values over the time at NDP and Figure 5.35 and Figure 5.37 at ODP.



Figure 5.34: δ^{18} O ratio profiles at "New deepest point".



Figure 5.35: δ^{18} O ratio profiles at "Old deepest point".

Figure 5.34 for NDP and Figure 5.35 for ODP exhibit similar characteristic in the δ^{18} O ratio. The first four metres down from the lake surface get more enriched every month. The largest enrichment of 0.7 ‰ at NDP and 0.6 ‰ VSMOW at ODP between two monthly measuring dates occurs between June and July. The values of δ^{18} O in the end of July and in the end of August do not differ very much in the upper zone. At ODP the negative peak in the end of June at six metres lake depth is striking. At NDP from eleven metres lake depth on to the lake ground and at ODP from ten metres on, the δ^{18} O values remain in the same range in all six months between about -9.2 ‰ and -8.9 ‰ VSMOW. At NDP, it is noticeable that the δ^{18} O values between the lake depths of 10 and 16 metres are a bit more enriched in end of July than in the end of August.



Figure 5.36: Contour graph of δ^{18} O ratio [‰ VSMOW] at the "New deepest point" on the lake over the time and lake depth.



Figure 5.37: Contour graph of δ^{18} O ratio [‰ VSMOW] at the "Old deepest point" on the lake over the time and lake depth.

In Figure 5.36 and Figure 5.37 the δ^{18} O ratio of NDP and ODP is presented as a function of time and lake depth in contour graphs. The enrichment from spring to summer in the upper metres can be seen clearly as well as the small variation in the deeper zone and the negative peaks in diverse lake depths of δ^{18} O. Eye-catching in both

graphs is the positive peak in the depth of four metres at end of July and August. In July the water in four metres depth is even more enriched than the surface water.

The δ^2 H ratio of NDP and ODP as a function of time and lake depth in a contour graph is presented in Figure 5.38 and Figure 5.39. The former described characteristics of the δ^{18} O ratio in the lake can also be found, but they are so distinct.



Figure 5.38: Contour graph of δ^2 H ratio [% VSMOW] at the "New deepest point" on the lake over the time and with the lake depth.



Figure 5.39: Contour graph of δ^2 H ratio [‰ VSMOW] at the "Old deepest point" on the lake over the time and with the lake depth.

MIA (Figure 5.40a, Figure 5.41a) and MOA (Figure 5.40b, Figure 5.41b) show similar trends in the ratio of δ^{18} O and δ^{2} H. The only difference is the smoother profile of MOA, for example, the positive peak at four metres in July is not as concise at MOA as in MIA.



Figure 5.40a, b: δ¹⁸O ratio profiles at "Marginal inflow area" (a) and "Marginal outflow area" (b).



Figure 5.41a, b: δ²H ratio profiles at "Marginal inflow area" (a) and "Marginal outflow area" (b).

5.4.5 δ^{18} O / δ^{2} H relationship

The relationship between δ^{18} O and δ^{2} H is illustrated in the next graphs, whereby Figure 5.42 contains all measured data of the campaign of 2010, Figure 5.43 all data points of 2009 and Figure 5.44 to Figure 5.49 the monthly values in 2010. The different measuring points or sample depths of the lake were classified and marked differently when appropriate. Figure 5.42 and Figure 5.43 contains all data of 2010 and 2009. Thereby the stable isotope data of the groundwater points is drawn in dark blue whether it is an upgradient or a downgradient point. The lake water isotope ratios were divided in three zones with different colours and an extra colour for Pier1. The zones cover the lake depth 0-4 metres, 5-10 metres and 11-16 metres. In the monthly graphs the groundwater measuring points differ in sign and colour. The ratios of the observation well P33 are only regarded in the Figure 5.42. Moreover, the GMWL is drawn in the graphs as well as the LMWL of Constance at the Lake of Constance. The LMWL is

calculated from monthly data of the years 1978-2005 by means of reduced major axis regression (IAEA/WMO, 2006):

$$\delta^2 H = (8.03 \pm 0.05) \cdot \delta^{18} O + (7.51 \pm 0.49)$$

Additionally, EP line is drawn within in the graphs with a fixed slope of m = 5 and intercept of (-20). This EP line goes through the intersection of the trend line with the GMWL at the ratios $\delta^{18}O = (-10)$ and $\delta^{2}H = (-70)$. The intersection point is almost the same in 2009 and 2010 (Figure 5.42, Figure 5.43). The EP line should approximately equate the trend line and is constructed for comparison reasons. The equations of the monthly trend lines are noted within the graphs.

In Figure 5.42 and Figure 5.43 the gathering of groundwater samples around the GMWL can be seen. The stable isotope ratios of P33 are isotopically lighter, yet the ratios can also be found in the vicinity of the GMWL. The trend line was a bit steeper in 2009 with a slope of 4.9 in comparison of the slope of 4.4 in 2010.

In all months the GMWL fits better to the groundwater isotope ratios than the LMWL of Constance. The slope of the trend line gets steeper over the summer from 3.9 and 4.9.







Figure 5.43: $\delta^{18}O / \delta^{2}H$ relationship diagram of all samples of the measuring campaign of 2009.

In March 2010 (Figure 5.44) the δ^{18} O and δ^{2} H ratios of the lake and P36 were similar. The groundwater measuring point P1/09 indicates water which has undergone stronger fractionation than the lake. The observation wells P2/09, P34, P12/75 and P37 are very close to the GMWL.



Figure 5.44: $\delta^{18}O / \delta^2H$ relationship diagram of the samples of the measuring date in the end of March 2010.

In April (Figure 5.45) the lake water samples start to separate from each other along the EP line or trend line. Groundwater from "TB Stefansfeld" and "Schapbuchquelle" are added and they also plot around the GMWL-EP line intersection but with a lighter isotope ratio than P2/09 and P34. The P37 data are the exception, because they plot now on the EP line in the same range as the lake water and the downgradient wells P1/09 and P36, and not on the GMWL anymore.



Figure 5.45: δ^{18} O / δ^{2} H relationship diagram of the samples of the measuring date in April 2010.

The separation due to higher fractionation proceeds in the summer months. In May (Figure 5.46) is remarkable that the groundwater from P12/75 and P37 gathers around the intersection of the GMWL with the trend line like "TB Stefansfeld", P2/09 and P34. Less enriched water is found at the "Schapbuchquelle". In May the water of P36 is isotopically lighter than the lake water.



Figure 5.46: $\delta^{18}O / \delta^{2}H$ relationship diagram of the samples of the measuring date in May 2010.

The lake water in June (Figure 5.47) shows a strong separation. The upper metres are most enriched, P1/09 is between the upper and the deeper metres, and P36 is between the upgradient groundwater and the lake water. P37 gathers with the other upgradient observation wells around the intersection of GMWL with the EP line. P12/75 shifts away from the EP line. It is more enriched in δ^{18} O and δ^{2} H than the other waters, but it does not lie on the EP or trend line anymore.



Figure 5.47: δ^{18} O / δ^{2} H relationship diagram of the samples of the measuring date in June 2010.

From March to June the EP line and the trend line equal each other in the range of interest. In July and August (Figure 5.48 and Figure 5.49) the trend line passes the EP line almost parallel but lowered, so that the intersection of the trend lines with the GMWL differs. Aside from the trend line, the characteristics of the points are similar to June. Only the upper lake metres are more enriched and all points seemed to undergo enrichment in δ^{18} O but not in δ^{2} H. In August the strongest separation between the upper, the middle and the deeper zone of the lake is conspicuous. The δ^{18} O / δ^{2} H relationship graph of August 2010 includes the scooped and pumped sample ratios of P37 (Figure 5.49). While the scooped sample plots in the same range as the upgradient water samples, the pumped ones lie on the trend line between the lake samples.



Figure 5.48: δ^{18} O / δ^{2} H relationship diagram of the samples of the measuring date in July 2010.



Figure 5.49: $\delta^{18}O / \delta^{2}H$ relationship diagram of the samples of the measuring date in August 2010.

5.4.6 Radon

At the 29th of July and 20th/21st of August 2010 water samples were taken to measure the radon content. The sample points in July were lake depths of MIA (1-10 m) and NDP (3, 5-10, 15 m). In August P34 and G2-G10 were sampled. The aim was not to quantify the groundwater inflow, but to make a qualitative statement about the main inflow location. The measuring program for the July samples was not appropriate for the low content in the samples (Figure 5.50 and Table 5.3). The standard error given by the device RAD7 is very high due to rare counts of α particles.

Measuring point	Sampling depth	Elapsed hours between sampling and measuring	Decay correction factor	Volume	RAD7 result	RAD7 Standard Deviation	Corrected Radon level
	[m]	[h]		[ml]	[Bq/m ³]	[Bq/m ³]	[Bq/m ³]
MIA	1	8.0	1.062	40	421	488	447
MIA	2	8.9	1.070	40	1010	404	1080
MIA	3	9.6	1.075	40	807	659	868
MIA	4	17.3	1.139	40	806	2	918
MIA	5	18.1	1.146	40	1010	1020	1158
MIA	6	19.1	1.155	40	403	466	466
MIA	7	19.9	1.162	40	1010	1020	1174
MIA	8	20.6	1.168	40	0	-	0
MIA	9	21.5	1.176	40	1410	1380	1658
MIA	10	22.2	1.182	40	201	401	238
NDP	3	25.5	1.212	250	215	185	261
NDP	5	27.0	1.226	40	402	465	493
NDP	6	24.8	1.206	250	72	144	87
NDP	7	24.1	1.200	250	215	144	258
NDP	8	23.5	1.194	250	144	117	172
NDP	9	22.7	1.187	250	609	357	723
NDP	10	26.5	1.222	40	202	403	247
NDP	15	22.1	1.182	250	144	117	170

Table 5.3: Radon level results of the measuring campaign 29.07.2010.



Figure 5.50: Radon level in Schlosssee Salem in the end of July.

The different measuring scheme of August worked better, the results are summarised in Table 5.4 and presented in Figure 5.51. The groundwater sample of P34 has got the highest radon level with (7036 \pm 522) Bq/m³ as expected. The lake water is in the range of 272 - 561 Bq/m³ with a maximum at G10.

Measuring point	Sampling depth	Elapsed hours between sampling and measuring	Decay correction factor	Volume	RAD7 result	RAD7 Standard Deviation	Corrected Radon level
	[m]	[h]		[ml]	[Bq/m ³]	[Bq/m ³]	[Bq/m ³]
P34		32.9	1.282	250	5490	522	7036
G2	1	11.1	1.087	250	294	56.2	320
G4	3	13.7	1.109	250	245	62.8	272
G6	5	16.2	1.130	250	353	142	399
G8	7	18.6	1.151	250	263	51.9	303
G10	9	21.0	1.172	250	479	102	561

Table 5.4: Radon level results of the measuring campaign of the 20./21.08.2010.



Figure 5.51: Radon level at the measuring points G2-G10 in August.

The radon levels and the stable isotope data were sampled at the same time and place. A good correlation is found (Table 5.5). Only one value does not fit well, for unknown reasons, but when taking out the outlier G8, the coefficient of determination is high with $R^2 = 0.9709$ for the correlation with $\delta^{18}O$ (Figure 5.52) and with $R^2 = 0.9966$ for the correlation with $\delta^{2}H$ (Figure 5.53).

Measuring point	Sampling depth	Corrected Radon level	δ ¹⁸ Ο	δ²Η
	[m]	[Bq/m ³]	[‰ VSMOW]	[‰ VSMOW]
P34		7036	-9.62	-67.98
G2	1	320	-7.82	-61.03
G4	3	272	-7.85	-60.33
G6	5	399	-8.32	-62.92
G8	7	303	-8.94	-65.97
G10	9	561	-9.15	-66.74

Table 5.5: Comparison radon level with stable isotope data.


Figure 5.52: Correlation of radon levels with δ^{18} O values at G2 to G10.



Figure 5.53: Correlation of radon levels with $\delta^2 H$ values at G2 to G10.

5.5 Hydrochemistry

The hydrochemistry was examined at the groundwater measuring points P1/09, P2/09, P34, P36, P37 and at the two lake points NDP and ODP. The sample dates coincide with the first and the last sample campaign at the $25^{\text{th}}/26^{\text{th}}$ of March and $20^{\text{th}}/21^{\text{st}}$ of August 2010. In both times the measurement in the laboratory took place within a week. In March a mixed sample and a sample one metre over the ground was taken out of the lake at the two points. In August first epilimnion, thermocline and hypolimnion was determined by means of EC and temperature measurements and then samples were taken out of the middle of these layers as well as one sample one metre over the lake ground. The sample depths were at NDP 2, 7, 13, 15.5 m and at ODP 1.5, 5, 10 and 13 m.

The results are listed in Table 5.6 and Table 5.7, whereby the arrangement of the measuring points reflects the position to the dredge lake. Again, P37 has a special role because of its position besides the lake and of its variable behaviour in former studies (HYDRO-DATA, 2009).

Measuring Point	Total H [°d	ardness [H]	Hydro carbonat	ogen e [mg/l]	Carbo	nate (/I]	ΞĔ	u [1/2	Total ph [m	osphate g/l]	Total pho [m	osphorus g/l]	Total pho [με	sphorus //]
	March	August	March	August	March	August	March	August	March	August	March	August	March	August
P2/09	18.6	23.0	455	459	0	0	<0.05	<0.05	0.013	0.004	0.004	0.001	4	1
P34	23.2	22.5	464	453	0	0	<0.05	<0.05	0.050	0.047	0.016	0.015	16	15
P37	18.0	18.2	442	362	0	0	<0.05	<0.05	0.044	0.033	0.014	0.011	14	11
Lake NDP Mixed Sample	17.8		367		0		0.08		0.014		0.004		4	
Lake ODP Mixed Sample	17.8		375		0		0.07		0.010		0.003		æ	
Lake NDP Epilimnion		12.5		212		19		<0.05		0.017	- 	0.005		5
Lake ODP Epilimnion		12.6		217		14				0.018		0.006		9
Lake NDP Thermocline		18.2		366		0		<0.05		0.010		0.003		æ
Lake ODP Thermocline		14.8		298		0				0.016		0.005		S
Lake NDP Hypolimnion		18.5		392		0		0.08		0.020		0.007		7
Lake ODP Hypolimnion		18.5		377		0				0:030		0.010		10
Lake NDP 1 m over ground	17.8	18.8	367	406	0	0	0.10	0.70	0.026	0.029	0.008	600.0	∞	6
Lake ODP 1 m over ground	17.8	18.5	372	395	0	0	<0.05		0.014	0.038	0.004	0.012	4	12
P1/09	16.6	16.6	358	346	0	0	0.13	0.10	0.016	0.017	0.005	0.006	S	9
P36	17.8	20.2	417	402	0	0	0.08	<0.05	0.026	0.025	0.009	0.008	6	8
upgradient	varia	able behav	iour	-	ake water		ğ	owngradie	ť					

 Table 5.6: Results of the hydrochemical analysis in March and August.

Measuring Point	Chloric [m]	de ions g/l]	Nitrat [mg	e ions [/]	Sulpha [mg	te ions (/I]	Sodiur [mg	n ions s/I]	Potassiu [mi	im ions [/]	Magnesi [m	um ions [/]	Calciur [mg	n ions [/]
	March	August	March	August	March	August	March	August	March	August	March	August	March	August
P2/09	17	18	23	29	25	25	10	8	æ	2	24	19	133	91
P34	23	22	30	29	28	29	15	12	9	S	24	19	134	92
P37	22	28	24	13	27	26	15	12	S	4	26	19	126	79
Lake NDP Mixed Sample	20		12		24		12		4		24		66	
Lake ODP Mixed Sample	22		12		24		12		4		23		96	
Lake NDP Epilimnion		21		6		25		10		æ		19		51
Lake ODP Epilimnion		21		6		25		10		e		19		52
Lake NDP Thermocline		21		12		26		10		S		20		77
Lake ODP Thermocline		21		12		25		10		3		20		64
Lake NDP Hypolimnion		20		5		25		10		æ		20		78
Lake ODP Hypolimnion		21		9		25		10		e		20		77
Lake NDP 1 m over ground	20	20	12	2	26	21	12	10	4	æ	24	20	93	77
Lake ODP 1 m over ground	20	21	12	4	24	25	12	10	4	З	24	20	97	85
P1/09	18	19	4	5	20	22	11	6	S	2	21	16	92	99
P36	22	22	17	17	25	25	14	11	4	4	24	20	112	84
upgradient	varia	able behavi	our		ake water		op	wngradien	t					

Table 5.7: Results of the analysis of the ion chromotograph.

In Figure 5.54 the values are converted from the mg/l into mmol(eq)/l for a better representation. In March the values within the lake show no greater variations due to spring circulation. Therefore an averaged value of all lake samples is taken (Figure 5.54a). The lake samples in August are arranged from top to bottom within Figure 5.54b and Figure 5.55b.

Generally the concentration of the determined hydrochemical parameters is higher in groundwater upgradient to the lake than in the lake and downgradient to it. The concentration increases downgradient with the distance from the lake (Figure 5.54 a, b). One exception is the parameter iron (Table 5.6). The iron content of the upgradient observation wells is under the detection limit of the used laboratory test. In the lake the iron content increases with the lake depth to values around 0.1 mg/l. The maximum is found at NDP in August at one meter over the ground with an iron content of 0.7 mg/l. The iron content in the downgradient observation wells decreases with the distance.



Figure 5.54 a, b: Main ions concentrations in mmol(eq)/l in March (a) and August (b)

The parameters of P37 are closest to the values of P34. Only the calcium content of August is more similar to the lake water than to the upgradient observation wells.

In August the parameters of calcium, hydrogen carbonate, magnesium and total hardness increase with the lake depth. In August Nitrate and total phosphorus do not behave like that. Nitrate has a peak in the thermocline (12 mg/l) and then its concentration decreases (Table 5.7). The total phosphorus content behaves contrarily to nitrate. It has a negative peak in the thermocline $(3 - 5 \mu g/l)$ and then it increases with the depth to 9 - 12 μ g/l (Figure 5.55). The total phosphorus concentration is higher in NDP than in ODP in March and in August otherwise. All other parameters of ODP match the values of NDP quite well.

The total phosphorus content is much higher in P34 (15 - 16 μ g/l) than in the other upgradient groundwater measuring point P2/09 (1 - $4 \mu g/l$).



Figure 5.55 a, b: Total phosphorus content in March (a) and August (b) in the alignment upgradient groundwater- lake - downgradient groundwater.

5.6 Mixing calculation

In the expertise of HYDRO-DATA (2009) the groundwater inflow was calculated to 45 l/s by means of stable isotopes and to 65 l/s by using hydraulic considerations and with neglecting the sealing of the lake bed. The "Schapbuchquelle" accounts for about 7.5 l/s. Therefore, another endmember was created consisting of about 20 % "Schapbuchquelle" water and 80 % groundwater from P2/09 and P34.

Between 12th November 2009 and the 25th March 2010, 254.1 mm precipitation fell in 133 days. The averaged monthly isotope data from 2000 to 2005 (Appendix B.4) are weighted with the amount of every month between 12.11.2009 and 25.03.2010. With the use of this value and by taking into account the volume and the area of the lake, the isotope ratio of the lake water in March was corrected.

Endmomber / complexitor	δ ¹⁸ Ο	δ²H
Endmember / sample water	[‰ VSMOW]	[‰ VSMOW]
Weighted precipitation 12.11.09 - 25.03.2010	-12.22	-90.48
Lake water November 2009	-8.24	-60.74
Lake water March 2010	-9.01	-65.21
Precipitation corrected lake water March 2009	-8.87	-64.10
Groundwater	-9.72	-68.40
Schapbuchquelle	-10.15	-70.52
Groundwater 80 % and Schapbuchquelle 20 %	-9.81	-68.82

Table 5.8: Endmember and sample waters for the mixing analysis for the groundwater fraction.

Finally four different endmember combinations for the mixing analysis were used separately:

- a, with the endmembers groundwater, lake water March 2010 and lake water November 2009,
- b, with the endmembers groundwater 80 % and "Schapbuchquelle" 20%, lake water March 2010 and lake water November 2009,
- c, with the endmembers groundwater, precipitation-corrected lake water March 2010 and lake water November 2009,
- d, with the endmembers groundwater 80 % and "Schapbuchquelle" 20%, precipitation-corrected lake water March 2010 and lake water November 2009.

In Table 5.9 the results of the endmember mixing analysis are listed. The fraction of the inflow water in the lake X_{inflow} , the total inflow inclusive the "Schapbuchquelle" Q_{inflow} , the inflow of groundwater without "Schapbuchquelle" (Q_{GWin}) and the mean transit time

 τ are recorded. For calculation the Formulas (35), (36) and (40) were used once with $\delta^{18}O$ and once with $\delta^{2}H$ values.

Endmember combination	X _{in}	flow	Q _{In}	flow	Q_{G}	Win	٦	T
			[l/s]	[l/s]	[l/s]	[l/s]	[days]	[days]
	w. δ ¹⁸ Ο	w. $\delta^2 H$	w. δ ¹⁸ Ο	w. $\delta^2 H$	w. δ ¹⁸ Ο	w. $\delta^2 H$	w. δ ¹⁸ Ο	w. $\delta^2 H$
а	0.52	0.58	45	51	38	43	255	228
b	0.49	0.55	43	48	35	41	270	240
С	0.43	0.44	37	38	30	31	312	303
d	0.40	0.42	35	36	28	29	329	320

Table 5.9: Results of the endmember mixing analysis for calculating the groundwater inflow.

The results calculated with precipitation-corrected lake water are lower than those without correction and than there is nearly no discrepancy between the results calculated with δ^{18} O or with δ^{2} H. So the corrected values are preferable. Averaged, the total inflow is about 36.5 l/s, without the "Schapbuchquelle" the groundwater inflow is about 29.5 l/s and the mean transit time is about ten to eleven months.

The determined inflow rates are only valid for the winter month. Assuming that the results are applicable for a whole year, the groundwater outflow can be calculated over the lake water budget with averaged values for precipitation and evaporation. Finally, the outflow per time can be calculated backwards (Formula 37), it is determined to 37.8 l/s.

	Q	Yearly heights
	[l/s]	[mm/a]
Precipitation		880
GW inflow	29,5	5316
Schapbuchquelle	7.5	1352
Total Inflow	36.5	6578
Evaporation		650
GW outflow	37.8	6808

Table 5.10: Water balance.

With the Formula (38) the fraction of lake water in the water of the downgradient metering points can be determined. The downgradient points P1/09, P12/75, P36 and P37 are examined. For this purpose the endmember groundwater should not only be an average of the points P2/09 and P34, because the groundwater from the north-eastern channel contributes water as well especially for P36 and P12/75. Accordingly, the endmember value for the groundwater is the not weighted average from the points P2/09, P34 and "Schapbuchquelle". For P1/09 only the average of P2/09 and P34 was used because of P1/09's location. For every month the lake water endmember was

calculated as an average of the upper 12 metres. As tracers the ratios of δ^{18} O and δ^{2} H were chosen again. The results are listed in Table 5.11.

GW metering		March			April			May	
points	w. δ ¹⁸ Ο	w.δ ² Η	Mean	w. δ ¹⁸ Ο	w. δ ² Η	Mean	w. δ ¹⁸ Ο	w.δ ² Η	Mean
	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
P1/09	155	209	182	115	123	119	123	117	120
P36	88	119	104	85	96	90	66	75	70
P12/75	-26	-16	-21	-	-	-	-10	8	-1
P37	18	44	31	124	120	122	-17	-2	-9
GW metering		June			July			August	
points	w. δ ¹⁸ Ο	w.δ²Η	Mean	w. δ ¹⁸ Ο	w. δ²Η	Mean	w. δ ¹⁸ Ο	w.δ²Η	Mean
	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
P1/09	108	103	105	87	84	85	80	75	77
P36	42	47	45	41	17	29	50	41	45
P12/75	140	218	179	91	127	109	61	99	80
P37	-53	-67	-60	-9	-50	-30	17	-17	0
P37 pumped							70	63	67

Table 5.11: Fraction of lake water in groundwater metering points calculated by ratios of δ^{18} O and δ^{2} H.

A lot of fractions are higher than 100 % or lower than 0 %. The discrepancy of the pumped and scooped values of P37 results in a difference of nearly 70 % for the fraction of lake water. The fraction of lake water in P36 and P1/09 decreases during summer (Figure 5.56). The results of P37 and P12/75 behave in a not reliable fashion.



Figure 5.56: Fraction of lake water in groundwater measuring points as a function of time.

6 Discussion

6.1 The connection of Schlosssee Salem to its adjacent groundwater field

The "Schlosssee Salem" lake level appears to be not influenced by precipitation (Figure 5.2), as during the rainy April 2010 the lake level decreases and in the dry period of June/July it suddenly rises and continues in doing so.

As expected, the water levels in the upgradient observation wells are higher than the lake level or the downgradient ones. In general groundwater levels and the lake level show a similar behaviour. The levels of the lake, P37 and P34 differ from each other only about one centimetre and react simultaneously. The downgradient point P36 may be called in as well as its level is only ten centimetres lower (Figure 5.1). This indicates a very good connection between the lake and these groundwater points. The eastern wing of the lake, P34, P36; P37, "TB Stefansfeld", "TB Bunker" and "TB Stadion" are all situated in the same part of the aquifer as the groundwater level contour graph indicates (Figure 5.3).

P1/09 and P2/09 are located downgradient and upgradient to the lake. However, their levels differ 80 - 100 centimetres from the lake level (Figure 5.2; Figure 5.3). In their vicinity the aquifer ends in the west, therefore it is possible that the lake bed at the western wing is more sealed. The water is impounded at the upgradient side and levels dropping down fast at the downgradient side.

The levels measured in August differ only ten centimetres from the levels measured March. Therefore, the groundwater level contour maps are similar in these to months (Figure 5.3).

6.2 Characteristics of the groundwater and the dredge lake

6.2.1 δ^{18} O / δ^{2} H relationship

The $\delta^{18}O/\delta^2H$ relationship provides information about the recharge region of groundwater and fractionation due to evaporation of the lake water. The plot of all sample data of the measuring campaign 2009 and 2010 (Figure 5.42 and Figure 5.43) shows, as expected, that the isotope ratios of the lake samples lie on an evaporation line (EP line). For unknown reasons the LMWL of Constance does not match as well as the GMWL. The reason may be that the Lake of Constance provides a special climate. Thus, the GMWL is favourable and the intersection of the GMWL and the EP line is the source of the lake water with a $\delta^{18}O$ value of -10 ‰ VSMOW and a δ^2H value of -70 ‰ VSMOW.

As expected the stable isotopes ratios of the lake water form an EP line with a slope lower than eight. Over the months it is visible that the lake water gets more and more enriched along the EP line. Due to the spring circulation, the stable isotope ratios of different lake depths are all similar in March but during the summer the waters of the epilimnion, thermocline and hypolimnion get more and more separated along the EP line. Thereby, as anticipated, the water of the upper four metres experienced the strongest enrichment due to evaporation and mixing of the epilimnion.

6.2.2 Upgradient groundwater metering points and P37

This section includes the upgradient groundwater measuring points P33, P2/09, P34, and "Schapbuchquelle". The measuring points P37 and "TB Stefansfeld" are situated besides the lake but show less to almost no lake influence. Therefore, they are added to this section, too. From "Schapbuchquelle" and "TB Stefansfeld" no temperature data exist but weekly retain samples of stable isotope ratios and EC are on hand.

The temperature of the upgradient groundwater proceeds in a sinusoidal fashion (Figure 5.14). Apart from P33 the water of every observation well features a minimum in spring or summer. The temperature of the upgradient groundwater measuring points P2/09 and P34 tends to be around 11°C.

The groundwater metering point P33 cannot be associated to other measuring points. Despite its relative proximity to P34, the measured parameters EC (Figure 5.8) and the stable isotope ratios (Figure 5.42) do not fit to other upgradient observation points. The temperature follows the same tendency as in P12/75. The EC is about 400 μ S/cm but

when the water is pumped, it rises to 657 μ S/cm (Appendix B.2) which is still lower than in the other groundwater metering points. It could be suggested that pumping would be a better way to obtain a water sample of P33. However, the pumped stable isotope ratio of P33 in March is still lower than in the other points. In the vicinity of P33 is a dump and a sand barrier which was only described in the expertise of 1994 (Geologisches Landesamt Baden-Württemberg, 1994). The lower EC suggests a different aquifer with less calcium and magnesium containing rocks and the stable isotope ratios allude to a higher recharge catchment. In the end it cannot be concluded, whether the singularity of P33 is the result of a different aquifer, of the influence of the near dump or of something completely different.

The groundwater metering points P2/09 and P34 exhibit similar values in reference to EC, temperature, stable isotopes and chemical parameters. Only the total phosphorus content substantially differs (Figure 5.55). Furthermore, the EC values of P2/09 and P34 are within the highest ones (about 800 μ S/cm).

The "Schapbuchquelle" features the lowest EC values (about 700 μ S/cm) among the upgradient groundwater points (Figure 5.9). The EC values of "TB Stefansfeld" are similar to the values of P2/09 and P34.

The points P2/09, P34, "TB Stefansfeld" and "Schapbuchquelle" feature no greater variations in δ^{18} O and δ^{2} H (Figure 5.22; Figure 5.23) during the measuring campaigns. They are isotopically lighter than the lake water and the downgradient measuring points P1/09 and P36. Apart from P33, "Schapbuchquelle" contents the isotopically lightest water due to a higher recharge catchment of the north-eastern channel (Geologisches Landesamt Baden-Württemberg, 1994).

In the monthly $\delta^{18}O/\delta^2H$ relation graphs (Figure 5.44 to Figure 5.49) the upgradient groundwater samples including water of P2/09, P34, "Schapbuchquelle" and "TB Stefansfeld" gather around the intersection of GMWL with the EP line. In July and August they are slightly shifted along the EP line, probably because of the hot weather and evaporation effects inside the metering points and during the sample storage.

During the measuring campaigns, the EC values and the stable isotope ratios of P37 perform similar to those in upgradient groundwater. Only the temperature is different. It is higher than even in the downgradient groundwater, which is influenced by the lake water.

In the upper metres of P37 the EC values are low. This could be an effect of outgassing of CO_2 or a result of lake water influence due to the well connection between lake and P37. In the deeper metres, however, P37 demonstrates the highest EC values of all

points (over 800 μ S/cm). This may indicate strong influence of groundwater even in the vicinity of the lake.

Comparison measurement of stable isotope ratios between scooped and pumped water were done in March and August (Figure 5.19). It turned out that in general the ratios of δ^{18} O of the scooped and pumped water fit well within the method's accuracy. For δ^{2} H the fitting is still acceptable. Solely the ratios of P37 of scooped and pumped water in August differ substantially. Therefore, the scooped stable isotope values of P37 cannot be trusted. The pumped water has enriched isotope ratios (Figure 5.49), thus, an evaporation effect in the scooped water can be excluded. On the other hand the lake is not that closely located to P37, that pumping would suddenly pull enriched lake water into the observation well. It would have been necessary to use both, bailer and pump, for monthly characterising of this special point by stable isotopes. On the other hand, Bertleff et al. (2001) recommend the use of the bailer because pumping could pull in water from an different aquifer. Yet, in P37 this can be excluded.

If the stable isotope results of the scooped samples can be trusted, P37 varies in this content. P37 contains isotopically lighter water in spring 2009 and gets enriched in summer 2009. In the monthly $\delta^{18}O/\delta^2H$ relation graphs of 2010 (Figure 5.44 to Figure 5.49) the stable isotope ratios of P37 gather around the intersection of GMWL and EP line similar to the ratios of the upgradient groundwater. In the end of April the ratios get enriched along the EP line like the ratios of downgradient groundwater. This could be a consequence of the rainy April of 2010. The pumped sample of P37 in August can also be found along the EP line between the ratios of the lake water but the scooped sample is found among the upgradient groundwater again.

In conclusion some characteristics refer to add P37 to the upgradient points but there are other parameters which allude to a strong lake water influence at least temporally.

6.2.3 Dredge lake

The Schlosssee Salem is a dimictic lake. The development of the summer stratification after spring circulation can be seen in Figure 5.10 illustrating the temperature of the lake with increasing depth. The heating starts at the surface due to solar radiation. The temperature gradient of the thermocline gets steeper every month, the epilimnion is heated the most and the hypolimnion the fewest. Thereby, the temperature within the hypolimnion and the epilimnion is each well mixed. The thermocline acts like a boundary between epilimnion and hypolimnion (Schwoerbel & Brendelberger, 2005).

The density depends mainly on the temperature in fresh water lakes. Thus the greatest density variation flags the thermocline (Lampert & Sommer, 1993).

The water in the epilimnion layer of the lake becomes more and more isotopically enriched over summer because of isotope fractionation as a consequence of evaporation (Figure 5.44 to Figure 5.49). The hypolimnion, divided from the epilimnion by the thermocline, remains almost unchanged during the whole measuring campaign of 2010 (Figure 5.34). Within the hypolimnion no trend for enrichment or depletion is recognisable.

At the lake's surface CO_2 can outgas (Bertleff et al., 2001) with the consequence of a decreasing in calcium, total hardness and EC in the epilimnion (Figure 5.4; Table 5.6). The epilimnion is well mixed, thus the EC decreases in the whole epilimnion monthly.

Assuming that the upgradient groundwater with 11°C tends to stratify into the lake depth in which the same temperature prevails, the inflow gets mainly into the thermocline layer where the greatest variation in temperature and density is present. The temperature 11°C was found in the lake at the surface in March, in five metres depth in April, in six metres depth in May, in eight metres depth in June and in July and August in 9.5 metres depth. A similar trend can be seen in the higher EC peaks (Figure 5.4) and the isotopically lighter δ^{18} O peaks (Figure 5.27 to Figure 5.32). The lake depths of the peaks of stable isotope ratios and EC migrate to deeper lake depth over summer in the same way the lake temperature of 11°C did (Table 6.1). This emphasises that the peaks are a result of inflowing groundwater. This does not mean that the groundwater inflow occurs mainly in this lake depth, it is just a hint that the inflowing groundwater prefers to sink or rise to a distinct lake depth due to its buoyancy, wherever it has entered the lake for the first time.

	Inflow str	atification depth acco	ording to
	Temperature	EC	δ ¹⁸ 0
	[m]	[m]	[m]
March	0	-	-
April	5	5	5
May	6	5	6
June	8	6	6 and 9
July	9.5	9	9
August	9.5	9	10

Table 6.1: Preferred lake depth for inflow stratification.

The error of the July radon measurement is enormous due to the undersized sample size. So the values are not useable. In August the samples were taken one metre over ground so that the dilution effect would be the same at every point. The groundwater radon level of P34 of (7036 ± 522) Bq/m³ in August is, as expected, much higher than in lake water (272 - 561 Bq/m³). Yet, the groundwater radon content is in the lower range of typical radon levels in groundwater of 7400 to 22200 Bq/m³ (RAD7 RAD H2O, Radon in Water Accessory, Owner's Manual, 2009). The radon content measurements at G2 to G10 refer to no special point where more inflow occurs. Only at G10 more radon activity was recognisable. Radon activity and stable isotope ratios are negatively correlated with each other (Figure 5.52; Figure 5.53). This reinforce the statement that if a relatively isotopically lighter ratio can be found in a distinct lake depth, it probably outcomes from inflowing groundwater.

The very high values of EC in NDP in August in the deepest metres (Figure 5.4) could be a result of sediment from the ground on the measuring device because at ODP such increased values did not occur. As the EC values in ODP were higher in August, too, this may signify a higher groundwater inflow to the hypolimnion (Figure 5.6). The relatively lower δ^{18} O values at NDP in August in the hypolimnion could be also a hint for groundwater inflow (Figure 5.34).

Between MIA and MOA a greater difference cannot be acknowledged in regard to temperature, EC and stable isotopes. If an isotopically depleted peak in MIA or NDP is noticeable, it can also be found in ODP and MOA, though usually less pronounced. The analogousness of MIA, MOA, NDP and ODP portends a throughout stratification of the lake.

In the end, it was shown that the measuring point MIA does not, as was expected, represent an area, where groundwater preferably flows into the lake. It is rather a point, where groundwater and lake water are well connected, and not the main inflow direction as previously thought.

6.2.4 Downgradient groundwater metering points

The downgradient measuring points are P1/09, P36 and P12/75, whereby P1/09 shows a strong influence of lake water, P36 a smaller influence and P12/75 almost no influence at all.

The temperature of the downgradient groundwater proceeds in a sinusoidal fashion like the upgradient groundwater (Figure 5.14). Apart from P12/75 the water of every observation well features a minimum in spring or summer. P12/75 and P33 equal in temperature. As expected, the water of P1/09 is warmer than in the upgradient points due to lake water influence. The coldest water was found in downgradient P36 which was unforeseen. The EC values of P1/09 are relatively low (about 600 μ S/cm) probably because of the influence of lake water (Figure 5.8). The EC values of 600 μ S/cm are usually found in the thermocline of the lake. However, in March and April the EC values in all depths of the lake are higher than in P1/09 (Figure 5.4). In summer the EC profiles of P1/09 show a wider range in the upper metres than in spring.

In the δ^{18} H/ δ^{2} H relationship graphs P1/09 is situated along the EP line, whereby the stable isotope ratio is found among the epilimnion water in April and May. From June to August the stable isotope ratios of P1/09 lie between the ratios of the heavy enriched epilimnion water and water of greater lake depths. In March the water of P1/09 is even more enriched than the lake water. These characteristics are similar to the EC values.

Therefore, the performance of the EC values and stable isotope ratios of P1/09 could indicate two things: first, at P1/09 the upper metres are probably more influenced by lake water of the epilimnion and thermocline and secondly the lake water needs time to get to P1/09. Thus, lake and P1/09 water of the same month should not be compared. P1/09 is situated at the southern lake end of the shallow western wing. Therefore, it is reasonable to conclude that mostly the upper metres of the lake contribute to P1/09's water. The lake bed of the western wing is more sealed, thus the water needs longer to flow out than at the well- connected eastern wing.

P36's EC profiles have values between the values of the upgradient observation wells and the lake and they show the greatest range of all groundwater's EC profiles (700-800 μ S/cm).

The water of P36 is isotopically less enriched than the lake water. However, its stable isotope ratio still lies on the EP line and is more enriched than the upgradient groundwater.

EC values and stable isotope contents clearly display that the water in P36 is a mixing of groundwater and lake water.

The EC profiles of P12/75 are smaller than 800 μ S/cm but higher than or equal to the EC values of P36 (Figure 5.9). The filter section is in the lower ten metres. Thus, the wider range of EC values in the upper ten metres is meaningless.

For P12/75 no comparison measurement was performed between scooped and pumped water and only stable isotope values for 2010 are existent. If the results of the scooped samples could be trusted, P12/75 varies in the stable isotope content (Figure 5.44 to Figure 5.49). In March and May 2010 P12/75's water contains stable isotope ratios like upgradient measuring points. Over summer the water gets more and more enriched but EP line. For that reason, an influence of lake water could not be proved, but the decreasing EC values suggests that an increasing influence of lake water over the

summer is possible. At P12/75 only a very simple bailer was used because of the pipe width. Therefore, it is possible that the sampled water was only surface water of the observation well.

6.2.5 Oxygen content, pH, hydrochemistry and biological activity

The highest oxygen contents in groundwater are found in the upgradient measuring points P34 and P2/09 as well as in P37 and P12/75. The contents are within the expected value (4-8 mg/l) for the region (LfU, 2001 cited in Mader et al., 2004). At these points oxidising conditions prevail. The water of P34 contains the highest oxygen concentration. In the downgradient groundwater metering points, the oxygen content tends to zero. Consequently, reducing conditions prevail.

The oxygen contents in lake and groundwater follow a special pattern: Upgradient P33, with a relatively low content, is peculiar again, the other upgradient points content more oxygen. P37 can be assigned to the upgradient points. In the lake samples, both the highest and the lowest oxygen contents are found. P1/09 exhibits very low oxygen contents of 0.0 - 0.7 mg/l, P36's oxygen content is between 0.8 - 2.4 mg/l and P12/75 shows no influence of the lake water as for its concentration of 4.8 mg/l.

The downgradient measuring points exhibit low oxygen contents. This is the result of the degradation of organic matter, which consumes oxygen by flowing out of the lake (Bertleff et al., 2001).

In the lake relatively high oxygen contents, up to 17 mg/l, are found. From the end of June on, no oxygen can be measured below nine metres at NDP (Figure 5.15). The lack of oxygen in summer in the hypolimnion is typical for a dimictic lake (Lampert & Sommer, 1993). The thermocline prevents the exchange with the physical ventilated epilimnion. Therefore, the oxygen of the hypolimnion is quickly consumed. Even if groundwater would flow into this layer, the oxygen would soon be consumed.

Apart from the hypolimnion from June on, in most lake depths more oxygen is found than in the groundwater. The highest oxygen content appeared in the thermocline in the end of May (Figure 5.15) which cannot be a result of groundwater inflow.

One reason may be the physical ventilation of the epilimnion. The oxygen content was always measured around midday. Therefore, an explanation for the high oxygen content in the thermocline may be the photosynthesis by algae in this depth with the production of oxygen. The pH values of groundwater are akin. Except of P37 in March (pH 6.4) the pH values are in the range of pH 7.0 and 7.4 (Table 5.1).

 CO_2 outgas over the lake surface. Thus, the pH of the lake achieves higher values than in the upgradient groundwater. Consequently, the lime-carbonic acid balance shifts and calcite precipitates chemically (Bertleff et al., 2001). Accordingly, it is expected that in the whole lake in March, and in the epilimnion in August the calcium content, the hydrogen carbonate content, the total hardness and the EC decreases in comparison with the groundwater (Figure 5.54). These effects can be easily seen in the data of this study. Moreover, the degree of mineralisation increases again in the downgradient groundwater as anticipated.

The O_2 ventilated epilimnion provides aerobe conditions for a chemical precipitation of iron. In the hypolimnion in August the reductive environment cause a re-dissolution of iron. The iron content in the upgradient groundwater and in the lake's upper metres was under the detection limit of the measuring method. However, in one metre over the lake bed and in the hypolimnion in August the greatest iron content is evident. In downgradient metering points still iron is still detectable.

Nitrate and phosphate should be incorporated by biological activity in a lake (Bertleff et al., 2001). Thus, a fewer content should be found when algae are present And indeed, in August a smaller content of phosphate is measured in the epilimnion and especially in the thermocline. In greater depths the phosphate content increases. This refers to a higher algae density in the thermocline and epilimnion which decreases with the lake depth.

In August the nitrate concentration shows a reverse behaviour compared to phosphorus. The highest content is found in the thermocline and the lowest content is in one metre over ground. An explanation for this distribution is that in a reducing milieu, such as in the oxygen free hypolimnion, sulphate and nitrate are transformed. (Bertleff et al., 2001). In March the nitrate concentration is the same in the whole lake. In March and August the sulphate shows the same content in every layer.

The lowest total phosphorus content with 1-4 μ g/l is present in upgradient P2/09. This is extraordinary in comparison with other upgradient groundwater points and it is even lower than in the lake. The other upgradient point P34 contains the highest phosphorus load with 15-16 μ g/l. As P2/09 is on the edge of the aquifer, one possible explanation is that the contamination path starts shortly before P34 and it has not been mixed throughout the whole width of the aquifer. P34 is in a private garden with a wellgroomed lawn and very close to a meadow. Thus, the sources of phosphate could be fertilizer used in gardens or agriculture. In general the highest contents of substances can be found upgradient of the lake. The characteristics of P37 fit perfectly to P34. The lake acts as a nutrient trap, and downgradient the mineralisation and the ion contents increase again with the distance from the lake.

Only speculations can be postulated concerning the biological activity. First, the high oxygen content within the thermocline refers to a higher algae density. Secondly the colour of the lake could be taken into account. The clear water in March propose to a small algae density. From April to July the blue-green water probably refers rather to a mineral turbidity than to cyano bacteria. The flashy green colour in August, indeed, indicate a high density of cyano bacteria or green algae (Boos, 2004). The secchi depth in August is at 2.4 metres lake depth. Therefore, the euphotic zone D_{eu} ends in 7.7 m lake depth. In August oxygen is still present in eight metres lake depth, which suggest that algae could live in the upper eight metres. In the end of August 1999 LUBW (2008) found an olive lake colour and a chlorophyll a concentration of 7.4 µg/l, which is, referred to Boos (2004), a moderate activity.

6.2.6 Influence of precipitation

In general precipitation has got a very limited direct influence on the dredge lake and its adjacent groundwater field. The lake level proves no influence at all as is stated above. In the stable isotope data only one influence is detectable, when a heavy rain event occurs on the 17th/18th of June 2010. Although the rain should have been more enriched than the lake surface water in the end of June, the isotope ratios of the water of Pier1, P1/09, "Schapbuchquelle" and "TB Stefansfeld" get isotopically lighter for a short time, which can only be seen in the retain samples (Figure 5.25). The rain event must have been long and heavy, so that an amount effect became appearent (Clark & Fritz, 1997). Twice in the EC values of the retain samples of "Schapbuchquelle" and "TB Stefansfeld", an influence of precipitation is found (Figure 5.9). This refers to a very short time influence of heavy rain events. The influence of snow or of snowmelt cannot be examined, because of the lack of winter data.

6.3 Mixing analysis results

6.3.1 Groundwater in- and outflow

The calculated value for groundwater inflow of 29.5 l/s without inflow of the "Schapbuchquelle" seems reasonable. It is lower than the calculated total inflow of 65 l/s by HYDRO-DATA (2009) by means of hydraulic considerations and measurements. However, hydraulic parameters such as the k_f value consist of large uncertainties. The correction of the endmember "Lake water in March" had a strong influence. The calculated inflow decreases with the corrected endmember about 10 l/s and the values determined with δ^{18} O and δ^{2} H do not differ anymore. Without the correction, they differ about 5-6 l/s from each other. The determined transit time τ of ten to eleven month fits to the good connection of the Schlosssee Salem with its adjacent groundwater field.

It has to be noted that the whole mixing calculation establishes only one valid inflow value for the winter month 2009/2010. Due to temporal and spatial variability of the inflow, in summer month could evolve a different picture.

Moreover, the transit time in summer could be shorter. The measured values of EC, stable isotopes and temperature are signs for a preferred throughflow depth. This emphasised throughflow layer ranges across the whole lake. It could be suggested that in this layer the throughflow is faster and that would reduce the transit time. In winter the temperature is between 0-4°C. Therefore, the groundwater would prefer the upper metres because of its lower density or even rise to the surface, where the coldest water occurs. People of the local fishing club have reported that in winter, ice free spots often appear at the northern part of the Schlosssee Salem. When the warmer groundwater enters the 0-4°C cold lake, the groundwater would starts flowing to the surface but cooling down on its way. If it gets cooled down to 4°C, it would sink back down. Therefore, a preferred depth for throughflow is unlikely to be developed in the lake in winter.

The $\delta^{18}O/\delta^2H$ relationship reveals that the LMWL of Constance does not fit well to the measured stable isotope contents of the ground- and lake water. But still, the mixing calculation performs better with the local precipitation values than without precipitation correction.

The established annual water balance again reinforces the dominant groundwater influence.

The mixing analysis used for the determination of the lake water fraction in downgradient observation wells, does not work very well. One reason for the failure is

that the water was mainly taken by means of a bailer. But even when the water is pumped, in March, the values are not within the reasonable range with results of more than 100 % and less than 0 %. A reason could be that the lake water needs time to flow out of the lake to the points. Thus, the endmember of the lake would have the isotope concentration of some month before. This also suggested by the more enriched water of P1/09, compared to the lake water in March. The stable isotope ratios of P1/09 in the $\delta^{18}O/\delta^2H$ relation graphs imply that the P1/09 groundwater is only a mixture of different lake depths or of the upper metres of the lake and the groundwater. In each case, the endmembers are not well chosen, and the lack of winter data limits any refinement. At least some statements can be developed from this mixing analysis: The water of P1/09 is probably entirely lake water; P36 includes less lake water than P1/09, and the fraction thereof decreases over summer; P12/75 could gain more lake water during the summer; Finally the water of P37 is usually like the upgradient groundwater except after the rainy period in April and when it is pumped in August.

7 Conclusion

The issues of this thesis concerned a refined groundwater inflow and outflow estimation and mean transit time of the "Schlosssee Salem". Second, the contributing groundwater inflow and outflow areas should be identified. Furthermore, the influence of the dredge lake on the hydrochemistry of the surrounding groundwater should be investigated.

The refined estimation of the groundwater inflow worked well. The endmember "Lake water in March" was corrected with the precipitation fallen in winter. It was calculated to 29.5 l/s and in addition, the "Schapbuchquelle contributes 7.5 l/s. The groundwater outflow was estimated to 37.8 l/s over a water budget of the dredge lake.

At the western wing of "Schlosssee Salem" the aquifer outcrops. The eastern wing instead, is well connected to the groundwater field – here the most groundwater inflow and outflow occur. A distinct depth of groundwater inflow in the eastern wing could not be identified. However, it there are clues that the groundwater tends to stratify to the thermocline no matter where it first enters the lake. Therefore, the calculated mean transit time of ten to eleven months could be shortened, because of the smaller throughflow volume of the thermocline in comparison to the whole lake.

The hydrochemical analyses show that the dredge lake acts mainly as a nutrient trap. The most ions in upgradient groundwater are in higher concentrations then in the lake or downgradient. A review of the possible reactions in the lake has been demonstrated.

Finally, the conditions of the lake will alter soon, because remedial actions have been taken place since September 2010.

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Appendix A Graphs





Figure A 1. Electric conductivity of P34 measured with data logger "Diver" in comparison to monthly field measurements.



Figure A 2: Electric conductivity of P1/09 measured with data logger "Diver" in comparison to monthly field measurements.



Figure A 3: Monthly electric conductivity profiles at P1/09 during the measuring campaign in 2010.



Figure A 4: Monthly electric conductivity profiles at P2/09 during the measuring campaign in 2010.



Figure A 5: Monthly electric conductivity profiles at P12/75 during the measuring campaign in 2010.



Figure A 6: Monthly electric conductivity profiles at P33 during the measuring campaign in 2010.



Figure A 7: Monthly electric conductivity profiles at P34 during the measuring campaign in 2010.



Figure A 8: Monthly electric conductivity profiles at P36 during the measuring campaign in 2010.



Figure A 9: Monthly electric conductivity profiles at P37 during the measuring campaign in 2010.



Figure A 10: Electric conductivity profiles of all sample points in March 2010.



Figure A 11: Electric conductivity profiles of all sample points in April 2010.



Figure A 12: Electric conductivity profiles of all sample points in May 2010.



Figure A 13: Electric conductivity profiles of all sample points in June 2010.



Figure A 14: Electric conductivity profiles of all sample points in July 2010.



Figure A 15: Electric conductivity profiles of all sample points in August 2010.





Figure A 16: Temperature of P34 measured with data logger "Diver" in comparison to monthly field measurements.


Figure A 17: Temperature of P1/09 measured with data logger "Diver" in comparison to monthly field measurements.



Figure A 18: Monthly temperature profiles at P1/09 during the measuring campaign in 2010.



Figure A 19: Monthly temperature profiles at P2/09 during the measuring campaign in 2010.



Figure A 20: Monthly temperature profiles at P12/75 during the measuring campaign in 2010.



Figure A 21: Monthly temperature profiles at P33 during the measuring campaign in 2010.



Figure A 22: Monthly temperature profiles at P34 during the measuring campaign in 2010.



Figure A 23: Monthly temperature profiles at P36 during the measuring campaign in 2010.



Figure A 24: Monthly temperature profiles at P37 during the measuring campaign in 2010.



Figure A 25: Temperature profiles of all sample points in March 2010.



Figure A 26: Temperature profiles of all sample points in April 2010.



Figure A 27: Temperature profiles of all sample points in May 2010.



Figure A 28: Temperature profiles of all sample points in June 2010.



Figure A 29 Temperature profiles of all sample points in July 2010.



Figure A 30: Temperature profiles of all sample points in August 2010.

Appendix B Tables

Appendix B.1 Coordinates, altitude and water levels

Table B 1: Coordinates, altitude and water levels.

				Depth to	Depth to
Management	Easting	Northing	Altitude	water	water
weasuring point				(25./26.03.10)	(20./21.08.10)
			[m a.s.l.]	[m]	[m]
GWM1	3522384.06	5293807.04	443.27	6.79	6.76
GWM2	3522298.22	5293369.57	444.50	10.25	10.16
GWM3	3522397.71	5293452.83	443.56	9.07	9.00
P6/00	3522585.37	5293299.27	447.28	13.26	13.12
P10/00	3522590.44	5293194.23	445.12	11.09	-
P11/00	3522594.55	5293094.83	445.78	12.05	11.96
P12/00	3522720.73	5293074.45	446.95	12.25	12.04
P13/00	3522817.45	5292978.00	448.15	13.16	12.78
P33	3522457.00	5293228.00	444.47	10.78	10.68
P34/92	3522181.53	5292967.12	441.06	7.77	7.68
P36/92	3522483.31	5292574.52	436.26	3.05	2.99
P37/92	3522287.55	5292782.10	443.74	10.45	10.36
P35	3522604.00	5292868.00	445.17	11.83	11.84
P24	3522761.72	5291582.59	434.93	3.39	-
P2 Riffenzell	3522278.00	5291521.00	434.94	3.39	3.36
P3 Riffenzell	3522459.00	5291729.00	435.57	-	-
P4 Riffenzell	3522201.00	5291866.00	436.04	3.96	-
P15	3522438.72	5292749.55	438.97	5.68	5.59
Seepegel	3522314.70	5292648.41	434.53	1.22	1.15
P1/09	3522080.51	5292265.57	437.28	4.96	4.88
P2/09	3521864.16	5292909.52	440.62	6.61	6.55
TB Stadion	3522322.96	5292497.48	434.75	1.54	1.46
TB Bunker	3522179.38	5292556.84	435.01	1.79	1.72
P12/75	3522648.21	5292325.29	439.12	6.58	6.52

P10 Neufrach	3522975.80 5291962.13	436.72	4.51	4.46
P11/75	3522620.00 5292120.00	437.45	-	-
P13/75	3522890.00 5292240.00	438.85	6.71	-
P7/75	3522800.00 5292780.00	442.96	-	-

Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	рН
				[m]	[m a.s.l.]	[μS/ cm)	[°C]	[mg/l]	
P1/09	25.3.10	downgradient	WTW Cond 197i	8.2	429.08	624	12.9		
P1/09	25.3.10	downgradient	WTW Cond 197i	9.2	428.08	616	12.8		
P1/09	25.3.10	downgradient	WTW Cond 197i	10.2	427.08	600	12.7		
P1/09	25.3.10	downgradient	WTW Cond 197i	11.2	426.08	597	12.6		
P1/09	25.3.10	downgradient	WTW Cond 197i	12.2	425.08	595	12.6		
P1/09	25.3.10	downgradient	WTW Cond 197i	13.2	424.08	595	12.6		
P1/09	25.3.10	downgradient	WTW Cond 197i	14.2	423.08	595	12.6		
P1/09	25.3.10	downgradient	WTW Cond 197i	15.2	422.08	595	12.6		
P1/09	25.3.10	downgradient	WTW Cond 197i	16.2	421.08	595	12.6		
P1/09	25.3.10	downgradient	WTW Cond 197i	17.2	420.08	594	12.6		
P1/09	25.3.10	downgradient	WTW Cond 197i	18.2	419.08	593	12.8		
P1/09	25.3.10	downgradient	WTW Cond 197i	19.2	418.08	607	13.0		
P1/09	25.3.10	downgradient	pumped			594	13.0	0.7	7.3
P1/09	6.4.10	downgradient	bailer					5.3	7.3
P1/09	12.4.10	downgradient	bailer			614			
P1/09	19.4.10	downgradient	bailer			610			
P1/09	26.4.10	downgradient	bailer			608			
P1/09	28.4.10	downgradient	WTW Cond 197i	5.2	432.08	599	12.6		
P1/09	28.4.10	downgradient	WTW Cond 197i	6.2	431.08	606	12.2		
P1/09	28.4.10	downgradient	WTW Cond 197i	7.2	430.08	603	12.2		
P1/09	28.4.10	downgradient	WTW Cond 197i	8.2	429.08	597	12.3		
P1/09	28.4.10	downgradient	WTW Cond 197i	9.2	428.08	593	12.3		
P1/09	28.4.10	downgradient	WTW Cond 197i	10.2	427.08	593	12.3		
P1/09	28.4.10	downgradient	WTW Cond 197i	11.2	426.08	593	12.3		
P1/09	28.4.10	downgradient	WTW Cond 197i	12.2	425.08	593	12.3		
P1/09	28.4.10	downgradient	WTW Cond 197i	13.2	424.08	593	12.3		
P1/09	28.4.10	downgradient	WTW Cond 197i	14.2	423.08	593	12.3		
P1/09	28.4.10	downgradient	WTW Cond 197i	15.2	422.08	593	12.3		
P1/09	28.4.10	downgradient	WTW Cond 197i	16.2	421.08	594	12.3		
P1/09	28.4.10	downgradient	WTW Cond 197i	17.2	420.08	591	12.3		
P1/09	28.4.10	downgradient	WTW Cond 197i	18.2	419.08	588	12.4		
P1/09	28.4.10	downgradient	WTW Cond 197i	19.2	418.08	689	12.6		
P1/09	28.4.10	downgradient	bailer					1.3	7.5
P1/09	3.5.10	downgradient	bailer			605			
P1/09	10.5.10	downgradient	bailer			614			
P1/09	17.5.10	downgradient	bailer			617			
P1/09	26.5.10	downgradient	WTW Cond 197i	5.2	432.08	608	12.2		
P1/09	26.5.10	downgradient	WTW Cond 197i	6.2	431.08	623	12.0		
P1/09	26.5.10	downgradient	WTW Cond 197i	7.2	430.08	612	12.0		
P1/09	26.5.10	downgradient	WTW Cond 197i	8.2	429.08	610	12.1		
P1/09	26.5.10	downgradient	WTW Cond 197i	9.2	428.08	608	12.2		
P1/09	26.5.10	downgradient	WTW Cond 197i	10.2	427.08	607	12.2		
P1/09	26.5.10	downgradient	WTW Cond 197i	11.2	426.08	606	12.2		
P1/09	26.5.10	downgradient	WTW Cond 197i	12.2	425.08	606	12.2		
P1/09	26.5.10	downgradient	WTW Cond 197i	13.2	424.08	606	12.2		

Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	рН
				[m]	[m asl]	[μS/ (m)	[°C]	[mg/l]	
P1/09	26.5.10	downgradient	WTW Cond 197i	14.2	423.08	606	12.2		
P1/09	26.5.10	downgradient	WTW Cond 197i	15.2	422.08	607	12.2		
P1/09	26.5.10	downgradient	WTW Cond 197i	16.2	421.08	608	12.2		
P1/09	26 5 10	downgradient	WTW Cond 197i	17.2	420.08	606	12.2		
P1/09	26.5.10	downgradient	WTW Cond 197i	18.2	419.08	609	12.2		
P1/09	26.5.10	downgradient	WTW Cond 197i	19.2	418.08	615	12.2		
P1/09	26.5.10	downgradient	bailer	1012	120100	605	13.6	4.5	7.4
P1/09	21.6.10	downgradient	bailer			626			
P1/09	25.6.10	downgradient	WTW Cond 197i	5.2	432.08	643	12.6		
P1/09	25.6.10	downgradient	WTW Cond 197i	6.2	431.08	654	12.1		
P1/09	25.6.10	downgradient	WTW Cond 197i	7.2	430.08	650	12.0		
P1/09	25.6.10	downgradient	WTW Cond 197i	8.2	429.08	636	12.1		
P1/09	25.6.10	downgradient	WTW Cond 197i	9.2	428.08	625	12.1		
P1/09	25.6.10	downgradient	WTW Cond 197i	10.2	427.08	615	12.2		
P1/09	25.6.10	downgradient	WTW Cond 197i	11.2	426.08	606	12.2		
P1/09	25.6.10	downgradient	WTW Cond 197i	12.2	425.08	602	12.2		
P1/09	25.6.10	downgradient	WTW Cond 197i	13.2	424.08	600	12.3		
P1/09	25.6.10	downgradient	WTW Cond 197i	14.2	423.08	600	12.3		
P1/09	25.6.10	downgradient	WTW Cond 197i	15.2	422.08	600	12.3		
P1/09	25.6.10	downgradient	WTW Cond 197i	16.2	421.08	600	12.3		
P1/09	25.6.10	downgradient	WTW Cond 197i	17.2	420.08	600	12.3		
P1/09	25.6.10	downgradient	WTW Cond 197i	18.2	419.08	602	12.1		
P1/09	25.6.10	downgradient	WTW Cond 197i	19.2	418.08	632	12.1		
P1/09	25.6.10	downgradient	bailer	1012	120100	610	13.3	1.6	7.2
P1/09	27.7.10	downgradient	WTW Cond 197i	5.2	432.08	580	13.1		
P1/09	27.7.10	downgradient	WTW Cond 197i	6.2	431.08	584	12.6		
P1/09	27.7.10	downgradient	WTW Cond 197i	7.2	430.08	585	12.4		
P1/09	27.7.10	downgradient	WTW Cond 197i	8.2	429.08	585	12.5		
P1/09	27.7.10	downgradient	WTW Cond 197i	9.2	428.08	585	12.6		
P1/09	27.7.10	downgradient	WTW Cond 197i	10.2	427.08	585	12.6		
P1/09	27.7.10	downgradient	WTW Cond 197i	11.2	426.08	585	12.6		
P1/09	27.7.10	downgradient	WTW Cond 197i	12.2	425.08	586	12.6		
P1/09	27.7.10	downgradient	WTW Cond 197i	13.2	424.08	585	12.6		
P1/09	27.7.10	downgradient	WTW Cond 197i	14.2	423.08	585	12.6		
P1/09	27.7.10	downgradient	WTW Cond 197i	15.2	422.08	586	12.6		
P1/09	27.7.10	downgradient	WTW Cond 197i	16.2	421.08	586	12.7		
P1/09	27.7.10	downgradient	WTW Cond 197i	17.2	420.08	585	12.6		
P1/09	27.7.10	downgradient	WTW Cond 197i	18.2	419.08	584	12.5		
P1/09	27.7.10	downgradient	WTW Cond 197i	19.2	418.08	610	12.4		
P1/09	27.7.10	downgradient	bailer			585	13.4	4.4	7.2
P1/09	20.8.10	downgradient	WTW Cond 197i	5.2	432.08	579	13.9		
P1/09	20.8.10	downgradient	WTW Cond 197i	6.2	431.08	584	13.1		
P1/09	20.8.10	downgradient	WTW Cond 197i	7.2	430.08	583	12.8		
P1/09	20.8.10	downgradient	WTW Cond 197i	8.2	429.08	584	12.8		
P1/09	20.8.10	downgradient	WTW Cond 197i	9.2	428.08	584	12.9		
P1/09	20.8.10	downgradient	WTW Cond 197i	10.2	427.08	583	12.9		
P1/09	20.8.10	downgradient	WTW Cond 197i	11.2	426.08	583	12.9		
P1/09	20.8.10	downgradient	WTW Cond 197i	12.2	425.08	583	12.9		
P1/09	20.8.10	downgradient	WTW Cond 197i	13.2	424.08	583	13.0		
P1/09	20.8.10	downgradient	WTW Cond 197i	14.2	423.08	583	13.0		
P1/09	20.8.10	downgradient	WTW Cond 197i	15.2	422.08	583	13.0		
P1/09	20.8.10	downgradient	WTW Cond 197i	16.2	421.08	583	13.0		

Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	рН
				[m]	[m a.s.l.]	[μS/ cm)	[°C]	[mg/l]	
P1/09	20.8.10	downgradient	WTW Cond 197i	17.2	420.08	583	13.0		
P1/09	20.8.10	downgradient	WTW Cond 197i	18.2	419.08	583	12.9		
P1/09	20.8.10	downgradient	WTW Cond 197i	19.2	418.08	603	12.8		
P1/09	20.8.10	downgradient	bailer			598	15.1	0.4	7.2
P1/09	20.8.10	downgradient	pumped			582	13.5	0.0	7.4
P2/09	25.3.10	upgradient	WTW Cond 197i	6.8	433.82	782	10.6		
P2/09	25.3.10	upgradient	WTW Cond 197i	7.7	432.92	785	10.4		
P2/09	25.3.10	upgradient	pumped			787	10.8	3.5	7.0
P2/09	27.4.10	upgradient	WTW Cond 197i	6.8	433.82	779	10.5		
P2/09	27.4.10	upgradient	WTW Cond 197i	7.7	432.92	783	10.4		
P2/09	27.4.10	upgradient	bailer					6.3	7.3
P2/09	25.5.10	upgradient	WTW Cond 197i	6.8	433.82	789	10.7		
P2/09	25.5.10	upgradient	WTW Cond 197i	7.7	432.92	798	10.6		
P2/09	25.5.10	upgradient	bailer			799	12.9	9.3	7.3
P2/09	25.6.10	upgradient	WTW Cond 197i	6.8	433.82	770	11.0		
P2/09	25.6.10	upgradient	WTW Cond 197i	7.7	432.92	784	10.7		
P2/09	25.6.10	upgradient	bailer			786	13.6	6.6	7.0
P2/09	27.7.10	upgradient	WTW Cond 197i	6.8	433.82	762	12.1		
P2/09	27.7.10	upgradient	WTW Cond 197i	7.7	432.92	770	11.2		
P2/09	27.7.10	upgradient	bailer			769	12.8	3.7	6.8
P2/09	20.8.10	upgradient	WTW Cond 197i	6.8	433.82	733	12.5		
P2/09	20.8.10	upgradient	WTW Cond 197i	7.7	432.92	769	11.6		
P2/09	20.8.10	upgradient	bailer			776	16.4	4.8	7.1
P2/09	20.8.10	upgradient	pumped			771	12.0	2.5	7.1
P12/75	26.3.10	downgradient	WTW Cond 197i	21.2	417.92	779	10.4		
P12/75	26.3.10	downgradient	WTW Cond 197i	22.2	416.92	779	10.3		
P12/75	26.3.10	downgradient	WTW Cond 197i	23.2	415.92	779	10.3		
P12/75	26.3.10	downgradient	WTW Cond 197i	24.2	414.92	779	10.2		
P12/75	26.3.10	downgradient	WTW Cond 197i	25.2	413.92	783	10.2		
P12/75	26.3.10	downgradient	WTW Cond 197i	26.2	412.92	783	10.2		
P12/75	26.3.10	downgradient	WTW Cond 197i	27.2	411.92	784	10.2		
P12/75	26.3.10	downgradient	WTW Cond 197i	28.2	410.92	785	10.2		
P12/75	26.3.10	downgradient	WTW Cond 197i	29.2	409.92	786	10.2		
P12/75	26.3.10	downgradient	WTW Cond 197i	30.2	408.92	780	10.2		
P12/75	26.3.10	downgradient	WTW Cond 197i	31.2	407.92	779	10.2		
P12/75	26.3.10	downgradient	WTW Cond 197i	32.2	406.92	779	10.2		
P12/75	26.3.10	downgradient	pumped			787	10.9	4.8	7.4
P12/75	27.4.10	downgradient	WTW Cond 197i	7.2	431.92	779	10.9		
P12/75	27.4.10	downgradient	WTW Cond 197i	8.2	430.92	777	10.8		
P12/75	27.4.10	downgradient	WTW Cond 197i	9.2	429.92	776	10.7		
P12/75	27.4.10	downgradient	WTW Cond 197i	10.2	428.92	776	10.7		
P12/75	27.4.10	downgradient	WTW Cond 197i	11.2	427.92	776	10.7		
P12/75	27.4.10	downgradient	WTW Cond 197i	12.2	426.92	776	10.7		
P12/75	27.4.10	downgradient	WTW Cond 197i	13.2	425.92	776	10.7		
P12/75	27.4.10	downgradient	WTW Cond 197i	14.2	424.92	776	10.7		
P12/75	27.4.10	downgradient	WTW Cond 197i	15.2	423.92	776	10.6		
P12/75	27.4.10	downgradient	WTW Cond 197i	16.2	422.92	776	10.6		
P12/75	27.4.10	downgradient	WTW Cond 197i	17.2	421.92	776	10.6		
P12/75	27.4.10	downgradient	WTW Cond 197i	18.2	420.92	776	10.6		
P12/75	27.4.10	downgradient	WTW Cond 197i	19.2	419.92	776	10.6		
P12/75	27.4.10	downgradient	WTW Cond 197i	20.2	418.92	776	10.5		
P12/75	27.4.10	downgradient	WTW Cond 197i	21.2	417.92	775	10.5		

Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	рН
				[m]	[m a.s.l.]	[μS/ cm)	[°C]	[mg/l]	
P12/75	27.4.10	downgradient	WTW Cond 197i	22.2	416.92	775	10.5		
P12/75	27.4.10	downgradient	WTW Cond 197i	23.2	415.92	776	10.4		
P12/75	27.4.10	downgradient	WTW Cond 197i	24.2	414.92	777	10.4		
P12/75	27.4.10	downgradient	WTW Cond 197i	25.2	413.92	779	10.3		
P12/75	27.4.10	downgradient	WTW Cond 197i	26.2	412.92	780	10.4		
P12/75	27.4.10	downgradient	WTW Cond 197i	27.2	411.92	781	10.3		
P12/75	27.4.10	downgradient	WTW Cond 197i	28.2	410.92	783	10.3		
P12/75	27.4.10	downgradient	WTW Cond 197i	29.2	409.92	782	10.3		
P12/75	27.4.10	downgradient	WTW Cond 197i	30.2	408.92	780	10.3		
P12/75	27.4.10	downgradient	WTW Cond 197i	31.2	407.92	776	10.3		
P12/75	27.4.10	downgradient	WTW Cond 197i	32.2	406.92	776	10.2		
P12/75	27.4.10	downgradient	WTW Cond 197i	33.2	405.92	813	10.3		
P12/75	25.5.10	downgradient	WTW Cond 197i	7.2	431.92	783	11.8		
P12/75	25.5.10	downgradient	WTW Cond 197i	8.2	430.92	784	10.5		
P12/75	25.5.10	downgradient	WTW Cond 197i	9.2	429.92	786	10.5		
P12/75	25.5.10	downgradient	WTW Cond 197i	10.2	428.92	787	10.5		
P12/75	25.5.10	downgradient	WTW Cond 197i	11.2	427.92	787	10.5		
P12/75	25.5.10	downgradient	WTW Cond 197i	12.2	426.92	788	10.6		
P12/75	25.5.10	downgradient	WTW Cond 197i	13.2	425.92	788	10.6		
P12/75	25.5.10	downgradient	WTW Cond 197i	14.2	424.92	788	10.6		
P12/75	25.5.10	downgradient	WTW Cond 197i	15.2	423.92	788	10.6		
P12/75	25.5.10	downgradient	WTW Cond 197i	16.2	422.92	788	10.6		
P12/75	25.5.10	downgradient	WTW Cond 197i	17.2	421.92	788	10.6		
P12/75	25.5.10	downgradient	WTW Cond 197i	18.2	420.92	788	10.6		
P12/75	25.5.10	downgradient	WTW Cond 197i	19.2	419.92	788	10.5		
P12/75	25.5.10	downgradient	WTW Cond 197i	20.2	418.92	788	10.5		
P12/75	25.5.10	downgradient	WTW Cond 197i	21.2	417.92	788	10.5		
P12/75	25.5.10	downgradient	WTW Cond 197i	22.2	416.92	788	10.5		
P12/75	25.5.10	downgradient	WTW Cond 197i	23.2	415.92	787	10.4		
P12/75	25.5.10	downgradient	WTW Cond 197i	24.2	414.92	788	10.3		
P12/75	25.5.10	downgradient	WTW Cond 197i	25.2	413.92	789	10.3		
P12/75	25.5.10	downgradient	WTW Cond 197i	26.2	412.92	790	10.3		
P12/75	25.5.10	downgradient	WTW Cond 197i	27.2	411.92	791	10.3		
P12/75	25.5.10	downgradient	WTW Cond 197i	28.2	410.92	792	10.3		
P12/75	25.5.10	downgradient	WTW Cond 197i	29.2	409.92	793	10.3		
P12/75	25.5.10	downgradient	WTW Cond 197i	30.2	408.92	788	10.3		
P12/75	25.5.10	downgradient	WTW Cond 197i	31.2	407.92	787	10.3		
P12/75	25.5.10	downgradient	WTW Cond 197i	32.2	406.92	787	10.3		
P12/75	25.5.10	downgradient	WTW Cond 197i	33.2	405.92	794	10.3		
P12/75	25.5.10	downgradient	bailer			794	14.0	7.8	7.3
P12/75	25.6.10	downgradient	WTW Cond 197i	7.2	431.92	161	10.7		
P12/75	25.6.10	downgradient	WTW Cond 197i	8.2	430.92	520	10.5		
P12/75	25.6.10	downgradient	WTW Cond 197i	9.2	429.92	735	10.4		
P12/75	25.6.10	downgradient	WTW Cond 197i	10.2	428.92	761	10.4		
P12/75	25.6.10	downgradient	WTW Cond 197i	11.2	427.92	769	10.4		
P12/75	25.6.10	downgradient	WTW Cond 197i	12.2	426.92	771	10.4		
P12/75	25.6.10	downgradient	WTW Cond 197i	13.2	425.92	772	10.5		
P12/75	25.6.10	downgradient	WTW Cond 197i	14.2	424.92	772	10.5		
P12/75	25.6.10	downgradient	WTW Cond 197i	15.2	423.92	772	10.5		
P12/75	25.6.10	downgradient	WTW Cond 197i	16.2	422.92	773	10.5		
P12/75	25.6.10	downgradient	WTW Cond 197i	17.2	421.92	773	10.5		
P12/75	25.6.10	downgradient	WTW Cond 197i	18.2	420.92	773	10.5		

Table B 2. Field measurements 2010
Tuble D 2. There measurements 2010.

Im Im <thim< th=""> Im Im Im<!--</th--><th>Measuring point</th><th>Date</th><th>Location</th><th>Sampling method</th><th>Depth</th><th>Altitude</th><th>EC</th><th>Tem- pera- ture</th><th>Oxygen content</th><th>рН</th></thim<>	Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	рН
P12/75 25.6.10 downgradient WTW Cond 1971 2.2 419.92 773 10.5 P12/75 25.6.10 downgradient WTW Cond 1971 2.2 418.92 773 10.5 P12/75 25.6.10 downgradient WTW Cond 1971 2.2 416.92 773 10.5 P12/75 25.6.10 downgradient WTW Cond 1971 2.2 416.92 775 10.4 P12/75 25.6.10 downgradient WTW Cond 1971 2.2 413.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 2.2 409.92 779 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 3.2 409.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 3.2 409.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 3.2 409.92 75 10.3 P12/75 27.7.10 downgradient					[m]	[m a.s.l.]	[μS/ cm)	[°C]	[mg/l]	
P12/7525.6.10downgradientWTW Cond 19712.0.2418.9277310.5P12/7525.6.10downgradientWTW Cond 19712.2.2416.9277310.5P12/7525.6.10downgradientWTW Cond 19712.2.2416.9277310.4P12/7525.6.10downgradientWTW Cond 19712.2.241.9277510.3P12/7525.6.10downgradientWTW Cond 19712.2.241.9277510.3P12/7525.6.10downgradientWTW Cond 19712.2.241.9277510.3P12/7525.6.10downgradientWTW Cond 19712.2.440.9277910.3P12/7525.6.10downgradientWTW Cond 19713.2.440.9277510.3P12/7525.6.10downgradientWTW Cond 19713.2.440.9277510.3P12/7525.6.10downgradientWTW Cond 19713.2.440.9277510.3P12/7525.6.10downgradientWTW Cond 19713.2.440.9277510.3P12/7525.6.10downgradientWTW Cond 19713.2.440.9241.110.6P12/7527.7.10downgradientWTW Cond 19711.2.443.9241.110.6P12/7527.7.10downgradientWTW Cond 19711.2.443.9276.110.4P12/7527.7.10downgradientWTW Cond 19711.2.445.9276.110.4<	P12/75	25.6.10	downgradient	WTW Cond 197i	19.2	419.92	773	10.5		
P12/7525.6.10downgradientWTW Cond 197121.241.79277.310.5P12/7525.6.10downgradientWTW Cond 197122.241.69277.310.4P12/7525.6.10downgradientWTW Cond 197122.241.69277.510.4P12/7525.6.10downgradientWTW Cond 197122.241.9277.610.3P12/7525.6.10downgradientWTW Cond 197122.441.9277.710.3P12/7525.6.10downgradientWTW Cond 197128.240.9277.910.3P12/7525.6.10downgradientWTW Cond 197132.240.9277.310.3P12/7525.6.10downgradientWTW Cond 197132.240.9277.310.3P12/7525.6.10downgradientWTW Cond 197132.240.9277.310.3P12/7525.6.10downgradientWTW Cond 197132.240.9277.310.3P12/7525.6.10downgradientWTW Cond 197112.243.9241.811.2P12/7527.7.10downgradientWTW Cond 197112.243.9278.110.6P12/7527.7.10downgradientWTW Cond 197112.243.9278.110.4P12/7527.7.10downgradientWTW Cond 197112.443.9278.110.4P12/7527.7.10downgradientWTW Cond 197112.443.9278.110.4	P12/75	25.6.10	downgradient	WTW Cond 197i	20.2	418.92	773	10.5		
P12/75 25.6.10 downgradient WTW Cond 1971 2.22 415.92 773 10.4 P12/75 25.6.10 downgradient WTW Cond 1971 2.22 413.92 775 10.4 P12/75 25.6.10 downgradient WTW Cond 1971 2.52 413.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 2.22 410.92 770 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 2.22 40.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 3.22 405.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 3.22 405.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 3.22 405.92 776 10.3 P12/75 27.7.10 downgradient WTW Cond 1971 12.2 429.92 61 10.5 P12/75 27.7.10 downgradient </td <td>P12/75</td> <td>25.6.10</td> <td>downgradient</td> <td>WTW Cond 197i</td> <td>21.2</td> <td>417.92</td> <td>773</td> <td>10.5</td> <td></td> <td></td>	P12/75	25.6.10	downgradient	WTW Cond 197i	21.2	417.92	773	10.5		
P12/75 25.6.10 downgradient WTW Cond 1971 23.2 415.92 77.3 10.4 P12/75 25.6.10 downgradient WTW Cond 1971 22.2 413.92 77.5 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 22.2 413.92 77.6 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 22.2 409.92 77.9 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 32.2 406.92 77.8 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 32.2 405.92 77.8 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 32.2 405.92 77.8 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 32.4 405.92 73.8 10.4 P12/75 27.7.10 downgradient WTW Cond 1971 12.2 41.92 74.8 10.4 P12/75 27.7.10 down	P12/75	25.6.10	downgradient	WTW Cond 197i	22.2	416.92	773	10.5		
P12/7525.6.10downgradientWTW Cond 197124.241.9.277510.3P12/7525.6.10downgradientWTW Cond 197125.241.9.277610.3P12/7525.6.10downgradientWTW Cond 197122.241.9.277710.3P12/7525.6.10downgradientWTW Cond 197122.241.9.277010.3P12/7525.6.10downgradientWTW Cond 197132.2405.9.277310.3P12/7525.6.10downgradientWTW Cond 197132.2405.9.277310.3P12/7525.6.10downgradientWTW Cond 197132.2405.9.277310.3P12/7525.6.10downgradientWTW Cond 197132.2405.9.277310.3P12/7525.6.10downgradientWTW Cond 197132.243.9.210.3P12/7527.7.10downgradientWTW Cond 197112.243.9.210.3P12/7527.7.10downgradientWTW Cond 197112.242.9.273.010.4P12/7527.7.10downgradientWTW Cond 197112.242.9.274.010.4P12/7527.7.10downgradientWTW Cond 197112.242.9.274.010.4P12/7527.7.10downgradientWTW Cond 197112.242.9.274.010.4P12/7527.7.10downgradientWTW Cond 197112.24	P12/75	25.6.10	downgradient	WTW Cond 197i	23.2	415.92	773	10.4		
P12/75 25.6.10 downgradient WTW Cond 1971 25.2 41.9.2 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 22.2 41.9.2 776 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 82.2 409.9.2 779 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 82.2 409.9.2 773 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 31.2 406.9.2 773 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 31.2 405.9.2 77.0 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 82.4 41.0.6 10.4 11.2 P12/75 27.7.10 downgradient WTW Cond 1971 82.4 42.9.2 730 10.4 11.2 P12/75 27.7.10 downgradient WTW Cond 1971 12.2 42.9.2 740 10.4 11.2 P12/75 27.7.10 downgradient WTW Cond 1971 12.2 42.9.2 740 <td>P12/75</td> <td>25.6.10</td> <td>downgradient</td> <td>WTW Cond 197i</td> <td>24.2</td> <td>414.92</td> <td>775</td> <td>10.4</td> <td></td> <td></td>	P12/75	25.6.10	downgradient	WTW Cond 197i	24.2	414.92	775	10.4		
P12/75 25.6.10 downgradient WTW Cond 1971 26.2 41.9.2 776 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 22.2 40.9.2 779 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 30.2 408.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 31.2 407.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 31.2 405.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 31.2 405.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 32.2 40.92 418 10.6 P12/75 27.7.10 downgradient WTW Cond 1971 13.2 418.9 10.3 11.2 P12/75 27.7.10 downgradient WTW Cond 1971 12.2 42.92 736 10.4 11.2 P12/75 27.7.10 downgradient WTW Cond 1971 12.2 42.92 741 10.4 <	P12/75	25.6.10	downgradient	WTW Cond 197i	25.2	413.92	775	10.3		
P12/75 25.6.10 downgradient WTW Cond 1971 27.2 411.92 777 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 28.2 40.9.92 779 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 30.2 408.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 31.2 405.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 32.2 405.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 82.2 405.92 780 10.3 P12/75 27.7.10 downgradient WTW Cond 1971 9.2 43.92 481 10.6 10.4 P12/75 27.7.10 downgradient WTW Cond 1971 12.2 42.92 780 10.4 14.2 P12/75 27.7.10 downgradient WTW Cond 1971 12.2 42.92 740 10.4 14.2 P12/75 27.7.10 downgradient WTW Cond 1971 12.2 42.92 <	P12/75	25.6.10	downgradient	WTW Cond 197i	26.2	412.92	776	10.3		
P12/75 25.6.10 downgradient WTW Cond 1971 28.2 410.92 780 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 30.2 408.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 31.2 407.92 773 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 31.2 405.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 7.2 413.92 418 11.2 7.7 P12/75 27.7.10 downgradient WTW Cond 1971 9.2 429.92 629 10.5 1.4 P12/75 27.7.10 downgradient WTW Cond 1971 11.2 429.92 735 10.4 1.4 P12/75 27.7.10 downgradient WTW Cond 1971 12.2 42.92 735 10.4 1.4 42.92 745 10.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4 1.4<	P12/75	25.6.10	downgradient	WTW Cond 197i	27.2	411.92	777	10.3		
P12/75 25.6.10 downgradient WTW Cond 1971 29.2 409.92 779 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 32.2 406.92 773 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 32.2 406.92 772 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 7.2 418.9 11.2 7.0 P12/75 27.7.10 downgradient WTW Cond 1971 9.2 438.9 481 10.6 - 7.0 P12/75 27.7.10 downgradient WTW Cond 1971 10.2 428.92 730 10.3 - - 10.4 - - 10.4 - - 10.4 - 10.4 - - 10.4 - - 10.4 - 10.4 - 10.4 - - 10.4 - 10.4 - 10.4 - 10.4 - - 10.4 - 10.4	P12/75	25.6.10	downgradient	WTW Cond 197i	28.2	410.92	780	10.3		
P12/75 25.6.10 downgradient WTW Cond 197 3.0.2 408.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 197 3.2.2 406.92 772 10.3 P12/75 25.6.10 downgradient WTW Cond 197 3.2.2 405.92 775 10.3 P12/75 25.6.10 downgradient WTW Cond 197 7.2 431.92 431.9 10.6 5.7 7.0 P12/75 27.7.10 downgradient WTW Cond 1971 9.2 428.92 7.30 10.3 4.12 4.12 P12/75 27.7.10 downgradient WTW Cond 1971 12.2 428.92 7.35 10.4 4.14 P12/75 27.7.10 downgradient WTW Cond 1971 12.2 428.92 7.35 10.4 4.14 P12/75 27.7.10 downgradient WTW Cond 1971 12.2 425.92 7.64 10.4 4.14 P12/75 27.7.10 downgradient WTW Cond 1971 12.2	P12/75	25.6.10	downgradient	WTW Cond 197i	29.2	409.92	779	10.3		
P12/75 25.6.10 downgradient WTW Cond 1971 31.2 407.92 773 10.3 P12/75 25.6.10 downgradient WTW Cond 1971 32.2 406.92 772 10.3 P12/75 25.6.10 downgradient Baller	P12/75	25.6.10	downgradient	WTW Cond 197i	30.2	408.92	775	10.3		
P12/75 25.6.10 downgradient WTW Cond 197 3.2. 406.92 772 10.3 P12/75 25.6.10 downgradient WTW Cond 197 3.2. 405.92 775 10.3 P12/75 27.7.10 downgradient WTW Cond 197 7.2 431.92 481 11.2 P12/75 27.7.10 downgradient WTW Cond 197 7.2 431.92 629 10.5 - - - - 7.0 P12/75 27.7.10 downgradient WTW Cond 1971 12.2 426.92 730 10.4 - - - - - - - - - - 7.10 10.4 - - - - - - - - - 7.10 10.4 - - - - - - 10.4 - - 10.4 - - - - - 10.4 - - 10.4 - - -	P12/75	25.6.10	downgradient	WTW Cond 197i	31.2	407.92	773	10.3		
P12/75 25.6.10 downgradient WTW Cond 197i 3.3.2 405.92 7.75 10.3 P12/75 27.6.10 downgradient WTW Cond 197i 7.2 431.92 481 11.2 P12/75 27.7.10 downgradient WTW Cond 197i 8.2 430.92 481 10.6 P12/75 27.7.10 downgradient WTW Cond 197i 10.2 428.92 629 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 11.2 426.92 735 10.4	P12/75	25.6.10	downgradient	WTW Cond 197i	32.2	406.92	772	10.3		
P12/75 25.6.10 downgradient baller 405 1.2.6 5.7 7.0 P12/75 27.7.10 downgradient WTW Cond 197i 8.2 430.92 418 11.2 P12/75 27.7.10 downgradient WTW Cond 197i 8.2 429.92 629 10.5 1.2.4 P12/75 27.7.10 downgradient WTW Cond 197i 11.2 427.92 734 10.4 1.2.4 P12/75 27.7.10 downgradient WTW Cond 197i 12.2 426.92 749 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.4 1.2.4 10.2 1.2.4 10.2 1.2.4 10.2 1.2.4 10.5 1.2.4	P12/75	25.6.10	downgradient	WTW Cond 197i	33.2	405.92	775	10.3		
P12/75 27.7.10 downgradient WTW Cond 197i 7.2 431.92 418 11.2 P12/75 27.7.10 downgradient WTW Cond 197i 8.2 430.92 481 10.6 P12/75 27.7.10 downgradient WTW Cond 197i 9.2 429.92 630 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 11.2 427.92 734 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 13.2 426.92 735 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 15.2 423.92 749 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 15.2 423.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 15.2 423.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 12.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 2.2 416.92 761 10.4 <td< td=""><td>P12/75</td><td>25.6.10</td><td>downgradient</td><td>bailer</td><td></td><td></td><td>405</td><td>12.6</td><td>5.7</td><td>7.0</td></td<>	P12/75	25.6.10	downgradient	bailer			405	12.6	5.7	7.0
P12/75 27.7.10 downgradient WTW Cond 197i 8.2 430.92 481 10.6 P12/75 27.7.10 downgradient WTW Cond 197i 9.2 429.92 629 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 10.2 428.92 735 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 11.2 425.92 746 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 13.2 425.92 746 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 15.2 423.92 749 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 15.2 420.92 754 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 18.2 420.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 12.2 41.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 <t< td=""><td>P12/75</td><td>27.7.10</td><td>downgradient</td><td>WTW Cond 197i</td><td>7.2</td><td>431.92</td><td>418</td><td>11.2</td><td></td><td></td></t<>	P12/75	27.7.10	downgradient	WTW Cond 197i	7.2	431.92	418	11.2		
P12/75 27.7.10 downgradient WTW Cond 197i 9.2 429.92 629 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 10.2 428.92 730 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 11.2 427.92 734 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 13.2 425.92 746 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 15.2 423.92 749 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 15.2 423.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 18.2 420.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 19.2 419.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4	P12/75	27.7.10	downgradient	WTW Cond 197i	8.2	430.92	481	10.6		
P12/75 27.7.10 downgradient WTW Cond 197i 10.2 428.92 730 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 11.2 427.92 734 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 12.2 426.92 735 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 13.2 424.92 749 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 16.2 422.92 754 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 18.2 420.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 12.2 419.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4	P12/75	27.7.10	downgradient	WTW Cond 197i	9.2	429.92	629	10.5		
P12/75 27.7.10 downgradient WTW Cond 197i 11.2 427.92 734 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 12.2 426.92 735 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 13.2 425.92 746 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 15.2 423.92 749 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 16.2 422.92 754 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 18.2 420.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 12.2 418.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 21.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 762 10.4	P12/75	27.7.10	downgradient	WTW Cond 197i	10.2	428.92	730	10.3		
P12/75 27.7.10 downgradient WTW Cond 197i 12.2 426.92 735 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 13.2 425.92 746 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 14.2 424.92 749 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 15.2 423.92 754 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 15.2 423.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 18.2 420.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 12.2 418.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 21.2 418.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 411.92 762 10.4	P12/75	27.7.10	downgradient	WTW Cond 197i	11.2	427.92	734	10.4		
P12/75 27.7.10 downgradient WTW Cond 197i 13.2 425.92 746 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 14.2 424.92 749 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 15.2 423.92 749 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 15.2 421.92 764 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 15.2 421.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 19.2 419.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 41.92 764 10.4	P12/75	27.7.10	downgradient	WTW Cond 197i	12.2	426.92	735	10.4		
P12/75 27.7.10 downgradient WTW Cond 197i 14.2 424.92 749 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 15.2 423.92 749 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 16.2 422.92 754 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 16.2 420.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 19.2 419.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 12.2 417.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 410.92 768 10.3	P12/75	27.7.10	downgradient	WTW Cond 197i	13.2	425.92	746	10.4		
P12/75 27.7.10 downgradient WTW Cond 197i 15.2 423.92 749 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 16.2 422.92 754 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 17.2 421.92 760 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 18.2 420.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 19.2 419.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 20.2 418.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 20.2 418.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 23.2 415.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 24.2 414.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 25.2 413.92 768 10.3	P12/75	27.7.10	downgradient	WTW Cond 197i	14.2	424.92	749	10.4		
P12/75 27.7.10 downgradient WTW Cond 197i 16.2 422.92 754 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 17.2 421.92 760 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 18.2 420.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 19.2 419.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 20.2 418.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 21.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 23.2 415.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 24.2 414.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 25.2 413.92 764 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 27.2 411.92 767 10.4	P12/75	27.7.10	downgradient	WTW Cond 197i	15.2	423.92	749	10.4		
P12/75 27.7.10 downgradient WTW Cond 1971 17.2 421.92 760 10.4 P12/75 27.7.10 downgradient WTW Cond 1971 18.2 420.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 1971 19.2 419.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 1971 20.2 418.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 1971 21.2 417.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 1971 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 1971 23.2 414.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 1971 24.2 414.92 764 10.3 P12/75 27.7.10 downgradient WTW Cond 1971 26.2 413.92 764 10.4 P12/75 27.7.10 downgradient WTW Cond 1971 28.2 410.92 768 10.3	P12/75	27.7.10	downgradient	WTW Cond 197i	16.2	422.92	754	10.4		
P12/75 27.7.10 downgradient WTW Cond 1971 18.2 420.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 1971 19.2 419.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 1971 20.2 418.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 1971 21.2 417.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 1971 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 1971 23.2 415.92 764 10.3 P12/75 27.7.10 downgradient WTW Cond 1971 26.2 413.92 764 10.4 P12/75 27.7.10 downgradient WTW Cond 1971 26.2 413.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 1971 28.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 1971 30.2 408.92 768 10.3	P12/75	27.7.10	downgradient	WTW Cond 197i	17.2	421.92	760	10.4		
P12/75 27.7.10 downgradient WTW Cond 197i 19.2 419.92 761 10.5 P12/75 27.7.10 downgradient WTW Cond 197i 20.2 418.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 21.2 417.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 23.2 415.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 24.2 414.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 25.2 413.92 764 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 26.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 28.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 31.2 407.92 763 10.3	P12/75	27.7.10	downgradient	WTW Cond 197i	18.2	420.92	761	10.5		
P12/75 27.7.10 downgradient WTW Cond 197i 20.2 418.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 21.2 417.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 23.2 415.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 23.2 413.92 764 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 25.2 413.92 764 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 25.2 410.92 768 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 28.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 30.2 408.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 31.2 407.92 763 10.3	P12/75	27.7.10	downgradient	WTW Cond 197i	19.2	419.92	761	10.5		
P12/75 27.7.10 downgradient WTW Cond 197i 21.2 417.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 23.2 415.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 23.2 415.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 25.2 413.92 764 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 26.2 412.92 764 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 28.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 28.2 40.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 30.2 408.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 31.2 407.92 763 10.3	P12/75	27.7.10	downgradient	WTW Cond 197i	20.2	418.92	761	10.4		
P12/75 27.7.10 downgradient WTW Cond 197i 22.2 416.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 23.2 416.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 23.2 416.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 24.2 414.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 25.2 413.92 764 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 26.2 410.92 768 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 28.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 28.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 30.2 408.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 31.2 407.92 763 10.3	P12/75	27.7.10	downgradient	WTW Cond 197i	21.2	417.92	761	10.4		
P12/75 27.7.10 downgradient WTW Cond 197i 23.2 415.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 23.2 415.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 24.2 414.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 25.2 413.92 764 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 26.2 412.92 764 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 26.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 28.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 30.2 408.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 31.2 405.92 761 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 406.92 761 10.3	P12/75	27.7.10	downgradient	WTW Cond 197i	22.2	416.92	761	10.4		
P12/75 27.7.10 downgradient WTW Cond 197i 24.2 414.92 762 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 25.2 413.92 764 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 25.2 413.92 764 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 26.2 412.92 764 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 26.2 410.92 768 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 28.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 28.2 409.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 30.2 408.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 31.2 407.92 763 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 406.92 711 10.4	P12/75	27.7.10	downgradient	WTW Cond 197i	23.2	415.92	762	10.4		
P12/75 27.7.10 downgradient WTW Cond 197i 25.2 413.92 764 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 26.2 412.92 764 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 26.2 412.92 764 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 27.2 411.92 767 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 28.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 29.2 409.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 30.2 408.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 31.2 407.92 763 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 406.92 761 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 405.92 771 10.4	P12/75	27.7.10	downgradient	WTW Cond 197i	24.2	414.92	762	10.4		
P12/75 27.7.10 downgradient WTW Cond 197i 26.2 412.92 764 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 27.2 411.92 767 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 27.2 411.92 767 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 28.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 29.2 409.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 30.2 408.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 31.2 407.92 763 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 406.92 761 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 33.2 405.92 771 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 7.2 431.92 527 11.8	P12/75	27.7.10	downgradient	WTW Cond 197i	25.2	413 92	764	10.1		
P12/75 27.7.10 downgradient WTW Cond 197i 27.2 411.92 767 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 28.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 28.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 30.2 408.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 30.2 408.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 31.2 407.92 763 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 406.92 761 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 33.2 405.92 771 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 430.92 550 10.7 P12/75 20.8.10 downgradient WTW Cond 197i 8.2 430.92 550 10.7	P12/75	27.7.10	downgradient	WTW Cond 197i	26.2	412 92	764	10.5		
P12/75 27.7.10 downgradient WTW Cond 197i 28.2 410.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 29.2 409.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 30.2 408.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 30.2 408.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 31.2 407.92 763 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 31.2 405.92 761 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 406.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 405.92 771 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 405.92 711 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 7.2 431.92 527 11.8	P12/75	27.7.10	downgradient	WTW Cond 197i	27.2	411 92	767	10.1		
P12/75 27.7.10 downgradient WTW Cond 197i 29.2 409.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 30.2 408.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 30.2 408.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 31.2 407.92 763 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 406.92 761 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 406.92 761 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 405.92 771 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 431.92 527 11.8 P12/75 20.8.10 downgradient WTW Cond 197i 8.2 430.92 550 10.7 P12/75 20.8.10 downgradient WTW Cond 197i 9.2 429.92 629 10.5 <	P12/75	27.7.10	downgradient	WTW Cond 197i	27.2	410.92	768	10.4		
P12/75 27.7.10 downgradient WTW Cond 197i 30.2 408.92 768 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 31.2 407.92 763 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 31.2 407.92 763 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 406.92 761 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 33.2 405.92 771 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 33.2 405.92 771 10.4 P12/75 27.7.10 downgradient WTW Cond 197i 33.2 405.92 771 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 7.2 431.92 527 11.8 P12/75 20.8.10 downgradient WTW Cond 197i 8.2 430.92 550 10.7 P12/75 20.8.10 downgradient WTW Cond 197i 10.2 428.92 684 10.5 <	P12/75	27.7.10	downgradient	WTW Cond 197i	20.2	409.92	768	10.3		
P12/75 27.7.10 downgradient WTW Cond 197i 31.2 407.92 763 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 406.92 761 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 406.92 761 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 33.2 405.92 771 10.4 P12/75 27.7.10 downgradient bailer 541 12.7 4.3 6.9 P12/75 20.8.10 downgradient WTW Cond 197i 7.2 431.92 527 11.8 P12/75 20.8.10 downgradient WTW Cond 197i 8.2 430.92 550 10.7 P12/75 20.8.10 downgradient WTW Cond 197i 9.2 429.92 629 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 10.2 428.92 684 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 11.2 427.92 729 10.4 P12/75 <td>P12/75</td> <td>27.7.10</td> <td>downgradient</td> <td>WTW Cond 197i</td> <td>30.2</td> <td>409.92</td> <td>768</td> <td>10.3</td> <td></td> <td></td>	P12/75	27.7.10	downgradient	WTW Cond 197i	30.2	409.92	768	10.3		
P12/75 27.7.10 downgradient WTW Cond 197i 31.2 407.32 703 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 32.2 406.92 761 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 33.2 405.92 771 10.4 P12/75 27.7.10 downgradient bailer 541 12.7 4.3 6.9 P12/75 20.8.10 downgradient WTW Cond 197i 7.2 431.92 527 11.8 P12/75 20.8.10 downgradient WTW Cond 197i 8.2 430.92 550 10.7 P12/75 20.8.10 downgradient WTW Cond 197i 9.2 429.92 629 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 10.2 428.92 684 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 11.2 427.92 729 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 12.2 426.92 734 10.4 P12/75 <td>D12/75</td> <td>27.7.10</td> <td>downgradient</td> <td>WTW Cond 197i</td> <td>31.2</td> <td>400.52</td> <td>763</td> <td>10.3</td> <td></td> <td></td>	D12/75	27.7.10	downgradient	WTW Cond 197i	31.2	400.52	763	10.3		
P12/75 27.7.10 downgradient WTW Cond 1971 32.2 400.92 701 10.3 P12/75 27.7.10 downgradient WTW Cond 197i 33.2 405.92 771 10.4 P12/75 27.7.10 downgradient bailer 541 12.7 4.3 6.9 P12/75 20.8.10 downgradient WTW Cond 197i 7.2 431.92 527 11.8 P12/75 20.8.10 downgradient WTW Cond 197i 8.2 430.92 550 10.7 P12/75 20.8.10 downgradient WTW Cond 197i 9.2 429.92 629 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 10.2 428.92 684 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 11.2 427.92 729 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 12.2 426.92 734 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 13.2 425.92 739 10.4 P12/75 <td>P12/75</td> <td>27.7.10</td> <td>downgradient</td> <td>WTW Cond 1971</td> <td>22.2</td> <td>407.92</td> <td>703</td> <td>10.3</td> <td></td> <td></td>	P12/75	27.7.10	downgradient	WTW Cond 1971	22.2	407.92	703	10.3		
P12/75 27.7.10 downgradient WTW Cond 1971 33.2 403.92 771 10.4 P12/75 27.7.10 downgradient bailer 541 12.7 4.3 6.9 P12/75 20.8.10 downgradient WTW Cond 197i 7.2 431.92 527 11.8 P12/75 20.8.10 downgradient WTW Cond 197i 8.2 430.92 550 10.7 P12/75 20.8.10 downgradient WTW Cond 197i 9.2 429.92 629 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 10.2 428.92 684 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 11.2 427.92 729 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 12.2 426.92 734 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 13.2 425.92 739 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 13.2 425.92 739 10.4 P12/75 <td>D12/75</td> <td>27.7.10</td> <td>downgradient</td> <td>WTW Cond 197i</td> <td>22.2</td> <td>400.52</td> <td>701</td> <td>10.5</td> <td></td> <td></td>	D12/75	27.7.10	downgradient	WTW Cond 197i	22.2	400.52	701	10.5		
P12/75 20.8.10 downgradient WTW Cond 197i 7.2 431.92 527 11.8 P12/75 20.8.10 downgradient WTW Cond 197i 8.2 430.92 550 10.7 P12/75 20.8.10 downgradient WTW Cond 197i 9.2 429.92 629 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 10.2 428.92 684 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 11.2 427.92 729 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 12.2 426.92 734 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 13.2 425.92 739 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 13.2 425.92 739 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 14.2 424.92 750 10.4	P12/75	27.7.10	downgradient	bailor	55.2	405.92	5/1	10.4	12	60
P12/75 20.8.10 downgradient WTW Cond 1971 7.2 431.32 327 11.8 P12/75 20.8.10 downgradient WTW Cond 197i 8.2 430.92 550 10.7 P12/75 20.8.10 downgradient WTW Cond 197i 9.2 429.92 629 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 10.2 428.92 684 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 11.2 427.92 729 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 12.2 426.92 734 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 13.2 425.92 739 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 13.2 425.92 739 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 14.2 424.92 750 10.4	P12/75	27.7.10	downgradient	WTW Cond 197i	7 2	121 02	527	11.0	4.5	0.9
P12/75 20.8.10 downgradient WTW Cond 1971 3.2 430.32 530 10.7 P12/75 20.8.10 downgradient WTW Cond 197i 9.2 429.92 629 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 10.2 428.92 684 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 11.2 427.92 729 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 12.2 426.92 734 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 13.2 425.92 739 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 14.2 424.92 750 10.4	F12/75	20.8.10	downgradient	WTW Cond 1971	7.2 0.2	431.92	527	10.7		
P12/75 20.8.10 downgradient WTW Cond 197i 5.2 429.92 629 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 10.2 428.92 684 10.5 P12/75 20.8.10 downgradient WTW Cond 197i 11.2 427.92 729 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 12.2 426.92 734 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 13.2 425.92 739 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 14.2 424.92 750 10.4	1 12/75 D12/75	20.0.10	downgradiant	WTW/ Cond 1971	0.2	430.92	220	10.7		
P12/75 20.8.10 downgradient WTW Cold 1971 10.2 428.92 684 10.5 P12/75 20.8.10 downgradient WTW Cold 1971 11.2 427.92 729 10.4 P12/75 20.8.10 downgradient WTW Cold 1971 12.2 426.92 734 10.4 P12/75 20.8.10 downgradient WTW Cold 1971 12.2 426.92 734 10.4 P12/75 20.8.10 downgradient WTW Cold 1971 13.2 425.92 739 10.4 P12/75 20.8.10 downgradient WTW Cold 1971 14.2 424.92 750 10.4	1 12/75	20.0.10	downgradiant	WTW Cond 107	9.Z	423.32	601	10.5		
P12/75 20.8.10 downgradient WTW Cond 1971 11.2 427.92 729 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 12.2 426.92 734 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 13.2 425.92 739 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 13.2 425.92 739 10.4	F12//3	20.8.10	downgradient		11.2	428.92	084	10.5		
P12/75 20.8.10 downgradient WTW Cond 197i 12.2 426.92 734 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 13.2 425.92 739 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 13.2 425.92 739 10.4	F12//3	20.8.10	downgradient		12.2	427.92	729	10.4		
P12/75 20.8.10 downgradient WTW Cond 1971 13.2 425.92 739 10.4 P12/75 20.8.10 downgradient WTW Cond 197i 14.2 424.92 750 10.4	r12//J	20.8.10	downgradient	WTW Cond 197	12.2	420.92	734	10.4		
	P12/75	20.0.10	downgradiant	WTW Cond 1971	17.2 1/1 2	423.92 121 02	750	10.4		

Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	рН
				[m]	[m a.s.l.]	[μS/ cm)	[°C]	[mg/l]	
P12/75	20.8.10	downgradient	WTW Cond 197i	15.2	423.92	751	10.4		
P12/75	20.8.10	downgradient	WTW Cond 197i	16.2	422.92	751	10.4		
P12/75	20.8.10	downgradient	WTW Cond 197i	17.2	421.92	758	10.4		
P12/75	20.8.10	downgradient	WTW Cond 197i	18.2	420.92	760	10.4		
P12/75	20.8.10	downgradient	WTW Cond 197i	19.2	419.92	761	10.4		
P12/75	20.8.10	downgradient	WTW Cond 197i	20.2	418.92	761	10.4		
P12/75	20.8.10	downgradient	WTW Cond 197i	21.2	417.92	761	10.4		
P12/75	20.8.10	downgradient	WTW Cond 197i	22.2	416.92	761	10.4		
P12/75	20.8.10	downgradient	WTW Cond 197i	23.2	415.92	762	10.3		
P12/75	20.8.10	downgradient	WTW Cond 197i	24.2	414.92	762	10.3		
P12/75	20.8.10	downgradient	WTW Cond 197i	25.2	413.92	763	10.3		
P12/75	20.8.10	downgradient	WTW Cond 197i	26.2	412.92	764	10.3		
P12/75	20.8.10	downgradient	WTW Cond 197i	27.2	411.92	765	10.3		
P12/75	20.8.10	downgradient	WTW Cond 197i	28.2	410.92	766	10.3		
P12/75	20.8.10	downgradient	WTW Cond 197i	29.2	409.92	767	10.3		
P12/75	20.8.10	downgradient	WTW Cond 197i	30.2	408.92	763	10.3		
P12/75	20.8.10	downgradient	WTW Cond 197i	31.2	407.92	761	10.3		
P12/75	20.8.10	downgradient	WTW Cond 197i	32.2	406.92	759	10.3		
P12/75	20.8.10	downgradient	WTW Cond 197i	33.2	405.92	768	10.3		
P12/75	20.8.10	downgradient	bailer			639	15.4	2.2	6.9
P33	25.3.10	upgradient	WTW Cond 197i	11.5	432.97	408	10.7		
P33	25.3.10	upgradient	WTW Cond 197i	12.5	431.97	629	10.4		
P33	25.3.10	upgradient	WTW Cond 197i	13.5	430.97	814	10.3		
P33	25.3.10	upgradient	WTW Cond 197i	14.5	429.97	735	10.3		
P33	25.3.10	upgradient	WTW Cond 197i	15.5	428.97	506	10.3		
P33	25.3.10	upgradient	WTW Cond 197i	16.5	427.97	404	10.2		
P33	25.3.10	upgradient	WTW Cond 197i	17.5	426.97	404	10.2		
P33	25.3.10	upgradient	WTW Cond 197i	18.5	425.97	403	10.2		
P33	25.3.10	upgradient	WTW Cond 197i	19.5	424.97	403	10.2		
P33	25.3.10	upgradient	WTW Cond 197i	20.5	423.97	404	10.2		
P33	25.3.10	upgradient	WTW Cond 197i	21.5	422.97	411	10.2		
P33	25.3.10	upgradient	WTW Cond 197i	22.5	421.97	400	10.2		
P33	25.3.10	upgradient	WTW Cond 197i	23.5	420.97	399	10.2		
P33	25.3.10	upgradient	WTW Cond 197i	24.5	419.97	395	10.2		
P33	25.3.10	upgradient	WTW Cond 197i	25.5	418.97	396	10.2		
P33	25.3.10	upgradient	WTW Cond 197i	26.5	417.97	378	10.2		
P33	25.3.10	upgradient	WTW Cond 197i	27.5	416.97	377	10.2		
P33	25.3.10	upgradient	WTW Cond 197i	28.5	415.97	377	10.2		
P33	25.3.10	upgradient	WTW Cond 197i	29.5	414.97	376	10.2		
P33	25.3.10	upgradient	WTW Cond 197i	30.5	413.97	376	10.3		
P33	25.3.10	upgradient	WTW Cond 197i	31.5	412.97	375	10.3		
P33	25.3.10	upgradient	pumped			657	10.8	2.4	7.2
P33	27.4.10	upgradient	WTW Cond 197i	11.5	432.97	522	10.5		
P33	27.4.10	upgradient	WTW Cond 197i	12.5	431.97	651	10.4		
P33	27.4.10	upgradient	WTW Cond 197i	13.5	430.97	797	10.4		
P33	27.4.10	upgradient	WTW Cond 197i	14.5	429.97	750	10.4		
P33	27.4.10	upgradient	WTW Cond 197i	15.5	428.97	623	10.3		
P33	27.4.10	upgradient	WTW Cond 197i	16.5	427.97	413	10.4		
P33	27.4.10	upgradient	WTW Cond 197i	17.5	426.97	402	10.3		
P33	27.4.10	upgradient	WTW Cond 197i	18.5	425.97	402	10.3		
P33	27.4.10	upgradient	WTW Cond 197i	19.5	424.97	403	10.3		
P33	27.4.10	upgradient	WTW Cond 197i	20.5	423.97	402	10.3		

Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	рН
				[m]	[m a.s.l.]	[μS/ cm)	[°C]	[mg/l]	
P33	27.4.10	upgradient	WTW Cond 197i	21.5	422.97	405	10.3		
P33	27.4.10	upgradient	WTW Cond 197i	22.5	421.97	402	10.3		
P33	27.4.10	upgradient	WTW Cond 197i	23.5	420.97	393	10.3		
P33	27.4.10	upgradient	WTW Cond 197i	24.5	419.97	391	10.3		
P33	27.4.10	upgradient	WTW Cond 197i	25.5	418.97	387	10.3		
P33	27.4.10	upgradient	WTW Cond 197i	26.5	417.97	377	10.3		
P33	27.4.10	upgradient	WTW Cond 197i	27.5	416.97	376	10.4		
P33	27.4.10	upgradient	WTW Cond 197i	28.5	415.97	375	10.4		
P33	27.4.10	upgradient	WTW Cond 197i	29.5	414.97	374	10.4		
P33	27.4.10	upgradient	WTW Cond 197i	30.5	413.97	374	10.4		
P33	27.4.10	upgradient	WTW Cond 197i	31.5	412.97	374	10.4		
P33	27.4.10	upgradient	bailer					7.8	7.5
P33	25.5.10	upgradient	WTW Cond 197i	11.5	432.97	601	10.9		
P33	25.5.10	upgradient	WTW Cond 197i	12.5	431.97	654	10.4		
P33	25.5.10	upgradient	WTW Cond 197i	13.5	430.97	687	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	14.5	429.97	585	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	15.5	428.97	450	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	16.5	427.97	408	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	17.5	426.97	407	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	18.5	425.97	408	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	19.5	424.97	408	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	20.5	423.97	409	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	21.5	422.97	410	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	22.5	421.97	404	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	23.5	420.97	404	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	24.5	419.97	400	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	25.5	418.97	395	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	26.5	417.97	390	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	27.5	416.97	381	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	28.5	415.97	381	10.3		
P33	25.5.10	upgradient	WTW Cond 197i	29.5	414.97	380	10.4		
P33	25.5.10	upgradient	WTW Cond 197i	30.5	413.97	380	10.4		
P33	25.5.10	upgradient	WTW Cond 197i	31.5	412.97	380	10.4		
P33	25.5.10	upgradient	WTW Cond 197i	32.5	411.97	378	10.4		
P33	25.5.10	upgradient	bailer			441	11.5	6.5	7.8
P33	25.6.10	upgradient	WTW Cond 197i	11.5	432.97	402	10.9		
P33	25.6.10	upgradient	WTW Cond 197i	12.5	431.97	504	10.2		
P33	25.6.10	upgradient	WTW Cond 197i	13.5	430.97	682	10.2		
P33	25.6.10	upgradient	WTW Cond 197i	14.5	429.97	591	10.2		
P33	25.6.10	upgradient	WTW Cond 197i	15.5	428.97	452	10.3		
P33	25.6.10	upgradient	WTW Cond 197i	16.5	427.97	402	10.3		
P33	25.6.10	upgradient	WTW Cond 197i	17.5	426.97	401	10.3		
P33	25.6.10	upgradient	WTW Cond 197i	18.5	425.97	401	10.3		
P33	25.6.10	upgradient	WTW Cond 197i	19.5	424.97	401	10.3		
P33	25.6.10	upgradient	WTW Cond 197i	20.5	423.97	402	10.3		
P33	25.6.10	upgradient	WTW Cond 197i	21.5	422.97	406	10.3		
P33	25.6.10	upgradient	WTW Cond 197i	22.5	421.97	403	10.3		
P33	25.6.10	upgradient	WTW Cond 197i	23.5	420.97	399	10.3		
P33	25.6.10	upgradient	WTW Cond 197i	24.5	419.97	393	10.3		
P33	25.6.10	upgradient	WTW Cond 197i	25.5	418.97	390	10.3		
P33	25.6.10	upgradient	WTW Cond 197i	26.5	417.97	388	10.3		
P33	25.6.10	upgradient	WTW Cond 197i	27.5	416.97	377	10.3		

Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	рН
				[m]	[m a.s.l.]	[µS/ cm)	[°C]	[mg/l]	
P33	25.6.10	upgradient	WTW Cond 197i	28.5	415.97	374	10.4		
P33	25.6.10	upgradient	WTW Cond 197i	29.5	414.97	374	10.4		
P33	25.6.10	upgradient	WTW Cond 197i	30.5	413.97	373	10.4		
P33	25.6.10	upgradient	WTW Cond 197i	31.5	412.97	373	10.4		
P33	25.6.10	upgradient	WTW Cond 197i	32.5	411.97	372	10.4		
P33	25.6.10	upgradient	bailer			422	12.0	6.9	7.6
P33	27.7.10	upgradient	WTW Cond 197i	11.5	432.97	410	10.8		
P33	27.7.10	upgradient	WTW Cond 197i	12.5	431.97	414	10.3		
P33	27.7.10	upgradient	WTW Cond 197i	13.5	430.97	423	10.3		
P33	27.7.10	upgradient	WTW Cond 197i	14.5	429.97	411	10.3		
P33	27.7.10	upgradient	WTW Cond 197i	15.5	428.97	395	10.3		
P33	27.7.10	upgradient	WTW Cond 197i	16.5	427.97	394	10.3		
P33	27.7.10	upgradient	WTW Cond 197i	17.5	426.97	394	10.3		
P33	27.7.10	upgradient	WTW Cond 197i	18.5	425.97	395	10.3		
P33	27.7.10	upgradient	WTW Cond 197i	19.5	424.97	395	10.3		
P33	27.7.10	upgradient	WTW Cond 197i	20.5	423.97	395	10.3		
P33	27.7.10	upgradient	WTW Cond 197i	21.5	422.97	399	10.3		
P33	27.7.10	upgradient	WTW Cond 197i	22.5	421.97	397	10.3		
P33	27.7.10	upgradient	WTW Cond 197i	23.5	420.97	392	10.3		
P33	27.7.10	upgradient	WTW Cond 197i	24.5	419.97	386	10.3		
P33	27.7.10	upgradient	WTW Cond 197i	25.5	418.97	385	10.4		
P33	27.7.10	upgradient	WTW Cond 197i	26.5	417.97	372	10.4		
P33	27.7.10	upgradient	WTW Cond 197i	27.5	416.97	370	10.4		
P33	27.7.10	upgradient	WTW Cond 197i	28.5	415.97	368	10.4		
P33	27.7.10	upgradient	WTW Cond 197i	29.5	414.97	368	10.4		
P33	27.7.10	upgradient	WTW Cond 197i	30.5	413.97	367	10.4		
P33	27.7.10	upgradient	WTW Cond 197i	31.5	412.97	367	10.4		
P33	27.7.10	upgradient	WTW Cond 197i	32.5	411.97	367	10.4		
P33	27.7.10	upgradient	bailer			402	11.3	4.8	7.3
P33	20.8.10	upgradient	WTW Cond 197i	11.5	432.97	435	10.6		
P33	20.8.10	upgradient	WTW Cond 197i	12.5	431.97	434	10.3		
P33	20.8.10	upgradient	WTW Cond 197i	13.5	430.97	444	10.2		
P33	20.8.10	upgradient	WTW Cond 197i	14.5	429.97	412	10.2		
P33	20.8.10	upgradient	WTW Cond 197i	15.5	428.97	394	10.3		
P33	20.8.10	upgradient	WTW Cond 197i	16.5	427.97	394	10.3		
P33	20.8.10	upgradient	WTW Cond 197i	17.5	426.97	394	10.3		
P33	20.8.10	upgradient	WTW Cond 197i	18.5	425.97	394	10.3		
P33	20.8.10	upgradient	WTW Cond 197i	19.5	424.97	394	10.3		
P33	20.8.10	upgradient	WTW Cond 197i	20.5	423.97	396	10.3		
P33	20.8.10	upgradient	WTW Cond 197i	21.5	422.97	398	10.3		
P33	20.8.10	upgradient	WTW Cond 197i	22.5	421.97	399	10.3		
P33	20.8.10	upgradient	WTW Cond 197i	23.5	420.97	383	10.3		
P33	20.8.10	upgradient	WTW Cond 197i	24.5	419.97	381	10.3		
P33	20.8.10	upgradient	WTW Cond 197i	25.5	418.97	378	10.3		
P33	20.8.10	upgradient	WTW Cond 197i	26.5	417.97	372	10.3		
P33	20.8.10	upgradient	WTW Cond 197i	27.5	416.97	369	10.4		
P33	20.8.10	upgradient	WTW Cond 197i	28.5	415.97	368	10.4		
P33	20.8.10	upgradient	WTW Cond 197i	29.5	414.97	368	10.4		
P33	20.8.10	upgradient	WTW Cond 197i	30.5	413.97	367	10.4		
P33	20.8.10	upgradient	WTW Cond 197i	31.5	412.97	367	10.4		
P33	20.8.10	upgradient	WTW Cond 197i	32.5	411.97	366	10.4		
P33	20.8.10	upgradient	bailer			408	13.6	0.9	7.6

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Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	pН
				[m]	[m asl]	[μS/ cm)	[°C]	[mg/l]	
P34	25.3.10	upgradient	WTW Cond 197i	8.0	433.06	825	11.1		
P34	25.3.10	upgradient	WTW Cond 197i	9.0	432.06	825	11.0		
P34	25.3.10	upgradient	WTW Cond 197i	10.0	431.06	825	11.0		
P34	25.3.10	upgradient	WTW Cond 197i	11.0	430.06	826	11.0		
P34	25.3.10	upgradient	WTW Cond 197i	12.0	429.06	826	11.0		
P34	25.3.10	upgradient	WTW Cond 197i	13.0	428.06	826	11.0		
P34	25.3.10	upgradient	WTW Cond 197i	14.0	427.06	825	11.0		
P34	25.3.10	upgradient	WTW Cond 197i	15.0	426.06	825	11.0		
P34	25.3.10	upgradient	WTW Cond 197i	16.0	425.06	825	11.0		
P34	25.3.10	upgradient	pumped			828	11.4	7.3	7.4
P34	6.4.10	upgradient	bailer					8.8	7.0
P34	27.4.10	upgradient	WTW Cond 197i	8.0	433.06	808	11.2		
P34	27.4.10	upgradient	WTW Cond 197i	9.0	432.06	818	11.0		
P34	27.4.10	upgradient	WTW Cond 197i	10.0	431.06	819	10.9		
P34	27.4.10	upgradient	WTW Cond 197i	11.0	430.06	821	10.9		
P34	27.4.10	upgradient	WTW Cond 197i	12.0	429.06	822	10.9		
P34	27.4.10	upgradient	WTW Cond 197i	13.0	428.06	822	10.9		
P34	27.4.10	upgradient	WTW Cond 197i	14.0	427.06	822	10.9		
P34	27.4.10	upgradient	WTW Cond 197i	15.0	426.06	822	10.9		
P34	27.4.10	upgradient	WTW Cond 197i	16.0	425.06	822	10.9		
P34	27.4.10	upgradient	WTW Cond 197i	17.0	424.06	822	10.9		
P34	27.4.10	upgradient	bailer					7.8	7.2
P34	25.5.10	upgradient	WTW Cond 197i	8.0	433.06	819	11.0		
P34	25.5.10	upgradient	WTW Cond 197i	9.0	432.06	826	11.0		
P34	25.5.10	upgradient	WTW Cond 197i	10.0	431.06	828	10.9		
P34	25.5.10	upgradient	WTW Cond 197i	11.0	430.06	830	10.9		
P34	25.5.10	upgradient	WTW Cond 197i	12.0	429.06	831	10.8		
P34	25.5.10	upgradient	WTW Cond 197i	13.0	428.06	832	10.8		
P34	25.5.10	upgradient	WTW Cond 197i	14.0	427.06	832	10.8		
P34	25.5.10	upgradient	WTW Cond 197i	15.0	426.06	831	10.8		
P34	25.5.10	upgradient	WTW Cond 197i	16.0	425.06	831	10.8		
P34	25.5.10	upgradient	WTW Cond 197i	17.0	424.06	831	10.8		
P34	25.5.10	upgradient	bailer			830	12.7	10.1	7.2
P34	25.6.10	upgradient	WTW Cond 197i	8.0	433.06	787	11.4		
P34	25.6.10	upgradient	WTW Cond 197i	9.0	432.06	807	10.9		
P34	25.6.10	upgradient	WTW Cond 197i	10.0	431.06	809	10.8		
P34	25.6.10	upgradient	WTW Cond 197i	11.0	430.06	810	10.8		
P34	25.6.10	upgradient	WTW Cond 197i	12.0	429.06	811	10.7		
P34	25.6.10	upgradient	WTW Cond 197i	13.0	428.06	811	10.7		
P34	25.6.10	upgradient	WTW Cond 197i	14.0	427.06	810	10.7		
P34	25.6.10	upgradient	WTW Cond 197i	15.0	426.06	810	10.7		
P34	25.6.10	upgradient	WTW Cond 197i	16.0	425.06	810	10.7		
P34	25.6.10	upgradient	WTW Cond 197i	17.0	424.06	811	10.7		
P34	25.6.10	upgradient	bailer			808	12.7	9.4	7.4
P34	27.7.10	upgradient	WTW Cond 197i	8.0	433.06	786	10.8		
P34	27.7.10	upgradient	WTW Cond 197i	9.0	432.06	793	10.9		
P34	27.7.10	upgradient	WTW Cond 197i	10.0	431.06	795	10.7		
P34	27.7.10	upgradient	WTW Cond 197i	11.0	430.06	796	10.8		
P34	27.7.10	upgradient	WTW Cond 197i	12.0	429.06	796	10.7		
P34	27.7.10	upgradient	WTW Cond 197i	13.0	428.06	796	10.7		
P34	27.7.10	upgradient	WTW Cond 197i	14.0	427.06	797	10.7		
P34	27.7.10	upgradient	WTW Cond 197i	15.0	426.06	797	10.7		

P36

25.5.10 downgradient

Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	рН
				[m]	[m a.s.l.]	[μS/ cm)	[°C]	[mg/l]	
P34	27.7.10	upgradient	WTW Cond 197i	16.0	425.06	797	10.6		
P34	27.7.10	upgradient	WTW Cond 197i	17.0	424.06	798	10.7		
P34	27.7.10	upgradient	bailer			793	12.4	7.3	7.2
P34	20.8.10	upgradient	WTW Cond 197i	8.0	433.06	776	11.3		
P34	20.8.10	upgradient	WTW Cond 197i	9.0	432.06	786	10.9		
P34	20.8.10	upgradient	WTW Cond 197i	10.0	431.06	789	10.9		
P34	20.8.10	upgradient	WTW Cond 197i	11.0	430.06	789	10.8		
P34	20.8.10	upgradient	WTW Cond 197i	12.0	429.06	789	10.8		
P34	20.8.10	upgradient	WTW Cond 197i	13.0	428.06	789	10.7		
P34	20.8.10	upgradient	WTW Cond 197i	14.0	427.06	789	10.8		
P34	20.8.10	upgradient	WTW Cond 197i	15.0	426.06	789	10.8		
P34	20.8.10	upgradient	WTW Cond 197i	16.0	425.06	789	10.7		
P34	20.8.10	upgradient	WTW Cond 197i	17.0	424.06	790	10.8		
P34	20.8.10	upgradient	bailer			793	14.4	7.9	7.1
P34	20.8.10	upgradient	pumped			789	11.5	7.2	7.1
P36	25.3.10	downgradient	WTW Cond 197i	4.0	432.26	725	10.4	/12	/12
P36	25 3 10	downgradient	WTW Cond 197i	5.0	431 26	720	10.1		
P36	25 3 10	downgradient	WTW Cond 197i	6.0	430.26	721	10.0		
P36	25.3.10	downgradient	WTW Cond 197i	7.0	429.26	725	11.0		
P36	25.3.10	downgradient	WTW Cond 197i	8.0	429.20	723	10.0		
P36	25.3.10	downgradient	WTW Cond 197i	9.0	420.20	730	10.5		
P36	25.3.10	downgradient	WTW Cond 197i	10.0	427.20	730	10.0		
P26	25.3.10	downgradient	WTW Cond 197i	11.0	420.20	721	10.0		
P36	25.3.10	downgradient	WTW Cond 197i	12.0	423.20	731	10.4		
P26	25.3.10	downgradient	WTW Cond 197i	12.0	424.20	721	10.4		
P36	25.3.10	downgradient	WTW Cond 197i	14.0	423.20	731	10.4		
P36	25.3.10	downgradient	WTW Cond 197i	14.0	422.20	732	10.4		
P36	25.3.10	downgradient	numped	15.0	421.20	732	10.4	2.4	7 2
P30	25.5.10	downgradient	WTW Cond 107	4.0	122.26	725	10.0	2.4	1.2
P30	27.4.10	downgradient	WTW Cond 197	4.0	452.20	712	10.9		
P30	27.4.10	downgradient	WTW Cond 1971	5.0	451.20	712	10.5		
P36	27.4.10	downgradient	WTW Cond 197	6.U	430.26	/11	10.3		
P30	27.4.10	downgradient	WTW Cond 197	7.0	429.20	710	10.3		
P36	27.4.10	downgradient	WTW Cond 197	8.0	428.26	713	10.2		
P36	27.4.10	downgradient	WTW Cond 197	9.0	427.26	714	10.2		
P36	27.4.10	downgradient	WTW Cond 197	10.0	426.26	715	10.2		
P36	27.4.10	downgradient	WTW Cond 197	11.0	425.26	715	10.1		
P36	27.4.10	downgradient	WTW Cond 197	12.0	424.26	715	10.1		
P36	27.4.10	downgradient	WTW Cond 197	13.0	423.26	/16	10.1		
P36	27.4.10	downgradient	WTW Cond 197	14.0	422.26	714	10.1		
P36	27.4.10	downgradient	WTW Cond 197	15.0	421.26	/12	10.0		
P36	27.4.10	downgradient	bailer					4.8	7.4
P36	25.5.10	downgradient	WTW Cond 197i	4.0	432.26	720	11.4		
P36	25.5.10	downgradient	WTW Cond 197i	5.0	431.26	726	10.5		
P36	25.5.10	downgradient	WTW Cond 197i	6.0	430.26	725	10.5		
P36	25.5.10	downgradient	WTW Cond 197i	7.0	429.26	730	10.3		
P36	25.5.10	downgradient	WTW Cond 197i	8.0	428.26	733	10.1		
P36	25.5.10	downgradient	WTW Cond 197i	9.0	427.26	733	9.9		
P36	25.5.10	downgradient	WTW Cond 197i	10.0	426.26	734	9.9		
P36	25.5.10	downgradient	WTW Cond 197i	11.0	425.26	734	9.8		
P36	25.5.10	downgradient	WTW Cond 197i	12.0	424.26	738	9.8		
P36	25.5.10	downgradient	WTW Cond 197i	13.0	423.26	738	9.8		

WTW Cond 197i

14.0 422.26

734

9.8

Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	рН
				[m]	[m a.s.l.]	[μS/ cm)	[°C]	[mg/l]	
P36	25.5.10	downgradient	WTW Cond 197i	15.0	421.26	730	9.8		
P36	25.5.10	downgradient	bailer			724	13.4	10.0	7.3
P36	25.6.10	downgradient	WTW Cond 197i	4.0	432.26	698	13.3		
P36	25.6.10	downgradient	WTW Cond 197i	5.0	431.26	736	10.8		
P36	25.6.10	downgradient	WTW Cond 197i	6.0	430.26	737	10.4		
P36	25.6.10	downgradient	WTW Cond 197i	7.0	429.26	737	10.3		
P36	25.6.10	downgradient	WTW Cond 197i	8.0	428.26	759	10.1		
P36	25.6.10	downgradient	WTW Cond 197i	9.0	427.26	762	9.9		
P36	25.6.10	downgradient	WTW Cond 197i	10.0	426.26	762	9.8		
P36	25.6.10	downgradient	WTW Cond 197i	11.0	425.26	763	9.7		
P36	25.6.10	downgradient	WTW Cond 197i	12.0	424.26	761	9.6		
P36	25.6.10	downgradient	WTW Cond 197i	13.0	423.26	762	9.6		
P36	25.6.10	downgradient	WTW Cond 197i	14.0	422.26	762	9.6		
P36	25.6.10	downgradient	WTW Cond 197i	15.0	421.26	764	9.6		
P36	25.6.10	downgradient	bailer			714	13.4	6.0	7.2
P36	27.7.10	downgradient	WTW Cond 197i	4.0	432.26	698	13.8		
P36	27.7.10	downgradient	WTW Cond 197i	5.0	431.26	731	10.5		
P36	27.7.10	downgradient	WTW Cond 197i	6.0	430.26	741	10.1		
P36	27.7.10	downgradient	WTW Cond 197i	7.0	429.26	743	10.0		
P36	27.7.10	downgradient	WTW Cond 197i	8.0	428.26	744	9.9		
P36	27.7.10	downgradient	WTW Cond 197i	9.0	427.26	745	9.9		
P36	27.7.10	downgradient	WTW Cond 197i	10.0	426.26	745	9.9		
P36	27.7.10	downgradient	WTW Cond 197i	11.0	425.26	745	9.9		
P36	27.7.10	downgradient	WTW Cond 197i	12.0	424.26	746	9.9		
P36	27.7.10	downgradient	WTW Cond 197i	13.0	423.26	750	9.9		
P36	27.7.10	downgradient	WTW Cond 197i	14.0	422.26	745	9.9		
P36	27.7.10	downgradient	WTW Cond 197i	15.0	421.26	744	9.8		
P36	27.7.10	downgradient	bailer			718	13.5	6.8	7.3
P36	20.8.10	downgradient	WTW Cond 197i	4.0	432.26	727	14.6		
P36	20.8.10	downgradient	WTW Cond 197i	5.0	431.26	749	11.3		
P36	20.8.10	downgradient	WTW Cond 197i	6.0	430.26	747	10.8		
P36	20.8.10	downgradient	WTW Cond 197i	7.0	429.26	759	10.7		
P36	20.8.10	downgradient	WTW Cond 197i	8.0	428.26	772	10.5		
P36	20.8.10	downgradient	WTW Cond 197i	9.0	427.26	781	10.4		
P36	20.8.10	downgradient	WTW Cond 197i	10.0	426.26	781	10.3		
P36	20.8.10	downgradient	WTW Cond 197i	11.0	425.26	782	10.3		
P36	20.8.10	downgradient	WTW Cond 197i	12.0	424.26	783	10.3		
P36	20.8.10	downgradient	WTW Cond 197i	13.0	423.26	783	10.3		
P36	20.8.10	downgradient	WTW Cond 197i	14.0	422.26	783	10.3		
P36	20.8.10	downgradient	WTW Cond 197i	15.0	421.26	784	10.3		
P36	20.8.10	downgradient	bailer			716	18.9	3.9	7.4
P36	20.8.10	downgradient	pumped			708	11.1	0.8	7.2
P37	26.3.10	beside lake	WTW Cond 197i	11.0	432.74	642	14.2		
P37	26.3.10	beside lake	WTW Cond 197i	12.0	431.74	676	14.1		
P37	26.3.10	beside lake	WTW Cond 197i	13.0	430.74	813	13.7		
P37	26.3.10	beside lake	WTW Cond 197i	14.0	429.74	815	13.6		
P37	26.3.10	beside lake	WTW Cond 197i	15.0	428.74	842	13.4		
P37	26.3.10	beside lake	WTW Cond 197i	16.0	427.74	844	13.3		
P37	26.3.10	beside lake	WTW Cond 197i	17.0	426.74	845	13.5		
P37	26 3 10	heside lake	WTW Cond 197i	18.0	425 74	845	13.1		
P37	26 3 10	heside lake	numned	10.0	123./4	5-5	13.0	4 8	64
P37	26.3.10	beside lake	bailer					5.3	6.5

Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	рН
				[m]	[m a.s.l.]	[μS/ cm)	[°C]	[mg/l]	
P37	27.4.10	beside lake	WTW Cond 197i	11.1	432.64	626	13.8		
P37	27.4.10	beside lake	WTW Cond 197i	12.2	431.54	723	13.7		
P37	27.4.10	beside lake	WTW Cond 197i	13.3	430.44	808	13.5		
P37	27.4.10	beside lake	WTW Cond 197i	14.4	429.34	832	13.3		
P37	27.4.10	beside lake	WTW Cond 197i	15.5	428.24	839	13.2		
P37	27.4.10	beside lake	WTW Cond 197i	16.6	427.14	840	13.0		
P37	27.4.10	beside lake	WTW Cond 197i	17.7	426.04	841	13.0		
P37	27.4.10	beside lake	WTW Cond 197i	18.8	424.94	842	12.8		
P37	27.4.10	beside lake	bailer					5.2	7.4
P37	25.5.10	beside lake	WTW Cond 197i	11.0	432.74	629	13.8		
P37	25.5.10	beside lake	WTW Cond 197i	12.0	431.74	687	13.5		
P37	25.5.10	beside lake	WTW Cond 197i	13.0	430.74	818	13.3		
P37	25.5.10	beside lake	WTW Cond 197i	14.0	429.74	823	13.2		
P37	25.5.10	beside lake	WTW Cond 197i	15.0	428.74	849	13.0		
P37	25.5.10	beside lake	WTW Cond 197i	16.0	427.74	852	13.0		
P37	25.5.10	beside lake	WTW Cond 197i	17.0	426.74	853	12.9		
P37	25.5.10	beside lake	WTW Cond 197i	18.0	425.74	853	12.8		
P37	25.5.10	beside lake	bailer			770	16.1	9.7	7.2
P37	25.6.10	beside lake	WTW Cond 197i	11.0	432.74	617	13.6		
P37	25.6.10	beside lake	WTW Cond 197i	12.0	431.74	690	13.2		
P37	25.6.10	beside lake	WTW Cond 197i	13.0	430.74	803	13.1		
P37	25.6.10	beside lake	WTW Cond 197i	14.0	429.74	813	13.0		
P37	25.6.10	beside lake	WTW Cond 197i	15.0	428.74	831	12.9		
P37	25.6.10	beside lake	WTW Cond 197i	16.0	427.74	836	12.8		
P37	25.6.10	beside lake	WTW Cond 197i	17.0	426.74	837	12.8		
P37	25.6.10	beside lake	WTW Cond 197i	18.0	425.74	838	12.7		
P37	25.6.10	beside lake	bailer			799	14.2	4.0	7.2
P37	27.7.10	beside lake	WTW Cond 197i	11.0	432.74	615	13.2		
P37	27.7.10	beside lake	WTW Cond 197i	12.0	431.74	637	12.9		
P37	27.7.10	beside lake	WTW Cond 197i	13.0	430.74	660	12.9		
P37	27.7.10	beside lake	WTW Cond 197i	14.0	429.74	740	12.9		
P37	27.7.10	beside lake	WTW Cond 197i	15.0	428.74	808	12.8		
P37	27.7.10	beside lake	WTW Cond 197i	16.0	427.74	824	12.8		
P37	27.7.10	beside lake	WTW Cond 197i	17.0	426.74	825	12.7		
P37	27.7.10	beside lake	WTW Cond 197i	18.0	425.74	826	12.6		
P37	27.7.10	beside lake	bailer			779	14.1	7.4	7.4
P37	20.8.10	beside lake	WTW Cond 197i	11.0	432.74	569	14.6		
P37	20.8.10	beside lake	WTW Cond 197i	12.0	431.74	579	13.9		
P37	20.8.10	beside lake	WTW Cond 197i	13.0	430.74	580	13.6		
P37	20.8.10	beside lake	WTW Cond 197i	14.0	429.74	584	13.5		
P37	20.8.10	beside lake	WTW Cond 197i	15.0	428.74	807	12.9		
P37	20.8.10	beside lake	WTW Cond 197i	16.0	427.74	814	12.8		
P37	20.8.10	beside lake	WTW Cond 197i	17.0	426.74	819	12.7		
P37	20.8.10	beside lake	WTW Cond 197i	18.0	425.74	820	12.6		
P37	20.8.10	beside lake	bailer			748	23.2	3.9	7.2
P37	20.8.10	beside lake	pumped			666	13.9	2.4	7.2
Schapbuchquelle	13.4.10	upgradient	pumped			591			
Schapbuchquelle	19.4.10	upgradient	pumped			706			
Schapbuchquelle	26.4.10	upgradient	pumped			707			
Schapbuchquelle	3.5.10	upgradient	pumped			710			
Schapbuchquelle	10.5.10	upgradient	pumped			710			
Schapbuchquelle	17.5.10	upgradient	pumped			711			

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Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	рН
				[m]	[m a.s.l.]	[µS/ cm)	[°C]	[mg/l]	
Schapbuchquelle	26.5.10	upgradient	pumped			, 695			
Schapbuchquelle	31.5.10	upgradient	pumped			560			
Schapbuchquelle	7.6.10	upgradient	pumped			615			
Schapbuchquelle	14.6.10	upgradient	pumped			705			
Schapbuchquelle	23.6.10	upgradient	pumped			707			
Schapbuchquelle	28.6.10	upgradient	pumped			590			
Schapbuchquelle	5.7.10	upgradient	pumped			650			
Schapbuchquelle	12.7.10	upgradient	pumped			661			
Schapbuchquelle	19.7.10	upgradient	pumped			688			
Schapbuchquelle	2.8.10	upgradient	pumped			678			
Schapbuchquelle	9.8.10	upgradient	pumped			689			
Schapbuchquelle	16.8.10	upgradient	pumped			688			
TB Stefansfeld	13.4.10	beside lake	pumped			766			
TB Stefansfeld	19.4.10	beside lake	pumped			796			
TB Stefansfeld	26.4.10	beside lake	pumped			796			
TB Stefansfeld	3.5.10	beside lake	pumped			802			
TB Stefansfeld	10.5.10	beside lake	pumped			804			
TB Stefansfeld	17.5.10	beside lake	pumped			804			
TB Stefansfeld	26.5.10	beside lake	pumped			792			
TB Stefansfeld	31.5.10	beside lake	pumped			794			
TB Stefansfeld	7.6.10	beside lake	pumped			672			
TB Stefansfeld	14.6.10	beside lake	pumped			794			
TB Stefansfeld	23.6.10	beside lake	pumped			794			
TB Stefansfeld	28.6.10	beside lake	pumped			752			
TB Stefansfeld	5.7.10	beside lake	pumped			769			
TB Stefansfeld	12.7.10	beside lake	pumped			774			
TB Stefansfeld	19.7.10	beside lake	pumped			776			
TB Stefansfeld	2.8.10	beside lake	pumped			767			
TB Stefansfeld	9.8.10	beside lake	pumped			777			
TB Stefansfeld	16.8.10	beside lake	pumped			777			
Pier1	25.3.10	Lake	scooped	0.0	433.31			11.7	8.2
Pier1	6.4.10	Lake	scooped	0.0	433.30			12.0	8.0
Pier1	12.4.10	Lake	scooped	0.0		604			
Pier1	19.4.10	Lake	scooped	0.0		612			
Pier1	26.4.10	Lake	scooped	0.0		611			
Pier1	27.4.10	Lake	scooped	0.0	433.23			10.5	8.1
Pier1	3.5.10	Lake	scooped	0.0		601			
Pier1	10.5.10	Lake	scooped	0.0		598			
Pier1	17.5.10	Lake	scooped	0.0		595			
Pier1	25.5.10	Lake	scooped	0.0	433.21			11.3	8.0
Pier1	31.5.10	Lake	scooped	0.0		553			
Pier1	7.6.10	Lake	scooped	0.0		521			
Pier1	14.6.10	Lake	scooped	0.0		542			
Pier1	21.6.10	Lake	scooped	0.0		538			
Pier1	26.6.10	Lake	scooped	0.0	433.32	530	24.0	9.4	7.7
Pier1	28.6.10	Lake	scooped	0.0		532			
Pier1	5.7.10	Lake	scooped	0.0		503			
Pier1	12.7.10	Lake	scooped	0.0		503			
Pier1	19.7.10	Lake	scooped	0.0		519			
Pier1	26.7.10	Lake	scooped	0.0		526			
Pier1	29.7.10	Lake	scooped	0.0	433.36	531	22.1		8.5
Pier1	2.8.10	Lake	scooped	0.0		519			

Table B 2: Field measurements 2010.											
Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content			
				[m]	[m a.s.l.]	[μS/ cm)	[°C]	[mg/l]			
Pier1	9.8.10	Lake	scooped	0.0		504					
Pier1	16.8.10	Lake	scooped	0.0		466					
Pier1	21.8.10	Lake	scooped	0.0	433.38	480	23.4	5.8			
New deepest point	25.3.10	Lake	WTW devices, pump	0.0	433.31	640	10.3	11.5			
New deepest point	25.3.10	Lake	WTW devices, pump	1.0	432.31	642	10.2	11.3			
New deepest point	25.3.10	Lake	WTW devices, pump	2.0	431.31	642	9.7	11.4			
New deepest point	25.3.10	Lake	WTW devices, pump	3.0	430.31	637	7.2	11.6			
New deepest point	25.3.10	Lake	WTW devices, pump	4.0	429.31	641	6.6	12.0			
New deepest point	25.3.10	Lake	WTW devices, pump	5.0	428.31	640	5.9	12.9			
New deepest point	25.3.10	Lake	WTW devices, pump	6.0	427.31	640	5.5	13.1			
New deepest point	25.3.10	Lake	WTW devices, pump	7.0	426.31	641	5.0	13.0			
Now doopost point	2E 2 10	Lako	WTW dovicos pump	00	125 21	612	10	12.0			

Table B 2

Pier1	9.8.10	Lake	scooped	0.0		504			
Pier1	16.8.10	Lake	scooped	0.0		466			
Pier1	21.8.10	Lake	scooped	0.0	433.38	480	23.4	5.8	8.2
New deepest point	25.3.10	Lake	WTW devices, pump	0.0	433.31	640	10.3	11.5	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	1.0	432.31	642	10.2	11.3	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	2.0	431.31	642	9.7	11.4	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	3.0	430.31	637	7.2	11.6	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	4.0	429.31	641	6.6	12.0	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	5.0	428.31	640	5.9	12.9	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	6.0	427.31	640	5.5	13.1	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	7.0	426.31	641	5.0	13.0	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	8.0	425.31	642	4.8	13.0	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	9.0	424.31	644	4.7	12.4	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	10.0	423.31	646	4.6	11.8	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	11.0	422.31	648	4.6	11.4	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	12.0	421.31	650	4.5	11.0	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	13.0	420.31	651	4.6	10.5	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	14.0	419.31	652	4.5	9.6	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	15.0	418.31	653	4.6	9.8	8.1
New deepest point	25.3.10	Lake	WTW devices, pump	16.0	417.31	653	4.7	9.3	8.1
New deepest point	28.4.10	Lake	WTW devices, pump	0.0	433.23	605	15.8	10.8	8.1
New deepest point	28.4.10	Lake	WTW devices, pump	1.0	432.23	614	15.6	10.8	8.1
New deepest point	28.4.10	Lake	WTW devices, pump	2.0	431.23	613	15.1	10.5	8.1
New deepest point	28.4.10	Lake	WTW devices, pump	3.0	430.23	617	14.5	11.5	8.1
New deepest point	28.4.10	Lake	WTW devices, pump	4.0	429.23	629	13.0	12.6	8.1
New deepest point	28.4.10	Lake	WTW devices, pump	5.0	428.23	687	11.7	12.7	7.8
New deepest point	28.4.10	Lake	WTW devices, pump	6.0	427.23	656	9.8	14.1	8.0
New deepest point	28.4.10	Lake	WTW devices, pump	7.0	426.23	640	7.9	14.4	8.4
New deepest point	28.4.10	Lake	WTW devices, pump	8.0	425.23	640	6.6	14.3	8.2
New deepest point	28.4.10	Lake	WTW devices, pump	9.0	424.23	642	6.2	11.9	8.0
New deepest point	28.4.10	Lake	WTW devices, pump	10.0	423.23	642	5.8	10.8	7.9
New deepest point	28.4.10	Lake	WTW devices, pump	11.0	422.23	643	5.8	10.5	7.9
New deepest point	28.4.10	Lake	WTW devices, pump	12.0	421.23	643	5.6	9.8	7.9
New deepest point	28.4.10	Lake	WTW devices, pump	13.0	420.23	645	5.6	9.1	7.8
New deepest point	28.4.10	Lake	WTW devices, pump	14.0	419.23	646	5.6	8.8	7.8
New deepest point	28.4.10	Lake	WTW devices, pump	15.0	418.23	648	5.6	7.6	7.6
New deepest point	28.4.10	Lake	WTW devices, pump	16.0	417.23	649	5.6	6.9	7.7
New deepest point	26.5.10	Lake	WTW devices, pump	0.0	433.21	582	18.9	11.8	8.1
New deepest point	26.5.10	Lake	WTW devices, pump	1.0	432.21	583	18.8	12.4	8.0
New deepest point	26.5.10	Lake	WTW devices, pump	2.0	431.21	585	18.3	12.4	8.0
New deepest point	26.5.10	Lake	WTW devices, pump	3.0	430.21	593	15.8	12.6	7.9
New deepest point	26.5.10	Lake	WTW devices, pump	4.0	429.21	607	14.7	12.7	7.9
New deepest point	26.5.10	Lake	WTW devices, pump	5.0	428.21	676	13.7	12.0	7.6
New deepest point	26.5.10	Lake	WTW devices, pump	6.0	427.21	670	11.8	16.5	7.8
New deepest point	26.5.10	Lake	WTW devices, pump	7.0	426.21	661	9.2	15.3	7.9
New deepest point	26.5.10	Lake	WTW devices, pump	8.0	425.21	655	7.5	13.3	7.9
New deepest point	26.5.10	Lake	WTW devices, pump	9.0	424.21	657	6.7	10.3	7.9
New deepest point	26.5.10	Lake	WTW devices, pump	10.0	423.21	655	6.3	9.4	7.8
New deepest point	26.5.10	Lake	WTW devices, pump	11.0	422.21	655	6.2	8.2	7.8
New deepest point	26.5.10	Lake	WTW devices, pump	12.0	421.21	657	6.1	7.0	7.8
New deepest point	26.5.10	Lake	WTW devices, pump	13.0	420.21	657	6.1	6.8	7.8
New deepest point	26.5.10	Lake	WTW devices, pump	14.0	419.21	658	6.1	6.4	7.8

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Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera-	Oxygen	pН
					ſm	ſuS/	ture	content	
				[m]	a.s.l.]	cm)	[°C]	[mg/l]	
New deepest point	26.5.10	Lake	WTW devices, pump	15.0	418.21	659	6.2	5.8	7.8
New deepest point	26.5.10	Lake	WTW devices, pump	16.0	417.21	663	6.2	3.9	7.7
New deepest point	26.6.10	Lake	WTW devices, pump	0.0	433.32	539	21.1	6.9	7.9
New deepest point	26.6.10	Lake	WTW devices, pump	1.0	432.32	537	20.3	7.6	7.7
New deepest point	26.6.10	Lake	WTW devices, pump	2.0	431.32	539	19.9	8.3	7.7
New deepest point	26.6.10	Lake	WTW devices, pump	3.0	430.32	542	19.2	8.7	7.6
New deepest point	26.6.10	Lake	WTW devices, pump	4.0	429.32	552	18.5	9.1	7.6
New deepest point	26.6.10	Lake	WTW devices, pump	5.0	428.32	599	17.3	8.4	7.3
New deepest point	26.6.10	Lake	WTW devices, pump	6.0	427.32	652	16.0	11.5	7.2
New deepest point	26.6.10	Lake	WTW devices, pump	7.0	426.32	650	12.5	11.7	7.3
New deepest point	26.6.10	Lake	WTW devices, pump	8.0	425.32	642	9.9	9.0	7.3
New deepest point	26.6.10	Lake	WTW devices, pump	9.0	424.32	651	8.1	3.0	7.1
New deepest point	26.6.10	Lake	WTW devices, pump	10.0	423.32	647	7.1	1.0	7.2
New deepest point	26.6.10	Lake	WTW devices, pump	11.0	422.32	654	6.8	0.0	7.3
New deepest point	26.6.10	Lake	WTW devices, pump	12.0	421.32	660	6.7	0.0	7.4
New deepest point	26.6.10	Lake	WTW devices, pump	13.0	420.32	664	6.7	0.0	7.4
New deepest point	26.6.10	Lake	WTW devices, pump	14.0	419.32	665	6.7	0.0	7.5
New deepest point	26.6.10	Lake	WTW devices, pump	15.0	418.32	668	6.7	0.0	7.5
New deepest point	26.6.10	Lake	WTW devices, pump	16.0	417.32	671	6.7	0.0	7.6
New deepest point	29.7.10	Lake	WTW devices, pump	0.0	433.36	522	22.1		7.9
New deepest point	29.7.10	Lake	WTW devices, pump	1.0	432.36	522	22.0		7.9
New deepest point	29.7.10	Lake	WTW devices, pump	2.0	431.36	522	22.0		7.9
New deepest point	29.7.10	Lake	WTW devices, pump	3.0	430.36	523	21.9		7.9
New deepest point	29.7.10	Lake	WTW devices, pump	4.0	429.36	525	21.8		7.8
New deepest point	29.7.10	Lake	WTW devices, pump	5.0	428.36	570	21.3		7.4
New deepest point	29.7.10	Lake	WTW devices, pump	6.0	427.36	641	19.2		7.5
New deepest point	29.7.10	Lake	WTW devices, pump	7.0	426.36	647	15.5		7.5
New deepest point	29.7.10	Lake	WTW devices, pump	8.0	425.36	650	11.6		7.4
New deepest point	29.7.10	Lake	WTW devices, pump	9.0	424.36	706	10.0		7.3
New deepest point	29.7.10	Lake	WTW devices, pump	10.0	423.36	676	8.4		7.3
New deepest point	29.7.10	Lake	WTW devices, pump	11.0	422.36	666	7.7		7.3
New deepest point	29.7.10	Lake	WTW devices, pump	12.0	421.36	660	7.3		7.3
New deepest point	29.7.10	Lake	WTW devices, pump	13.0	420.36	659	7.2		7.3
New deepest point	29.7.10	Lake	WTW devices, pump	14.0	419.36	661	7.3		7.3
New deepest point	29.7.10	Lake	WTW devices, pump	15.0	418.36	661	7.3		7.3
New deepest point	29.7.10	Lake	WTW devices, pump	15.5	417.86	683	7.4		7.3
New deepest point	21.8.10	Lake	WTW devices, pump	0.0	433.38	472	24.1	12.8	8.5
New deepest point	21.8.10	Lake	WTW devices, pump	1.0	432.38	470	21.8	9.6	8.3
New deepest point	21.8.10	Lake	WTW devices, pump	2.0	431.38	468	20.7	9.9	8.3
New deepest point	21.8.10	Lake	WTW devices, pump	3.0	430.38	466	20.1	10.5	8.3
New deepest point	21.8.10	Lake	WTW devices, pump	4.0	429.38	480	19.7	10.9	8.2
New deepest point	21.8.10	Lake	WTW devices, pump	5.0	428.38	529	19.3	10.8	7.9
New deepest point	21.8.10	Lake	WTW devices, pump	6.0	427.38	569	18.2	9.3	7.7
New deepest point	21.8.10	Lake	WTW devices, pump	7.0	426.38	646	15.9	8.2	7.7
New deepest point	21.8.10	Lake	WTW devices, pump	8.0	425.38	658	11.7	5.8	7.6
New deepest point	21.8.10	Lake	WTW devices, pump	9.0	424.38	676	10.0	3.0	7.6
New deepest point	21.8.10	Lake	WTW devices, pump	10.0	423.38	675	8.7	0.4	7.7
New deepest point	21.8.10	Lake	WTW devices, pump	11.0	422.38	669	8.1	0.0	7.8
New deepest point	21.8.10	Lake	WTW devices, pump	12.0	421.38	774	7.7	0.0	7.8
New deepest point	21.8.10	Lake	WTW devices, pump	13.0	420.38	778	7.6	0.0	7.8
New deepest point	21.8.10	Lake	WTW devices, pump	14.0	419.38	779	7.7	0.0	7.8
New deepest point	21.8.10	Lake	WTW devices, pump	15.0	418.38	779	7.6	0.0	7.8

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Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera-	Oxygen content	pН
				[m]	[m a.s.l.]	[μS/ cm)	[°C]	[mg/l]	
New deepest point	21.8.10	Lake	WTW devices, pump	15.5	417.38	779	7.6	0.0	7.7
Old deepest point	25.3.10	Lake	WTW devices, pump	0.0	433.31	641	9.6	10.9	8.1
Old deepest point	25.3.10	Lake	WTW devices, pump	1.0	432.31	642	9.4	11.3	8.1
Old deepest point	25.3.10	Lake	WTW devices, pump	2.0	431.31	642	9.2	11.0	8.1
Old deepest point	25.3.10	Lake	WTW devices, pump	3.0	430.31	641	8.2	11.8	8.1
Old deepest point	25.3.10	Lake	WTW devices, pump	4.0	429.31	639	7.0	12.0	8.1
Old deepest point	25.3.10	Lake	WTW devices, pump	5.0	428.31	641	5.8	12.8	8.1
Old deepest point	25.3.10	Lake	WTW devices, pump	6.0	427.31	639	5.3	13.0	8.1
Old deepest point	25.3.10	Lake	WTW devices, pump	7.0	426.31	642	4.9	12.8	8.1
Old deepest point	25.3.10	Lake	WTW devices, pump	8.0	425.31	644	4.7	12.8	8.1
Old deepest point	25.3.10	Lake	WTW devices, pump	9.0	424.31	646	4.6	12.0	8.1
Old deepest point	25.3.10	Lake	WTW devices, pump	10.0	423.31	647	4.5	11.5	8.1
Old deepest point	25.3.10	Lake	WTW devices, pump	11.0	422.31	649	4.6	10.5	8.1
Old deepest point	26.5.10	Lake	WTW devices, pump	0.0	433.21	581	19.2	12.1	8.1
Old deepest point	26.5.10	Lake	WTW devices, pump	1.0	432.21	581	19.0	12.2	8.1
Old deepest point	26.5.10	Lake	WTW devices, pump	2.0	431.21	582	17.7	12.4	8.0
Old deepest point	26.5.10	Lake	WTW devices, pump	3.0	430.21	586	15.8	13.1	8.0
Old deepest point	26.5.10	Lake	WTW devices, pump	4.0	429.21	597	15.1	13.4	8.0
Old deepest point	26.5.10	Lake	WTW devices, pump	5.0	428.21	657	14.0	14.2	7.8
Old deepest point	26.5.10	Lake	WTW devices, pump	6.0	427.21	665	11.7	17.5	7.9
Old deepest point	26.5.10	Lake	WTW devices, pump	7.0	426.21	648	9.1	17.5	8.1
Old deepest point	26.5.10	Lake	WTW devices, pump	8.0	425.21	646	7.5	13.5	8.0
Old deepest point	26.5.10	Lake	WTW devices, pump	9.0	424.21	650	6.6	11.0	7.9
Old deepest point	26.5.10	Lake	WTW devices, pump	10.0	423.21	652	6.3	9.6	7.8
Old deepest point	26.5.10	Lake	WTW devices, pump	11.0	422.21	653	6.3	7.4	7.7
Old deepest point	26.5.10	Lake	WTW devices, pump	12.0	421.21	653	6.2	5.5	7.7
Old deepest point	26.5.10	Lake	WTW devices, pump	13.0	420.21	654	6.2	4.8	7.7
Old deepest point	26.6.10	Lake	WTW devices, pump	0.0	433.32	535	21.9	8.5	7.9
Old deepest point	26.6.10	Lake	WTW devices, pump	1.0	432.32	535	20.6	8.2	7.9
Old deepest point	26.6.10	Lake	WTW devices, pump	2.0	431.32	538	20.8	8.3	7.9
Old deepest point	26.6.10	Lake	WTW devices, pump	3.0	430.32	537	19.2	8.3	7.9
Old deepest point	26.6.10	Lake	WTW devices, pump	4.0	429.32	541	18.6	8.5	7.8
Old deepest point	26.6.10	Lake	WTW devices, pump	5.0	428.32	618	17.5	9.6	7.5
Old deepest point	26.6.10	Lake	WTW devices, pump	6.0	427.32	658	15.8	12.1	7.5
Old deepest point	26.6.10	Lake	WTW devices, pump	7.0	426.32	642	13.1	13.6	7.7
Old deepest point	26.6.10	Lake	WTW devices, pump	8.0	425.32	633	10.2	11.8	7.6
Old deepest point	26.6.10	Lake	WTW devices, pump	9.0	424.32	634	8.0	8.2	7.5
Old deepest point	26.6.10	Lake	WTW devices, pump	10.0	423.32	639	7.0	4.6	7.4
Old deepest point	26.6.10	Lake	WTW devices, pump	11.0	422.32	642	6.8	2.9	7.4
Old deepest point	26.6.10	Lake	WTW devices, pump	12.0	421.32	645	6.7	2.3	7.3
Old deepest point	26.6.10	Lake	WTW devices, pump	13.0	420.32	645	6.7	0.7	7.3
Old deepest point	29.7.10	Lake	WTW devices, pump	0.0	433.36	523	21.9	9.1	7.6
Old deepest point	29.7.10	Lake	WTW devices, pump	1.0	432.36	522	21.9	8.9	7.9
Old deepest point	29.7.10	Lake	WTW devices, pump	2.0	431.36	522	22.0	9.3	7.9
Old deepest point	29.7.10	Lake	WTW devices, pump	3.0	430.36	522	22.0	8.9	7.9
Old deepest point	29.7.10	Lake	WTW devices, pump	4.0	429.36	522	22.0	9.3	7.9
Old deepest point	29.7.10	Lake	WTW devices, pump	5.0	428.36	578	21.4	9.5	7.6
Old deepest point	29.7.10	Lake	WTW devices, pump	6.0	427.36	639	18.9	11.4	7.5
Old deepest point	29.7.10	Lake	WTW devices, pump	7.0	426.36	638	15.2	10.7	7.5
Old deepest point	29.7.10	Lake	WTW devices, pump	8.0	425.36	637	12.1	9.7	7.5
Old deepest point	29.7.10	Lake	WTW devices, pump	9.0	424.36	646	9.5	5.7	7.4
Old deepest point	29.7.10	Lake	WTW devices, pump	10.0	423.36	643	8.1	2.9	7.4

Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	рН
				[m]	[m a.s.l.]	[μS/ cm)	[°C]	[mg/l]	
Old deepest point	29.7.10	Lake	WTW devices, pump	11.0	422.36	652	7.7	2.2	7.4
Old deepest point	29.7.10	Lake	WTW devices, pump	11.5	421.86	653	7.7		
Old deepest point	21.8.10	Lake	WTW devices, pump	0.0	433.38	472	22.8	9.4	8.2
Old deepest point	21.8.10	Lake	WTW devices, pump	1.0	432.38	474	21.3	5.6	8.2
Old deepest point	21.8.10	Lake	WTW devices, pump	2.0	431.38	469	20.5	5.5	8.2
Old deepest point	21.8.10	Lake	WTW devices, pump	3.0	430.38	467	20.1	8.0	8.2
Old deepest point	21.8.10	Lake	WTW devices, pump	4.0	429.38	483	19.7	11.6	8.1
Old deepest point	21.8.10	Lake	WTW devices, pump	5.0	428.38	600	14.8	10.0	7.8
Old deepest point	21.8.10	Lake	WTW devices, pump	6.0	427.38	635	11.2	9.5	7.6
Old deepest point	21.8.10	Lake	WTW devices, pump	7.0	426.38	653	9.6	8.9	7.6
Old deepest point	21.8.10	Lake	WTW devices, pump	8.0	425.38	667	8.1	5.8	7.5
Old deepest point	21.8.10	Lake	WTW devices, pump	9.0	424.38	667	8.1	1.7	7.5
Old deepest point	21.8.10	Lake	WTW devices, pump	10.0	423.38	667	8.1	0.0	7.5
Old deepest point	21.8.10	Lake	WTW devices, pump	11.0	422.38	666	8.1	0.0	7.7
Old deepest point	21.8.10	Lake	WTW devices, pump	12.0	421.38	666	8.1	0.0	7.5
Old deepest point	21.8.10	Lake	WTW devices, pump	13.0	420.38	666	8.0	0.0	7.5
Marginal inflow area	26.6.10	Lake	WTW Cond 197i	0.0	433.32	538	23.1		
Marginal inflow area	26.6.10	Lake	WTW Cond 197i	1.0	432.32	535	20.7		
Marginal inflow area	26.6.10	Lake	WTW Cond 197i	2.0	431.32	535	20.2		
Marginal inflow area	26.6.10	Lake	WTW Cond 197i	3.0	430.32	539	19.1		
Marginal inflow area	26.6.10	Lake	WTW Cond 197i	4.0	429.32	550	18.4		
Marginal inflow area	26.6.10	Lake	WTW Cond 197i	5.0	428.32	615	17.4		
Marginal inflow area	26.6.10	Lake	WTW Cond 197i	6.0	427.32	656	15.4		
Marginal inflow area	26.6.10	Lake	WTW Cond 197i	7.0	426.32	648	12.4		
Marginal inflow area	26.6.10	Lake	WTW Cond 197i	8.0	425.32	653	10.0		
Marginal inflow area	26.6.10	Lake	WTW Cond 197i	9.0	424.32	659	7.9		
Marginal inflow area	26.6.10	Lake	WTW Cond 197i	10.0	423.32	658	7.3		
Marginal inflow area	29.7.10	Lake	WTW Cond 197i	0.0	433.36	524	21.9		
Marginal inflow area	29.7.10	Lake	WTW Cond 197i	1.0	432.36	522	22.0		
Marginal inflow area	29.7.10	Lake	WTW Cond 197i	2.0	431.36	522	21.9		
Marginal inflow area	29.7.10	Lake	WTW Cond 197i	3.0	430.36	522	21.9		
Marginal inflow area	29.7.10	Lake	WTW Cond 197i	4.0	429.36	522	21.9		
Marginal inflow area	29.7.10	Lake	WTW Cond 197i	5.0	428.36	609	21.1		
Marginal inflow area	29.7.10	Lake	WTW Cond 197i	6.0	427.36	642	18.8		
Marginal inflow area	29.7.10	Lake	WTW Cond 197i	7.0	426.36	642	14.9		
Marginal inflow area	29.7.10	Lake	WTW Cond 197i	8.0	425.36	665	11.5		
Marginal inflow area	29.7.10	Lake	WTW Cond 197i	9.0	424.36	704	10.2		
Marginal inflow area	29.7.10	Lake	WTW Cond 197i	9.5	423.86	690	9.6		
Marginal inflow area	21.8.10	Lake	WTW Cond 197i	0.0	433.38	470	25.3		
Marginal inflow area	21.8.10	Lake	WTW Cond 197i	1.0	432.38	471	22.2		
Marginal inflow area	21.8.10	Lake	WTW Cond 197i	2.0	431 38	464	20.8		
Marginal inflow area	21.0.10	Lake	WTW Cond 197i	3.0	430 38	469	20.0		
Marginal inflow area	21.0.10	Lake	WTW Cond 197i	4.0	429 38	491	19.9		
Marginal inflow area	21.0.10	Lake	WTW Cond 197i	5.0	428 38	563	19.2		
Marginal inflow area	21.0.10	Lake	WTW Cond 197i	6.0	427 38	599	17.9		
Marginal inflow area	21.8.10	Lake	WTW Cond 197i	7.0	426 38	646	15.4		
Marginal inflow area	21.8.10	Lake	WTW Cond 197i	8.0	425 38	657	12.1		
Marginal inflow area	21.8.10	Lake	WTW Cond 197i	9.0	424 38	682	10 3		
Marginal inflow area	21.8.10	Lake	WTW Cond 197i	10.0	423.38	520	9.0		
Marginal outflow area	26.6.10	Lake	WTW Cond 197i	0.0	433 32	534	22.0		
Marginal outflow area	26.6.10	Lake	WTW Cond 197i	1.0	432.32	534	20.9		

Marginal outflow area 26.6.10

Lake

WTW Cond 197i

2.0 431.32 534

20.3

Measuring point	Date	Location	Sampling method	Depth	Altitude	EC	Tem- pera- ture	Oxygen content	рН
				[m]	[m a.s.l.]	[μS/ cm)	[°C]	[mg/l]	
Marginal outflow area	26.6.10	Lake	WTW Cond 197i	3.0	430.32	540	19.6		
Marginal outflow area	26.6.10	Lake	WTW Cond 197i	4.0	429.32	550	18.5		
Marginal outflow area	26.6.10	Lake	WTW Cond 197i	5.0	428.32	618	17.5		
Marginal outflow area	26.6.10	Lake	WTW Cond 197i	6.0	427.32	645	16.0		
Marginal outflow area	26.6.10	Lake	WTW Cond 197i	7.0	426.32	646	12.3		
Marginal outflow area	29.7.10	Lake	WTW Cond 197i	0.0	433.36	527	22.0		
Marginal outflow area	29.7.10	Lake	WTW Cond 197i	1.0	432.36	527	22.0		
Marginal outflow area	29.7.10	Lake	WTW Cond 197i	2.0	431.36	527	22.0		
Marginal outflow area	29.7.10	Lake	WTW Cond 197i	3.0	430.36	527	22.0		
Marginal outflow area	29.7.10	Lake	WTW Cond 197i	4.0	429.36	557	22.0		
Marginal outflow area	29.7.10	Lake	WTW Cond 197i	5.0	428.36	630	21.1		
Marginal outflow area	29.7.10	Lake	WTW Cond 197i	6.0	427.36	634	19.2		
Marginal outflow area	29.7.10	Lake	WTW Cond 197i	7.0	426.36	633	15.6		
Marginal outflow area	21.8.10	Lake	WTW Cond 197i	0.0	433.38	470	24.8		
Marginal outflow area	21.8.10	Lake	WTW Cond 197i	1.0	432.38	465	22.4		
Marginal outflow area	21.8.10	Lake	WTW Cond 197i	2.0	431.38	462	20.9		
Marginal outflow area	21.8.10	Lake	WTW Cond 197i	3.0	430.38	469	20.5		
Marginal outflow area	21.8.10	Lake	WTW Cond 197i	4.0	429.38	490	20.1		
Marginal outflow area	21.8.10	Lake	WTW Cond 197i	5.0	428.38	585	19.5		
Marginal outflow area	21.8.10	Lake	WTW Cond 197i	6.0	427.38	606	18.6		
Marginal outflow area	21.8.10	Lake	WTW Cond 197i	6.5	426.88	625	17.7		

Appendix B.2 Stable isotope data

able B 3: Stable isotope ratios of the measuring campaign 2009 and 2010.

Measuring point	Sampling date	Location	Sampling method	Depth	δ ¹⁸ Ο	$\delta^2 H$	D- Excess
				[m]	[‰ VSMOW]		
P1/09	26.02.2009	downgradient			-8.25	-63.28	2.70
P1/09	06.05.2009	downgradient			-8.56	-64.00	4.51
P1/09	04.06.2009	downgradient			-8.75	-64.42	5.60
P1/09	09.07.2009	downgradient			-8.69	-64.23	5.32
P1/09	11.08.2009	downgradient		10	-8.71	-65.18	4.52
P1/09	11.08.2009	downgradient		13	-8.50	-63.38	4.62
P1/09	11.08.2009	downgradient		16	-8.54	-63.57	4.77
P1/09	11.08.2009	downgradient		18	-8.61	-63.77	5.11
P1/09	09.09.2009	downgradient			-8.43	-63.05	4.43
P1/09	12.11.2009	downgradient			-8.60	-62.64	6.18
P1/09	25.03.2010	downgradient	pumped		-8.64	-62.11	7.00
P1/09	25.03.2010	downgradient	bailer		-8.71	-62.74	6.95
P1/09	06.04.2010	downgradient	bailer		-8.68	-63.42	6.06
P1/09	12.04.2010	downgradient	bailer		-9.00	-64.51	7.50
P1/09	19.04.2010	downgradient	bailer		-8.98	-64.33	7.50
P1/09	26.04.2010	downgradient	bailer		-8.89	-64.31	6.78
P1/09	28.04.2010	downgradient	bailer		-8.86	-64.02	6.87
P1/09	03.05.2010	downgradient	bailer		-8.75	-64.02	6.01

Measuring point	Sampling date	Location	Sampling method	Depth	δ ¹⁸ Ο	$\delta^2 H$	D- Excess
	uute		methou	[m]	[‰ VS	MOWI	LACCOD
P1/09	10.05.2010	downgradient	bailer	[]	-8.82	-64.27	6.26
P1/09	17.05.2010	downgradient	bailer		-8.82	-64.33	6.23
P1/09	26.05.2010	downgradient	bailer		-8.84	-64.09	6.61
P1/09	31.05.2010	downgradient	bailer		-8.71	-64.29	5.41
P1/09	07.06.2010	downgradient	bailer		-8.86	-64.65	6.22
P1/09	14.06.2010	downgradient	bailer		-8.86	-64.24	6.65
P1/09	25.06.2010	downgradient	bailer		-8.94	-64.97	6.53
P1/09	28.06.2010	downgradient	bailer		-8.70	-64.46	5.18
P1/09	05.07.2010	downgradient	bailer		-8.66	-64.56	4.76
P1/09	12.07.2010	downgradient	bailer		-8.64	-64.04	5.10
P1/09	19.07.2010	downgradient	bailer		-8.61	-64.63	4.26
P1/09	26.07.2010	downgradient	bailer		-8.61	-64.26	4.65
P1/09	27.07.2010	downgradient	bailer		-8.57	-64.10	4.47
P1/09	02.08.2010	downgradient	bailer		-8.73	-64.78	5.04
P1/09	09.08.2010	downgradient	bailer		-8.67	-64.69	4.69
P1/09	16.08.2010	downgradient	bailer		-8.56	-64.02	4.47
P1/09	20.08.2010	downgradient	bailer		-8.71	-64.47	5.24
P1/09	20.08.2010	downgradient	pumped		-8.68	-64.73	4.71
P2/09	26.02.2009	upgradient			-9.43	-68.08	7.38
P2/09	04.06.2009	upgradient			-9.61	-67.24	9.61
P2/09	09.07.2009	upgradient			-9.57	-68.93	7.61
P2/09	11.08.2009	upgradient			-9.59	-67.86	8.88
P2/09	09.09.2009	upgradient			-9.76	-68.11	9.94
P2/09	25.03.2010	upgradient	pumped		-9.83	-67.96	10.67
P2/09	27.04.2010	upgradient	bailer		-9.74	-67.71	10.22
P2/09	25.05.2010	upgradient	bailer		-9.78	-68.00	10.25
P2/09	25.06.2010	upgradient	bailer		-9.93	-68.53	10.90
P2/09	27.07.2010	upgradient	bailer		-9.54	-68.30	8.03
P2/09	20.08.2010	upgradient	bailer		-9.65	-68.54	8.63
P2/09	20.08.2010	upgradient	pumped		-9.52	-68.43	7.76
P12/75	26.03.2010	downgradient	pumped		-10.08	-69.69	10.93
P12/75	25.05.2010	downgradient	bailer		-9.95	-68.74	10.89
P12/75	25.06.2010	downgradient	bailer		-8.52	-59.50	8.66
P12/75	27.07.2010	downgradient	bailer		-8.58	-62.04	6.61
P12/75	20.08.2010	downgradient	bailer		-8.97	-63.34	8.41
P33	25.03.2010	upgradient	pumped		-10.43	-72.52	10.93
P33	27.04.2010	upgradient	bailer		-10.39	-/1.29	11.86
P33	25.05.2010	upgradient	bailer		-11.04	-76.29	12.06
P33	25.06.2010	upgradient	bailer		-11.02	-/5.65	12.55
P33	27.07.2010	upgradient	baller		-10.64	-75.79	9.32
P33	20.08.2010	upgradient	baller		-10.39	-74.45	8.66
P34	26.02.2009	upgradient			-9.71	-68.77	8.87
P34	04.06.2009	upgradient			-9.69	-67.99	9.51
P34	09.07.2009	upgradient			-9.65	-68.71	8.40
P34	11.08.2009	upgradient			-9.80	-69.04	9.37
P34	09.09.2009	upgradient	numnad		-9.81	-08.04	9.80
P34	25.03.2010	upgradient	pumped		-9.83	-07.77	10.88
P34	06.04.2010	upgradient	baller		-9.80	-08.04	10.36
г 54 D2/	27.04.2010	upgradient	bailor		-9.01	-00.23	10.71
г 54 D2/	25.05.2010	upgradient	bailor		-9.90	-00.01	10.00
r 54 D2/	23.00.2010	upgradient	bailer		-9.90	-03.23	8 VC TO'OT
г 54 D2/	27.07.2010	upgradient	bailor		-9.70	-09.00	0.40 Q 02
г 34 РЗЛ	20.08.2010	ungradient	numped		-9.70	-09.34	0.05 8 00
P36	04 06 2000	downgradiont	pumpeu		-9.02 _9.02	-66 11	5 76
P36	09.07.2009	downgradient			-0.90 -8 80	-00.11	7.05
P36	11.08 2009	downgradient			-8.82	-64 71	5.86
	11.00.2000	ao manual cint			0.02	0- 1 .7 1	5.00

Table B 3: Stable isotope ratios of the measuring campaign 2009 and 2010.

mpaign 200	9 and 2010	0.		
Sampling method	Depth	δ ¹⁸ Ο	$\delta^2 H$	D Exc
	[m]	[‰ VS	MOW]	
		-8.80	-64.30	6.0
pumped		-9.12	-64.69	8.2
		0.40	CF 00	

Table B 3: Stable isotope ratios of the measuring campai

Sampling

Measuring point	Sampling	Location	Sampling	Depth	δ ¹⁸ Ο	$\delta^2 H$	D-
011	date		method				Excess
				[m]	[‰ VS	MOWJ	
P36	09.09.2009	downgradient			-8.80	-64.30	6.06
P36	25.03.2010	downgradient	pumped		-9.12	-64.69	8.27
P36	27.04.2010	downgradient	bailer		-9.13	-65.08	7.94
P36	25.05.2010	downgradient	bailer		-9.27	-65.89	8.27
P36	25.06.2010	downgradient	bailer		-9.46	-67.01	8.67
P36	27.07.2010	downgradient	bailer		-9.29	-68.17	6.17
P36	20.08.2010	downgradient	bailer		-9.26	-67.57	6.50
P36	20.08.2010	downgradient	pumped		-9.13	-66.73	6.33
P37	05.03.2009	beside lake			-9.67	-68.69	8.68
P37	04.06.2009	beside lake			-10.13	-71.29	9.77
P37	09.07.2009	beside lake			-9.92	-69.73	9.67
P37	11.08.2009	beside lake			-8.51	-63.17	4.92
P37	09.09.2009	beside lake			-8.08	-59.94	4.70
P37	12.11.2009	beside lake			-8.18	-60.00	5.45
P37	26.03.2010	beside lake	pumped		-9.71	-67.48	10.18
P37	26.03.2010	beside lake	bailer		-9.61	-67.15	9.74
P37	27.04.2010	beside lake	bailer		-8.79	-64.07	6.25
P37	25.05.2010	beside lake	bailer		-10.01	-69.18	10.92
P37	25.06.2010	beside lake	bailer		-10.37	-72.05	10.95
P37	27.07.2010	beside lake	bailer		-9.99	-71.91	8.02
P37	20.08.2010	beside lake	bailer		-9.61	-70.09	6.78
P37	20.08.2010	beside lake	pumped		-8.85	-65.44	5.33
Schapbuchquelle	04.03.2009	upgradient	pumped		-10.03	-70.72	9.53
Schapbuchquelle	04.06.2009	upgradient	pumped		-9.95	-69.36	10.25
Schapbuchquelle	09.07.2009	upgradient	pumped		-9.96	-69.37	10.31
Schapbuchquelle	11.08.2009	upgradient	pumped		-10.15	-69.09	12.07
Schapbuchquelle	09.09.2009	upgradient	pumped		-10.15	-70.10	11.13
Schapbuchquelle	13.04.2010	upgradient	pumped		-10.44	-71.23	12.31
Schapbuchquelle	19.04.2010	upgradient	pumped		-10.43	-71.19	12.28
Schapbuchquelle	26.04.2010	upgradient	pumped		-10.15	-69.84	11.33
Schapbuchquelle	03.05.2010	upgradient	pumped		-10.27	-70.77	11.40
Schapbuchquelle	10.05.2010	upgradient	pumped		-10.23	-70.80	11.06
Schapbuchquelle	17.05.2010	upgradient	pumped		-10.26	-70.39	11.69
Schapbuchquelle	26.05.2010	upgradient	pumped		-10.21	-70.50	11.19
Schapbuchquelle	31.05.2010	upgradient	pumped		-10.18	-70.92	10.51
Schapbuchquelle	07.06.2010	upgradient	pumped		-10.12	-70.39	10.58
Schapbuchquelle	14.06.2010	upgradient	pumped		-10.22	-70.78	10.95
Schapbuchquelle	23.06.2010	upgradient	pumped		-10.30	-70.82	11.62
Schapbuchquelle	28.06.2010	upgradient	pumped		-10.10	-70.68	10.10
Schapbuchquelle	05.07.2010	upgradient	pumped		-10.13	-71.83	9.20
Schapbuchquelle	12.07.2010	upgradient	pumped		-10.02	-71.03	9.10
Schapbuchquelle	19.07.2010	upgradient	pumped		-10.07	-70.38	10.20
Schapbuchquelle	02.08.2010	upgradient	pumped		-10.00	-70.44	9.58
Schapbuchquelle	09.08.2010	upgradient	pumped		-10.00	-70.66	9.33
Schapbuchquelle	16.08.2010	upgradient	pumped		-9.98	-70.62	9.25
TB Stadion	26.02.2009	downgradient	pumped		-8.42	-63.70	3.63
TB Stadion	04.06.2009	downgradient	pumped		-8.83	-64.53	6.10
TB Stadion	09.07.2009	downgradient	pumped		-8.32	-61.42	5.17
TB Stadion	11.08.2009	downgradient	pumped		-8.06	-61.55	2.91
TB Stadion	09.09.2009	downgradient	pumped		-7.95	-58.70	4.90
TB Stefansfeld	04.03.2009	beside lake	pumped		-9.78	-69.88	8.39
TB Stefansfeld	04.06.2009	beside lake	pumped		-10.24	-70.35	11.58
TB Stefansfeld	09.07.2009	beside lake	pumped		-10.26	-70.38	11.69
TB Stefansfeld	11.08.2009	beside lake	pumped		-9.85	-68.58	10.24
TB Stefansfeld	09.09.2009	beside lake	pumped		-9.90	-67.85	11.32
TB Stefansfeld	12.11.2009	beside lake	pumped		-10.03	-69.89	10.35
TB Stefansfeld	13.04.2010	beside lake	pumped		-10.00	-69.44	10.57

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Measuring point	Sampling	Location	Sampling	Depth	δ ¹⁸ Ο	δ ² H	D-
	date	Location	method				Excess
				[m]	[‰ VS	MOW]	
TB Stefansfeld	19.04.2010	beside lake	pumped		-9.97	-69.39	10.35
TB Stefansfeld	26.04.2010	beside lake	pumped		-10.15	-69.07	12.16
TB Stefansfeld	03.05.2010	beside lake	pumped		-10.00	-69.35	10.63
TB Stefansfeld	10.05.2010	beside lake	pumped		-9.97	-69.50	10.29
TB Stefansfeld	17.05.2010	beside lake	pumped		-9.99	-68.60	11.29
TB Stefansfeld	26.05.2010	beside lake	pumped		-9.92	-69.11	10.25
TB Stefansfeld	31.05.2010	beside lake	pumped		-10.01	-69.76	10.29
TB Stefansfeld	07.06.2010	beside lake	pumped		-9.94	-09.05	9.83
TB Stefansfeld	14.06.2010	beside lake	pumped		-10.03	-70.14	10.10
TB Stefansfeld	23.06.2010	beside lake	pumped		-10.04	-09.33	0.24
TB Stelansield	28.06.2010	beside lake	pumped		-9.84	-09.30	9.34
TB Stelansfeld	12 07 2010	beside lake	pumped		-9.85	-70.39	8.43 0.00
TB Stelansfeld	12.07.2010	beside lake	pumped		-9.79 0.75	-70.28	0.08 0.17
TD Stelansfeld	19.07.2010	beside lake	pumped		-9.75	-00.00	9.17
TB Stefansfeld	02.08.2010	beside lake	pumped		-9.02	-00.00	0.15
TB Stelansfeld	16 08 2010	beside lake	pumped		-9.72	-08.08	9.12
Dior1	10.08.2010		pumped		-9.74 0 CE	-09.28	8.01 4.90
Pier1	00.05.2009	Lake			-0.05 0 OE	-04.55	4.09
Pier1	04.00.2009	Lake			-0.05 7 75	-01.15	3.27
Pier1	11 08 2000	Lake			-7.75	-00.00	2.03
Pier1	25 02 2010	Lake		0	-7.01	-57.00	5.25 7.10
Pier1	25.05.2010	Lake		0	-9.15	-05.90 6E 21	6.42
Pier1 Dior1	12 04 2010	Lake		0	-0.97	-05.51	0.42
Pier1	12.04.2010	Lake		0	-9.10	-05.00	7.14 9.40
Pier1 Dior1	19.04.2010 26.04.2010	Lake		0	-9.20	-05.25	0.40 7.22
Pier1	20.04.2010	Lake		0	-9.01	-04.90	5 56
Pier1	27.04.2010	Lake		0	-0.72	-04.21 62.57	6.92
Pier1	10.05.2010	Lake		0	-0.00	-64.85	6.38
Dior1	17.05.2010	Lake		0	-8.90	-04.05	6.17
Dior1	25 05 2010	Lake		0	-8.50	-63.58	6.12
Pier1	31 05 2010	Lake		0	-8.64	-63.58	5.48
Pier1	07.06.2010	Lake		0	-8.04	-63.05	5.40
Dior1	14.06.2010	Lake		0	_8 /10	-62.10	5.57
Pier1	21 06 2010	Lake		0	-8 72	-63 78	5.98
Pier1	26.06.2010	Lake		0	-8.35	-62.62	2.50 4.15
Pier1	28.06.2010	Lake		0	-8 15	-62.23	2 95
Pier1	05 07 2010	Lake		0	-8 27	-61 99	2.33 4 17
Pier1	12 07 2010	Lake		0	-8.05	-61.82	2 59
Pier1	19.07.2010	Lake		0	-7.97	-61.86	1.89
Pier1	26.07.2010	Lake		0	-8.02	-61.18	3.02
Pier1	29.07.2010	Lake		0	-8.07	-61.21	3.37
Pier1	02.08.2010	Lake		0	-8.12	-61.91	3.03
Pier1	09.08.2010	Lake		0	-8.07	-62.05	2.50
Pier1	16.08.2010	Lake		0	-8.00	-60.75	3.26
Pier1	21.08.2010	Lake		0	-7.88	-59.48	3.59
New deepest point	25.03.2010	Lake	case pump	0	-8.96	-64.66	7.02
New deepest point	25.03.2010	Lake	case pump	1	-9.00	-65.48	6.55
New deepest point	25.03.2010	Lake	case pump	2	-9.04	-65.64	6.64
New deepest point	25.03.2010	Lake	case pump	3	-9.09	-65.29	7.43
New deepest point	25.03.2010	Lake	case pump	4	-8.95	-64.98	6.59
New deepest point	25.03.2010	Lake	case pump	5	-8.99	-65.65	6.23
New deepest point	25.03.2010	Lake	case pump	- 6	-9.02	-65.41	6.76
New deepest point	25.03.2010	Lake	case pump	7	-8.98	-65.14	6.69
New deepest point	25.03.2010	Lake	case pump	8	-8.98	-65.15	6.68
New deepest point	25.03.2010	Lake	case pump	9	-8.98	-64.45	7.42
New deepest point	25.03.2010	Lake	case pump	10	-9.00	-64.90	7.08

Table B 3: Stable isotope ratios of the measuring campaign 2009 and 2010.

 Table B 3: Stable isotope ratios of the measuring campaign 2009 and 2010.

Measuring point	Sampling	Location	Sampling	Depth	δ ¹⁸ Ο	$\delta^2 H$	D-
	uate		method	[m]	[%, \/S		Excess
New deepest point	25.03.2010	Lako		11	_8 97	-65.44	6 35
New deepest point	25.03.2010	Lake	case pump	12	-8.99	-65 42	6.48
New deepest point	25.03.2010	Lake	case pump	13	-9.05	-65.42	0.40 7.01
New deepest point	25.03.2010	Lake	case pump	14	-9.00	-65.27	6.76
New deepest point	25.03.2010	Lake	case pump	15	-9.03	-64 47	7 75
New deepest point	25.03.2010	Lake	case pump	16	-9.03	-65 16	7.05
New deepest point	28.04.2010	Lake	case pump	0	-8.81	-63 77	6.73
New deepest point	28.04.2010	Lake	case pump	1	-8.86	-63.89	6.95
New deepest point	28.04.2010	Lake	case nump	2	-8.85	-63 22	7 55
New deepest point	28.04.2010	Lake	case pump	3	-8.96	-64.15	7.55
New deepest point	28.04.2010	Lake	case pump	4	-8.99	-65.63	6.31
New deepest point	28.04.2010	Lake	case pump	5	-9.21	-66.32	7.38
New deepest point	28.04.2010	Lake	case pump	6	-9.11	-65.19	7.67
New deepest point	28.04.2010	Lake	case pump	7	-9.04	-65.43	6.90
New deepest point	28.04.2010	Lake	case pump	8	-9.06	-64.89	7.58
New deepest point	28.04.2010	Lake	case pump	9	-8.98	-65 36	6 51
New deepest point	28.04.2010	Lake	case pump	10	-9.03	-65.22	7.00
New deepest point	28.04.2010	Lake	case pump	11	-9.00	-65.44	6.57
New deepest point	28.04.2010	Lake	case pump	12	-9.03	-65 36	6.88
New deepest point	28.04.2010	Lake	case pump	13	-9.03	-64.83	7 26
New deepest point	28.04.2010	Lake	case pump	14	-9.01	-65 10	7.20
New deepest point	28.04.2010	Lake	case pump	15	-9.01	-65 27	6.99
New deepest point	28.04.2010	Lake	case pump	16	-9.08	-65.26	7 40
New deepest point	26.05.2010	Lake	case pump	0	-8 75	-64 16	5.86
New deepest point	26.05.2010	Lake	case pump	1	-8 74	-63.83	6.07
New deepest point	26.05.2010	Lake	case pump	2	-8 78	-64 07	6.20
New deepest point	26.05.2010	Lake	case nump	3	-8.88	-64 55	6.45
New deepest point	26.05.2010	Lake	case pump	4	-8.90	-63.85	7.36
New deepest point	26.05.2010	Lake	case pump	5	-9.12	-65.62	7.37
New deepest point	26.05.2010	Lake	case pump	6	-9.22	-66.09	7.68
New deepest point	26.05.2010	Lake	case pump	7	-9.13	-65.98	7.08
New deepest point	26.05.2010	Lake	case pump	8	-9.05	-65.23	7.20
New deepest point	26.05.2010	Lake	case pump	9	-9.06	-65.26	7.25
New deepest point	26.05.2010	Lake	case pump	10	-9.07	-64.60	7.98
New deepest point	26.05.2010	Lake	case pump	11	-9.09	-65.24	7.45
New deepest point	26.05.2010	Lake	case pump	12	-9.08	-65.50	7.12
New deepest point	26.05.2010	Lake	case nump	13	-9.06	-65 39	7 1 2
New deepest point	26.05.2010	Lake	case pump	14	-8.97	-64.71	7.02
New deepest point	26.05.2010	Lake	case pump	15	-9.04	-65.48	6.80
New deepest point	26.05.2010	Lake	case pump	16	-9.08	-66.06	6.54
New deepest point	26.06.2010	Lake	case nump	0	-8 59	-62.62	6.12
New deepest point	26.06.2010	Lake	case pump	1	-8.61	-63.21	5.65
New deepest point	26.06.2010	Lake	case pump	2	-8.73	-63.42	6.45
New deepest point	26.06.2010	Lake	case pump	3	-8.69	-63.52	6.01
New deepest point	26.06.2010	Lake	case nump	4	-8 75	-63 32	6 64
New deepest point	26.06.2010	Lake	case pump	5	-8.95	-64 97	6.62
New deepest point	26.06.2010	Lake	case pump	6	-9.25	-65.89	8.10
New deepest point	26.06.2010	Lake	case pump	7	-9 11	-66 16	6 70
New deepest point	26.06.2010	Lake	case pump	, 8	-9.14	-65.87	7.24
New deepest point	26.06.2010	Lake	case pump	9	-9.25	-66.07	7.92
New deepest point	26.06 2010	Lake	case pump	10	-9.14	-65 77	7.32
New deepest point	26.06.2010	Lake	case pump	11	-9 08	-65 34	7.26
New deenest point	26.06 2010	Lake	case pump	12	-9.13	-65 25	7 77
New deenest point	26.06 2010	Lake	case pump	13	-9.16	-65 82	7 45
New deenest point	26.06.2010	Lake	case pump	14	-9.16	-66 15	7 17
New deepest point	26.06 2010	Lake	case pump	15	-9.16	-66 02	7.28
New deepest point	26.06.2010	Lake	case pump	16	-9.23	-66.43	7.38

Measuring point	Sampling	Location	Sampling	Depth	δ ¹⁸ Ο	δ ² H	D-
incusuing point	date	Lotation	method			• 11	Excess
	20.07.2040			[m]	[‰ VS	MOW	4 74
New deepest point	29.07.2010	Lake	case pump	0	-7.94	-61.82	1./1
New deepest point	29.07.2010	Lake	case pump	1	-7.92	-61.39	1.95
New deepest point	29.07.2010	Lake	case pump	2	-7.97	-01.44	2.34
New deepest point	29.07.2010	Lake	case pump	2	-7.00	-01.10	1.00
New deepest point	29.07.2010	Lake	case pump	4 5	-7.07	-61.00	1.92 5.41
New deepest point	29.07.2010	Lake	case pump	5	-0.01	-66.18	5.98
New deepest point	29.07.2010	Lake	case pump	7	-9.02	-66 50	5.50
New deepest point	29.07.2010	Lake	case pump	, 8	-9 11	-66 14	6 73
New deepest point	29.07.2010	Lake	case pump	9	-9.28	-66 48	7.80
New deepest point	29.07.2010	Lake	case pump	10	-8.86	-65.39	5.50
New deepest point	29.07.2010	Lake	case pump	11	-8.97	-65.83	5.91
New deepest point	29.07.2010	Lake	case pump	12	-8.96	-65.33	6.32
New deepest point	29.07.2010	Lake	case pump	13	-8.93	-64.73	6.69
New deepest point	29.07.2010	Lake	case pump	14	-8.90	-65.77	5.47
New deepest point	29.07.2010	Lake	case pump	15	-8.96	-65.76	5.95
New deepest point	21.08.2010	Lake	case pump	0	-7.74	-60.82	1.09
New deepest point	21.08.2010	Lake	case pump	1	-7.81	-60.60	1.91
New deepest point	21.08.2010	Lake	case pump	2	-7.91	-60.23	3.05
New deepest point	21.08.2010	Lake	case pump	3	-7.82	-60.81	1.77
New deepest point	21.08.2010	Lake	case pump	4	-7.92	-61.49	1.88
New deepest point	21.08.2010	Lake	case pump	5	-8.26	-62.33	3.76
New deepest point	21.08.2010	Lake	case pump	6	-8.20	-63.59	1.99
New deepest point	21.08.2010	Lake	case pump	7	-9.06	-66.61	5.84
New deepest point	21.08.2010	Lake	case pump	8	-8.96	-66.38	5.32
New deepest point	21.08.2010	Lake	case pump	9	-9.05	-67.34	5.04
New deepest point	21.08.2010	Lake	case pump	10	-9.25	-68.10	5.91
New deepest point	21.08.2010	Lake	case pump	11	-9.15	-67.52	5.71
New deepest point	21.08.2010	Lake	case pump	12	-9.13	-67.33	5.75
New deepest point	21.08.2010	Lake	case pump	13	-9.08	-67.20	5.40
New deepest point	21.08.2010	Lake	case pump	14	-9.07	-66.12	6.44
New deepest point	21.08.2010	Lake	case pump	15	-9.12	-66.38	6.59
New deepest point	21.08.2010	Lake	case pump	16	-9.07	-66.49	6.06
New deepest point	21.08.2010	Lake	case pump	17	-9.03	-65.58	6.67
Old deepest point	16.03.2009	Lake	case pump	0	-8.94	-65.46	6.10
Old deepest point	16.03.2009	Lake	case pump	4	-8.94	-66.00	5.55
Old deepest point	16.03.2009	Lake	case pump	8	-8.96	-65.35	6.36
Old deepest point	16.03.2009	Lake	case pump	12	-8.99	-64.60	7.33
Old deepest point	09.04.2009	Lake	case pump	0	-8.90	-65.18	5.98
Old deepest point	09.04.2009	Lake	case pump	4	-9.01	-05.00	7.00
Old deepest point	09.04.2009	Lake	case pump	8 10	-8.81	-05.21	5.24
Old deepest point	09.04.2009	Lake	case pump	10	-0.03	-04.05	0.01
Old deepest point	27.08.2009	Lake	case pump	0	-7.50	-50.90	2.54
Old deepest point	27.08.2009	Lake	case pump	4 Q	-7.04	-57.42	2.09 8.48
Old deepest point	27.08.2009	Lake	case pump	0 12	-9.10	-04.33	8.40 8.08
Old deepest point	15 10 2009	Lake	case pump	0	-7.80	-59 53	2.88
Old deepest point	15 10 2009	Lake	case pump	4	-7.90	-59 50	3.69
Old deepest point	15 10 2009	Lake	case pump	8	-7.81	-57 79	4 72
Old deepest point	15.10.2009	Lake	case pump	12	-9.31	-65.98	8.48
Old deepest point	12.11.2009	Lake	case pump	0	-8.32	-61.30	5.25
Old deepest point	12.11.2009	Lake	case pump	4	-8.23	-60.69	5.14
Old deepest point	12.11.2009	Lake	case pump	8	-8.13	-59.61	5.42
Old deepest point	12.11.2009	Lake	case pump	12	-8.20	-60.44	5.15
Old deepest point	25.03.2010	Lake	case pump	0	-9.06	-64.99	7.49
Old deepest point	25.03.2010	Lake	case pump	2	-9.10	-65.85	6.97
Old deepest point	25.03.2010	Lake	case pump	4	-9.10	-66.51	6.30

Table B 3: Stable isotope ratios of the measuring campaign 2009 and 2010.

 Table B 3: Stable isotope ratios of the measuring campaign 2009 and 2010.

Measuring point	Sampling date	Location	Sampling method	Depth	δ ¹⁸ Ο	$\delta^2 H$	D- Excess
				[m]	[‰ VS	MOW]	
Old deepest point	25.03.2010	Lake	case pump	6	-9.12	-66.32	6.68
Old deepest point	25.03.2010	Lake	case pump	8	-9.08	-66.08	6.55
Old deepest point	25.03.2010	Lake	case pump	10	-9.02	-65.93	6.24
Old deepest point	25.03.2010	Lake	case pump	11	-9.03	-64.58	7.66
Old deepest point	26.05.2010	Lake	case pump	0	-8.68	-63.73	5.72
Old deepest point	26.05.2010	Lake	case pump	2	-8.75	-63.67	6.31
Old deepest point	26.05.2010	Lake	case pump	4	-8.82	-64.16	6.40
Old deepest point	26.05.2010	Lake	case pump	6	-9.06	-64.69	7.75
Old deepest point	26.05.2010	Lake	case pump	8	-9.00	-65.08	6.91
Old deepest point	26.05.2010	Lake	case pump	10	-8.99	-65.50	6.41
Old deepest point	26.05.2010	Lake	case pump	12	-9.03	-65.29	6.99
Old deepest point	26.06.2010	Lake	case pump	0	-8.43	-62.94	4.52
Old deepest point	26.06.2010	Lake	case pump	1	-8.40	-02.93	4.71
Old deepest point	26.06.2010	Lake	case pump	2	-0.42	-03.32	3.04 // 82
Old deepest point	26.06.2010	Lake	case pump	7	-8.49	-63.10	5.02
Old deepest point	26.06.2010	Lake	case pump	5	-8.98	-65.18	6.68
Old deepest point	26.06.2010	Lake	case pump	6	-9.43	-66 29	9.11
Old deepest point	26.06.2010	Lake	case pump	7	-9.22	-65.70	8.09
Old deepest point	26.06.2010	Lake	case pump	8	-9.28	-64.94	9.28
Old deepest point	26.06.2010	Lake	case pump	9	-9.19	-65.63	7.87
Old deepest point	26.06.2010	Lake	case pump	10	-9.05	-65.30	7.12
Old deepest point	26.06.2010	Lake	case pump	11	-9.13	-65.34	7.67
Old deepest point	26.06.2010	Lake	case pump	12	-9.00	-65.16	6.85
Old deepest point	26.06.2010	Lake	case pump	13	-9.08	-65.27	7.40
Old deepest point	29.07.2010	Lake	case pump	0	-7.80	-61.31	1.12
Old deepest point	29.07.2010	Lake	case pump	1	-7.81	-61.04	1.45
Old deepest point	29.07.2010	Lake	case pump	2	-7.82	-60.90	1.67
Old deepest point	29.07.2010	Lake	case pump	3	-7.89	-60.83	2.27
Old deepest point	29.07.2010	Lake	case pump	4	-7.70	-61.39	0.23
Old deepest point	29.07.2010	Lake	case pump	5	-8.12	-62.35	2.60
Old deepest point	29.07.2010	Lake	case pump	6	-8.79	-65.78	4.52
Old deepest point	29.07.2010	Lake	case pump	7	-8.78	-65.83	4.40
Old deepest point	29.07.2010	Lake	case pump	8	-8.80	-65.54	4.89
Old deepest point	29.07.2010	Lake	case pump	9	-8.93	-66.04	5.37
Old deepest point	29.07.2010	Lake	case pump	10	-8.99	-65.89	6.00
Old deepest point	29.07.2010	Lake	case pump	11	-8.96	-66.08	5.64
Old deepest point	21.08.2010	Lake	case pump	0	-8.73	-63.60	6.27
Old deepest point	21.08.2010	Lake	case pump	1	-7.90	-60.45	2.72
Old deepest point	21.08.2010	Lake	case pump	2	-8.00	-61.20	2.77
Old deepest point	21.08.2010	Lake	case pump	3	-7.93	-60.87	2.60
Old deepest point	21.08.2010	Lake	case pump	4	-7.97	-60.14	3.64
Old deepest point	21.08.2010	Lake	case pump	5	-8.28	-02.10	4.09
Old deepest point	21.08.2010	Lake	case pump	7	-0.30 9.07	-04.07	5.05
Old deepest point	21.08.2010	Lake	case pump	2 2	-8.97	-66.29	5.76
Old deepest point	21.08.2010	Lake	case pump	9	-9.07	-66.83	5.40
Old deepest point	21.08.2010	Lake	case pump	10	-9.07	-65.99	6.17
Old deepest point	21.08.2010	Lake	case pump	11	-9.02	-66 49	6.02
Old deepest point	21.08.2010	Lake	case pump	12	-9.15	-67.38	5.82
Old deepest point	21.08.2010	Lake	case pump	13	-9.04	-66.62	5.68
Old deepest point	21.08.2010	Lake	case pump	14	-9.07	-66.48	6.10
Marginal inflow area	26.06.2010	Lake	case pump	0	-8.52	-63.27	4.91
Marginal inflow area	26.06.2010	Lake	case pump	1	-8.64	-63.21	5.92
Marginal inflow area	26.06.2010	Lake	case pump	2	-8.63	-63.73	5.34
Marginal inflow area	26.06.2010	Lake	case pump	3	-8.66	-64.15	5.12
Marginal inflow area	26.06.2010	Lake	case pump	4	-8.80	-63.90	6.48

Measuring point	Sampling	Location	Sampling	Depth	δ ¹⁸ Ο	δ²H	D-
	date		method				Excess
Manajaal jaflass avaa	26.06.2010	Laka		[m]	[‰ VS	MOW	6 74
Marginal Inflow area	26.06.2010	Lake	case pump	5	-8.98	-65.07	6.74 6.79
Marginal inflow area	26.06.2010	Lake	case pump	6 7	-9.14	-00.31	0.78 7.04
Marginal inflow area	26.06.2010	Lake	case pump	2 2	-9.25	-66.23	7.94
Marginal inflow area	20.00.2010	Lake	case pump	0	-9.10	-00.23	7.02
Marginal inflow area	26.00.2010	Lake	case pump	9 10	-9.52	-65.96	836
Marginal inflow area	20.00.2010	Lake	case pump	10	-5.25	-60.47	2.30
Marginal inflow area	29.07.2010	Lake	case pump	1	-8.02	-61 95	2.00
Marginal inflow area	29.07.2010	Lake	case pump	2	-8.02	-61 70	2.10
Marginal inflow area	29.07.2010	Lake	case pump	2	-8.08	-60.74	2.54
Marginal inflow area	29.07.2010	Lake	case pump	4	-7.88	-59.96	3.02
Marginal inflow area	29.07.2010	Lake	case pump	5	-8 75	-64 18	5.83
Marginal inflow area	29.07.2010	Lake	case pump	6	-8.89	-64 63	6 50
Marginal inflow area	29.07.2010	Lake	case pump	7	-8.80	-64 20	6.20
Marginal inflow area	29.07.2010	Lake	case pump	8	-8.91	-64.90	6.41
Marginal inflow area	29.07.2010	Lake	case pump	9	-9.04	-65.60	6.73
Marginal inflow area	29.07.2010	Lake	case pump	10	-9.14	-66.80	6.30
Marginal inflow area	21.08.2010	Lake	case pump	0	-7.78	-58.83	3.37
Marginal inflow area	21.08.2010	Lake	case pump	1	-7.79	-58.76	3.53
Marginal inflow area	21.08.2010	Lake	case pump	2	-7.87	-61.47	1.50
Marginal inflow area	21.08.2010	Lake	case pump	3	-7.89	-61.46	1.64
Marginal inflow area	21.08.2010	Lake	case pump	4	-7.94	-60.78	2.71
Marginal inflow area	21.08.2010	Lake	case pump	5	-8.40	-63.09	4.07
Marginal inflow area	21.08.2010	Lake	case pump	6	-8.66	-64.45	4.80
Marginal inflow area	21.08.2010	Lake	case pump	7	-8.95	-65.96	5.66
Marginal inflow area	21.08.2010	Lake	case pump	8	-9.05	-66.32	6.11
Marginal inflow area	21.08.2010	Lake	case pump	9	-9.16	-67.04	6.24
Marginal inflow area	21.08.2010	Lake	case pump	10	-9.08	-65.75	6.89
Marginal outflow area	26.06.2010	Lake	case pump	1	-8.38	-62.36	4.67
Marginal outflow area	26.06.2010	Lake	case pump	2	-8.55	-63.79	4.58
Marginal outflow area	26.06.2010	Lake	case pump	3	-8.61	-63.61	5.24
Marginal outflow area	26.06.2010	Lake	case pump	4	-8.69	-63.96	5.59
Marginal outflow area	26.06.2010	Lake	case pump	5	-8.93	-65.28	6.12
Marginal outflow area	26.06.2010	Lake	case pump	6	-8.99	-65.31	6.65
Marginal outflow area	26.06.2010	Lake	case pump	7	-9.08	-66.14	6.49
Marginal outflow area	29.07.2010	Lake	case pump	0	-8.05	-62.18	2.23
Marginal outflow area	29.07.2010	Lake	case pump	1	-8.06	-61.14	3.33
Marginal outflow area	29.07.2010	Lake	case pump	2	-8.09	-61.42	3.27
Marginal outflow area	29.07.2010	Lake	case pump	3	-8.13	-62.22	2.82
Marginal outflow area	29.07.2010	Lake	case pump	4	-8.08	-61.67	2.99
Marginal outflow area	29.07.2010	Lake	case pump	5	-8.48	-63.91	3.90
Marginal outflow area	29.07.2010	Lake	case pump	6	-8.88	-65.17	5.91
Marginal outflow area	29.07.2010	Lake	case pump	7	-8.95	-65.33	6.27
Marginal outflow area	21.08.2010	Lake	case pump	0	-7.84	-60.62	2.09
Marginal outflow area	21.08.2010	Lake	case pump	1	-7.89	-60.10	3.04
Marginal outflow area	21.08.2010	Lake	case pump	2	-7.94	-60.74	2.80
Marginal outflow area	21.08.2010	Lake	case pump	3	-7.84	-60.19	2.50
Marginal outflow area	21.08.2010	Lake	case pump	4	-7.93	-60.44	2.97
Marginal outflow area	21.08.2010	Lake	case pump	5	-8.24	-61.71	4.21
Marginal outflow area	21.08.2010	Lake	case pump	6	-8.62	-64.00	4.98
G2	21.08.2010	Lake	case pump	1	-7.82	-61.03	1.55
G4	21.08.2010	Lake	case pump	3	-7.85	-60.33	2.44
G6	21.08.2010	Lake	case pump	5	-8.32	-62.92	3.65
G8	21.08.2010	Lake	case pump	7	-8.94	-65.97	5.52
G10	21.08.2010	Lake	case pump	9	-9.15	-66.74	6.43
Shallow water	16.03.2009	Lake		0	-8.84	-65.63	5.08
Shallow water	16.03.2009	Lake	case pump	3	-8.76	-65.48	4.59

Table B 3: Stable isotope ratios of the measuring campaign 2009 and 2010.

Measuring point	Sampling date	Location	Sampling method	Depth	δ ¹⁸ Ο	$\delta^2 H$	D- Excess
				[m]	[‰ VS	MOW]	
Shallow water	09.04.2009	Lake	case pump	0	-8.88	-65.13	5.90
Shallow water	09.04.2009	Lake	case pump	2	-8.90	-65.34	5.87
Shallow water	27.08.2009	Lake	case pump	0	-7.45	-57.28	2.29
Shallow water	27.08.2009	Lake	case pump	3	-7.47	-56.77	3.00
Shallow water	15.10.2009	Lake	case pump	0	-7.84	-59.50	3.19
Shallow water	15.10.2009	Lake	case pump	3	-7.71	-58.61	3.03
Shallow water	12.11.2009	Lake	case pump	0	-8.29	-61.25	5.04
Shallow water	12.11.2009	Lake	case pump	3	-8.25	-61.13	4.87

Table B 3: Stable isotope ratios of the measuring campaign 2009 and 2010.

Appendix B.3 Precipitation

Table B 4: Monthly isotopic composition of precipitation in Konstanz at the Lake of Constance(IAEA/WMO, 2006) averaged months of data of the years 2000 – 2005.

Month	δ ¹⁸ Ο	δ²H
Month	[‰ VSMOW]	[‰ VSMOW]
January	-10.75	-81.35
February	-12.30	-91.20
March	-9.70	-71.67
April	-9.49	-68.67
Мау	-7.43	-53.33
June	-5.74	-39.30
July	-5.92	-41.72
August	-5.52	-36.02
September	-9.07	-62.80
October	-9.74	-68.25
November	-13.60	-99.62
December	-12.53	-92.82
Mean	-9.31	-67.23

Table B 5:	Tempe	erature, rel. humi	dity
	and	precipitation	in
	Frick	ingen (LTZ, 2010)	

Date	Tempe- rature Ø 2 m	Relative Humidity Ø 2 m	Precipi- tation
	[°C]	[%]	[mm]
20.02.2009	-5.3	95.1	0.2
21.02.2009	0.6	93.4	3.2
22.02.2009	0.5	100	10.2
23.02.2009	1.8	96.4	3.4
24.02.2009	1.2	94.2	0.2
25.02.2009	0.4	87.7	0
26.02.2009	0.1	89.3	0.6

Table B 5: Temperature, rel. humidity
and precipitation in
Frickingen (LTZ, 2010).

Date	Tempe- rature Ø 2 m	Relative Humidity Ø 2 m	Precipi- tation
	[°C]	[%]	[mm]
27.02.2009	2.7	92.3	0.2
28.02.2009	3.4	83.6	0.2
01.03.2009	3.2	90	0
02.03.2009	4.3	100	8.6
03.03.2009	3.7	99.6	1.4
04.03.2009	2	94.7	0.2
05.03.2009	1.2	100	6.6

Date	Tempe- rature Ø 2 m	Relative Humidity Ø 2 m	Precipi- tation	Date	
	[°C]	[%]	[mm]		
.03.2009	0.2	100	15.8	02.05	5.2009
7.03.2009	0.8	90.9	10.6	03.05	5.2009
8.03.2009	1	87.7	1.8	04.05	5.2009
9.03.2009	2.9	91.1	6.6	05.05	5.2009
0.03.2009	2.5	96.1	4.4	06.05	5.2009
1.03.2009	2.8	90.6	5.8	07.05	5.2009
2.03.2009	1.9	83.9	0	08.05	5.2009
3.03.2009	7.1	82.4	0	09.05	5.2009
4.03.2009	5.5	86.8	0	10.05	5.2009
5.03.2009	6.6	82.1	0.4	11.05	5.2009
6.03.2009	6.1	81.7	0	12.05	5.2009
7.03.2009	6	81.4	0	13.0	5.2009
8 03 2009	51	69.4	Õ	14.05	5 2009
9.03.2009	3	65.1	0.2	15.05	5.2009
0 03 2009	04	68.4	0	16.05	5 2009
1.03.2009	0.7	64 2	0 0	17 OF	5.2009
2 03 2009	19	04.2 73.7	0	12 0	5 2009
2.03.2005	5.6	74.0	0	10.00	: 2005
1 03 2009	2.6	90 1	96	20.00	,.2009
5 02 2009	2.0	90.1	6.8	20.00	: 2009
6 03 2009	12	98.5	0.8	21.0	: 2009
7 02 2009	4.2	90.2	27	22.0	2009
2 02 2009	5 2	90.2	5.Z 7 0	23.0	.2009
	2.0	97.4	7.2	24.0	.2009
02 2009	3.5 1 0	93.9 00 E	2.2	25.0	2009
1 02 2009	4.0	90.5	0	20.0	2009
1 04 2009	62	04 7	0	27.0	2009
.04.2009	0.5	94.7	0	20.03	- 2009
2.04.2009	12.7	05 01 /	0	29.03	2009
04.2009	11 2	01.4 02 E	0	21.05	2009
.04.2009	11.5	05.5	0	51.05	3.2009
04.2009	12.3	81.7	0	01.00	3.2009
7 04 2009	12	77.8	0	02.00	2009
04.2009	12.0	70 2	0.2	03.00	2009
0.04.2009	11.5	79.5	0.2	04.00	3.2009 2.2009
104.2009	12 D	25 J L J	0		·.2009
1 04 2009	10.Z	64 7	0		.2009
2 04 2009	12.0 12.0	04.7 65 6	0		1.2009 3000
2.04.2009	12.9	68 4	0		1.2009 3000
1 01 2009	12./ 12.1	60.4	0	10 04	2009
5 01 2009	12 Q	62 0	0	11 04	.2009
5.04.2009 6 0/ 2000	10.0 10.2	70 1	21	12.00	2009
7 04 2009	10.2	75.1 85.2	2.4	12.00	3.2009 3.2009
2 04 2009	9 Q 1	85.5 85.4	2.4	14.00	3.2009 5.2009
0.04.2009	0.1 12.2	03.4 72.6	2.0	14.00	.2009 2000
5.04.2009 0.04.2009	14.0	12.0 65.6	0	15.00	.2009 2000
1 04 2009	14.9	05.0	0	17.00	1.2009 2000
1.04.2009	15.9	05.0 65.5	0	17.06	3.2009
2.04.2009	14.4	05.5 61 0	0	18.06	3.2009
3.04.2009	9.4	61.3 CO 2	0	19.06	J.ZUU9
4.04.2009	9.6	b9.3	U	20.06).2009 - 2009
5.04.2009	14.8	53.2	U	21.00	.2009
6.04.2009	12.6	67.5	0	22.06	5.2009
7.04.2009	11.8	84.8	0	23.06	.2009
8.04.2009	8.1	97.7	3.6	24.06	.2009
9.04.2009	6.5	98.8	12.2	25.06	.2009
0.04.2009	8.1	92.2	1	26.06	.2009
1.05.2009	12	76.8	0	27.06	2009،

 Table B 5: Temperature, rel. humidity

 and precipitation Frickingen (LTZ, 2010). in

Table B 5:	Tempe	rature, rel. humio	dity
	and	precipitation	in
	Fricki	ngen (LTZ, 2010)	•

Date	Tempe- rature Ø 2 m	Relative Humidity Ø 2 m	Precipi- tation
	[°C]	[%]	[mm]
02.05.2009	12.4	91	8.4
03.05.2009	13.1	84	1
04.05.2009	9.1	90.7	5.6
05.05.2009	8.3	79.4	0.4
06.05.2009	11.8	80.7	0.4
07.05.2009	13.3	71.3	0
08.05.2009	14.7	83.8	2.4
09.05.2009	17.3	80.7	10.6
10.05.2009	17	76.4	0
11.05.2009	15.9	90.5	1.2
12.05.2009	15.5	92.2	7.6
13.05.2009	16.9	90.1	3.2
14.05.2009	16.6	90.9	3
15.05.2009	15.7	91.3	0.4
16.05.2009	14.1	79.4	1
17.05.2009	17.5	72.6	0.6
18.05.2009	12.8	93.4	4
19.05.2009	15.7	77.4	0
20.05.2009	17.9	71.1	0
21.05.2009	18	78.3	7.2
22.05.2009	17.3	85.7	3
23.05.2009	18.5	71.3	0
24.05.2009	21.7	80.7	0
25.05.2009	23.6	70.8	0
26.05.2009	17.5	89.9	32.6
27.05.2009	13	81	6.2
28.05.2009	14.5	79.6	0
29.05.2009	14.3	65.1	0
30.05.2009	14	65.7	0
31.05.2009	13.7	72	0
01.06.2009	14.7	74.7	0
02.06.2009	16.5	71.3	0
03.06.2009	16.1	67.4	0
04.06.2009	14.6	63.1	0
05.06.2009	14.7	65.6	0
06.06.2009	12.2	95.3	20.6
07.06.2009	15.1	77.8	0.2
08.06.2009	16.1	75.5	0
09.06.2009	15.1	90.4	2.6
10.06.2009	16.8	/8.8	0.4
11.06.2009	16.1	73.7	5
12.06.2009	15.1	/2.2	0
13.06.2009	18.4	/1	0
14.06.2009	19.6	/5.9	0.4
15.06.2009	18.6	98	
12.06.2009	18.4	75.6	5.4
17.06.2009	18	/2.5	0
10.06.2009	21.2	76.9	
19.06.2009	16	99.9	26.4
20.06.2009	12.9	94.3	0.8
21.06.2009	12.7	91.6	10.6
22.06.2009	11.2	92.9	5.4
23.06.2009	11.6	99.9	6.2
24.00.2009	14 10 0	97.0	0.4
25.00.2009	10.0 10.0	00.3 00.2	0
20.00.2009	10.3	69.3	U

38.2

98.3

		,• (===,=	
Date	Tempe- rature Ø	Relative Humidity	Precipi- tation
	2 m	Ø 2 m	[]
28.06.2000	10.7	[%] 00 0	
28.00.2009	19.7	00.0 01 0	0
29.06.2009	21.2	81.9 70.2	0
01 07 2009	22.1 20 E	79.2	0
01.07.2009	20.5	35.9	0.0
02.07.2009	22.Z	79.8	0.4
03.07.2009	19.6	92.9	0.4
04.07.2009	20.6	85.5	0
05.07.2009	20.9	85.5	2.8
06.07.2009	19.2	90.5	7.2
J7.07.2009	15.4	92.4	2.2
08.07.2009	14.8	85.3	2.8
J9.07.2009	14.8	88.6	6.2
10.07.2009	15.1	79.8	0.2
11.07.2009	15.1	78.9	0
12.07.2009	15	93.9	1.8
13.07.2009	21.3	85.7	0
14.07.2009	22.8	82.7	2
15.07.2009	20.1	93.6	17
16.07.2009	23.3	81.2	0
17.07.2009	17.1	96.8	41.6
18.07.2009	12.5	98.1	15
19.07.2009	14.4	87.3	1.6
20.07.2009	17.9	79.9	0
21.07.2009	20.9	79.4	0
22.07.2009	19.6	86.9	0
23.07.2009	20.1	85.9	8.2
24.07.2009	17.7	89.8	7.6
25.07.2009	16.1	82.8	0.2
26.07.2009	17.1	77.9	0
27.07.2009	19.3	77.8	8.2
28.07.2009	19	82.9	13.4
29.07.2009	19.7	79.5	0
30.07.2009	18.7	80.6	0
31.07.2009	18.5	70.7	0
01 08 2009	19.9	80.1	0 0
02.08.2009	17.1	95.1	6.6
13 08 2009	15 5	00.0	28
74 08 2009	17	99.9 81.8	2.0
14.08.2009	10 /	01.0 75 1	0
15.08.2009	19.4	75.1	0
7 08 2009	21.9	75.0	0
07.08.2009	21.2	80.2	7.0
J8.08.2009	19.6	92.3	7.8
J9.08.2009	20.8	86.7	0.2
10.08.2009	18.2	97.2	8.2
11.08.2009	19.9	86.2	0
12.08.2009	20.2	80.9	0
13.08.2009	18.6	89.4	0.6
14.08.2009	19.9	84	0
15.08.2009	20.5	81.4	0
16.08.2009	21.6	80.7	0
17.08.2009	22.1	80.6	0.6
18.08.2009	22.8	78.1	0
19.08.2009	22.9	80.4	0
20.08.2009	23.5	78.6	0
21.08.2009	21.6	84.4	1
22.08.2009	15.6	90.5	4.2
23.08.2009	17	79.5	0
		-	

Table B5:	Tempe	erature, rel. humic	lity
	and	precipitation	in
	Fricki	ingen (LTZ, 2010).	

Table B 5: Temperature, rel. humidity
and precipitation in
Frickingen (LTZ, 2010).

	_		
Date	Tempe- rature Ø	Relative Humidity	Precipi- tation
		Ø2m 10/1	[mm]
24.08.2000	10.6	[%] 02.1	
24.06.2009	19.0	05.1 96.6	6.6
25.08.2009	20.3	86.6	0.0
20.08.2009	19.1	95.4	0.2
27.08.2009	20.4	85	0
28.08.2009	20.1	82.4	0
29.08.2009	16.3	69.7	0
30.08.2009	14.1	76.8	0
31.08.2009	16	78.9	0
01.09.2009	20.3	//.6	6.2
02.09.2009	18.7	94.3	1.6
03.09.2009	17.1	93.4	9.6
04.09.2009	14	97.1	8.2
05.09.2009	12.1	83.8	0
06.09.2009	12	83	0
07.09.2009	13.4	84.8	0
08.09.2009	15.4	77.2	0
09.09.2009	15.8	77.7	0
10.09.2009	15.6	76.9	0
11.09.2009	16.1	86.8	0
12.09.2009	15.7	81.8	0
13.09.2009	14.9	74.1	0
14.09.2009	10.4	93.2	0.4
15.09.2009	12.9	88.6	0
16.09.2009	15.8	94.1	1
17.09.2009	16.1	99.7	5.4
18.09.2009	17.2	97	0
19.09.2009	18	90.6	0
20.09.2009	16.8	95.2	8.2
21.09.2009	18.3	89	0
22.09.2009	17	92.3	0
23.09.2009	14.9	97.4	0
24.09.2009	16	87.6	0
25.09.2009	15.7	89.5	0
26.09.2009	15.2	84.1	0
27.09.2009	13.4	88.7	0
28.09.2009	13.4	91.9	0
29.09.2009	13	85.5	0
30.09.2009	12.8	87.2	0
01.10.2009	12.3	89.7	0
02.10.2009	12.1	85.5	0
03.10.2009	9.9	85.2	0
04.10.2009	10.7	85.2	0
05.10.2009	11.4	92.1	0
06.10.2009	14	93.9	0.4
07.10.2009	16.6	85.8	0
08.10.2009	15.2	98.5	16.2
09.10.2009	14.8	99.8	2.6
10.10.2009	13	100	8
11.10.2009	11.7	91.6	0.2
12.10.2009	7.9	94.9	9.2
13.10.2009	5.4	91.1	2.2
14.10.2009	3.3	81.8	0.2
15.10.2009	1.5	80.5	0
16.10.2009	3.5	86.1	0.4
17.10.2009	4.1	97.9	3.8
18.10.2009	2.5	99.2	1
19.10.2009	1.5	91.3	0.2

I[*C][%][mm] 10.2009 0.595.40 10.2009 6.686.60 10.2009 5.198.70 10.2009 5.71003.8 10.2009 9.71006 10.2009 9.71006 10.2009 7.689.40 10.2009 7.696.60 10.2009 7.696.60 10.2009 7.696.60 10.2009 7.696.60 11.2009 7.210022.2 11.2009 6.392.94 11.2009 7.4900.4 11.2009 1.698.80.4 11.2009 2.192.10 11.2009 2.41009.2 11.2009 3.396.70 11.2009 3.396.70 11.2009 3.31001.6 11.2009 3.31001.6 11.2009 3.31001.6 11.2009 3.31000.2 11.2009 5.898.60.4 11.2009 5.797.72.2 11.2009 3.31000.4 11.2009 3.31000.4 11.2009 3.71000.2 11.2009 3.799.60 11.2009 3.99.76.2 11.2009 3.99.76.2 11.2009 1.11.1	Date	Tempe- rature Ø <u>2 m</u>	Relative Humidity Ø <u>2 m</u>	Precipi- tation
10.2009 0.5 95.4 0 10.2009 5.1 98.7 0 10.2009 5.1 98.7 0 10.2009 8.8 93.8 0 10.2009 9.7 100 6 10.2009 9.7 100 6 10.2009 7.6 89.4 0 10.2009 7.6 89.4 0 10.2009 7.6 96.6 0 10.2009 7.6 96.6 0 11.2009 7.2 100 22.2 11.2009 6.3 92.9 4 11.2009 4.8 90 0.4 11.2009 2.1 9 1 11.2009 2.4 100 9.2 11.2009 3.1 100 0.6 11.2009 3.3 96.7 0 11.2009 3.1 100 1.6 11.2009 3.1 100 1.6 11.2009 3.1 100 2.2 11.2009 3.1 100		[°C]	[%]	[mm]
10.2009 6.6 86.6 0 10.2009 5.7 100 3.8 10.2009 5.7 100 6 10.2009 9.7 100 6 10.2009 9.7 100 6 10.2009 1.5 96.1 0.2 10.2009 7.6 89.4 0 10.2009 4.3 100 0.2 10.2009 7.6 96.6 0 10.2009 7.6 96.6 0 11.2009 6.3 92.9 4 11.2009 6.3 92.9 4 11.2009 1.6 98.8 0.4 11.2009 2.4 100 9.2 11.2009 3.1 100 0.6 11.2009 3.1 100 16 11.2009 3.3 96.7 0 11.2009 3.1 100 16 11.2009 3.1 100 16 11.2009 3.1 100 12 11.2009 3.1 100	.10.2009	0.5	95.4	0
10.20095.1 98.7 0 10.2009 5.7 100 3.8 10.2009 8.8 93.8 0 10.2009 10.5 96.1 0.2 10.2009 7.6 89.4 0 10.2009 7.6 89.4 0 10.2009 7.6 89.4 0 10.2009 7.6 89.4 0 10.2009 7.6 89.6 0 10.2009 7.6 96.6 0 11.2009 4.7 96.2 0 11.2009 $6.94.6$ 2 11.2009 6.3 92.9 4 11.2009 6.8 90 0.4 11.2009 1.6 98.8 0.4 11.2009 2.1 92.1 0 11.2009 2.4 100 9.2 11.2009 3.3 96.7 0 11.2009 3.3 96.7 0 11.2009 3.3 96.7 0 11.2009 5.8 98.6 0.4 11.2009 5.8 98.6 0.4 11.2009 5.8 99 2.2 11.2009 5.7 97.7 2.2 11.2009 3.7 100 0.2 11.2009 3.7 99.6 0 11.2009 3.7 99.6 0 11.2009 3.8 84.4 7.2 11.2009 3.8 84.4 7.2 11.2009 4.5 87.3 0.2 <td>21.10.2009</td> <td>6.6</td> <td>86.6</td> <td>0</td>	21.10.2009	6.6	86.6	0
10.2009 5.7 100 3.8 10.2009 8.8 93.8 0 10.2009 9.7 100 6 10.2009 7.6 96.1 0.2 10.2009 7.6 96.4 0 10.2009 7.6 96.6 0 10.2009 7.6 96.6 0 11.2009 7.2 100 22.2 11.2009 6 94.6 2 11.2009 7.2 100 22.2 11.2009 6.3 92.9 4 11.2009 1.6 98.8 0.4 11.2009 2.1 92.1 0 11.2009 3.1 100 0.6 11.2009 3.1 100 0.6 11.2009 3.1 100 1.6 11.2009 3.3 96.7 0 11.2009 3.3 100 1.6 11.2009 5.8 98.6 0.4 11.2009 5.9 97.7 2.2 11.2009 3.3 <td< td=""><td>22.10.2009</td><td>5.1</td><td>98.7</td><td>0</td></td<>	22.10.2009	5.1	98.7	0
10.2009 8.8 93.8 0 10.2009 9.7 100 6 10.2009 10.5 96.1 0.2 10.2009 3.9 97.3 0 10.2009 3.9 97.3 0 10.2009 4.3 100 0.2 10.2009 7.6 96.6 0 11.2009 7.7 96.2 0 11.2009 6.3 92.9 4 11.2009 1.6 98.8 0.4 0 11.2009 1.6 98.8 0.4 0 11.2009 2.4 100 9.2 0 11.2009 3.1 100 0.6 0 11.2009 3.1 100 0.6 0 11.2009 3.1 100 0.6 0 11.2009 5.1 100 2.2 0 11.2009 5.1 100 2.2 0 11.2009 5.1 100 2.2 0 11.2009 3.7 100 0.2 0 <td>3.10.2009</td> <td>5.7</td> <td>100</td> <td>3.8</td>	3.10.2009	5.7	100	3.8
10.2009 9.7 100 6 2 10.2009 10.5 96.1 0.2 2 10.2009 7.6 89.4 0 2 10.2009 4.3 100 0.2 2 10.2009 7.6 96.6 0 2 10.2009 7.6 96.6 0 2 11.2009 6.7 94.6 2 3 11.2009 6.3 92.9 4 3 11.2009 $6.88.8$ 0.4 0 0 11.2009 2.1 92.1 0 0 11.2009 2.4 100 9.2 0 11.2009 3.1 100 0.6 0 11.2009 3.3 96.7 0 0 11.2009 5.1 100 2.2 10 11.2009 5.1 100 2.2 10 11.2009 3.7 100 0.2 10	24.10.2009	8.8	93.8	0
10.2009 10.5 96.1 0.2 2 10.2009 7.6 89.4 0 2 10.2009 3.9 97.3 0 2 10.2009 7.6 96.6 0 2 10.2009 7.6 96.6 0 2 11.2009 4.7 96.2 0 2 11.2009 6.3 92.9 4 33 11.2009 6.3 92.9 4 33 11.2009 6.3 92.9 4 33 11.2009 6.1 92.1 0 0 11.2009 2.1 92.1 0 0 11.2009 2.1 92.1 0 0 11.2009 3.1 100 0.6 0 11.2009 3.1 100 1.6 0 11.2009 5.1 100 2.2 11 11.2009 5.7 97.7 2.2 12	5.10.2009	9.7	100	6
10.2009 7.6 89.4 0 22 10.2009 3.9 97.3 0 22 10.2009 4.3 100 0.2 22 10.2009 7.6 96.6 0 22 11.2009 4.7 96.2 0 22 11.2009 6.3 92.9 4 33 11.2009 6.3 92.9 4 33 11.2009 4.8 90 0.4 00 11.2009 4.8 90 0.4 00 11.2009 2.4 100 9.2 00 11.2009 3.1 100 0.6 00 11.2009 3.1 100 1.6 00 11.2009 3.3 96.7 0 0 00 11.2009 3.3 96.7 0 0 0 0 11.2009 3.3 100 1.6 00 0 0 0 11.2009 8.5 99 <t< td=""><td>26.10.2009</td><td>10.5</td><td>96.1</td><td>0.2</td></t<>	26.10.2009	10.5	96.1	0.2
10.2009 3.9 97.3 0 24 10.2009 4.3 100 0.2 25 10.2009 7.6 96.6 0 27 10.2009 7.6 96.6 0 27 11.2009 4.7 96.2 0 28 11.2009 6 94.6 2 33 11.2009 6.3 92.9 4 33 11.2009 4.8 90 0.4 07 11.2009 2.1 92.1 0 07 11.2009 2.4 100 9.2 05 11.2009 3.3 96.7 0 07 11.2009 3.3 100 1.6 08 11.2009 5.8 98.6 0.4 09 11.2009 5.1 100 2.2 112 11.2009 5.7 97.7 2.2 12 11.2009 3.7 99.6 0 17	7.10.2009	7.6	89.4	0
10.2009 4.3 100 0.2 25 10.2009 7.6 96.6 0 26 10.2009 5.8 96.7 0 28 11.2009 4.7 96.2 0 28 11.2009 6.3 92.9 4 31 11.2009 6.3 92.9 4 31 11.2009 4.8 90 0.4 01 11.2009 4.8 90 0.4 01 11.2009 4.8 90 0.4 02 11.2009 4.8 90 0.4 02 11.2009 4.9 98.5 1 04 11.2009 4.9 98.5 1 04 11.2009 3.1 100 0.6 06 11.2009 3.1 100 0.6 06 11.2009 3.3 96.7 0 07 11.2009 5.1 100 2.2 11 11.2009 5.1 100 2.2 11 11.2009 8.5 99 2.2 13 11.2009 3.7 100 0.2 16 11.2009 3.7 100 0.2 18 11.2009 3.7 100 0.2 18 11.2009 3.7 99.6 0 17 11.2009 3.7 99.7 6.2 200 11.2009 3.7 99.7 6.2 200 11.2009 3.7 99.7 6.2 200	8.10.2009	3.9	97.3	0
10.20097.696.6026. 10.2009 5.896.7027. 11.2009 4.796.2028. 11.2009 6.392.9431. 11.2009 6.392.9431. 11.2009 6.392.9431. 11.2009 1.698.80.403. 11.2009 2.192.1002. 11.2009 2.41009.205. 11.2009 2.41009.205. 11.2009 3.11000.606. 11.2009 3.396.7007. 11.2009 3.396.7007. 11.2009 5.898.60.409. 11.2009 5.11002.211. 11.2009 5.11002.211. 11.2009 5.11002.213. 11.2009 5.11002.213. 11.2009 3.31000.415. 11.2009 3.71000.218. 11.2009 3.71000.218. 11.2009 3.71000.218. 11.2009 3.99.50.823. 11.2009 3.99.50.823. 11.2009 3.99.50.823. 11.2009 3.99.50.823. 11.2009 3.99.50.823. 11.2009 </td <td>9.10.2009</td> <td>4.3</td> <td>100</td> <td>0.2</td>	9.10.2009	4.3	100	0.2
10.2009 5.8 96.7 0 $27.$ 11.2009 4.7 96.2 0 $28.$ 11.2009 6 94.6 2 $30.$ 11.2009 6.3 92.9 4 $31.$ 11.2009 4.8 90 0.4 $01.$ 11.2009 4.8 90 0.4 $01.$ 11.2009 2.1 92.1 0 $02.$ 11.2009 1.6 98.8 0.4 $03.$ 11.2009 4 98.5 1 $04.$ 11.2009 2.4 100 9.2 $05.$ 11.2009 3.1 100 0.6 $06.$ 11.2009 3.3 96.7 0 $07.$ 11.2009 5.8 98.6 0.4 $09.$ 11.2009 5.1 100 2.2 $11.$ 11.2009 5.1 100 2.2 $11.$ 11.2009 5.1 100 2.2 $13.$ 11.2009 3.3 100 0.4 $15.$ 11.2009 3.7 99.6 0 $17.$ 11.2009 3.7 100 0.2 $16.$ 11.2009 3.7 99.6 0 $17.$ 11.2009 3.7 100 0.2 $16.$ 11.2009 3.7 99.6 0 $17.$ 11.2009 4.4 98.7 1 $22.$ 11.2009 4.4 98.7 1 $22.$ 11.2009 4.5 87.3 0.2 <	0.10.2009	7.6	96.6	0
11.2009 4.7 96.2 0 $28.$ 11.2009 7.2 100 22.2 $29.$ 11.2009 6.3 92.9 4 $31.$ 11.2009 4.8 90 0.4 01.1 11.2009 4.8 90 0.4 03.1 11.2009 1.6 98.8 0.4 03.1 11.2009 4.8 90.5 1 04.4 11.2009 2.4 $100.9.2$ 05.1 11.2009 2.4 $100.9.2$ 05.1 11.2009 2.3 $100.1.6$ 06.1 11.2009 2.3 $100.1.6$ 08.1 11.2009 5.8 98.6 0.4 09.4 11.2009 5.1 $100.2.2$ 11.1 11.2009 5.1 $100.2.2$ 11.1 11.2009 9.1 $100.11.1$ 12.4 11.2009 9.5 $99.2.2$ 13.1 11.2009 3.3 $100.0.4$ 15.1 11.2009 3.7 99.6 0 17.4 11.2009 3.7 99.6 0 17.4 11.2009 3.7 $100.0.2$ 18.1 11.2009 4.4 98.7 1 22.4 11.2009 4.4 98.7 1 22.4 11.2009 4.4 98.7 1 22.4 11.2009 4.4 98.7 1 22.4 11.2009 4.5 87.3 0.2 24.4 11.2009 4.5 87.3 0.2 24.4 11.200	1.10.2009	5.8	96.7	0
11.20097.210022.229.311.2009694.6230.311.20096.392.9431.311.20094.8900.401.011.20091.698.80.403.011.20091.698.80.403.011.20091.698.80.403.011.20092.41009.205.011.20093.11000.606.611.20093.396.7007.011.20095.898.60.409.011.20095.11002.211.011.20095.11002.211.011.20095.11002.213.011.20095.11001112.011.20098.5992.213.011.20093.31000.415.011.20093.21000.218.011.20093.799.6017.011.20093.799.6017.011.20093.393.50.823.011.20094.692.5021.011.20094.692.5021.011.20091.610.011.626.011.20090.110.014.428.011.20091.499.24.630.011.20091.499.24.630.011.20091.499.	1.11.2009	4.7	96.2	0
11.20096 94.6 2 30.7 11.2009 6.3 92.9 4 31.7 11.2009 4.8 90 0.4 01.0 11.2009 2.1 92.1 0 02.0 11.2009 2.1 92.1 0 02.0 11.2009 2.1 92.1 0 02.0 11.2009 2.4 100 9.2 05.0 11.2009 3.1 100 0.6 06.0 11.2009 3.3 96.7 0 07.0 11.2009 5.8 98.6 0.4 09.0 11.2009 5.1 100 2.2 11.0 11.2009 5.1 100 2.2 11.0 11.2009 5.1 100 2.2 11.0 11.2009 8.5 99 2.2 13.0 11.2009 8.5 99 2.2 13.0 11.2009 3.3 100 0.4 15.0 11.2009 3.7 100 0.2 18.0 11.2009 3.7 90.6 0 17.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 9	2.11.2009	7.2	100	22.2
11.2009 6.3 92.9 4 31.1 11.2009 4.8 90 0.4 01.0 11.2009 2.1 92.1 0 02.0 11.2009 1.6 98.8 0.4 03.0 11.2009 4 98.5 1 04.0 11.2009 2.4 100 9.2 05.0 11.2009 2.3 100 1.6 08.0 11.2009 2.3 100 1.6 08.0 11.2009 5.8 98.6 0.4 09.0 11.2009 5.1 100 2.2 11.0 11.2009 5.1 100 2.2 11.0 11.2009 5.1 100 2.2 13.0 11.2009 5.5 99 2.2 13.0 11.2009 3.3 100 0.4 15.0 11.2009 3.3 100 0.4 15.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0.2 20.0 11.2009 4.6 92.5 0.2 20.0 11.2009 0.7 98.8 0.2 24.0 11.2009 0.7 99.8 0.6 01.0 12.2009	3.11.2009	6	94.6	2
11.2009 4.8 90 0.4 01.0 11.2009 2.1 92.1 0 02.0 11.2009 1.6 98.8 0.4 03.0 11.2009 4 98.5 1 04.0 11.2009 2.4 100 9.2 05.0 11.2009 3.1 100 0.6 06.0 11.2009 3.3 96.7 0 07.0 11.2009 2.3 100 1.6 08.0 11.2009 5.8 98.6 0.4 09.0 11.2009 5.1 100 2.2 11.0 11.2009 5.1 100 2.2 11.0 11.2009 5.1 100 2.2 13.0 11.2009 8.5 99 2.2 13.0 11.2009 3.3 100 0.4 15.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 0.6 100 11.6 26.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.7 99.8 2.6 01.0 12.2009 0.7	4.11.2009	6.3	92.9	4
11.2009 2.1 92.1 0 02.0 11.2009 1.6 98.8 0.4 03.0 11.2009 4 98.5 1 04.0 11.2009 2.4 100 9.2 05.0 11.2009 3.1 100 0.6 06.0 11.2009 3.3 96.7 0 07.0 11.2009 2.3 100 1.6 08.0 11.2009 5.8 98.6 0.4 09.0 11.2009 5.1 100 2.2 11.0 11.2009 5.1 100 2.2 11.0 11.2009 5.5 99 2.2 13.0 11.2009 8.5 99 2.2 13.0 11.2009 8.5 99 2.2 13.0 11.2009 3.3 100 0.4 15.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 0.7 98.8 0 25.0 11.2009 0.7 <	5.11.2009	4.8	90	0.4
11.20091.698.80.403.011.2009498.5104.011.20092.41009.205.011.20093.11000.606.011.20093.396.7007.011.20092.31001.608.011.20095.898.60.409.011.20095.11002.211.011.20095.11002.211.011.20099.11001112.011.20098.5992.213.011.20097.597.72.214.011.20093.31000.415.011.20093.799.6017.011.20093.71000.218.011.20093.799.6021.011.20094.692.5021.011.20094.692.5021.011.20094.692.5021.011.20094.587.30.224.011.20090.610011.626.011.20090.798.8025.011.20090.799.30.231.012.20090.799.30.231.012.20090.799.82.601.012.20090.71000.605.012.20091.499.24.630.012.20091.992.1 </td <td>5.11.2009</td> <td>2.1</td> <td>92.1</td> <td>0</td>	5.11.2009	2.1	92.1	0
11.2009498.5104.011.20092.41009.205.011.20093.11000.606.011.20093.396.7007.011.20092.31001.608.011.20095.898.60.409.011.20095.11002.211.011.20099.11001112.011.20099.11001112.011.20097.597.72.214.011.20093.31000.415.011.20093.799.6017.011.20093.71000.218.011.20093.71000.218.011.20093.71000.218.011.20094.692.5021.011.20094.692.5021.011.20094.692.5021.011.20094.692.5021.011.20094.692.5021.011.20090.610011.626.011.20090.797.910.229.011.20090.610011.626.011.20090.797.910.229.012.20090.797.910.229.012.20090.797.910.229.012.20091.499.24.630.012.20091.499	.11.2009	1.6	98.8	0.4
11.2009 2.4 100 9.2 05.0 11.2009 3.1 100 0.6 06.0 11.2009 3.3 96.7 0 07.0 11.2009 2.3 100 1.6 08.0 11.2009 5.8 98.6 0.4 09.0 11.2009 5.1 100 2.2 11.0 11.2009 5.1 100 2.2 11.0 11.2009 5.1 100 2.2 11.0 11.2009 8.5 99 2.2 13.0 11.2009 8.5 99 2.2 13.0 11.2009 8.5 99 2.2 13.0 11.2009 8.5 99 2.2 13.0 11.2009 3.3 100 0.4 15.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 100 0.2 18.0 11.2009 3.7 100 0.2 18.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 0.7 98.8 0 25.0 11.2009 0.7 98.8 0 25.0 11.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 <td< td=""><td>8.11.2009</td><td>4</td><td>98.5</td><td>1</td></td<>	8.11.2009	4	98.5	1
11.2009 3.1 100 0.6 06.6 11.2009 3.3 96.7 0 07.0 11.2009 2.3 100 1.6 08.0 11.2009 5.8 98.6 0.4 09.0 11.2009 5.1 100 2.2 11.0 11.2009 5.1 100 2.2 11.0 11.2009 5.1 100 2.2 11.0 11.2009 8.5 99 2.2 13.0 11.2009 8.5 99 2.2 13.0 11.2009 8.5 99 2.2 13.0 11.2009 8.5 99 2.2 13.0 11.2009 3.3 100 0.4 15.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 100 0.2 18.0 11.2009 8.8 84.4 7.2 19.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 0.7 98.8 0 25.0 11.2009 0.7 98.8 0 25.0 11.2009 0.7 99.8 0.6 01.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 <t< td=""><td>9.11.2009</td><td>2.4</td><td>100</td><td>9.2</td></t<>	9.11.2009	2.4	100	9.2
11.2009 3.3 96.7 0 07.0 11.2009 2.3 100 1.6 08.0 11.2009 5.8 98.6 0.4 09.0 11.2009 6.1 97.9 4 10.0 11.2009 6.1 97.9 4 10.0 11.2009 5.1 100 2.2 11.0 11.2009 8.5 99 2.2 13.0 11.2009 8.5 97.7 2.2 14.0 11.2009 3.3 100 0.4 15.0 11.2009 3.2 100 0.2 16.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 0.7 98.8 0 25.0 11.2009 0.7 98.8 0 25.0 11.2009 0.7 99.9 10.2 29.0 11.2009 0.7 99.8 0.6 01.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 99.8 2.6 01.0 12.2009 0.7 99.8 2.6 01.0 12.2009 <td< td=""><td>0.11.2009</td><td>3.1</td><td>100</td><td>0.6</td></td<>	0.11.2009	3.1	100	0.6
11.2009 2.3 100 1.6 08.0 11.2009 5.8 98.6 0.4 09.0 11.2009 6.1 97.9 4 10.0 11.2009 5.1 100 2.2 11.0 11.2009 9.1 100 11 12.0 11.2009 8.5 99 2.2 13.0 11.2009 8.5 97.7 2.2 14.0 11.2009 3.3 100 0.4 15.0 11.2009 3.2 100 0.2 16.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 8.8 84.4 7.2 19.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.6 11.2009 0.7 99.9 10.2 29.0 11.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 99.8 2.6 01.0 12.2009 1.4 99.2 4.6 30.0 12.2009 <td>1.11.2009</td> <td>3.3</td> <td>96.7</td> <td>0</td>	1.11.2009	3.3	96.7	0
11.2009 5.8 98.6 0.4 09.0 11.2009 6.1 97.9 4 10.0 11.2009 5.1 100 2.2 11.0 11.2009 9.1 100 11 12.0 11.2009 8.5 99 2.2 13.0 11.2009 7.5 97.7 2.2 14.0 11.2009 3.3 100 0.4 15.0 11.2009 3.2 100 0.2 16.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 0.7 98.8 0 25.0 11.2009 0.7 99.7 0.2 24.0 11.2009 0.7 99.2 10.2 29.0 12.2009 0.7 99.3 0.2 31.0 12.2009 0.7 99.8 2.6 01.0 12.2009 1.4 99.2 4.6 30.0 12.2009 0.7 100 0.6 07.0 12.2009 0.7 100 0.6 07.0 </td <td>2.11.2009</td> <td>2.3</td> <td>100</td> <td>1.6</td>	2.11.2009	2.3	100	1.6
11.2009 6.1 97.9 4 10.0 11.2009 5.1 100 2.2 11.0 11.2009 9.1 100 11 12.0 11.2009 8.5 99 2.2 13.0 11.2009 7.5 97.7 2.2 14.0 11.2009 3.3 100 0.4 15.0 11.2009 3.2 100 0.2 16.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 100 0.2 18.0 11.2009 3.7 100 0.2 18.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 0.2 31.0 12.2009 1.4 99.2 4.6 30.0 12.2009 1.4 99.2 0.6 07.0 12.2009 1.9 92.1 0.2 04.0 12.2009 1.9 92.1 0.2 04.0 12.2009 0.6 97.3 0.6 $07.$	3.11.2009	5.8	98.6	0.4
11.2009 5.1 100 2.2 11.0 11.2009 9.1 100 11 12.0 11.2009 8.5 99 2.2 13.0 11.2009 7.5 97.7 2.2 14.0 11.2009 3.3 100 0.4 15.0 11.2009 3.2 100 0.2 16.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 100 0.2 18.0 11.2009 8.8 84.4 7.2 19.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0.8 23.0 11.2009 4.6 92.5 0.8 23.0 11.2009 4.6 92.5 0.8 23.0 11.2009 4.6 92.5 0.8 23.0 11.2009 0.7 98.8 0 25.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 1.4 99.2 0.6 01.0 12.2009 0.7 100 0.6 05.0 12.2009	4.11.2009	6.1	97.9	4
11.2009 9.1 100 11 12.0 11.2009 8.5 99 2.2 13.0 11.2009 7.5 97.7 2.2 14.0 11.2009 3.3 100 0.4 15.0 11.2009 3.2 100 0.2 16.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 100 0.2 18.0 11.2009 3.7 100 0.2 18.0 11.2009 8.8 84.4 7.2 19.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 0.7 98.8 0 25.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.1 0.2 04.0 12.2009	5.11.2009	5.1	100	2.2
11.2009 8.5 99 2.2 13.0 11.2009 7.5 97.7 2.2 14.0 11.2009 3.3 100 0.4 15.0 11.2009 3.2 100 0.2 16.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 99.6 0 17.0 11.2009 8.8 84.4 7.2 19.0 11.2009 9 99.7 6.2 20.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.5 87.3 0.2 24.0 11.2009 4.5 87.3 0.2 24.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 1.4 99.2 4.6 30.0 12.2009 1.4 99.1 0.2 04.0 12.2009 5.1 94.6 7.6 03.0 12.2009 1.9 92.1 0.2 04.0 12.2009 1.9 91.2 0 08.0 12.2009	6.11.2009	9.1	100	11
11.2009 7.5 97.7 2.2 14.0 11.2009 3.3 100 0.4 15.0 11.2009 3.2 100 0.2 16.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 100 0.2 18.0 11.2009 3.7 100 0.2 18.0 11.2009 8.8 84.4 7.2 19.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.5 87.3 0.2 24.0 11.2009 4.5 87.3 0.2 24.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.2 100 12.4 27.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.8 2.6 01.0 12.2009 -1 $99.2.1$ 0.2 04.0 12.2009 -1.9 91.2 0 08.0 12.2009 -1.9 91.2 0 08.0 12.2009 -1.9 91.2 0 09.0 12.2	7.11.2009	8.5	99	2.2
11.2009 3.3 100 0.4 15.0 11.2009 3.2 100 0.2 16.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 100 0.2 18.0 11.2009 3.7 100 0.2 18.0 11.2009 8.8 84.4 7.2 19.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.5 87.3 0.2 24.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.2 100 12.4 27.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 1.4 99.2 4.6 30.0 12.2009 1.9 92.1 0.2 04.0 12.2009 5.1 94.6 7.6 03.0 12.2009 0.7 100 0.6 05.0 12.2009 0.7 100 0.6 05.0 12.2009 0.7 000 0.6 07.0 12.2009 0.6 97.3 0.6 07.0 12.2009 -4.5 83.5 0 09.0	8.11.2009	7.5	97.7	2.2
11.2009 3.2 100 0.2 16.0 11.2009 3.7 99.6 0 17.0 11.2009 3.7 100 0.2 18.0 11.2009 8.8 84.4 7.2 19.0 11.2009 9 99.7 6.2 20.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 98.7 1 22.0 11.2009 4.5 87.3 0.2 24.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.2 100 12.4 27.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 1.4 99.2 4.6 30.0 12.2009 2.1 99.8 2.6 01.0 12.2009 5.1 94.6 7.6 03.0 12.2009 0.7 100 0.6 05.0 12.2009 0.7 100 0.6 05.0 12.2009 0.6 97.3 0.6 07.0 12.2009 -4.5 83.5 0 09.0	9.11.2009	3.3	100	0.4
11.2009 3.7 99.6 0 17.0 11.2009 3.7 100 0.2 18.0 11.2009 8.8 84.4 7.2 19.0 11.2009 9 99.7 6.2 20.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.4 98.7 1 22.0 11.2009 4.5 87.3 0.2 24.0 11.2009 4.5 87.3 0.2 24.0 11.2009 0.6 100 11.6 26.0 12.2009 0.2 100 12.4 27.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.8 2.6 01.0 12.2009 -1 99.8 2.6 01.0 12.2009 5.1 94.6 7.6 03.0 12.2009 5.1 94.6 7.6 03.0 12.2009 0.7 100 0.6 05.0 12.2009 2.8 100 2.4 06.0 12.2009 -1.9 91.2 0 08.0 12.2009 -1.9 91.2 0 08.0 12.2009 -4.5 83.5 0 10.0	0.11.2009	3.2	100	0.2
11.2009 3.7 100 0.2 18.0 11.2009 8.8 84.4 7.2 19.0 11.2009 9 99.7 6.2 20.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.4 98.7 1 22.0 11.2009 4.5 87.3 0.2 24.0 11.2009 4.5 87.3 0.2 24.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.2 100 12.4 27.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.8 2.6 01.0 12.2009 5.1 94.6 7.6 03.0 12.2009 5.1 94.6 7.6 03.0 12.2009 1.9 92.1 0.2 04.0 12.2009 2.8 100 2.4 06.0 12.2009 2.8 100 2.4 06.0 12.2009 -1.9 91.2 0 08.0 12.2009 -3.8 82.2 0 09.0	1.11.2009	3.7	99.6	0
11.2009 8.8 84.4 7.2 19.0 11.2009 9 99.7 6.2 20.0 11.2009 4.6 92.5 0 21.0 11.2009 4.6 92.5 0 21.0 11.2009 4.4 98.7 1 22.0 11.2009 3.3 93.5 0.8 23.0 11.2009 4.5 87.3 0.2 24.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.2 100 12.4 27.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.8 2.6 01.0 12.2009 5.1 94.6 7.6 03.0 12.2009 5.1 94.6 7.6 03.0 12.2009 0.7 100 0.6 05.0 12.2009 0.6 97.3 0.6 07.0 12.2009 -1.9 91.2 0 08.0 12.2009 -4.5 83.5 0 10.0	2.11.2009	3.7	100	0.2
11.20099 99.7 6.2 20.0 11.2009 4.6 92.5 0 21.0 11.2009 4.4 98.7 1 22.0 11.2009 3.3 93.5 0.8 23.0 11.2009 4.5 87.3 0.2 24.0 11.2009 4.5 87.3 0.2 24.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.2 100 12.4 27.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.8 2.6 01.0 12.2009 5.1 94.6 7.6 03.0 12.2009 5.1 94.6 7.6 03.0 12.2009 0.7 100 0.6 05.0 12.2009 2.8 100 2.4 06.0 12.2009 2.8 100 2.4 06.0 12.2009 -1.9 91.2 0 08.0 12.2009 -4.5 83.5 0 10.0	3.11.2009	8.8	84.4	7.2
11.2009 4.6 92.5 0 21.0 11.2009 4.4 98.7 1 22.0 11.2009 3.3 93.5 0.8 23.0 11.2009 4.5 87.3 0.2 24.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.2 100 12.4 27.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.8 2.6 01.0 12.2009 5.1 94.6 7.6 03.0 12.2009 5.1 94.6 7.6 03.0 12.2009 0.7 100 0.6 05.0 12.2009 2.8 100 2.4 06.0 12.2009 2.8 100 2.4 06.0 12.2009 -1.9 91.2 0 08.0 12.2009 -4.5 83.5 0 10.0	4.11.2009	9	99.7	6.2
11.2009 4.4 98.7 1 22.0 11.2009 3.3 93.5 0.8 23.0 11.2009 4.5 87.3 0.2 24.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.2 100 12.4 27.0 12.2009 0.2 100 4.4 28.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.8 2.6 01.0 12.2009 5.1 94.6 7.6 03.0 12.2009 5.1 94.6 7.6 03.0 12.2009 0.7 100 0.6 05.0 12.2009 0.7 100 0.6 07.0 12.2009 0.6 97.3 0.6 07.0 12.2009 -1.9 91.2 0 08.0 12.2009 -4.5 83.5 0 10.0	5.11.2009	4.6	92.5	0
11.2009 3.3 93.5 0.8 23.0 11.2009 4.5 87.3 0.2 24.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.2 100 12.4 27.0 12.2009 0.2 100 4.4 28.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.8 2.6 01.0 12.2009 6.4 100 7.4 02.0 12.2009 5.1 94.6 7.6 03.0 12.2009 1.9 92.1 0.2 04.0 12.2009 0.7 100 0.6 05.0 12.2009 2.8 100 2.4 06.0 12.2009 -1.9 91.2 0 08.0 12.2009 -1.9 91.2 0 09.0 12.2009 -3.8 82.2 0 09.0 12.2009 -4.5 83.5 0 10.0	5.11.2009	4.4	98.7	1
11.2009 4.5 87.3 0.2 24.0 11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.2 100 12.4 27.0 12.2009 0.2 100 4.4 28.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.8 2.6 01.0 12.2009 6.4 100 7.4 02.0 12.2009 5.1 94.6 7.6 03.0 12.2009 1.9 92.1 0.2 04.0 12.2009 0.7 100 0.6 05.0 12.2009 0.7 100 2.4 06.0 12.2009 -1.9 91.2 0 08.0 12.2009 -1.9 91.2 0 09.0 12.2009 -4.5 83.5 0 10.0	7.11.2009	3.3	93.5	0.8
11.2009 0.7 98.8 0 25.0 11.2009 0.6 100 11.6 26.0 12.2009 0.2 100 12.4 27.0 12.2009 0.2 100 4.4 28.0 12.2009 0.7 97.9 10.2 29.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.8 2.6 01.0 12.2009 6.4 100 7.4 02.0 12.2009 5.1 94.6 7.6 03.0 12.2009 5.1 94.6 7.6 03.0 12.2009 0.7 100 0.6 05.0 12.2009 0.7 100 0.6 07.0 12.2009 0.6 97.3 0.6 07.0 12.2009 -1.9 91.2 0 08.0 12.2009 -1.9 91.2 0 09.0 12.2009 -4.5 83.5 0 10.0	8.11.2009	4.5	87.3	0.2
11.2009 0.6 100 11.6 26.0 12.2009 0.2 100 12.4 27.0 12.2009 0 100 4.4 28.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.8 2.6 01.0 12.2009 2.1 99.8 2.6 01.0 12.2009 6.4 100 7.4 02.0 12.2009 5.1 94.6 7.6 03.0 12.2009 1.9 92.1 0.2 04.0 12.2009 0.7 100 0.6 05.0 12.2009 0.6 97.3 0.6 07.0 12.2009 -1.9 91.2 0 08.0 12.2009 -1.9 91.2 0 09.0 12.2009 -4.5 83.5 0 10.0	9.11.2009	0.7	98.8	0
12.2009 0.2 100 12.4 27.0 12.2009 0 100 4.4 28.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.8 2.6 01.0 12.2009 2.1 99.8 2.6 01.0 12.2009 6.4 100 7.4 02.0 12.2009 5.1 94.6 7.6 03.0 12.2009 1.9 92.1 0.2 04.0 12.2009 0.7 100 0.6 05.0 12.2009 0.6 97.3 0.6 07.0 12.2009 -1.9 91.2 0 08.0 12.2009 -3.8 82.2 0 09.0 12.2009 -4.5 83.5 0 10.0	0.11.2009	0.6	100	11.6
12.200901004.428.0 12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 -1 99.3 0.2 31.0 12.2009 -1 99.8 2.6 01.0 12.2009 2.1 99.8 2.6 01.0 12.2009 6.4 100 7.4 02.0 12.2009 5.1 94.6 7.6 03.0 12.2009 1.9 92.1 0.2 04.0 12.2009 0.7 100 0.6 05.0 12.2009 2.8 100 2.4 06.0 12.2009 -1.9 91.2 0 08.0 12.2009 -1.9 91.2 0 09.0 12.2009 -3.8 82.2 0 09.0	1.12.2009	0.2	100	12.4
12.2009 0.7 97.9 10.2 29.0 12.2009 1.4 99.2 4.6 30.0 12.2009 -1 99.3 0.2 31.0 12.2009 2.1 99.8 2.6 01.0 12.2009 6.4 100 7.4 02.0 12.2009 5.1 94.6 7.6 03.0 12.2009 5.1 94.6 7.6 03.0 12.2009 1.9 92.1 0.2 04.0 12.2009 0.7 100 0.6 05.0 12.2009 2.8 100 2.4 06.0 12.2009 -1.9 91.2 0 08.0 12.2009 -1.9 91.2 0 09.0 12.2009 -3.8 82.2 0 09.0	2.12.2009	0	100	4.4
12.2009 1.4 99.2 4.6 30.0 12.2009 -1 99.3 0.2 31.0 12.2009 2.1 99.8 2.6 01.0 12.2009 6.4 100 7.4 02.0 12.2009 6.4 100 7.4 02.0 12.2009 5.1 94.6 7.6 03.0 12.2009 1.9 92.1 0.2 04.0 12.2009 0.7 100 0.6 05.0 12.2009 2.8 100 2.4 06.0 12.2009 0.6 97.3 0.6 07.0 12.2009 -1.9 91.2 0 08.0 12.2009 -3.8 82.2 0 09.0 12.2009 -4.5 83.5 0 10.0	3.12.2009	0.7	97.9	10.2
12.2009 -1 99.3 0.2 31.0 12.2009 2.1 99.8 2.6 01.0 12.2009 6.4 100 7.4 02.0 12.2009 5.1 94.6 7.6 03.0 12.2009 5.1 94.6 7.6 03.0 12.2009 1.9 92.1 0.2 04.0 12.2009 0.7 100 0.6 05.0 12.2009 2.8 100 2.4 06.0 12.2009 0.6 97.3 0.6 07.0 12.2009 -1.9 91.2 0 08.0 12.2009 -3.8 82.2 0 09.0 12.2009 -4.5 83.5 0 10.0	4.12.2009	1.4	99.2	4.6
12.2009 2.1 99.8 2.6 01.0 12.2009 6.4 100 7.4 02.0 12.2009 5.1 94.6 7.6 03.0 12.2009 5.1 94.6 7.6 03.0 12.2009 1.9 92.1 0.2 04.0 12.2009 0.7 100 0.6 05.0 12.2009 2.8 100 2.4 06.0 12.2009 0.6 97.3 0.6 07.0 12.2009 -1.9 91.2 0 08.0 12.2009 -3.8 82.2 0 09.0 12.2009 -4.5 83.5 0 10.0	5.12.2009	-1	99.3	0.2
12.2009 6.4 100 7.4 02.0 12.2009 5.1 94.6 7.6 03.0 12.2009 1.9 92.1 0.2 04.0 12.2009 0.7 100 0.6 05.0 12.2009 0.7 100 0.6 05.0 12.2009 2.8 100 2.4 06.0 12.2009 0.6 97.3 0.6 07.0 12.2009 -1.9 91.2 0 08.0 12.2009 -3.8 82.2 0 09.0 12.2009 -4 5 83.5 0 10.0	6.12.2009	2.1	99.8	2.6
12.2009 5.1 94.6 7.6 03.0 12.2009 1.9 92.1 0.2 04.0 12.2009 0.7 100 0.6 05.0 12.2009 2.8 100 2.4 06.0 12.2009 0.6 97.3 0.6 07.0 12.2009 -1.9 91.2 0 08.0 12.2009 -3.8 82.2 0 09.0 12.2009 -4.5 83.5 0 10.0	7.12.2009	6.4	100	7.4
12.2009 1.9 92.1 0.2 04.0 12.2009 0.7 100 0.6 05.0 12.2009 0.7 100 0.6 05.0 12.2009 2.8 100 2.4 06.0 12.2009 0.6 97.3 0.6 07.0 12.2009 -1.9 91.2 0 08.0 12.2009 -3.8 82.2 0 09.0 12.2009 -4.5 83.5 0 10.0	8.12.2009	5.1	94.6	7.6
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	9.12.2009	1.9	92.1	0.2
12.2009 2.8 100 2.4 06.02 12.2009 0.6 97.3 0.6 07.02 12.2009 -1.9 91.2 0 08.02 12.2009 -3.8 82.2 0 09.02 12.2009 -4.5 83.5 0 10.02	0.12.2009	0.7	100	0.6
100 100 111 0002 12.2009 0.6 97.3 0.6 07.02 12.2009 -1.9 91.2 0 08.02 12.2009 -3.8 82.2 0 09.02 12.2009 -4.5 83.5 0 10.02	1.12.2009	2.8	100	2.4
12.2009 -1.9 91.2 0 08.02 12.2009 -3.8 82.2 0 09.02 12.2009 -3.8 82.2 0 10.02	12.12.2009	0.6	97.3	0.6
12.2009 -3.8 82.2 0 09.02 12.2009 -4.5 83.5 0 10.02	3.12.2009	-1 9	91.5	0
12 2009 -4 5 83 5 0 10.02	4.12.2009	-3.8	82.2	0
	12.2009	-4 5	83.5	0

 Table B 5: Temperature, rel. humidity

 and precipitation Frickingen (LTZ, 2010). in

Table B 5: Tempe	rature, rel. humi	dity
and	precipitation	in
Fricki	ngen (LTZ, 2010)	•

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Date	Tempe- rature Ø 2 m	Relative Humidity Ø 2 m	Precipi- tation
	[°C]	[%]	[mm]
16.12.2009	-4	80.8	0
17.12.2009	-5.4	70	0
18.12.2009	-7	74.5	0
19.12.2009	-10.7	90.8	0
20.12.2009	-11.1	87.9	0
21.12.2009	0.3	98.3	5.4
22.12.2009	2.5	94.5	8.8
23.12.2009	2	99.7	8
24.12.2009	1	100	0.2
25.12.2009	2.9	91.8	1.6
26.12.2009	-1.2	87.5	0
27.12.2009	-1.3	92	0
28.12.2009	0.2	96.4	0
29.12.2009	0.3	100	2.8
30.12.2009	5.5	100	12.4
31.12.2009	4.9	100	6.4
01.01.2010	1.6	100	4
02.01.2010	-3.5	91.7	1
03.01.2010	-7.7	91.5	0.4
04.01.2010	-9.1	92.3	0
05.01.2010	-8	94.7	0
06.01.2010	-4.8	98.4	0
07.01.2010	-3.7	94.2	0.6
08.01.2010	-3.4	96.6	0
09.01.2010	-5.5	99.8	0
10.01.2010	-5	93.2	0
11.01.2010	-5.3	98.7	0
12.01.2010	-3.6	95.6	2.4
13.01.2010	-3.4	98.8	0.4 E 2
14.01.2010	-0.3	98.4	5.2
15.01.2010	-0.7	97.8	0
17.01.2010	-1.0	95.0	27
17.01.2010	2 0.9	99.5	0
19.01.2010	-2.6	94	02
20.01.2010	-3.2	100	0.2
20.01.2010	-0.5	100	2.6
22.01.2010	0.5	94.4	2.0
23.01.2010	-1.8	97	Õ
24.01.2010	-2.3	99	0
25.01.2010	-0.6	100	1
26.01.2010	-3.1	93.7	1
27.01.2010	-7.2	89.1	0
28.01.2010	-3.1	96.9	0
29.01.2010	-1	99.9	1
30.01.2010	-2.1	91.9	5.2
31.01.2010	-6.4	97.9	0
01.02.2010	-4.4	93.4	0.2
02.02.2010	-0.8	81.8	2.8
03.02.2010	2	99.7	10.6
04.02.2010	0.4	89.5	0
05.02.2010	-0.8	100	6.8
06.02.2010	1.4	99	7.8
07.02.2010	0.7	96	0.6
08.02.2010	-2.2	90.2	0
09.02.2010	-2.1	92.9	0
	- 8	 ,	
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	Tempe-	Relative	Precipi-
Date	rature Ø	Humidity	tation
	2 m	Ø 2 m	[
11 02 2010	[°C]	[%]	[mm]
11.02.2010	-/	92.1	0
12.02.2010	-5.9	83.2	1
13.02.2010	-5.0	89.7	0
14.02.2010	-4.4	80.7	0.2
15.02.2010	-5.0	85	0.2
16.02.2010	-0.7	89	0.8
17.02.2010	-1.1	87.7	0
18.02.2010	1.4	91.6	0
19.02.2010	0.6	99.8	9.4
20.02.2010	0.7	86.2	0
21.02.2010	0.9	/9.6	0
22.02.2010	2.6	85.3	0.6
23.02.2010	4.5	94.7	0.6
24.02.2010	4.3	95.2	1.2
25.02.2010	5.7	83.3	2.8
26.02.2010	5.4	87.3	1.2
27.02.2010	4.4	70.2	0.2
28.02.2010	7.9	72.8	0.6
01.03.2010	6.2	66.7	0
02.03.2010	3	97	2.4
03.03.2010	2	77.1	0
04.03.2010	1.4	65.6	0
05.03.2010	-1.8	57.6	0
06.03.2010	-2.8	81.6	2.8
07.03.2010	-4.8	73.6	0
08.03.2010	-5.2	63.9	0
09.03.2010	-5.3	67	0
10.03.2010	-2.6	61.7	0
11.03.2010	-2.7	94.6	2.4
12.03.2010	-2.9	88.5	2
13.03.2010	-0.8	86.9	0
14.03.2010	0.9	88.1	0
15.03.2010	1.9	95	0.8
16.03.2010	2.4	97.5	5.2
17.03.2010	1.8	88.5	0.2
18.03.2010	6.8	70.8	0
19.03.2010	8.8	69.6	0
20.03.2010	10.6	81.9	0.6
21.03.2010	9.9	99.9	9
22.03.2010	8.6	85.3	0
22.03.2010	0.0	75.6	0
23.03.2010	0.7 10.2	73.0	0
24.05.2010	10.5	74.1	0
25.03.2010	11.5	09.4	0
26.03.2010	7.5	87.5	3.8
27.03.2010	7.2	85.1	1.4
28.03.2010	7.3	94.4	/
29.03.2010	10.8	85.5	0
30.03.2010	10.2	76.8	0
31.03.2010	6.2	77.6	0.2
01.04.2010	1.7	96.5	2.8
02.04.2010	3	80.7	0
03.04.2010	8.4	72.7	0.4
04.04.2010	6.8	87.3	1.6
05.04.2010	5	84	0.6
06.04.2010	7.9	66.2	0
07.04.2010	10.7	67.9	0
08.04.2010	11.1	75.5	0

Table	B	5:	Tempe	erature, rel. humi	dity
			and	precipitation	in
			Frick	ingen (LTZ, 2010)	•

Table B 5: Temperature, rel. humidity and precipitation Frickingen (LTZ, 2010). in

		, , , , , , , , , , , , , , , , , , , ,	
Date	Tempe- rature Ø	Relative Humidity	Precipi- tation
	[°C]	[%]	[mm]
09.04.2010	10.2	81.9	0
10.04.2010	9.6	63.7	0
11.04.2010	4.5	73	0.4
12.04.2010	5.1	76.2	0
13.04.2010	6.3	74.8	0
14.04.2010	4.8	99.6	10.2
15.04.2010	6.4	85.6	0
16.04.2010	8.2	81.1	0
17.04.2010	10.8	69.4	0
18.04.2010	8.5	79.5	0
19.04.2010	10	75.5	0
20.04.2010	9	81.7	0.8
21.04.2010	10	67.9	0.2
22.04.2010	10	56	0
23.04.2010	11.7	51.3	0
24.04.2010	14.1	51.5	0
25.04.2010	14.6	61.7	0
26.04.2010	11.9	90.3	4.8
27.04.2010	13.9	69.3	0
28.04.2010	15.2	61.6	0
29.04.2010	15.1	71.4	0
30.04.2010	15.4	84.5	12.6
01.05.2010	11.7	100	19.8
02.05.2010	9.8	100	15.6
03.05.2010	9.5	92.6	5.8
04.05.2010	9.5	98.2	1.2
05.05.2010	8	100	0.2
06.05.2010	7.6	98.5	4.8
07.05.2010	7.4	91.2	7.4
08.05.2010	9.9	82.5	0
09.05.2010	11.4	86.5	6.8
10.05.2010	11.3	96.4	5.2
11.05.2010	12.6	86.3	6.4
12.05.2010	13.4	81.9	0.2
13.05.2010	8.4	99.6	5.6
14.05.2010	8.1	95	1
15.05.2010	7.3	96.2	0.6
16.05.2010	7.5	92.4	0.4
17.05.2010	9.1	85.8	0
18.05.2010	9.6	74.9	0.2
19.05.2010	8.1	86.5	6
20.05.2010	8.1	100	4.2
21.05.2010	12	90.1	0
22.05.2010	15.3	76.5	0
23.05.2010	15.0	/5.8 73 F	0
24.05.2010	10.9	72.5	0
25.05.2010	18.8	72.5	0
20.03.2010	10.0 117	0.00 0.2 0	∠ 1つつ
27.05.2010	14./	93.Z	12.2
20.05.2010	14.0 16.0	03.ð 91.2	0.4 0 /
29.02.2010	10.9 12 E	01.3 07 7	0.4 10 C
31 05 2010	10.2	92.2 87 7	2 A 19.0
01 06 2010	10.2 11 7	02.2 Q1 7	ጋ.4 በ ዩ
02.00.2010	11./ 11 /	94.7 QQ 1	0.0 2 /I
03 06 2010	11.4	100	10.2
22.20.2010	11.0	100	10.2

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0.2

	Tempe-	Relative	/e Brocini	
Date	rature Ø	Humidity	tation	
	2 m	Ø 2 m	tation	
	[°C]	[%]	[mm]	
05.06.2010	18.8	77.3	0	
06.06.2010	19.6	80.7	25.6	
07.06.2010	18.6	86	0.6	
08.06.2010	19.1	81.3	0.2	
09.06.2010	21.8	72.9	0	
10.06.2010	24.4	59.4	0	
11.06.2010	22.8	68.4	0	
12.06.2010	19.1	85	0.4	
13.06.2010	16.1	99.2	7.4	
14.06.2010	17.4	83.1	1	
15.06.2010	17.2	91.5	0.8	
16.06.2010	14.3	96.7	5.6	
17.06.2010	15.3	94.1	26.2	
18.06.2010	13.7	100	42.2	
19.06.2010	11.1	97.3	5	
20.06.2010	9.9	92.7	0	
21.06.2010	11.7	88.8	0.2	
22.06.2010	13.1	83.3	0	
23.06.2010	15.7	71.3	0	
24.06.2010	16.7	74	0	
25.06.2010	18	74.9	0	
26.06.2010	20.6	71.9	0	
27.06.2010	22.1	69	0	
28.06.2010	21.5	/3./	0	
29.06.2010	21.5	75.1	0	
30.06.2010	21.2	83.8	0	
01.07.2010	22.8	75.8	0	
02.07.2010	23.1	74.8	0	
03.07.2010	22.7	81.5	4.2	
04.07.2010	20.4	95	15.6	
05.07.2010	21.2	82.2	0	
05.07.2010	19.2	76.9	3.0	
07.07.2010	19.8	70.0	0	
08.07.2010	21.2	70.9	0	
10.07.2010	22.5	77.2	0	
10.07.2010	25.5	71.7	10	
12.07.2010	25	75.0	1.0	
12.07.2010	25	75.8 84 Q	2.8	
14.07.2010	21.0	76	28	
14.07.2010	20.7	87.2	2.0	
16.07.2010	20.7	77 1	23.0	
17 07 2010	19.1	91 3	12.8	
18.07.2010	18.7	79.5	0	
19.07.2010	20	72.5	0	
20.07.2010	21.6	75.3	0	
21.07.2010	23.3	77.4	0	
22.07.2010	23.5	87.2	18.2	
23.07.2010	16.8	99	35.6	
24.07.2010	13.8	99.7	1.8	
25.07.2010	15.3	79.3	0	
26.07.2010	15.2	96.2	12.6	
27.07.2010	15.9	92.2	1.4	
28.07.2010	14.6	98.4	2.4	
29.07.2010	14.2	99.5	24.6	
30.07.2010	14.2	93.1	7.2	
31.07.2010	16.2	79.1	0	

Table B 5: Temperature, rel. humidityandprecipitationprickingen (LTZ, 2010).

Date	Tempe- rature Ø 2 m	Relative Humidity Ø 2 m	Precipi- tation
	[°C]	[%]	[mm]
01.08.2010	19.5	80.2	10
02.08.2010	17.9	99.2	5
03.08.2010	16.3	96.3	5.2
04.08.2010	16.2	86.2	0
05.08.2010	13.7	100	24.8
06.08.2010	14	95.6	0.4
07.08.2010	16.8	80.6	0
08.08.2010	15.8	95.2	7.4
09.08.2010	18.4	83.3	0
10.08.2010	19.4	82.5	0
11.08.2010	20.2	85.6	0
12.08.2010	17.5	99.3	17.6
13.08.2010	16.7	94	0.4
14.08.2010	15.9	92.4	2.4
15.08.2010	15.9	90.8	2.8
16.08.2010	12.3	100	4
17.08.2010	14.2	94.1	3.8
18.08.2010	15.3	98.7	0.8
19.08.2010	17.2	92.2	2
20.08.2010	19.8	88.7	0
21.08.2010	21.8	87.4	0
22.08.2010	21.3	86.4	0

Table B 5: Temperature, rel. humidityandprecipitationprickingen (LTZ, 2010).

Appendix C Impressions



Figure C 1: Schlosssee Salem (2010/03/26).



Figure C 2: Schlosssee Salem (2010/04/06).



Figure C 3: Schlosssee Salem (2010/04/28).



Figure C 4: Schlosssee Salem (2010/05/25).



Figure C 5: Schlosssee Salem (2010/06/26).



Figure C 6: Schlosssee Salem (2010/07/29).



Figure C 7: Schlosssee Salem (2010/08/21).



Figure C 8: P36 (2010/05/25)



Figure C 9: Rotten roots in P36 (2010/05/25).



Figure C 10: P36 (2010/08/20)