



Selenium Treatment Study

NDEP 319 Grant

Lake Mead Water Quality Forum

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In Cooperation with City of Henderson, City of Las Vegas, and
Clark County Water Reclamation District

October 14, 2009

Reasons for Study

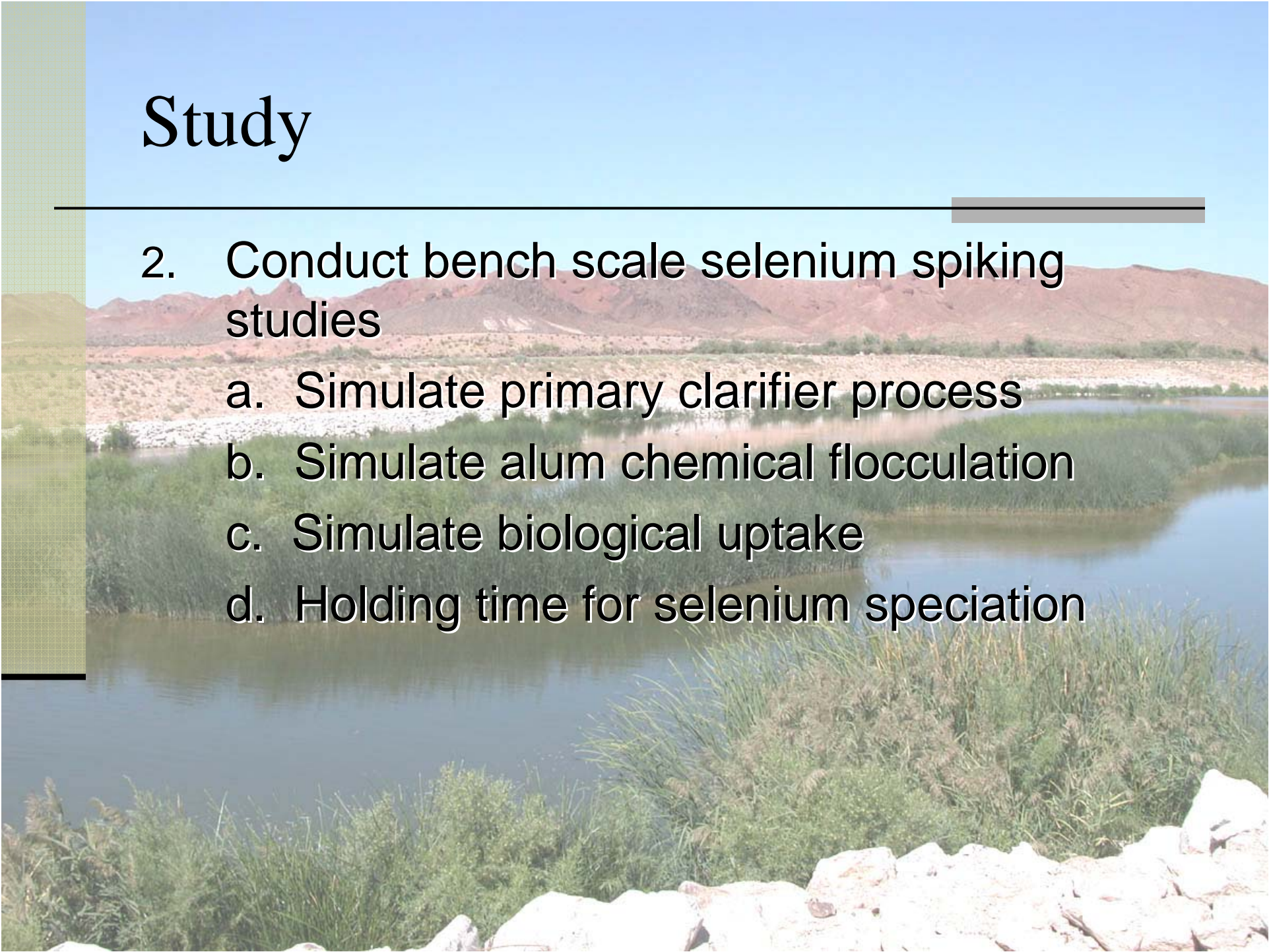
■ Sub-Committee Concerns:

- Aquatic life beneficial use standard for Se in water 5 ug/L
- Current Se concentration in Wash 4 ug/L
- 5 of 5 tributaries to Wash exceed standard
- Samples from Wash have exceeded toxicity thresholds.
- Preliminary mass balance show the concentration of Se in the Wash will be 6.5 ug/L with 30 MGD wastewater
- Shallow groundwater has the potential to release higher concentrations of Se
- Changing flows in the Wash has the potential to mobilize Se
- Development of land in areas with high selenium and over-watering soils may mobilize Se and create an attractive nuisance

Study

1. Gather data to determine existing Se removal of wastewater treatment plants
 - a. Weekly influent /effluent total selenium concentrations – 1 year
 - b. Influent/effluent sampling of 3 major treatment processes – 6 times
 - c. Hourly samples of influent to wastewater treatment plant for 24 hours

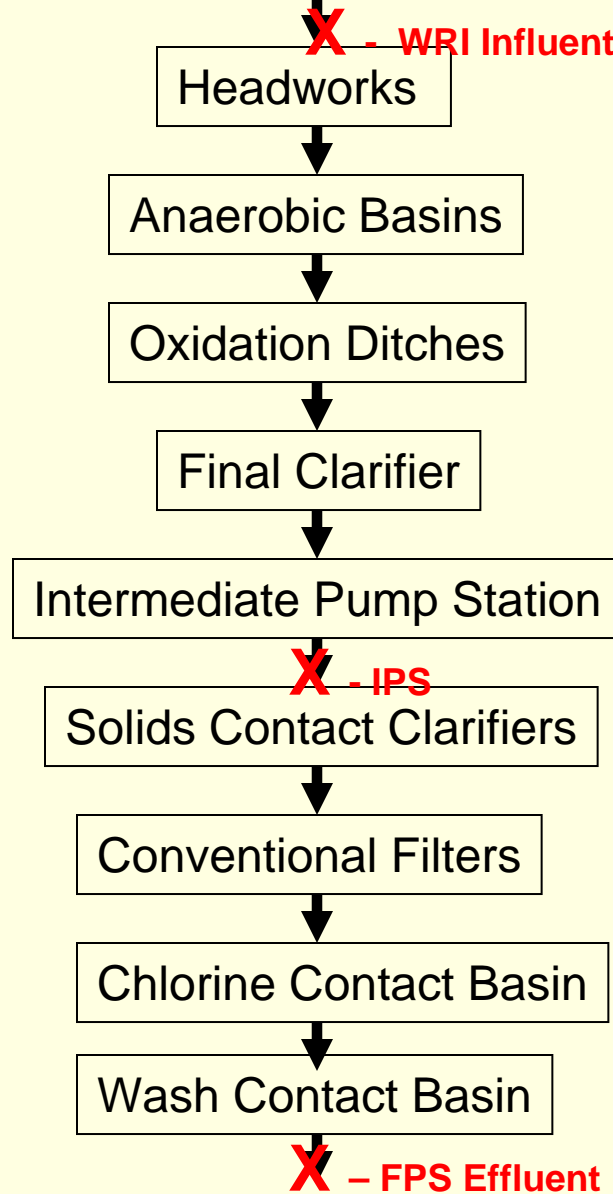
Study

2. Conduct bench scale selenium spiking studies
 - a. Simulate primary clarifier process
 - b. Simulate alum chemical flocculation
 - c. Simulate biological uptake
 - d. Holding time for selenium speciation
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Results – Total and Dissolved Se Influent and Effluent

Location	Influent Total ug/L	Effluent Total ug/L	Influent Dissolved ug/L	Effluent Dissolved ug/L	% Removal Total	% Removal Dissolved	% Difference Total and Dissolved Influent	% Difference Total and Dissolved Effluent
COH	3.3	1.7	2.6	1.6	48	38	21	6
CLV	2.4	1.1	1.7	1.1	54	35	29	0
CCWRD	3.3	1.5	2.7	1.5	55	44	18	0
Average	3	1.4	2.3	1.4	52	39	23	2

City of Henderson Water Reclamation Facility



X = sampling location

Results – COH Total and Dissolved Se Removal in Treatment Plant

Treatment Plant Location	Average Se Concentration ug/L	Comments
Influent – Total Se	3.3	
Influent – Dissolved Se	2.6	
IPS – Total Se	1.8	95% removed in biological process
IPS – Dissolved Se	1.7	
Effluent – Total Se	1.7	
Effluent – Dissolved Se	1.6	94% Se in effluent is dissolved

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X - Influent

Bar Screens

Vortex Grit Removal

Primary Clarifier

Primary Clarifier

Rock Media
Trickling Filters

Enhanced BRP
Activated Sludge

Intermediate
Clarifiers

Final Clarifier

Activated Sludge

X - Out BNR

Final
Clarifiers

X - NIT Effluent

Dual Media Effluent Filters

X - Effluent

X = sampling location



Results – CLV Total and Dissolved Se Removal in Treatment Plant

Treatment Plant Location	Average Se Concentration ug/L	Comments
Influent – Total Se	2.4	
Influent – Dissolved Se	1.7	
NIT Effluent – Total Se	1.3	46% Total Se Removal
NIT Effluent – Dissolved Se	1.3	24% Dissolved Se Removal
Out BNR – Total Se	1.1	Slightly more efficient – 54% Total Se Removal
Out BNR Dissolved Se	1.0	41% Dissolved Se Removal
Effluent – Total Se	1.1	
Effluent – Dissolved Se	1.1	All Se in effluent is dissolved

Clark County Water Reclamation Facility

X - Primary Influent (PI)

Screening and Grit Removal

Primary Clarifiers

X - Central Plant Aeration Basin Influent (CABI)

Aeration Basins

Secondary Clarifier

X - Central Plant Effluent (CE)

Tertiary Clarifier

Dual Media
Conventional
Filters

Filters

UV
Disinfection

X - Final Effluent Total

X = sampling location



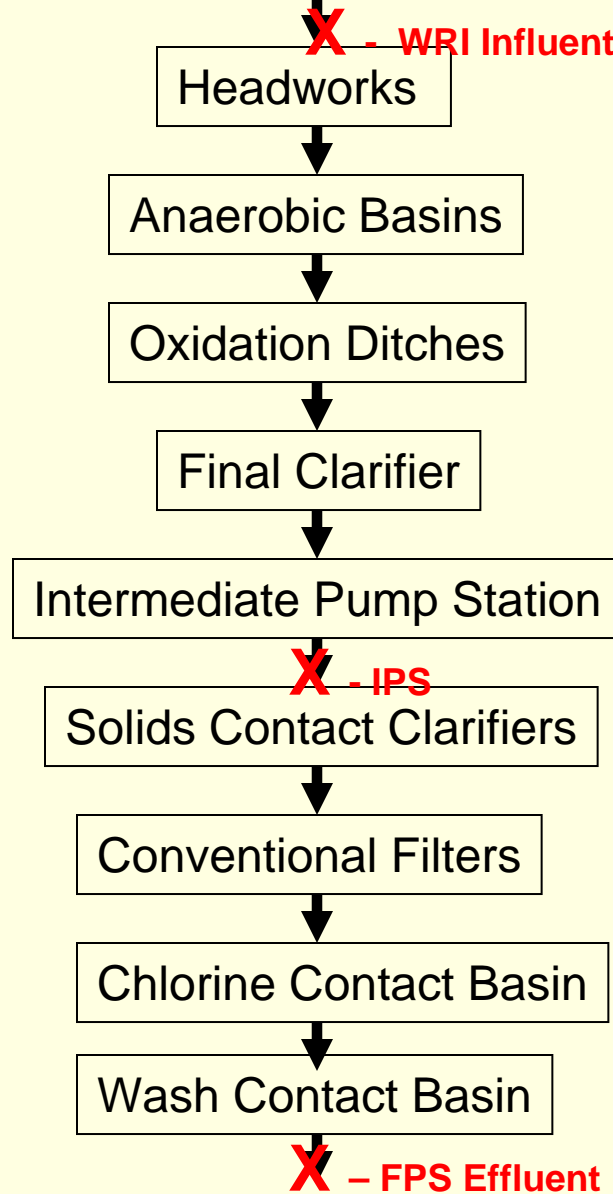
Results – CCWRD Total and Dissolved Se Removal in Treatment Plant

Treatment Plant Location	Avg Se Concentration ug/L	Comments
Primary Influent – Total Se	3.3	
Primary Influent – Dissolved Se	2.7	
CABI Influent – Total Se	2.5	Primary Clarifiers remove 24% Total Se
CABI Influent – Dissolved Se	2.1	Primary Clarifiers remove 22% Dissolved Se
CABI Effluent – Total Se	1.8	CAB removes 28% Total Se
CABI Effluent – Dissolved Se	1.7	CAB removes 19% Dissolved Se
Combined Effluent – Total Se	1.5	
Combined Effluent – Dissolved Se	1.5	All Se in effluent is dissolved

Results – Total Se Removal Influent to Effluent

Facility	Average Influent Se Concentration (ug/L)	Average Effluent Se Concentration (ug/L)	% Removal
COH	3.5	1.7	51
CLV	2.8	1.3	54
CCWRD	3.6	1.6	56

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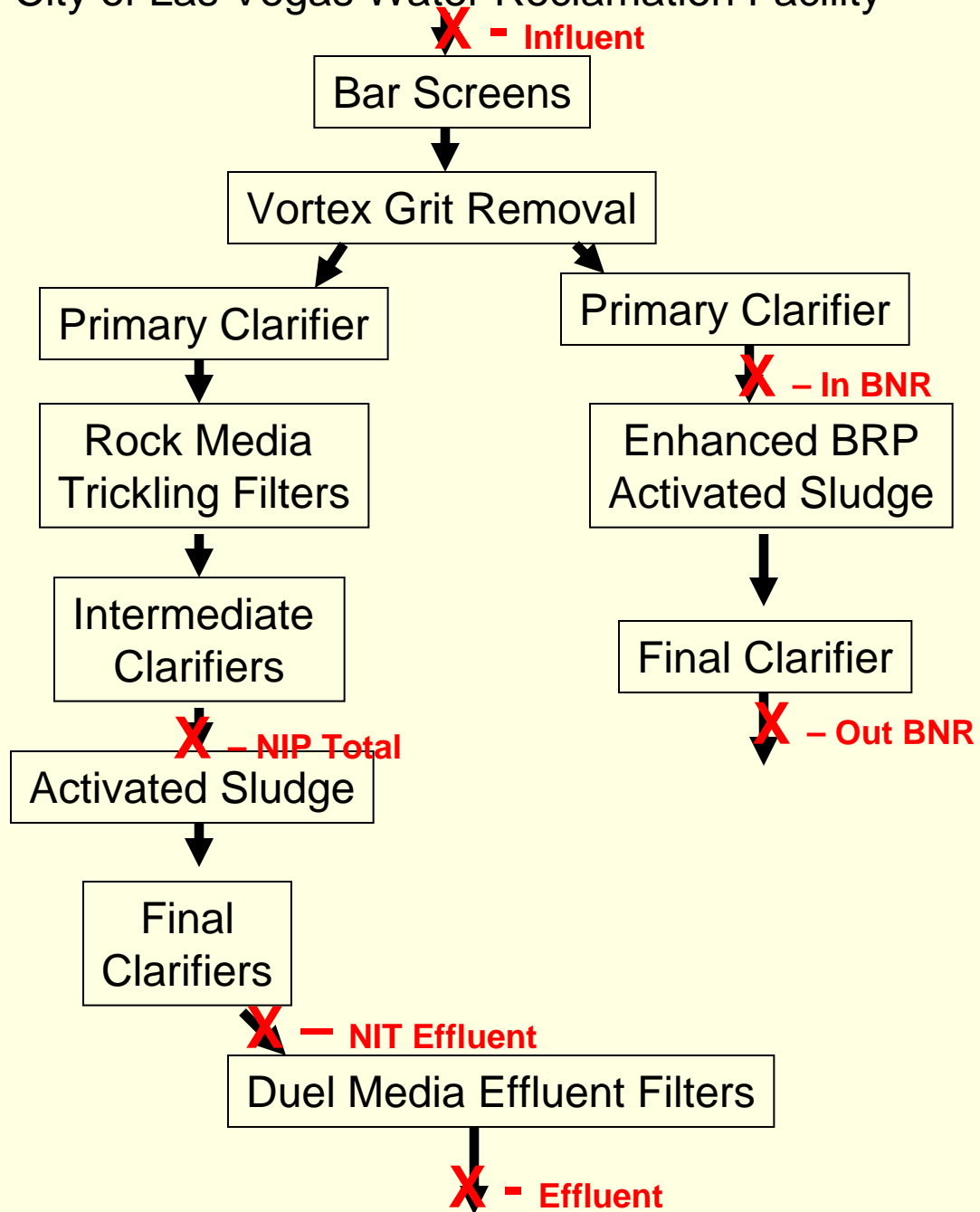


X = sampling location

Results – Total Selenium Removal COH

	WRI- Influent	IPS	FPS - Effluent
Avg total Se Concentration (ug/L)	3.5	1.8	1.8
Removal Influent to Effluent			49%
Removal Influent to IPS		49%	
Removal IPS to Effluent			0%

City of Las Vegas Water Reclamation Facility



Results – Total Selenium Removal CLV Old Plant

	Influent	NIP Total	NIT Eff	Effluent
Average Total Se Concentration (ug/L)	3.1	2.1	1.5	1.4
Removal Influent to NIP total		32%		
Removal NIP Total to NIT Eff			29%	
Removal NIT Eff to Effluent				6%
Removal Influent to Effluent				55%

Results – Total Selenium Removal – CLV New Plant

	Influent	In BNR	Out BNR	Effluent
Average Total Se Concentration (ug/L)	3.1	2.4	1.4	1.4
Removal influent to In BNR		23%		
Removal In BNR to Out BNR			42%	
Removal Out BNR to Effluent				0%
Removal Influent to Effluent				55%

Clark County Water Reclamation Facility

X - Primary Influent (PI)

Screening and Grit Removal

Primary Clarifiers

X - Central Plant Aeration Basin Influent (CABI)

Aeration Basins

Secondary Clarifier

X - Central Plant Effluent (CE)

Tertiary Clarifier

Dual Media
Conventional
Filters

Filters

UV
Disinfection

X - Final Effluent Total

X = sampling location

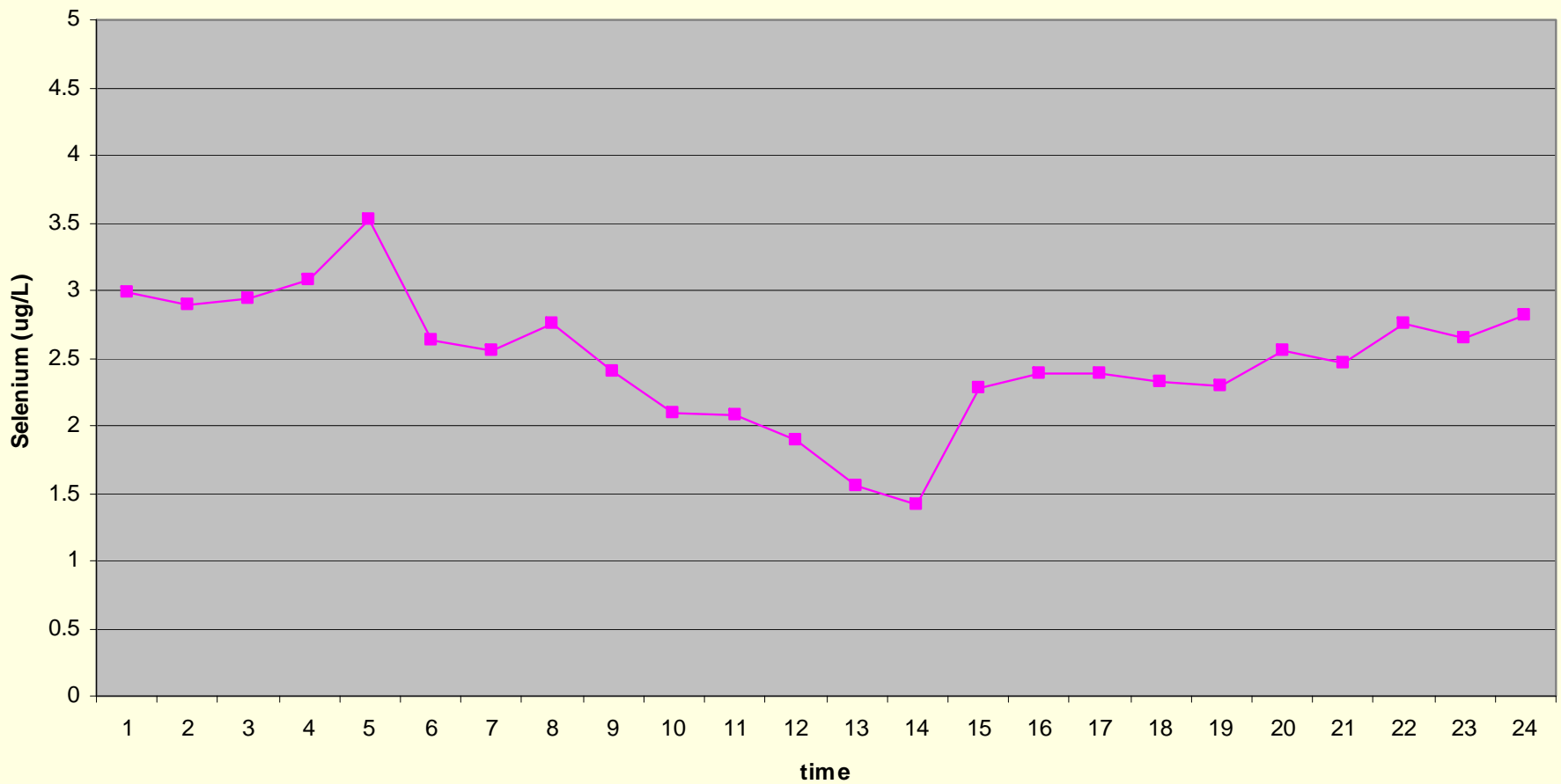


Results – Total Selenium Removal CCWRD

	Influent Total	CABI	CE	Final Effluent
Average Total Se Concentration (ug/L)	3.6	3.1	1.6	1.6
Removal Influent to CABI		14%		
Removal CABI to CE			48%	
Removal Influent to CE			55%	
Removal CE to Final Effluent				0%
Removal Influent to Effluent				55%

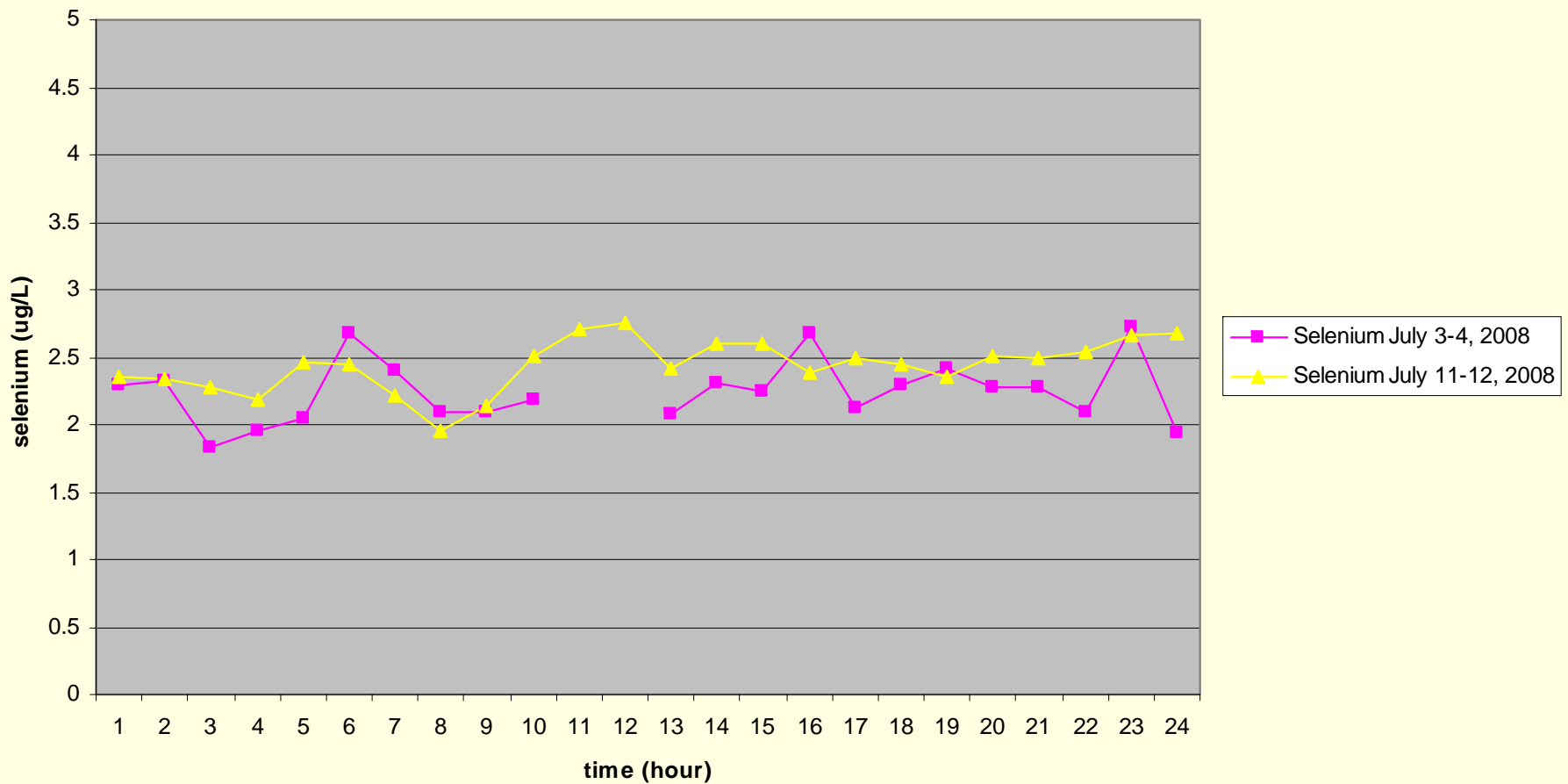
Results – 24 Hour Se Sampling COH

COH Influent Selenium Concentrations - 24 Hour Study - July 22 and 23, 2008



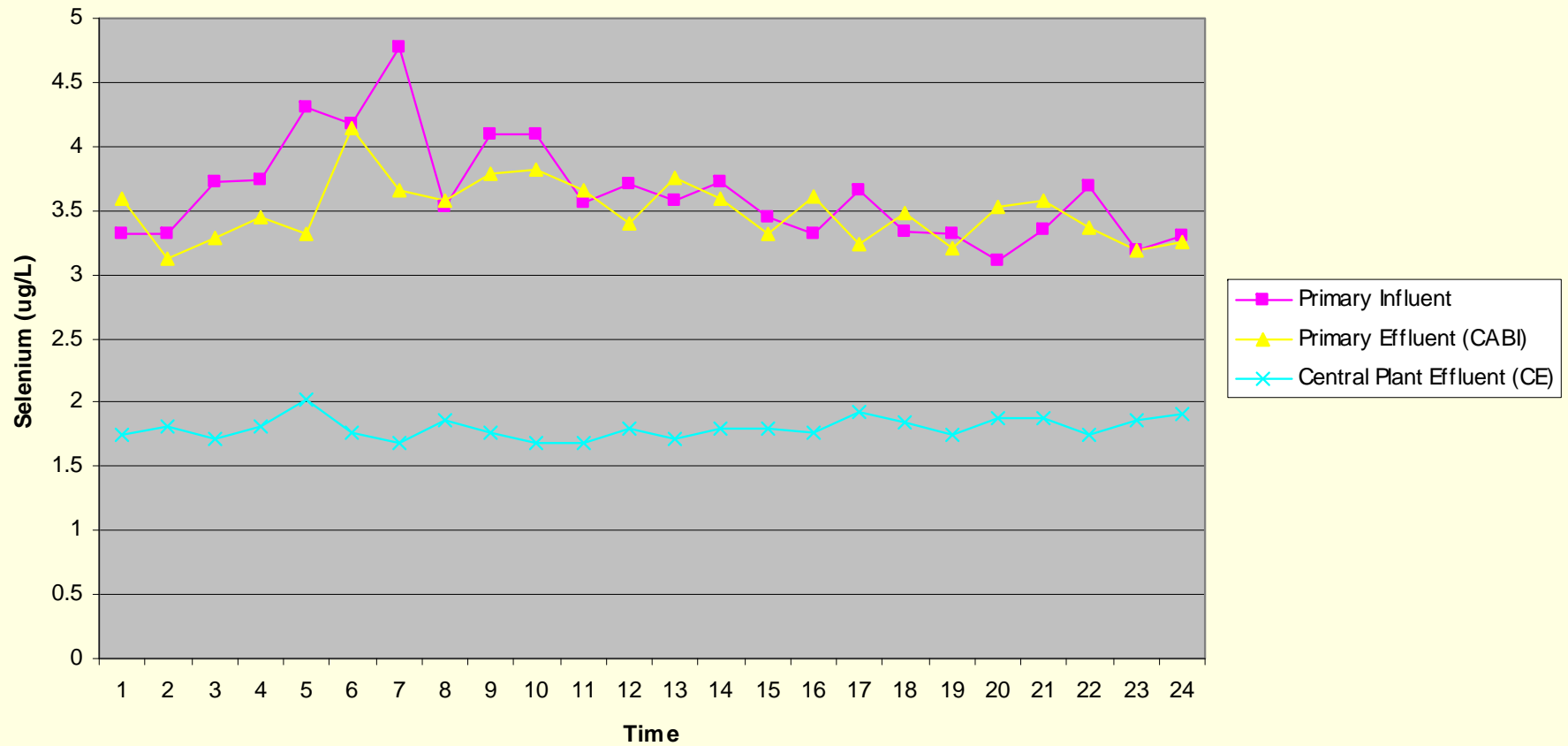
Results – 24 Hour Se Sampling CLV

City of Las Vegas Inflow Selenum Concentrations - 24 Hour Study - July 3 and 4 and July 11 and 12, 2008



Results – 24 Hour Se Sampling CCWRD

Clark County Water Reclamation District Influent, CABI, and CE Selenium Concentrations - 24 Hour Study -
May 8, 2008

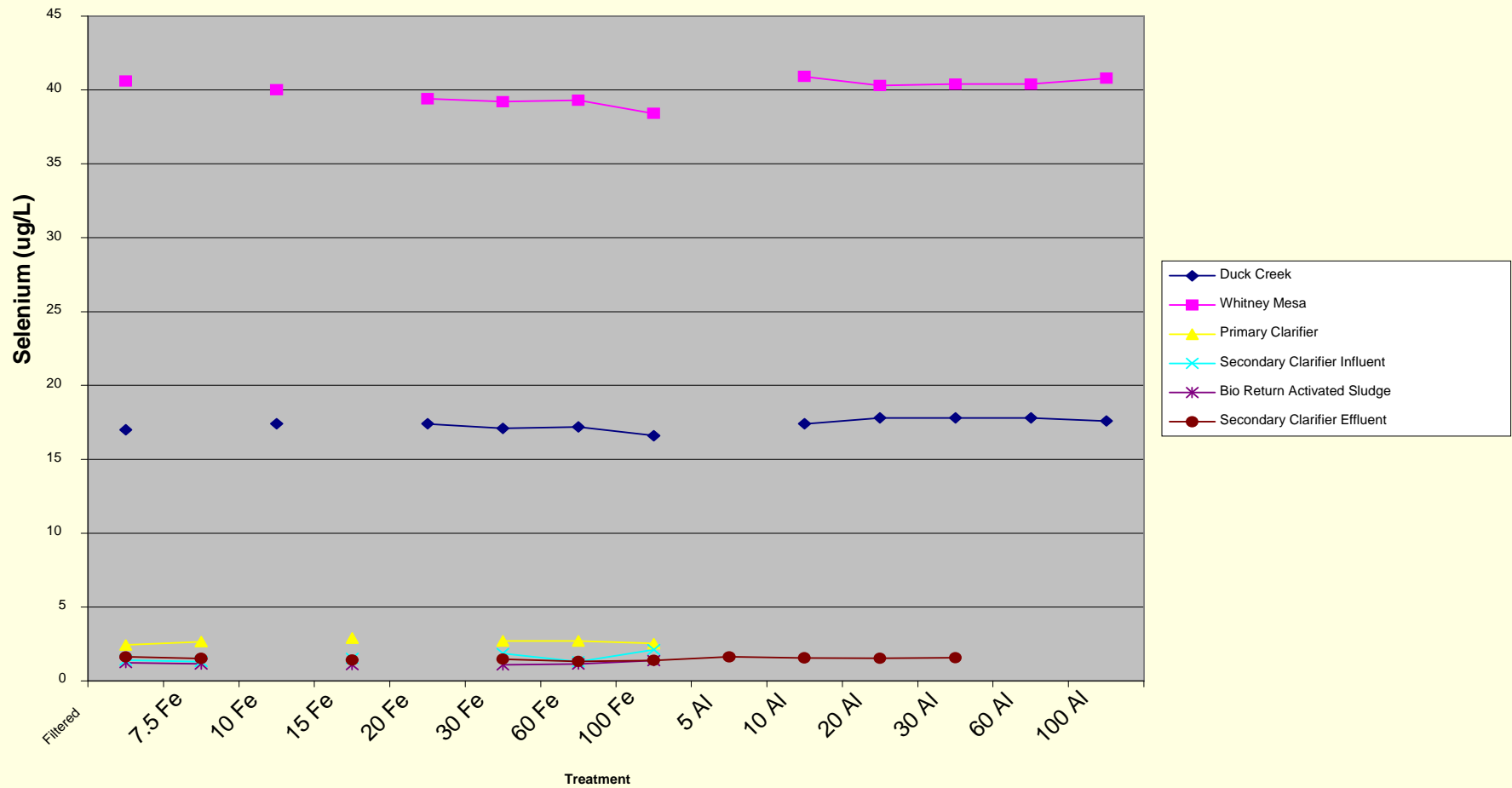


Treatment Optimization

Water Source	Ferric Chloride Dose (mg/L as Fe)	Alum Dose (mg/L as $Al_2(SO_4)_3$)	Total Tests
Duck Creek	0, 10, 20, 30, 60, 100		6
Duck Creek		10, 20, 30, 60, 100	5
Whitney Mesa	0, 10, 20, 30, 60, 100		6
Whitney Mesa		10, 20, 30, 60, 100	5
Primary Clarifier Influent	0, 7.5, 15, 30, 60, 100		6
Secondary Clarifier Influent	0, 7.5, 15, 30, 60, 100		6
Return Activated Sludge	0, 7.5, 15, 30, 60, 100		6
Secondary Clarifier Effluent	0, 7.5, 15, 30, 60, 100		6
Secondary Clarifier Effluent		5, 10, 20, 30	4
Total			50

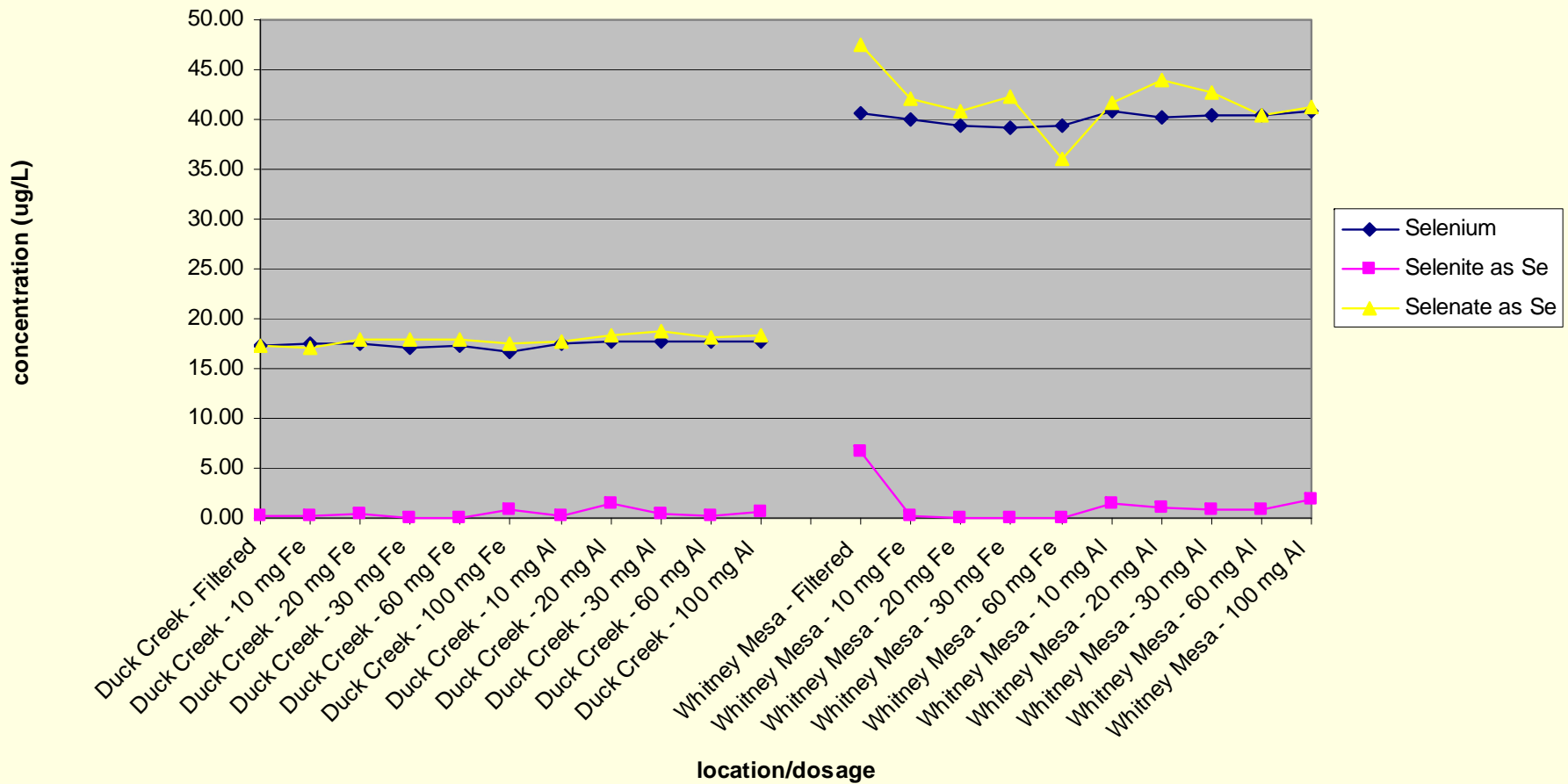
Results – Treatment Optimization

Selenium Treatment Optimization Study as Selenium - CCWRD



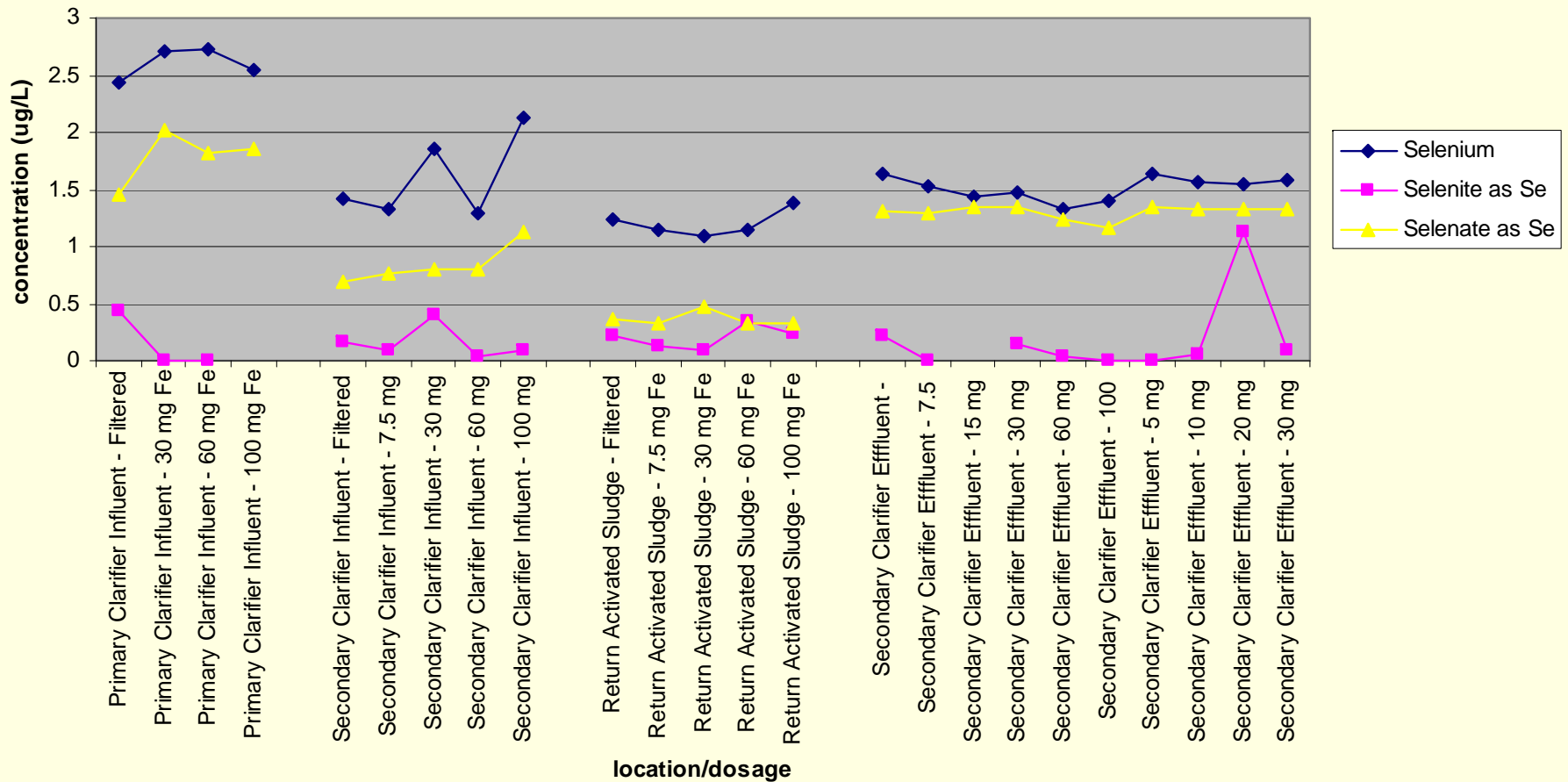
Results – Treatment Optimization Natural Waters Se Speciation

Treatment Optimization Study - Natural Waters - Selenium Speciation

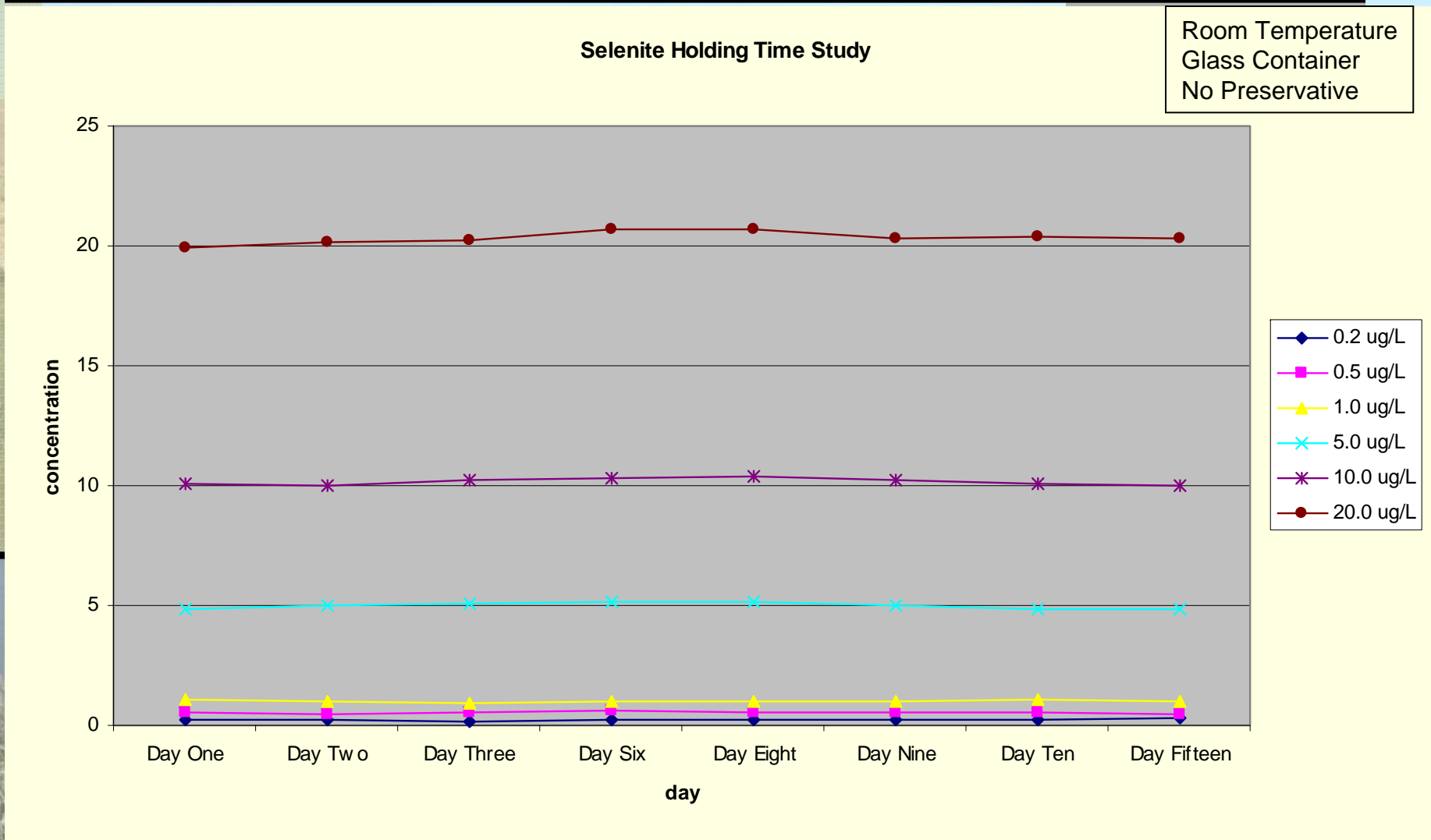


Results – Treatment Optimization CCWRD Se Speciation

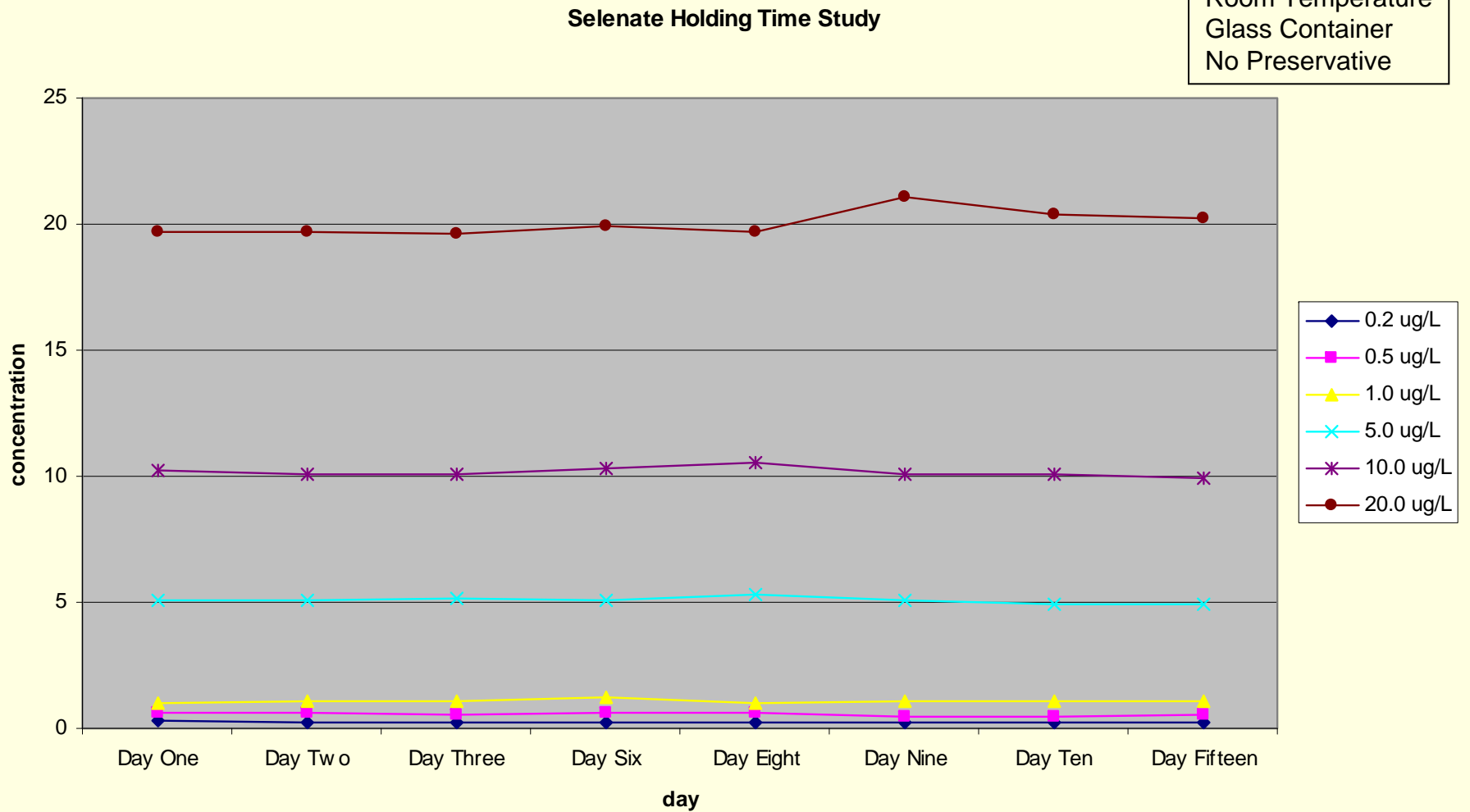
Treatment Optimization Study - CCWRD - Selenium Speciation



Results - Selenite Holding Time Study



Results – Selenate Holding Time Study



Conclusions

- Average removal of Total Se – 52%
- Majority of Se in effluent – Dissolved
- Influent total and dissolved Se concentrations for COH and CCWRD were similar
- CLV lower Influent total and dissolved Se
- COH 48% removal total and 39% removal of dissolved
- CLV 54% removal total and 35% removal of dissolved
- CCWRD 55% removal of total and 44% removal of dissolved

Conclusions

■ COH

- 49% Total Se removed in biological process

■ CLV

- Old Plant – 32% Total Se removed with higher chemical dose – Nitrification lower removal Total Se 29%
- New plant – 23% Total Se removal with lower chemical dose – BNR higher removal Total Se 42%

■ CCWRD

- Total Se removal before biological treatment 14%
- Total Se removal through biological process is 48%

Conclusions

- COH and CCWRD - variable Se concentrations over 24 hour period
- CCWRD had highest influent concentration of Se
- COH and CCWRD – variability in Se concentrations during low and high wastewater flow periods
- Treatment could not be optimized by adding different dosages of ferric chloride or alum
- Selenate and selenite are stable for a period of at least 15 days at room temperature, a in glass bottle, with no preservative

Questions/Comments

