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DELFT HYDRAULICS with
HALCROW, TAHAL, CES,
ORG & JPS

VOLUME 8
DATA PROCESSING AND ANALYSIS

OPERATION MANUAL – PART II
DATA ENTRY AND PRIMARY VALIDATION
WATER QUALITY DATA

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1 ENTRY OF WATER QUALITY DATA

1.1 GENERAL

Observations of water quality mainly refer to concentrations of dissolved constituents in the water in terms of physical (like turbidity, conductivity etc.), chemical (like sodium, potassium, cadmium etc.) and biological parameters (like algae, bacteria etc.). Data on water quality requires collection of a water sample followed by analysis (measurement) for specific water quality parameters. Some of these water quality parameters can be measured at site, the so-called 'field parameters'. The other parameters are analysed in a laboratory. Laboratories of different levels are distinguished under HP. Level I laboratories are small laboratories located at or near the surface water sampling location. These were originally established for determination of sediment load only, but now can also be used for determination of the water quality field parameters. Higher level laboratories (levels II and II+) for Surface Water (SW) and Groundwater (GW) quality monitoring are usually located in major cities and provide analytical capacity to a larger region covering more sampling locations.

Sixty eight (68) water quality parameters are considered to be the 'Standard HP Water Quality Parameters'. These parameters include many trace contaminants, such as heavy metals and organic pollutants which can only be analysed at Level II+ labs. The main information about these 68 parameters is already included in the WQDES_GW water quality database. Information about additional parameters can be added by a laboratory if it required

1.1.1 WHAT WATER QUALITY DATA ARE ENTERED IN WQDES_GW

Results of the field and laboratory analyses for water quality parameters are entered in to the data system using the WQDES_GW software. In addition to analytical results, the software is also designed for entry of relevant information on sample collection, water quality parameters (units, detection limits, method of analysis), and laboratories (capabilities, analytical methods used).

The WQDES_GW can store an unlimited number of water quality *parameters*. A basic set of parameters is supposed to be entered in a fixed order, format and unit. Moreover, it is possible to customise a form containing (additional) parameters in a user-defined order. The units of measurement for each parameter entered in WQDES_GW, are in conformity with the units prescribed in '*Guidelines on Standard Analytical Procedures for Water Analysis (Hydrology Project, May 1999)*'. For the sake of uniformity in reporting and comparability of the data, it is important that the data reported by all the laboratories are in the same unit. **Thus, no laboratory is allowed to change the unit of measurement for any of the standard HP water quality parameters.**

Groundwater quality data for a sampling location can only be entered into the WQDES_GW, when the *sampling location* is present in the database. Generally most of the water quality monitoring stations are the same as water level observation stations. Thus, the station may already exist in the database, entered as General Information. In case the water quality monitoring station does not exist in the database, it has to be added to the list by concerned Personnel in the office involved with creation of new observation sites.

The *frequency* of water quality sampling may vary, depending on the objective(s) of sampling, the agency or the nature of the well (perennial/seasonal). Mostly sampling frequencies vary between thrice a month to once or twice every year. However, it is possible to enter the results of up to 1000 samples within a single day, which might be useful in semi-continuous field measurements. Water quality data are stored together with the date of collection in what is called 'non-equidistant time series'.

The WQDES_GW is also suitable for storing water quality data collected under programmes other than HP monitoring plans, such as surveys for specific objective, that collect data for specific programmes.

1.1.2 WHO ENTERS WATER QUALITY DATA, AND WHERE

The WQDES_GW for entering water quality data is installed in each HP (level II and II+) laboratory, and the laboratory staff will enter the water quality data (i.e. the results of their water quality analyses). The entry forms are organised laboratory-wise as well as location-wise. Each laboratory is expected to indicate the analytical method used for every parameter in the database. Also, substantial attention is given to the recording of details with respect to collection of the sample.

1.1.3 ADDITIONAL FUNCTIONALITY OF WQDES_GW FOR WATER QUALITY

The water quality module is primarily for entering the analytical results for water quality parameters. In addition, the software has some extra functionality:

- Calculating certain water quality parameters based on results of other parameters
- Validating the water quality data
- Graphing water quality data
- Preparing reports of water quality results, including reports of customised parameters, stations or period and comparing water quality results with drinking water and irrigation water standards

After login, “OK” button is to be clicked. Immediately the water quality switchboard is displayed as shown in Figure 1.1. Generally, laboratory staff will enter water quality data. The station characteristics are entered by the other group (hydrogeologists). The laboratory staff can obtain the database file containing such information and from hydrogeologists and attach it to the software. In case, a new well is adopted for water quality monitoring, which is not existing in the file provided by the hydrogeologists, the user can click ‘Return to Main Switchboard’ button to get the main switchboard. In the main switchboard, when ‘Data Entry/editing’ is clicked, the user gets the form for entry of well characteristics.

For all the water quality data entry options, the user is directly prompted to Water Quality Switchboard or he can click on “Water Quality” on the main switchboard. The user then sees the switchboard displaying menu items for water quality data, as shown in Figure 1.1.



Figure 1.1:
Water Quality Switchboard











This switchboard gives access to the following 8 forms that will be described in detail in respective sections:

- Laboratory Information
- Parameter Information
- Sample Collection Information
- Sample Data Entry
- Reports and Graphs
- Options
- Import/Export old WQDES_GW Data
- AQC Data

With each form, a toolbar is displayed. In this toolbar, buttons are available for common functions. (See Table 1.1)

Toolbar

Each of the above first 4 forms contains the following buttons on the toolbar:

 View Data View Data Button	Button puts the form in 'view mode' and prevents editing. The importance of view mode is that no entry will get modified by mistake when looking at the records in the form. On opening, most forms are in viewing mode and this button is inactive. If the form is in another mode (e.g. edit-mode) this button is active and can bring the form back to view mode. The button is provided in the above first three forms.
 Edit Record Edit Record button	Button puts the form in 'edit mode' and allows editing. Only after the form is in edit mode, modifications in the existing records or addition of new record or deletion of existing record is possible. This button can only be clicked when not already in edit mode. The button is provided in the above first three forms.
 Add Record Add Record button	Button adds a new record. Button is only active when the form is in edit mode, after the "Edit Record" button is clicked. The button is provided in the above first three forms.
 Delete Record Delete Record button	Button deletes the currently displayed record. Button is only active when the form is in edit mode, after the "Edit Record" button is clicked. The button is provided in the above 1 st and 3 rd forms
 Move First button	Button navigates to the first record in the form. It is one of the four buttons for the purpose of navigation through the available records.
 Move Previous button	Button navigates to the previous record in the form. Inactive when first record is displayed. It is one of the four buttons for the purpose of navigation through the available records.
 Move Next button	Button navigates to the next record in the form. Inactive when last record is displayed. It is one of the four buttons for the purpose of navigation through the available records.
 Move Last button	Button navigates to the last record in the form. It is one of the four buttons for the purpose of navigation through the available records.
 Search button	This button is used to search the record with the desired entry in this field from all the available records. Usual options, like searching all the fields, setting the search direction, multiple search instances, matching the case type etc., are also available.
 Report button	The report button invokes an input box to <i>make</i> selection of fields to be reported in tabular form. Suitable queries can be built using conditions and the output can be grouped and sorted in the desired form. This is available on most forms.


 Print button	To print a single record along with the screen layout.
Note: Some specific buttons available on toolbar of specific form are explained in respective Sections. The toolbar of Data Entry and Validation Register form has some different features. There is a button for organising the data station-wise in alphabetical (ascending or descending) order or date-wise (ascending or descending) order. There is another button provided to prompt station-wise data entry. The details of the use of these buttons in respective cases are explained in the following Sections.	

Table 1.1: *Toolbar functions*

1.2 ENTRY OF LABORATORY INFORMATION

1.2.1 GENERAL

In this data entry section, a laboratory can enter and edit all the relevant information necessary to describe the laboratory as per the form depicted in Figure 1.2. An agency may enter information on multiple laboratories coming under its jurisdiction. This form also registers the number of parameters the laboratory can analyse along with the method of analysis. The Laboratory form allows the customisation of the data entry form as well. For example, if in a particular project the laboratory is analysing only a few parameters, the laboratory can customise the data entry form for those parameters.

1.2.2 LABORATORY INFORMATION TO ENTER

Figure 1.2: *Layout of the Laboratory Information Form*

Three functional parts may be distinguished in this form as shown in Figure 1.2.

- At the left side of the screen, a listbox with all the laboratories that are registered in the database is present. Each laboratory has a unique identification code (Lab ID) along with its name (Lab Name). Laboratories are listed alphabetically according to their names.
- The right upper half of the screen shows the information about the highlighted laboratory in the listbox on the left. Information on any laboratory listed in the left box can be viewed by clicking to that laboratory in the left box.

- The right lower half of the screen is reserved to define the analytical capacity of the laboratory regarding the number of parameters it can, and normally does, analyse. These parameters are ticked automatically (once the Level of the Laboratory is defined) in the respective boxes below 'All'.
- The laboratory can customise the parameters of interest from different groups as listed in the lower right part of the form. The customisation can be done by clicking (ticking) the desired parameters in the respective boxes below 'C'.
- It is seen that any parameter which is customised, will be automatically ticked in the "All" list.

Lab ID and Lab Name (mandatory)

The Lab ID is a unique eight-character code, which identifies each laboratory. The Lab Name is unique name given for each laboratory. Both Lab ID and Lab Name are mandatory information. The logic followed in the eight-character Lab ID code is as follows:

Position 1	'C' for central or 'S' for state organisations
Position 2 and 3	State code (e.g. AP for Andhra Pradesh and MH for Maharashtra etc.)
Position 4	Separation sign '-'
Position 5 to 8	Abbreviation for the city where the laboratory is located (e.g. NASK for Nashik or HYD1 for Hyderabad). In case there are two laboratories located in the same town one each of surface water and ground water then the 8 th position is numerically presented as 1 for surface water laboratory and 2 for ground water laboratory.

Although Lab IDs may be any unique combination of characters it is strongly suggested to conform to the above stated logic since sometimes, software may only display codes when space is too limited to display the full name.

The name of the laboratory includes the state code (for state organisations) or CGWB followed by the city in which the laboratory is located. Note that sorting of the laboratories is based according their name.

HP Domain (mandatory)

HP domain classifies the laboratory with respect to the types of agencies involved in surface water quality sampling as listed.

Possible options for the HP domain (from drop-down list) are:

- CGWB: all Central Ground Water Board laboratories
- SG&SW: all laboratories affiliated with a State Groundwater Department, where the laboratory is also carrying out analyses for surface water department
- non HP laboratory: all other laboratories that use WQDES_GW

Agency ID (mandatory)

The Agency ID is the name of the agency to which the laboratory belongs. For CGWB, the agency ID should include 'CGWB'. For states, the state abbreviation and exact Department name should be selected e.g. AP Ground Water Department. For CGWB, the region should be selected, e.g. CGWB Southern Region.

Note that agencies may only be selected from a pre-defined list. It is not possible to enter data in this field.

Regional Office

Here the regional office under which the laboratory comes is selected from the list. Only agencies available in the list may be selected.

Address, City, PIN Code, Telephone, Email, State and Fax

A laboratory should enter all relevant contact information about the laboratory: address, telephone, fax, e-mail etc.

Contact person and Laboratory In-charge

The administrative head and the chemist in-charge of the laboratory respectively should be entered in this field.

Level of the laboratory and remarks (mandatory)

Select the laboratory level from the drop-down list: I, II or II+.

The level of the laboratory is an indication of the analytical capacity of the laboratory based on the equipment available. The level is not necessarily linked to the actual number of parameters analysed, it rather represents the (potential) capability of the laboratory. The parameters associated with each laboratory level will all be placed on the standard data entry form.

The following practical guideline may be followed:

- Level I: Field parameters viz Temperature, pH, Conductivity, (Total) Suspended Solids, Dissolved Oxygen, Colour and odour are analysed by the sampling team for reporting to level II laboratory. For GW sample analysis level I laboratory is non-existent.
- Level II: Laboratory has facilities to analyse general water quality parameters, major ions, nutrients, indicators of organic and faecal pollution, etc.
- Level II+: Laboratory is in possession of advanced equipment, such as Atomic Adsorption Spectrophotometer (AAS), Gas Chromatograph (GC), or UV-Visible Spectrophotometer, besides the facilities of a Level II Laboratory.

Remarks

Any remarks about the laboratory may be entered, especially those remarks valuable during the interpretation of the data may be entered such as:

- record of malfunctioning and break-down of equipment (with dates);
- date when the last maintenance of equipment was performed;
- power failure events and their duration;
- record of within-laboratory AQC results and control chart results for different parameters;
- record and result of participation in inter-laboratory AQC.

Parameters

After selection of the HP-Level, a list of parameter packages ('PACK | DESCRIPTION'), parameters (PARAM_ID) and accompanying '(Analysis) Method Used' is displayed in the lower right section of the screen (note: 'parameter packs' are also called 'parameter groups').

The parameters are grouped in parameter packages. Select among the different packages by selecting the desired package under 'PACK | DESCRIPTION'. For the selected parameter pack, the relevant parameters and their analysis method(s) will be shown. Where more than one method is possible for the analysis, a default method is shown. The default method is the preferred (recommended) method based on the '*Guidelines for Standard Analytical Procedures*' (HP, May 1999). If the method used by a laboratory is different from the preferred method, **the actual method which a laboratory uses for analysis each parameter must be selected. It is very important for every laboratory to register the actual method used for analysis of a specific parameter along with date of its implementation.** There are several reasons for this:

- The accuracy of results can be related to the method used for analysis. Changes in water quality results may be related to a change in analysis method at a laboratory rather than to an actual change in the quality of the water.
- For comparison of results between different laboratories it is important to know if they are following the same method of analysis. Especially when it comes to comparison of data from the same region in case of groundwater or the same river in case of surface water.
- The analysis method used determines the Limit of Detection (LOD) for a particular parameter. This may be important for reporting of non-detectable concentrations.

The list of standard water quality parameters (for HP laboratories) and the methods that are available for analysis of each of the parameters are included in the WQDES_GW database. Section 1.3 describes how to add a parameter to the list or how to add an analytical method for an existing parameter.

To the right side of the parameters, two columns are displayed, the first labelled as 'C' (short for custom) and 'All'. Parameters that are ticked in these columns will be included in the customized or standardised data entry sheet, respectively. Parameters may be ticked in one or both columns. The purpose is twofold:

- Tick the 'C' column to place parameters on the 'customised' data entry sheet. Parameters that are already present on the standard data entry form (ticked under 'All') may be repeated on the custom form for convenience. *Note: parameters ticked in the 'C' column are automatically added to the 'All' column and may be removed as well from both columns;*
- The 'All' column displays all parameters the laboratory should be capable of analysing according to its level (I, II or II+). Commonly analysed parameters are ticked by default and are automatically put on the 'standardised data entry form'. Additional parameters may be selected for special cases.
- *Note: any parameter that is added to the 'C' column is automatically added to the 'All' column. Removal of a parameter from the 'All' column is not possible in unless it concerns a customised parameter (ticked in the 'C' column).*



Press this button on the toolbar to make the laboratory where this software is being used the '*default*' laboratory. The default lab will automatically be selected and displayed in all other forms (e.g. sample collection and data entry). This reduces the work of selecting a laboratory every time a different form is used.

 **Lab Selection (toolbar)**

Pressing the ‘Lab Selection’ button on the toolbar in edit mode will show the full list of laboratories available in the system and allow a selection of one or more laboratories from the complete list available in the system. Thereafter, only the selected laboratories will be shown on the Laboratory Information Form. Since the complete list contains all laboratories under HP, covering multiple states and multiple agencies, it is convenient to limit this list for day to day use. An agency can make a selection of laboratories within its organisation or within a region or within a river basin. When the ‘Lab Selection’ button on the toolbar is pressed, a form as shown in Figure 1.3 is loaded.

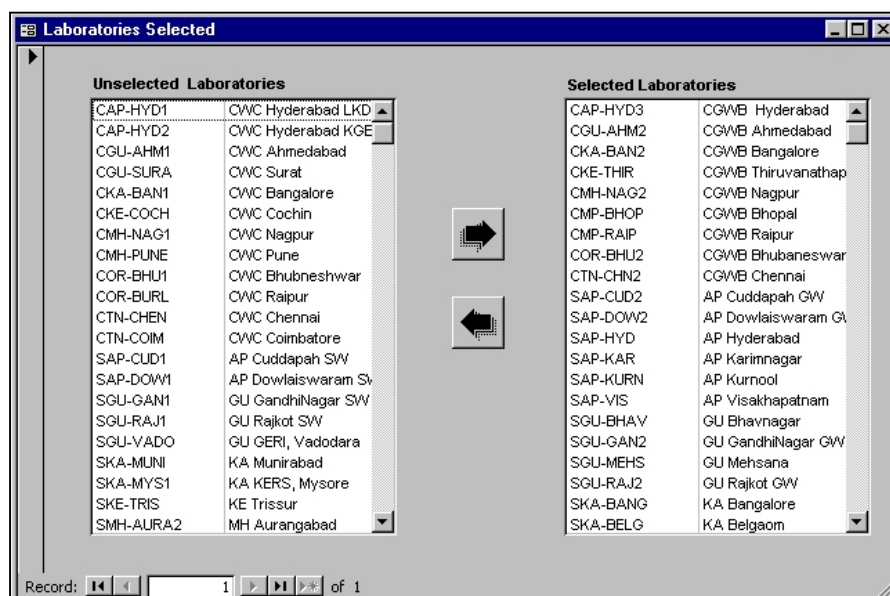


Figure 1.3: Layout of Laboratory Selection Form

In the form displayed in Figure 1.3, all laboratories available in the database are listed in either of the two columns. The laboratories in the ‘Unselected Laboratories’ column on the left will not be shown anywhere else in the software. The laboratories in the ‘Selected Laboratories’ column on the right will appear in all other forms of the software. The arrows in between the columns allow shifting of a laboratory from one to another column. This can be done by clicking the desired laboratory to be shifted and then clicking the arrow. Only a laboratory that is currently selected can be moved. Also note that a laboratory can only be present in either of the two columns. The default laboratory, can be chosen from the list of selected laboratories only.

1.2.3 COMMON DATA ENTRY TASKS

Editing, adding, or deleting a laboratory information record

From the menu bar, it is possible to edit the laboratory information record by using ‘Edit Record’ button. To add a new laboratory, select menu option ‘Add Record’. The right side of the screen will then have all blank records. Fill in all records for Lab ID, Name, HP Domain and Agency ID. Also, fill in all records relevant to Lab Contact Information. Laboratory information may be deleted with ‘Delete Record’.

Specifying the parameters analysed in a laboratory

Once Laboratory ID, Name, HP Level and the Agency are added, the Parameter list will automatically be added to the form. This starts as a full list of all parameters that potentially can be analysed by the selected laboratory (under 'All'). The list may be customised to the actual capacity of the laboratory by selecting parameters under column 'C'. The ticked parameters under column 'C' and 'All' will be on the customised and standard data entry form, respectively. The complete list under column 'A' cannot be limited; if parameters are not actually analysed, the concerned entry should simply be left blank in the data entry form.

Changing the method of analysis used for a parameter

For each parameter, the Analytical Method Used by the selected laboratory is shown next to the parameter. If more than one method is possible, the preferred method of analysis is indicated by default in the field 'Method Used', as explained in Section 1.3. If a laboratory uses another commonly used method, it must select the alternative method from the drop-down list in the form. In case the laboratory uses a method that is not present in the drop-down list, it should enter the method details in the 'Parameter Information' form and after that select this method from the drop-down list.

Changing the order of the parameters in the data-entry sheet

Press the 'up' or 'down' arrow on the right-lower half of the screen to change the order of the parameters. Use the cursor to indicate the parameter that is to be moved and press one of the arrows to move the parameter up or down position in the list.

Note: changing the parameter order only affects the custom-data entry form, not the standardised form.

1.3 ENTRY OF PARAMETER

1.3.1 GENERAL

In this form, all the important information about the water quality parameters and the analytical methods available for each parameter are shown. All standard water quality parameters for HP laboratories, their analysis method(s) and their preferred (recommended) methods of analysis are provided upon installation of the software, as well as e.g. units, categories, level, no. of decimals, etc.

Most of the information provided for the standard parameters *cannot* be changed. The laboratory can change only Maximum, Lower Warning Limit (LWL) and Upper Warning Limit (UWL). All other parameter information for the standard HP parameters are fixed and cannot be edited (e.g. units, no. of decimals). This is to ensure standardisation of data entered by different laboratories.

New parameters, if required, can be entered in this form. The form also allows specification of additional methods of analysis for the standard HP water quality parameters in the database. The Parameter Information Form Layout is presented in Figure 1.4.

Note: it is not possible to edit or delete parameters or preferred methods from the database provided on installation! If you add a new parameter or a new analysis method for an existing parameter, you will have to fill all the relevant data entry fields.

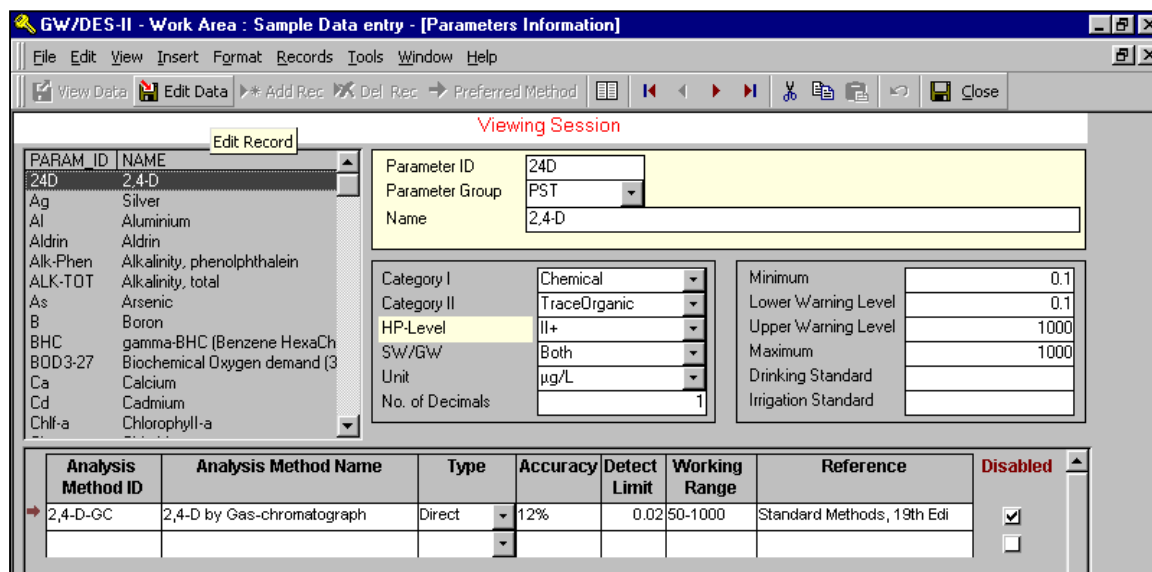


Figure 1.4: Layout of Parameter Information Form

1.3.2 SCREEN LAYOUT

Three functional parts may be distinguished in this form:

- The upper left half of the screen shows all parameters available and the selected one;
- The upper right half of the screen shows details about the selected parameter such as Parameter ID, Parameter Group (Pack), Name, Hymos ID, Category, HP-Level of laboratory where it can be analysed, whether the parameter is applicable to surface water or ground water or both, reporting units, the number of decimals it should be reported in, warning levels, min and max, and national drinking and irrigation water standards;
- The lower half of the screen is reserved for details about the analysis method(s) for the selected parameter and preferred (recommended) method.

Parameter ID and name

The parameter ID is a unique code which identifies each parameter while the name is generally the full name of the parameter. Both the parameter ID and parameter name are mandatory information.

Parameter group

The parameter group categorises a parameter. In the data entry form (see Section 1.5) parameters are ordered according to their group (also called parameter pack). Each parameter can be a member of one group only. The following groups are distinguished:

Group ID	Parameter group name	Examples
ALK	Alkalinity	Phenolphthalein Alkalinity
COL	Coliforms	Total Coliforms , Faecal Coliforms
FLD	Field Determinations	pH, EC
GEN	General parameters	Temperature
HAR	Hardness	Hardness
HM	Trace Heavy Metals	Cadmium, Copper, Zinc
MAJ	Major Ions	Sodium, Calcium, Potassium
NUT	Nutrients	Ammonia, Nitrate, Phosphate

Group ID	Parameter group name	Examples
OM	Organic Matter	Biochemical Oxygen Demand
OMP	Organic Micro Pollutants	PAHs, PCBs, etc.
OTH	Other inorganics	Fluoride, Cyanide
PST	Pesticides	Lindane, BHC, DDT, Endosulphan

Table 1.2: Parameter Groups in the data entry software

Category I and II

Category I and II give additional information on the nature of a parameter. It helps in sorting the parameters for reporting purpose. The following options exist for Category I and II:

Category I	Category II
Physical	Salts
Chemical	Solids
Biological	Gas
	Organics
	Bacteria
	Trace Metals
	Trace Organics
	Others

Table 1.3: Parameter categories I and II

Units

For the standard HP water quality parameters, which are included with the WQDES_GW upon installation, the units of measurements are fixed for each of the parameters. This is to ensure that all the laboratories report their data in the same unit. **The standard reporting units are very important for standardising the data received from different laboratories and allowing comparison of data.** The following units are recognised as standard units of data reporting and presentation:

Unit	Use
mg/L	For most of the chemical parameters
mgN/L	For nitrogen related parameters
mgP/L	For phosphorus related parameters
mgCaCO ₃ /L	For hardness and alkalinity parameters
µg/L	For most of the trace constituents
µmhos/cm	For conductivity
MPN/100mL	For bacteria measured by multiple tube fermentation
°C	For temperature
pH unit	For pH
NTU	For turbidity
%	For dissolved oxygen saturation percentage or percent sodium
-	For dimensionless parameters [e.g. SAR, RSC (numerical), odour and colour]

Table 4: Accepted units within WQDES_GW

For reasons of standardisation, other units are not accepted by WQDES_GW. If the laboratory uses different parameter units internally, conversion to one of the standard units listed above is required before entering the data. The procedures for analytical methods and the standard reporting units have been taken from 'Guidelines on Standard Analytical Procedures for Water Analysis' (Hydrology Project, May 1999) or 'Standard Methods for the Examination of Water and Wastewater (19th edition APHA, 1995 or later).

Some potentially useful conversions are provided below:

Parameter	Unit reported by State/Central Agencies	Multiply by	To get HP recommended unit
Electrical conductivity	mmhos/m or mS/m	10	µmhos/cm
-do-	µS/m	0.01	µmhos/cm
-do-	µS/cm	1	µmhos/cm
-do-	mmhos/cm	1000	µmhos/cm
Ammonia, NH ₄ ⁺	mg/L	14/18=0.778	mgN/L
Ammonia, NH ₃	mg/L	14/17=0.824	mgN/L
Ammonia, NH ₄ ⁺	meq/L	14	mgN/L
Nitrite, NO ₂ ⁻	mg/L	14/46=0.304	mgN/L
Nitrite, NO ₂ ⁻	meq/L	14	mgN/L
Nitrate, NO ₃ ⁻	mg/L	14/62=0.226	mgN/L
Nitrate, NO ₃ ⁻	meq/L	14	mgN/L
Orthophosphate, PO ₄ ⁻	mg/L	31/95=0.326	mgP/L
Orthophosphate, PO ₄ ⁻	meq/L	31/3=10.333	mgP/L
Total phosphate	mg/L	31/95=0.326	mgP/L
Alkalinity-pH	meq/L	50	mgCaCO ₃ /L
Alkalinity-total	meq/L	50	mgCaCO ₃ /L
Hardness-Total	meq/l	50	mgCaCO ₃ /L
Hardness-Ca	meq/l	50	mgCaCO ₃ /L
Carbonate, CO ₃ ⁻	meq/L	30	mg/L
Bicarbonate, HCO ₃ ⁻	meq/L	61	mg/L
Calcium	meq/L	20	mg/L
Magnesium	meq/L	12.15	mg/L
Sodium	meq/L	23.0	mg/L
Potassium	meq/L	39.1	mg/L
Iron, Fe ⁺⁺⁺	meq/L	56/3=18.67	mg/L
Iron, Fe ⁺⁺	meq/L	56/2=28	mg/L
Aluminum, Al ⁺⁺⁺	meq/L	9	mg/L
Chloride	meq/L	35.45	mg/L
F	meq/L	19	mg/L
Sulphate, SO ₄ ⁻	meq/L	96/2=48	mg/L
Silicate, H ₄ SiO ₄	mg/L	60/96=0.625	mgSiO ₂ /L
Silicate, SiO ₃ ⁻	meq/L	60/2=30	mgSiO ₂ /L
Arsenic	mg/L	1000	µg/L
Cadmium	mg/L	1000	µg/L
Chromium	mg/L	1000	µg/L
Copper	mg/L	1000	µg/L
Mercury	mg/L	1000	µg/L
Manganese	mg/L	1000	µg/L
Nickel	mg/L	1000	µg/L
Lead	mg/L	1000	µg/L
Selenium	mg/L	1000	µg/L
Zinc	mg/L	1000	µg/L
Any parameter	ppm	1	mg/L

1 ppm = 1 part per million. For aqueous solution with a density of around 1000 g/L, 1 ppm equals 1 mg/L

Table 1.5: Some conversion units for water quality parameters

Minimum and Maximum

Minimum and maximum values serve as a first validation for the parameter when it is entered in the data sheet. It is not possible to enter values below minimum or above maximum¹.

In case the software is preventing entry of any data, the user has to check the data entry, the data value, the data calculation or even analysis.

The maximum value represents the highest values that may be expected for the parameter under *natural conditions in surface waters in India*. For example, a usual maximum value for water temperature is something like 40°C. The main purpose of the maximum value is to prevent obvious mistakes during data entry or even in analysis or calculation. In case an obvious typing mistake is made and a value of 221 is entered for temperature (instead of the intended value of 22.1) the WQDES_GW will not accept such value for entry. *The maximum value can be edited by the laboratory.*

The minimum value is also used for checking the validation. The minimum value represents the lowest value that may be expected for the parameter under natural conditions in surface waters in India. This implicates that most of the parameters cannot be reported as zero (0.0) and a minimum value (a non zero) is therefore present in the database. Exceptions are all trace organic substances and the following parameters that may be reported as zero (0.0):

- Phenolphthalein alkalinity
- DO
- %DO
- Total coliforms
- Faecal coliforms
- Nitrite (NO₂)
- Carbonate
- Cyanide

Upper Warning Limit (UWL) and Lower Warning Limit (LWL)

These limits are provided in the software to warn the user in case the values are exceeding the usual lower or upper limits. UWL and LWL can be edited by the laboratory, but must meet the criteria:

UWL ≤ Maximum and

LWL ≥ Minimum

These limits will not prevent data entry but will display a warning symbol that the value is above/below the warning limits.

¹ It is possible data lower than the prevailing minimum are present in the database. This situation can occur as a result of importing historical data containing values lower than the minimum value. Also when the user changes the minimum or maximum value after entering data, the situation of data outside the minimum-maximum range may originate. Values outside minimum-maximum range are always indicated with red arrows in the data entry form and by arrows in the reports.

The usual lower and upper limits for a parameter vary with time and space. For a particular region such limits are usually known to the analysts, who have been working for long time in the region. Presently these limits are provided in the software based on the experience from national water quality data of Central Pollution Control Board (CPCB). These limits can be changed by the user based on his/her experience with the values (ranges) encountered for different parameters for a particular region/laboratory.

This provision is useful as a check on entry of unusual data for a region. If an unusual value is entered, which is higher than the UWL, a warning will appear on screen indicating range of values for that parameter usually encountered. The user then will have to check if there is any mistake in entry of the data, calculation or even in analysis. If he finds no mistake, then he can enter the data and the computer will accept the value with an indication of arrow either upward (for the values higher than the UWL) or downward (for the values lower than the LWL).

Limit of Detection (LOD) - part of the analysis method-

The lowest concentration that can be detected by a specific analytical method is indicated here. Different methods for analysing a single parameter can have different LODs. If a new parameter is added to the list, the LOD must be specified (in the same units as the reporting units).

The LOD value is only used for validation purposes in case of trace metals and trace organics!. See Table below for examples. Since trace contaminants are generally difficult to analyse and the instruments involved in the analysis (e.g. AAS and GC) have a limit below which the uncertainty of the result sharply increases, referred to as limit of detection (LOD), this limit is involved in the entry and reporting of the data in the following way.

No.	Entered value	reflection by software	comment
1	2.1	2.1	value within all ranges, nothing special
2	1000	1000	value is equal to maximum
2b	1000.01	reject	value is > maximum
3	2000	not accepted	value > maximum, possibly a error in entering the data (200?) or incorrect unit is used. If value is actually considered to be correct, the maximum can be changed in the parameter master
4	0.01	0.01	value is equal to LOD and LWL:
5	Alt-t	-0.005	value is <LOD# value stored in WQDES_GW is -1/2 of the LOD. The negative sign is the agreed convention to allow transfer of a numerical value to HYMOS (text string not accepted). A data report will show '<0.01', value of 0.005 will be used in statistical calculations and plots
6	0.005	0.005↓	value is <LOD\$ accepted by the software and the ↓ sign indicates the value is <LOD
7	0.0	0.0↓	value is <LOD\$ accepted by the software and the ↓ sign indicates the value is <LOD
8	-0.001	not accepted	value is <minimum
# analyst did not further try to specify this number			
\$ analyst gave his scientific best guess for the actual concentration, although below LOD of his instrument			

Table 1.6: *Example of how values entered are checked against Min, Max, LWL, UWL, and LOD values.*

No. of Decimals

The number of decimals refers to the number of digits after the decimal point. This determines the representation of the parameter in the data entry form and in the reports. The number of decimals is fixed for the standard HP water quality parameters and cannot be changed.

The number of decimals is set in accordance with the accuracy of the method by which the parameter is measured. As an example, there is no point in reporting the temperature value of surface water in two decimals (e.g. temperature = 13.32°C) since the accuracy of the thermometer used for the measurement is limited to 0.1°C. In other words, only significant numbers should be reported. The theory of expression of results is explained in *Standard Methods for the Examination of Water and Wastewater (19th edition APHA, 1995)* or in the WQ training module No. 2 - *Basic Chemistry Concepts (Hydrology Project, 1999)*.

HP-Level

The (minimum) laboratory level necessary for analysing a parameter is selected from the list: I, II or II+. The level of the laboratory is an indication of its analytical capacity. If a parameter can be analysed in the lowest level laboratory it implies that higher level laboratories are capable of analysing this parameter also.

Analysis Method ID and Name

The Analysis Method ID is a unique code which identifies each method. The Analysis Method Name is the full name/description of the method. Both the Method ID and name are mandatory information, and are specified for all the standard HP water quality parameters.

Preferred Method

For each water quality parameter, the preferred (recommended) method is indicated by a red arrow (➔) next to the list of analysis methods. If there is more than one possible method, the recommended method is based on the ‘Guidelines on Standard Analytical Procedures for Water Analysis’ (HP, May 1999). The preferred method cannot be changed for the standard HP water quality parameters. The preferred method may differ from the actual method used by a laboratory. Each laboratory should indicate the actual method used if it is different from the preferred method.

If a laboratory adopts a new method of analysis for a parameter and puts this information into the software it should select this new method of analysis. The software will need additional information on when this method was introduced. To provide this information, in the Lab Information window (Section 1.2) click dropdown box against the desired parameter in the ‘Method Used’ column. Then click the new method out of the list of methods displayed. If the method is not existing in the list add the method in the Parameter Information form as explained below in ‘Common Tasks’. Once the method is clicked, a new window will appear as shown in Figure 1.5. Put the date when the new method was introduced in the last column of the window.

Lab_ID	Param_ID	Analysis_Method_ID	Start Date
CAP-HYD1	Cl	Cl-Hg(NO3)2	01-01-1972
CAP-HYD1	Cl	Ion-meter	01-05-1995

Record: 1 of 2 (Filtered)

Figure 1.5: Analysis Method Time Series Form

Type

Two types of methods are distinguished: direct and indirect. Most parameters are determined directly by chemical analysis. Whenever a parameter is calculated from one or more other parameter(s) without chemical analysis, it is as indirect-type. For example SAR (Sodium Adsorption Ratio) is not directly measured in the laboratory, but calculated. Such parameters are typified as indirect.

Accuracy

It is an indication of combination of bias and precision of an analytical procedure, which reflects the closeness of a measured value to a true value. It is usually expressed as %. Indications of the accuracy of an analytical method are usually given along with the method, e.g. in a section on precision and bias in '*Standard Methods for the Examination of Water and Wastewater (19th edition APHA, 1995)*'.

Working range

The working range is related to an analytical method for a given parameter. It refers to the concentration range for which the analytical method can be used, without a dilution factor being applied. For BOD, the working range may e.g. be defined as 1-6 mg/L. If sample concentrations are above the working range, samples should be diluted prior to analysis.

Reference

It is important to enter the literature reference of each method that listed. The latest version of '*Standard Methods for the Examination of Water and Wastewater (19th edition APHA, 1995)*' and the '*Guidelines on Standard Analytical Procedures for Water Analysis*' prepared under HP (May, 1999) are the main references.

1.3.3 COMMON DATA ENTRY TASKS

Changing the Maximum, LWL and/or UWL

After selecting a specific parameter and choosing the edit mode of the software, the Maximum, LWL and UWL fields can be edited. Switch to editing mode by pressing the 'Edit Record' button on the toolbar. Scroll down the parameter list and highlight the desired parameter. After editing, return to the 'View Mode' by pressing this button of the toolbar.

Adding a parameter

A new parameter can be added to the database. Switch to editing mode by pressing the 'Edit Record' button on the toolbar followed by the 'Add Record' button. Fill in all information on the parameter in the upper right half of the form.

Adding a method to a parameter

A new analytical method can be added for one of the existing water quality parameters. Switch to editing mode by pressing the 'Edit Record' button on the toolbar first. Then select the parameter for which a method is to be added from the list box on the upper left part of the screen. Subsequently, move the cursor to the lower part of the screen and provide all methods details in the bottom line.

Changing or deleting parameters or their preferred methods

This action is not allowed.

1.4 ENTRY OF SAMPLE COLLECTION INFORMATION

1.4.1 GENERAL

In this data entry section, enter all the important information about when, where, and how a sample was collected. This form allows entering of new samples for a particular sampling date. The layout for the Sample Collection Information Form is presented in Figure 1.6.

Note: Many items in this form may not change frequently, especially not for routine monitoring. It is however important to keep track of all collection details. For that reason, many of the fields have a default value that is entered automatically when a new sample is created. This default value may be changed manually if required. There is also provision to save information about a specific sampling location in a template by pressing the toolbar button 'Template' and then 'Save Template'. This saves the template for a particular sampling location. Whenever a new sample is collected at the same sampling location, the template can be loaded by pressing 'Template' and then 'Load Template'. This saves lot of time in entering the same types of information again and again.

1.4.2 ENTRY OF DATA ON SAMPLE COLLECTION

Three functional parts may be distinguished in this form, corresponding to the types of information that must be entered:

- The upper left part of the screen shows the key information of a sample: where and when it is collected;
- The upper right part of the screen shows the laboratory where the sample is sent for analysis and the lab sample ID; The middle part of the screen shows sample collection details, among others the collection agency and the project under which the sample is collected. It furthermore specifies details of the water sample itself.

The lower part of the screen shows the details about the number of containers filled and the treatment of the sample on its way from the field to the laboratory.

Figure 1.6: Layout of the Form for Sample Collection Information

Sample ID

The sample ID is a code that uniquely identifies the sample. This field is filled automatically and is composed of **Station code + date of collection + letter code (A through ZZ)**. The letter code is used to distinguish between different samples collected on the same day (e.g. to be sent to different laboratories or for recording the change of water quality during pumping tests). The user cannot edit the Sample ID. On receipt, a laboratory may assign their own code, the Lab Sample ID, used in their internal administration.

Station Code

The Station Code is the unique name of the sampling location and is selected from the drop down box. The station codes in the drop down box are the available stations in the software.

In case the station (well) from where you have received the sample is not in the list existing in your database, you can add a new station. A new water quality monitoring station can be added through the 'station particulars' form. Click 'Return to Main Switchboard' button in the water quality switchboard (Figure 1.1) to get Main Switchboard. Then click 'Data Entry/editing' button in this switchboard to get form for well characteristics. Fill this form for the new well.

Date of Collection

The date of sample collection must be given in the DD/MM/YYYY format.

Time of Collection

Time of sample collection should be given in hours and minutes: HH:MM. Hours should be recorded in 24 hour system (e.g. 3:15 PM should be entered as 15:15).

Laboratory

The laboratory where the sample has gone for analysis must be selected from the drop down box. The list of laboratories may be changed using the 'select' option under the 'Filter' tab. Alternatively, a single laboratory can be selected as the 'Default Lab' in the Laboratory Information Form.

Lab Sample ID

The lab sample ID is a code or number given to the sample by the laboratory, which *may* be same or different than the Sample ID explained above. For example, a laboratory may have its own ID system, giving a sequential number to all the samples that it collects and analyses. In the WQDES_GW software, there are 3 options for entering Lab Sample ID:

1. retain sample ID as Lab-Sample ID,
2. manually enter sample ID, or
3. automatically generate the Lab-Sample ID (sequential numbering).

The desired option can be selected in the 'Water Quality Option' form, explained in Section 1.6.

Purging

If a well has been purged prior to sample collection, the “Purging” field should be ticked. This will then display several data entry fields for entering well purging details:

- Type of pump
- Pump Installation/Suction Depth (m) Pump installation depth (BGL)
- Rest Water Level (m) Static
- Pump Discharge (m³/h) Pump flow rate
- Pumping duration (minutes)
- Water Level after Pumping (m) Deepest water level after pumping (BGL)
- Volume Purged (m³) Calculated based on discharge rate and duration

Collecting Agency

The agency ID is the name of the agency that is collecting the sample from the field and is responsible for delivery to the laboratory. The laboratory may belong to the same agency, but not always. The agencies listed in the drop down box are currently available in the database. Agencies can be added or their attributes may be changed through the "Agency / Owner Agency & Offices definition" as described in “Customising State, District, Block, Taluk names”.

Source

Here the type of well that was sampled is specified. This field is a display field, i.e. it is filled automatically based on the station code. Source can be:

- dug well
- bore well
- dug-cum-bore well.
- tube well
- hand pump
- piezometer

Depth

Enter the depth at which the sample was collected. Typical values should be the aquifer being tapped.

Project

Here the name of the project, if any, may be given. In most cases, the project will be the ‘Regular Monitoring Programme’. If the sample is collected as part of a special survey or surveillance programme, the name of this programme or project should be given.

Collector

The name of the person who collected the sample is entered here.

Monitoring Type

Identify the type of monitoring sample, namely:

- Baseline
- Trend
- Surveillance
- Survey

See "Protocol for Water Quality Monitoring" (Hydrology Project, August 1999) and for necessary details.

Remarks

Any relevant remarks to the sample collection can be added here: weather (raining, cloudy, windy), condition of the well surrounding events happening during sampling etc.

Container, Sample Specification, Volume, Sampling Device, Preservation and Treatment

In the lower half of the form, specific information on the sample containers that were filled is entered, including sample specification, volume collected, sampling device used, preservation in the field, and treatment in the laboratory. Enter this information in the table for EACH type of sample container that is filled. If only one sample bottle is filled, complete only 1 row of the table.

An example of data entry for 'Container, Sample Specification, Volume, Sampling Device, Preservation, Treatment' is given below.

Container	Sample Specification	No. Containers	Volume per container(ml)	Sampling Device	Preservation in field	Treatment at lab
Plastic	General	1	1000mL	Submersible pump	None	None
Glass	Coliforms	2	300	Submersible pump	None	None

Table 1.7: Sample collection data entry information

Container

Select from the pull-down menu the sample container that is filled:

- DO bottle
- Glass
- Amber Glass Bottle
- Polyethylene (PET)
- PVC
- Other plastic
- Stainless steel
- Other Metal
- Unknown

Discriminating between the different type of plastic (PET, PVC and others) may seem nit picking but the opposite is true. In general, the conditions of the sample before analysis are very important, the material of the container is one of them. Most plastics are not airtight, even when properly sealed. e.g., PVC containers are not suitable for collecting trace metals because the material contains metals itself. For each group of parameters to be analysed, a specific container may be needed. See '*Guidelines on Standard Analytical Procedures for Water Analysis*' (Hydrology Project, May 1999) or '*Standard Methods for the Examination of Water and Wastewater* (19th edition APHA, 1995) for details. If more details about the material of the container are known, please supply this information.

Sample Specification

It is important to specify the type of analysis to be performed on the sample collected in each container in the 'Sample Specification' column. This is important for the laboratory staff and field staff to ensure the right container for different parameters, right preservation and precautions during transportation and holding time for analysis. In this column the pull-down menu contains following options:

Option	Type of analysis to be performed
General	For measurement of general parameters like, pH, conductivity, solids, ions, nutrients, BOD etc. sample is generally collected in polythene bottle and cold preserved.
DO sample	For measurement of Dissolved Oxygen, needs special DO bottles and fixed with DO reagents (Manganous sulphate and sodium iodide-azide solutions).
Coliform	For coliform measurement, sterilised glass bottles are required. Sample is to be preserved in cold.
Heavy metals	For heavy metal analysis, samples are collected in polythene bottles and acidified with nitric acid.
Ammonia, oxidised nitrogen and COD	For ammonia, total oxidised nitrogen and COD the samples are to be acidified with sulphuric acid.
Pesticide	Pesticide samples are collected in amber colour glass bottles and preserved in cold (ice-box).

Table 1.8: Sample specification options

Number of Containers

Enter the number of containers that are collected for each container type.

Volume

Enter the volume of sample collected in each container, *in ml*. Typical volume for a sample bottle is 1000 ml.

Sampling device

Select from the pull-down menu the sampling device used:

- Submersible pump
- Compressor pump
- Other type of pump
- Bailer
- Bucket
- Bottle
- Weighted Bottle
- Depth sampler
- Multi purpose sampler

Preservation in field

Select from the pull-down menu the type of preservation that is used on the sample after it is collected in the field:

- Cooling (4°C)
- Acidification
- Freezing
- Other
- None

In principle, *all samples* should be cooled during transport to the laboratory. For this purpose, a cool-box with ice cubes or cooling elements should be carried on a sampling tour.

Treatment at laboratory

Select from the pull-down menu the type of treatment that is applied to the sample in the laboratory:

- None
- Centrifuged
- Filtered (0.45 µm)
- Solvent Extraction
- Resin Extraction



Press 'Template' button on toolbar to get two options, 'Save Template' and 'Load Template'. Press 'Save Template' button to save the current settings of the form to a location specific template. The following items will be saved in the template: Laboratory, Collecting Agency, Source, Medium, Matrix, Type, Depth, Collector, Project, Monitoring Type and all Container details. The Remarks, the date and time of sampling and sample_id are not stored. The button is useful when samples are collected regularly (e.g. monthly) at a given location since many of the sample collection details remain the same.



By pressing 'Template' and then 'Load Template' option as indicated above, one can load the saved settings for a specific location- this is useful when entering new sample collection information for the location. First, the desired location must be selected from the sample location list. The following fields are then filled with information stored in the template: Laboratory, Collecting Agency, Source, Medium, Matrix, Type, Depth, Collector, Project, Monitoring Type and all Container details.

Filtering Sample Collection Information

The data records can be filtered in case information on how many sample data records are available in the WQDES_GW for a particular sampling location or locations attached to a particular Laboratory for a particular period is required. In the WQDES_GW there is an option available to find that through filtering option. By selecting 'Filter' 'tab' on the 'Sample Collection Information Form' user can prompt to filtering option form (Figure 1.7). In this form user can define the station(s) and desired period from the calendar. User can also define the sort order either by date-ascending or descending and by station.

The selected filter becomes effective after leaving the filter form. To get the full list of samples available in the database the user has to de-select all filters applied. This is again done in the filter form by double –clicking on selected stations and dates.

Screen Layout – Filter

Under the tab key ‘Filter’, you can select specific stations, laboratories or dates to be shown on the data entry form (ref. Figure 1.7). Limiting these variables to those that are relevant to a specific laboratory can simplify the data entry process.

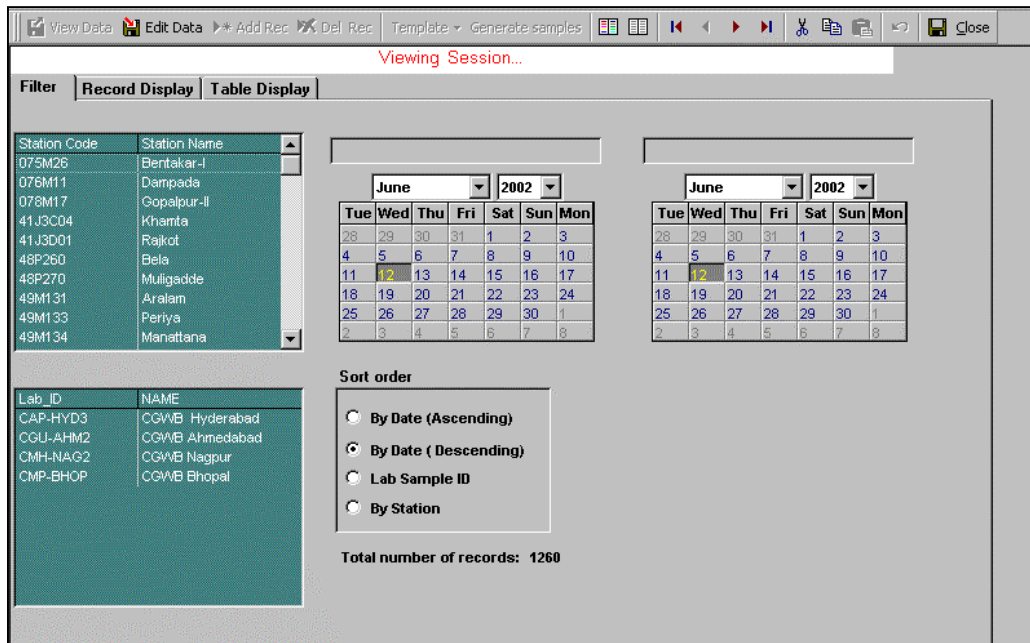


Figure 1.7: Layout of the Form for Filtering Sample Collection Information

Generate Samples

This option allows multiple sample records to be generated. When a number of samples are collected on same date, the records can be generated automatically. Press 'Generate Samples' tab. The form as shown in Figure 1.8 will appear. Select the wells from where samples were collected, put the date of collection, date of receipt, monitoring type and name of collector and then press the button 'Generate Samples'. All the sample records will be generated automatically, taking the other sample details from the template saved earlier for respective wells. This saves lot of time in entering the sample information. The 'Generate Sample' form is shown in Figure 1.8.

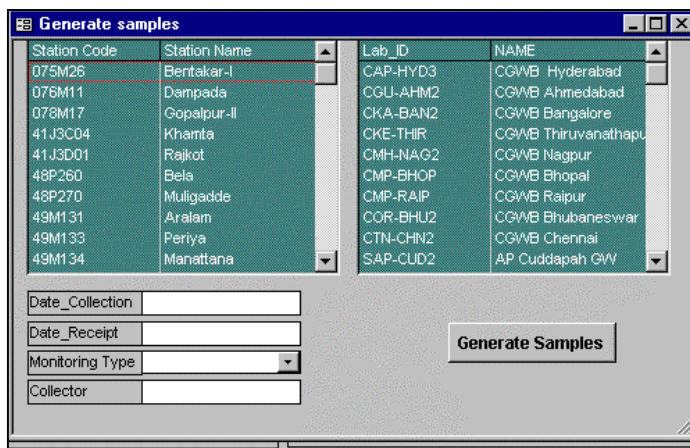


Figure 1.8: Layout of Generate Sample Forms

Table Display

There is a tab provided on the on the toolbar for 'Table Display'. By pressing this button, one can prompt to datasheet view. The datasheet view shows the sample records in a tabular form, which gives a clear overview of available samples. It is now much more convenient to check the sampling details for correctness and fill in the missing details such as Remarks, Date and Time of Sampling and Sample_ID. It allows editing the information in the column itself. This saves lot of time in doing the same job sample wise. The layout form for Table Display is shown in Figure 1.9.

Site Code	Date_collection	Time_collection	Lab_ID	Lab_Sample_ID	Depth (cm)	Collector	Containers
076M11	22/10/1998	00:00	CMH-NAG2	1291			<input type="checkbox"/>
076M11	22/10/1998	00:00	CMH-NAG2	1290			<input type="checkbox"/>
076M11	22/10/1998	00:00	CAP-HYD3	1296			<input type="checkbox"/>
076M11	22/10/1998	00:00	CAP-HYD3	1295			<input type="checkbox"/>
AMRPZ	19/09/1998	00:00	CMP-BHOP	1331	7		<input type="checkbox"/>
AQA23A	07/09/1998	00:00	CMP-BHOP	1336			<input type="checkbox"/>
076M11	03/08/1998	00:00	CMP-BHOP	1299			<input type="checkbox"/>
AMRPZ	03/08/1998	00:00	CMP-BHOP	1330	11		<input type="checkbox"/>
AMRPZ	02/07/1998	00:00	CMP-BHOP	1329	19		<input type="checkbox"/>
AMRPZ	05/06/1998	00:00	CMP-BHOP	1328	16		<input type="checkbox"/>
G/PB-005	21/05/1998	00:00	CMP-BHOP	1374			<input type="checkbox"/>
AMRPZ	02/05/1998	00:00	CMP-BHOP	1325	14		<input type="checkbox"/>
AMRPZ	04/04/1998	00:00	CMP-BHOP	1324	11		<input type="checkbox"/>
AMRPZ	02/03/1998	00:00	CMP-BHOP	1327	9		<input type="checkbox"/>
AMRPZ	07/02/1998	00:00	CMP-BHOP	1326	9		<input type="checkbox"/>
AMRPZ	30/12/1997	00:00	CMP-BHOP	1323	9		<input type="checkbox"/>
58C121	23/12/1997	00:00	CAP-HYD3	3034	0		<input type="checkbox"/>
48P260	15/12/1997	00:00	CAP-HYD3	2994	0		<input type="checkbox"/>
48P270	13/12/1997	00:00	CAP-HYD3	3006	0		<input type="checkbox"/>
AMKOLO	12/12/1997	00:00	CAP-HYD3	3046	0		<input type="checkbox"/>

Figure 1.9 : Layout of Data Entry Form

1.4.3 COMMON DATA ENTRY TASKS

Create a new sample record

Switch to editing mode by pressing the 'Edit Record' button on the toolbar followed by the 'Add Record' button. Fill in the location, data and time of collection. Notice the SAMPLE_ID being created. Then check the fields on the form that are created by default and make any necessary changes. Subsequently provide the required information for all blank fields.

Add a new sampling location

Adding or modifying location/site characteristics cannot be done from the Water Quality Data Entry Form. See "Well Information General and Well Details" in the main menu.

1.5 ENTRY OF FIELD AND LABORATORY ANALYTICAL RESULTS

1.5.1 GENERAL

In the data entry section, water quality analytical results as measured in the field and in the laboratory are entered into the database. This section has two main functions:

- Data entry
- Data validation

Data values are entered in the form displayed in Figure 1.10, which shows the tab-sheet 'Standard Parameters' where data are entered. A similar form for customised parameters is available under the tab-sheet 'Customised Parameters' which includes only the customised parameters selected in the 'Laboratory Information Form'. Note that there is only one mode available for the data entry form (i.e. editing mode).

All samples which have been entered in the 'Sample Collection Information' Form are listed automatically in the Data Entry form (with Lab Sample No. and Sample ID).

The screenshot shows a software interface titled 'Sample Data Entry'. At the top, there are fields for 'Well No' (19), 'Laboratory ID' (CGWB Bhopal), and 'Lab Sample No'. Below these are three tabs: 'Standard Parameters', 'Check Analysis Results', and 'Customised Parameters'. The 'Standard Parameters' tab is active, displaying a table with columns for 'Sample ID', 'Nutrients', 'Org Matter', 'Alkalinity', 'Hardness', and 'Other Inorganics'. The table lists 20 rows of data for samples collected between 19-07-01-1992 and 19-09-07-1992. Each row contains numerical values for various parameters, with some cells containing red or blue arrows indicating trends or status.

Sample ID	Nutrients			Org Matter		Alkalinity		Hardness		Other Inorganics		Sample	
	NH3 mg N/L	NO2+ NO3 mg N/L	Total P mg P/L	Si mg/L	BOD mg/L	COD mg/L	Phen mg CaCO3/ L	Total mg CaCO3 /L	Total mg CaCO3/ L	Ca mg CaCO3 /L	F mg/L		B mg/L
19-07-01-1992- A		1.5			0.5	8.0	0.0	12.0	18	5			19-07-01-1992- A
19-07-01-1992- B		1.5			0.5	8.0	0.0	12.0	18	5			19-07-01-1992- B
19-07-01-1992- B		1.5			0.5	8.0	0.0	12.0	18	5			19-07-01-1992- B
19-05-02-1992- A		1.7			0.6	7.0	0.0	9.0	19	8			19-05-02-1992- A
19-05-02-1992- B		1.7			0.6	7.0	0.0	9.0	19	8			19-05-02-1992- B
19-05-02-1992- B		1.7			0.6	7.0	0.0	9.0	19	8			19-05-02-1992- B
19-05-03-1992- A	0.00	2.2	0.00		0.0	9.0	0.0	11.0	20	3		0.00	19-05-03-1992- A
19-05-03-1992- B	0.00	2.2	0.00		0.0	9.0	0.0	11.0	20	3		0.00	19-05-03-1992- B
19-05-03-1992- B	0.00	2.2	0.00		0.0	9.0	0.0	11.0	20	3		0.00	19-05-03-1992- B
19-07-05-1992- A		0.5			1.0	11.0	0.0	19.0	19	4			19-07-05-1992- A
19-07-05-1992- B		0.5			1.0	11.0	0.0	19.0	19	4			19-07-05-1992- B
19-07-05-1992- B		0.5			1.0	11.0	0.0	19.0	19	4			19-07-05-1992- B
19-09-07-1992- A		2.0			0.8	9.0	0.0	19.0	30	7			19-09-07-1992- A
19-09-07-1992- B		2.0			0.8	9.0	0.0	19.0	30	7			19-09-07-1992- B

Figure 1.10: Layout of Data Entry Form

Laboratory ID

Select the laboratory for which data are to be entered or validated from the pull-down menu. A list of selected laboratories is given (the selection may be changed). Alternatively, if a laboratory is set as a 'Default Lab' (on the Laboratory Information Form) this lab will automatically be shown on the data entry form.

Lab Sample No.

Here a sample is selected through its Lab-Sample ID. The Lab-Sample ID is assigned to a sample in the sample collection form as described in Section 1.6.

Sample ID

Here a sample is selected through its sample ID. The sample ID cannot be changed since it is automatically assigned by WQDES_GW in the sample collection form as described in Section 1.6. From the Sample ID, it is easy to read the station code and the date of collection.

Date of Receipt

The date on which the sample was received by the laboratory should be entered in this form as follows: dd/mm/yyyy, e.g. 21/01/2000.

Date of Analysis

For some of the parameters, it is important to know how soon they were analysed after the collection date (i.e. the holding time of the sample before analysis). This is especially important for BOD and Coliforms, where the sample should be analysed within 24 hours of collection. The analysis date for these parameters should be entered as: dd/mm/yyyy, e.g. 21/01/2000.

Laboratory results

In the remaining fields, the data of laboratory results must be entered.

A warning is issued when a result beyond the warning limits (both UWL and LWL) is entered and the data is tagged with a symbol indicating that the value is above/below the warning limit.

If the values are below detection limit of the method being used, the *value will not be accepted by the computer*. Similarly, if the value is higher than the maximum limit set for a particular parameter, the *value will not be accepted* for entry. This is to prevent entry of the exceptionally high or low values.

Calculated Parameters

Some of the parameters need not be entered in the form because they are automatically calculated. These parameters are called indirect parameters.

In DES, six (indirect) parameters are calculated based on the measured results of other (direct) parameters. The formulas are given below. Once the value for the required (direct) parameters is entered, the indirect parameters are automatically calculated and their values are incorporated in the data entry form.

Note: all ionic species in the equations 1, 2 and 3 below are in meq/L. Data for these ionic species is entered in mg/L and WQDES_GW automatically makes the conversion.

1) Sodium Adsorption Ratio (SAR)

$$\text{SAR} = \frac{\text{Na}^+}{\sqrt{(\text{Ca}^{2+} + \text{Mg}^{2+})/2}}$$

2) Percent Sodium

$$\% \text{Na} = \frac{\text{Na}^+ \times 100}{\text{Ca}^{2+} + \text{Mg}^{2+} + \text{Na}^+ + \text{K}^+}$$

3) Residual Sodium Carbonate (RSC)

$$\text{RSC} = (\text{CO}_3^{2-} + \text{HCO}_3^-) - (\text{Ca}^{2+} + \text{Mg}^{2+})$$

4) Calcium Ion (Ca²⁺)

$$\text{Ca}^{2+} \text{ (mg/L)} = 0.4 \times (\text{Calcium Hardness (mg CaCO}_3\text{/L)})$$

5) Magnesium ion (Mg²⁺)

$$\text{Mg}^{2+} \text{ (mg/L)} = 0.24 \times [\text{Total Hardness (mg CaCO}_3\text{/L)} - \text{Calcium Hardness (mg CaCO}_3\text{/L)}]$$

6) Calculated Total Dissolved Solids (TDS_Calc)

$$\text{TDS_Calc} = 0.6 \times \text{Total Alkalinity (mgCaCO}_3\text{)} + \text{Ca}^{2+} + \text{Mg}^{2+} + \text{Na}^+ + \text{K}^+$$

**7) Carbonate ion (CO₃²⁻) and Bicarbonate ion (HCO₃⁻)**

By using measured values of Phenolphthalein Alkalinity (P) and Total Alkalinity (T) one can calculate the hydroxide, Carbonate and Bicarbonate alkalinity in water using following formulas:

Condition	OH alkalinity as in mg CaCO ₃ /L	CO ₃ ²⁻ alkalinity as mg CaCO ₃ /L	HCO ₃ ⁻ alkalinity as mg CaCO ₃ /L
P = 0	0	0	T
P < ½ T	0	2P	T-2P
P = ½ T	0	2P	0
P > ½ T	2P-T	2(T-P)	0
P = T	T	0	0

The alkalinity values of CO₃²⁻ and HCO₃⁻ (in mgCaCO₃/L) are then converted to mg/L by multiplying with the factors of 0.6 and 1.22, respectively (60g CO₃²⁻ per 100g CaCO₃ and 122g HCO₃⁻ per 100g CaCO₃)

1.5.2 COMMON DATA ENTRY TASKS***Adding laboratory results for a sample***

The data entry form is always in edit mode so the user can directly select a sample for which laboratory results will be entered. If sample information has been entered in the Sample Collection Information Form, then the sample (Lab Sample No. and Sample ID) will automatically show up in the Data Entry Form.

Deleting or changing a sample

Deleting a sample is only possible when it does not contain any data. In case a sample record containing data is to be deleted, first all data from the record must be deleted from the record.

Sorting Data

Data records can be sorted by station or date by selecting one of the toolbar buttons

1.6 OPTIONS FOR WATER QUALITY DATA ENTRY**1.6.1 GENERAL**

One of the data entry forms allows for changing some of the options in the data entry system (Figure 1.11). Such options exists for:

- Method of entry for Lab-Sample ID in 'Sample Collection Information' Form ,
- Validation of ion balance in the Data Validation option of 'Sample Data Entry and Validation Register', and
- Selection of Drinking Water Standards to be used for comparison with data.
- Definition of the seasons used in creating Seasonal Box Whisker plots

Figure 1.11:
Form showing the options for the water quality part of the data entry software

1.6.2 OPTION FOR CHANGING METHOD OF ENTERING THE LAB SAMPLE ID

On the 'Sample Collection Information' form, there is provision to enter a Lab Sample ID, which may be the same as, or different from the (automatically generated) Sample ID. The Lab-Sample ID option has provision to change the method of defining/entering the Lab Sample ID. These options are:

- 1) Auto-Generate: in which the Lab Sample ID is automatically generated. The first sample collected by a laboratory and entered into the database is number '1'. For every new sample collected and entered, the next consecutive number will appear in the box automatically. The number assigned is based on the number of records already in the database;
- 2) Duplicate Sample ID: in which the Lab-Sample ID is created same as Sample ID.
- 3) Manual: in which the Lab-Sample ID can be manually entered.

1.6.3 OPTION FOR CHANGING PERCENT DIFFERENCE IN ION BALANCE

One of the data validation steps on the Data Validation Form checks the validity of sample analysis result based on the percentage difference between the sum of anions and the sum of cations. The sum of the major anions and cations, when expressed as milliequivalents per liter, should be nearly equal, as the natural water is electrically neutral. Since water may contain a large number of ions and not all the ions are analysed, the sum of measured major cations and anions may not be exactly equal. However, the percent difference should be small. The percent difference may vary with concentration of the total ions and the accuracy with which they are measured. It is common procedure to accept a percent difference $\leq 10\%$. In the software, there is a provision to choose either 5% or 10%.

The default value for the acceptable percent difference is 10%.

1.6.4 OPTION FOR CHANGING THE TYPE OF DRINKING WATER STANDARDS

There are four different sets of Drinking Water Standards commonly used in India. In the WQDES_GW software, the default set of drinking water standards used for comparison with data is BIS. The options are:

- 1) BIS (Bureau of Indian Standards) (*default*) desirable, permissible (two options)

- 2) ICMR (Indian Council on Medical Research)
- 3) CPHEEO (Central Public Health & Environmental Engineering Organisation)
- 4) WHO (World Health Organisation)

These values from the selected set of standards are shown in the 'Parameter Information Form' in the field 'Drinking Standard'. One option of the Water Quality Report is to show water quality results compared with the selected standards.

All standards are currently expressed in the units prescribed by the data entry software.

1.7 Data Entry for AQC Data

1.7.1 GENERAL

Under the Hydrology Project, a system of quality control in laboratories based on Inter-laboratory Analytical Quality Control (AQC) exercises has been introduced. The results of the first two exercises were analysed manually. Upon reviewing the results, questions of uncertainties about the processing of exercise results were encountered. The results of AQC exercise are important since the proficiency and credibility of laboratories is involved. To avoid ambiguity in future, special software for "Automatic Processing of Inter-Laboratory AQC Exercise Data" was developed (available on request).

Participating laboratories use their Data Entry Software (WQDES_GW) to enter their analytical results of the AQC samples. This facility is provided in the WQDES_GW and is referred as **AQC Data**. This part of the software can store the analysis results generated from the exercise for all the required parameters in samples A and B.

When the option "**AQC Data**" is chosen in the Water Quality Switchboard, AQC Data switchboard will be displayed. The switchboard has the following options see Figure 1.12:

- AQC Parameters
- AQC Data Entry
- AQC Export

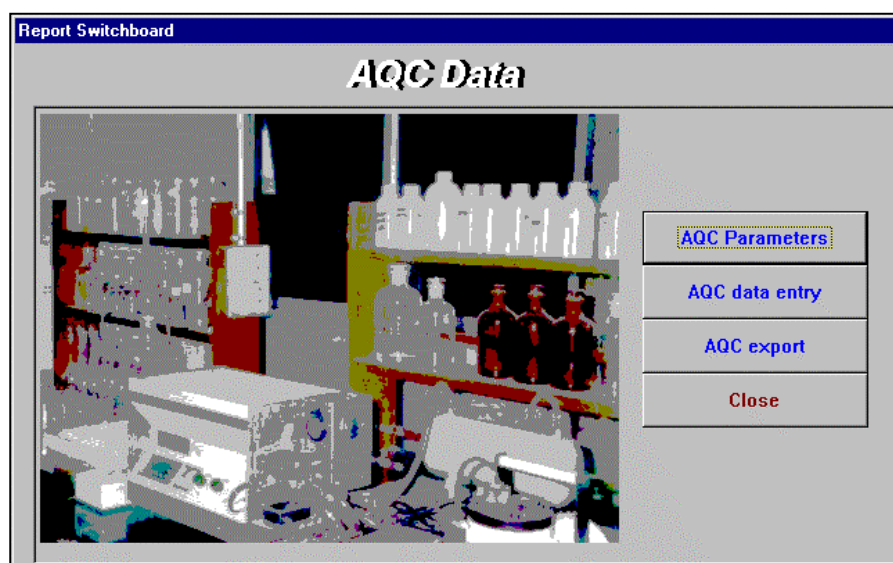


Figure 1.12: Layout of the AQC Data Switchboard

1.7.2 AQC PARAMETERS

When AQC Parameters button is clicked, the parameter form is displayed as shown in Figure 1.13. In this form, one can choose the parameters for which AQC is conducted after entering appropriate AQC Round ID. For selection of the parameters for which AQC was conducted, click on the desired parameter in the left column and click the rightward arrow. In case you want to unselect a parameter from the selected list, you can do so by again clicking the parameter to be unselected in the AQC Parameters column (in the right) and then clicking the leftward arrow. The number of decimal places and units can be changed in the lower portion of the form, if required.

Param_ID	Decimals	Unit
B		2mg/L
Na		0mg/L
EC_GEN		0µmho/cm
F		2mg/L
HAR_Total		0mgCaCO3/L
α-PO4-P		3mg P/L
SO4		0mg/L

Figure 1.13: Layout of AQC Parameters Form

1.7.3 AQC DATA ENTRY FORM

When the button for AQC Data Entry is pressed, the AQC data entry form will be displayed. Select appropriate AQC Round ID, the parameter list of selected AQC Round will appear. The analysis results for different parameters as obtained for both the samples A and B can be entered in this form. Once all the results are entered, the data can be exported to organising laboratory through e-mail or floppy. The data entry form is displayed in Figure 1.14.

Round ID

The software will store all the data from many rounds of AQC exercises, each round is to be given a unique round ID number. The organising laboratory needs to provide a unique round identification code to the participating laboratories along with the dispatch of the samples for each new round. A meaningful identification code will include a serial number followed by the year in which exercise was conducted e.g. 12-2005 (round 12 conducted in the year 2005).

Parameter	Sample		Analysis Method	Analysis Date (dd/mm/yyyy)
	A	B		
B (mg/L)				
Na (mg/L)				
EC_GEN (µmho/cm)				
F (mg/L)				
HAR_Total (mgCaCO3/L)				
o-P04-P (mg P/L)				
SO4 (mg/L)				
TDS (mg/L)				

Figure 1.14: Layout of AQC Data Entry Form

The overall procedure for AQC data entry is as follows:

- 1) organising laboratory provides the participating laboratory with a unique ID for the current round of AQC.
- 2) The receiving laboratory enters the results of their AQC analysis (Sample A and B) in the data entry software together with the method of analysis used (select from a list), date of sample receipt and date of analysis for each parameter (see Figure 1.14).
- 3) Note that the reporting format (i.e. number of digits after the decimal point) for each parameter is fixed as follows:

Conductivity (EC)	0	Sulphate (SO ₄)	0
Total Dissolved Solids (TDS)	0	Nitrate (NO ₃ -N)	1
Total Hardness (TH)	0	Phosphate (PO ₄ -P)	3
Sodium (Na)	0	Boron (B)	2
Fluoride (F)	2		

The number of digits entered in the AQC data entry form for each parameter should not be more than those specified above. If more digits are entered, **the data will be rounded to the listed number of digits before comparison with acceptable limits.**

1.7.4 EXPORT OF AQC DATA

After completion of the entry form, the participating laboratories export the data to a file (on DES toolbar). It is possible for a laboratory to enter AQC results from another laboratory also. During export, all data available in the AQC-database for the selected round-ID will be exported. The name of the file in which the data are stored includes Laboratory ID followed by AQC round ID with MDB extension e.g. CTN-COIM_122005.MDB. this indicates that the file is sent from the CWC laboratory at Coimbatore and contains data of the twelfth AQC round conducted in the year 2005, the file extension MDB indicates it is an microsoft Access Database. The data can be easily sent either through e-mail or floppy to the organising laboratory for further processing.

1.8 Data Entry (Import) of Historical Water Quality Data

1.8.1 GENERAL

Most of the agencies involved in the Hydrology Project have a rich archive of observed water quality data. The period of available data varies from agency to agency and from well to well within an agency. While some agencies have put a part of the WQ data on to magnetic media, others are yet to start. For achieving better efficiency in using this vast amount of data, which is an asset created by various agencies at a huge cost, it is essential to properly organise it on computer. The benefits derived from such an effort need no emphasis.

It is important to make an inventory of all historical data available with the agency. All the water quality wells along with their ID must be available district-wise or division-wise along with the associated characteristics. This is already available with Water Level Recording Groups. The inventory must indicate the period of availability of data (in years) for each well. The inventory should also include those wells which were WQ wells for quite a long period but now non-functional. Many agencies have already entered the data in different softwares (e.g. lotus, excel, dbase, WQDES_GW 2.04 etc). it is normally possible to read such data automatically and write back in formats desired by WQDES_GW and, therefore, it is not necessary to enter them again. Provisions have been made in WQDES_GW for importing such historical data.

It is important for import that information on Station (Well) ID to which WQ data belong, date of sampling (or at least year and month), parameters along with their values and Laboratory (along with its ID), where the sample was analysed is available.

When 'Import Old GWDES Data' button is pressed, you are prompted to 'Import Water Quality Data' switchboard. The switchboard is shown in Figure 1.15. The switchboard has two different options, i.e. 'Import from GWDES 2.04' and 'Import external data'. The functionality of these options is explained below:



Figure 1.15: Layout of Import Water Quality Data Switchboard

1.8.2 IMPORT FROM WQDES_GW 2.04

Many laboratories have entered the WQ data in GWDES 2.04. Since, the WQDES_GW has been modified with much more functions for data analysis and attached information, it is important that the data are imported into the present version of the WQDES_GW. By pressing 'Import from GWDES 2.04' one can prompt to the form as shown in Figure 1.16. For importing the data, one has to select the desired file containing data by clicking the button in lower part of the form. Then select the lab from the list on the right side of the format and the stations (wells) for which the data are to be imported in the left column. Finally click 'Import' button to import the data.

Well No	Laboratory ID	
	Lab_ID	NAME
	CAP-HYD3	CGWB Hyderabad
	CGU-AHM2	CGWB Ahmedabad
	CKA-BAN2	CGWB Bangalore
	CKE-THIR	CGWB Thiruvananthapuram
	CMH-NAG2	CGWB Nagpur
	CMP-BHOP	CGWB Bhopal
	CMP-RAIP	CGWB Raipur
	COR-BHU2	CGWB Bhubaneswar
	CTN-CHN2	CGWB Chennai
	SAP-CUD2	AP Cuddapah GW
	SAP-DOW2	AP Dowlaiswaram GW
	SAP-HYD	AP Hyderabad
	SAP-KAR	AP Karimnagar (+)
	SAP-KURN	AP Kurnool
	SAP-VIS	AP Visakhapatnam (+)

Figure 1.16:
Layout form for importing water quality data from GWDES 2.04

Import of External Data

Access to Import Function

For importing external data click 'Import external data' button on the 'Import Water Quality' switchboard (Figure 1.15), is clicked you are prompted to format as shown in Figure 1.17. For importing data existing in excel or dbase format you have to perform as follows:

Select the file

The import can be done from excel or dbase files. By clicking the file name button on the lower right part of the format one can prompt to desired file either from hard disk or floppy.

Link the parameters (columns)

Once the desired file is opened, the second column of the right half of the format will get list of the parameters existing in the external file. One has to link the parameters of the external file with the parameters of the WQDES_GW, including site code, date of sampling, WQ parameters etc. The linking can be done by clicking the corresponding parameters in the two columns, then clicking the arrow-button in between the columns.

Define the conversion factor

In case, there is a difference in unit of a particular parameter, a factor of multiplication is required to be put in the middle part of the two right columns. The clicked parameters will appear in the right top columns along with the factor of multiplication. In case, one wants to edit the factor of multiplication, he can do so by clicking the desired factor in the column and retyping it.

Date of Sampling

In case the date of sampling is not known, only month and year is known, one can put an arbitrary date in the 'Date of Collection' in the lower right part of the format.

Define missing value(s)

For missing values (parameter not analysed), in the external database some sign might have been used e.g. ND for not done, NA for data not available, -1 or any other sign. The user can put that sign in the lower right part of the format against 'Missing Value'. Ensure that the same sign is used in the entire database. In case different signs were used, first make them same in the external database itself. Once all the linkages are made, click 'Import data' button to import the data.

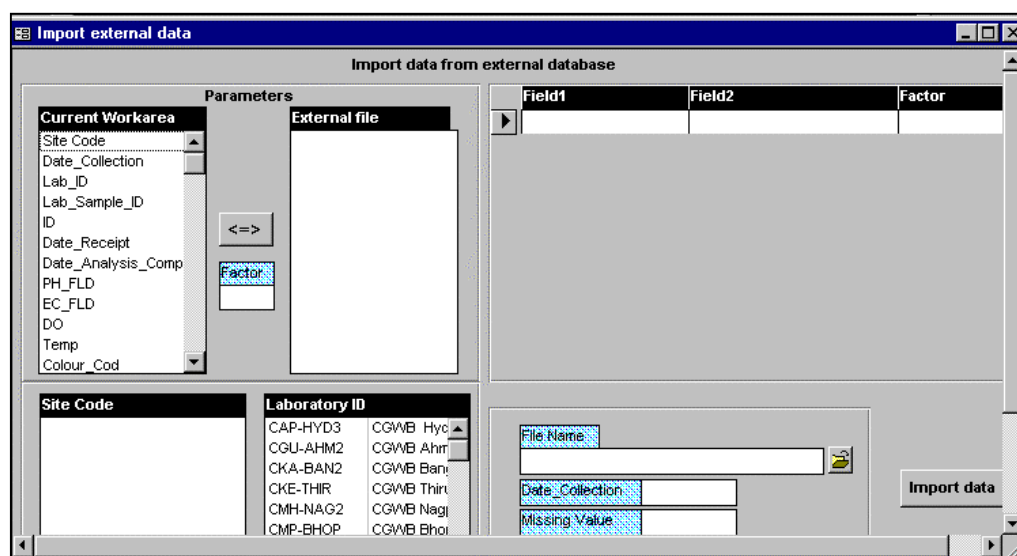


Figure 1.17: Layout form for import of external data

1.8.3 RULES FOR IMPORTING HISTORICAL DATA

A number of basic rules are relevant for importing historical water quality data:

- Calculated parameters in the historical database (such as SAR, %DO, %Na etc) cannot be imported into WQDES_GW, the calculation will be re-done in WQDES_GW.
- Units of parameters in historical database must be converted to the prescribed units of the WQDES_GW (use factor or correct in original file).
- The method by which a parameter is analysed in the past must be entered in the WQDES_GW. The laboratory must also record if, and when, the method of analysis was changed. This date of change in method can be incorporated in the database as explained in section 1.3, Figure 1.5.
- Ensure that repeated sampling was done at the same stations for at least 3 to 5 years. In one of the HP States, the Ground Water Survey Agency collects samples from new wells every year for water quality, data generated from such sampling can not be put to any statistical analysis and thus of very little significance putting in the software.

2 VALIDATION OF WQ DATA

The validation results can be viewed in the tab-sheet 'Standard Validations', as shown in Fig. xx.1 WQDES_GW performs several data validation checks for each sample. If the water quality data for a sample do not meet a specific validation check, a arrow will indicate that the result is above (↑) or below (↓) the allowed limit for that check. Furthermore, a small box will indicate a check (✓) or cross (✗), indicating passing or failing of the validation check.

Sample ID	Ion Balance		EC bal	Carbon Bal	CO3 Bal	TDS Check	Checked by & Date
	(((9)-(15)) / ((9)+(15)))	(Na) / (Cl)	(TDS) / (EC)	(COD) / (BOD3)	if (pH) < 8.3, is (Phen)=0?	TDS/ Calculated TDS	
	(2)	(16)	(17)	(18)	(19)	(20)	
19-07-01-1992- A	✗ ↑ 29.29%	✗ 0.82	☐ NA	✗ ↑ 16.00	☑ OK	↓ 0.00	
19-07-01-1992- B	✗ ↑ 29.29%	✗ 0.82	☐ NA	✗ ↑ 16.00	☑ OK	↓ 0.00	
19-07-01-1992- B	✗ ↑ 29.29%	✗ 0.82	☐ NA	✗ ↑ 16.00	☑ OK	↓ 0.00	
19-05-02-1992- A	✗ ↑ 32.11%	✗ 0.82	☐ NA	✗ ↑ 11.67	☑ OK	↓ 0.00	
19-05-02-1992- B	✗ ↑ 32.11%	✗ 0.82	☐ NA	✗ ↑ 11.67	☑ OK	↓ 0.00	
19-05-02-1992- B	✗ ↑ 32.11%	✗ 0.82	☐ NA	✗ ↑ 11.67	☑ OK	↓ 0.00	
19-05-03-1992- A	✗ ↓ -16.25%	✗ ↓ 0.77	☑ 0.00	☑	☑ OK	↓ 0.00	
19-05-03-1992- B	✗ ↓ -16.25%	✗ ↓ 0.77	☑ 0.00	☑	☑ OK	↓ 0.00	
19-05-03-1992- B	✗ ↓ -16.25%	✗ ↓ 0.77	☑ 0.00	☑	☑ OK	↓ 0.00	
19-07-05-1992- A	✗ ↓ -7.03%	✗ 0.88	☐ NA	✗ ↑ 11.00	☑ OK	↓ 0.00	
19-07-05-1992- B	✗ ↓ -7.03%	✗ 0.88	☐ NA	✗ ↑ 11.00	☑ OK	↓ 0.00	
19-07-05-1992- B	✗ ↓ -7.03%	✗ 0.88	☐ NA	✗ ↑ 11.00	☑ OK	↓ 0.00	
19-09-07-1992- A	✗ ↓ -7.39%	✗ 0.87	☐ NA	✗ ↑ 11.25	☑ OK	↓ 0.00	
19-09-07-1992- B	✗ ↓ -7.39%	✗ 0.87	☐ NA	✗ ↑ 11.25	☑ OK	↓ 0.00	

Figure 2.1: Layout of Form for Data Validation

Ion balance for cations and anions

In any water seems of cations and onions, when expressed as milli-equivalents per litre, must balance, because the water is generally electrically neutral. The relative imbalance is expressed in percentage and is calculated using following formula:

$$\text{Percent difference} = 100 \frac{\sum \text{cations} - \sum \text{anions}}{\sum \text{cations} + \sum \text{anions}}$$

Where,

Normally the % difference should not exceed 5 – 10%. Cations and anions are expressed as milli-equivalents per litre.

The percent difference may be somewhat lower for samples with low TDS values. In the software, the default value for this check has been put at 10% but this value can be more strict (5%) depending upon the requirements of the monitoring programme.

Note: The ion balance is not calculated (NA) if one of the major cations or anions (except for NO₃⁻ +NO₂⁻) is missing. The WQDES_GW software automatically converts the parameter concentrations entered in mg/L to meq/L.

Na and Cl ratio

Normally, in sodium dominated waters, most of the Na is associated with Cl, and thus, the ratio between Na and Cl (in meq/L) remain within 0.8 to 1.2. The software indicates if the ratio is outside this range. *Note: The WQDES_GW software converts the parameter concentrations which are entered in mg/L to meq/L.*

EC and TDS ratio

For fresh water conductivity (EC, in $\mu\text{mhos/cm}$) and Total Dissolved Solids (TDS in mg/L) usually obey the following relationship:

$$\text{EC} = \text{TDS} \times a$$

Where 'a' ranges from 0.55 to 0.9, the constant 'a' is usually high for chloride rich waters and low for sulphate rich waters. The software indicates if the value of 'a' is outside this range.

TDS-calculated and TDS-measured

The measured TDS concentration should be higher than the calculated one because the significant contributor may not be included in the calculation. If the measured value is less than the calculated one, the higher ion sum and measured value are suspect; the sample should be reanalysed. If the measure solids concentration is more than 20% higher than the calculated one, the low ion sum is suspect and selected constituents should be reanalysed. The acceptable ratio is as follows:

$$1.0 < \frac{\text{TDS} - \text{measured}}{\text{TDS} - \text{calculated}} < 1.2$$

COD and BOD ratio

Values measured for COD should always be higher than BOD values. WQDES_GW checks if the ratio COD/BOD >1 and indicates if the values do not meet this criteria.

Carbonate and pH relation

At pH values below 8.3 the CO_3^{2-} (phenolphthalein alkalinity) alkalinity should be zero. WQDES_GW checks if this condition is met and indicates if the values do not meet this criteria.

Checked by

Here the responsible person, e.g. the head of the laboratory, should put his name or initials after checking the outcome of the validation.

Remarks

In this field the person who has checked the data may put some remarks, e.g. to explain why a sample did not pass a certain validation check.