Transboundary Water Management Adaptation in the Amudarya Basin to Climate Change Uncertainties

Planning zone model

Report on position 2.8.3 Testing

Project coordinator _____ Prof. V.A.Dukhovniy

Responsible for position 2.8 _____ A.G.Sorokin

Executor _____ R.R.Khafazov

1 Objective and tasks

Objective – testing the planning zone model

Tasks:

1. methodology of testing;
2. automate the methodology of testing;
3. test the main indicators of the planning zone mode.

2 Methodology of planning zone model testing

The testing methodology consists in comparison of the main indicators simulated by the model with their actual values.

The results of testing are to be presented in form of a table, which has the following rows:

1. simulated value of indicator – P;

2. actual value of indicator – F;

3. relative deviation - .

and in form of a graph (Figures 2.1 - 2.2).

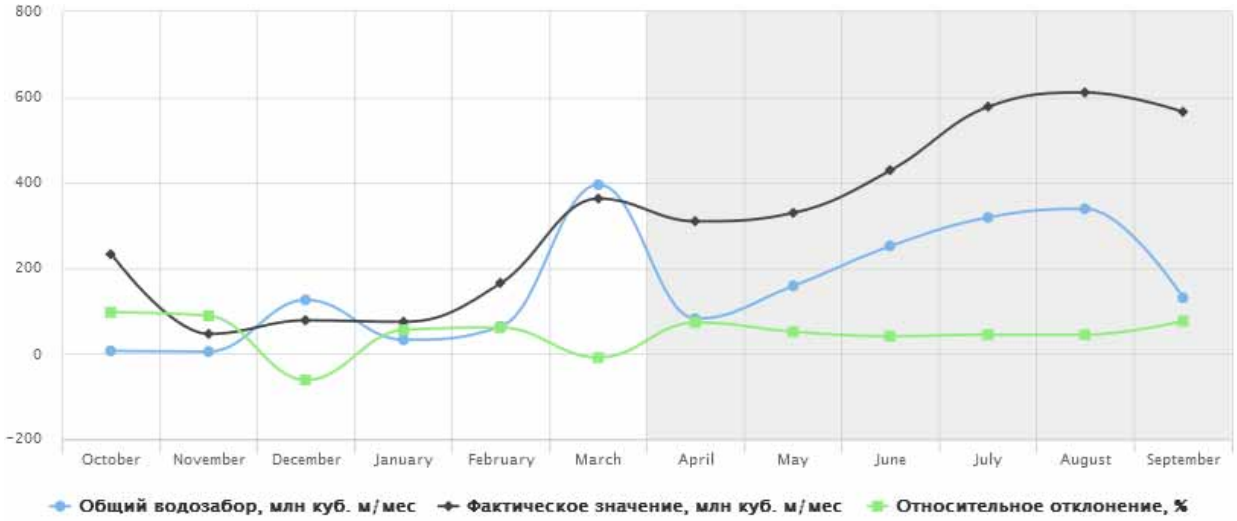


Figure 2.1. Graphical representation of testing results

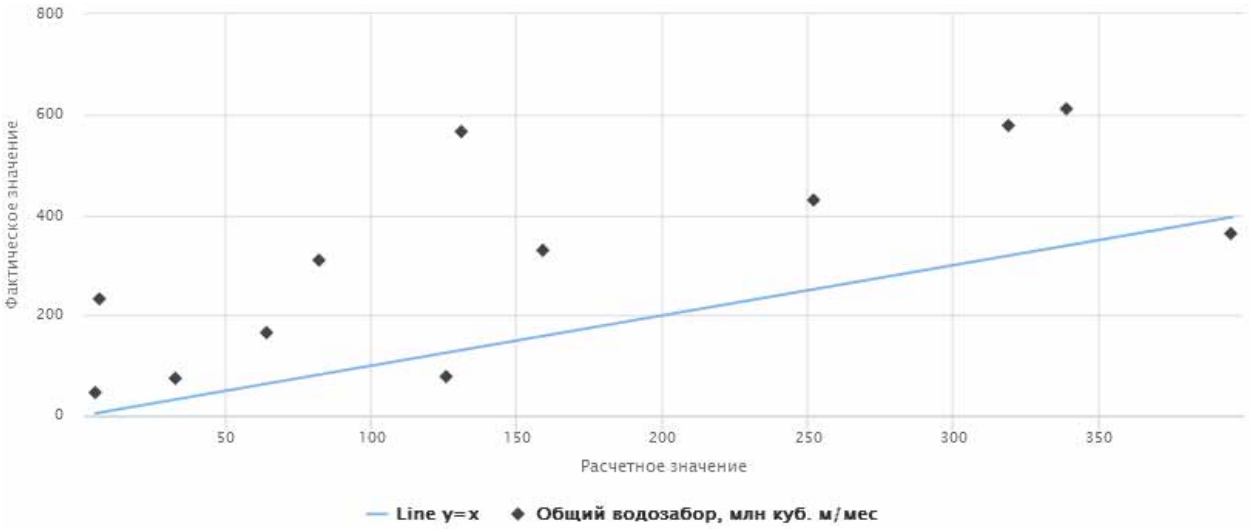


Figure 2.2. Graphical representation of testing results

3 Automation of the testing methodology

For automation, it is necessary to develop the server and client sides of the testing module for the planning zone model.

3.1 Server side of the testing module

Development of the module's server side starts with physical model. To this end, a table (zone_var_value_an) should be added to store the actual values of the main indicators (Figure 3.1).

Then, we add the stored procedures (create_var_value_out_an – analysis of simulated and actual data, get_var_value_out_an – selection of the results of analysis) that describe the testing methodology (Figure 3.2).

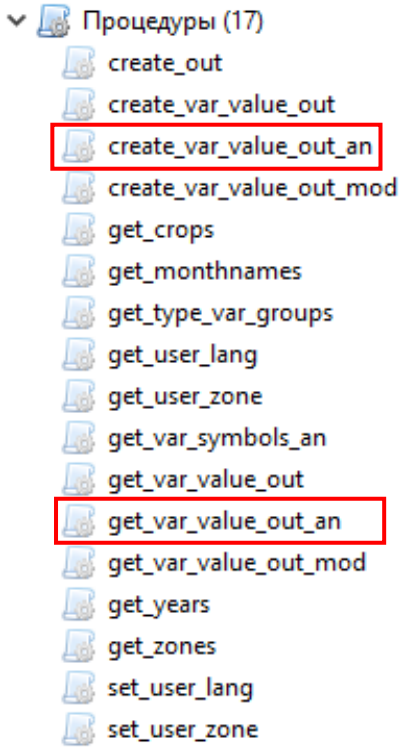


Figure 3.2 – Stored procedures of the planning zone model

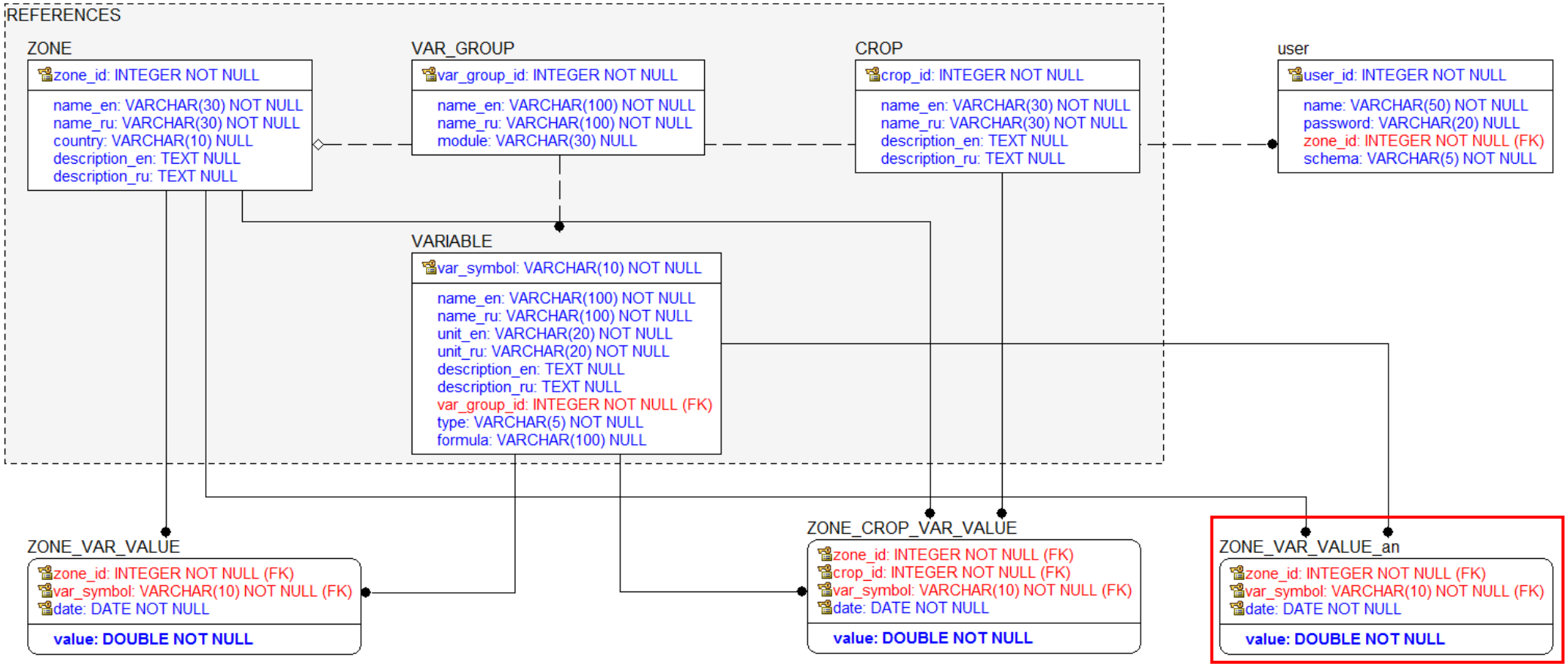


Figure 3.1 – Physical model of database in the planning zone model

3.2 Client side of the testing module

The client side of the module is realized through the web-framework Yii 2.0.

Yii is an object-oriented, component based MVC PHP web-application framework[1].

The following MVC components were added when developing the client side of the testing module (Table 3.1)

[1] The MVC design pattern was described in detail in previous report.

Table 3.1 – Description of MVC major components for the planning zone model

<table>
<tr><th>Model</th><th colspan="2">Controller</th><th colspan="2">View</th></tr>
<tr><td rowspan="4">Model is implemented in form of DBMS stored procedures</td><td colspan="2">Controller SiteController</td><td rowspan="2">calculation</td><td rowspan="2">Representation of water balance calculation results</td></tr>
<tr><td>actionCalculation</td><td rowspan="2">Method (controller) for model calculations</td></tr>
<tr><td rowspan="2">actionAnalysis</td><td rowspan="2">calculationmod</td><td rowspan="2">Representation of calculation results</td></tr>
<tr><td rowspan="2">Method (controller) for analysis of simulated and actual data</td></tr>
<tr><td>analysis</td><td>Representation of analysis results</td></tr>
</table>

4 Testing the main indicators of the planning zone model

The testing of main indicators of the planning zone model (using Khorezm planning zone as an example, 2014) is shown in Figures 4.1-4.4.

The current version of the planning zone model allows testing main indicators for all planning zone in the Amudarya lower reaches. The main indicators for other planning zones can be tested as additional input data (responsible A.Nazariy, I.Ergashev) and actual data (responsible I.Ergashev) become available.

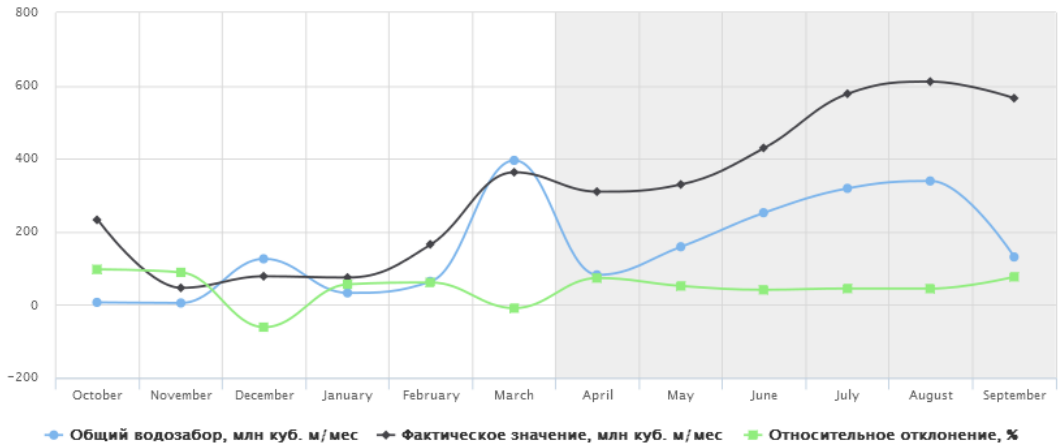
In order to detect errors in the planning zone model, we analyzed how the simulated values fitted the actual ones for planning zones in the Amudarya lower reaches. Minor errors were found in input data (Annex 1). For correction of the detected errors, we have made calibration for closer fitting of the data (Annex 2).

The calibration for planning zones in the Amudarya lower reaches showed that the methodology and algorithm of the planning zone model are correct, i.e. when the inputted data are correct, the model produces right outputs.

Выберите индикатор > Общий водозабор | Водозабор из трансграничных водных ресурсов | Водозабор для орошения, включая промывку | Общий объем дренажных и сточных вод | Объем возвратного стока, поступающего в озера и понижения | Объем возвратного стока, поступающего в соседние ЗП - Сарыкамышское озеро | Объем возвратного стока, поступающего в реки

Всего 3 записи.

Наименование	Ед измерения	Формула	October	November	December	January	February	March	April	May	June	July	August	September	Межвегетация	Вегетация	Год
Общий водозабор	млн куб. м/мес	W=W_tr+W_loc+WP_gr+WP_rp	6.77	5.15	126.04	32.75	64.34	395.59	82.12	159.07	252.31	319.04	339.17	131.12	630.64	1282.83	1913.47
Фактическое значение	млн куб. м/мес	fW=	232.76	46.46	78.23	74.75	165.72	363.06	309.88	329.63	429.57	578.01	611.17	565.86	960.98	2824.12	3785.10
Относительное отклонение	%	rW=(fW-W)/fW	97.09	88.92	-61.11	56.19	61.18	-8.96	73.50	51.74	41.27	44.80	44.50	76.83	34.38	54.58	49.45



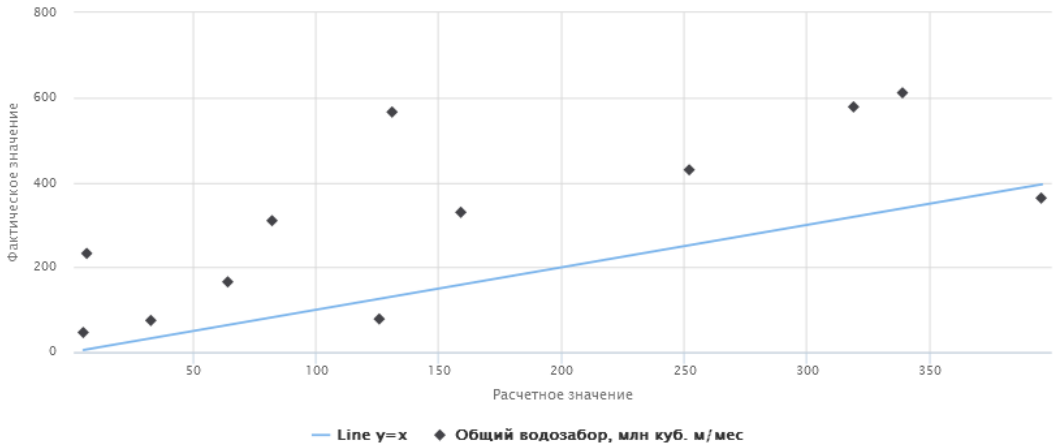


Figure 4.1 – Testing of the indicator “Total water intake”

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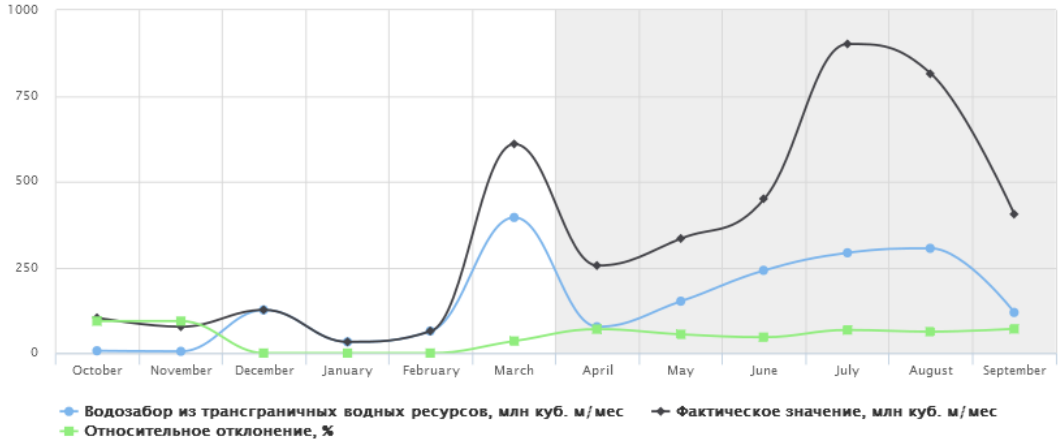
Всего 3 записи.

Наименование	Ед измерения	Формула	October	November	December	January	February	March	April	May	June	July	August	September	Межвегетация	Вегетация	Год
Водозабор из трансграничных водных ресурсов	млн куб. м/мес	W_tr=IF(WP_tr<=WN-WP_gr-WP_rp+V_r,WP_tr,WN-WP_gr-WP_rp+V_r)	6.77	5.15	126.04	32.75	64.34	395.59	76.84	151.36	241.35	292.52	305.53	118.57	630.64	1186.17	1816.81
Фактическое значение	млн куб. м/мес	fW_tr=	102.85	76.88	126.04	32.75	64.34	609.83	255.25	334.15	450.02	901.53	814.49	405.12	1012.69	3160.56	4173.25
Относительное отклонение	%	rW_tr=(fW_tr-W_tr)/fW_tr	93.42	93.30	0.00	0.00	0.00	35.13	69.89	54.70	46.37	67.55	62.49	70.73	37.73	62.47	56.47



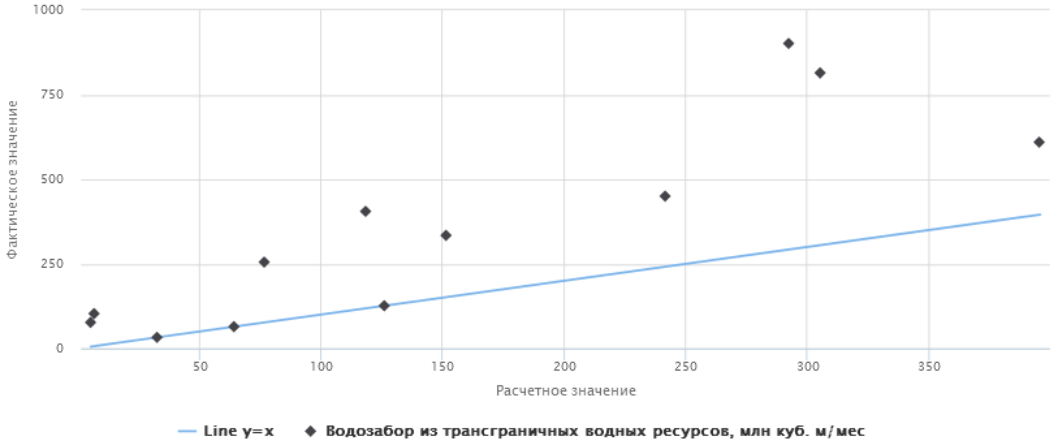


Figure 4.2 – Testing of the indicator “Intake from transboundary water”

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Всего 3 записи.

Наименование	Ед измерения	Формула	October	November	December	January	February	March	April	May	June	July	August	September	Межвегетация	Вегетация	Год
Водозабор для орошения, включая промывку	млн куб. м/мес	W_irrflu=W-WN_ind-WN_dom-WN_oth	0.00	0.00	121.10	26.56	58.27	389.11	74.35	151.02	244.26	310.88	331.21	123.68	595.04	1235.40	1830.44
Фактическое значение	млн куб. м/мес	fW_irrflu=	225.99	41.31	73.29	68.56	159.65	356.58	302.11	321.58	421.52	569.85	603.21	558.42	925.38	2776.69	3702.07
Относительное отклонение	%	rW_irrflu=(fW_irrflu-W_irrflu)/fW_irrflu	100.00	100.00	-65.23	61.27	63.50	-9.12	75.39	53.04	42.05	45.44	45.09	77.85	35.70	55.51	50.56

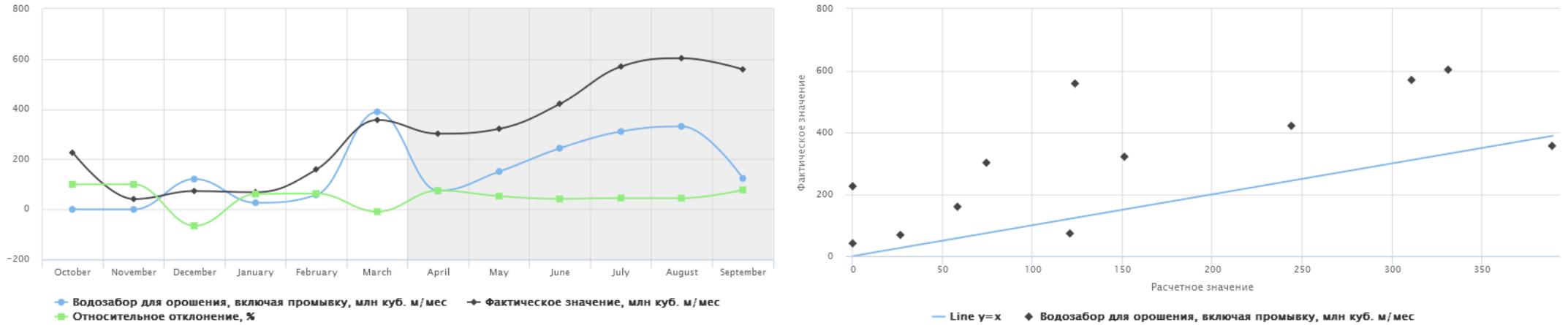

Figure 4.3 - Testing of the indicator “Water intake for irrigation, including leaching”

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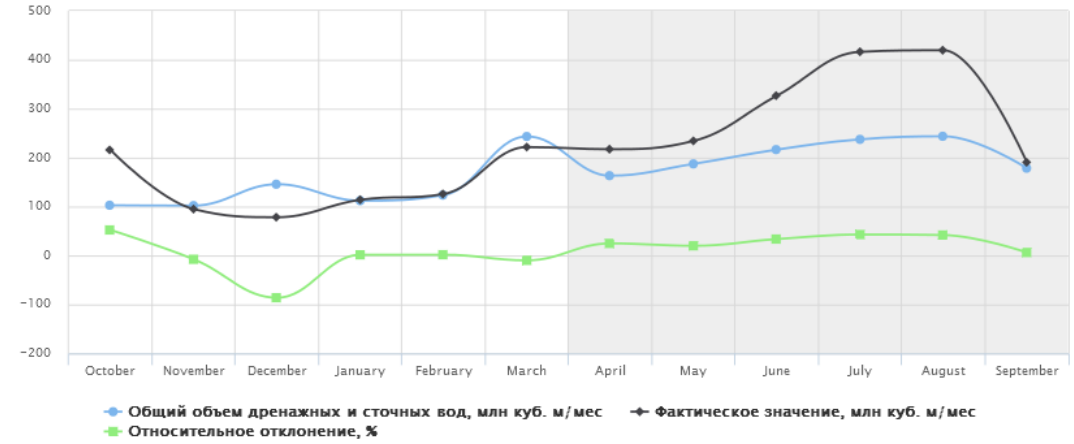
Всего 3 записи.

Наименование	Ед измерения	Формула	October	November	December	January	February	March	April	May	June	July	August	September	Межвегетация	Вегетация	Год
Общий объем дренажных и сточных вод	млн куб. м/мес	W_drwas=W_dr+W_was	102.85	102.12	145.79	112.19	123.59	243.34	163.27	187.40	216.58	237.49	243.76	178.57	829.88	1227.07	2056.95
Фактическое значение	млн куб. м/мес	fW_drwas=	215.83	94.91	78.34	114.00	125.86	221.69	217.32	234.31	326.77	416.37	419.59	190.66	850.63	1805.02	2655.65
Относительное отклонение	%	rW_drwas=(fW_drwas-W_drwas)/fW_drwas	52.35	-7.59	-86.09	1.59	1.80	-9.77	24.87	20.02	33.72	42.96	41.91	6.34	2.44	32.02	22.54



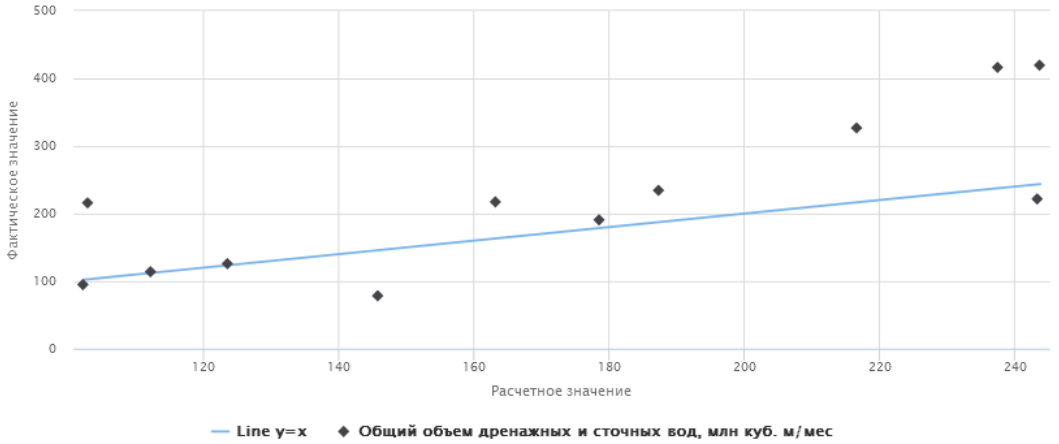


Figure 4.4 - Testing of the indicator “Total drainage water and wastewater”

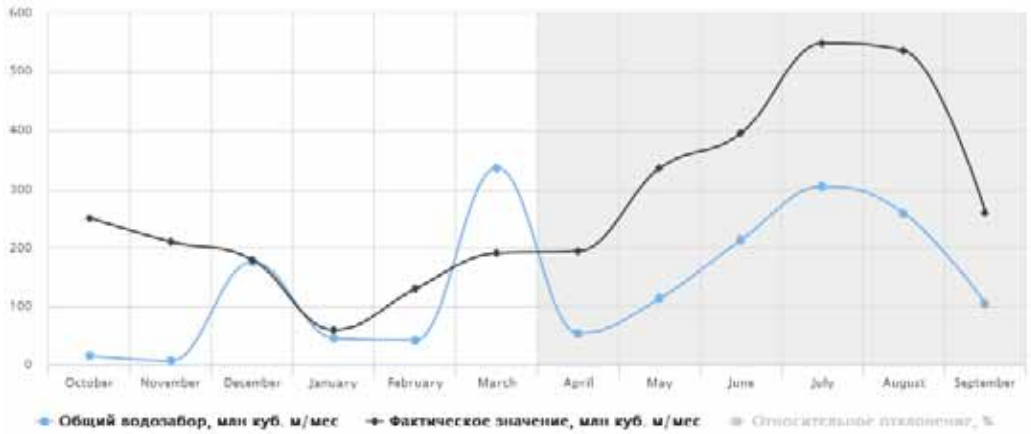
Annex 1 to the report, position 2.8.3 Testing

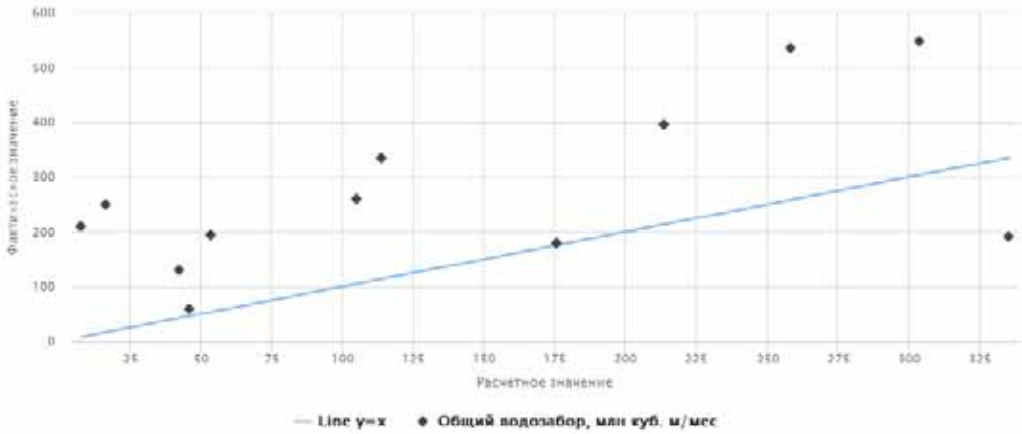
Fitting of simulated and actual values for planning zones in the lower reaches of the Amudarya (before the model calibration)

Planning zone: Khorezm

Indicator: Total water intake

Year: 2011





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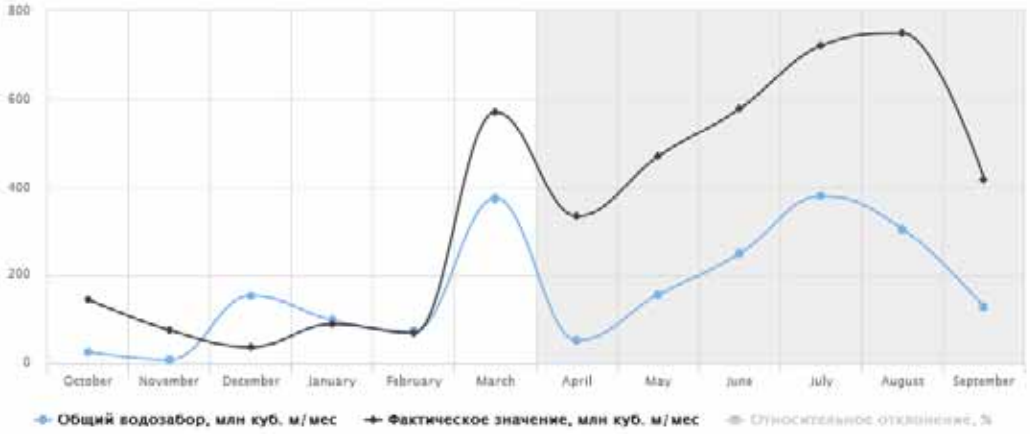
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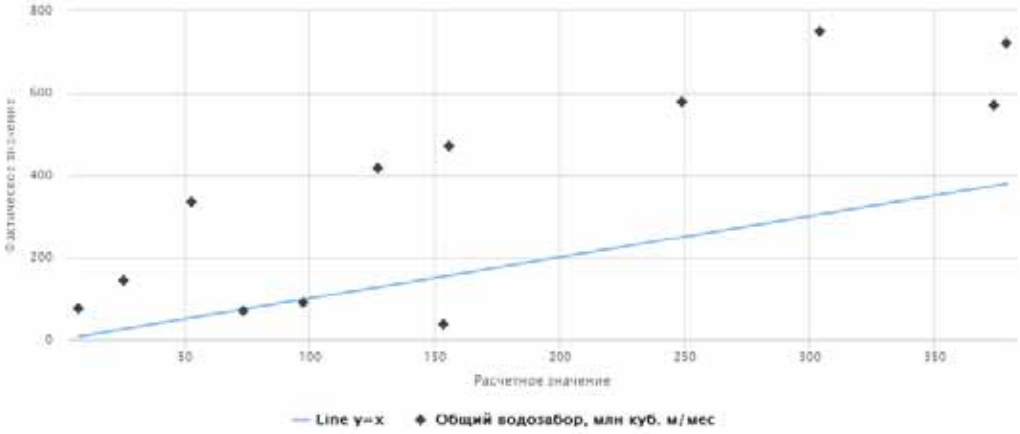
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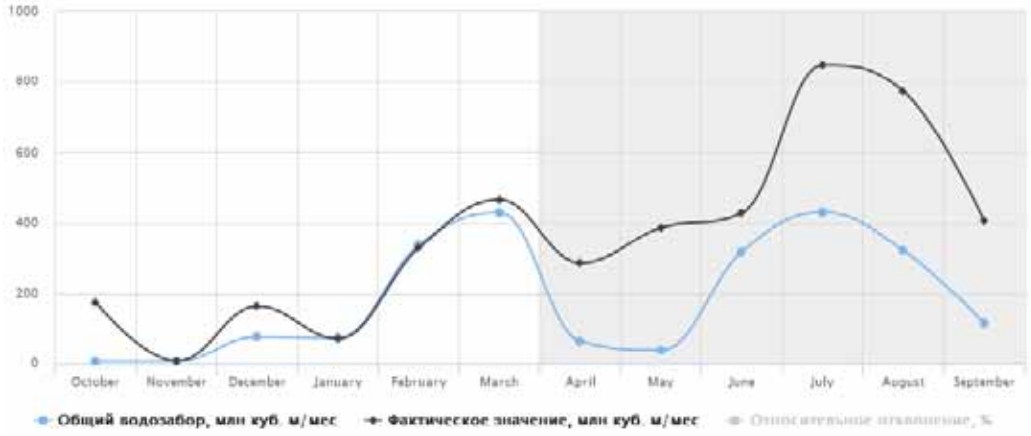
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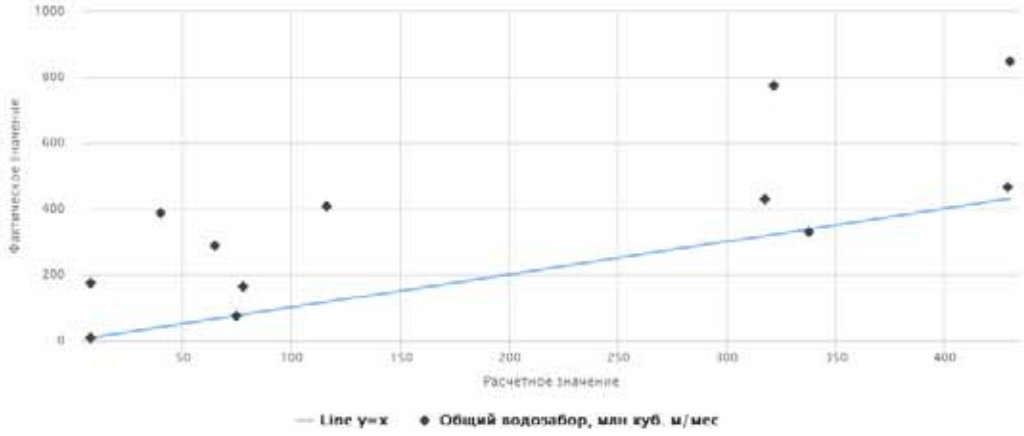
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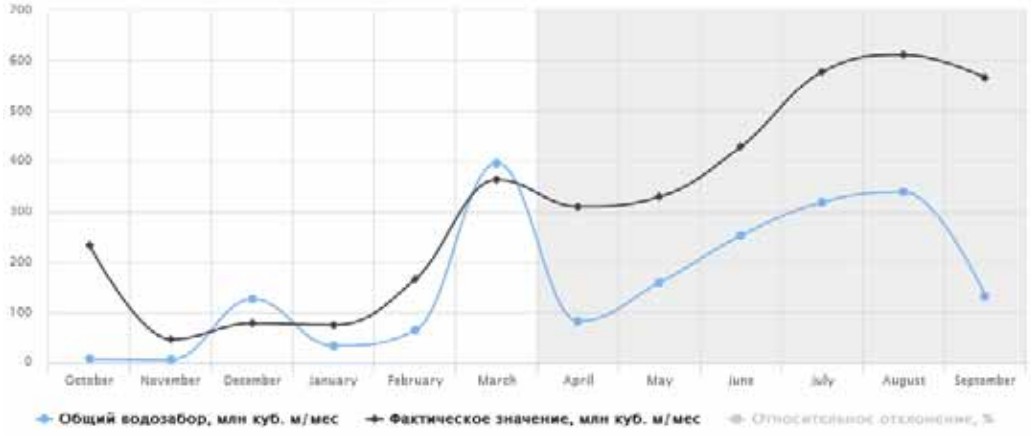
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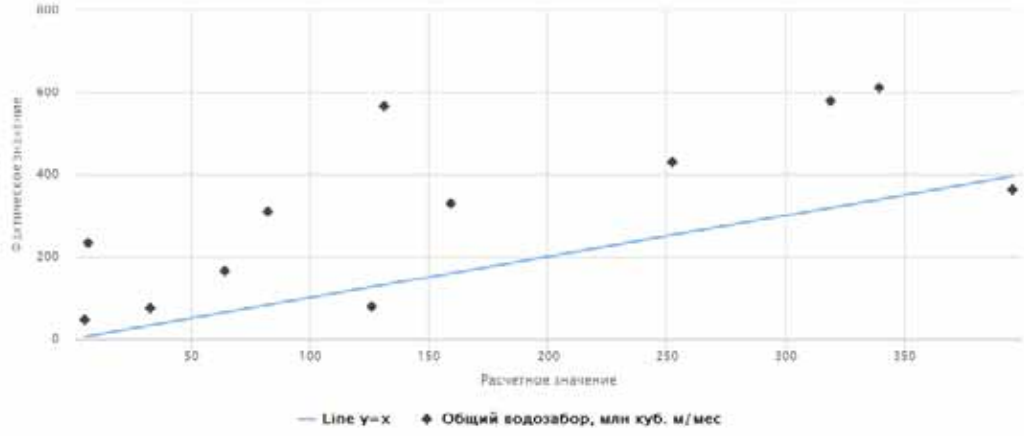
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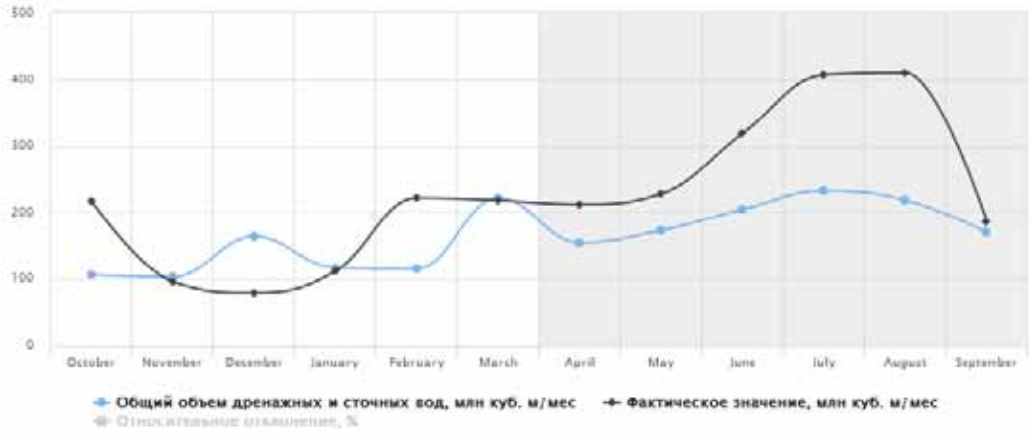
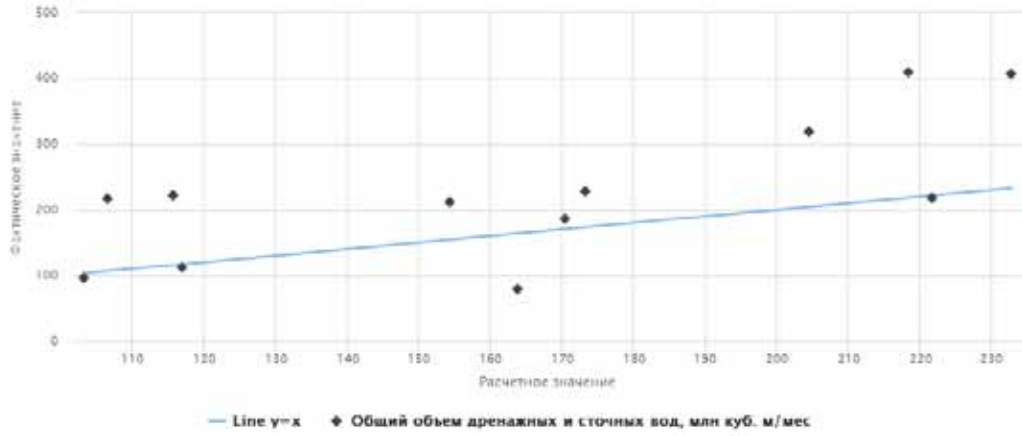
Indicator: Total drainage water and wastewater

Year: 2011





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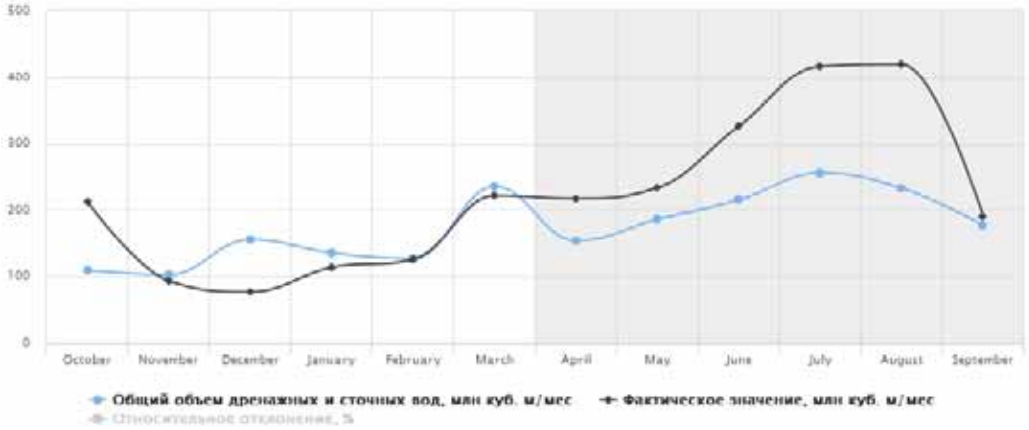

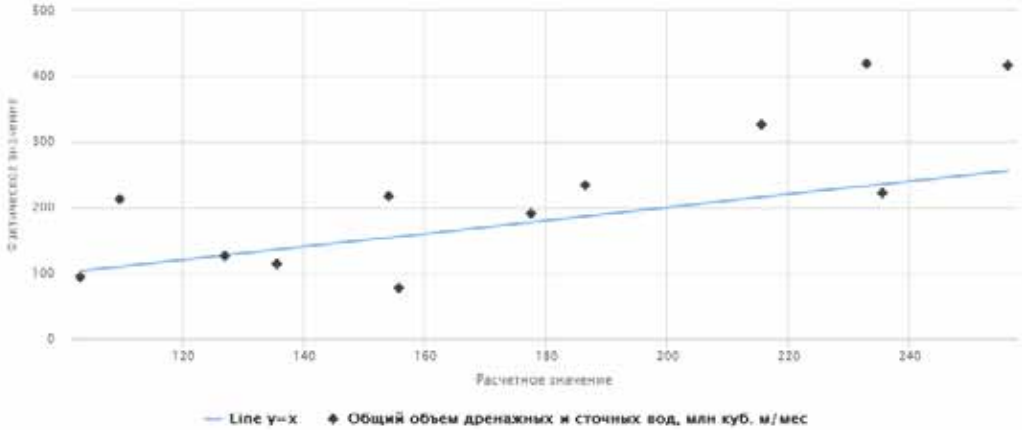

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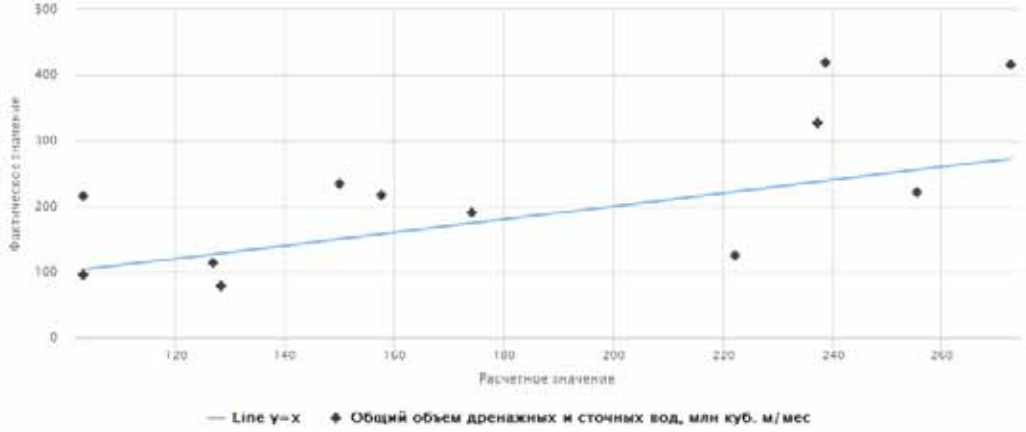
Относительное отклонение, %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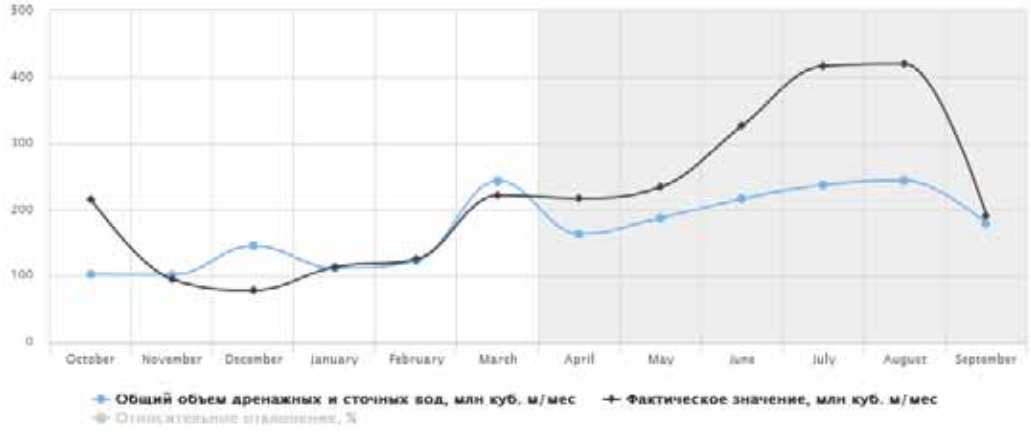
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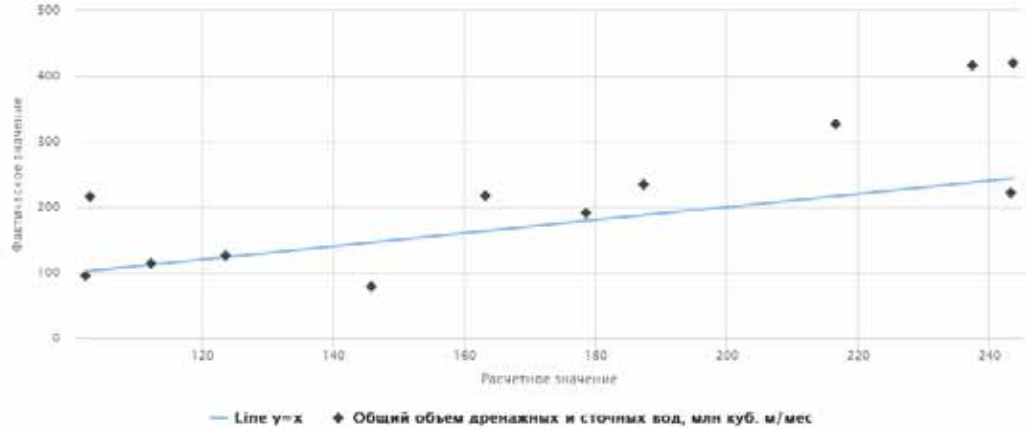
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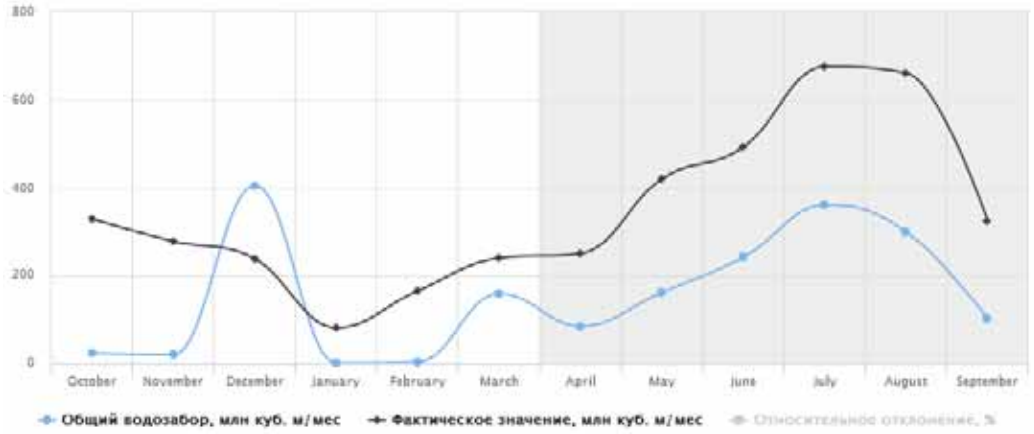
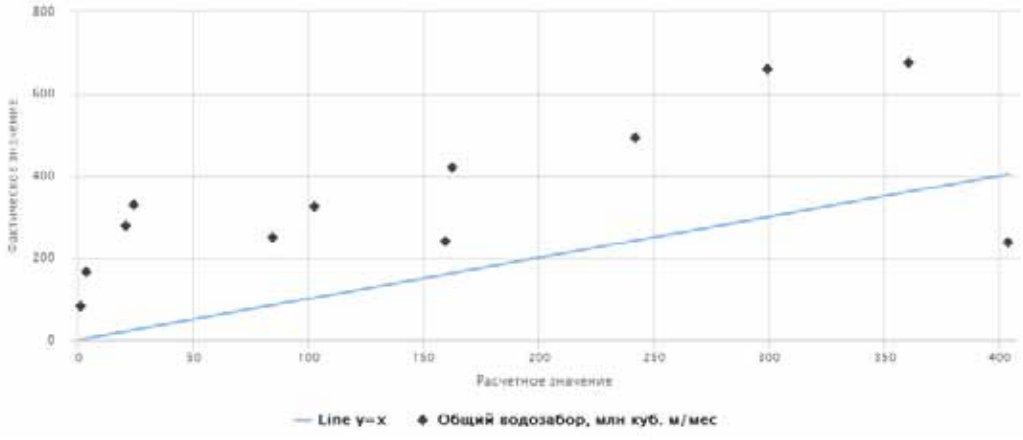
Planning zone: Northern Karakalpakstan

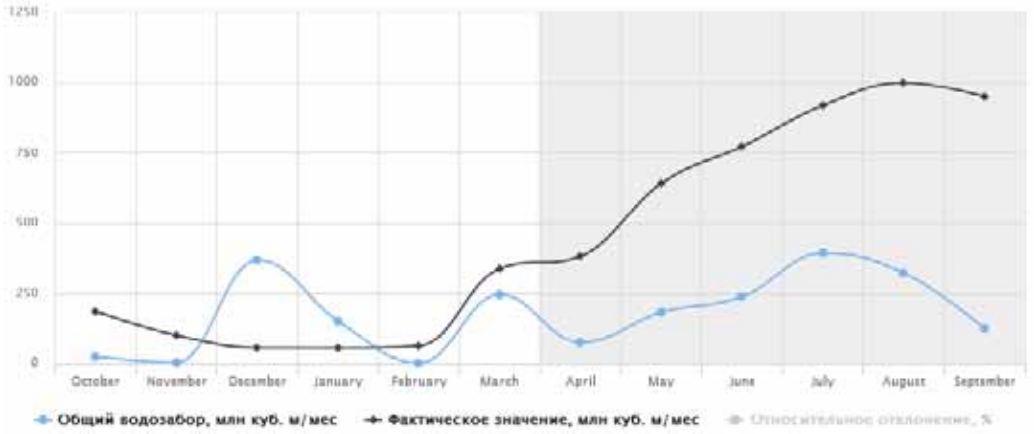
Indicator: Total water intake

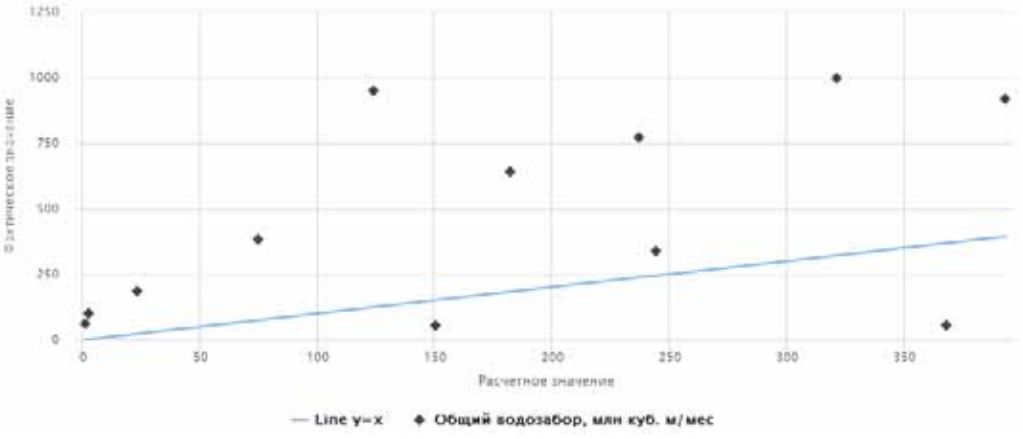
Year: 2011



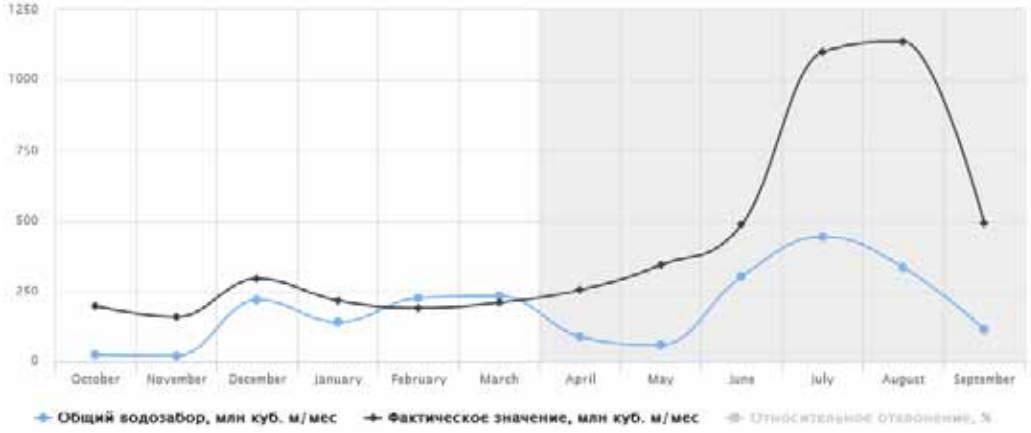


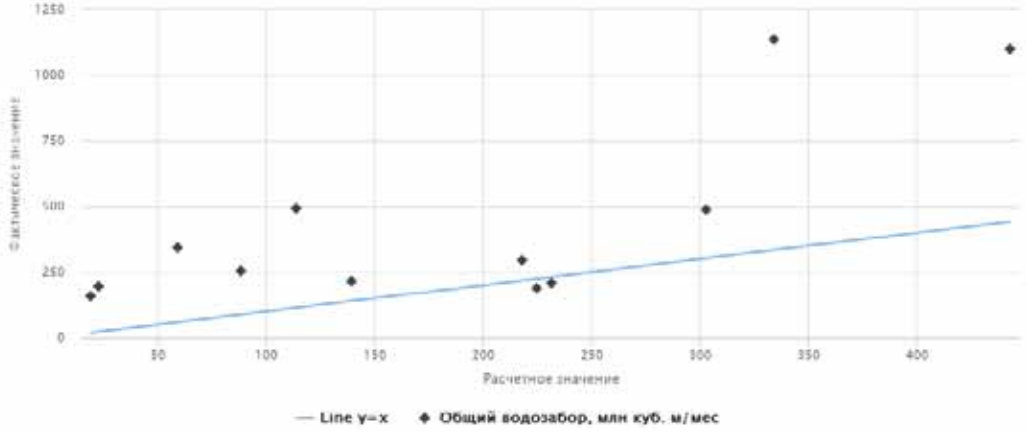
2012





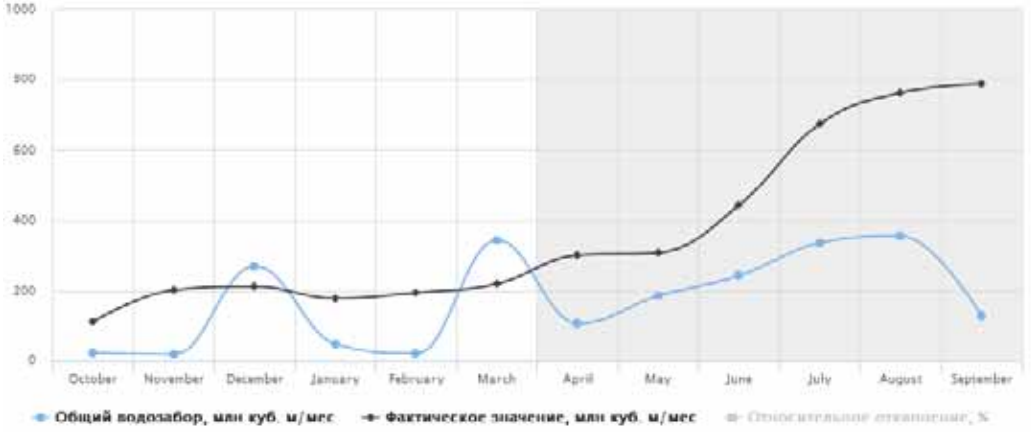
2013


1250
1000
750
500
250
0
October
November
December
January
February
March
April
May
June
July
August
September
Общий водозабор, млн куб. м/мес
Фактическое значение, млн куб. м/мес


1250
1000
750
500
250
0
50
100
150
200
250
300
350
400
Расчетное значение
Line y=x
Общий водозабор, млн куб. м/мес

201

4


1000
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600
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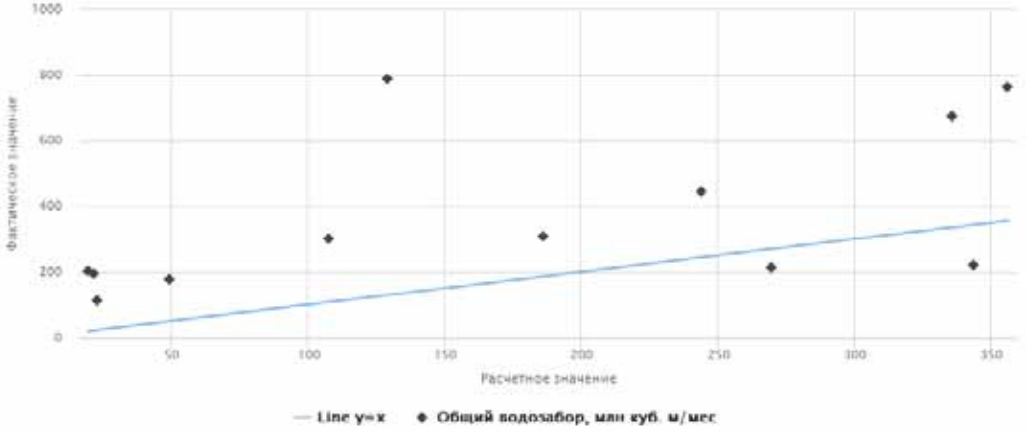
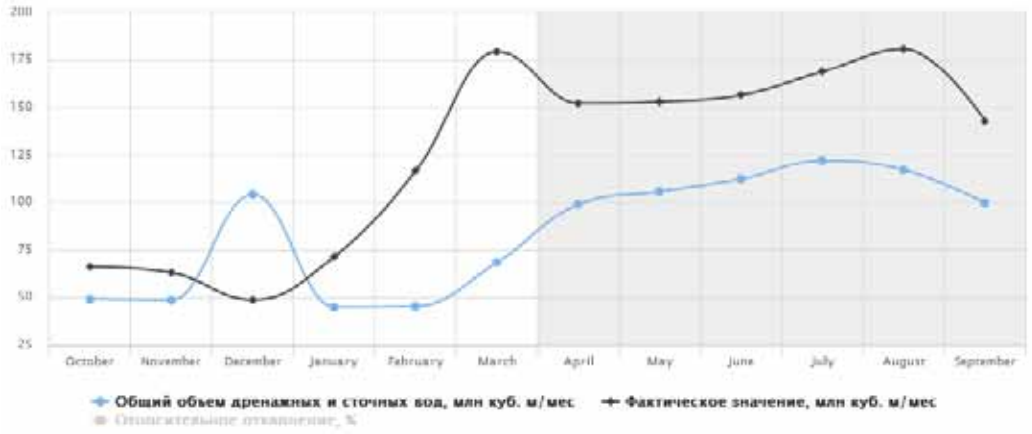
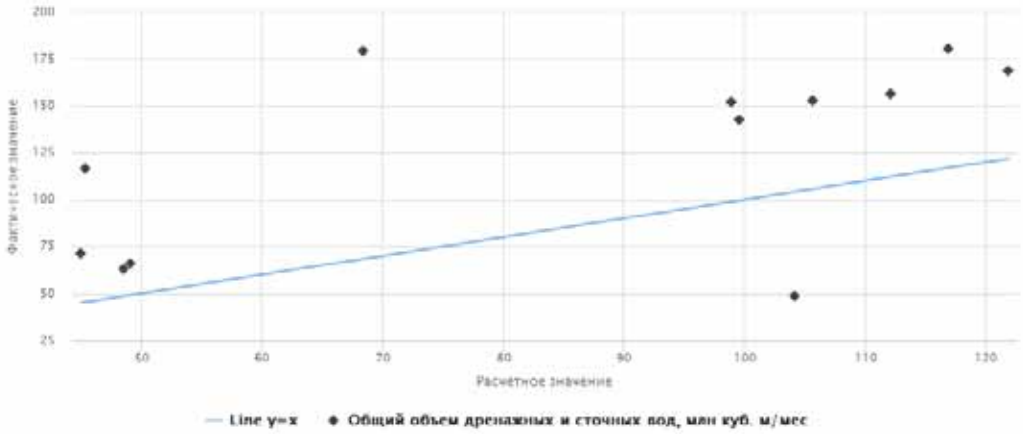
200
0
October
November
December
January
February
March
April
May
June
July
August
September
Общий водозабор, млн куб. м/мес
Фактическое значение, млн куб. м/мес


1000
800
600
400
200
0
50
100
150
200
250
300
350
Расчетное значение
Line y=x
Общий водозабор, млн куб. м/мес

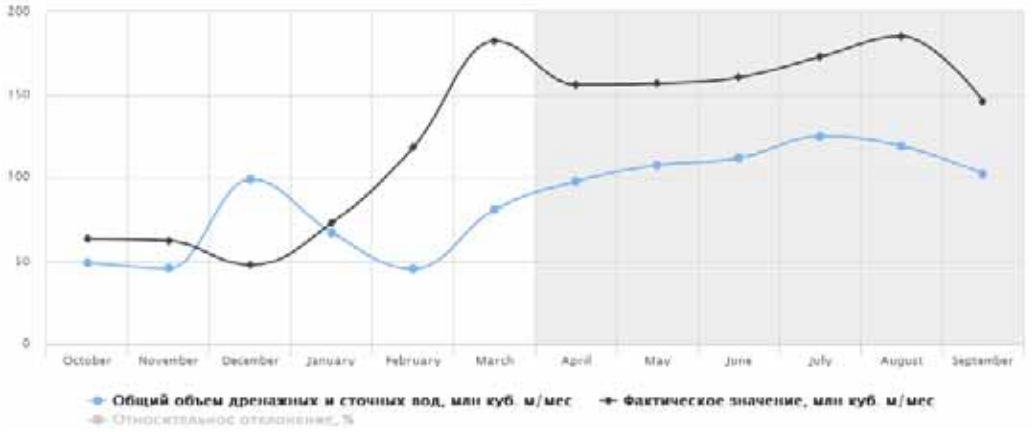
Indicator: Total drainage water and wastewater

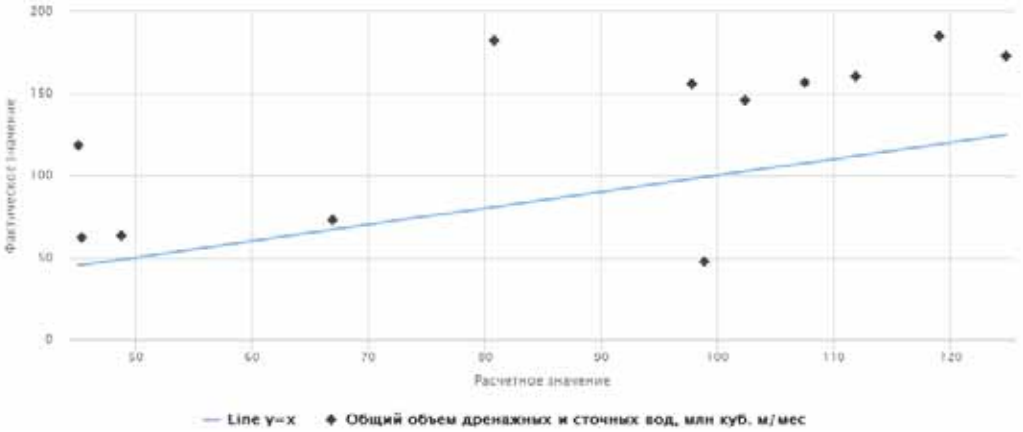
Year: 2011



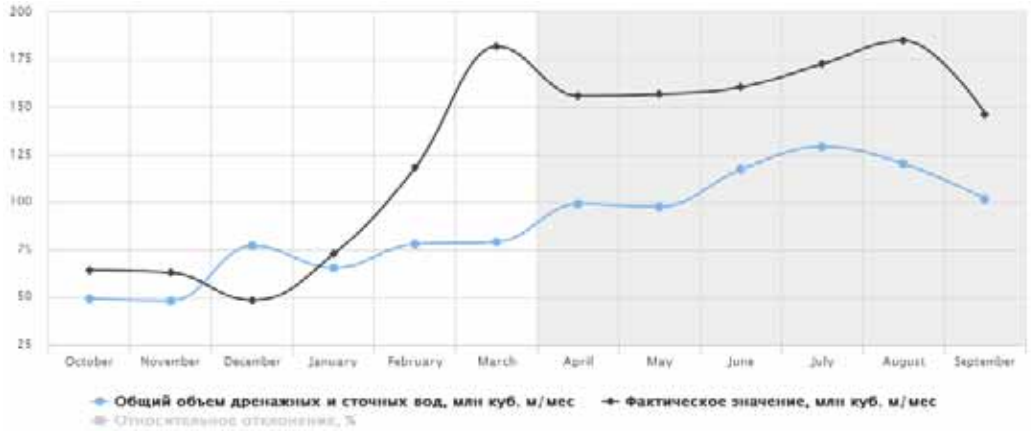


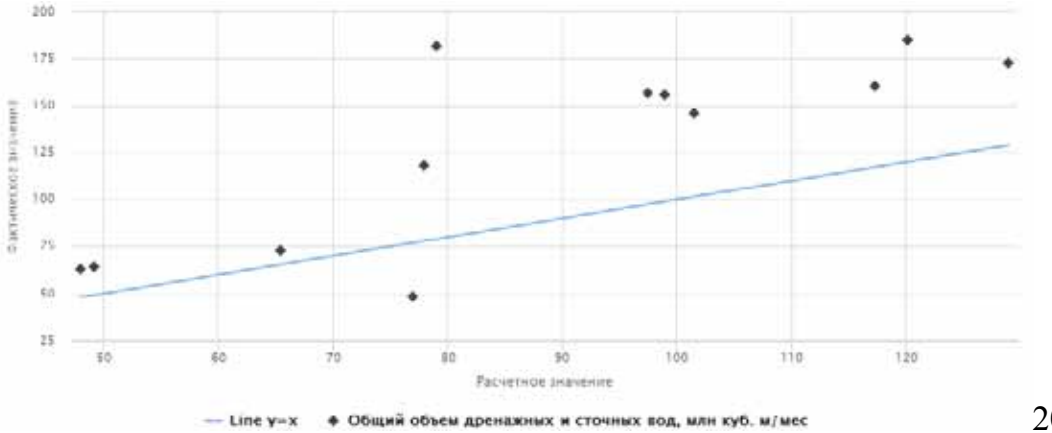
2012





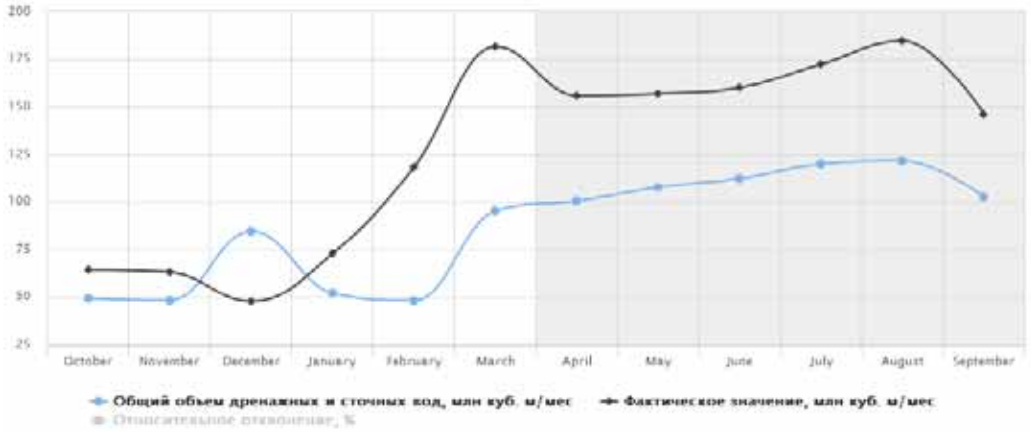
2013

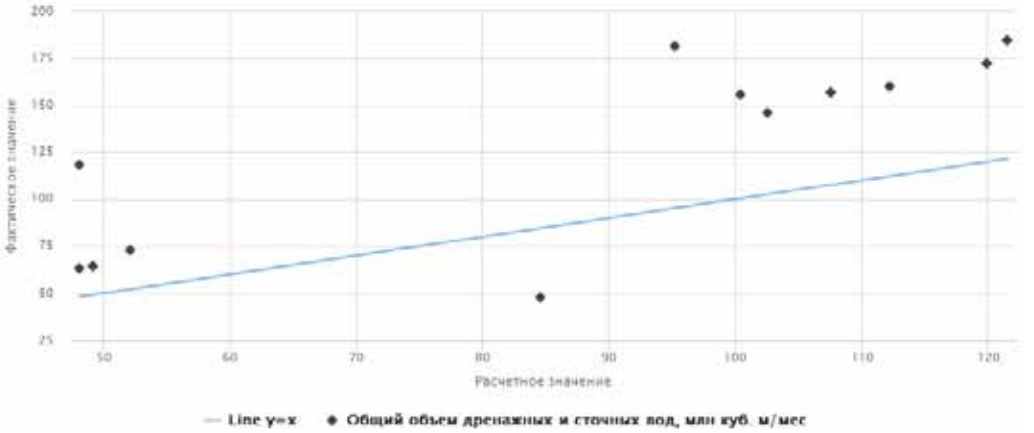

200
175
150
125
100
75
50
25
October
November
December
January
February
March
April
May
June
July
August
September
Общий объем дренажных и сточных вод, млн куб. м/мес
Фактическое значение, млн куб. м/мес
Относительное отклонение, %


200
175
150
125
100
75
50
25
50
60
70
80
90
100
110
120
Расчетное значение
Line y=x
Общий объем дренажных и сточных вод, млн куб. м/мес

201

4

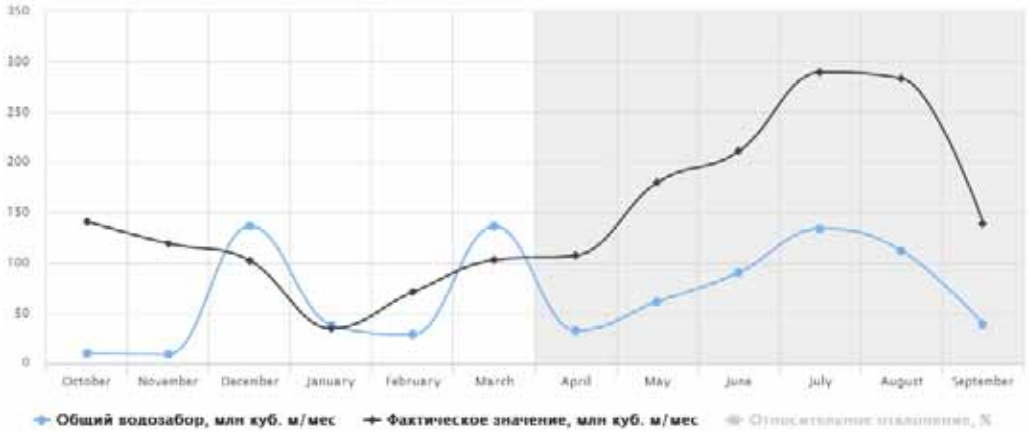

200
175
150
125
100
75
50
25
October
November
December
January
February
March
April
May
June
July
August
September
Общий объем дренажных и сточных вод, млн куб. м/мес
Фактическое значение, млн куб. м/мес
Относительное отклонение, %

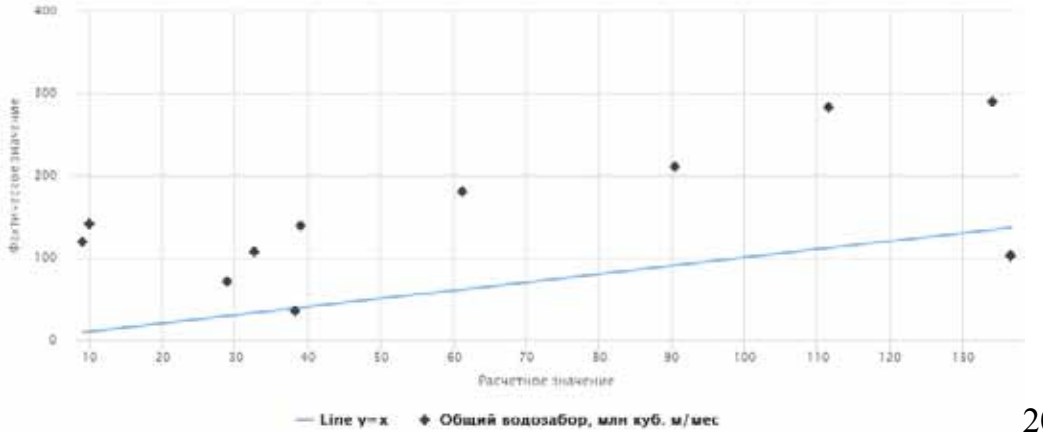

200
175
150
125
100
75
50
25
50
60
70
80
90
100
110
120
Расчетное значение
Line y=x
Общий объем дренажных и сточных вод, млн куб. м/мес

Planning zone: Southern Karakalpakstan

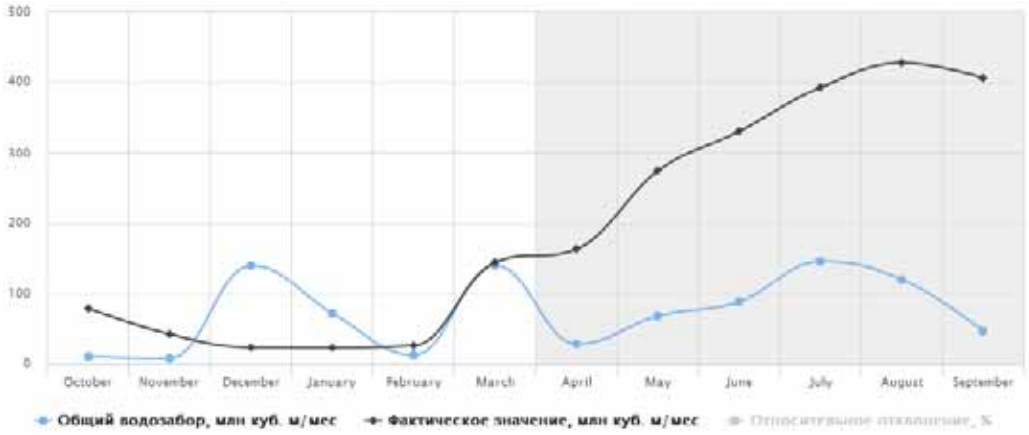
Indicator: Total water intake

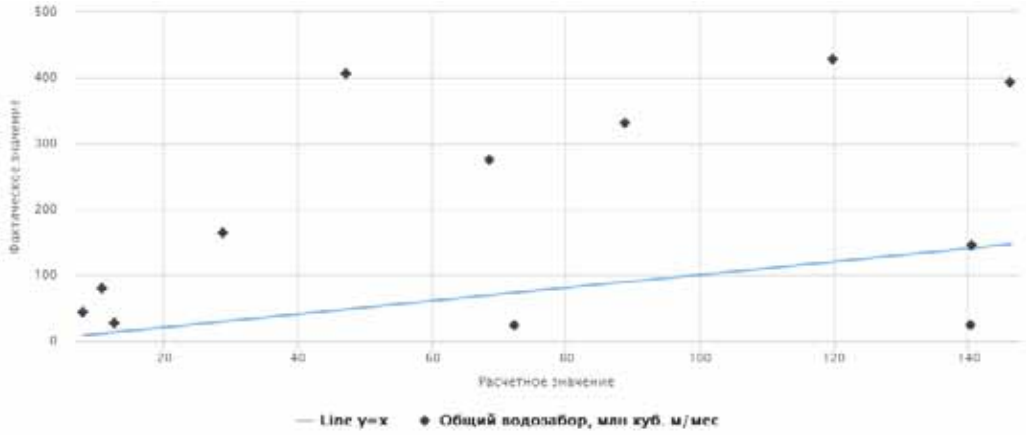
Year: 2011





2012





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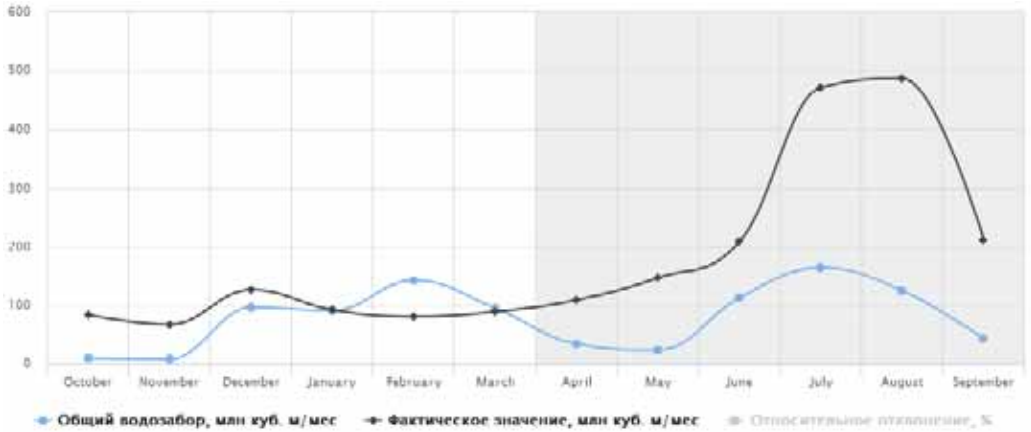
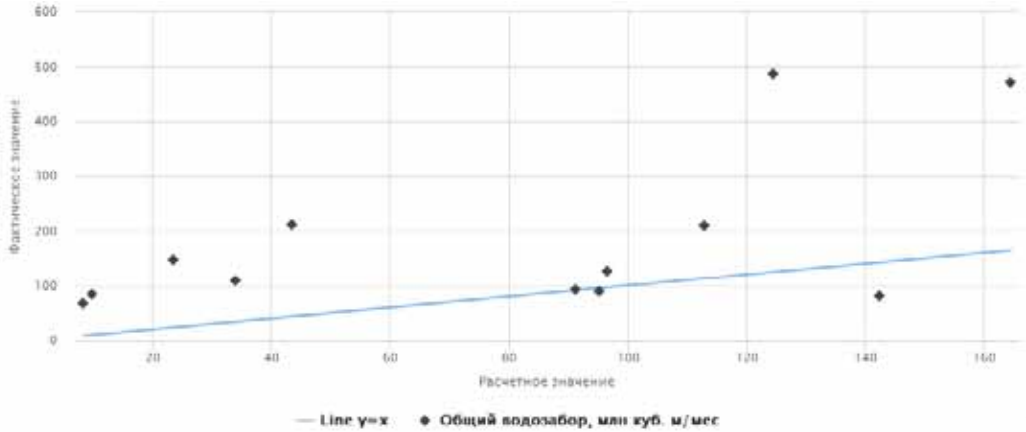
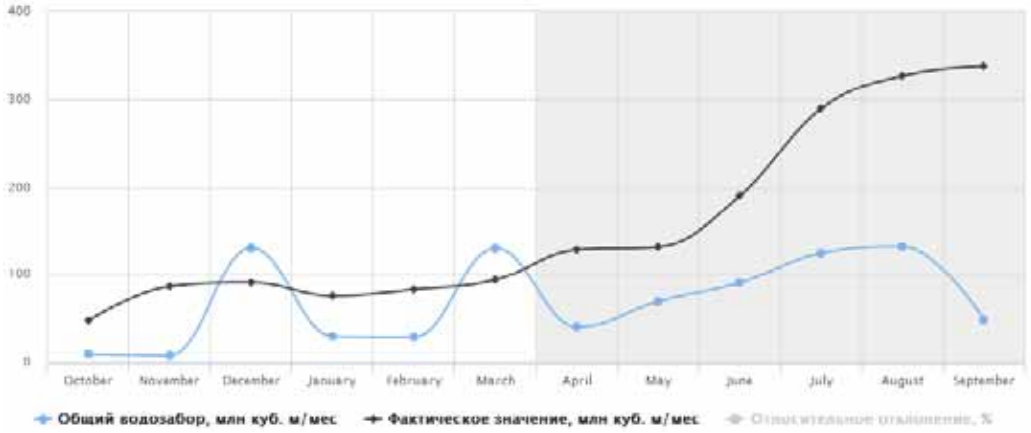
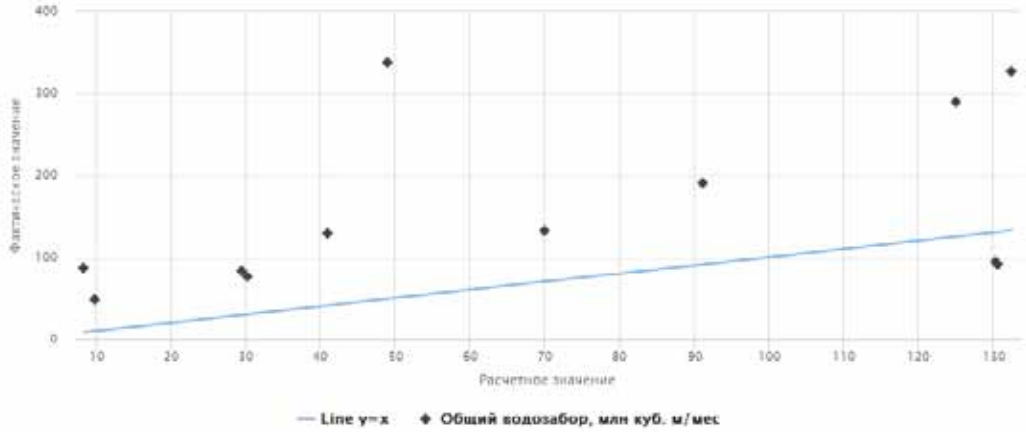

600
500
400
300
200
100
0
October
November
December
January
February
March
April
May
June
July
August
September
Общий водозабор, млн куб. м/мес
Фактическое значение, млн куб. м/мес


600
500
400
300
200
100
0
20
40
60
80
100
120
140
160
Расчетное значение
Line y=x
Общий водозабор, млн куб. м/мес

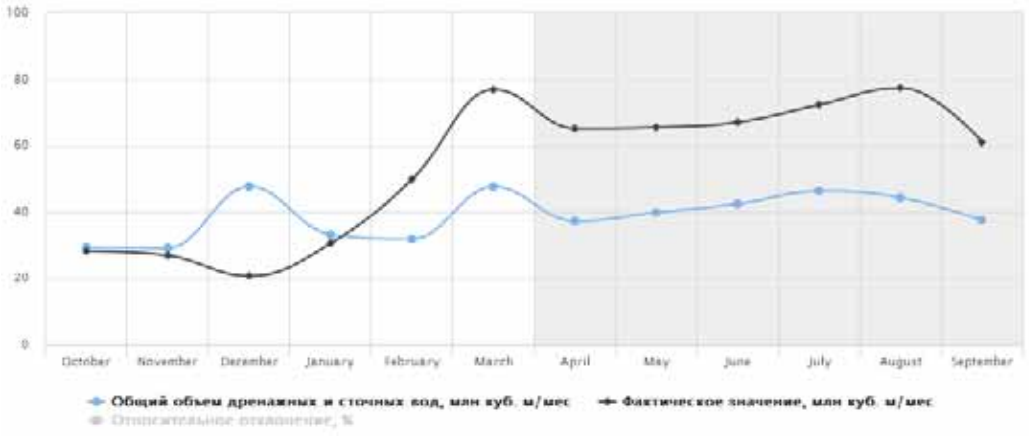
2014

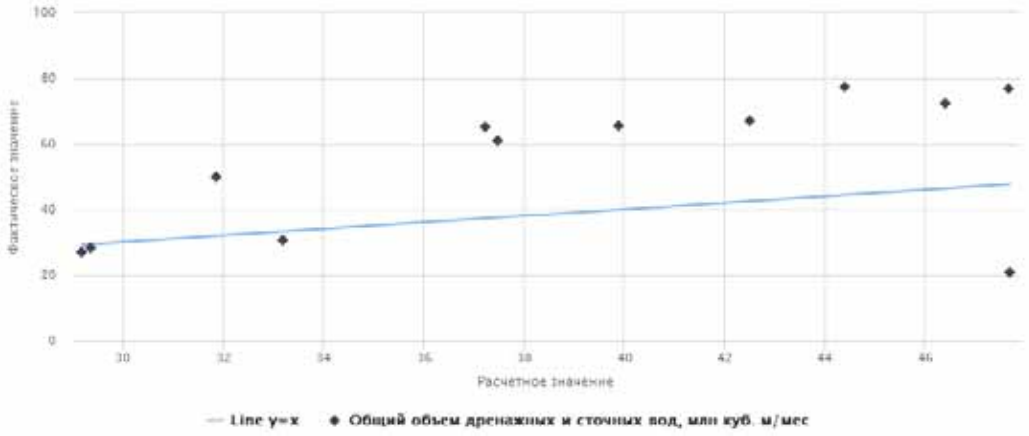

400
300
200
100
0
October
November
December
January
February
March
April
May
June
July
August
September
Общий водозабор, млн куб. м/мес
Фактическое значение, млн куб. м/мес


400
300
200
100
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Расчетное значение
Line y=x
Общий водозабор, млн куб. м/мес

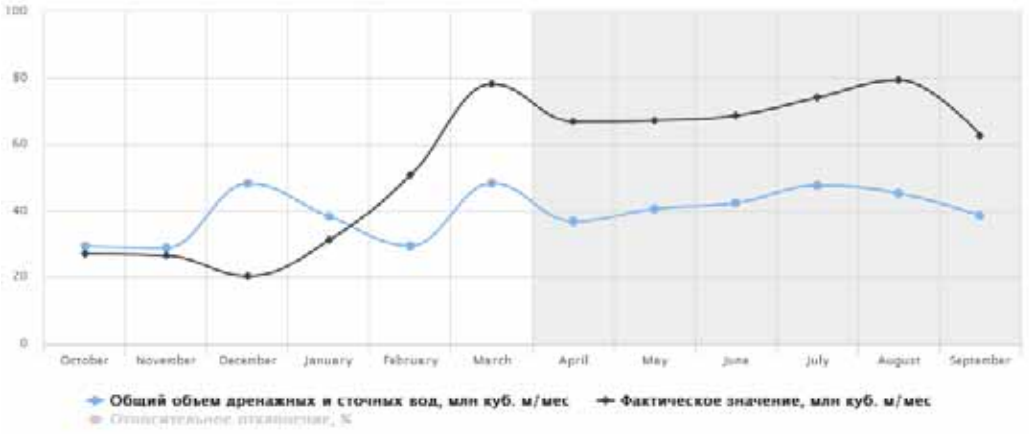
Indicator: Total drainage water and wastewater

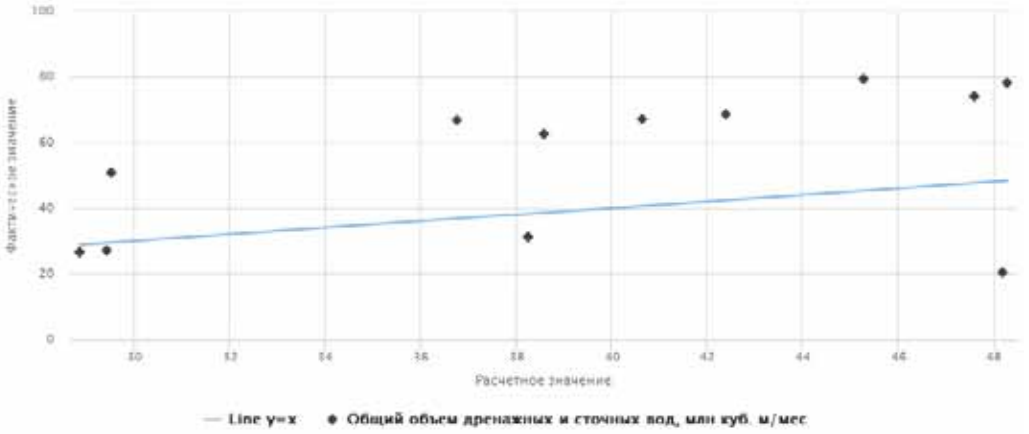
Year: 2011



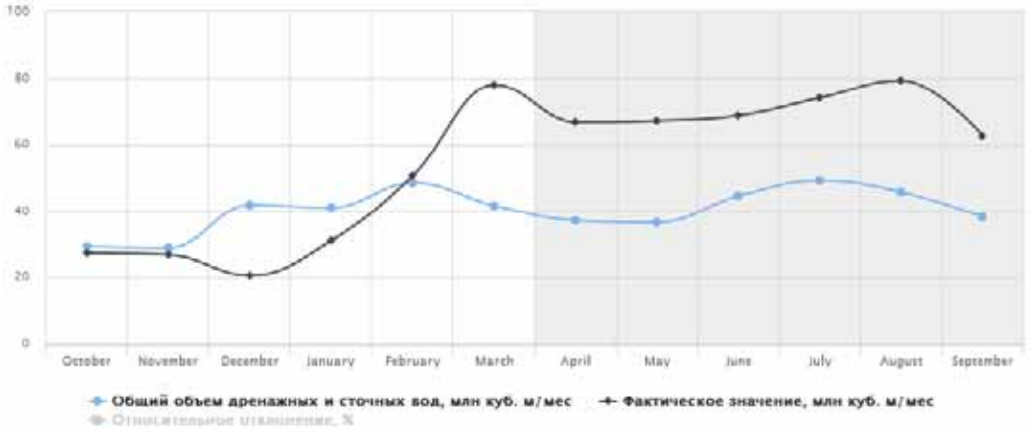


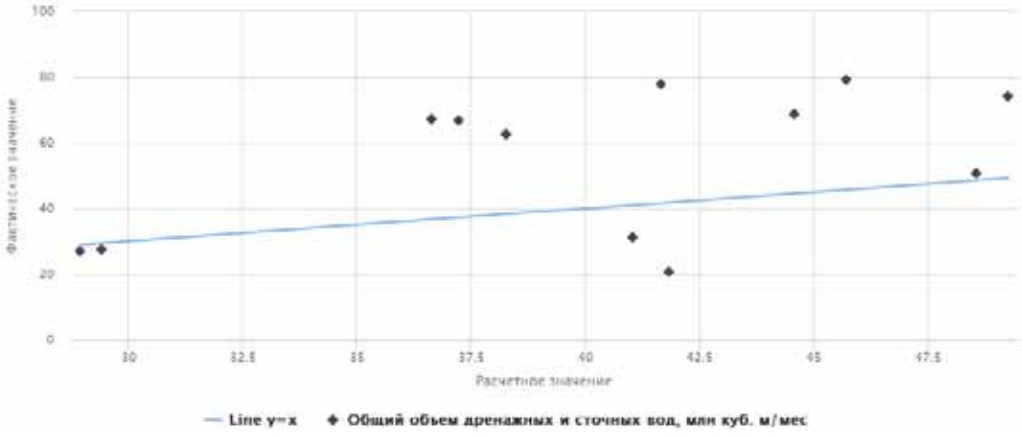
2012



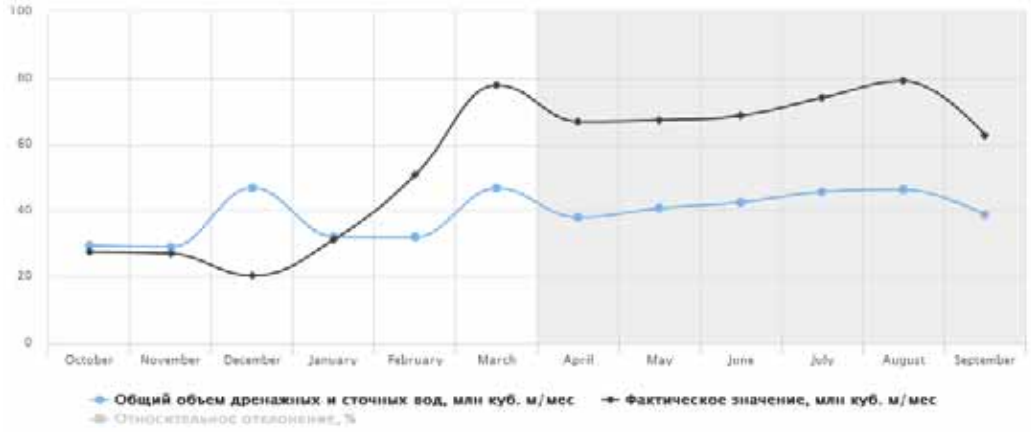


2013


100
80
60
40
20
0
October
November
December
January
February
March
April
May
June
July
August
September
Общий объем дренажных и сточных вод, млн куб. м/мес
Фактическое значение, млн куб. м/мес
Относительное отклонение, %


100
80
60
40
20
0
30
32.5
35
37.5
40
42.5
45
47.5
Расчетное значение
Line y=x
Общий объем дренажных и сточных вод, млн куб. м/мес

2014


100
80
60
40
20
0
October
November
December
January
February
March
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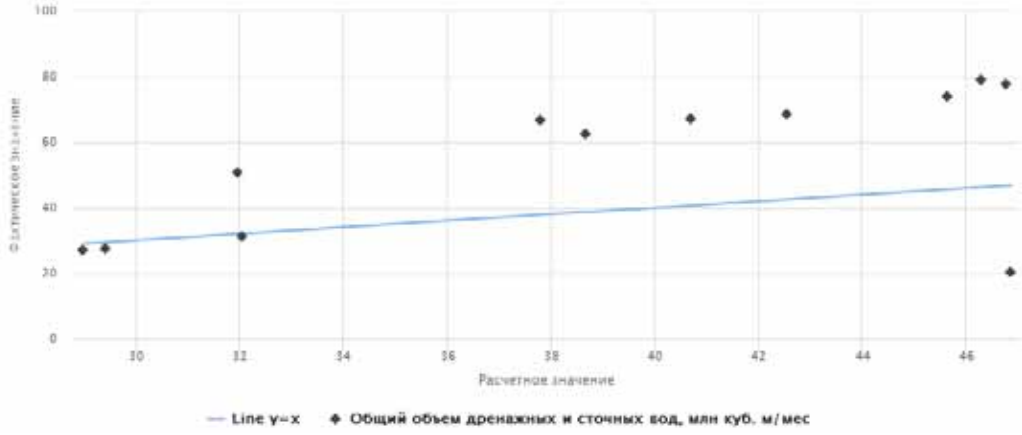
July
August
September
Общий объем дренажных и сточных вод, млн куб. м/мес
Фактическое значение, млн куб. м/мес
Относительное отклонение, %


100
80
60
40
20
0
30
32
34
36
38
40
42
44
46
Расчетное значение
Line y=x
Общий объем дренажных и сточных вод, млн куб. м/мес

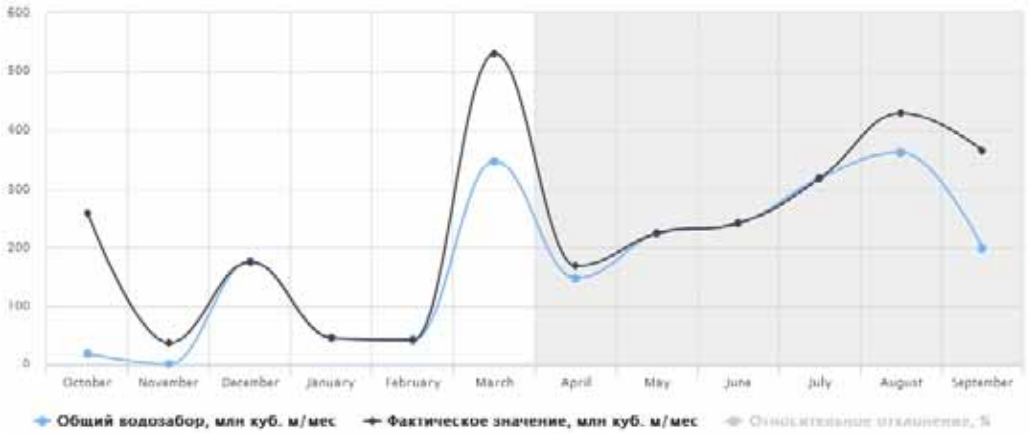
Annex 2 to the report, position 2.8.3 Testing

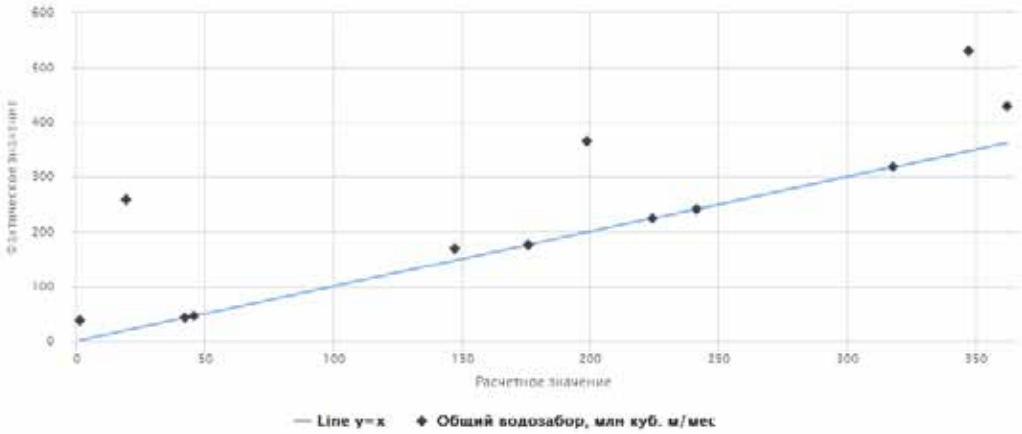
Fitting of simulated and actual values for planning zones in the lower reaches of the Amudarya (after the model calibration)

Planning zone: Khorezm

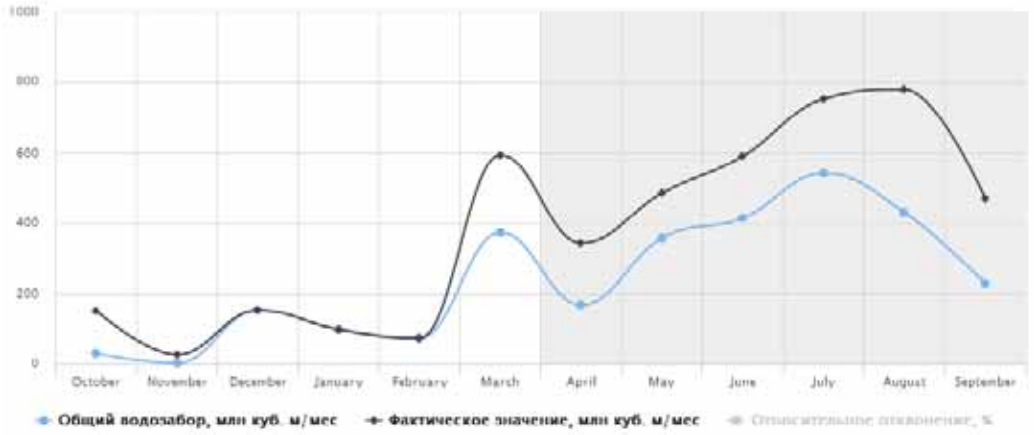
Indicator: Total water intake

Year: 2011





2012


1000
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October
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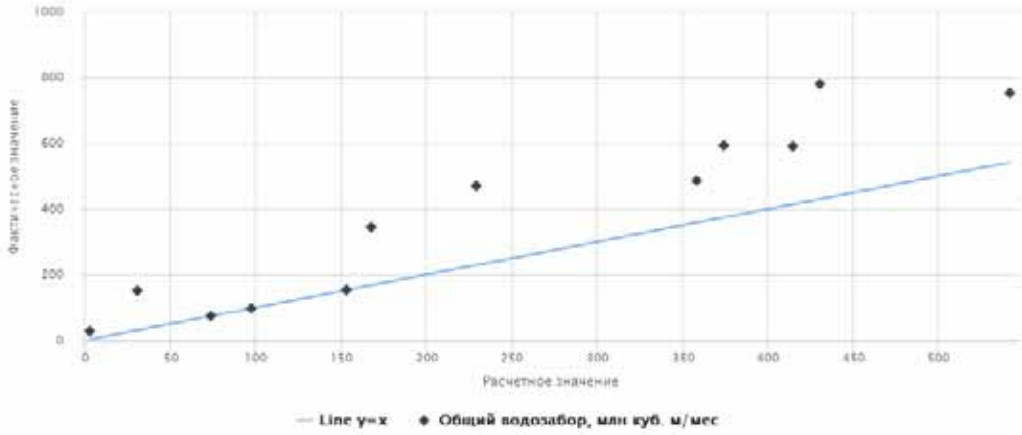
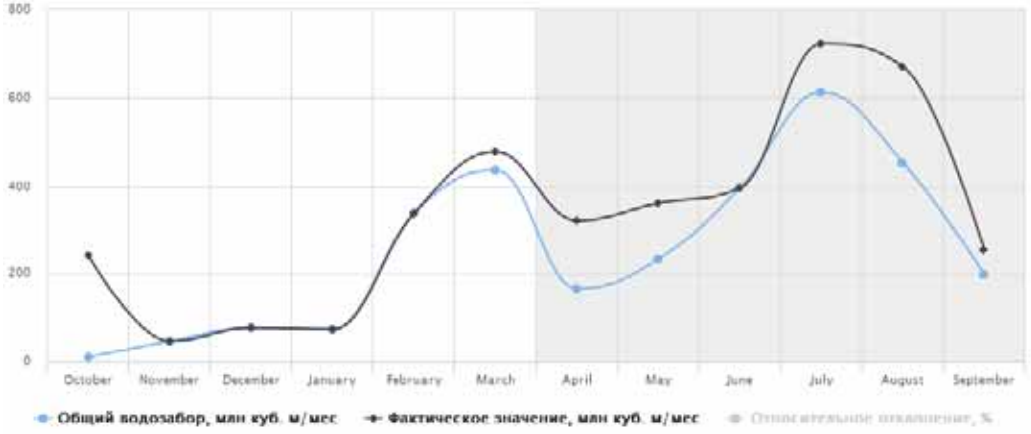
July
August
September
Общий водозабор, млн куб. м/мес
Фактическое значение, млн куб. м/мес
Относительное отклонение, %


1000
800
600
400
200
0
0
50
100
150
200
250
300
350
400
450
500
Расчетное значение
Line y=x
Общий водозабор, млн куб. м/мес

2013


800
600
400
200
0
October
November
December
January
February
March
April
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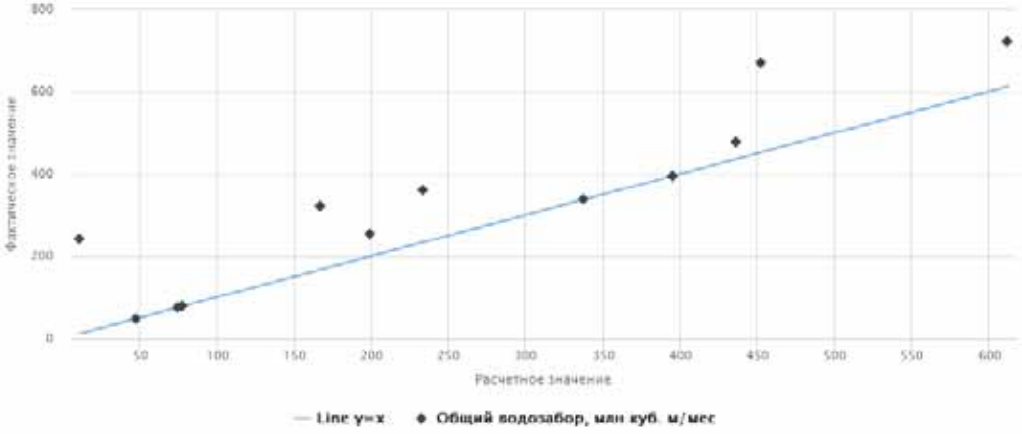
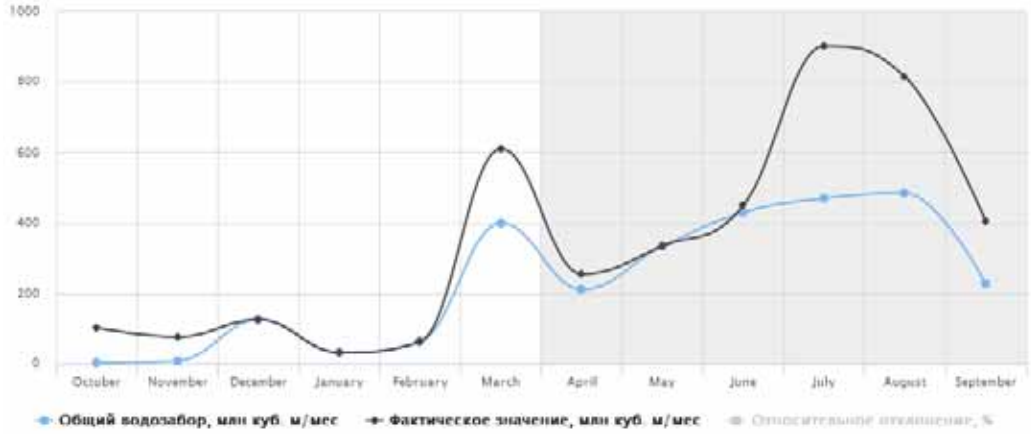
June
July
August
September
Общий водозабор, млн куб. м/мес
Фактическое значение, млн куб. м/мес


800
600
400
200
0
50
100
150
200
250
300
350
400
450
500
550
600
Расчетное значение
Line y=x
Общий водозабор, млн куб. м/мес

2014


1000
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October
November
December
January
February
March
April
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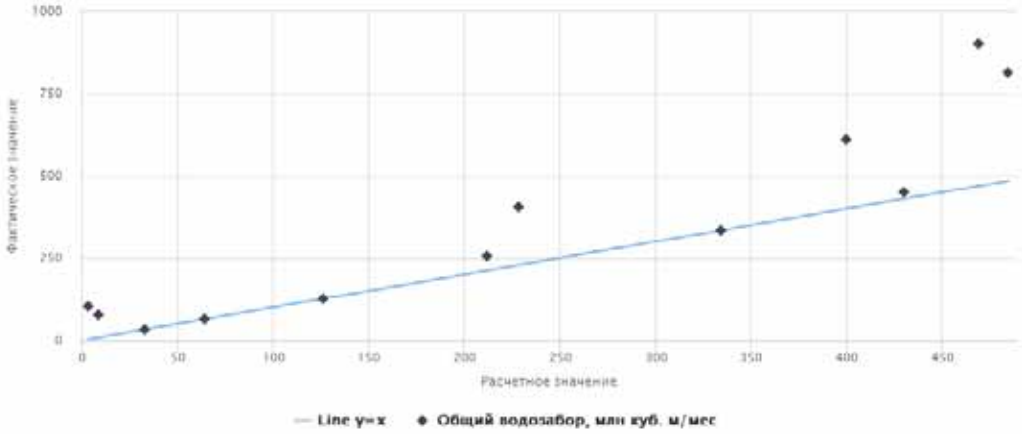
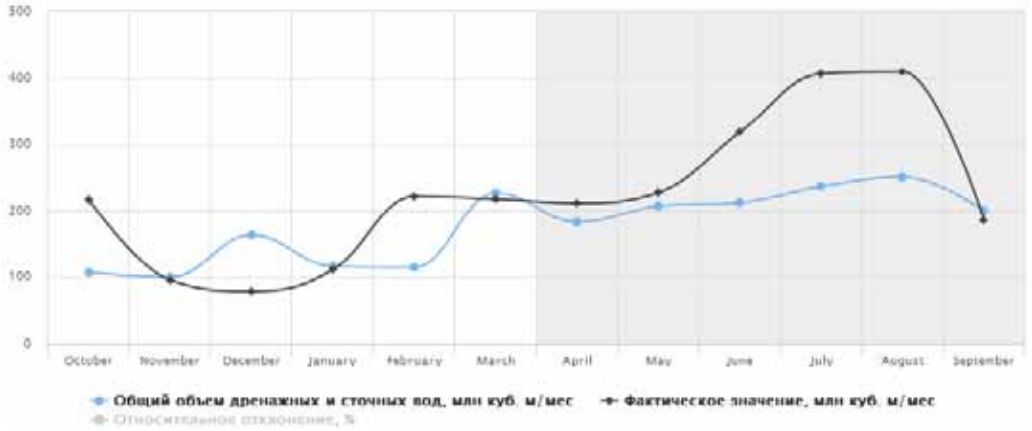
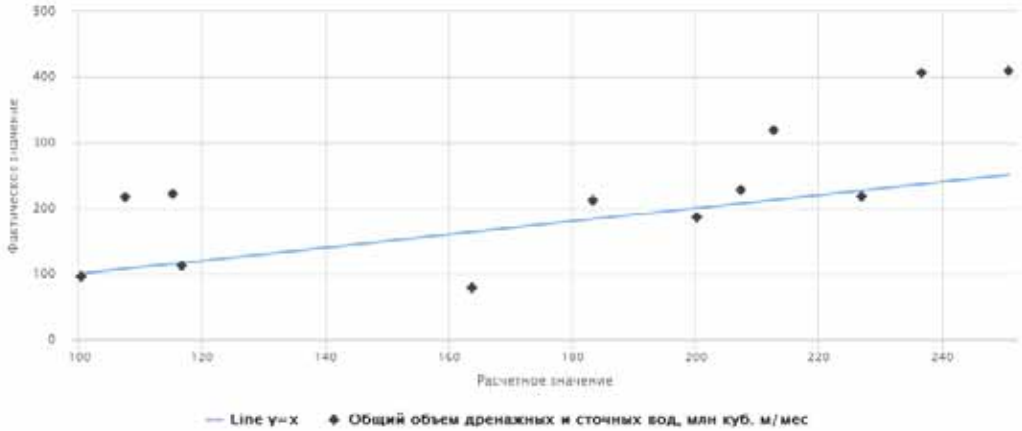
June
July
August
September
Общий водозабор, млн куб. м/мес
Фактическое значение, млн куб. м/мес


1000
750
500
250
0
50
100
150
200
250
300
350
400
450
Расчетное значение
Line y=x
Общий водозабор, млн куб. м/мес

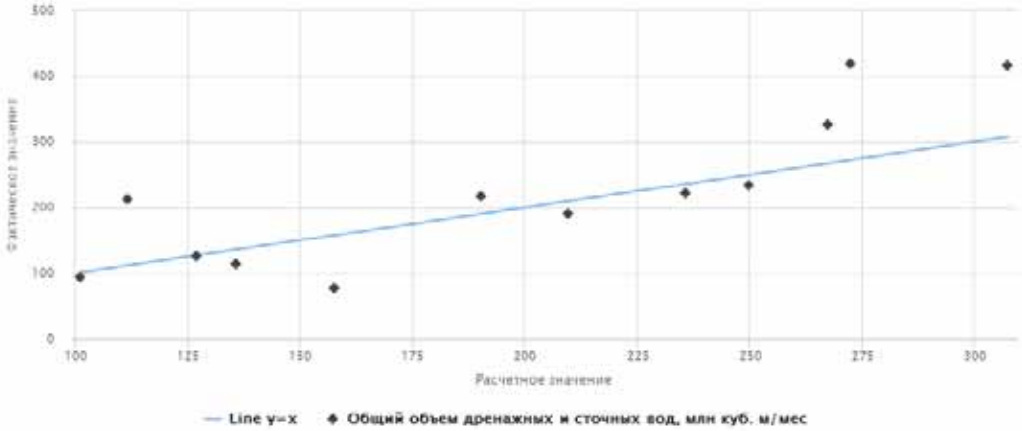
Indicator: Total drainage water and wastewater

Year: 2011





2012



2013


500
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300
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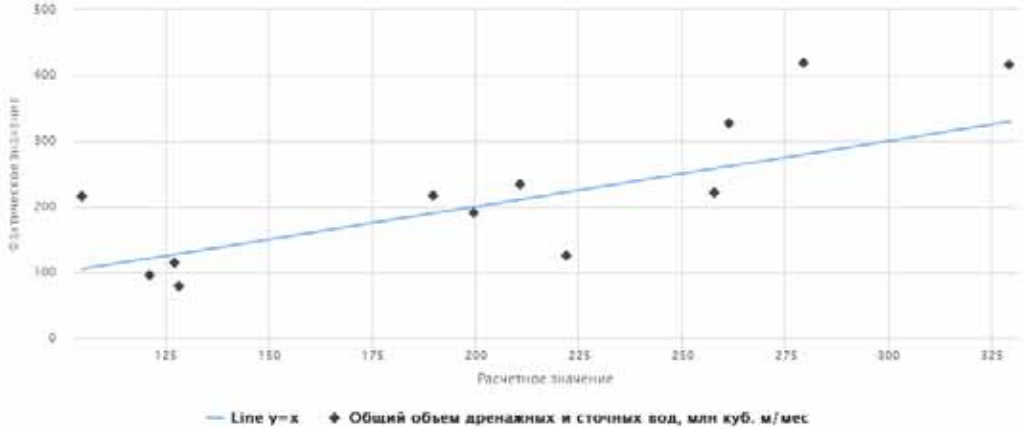
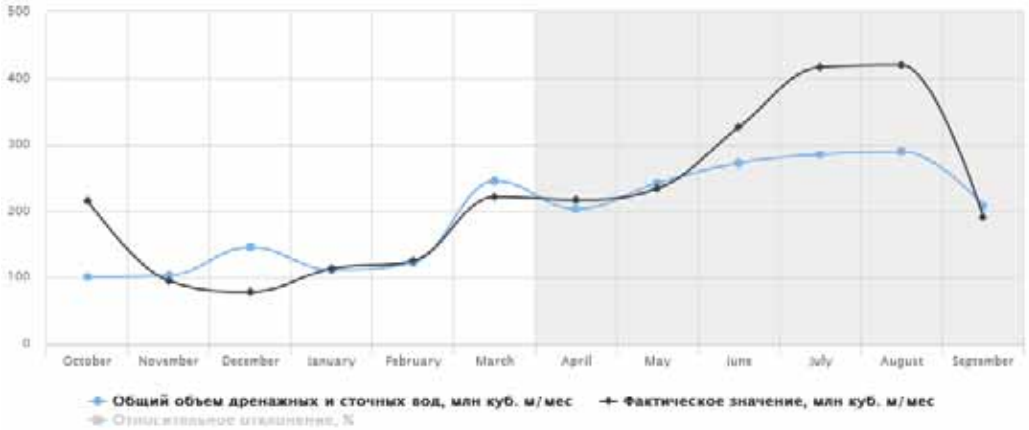
October
November
December
January
February
March
April
May
June
July
August
September
Общий объем дренажных и сточных вод, млн куб. м/мес
Фактическое значение, млн куб. м/мес
Относительное отклонение, %


500
400
300
200
100
0
125
150
175
200
225
250
275
300
325
Расчетное значение
Line y=x
Общий объем дренажных и сточных вод, млн куб. м/мес

2014


500
400
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100
0
October
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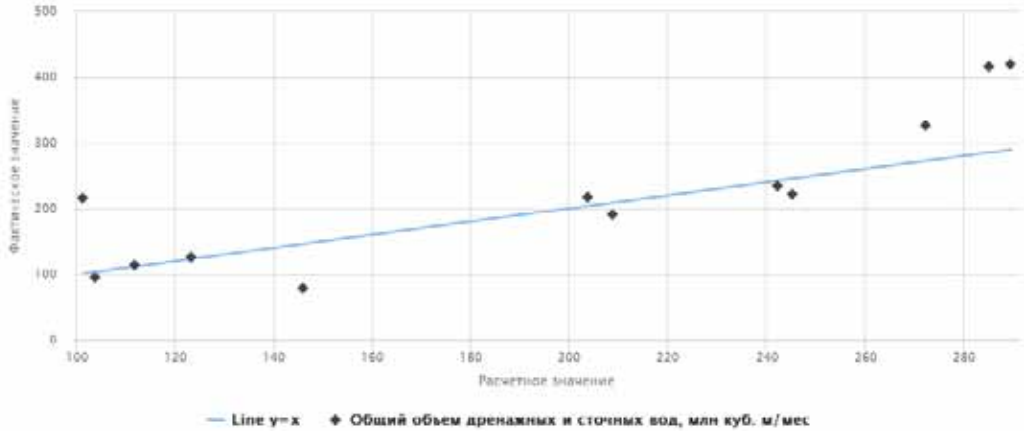
August
September
Общий объем дренажных и сточных вод, млн куб. м/мес
Фактическое значение, млн куб. м/мес
Относительное отклонение, %


500
400
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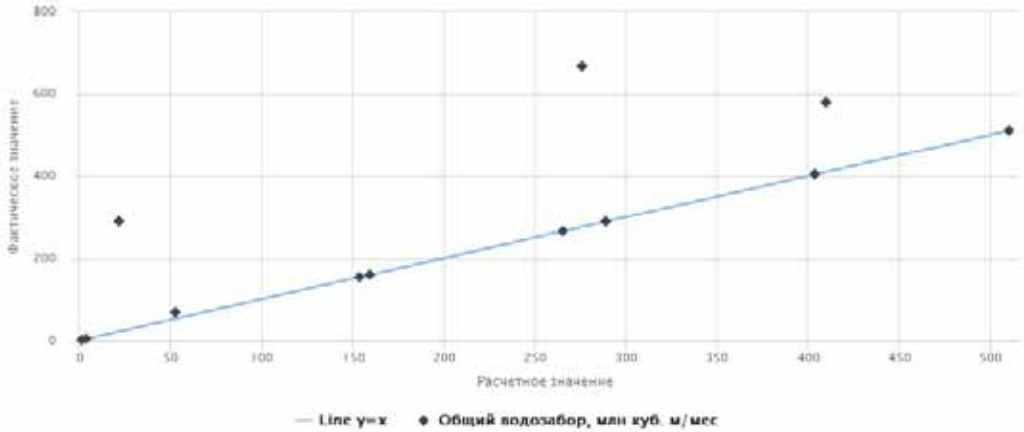
100
120
140
160
180
200
220
240
260
280
Расчетное значение
Line y=x
Общий объем дренажных и сточных вод, млн куб. м/мес

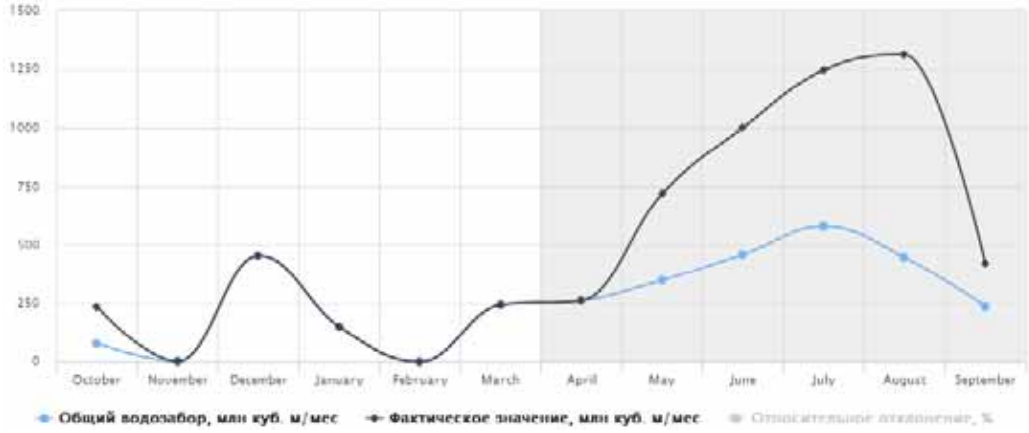
Planning zone: Northern Karakalpakstan

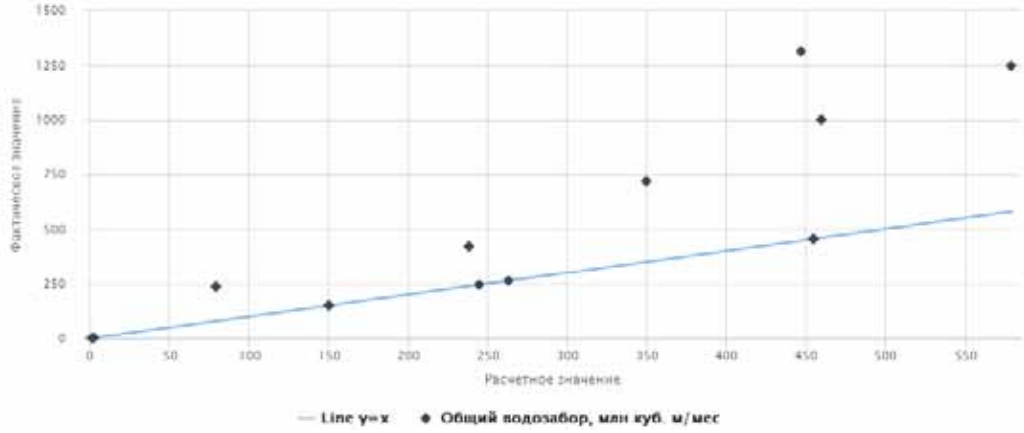
Indicator: Total water intake

Year: 2011



2012





2013


1250
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October
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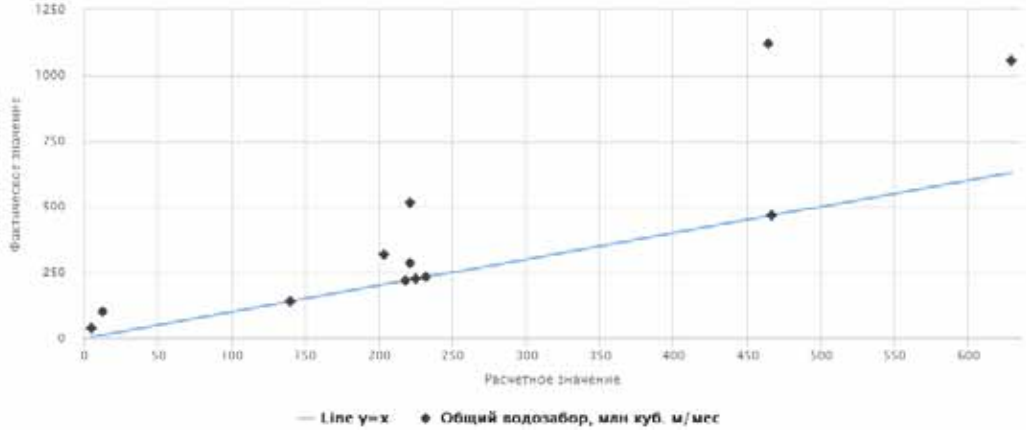
August
September
Общий водозабор, млн куб. м/мес
Фактическое значение, млн куб. м/мес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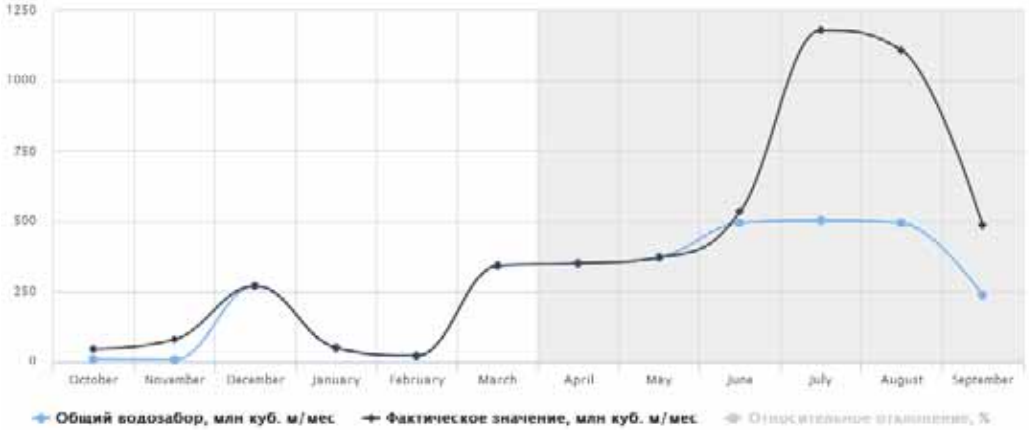
Фактическое значение
Расчетное значение
Line y=x
Общий водозабор, млн куб. м/мес

2014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October
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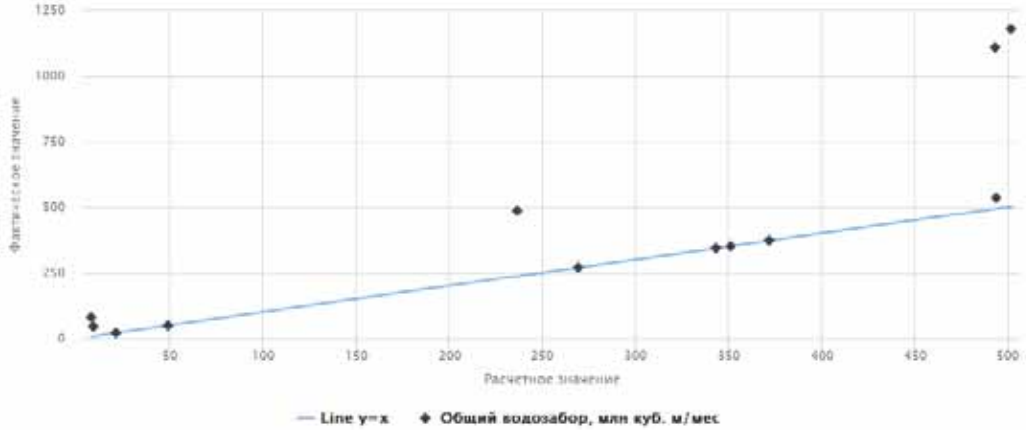
Общий водозабор, млн куб. м/мес
Фактическое значение, млн куб. м/мес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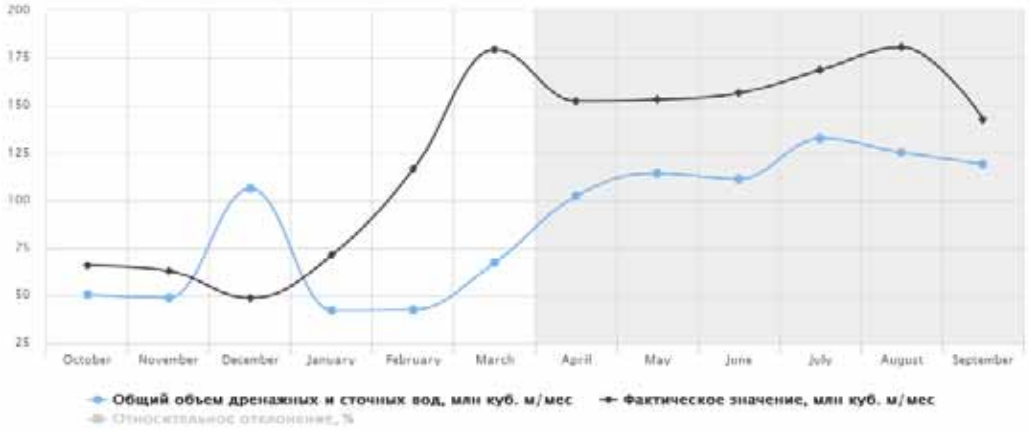
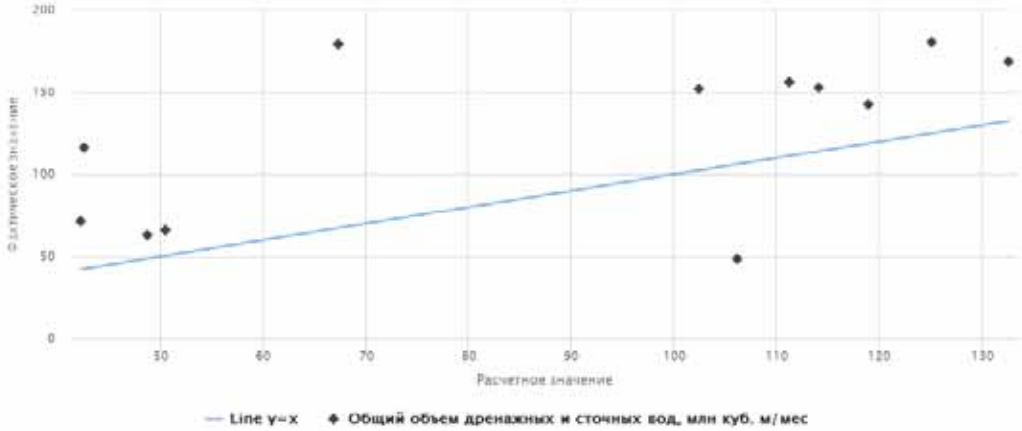
500
Фактическое значение
Расчетное значение
Line y=x
Общий водозабор, млн куб. м/мес

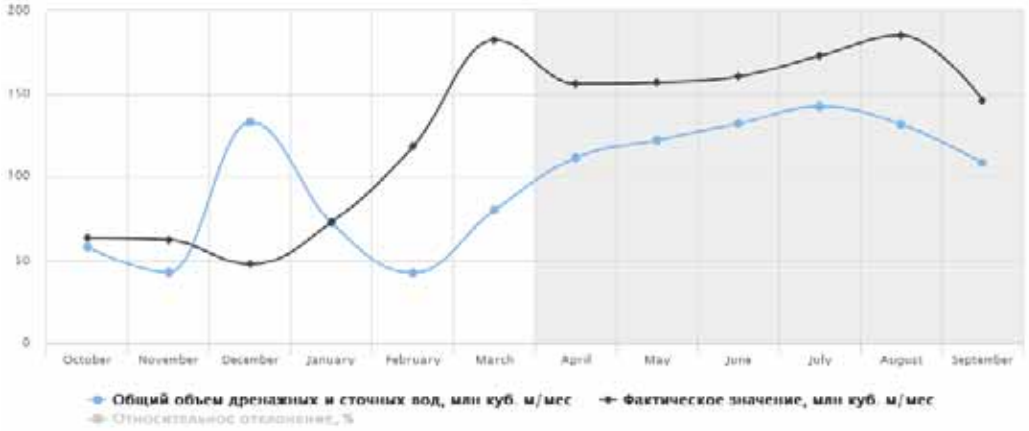
Indicator: Total drainage water and wastewater

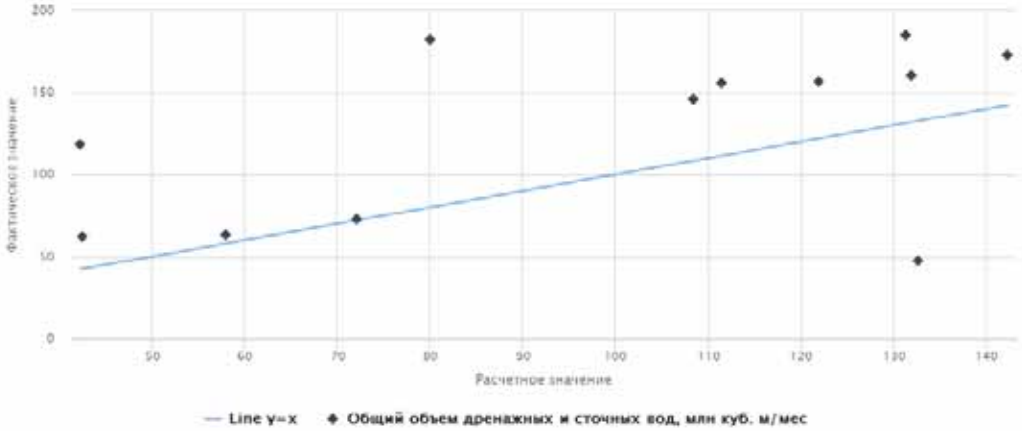
Year: 2011



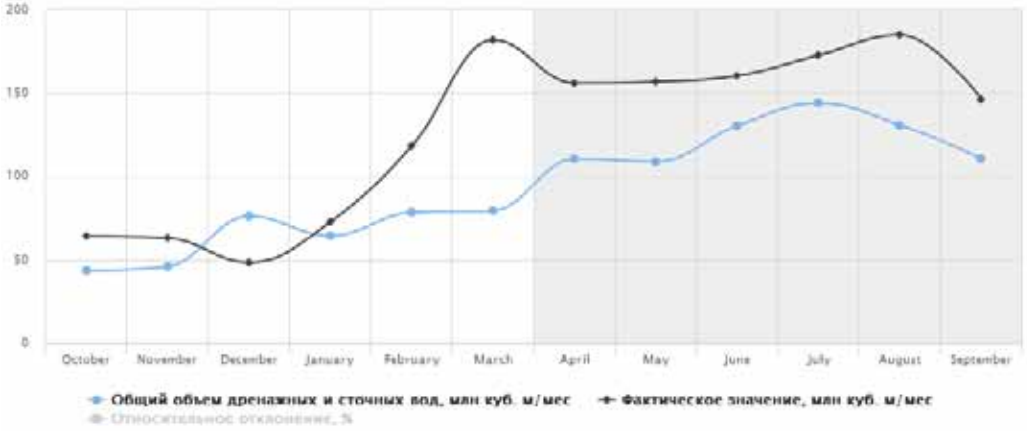


2012





2013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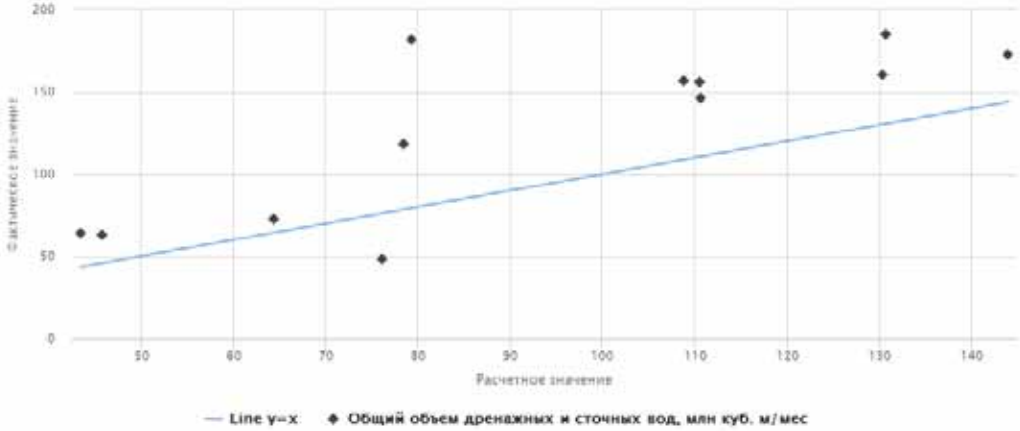
September
Общий объем дренажных и сточных вод, млн куб. м/мес
Фактическое значение, млн куб. м/мес
Относительное отклонение, %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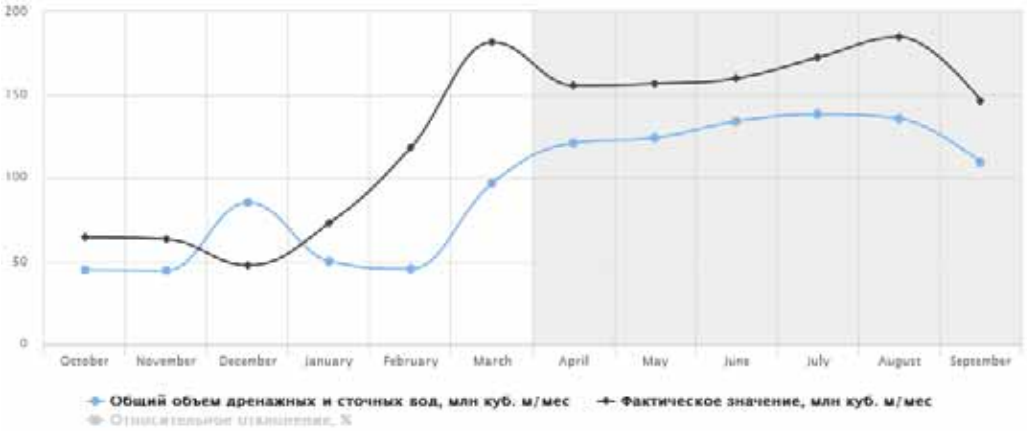
100
110
120
130
140
Расчетное значение
Line y=x
Общий объем дренажных и сточных вод, млн куб. м/мес

2014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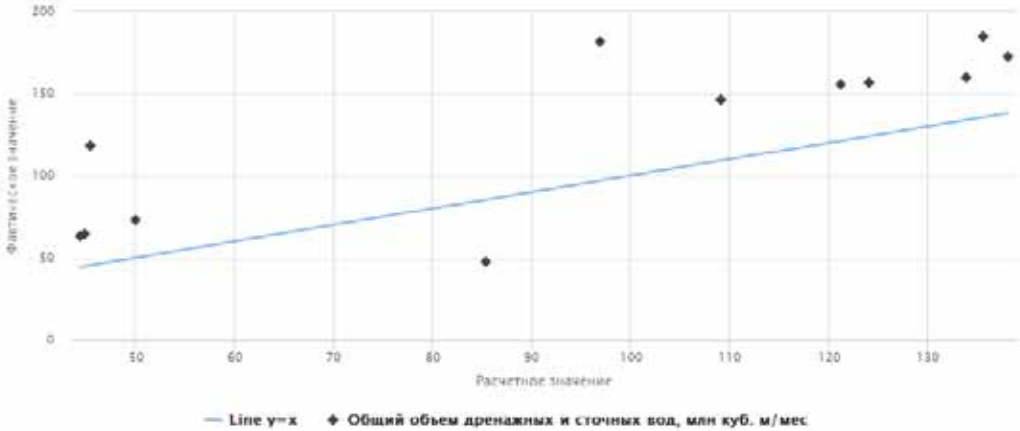
Общий объем дренажных и сточных вод, млн куб. м/мес
Фактическое значение, млн куб. м/мес
Относительное отклонение, %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100
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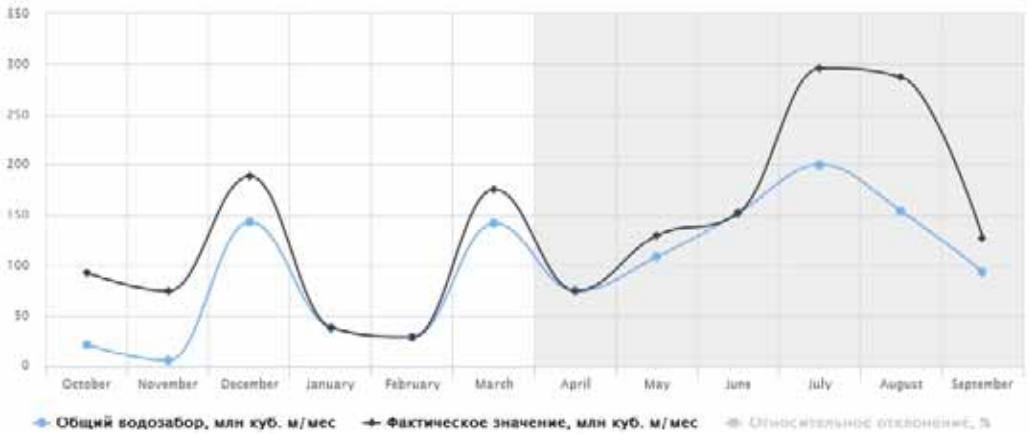
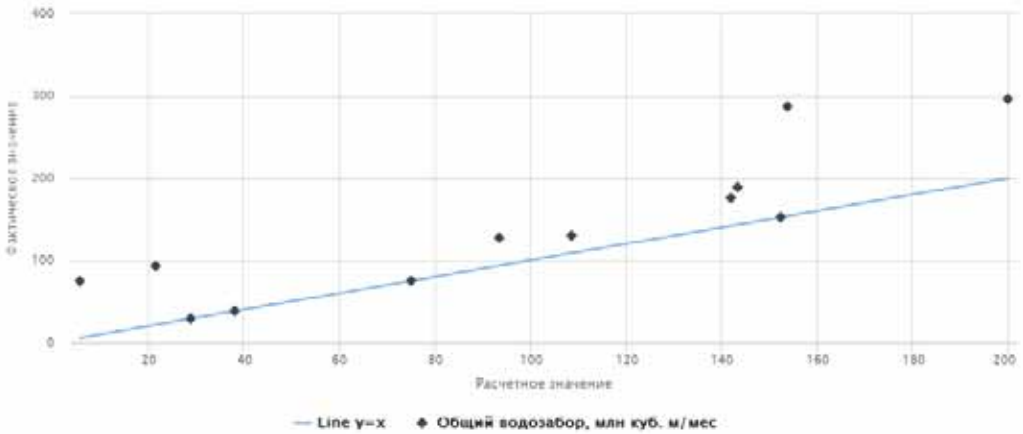
130
Расчетное значение
Line y=x
Общий объем дренажных и сточных вод, млн куб. м/мес

Planning zone: Southern Karakalpakstan

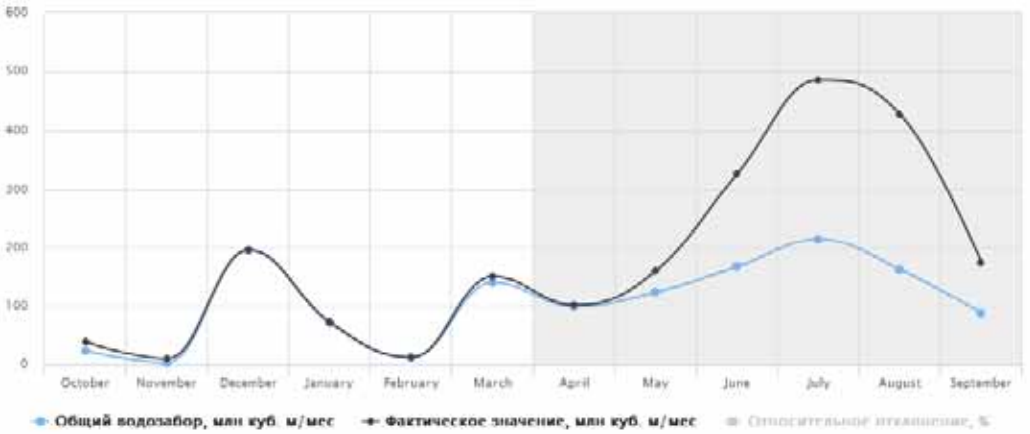
Indicator: Total water intake

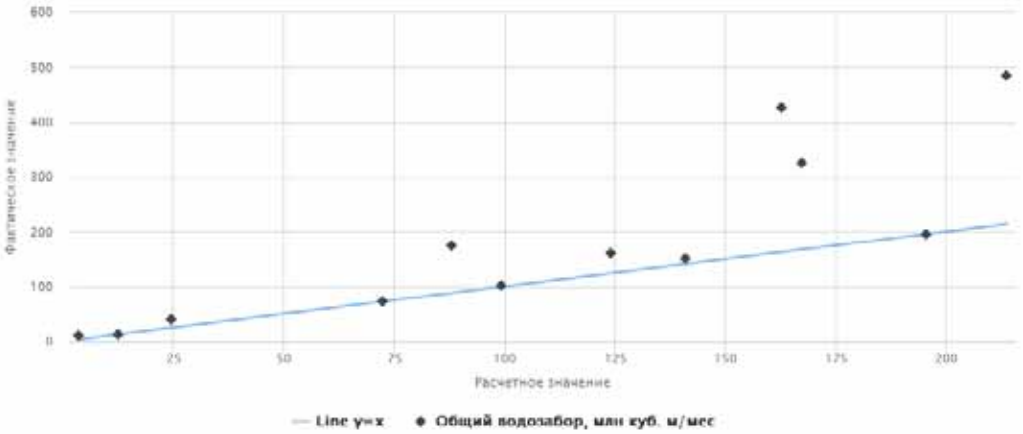
Year: 2011



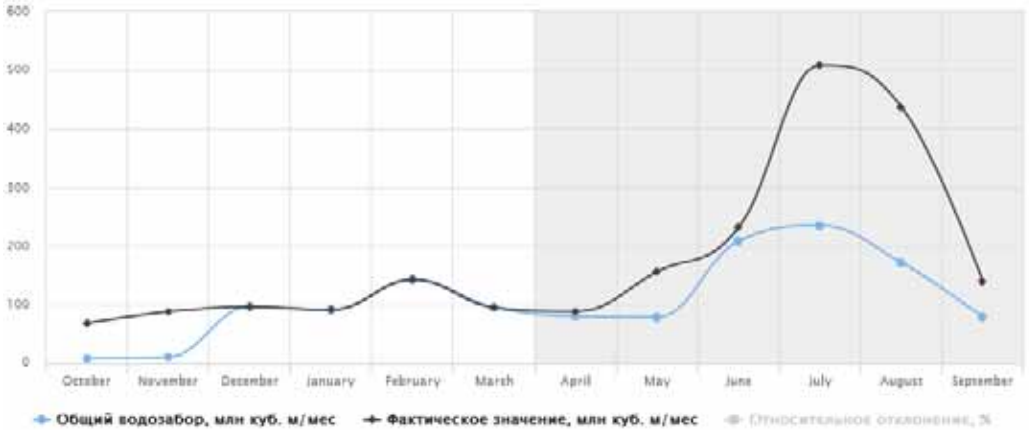


2012





2013


600
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October
November
December
January
February
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April
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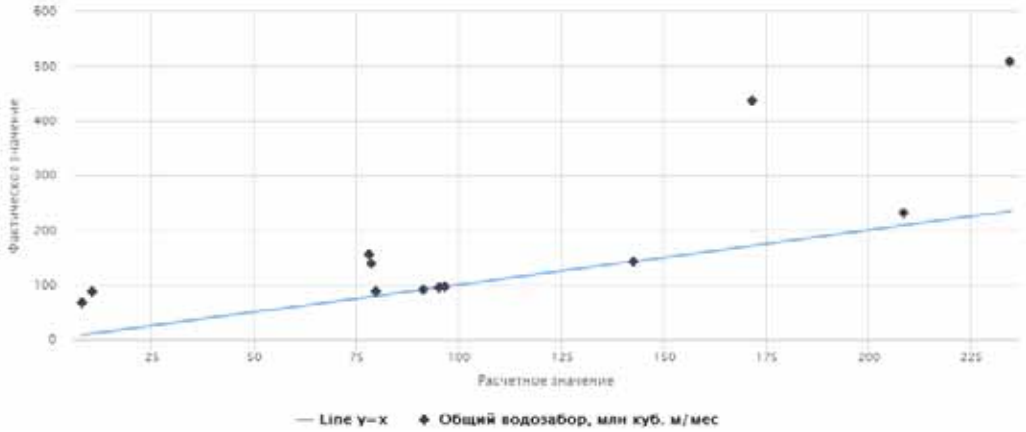
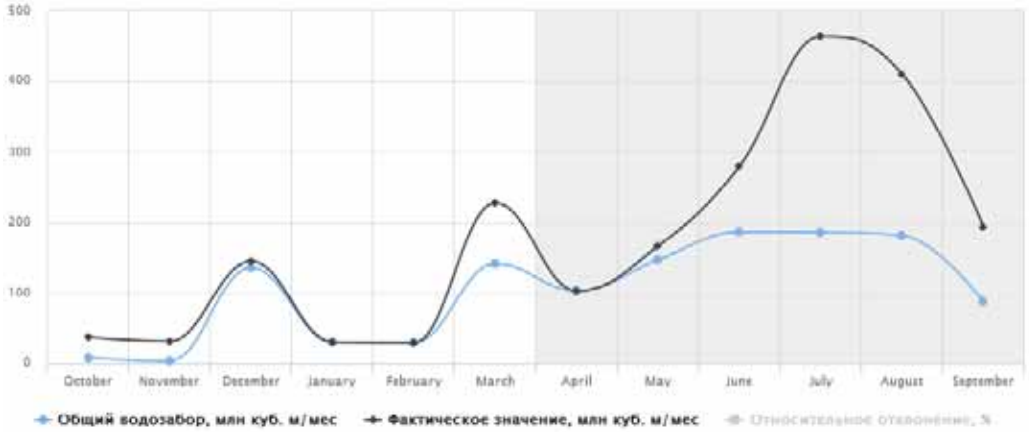
June
July
August
September
Общий водозабор, млн куб. м/мес
Фактическое значение, млн куб. м/мес


600
500
400
300
200
100
0
25
50
75
100
125
150
175
200
225
Расчетное значение
Line y=x
Общий водозабор, млн куб. м/мес

2014


500
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October
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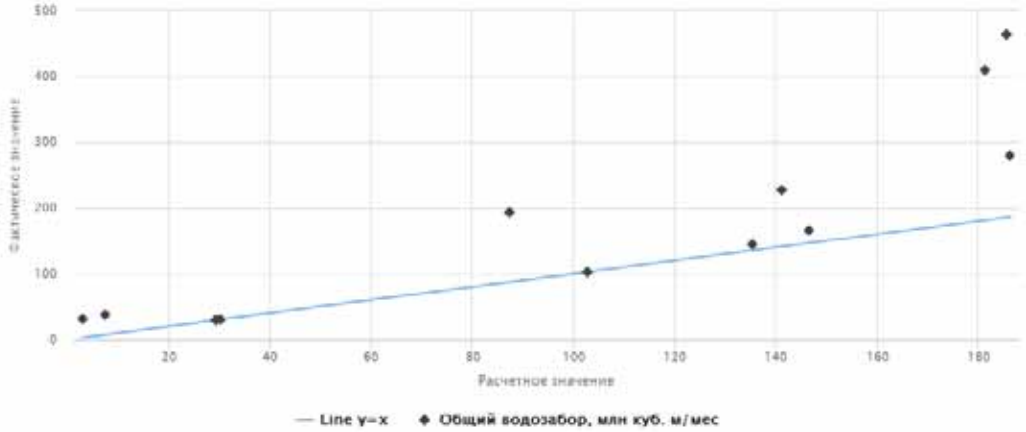
July
August
September
Общий водозабор, млн куб. м/мес
Фактическое значение, млн куб. м/мес


500
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100
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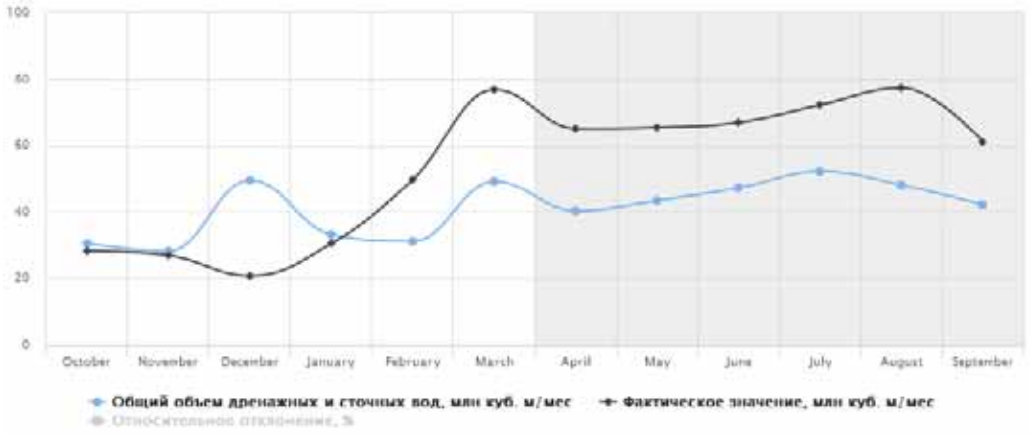
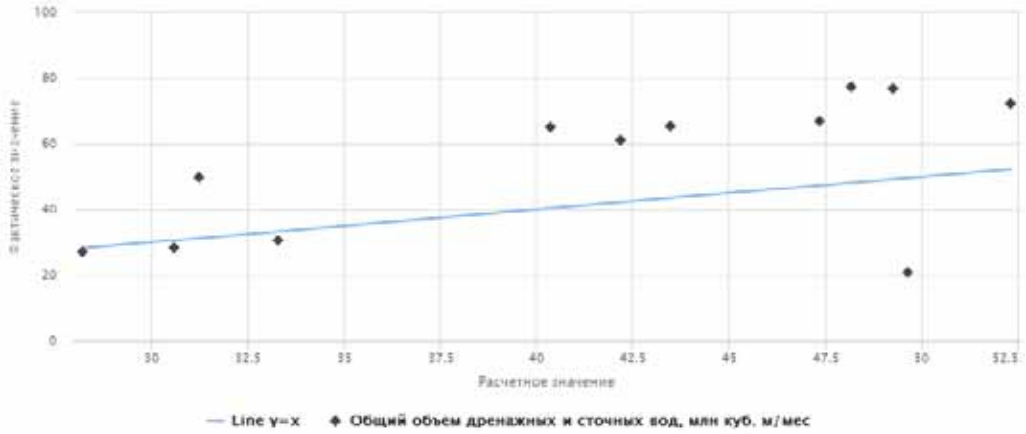
60
80
100
120
140
160
180
Расчетное значение
Line y=x
Общий водозабор, млн куб. м/мес

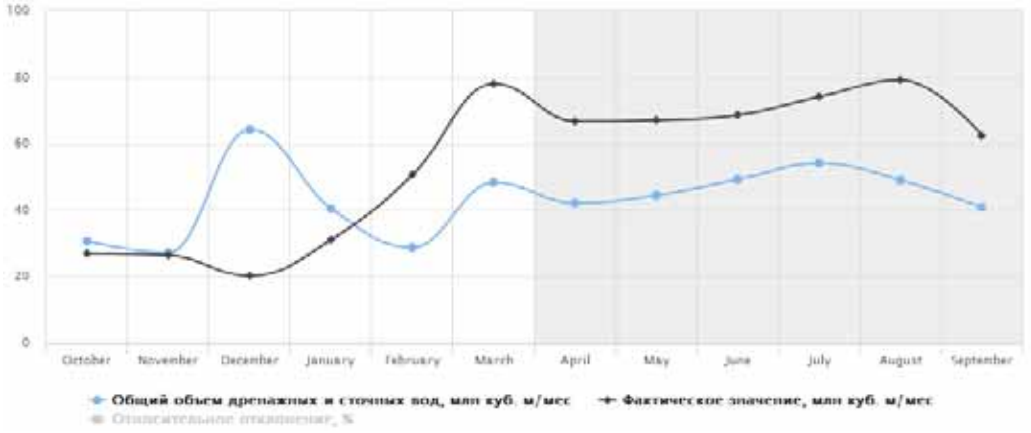
Indicator: Total drainage water and wastewater

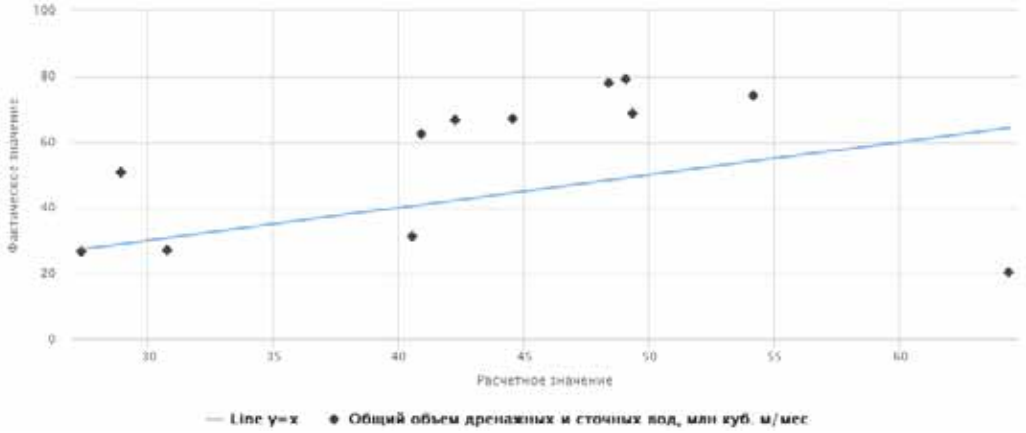
Year: 2011



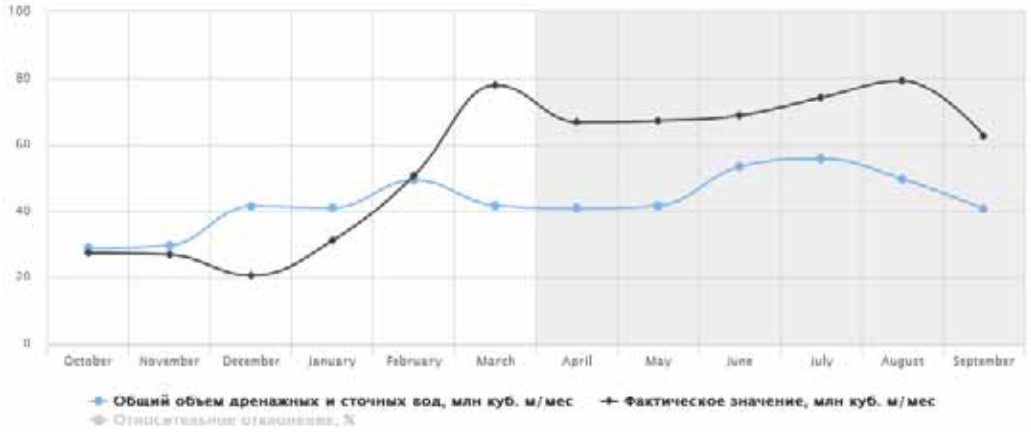


2012





2013


100
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October
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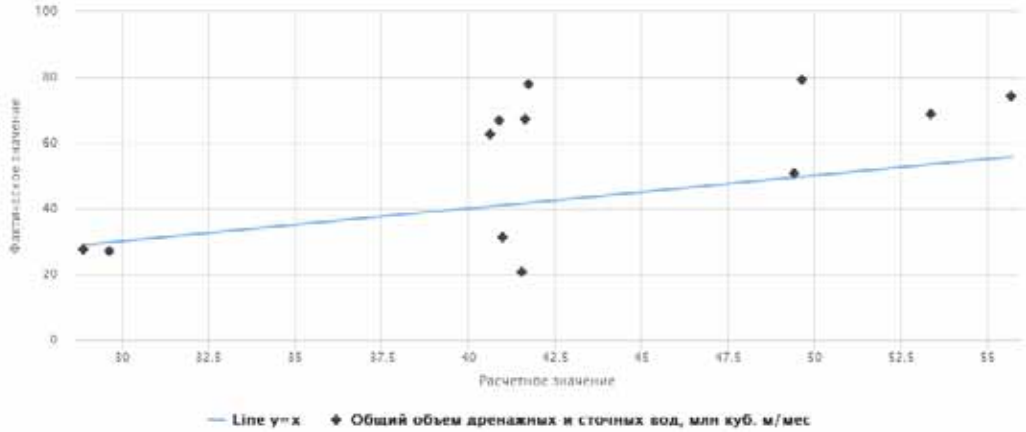
July
August
September
Общий объем дренажных и сточных вод, млн куб. м/мес
Фактическое значение, млн куб. м/мес


100
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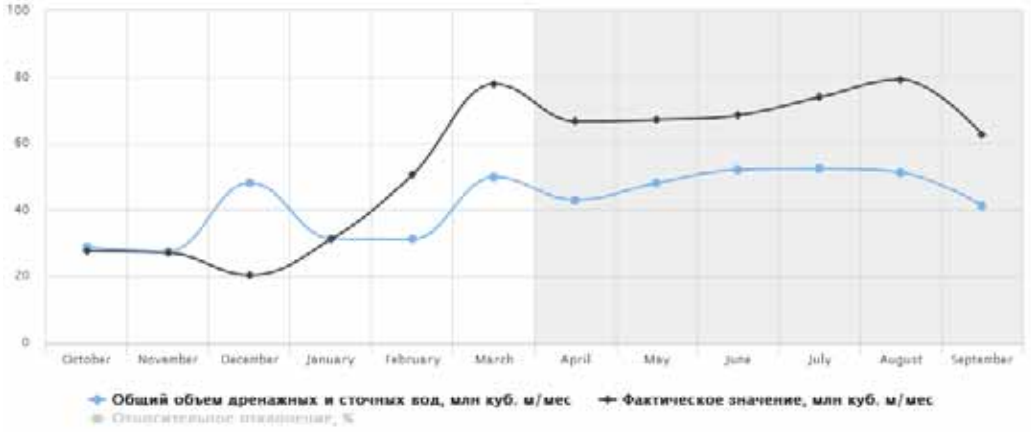
60
40
20
0
30
32.5
35
37.5
40
42.5
45
47.5
50
52.5
55
Расчетное значение
Line y=x
Общий объем дренажных и сточных вод, млн куб. м/мес

2014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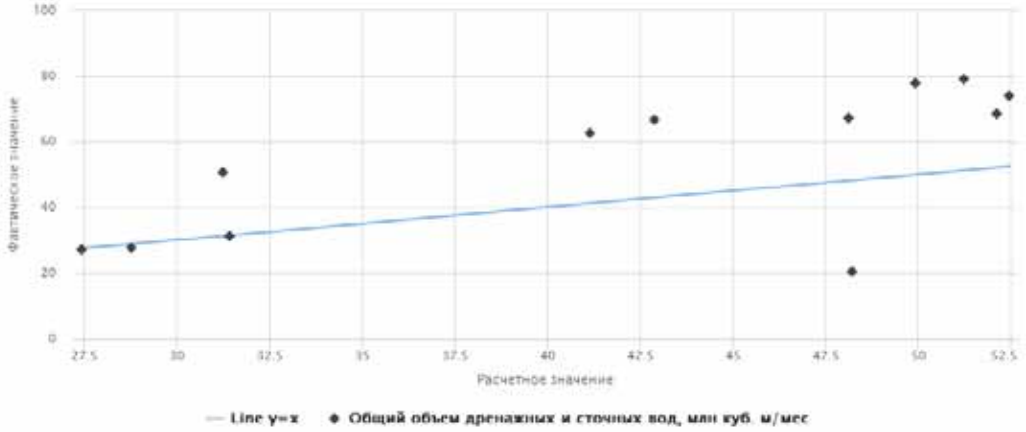
September
Общий объем дренажных и сточных вод, млн куб. м/мес
Фактическое значение, млн куб. м/мес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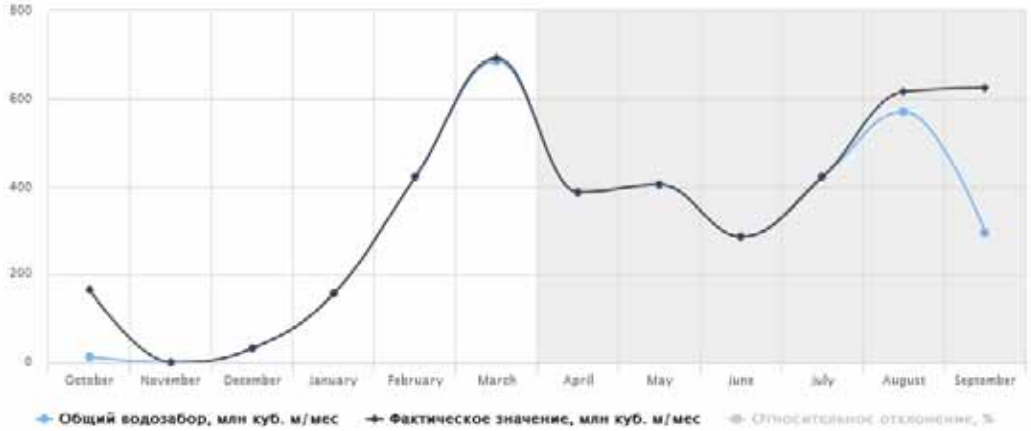
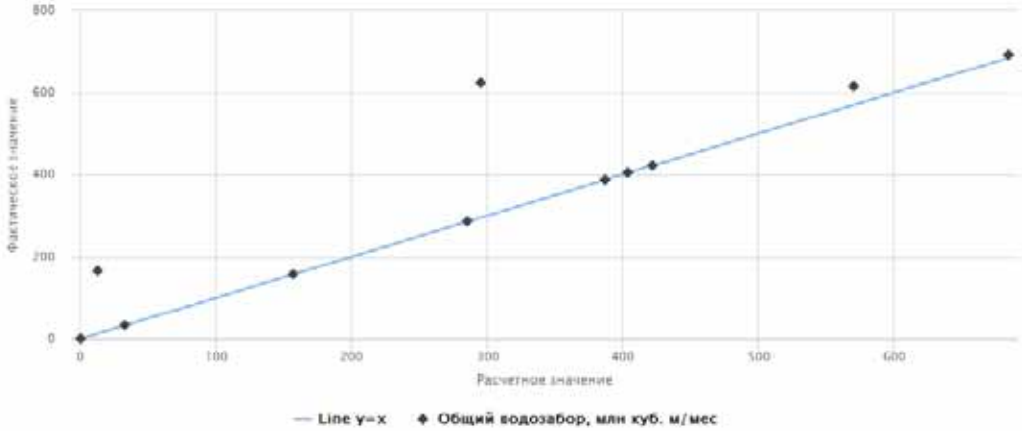
32.5
35
37.5
40
42.5
45
47.5
50
52.5
Расчетное значение
Line y=x
Общий объем дренажных и сточных вод, млн куб. м/мес

Зона планирования: Дашогузская

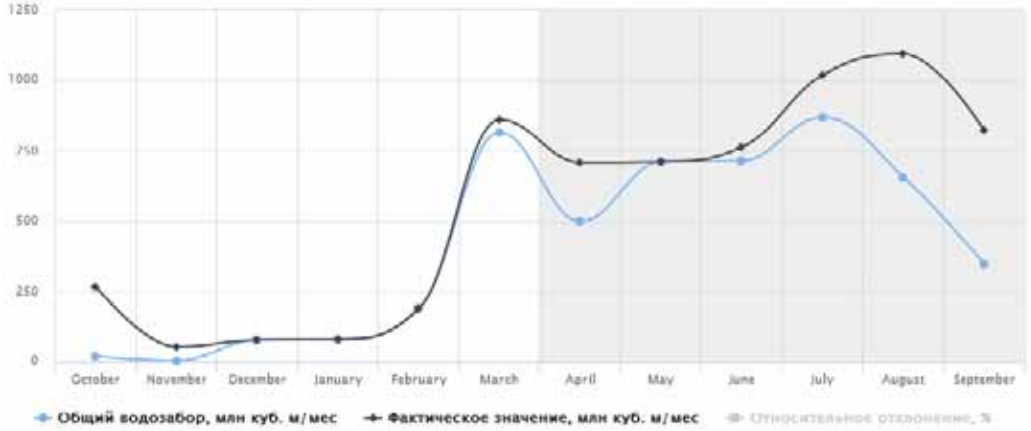
Индикатор: Общий водозабор

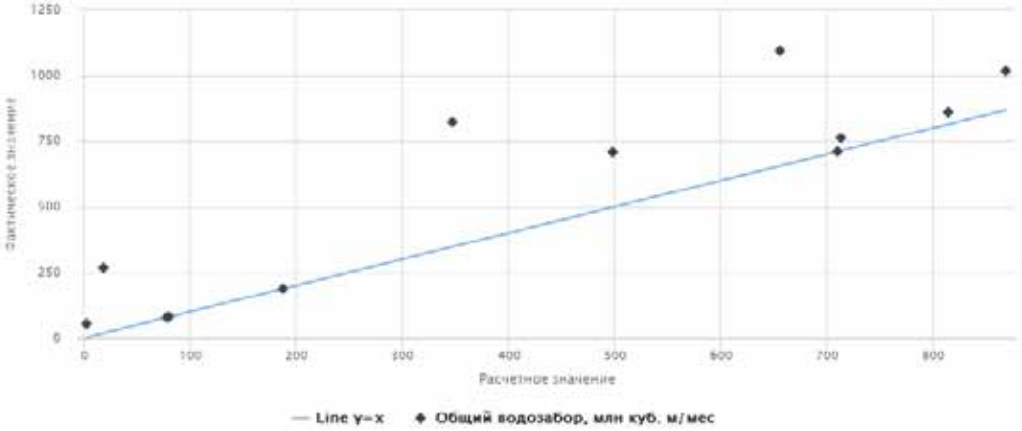
Год: 2011



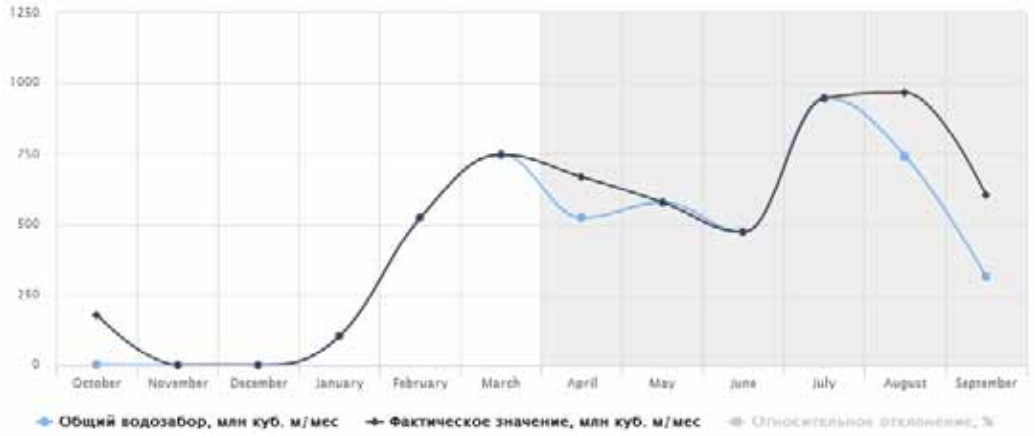


2012





2013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October
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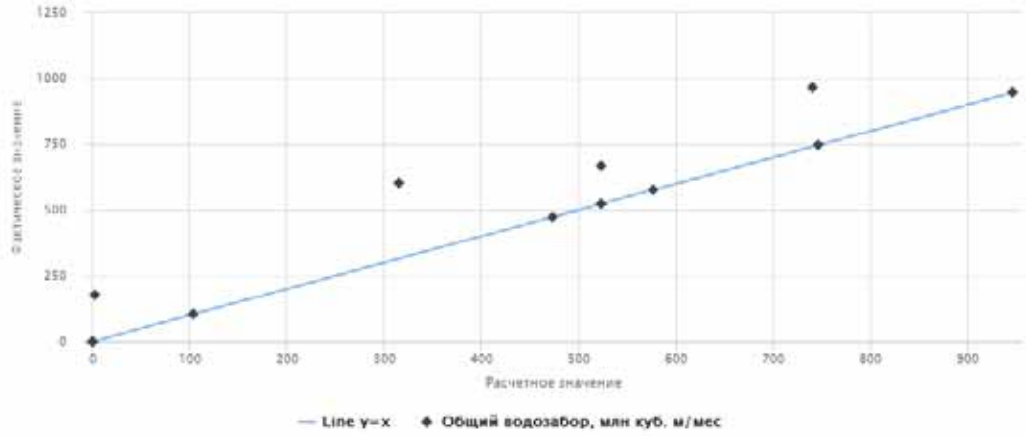
Общий водозабор, млн куб. м/мес
Фактическое значение, млн куб. м/мес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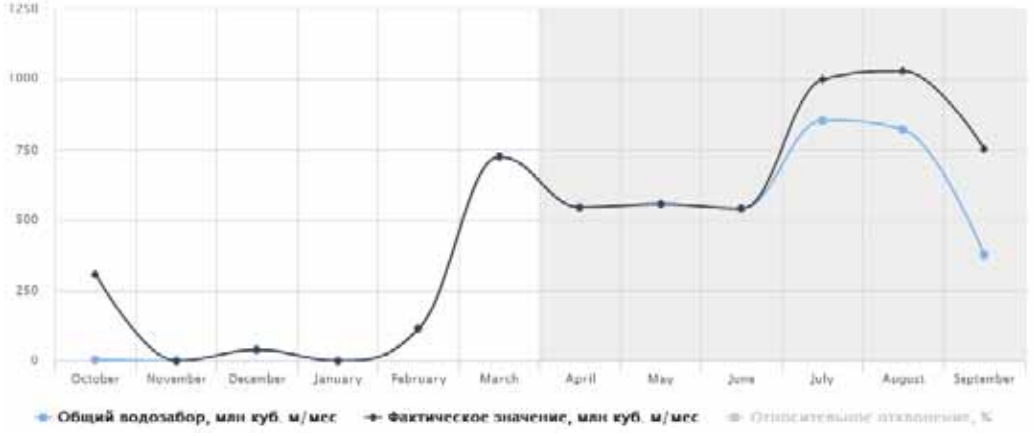
Расчетное значение
Line y=x
Общий водозабор, млн куб. м/мес

2014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October
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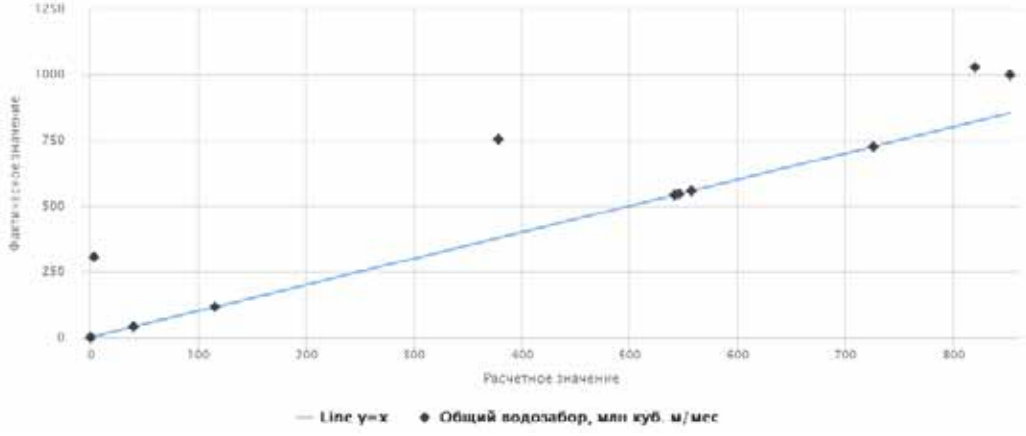
Общий водозабор, млн куб. м/мес
Фактическое значение, млн куб. м/мес


1250
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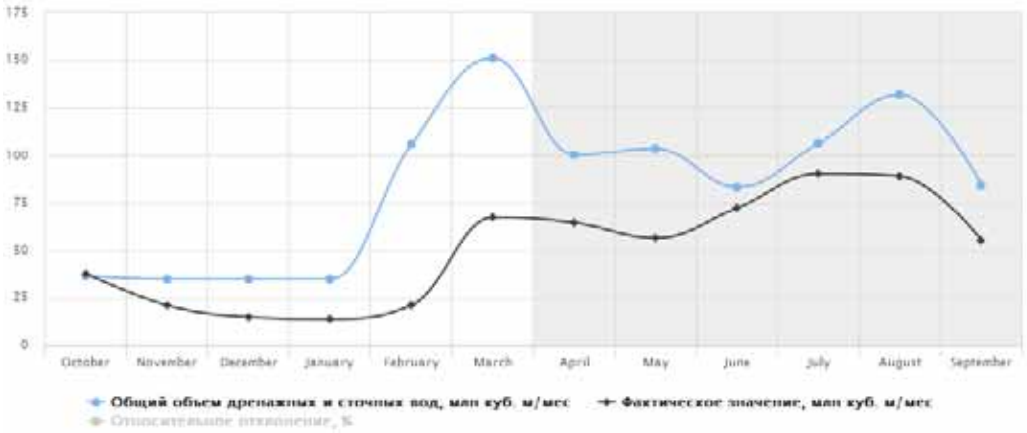
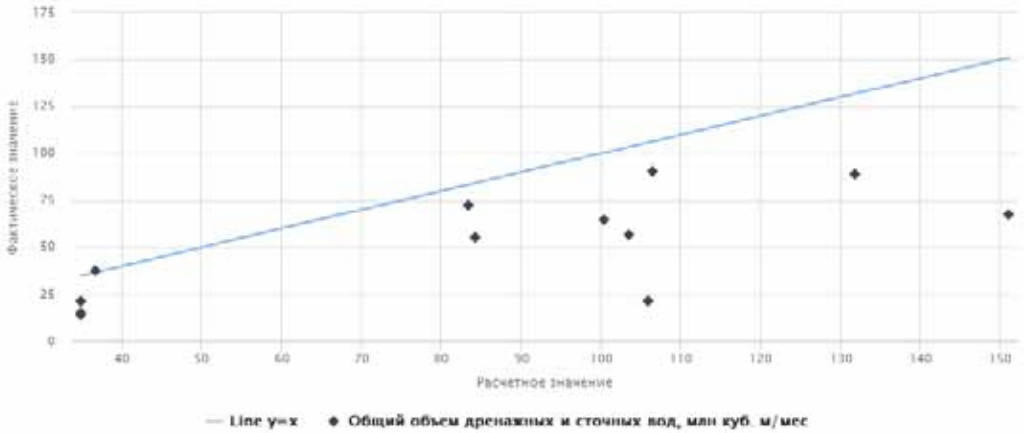
700
800
Расчетное значение
Line y=x
Общий водозабор, млн куб. м/мес

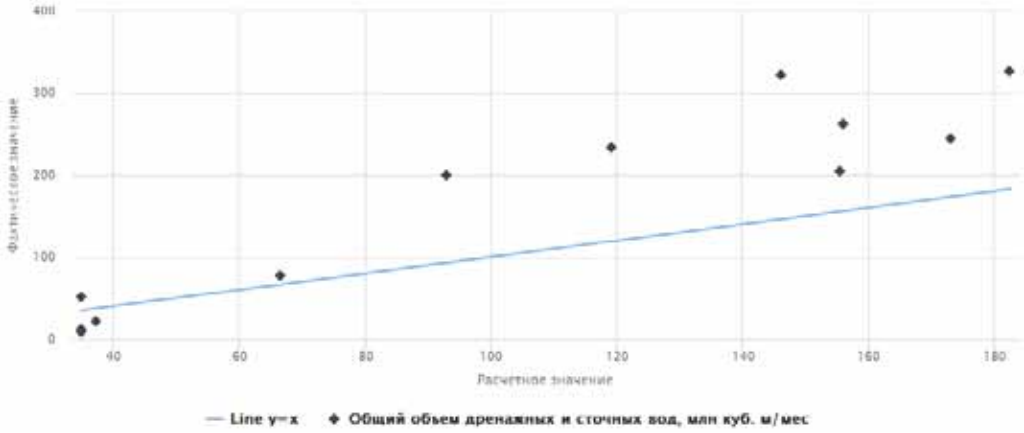
Индикатор: Общий объем дренажных и сточных вод

Год: 2011

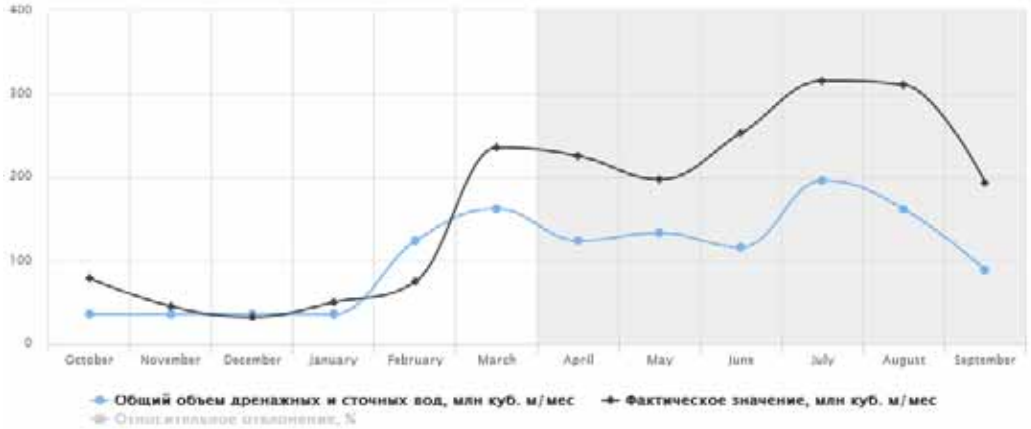




2012



2013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October
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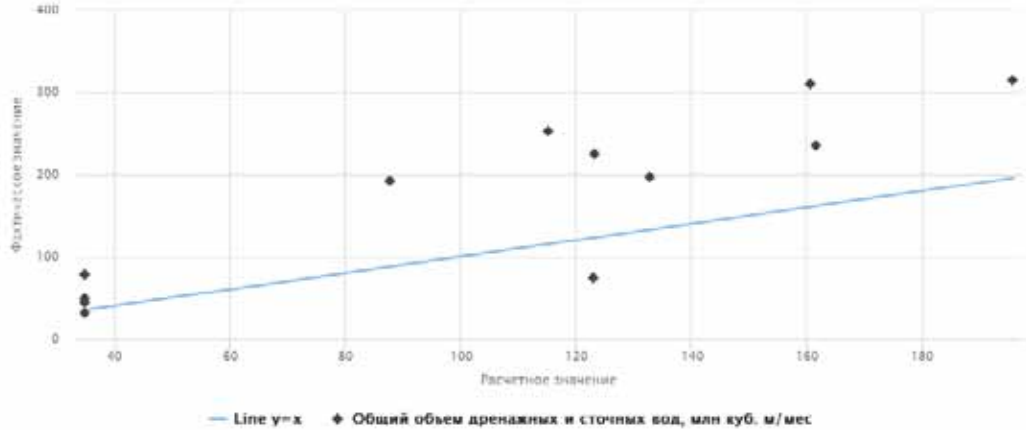
August
September
Общий объем дренажных и сточных вод, млн куб. м/мес
Фактическое значение, млн куб. м/мес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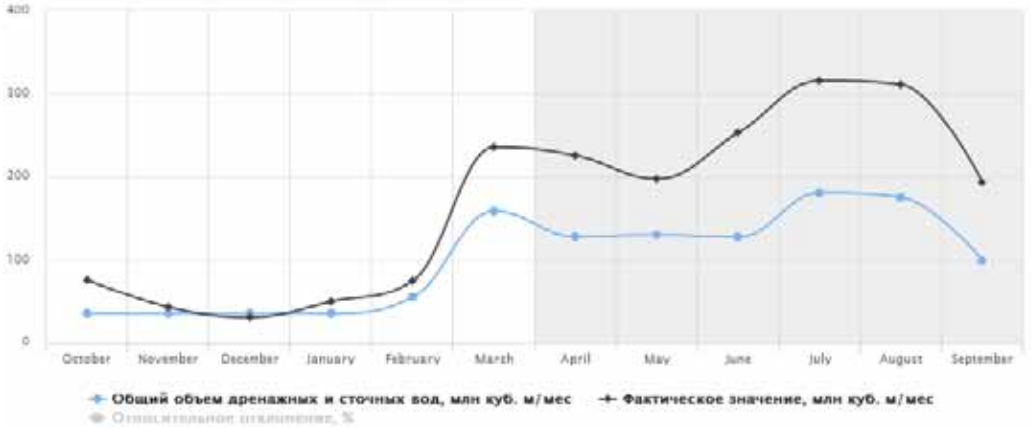
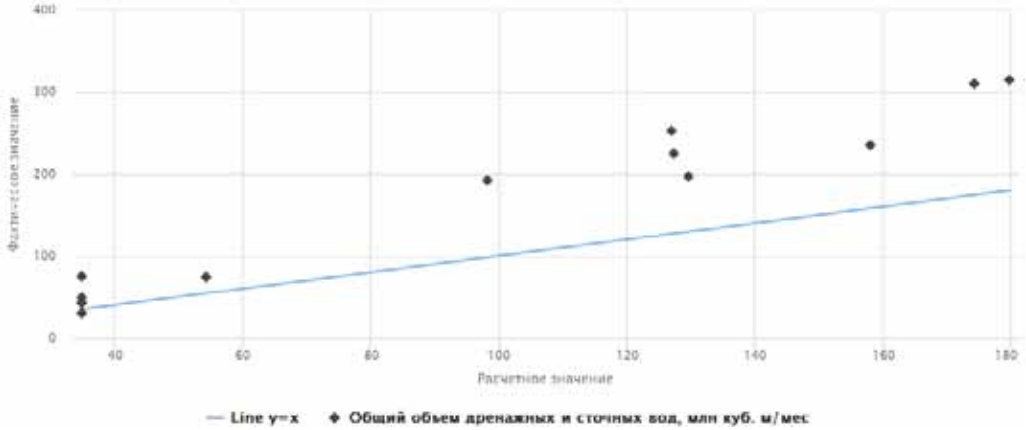
80
100
120
140
160
180
Расчетное значение
Line y=x
Общий объем дренажных и сточных вод, млн куб. м/мес

2014


400
300
200
100
0
October
November
December
January
February
March
April
May
June
July
August
September
Общий объем дренажных и сточных вод, млн куб. м/мес
Фактическое значение, млн куб. м/мес


400
300
200
100
0
40
60
80
100
120
140
160
180
Расчетное значение
Line y=x
Общий объем дренажных и сточных вод, млн куб. м/мес