CITY OF LONG BEACH
Gas & Oil
DEPARTMENT

C-11

CHRISTOPHER J. GARNER
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www.lbgo.org

October 2, 2012

HONORABLE MAYOR AND CITY COUNCIL
City of Long Beach
California

RECOMMENDATION:

Receive and file the attached report, "Elevation Changes in the City of Long Beach, November 2011 through April 2012." (Citywide)

DISCUSSION

The City of Long Beach, through the Long Beach Gas and Oil Department (LBGO), supervises oil production and subsidence control operations in the Wilmington Oil Field. LBGO conducts elevation surveys every six months to monitor elevation changes in the oil fields and adjacent city areas. This report focuses on elevation changes that have occurred from November 2011 through April 2012. The LBGO survey includes the following areas: Civic Center, Central City, Alamitos Bay, Naples, Harbor District, and an offshore area encompassing the four oil islands.

The results of the six-month survey show that elevations were stable in the Civic Center, Central City, Alamitos Bay, Naples, and the offshore areas. The Harbor District remained stable except for two areas of minor elevation change. An elevation loss of up to 0.07 foot (0.8 inch) occurred on Pier S, while portions of Piers D, E, and T experienced an elevation rise of up to 0.09 foot (1.1 inch). Ongoing oil development activities are occurring in both of these areas. LBGO is taking steps to mitigate the minor variations in elevation. However, the elevation changes do fall within the range of historical fluctuations.

The LBGO survey uses a series of benchmarks to determine elevation changes. Studies by the Department's engineers and geologists show that the benchmarks may rise and fall in such a manner as to make a survey either optimistic (slightly up in elevation) or pessimistic (slightly down in elevation). These changes in elevations may be associated with tidal cycles, temperature changes, and/or deep earth tectonic changes or re-pressuring operations. Surface elevations in a rebounded area can be expected to fluctuate under changing water flood conditions.

This matter was reviewed by Deputy City Attorney Richard Anthony on September 13, 2012 and by Budget Management Officer Victoria Bell on September 10, 2012.

TIMING CONSIDERATIONS

City Council action on this matter is not time critical.

FISCAL IMPACT

There is no fiscal impact or local job impact associated with this action.

SUGGESTED ACTION:

Approve recommendation.

Respectfully submitted,

CHRISTOPHER J. GARNER
DIRECTOR OF LONG BEACH GAS AND OIL

CJG:JJ

Attachment

APPROVED:

PATRICK H. WEST
CITY MANAGER

ELEVATION CHANGES
IN THE
CITY OF LONG BEACH

NOVEMBER 2011 THROUGH APRIL 2012

PREPARED

FOR

LONG BEACH CITY COUNCIL

BY THE

LONG BEACH GAS AND OIL
DEPARTMENT

CONTENTS

ELEVATION SURVEY ANALYSIS

The City of Long Beach semi-annual elevation survey of the Civic Center, Central City, Harbor District, Alamitos Bay, Naples, and offshore areas was conducted during May 2012. Changes in elevation that have occurred since the last two surveys, November 2011 and May 2011, are discussed in this report. The results in this report reflect elevation changes both within and beyond the scope of oilfield operations. Some changes are due to natural geologic factors.

Elevation Change – November 2011 through April 2012 (Figure 1)

Elevations throughout the Civic Center, Alamitos Bay, Naples, and offshore areas were considered stable during the six-month period. The Harbor District remained stable except for two areas of minor elevation change. An elevation loss of up to 0.07 foot (0.8 inch) occurred on Pier S, while portions of Piers D, E, and T experienced an elevation rise of up to 0.09 foot (1.1 inch). Activity in this general area includes ongoing oil operations and surface development related to the Heim Bridge (Port of Los Angeles), Gerald Desmond Bridge and Middle Harbor projects (Port of Long Beach). Specific actions have been implemented to counter these trends. LBGO will continue to investigate and will make additional adjustments and recommendations if the elevation trends are confirmed in successive surveys.

Elevations in the City of Long Beach beyond the boundaries of the Wilmington Oil Field were stable.

Elevation Change – May 2011 through April 2012 (Figure 2)

Elevations in the Central City and offshore areas near Island Grissom increased during the 12-month period by as much as 0.07 foot (0.8 inch). The elevation change was relatively minor and may be attributable to slightly higher water injection to voidage ratios during the period. Elevations throughout the Alamitos Bay and Naples areas remained stable during the 12-month period.

In the Harbor District, Piers D, E and the eastern portion of Pier T rose by as much as 0.12 foot (1.4 inch) during the 12-month period. As previously stated, LBGO is reviewing potential causes related to oil field activities. Piers A and S experienced an elevation decrease of up to 0.08 foot (1.0 inch) during the 12 month period. Increased water injection into this area is expected soon with the addition of new water injection wells, which should mitigate the trend. These elevation changes still fall within the range of historical annual fluctuations and do not warrant significant concern.

Use of Global Positioning System (GPS)

This report is based solely upon computer processed data utilizing the Long Beach Deformation Network (LBDN). The LBDN consists of thirteen permanent, reference GPS base stations, communication equipment, computer server, monitoring software and five mobile GPS receivers. The Public Works Department's Bureau of Engineering surveyors utilize the mobile GPS receivers linked to the reference base stations to measure approximately 240 City and Harbor bench marks.

APPENDIX

Brief History of Long Beach Subsidence

Long Beach and the general vicinity have a history of regional subsidence (losses of elevation) since 1929. Elevation changes were minor amounting to an average of about -0.036 foot (-0.43 inch) per year until about 1939. Geologic movement such as the Long Beach Earthquake of March 1933 altered this average rate at times. Contributing causes of the subsidence were groundwater withdrawal from aquifers in the Long Beach area, regional basin sediment compaction, and tectonic effects of local faulting.

Development of the Wilmington Oil Field began in 1932. Oil operations accelerated subsidence and created a 29-feet deep subsidence bowl centered in the Wilmington-Long Beach Harbor area near Bench Mark 8772, at the Edison power plant. Development of the Ranger Zone west of Pine Avenue and its extension seaward in 1947 started the first definitive subsidence in the Central Business District that could be attributed to oil production.

Repressuring operations began in the 1950s. By 1965, subsidence stopped throughout the Long Beach portion of the Wilmington Oil Field. Several bench marks recovered over one foot in elevation, due to waterflood repressuring. As an example, from 1960 to 1970, Bench Mark 1735 near the corner of Ocean Boulevard and Magnolia Avenue recovered approximately one foot of elevation. The recovery of bench mark elevations is known as rebound.

The Alamitos Bay and Naples area had losses in elevation prior to development of the adjacent oil operations. These original small losses were most likely due to the regional affects of basin sediment compaction and tectonic movements along the Newport-Inglewood Fault Zone. Later, the coastal strip from the Civic Center eastward to the Alamitos Bay Peninsula lost elevation due to oil and gas production from the West

Wilmington Oil Field and possibly the adjacent oil fields. The coastal strip rebounded slightly due to water injection from the offshore Oil Islands that began in 1965.

Survey Accuracy

The May 2002 Elevation Leveling Campaign marked the conversion from spirit, first and second order rod leveling, to GPS surveying of bench mark elevations.

Through statistical analysis of satellite, base station, mobile instrument geometries, a coincident spirit leveling and GPS bench mark elevation survey, City surveyors estimate the accuracy of GPS elevations to be 8 to 10 millimeters (0.025 foot or 0.30 inch). Areas are considered to be stable where elevation change is less than 0.050 foot (0.60 inch) over a six month survey period.

Studies by the City's subsidence control engineers, geologists, and consultants show that the bench marks may at times rise and fall somewhat concurrently city-wide in such a manner as to make an entire survey either optimistic or pessimistic. These elevation changes are random and not well understood. Repressuring operations and the resulting rebound can mask the rise or fall pattern. Surface elevations in a rebounded area can be expected to fluctuate under changing water flood conditions. Because of these fluctuations, conclusions based upon short-term survey data should be viewed with caution. Short-term survey data are useful for possible early detection and confirmation of subsidence trends or relative elevation changes but should not be accepted without consideration of the above factors. Annual survey data tend to average these fluctuations and depict a more dependable picture of the relative movements of bench marks.

Elevation Change Map Construction (Figures 1 and 2)

All data are presented as contour lines showing the average change in surface elevation during a particular time period. For example, any point along a line reading 0.05 foot (0.60 inch) on an Elevation Change Map gained an elevation of one-twentieth of a foot or six-tenth of an inch during that period. The small hachures along contour lines point towards a loss in elevation.

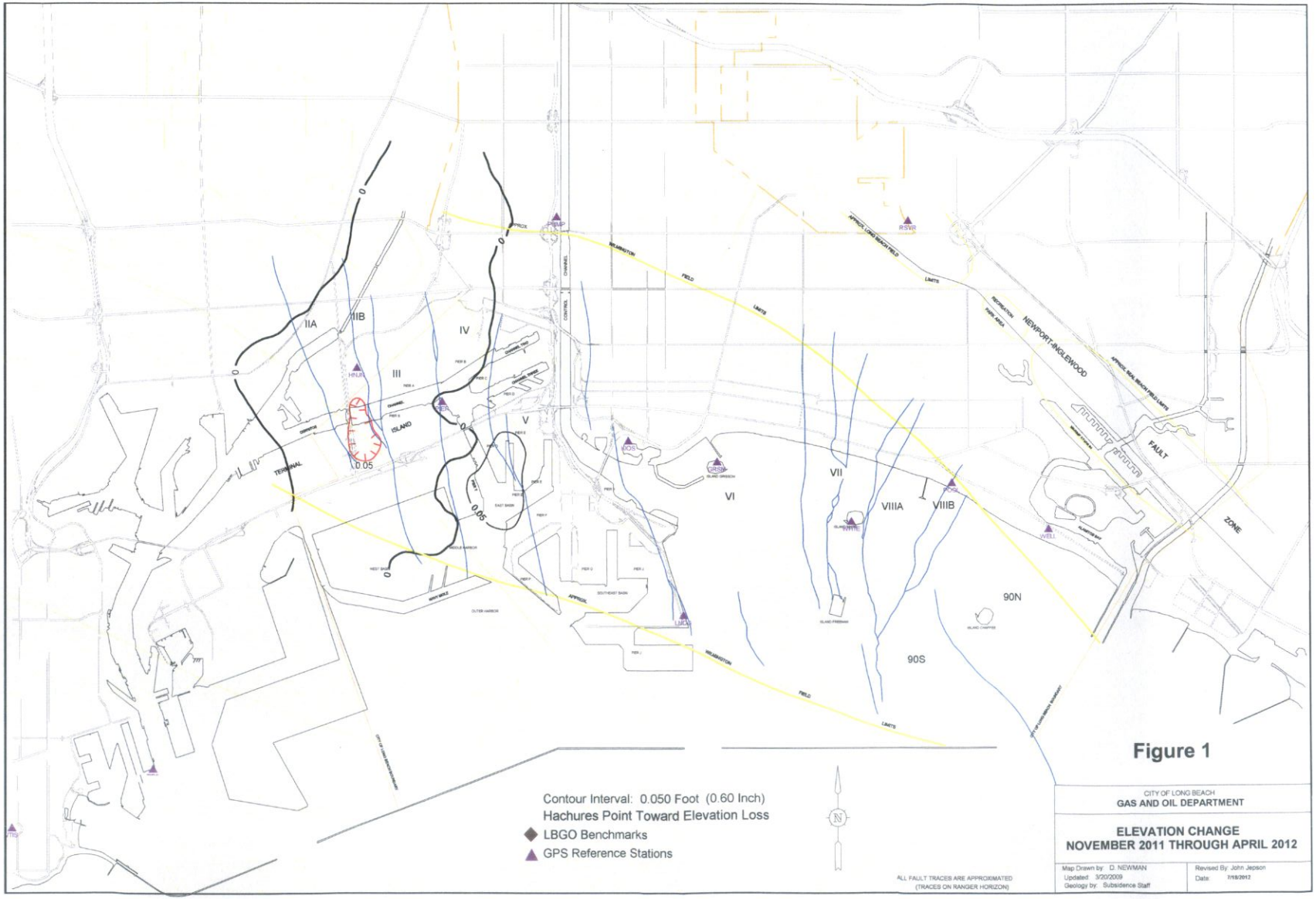
Net Injection Graphs, Harbor District (Figures 3 – 6)

The net injection is the amount of water injected into the reservoirs minus the gross fluid produced from the reservoirs in barrels per day. The net injection graphs for the Harbor District are shown on Figures 3 through 6.

In general, these graphs show a good correlation between the net injection and elevation change. For example, an increase in net injection is usually followed by an increase in elevation. There tends to be a lag time of months and sometimes years between the net injection change and the subsequent elevation change.

Net Injection Graphs, Ocean Boulevard and the Offshore Drilling Islands (Figures 7 – 12)

The last 20 years of net injection histories are shown on Figures 7 through 12 for areas located along Ocean Boulevard and on the offshore drilling islands.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ZONE
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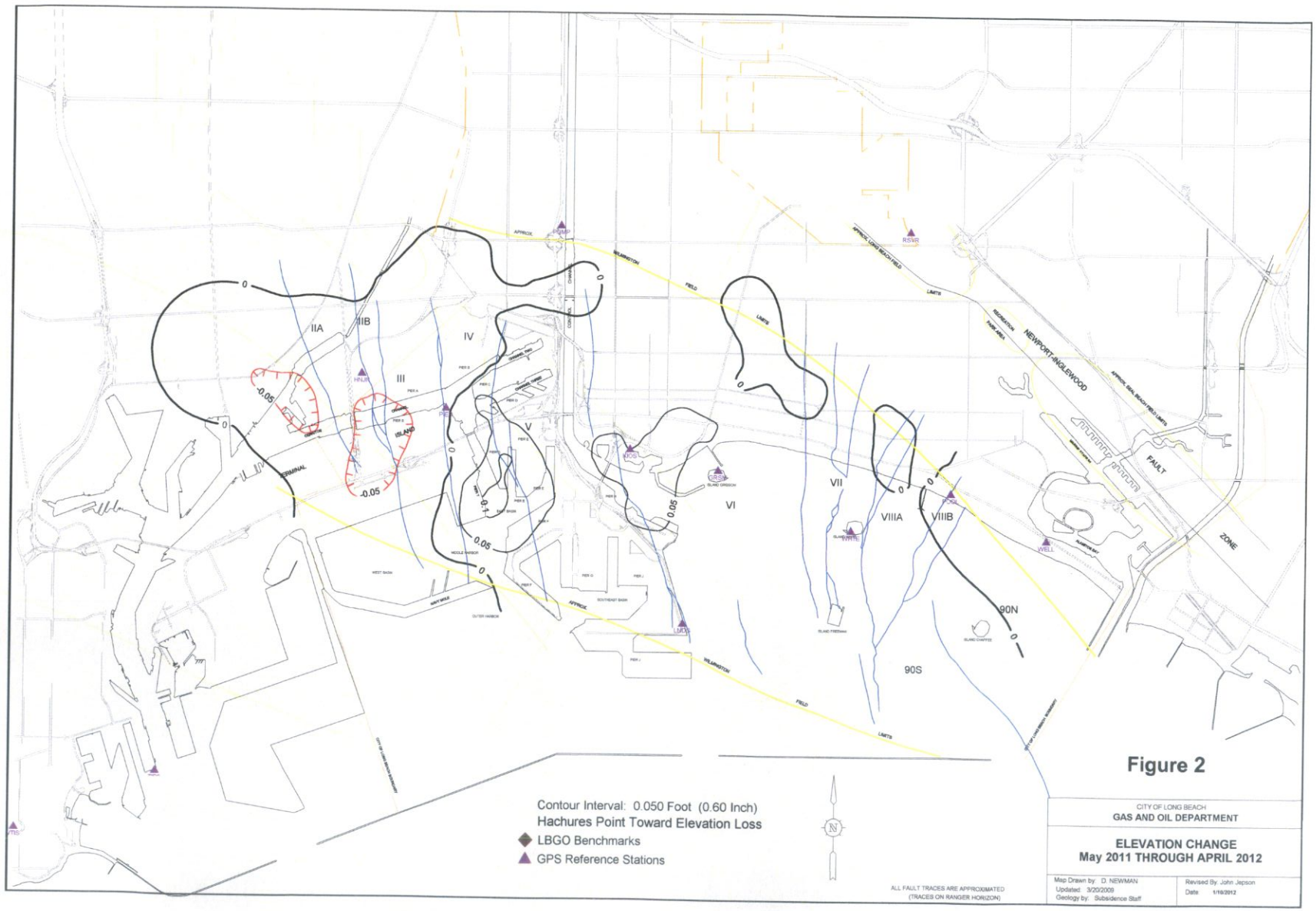
LIMITS
Contour Interval: 0.050 Foot (0.60 Inch)
Hachures Point Toward Elevation Loss
LBGO Benchmarks
GPS Reference Stations
ALL FAULT TRACES ARE APPROXIMATED
(TRACES ON RANGER HORIZON)
Figure 1
CITY OF LONG BEACH
GAS AND OIL DEPARTMENT
ELEVATION CHANGE
NOVEMBER 2011 THROUGH APRIL 2012
Map Drawn by: D. NEWMAN
Updated: 3/20/2009
Geology by: Subsidence Staff
Revised By: John Jepson
Date: 7/18/2012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FAULT
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Contour Interval: 0.050 Foot (0.60 Inch)
Hachures Point Toward Elevation Loss
LBGO Benchmarks
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ALL FAULT TRACES ARE APPROXIMATED
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CITY OF LONG BEACH
GAS AND OIL DEPARTMENT
ELEVATION CHANGE
May 2011 THROUGH APRIL 2012
Map Drawn by: D. NEWMAN
Updated: 3/20/2009
Geology by: Subsidence Staff
Revised By: John Jepson
Date: 1/10/2012

Figure 2

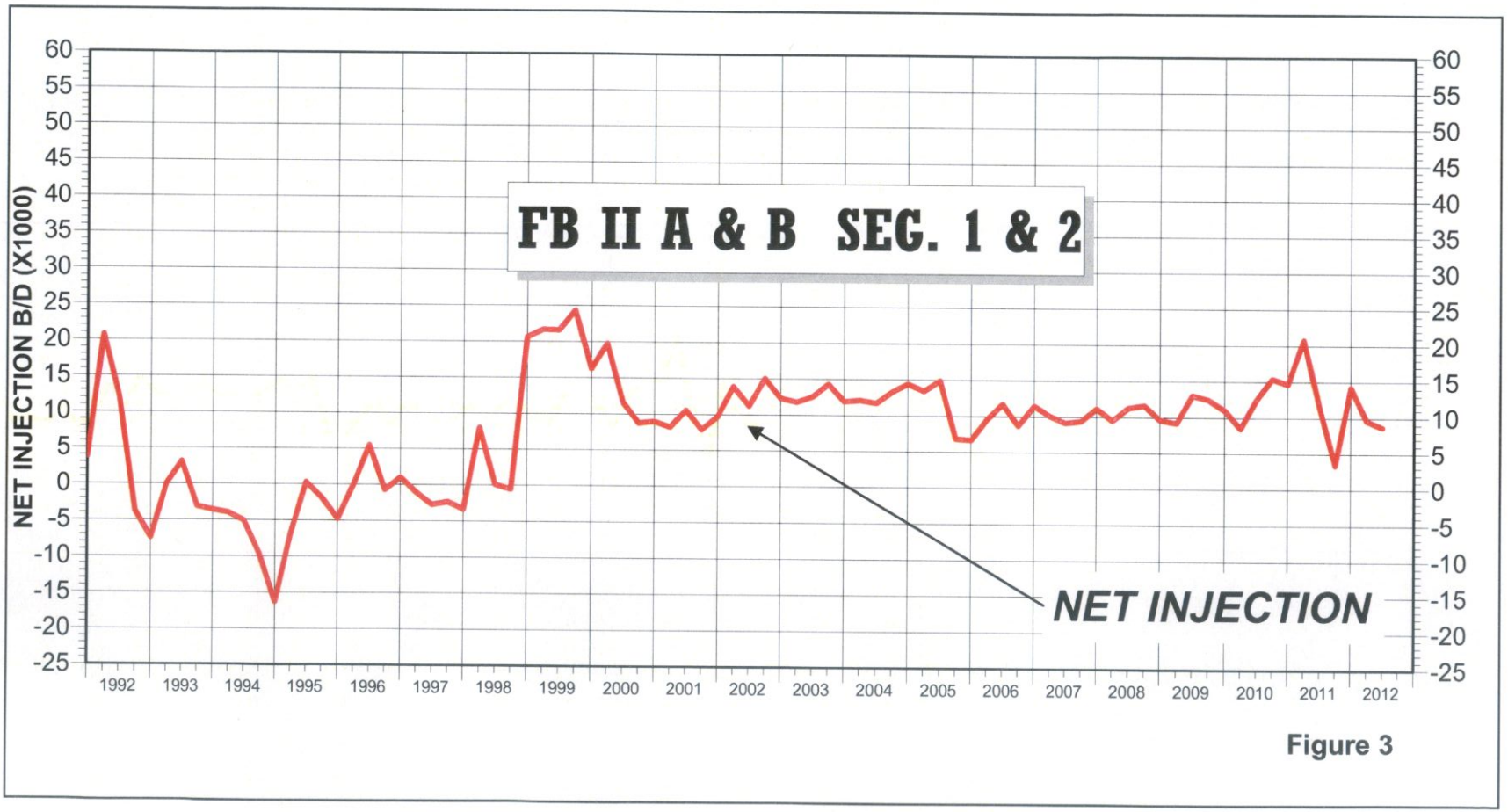
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Figure 3

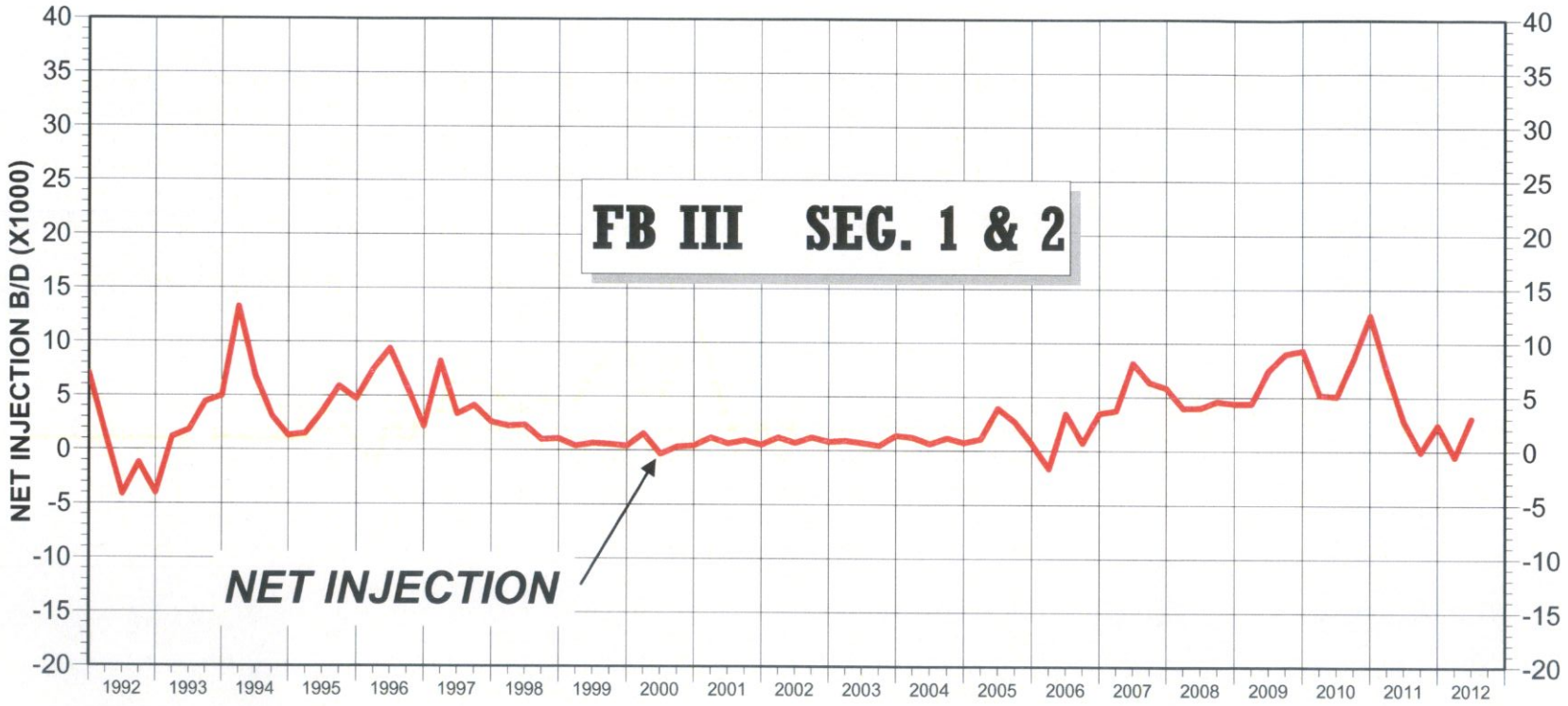
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Figure 4

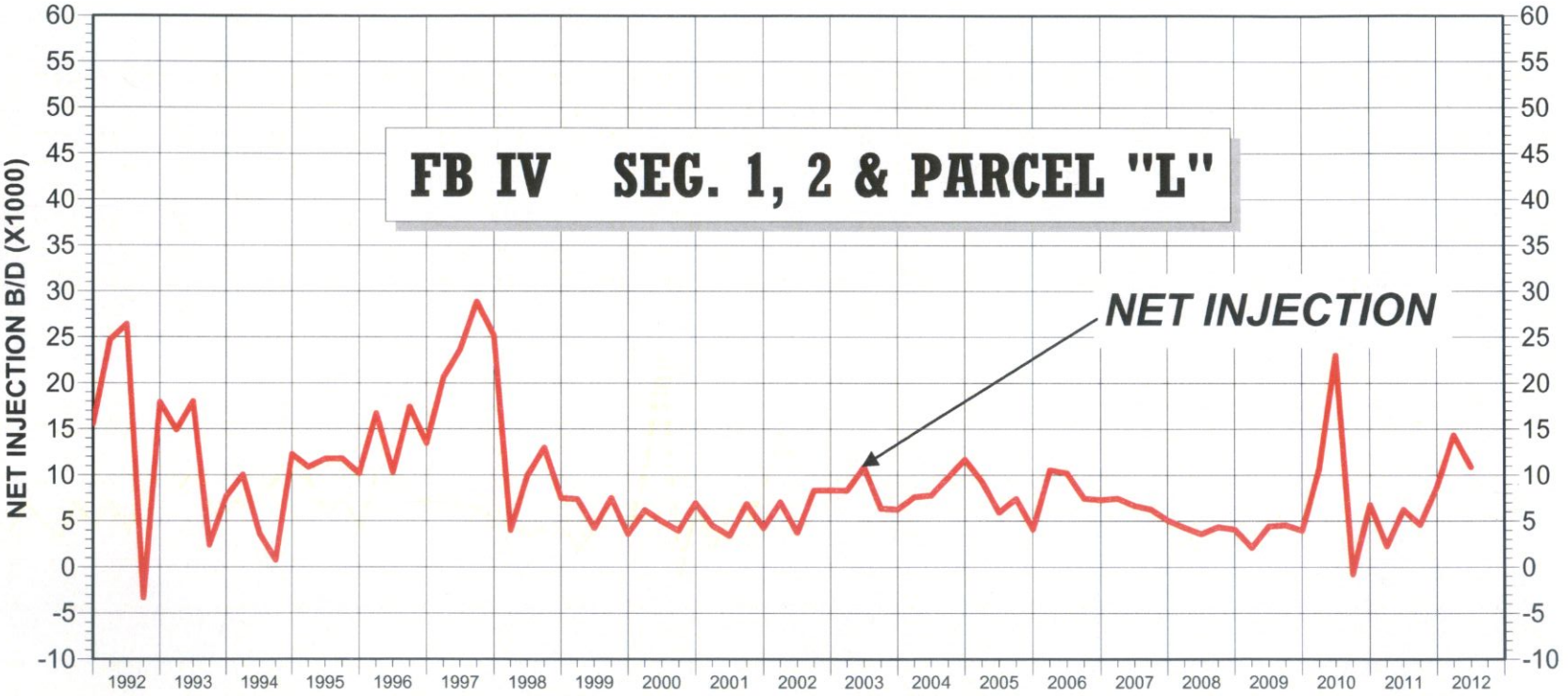
FB IV SEG. 1, 2 & PARCEL "L"
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Figure 5

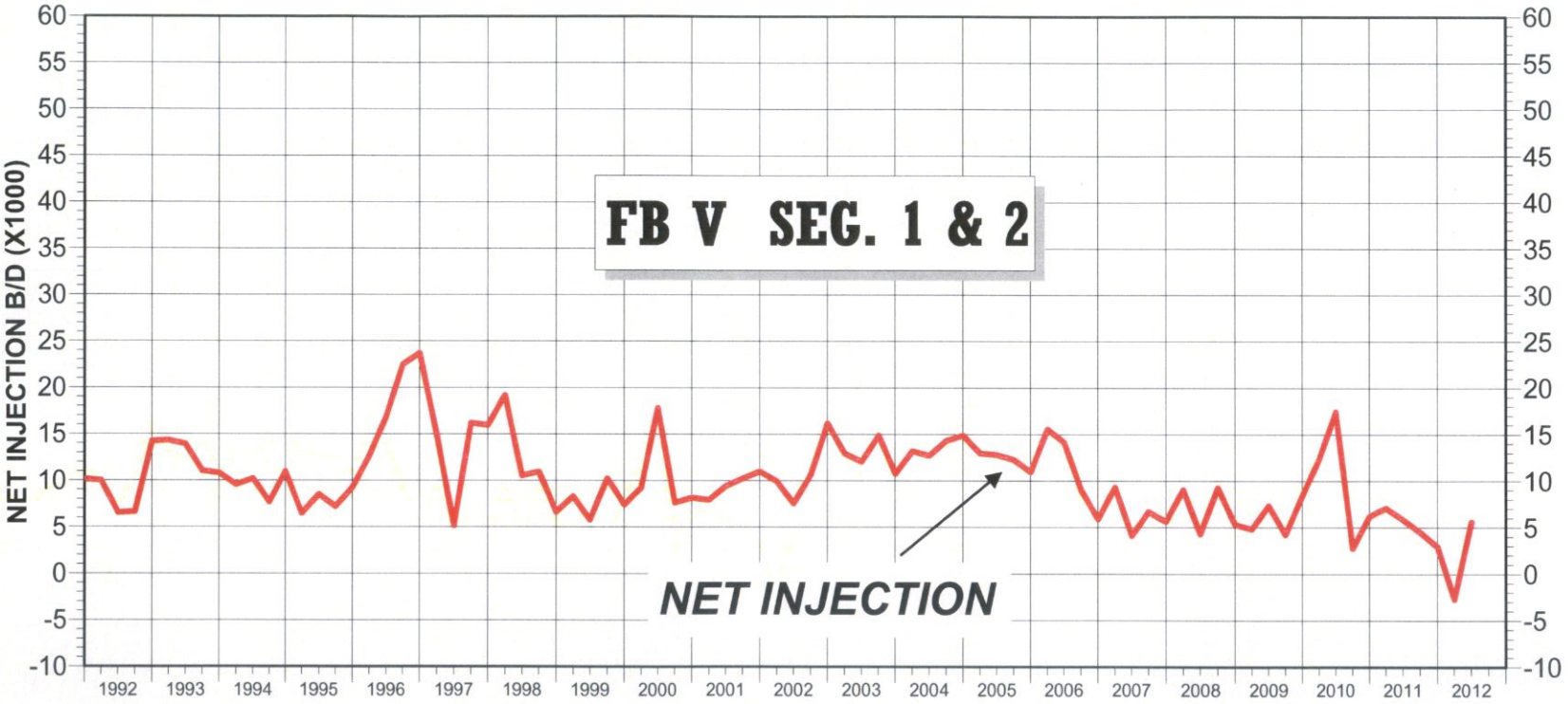
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Figure 6

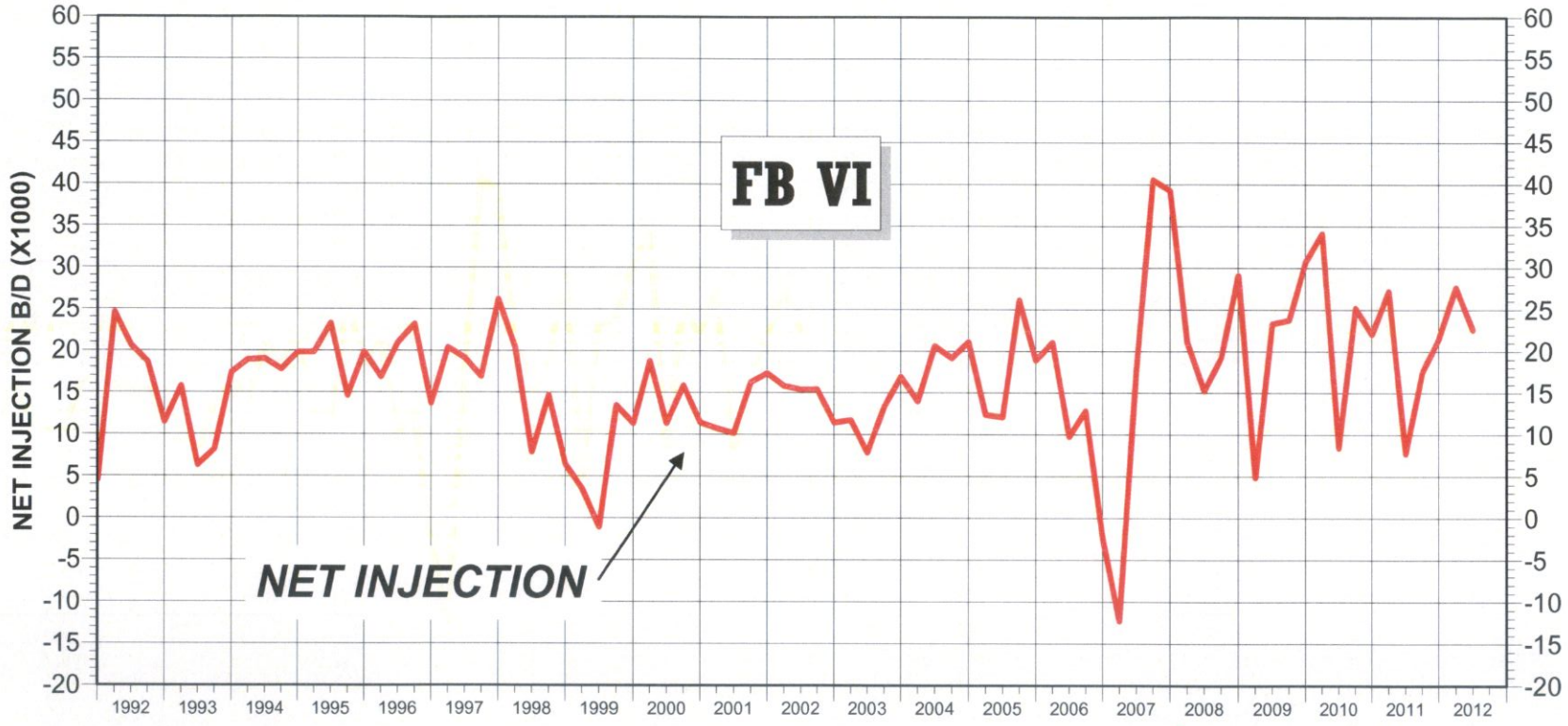
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Figure 7

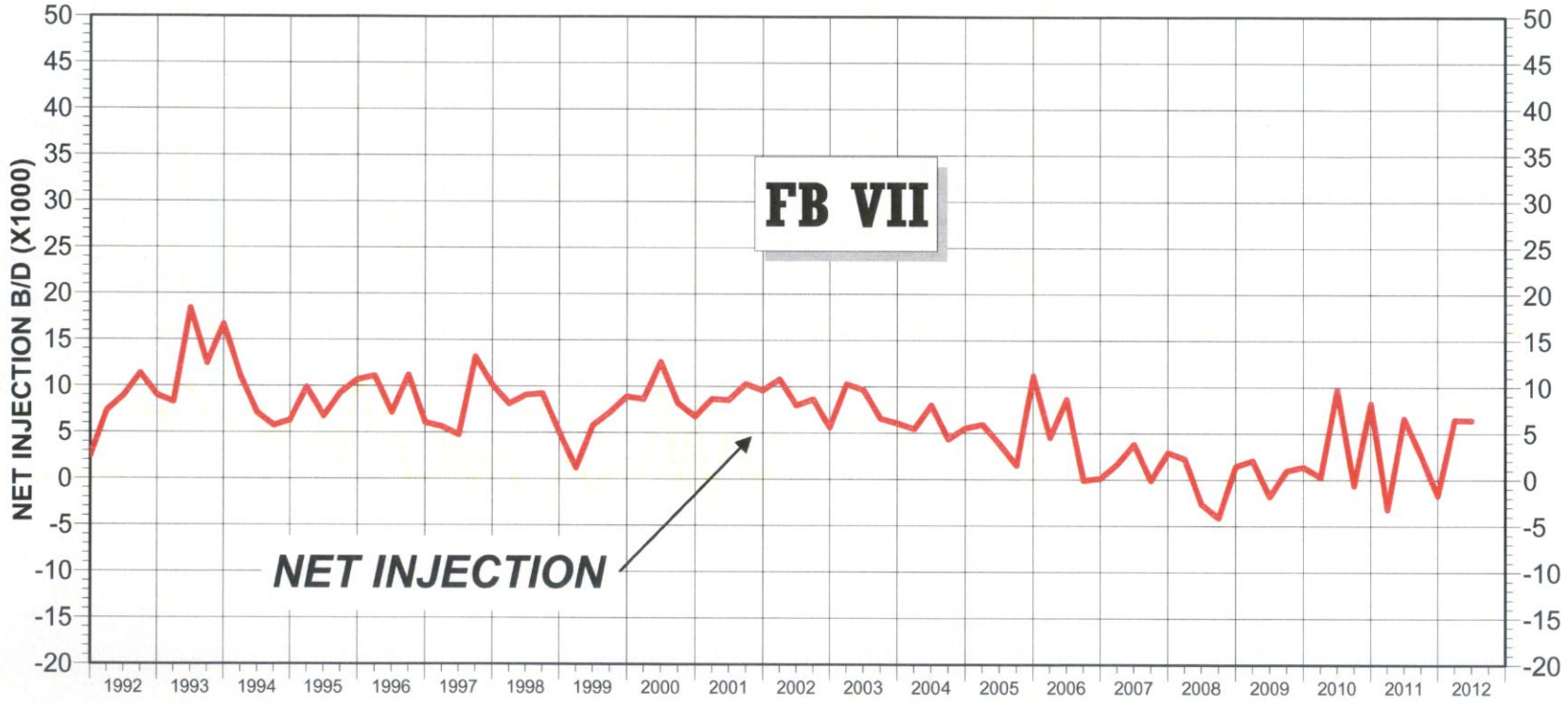
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Figure 8

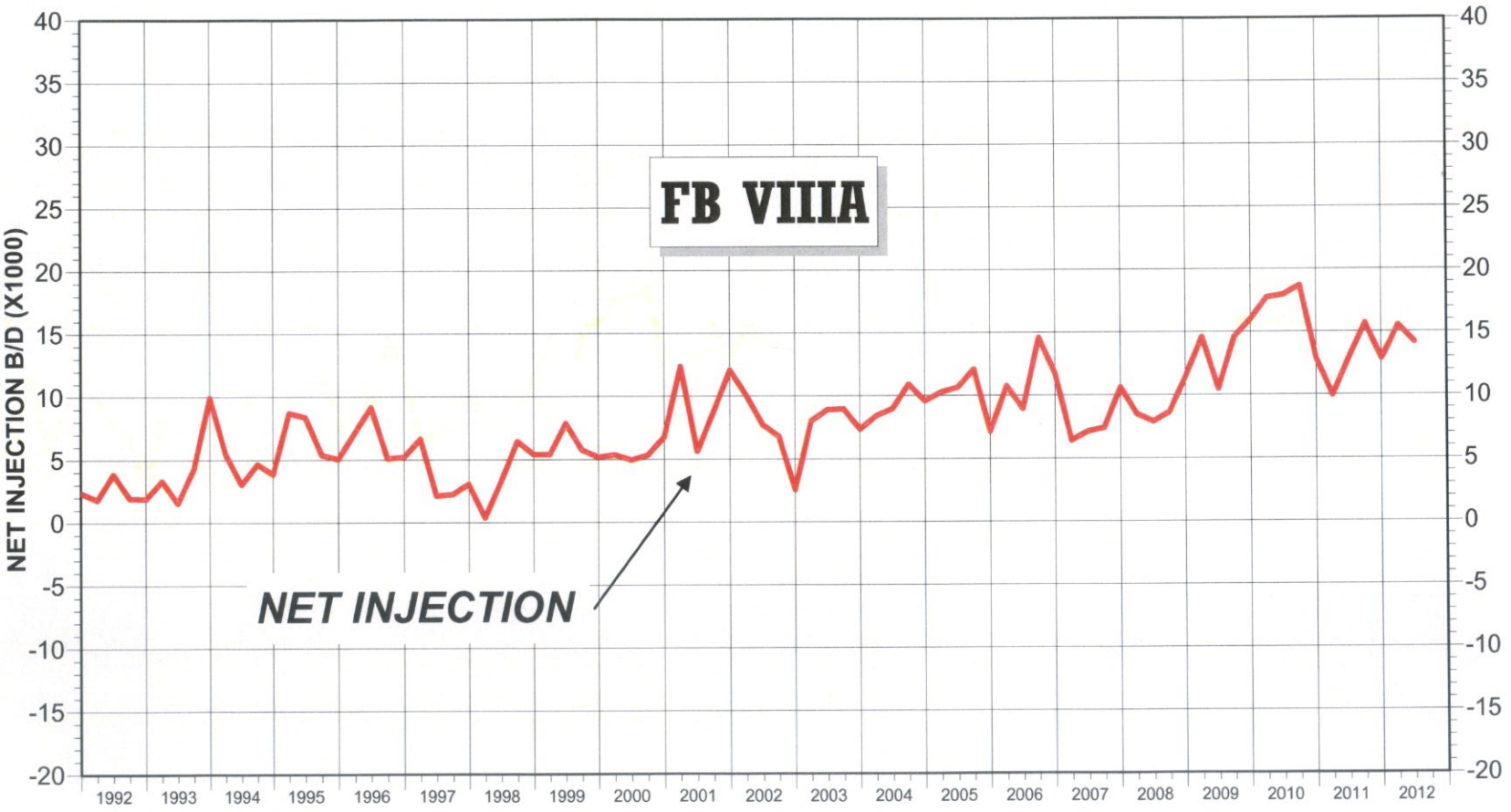
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Figure 9

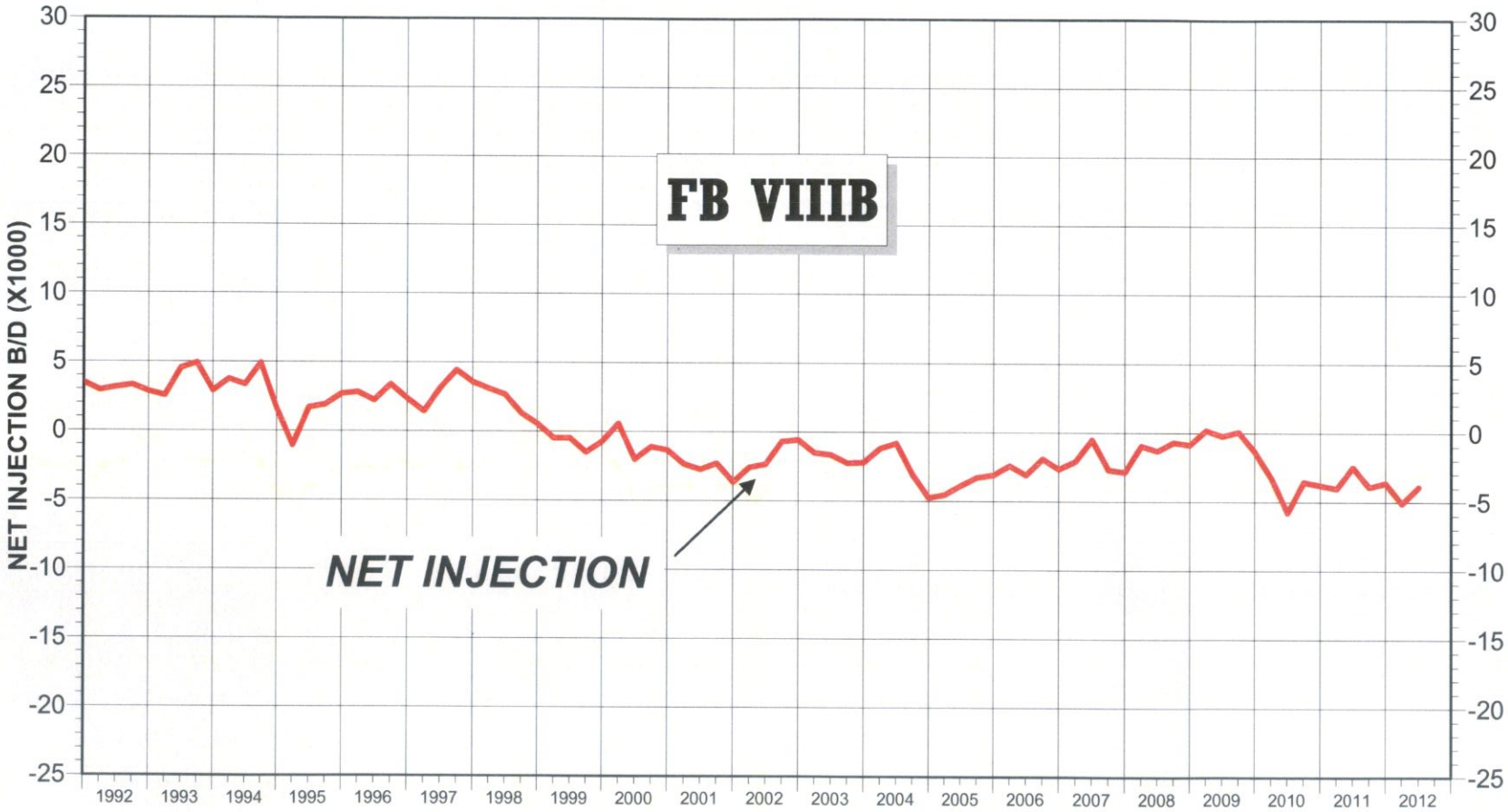
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Figure 10

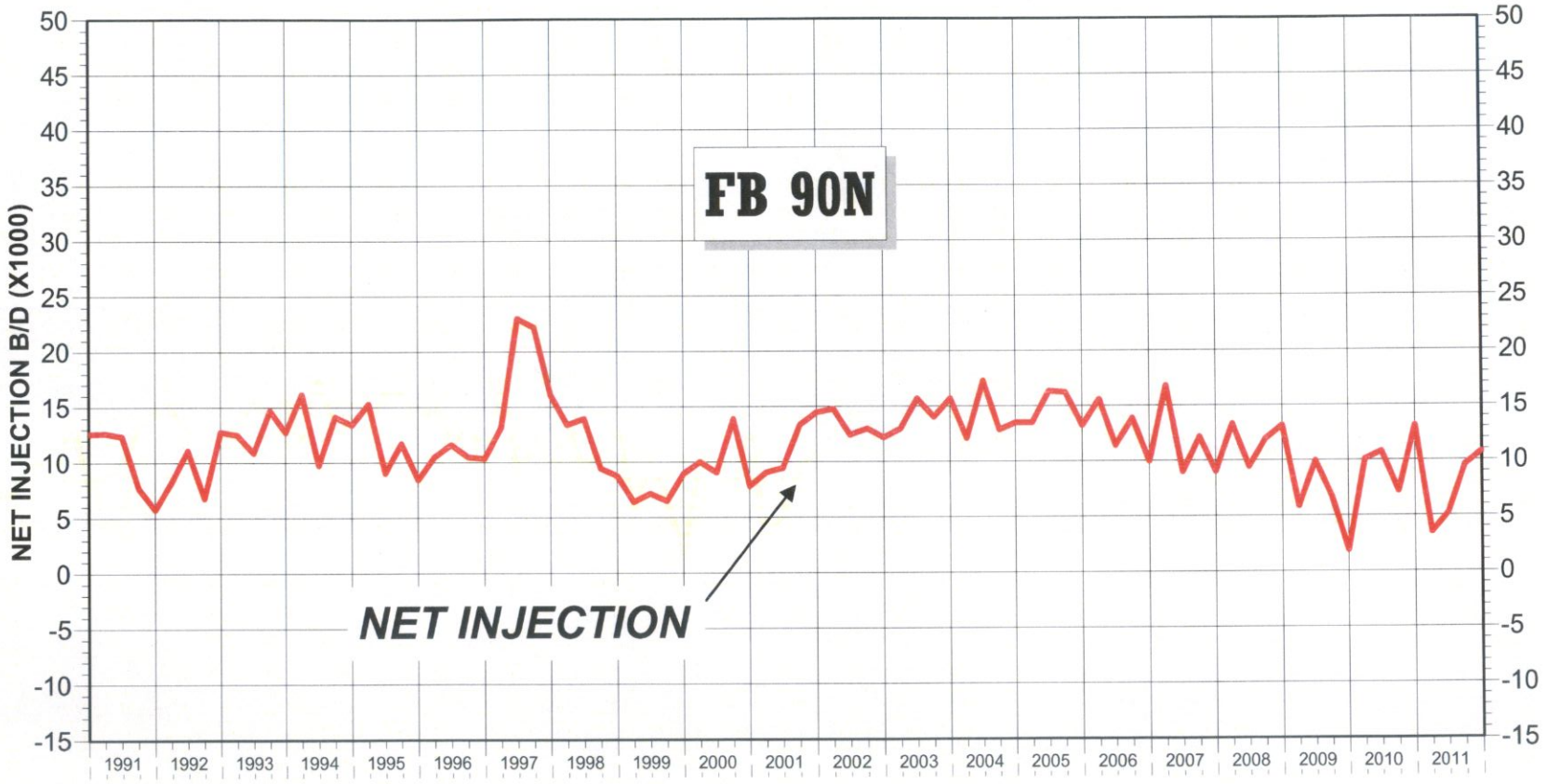
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Figure 11

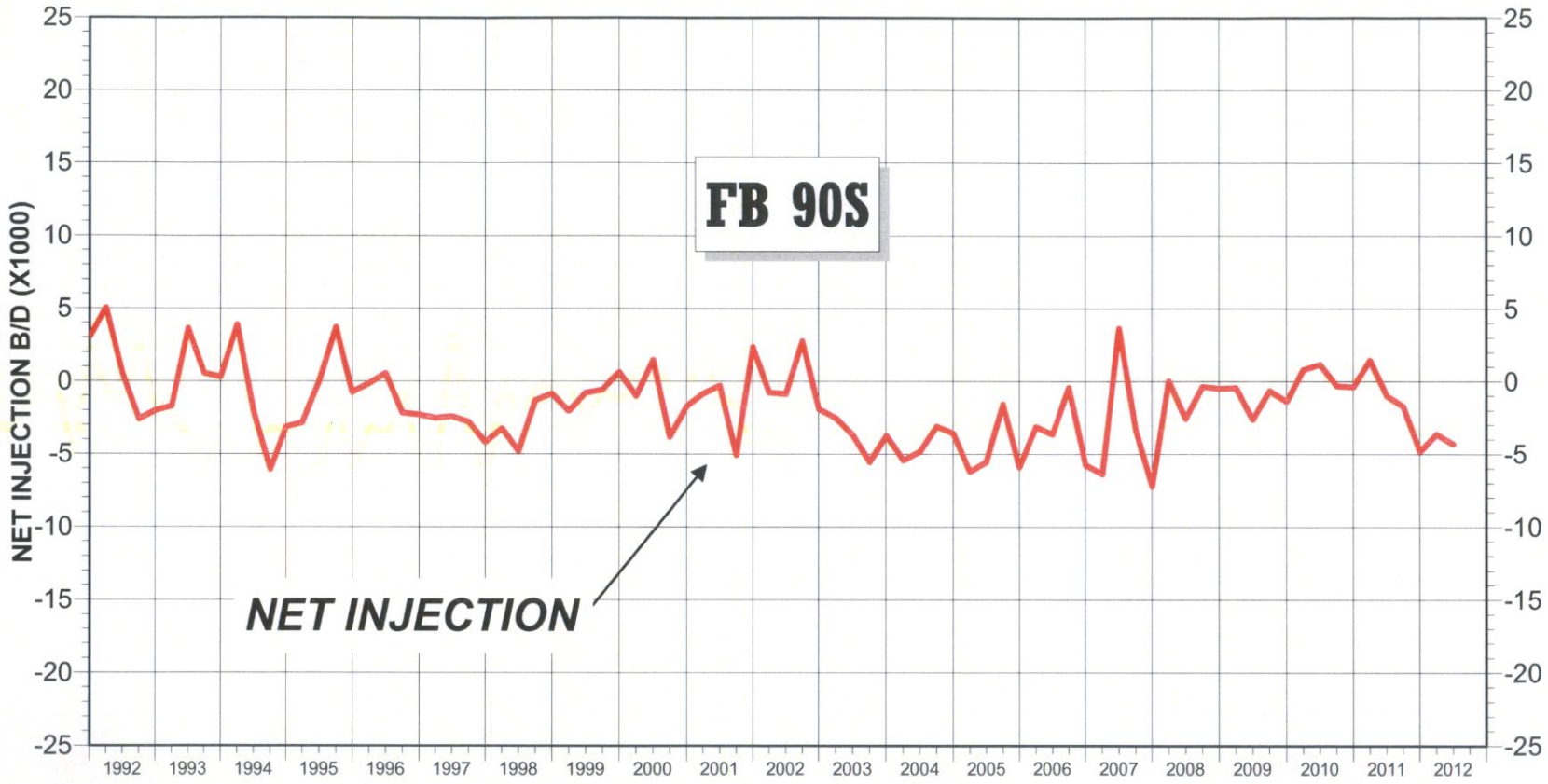
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Figure 12