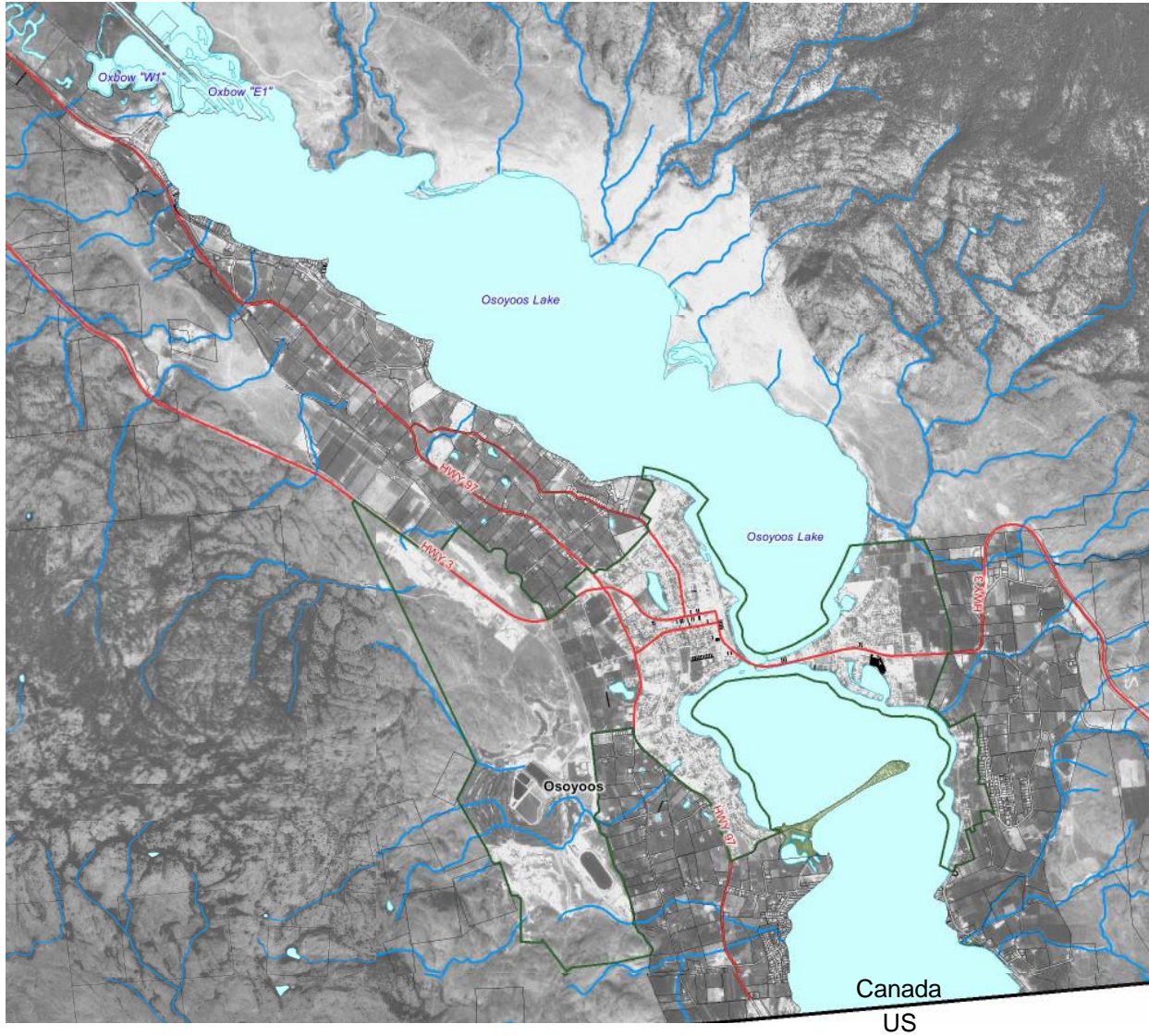

Source, Fate and Transport of Nitrate in Groundwater in the Osoyoos Area: Preliminary Results

Pana Athanasopoulos, M. Jim Hendry, and L. I. Wassenaar



Presentation Outline

- Location of study area
 - Objectives
 - Background
 - Agricultural activities
 - Tile drainage systems
 - Methodology
 - Preliminary results
 - Preliminary conclusions
 - Ongoing and future work
-



Regional District of Okanagan-Similkameen website

Objectives of Study

1. Confirm source of groundwater recharge using stable isotopes of hydrogen and oxygen
 2. Determine age of groundwater using $^3\text{H}/^3\text{He}$
 3. Identify trends in nitrate (NO_3) concentrations in groundwater and tile drains
 4. Determine source(s) of and control(s) on NO_3 using stable isotopes of nitrogen and oxygen
-

Agricultural Activities

- Fruit tree orchards in areas near wells
 - N-based fertilizers predominantly used; some mixed fertilizers; minor manure (Tim Watson, pers. comm.)
 - Osoyoos Lake - source of irrigation water
 - Irrigation rates (Ron Doucette, pers. comm.)
 - ~ 3,000 to 6,000 m³/acre at orchards
-

Tile Drainage Systems



Tile Drainage Systems



Methodology

RECHARGE SOURCES

Precipitation, surface water, irrigation water

- Monthly sampling in 2006
 - Precipitation: 3 locations in Okanagan Basin
 - Okanagan Lake/River: 6 locations
 - Osoyoos Lake: 4 locations
 - Periodic sampling in 2006
 - Irrigation water supply (two deep intakes in Osoyoos Lake)
 - Smaller surface water bodies (kettle lakes)
 - Analysis of isotopes ($\delta^2\text{H}$ and $\delta^{18}\text{O}$) of water
-

Methodology

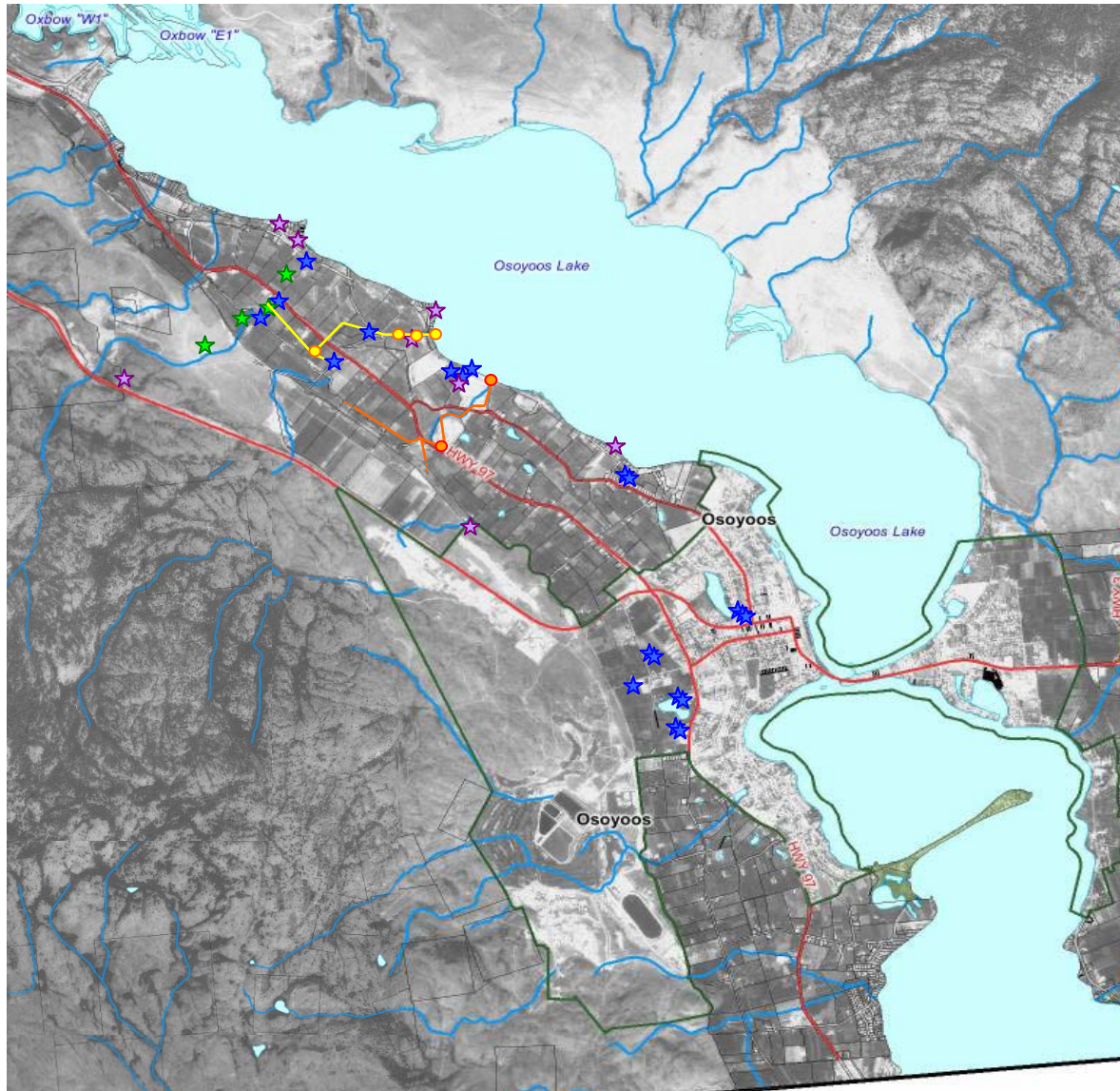
GROUNDWATER

- Drilled and installed 9 wells in December 2005
 - Groundwater sampling and analysis
 - Analysis of geochemical parameters, $\delta^2\text{H}$ and $\delta^{18}\text{O}$ of water, $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ of nitrate, dissolved oxygen, $\delta^{18}\text{O}$ of dissolved oxygen
 - Water level measurements
 - Age dating
 - Nine wells
-

Methodology

TILE DRAINAGE SYSTEMS

- Bi-monthly to monthly water sampling
 - Analysis of geochemical parameters, isotopes of water, isotopes of nitrate
 - Estimates of discharge rates
 - Historical NO₃ data & discharge rates
(1997 – 2002; Agriculture and Agri-Food Canada)
-

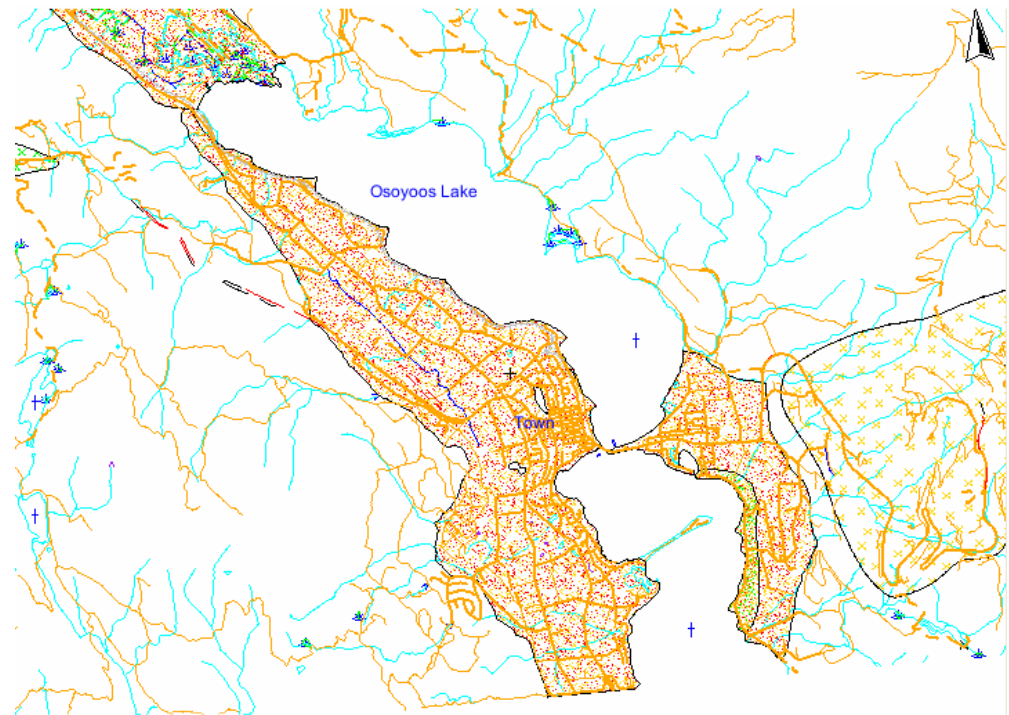


- ★ December 2005 Well
- ★ Environment Canada/
Provincial Obs. Well
- ★ Private Well
- North tile drain –
sample location
- South tile drain –
sample location

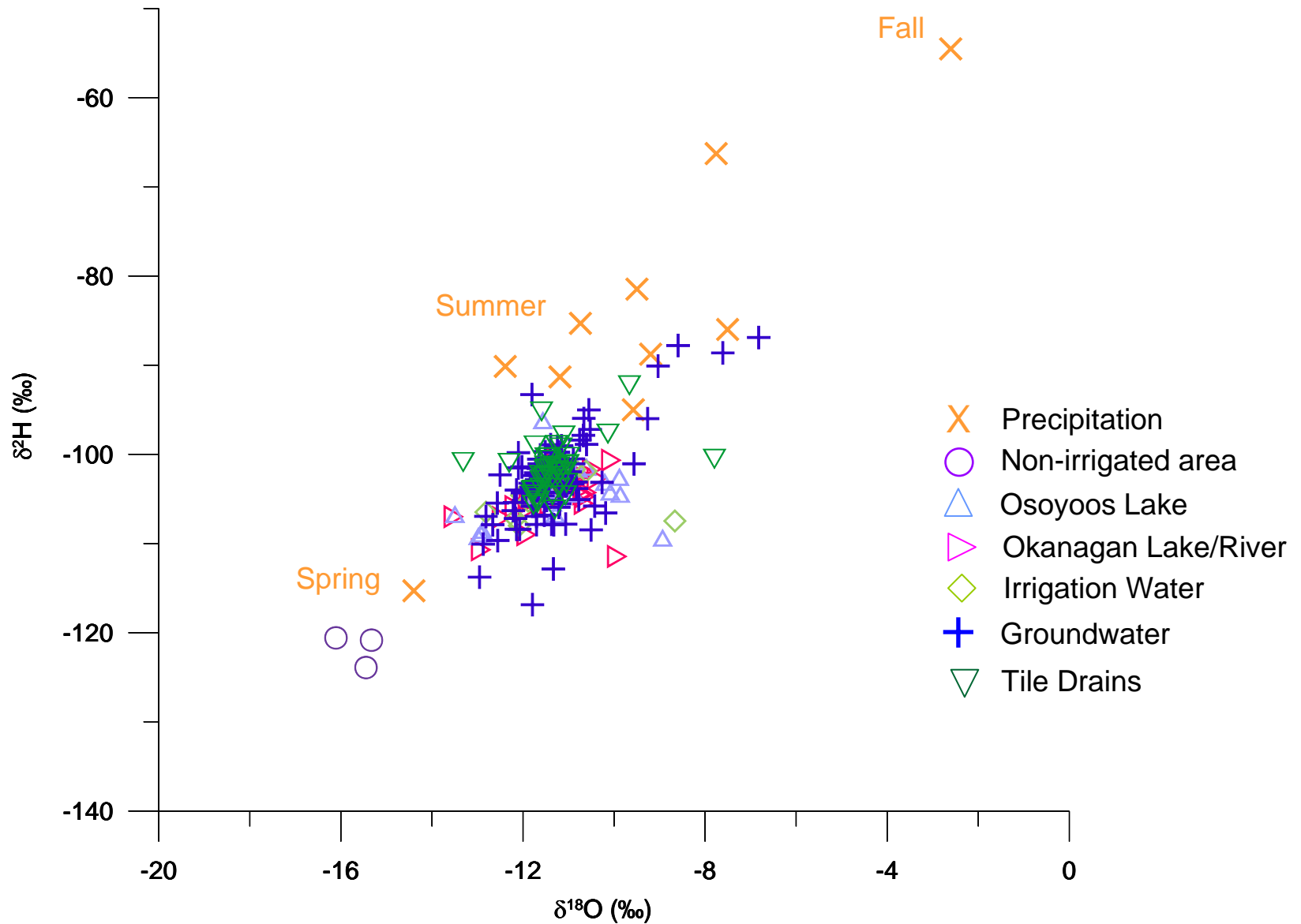
Hydrogeology of Study Area

■ Osoyoos West Aquifer

- Shallow, unconfined
- Glaciofluvial
 - Sand and gravel
- Not as extensive in northern study area
- Underlain by thick silt aquitard

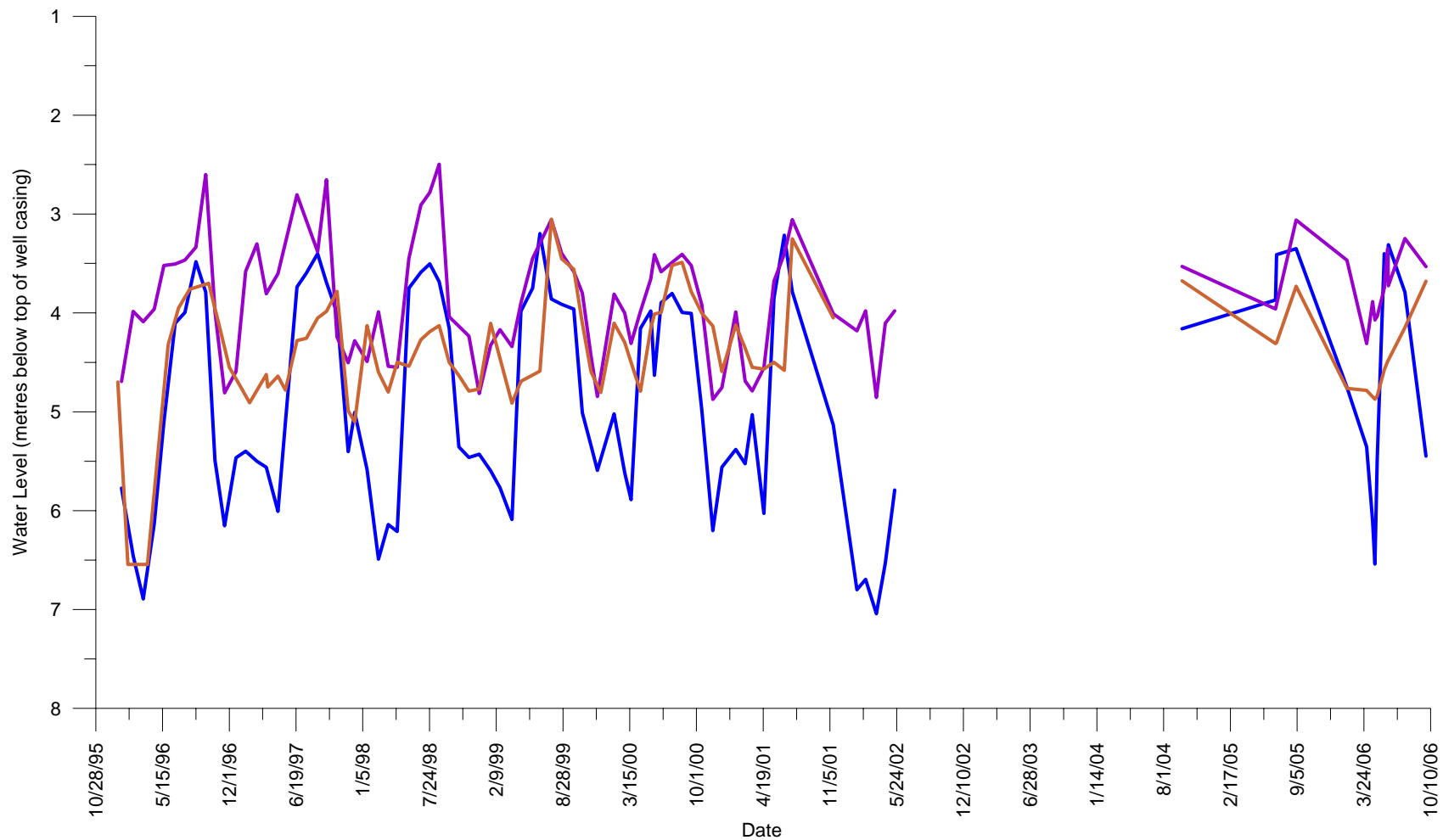


Results – Recharge Sources



Results – Water Levels

- Water level fluctuations apparent in all wells
- Water levels are highest after peak irrigation

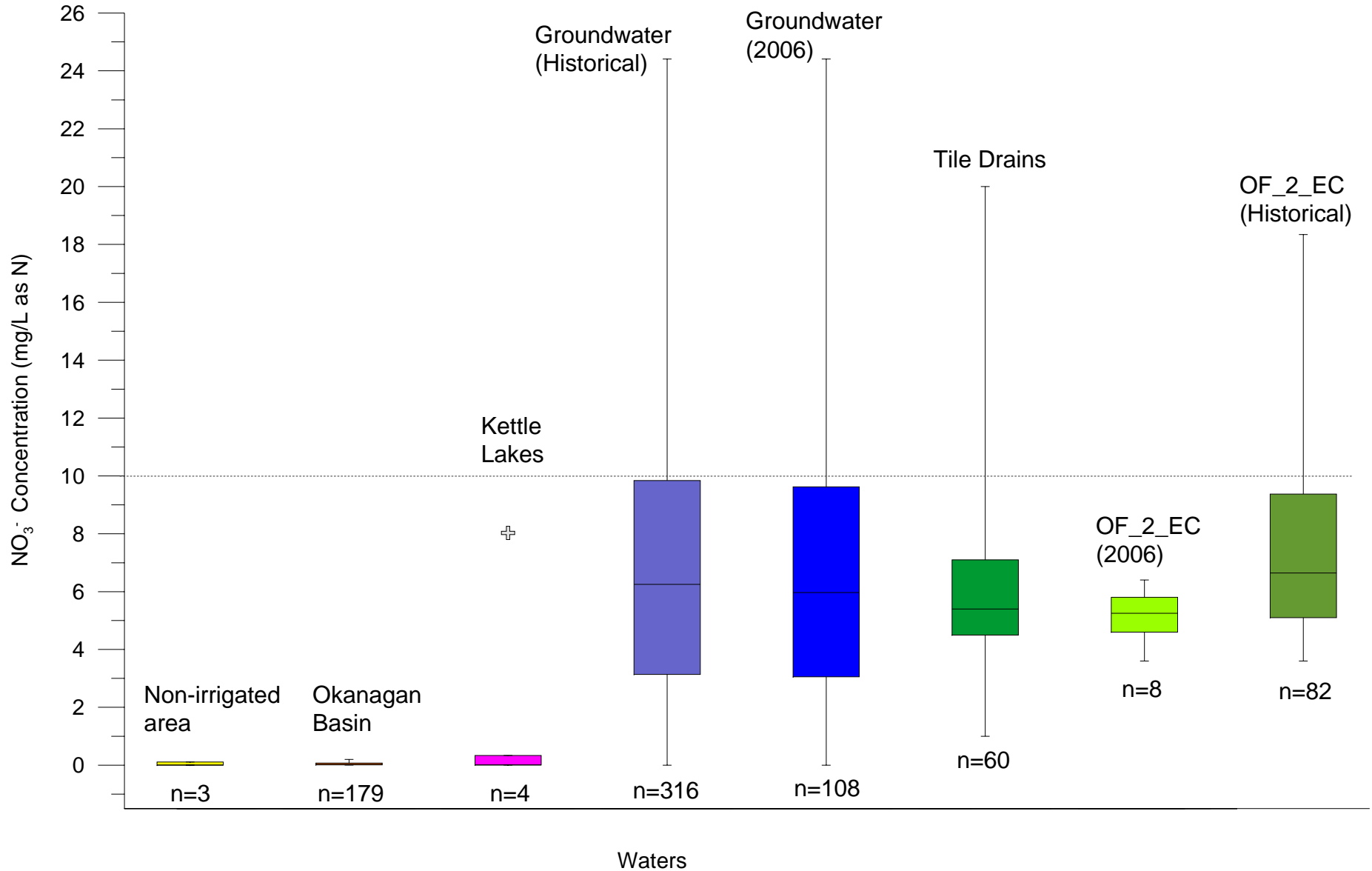


Results – Age Dating

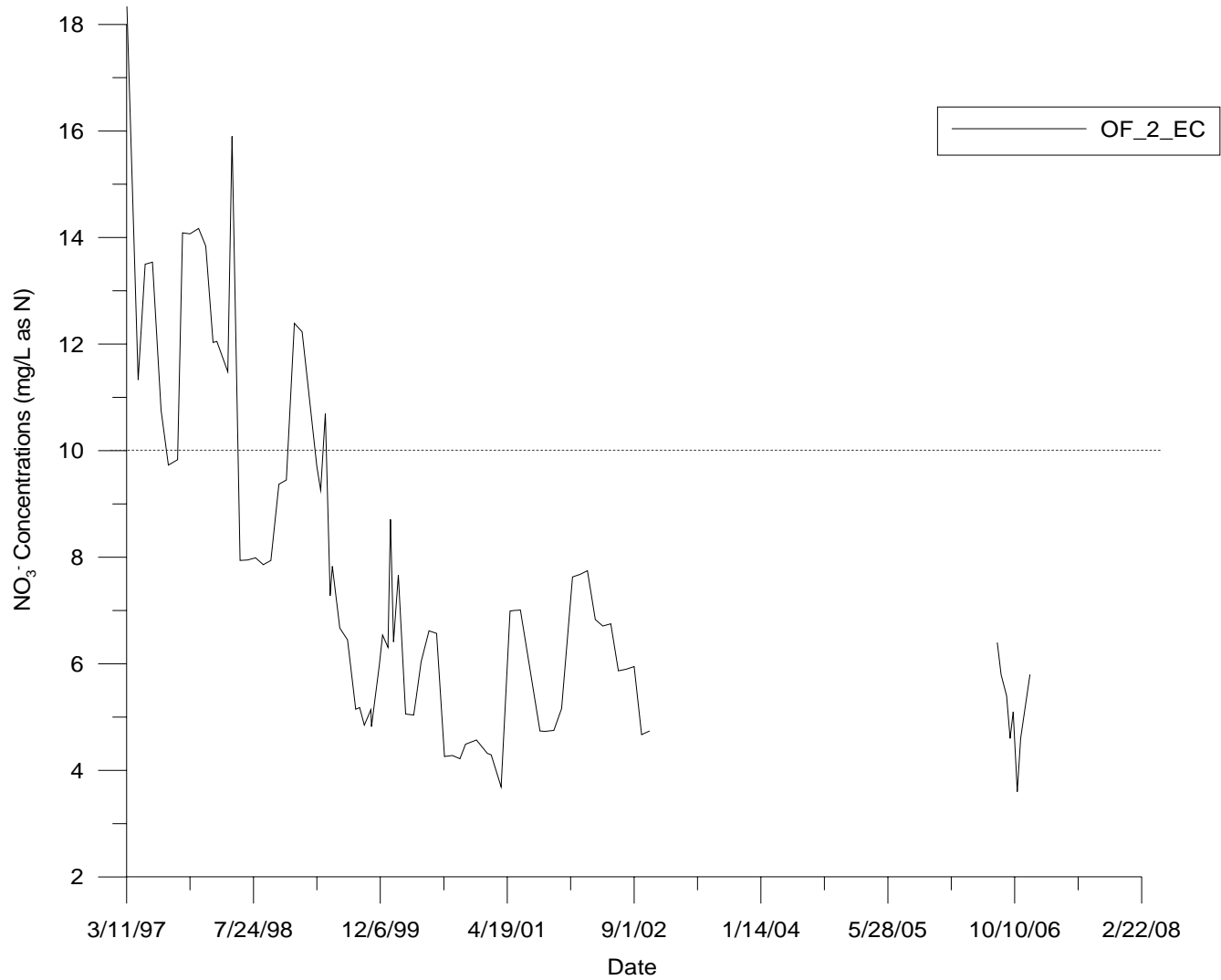
- Ages of groundwater in aquifer range from 0.5 to 5 years



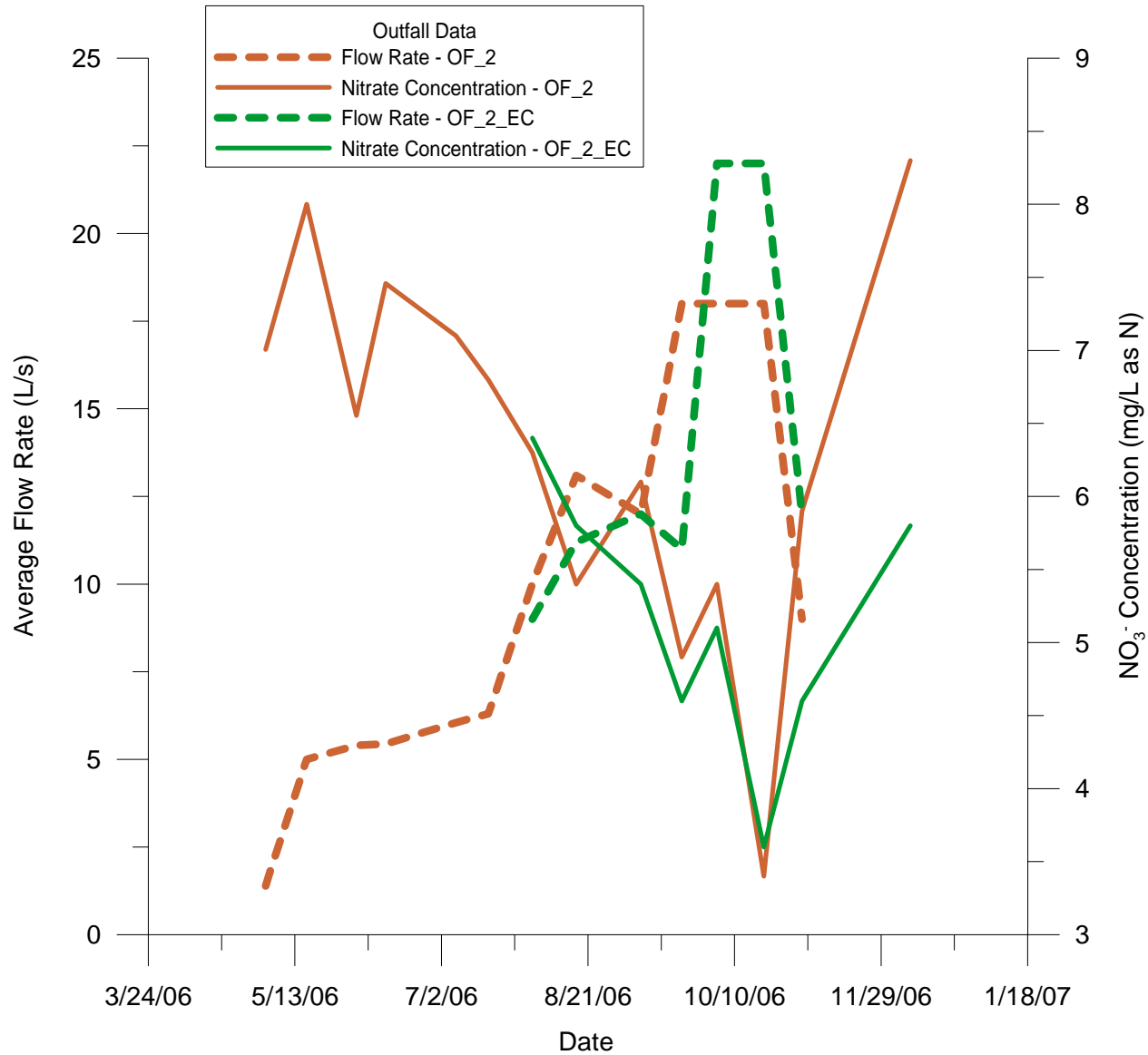
Results - Waters



Results – Tile Drainage System



Results – Tile Drainage System



Preliminary Conclusions

Recharge Sources

- Irrigated areas - Irrigation water
- Non-irrigated areas - spring precipitation (possibly snow melt)

Groundwater NO₃ Chemistry

- 24% of wells exhibited NO₃ concentrations greater than the CDWQG on at least one sampling event in 2006

Tile Drainage Systems

- 10% of samples collected in 2006 exceed CDWQG
- Historical NO₃ concentrations > 2006 NO₃ concentrations
- NO₃ concentration decreases as discharge rate increases
- Flux of N into Osoyoos Lake from drainage tiles is 3 orders of magnitude greater than from Okanagan River at mouth

Nitrate Source(s) and Control(s)

- In progress
-

Ongoing Work

- Continued water sampling and analysis
 - Precipitation
 - Outfalls
 - Okanagan basin
 - Groundwater
 - Upland areas
 - Analysis of $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ of NO_3
 - Aqueous geochemical modeling
 - Geochemistry
 - Isotopes
-

Future Work

- Aquitard Characterization
 - Distribution of NO_3 and geochemical processes in aquitard
 - Drilling two boreholes in aquitard in February 2007
 - Analysis of geochemical and isotopic parameters in pore waters
 - Management of Tile Drain Effluent
 - Installation of passive denitrification wall at outfall discharge point
 - Reduce nitrate (N) going into lake
 - Column experiments in progress
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 - Geological Survey of Canada

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 - Local Osoyoos Residents
 - Osoyoos Lake Water Quality Society
 - Town of Osoyoos
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