THE STUDY
ON SUSTAINABLE GROUNDWATER DEVELOPMENT
FOR BOGOTA PLAIN
IN THE REPUBLIC OF COLOMBIA

FINAL REPORT
SUPPORTING REPORT

PART 11

WELL INVENTORY

Final Report
(Supporting Report)

Part 11 Well Inventory

Table of Contents

List of Tables and Figures

PART - 11 WELL INVENTORY

CHAPTER 1 Method of Well Inventory

The Study Team carried out Well Inventory survey for all the wells in Study Area. The Study Team collected well data that was stored in well Data-base of INGEOMINAS and well data registered to CAR and DAMA. It is possible to compile most of the wells that exist in the Study Area by putting all the data together. The number of wells that was collected by the Study Team is shown in Table-1.1. The total number of wells in the Study Area is estimated around 7,081 as shown in Table-1.1.

Table-1.1 The Number of Wells in the Study Area

Classification	Well Number	
	Well data with location	Well data without location
Wells recorded in well data-base of INGEOMINAS	3,027	694
Wells registered to CAR	1,672	1,439
Wells registered to DAMA	248	1
Sub Total	4,947	2,134
Total	7,081	

Well Inventory items by the Study Team are shown in Table-1.2.

Table-1.2 Well Inventory Items by the Study Team

Items	Items	Item
Location of well	Electric logging result	Recharge (mm/Year)
Ownership	Gamma logging result	Water quality concentration (mg/L)
Address of well	Coordinate of well location	Date of drilling
Map coordinates of well	Depth of well (m)	Soil type
Grand elevation of well top	Grand water level	Results of water quality test
Installed year	Pumping rate (m^3/Day)	The position of screen
Equipment description	Aquifer for pumping	Geological cross section
Well observation item	Conductivity (m/s)	-

(1) Current Yield from Pumping Wells in the Study Area

Data-base arranged by the Study Team has nearly all the well data that were drilled in the Study Area by year of 2002. Based on this data-base, the current yield from pumping wells in the Study Area was estimated. This data-base has 7,081 well data, most of which has information on yield. Situation of well data is as follows.

Information type of the data-base	Well Number	Total Yield (m^3/day)
Date with unit yield and operation hours	2,644	162,900
Data without unit yield or without operation hours.	4,437	Unknown
Total	7,081	Unknown

Daily yield of well is calculated from unit yield and daily operation hours. Daily yield of well was calculated from relation below:

Daily yield from well = Unit yield (m^3/day) $\times$ Daily well operation hours (hours/day)

On the other hand, unit yield or operation hours must be assumed for wells without these information. To estimate total yield of pumping wells, unit yield and operation hours were assumed for wells without these information. Method and result of this analysis are explained below.

(2) Estimation of Unit Yield

Unit yield was estimated for wells without this information. Usually well data-base already has yield information of wells which pump up much groundwater. On the other hand, data-base sometimes does not have yield information of wells that pump up little groundwater. Histogram of yield is shown in Figure-1. This histogram was made from well data with yield information. As shown in Figure-1.1, its distribution is approximated by log normal distribution. The average of this distribution is 1.54(l/s). Hence, unit yield of 1.54(l/s) was assumed for wells without unit yield information.

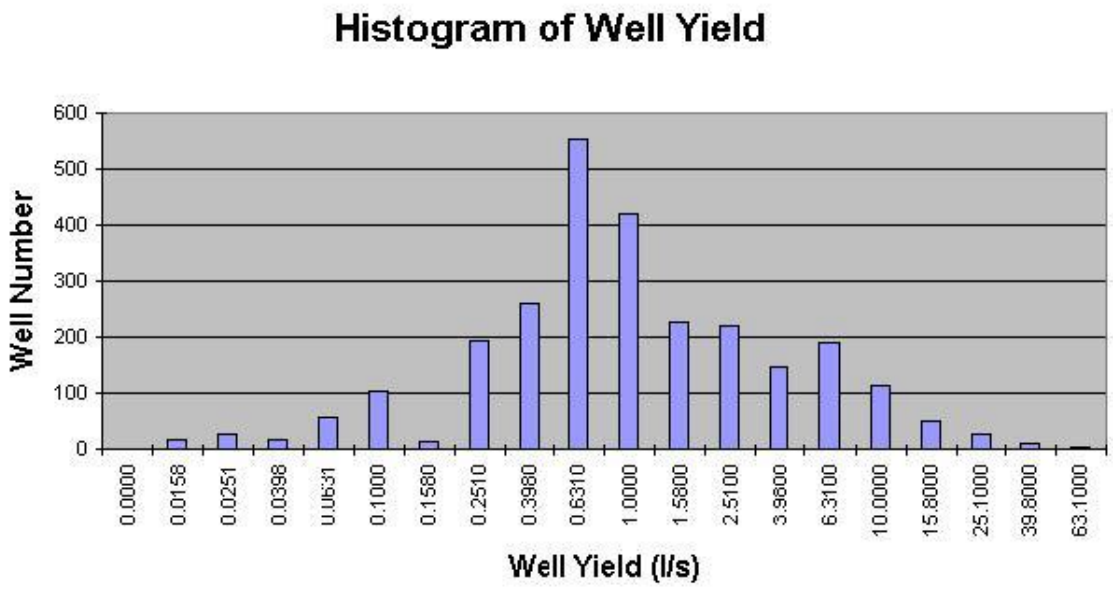

Figure-1.1 Histogram of Unit Yield

(3) Daily Well Operation Hours

Daily well operation hour was estimated for wells without this information. Histogram of daily operation hour is shown in Figure-1.2. This histogram was made from well data with information on daily operation hour, and average operation hours are 6.54 hours/day. As shown in Figure-1.1, there is not clear relation between unit yield and daily operation hours. Hence, daily operation hour was assumed as 6.54 hours for wells without information on daily operation hours.

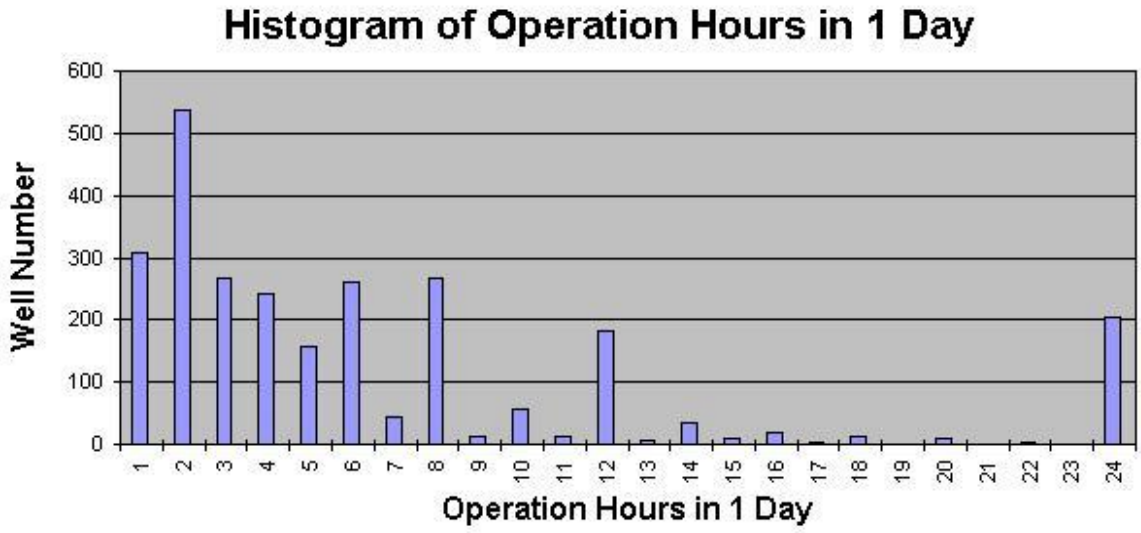

Figure-1.2 Histogram of Daily Operation Hour of Wells

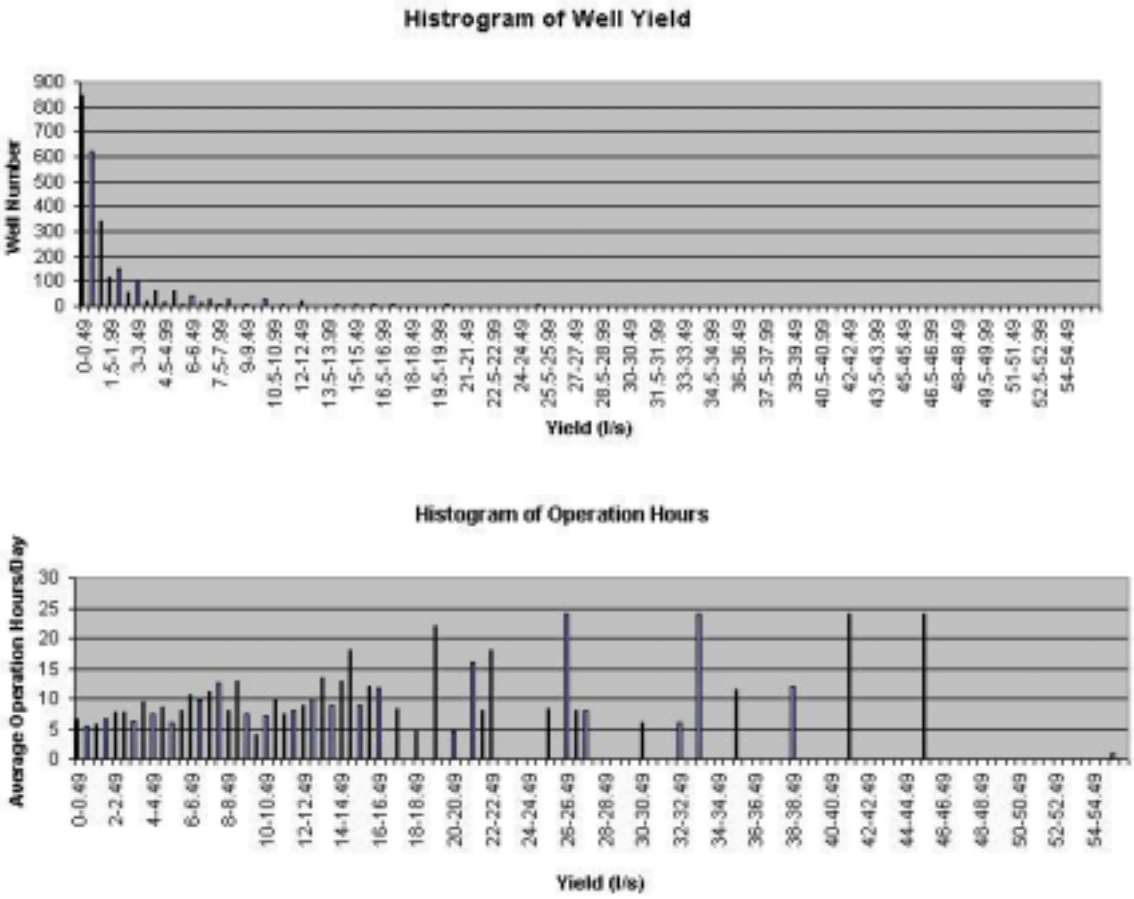

Figure-1.3 Histogram of Unit Yield and Average Daily Operation Hours (Above)

CHAPTER 2 Result of Well Inventory Survey

Total yield from the current wells in the Study Area was estimated based on the assumption explained above. The result is shown in Table-2.1.

Table-2.1 Total Yield of Study Area

Classification of Well Data	Well Number	Estimated unit yield (l/s)	Well operation hours in 1 day (hours)	Total yield (m^3/day)
Date with unit yield and daily operation hours	2,644	Known	Known	158,690
Data without unit yield or without operation hours.	4,437	1.54(l/s)	6.54 (hours)	160,800
Total	7,081	-	-	320,490

As shown in Table-2.3, total yield from pumping wells in the Study Area is estimated 320,490m^3/day. The estimated total yield is expressed by other unit below.

Total Yield of the Study Area

320,490m^3/day	$117 \times 10^6 m^3$/year	3.7m^3/s	27mm/year

Annual yield of 27mm/year above is calculated from total area of 4,268km^2.

(1) Well Number and Yield by Geology

Well Data-base by the Study Team has information on aquifer type of wells. Most of INGEOMONAS well data of the Well Data-base has information on aquifer. Based on this information, well number and aquifer of well is analyzed by geology type. The result is shown in Table-2.2.

Table-2.2 The Number and Aquifer of Wells by Geological Type

Geology of aquifer		The number of well		Yield of well	
		Well number	% of total number	Yield (m^3/day)	% of total yield
Quaternary		6,570	92.9	248,830	77.6
Tertiary	Cacho	60	0.8	4,200	1.3
	Guaduas	50	0.7	3,900	1.2
	Other Tertiary	50	0.7	700	0.2
Cretaceous	Labor y Tierna	246	3.5	48,060	15.0
	Pleaners and Dura	90	0.13	14,400	4.5
	Chipaque	15	0.02	400	0.1
Total		7,081	100	320,490	100

Of 7,081 wells in the Data-base, around 3,400 wells have information on aquifer geology. As shown Table-2.2, 93% of wells of the Study Area take groundwater from Quaternary aquifer, 2.2% from Tertiary aquifer, 3.7% from Cretaceous aquifer. As shown in Table-2.2, wells in the Study Area pump up groundwater, 78% from Quaternary aquifer, 3% from Tertiary aquifer and 19% from Cretaceous aquifer. As explained above, most of groundwater is currently pumped up from Quaternary aquifer, and groundwater pumped up from Cretaceous is only little. Groundwater pumped up from Tertiary aquifer is extremely little. From this result, items below are concluded.

- Quaternary aquifer is excellent and easy to drill, and many wells were drilled in Quaternary aquifer up-to now.
- Tertiary has low capacity for aquifer, it is not suitable for well drilling.
- Cretaceous aquifer is more excellent than Quaternary aquifer. However, up-to now,

wells were drilled only where Cretaceous distributes near the ground surface. Most of Cretaceous distributes deep in the ground, and it is very difficult to reach Cretaceous aquifer. Then few wells were drilled to Cretaceous aquifer up-to now.

(2) Well Distribution by River Basin

Well number and well yield by river basin were calculated based on Well Inventory Result. The results are shown in Table-2.3 and Figure-2.3. In Figure-2.3, well yields were summed up for every 1lm × 1km mesh. As shown in Figure-2.3, distribution of wells is partially concentrated. There are many wells concentrating especially in the west of Bogotá City, Subachoque River Basin, Chicu River Basin.

Table-2.3 Total number and yield of Wells by River Basin

Basin	Well Number	Yield (m^3/day)	Basin	Well Number	Yield (m^3/day)
Bogotá 1 – Bogotá 3	1,559	77,651	Sisga	1	30
Bogotá 4 – Bogotá 6	1,141	45,797	Muna	40	1,298
Bogotá 7 -Bogotá 9	429	27,451	Subachoque 1	18	293
Bojaca	311	21,549	Subachoque 2	1,078	54,751
Chicu	1,620	44,636	Teusaca	256	14,467
Frio	320	12,476	Tomine	21	719
Neusa	185	8,333	Tunjuelito	103	11,038
Total	Well number=7,081, Total Yield= 320,490 (m^3/day)				

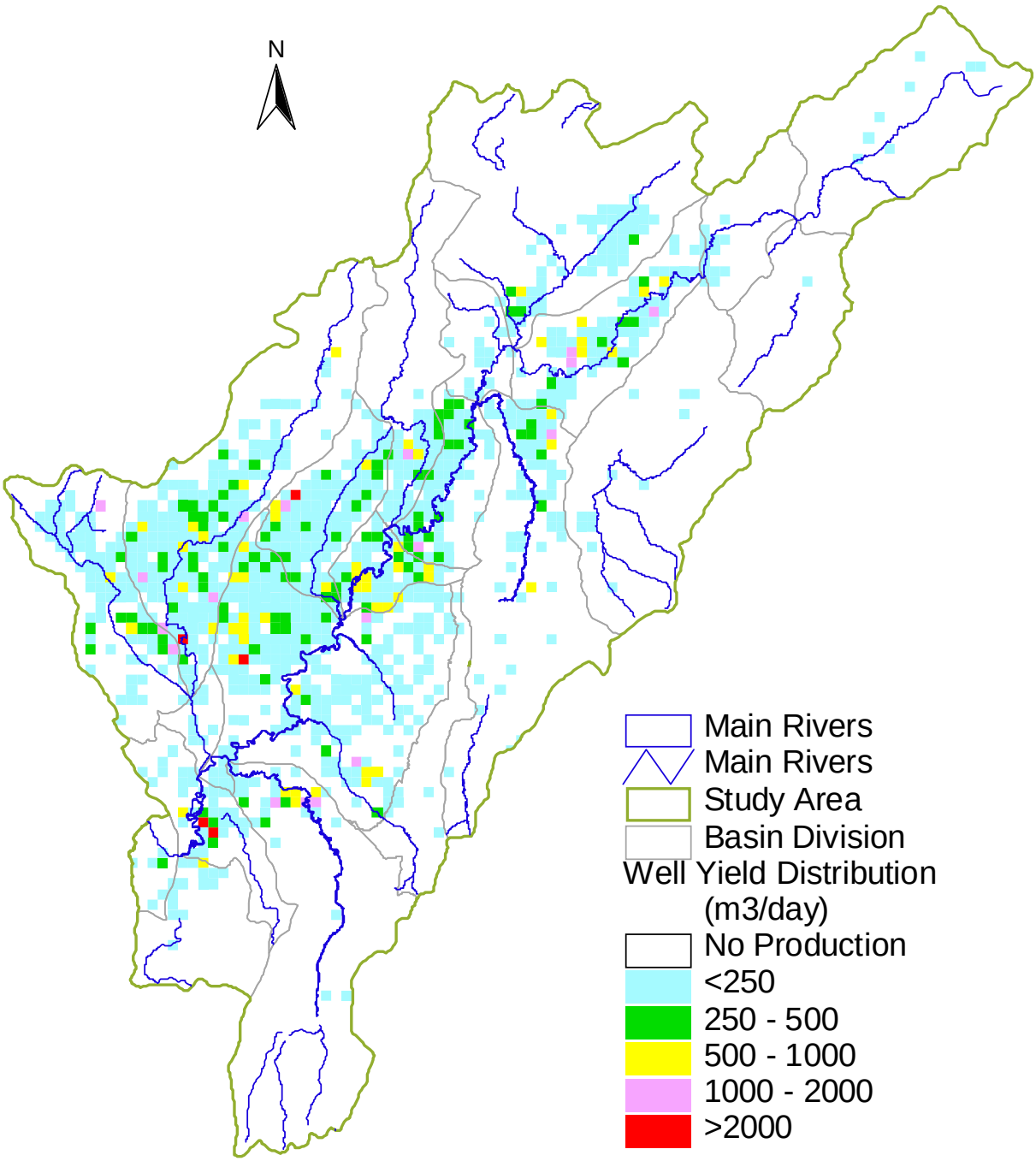

Figure-2.1 Distribution of Yield of Study Area