

**CRECIMIENTO POBLACIONAL  
DISTRITO DE  
QUEROCOTILLO**

**1.0 METODO DE INTERES SIMPLE**

CENSO (Año)	POBLACION (Habitantes)
1,981	445
1,993	671
2,007	898
2,017	1,598

**Ecuación :**  $P_f = P_o ( 1 + r t )$

Combinaciones con dos censos :

1,981	1,993	====>	r1 =	4.23%
1,981	2,007	====>	r2 =	3.92%
1,981	2,017	====>	r3 =	7.20%
1,993	2,007	====>	r4 =	2.42%
1,993	2,017	====>	r5 =	5.76%
2,007	2,017	====>	r6 =	7.80%

Combinaciones de tres censos :

1,981	1,993	2,007	====>	r7 =	3.25%
1,981	1,993	2,017	====>	r8 =	5.25%
1,981	2,007	2,017	====>	r9 =	4.99%
1,993	2,007	2,017	====>	r10 =	4.66%

Combinación con cuatro censos :

1,981	1,993	2,007	2,017	====>	r11 =	4.52%
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Aplicando minimos cuadrados :

$$Y = A + B * X$$

$$\Delta = (Y - A - B * X) ^ 2$$

$$\Delta' B = 2 * \Sigma (Y - A - B * X) * (-X)$$

$$B = (\Sigma X * Y - A * \Sigma X) / \Sigma X^2$$

$$A = \frac{\Sigma Y - B * \Sigma X}{n}$$

Año Sensal	X (años)	Y (hab)	X*Y	X^2
1,981	-36	445	-16020	1,296
1,993	-24	671	-16104	576
2,007	-10	898	-8980	100
2,017	0	1,598	0	0

$$-\Sigma = 70$$

$$-\Sigma = 41104$$

$$\Sigma = 1972$$

$$B = \frac{-\Sigma X * Y}{-\Sigma X^2} = \frac{41104}{1972} = 20.84$$

$$r12 = \frac{B}{100} = \frac{20.84}{100} = 20.84\%$$

Comportamiento histórico de las ecuaciones :

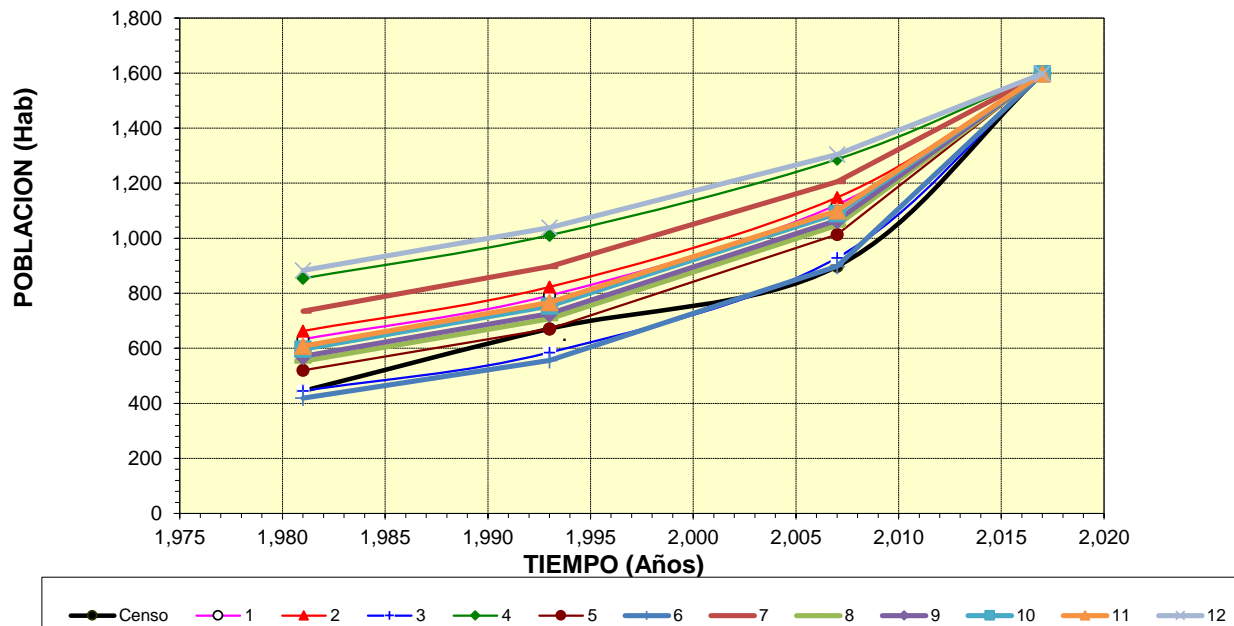
Curva	Tasa	1,981	1,993	2,007	2,017	Sumatoria	Diferencia
Censo		445	671	898	1,598	3,612	---
1	4.23%	633	792	1,122	1,598	4,145	533
2	3.92%	663	823	1,148	1,598	4,232	620
3	7.20%	445	585	929	1,598	3,557	55
4	2.42%	854	1,011	1,287	1,598	4,750	1,138
5	5.76%	520	671	1,014	1,598	3,803	191
6	7.80%	419	556	898	1,598	3,471	141
7	3.25%	735	897	1,205	1,598	4,435	823
8	5.25%	553	707	1,047	1,598	3,905	293
9	4.99%	571	726	1,065	1,598	3,960	348
10	4.66%	597	754	1,090	1,598	4,039	427
11	4.52%	608	766	1,100	1,598	4,072	460
12	2.25%	883	1,038	1,304	1,598	4,823	1,211

Curva seleccionada:

Po = 1,598 habitantes

r = 7.20%

### METODO DE INTERES SIMPLE



### 2.0. METODO DE INTERES COMPUESTO

CENSO (Año)	POBLACION (Habitantes)
1,981	445
1,993	671
2,007	898
2,017	1,598

Ecuación:  $Pf = Po (1 + r)^t$

Combinaciones con dos censos :

1,981	1,993	===>	r1 =	3.48%
1,981	2,007	===>	r2 =	2.74%
1,981	2,017	===>	r3 =	3.62%
1,993	2,007	===>	r4 =	2.10%
1,993	2,017	===>	r5 =	3.68%
2,007	2,017	===>	r6 =	5.93%

Combinaciones con tres censos :

1,981	1,993	2,007	===>	r7 =	2.65%
1,981	1,993	2,017	===>	r8 =	3.61%
1,981	2,007	2,017	===>	r9 =	3.39%
1,993	2,007	2,017	===>	r10 =	3.24%

Mínimos cuadrados :

1,981      1,993      2,007      2,017      ===>      r11 =      3.75%

Mínimos cuadrados :

$$\log Pf = \log Po + t \log (1 + r)$$

$$B = (\sum X*Y - A * \sum X) / (\sum X^2)$$

$$10^B - 1 = r$$

Año Sensal	X (años)	Y= log Pf	X*Y	X^2
1,981	-36	2.65	-95.3409604	1,296
1,993	-24	2.83	-67.84134048	576
2,007	-10	2.95	-29.53276337	100
2,017	0	3.20	0	0
-Σ= 70			-Σ= 193	Σ= 1972

B=      0.016

r12 =      3.75%

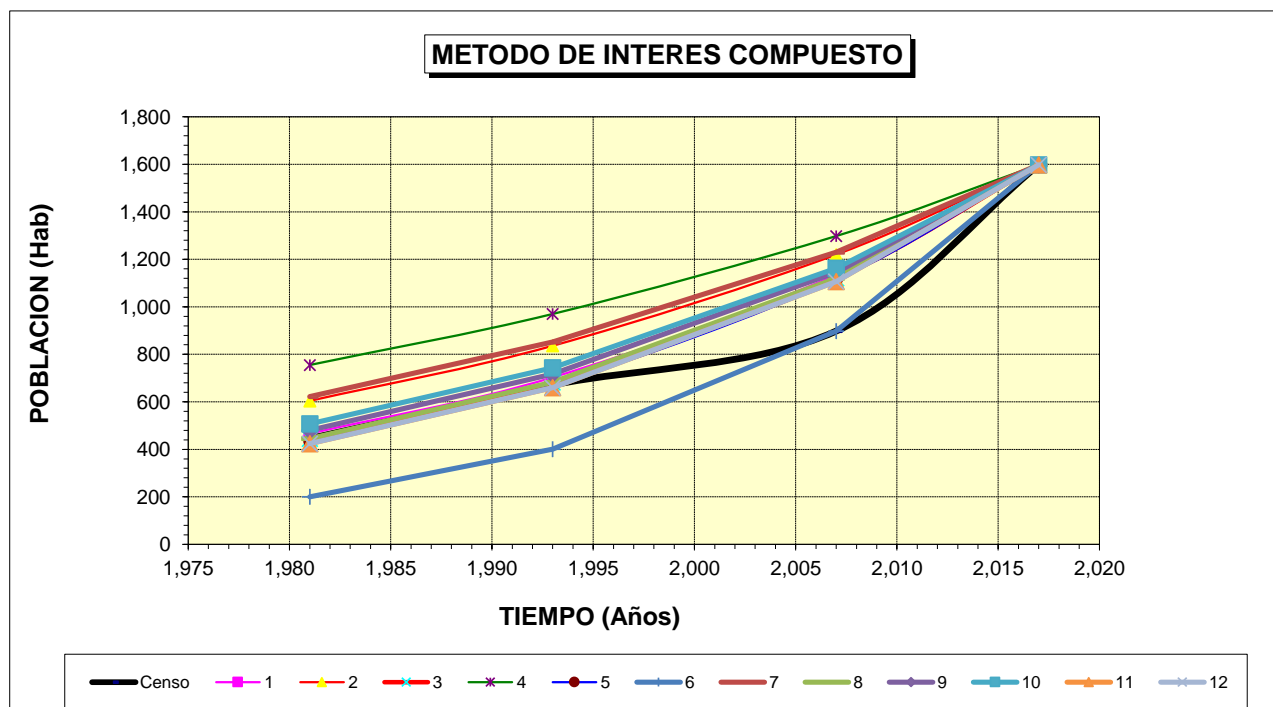
Comportamiento histórico de las ecuaciones :

Curva	Tasa de Crecimiento	1,981	1,993	2,007	2,017	Sumatoria	Diferencia
Censo		445	671	898	1,598	3,612	---
1	3.48%	466	703	1,135	1,598	3,902	290
2	2.74%	604	836	1,220	1,598	4,258	646
3	3.62%	444	681	1,120	1,598	3,843	231
4	2.10%	755	970	1,298	1,598	4,621	1,009
5	3.68%	434	671	1,113	1,598	3,816	204
6	5.93%	200	401	898	1,598	3,097	515
7	2.65%	622	852	1,230	1,598	4,302	690
8	3.61%	445	682	1,120	1,598	3,845	233
9	3.39%	480	717	1,145	1,598	3,940	328
10	3.24%	507	743	1,162	1,598	4,010	398
11	3.75%	424	660	1,106	1,598	3,788	176
12	3.75%	424	660	1,106	1,598	3,788	176

Curva seleccionada:

Po =      1,598 habitantes

r =      3.75%



### 3.0. METODO PARABOLA DE SEGUNDO GRADO

CENSO (Año)	POBLACION (Habitantes)
1,981	445
1,993	671
2,007	898
2,017	1,598

Ecuación :  $Pf = A + B \cdot t + C \cdot t^2$

Combinaciones con tres censos :

1981	1993	2007				
Para t=0 en el año 1981, tenemos a						
Pf1:	A1	B1(0)	C1(0)^2	=Pf93	====>	A1 = 445
Pf1:	A1	B1(12)	C1(12)^2	=Pf07		
Pf1:	A1	B1(26)	C1(26)^2	=Pf17		
A=		B1	C1		R	
		12	144		226	
		26	676		453	
B1 =		20.04				
C1 =		-0.10				
X (AÑOS)	CENSO	Y1	Y1 (corregido)			
0	445.00	445.00	1007.03			
12	671.00	671.00	1233.03			
26	898.00	898.00	1460.03			
36	1,598.00	1035.97	1598.00			
A' = P21-B*X-C*X^2						
A'1=		1007.032967	====>	A1 =	1,007.03	
			====>	B1 =	20.04	
			====>	C1 =	-0.10	

1981	1993	2017				
Para t=0 en el año 1981, tenemos a						
Pf2:	A2	B2(0)	C2(0)^2	=Pf93	====>	A2 = 445
Pf2:	A2	B2(12)	C2(12)^2	=Pf07		
Pf2:	A2	B2(36)	C2(36)^2	=Pf21		
A=		B2	C2		R	
		12	144		226	
		36	1296		1,153	
B2 =		12.24				
C2 =		0.55				
X (AÑOS)	CENSO	Y2	====>	A2 =	445.00	
0	445.00	445.00	====>	B2 =	12.24	
12	671.00	671.00	====>	C2 =	0.55	
26	898.00	1134.78				
36	1,598.00	1598.00				
A' = P21-B*X-C*X^2						
A'2=		445				

1981	2007	2017				
Para t=0 en el año 1981, tenemos a						
Pf3:	A3	B3(0)	C3(0)^2	=Pf93	=== >	A3 = 445
Pf3:	A3	B3(26)	C3(26)^2	=Pf17		
Pf3:	A3	B3(36)	C3(36)^2	=Pf21		
A=		B1	C1		R	
		26	676		453	
		36	1296		1,153	
B3 =		-20.55				
C3 =		1.46				
X (AÑOS)	CENSO	Y3				
0	445.00	445.00	=== >	A3 =	445.00	
12	671.00	408.72	=== >	B3 =	-20.55	
26	898.00	898.00	=== >	C3 =	1.46	
36	1,598.00	1598.00				
A' = P21-B*X-C*X^2						
A'1=		445				

1993	2007	2017				
Para t=0 en el año 1993, tenemos a						
Pf4:	A4	B4(0)	C4(0)^2	=Pf07	==== >	A4 = 671
Pf4:	A4	B4(10)	C4(10)^2	=Pf17		
Pf4:	A4	B4(14)	C4(14)^2	=Pf21		
A=		B1	C1		R	
		14	196		227	
		24	576		927	
B1 =		-15.16				
C1 =		2.24				
X (AÑOS)	CENSO	Y4				
0	445.00	445.00	==== >	A4 =	671.00	
0	671.00	671.00	==== >	B4 =	-15.16	
14	898.00	898.00	==== >	C4 =	2.24	
24	1,598.00	1598.00				
A' = P21-B*X-C*X^2						
A'1=		671				

Mínimos cuadrados :

1981	1993	2007	2017	=== >	A5 =	1,598.00
Mínimos cuadrados : Pf = A + B t + C t ^ 2						
( A*ΣX + B *ΣX^2 + C*ΣX^3) = ΣX*Y						
( A*ΣX^2 + B *ΣX^3 + C*ΣX^4) = ΣX^2. Y						
X	Y	X*Y	X ^ 2	Y*X ^ 2	X ^ 3	X ^ 4
0	1,598	0	0	0	0	0
-10	898	-8,980	100	89,800	-1,000	10,000
-24	671	-16,104	576	386,496	-13,824	331,776
-36	445	-16,020	1,296	576,720	-46,656	1,679,616
-70	3,612	-41,104	1,972	1,053,016	-61,480	2,021,392
-111860.00 + B5 1972.00		- C5 61480.00		=	-41104.00	
3151256.00 - B5 61480.00		+ C5 2021392.00		=	1053016.00	

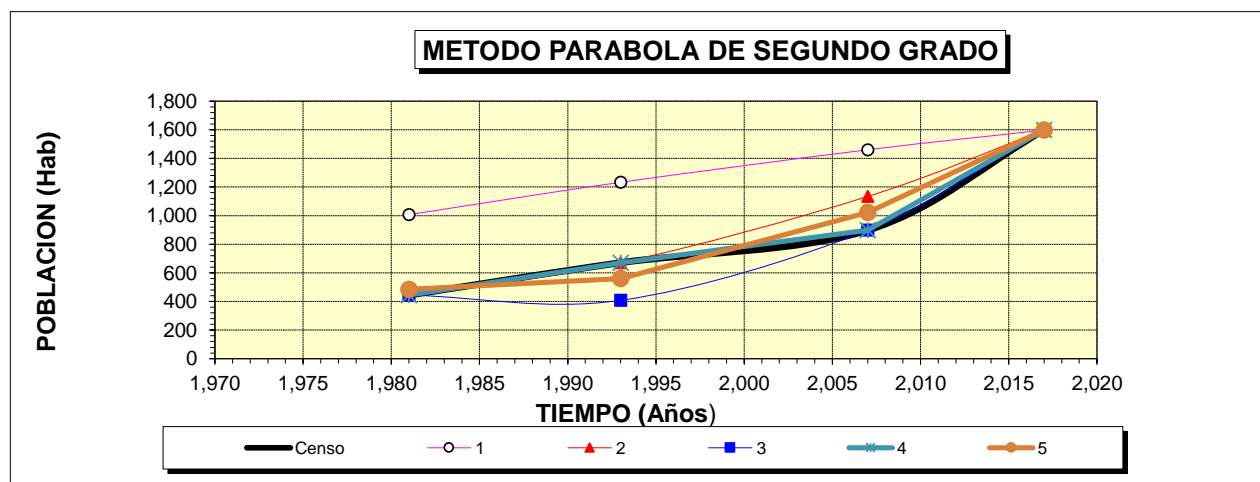
A=		B5	C5			R
		1972.00	-61480.00	=		70756.00
		-61480.00	2021392.00	=		-2098240.00
	B5 =	67.96				
	C5 =	1.03				
X (AÑOS)	CENSO	Y5				
-36	445.00	484.97		==== >	A5 =	1,598.00
-24	671.00	559.67		==== >	B5 =	67.96
-10	898.00	1021.32		==== >	C5 =	1.03
0	1,598.00	1598.00				

Comportamiento histórico de las ecuaciones :

Curva	1,981	1,993	2,007	2,017	Sumator.	Diferenc.
Censo	445	671	898	1,598	3,612	---
1	1,007	1,233	1,460	1,598	5,298	1,686
2	445	671	1,134	1,598	3,848	236
3	445	408	898	1,598	3,349	263
4	445	671	898	1,598	3,612	0
5	485	560	1,021	1,598	3,664	52

Curva seleccionada:

A =	1,598.00
B =	67.96
C =	1.03



#### 4.0. METODO PROGRESION ARITMETICA

CENSO (Año)	POBLACION (Habitantes)
1,981	445
1,993	671
2,007	898
2,017	1,598

Ecuación :  $Pf = Po + K * t$

Combinaciones con dos censos :

1,981	1,993	=== >	K1 =	18.83
1,981	2,007	=== >	K2 =	17.42
1,981	2,017	=== >	K3 =	32.03
1,993	2,007	=== >	K4 =	16.21
1,993	2,017	=== >	K5 =	38.63
2,007	2,017	=== >	K6 =	70.00

Combinaciones de tres censos :

1,981	1,993	2,007	=== >	K7 =	17.42
1,981	1,993	2,017	=== >	K8 =	32.03
1,981	2,007	2,017	=== >	K9 =	32.03
1,993	2,007	2,017	=== >	K10 =	38.63

Combinación con cuatro censos :

1,981	1,993	2,007	2,017	=== >	K11 =	32.03
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Mínimos cuadrados :

1,981	1,993	2,007	2,017	=== >	K12=	35.88
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Aplicando minimos cuadrados :

$$Y = A + B * X$$

$$\Delta = (Y - A - B * X)^2$$

$$\Sigma Y = n * A + B * \Sigma X \quad \text{-----}(1)$$

$$\Sigma X * Y = A * \Sigma X + B * \Sigma X^2 \quad \text{-----}(2)$$

$$A = 1,598$$

Y (hab)	X (años)	X*Y	X^2
445	-36	-16020	1296
671	-24	-16104	576
898	-10	-8980	100
1,598	0	0	0

$$\Sigma = 3612 \quad -\Sigma = 70 \quad -\Sigma = 41104 \quad \Sigma = 1972$$

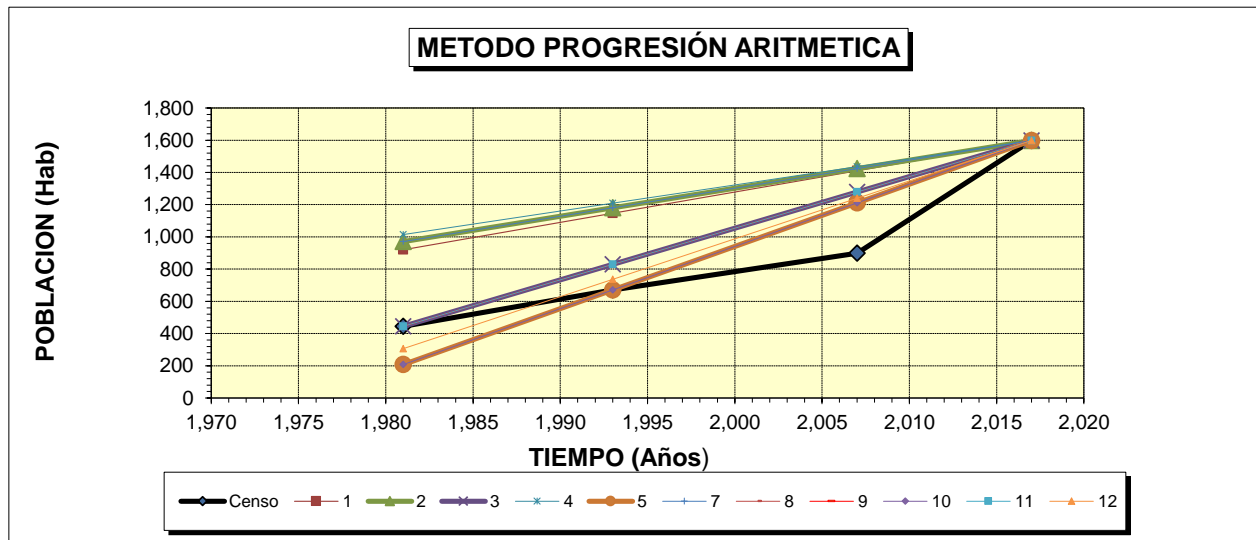
$$K12 = 35.880$$

Comportamiento histórico de las ecuaciones :

Curva	Tasa de Crecimiento	1,981	1,993	2,007	2,017	Sumatoria	Diferencia
Censo		445	671	898	1,598	3,612	---
1	18.83	920	1,146	1,410	1,598	5,074	1,462
2	17.42	971	1,180	1,424	1,598	5,172	1,560
3	32.03	445	829	1,278	1,598	4,150	538
4	16.21	1,014	1,209	1,436	1,598	5,257	1,645
5	38.63	208	671	1,212	1,598	3,688	76
6	70.00	-922	-82	898	1,598	1,492	2,120
7	17.42	971	1,180	1,424	1,598	5,172	1,560
8	32.03	445	829	1,278	1,598	4,150	538
9	32.03	445	829	1,278	1,598	4,150	538
10	38.63	208	671	1,212	1,598	3,688	76
11	32.03	445	829	1,278	1,598	4,150	538
12	35.88	306	737	1,239	1,598	3,880	268

Curva seleccionada:

Po = 1,598 habitantes  
K = 38.63



## 5.0 SELECCION DEL MODELO DE CRECIMIENTO POBLACIONAL

Tasa de crecimiento departamental=

1.30% actual

3.40%

ETAPA	Año	Censo	INTERES	INTERES COMPUESTO	PARABOLA DE	Progresion Aritmetica	Curva Elegida
	1,981	445					
	1,993	671					
	2,007	898					
-	2,017	1,598	1,598	1,598	1,598	1,598	1,598
Pre - inv	2,018		1,713	1,657	1,666	1,637	1,652
Pre - inv	2,019		1,828	1,720	1,738	1,675	1,708
Exp. Tec	2,020		1,943	1,784	1,811	1,714	1,766
Obras	2,021		2,058	1,851	1,886	1,753	1,826
1	2,022		2,173	1,921	1,963	1,791	1,888
2	2,023		2,288	1,993	2,042	1,830	1,952
3	2,024		2,403	2,067	2,124	1,868	2,018
4	2,025		2,518	2,145	2,207	1,907	2,087
5	2,026		2,633	2,225	2,292	1,946	2,158
6	2,027		2,748	2,309	2,380	1,984	2,231
7	2,028		2,863	2,395	2,470	2,023	2,307
8	2,029		2,978	2,485	2,561	2,062	2,386
9	2,030		3,093	2,579	2,655	2,100	2,467
10	2,031		3,208	2,675	2,751	2,139	2,550
11	2,032		3,323	2,776	2,848	2,177	2,637
12	2,033		3,438	2,880	2,948	2,216	2,727
13	2,034		3,553	2,988	3,050	2,255	2,819
14	2,035		3,668	3,100	3,154	2,293	2,915
15	2,036		3,783	3,216	3,260	2,332	3,014
16	2,037		3,898	3,337	3,368	2,371	3,116
17	2,038		4,013	3,462	3,478	2,409	3,222
18	2,039		4,128	3,592	3,591	2,448	3,332
19	2,040		4,243	3,727	3,705	2,486	3,445
20	2,041		4,358	3,866	3,821	2,525	3,562
21	2,042		4,473	4,012	3,939	2,564	3,683
22	2,043		4,588	4,162	4,060	2,602	3,808
23	2,044		4,703	4,318	4,182	2,641	3,938
24	2,045		4,818	4,480	4,307	2,680	4,071



# **CURVA DE CRECIMIENTO POBLACIONAL DEL DISTRITO DE QUEROCOTILLO**

