WATER QUALITY MEMORANDUM

Utah Coal Regulatory Program

DF

February 25, 2008

TO: Internal File

THRU: Daron Haddock, Permit Supervisor

FROM: Dana Dean, P.E., Senior Reclamation Hydrologist

RE: 2007 Third Quarter Water Monitoring, Genwal Resources, Inc., Crandall Canyon Mine, Permit & Tracking #2731

The Crandall Canyon Mine was conducting continuous miner retreat mining in barrier pillars along the mains during the second quarter of 2007. Water monitoring requirements can be found in Section 7.31.21, and 7.31.22 of the MRP, especially Tables 7-4, 7-5, 7-8, 7-9, and 7-10.

1. Was data submitted for all of the MRP required sites? YES ☒ NO ☐

Springs

The MRP requires the Permittee to monitor 24 springs each quarter. Some require full laboratory analysis according to Table 7-4, while others simply require field measurements.

The Permittee submitted all required samples for the spring sites.

Streams

The MRP requires the Permittee to monitor12 streams each quarter. Some require full laboratory analysis according to Table 7-8, while others simply require field measurements.

The Permittee submitted all required samples for the stream sites.

Wells

The MRP requires the Permittee to monitor 7 wells during the second quarter. All require full laboratory analysis according to Table 7-4.

The Permittee submitted all required samples for the wells. Two were dry, and five were in-mine wells located in now inaccessible areas of the mine.

UPDES

The UPDES Permit/MRP require monthly monitoring of 2 outfalls: 001,sed. pond

discharge, and 002, mine water discharge.

The Permittee submitted all required samples for the UPDES sites. Outfall 001 reported no flow.

2. Were all required parameters reported for each site? YES ☒ NO ☐

3. Were any irregularities found in the data? YES ☒ NO ☐

Site	Paramter	Value	Standard Deviations from Mean	Mean
Horse Canyon Creek	Dissolved Sodium	0.98 mg/L	2.06	8.97 mg/L
Indian Creek	Total Hardness	232.7 mg/L	2.04	258.33 mg/L
Indian Creek	Bicarbonate as $CaCO_3$	237 mg/L	3.34	255.86 mg/L
Indian Creek	Cation/Anion Balance	1.32 %	2.31	1.21 %
LOF-1	Total Hardness	509.57 mg/L	3.06	310.51 mg/L
LOF-1	Dissolved Calcium	108.8 mg/L	2.04	73.58 mg/L
LOF-1	Sulfate	220 mg/L	2.69	75.78 mg/L
LOF-1	Total Dissolved Solids	607 mg/L	2.16	354.72 mg/L
LOF-1	Cation/Anion Balance	5.14 %	2.23	1.89 %
Section 5 Creek	Dissolved Sodium	10.52 mg/L	5.14	7.24 mg/L
UPF-1	Total Dissolved Solids	550 mg/L	2.26	320.04 mg/L
UPF-1	Total Hardness	489.28 mg/L	2.58	287.89 mg/L
UPF-1	Sulfate	215 mg/L	2.04	72.71 mg/L
UPF-1	Total Cations	10.11 meq/L	2.30	6.43 meq/L
LB-12	Water Temperature	11.6 °C	2.21	9.80 °C
SP1-33	Sulfate	32.1 mg/L	2.12	20.11 mg/L
SP2-24	Dissolved Magnesium	17.54 mg/L	2.04	14.33 mg/L
SP-58	Total Dissolved Solids	515 mg/L	2.39	335.68 mg/L
SP-58	Total Hardness	480.33 mg/L	2.83	311.72 mg/L
SP-58	Dissolved Calcium	113.6 mg/L	2.95	85.52 mg/L
SP-58	Sulfate	154 mg/L	2.28	59.09 mg/L
SP-79	Dissolved Calcium	91 mg/L	2.67	81.32 mg/L
SP-79	Dissolved Magnesium	17.28 mg/L	2.94	15.42 mg/L
UT-0024368-002 – July 16	Specific Conductivity	950 µmhos/cm	2.45	755.46 µmhos/cm
UT-0024368-002 – July 16	Water Temperature	18.9 °C	3.23	11.96 °C
UT-0024368-002 – Aug 30	Water Temperature	17.1 °C	2.39	11.96 °C

There is no trend in bicarbonate as $CaCO_3$ at Indian Creek ($R^2 = 0.1097$). There are only nine samples in the population, and this, the lowest recorded concentration, is only 26 mg/L less than the highest concentration of 263 mg/L.

The cation/anion balance at Indian Creek and LOF-1 is not of concern, since it is within the expected range (<5%).

Dissolved calcium has a strong upward trend at LOF-1 and SP-58 (R^2= 0.7014, and 0.8264); and no trend at SP-79. The concentration at LOF-1 has come down since last quarter, but is is the highest concentration ever recorded at SP-58. There are no criteria for dissolved calcium, but it does contribute to water hardness. The total hardness at LOF-1 and SP-58 also has a somewhat strong upward trend (R^2 = 0.6054 and 0.6682). There is no trend in hardness at Indian Creek. This is the highest total hardness ever recorded at LOF-1 and SP-58. However, the hardness at these sites has always fluctuated between the hard (150-300 mg/l) and very hard (>300 mg/L) classifications, and continues to be in that range. The trend in total hardness is actually stronger at UPF-1, upstream of, and unaffected by the mine (R2 = 0.7768).

There is no trend in the dissolved magnesium at SP2-24 (R^2 = 0.1217) or SP-79 (R^2 = 0.0164).

There is no trend in dissolved sodium at Horse Canyon Creek (R^2 = 0.0176), and there is a weak upward trend at Section 5 Creek (0.3898). There are only eight samples in the population at Section 5 Creek. There is no water quality standard for sodium, but it does increase salinity. The salinity at Section 5 Creek (including Mg, Ca, CO_3, K, SO_4, HCO_3, Na, and Cl, as NaCl equivalent), based on just eight samples, has only a very weak upward trend (R^2 = 0.2177). The range in sodium is just 4.14 mg/L, and for salinity, it is just 63 mg/L.

There is a weak upward trend in the specific conductivity at Outfall 002 (R^2 = 0.321), with no real correlation to flow. There is no standard for specific conductivity, but it is closely related to total dissolved solids (TDS). The total dissolved solids concentration at Outfall 002 has no trend and is within the expected range.

There is a very strong upward trend in sulfate at LOF-1 (R^2 = 0.8134), a strong upward trend at UPF-1 (R^2 = 0.705), a fairly strong upward trend at SP1-33 (R^2 = 0.6112), and a weak upward trend at SP-58 (R^2 = 0.4707). Sulfate is not toxic to plants or animals (even at very high concentration), but has a cathartic effect on humans in concentrations over 500 mg/L. For this reason, the EPA has set the secondary standard as 250 mg/L. The sulfate at these sites has been less than 250 mg/L, except once at UPF-1, and is down from last quarter at all but SP-58.

There is a fairly strong upward trend in total cations at UPF-1 (R^2 = 0.6514), with no correlation to flow. The cation/anion balance is within the 5% recommended limit at UPF-1. The number of cations also relates to the total dissolved solids in the water sample.

There is a fairly strong upward trend in TDS at UPF-01 (R^2= 0.6112), and SP-58 (R^2= 0.6333), with no correlation to flow. Both of these sites are located above the minesite, in areas

unaffected by mining. As expected, because of the influence of UPF-1, the TDS at LOF-1 also has a fairly strong upward trend ($R^2 = 0.662$).

Many routine reliability checks fell outside of standard values:

Site	Reliability Check	Value Should Be...	Value is...
BCF	Conductivity/Cations	>90 & < 110	80
BCF	K/(Na + K)	< 20%	54%
BCF	Mg/(Ca + Mg)	< 40 %	59%
BCF	Na/(Na + Cl)	> 50%	31%
Horse Canyon Creek	Conductivity/Cations	>90 & < 110	82
Horse Canyon Creek	K/(Na + K)	< 20%	90%
Horse Canyon Creek	Mg/(Ca + Mg)	< 40 %	55%
Horse Canyon Creek	Na/(Na + Cl)	> 50%	5%
Indian Creek	Conductivity/Cations	>90 & < 110	89
Indian Creek	K/(Na + K)	< 20%	41%
Indian Creek	Na/(Na + Cl)	> 50%	35%
Little Bear Creek	Conductivity/Cations	>90 & < 110	78
Little Bear Creek	K/(Na + K)	< 20%	39%
Little Bear Creek	Mg/(Ca + Mg)	< 40 %	57%
Little Bear Creek	Na/(Na + Cl)	> 50%	28%
LOF-1	Cation/Anion Balance	< 5%	5.14%
LOF-1	Conductivity/Cations	>90 & < 110	76
LOF-1	K/(Na + K)	< 20%	28%
LOF-1	Mg/(Ca + Mg)	< 40 %	47%
LOF-1	Na/(Na + Cl)	> 50%	22%
Section 4 Creek	Conductivity/Cations	>90 & < 110	77
Section 4 Creek	K/(Na + K)	< 20%	43%
Section 4 Creek	Mg/(Ca + Mg)	< 40 %	63%
Section 4 Creek	Na/(Na + Cl)	> 50%	27%
Section 5 Creek	Conductivity/Cations	>90 & < 110	79
Section 5 Creek	K/(Na + K)	< 20%	34%
Section 5 Creek	Mg/(Ca + Mg)	< 40 %	64%
Section 5 Creek	Na/(Na + Cl)	> 50%	31%
UPF-1	Cation/Anion Balance	< 5%	5.09%
UPF-1	Conductivity/Cations	>90 & < 110	75
UPF-1	K/(Na + K)	< 20%	47%
UPF-1	Mg/(Ca + Mg)	< 40 %	46%
UPF-1	Na/(Na + Cl)	> 50%	37%

LB-5A	Conductivity/Cations	>90 & < 110	86
LB-5A	K/(Na + K)	< 20%	37%
LB-5A	Mg/(Ca + Mg)	< 40 %	55%
LB-5A	Na/(Na + Cl)	> 50%	31%
Little Bear Spring	Conductivity/Cations	>90 & < 110	81
Little Bear Spring	K/(Na + K)	< 20%	39%
Little Bear Spring	Mg/(Ca + Mg)	< 40 %	48%
Little Bear Spring	Na/(Na + Cl)	> 50%	36%
SP1-33	Conductivity/Cations	>90 & < 110	90
SP1-33	K/(Na + K)	< 20%	42%
SP1-33	Na/(Na + Cl)	> 50%	40%
SP1-9	Conductivity/Cations	>90 & < 110	82
SP1-9	K/(Na + K)	< 20%	58%
SP1-9	Na/(Na + Cl)	> 50%	38%
SP2-24	Cation/Anion Balance	< 5%	11.33%
SP2-24	Conductivity/Cations	>90 & < 110	87
SP2-24	K/(Na + K)	< 20%	86%
SP2-24	Na/(Na + Cl)	> 50%	13%
SP2-9	Cation/Anion Balance	< 5%	5.04%
SP2-9	Conductivity/Cations	>90 & < 110	82
SP2-9	Na/(Na + Cl)	> 50%	39%
SP-36	Conductivity/Cations	>90 & < 110	77
SP-36	K/(Na + K)	< 20%	34%
SP-36	Mg/(Ca + Mg)	< 40 %	56%
SP-36	Na/(Na + Cl)	> 50%	26%
SP-58	Conductivity/Cations	>90 & < 110	78
SP-58	Mg/(Ca + Mg)	< 40 %	41%
SP-79	Conductivity/Cations	>90 & < 110	72
SP-79	K/(Na + K)	< 20%	47%
SP-79	Mg/(Ca + Mg)	< 40 %	61%
SP-79	Na/(Na + Cl)	> 50%	28%
UT-0024368-002 – Aug 30	TDS/Conductivity	>0.55 & <0.75	0.83

These inconsistencies do not necessarily mean that a sample is wrong, but it does indicate that something is unusual. An analysis and explanation of the inconsistencies by the Permittee would help to increase the Division's confidence in the samples. The Permittee should work with the lab to make sure that samples pass all quality checks so that the reliability of the samples does not come into question. The Permittee can learn more about these reliability checks and some of the geological and other factors that could influence them by reading Chapter 4 of *Water Quality Data: Analysis and Interpretation* by Arthur W. Hounslow. A geological influence is most likely here, since most samples have the same inconsistencies, and

they recur each quarter.

4. On what date does the MRP require a five-year re-sampling of baseline water data.

Page 7-33 of the MRP states that groundwater samples collected during the low flow period every 5 years will be analyzed for baseline parameters.

Page 7-35 of the MRP states that surface water samples collected during the low flow period every 5 years will be analyzed for baseline parameters.

Therefore, the next re-sampling of baseline parameters is required by the fourth quarter of 2010.

5. Based on your review, what further actions, if any, do you recommend?

No further actions are necessary at this time.

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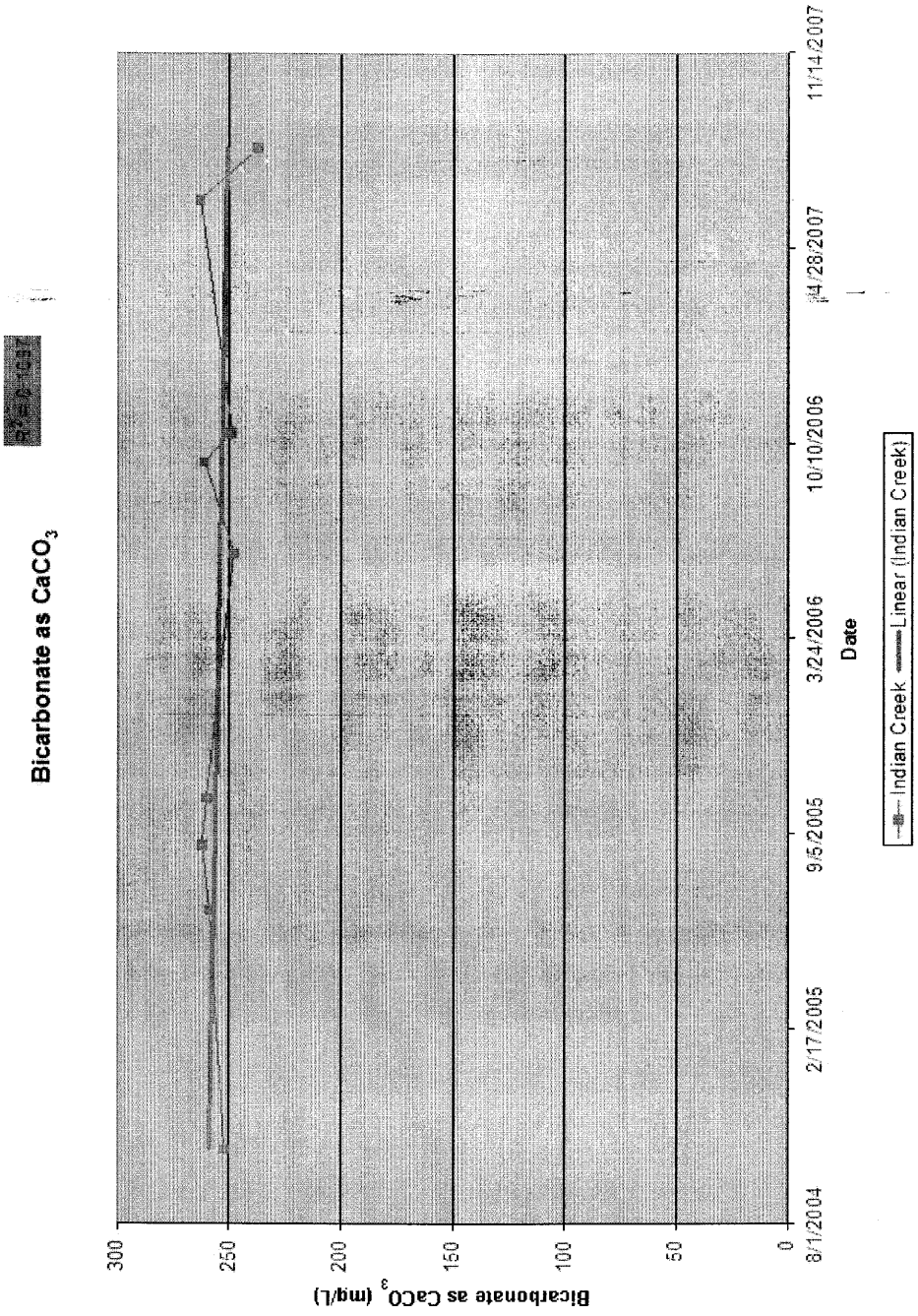
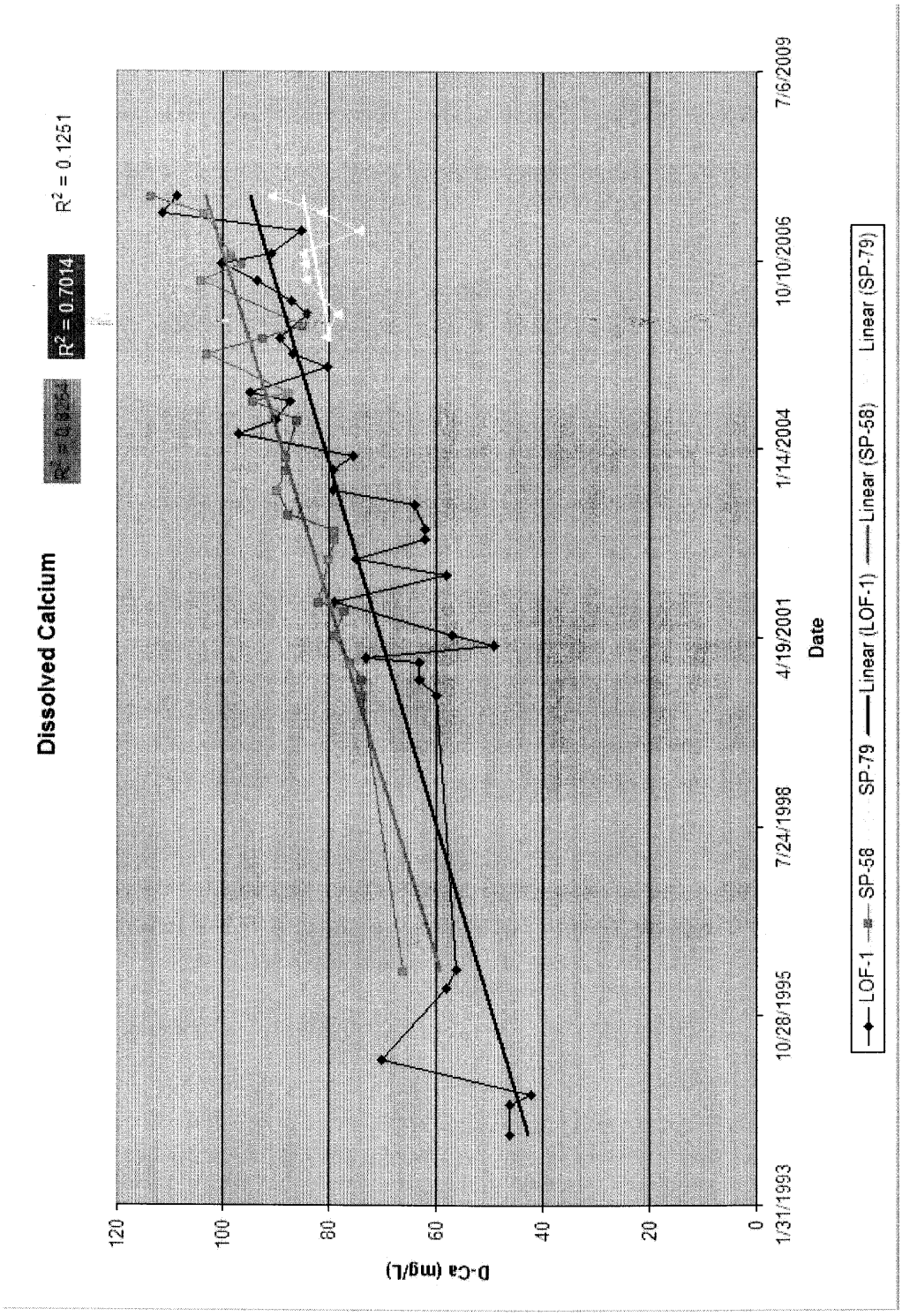
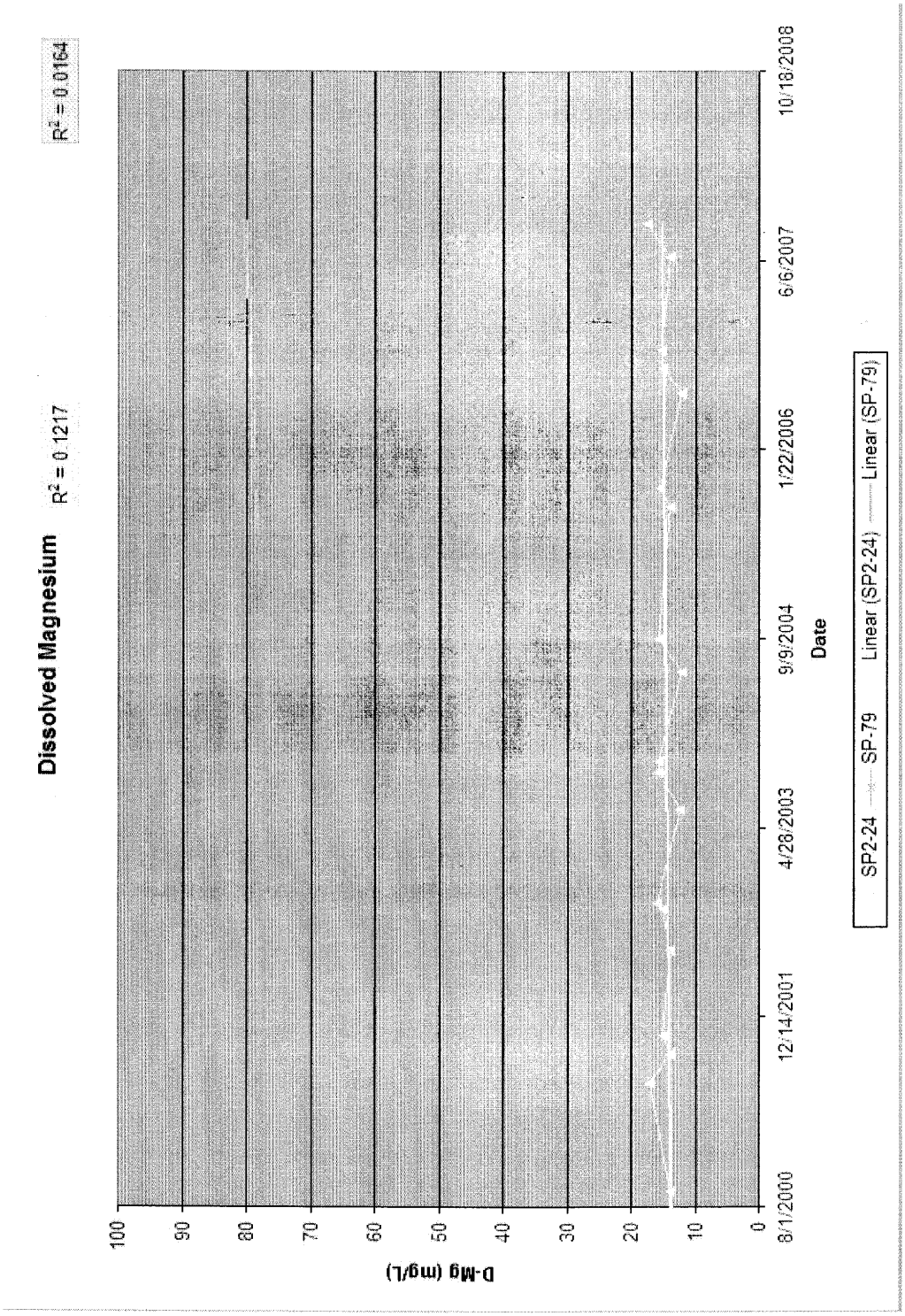
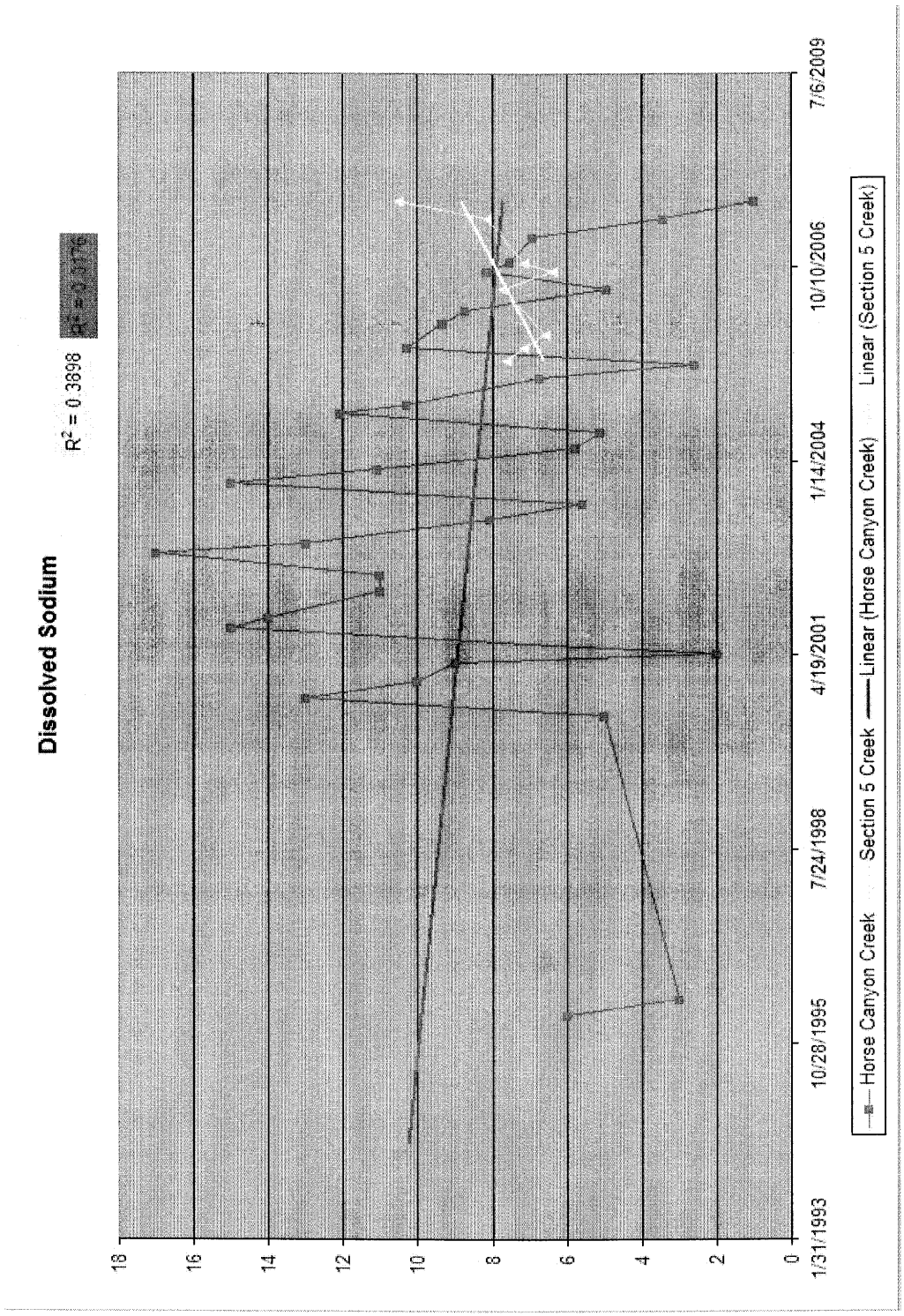
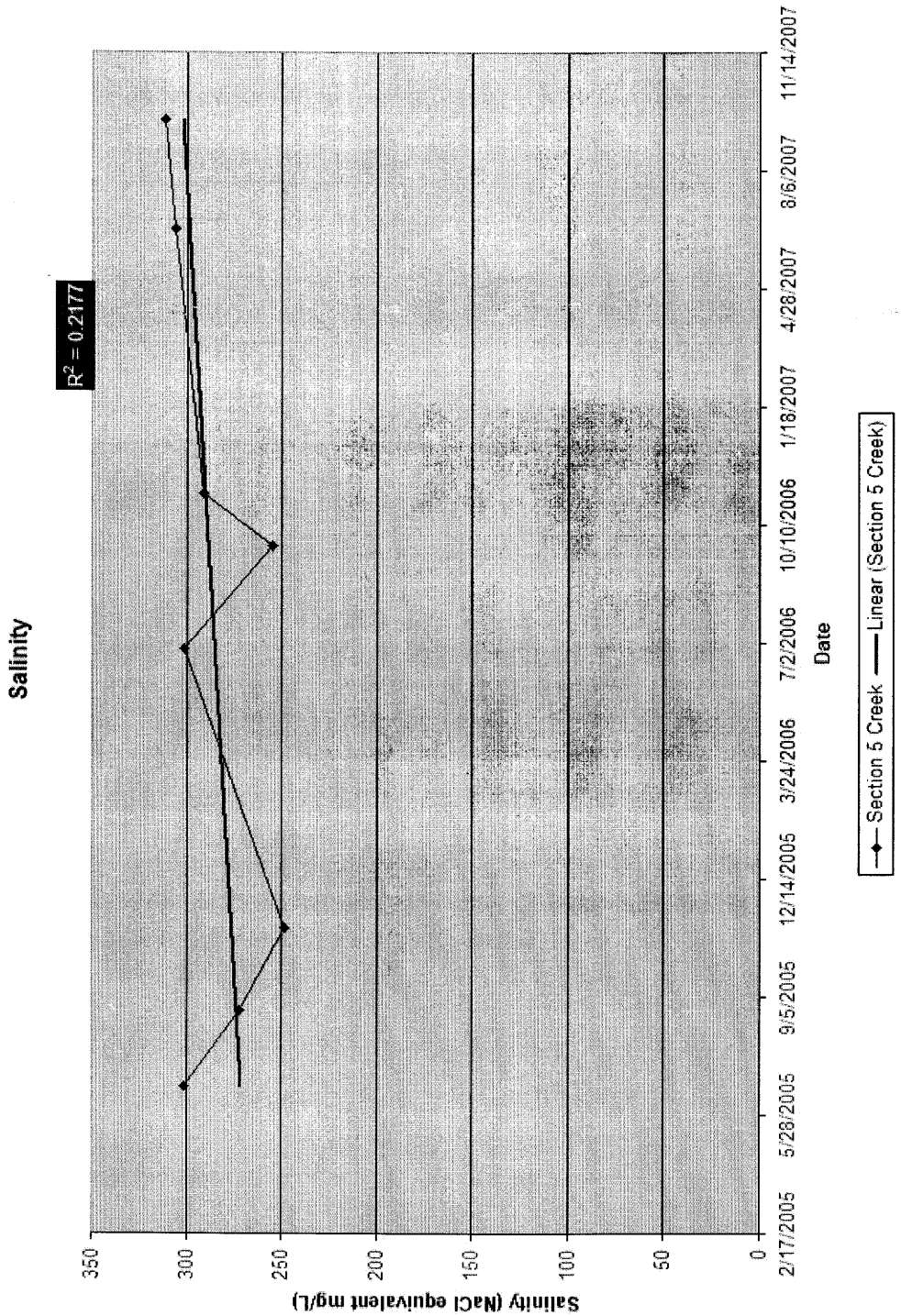
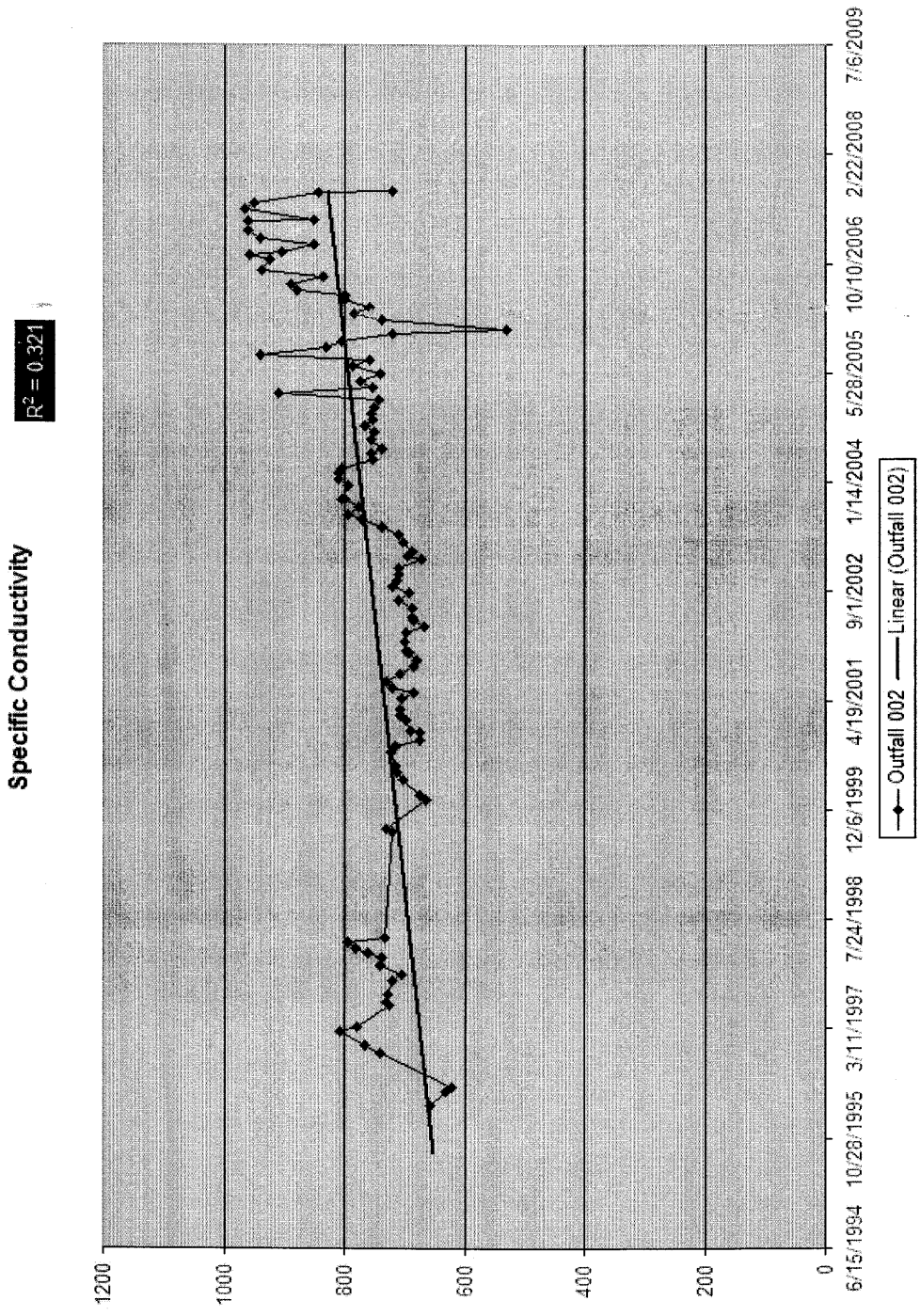

Bicarbonate as $CaCO_3$
R^2 = 0.1011
Bicarbonate as $CaCO_3$ (mg/L)
300
250
200
150
100
50
0
8/1/2004
2/17/2005
9/5/2005
3/24/2006
10/10/2006
4/28/2007
11/14/2007
Date
Indian Creek
Linear (Indian Creek)

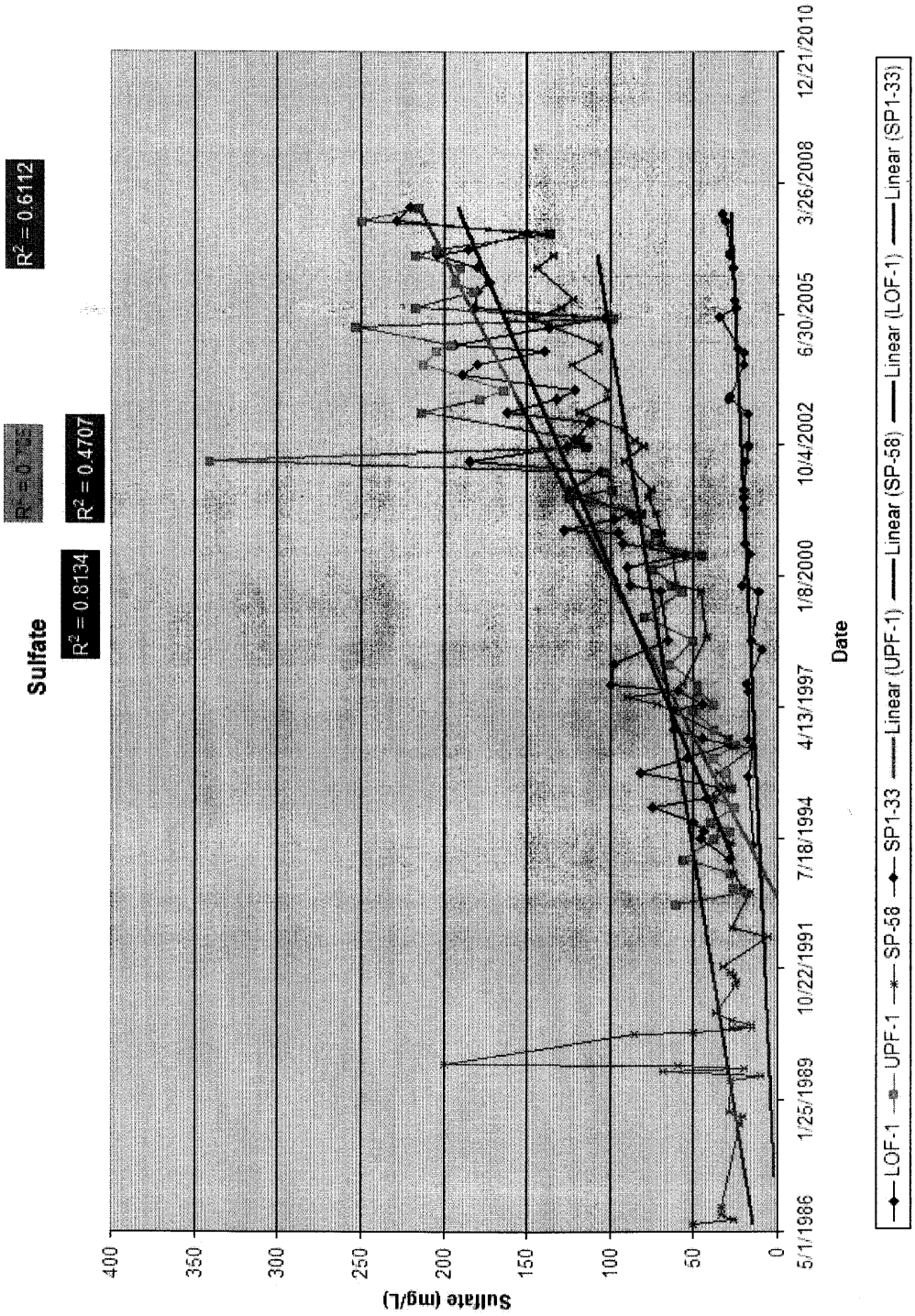

Dissolved Calcium
R² = 0.7014
R² = 0.1251
D-Ca (mg/L)
120
100
80
60
40
20
0
1/31/1993
10/28/1995
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009
Date
LOF-1
SP-58
SP-79
Linear (LOF-1)
Linear (SP-58)
Linear (SP-79)

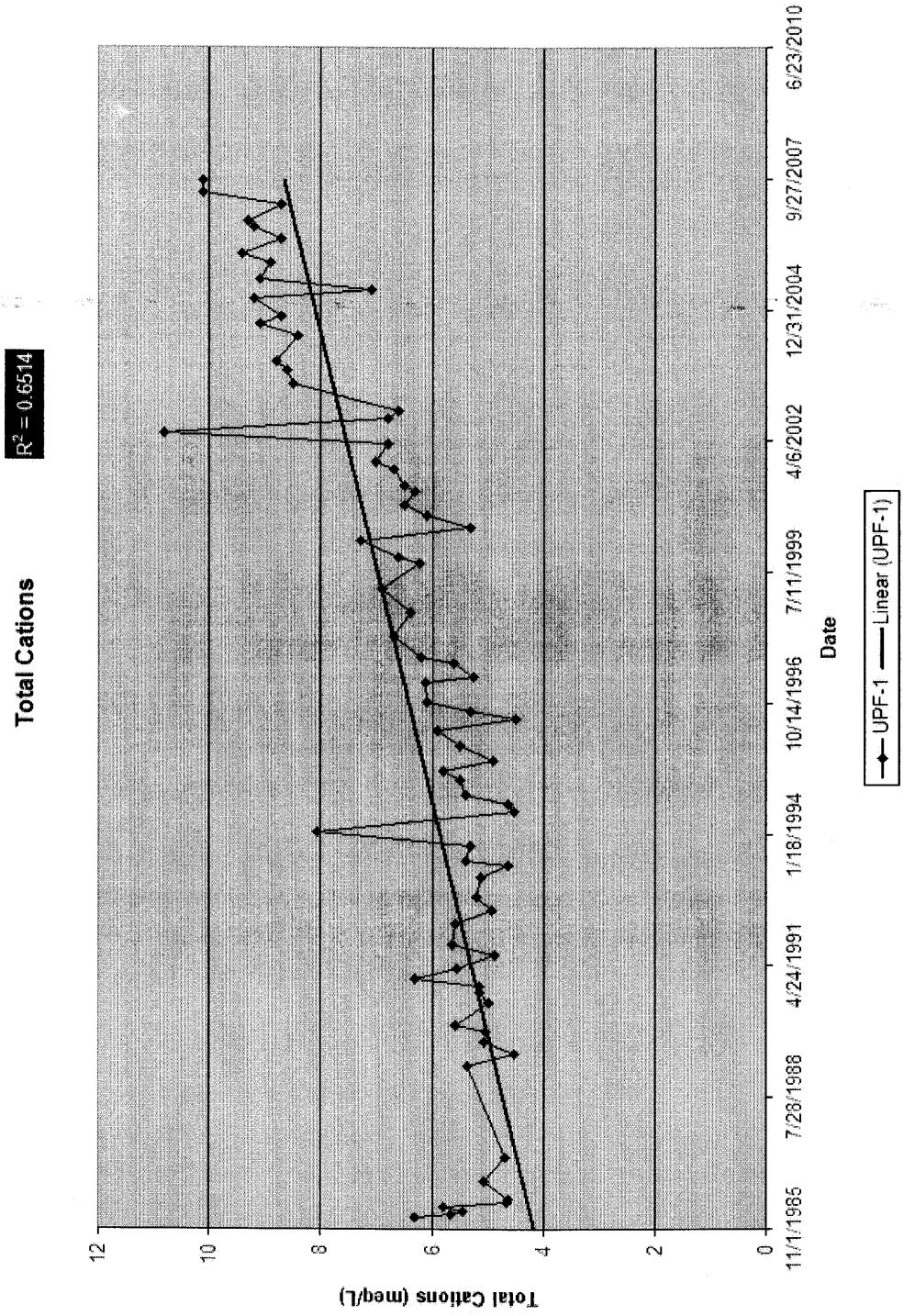

Dissolved Magnesium
R² = 0.1217
R² = 0.0164
D-Mg (mg/L)
100
90
80
70
60
50
40
30
20
10
0
8/1/2000
12/14/2001
4/28/2003
9/9/2004
1/22/2006
6/6/2007
10/18/2008
Date
SP2-24
SP-79
Linear (SP2-24)
Linear (SP-79)

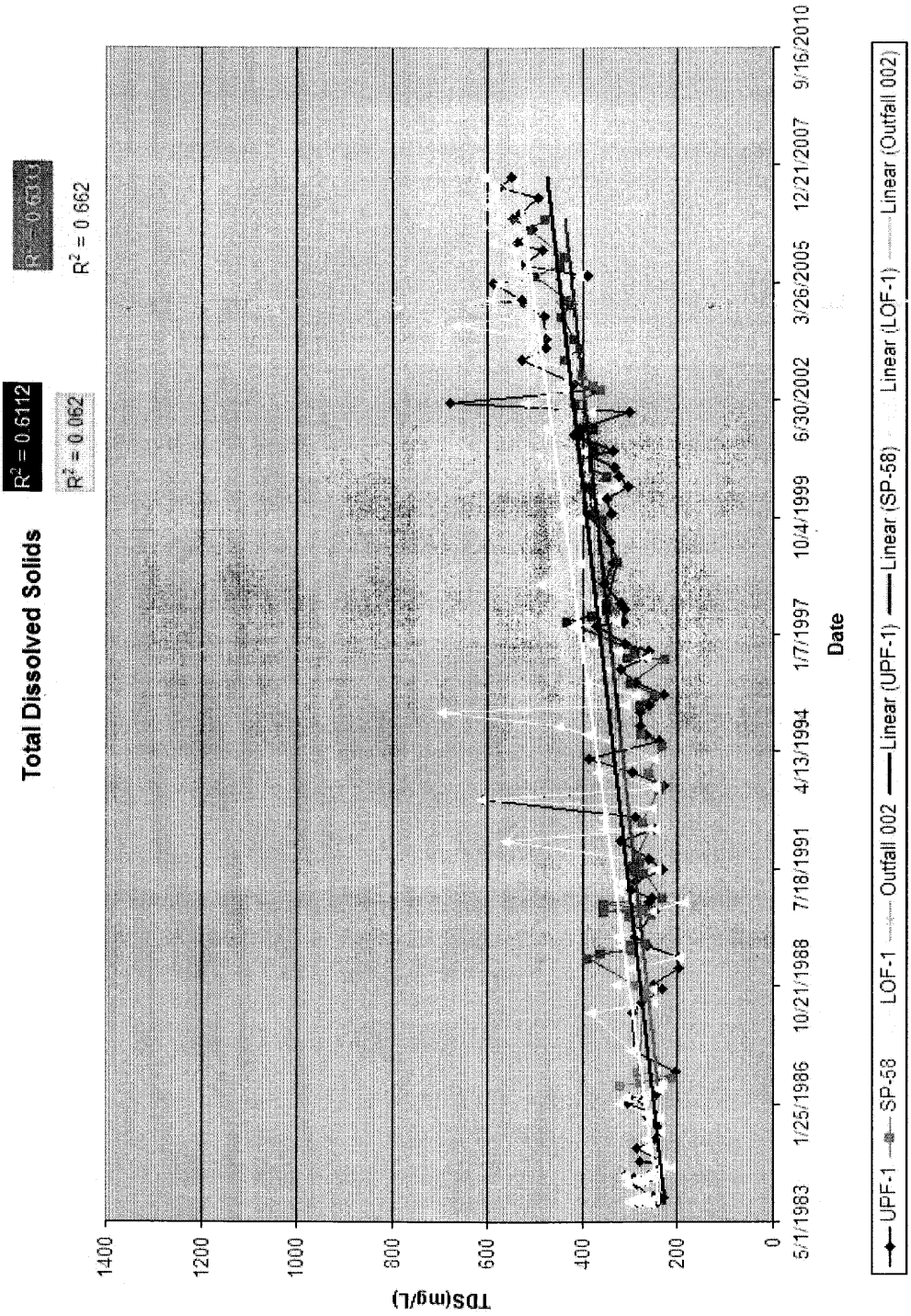

Dissolved Sodium
R² = 0.3898
18
16
14
12
10
8
6
4
2
0
1/31/1993
10/28/1995
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009
Horse Canyon Creek
Section 5 Creek
Linear (Horse Canyon Creek)
Linear (Section 5 Creek)

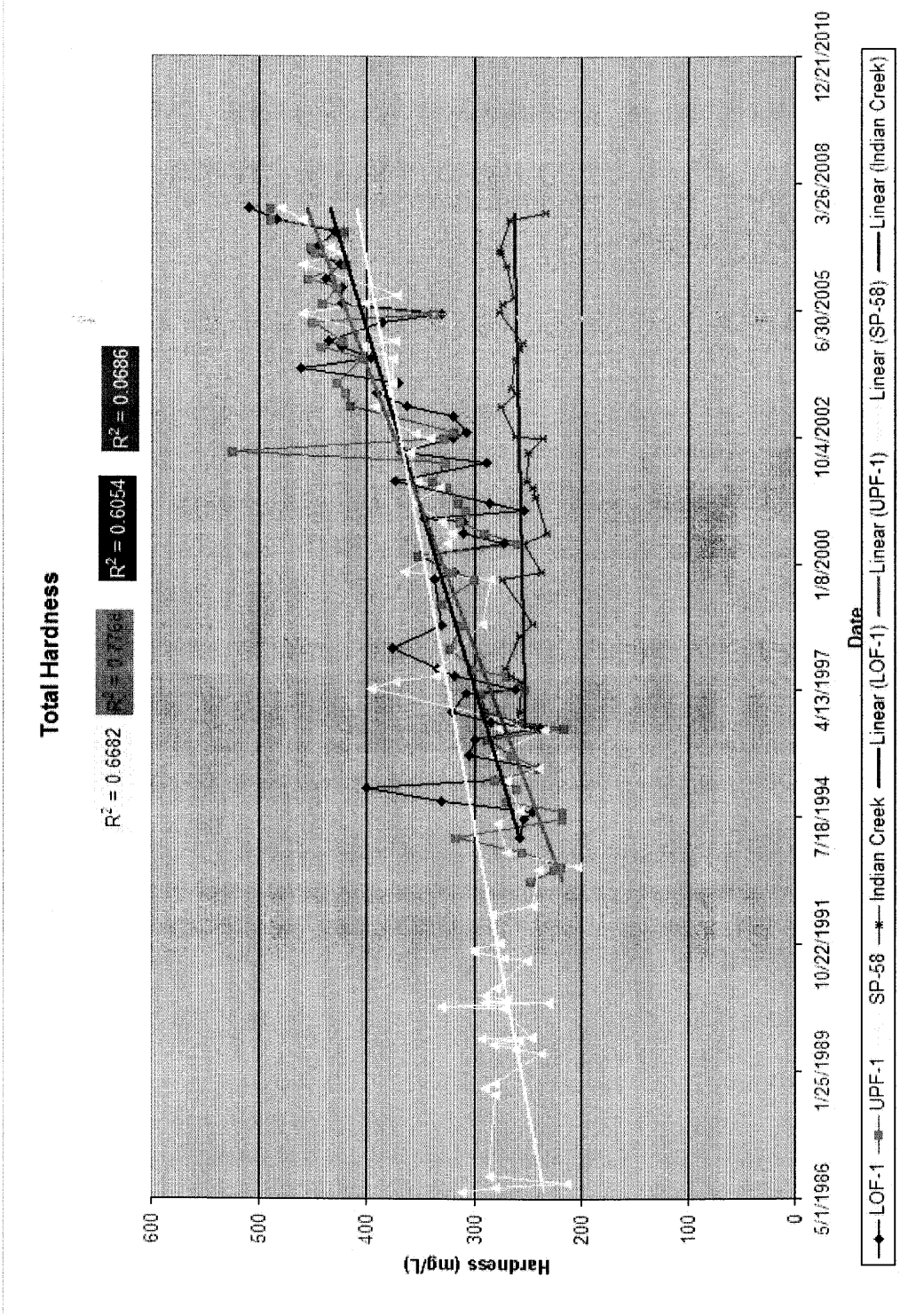

Salinity
R^2 = 0.2177
Salinity (NaCl equivalent mg/L)
350
300
250
200
150
100
50
0
2/17/2005
5/28/2005
9/5/2005
12/14/2005
3/24/2006
7/2/2006
10/10/2006
1/18/2007
4/28/2007
8/6/2007
11/14/2007
Date
Section 5 Creek
Linear (Section 5 Creek)


Specific Conductivity
R² = 0.321
1200
1000
800
600
400
200
0
6/15/1994
10/28/1995
3/11/1997
7/24/1998
12/6/1999
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
7/6/2009
Outfall 002
Linear (Outfall 002)


Sulfate
R² = 0.8134
R² = 0.4707
R² = 0.6112
Sulfate (mg/L)
400
350
300
250
200
150
100
50
0
5/1/1986
1/25/1989
10/22/1991
7/18/1994
4/13/1997
1/8/2000
10/4/2002
6/30/2005
3/26/2008
12/21/2010
Date
LOF-1
UPF-1
SP-58
SP1-33
Linear (UPF-1)
Linear (SP-58)
Linear (LOF-1)
Linear (SP1-33)


Total Cations
R^2 = 0.6514
Total Cations (meq/L)
12
10
8
6
4
2
0
11/1/1985
7/28/1988
4/24/1991
1/18/1994
10/14/1996
7/11/1999
4/6/2002
12/31/2004
9/27/2007
6/23/2010
Date
UPF-1
Linear (UPF-1)


Total Dissolved Solids
R² = 0.6112
R² = 0.062
R² = 0.662
TDS(mg/L)
1400
1200
1000
800
600
400
200
0
5/1/1983
1/25/1986
10/21/1988
7/18/1991
4/13/1994
1/7/1997
10/4/1999
6/30/2002
3/26/2005
12/21/2007
9/16/2010
Date
UPF-1
SP-58
LOF-1
Outfall 002
Linear (UPF-1)
Linear (SP-58)
Linear (LOF-1)
Linear (Outfall 002)


Total Hardness
R² = 0.6682
R² = 0.7766
R² = 0.6054
R² = 0.0686
Hardness (mg/L)
600
500
400
300
200
100
0
5/1/1986
1/25/1989
10/22/1991
7/18/1994
4/13/1997
1/8/2000
10/4/2002
6/30/2005
3/26/2008
12/21/2010
Date
LOF-1
UPF-1
SP-58
Indian Creek
Linear (LOF-1)
Linear (UPF-1)
Linear (SP-58)
Linear (Indian Creek)