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"NETWORK OF DANUBE WATERWAY ADMINISTRATIONS"

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STATUS QUO REPORT ON HYDROGRAPHICAL ACTIVITIES

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1 SCOPE OF DOCUMENT

The purpose of this document is to describe the main tasks of the hydrographical team in Austria's waterway management company. It contains information about surveying activities, measurement equipment and interval of measurements, data processing and management.

Introductorily this report gives an overview about the geographic and climatologically conditions in Austria, which are associated with hydrological and hydrographical processes.

2 ASSIGNED REGION OF INTEREST – GENERELL INFORMATION

2.1. Geographical position

Austria is a landlocked country in Central Europe with a total area of 83.872 km². Austria borders in the north to Germany and the Czech Republic, in the east to Slovakia and Hungary, in the south to Slovenia and Italy and in the west to Switzerland and Lichtenstein.

Austria's landscape is very heterogeneous. Most significant are the high mountains of the Alps in the west and the Danube region with wide-open plains in the east of the country.

2.2. Water river network – main basins and sub basins[1]

All together about 100.000 km of running waters can be found in Austria. The main stream is the river Danube with a length of 350 km. During its course between Passau (Germany) and Bratislava (Slovakia) the gradient is 156 m, the average gradient is 0.04 percent. The common boundary section to Germany is 21.43 km long (River-km 2223,20 to 2201,77), to Slovakia it is 7.5 km (River-km 1880,20 to 1872,70).

Total length in Austria	Right river bank		Both banks	Left river bank	
	km	River-km	km	km	River-km
350,5	350,5	2223,20 - 1872,70	321,5	321,5	2201,77-1880,26

The Inn, with a length of 515 km is the Danube's longest tributary. This river has at its river mouth in Germany a discharge of approximately 735 m³/sec by a medium water level. The extent of the catchment basin is 26.068 km².

[1] Republic of Austria, Federal Ministry of Agriculture, Forestry, Environment and Water Management (2005): EC Water Framework Directive 2000/60/EG – Summary report of the characterisation, impacts and economics analyses required by Article 5

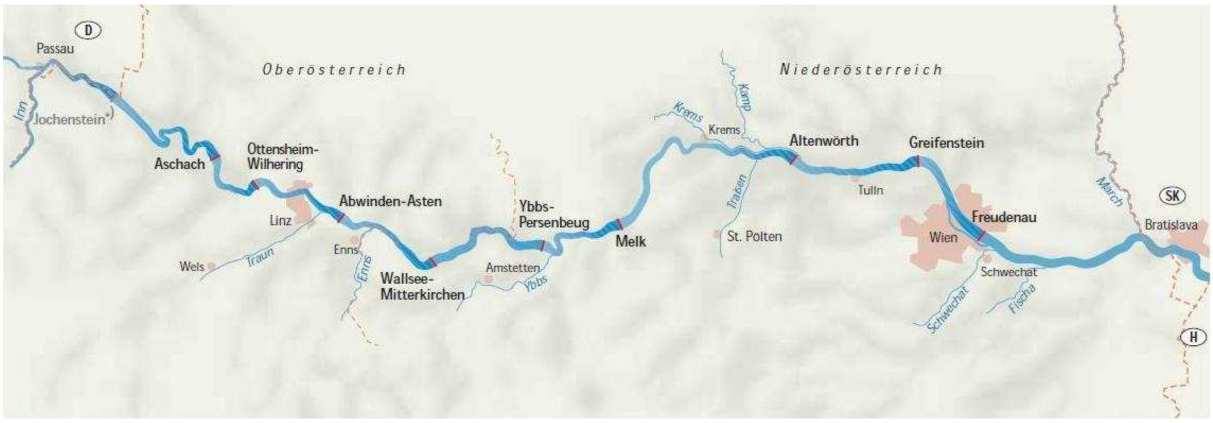

Figure 1: Power plants and main tributaries
(VERBUND-Austrian Hydro Power AG (2007): The power plants on the Austrian Danube)

The most important Danube tributaries in Austria are on the right river bank (see figure 1) the river Traun with a length of 146 km and the river Enns with a length of 349 km.

The Traun flows from the Northern Limestone Alps through the lakes of the Salzkammergut. The extent of the catchment basin is 4.277 km², the discharge is 155 m³/sec at its confluence with the Danube.

The Enns, with a catchment area of 6.080 km², has its source in the Alps (Lower Tauern), where the annual precipitation is high. The Enns brings a discharge of 200 m³/sec.

Further Danube tributaries on the right river bank are the following rivers: Ybbs, Erlauf, Pielach, Traisen, Schwechat, Fischa and Leitha.

On the left river bank are the main tributaries: Große Mühl, Aist, Krems, Kamp and along the Austrian-Slovakian border the river March.

The March, with a river length of 329 km and a catchment area of 26.658 km², has at its confluence with the Danube a discharge of 110 m³/sec.

The catchment area of the Danube increases from about 81.300 km² to 130.800 km² during its course through Austria.

The discharge is at the German-Austrian border (confluence with river Inn) about 1400 m³/s and at the Austrian-Slovakian Border it is 1955 m³/s.

Austria takes share at three international „River basin districts" – Danube, Rhine and Moldau (see figure 2). According to the European Water Framework Directive 2000/60 a River basin district means the area of land and sea, made up of one or more neighbouring river basins together with their associated ground waters and coastal waters, which is identified under Article 3(1) as the main unit for management of river basins.

Figure 2: River basin districts Danube, Rhine and Moldau with national units for the management of river basins (Republic of Austria, Federal Ministry of Agriculture, Forestry, Environment and Water Management (2005): EC Water Framework Directive 2000/60/EG - Summary report of the characterisation, impacts and economics analyses required by Article 5))

The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and ground water.

Round 96% of the national territory is drained by the river Danube (rd. 80.565 km² from Austria's national territory), 3% by river Rhine (2366 km²) and rd. 1 % by the river Moldau (921 km²).

The following table contents the river basin districts with their sub basins.

River basin	Area in Austria (km²)
Rhein (1)	2.366
Danube (1)	
- Danube before Jochenstein (2)	
Danube before the Inn	2.420
Inn before the Salzach	8.392
Salzach	5.543
Inn beyond the Salzach	1.976
- Danube beyond Jochenstein (2)	
Danube between the Inn and the Traun	2.455
Traun	4.274
Enns	6.075
Danube between the Traun and the Kamp (without Enns)	7.478
Donau between Kamp (included) and the Leitha (without March)	7.358
Moldau (1)	9.21
- Leitha (2)	2.145
- Rabnitz und Raab (2)	6.649
- Mur (2)	10.313
- Drau (2)	11.815
National Territory	**83.850**

(1) River Basin District

(2) National Management Unit

Figure 3: River basin districts with sub basins
(Hydrological Central Office (2006): “Hydrographisches Jahrbuch von Österreich 2006“, 114. Band)

The river basin district Danube includes 19 countries, the river basin district Rhine 9 and the river basin district Moldau 4 countries.

Austria’s part of the Danube’s entire basin area (rd. 800.000 km²) amounts to approximately 10 %.

3 CLIMATOLOGICAL CONDITIONS[2]

Austria's climate is allocated to the Central European climate, which is generally moderate and mild but varies due to topographical diversity (great differences in altitude) and different effects of atlantics, continental, sub mediterranean and polar, respectively sub polar influences. In Austria can be found five main climatic zones (see figure 4).

Figure 4: Main climate zones in Austria

3.1. Air Temperature

In Austria the mean annual air temperature amounts in the area of the Viennese Basin and the Lake Neusiedl between 10 and 12 ^{0}C. In the northern and south-eastern Alpine foreland, also in the Danube region the mean annual air temperature is between 8 und 10 ^{0}C, in the alpine regions the mean annual air temperature is appreciably lower.

[2] Federal Ministry of Agriculture, Forestry, Environment und Water Management (2005): Hydrological Atlas of Austria, 2. Edition 2005

3.2. Precipitation

In the alpine regions we have an alpine climate with abundant precipitations (except in the inner alpine valley regions), short summers and long cold winters. In the north and in the south of the Alpine divide - it is also the watershed and weather divide - the precipitation can be very high (between 2000 mm/year to 3000 mm/year), especially when the region is influenced by an area of low pressure from the Atlantic or the Mediterranean Sea. In the inner alpine valley regions a precipitation of 1000 mm/year can be measured, because of the barrier of the mountains.

The transient climate reaches from the Alpine foreland (in the south of river Danube) to the hilly regions of the Bohemian plateau (in the north of the Danube). This climate is influenced in the west by the Atlantic. In the south-east are continental and in the north polar, respectively sub polar influences. The precipitation amounts in the west of the Alpine foreland 1400 mm/year and in the East approximately 700 mm/year. In the hilly regions of the Bohemian plateau the precipitation is relatively low (500 mm/year).

The pannonian climate with continental influence dominates in the north-eastern part of the country (Marchfeld, Viennese Basin, Lake Neusiedl). This climatic zone is characterized by low precipitation (the mean annual precipitation varies between 500 mm und 600 mm/year), hot summers but only moderately cold winters.

In the south and south-eastern of the Alps we have the illyric climate zone, which is very similar to the pannonian climate, but the mean precipitation is a little bit higher - 700mm/year and 1000mm/year – as in the pannonian climate.

In Austria generally decreases the frequency of precipitation from the West to the East, as well as from the South-East to the North-East.

3.3. Evaporation

Many regions in Austria are characterized by a great water surplus, based on high precipitation and low potential evaporation. Rivers with a high rate of flow have their source in the Alps, where the mean annual potential evaporation is approximately 500 mm/year, while the rivers from the hilly regions of the Bohemian plateau have a lower discharge (the mean annual potential evaporation is between 600 and 625 mm/year). The highest evaporation values are measured in the Alpine foreland in the south of the river Danube, in the southern Viennese Basin and in the Styrian Basin. The mean annual potential evaporation amounts 625 to 650 mm/year.

4 MAIN BASIN DESCRIPTION

4.1. Physio-geographical classification

Austria's landscape is characterized by great contrasts. This heterogeneous landscape is divided into five main regions (types) (see figure 5).

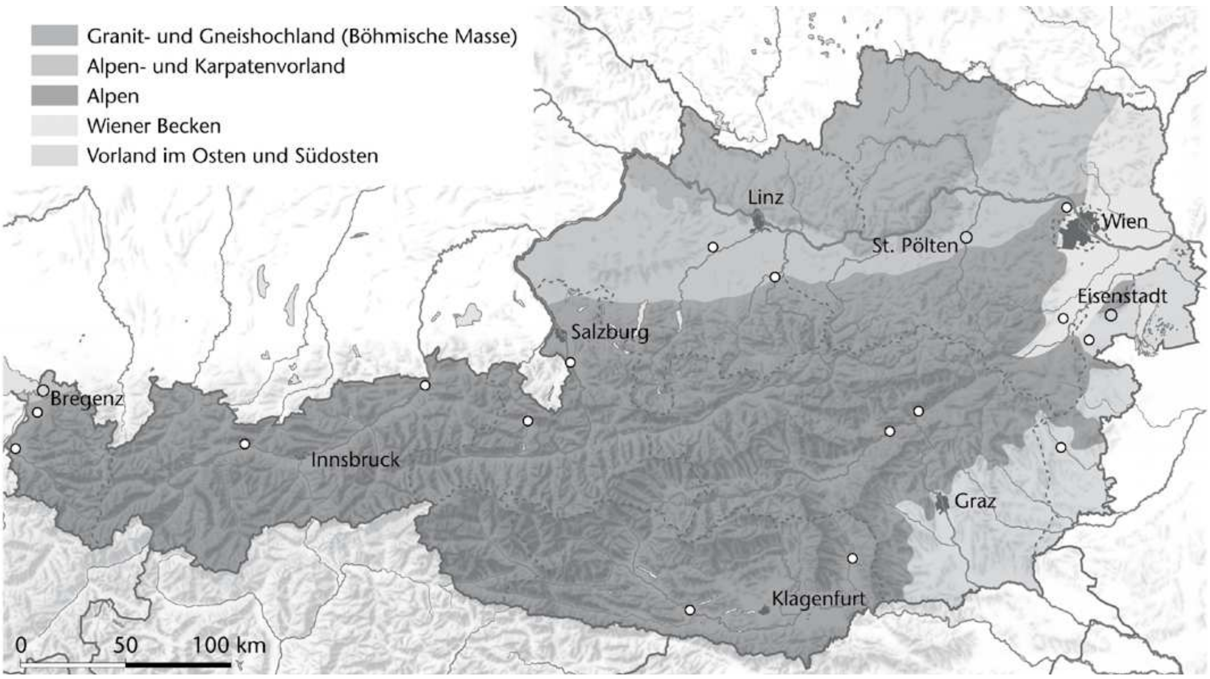

Figure 5: Main landscape types in Austria

Austria is strong influenced by the *Alps*, which cover about 62,8 % of the national territory. The Austrian Alps are a part of the Eastern Alps, situated between the French Rivera and the

Viennese Basin. South the main valleys Inn, Salzach and Enns is the Alpine divide with the Tyrolean Central Alps and the crystalline Tauern region. The Alpine divide is framed by the calcareous sediments of the Northern and Southern Limestone Alps.

Between the northern edge of the Alps and the granite massif of the Bohemian plateau is the *Alpine foreland*, which includes the Danube valley, the lowlands and hilly regions in northeastern and eastern Austria and the rolling hills and lowlands of the *Southeastern Alpine Foreland*. North of the river Danube is the Carpathians foreland.

In the north-eastern part of Austria large plains can be found, the Viennese Basin and the Pannonian Basin (round Lake Neusiedl). The Viennese Basin is divided by the river Danube in two parts, the northern (Marchfeld) and southern Viennese Basin.

The *granite massif* north the river Danube reaches from the Upper Austrian Mühlviertel to the Lower Austria Waldviertel and to Czechoslovakia. This landscape is part of the Bohemian Plateau, one of the oldest geological formations on the earth.

In Austria the difference in altitude is more than 3.600 m. The lowest point is 114 m (Hedwighof, Burgenland) and the highest point is 3798 m (Großglockner).

The landscape of the Austrian Danube section changes between narrow valleys through the foothills of the Bohemian Plateau and wide-open plains. The straitened sections are between Passau and west of Eferding, west of Linz (Linzer Gate), in the Strudengau between Grein and Ybbs-Persenbeug, in the Wachau between Melk and Dürnstein and northwest from Vienna (Viennese Gate).

Between these straitened sections the Danube flows through flat basins including the Eferdinger Basin, Linzer Basin, Machland, Melker Basin, Tullner Basin, Viennese Basin and the Marchfeld.

4.2. Geological overview

The hilly regions of the Bohemian Plateau consist of crystalline rock, granite and gneiss. The soils in the Bohemian Plateau are based on silicate non-calcareous parent material and have often low pH-values. In this region wide-spread woodland and agriculture use (pasture lands) can be found.

Along the northern Alpine foreland (Danube valley) and around the Lake Neusiedl dominate loess soils based on quaternary brash material. In the Alpine foreland and in the plains along the Danube and the Carinthian Basin brash material from the glacial period can be found. The soils of this landscape are partly very fertile and suitable for agriculture and viniculture. The alpine regions are used for forestry and pastures.

4.3. Land use

Austria's land cover is clearly dominated by forests (totally app. 44 %). Altitude and economic factors provide a dominance of coniferous forests (about 27% of Austria's surface) over deciduous and mixed forests (rd. 17%). Grassland amounts 31 %, farmland 14%, viniculture 1%, areas with sparse vegetation (mostly alpine regions) 8%, urban areas 2%.[3]

4.4. Water engineering and management

The Austrian Danube section is strongly influenced by human impacts.

In the past many river regulation measures were adopted with the objective to improve the flood protection, to improve the conditions for the ship navigation and last but not least to reclaim land by draining of marshes.

In the mid-18th century water rapids in the Strudengau and near Grein were removed. Because of the increasing importance as a trade route, many further river regulation measures were done, especially from 1850 to the fifties of the 19th century, as the first power station was built on the Austrian Danube.

[3] Federal Ministry of Agriculture, Forestry, Environment und Water Management (2005): Hydrological Atlas of Austria, 2. Edition 2005

Between 1830 and 1870 the Danube was regulated in the section of the Eferdinger Basin. 1870 the river regulation project started in the Viennese Basin combined with the building of a flood protection dam east of Vienna (Marchfeld).

The distributaries of river Danube were detached and the channel flow was concentrated to one main stream. The reduction of the flowing length and width leads to increasing flow velocities and in further consequence to progressive deepening of the river Danube.

In Austria the river Danube has been used to generate electricity since the late fifties. The first power plant was built in Ybbs-Persenbeug in 1959. Today 280 km of the total river course are influenced by 10 power plants.

River-km	Power Plant	Region	Reservoir length in km	Year of Commissioning
2203,3	Jochenstein	UA, Bavaria	27	1956
2162,7	Aschach	UA	40	1964
2146,1	Ottensheim-Wilhering	UA	16	1974
2119,5	Abwinden-Asten	UA	27	1979
2094,5	Wallsee-Mitterkirchen	LA,UA	25	1968
2060,4	Ybbs-Persenbeug	LA	34	1959
2038,2	Melk	LA	22,5	1982
1980,5	Altenwörth	LA	30	1976
1949,2	Greifenstein	LA	31	1985
1932,8	Nußdorf	Vienna		2005
1921,1	Freudenau	Vienna	28	1998
	Total		280,5	

Figure 6: Power plants on the Austrian Danube
UA Upper Austria
LA Lower Austria
(VERBUND-Austrian Hydro Power AG (2007): The power plants on the Austrian Danube))

The last remaining free-flowing sections of the Danube are in the Wachau between river kilometres 2008 – 2038 and between Vienna (Freudenau power plant) and the Austrian-Slovakian Border (river-kilometres 1921 - 1872,7).

On the one hand, the section between Vienna and the Austrian-Slovakian Border is characterized by a continued river bed erosion rate of approximately 3 cm per year. On the other hand the fairway depths are insufficient and fluctuating. The fairway depths are over a wide area 2,50 m related to RNW (Regulated Low Water) or less (shallow banks, fords). To insure good fairway conditions current maintenance measures, particularly dredging, are necessary.

These disturbances should be removed by the water engineering measures of the „Integrated Engineering Project on the Danube to the East of Vienna".
The project contains following measures:

- Granulometric river bed stabilisation

  A coarse gravel layer will be applied to the whole surface of the erosion-prone areas of the river bed. The application of coarse gravel to large parts of the river bed surface raises the water level and thus supports the linking of old and side arms.

- Low water regulation

  The regulation structures which were built in the past were designed for the Danube low water level. Because of the river bed erosion the groins now located at mean water level and therefore it is necessary to set them lower.

- Riverbank renaturation

  Especially the removal of bank protection from slip-off slopes paves the way for a natural re-development of the river banks.

- Waterway linkage

  A stronger linkage between the main river and its side arms is achieved by lowering the level of the tow path to low water level. With this measure, the side arms should be flowed through the whole year.

- Navigation- related measures

  Relocation resp. optimization of the navigation channel in certain sectors

The aim is to improve the currently valid fairway depth (see table) and to implement a fairway depth of 2,70 m in areas where gravel material is added and 2,80 m in areas without a gravel layer.

Region	**Fairway width**	**Fairway depth**
Free-flowing section	120m	2,50m / RNW*
Impounded section	150m	2,70m / RNW*

*Equivalent low water level

The „Integrated Engineering Project" is part of the "National Action Plan Danube Navigation" (Nationaler Aktionsplan Donauschifffahrt – NAP). The NAP consists of a bundle of measures, which is in line with the European Action Programme NAIADES. The improvement of the waterway infrastructure (maintenance and improvement of the navigation fairway, ports development and setup of modern information and communication systems - RIS) is one core element of the NAP.

The enlargement of the EU has resulted in an enormous growth of cross border goods transportation in the Danube region. The stepwise implementation of the ´National Action Plan Danube Navigation´ until the year 2015 shall increase goods transport on the waterway Danube, thus contributing to relieve the Austrian road network and creating a reliable, effective and cost- efficient transportation route to South East Europe and the Black Sea region.

5 HYDROGRAPHICAL MEASUREMENTS

The International Hydrographic Organization (IHO) defines hydrography as "the branch of applied science which deals with the measurement and description of the physical features of the navigable portion of the earth's surface [seas] and adjoining coastal areas, with special reference to their use for the purpose of navigation."

The focus of hydrographic work is the measurement and acquisition of all parameters, which are necessary to describe the constitution and form of the riverbed and the dynamic processes of open waters.

Main hydrographical tasks are:

- River bed measurements
- Discharge and current measurements
- Terrestrial surveying
- Cartography and hydrographical data management.

5.1. River bed measurements with echo-sounders

Basically we distinguish two different surveying systems, the single-beam and multi- beam echo sounding system.

In the following some principle advantages and disadvantages of single beam versus multi beam are given:

a) Single-beam echo sounder

- Measurements are linearly in the form of profiles
- Single-beam measurements are faster and cheaper as multi-beam measurements, at least along shallow water stretches
- Easier handling of data due to smaller amount

- Unfavourable distribution of soundings for generating 3D-Models and bathymetric plans, because of high density along profiles, lack of data between profiles

Assignment: Measurements for the preservation of evidence, Measurements for controlling dredging projects,…

b) Multi-beam echo sounder
  - Produce a „swath“ of sounding (i.e. depths) to ensure full coverage of an area
  - Higher expenditure in comparison to single-beam measurements
  - Data handling is more sensitive

Assignment: for special measurements, for example detecting wrecks or measurements for river engineering projects, Bridge pier erosion sounding, etc.

5.1.1. Echo sounding equipment

Hydrographic surveys are conducted primarily by mobile (transportable on a trailer) vessels using single-beam- or alternatively multi-beam sounding systems.

Vessel Beta (mobile)
Depth measurement with single-beam echo sounder Reson Navisound 215 (210 KHz), Software: Navisoft Survey (Navitronic)
2009 the Reson echo sounder will be replaced with Kongsberg EA 400, 200 KHz

Vessel Epsilon (mobile)
Depth measurement with Kongsberg EA 400 (38 KHz, 200 KHz)
Software: Navisoft Survey (Navitronic)

Vessel Alpha (mobile)

Depth measurement with single-beam echo sounder Kongsberg EA 400 (38 KHz, 200 KHz)

Software: Navisoft Survey (Navitronic)

This vessel can be equipped alternatively with a multi-beam echo sounding system. The acquisition of a second multi-beam echo sounder system is planned for 2009.

Vessel 4

Depth measurement with single-beam echo sounder Reson Navisound 415 (15 KHz, 33 KHz and 210 KHz

Software: Navisoft Survey (Navitronic)

This Vessel can be equipped alternatively with a multi-beam echo sounder.

Vessel Munin

Depth measurement with multi-beam echo sounder Reson SeaBat 8101 (240 KHz), IXSEA Octans (gyrocompass motion sensor)

Software: Navisoft Sweep (Navitronic)

For the positioning of soundings we are provided with Leica GPS530 (base station on land plus rover station on the vessel) or Leica GPS1200+ (with Glonass), which is more reliable and has a higher accuracy.

In regions where receiving of GPS-signals is not possible (Bridges), we use the automatic tacheometer Leica TCA1100 with a 360^0 prism. This system works really fast and has a high accuracy, but the range is limited and it can be influenced by atmospheric conditions.

The reference to the vertical datum is done by levelling the water level.

The following error limits are valid for our hydrographic measurements:

Depth accuracy: +/- 0.05 m (plus proportionately included depth error)

Positioning accuracy of soundings: +/- 0.20 m.

5.1.2. Interval of measurements

Basically we distinguish between project related measurements, which are mostly limited to a small area and periodically recurring measurements of river sections.

a) Periodically measurements for the preservation of evidence

   These measurements are primarily made to control and document the changes of the river bed. It was already mentioned that app. 280 km of the Austrian Danube stretch is impounded. The remaining 70 km are the free-flowing stretches in the Wachau and in the region east of Vienna to the Austrian-Slovakian border. For navigational and measurement purposes the free-flowing sections are more interesting, because the processes in the river bed are more dynamic. Along the Danube stretch 14 working stretches for river bed measurements (see figure 7) are defined. The river bed is usually measured by standard single-beam echo sounders in the form of cross profiles with a 50 m-distance between the profiles. Distance Marks define the profile start- and endpoints. In principle the free-flowing sections are measured once in spring and once in autumn. In addition 4 - 5 impounded sections are measured per year, so the resultant frequency of measurements is 2 -3 years.

   Since 2 years two sections of the annual working plan are measured with multi-beam echo sounder, in order to get full coverage of all sections by and by.

Section	River-km	Number of profiles	Frequency of measure-ments
01_Jochenstein	2223,200-2203,400	396	every 2-3 years
02_Aschach	2203,000-2162,800	804	every 2-3 years
03_Ottensheim	2162,800-2147,000	316	every 2-3 years
04_Abwinden	2146,600-2119,700	538	every 2-3 years
05_Wallsee	2119,300-2095,700	472	every 2-3 years
06_Ybbs	2094,400-2060,500	678	every 2-3 years
07_Melk	2060,100-2038,100	440	every 2-3 years
08_Wachau*	2038,000-2010,000	560	twice a year
09_Altenwörth	2009,950-1981,000	579	every 2-3 years
10_Greifenstein	1979,500-1949,400	602	every 2-3 years
11_Freudenau	1949,000-1921,100	558	every 2-3 years
12_Fischamend*	1921,000-1900,000	420	twice a year
13_Hainburg*	1899,950-1880,200	395	twice a year
14_Wolfsthal*	1880,150-1872,700	149	twice a year

Figure 7: Quantity of river bed measurements along the Austrian Danube stretch
*free-flowing section

b) Project related measurements

For this purpose we use either multi-beam or single-beam echo sounders. If single-beam comes to operation we measure cross profiles with a profile distance of 10 m, 20m or 25m.

- Controlling shallow water areas
- Controlling dredging projects
- River engineering projects
- Harbour and harbour entrances
- Bridge pier erosion
- Detecting wrecks

5.1.3. Processing of sounding data

The collected hydrographic data must be corrected, this means checking the data for blunders, performing corrections and merging the depths with position data. Furthermore it must be proved if there are GPS failures or incorrect echos.

Multi-beam data can be automatically filtered. For correction of single-beam soundings we use the hydrographic software Navisoft (Navitronic). To process the large quantities of multi-beam sounding data we use the Hydrographic Information Processing System HIPS (CARIS).

The cleaned geo-referenced data are now available for different purposes:

In most cases we produce bathymetric charts in different scales with the mapping software Surfer (Golden Software) or Caris GIS Professional (CARIS). The chart production includes the following working steps:

- Controlling the density and distribution of soundings (multi-beam data mostly require a data thinning)
- Calculation of a digital terrain model (3D-model)
- Calculation of isobaths (depth contours)
- Smoothing of isobaths
- Cartography

All cross profiles, which are measured for preservation of evidence are collected in a database (it is a special application based on ORACLE) and are available for the comparison of single-beam profiles of different years. Furthermore the computation of the cubature over an entire section is possible, so we can derive areas of erosion and accumulation in the river bed.

The database consist river section measurements from the last 20 years. Additionally in this database are stored all, for the visualization of profiles important data, like the characteristic water levels, fairway, profile start and end point, etc.

Another important task of the hydrographic team is the generation of depth information for the digital inland navigation map (Inland ECDIS). Data processing differs significantly for data derived from single-beam or multi-beam equipment.

Because of the unfavourable distribution of single-beam sounding data an aggregation of data on basis of a digital terrain model is necessary.

The data processing involves the thinning of multi-beam data or aggregation of single-beam data, calculating a digital terrain model, calculation and smoothing of isobaths, generation of depth polygons, transformation into WGS84 and conversion to S-57 format. The used software for these steps is CARIS GIS (data processing) und CARIS HOM (S-57 production).

The depth information for the free-flowing sections in the Inland ECDIS will be updated twice a year.

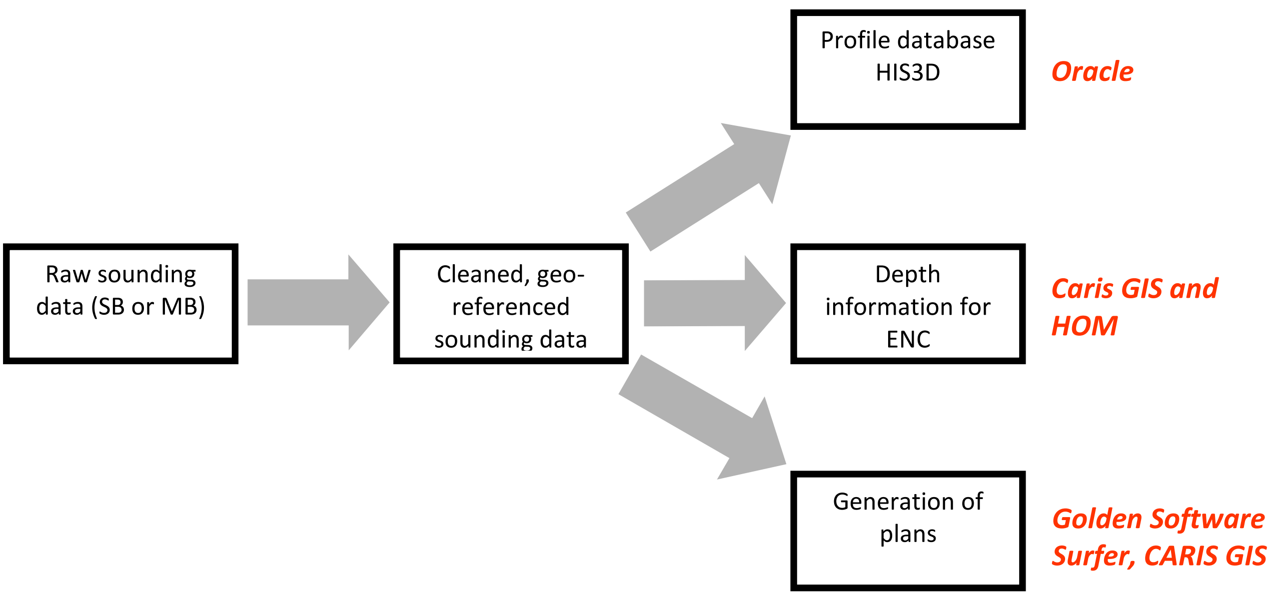

Figure 8: Data processing workflow

It is to mention that the hydrographic team started in 2009 with efforts to improve the surveying activities and the workflow of surveying with the purpose to build up a customer-specific waterway management system:

- Work out an annual plan for standard measurements of the free-flowing sections
- Improvement of the quality management for hydrographic surveys (calibration and tests)
- Efficient workflow for generating depth data for the Inland ENC
- Identifying and controlling of shallow water areas
- Evaluation of national and international specifications for waterways
- Evaluation of customer-specific parameters, as fairway dimensions, berths,…

5.2. Discharge and current measurements

Discharge and current measurements are mainly made with the ADCP (Acoustic Doppler Current Profiler) from the ship. In certain conditions (e.g.: extreme flood conditions) the measurements are made with a propeller gauge.

a) ADCP (Acoustic Doppler Current Profiler)

- Acoustic current meter which uses the Doppler effect for measuring
- By measuring the current velocity, ship velocity and water depth in a transverse movement across the river the discharge of the measuring profile is determined
- Very quick measuring process
- Application: monthly measurements on standardized profiles of the entire Danube to get base data for hydrology, since 2008 test phase at the March

b) Hydrometric propeller gauge

- Oldest method, which is performed by a special constructed measuring trolley from bridges or directly at the river by a ship.
- The propeller gauge is put into water. With the exactly amount of the rotations of the propeller gauge the current velocity can be determined.
- By comparison to the ADCP relatively work intensive because there have to be done measurements on several points of the profile.

- Application: in case of flood from bridges, bilateral measurements at the March

5.2.1. Measuring equipment

Vessel Epsilon (mobile)

The measurements are made with the "Teledyne RD Instruments ADCP Rio Grande" with 600 kHz (appropriate for mean water level to flood conditions) or in case of low water to mean water level conditions with the "ADCP Broad-Band" with 1200 kHz. The positioning is made with Leica GPS SR 50 (Racal).

For discharge measurements of smaller rivers (March, Thaya, Traun, New Danube) the "Teledyne RD Instruments WorkHorse Rio Grande" with 1200 kHz is used. The instrument is mounted on a trimaran which is moved by a boat inside the profile. To record the data the software WINRIVER is employed.

5.2.2. Interval of measurements

In different intervals propeller gauge measurements from bridges and ADCP measurements on standardized profiles are held along the entire Austrian Danube. Five times a year a long ADCP measurement series from Achleiten to Thebnerstraßl and four times a year a short measurement series from Grein to Thebnerstraßl is made. Additionally there are measurements at certain discharge values and in case of flood.

Discharge profile	river-km	Interval of measurement
Achleiten	2223,0-2223,0	March, May, July, September, November
Engelhartszell	2200,6-2200,6	March, May, July, September, November
Aschach	2159,9-2159,9	March, May, July, September, November
Ottensheim	2144,0-2144,0	March, May, July, September, November
Linz	2133,4-2133,4	March, May, July, September, November
Mauthausen	2110,7-2110,7	March, May, July, September, November
Grein	2078,6-2078,6	March to November, monthly
Ybbs	2058,8-2058,8	March to November, monthly
Melk	2033,6-2033,6	March to November, monthly
Aggsbach	2027,5-2027,5	April, July, October
Aggstein	2024,6-2024,7	March, June, September
Spitz	2019,0-2019,0	May, August, November
Kienstock	2015,1-2015,1	March to November, monthly
Weißenkirchen	2013,0-2013,0	March, May, July, September, November
Dürnstein	2008,3-2008,3	April, June, August, October
Greifenstein	1947,8-1947,8	March to November, monthly
Korneuburg	1941,5-1941,5	March to November, monthly
Freudenau UW	1917,1-1917,1	March to November, monthly
Fischamend	1908,4-1904,5	March to November, monthly
Wildungsmauer	1892,3-1892,3	March to November, monthly
Bad Deutsch Altenburg	1884,9-1884,9	March to November, monthly
Thebnerstrassl	1879,5-1879,5	March to November, monthly

Figure 9: Interval of discharge measurements

Additionally to the ADCP measurement series there is a propeller gauge measurement at seven bridges of the Danube once a year. These measurements are for the completion of the discharge series and for controlling the measurement equipment.

In cooperation with Slovakia propeller gauge measurements are held at the river March in Hohenau and Angern monthly and four times a year in conjunction with the Czech Republic in Bernhardsthal.

In case of flood and in consultation with the via donau team hydrology, propeller gauge measurements from bridges will be conducted.
After a plausibility check the values of the ADCP resp. propeller gauge measurements will be sent to the via donau team Hydrology for further analyses.

5.3. Terrestrial surveying

The terrestrial measuring provides the entire data basis for the Hydrography.

- Control and addition of the geodetic benchmark field and the hectometer along the Danube, March and Thaya
- Site plans and gradient diagrams (terrestrial), (e.g.: for flood protection works, oxbow lakes, biotopes, gravel bars, etc.)
- Leveling in case of flood or low water (water level measurement)
- Measuring of buildings (locks, bridges, etc.)
- Implementation and maintenance of the entire benchmark database (including hectometer, gauge, etc.)

5.4. Geographic Information System

For about three years ago the implementation of a geographic information system (ArcGIS/ESRI) started, which contains all relevant hydrographical and surveying data like:

- Orthophotos
- Aerial photo evaluation
- Digital cadastral map
- Project concerning riverbed evaluation
- Hectometer and benchmarks
- Navigation line
- Berths

All positions will be referenced to Gauß-Krüger projection, based on the ellipsoid Bessel 1841. The original Zero- (Prime-) Meridian of the Austrian Gauß-Krüger (Transverse Mercator) is Ferro ($17^0$40’ W Greenwich).

In Austria we use heights above Adriatic Sea Level. For navigational purposes all sounding data will be reduced to Equivalent Low Water Level (RNW). Heights of bridges and overhead cables will be referenced to the Highest Navigable Water Level (HSW).

6 LEGISLATIVE MEASURES

The tasks and duties of via donau are defined in the Waterway Act (Federal Law Gazette177/2004 of 30.12.2004). The company is mainly responsible for the administration of federal waterways, the development of inland waterway transport and the operation of navigation information systems (RIS).

Monitoring network and warning system:

The information about current fairway depths is very important for navigational purposes. The development of a monitoring and warning system for shallow water areas is within the scope of the customer-specific waterway management system.

The goal is to elaborate a work flow, including continuous control measurements, generating plans and publishing of the depth information on the website.

Transboundary cooperation:

In addition to the bilateral discharge measurements together with Slovakia and the Czech Republic the hydrographic team measures “evidence profiles” at the river March. For this reason 66 river cross profiles are defined, there from 13 profiles include the floodplains. The amount of work is divided between Slovakia and Austria, because these measurements are done within the scope of the Austrian-Slovakian Cross Border Commission every ten years.