0041

WATER QUALITY MEMORANDUM

Utah Coal Regulatory Program

March 24, 2008

TO: Internal File

THRU: Daron Haddock, Permit Supervisor

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

RE: 2007 Fourth Quarter Water Monitoring, Genwal Resources, Inc., Crandall Canyon Mine, Permit & Tracking #2731 C/015/0032

The Crandall Canyon Mine was conducting continuous miner retreat mining in barrier pillars along the mains during the first three quarters of 2007. All mining ceased in early August, when a "bounce" caused much of the working area to collapse. 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. One was dry, and six 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. Neither outfall reported flow during the quarter.

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	Cation/Anion Balance	1.85 %	2.16	1.47 %
IBC-1	Sulfate	91.4 mg/L	3.71	51.67 mg/L
LOF-1	Total Hardness	464.57 mg/L	2.24	312.54 mg/L
LOF-1	Sulfate	196 mg/L	2.15	77.26 mg/L
Section 4 Creek	Dissolved Calcium	64.77 mg/L	2.41	73.28 mg/L
Section 4 Creek	Specific Conductivity	636 µmhos/cm	8.46	805.88 µmhos/cm
Section 5 Creek	Total Alkalinity	368 mg/L	10.75	229.57 mg/L
Section 5 Creek	Bicarbonate as $CaCO_3$	344 mg/L	10.13	223 mg/L
Section 5 Creek	Total Cations	10.38 meq/L	6.80	6.03 meq/L
Section 5 Creek	Total Anions	9.86 meq/L	2.92	5.80 meq/L
Section 5 Creek	Dissolved Calcium	71.62 mg/L	6.84	46.38 mg/L
Section 5 Creek	Dissolved Magnesium	75.15 mg/L	9.60	41.03 mg/L
Section 5 Creek	Total Hardness	488.3 mg/L	8.99	284.87 mg/L
Section 5 Creek	Total Dissolved Solids	547 mg/L	9.63	293.57 mg/L
Section 5 Creek	Specific Conductivity	617 µmhos/cm	3.04	474.71 µmhos/cm
Section 5 Creek	Dissolved Sodium	12.7 mg/L	8.56	7.24 mg/L
Section 5 Creek	Dissolved Potassium	2.7 mg/L	2.43	1.51 mg/L
Section 5 Creek	Sulfate	105 mg/L	12.78	50.67 mg/L
Section 5 Creek	Chloride	11.1 mg/L	6.43	5.47 mg/L

UPR LF Section 5 Creek	Dissolved Oxygen	10.2 mg/L	2.92	8.44 mg/L
LB-12	Water Temperature	8 °C	2.21	9.80 °C
SP1-33	Dissolved Calcium	82.96 mg/L	3.19	71.76 mg/L
SP1-33	Dissolved Potassium	1.99 mg/L	5.47	1.04 mg/L
SP1-33	Sulfate	47.3 mg/L	4.82	20.11 mg/L
SP1-47	Flow	26.5 gpm	3.62	6.49 gpm
SP2-9	Dissolved Calcium	53.49 mg/L	2.02	47.41 mg/L
SP-58	Cation/Anion Balance	-3.27 %	3.43	1.63 %
SP-58	Total Dissolved Solids	516 mg/L	2.40	335.68 mg/L
SP-58	Sulfate	168 mg/L	2.62	59.09 mg/L
SP-79	Total Alkalinity	328 mg/L	2.41	341.71 mg/L
SP-79	Dissolved Calcium	73.49 mg/L	2.16	81.32 mg/L
SP-79	Specific Conductivity	751 µmhos/cm	6.24	908.50 µmhos/cm

Several parameters were outside of 2 standard deviations at Section 5 Creek this quarter. There are only nine samples the statistical population, and this quarter's concentrations are outliers in the current data set for this point.

There is a weak upward trend in bicarbonate as $CaCO_3$, and total alkalinity at Section 5 Creek (R^2 = 0.4484, and 0.3892). The total alkalinity at SP-79 has a fairly strong downward trend (R^2 = 0.7349), but has just ten samples in the population, and the spread is just 21 mg/L. The pH remains in the expected range at both sites.

The cation/anion balance at Horse Canyon Creek and SP-58 is not of concern, since it is within the expected range (<5%).

There is no strong trend in chloride at Section 5 Creek (R^2 = 0.4334), and the current concentration is well below any level of concern.

Dissolved calcium has a weak upward trend at SP2-9 and SP1-33 (R^2= 0.5488, and 0.5299); and no trend at Section 4 Creek, Section 5 Creek, or SP-79. There is a very weak upward trend in dissolved magnesium at Section 5 Creek (R^2 = 0.4338). This is the highest concentration ever recorded at Section 5 Creek for each metal, but less than 40 mg/L higher than the lowest recorded concentrations. There are no criteria for dissolved calcium or magnesium, but they do contribute to water hardness. There is a weak upward trend in the total hardness at LOF-1, and a very weak upward trend in the total hardness at Section 5 Creek (R^2 = 0.5912, and 0.3892). There is no trend in hardness at Section 4 Creek, SP1-33, SP2-9, or SP-79. This is the highest total hardness ever recorded at Section 5 Creek, and is 180 mg/L higher than the next highest reading. The hardness at Section 5 Creek 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 concentration at LOF-1 is down from last quarter.

There is no trend in the dissolved oxygen at the Upper Left Fork of Section 5 Creek. This unusually high concentration is consistent with a low temperature.

There is a very weak upward trend in dissolved potassium at Section 5 Creek and a weak upward trend at SP1-33 (R^2 = 0.3807 and 0.5761). There is a weak upward trend in dissolved sodium at Section 5 Creek (R^2 = 0.5355). There is no water quality standard for potassium or sodium.

The flow at SP1-47 seems to follow the Palmer Hydrologic Drought (PHDI) and Surface Water Supply (SWSI) Indices, with a bit of a lag. This higher than usual flow would be expected based on the patterns.

There is a very weak upward trend in the specific conductivity at Section (R^2 = 0.4735), and no trend at Section 4 Creek or SP-79. There is no standard for specific conductivity, but it is closely related to total dissolved solids (TDS). The total dissolved solids concentration at Section 5 Creek is within the expected range.

There is a strong upward trend in sulfate at LOF-1 (R^2 = 0.7314), weak upward trend at SP1-33 (R^2 = 0.5763), and SP-58 (R^2 = 0.5541) and very weak to no trend at IBC-1 (R^2 = 0.3713) and Section 5 Creek (R^2 = 0. 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 always been less than 250 mg/L.

There is a very weak upward trend in total cations and total anions Section 5 Creek (R^2 = 0.4017 and 0.3901). The cation/anion balance is within the 5% recommended limit at Section 5 Creek. The number of cations and anions relates to the specific conductivity and total dissolved solids in the water sample.

There is a fairly strong upward trend in TDS at SP-58 (R^2 = 0.6951), and a weak upward trend in TDS at Section 5 Creek (R^2 = 0.4807). SP-58 is located above the mine site, and nearby undermining took place in 2003. TDS at SP-58 started trending upward in 1996. The TDS reading at Section 5 Creek is an outlier compared to the rest of the data, the Division will continue to monitor the trends at Section 5 Creek.

Many routine reliability checks fell outside of standard values:

Site	Reliability Check	Value Should Be...	Value is...
BCF	TDS/Conductivity	>0.55 & <0.75	0.78
BCF	Conductivity/Cations	>90 & < 110	64

BCF	K/(Na + K)	< 20%	50%
BCF	Mg/(Ca + Mg)	< 40 %	54%
BCF	Na/(Na + Cl)	> 50%	29%
Horse Canyon Creek	TDS/Conductivity	>0.55 & <0.75	0.82
Horse Canyon Creek	Conductivity/Cations	>90 & < 110	65
Horse Canyon Creek	K/(Na + K)	< 20%	39%
Horse Canyon Creek	Mg/(Ca + Mg)	< 40 %	54%
Horse Canyon Creek	Na/(Na + Cl)	> 50%	31%
IBC-1	TDS/Conductivity	>0.55 & <0.75	0.79
IBC-1	Conductivity/Cations	>90 & < 110	65
IBC-1	K/(Na + K)	< 20%	35%
IBC-1	Mg/(Ca + Mg)	< 40 %	57%
IBC-1	Na/(Na + Cl)	> 50%	31%
Indian Creek	Conductivity/Cations	>90 & < 110	77
Indian Creek	K/(Na + K)	< 20%	45%
Indian Creek	Mg/(Ca + Mg)	< 40 %	34%
Indian Creek	Na/(Na + Cl)	> 50%	35%
LOF-1	TDS/Conductivity	>0.55 & <0.75	0.82
LOF-1	Conductivity/Cations	>90 & < 110	71
LOF-1	K/(Na + K)	< 20%	32%
LOF-1	Mg/(Ca + Mg)	< 40 %	47%
LOF-1	Na/(Na + Cl)	> 50%	20%
Section 4 Creek	TDS/Conductivity	>0.55 & <0.75	0.83
Section 4 Creek	Conductivity/Cations	>90 & < 110	66
Section 4 Creek	K/(Na + K)	< 20%	43%
Section 4 Creek	Mg/(Ca + Mg)	< 40 %	64%
Section 4 Creek	Na/(Na + Cl)	> 50%	27%
Section 5 Creek	TDS/Conductivity	>0.55 & <0.75	0.89
Section 5 Creek	Conductivity/Cations	>90 & < 110	59
Section 5 Creek	K/(Na + K)	< 20%	40%
Section 5 Creek	Mg/(Ca + Mg)	< 40 %	63%
Section 5 Creek	Na/(Na + Cl)	> 50%	25%
UPF-1	TDS/Conductivity	>0.55 & <0.75	0.91
UPF-1	Conductivity/Cations	>90 & < 110	67
UPF-1	K/(Na + K)	< 20%	47%
UPF-1	Mg/(Ca + Mg)	< 40 %	48%
UPF-1	Na/(Na + Cl)	> 50%	39%
LB-5A	Conductivity/Cations	>90 & < 110	79
LB-5A	K/(Na + K)	< 20%	40%
LB-5A	Mg/(Ca + Mg)	< 40 %	50%

LB-5A	Na/(Na + Cl)	> 50%	29%
Little Bear Spring	Conductivity/Cations	>90 & < 110	75
Little Bear Spring	K/(Na + K)	< 20%	42%
Little Bear Spring	Mg/(Ca + Mg)	< 40 %	47%
Little Bear Spring	Na/(Na + Cl)	> 50%	39%
SP1-33	TDS/Conductivity	>0.55 & <0.75	0.75
SP1-33	Conductivity/Cations	>90 & < 110	70
SP1-33	K/(Na + K)	< 20%	47%
SP1-33	Na/(Na + Cl)	> 50%	48%
SP1-9	Cation/Anion Balance	<5%	5.58%
SP1-9	TDS/Conductivity	>0.55 & <0.75	0.76
SP1-9	Conductivity/Cations	>90 & < 110	68
SP1-9	K/(Na + K)	< 20%	62%
SP1-9	Na/(Na + Cl)	> 50%	37%
SP2-24	Cation/Anion Balance	< 5%	10.36%
SP2-24	Conductivity/Cations	>90 & < 110	78
SP2-24	K/(Na + K)	< 20%	87%
SP2-24	Na/(Na + Cl)	> 50%	13%
SP2-9	Cation/Anion Balance	< 5%	5.26%
SP2-9	Conductivity/Cations	>90 & < 110	71
SP2-9	K/(Na + K)	< 20%	59%
SP2-9	Na/(Na + Cl)	> 50%	39%
SP-36	Conductivity/Cations	>90 & < 110	81
SP-36	K/(Na + K)	< 20%	34%
SP-36	Mg/(Ca + Mg)	< 40 %	57%
SP-36	Na/(Na + Cl)	> 50%	25%
SP-58	TDS/Conductivity	>0.55 & <0.75	0.79
SP-58	Conductivity/Cations	>90 & < 110	75
SP-58	K/(Na + K)	< 20%	52%
SP-58	Mg/(Ca + Mg)	< 40 %	41%
SP-58	Na/(Na + Cl)	> 50%	35%
SP-79	TDS/Conductivity	>0.55 & <0.75	0.83
SP-79	Conductivity/Cations	>90 & < 110	68
SP-79	K/(Na + K)	< 20%	46%
SP-79	Mg/(Ca + Mg)	< 40 %	64%
SP-79	Ca/(Ca + SO_4)	> 50 %	48%
SP-79	Na/(Na + Cl)	> 50%	28%

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.

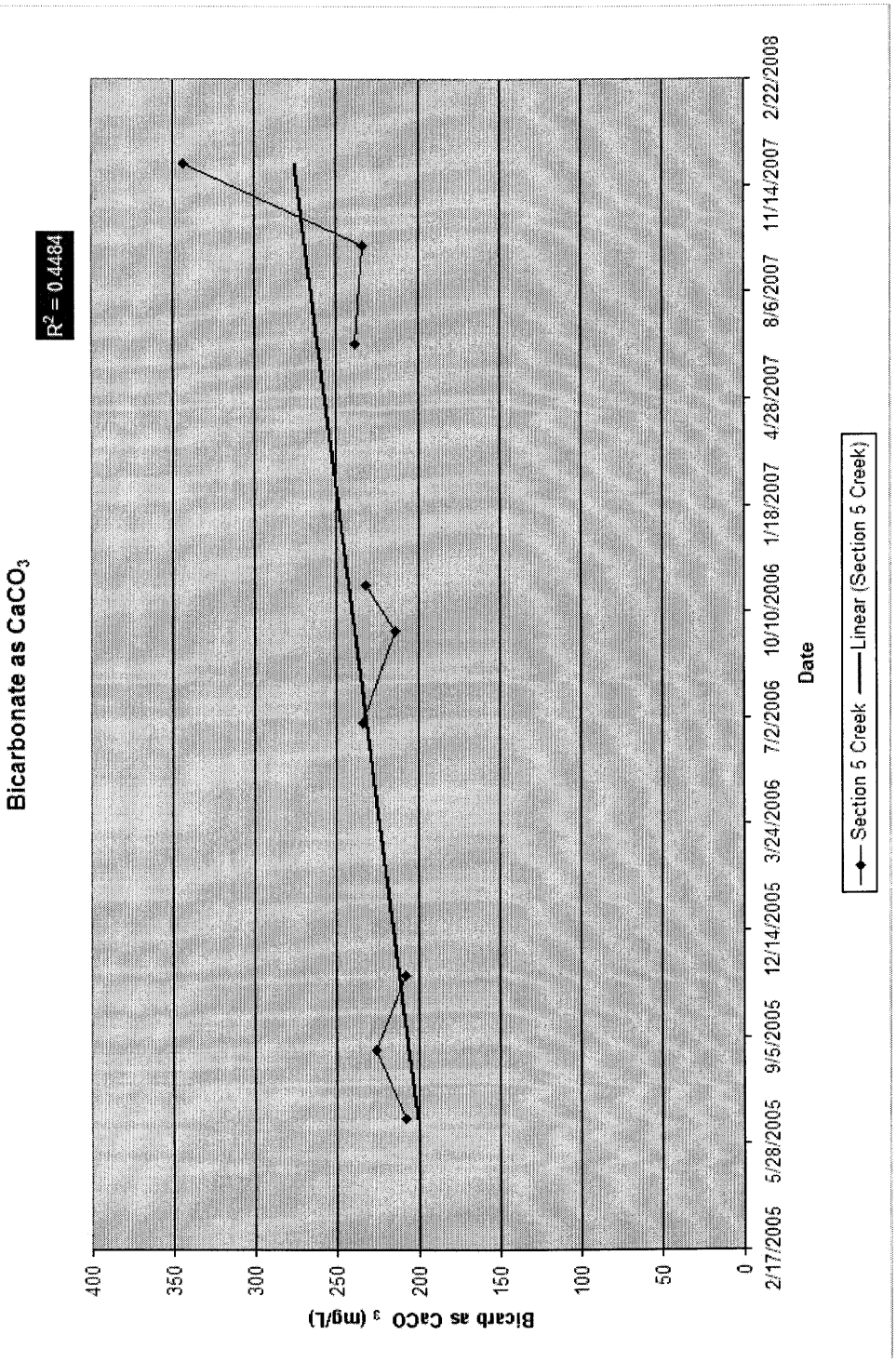
Page 7-33 of the MRP states that groundwater samples collected during the low flow period every 5 years will be analyzed for baseline parameters, 2010 will be the fifth year.

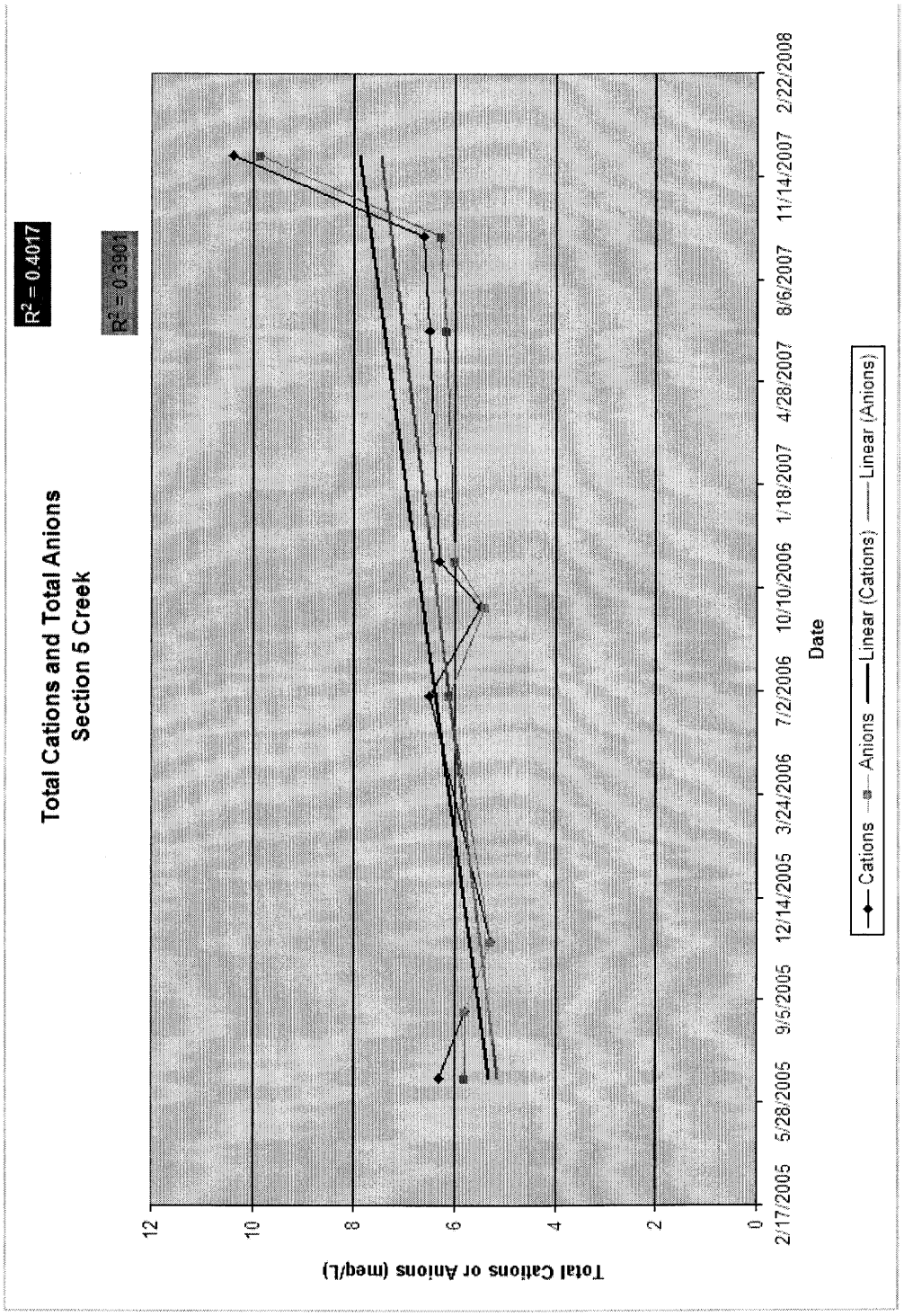
Page 7-35 of the MRP states that surface water samples collected during the low flow period every 5 years will be analyzed for baseline parameters, 2010 will be the fifth year

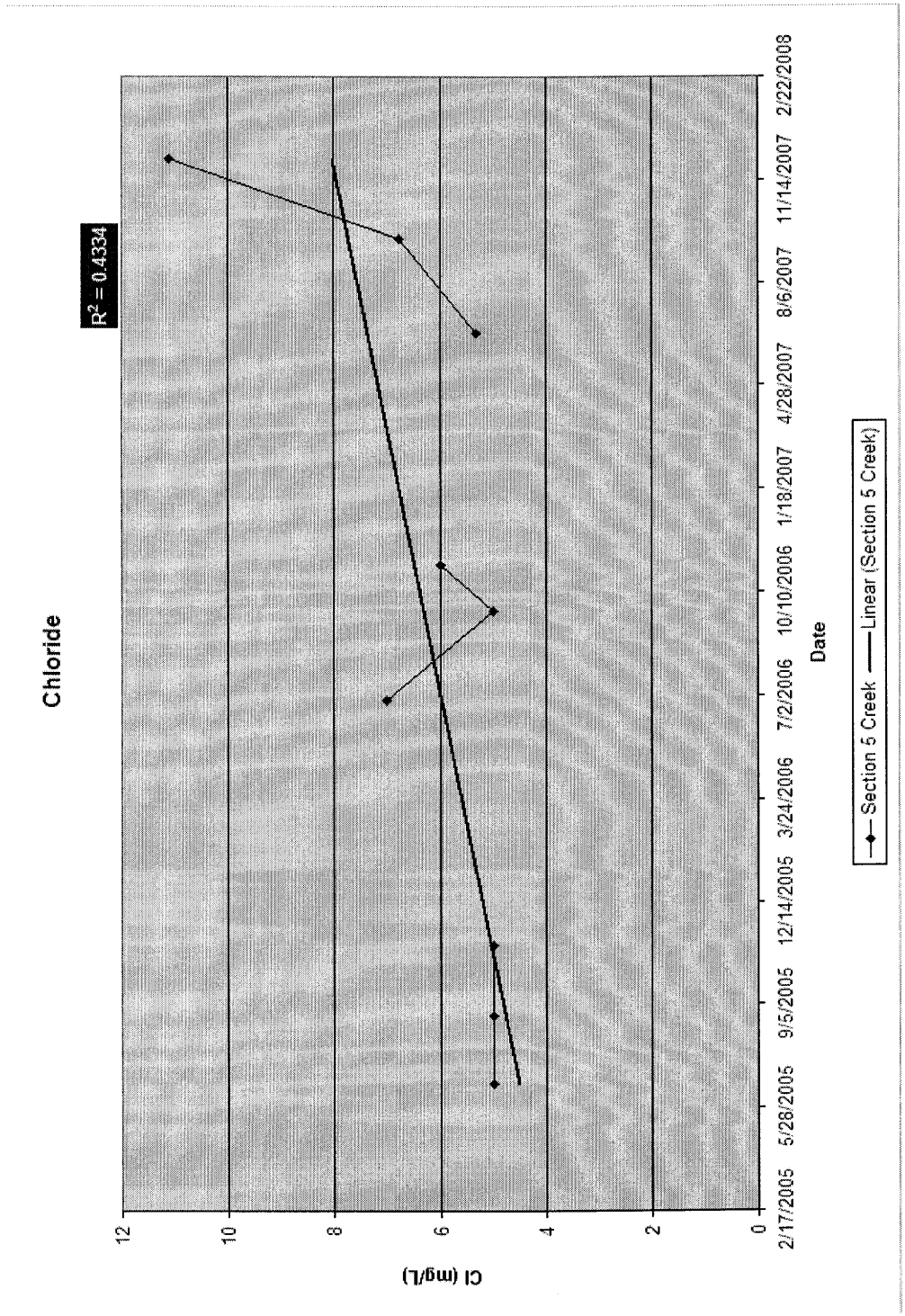
5. Based on your review, what further actions, if any, do you recommend?

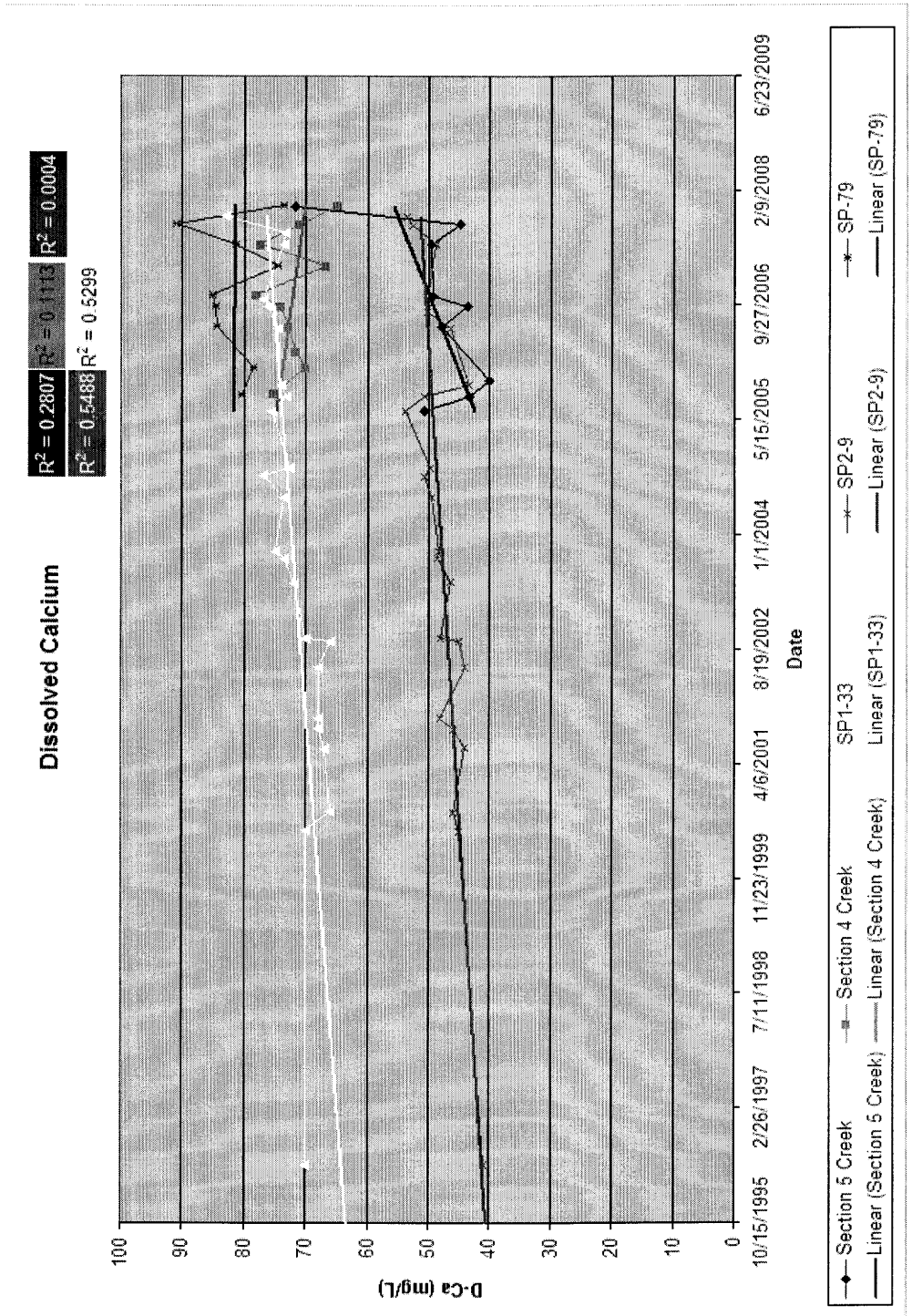
No further actions are necessary at this time.

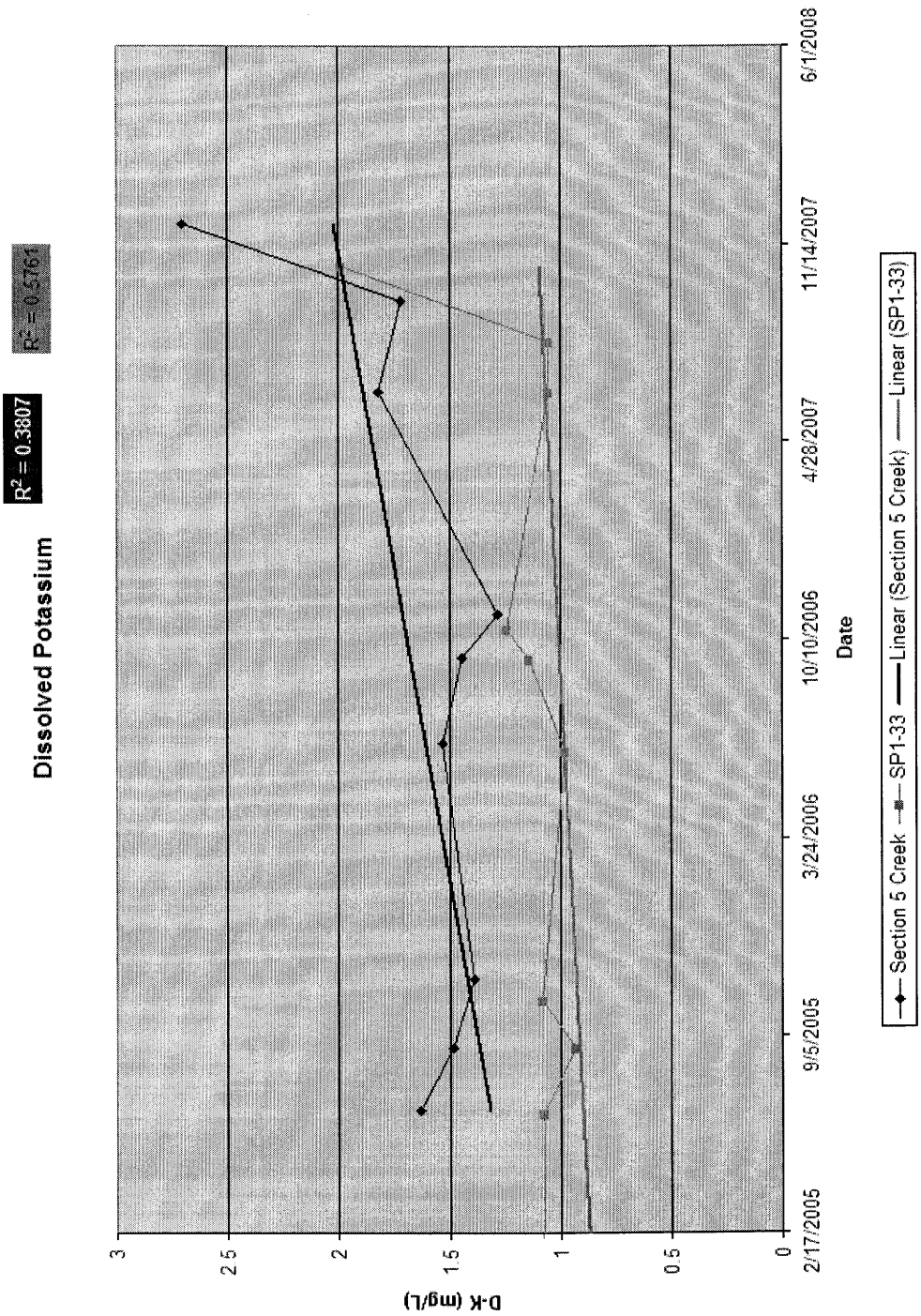
an
O:\015032.CRA\WATER QUALITY\DDWQ_07-4_2731.DOC

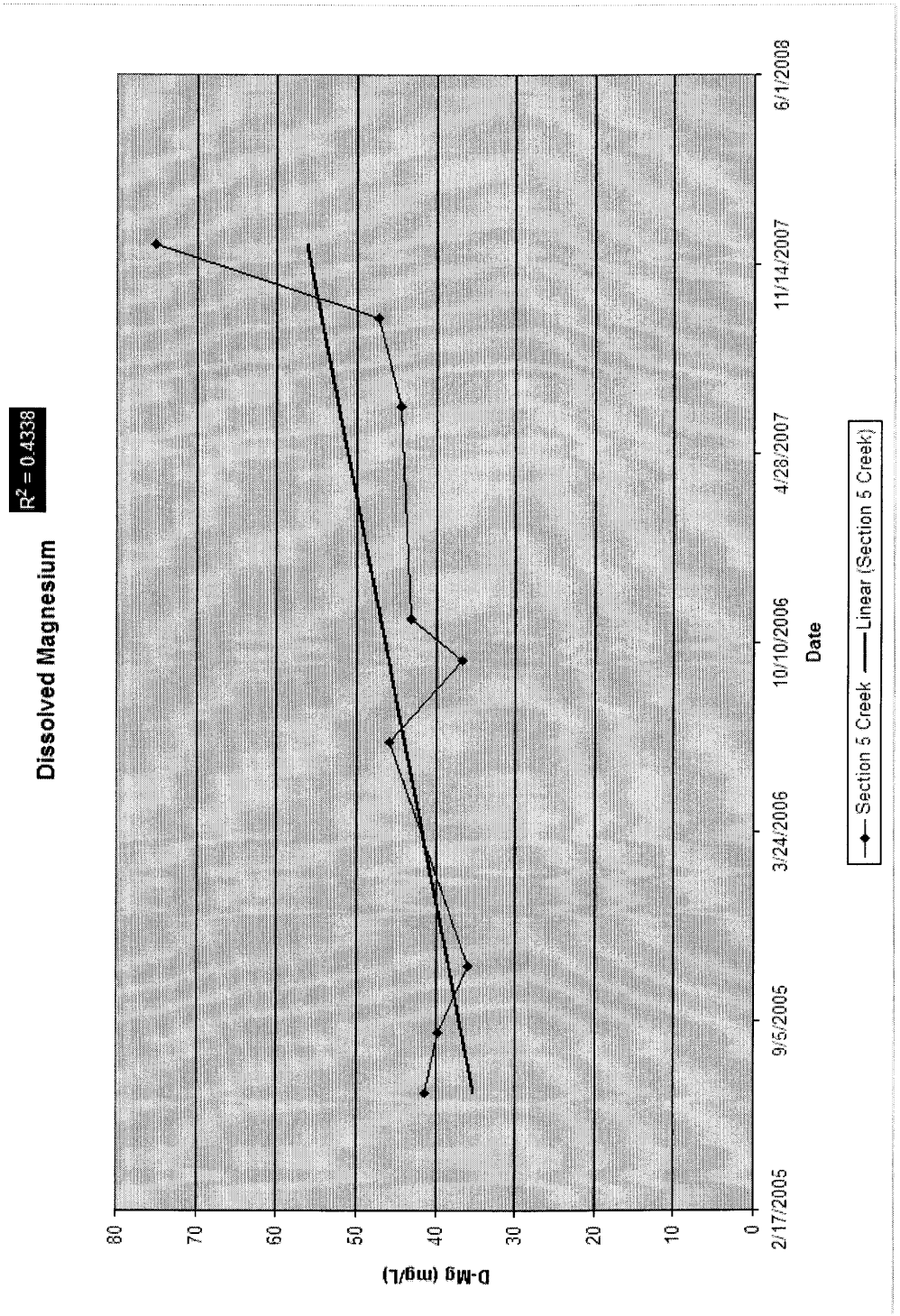

Bicarbonate as $CaCO_3$
R^2 = 0.4484
Bicarb as CaCO 3 (mg/L)
400
350
300
250
200
150
100
50
0
2/17/2005
5/28/2005
9/5/2005
12/14/2005
3/24/2006
7/2/2006
10/10/2006
1/18/2007
4/28/2007
8/6/2007
11/14/2007
2/22/2008
Date
Section 5 Creek
Linear (Section 5 Creek)

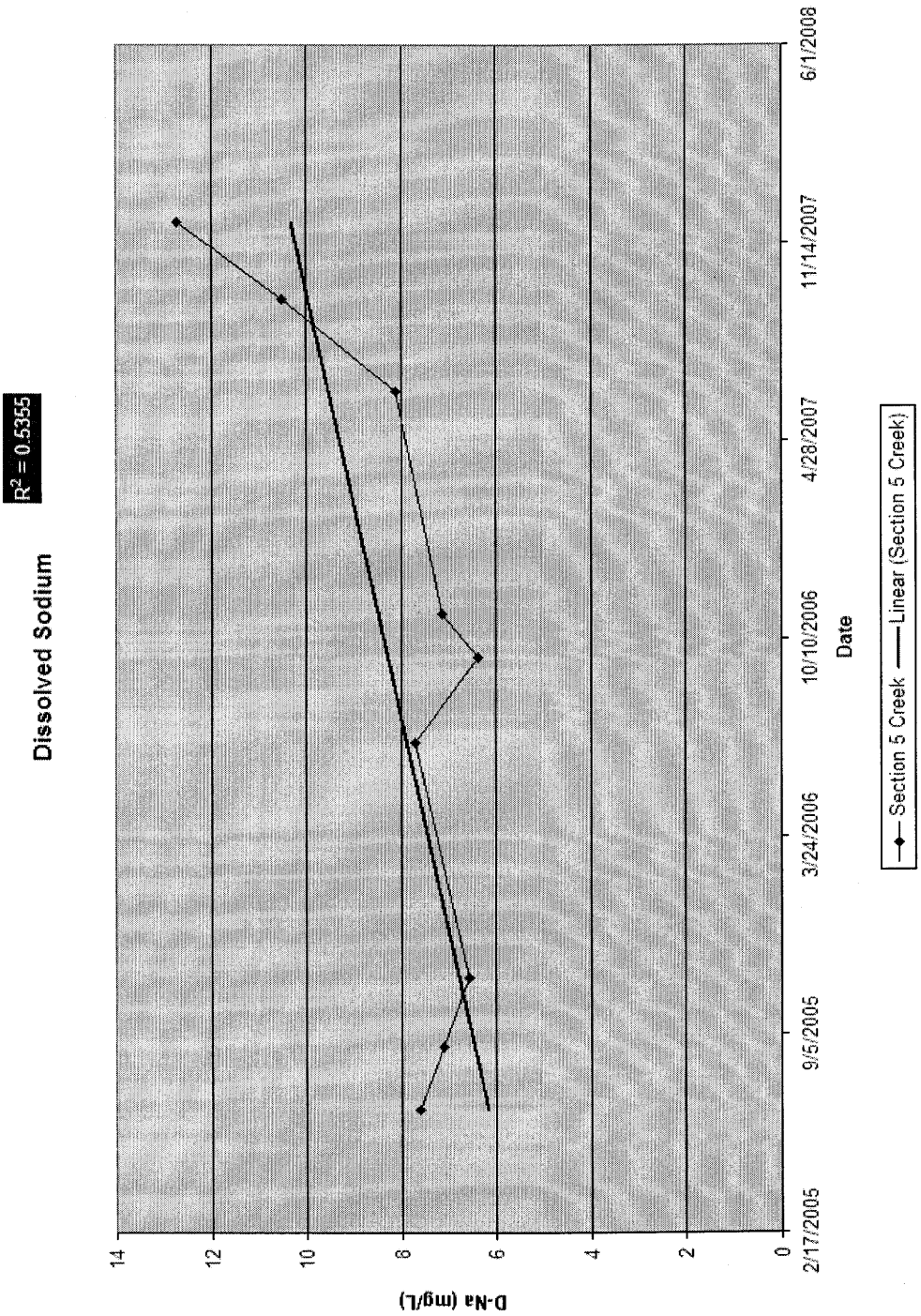

Total Cations and Total Anions
Section 5 Creek
R² = 0.4017
R² = 0.3901
Total Cations or Anions (meq/L)
0
2
4
6
8
10
12
2/17/2005
5/28/2005
9/5/2005
12/14/2005
3/24/2006
7/2/2006
10/10/2006
1/18/2007
4/28/2007
8/6/2007
11/14/2007
2/22/2008
Date
Cations
Anions
Linear (Cations)
Linear (Anions)

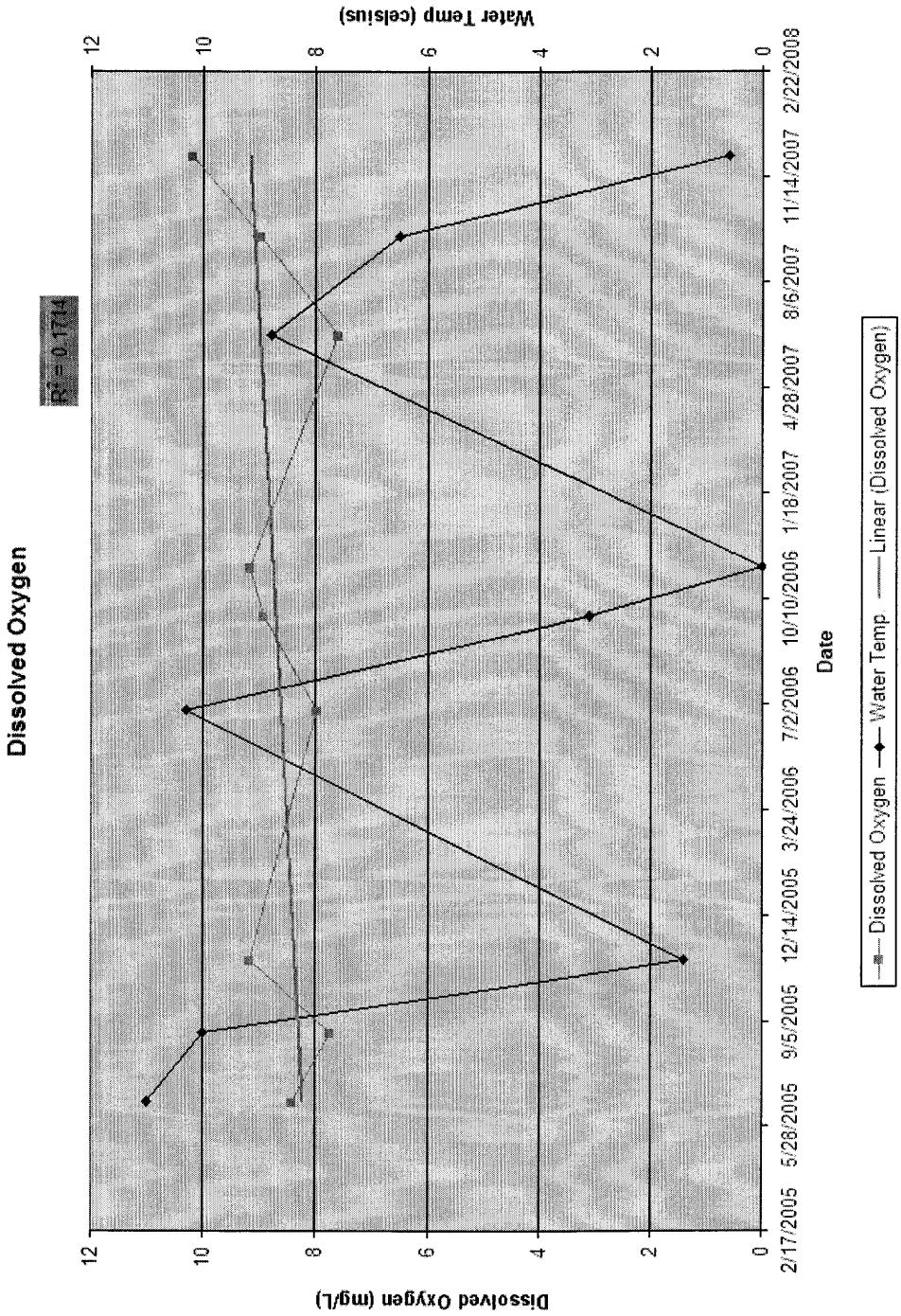

Chloride
R² = 0.4334
Cl (mg/L)
0
2
4
6
8
10
12
2/17/2005
5/28/2005
9/5/2005
12/14/2005
3/24/2006
7/2/2006
10/10/2006
1/18/2007
4/28/2007
8/6/2007
11/14/2007
2/22/2008
Date
Section 5 Creek
Linear (Section 5 Creek)

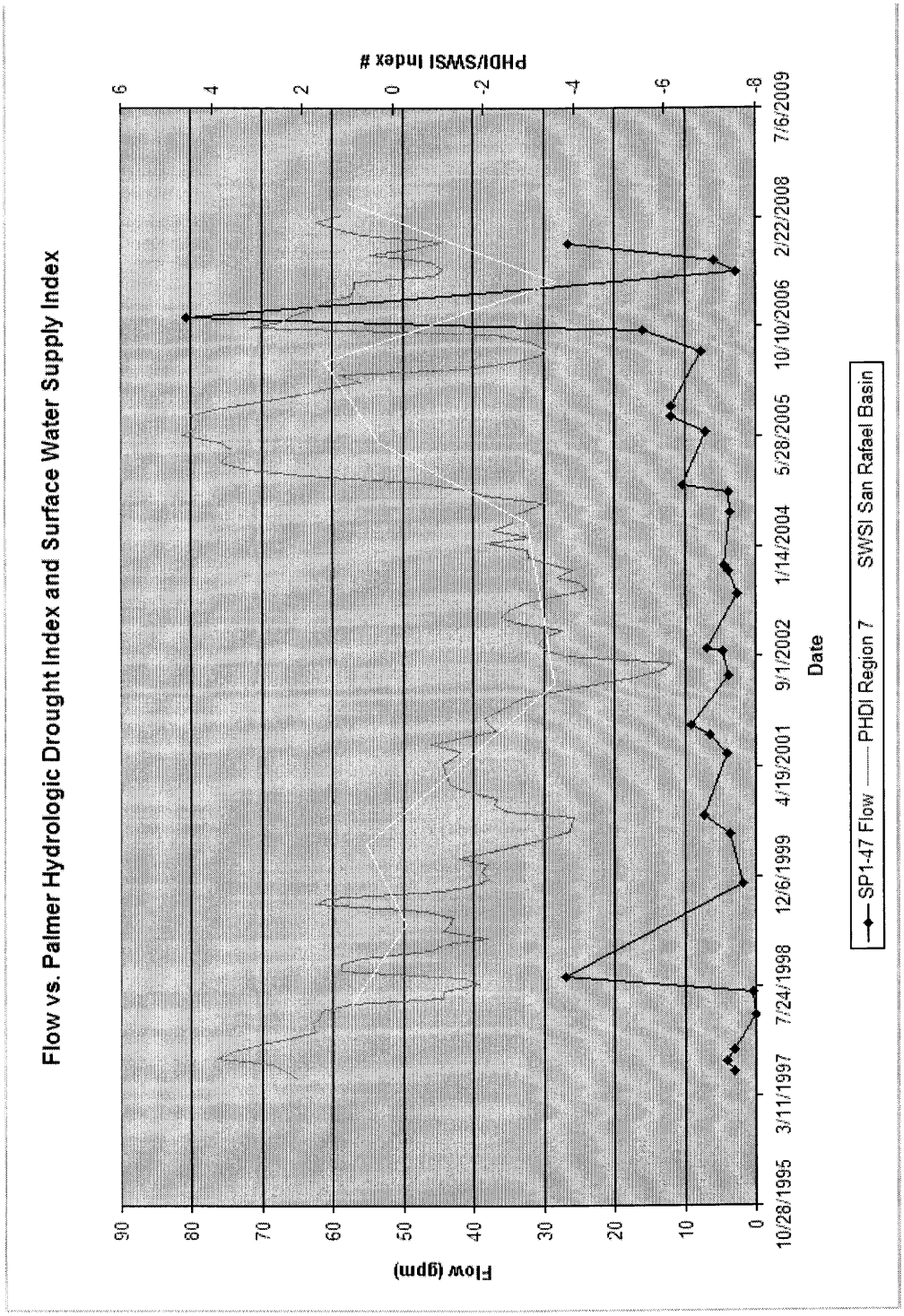

Dissolved Calcium
R² = 0.2807
R² = 0.1113
R² = 0.0004
R² = 0.5488
R² = 0.5299
D-Ca (mg/L)
100
90
80
70
60
50
40
30
20
10
0
10/15/1995
2/26/1997
7/11/1998
11/23/1999
4/6/2001
8/19/2002
1/1/2004
5/15/2005
9/27/2006
2/9/2008
6/23/2009
Date
Section 5 Creek
Section 4 Creek
SP1-33
SP2-9
SP-79
Linear (Section 5 Creek)
Linear (Section 4 Creek)
Linear (SP1-33)
Linear (SP2-9)
Linear (SP-79)

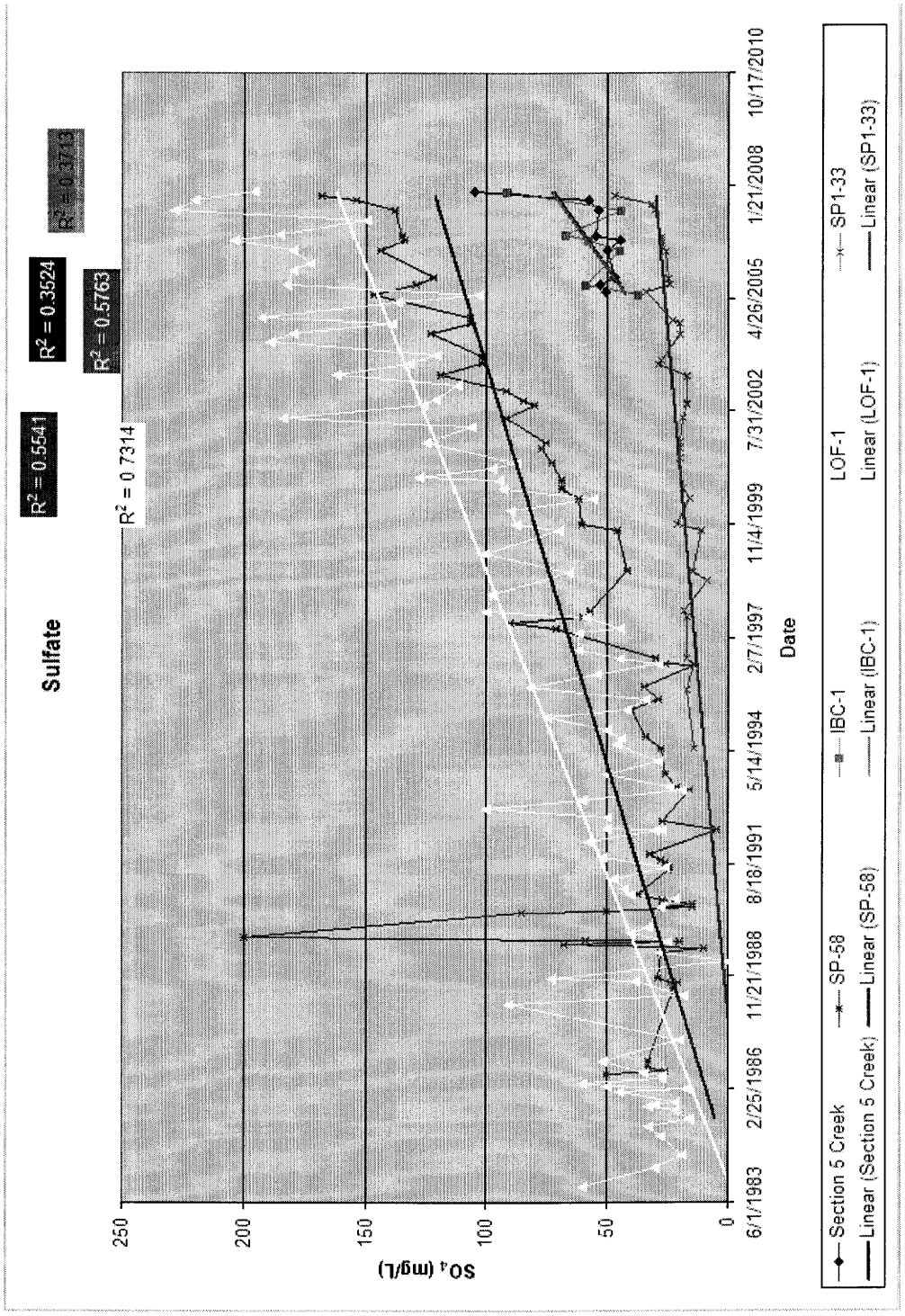

Dissolved Potassium
R² = 0.3807
R² = 0.5761
D-K (mg/L)
3
2.5
2
1.5
1
0.5
0
2/17/2005
9/5/2005
3/24/2006
10/10/2006
4/28/2007
11/14/2007
6/1/2008
Date
Section 5 Creek
SP1-33
Linear (Section 5 Creek)
Linear (SP1-33)

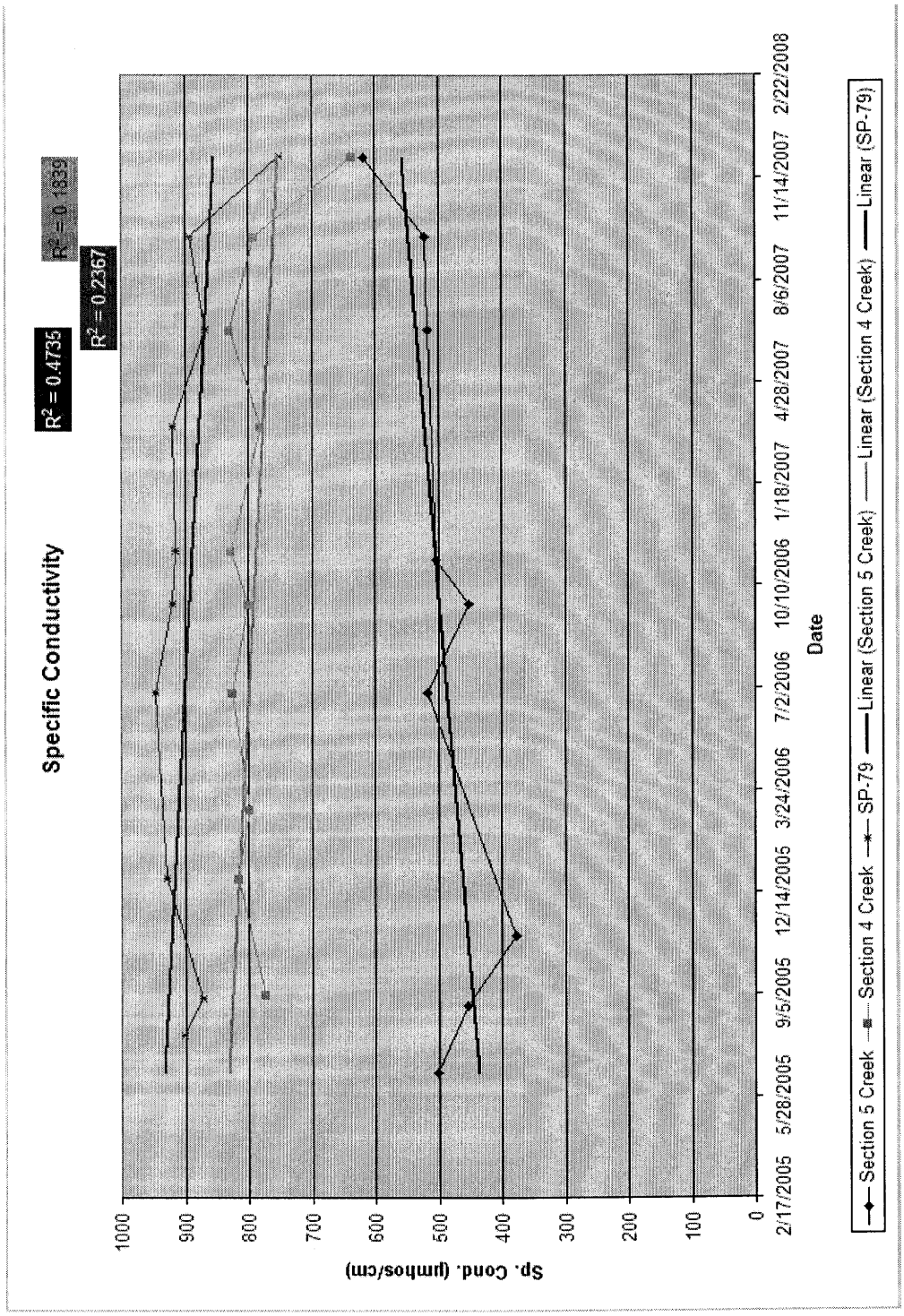

Dissolved Magnesium
R² = 0.4338
D-Mg (mg/L)
0
10
20
30
40
50
60
70
80
2/17/2005
9/5/2005
3/24/2006
10/10/2006
4/28/2007
11/14/2007
6/1/2008
Date
Section 5 Creek
Linear (Section 5 Creek)

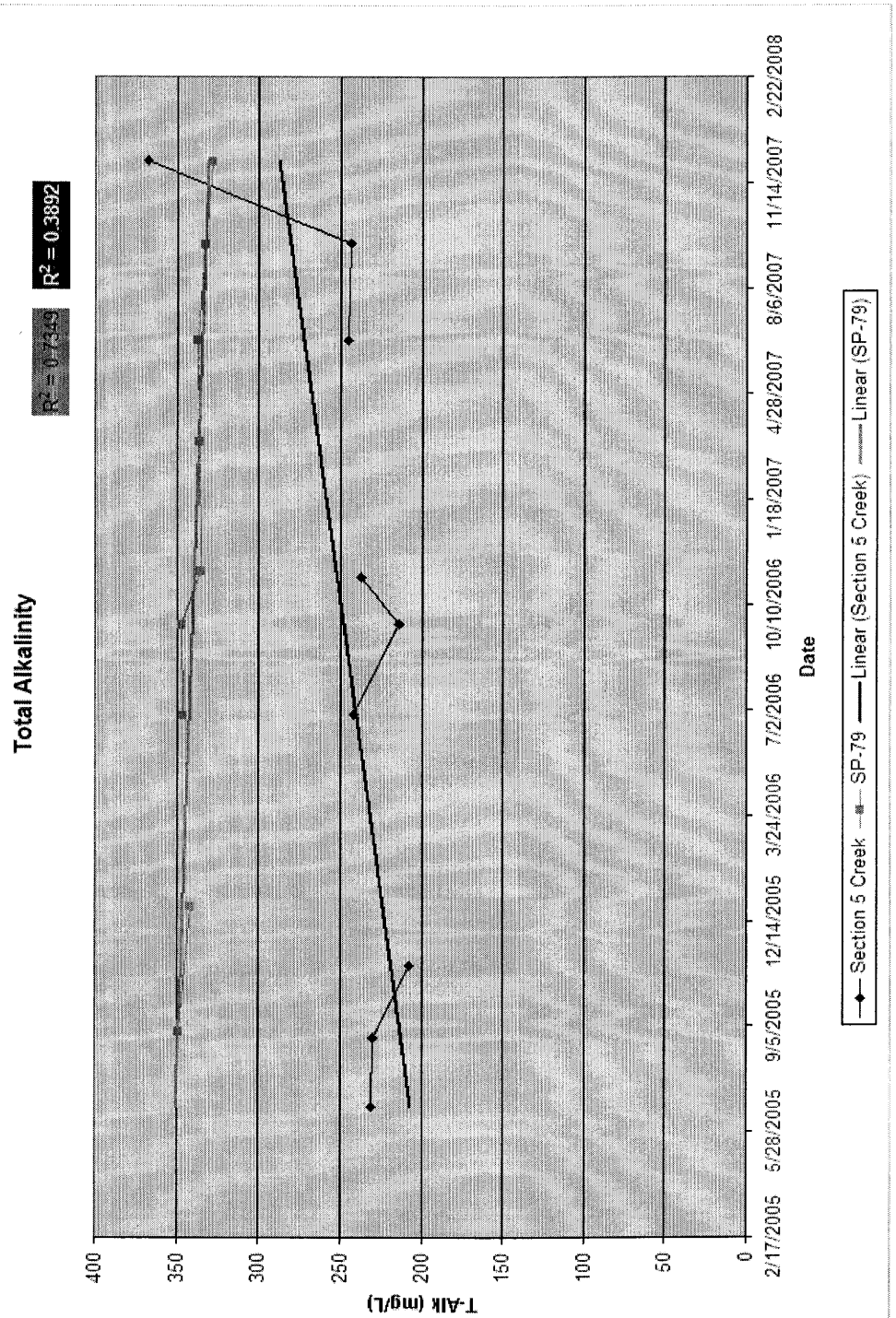

Dissolved Sodium
R2 = 0.5355
D-Na (mg/L)
14
12
10
8
6
4
2
0
2/17/2005
9/5/2005
3/24/2006
10/10/2006
4/28/2007
11/14/2007
6/1/2008
Date
Section 5 Creek
Linear (Section 5 Creek)

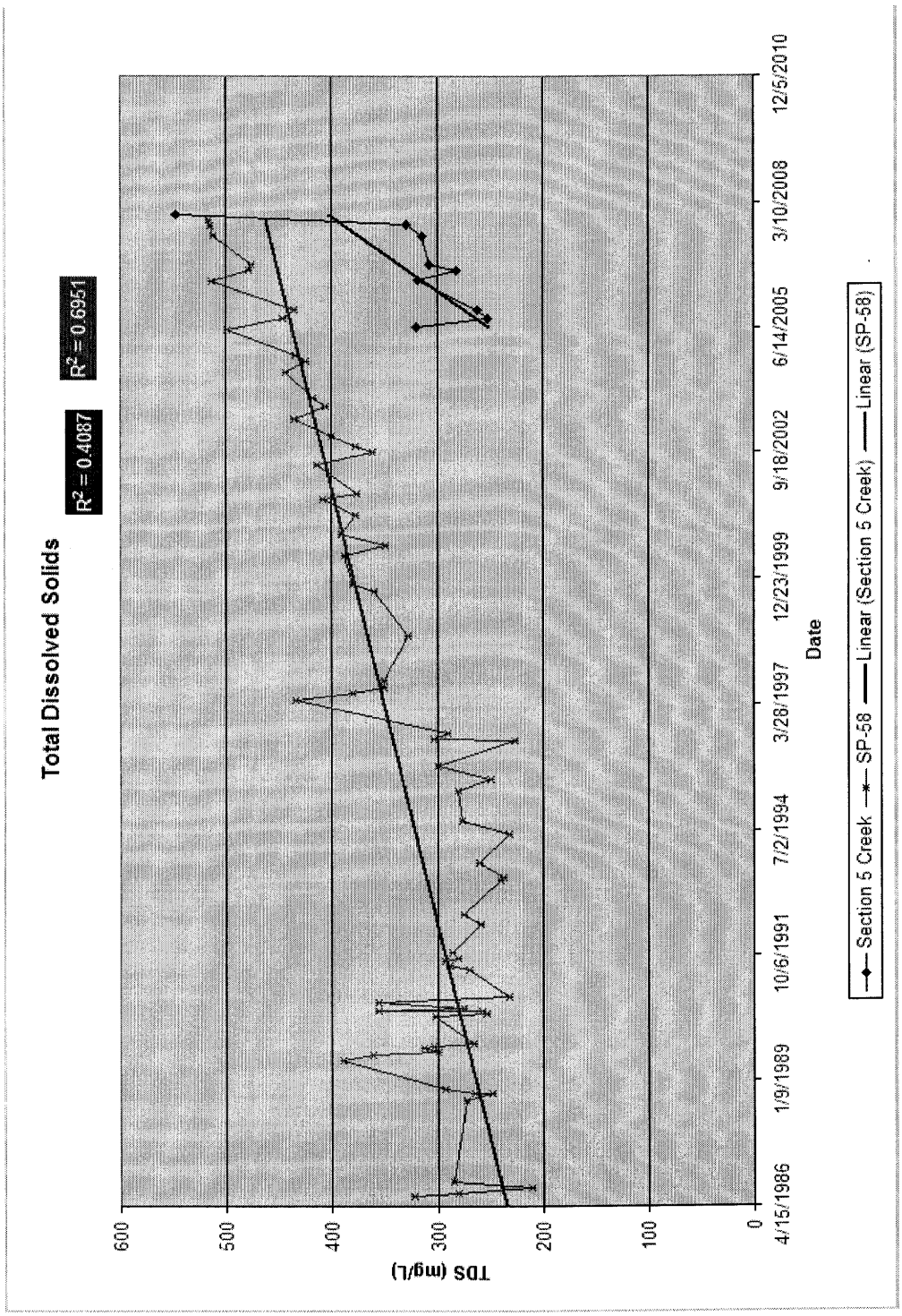

Dissolved Oxygen
R^2 = 0.1714
Water Temp (celsius)
Dissolved Oxygen (mg/L)
Date
2/17/2005
5/28/2005
9/5/2005
12/14/2005
3/24/2006
7/2/2006
10/10/2006
1/18/2007
4/28/2007
8/6/2007
11/14/2007
2/22/2008
0
2
4
6
8
10
12
Dissolved Oxygen
Water Temp
Linear (Dissolved Oxygen)

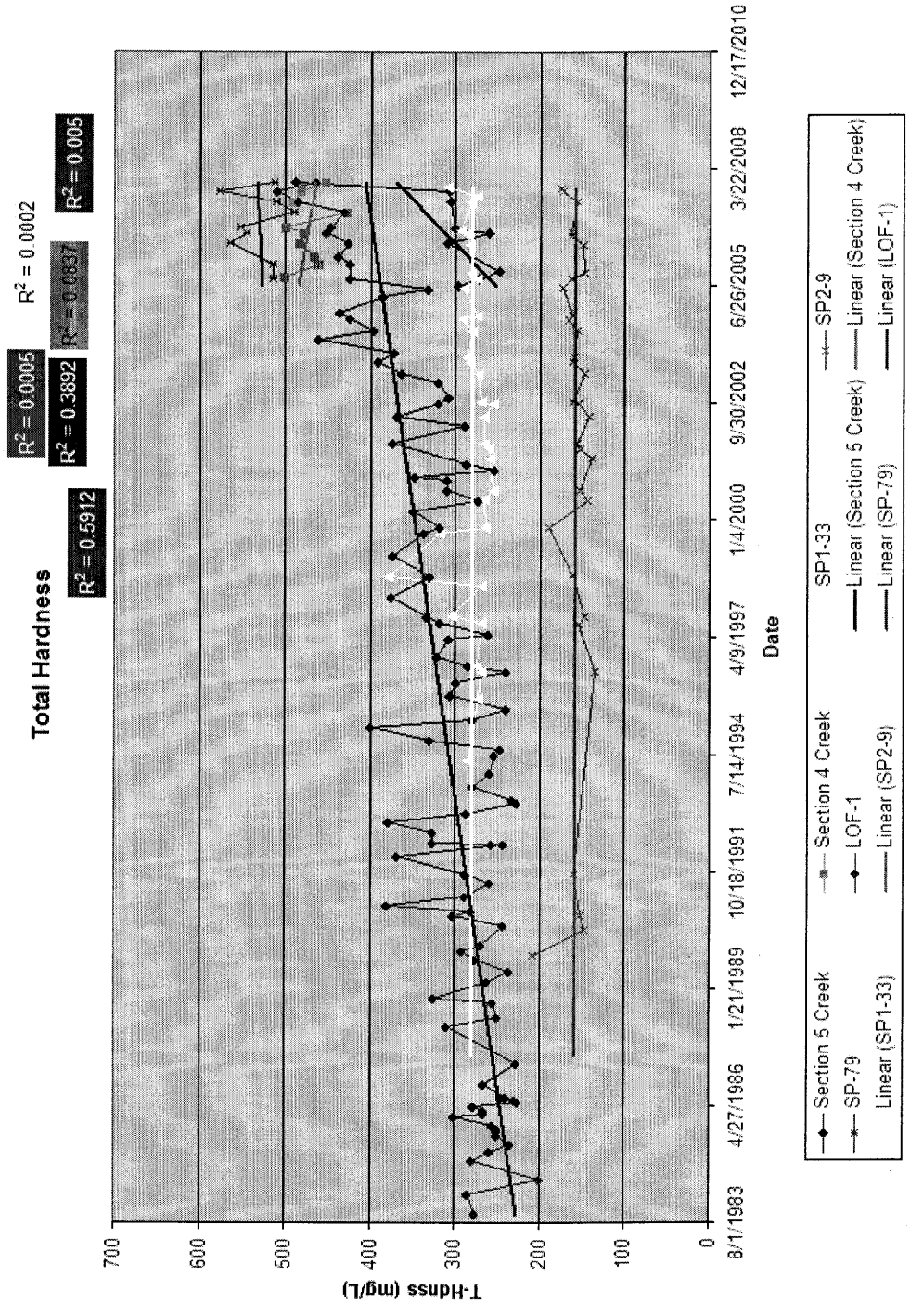

Flow vs. Palmer Hydrologic Drought Index and Surface Water Supply Index
Flow (gpm)
PHDI/SWSI Index #
Date
SP1-47 Flow
PHDI Region 7
SWSI San Rafael Basin
90
80
70
60
50
40
30
20
10
0
6
4
2
0
-2
-4
-6
-8
10/28/1995
3/11/1997
7/24/1998
12/6/1999
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
7/6/2009


Sulfate
R² = 0.5541
R² = 0.3524
R² = 0.5763
R² = 0.3713
R² = 0.7314
SO4 (mg/L)
250
200
150
100
50
0
6/1/1983
2/25/1986
11/21/1988
8/18/1991
5/14/1994
2/7/1997
11/4/1999
7/31/2002
4/26/2005
1/21/2008
10/17/2010
Date
Section 5 Creek
SP-58
IBC-1
LOF-1
SP1-33
Linear (Section 5 Creek)
Linear (SP-58)
Linear (IBC-1)
Linear (LOF-1)
Linear (SP1-33)


Specific Conductivity
R² = 0.4735
R² = 0.2367
R² = 0.1839
Sp. Cond. (µmhos/cm)
1000
900
800
700
600
500
400
300
200
100
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
2/22/2008
Date
Section 5 Creek
Section 4 Creek
SP-79
Linear (Section 5 Creek)
Linear (Section 4 Creek)
Linear (SP-79)


Total Alkalinity
R² = 0.7349
R² = 0.3892
T-Alk (mg/L)
400
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
2/22/2008
Date
Section 5 Creek
SP-79
Linear (Section 5 Creek)
Linear (SP-79)


Total Dissolved Solids
R² = 0.4087
R² = 0.6951
TDS (mg/L)
600
500
400
300
200
100
0
4/15/1986
1/9/1989
10/6/1991
7/2/1994
3/28/1997
12/23/1999
9/18/2002
6/14/2005
3/10/2008
12/5/2010
Date
Section 5 Creek
SP-58
Linear (Section 5 Creek)
Linear (SP-58)


Total Hardness
R² = 0.5912
R² = 0.0005
R² = 0.3892
R² = 0.0002
R² = 0.0837
R² = 0.005
T-Hdnss (mg/L)
0
100
200
300
400
500
600
700
8/1/1983
4/27/1986
1/21/1989
10/18/1991
7/14/1994
4/9/1997
1/4/2000
9/30/2002
6/26/2005
3/22/2008
12/17/2010
Date
Section 5 Creek
Section 4 Creek
SP1-33
SP2-9
SP-79
LOF-1
Linear (Section 5 Creek)
Linear (Section 4 Creek)
Linear (SP1-33)
Linear (SP2-9)
Linear (SP-79)
Linear (LOF-1)