1956 – 2009 DATA SUMMARY
LAS VEGAS WASH, LAS VEGAS BAY, AND LAKE MEAD

Clark County Water Reclamation DISTRICT

WINTER 2009

A REVIEW & SUMMARY OF PAST DATA

- Old Engineering reports
- Old Operational records
- Environmental sampling of Lake Mead by SNWA and other agencies
- Annual regulatory reports by City of Las Vegas

POTW EFFLUENT PHOSPHORUS

- **An attempt was made to characterize the amount of P being discharged daily from the treatment plants since the CCWRD plant came on line in 1956.**

1956 – 1968 City of Las Vegas and Clark County WRD Phosphorus Discharges

- City and County two year average discharge flows from *A History of Civil Engineering Infrastructure In Southern Nevada, September 2003* by Walt Johnson presented to the American Society of Civil Engineers, Southern Nevada Branch Life Members Forum

- Effluent total phosphorus reported as 7.2 mg/L. Clark County 208 plan by URS Company

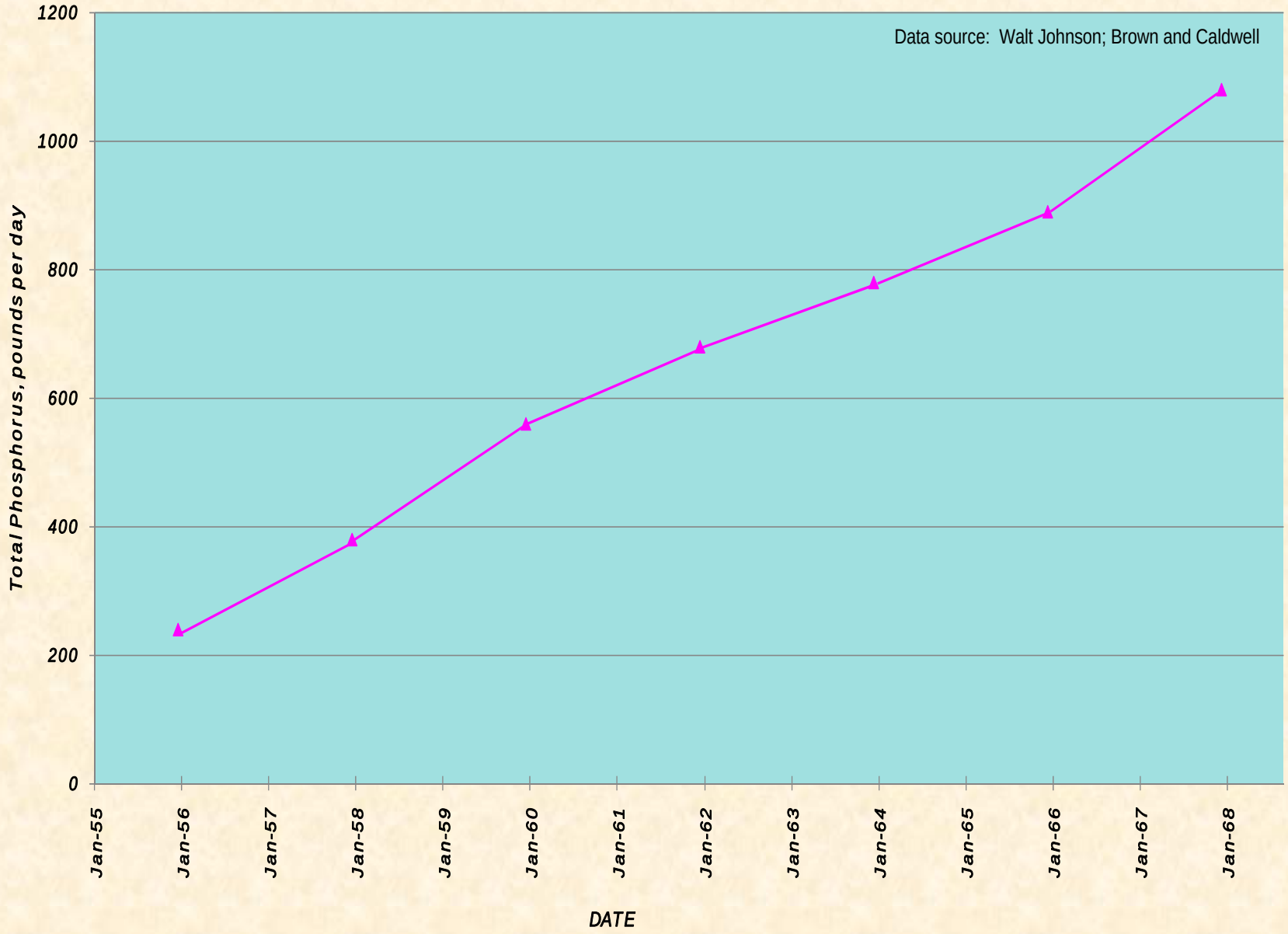
- Used an effluent total phosphorus concentration of 5 mg/L

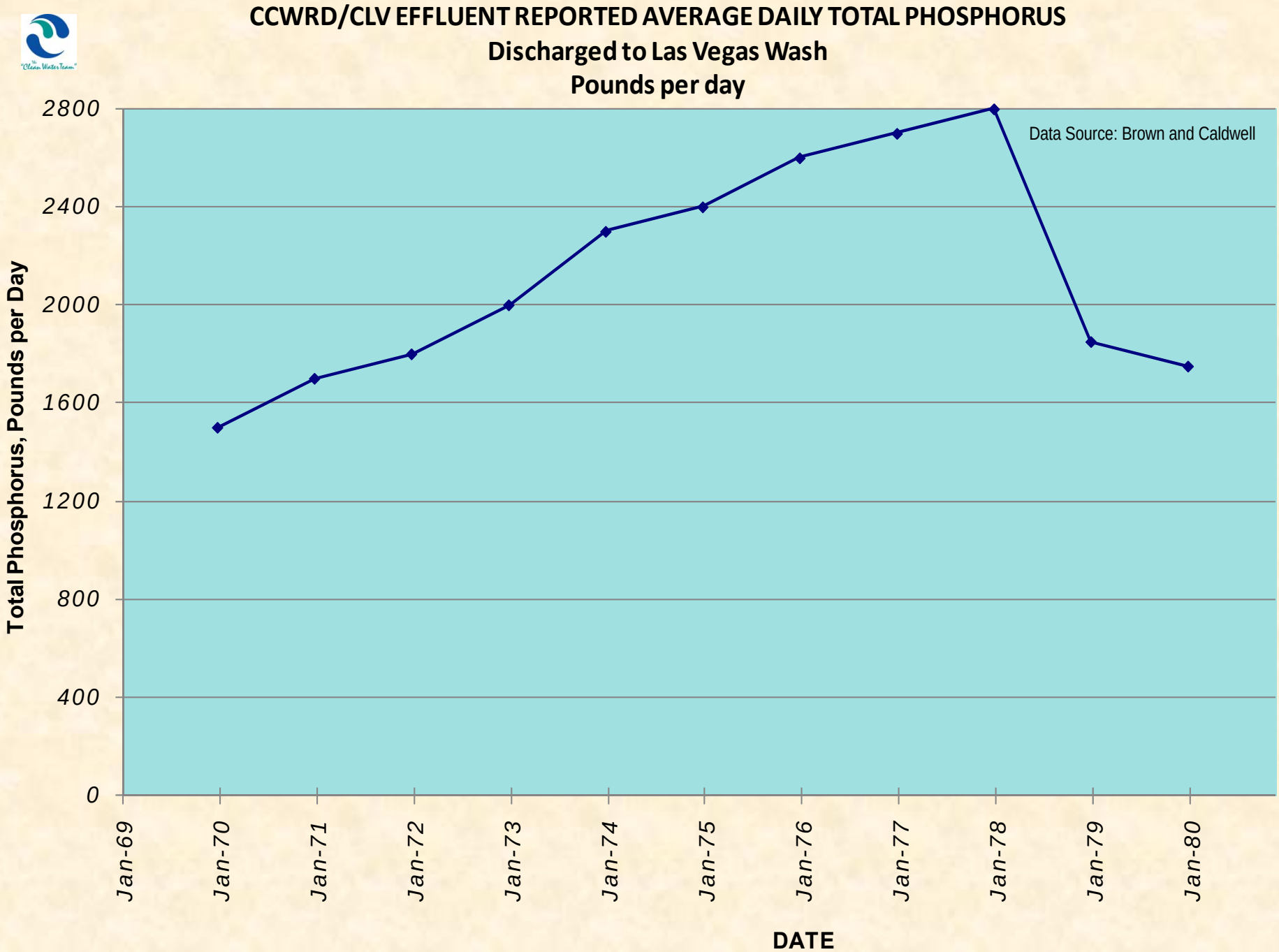
- Brown & Caldwell and Culp/Weisner/Culp Engineering reports

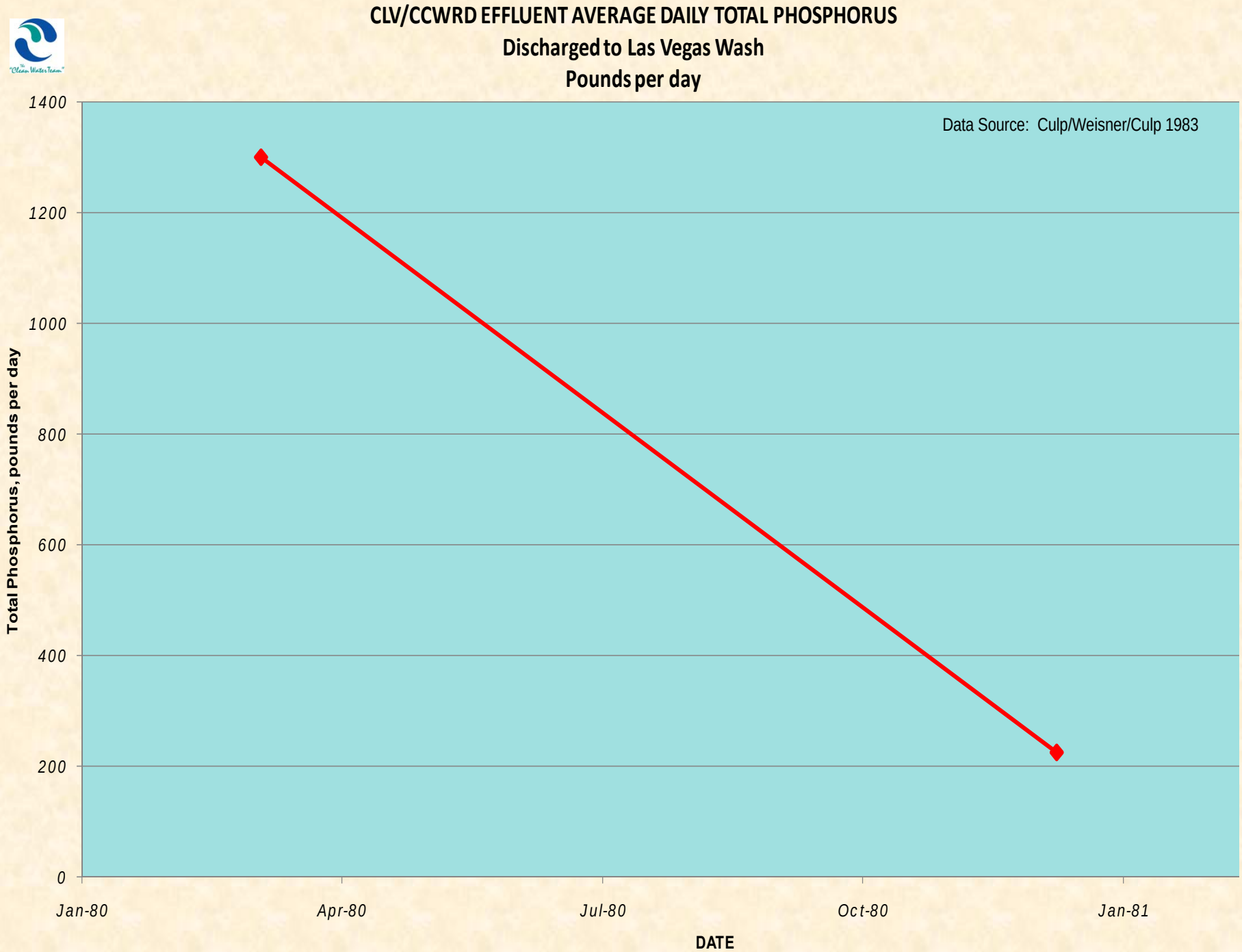
ESTIMATED DISCHARGERS' EFFLUENT AVERAGE DAILY TOTAL PHOSPHORUS

Discharged to Las Vegas Wash

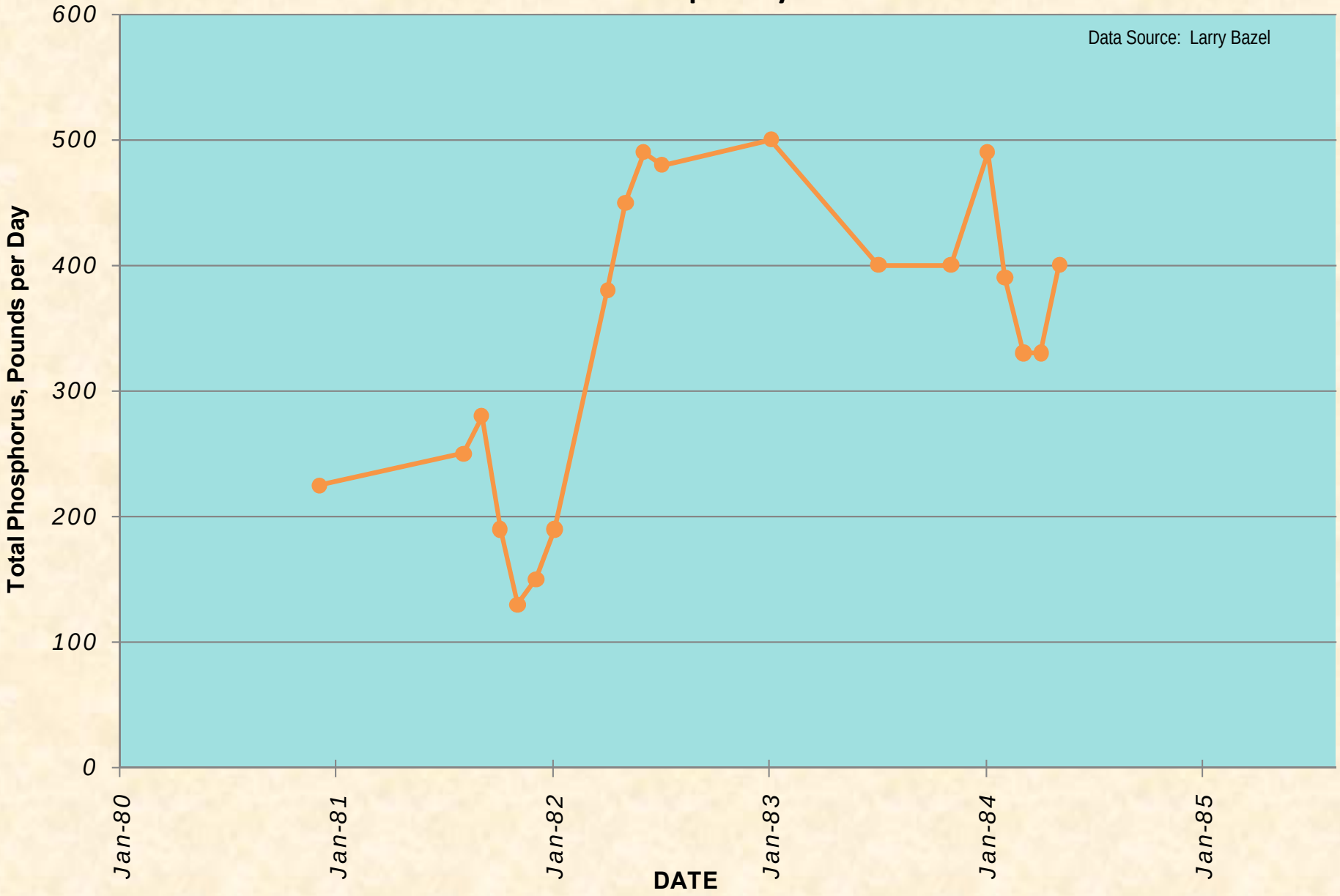
Pounds per day




CCWRD/CLV EFFLUENT REPORTED AVERAGE DAILY TOTAL PHOSPHORUS
Discharged to Las Vegas Wash
Pounds per day
Data Source: Brown and Caldwell
Total Phosphorus, Pounds per Day
2800
2400
2000
1600
1200
800
400
0
Jan-69
Jan-70
Jan-71
Jan-72
Jan-73
Jan-74
Jan-75
Jan-76
Jan-77
Jan-78
Jan-79
Jan-80
DATE

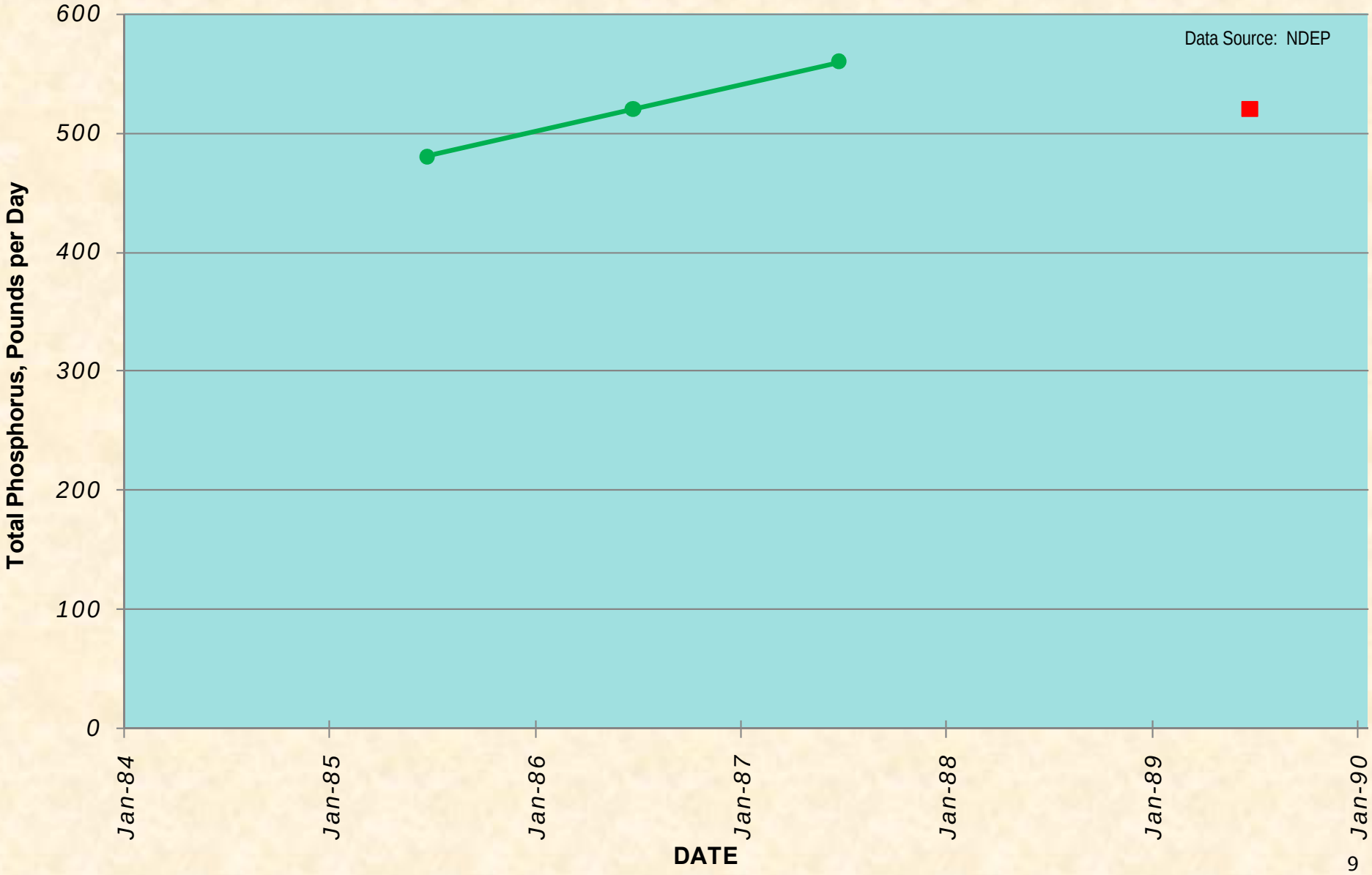

CLV/CCWRD EFFLUENT AVERAGE DAILY TOTAL PHOSPHORUS
Discharged to Las Vegas Wash
Pounds per day
Data Source: Culp/Weisner/Culp 1983
Total Phosphorus, pounds per day
1400
1200
1000
800
600
400
200
0
Jan-80
Apr-80
Jul-80
Oct-80
Jan-81
DATE

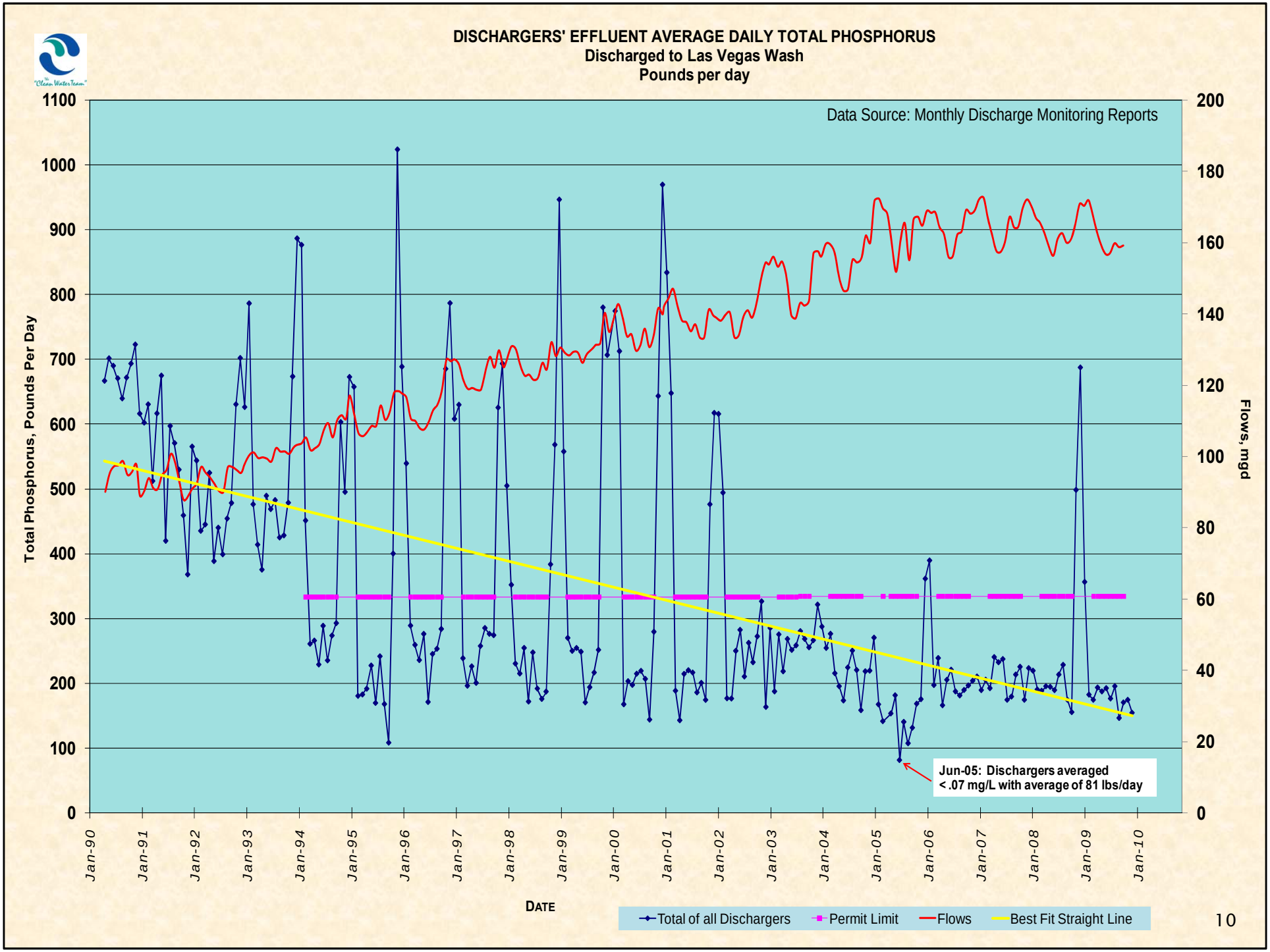
ESTIMATED DISCHARGERS' EFFLUENT AVERAGE DAILY TOTAL PHOSPHORUS
Discharged to Las Vegas Wash
Pounds per day



NDEP REPORTED LAS VEGAS WASH AVERAGE DAILY TOTAL PHOSPHORUS

Pounds per day

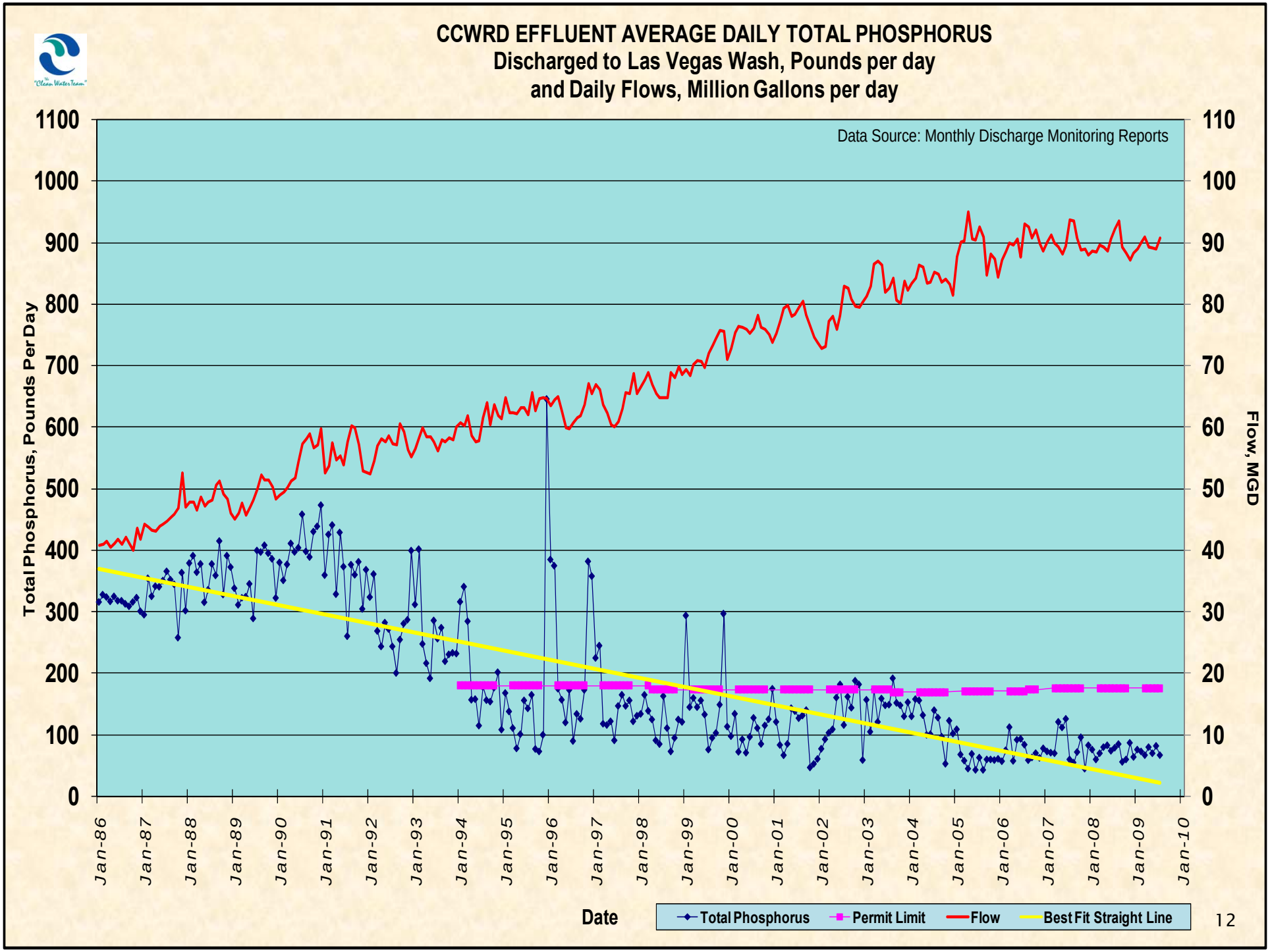



DISCHARGERS' EFFLUENT AVERAGE DAILY TOTAL PHOSPHORUS
Discharged to Las Vegas Wash
Pounds per day
Data Source: Monthly Discharge Monitoring Reports
Total Phosphorus, Pounds Per Day
Flows, mgd
Jun-05: Dischargers averaged
< .07 mg/L with average of 81 lbs/day
DATE
Total of all Dischargers
Permit Limit
Flows
Best Fit Straight Line

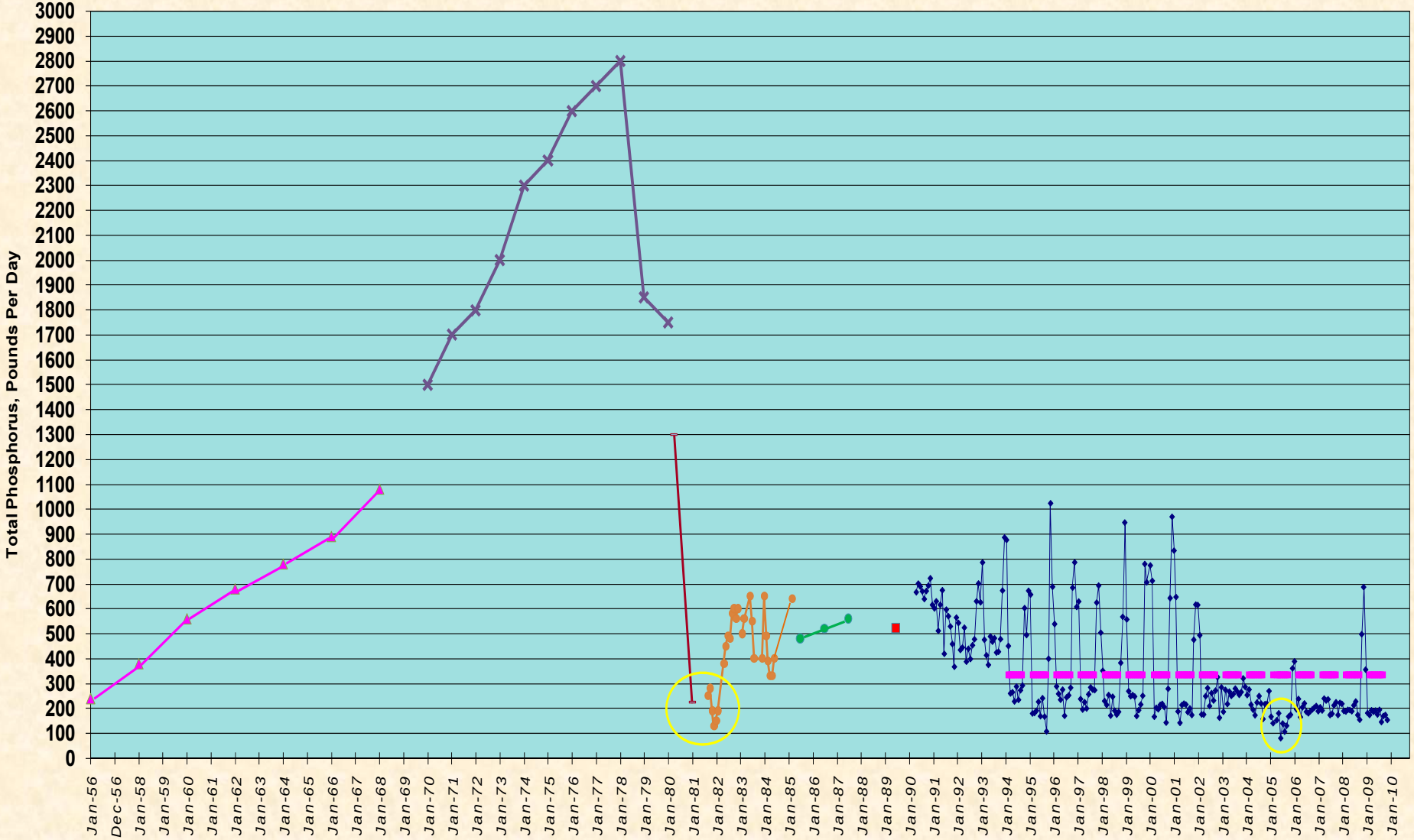
CCWRD EFFLUENT
1986 - PRESENT

- **CCWRD started optimizing P removal at its plant in the spring of 2004**

- **CCWRD began tertiary addition of alum in the last week of January 2005**


CCWRD EFFLUENT AVERAGE DAILY TOTAL PHOSPHORUS
Discharged to Las Vegas Wash, Pounds per day
and Daily Flows, Million Gallons per day
Data Source: Monthly Discharge Monitoring Reports
Total Phosphorus, Pounds Per Day
Flow, MGD
1100
1000
900
800
700
600
500
400
300
200
100
0
110
100
90
80
70
60
50
40
30
20
10
0
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Date
Total Phosphorus
Permit Limit
Flow
Best Fit Straight Line

ESTIMATED DISCHARGERS' EFFLUENT AVERAGE DAILY TOTAL PHOSPHORUS
Discharged to Las Vegas Wash
Pounds per day



1956-1969 Calculated annual average total P flow data from *A History of Civil Engineering Infrastructure In Southern Nevada, September 2003* by American Society of Civil Engineers, Southern Nevada Branch Life Members Forum. Effluent reported as 7.2 mg/L effluent Total P from *Water Quality Standard Study Report, March 1982* by Brown and Caldwell. A total phosphorus value of 5 mg/L was used to estimate phosphorus loadings

1970-1980 Annual average total P from *Las Vegas Valley Water Quality Program - Water Quality Standards Study Report, March 1982* by Brown and Caldwell

1980-1981 North Shore Road loadings annual average, lbs P/day from *Draft Report Water Quality Standards Study, March 1982* by Culp/Weisner/Culp February 1983

1981-1985 Data information from Larry Bazel

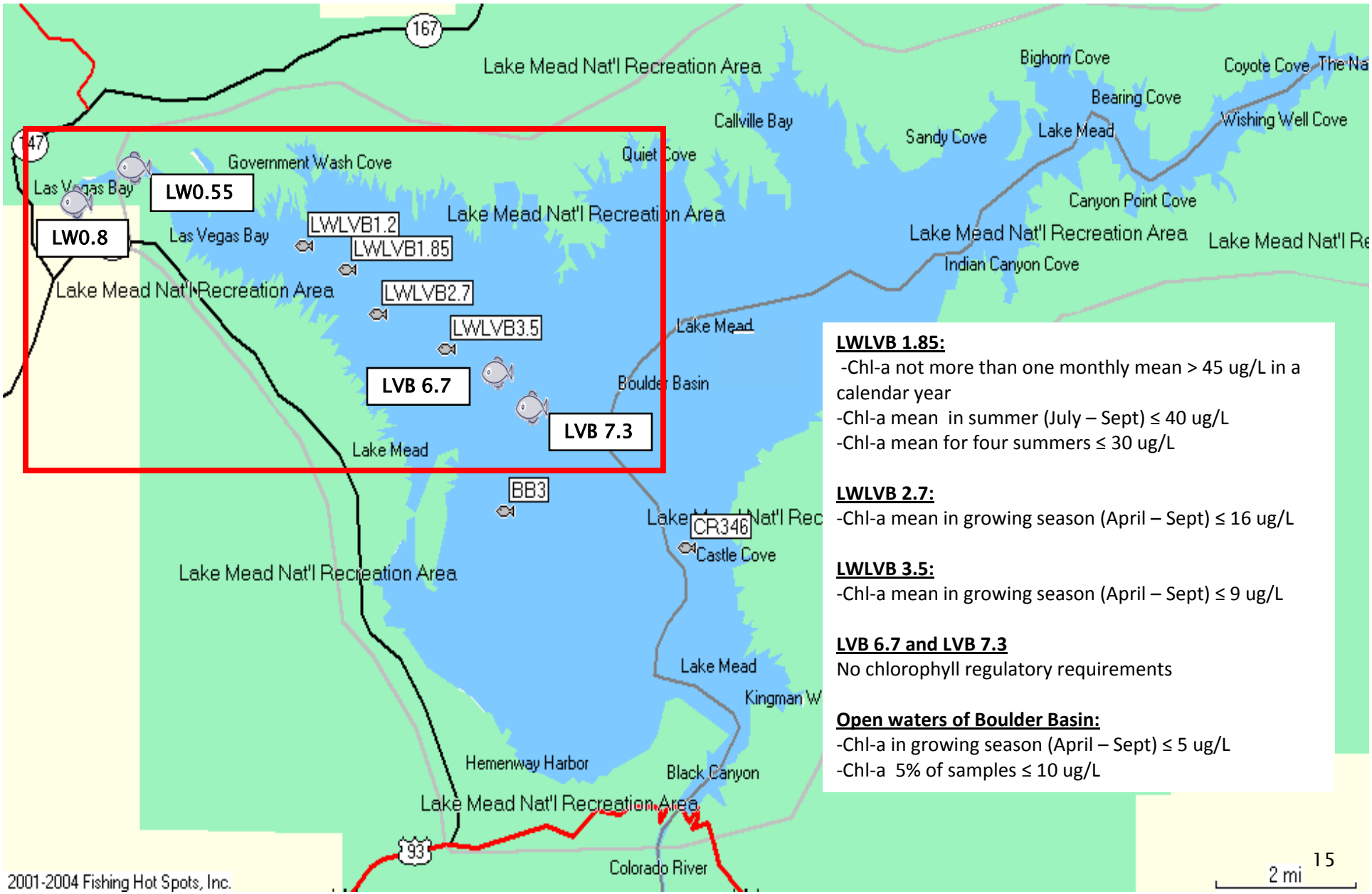
1985-1987 Growing season average total P in Las Vegas Wash from *Total Maximum Daily Loads at North Shore Road and Waste Load Allocations, May 1989* by Nevada Division of Environmental Protection

1989 *Interim Waste Load Allocation* from *Total Maximum Daily Loads at North Shore Road and Waste Load Allocations, May 1989* by Nevada Division of Environmental Protection

1990-2009 Monthly average total P from Discharge Monitoring Reports

- Overall, this graph shows that the lowest 4 years of total P being discharged by the treatment plants is from 2005 to present. Conversely stated, the water quality that we see today in Lake Mead, could be compared to the water quality in Lake Mead over 50 years ago.

Sampling Sites



LWLVB 1.85:
-Chl-a not more than one monthly mean > 45 ug/L in a calendar year
-Chl-a mean in summer (July – Sept) ≤ 40 ug/L
-Chl-a mean for four summers ≤ 30 ug/L

LWLVB 2.7:
-Chl-a mean in growing season (April – Sept) ≤ 16 ug/L

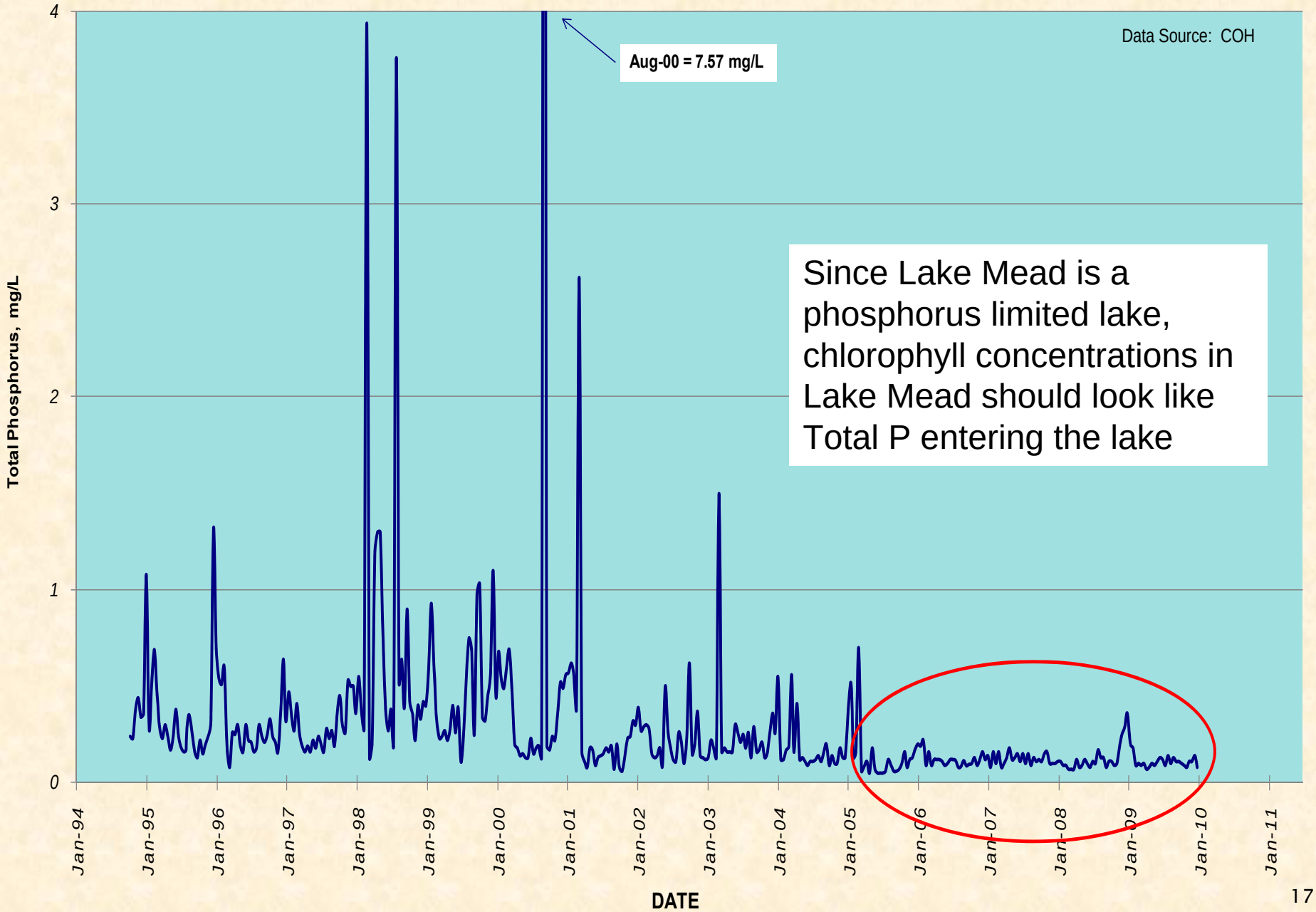
LWLVB 3.5:
-Chl-a mean in growing season (April – Sept) ≤ 9 ug/L

LVB 6.7 and LVB 7.3
No chlorophyll regulatory requirements

Open waters of Boulder Basin:
-Chl-a in growing season (April – Sept) ≤ 5 ug/L
-Chl-a 5% of samples ≤ 10 ug/L

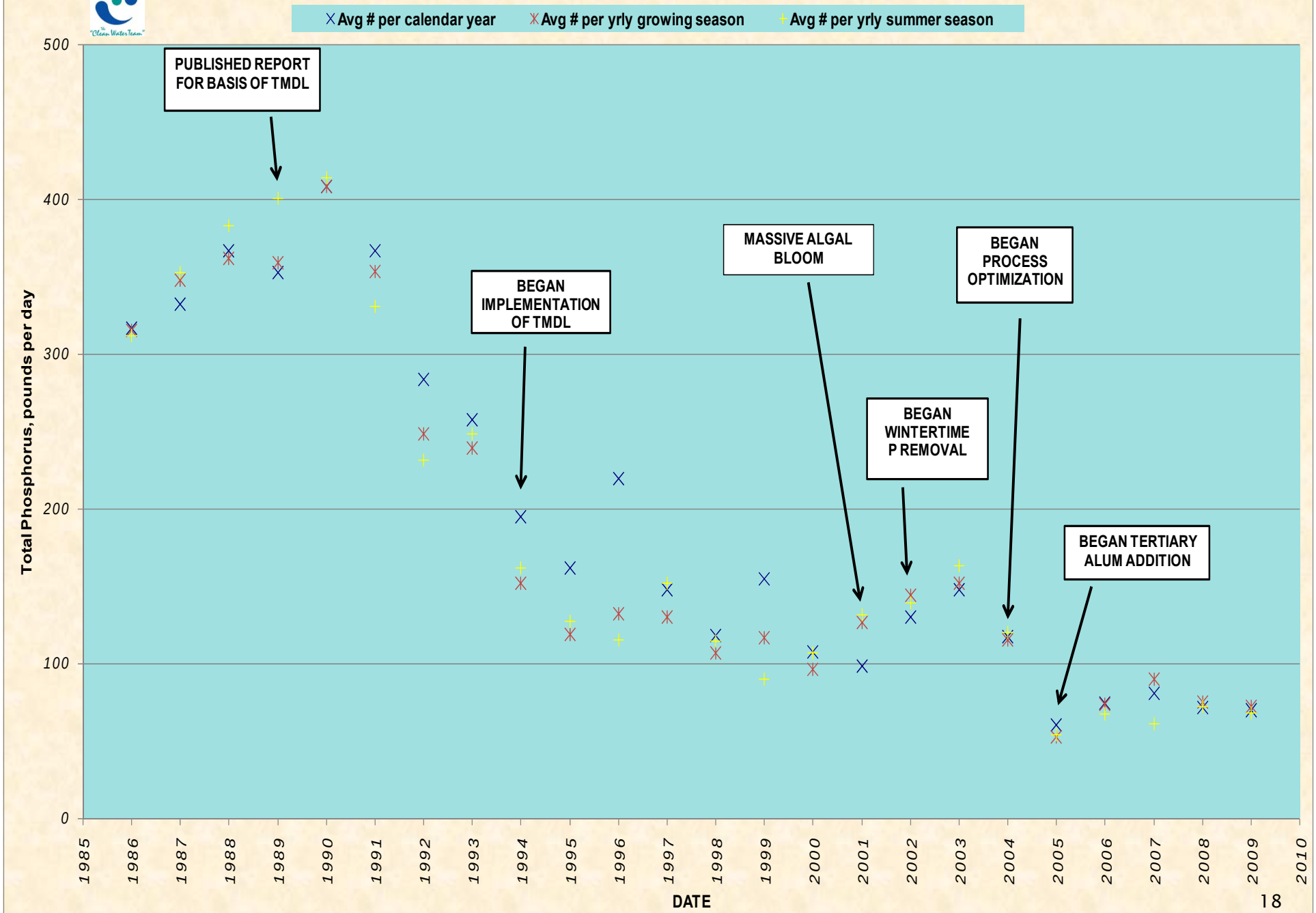
TOTAL P CONCENTRATIONS AND MASS ENTERING THE LAS VEGAS BAY 1985 TO PRESENT

- The concentration of total P entering the Las Vegas Bay is characterized by measuring the total P in the Las Vegas Wash at North Shore Road, LW0.55
- A significant reduction in the total P concentrations can be seen beginning in 2005
- The increased frequency of sampling can be readily seen in the recent past
- Some of the operational events in the last 5 years that impact water quality are shown

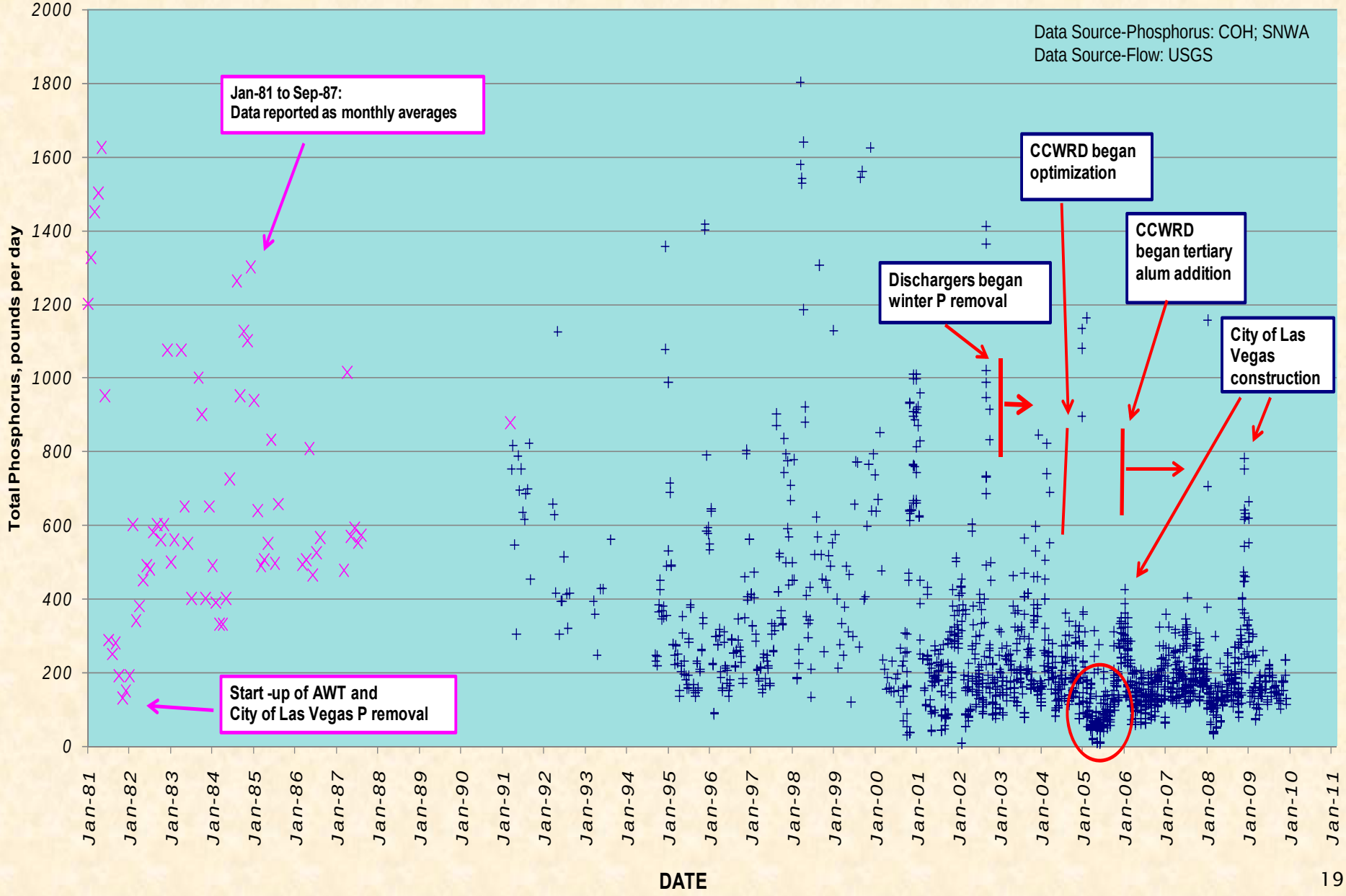


Since Lake Mead is a phosphorus limited lake, chlorophyll concentrations in Lake Mead should look like Total P entering the lake

CCWRD EFFLUENT AVERAGE TOTAL PHOSPHORUS

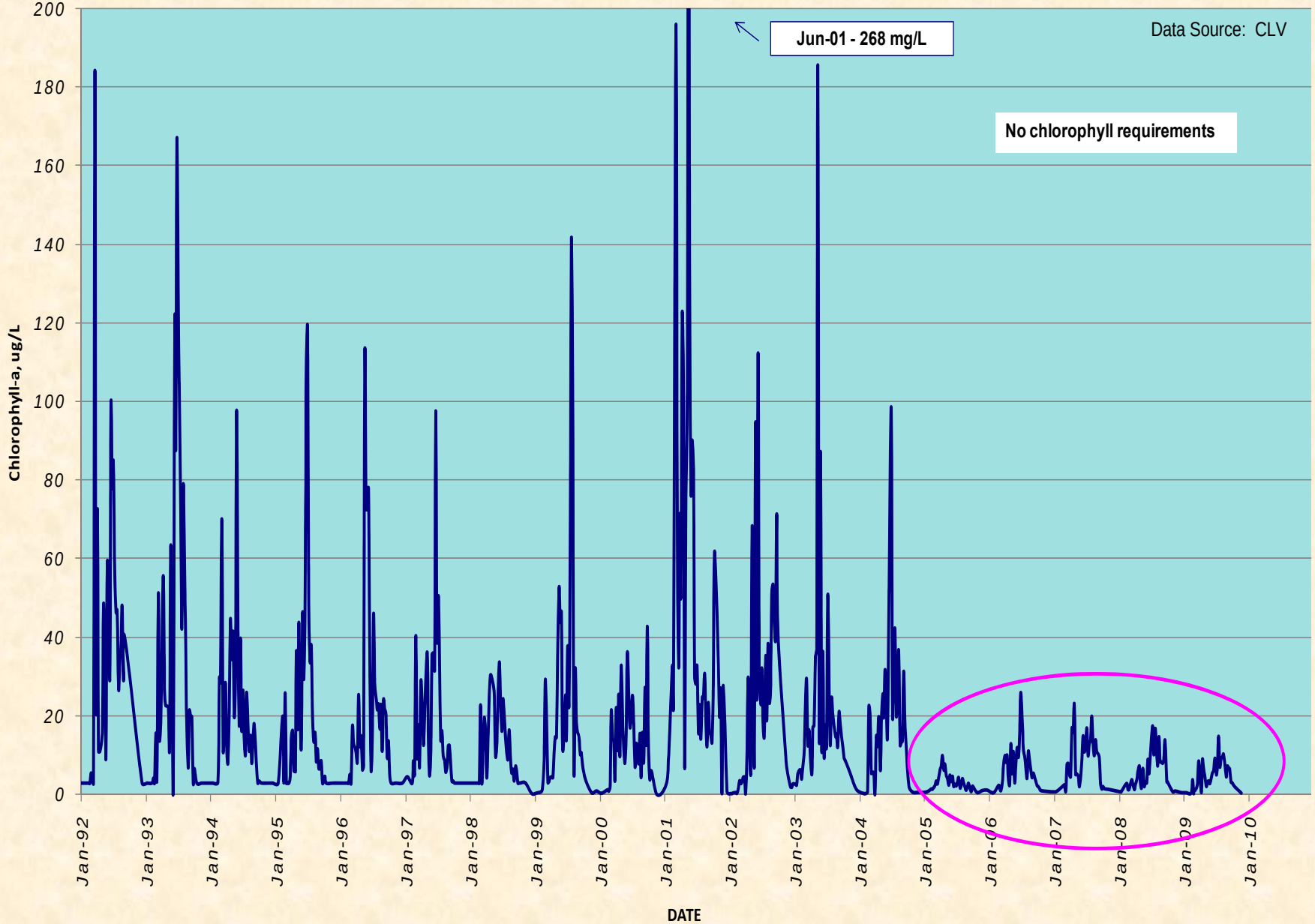


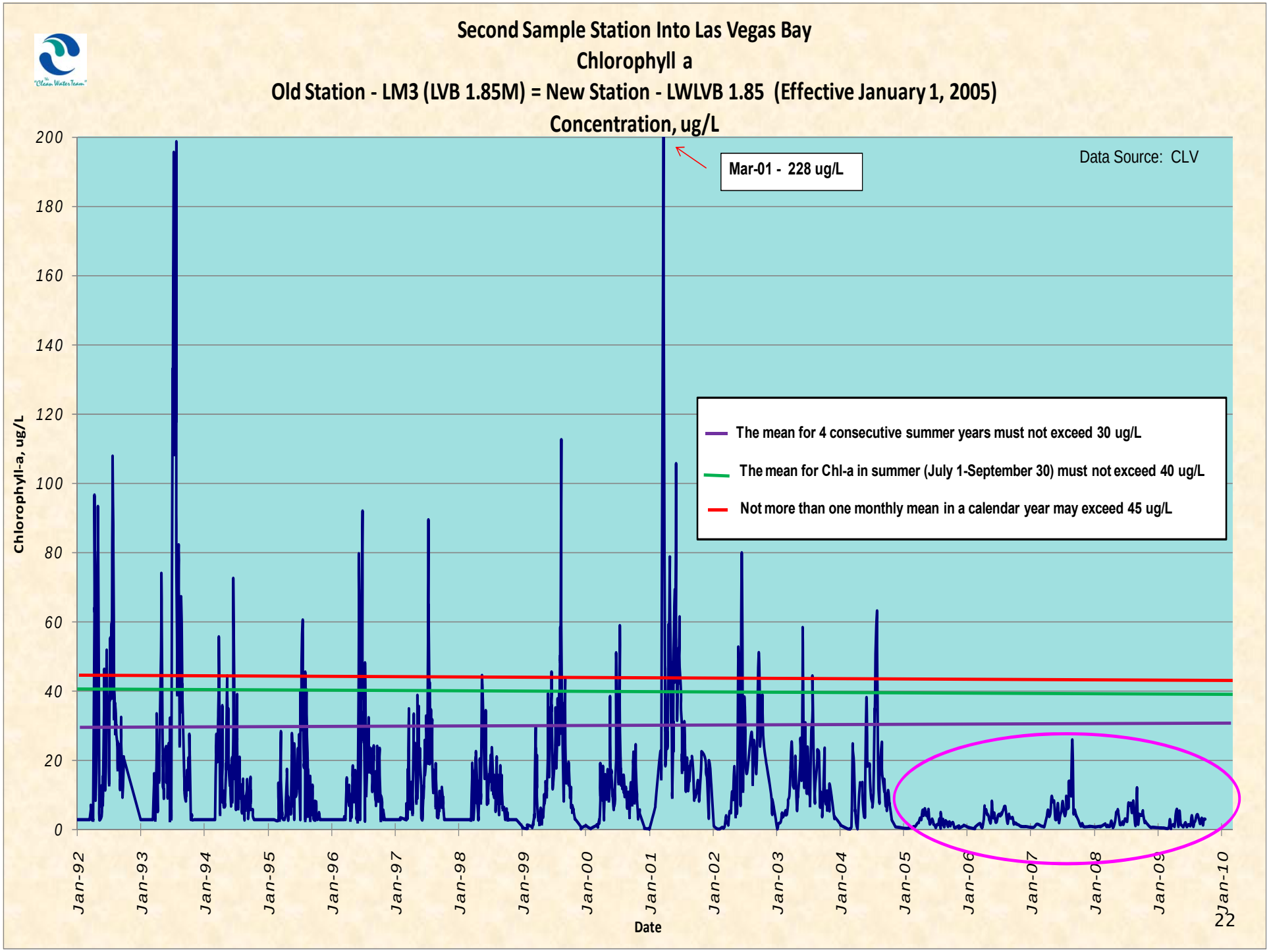
LAS VEGAS WASH ESTIMATED TOTAL PHOSPHORUS
LW0.55, LW0.8, USGS 09419700, USGS 09419753
Pounds per day



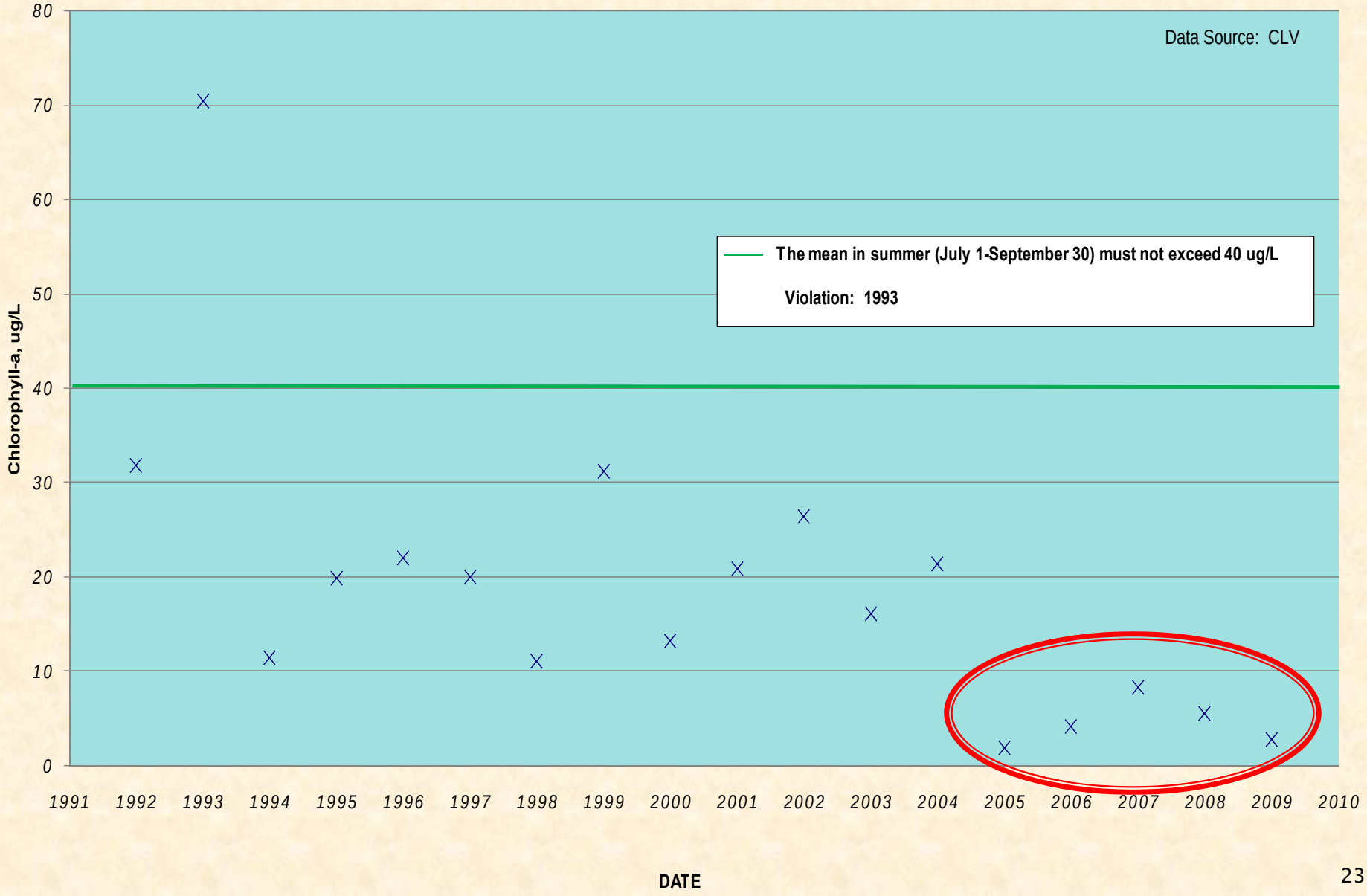
LAS VEGAS BAY CHLOROPHYLL-a 1992 - PRESENT

- The amount of algae growing in the Las Vegas Bay is determined by measuring the Chlorophyll-a concentration
- Note that the highest Chlorophyll-a concentration was observed during the algal bloom of 2001
- Chlorophyll-a concentrations have been very low since 2005

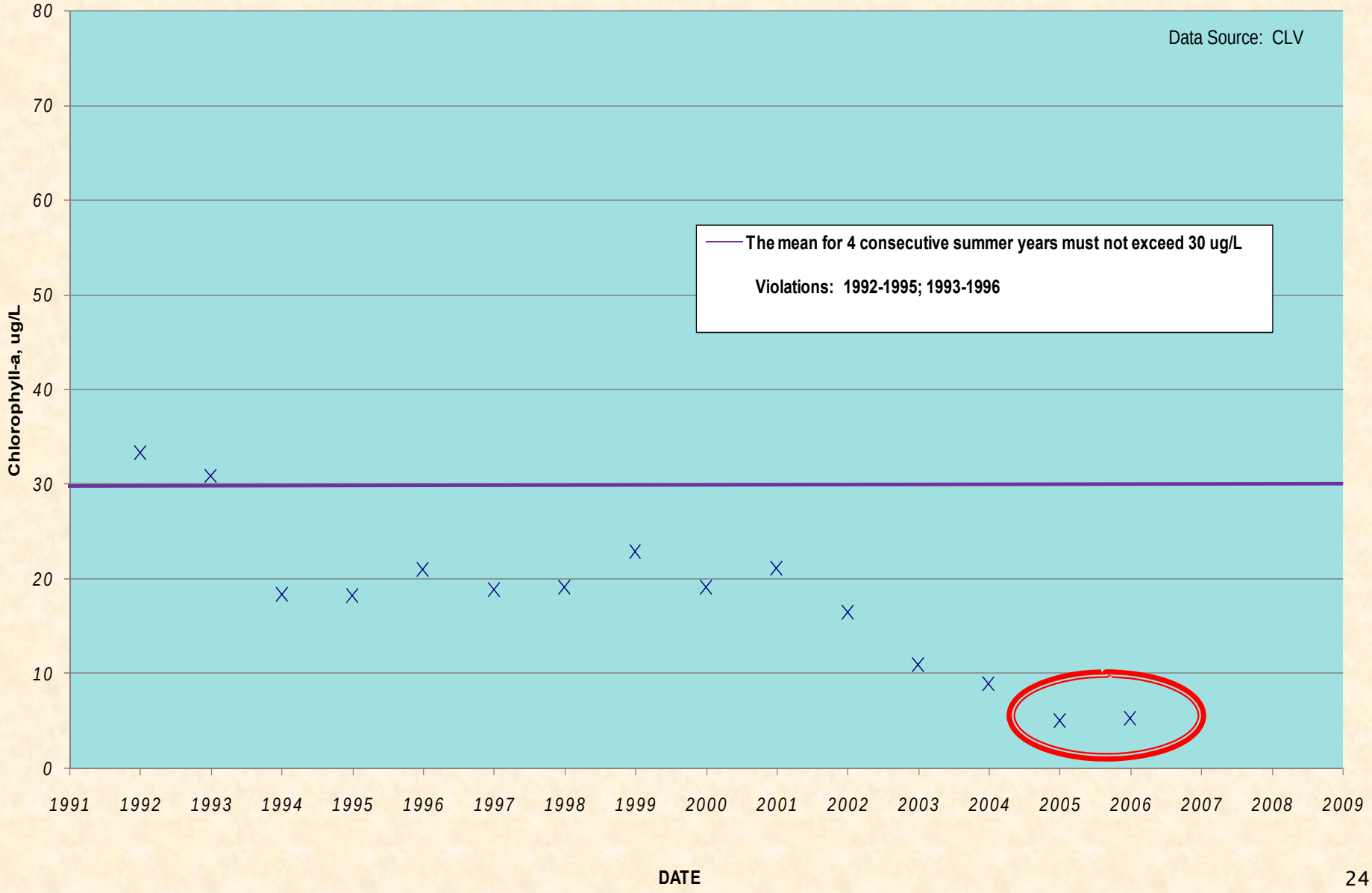

First Sample Station into Las Vegas Bay
Chlorophyll a
Old Station - LM2(LVB1.8M = New Station - LWLVB1.2 (effective Januay 1, 2005)
Concentration, ug/L
Jun-01 - 268 mg/L
Data Source: CLV
No chlorophyll requirements
Chlorophyll-a, ug/L
0
20
40
60
80
100
120
140
160
180
200
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
DATE

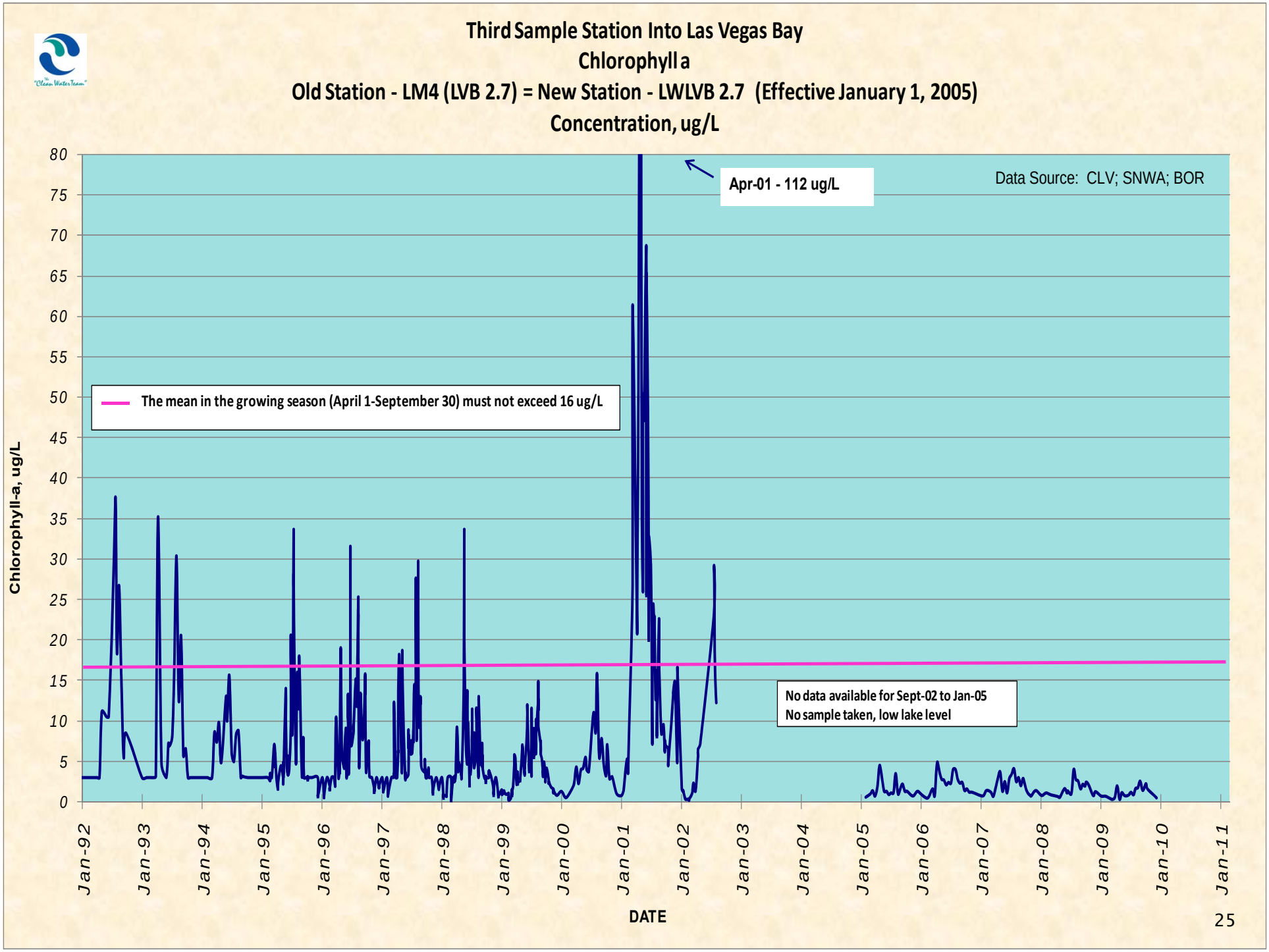

Second Sample Station Into Las Vegas Bay
Chlorophyll a
Old Station - LM3 (LVB 1.85M) = New Station - LWLVB 1.85 (Effective January 1, 2005)
Concentration, ug/L
Data Source: CLV
Mar-01 - 228 ug/L
The mean for 4 consecutive summer years must not exceed 30 ug/L
The mean for Chl-a in summer (July 1-September 30) must not exceed 40 ug/L
Not more than one monthly mean in a calendar year may exceed 45 ug/L
Chlorophyll-a, ug/L
0
20
40
60
80
100
120
140
160
180
200
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Date

Second Sample Station Into Las Vegas Bay
Chlorophyll a, ug/L
Old Station - LM3 (LVB 1.85M) = New Station - LWLVB 1.85 (Effective January 1, 2005)
Chl-a Mean in summer (7/1-9/30) <40 ug/L

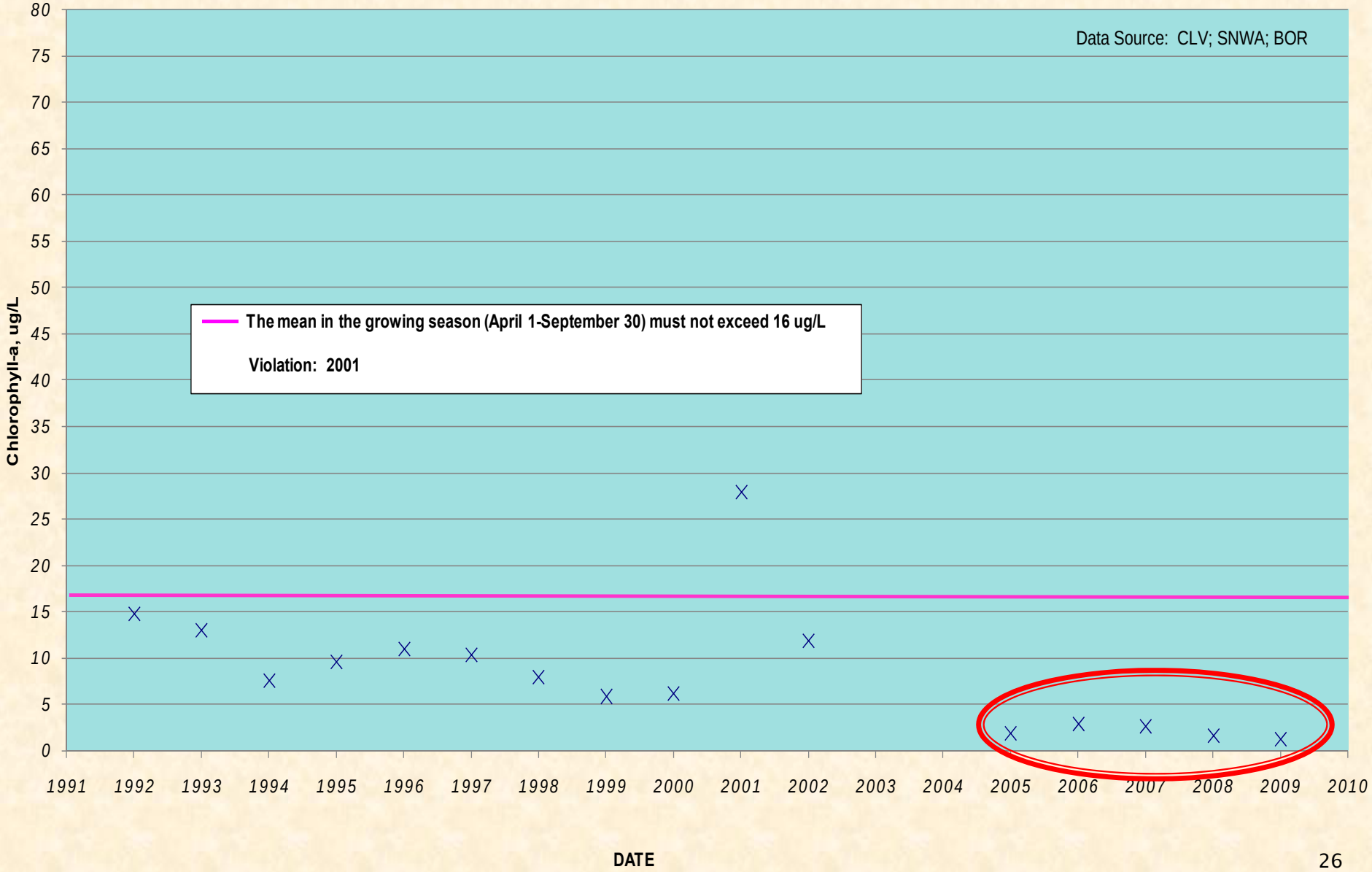


Second Sample Station Into Las Vegas Bay
Chlorophyll a, ug/L
Old Station - LM3 (LVB 1.85M) = New Station - LWLVB 1.85 (Effective January 1, 2005)
Chl-a Mean for 4 consecutive summer years (7/1-9/30) <30 ug/L

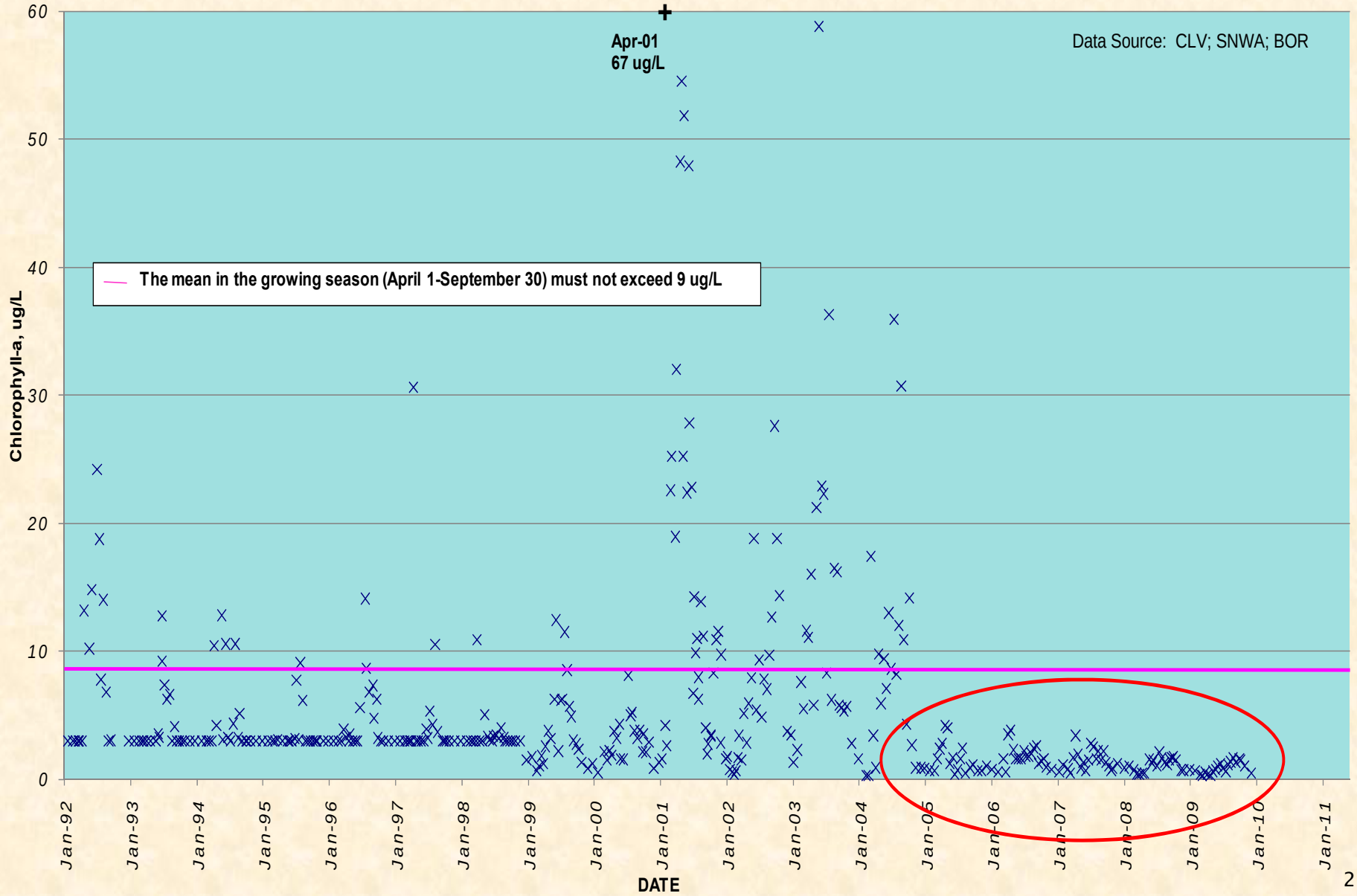



Third Sample Station Into Las Vegas Bay
Chlorophyll a
Old Station - LM4 (LVB 2.7) = New Station - LWLVB 2.7 (Effective January 1, 2005)
Concentration, ug/L
Apr-01 - 112 ug/L
Data Source: CLV; SNWA; BOR
The mean in the growing season (April 1-September 30) must not exceed 16 ug/L
No data available for Sept-02 to Jan-05
No sample taken, low lake level
Chlorophyll-a, ug/L
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
DATE

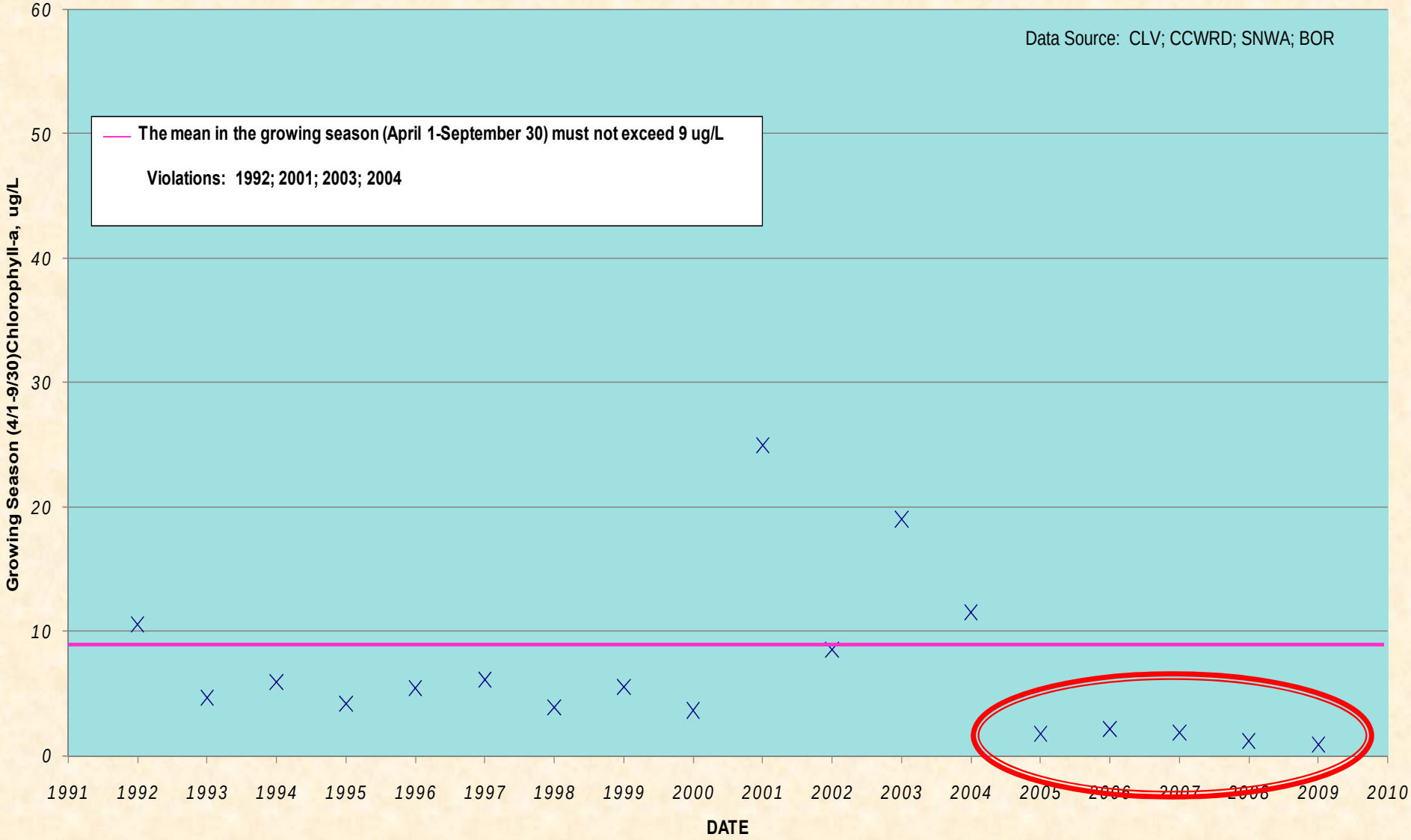
Third Sample Station Into Las Vegas Bay
Chlorophyll-a, ug/L
Old Station - LM4 (LVB 2.7) = New Station - LWLVB 2.7 (Effective January 1, 2005)
Chl-a Mean for Growing Season (4/1-9/30) <16 ug/L



Fourth Sample Station Into Las Vegas Bay
Chlorophyll a
Old Station - LM5 (LVB3.5) = New Station - LWLVB 3.5 (Effective January 1, 2005)
Concentration, ug/L



Fourth Station into Las Vegas Bay
Chlorophyll-a, ug/L
Old Station - LM5 (LVB 3.5) = New Station - LWLVB 3.5 (Effective January 1, 2005)
Chl-a Mean for Growing Season (4/1-9/30) <9 ug/L

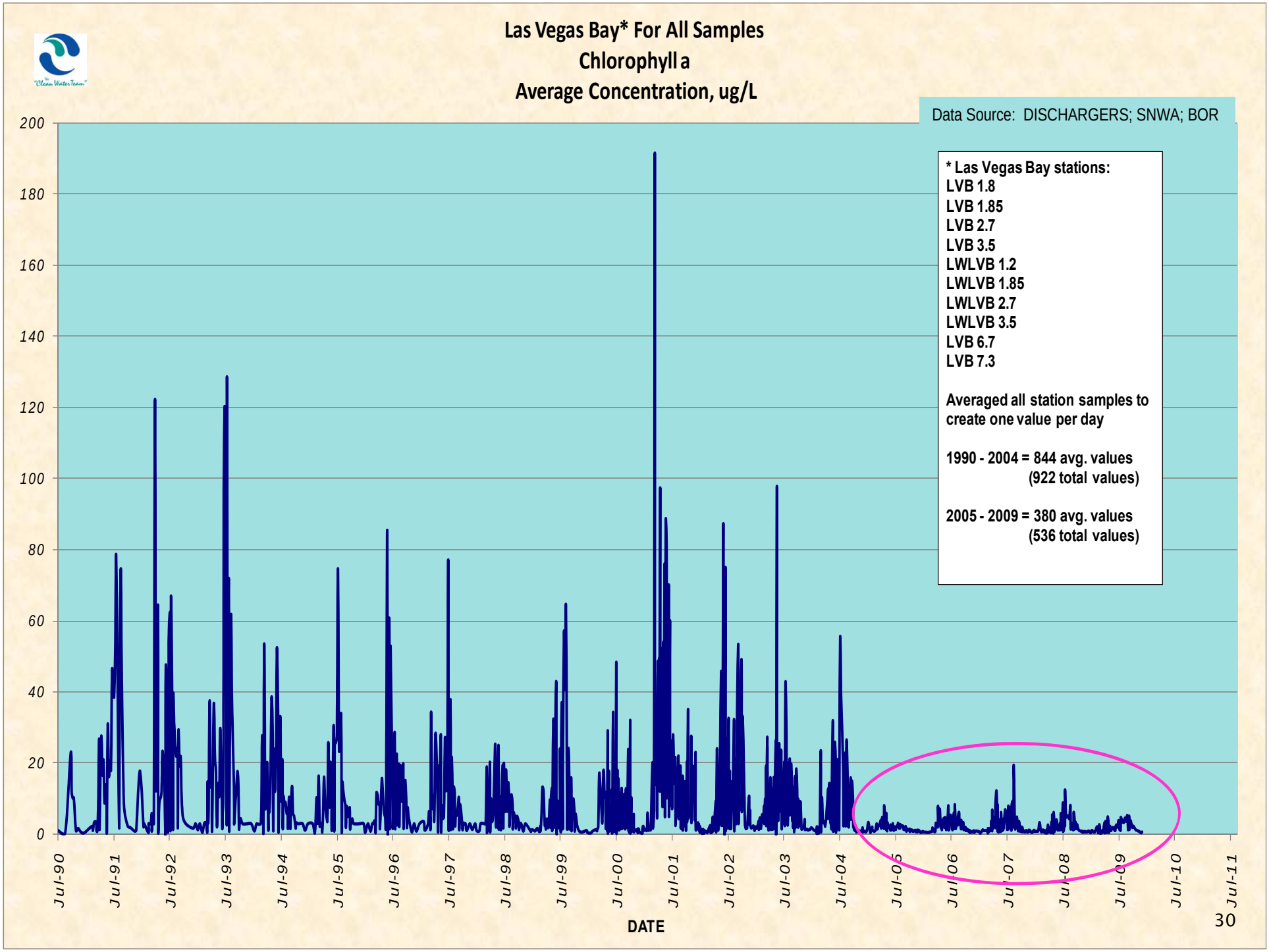


LAS VEGAS BAY

STATIONARY STATIONS THAT REMAINED STATIONARY

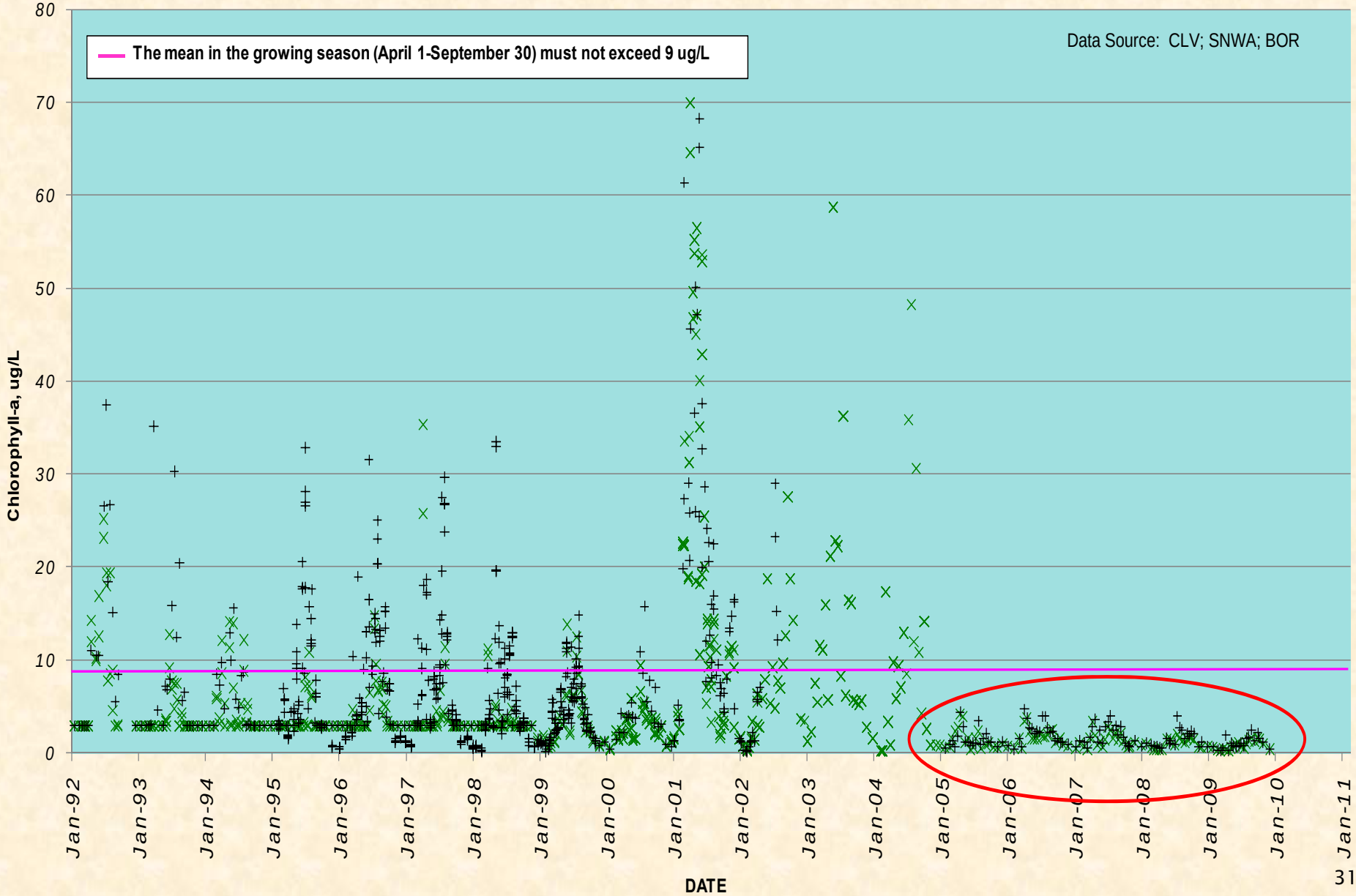
AND

STATIONARY STATIONS THAT BECAME MOVING

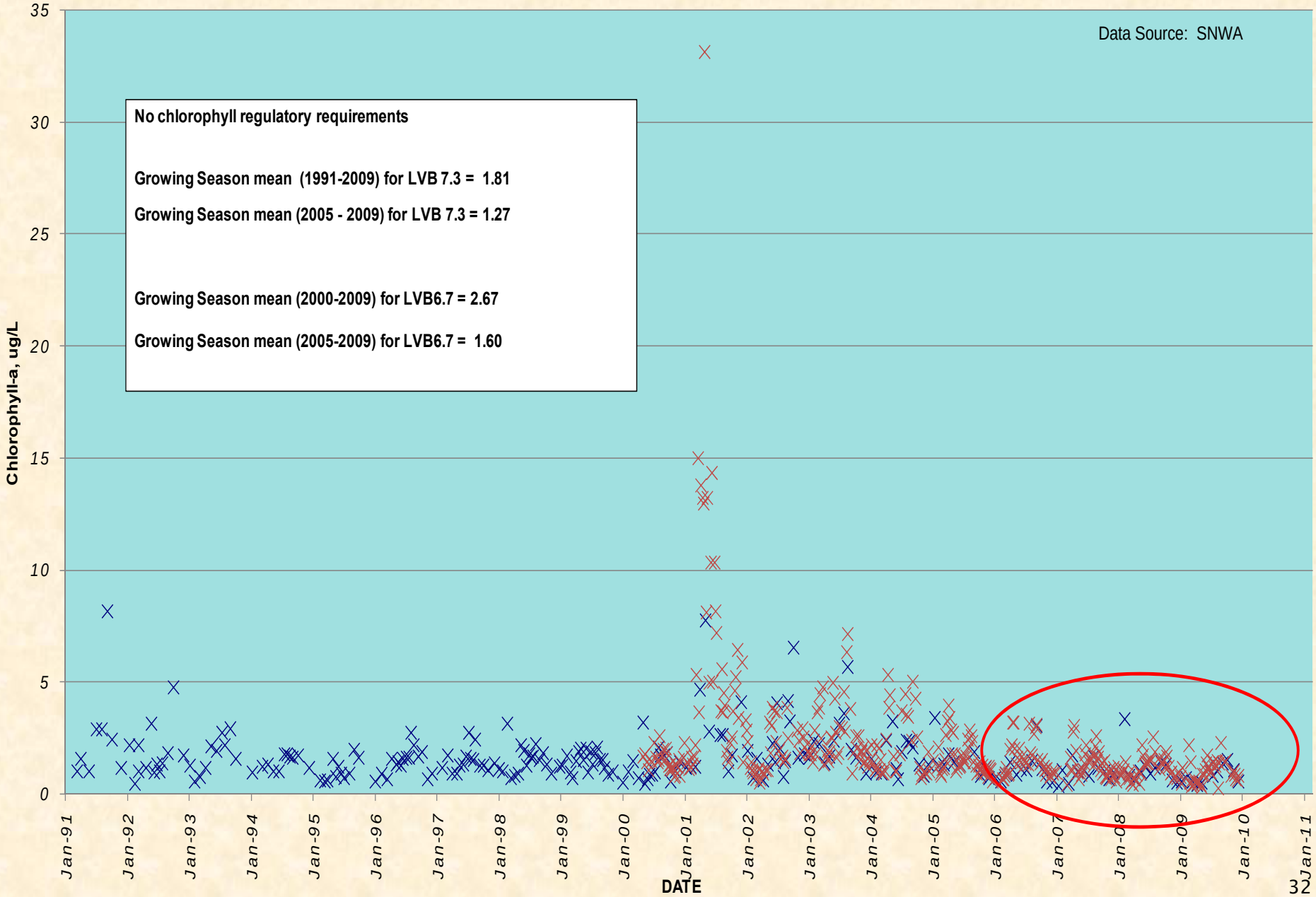

Las Vegas Bay* For All Samples
Chlorophyll a
Average Concentration, ug/L
Data Source: DISCHARGERS; SNWA; BOR
* Las Vegas Bay stations:
LVB 1.8
LVB 1.85
LVB 2.7
LVB 3.5
LWLVB 1.2
LWLVB 1.85
LWLVB 2.7
LWLVB 3.5
LVB 6.7
LVB 7.3
Averaged all station samples to create one value per day
1990 - 2004 = 844 avg. values (922 total values)
2005 - 2009 = 380 avg. values (536 total values)
200
180
160
140
120
100
80
60
40
20
0
Jul-90
Jul-91
Jul-92
Jul-93
Jul-94
Jul-95
Jul-96
Jul-97
Jul-98
Jul-99
Jul-00
Jul-01
Jul-02
Jul-03
Jul-04
Jul-05
Jul-06
Jul-07
Jul-08
Jul-09
Jul-10
Jul-11
DATE

Stationary Station - LM5 (LVB3.5) = Moving Station - LWLVB 3.5 (effective January 1, 2005) and Stationary Station - LM4 (LVB2.7) = Moving Station - LWLVB 2.7 (effective January 1, 2005)

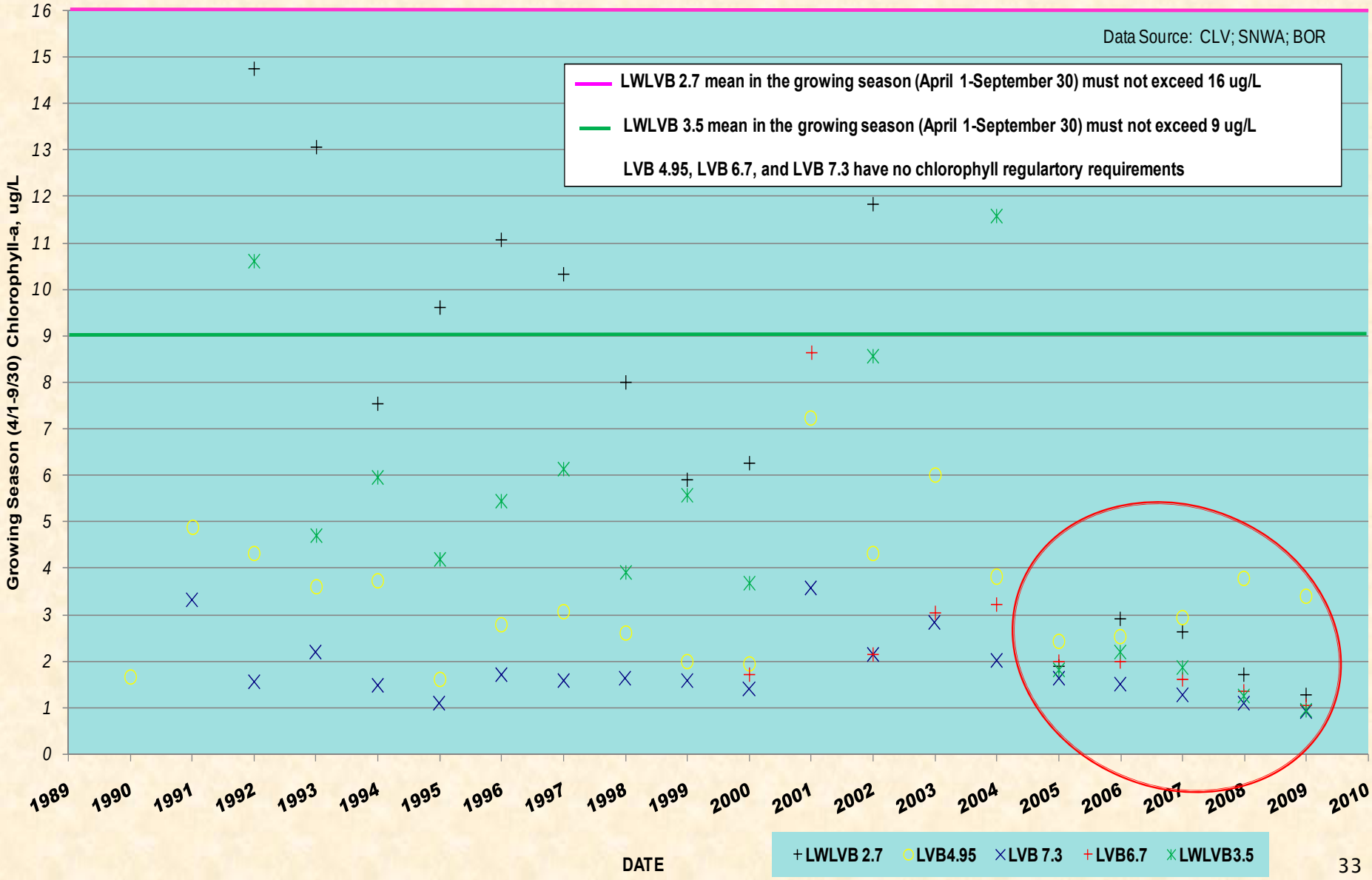
Chlorophyll Concentration, ug/L



Stationary Stations LVB6.7 and LVB7.3
Chlorophyll-a, ug/L

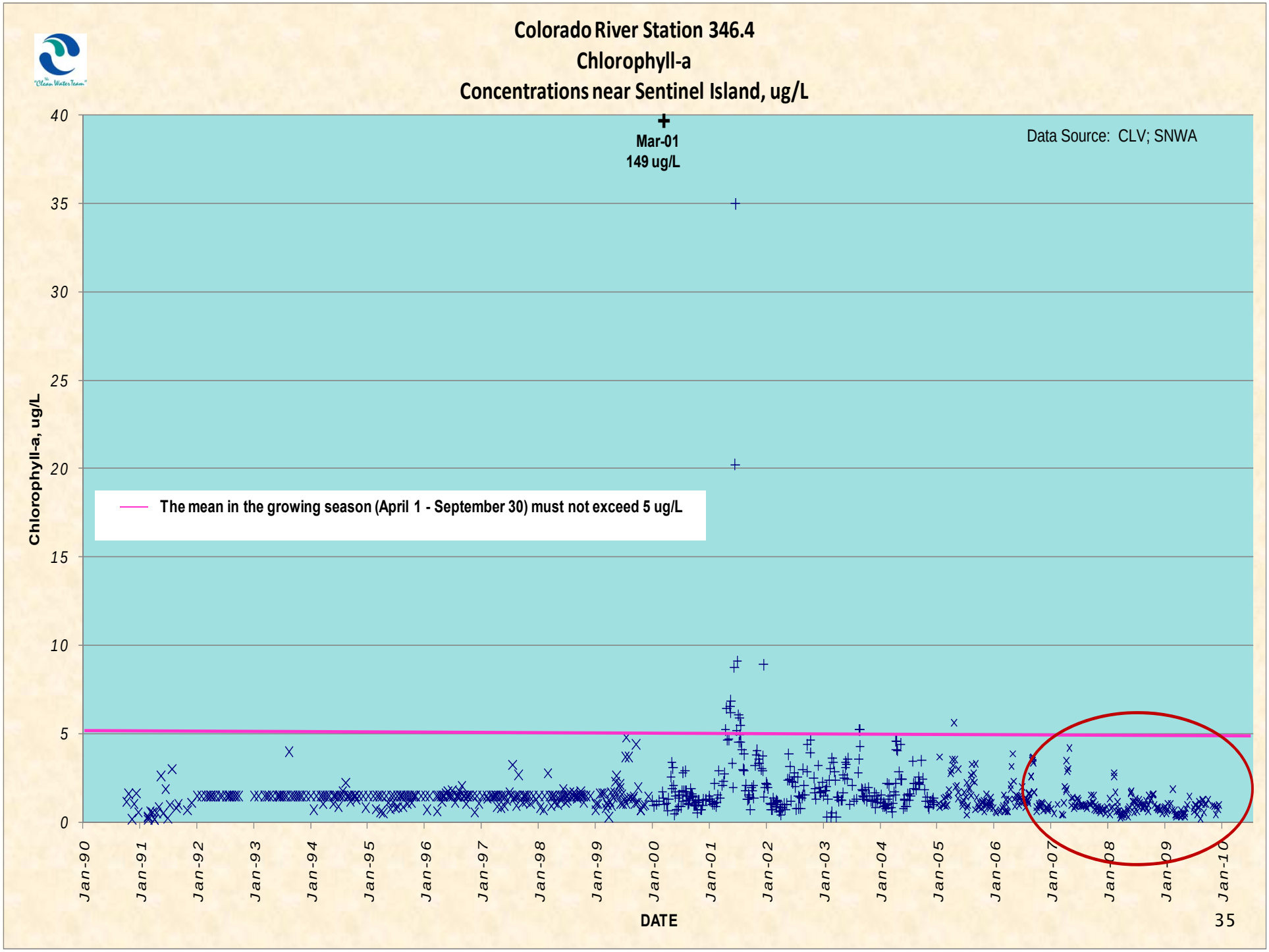


Stationary Stations: LVB4.95, LVB 6.7, and LVB 7.3 and Stationary Station - LM4 (LVB 2.7) = Moving Station - LWLVB 2.7 and Stationary Station - LM5 (LVB 3.5) = Moving Station - LWLVB 3.5 Chl-a Mean for Growing Season (4/1-9/30)

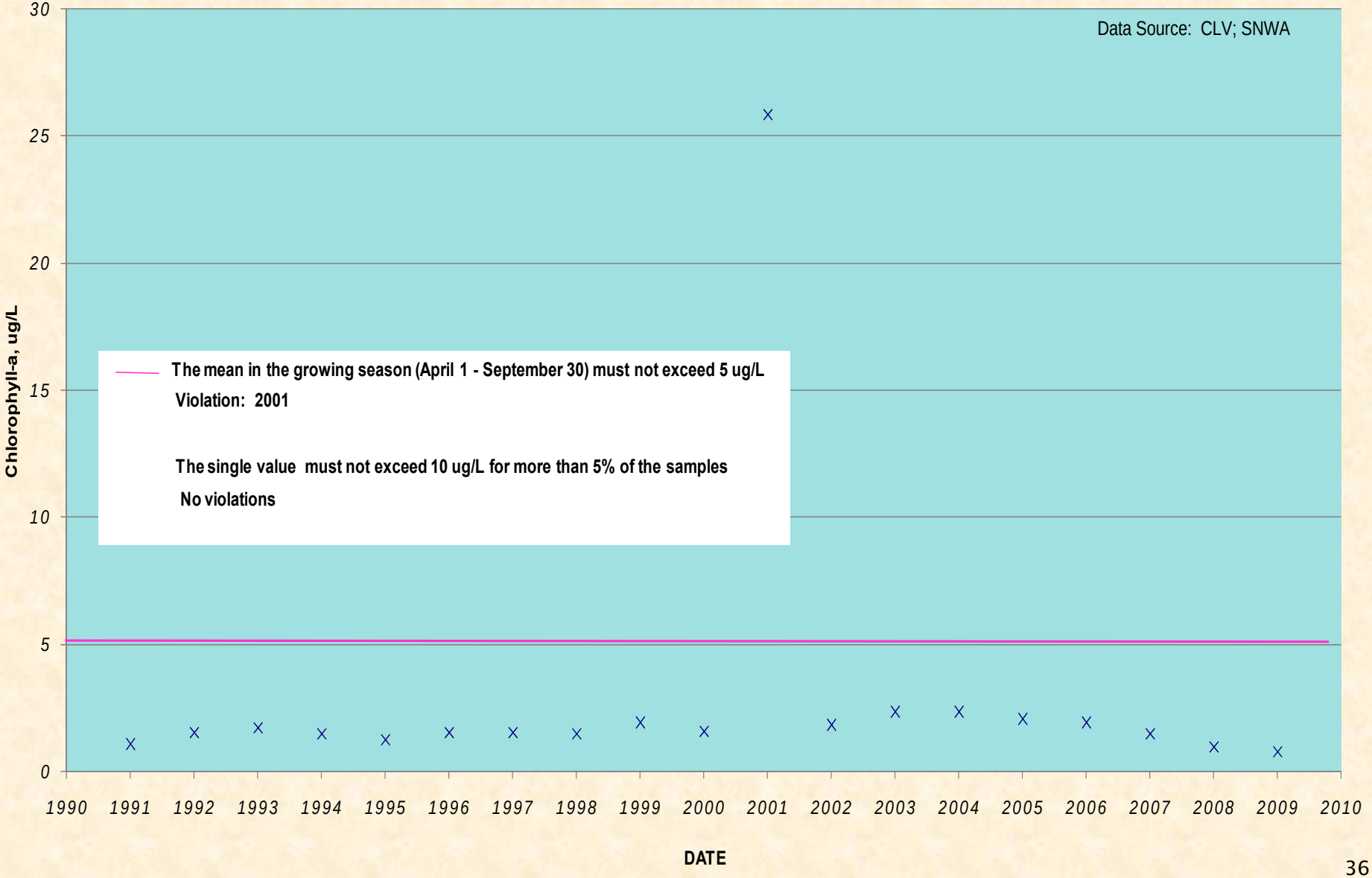


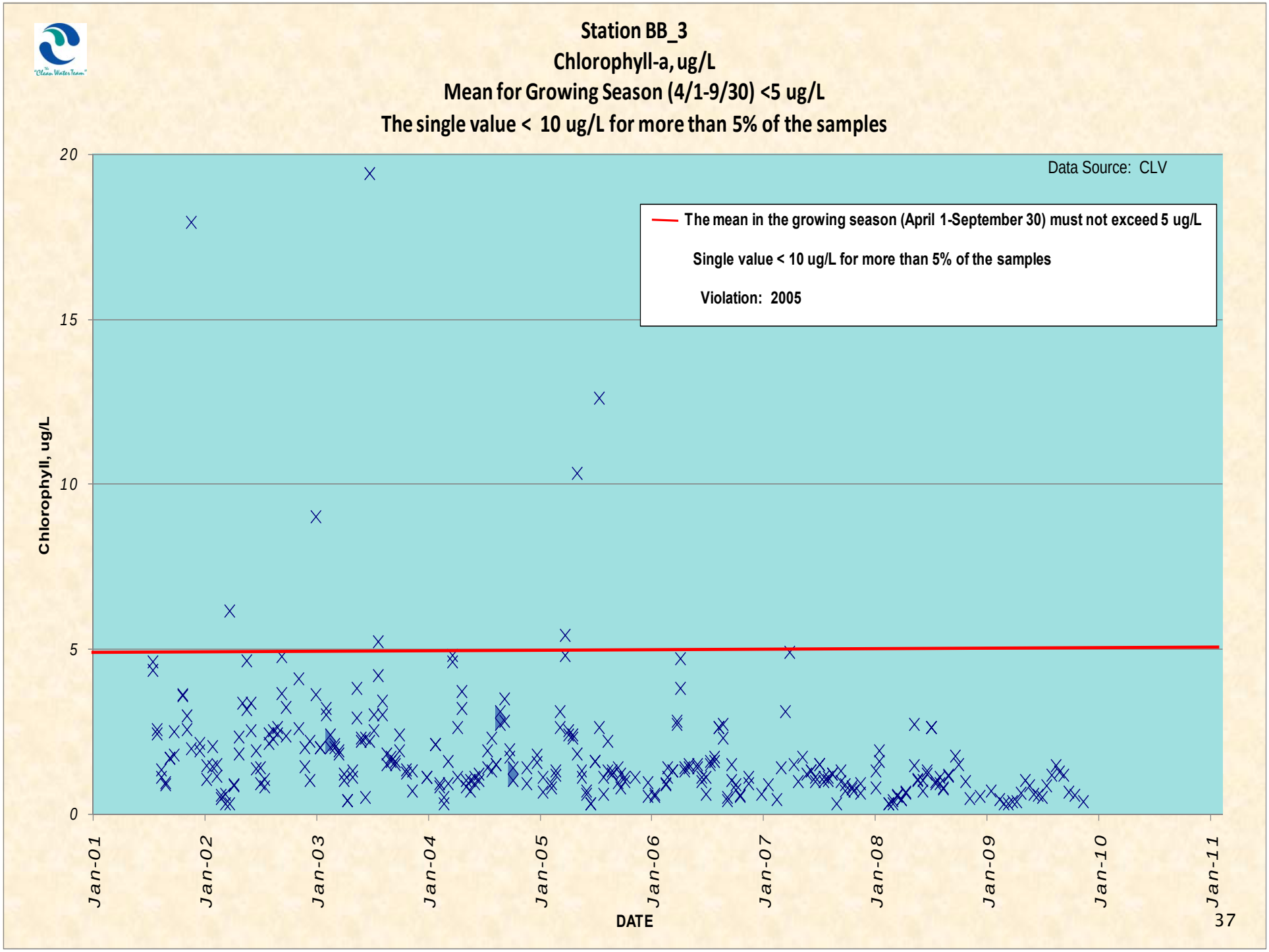
SENTINEL ISLAND AND BOULDER BASIN 3

- **The dischargers have regularly sampled the Sentinel Island site since 1990.**
- **BB_3 has been sampled since 2001**

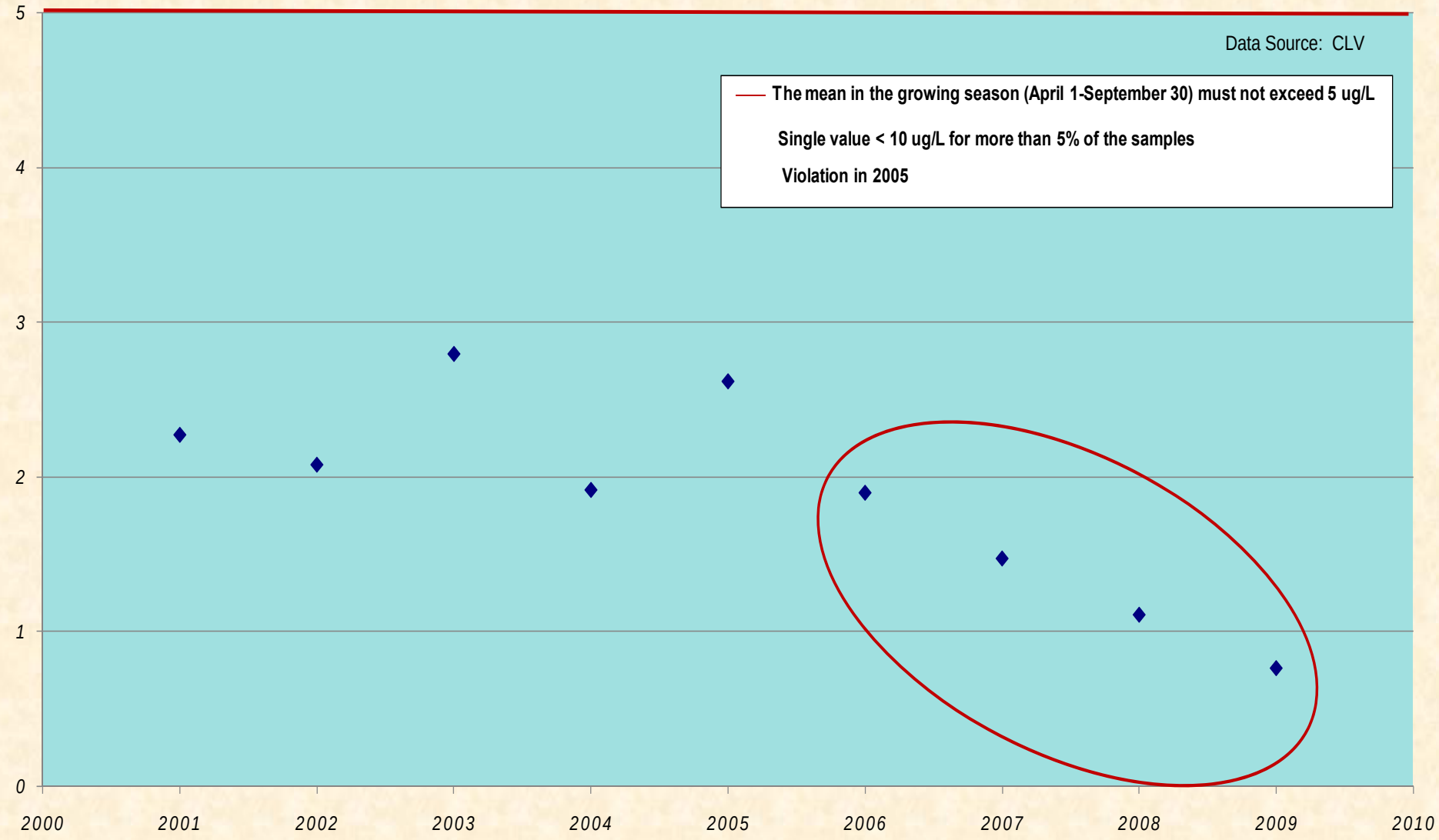

Colorado River Station 346.4
Chlorophyll-a
Concentrations near Sentinel Island, ug/L
Mar-01
149 ug/L
Data Source: CLV; SNWA
The mean in the growing season (April 1 - September 30) must not exceed 5 ug/L
Chlorophyll-a, ug/L
40
35
30
25
20
15
10
5
0
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
DATE

Colorado River Station 346.4
Chlorophyll-a
Mean for growing season (April-September) < 5ug/L
The single value < 10 ug/L for more than 5% of the samples




Station BB_3
Chlorophyll-a, ug/L
Mean for Growing Season (4/1-9/30) <5 ug/L
The single value < 10 ug/L for more than 5% of the samples
Data Source: CLV
The mean in the growing season (April 1-September 30) must not exceed 5 ug/L
Single value < 10 ug/L for more than 5% of the samples
Violation: 2005
Chlorophyll, ug/L
20
15
10
5
0
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
DATE

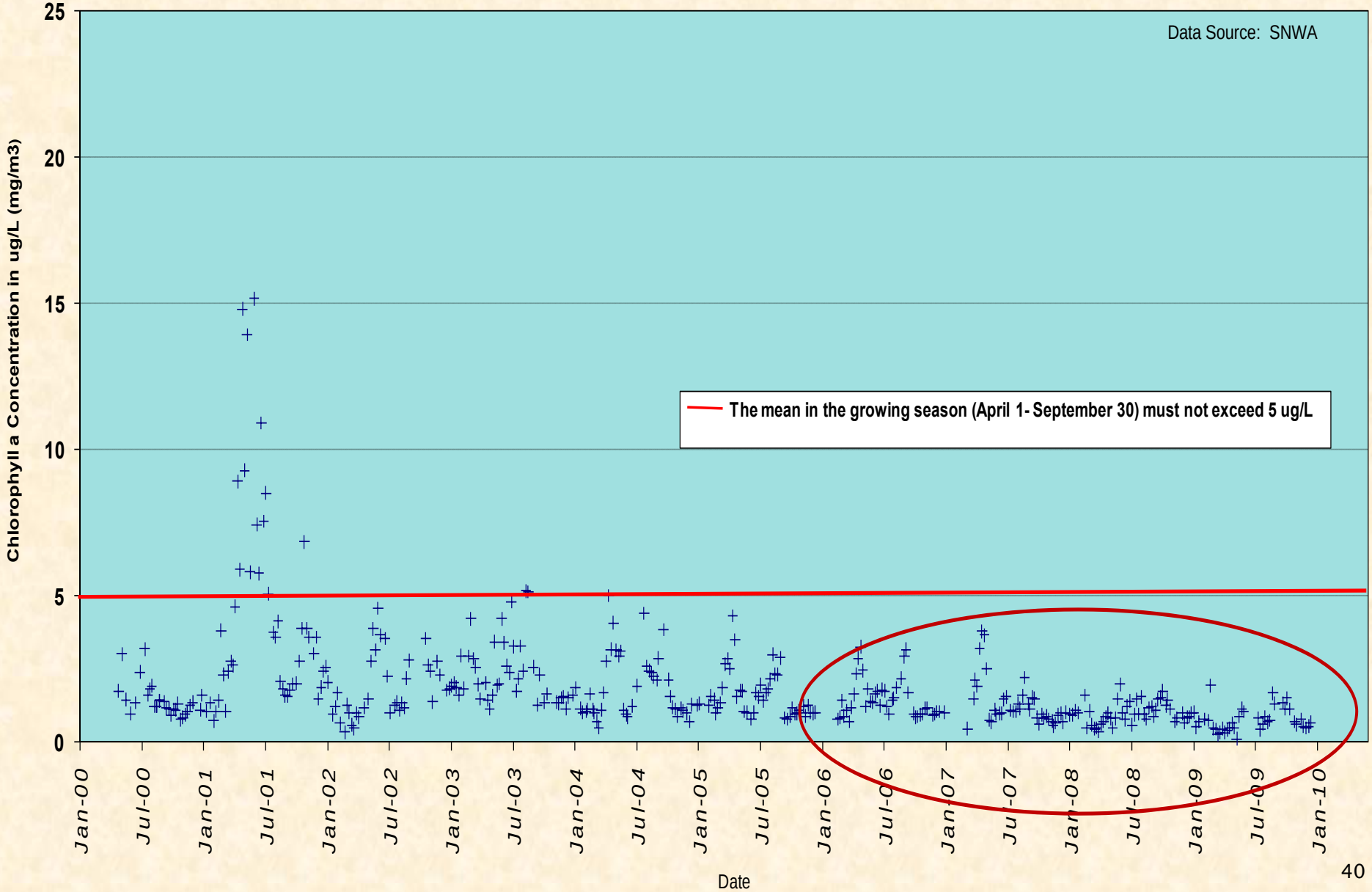
Station BB_3
Chlorophyll-a, ug/L
Mean for Growing Season (4/1-9/30) <5 ug/L
The single value < 10 ug/L for more than 5% of the samples

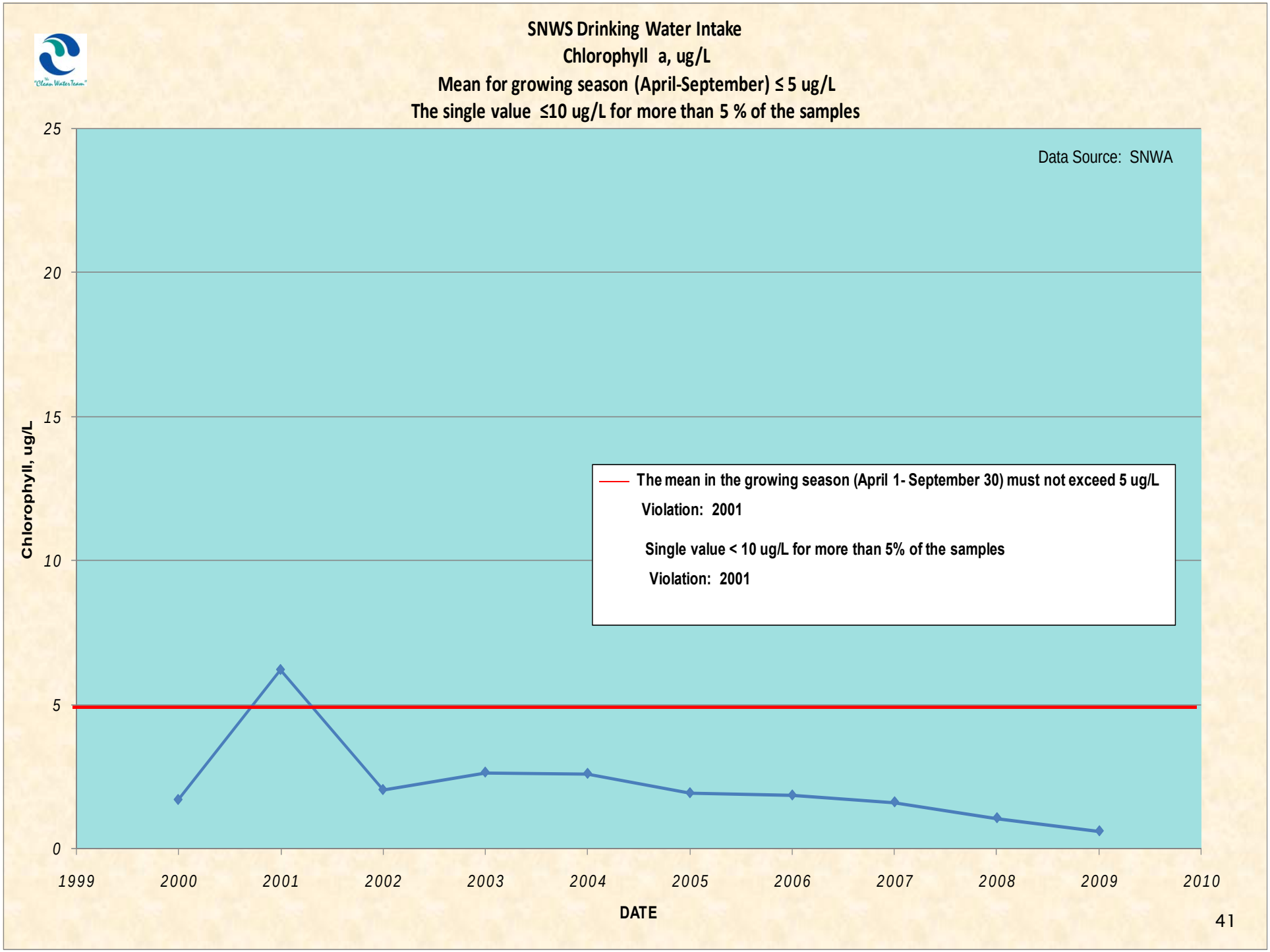


CHLOROPHYLL-a AT SNWA INTAKES 2001 TO PRESENT

- Since 2001, the dischargers have been removing P in the winter and have optimized their treatment processes.
- What impact has the lowering of P from the dischargers had on SNWA's water quality?
- SNWA monitors regularly the water quality of Lake Mead entering their drinking water intake structure.
- Lowest chlorophyll concentrations to date is 2009

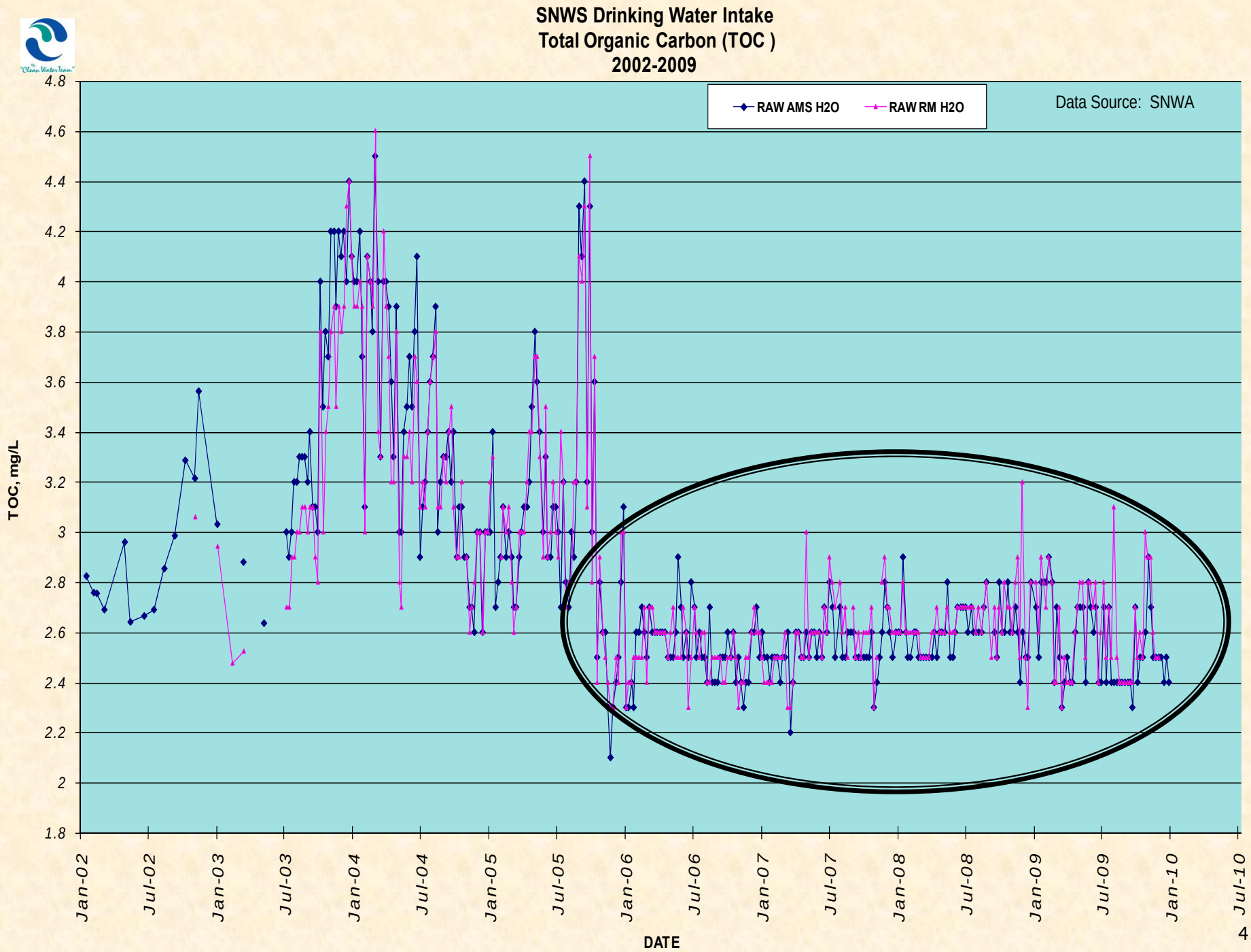
SNWS Drinking Water Intake
Chlorophyll a, ug/L
Mean for growing season (April-September) ≤ 5 ug/L
The single value ≤10 ug/L for more than 5 % of the samples




SNWS Drinking Water Intake
Chlorophyll a, ug/L
Mean for growing season (April-September) ≤ 5 ug/L
The single value ≤10 ug/L for more than 5 % of the samples
Data Source: SNWA
The mean in the growing season (April 1- September 30) must not exceed 5 ug/L
Violation: 2001
Single value < 10 ug/L for more than 5% of the samples
Violation: 2001
Chlorophyll, ug/L
0
5
10
15
20
25
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
DATE

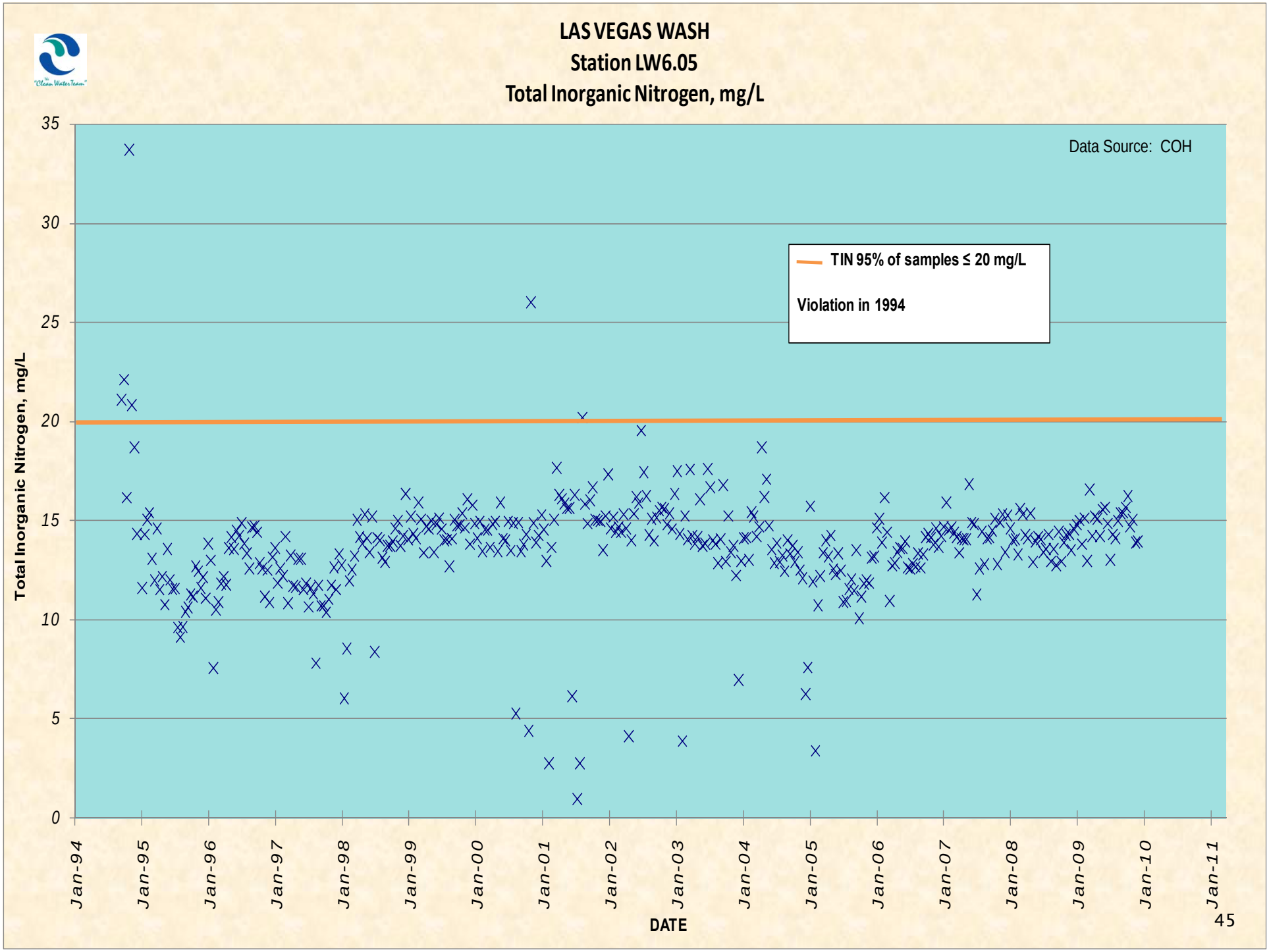
TOTAL ORGANIC CARBON AT SNWA'S INTAKES

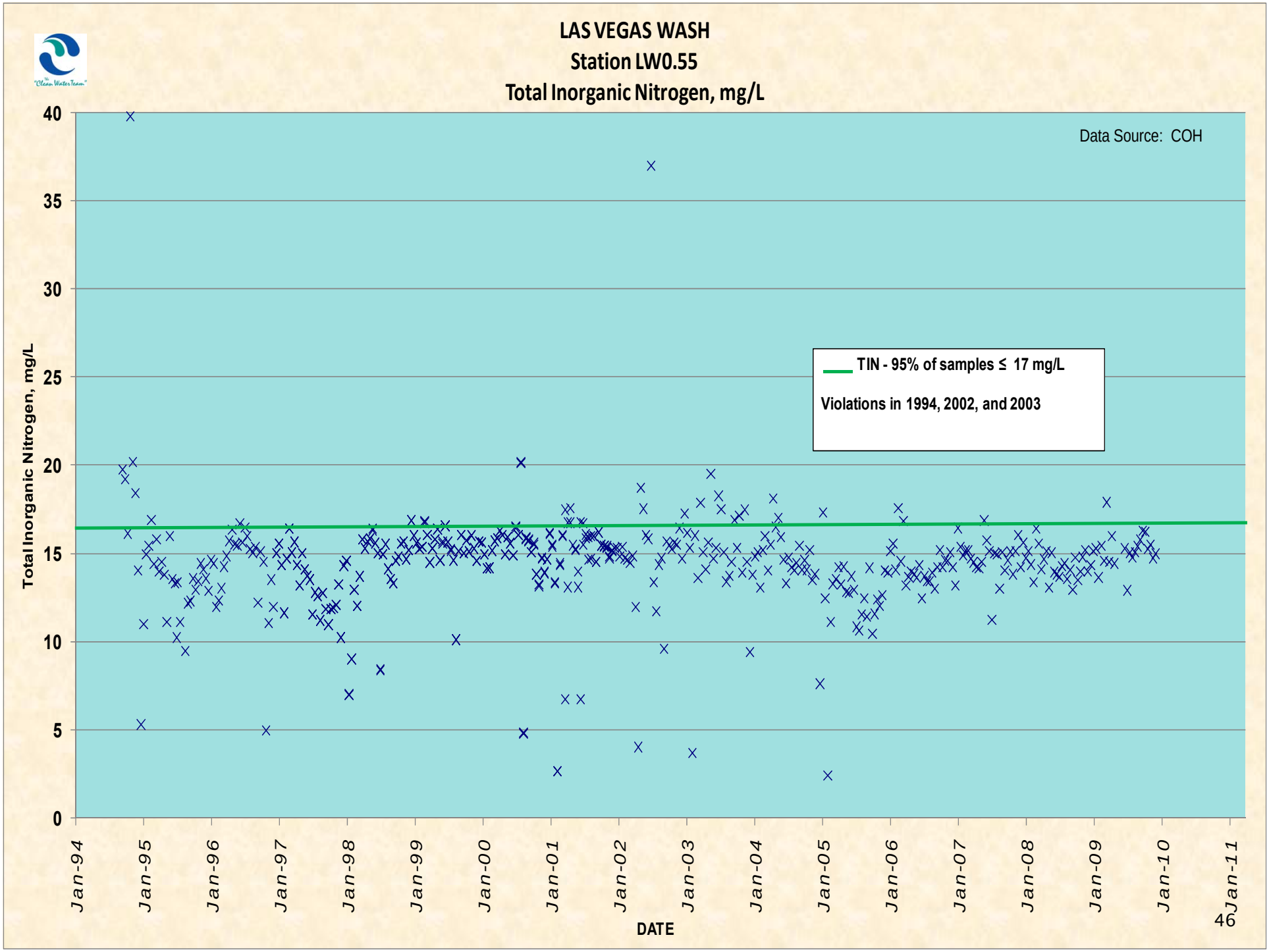
- Another parameter that SNWA monitors in their drinking water is Total Organic Carbon (TOC).
- Organic Carbon is a pre-cursor to disinfection by-products
- Prior to 2005 the TOC at the intakes was about 3-4 mg/l.
- Since 2005, the TOC at SNWAs intakes has decreased to 2-3 mg/l.
- The lowest TOC concentrations at the drinking water intakes, have been in the last four years.


SNWS Drinking Water Intake
Total Organic Carbon (TOC)
2002-2009
RAW AMS H2O
RAW RM H2O
Data Source: SNWA
TOC, mg/L
4.8
4.6
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
Jul-06
Jan-07
Jul-07
Jan-08
Jul-08
Jan-09
Jul-09
Jan-10
Jul-10
DATE

LAS VEGAS WASH AND BAY

TOTAL INORGANIC NITROGEN

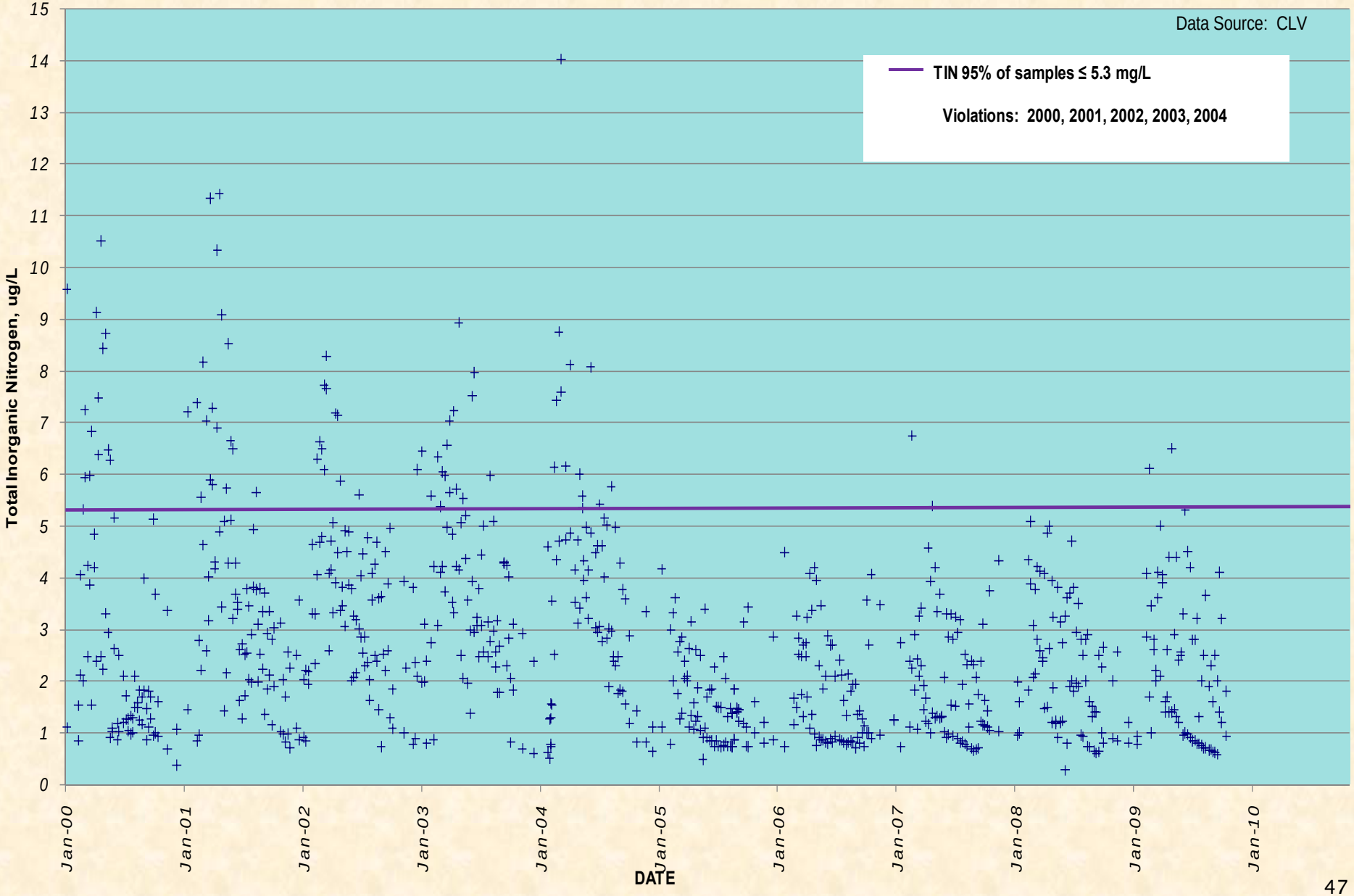

LAS VEGAS WASH
Station LW6.05
Total Inorganic Nitrogen, mg/L
Data Source: COH
TIN 95% of samples ≤ 20 mg/L
Violation in 1994
Total Inorganic Nitrogen, mg/L
35
30
25
20
15
10
5
0
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
DATE


LAS VEGAS WASH
Station LW0.55
Total Inorganic Nitrogen, mg/L
Data Source: COH
TIN - 95% of samples ≤ 17 mg/L
Violations in 1994, 2002, and 2003
Total Inorganic Nitrogen, mg/L
0
5
10
15
20
25
30
35
40
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
DATE

LAS VEGAS BAY

Old Station - LM2 (LVB1.8M) = New Station - LWLVB1.2 (effective January 1, 2005)

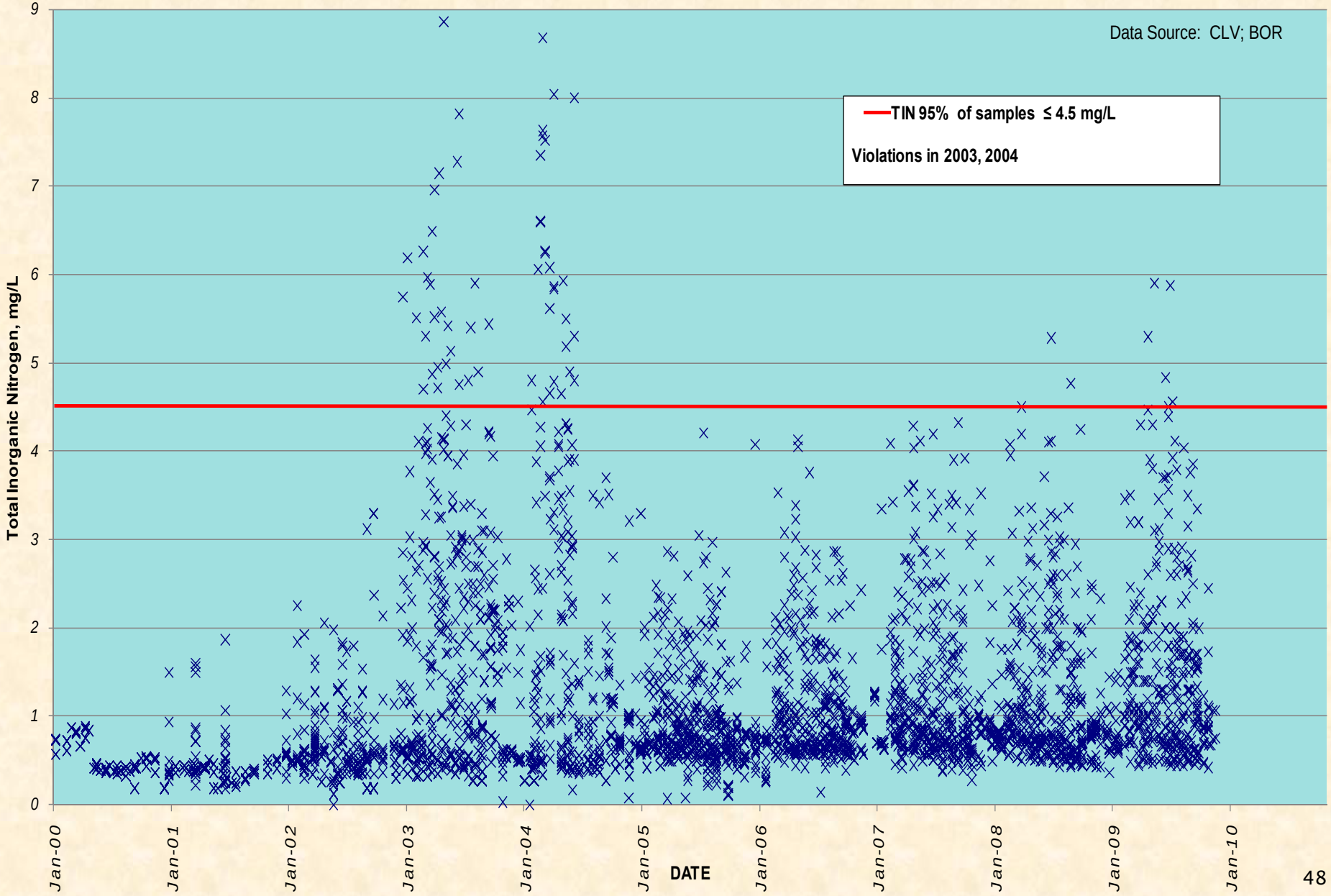
Total Inorganic Nitrogen, mg/L



LAS VEGAS BAY AND BOULDER BASIN

Stations LVB1.8, LVB1.85, LVB4.15, LVB4.95, LVB7.3, LWLVB1.85, LWLVB2.7, LWLVB3.5, CR346.4

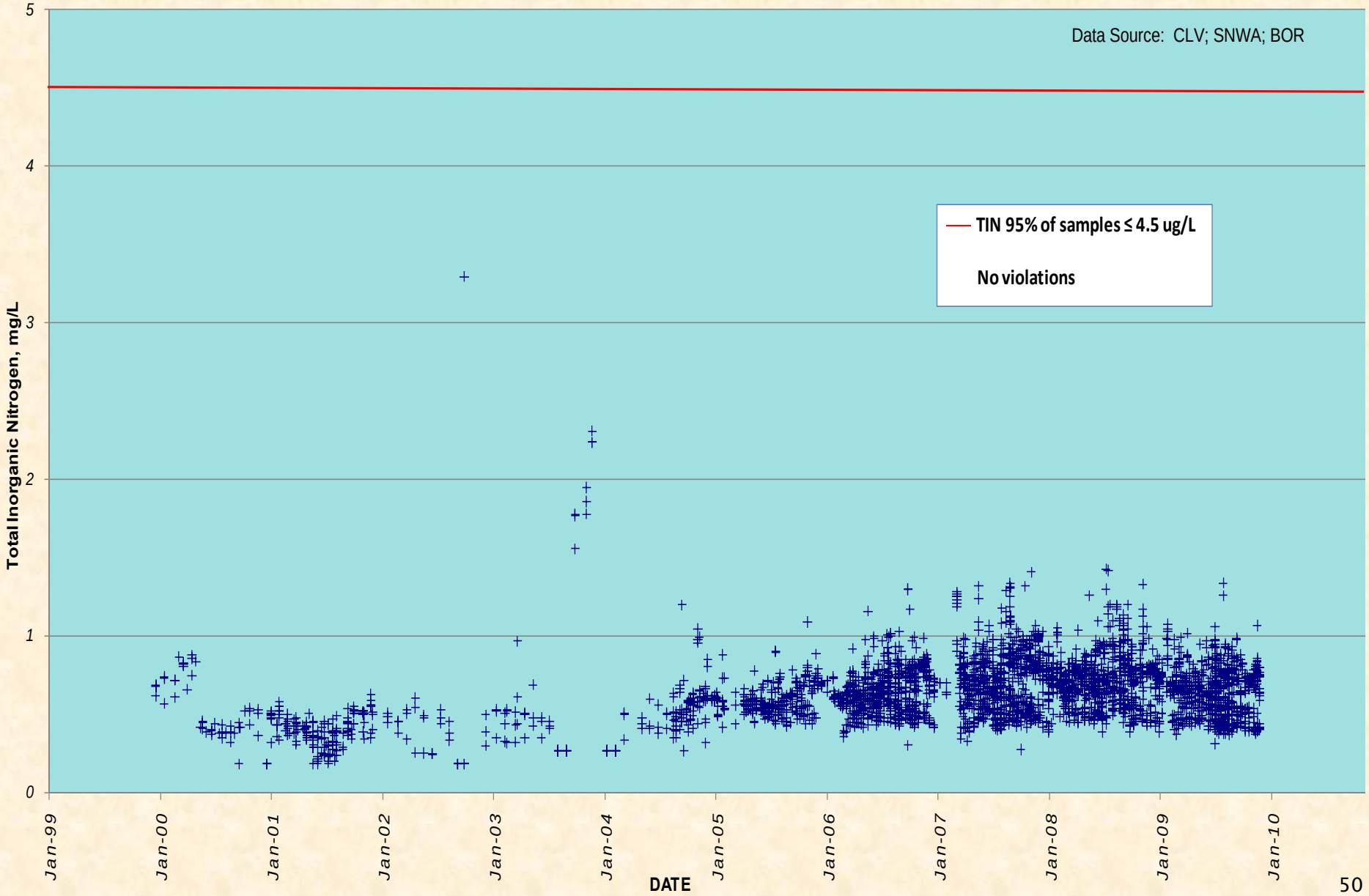
Total Inorganic Nitrogen, mg/L



BOULDER BASIN

TOTAL INORGANIC NITROGEN

Boulder Basin
Stations CR 342.5, CR346.4, CR348.4NW0.8, and SNWS Intake
Total Inorganic Nitrogen, mg/L



TOTAL P TREATMENT CAPACITY REMAINING ASSUMPTIONS

- **The analysis begins with effluent flows, SWAC 2008**
- **Reuse to effluent ratio remains constant**
- **CBER 2009 population growth projections used to project mgd growth**
- **All areas grow at same rate**

FUTURE DISCHARGERS' ACTIONS

- **CCWRD's AWT facility upgrade:**
  - **30 mgd in 2012**
  - **Plus an additional 35 mgd in 2014**
- **Henderson's SW plant complete in 2011**
- **North Las Vegas' plant complete in 2011**
- **City of Las Vegas' reduced flows in 2011**

EXISTING CAPITAL PROJECTS EFFECTING WATER QUALITY IN LAKE MEAD, Thru 2015

Data Source: SWAC Quarterly Report; CCWRD

Year	CC WATER RECLAMATION DISTRICT			CITY OF LAS VEGAS			CITY OF HENDERSON			CITY OF NORTH LAS VEGAS		Total Effluent Flow mgd
		@ T P 0.10 mg/l	@ T P 0.05 mg/l		@ T P 0.14 mg/l	@ T P 0.10 mg/l		@ T P 0.14 mg/l	@ T P 0.10 mg/l		@ T P 0.05 mg/l	
	Note	Effluent Flow mgd	Effluent Flow mgd	Note	Effluent Flow mgd	Effluent Flow mgd	Note	Effluent Flow mgd	Effluent Flow mgd	Note	Effluent Flow mgd	
2008		89.4			62.4			11.6				163
2009		92.4			64.5			12.0				169
2010		95.5			66.7			12.4				175
2011		98.6		NLV		48.8	SW Plant		12.8	New Plant	20.0	180
2012	AWT-1	71.5	30.0			50.3			13.2		20.6	186
2013		74.5	30.0			51.8			13.6		21.2	191
2014	AWT-2	42.3	65.0			53.3			13.9		21.8	196
2015		45.1	65.0			54.8			14.3		22.3	202

YEARS OF TOTAL PHOSPHORUS TREATMENT CAPACITY REMAINING (CR346.4 Sentinel Island)

Data Source: SWAC Quarterly Report; CCWRD

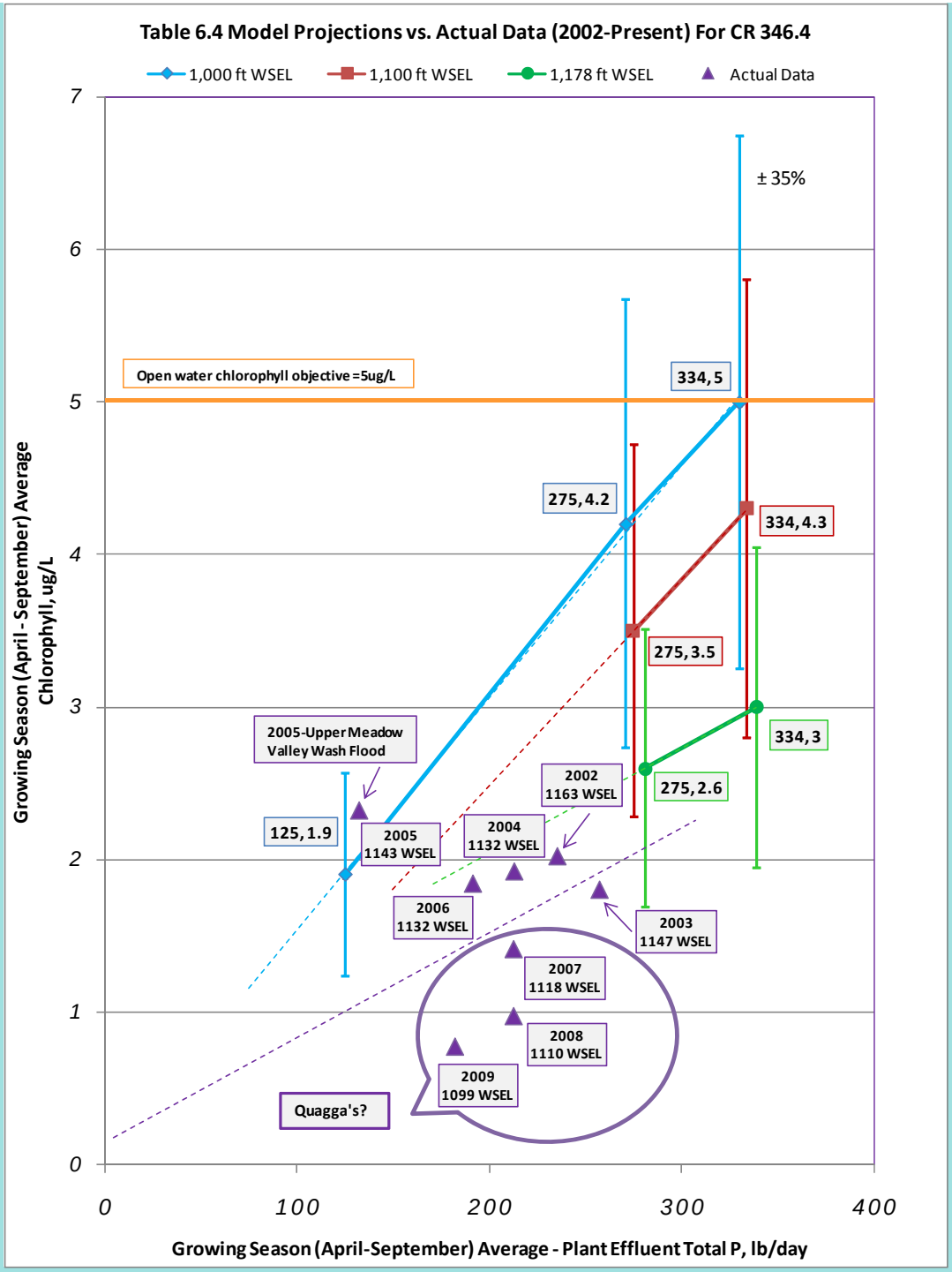
Year	Effluent Flow mgd	Pounds per day			Total P lbs/day	Total P at Compliance (lbs)	Total P Available (lbs)	Total Effluent Flow Available (mgd)	Years of Capacity Remaining
		@ T P 0.14 mg/l	@ T P 0.10 mg/l	@ T P 0.05 mg/l					
2008	163	86.4	74.6		161	243	82.0	83.2	23
2009	169	89.4	77.1		166	243	76.6	77.7	22
2010	175	92.4	79.7		172	243	71.0	72.0	20
2011	180		134	8.34	142	243	101	128	36
2012	186		113	21.1	134	243	109	152	42
2013	191		87.5	35.9	123	243	120	185	51
2014	196		91.4	36.2	128	243	115	178	49
2015	202		95.3	36.4	132	243	111	170	47

YEARS OF TOTAL PHOSPHORUS TREATMENT CAPACITY REMAINING (Boulder Beach)

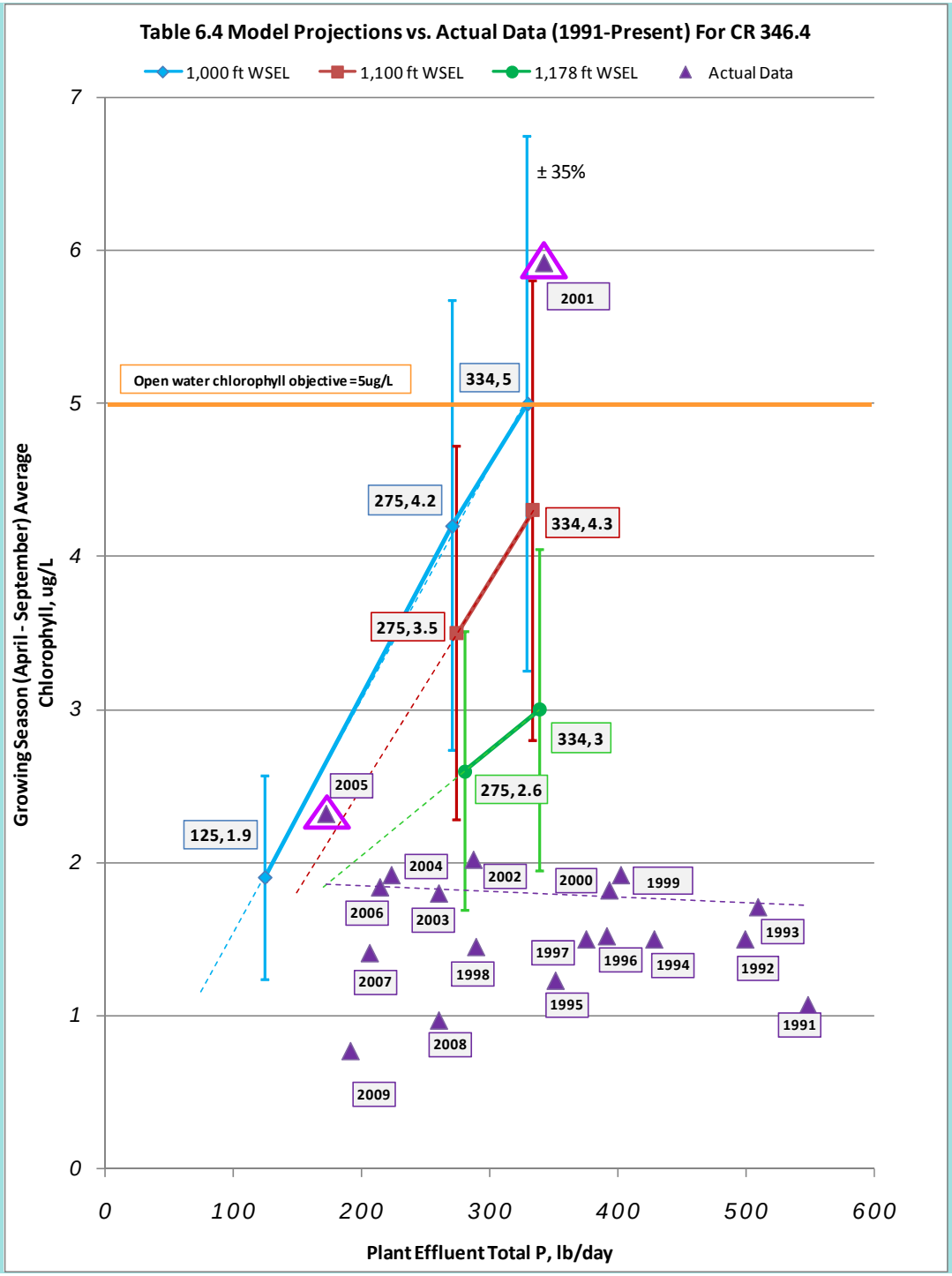
Data Source: SWAC Quarterly Report; CCWRD

Year	Effluent Flow mgd	Pounds per day			Total P lbs/day	Total P at Compliance (lbs)	Total P Available (lbs)	Total Effluent Flow Available (mgd)	Years of Capacity Remaining
		@ T P 0.14 mg/l	@ T P 0.10 mg/l	@ T P 0.05 mg/l					
2008	163	86.4	74.6		161	203	42.0	42.6	12
2009	169	89.4	77.1		166	203	36.6	37.1	10
2010	175	92.4	79.7		172	203	31.0	31.4	9
2011	180		134	8.34	142	203	61.1	77.6	22
2012	186		113	21.1	134	203	69.3	96.2	27
2013	191		87.5	35.9	123	203	79.6	123	34
2014	196		91.4	36.2	128	203	75.4	116	32
2015	202		95.3	36.4	132	203	71.3	109	30

Data Source: CCWRD; BOR; DISCHARGE MONITORING REPORTS



Data Source: CCWRD; DISCHARGE MONITORING REPORTS



CONCLUSIONS

- The dischargers year-round removal of phosphorus and process optimizations has significantly lowered the amount of Total P entering Lake Mead

- A corresponding decrease in Chlorophyll-a concentrations in the Lake was observed

- Future projects by dischargers using "state of the art" technologies can lower the Total P concentrations entering Lake Mead even more

DISCUSSION and QUESTIONS

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- BOR
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