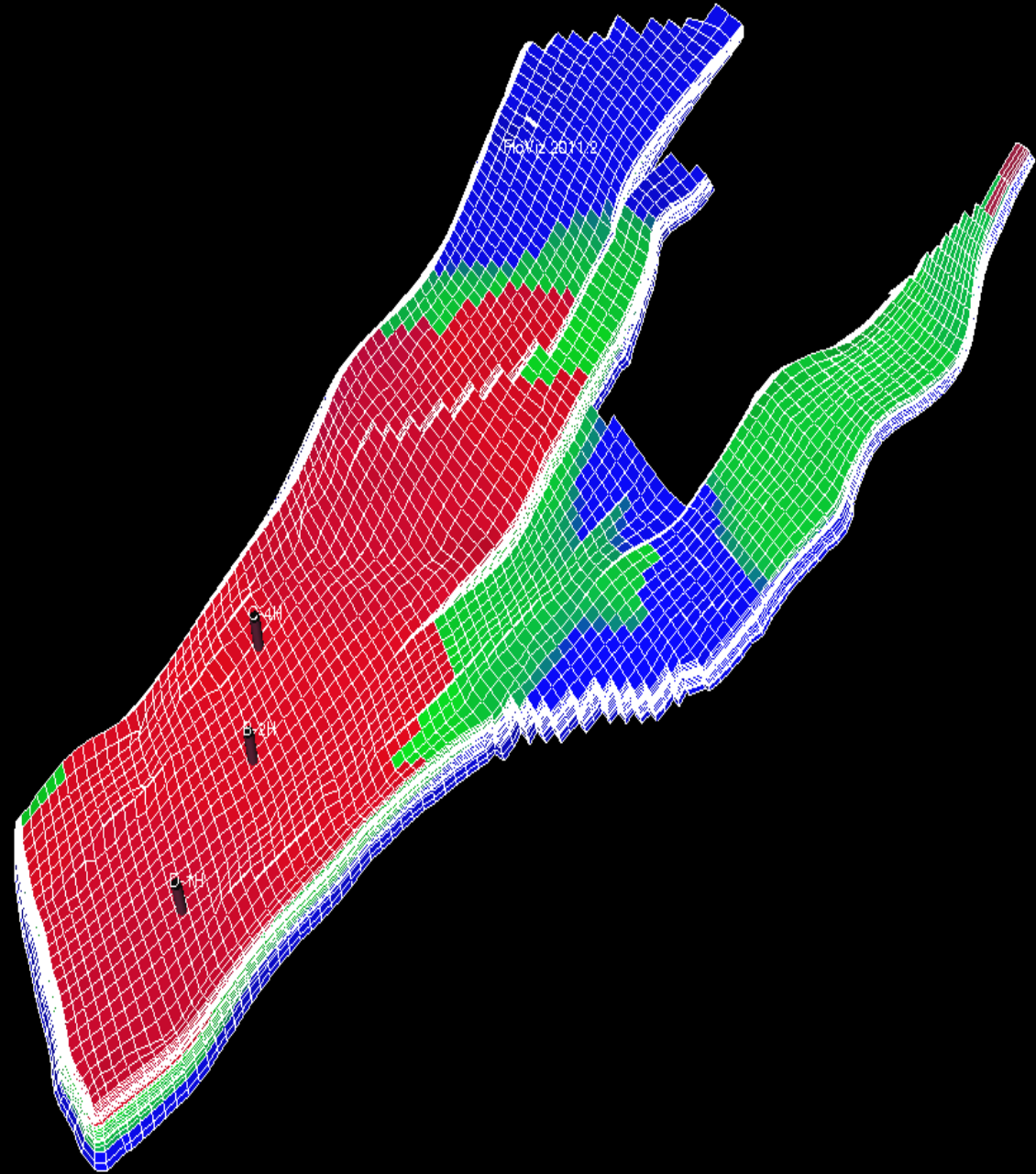


Update on Norne Full Field Simulation Model for IO Center NTNU

Nan Cheng - 2012





The previous Norne model at IO Center

- Rel. perm issue:
 - 88+ rel. perm. tables
 - End-point scaling done outside the dataset
 - SWL is a function of permeability of the cell
 - Two rock types: one for Tofte, one for Not, Ile & Tilje
- Saturation tables are permeability dependent in the model
 - Two Gas-oil rel. perm. tables: one for cell perm < 250 md and one for cell perm > 250 md
- Hysteresis in the model
- Extreme values in the model?

Saturation end-point values

- Implement end-point scaling
- End-point values for drainage: SWL, SGU, SWCR, SOWCR, SGL, SGWCR, SWU, SOGCR?
- End-point values for imbibition: ISWL, ISGU, ISWCR, ISOWCR, ISGL, ISGWCR, ISWU, ISOGCR?
- Investigate the impact of these end point values

Initialization

- Initial water saturations imported from the previous model (SWATINIT)
- One set of rock tables
- Hysteresis is included
- End-point scaling is used
- End-point values bearing uncertainty and may be used as tuning parameters in history matching
- Good match on fluid-in-place volumes

Volumetrics

Initial field fluid in-place volumes

	Oil Sm ³	Water Sm ³	Gas Sm ³	comments
New model	1.608E+08	4.021E+08	2.706E+10	end-point scaling used, initial water saturation export from the original model
Original model	1.608E+08	4.020E+08	2.706E+10	
Diff, %	0.028	-0.011	0.006	original model as reference

Schedule sections

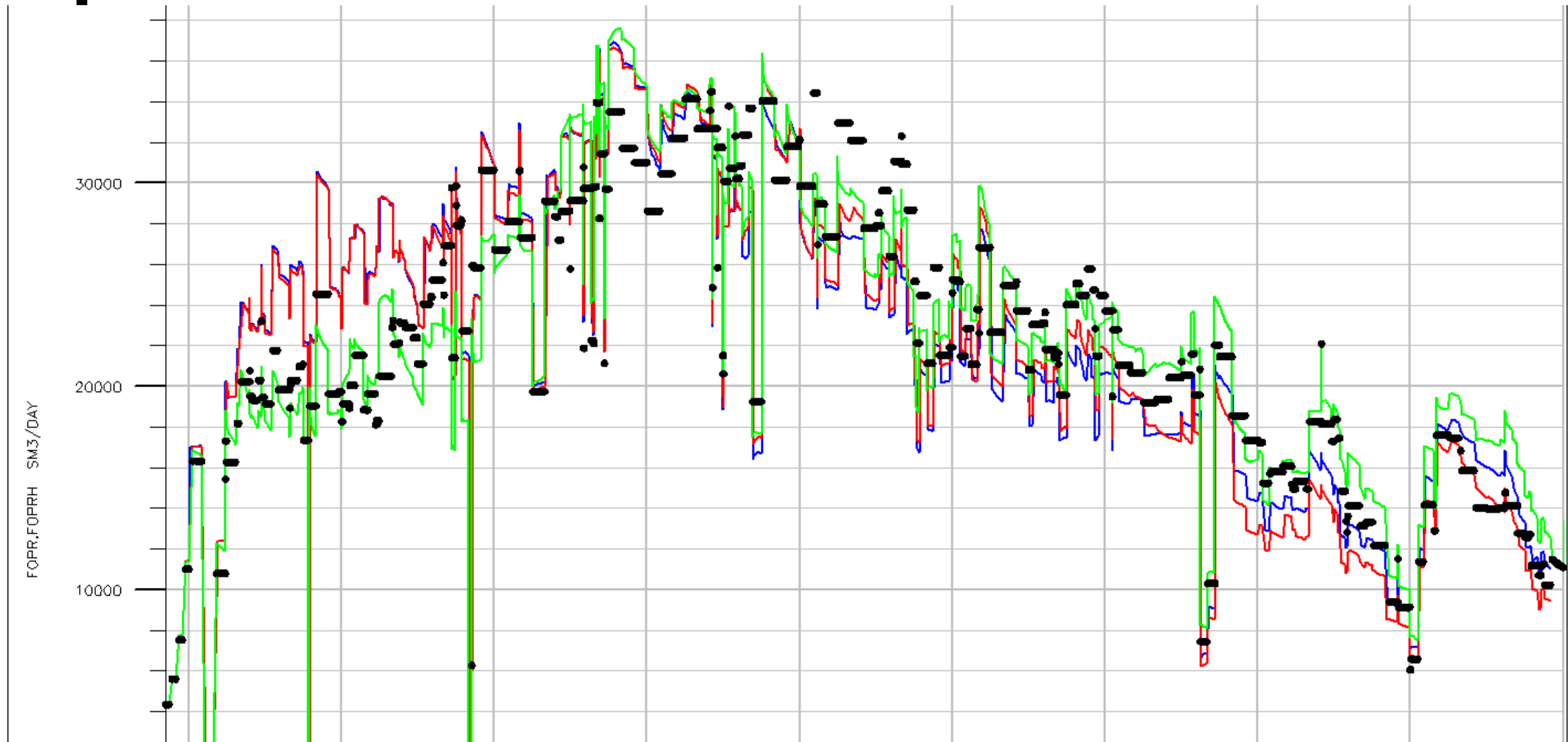
- Checked the Schedule section of the model
- No Schedule project provided and it is thus tedious to make changes to the Schedule section
- No essential changes made, but
 - Max. WBHP of 600 added to avoid many warnings and to help identify well injectivity problems
 - Excluded data for the prediction phase

Run performance

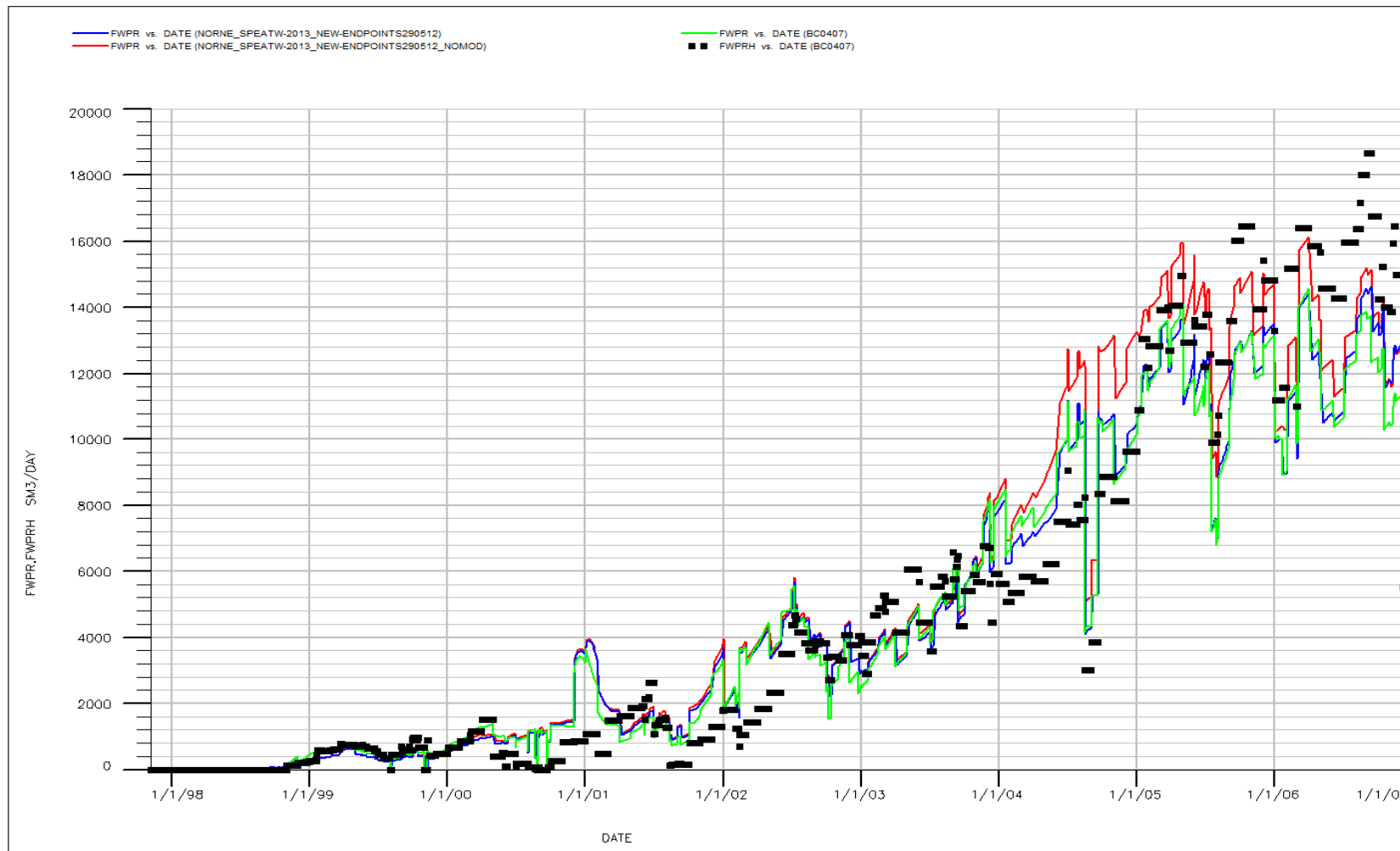
- CPU time investigated and model tuned when necessary
- CPU time reduced significantly (almost halved)
- Check and clarified all the comments in all files
-

Simulation results from the selected (final) run

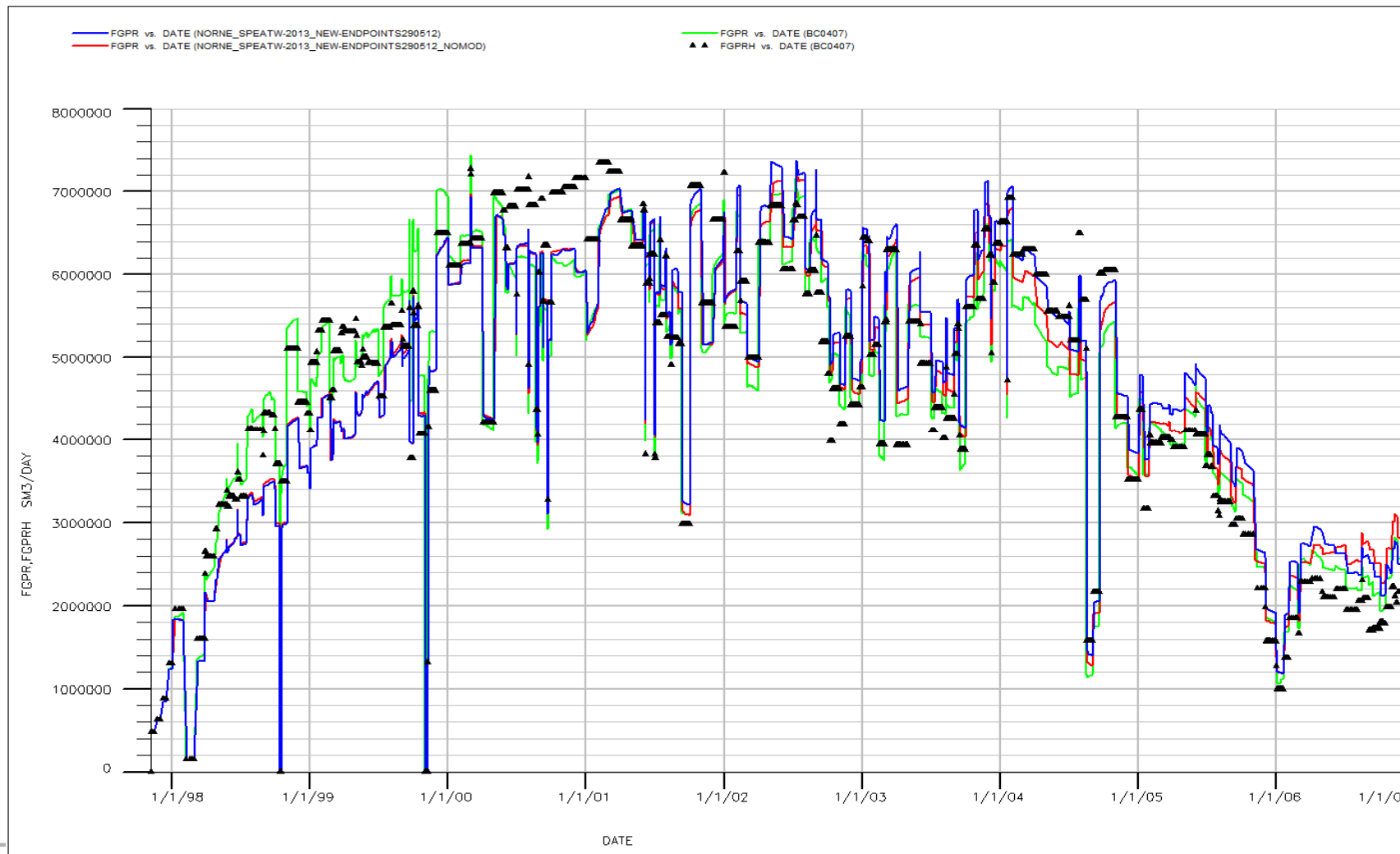
Performance plots – field oil production



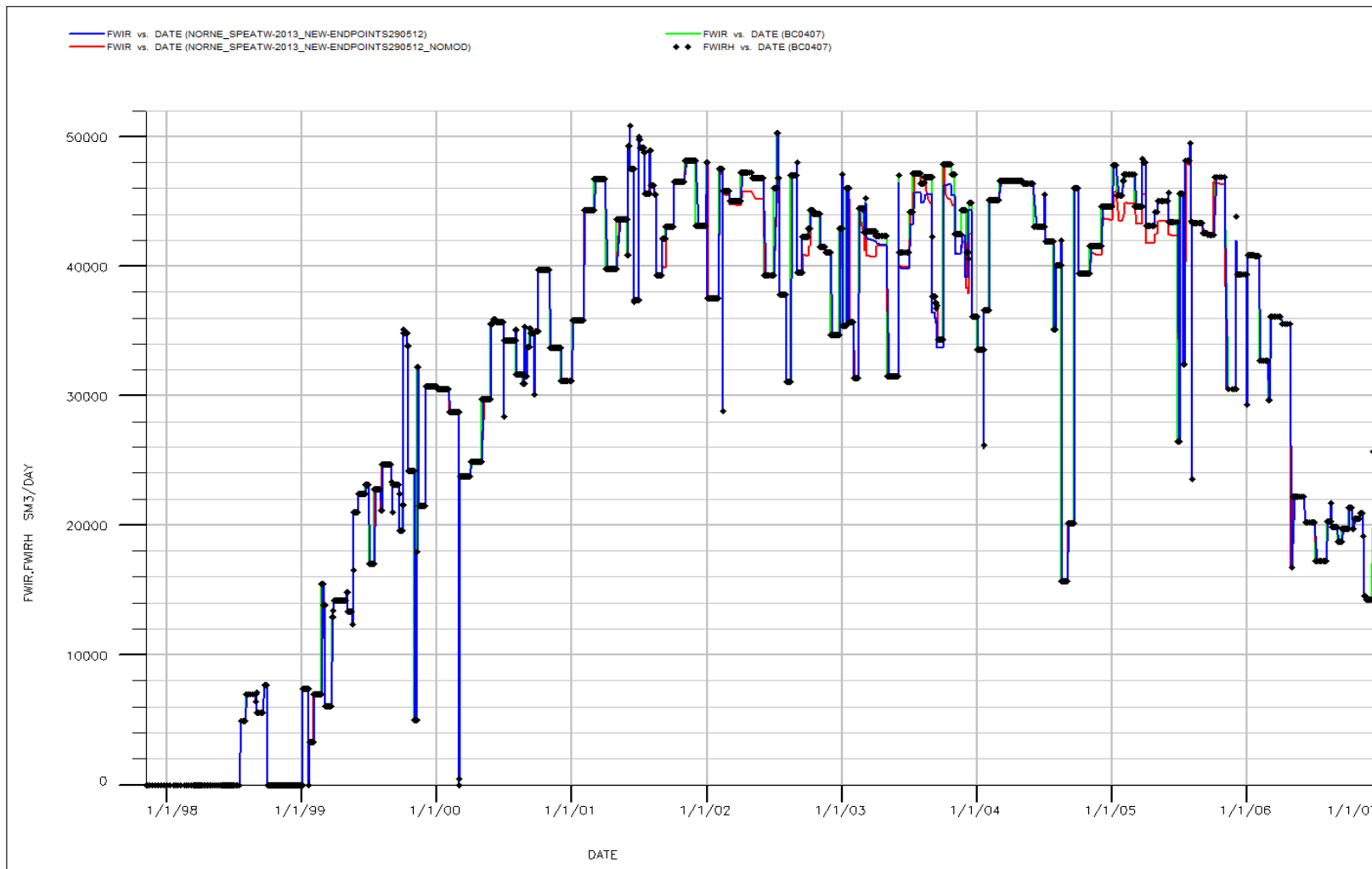
Performance plots – field water production



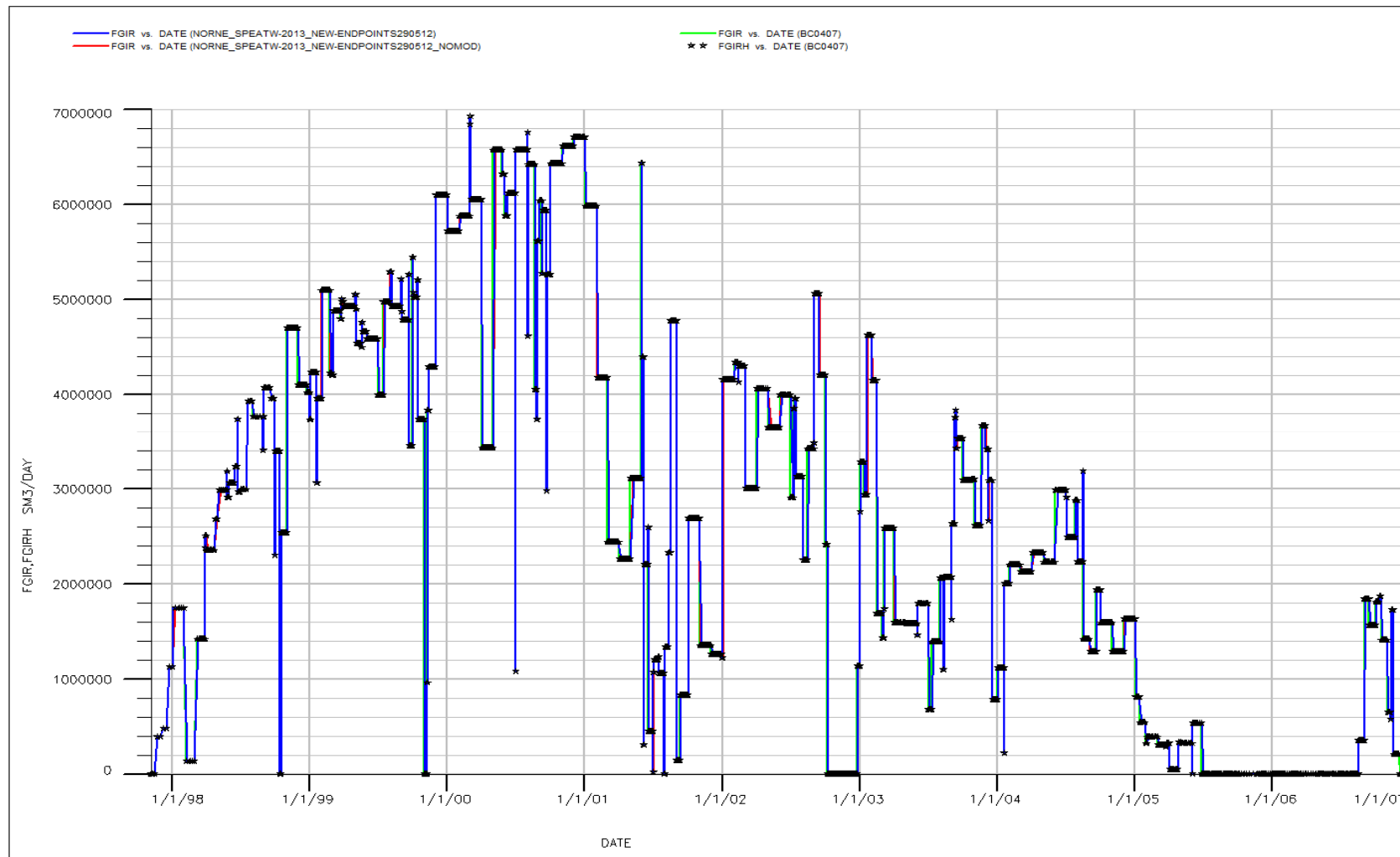
Performance plots – field gas production



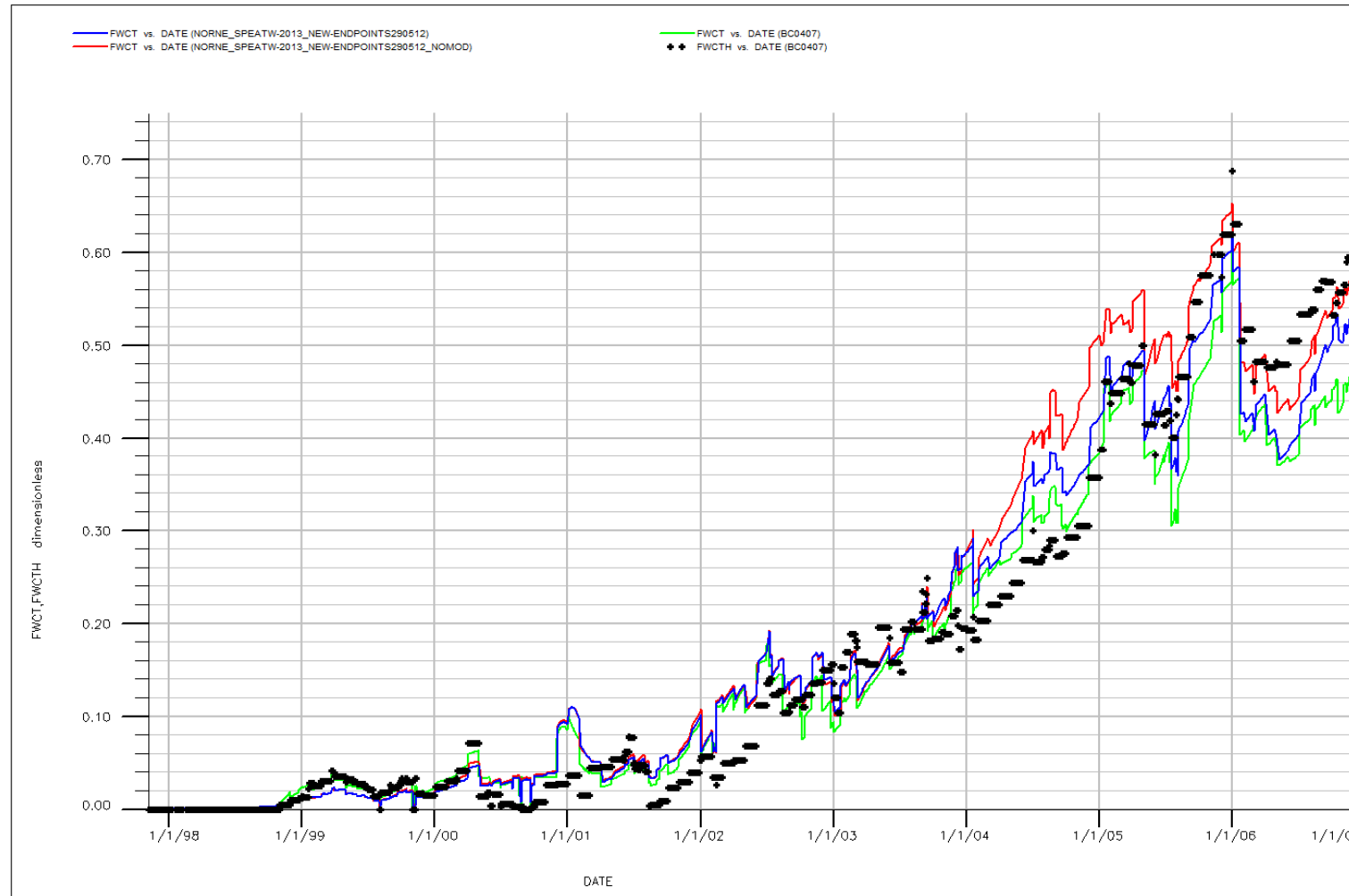
Performance plots – field water injection



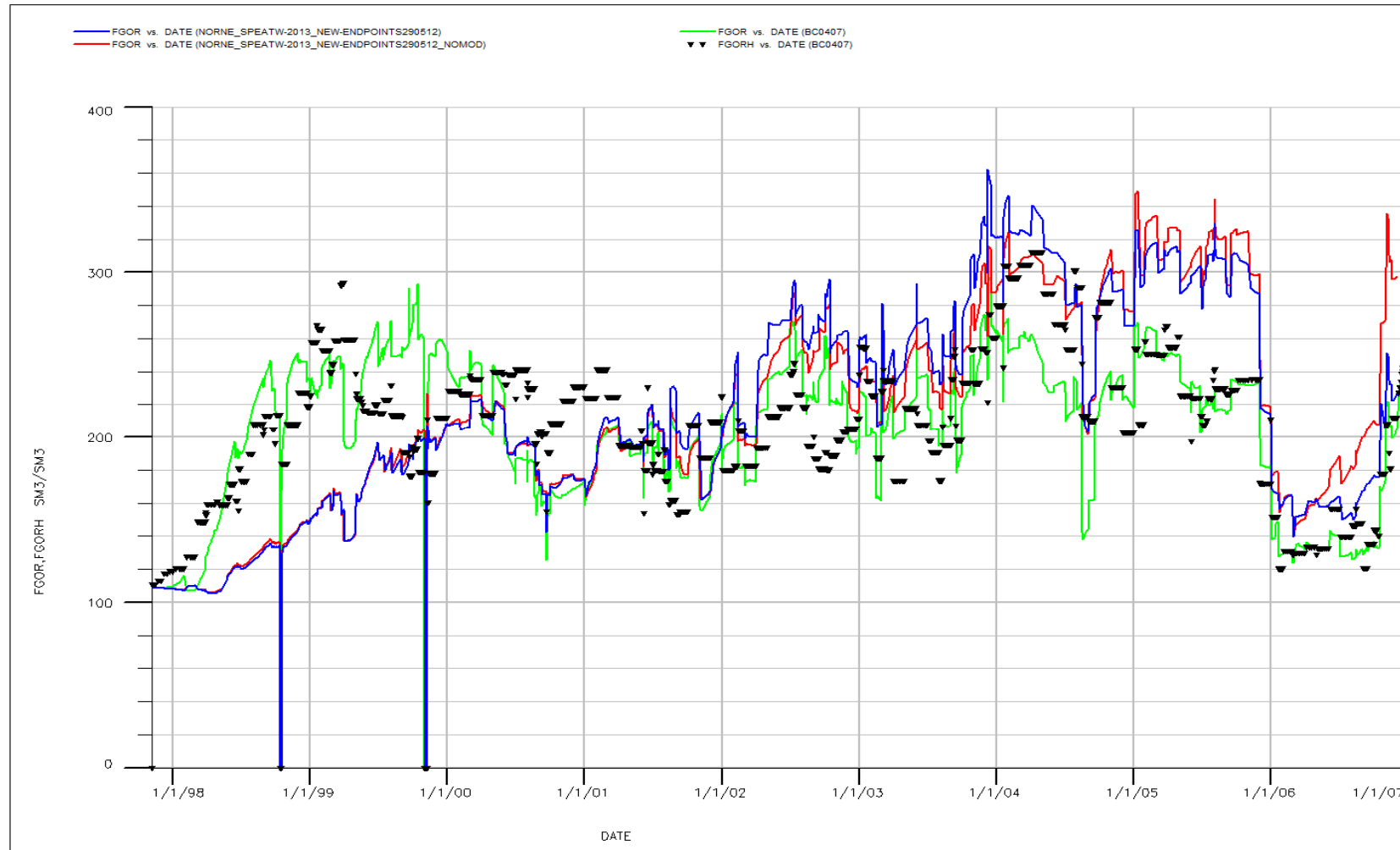
Performance plots – field gas injection



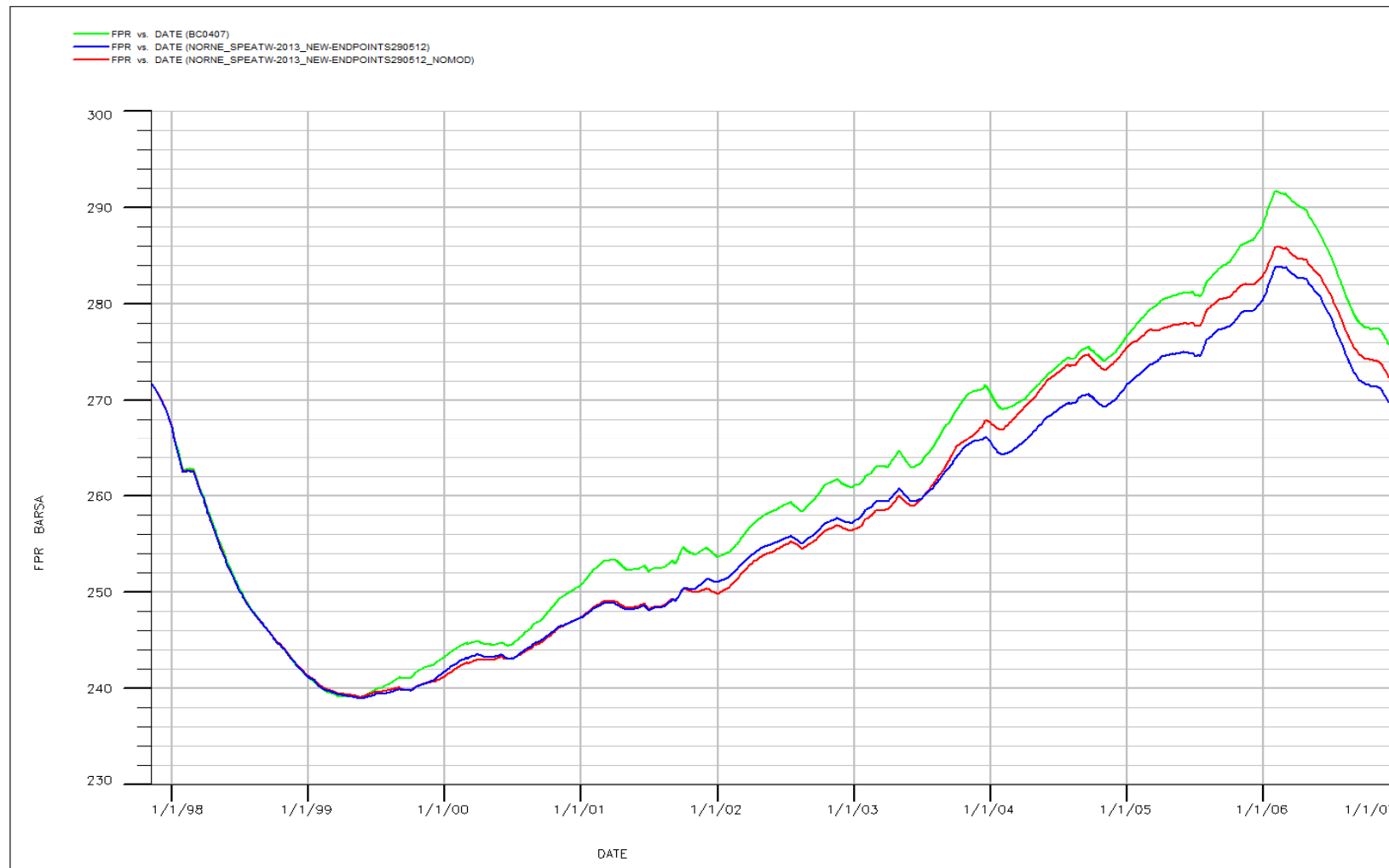
Performance plots – field water-cut



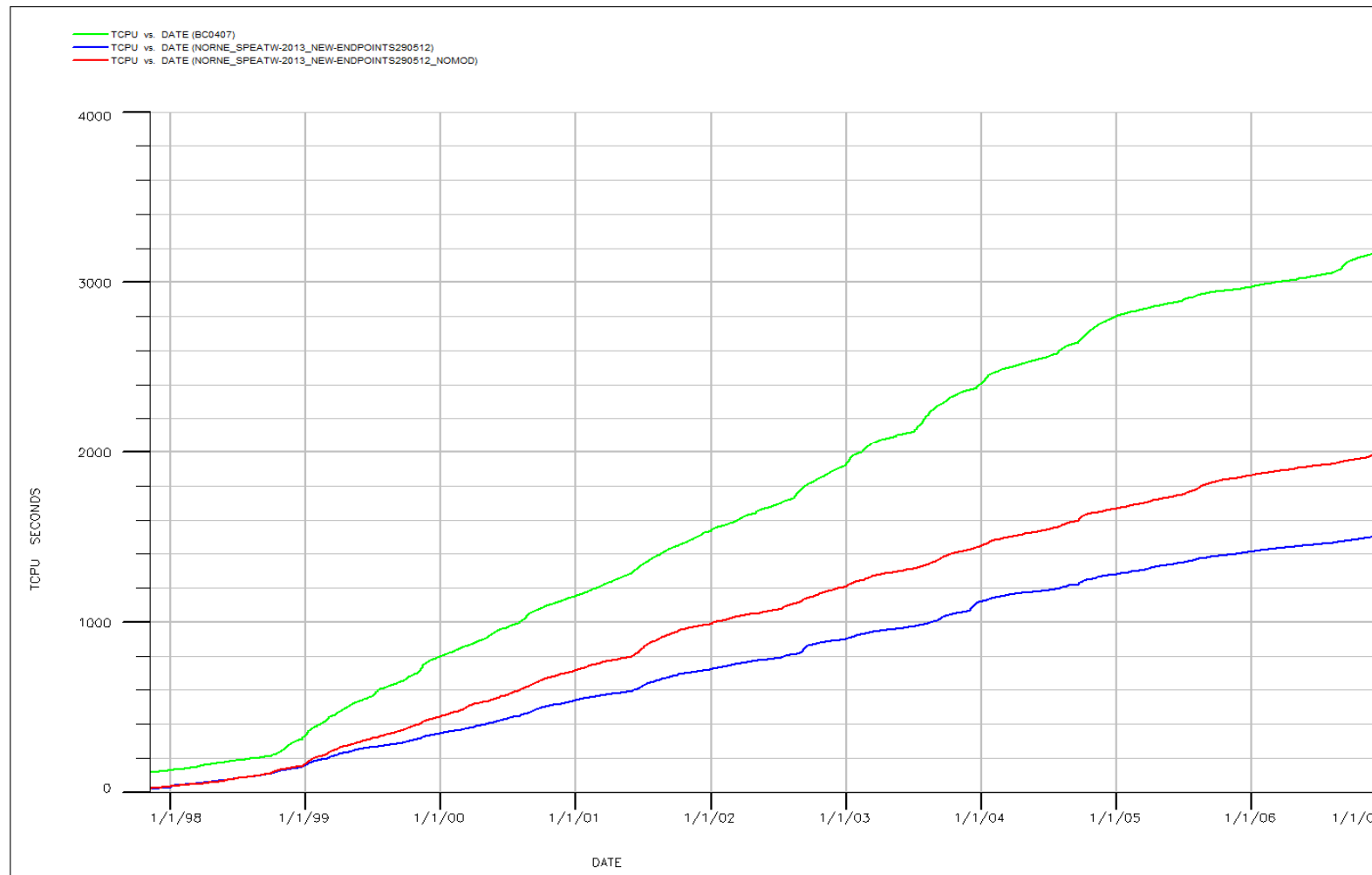
Performance plots – field producing GOR



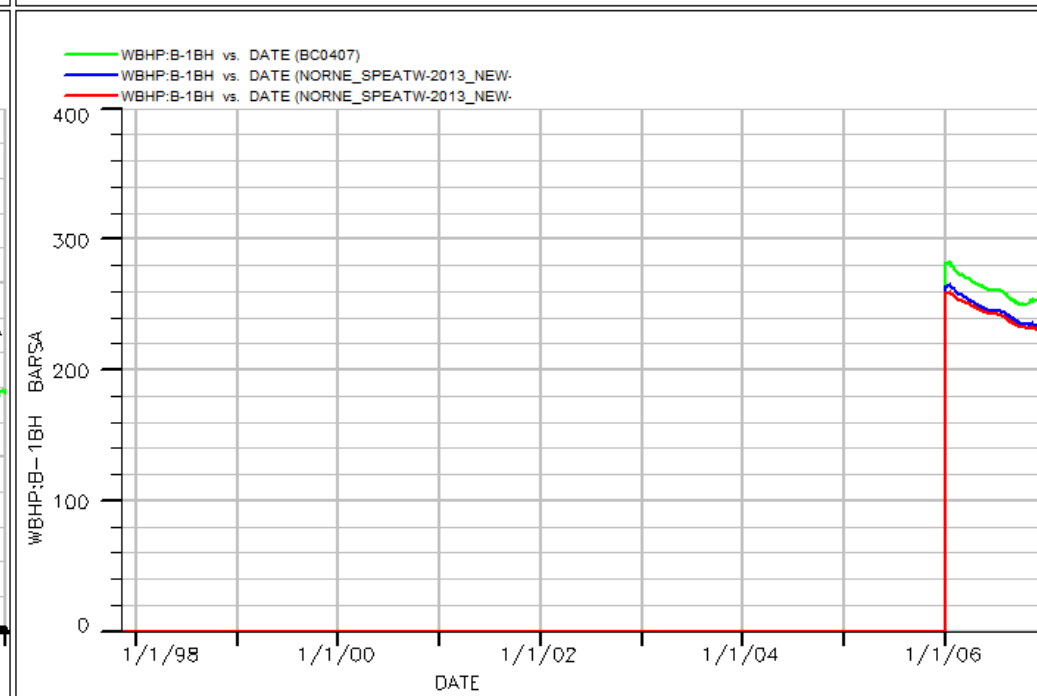
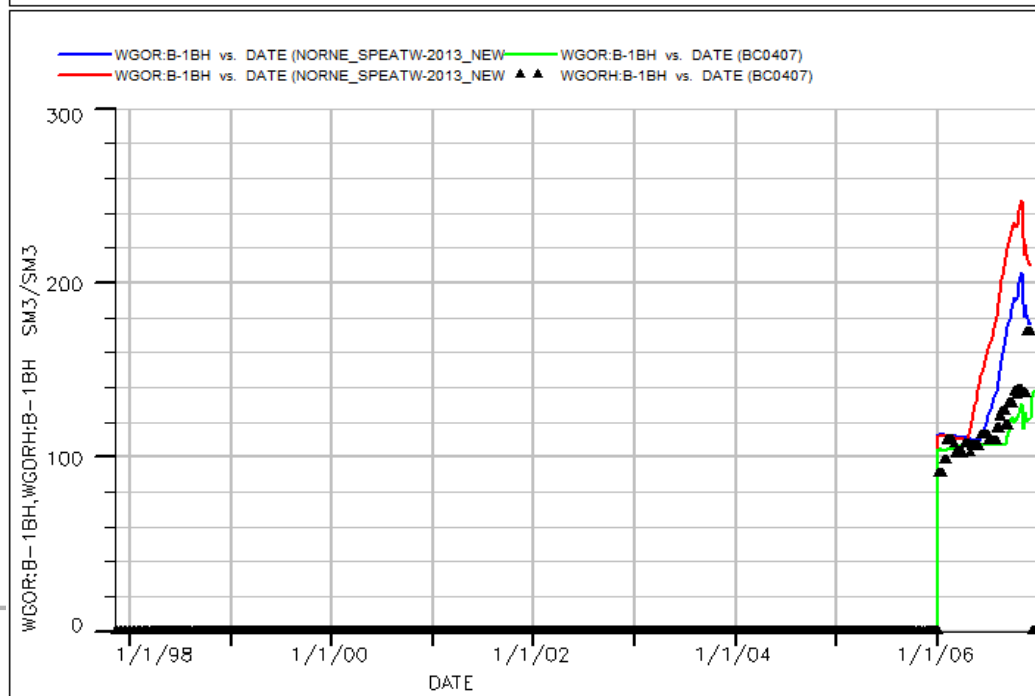
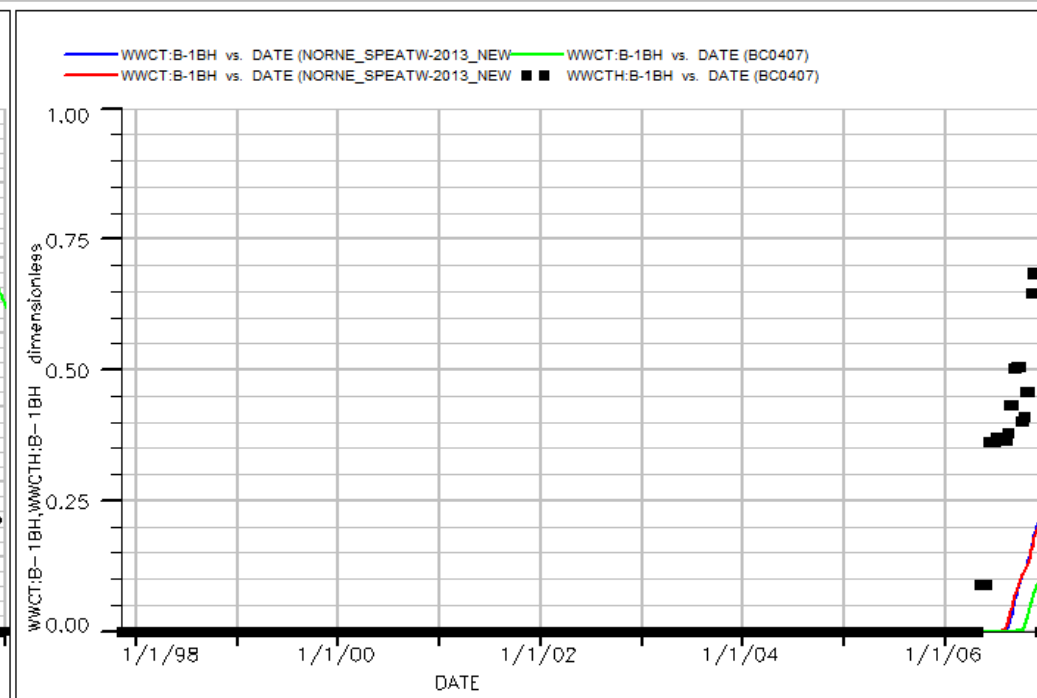
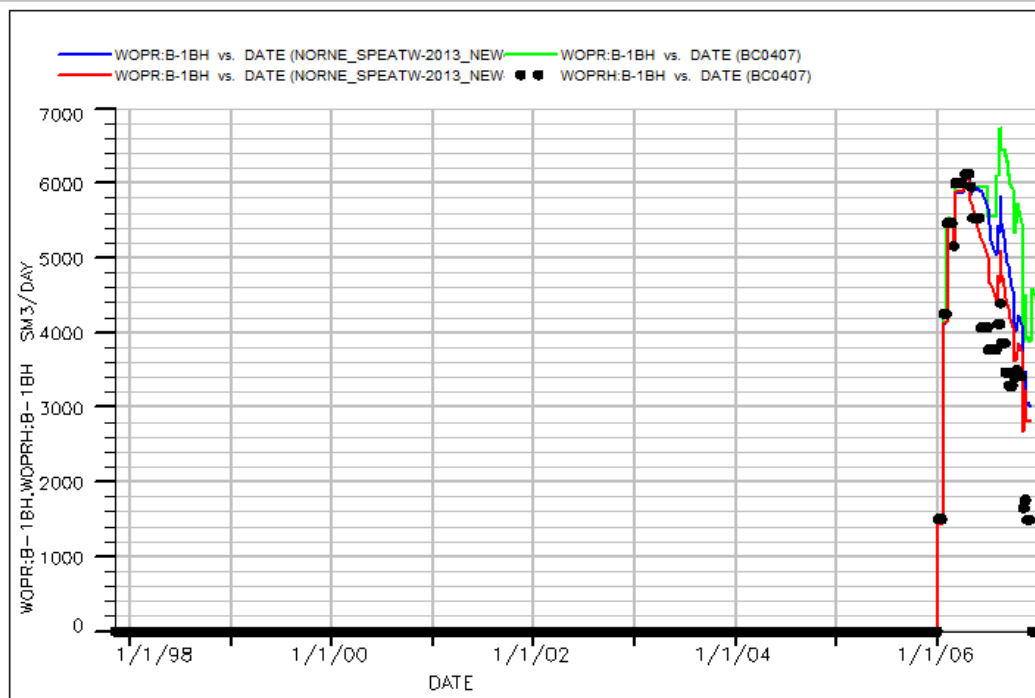
Performance plots – field average pressure

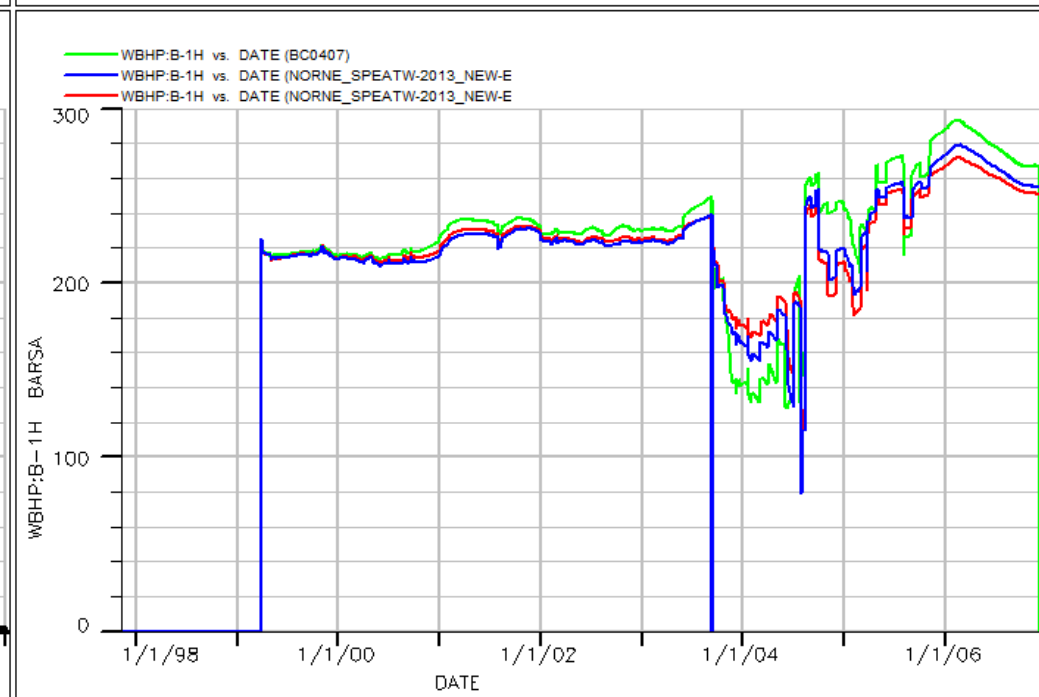
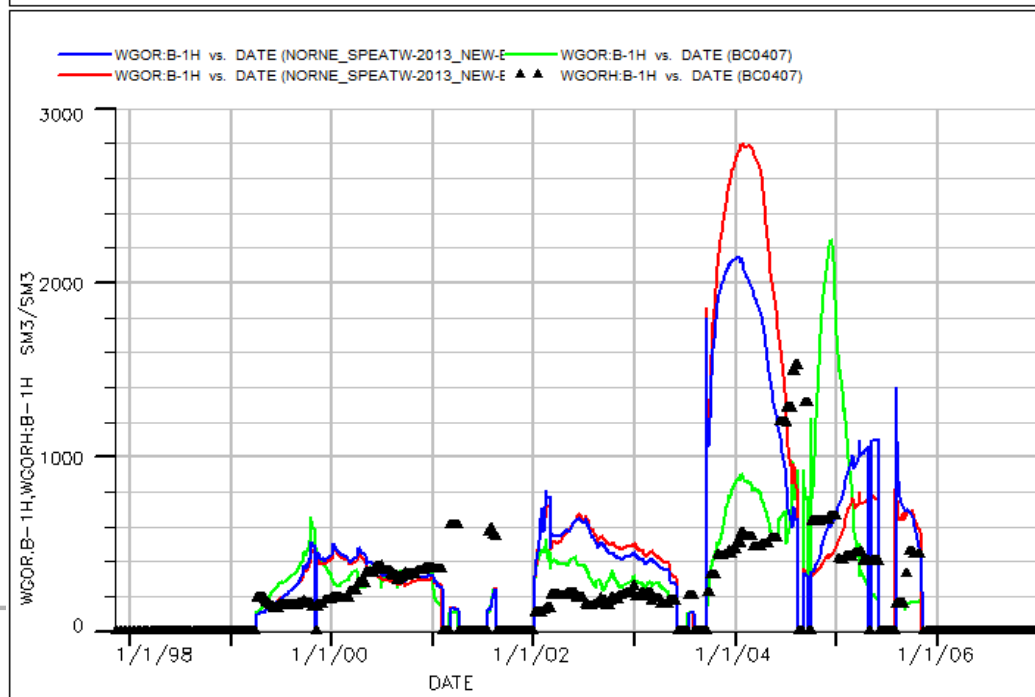
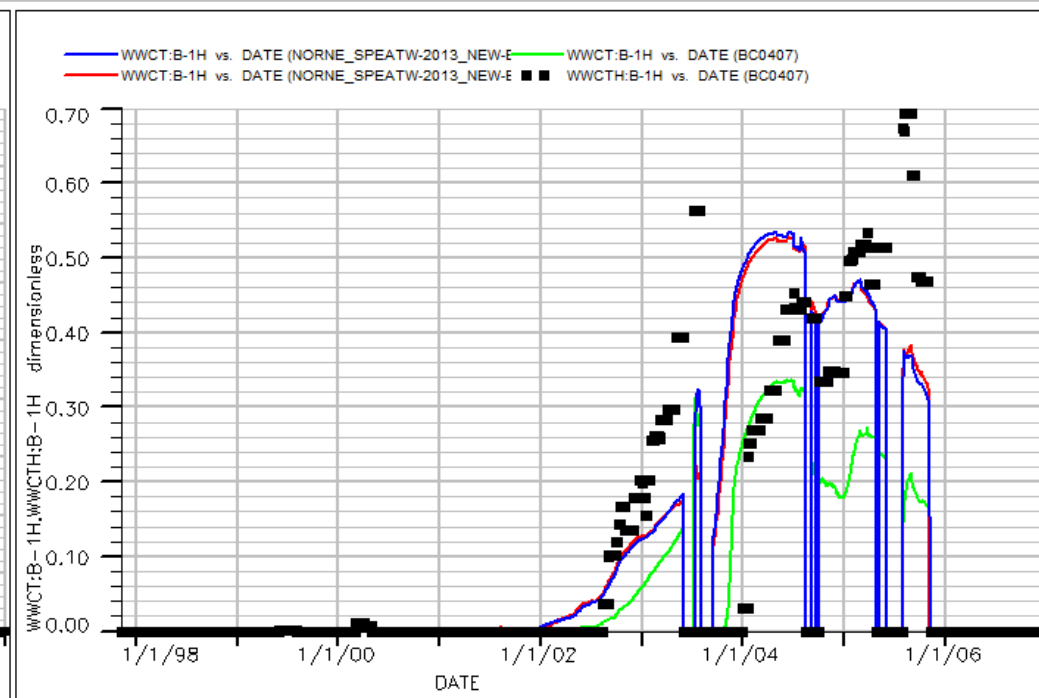
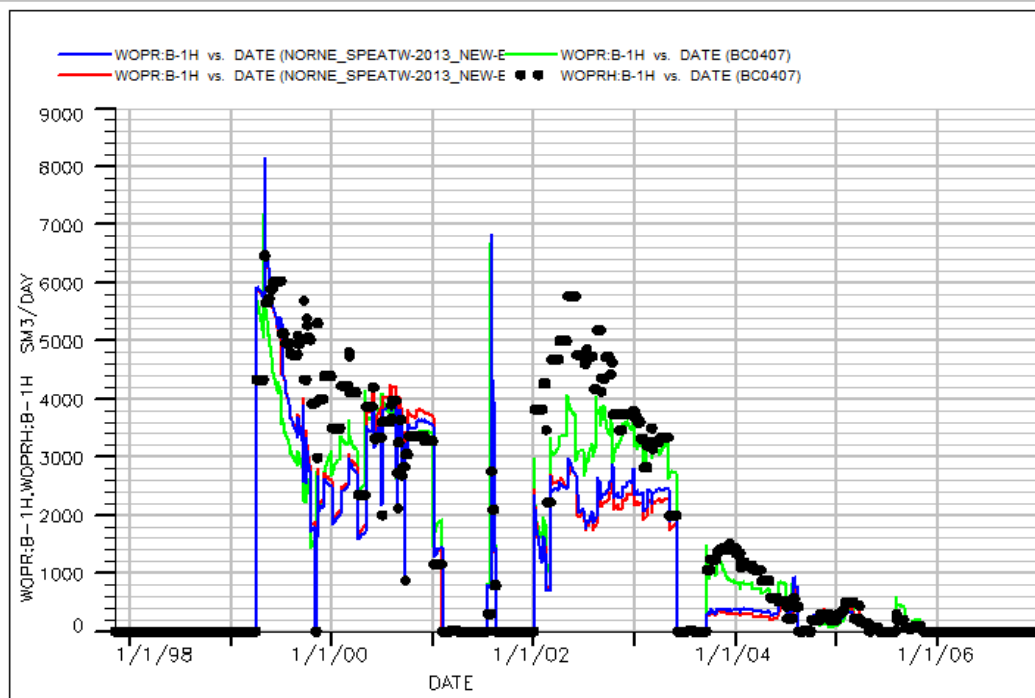


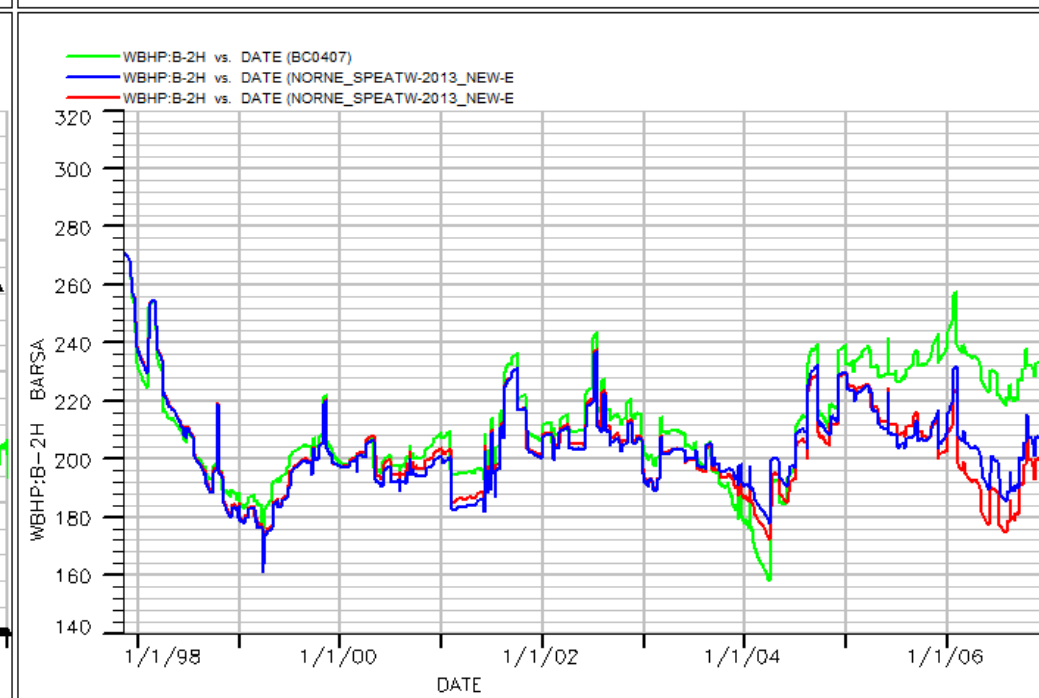
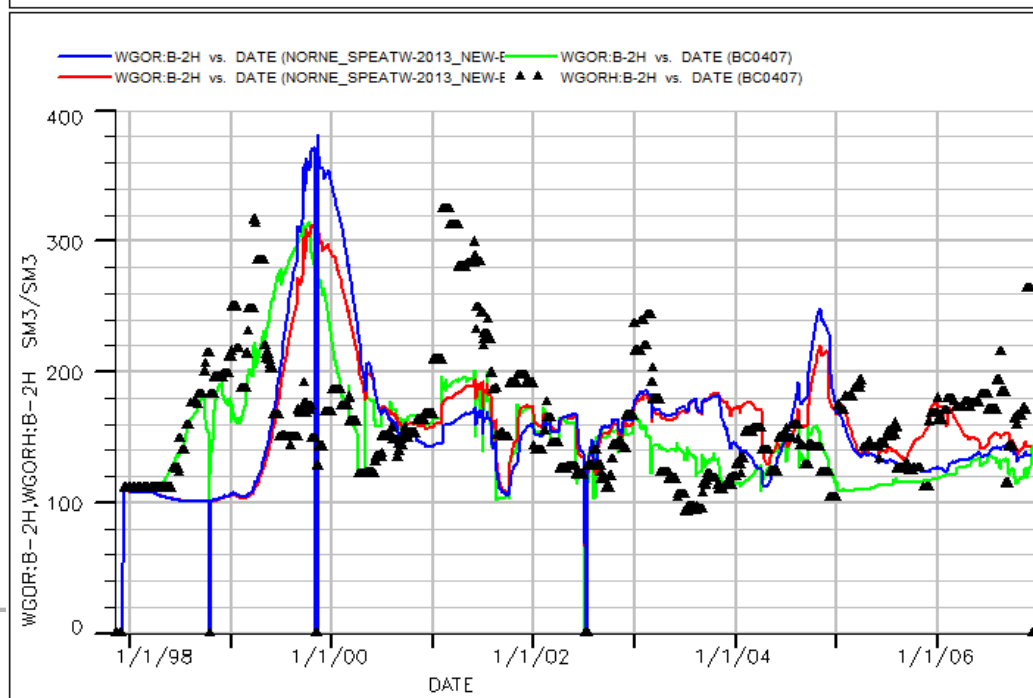
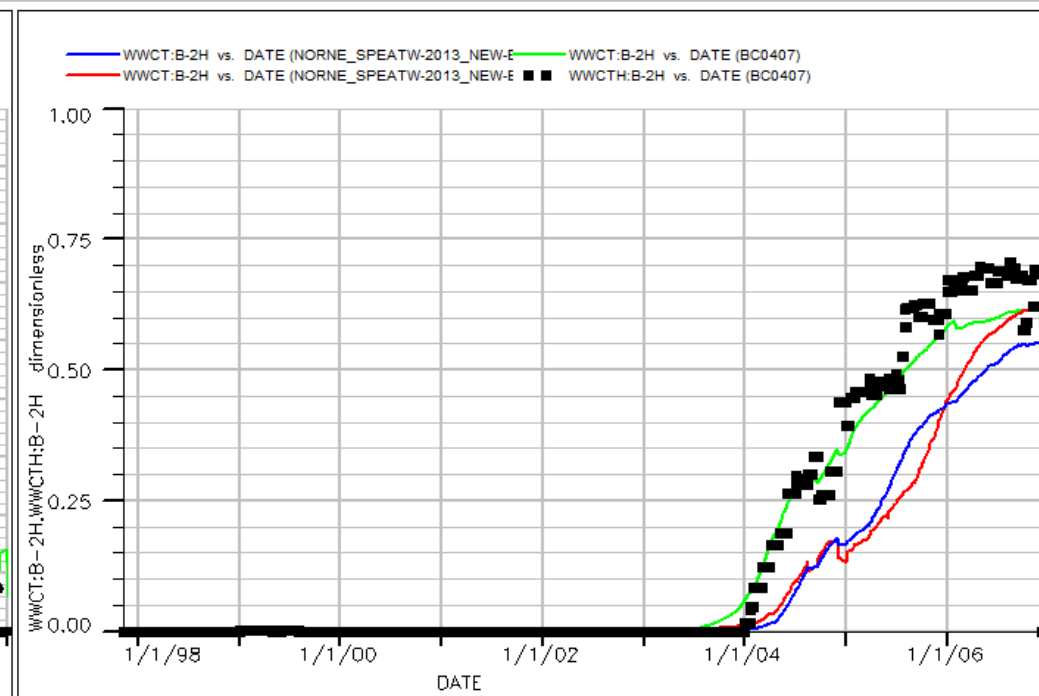
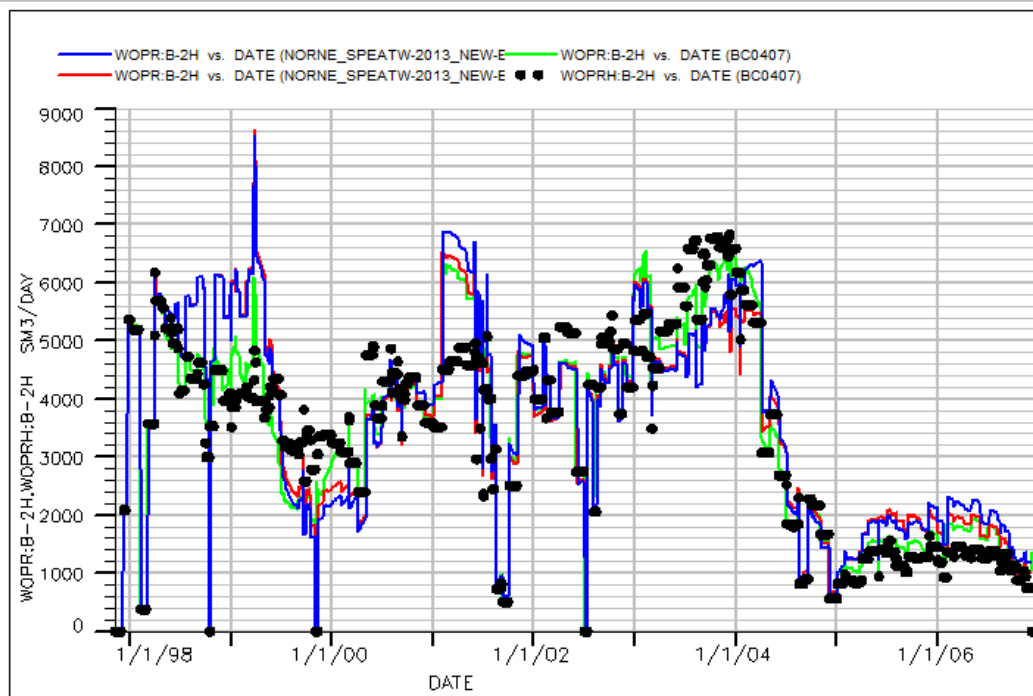
Performance plots – total CPU time

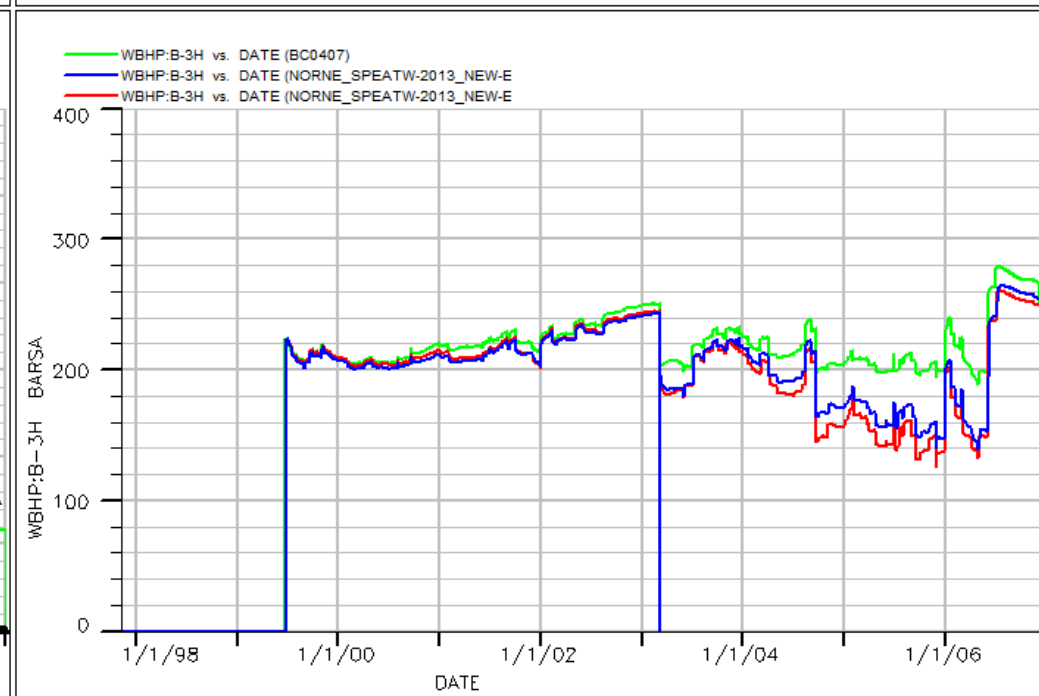
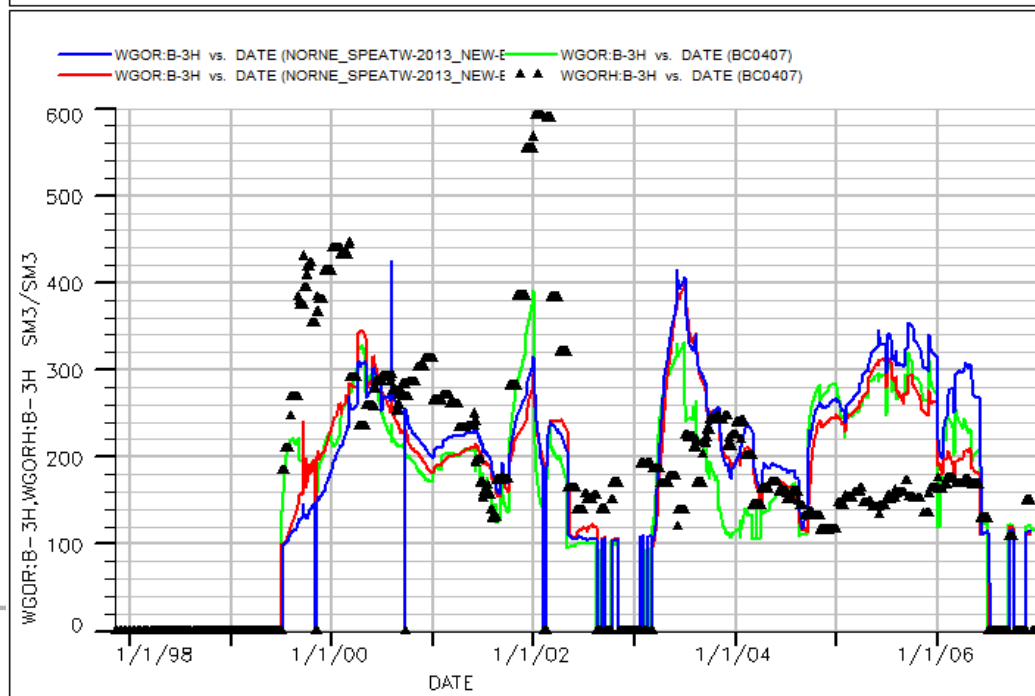
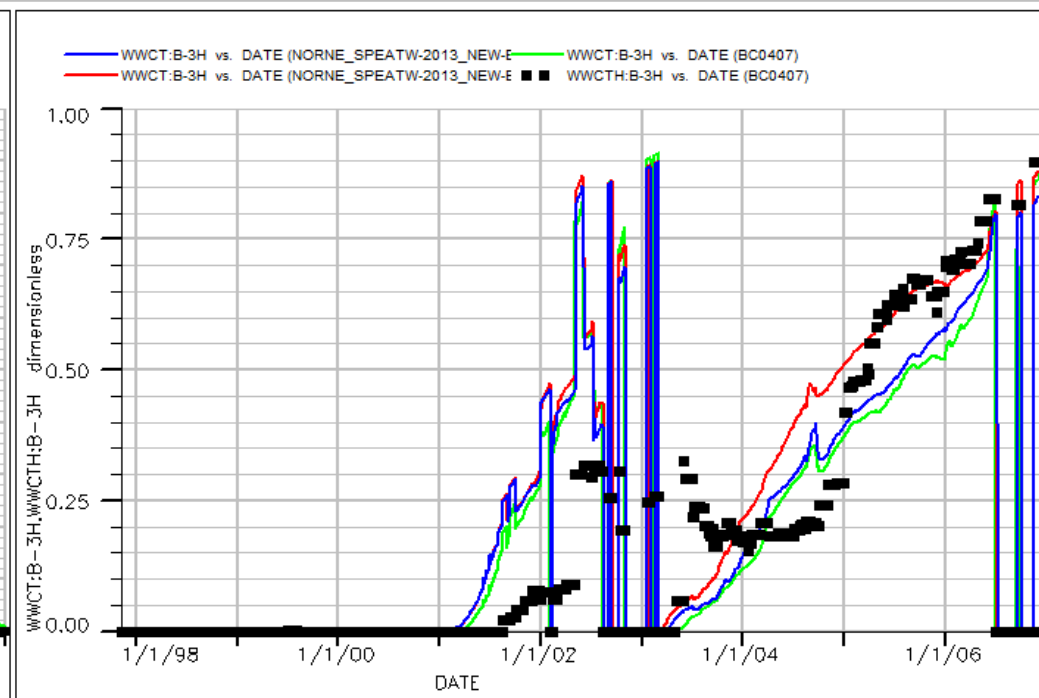
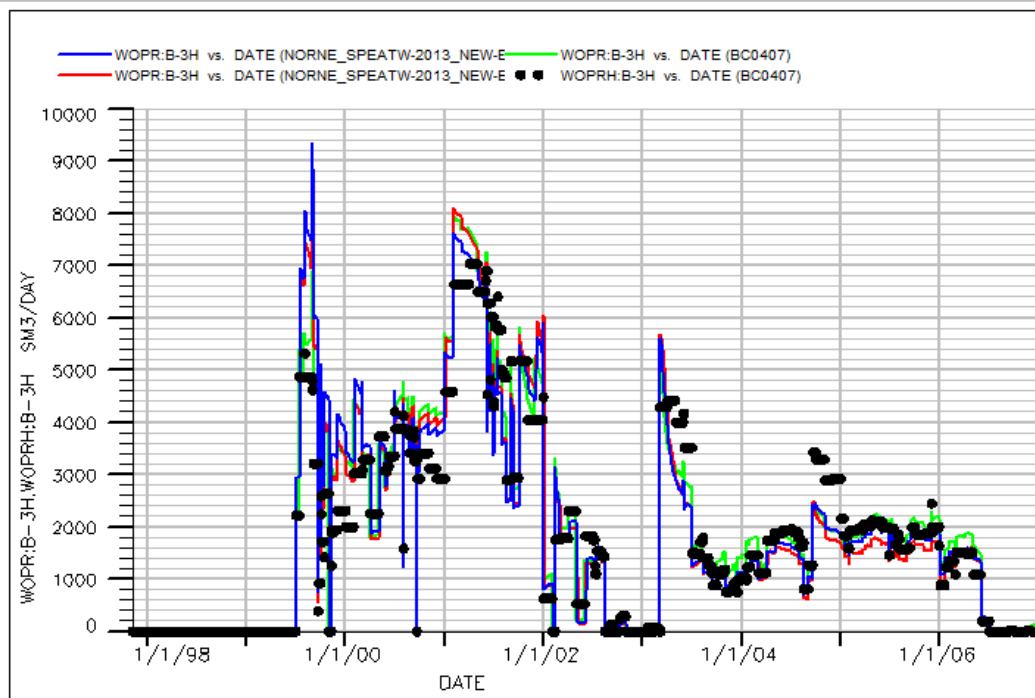


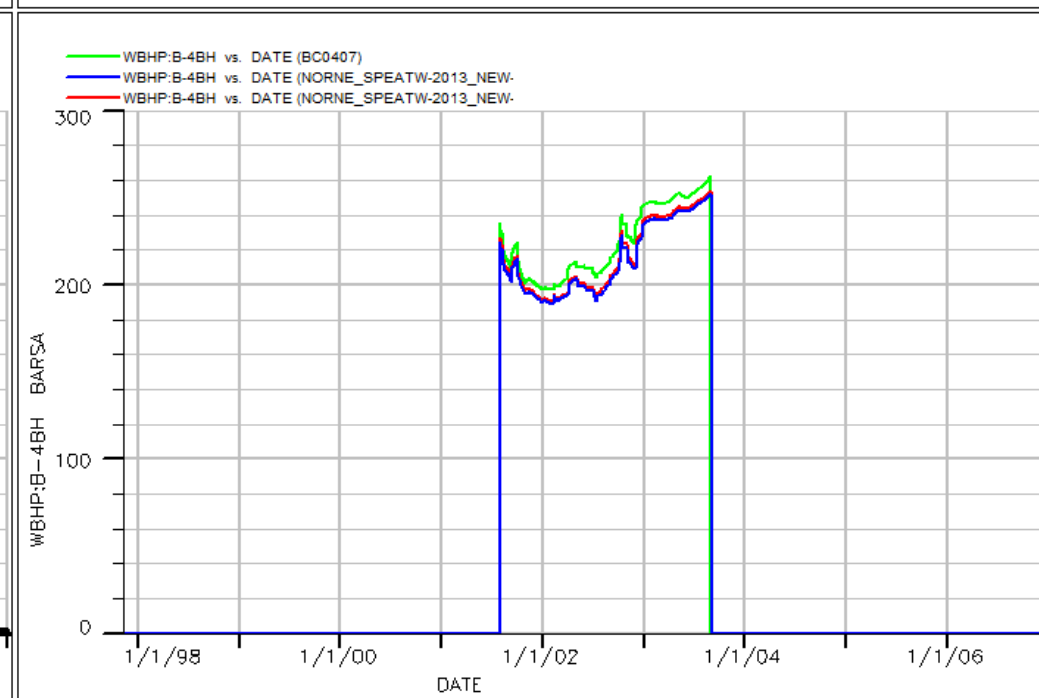
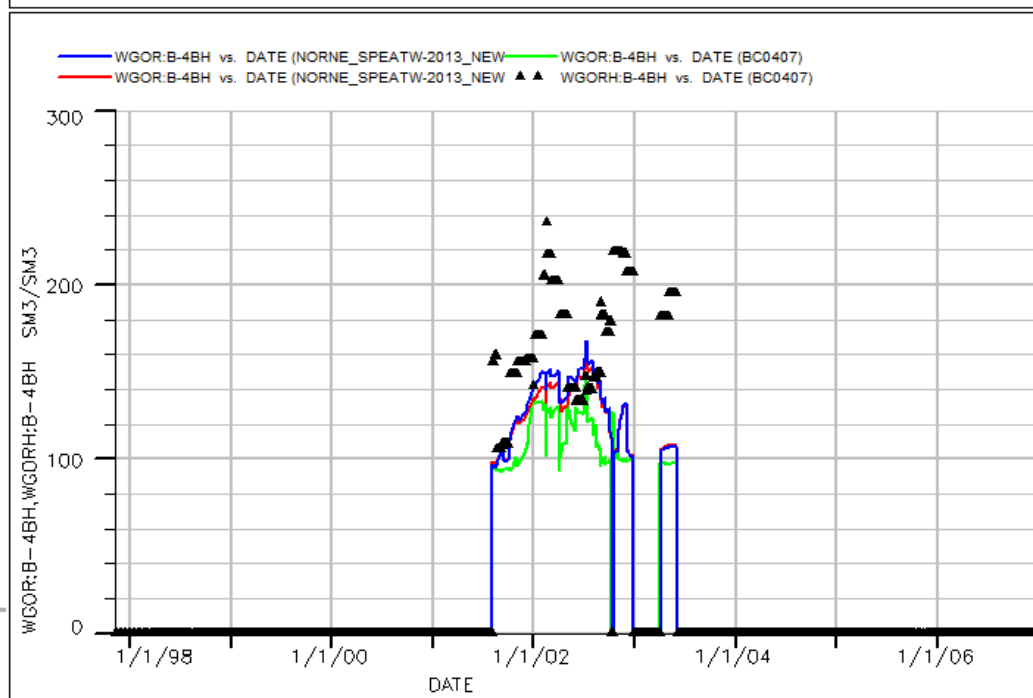
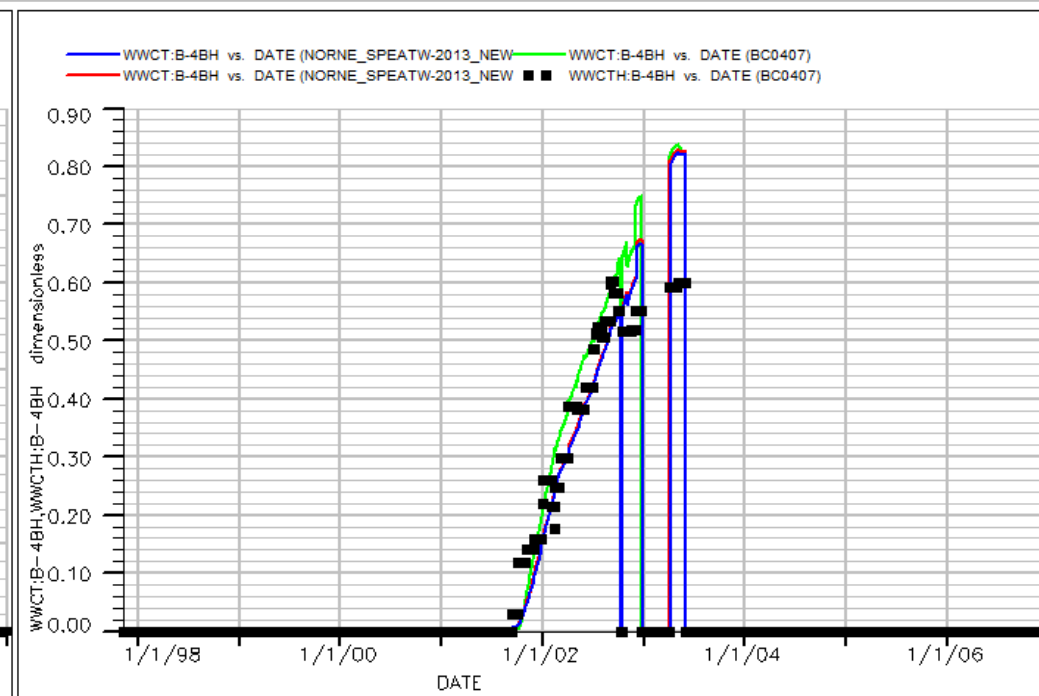
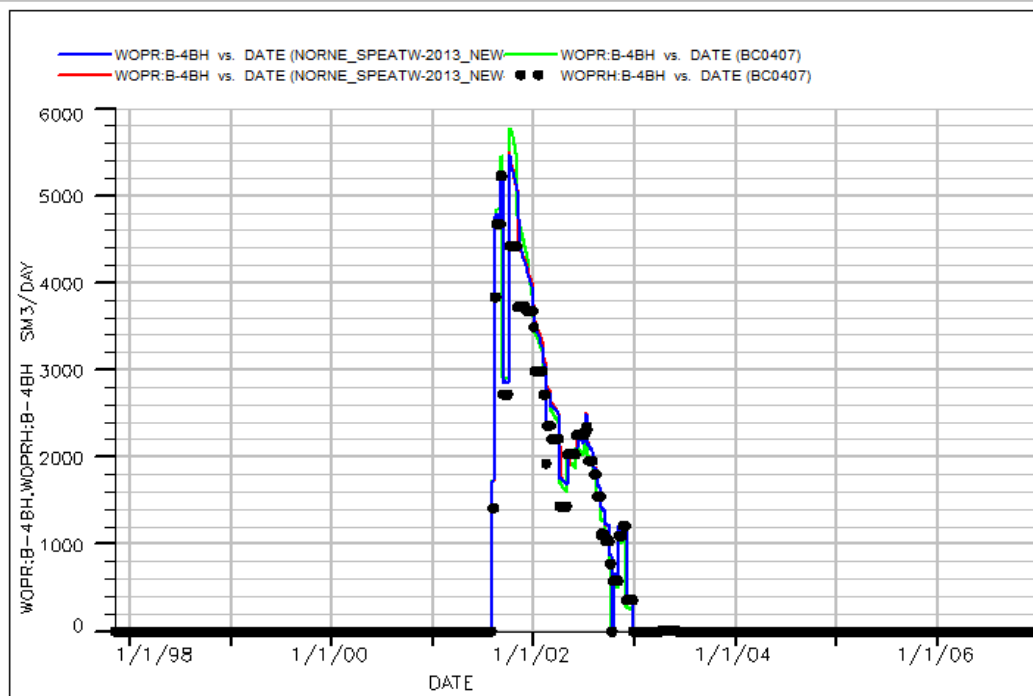
Production wells

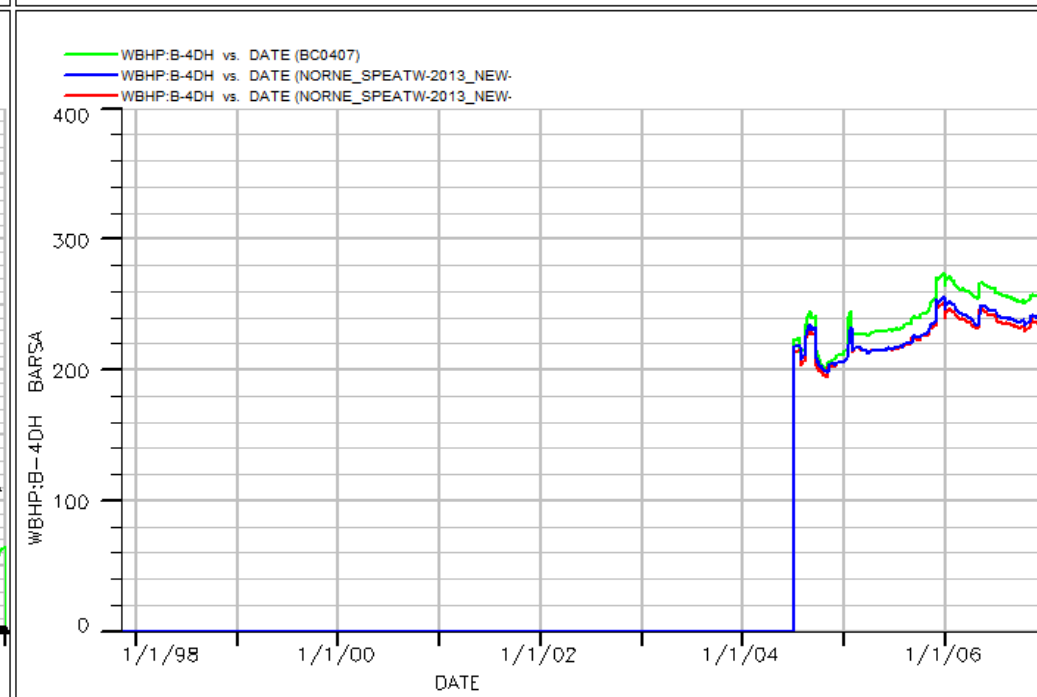
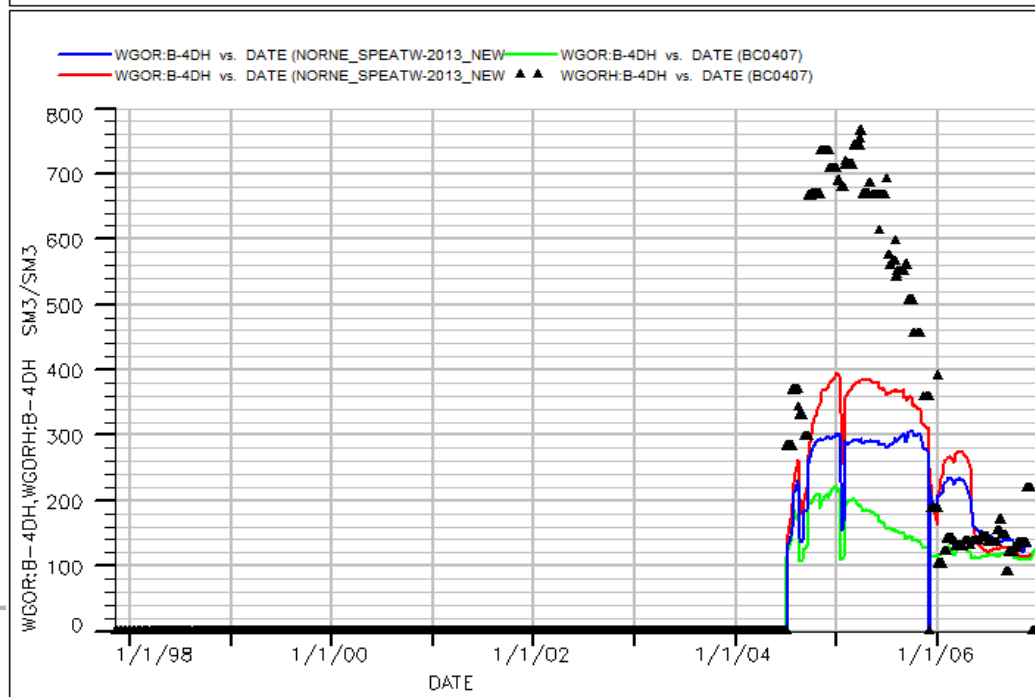
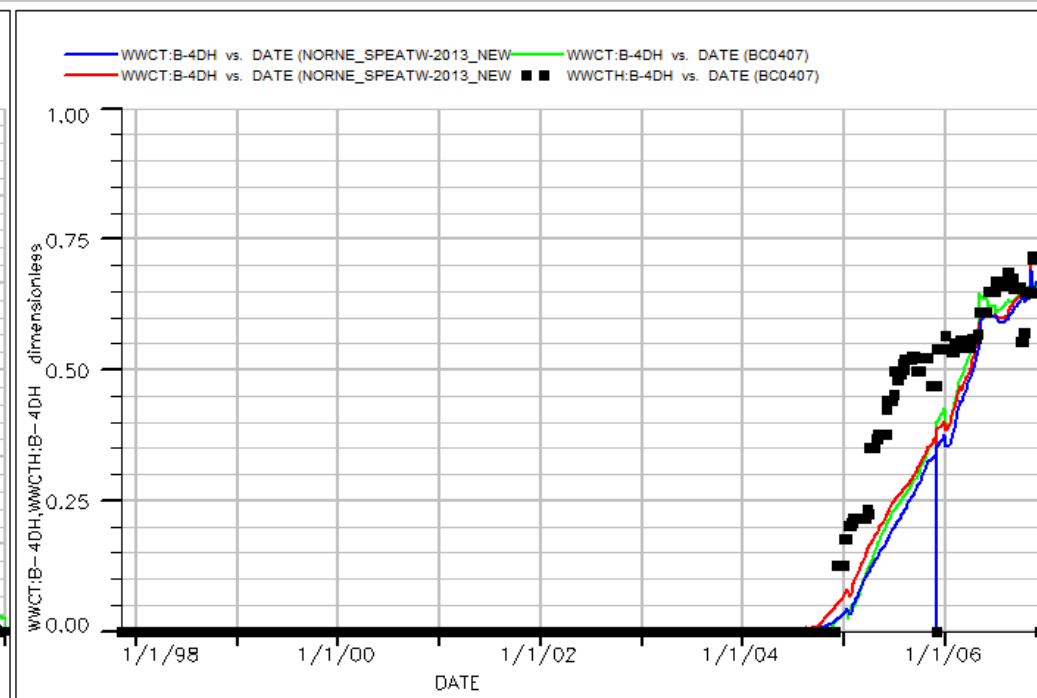
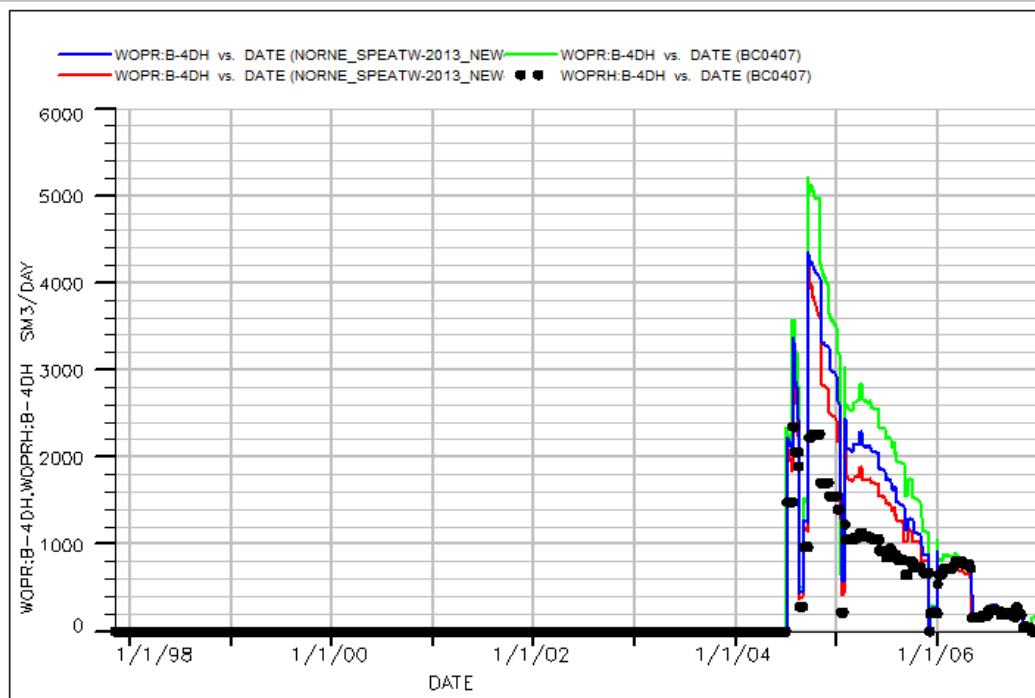


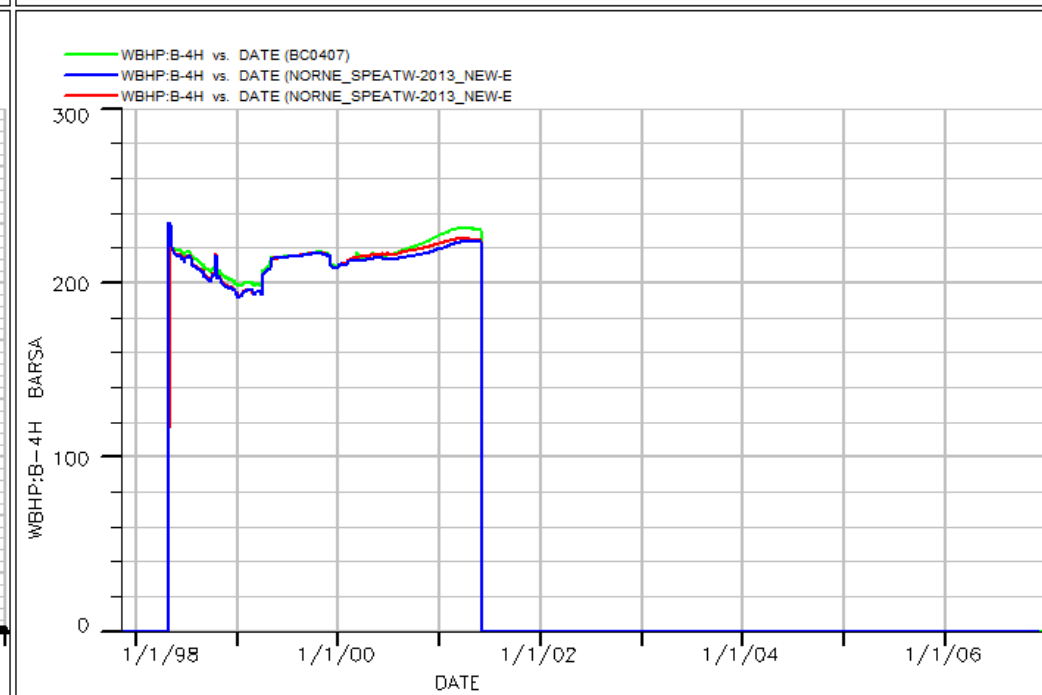
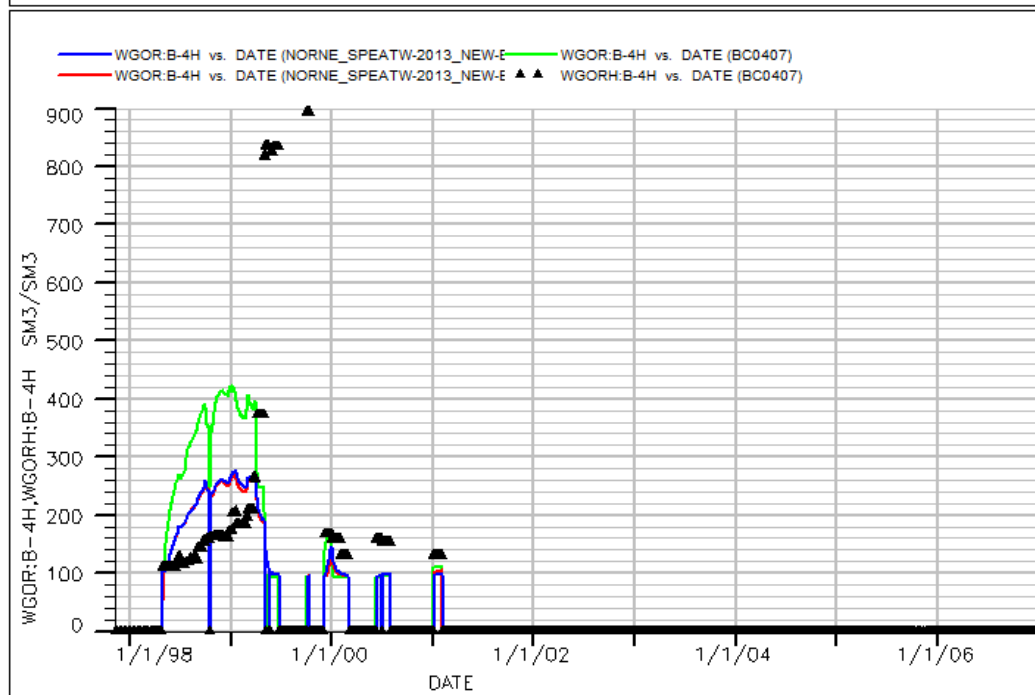
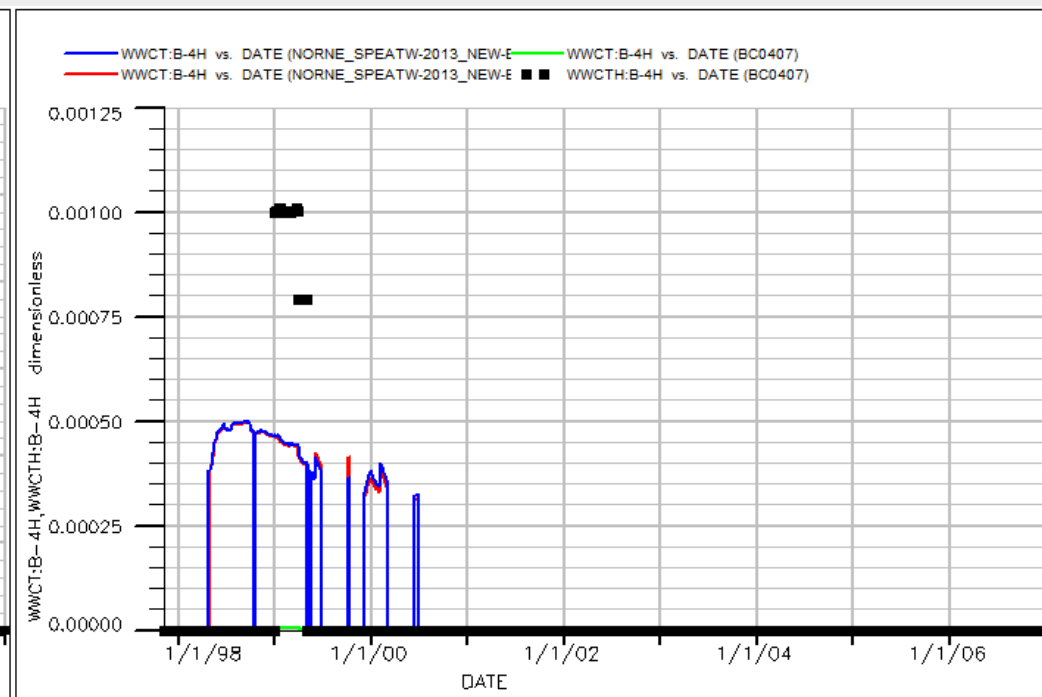
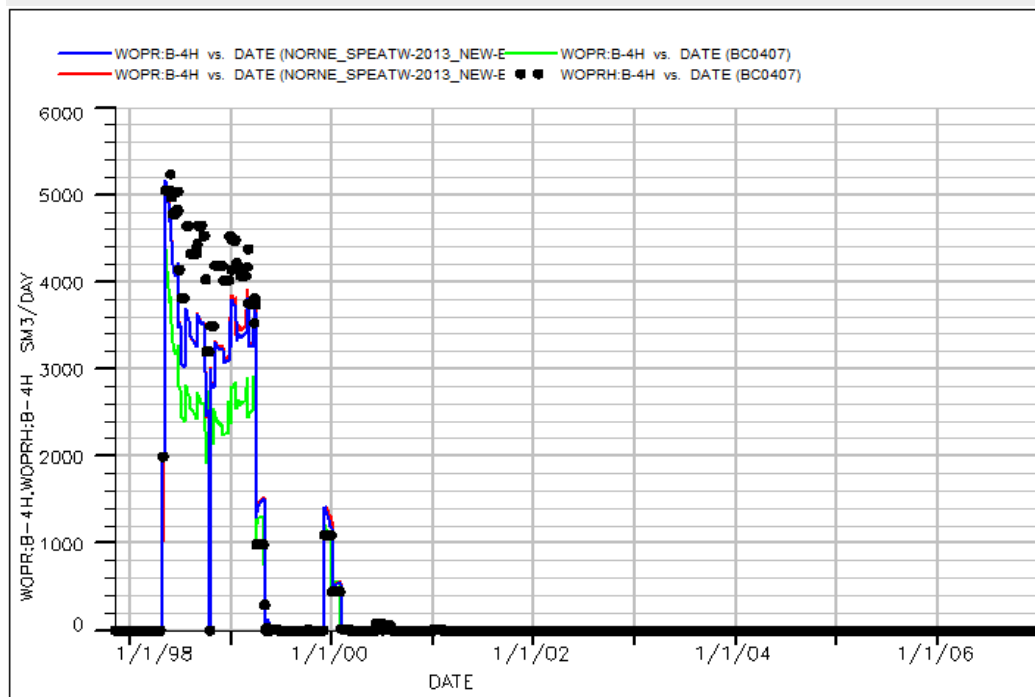


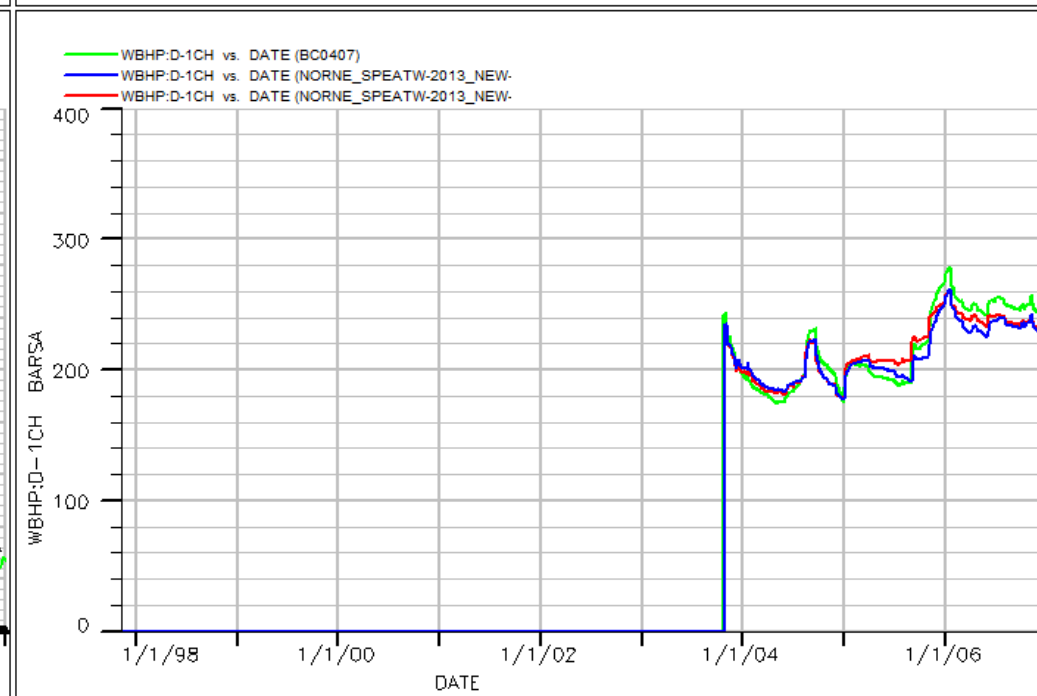
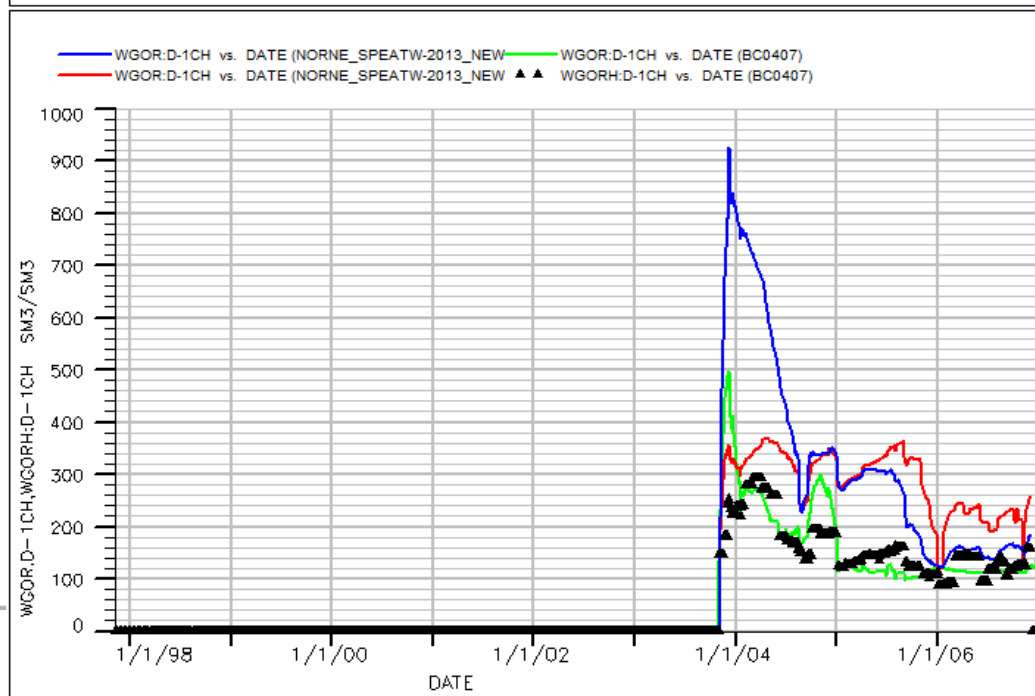
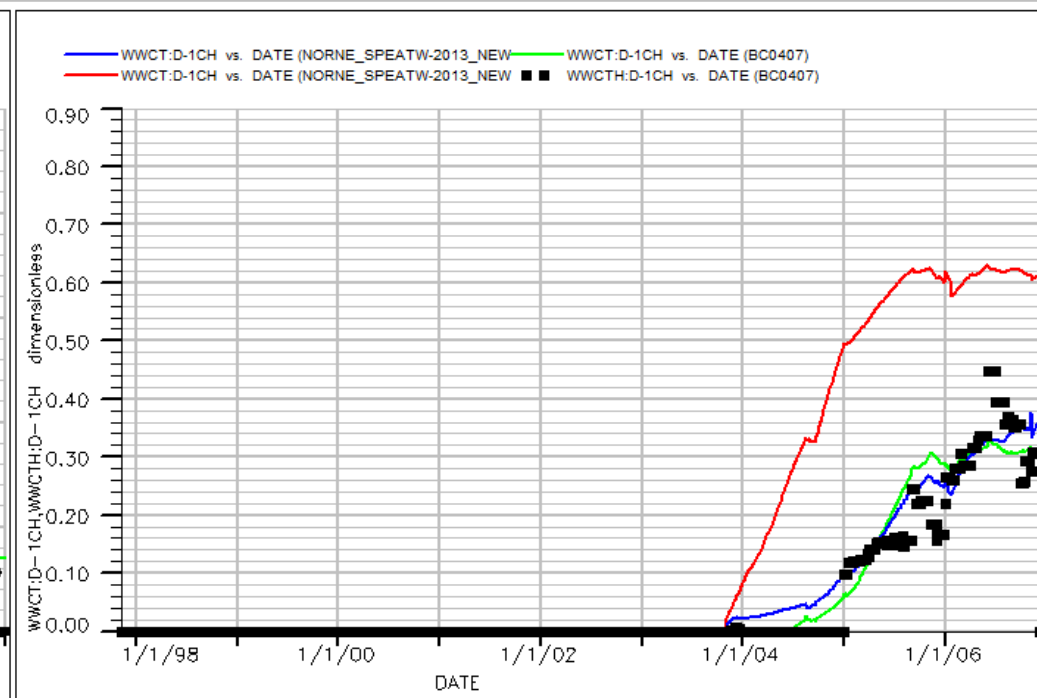
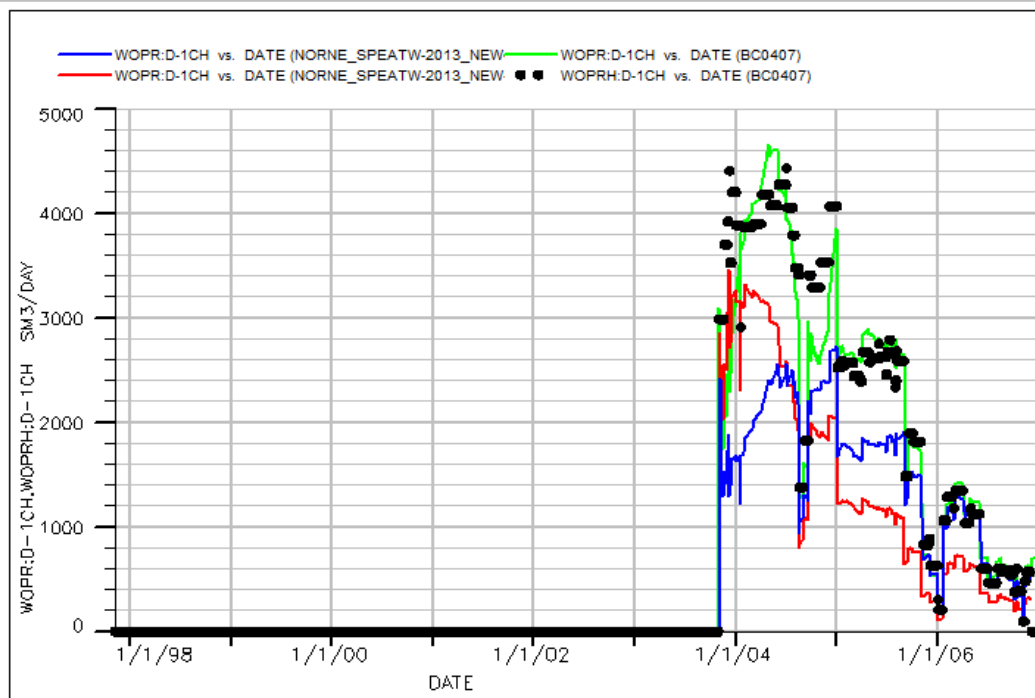


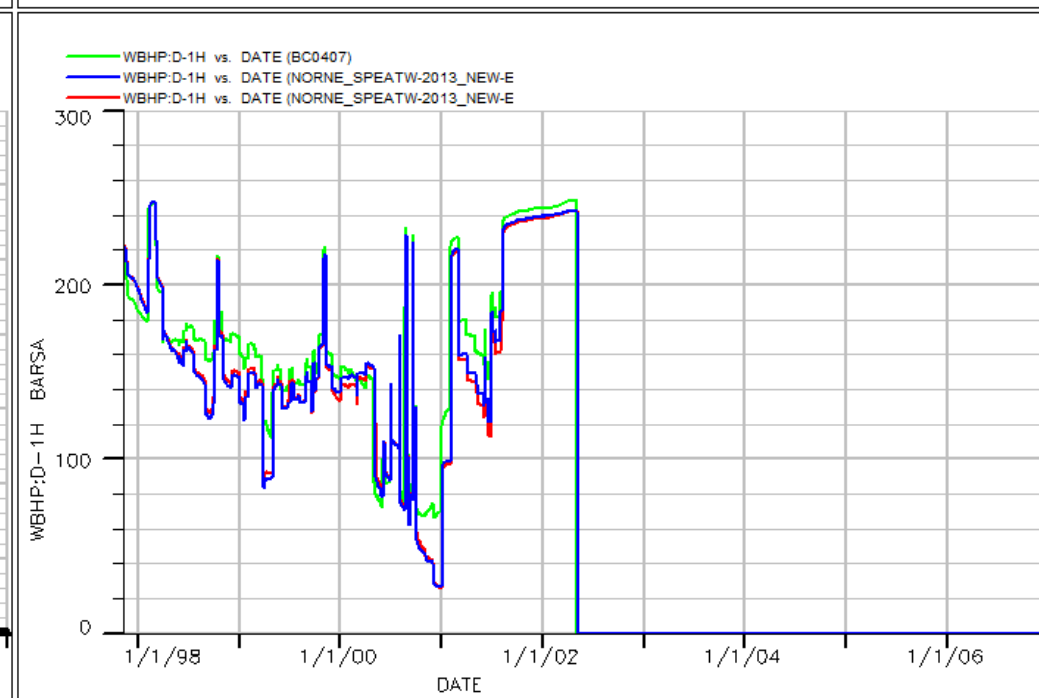
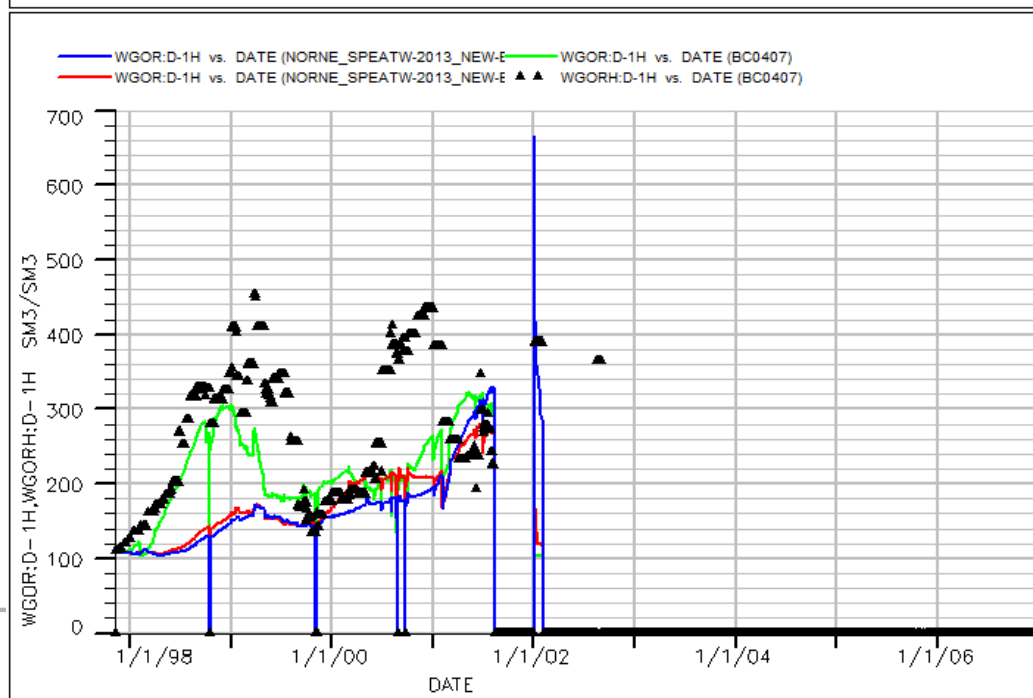
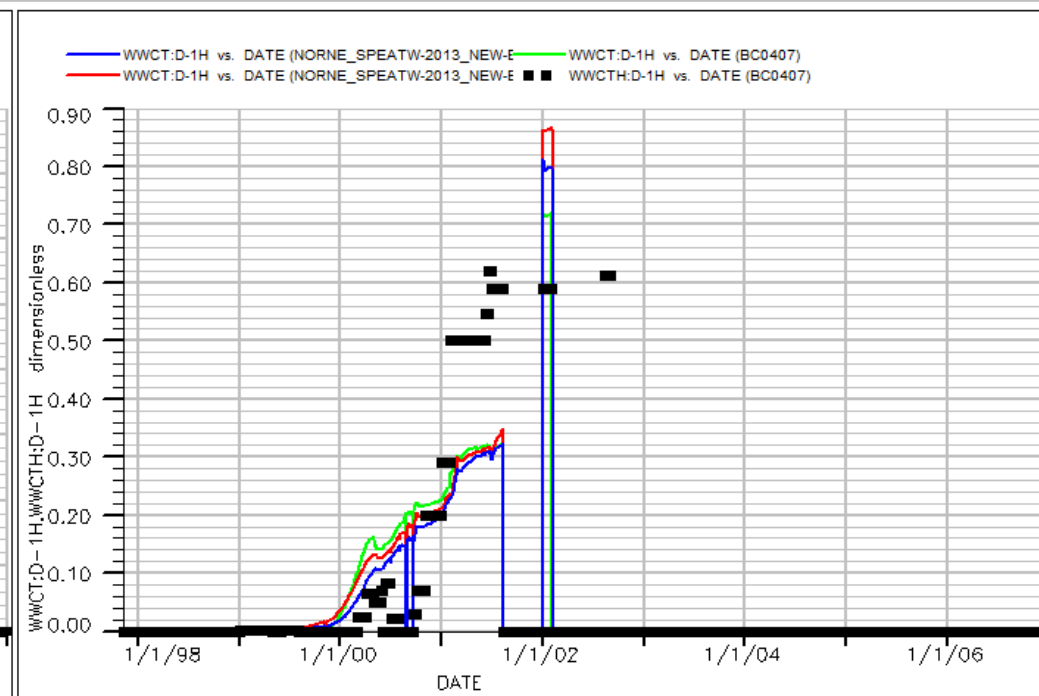
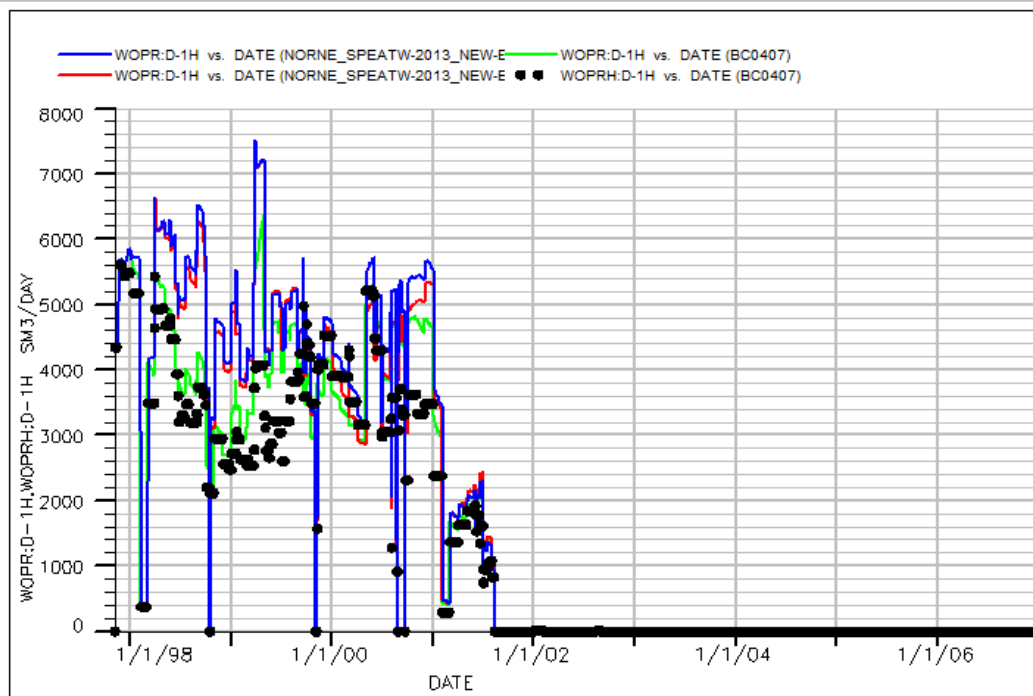


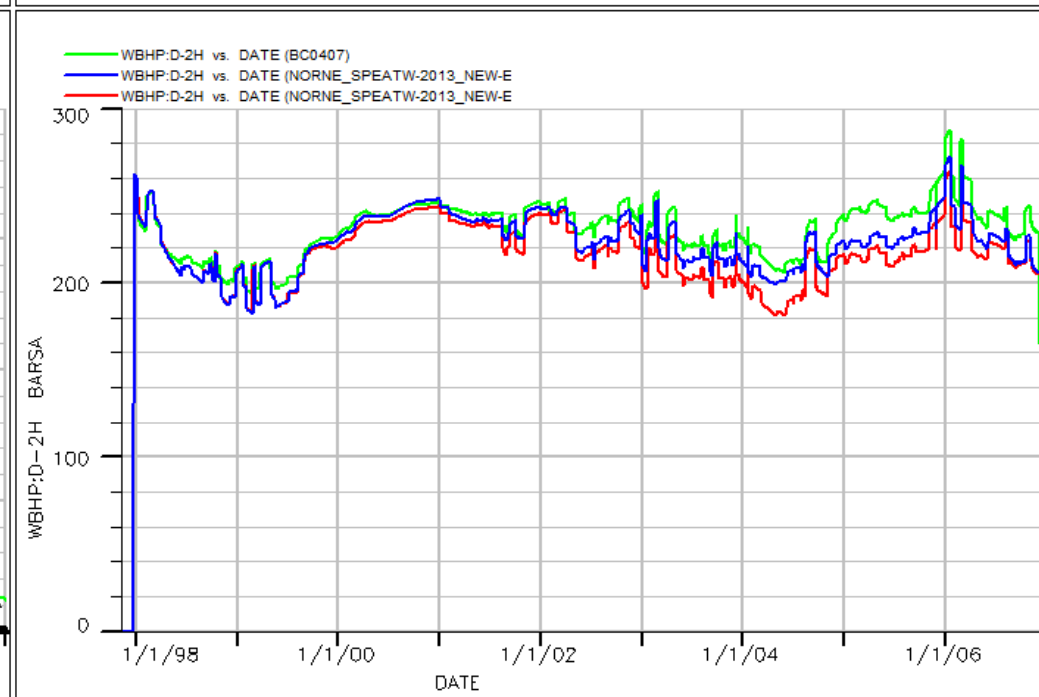
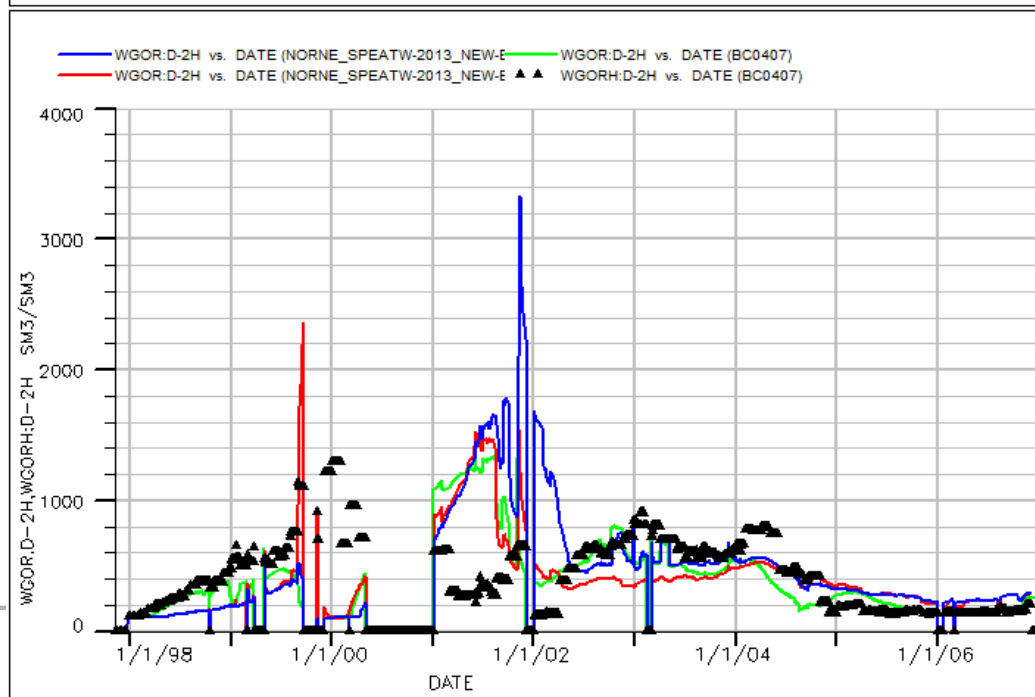
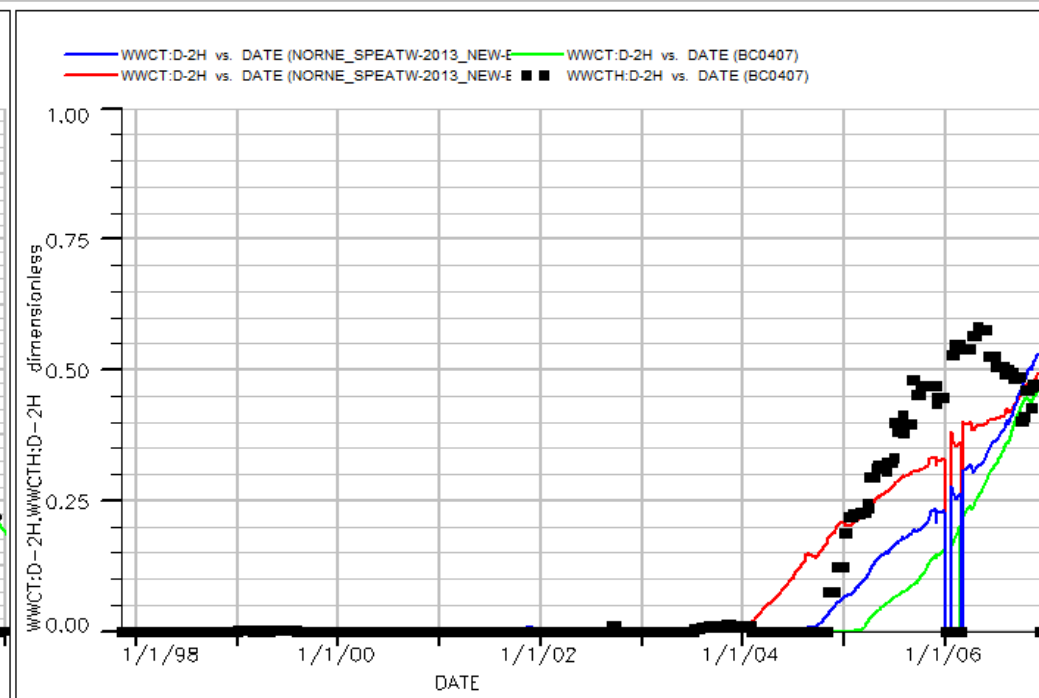
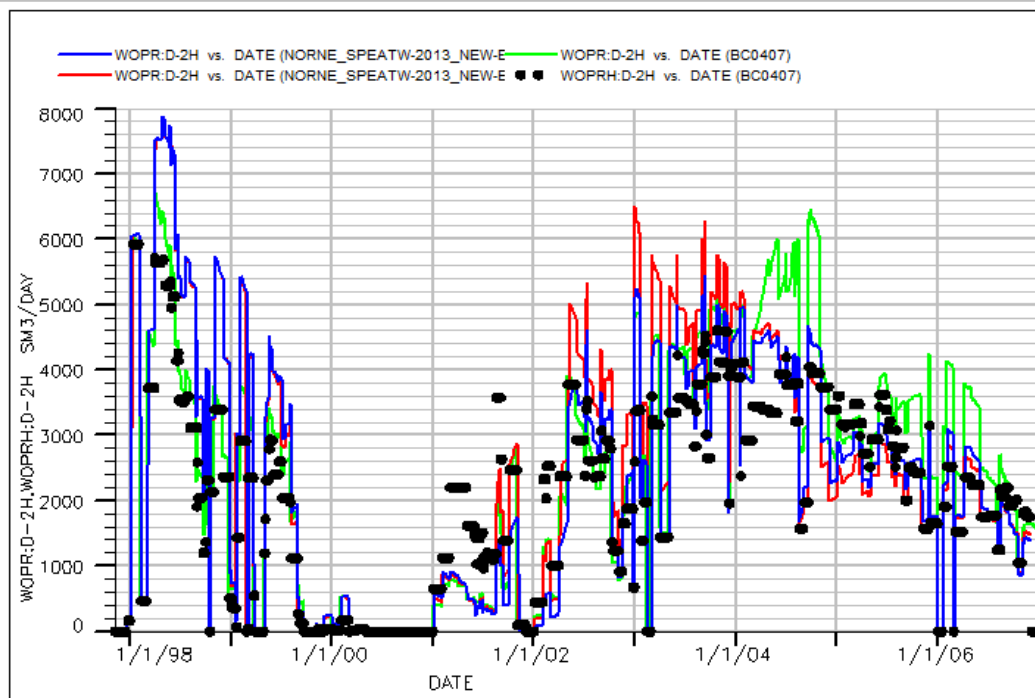


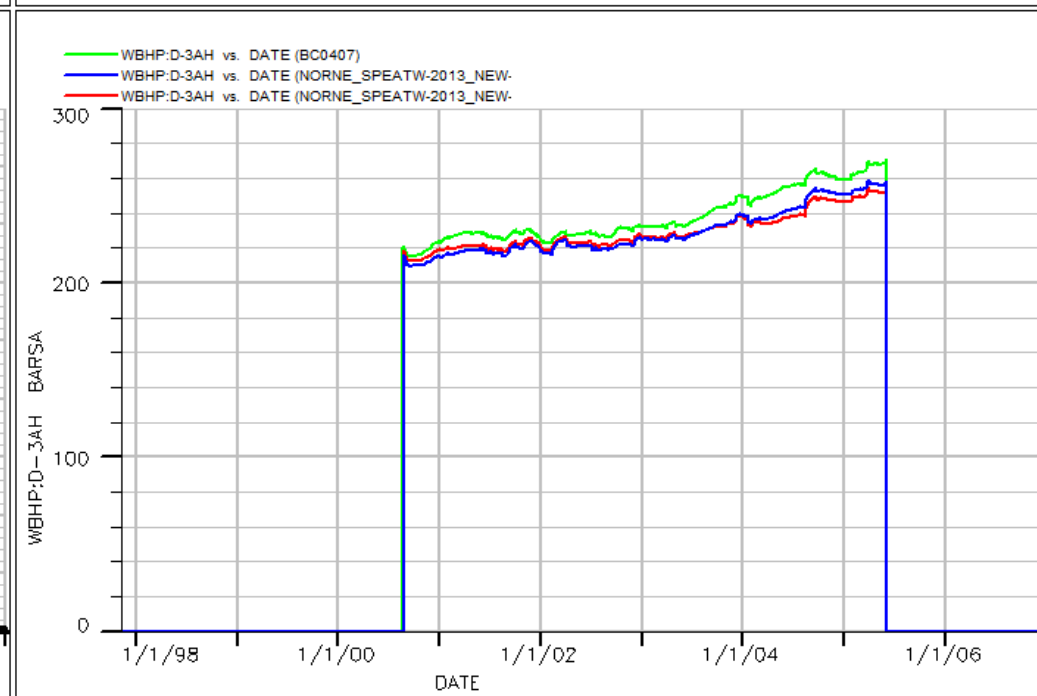
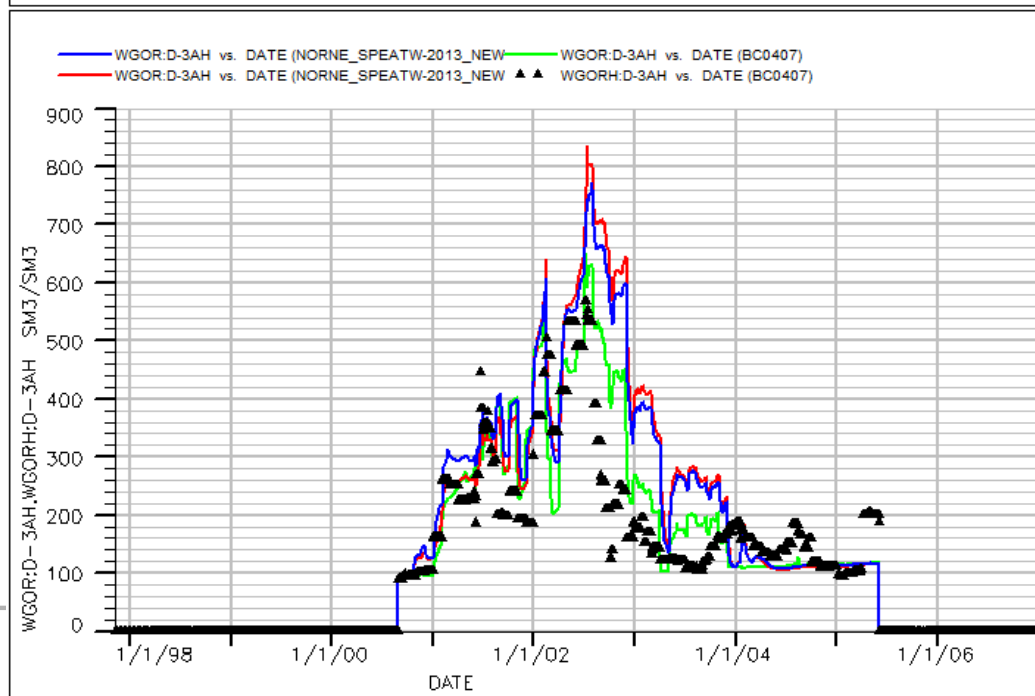
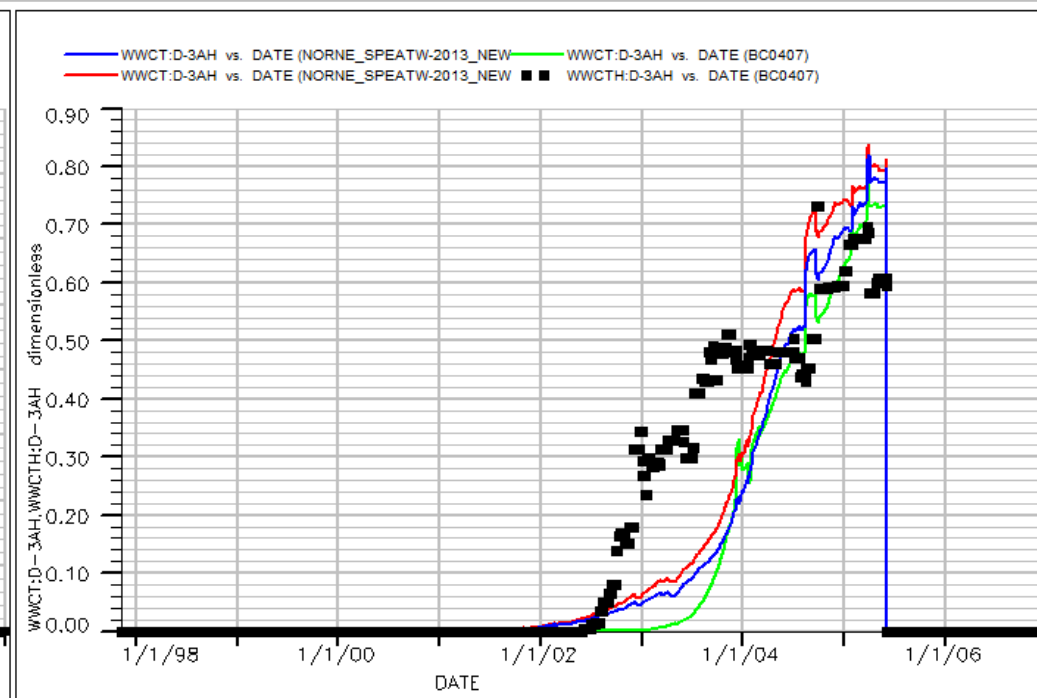
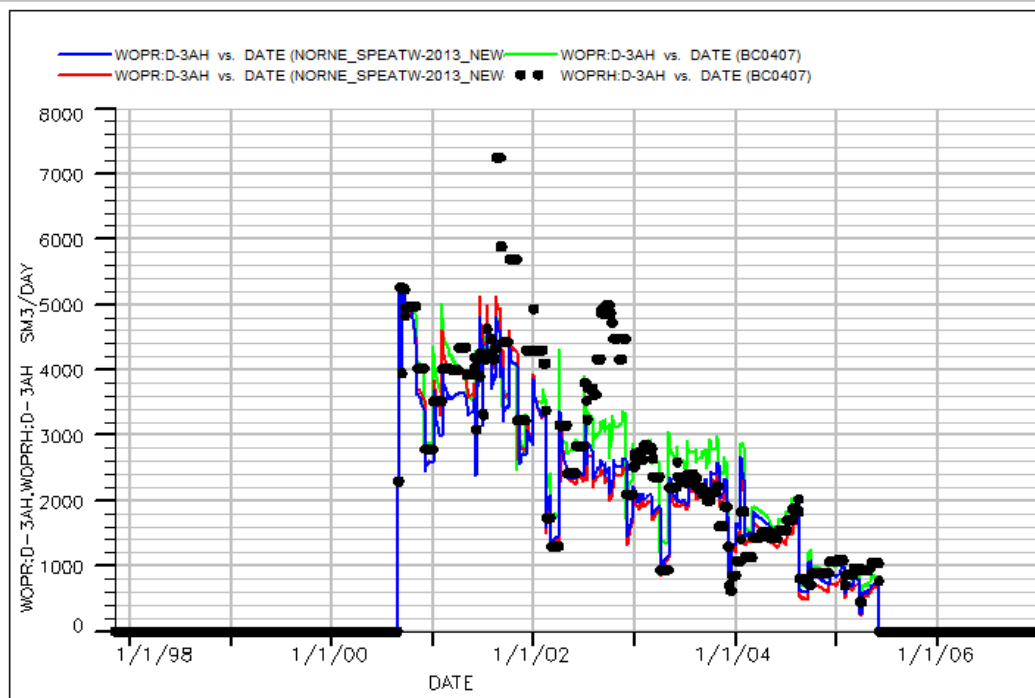


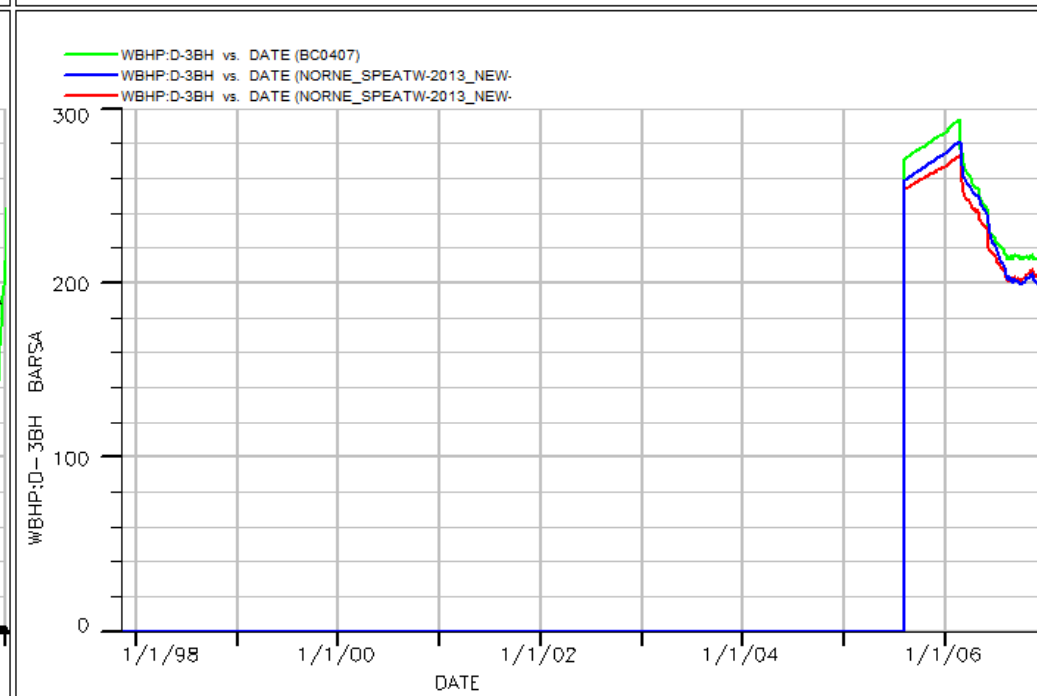
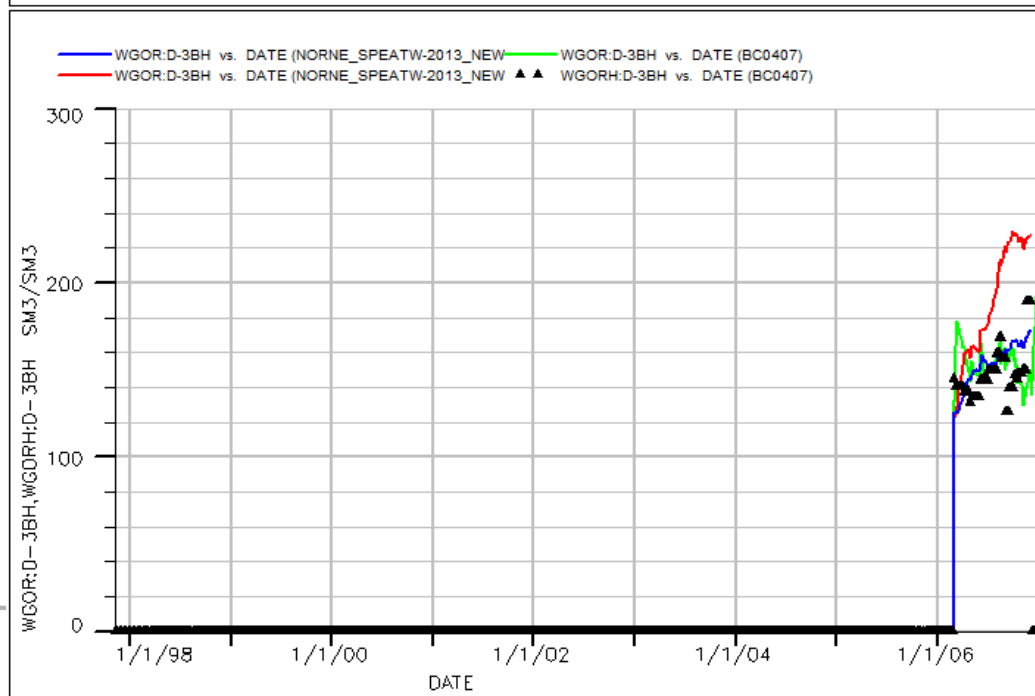
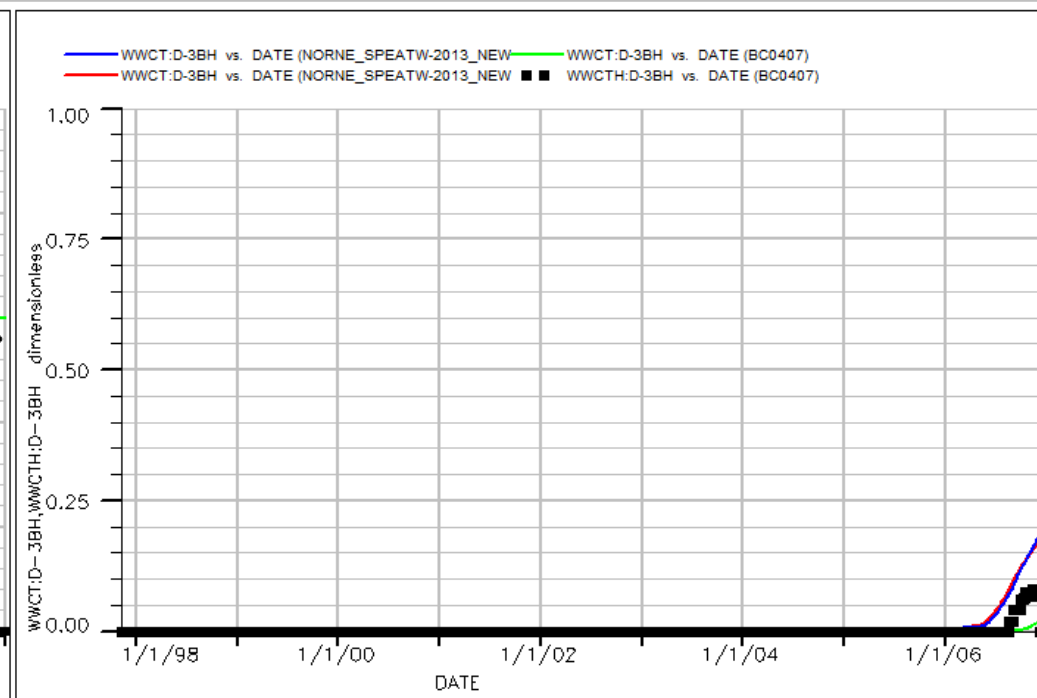
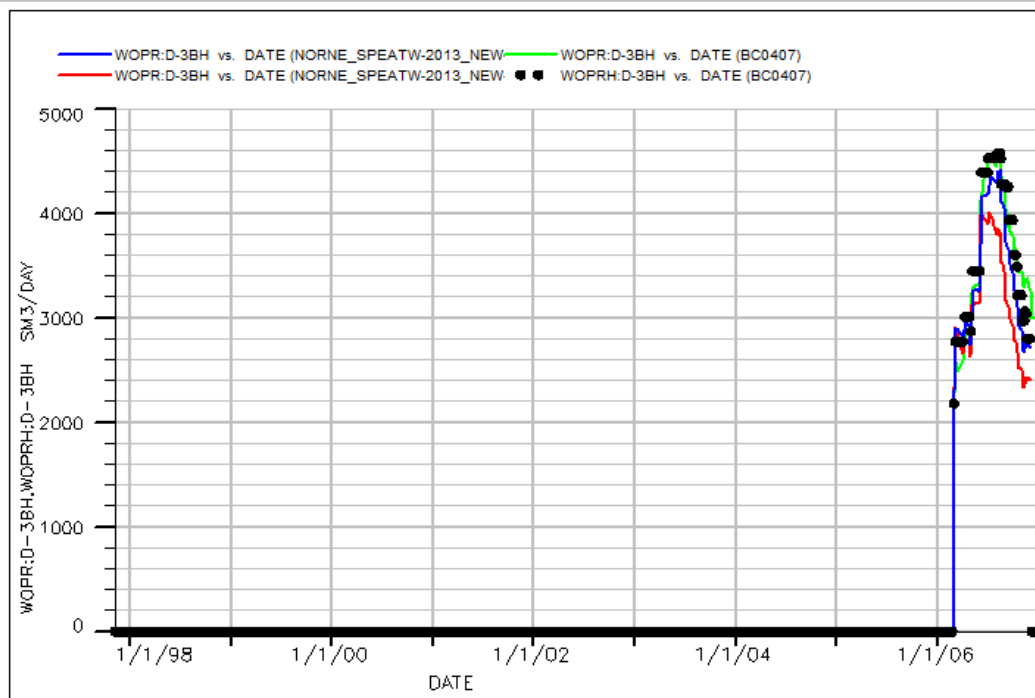


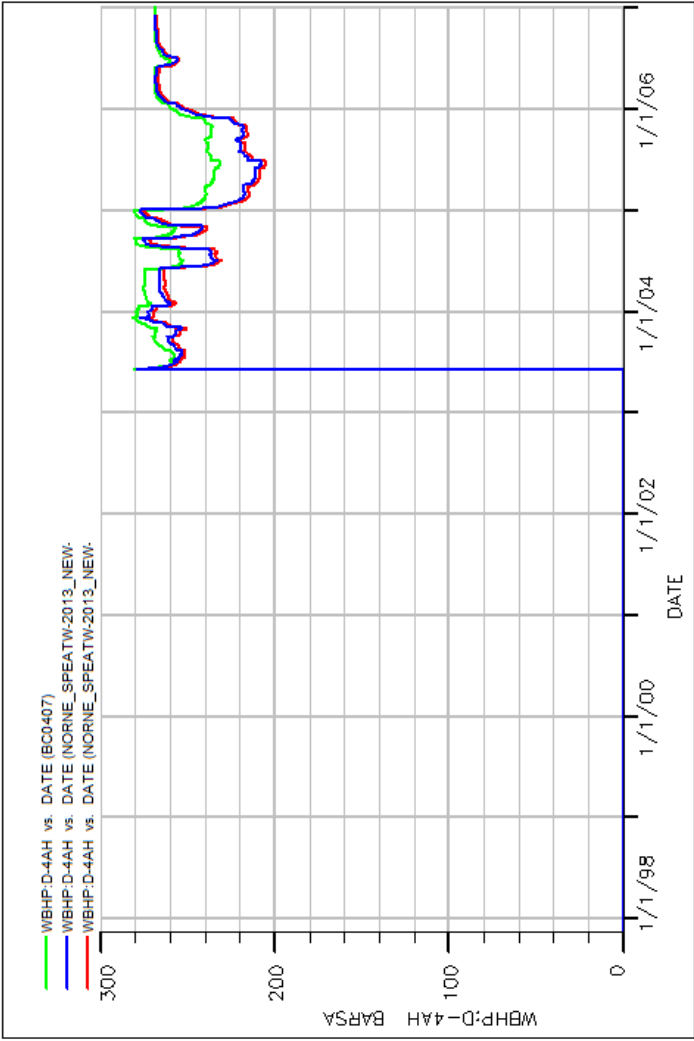
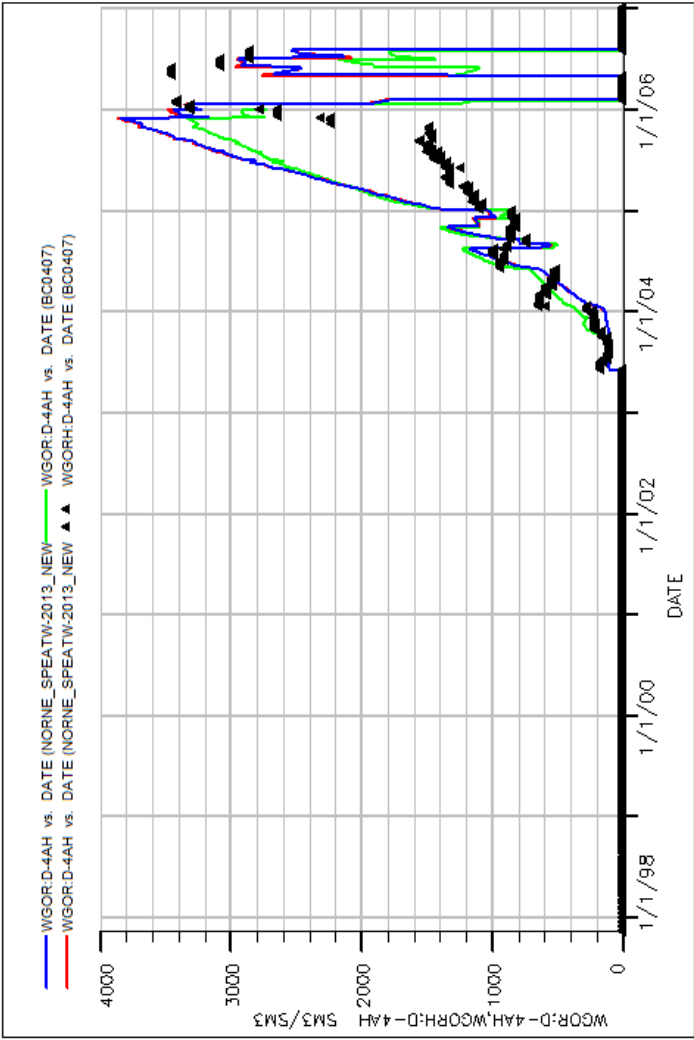
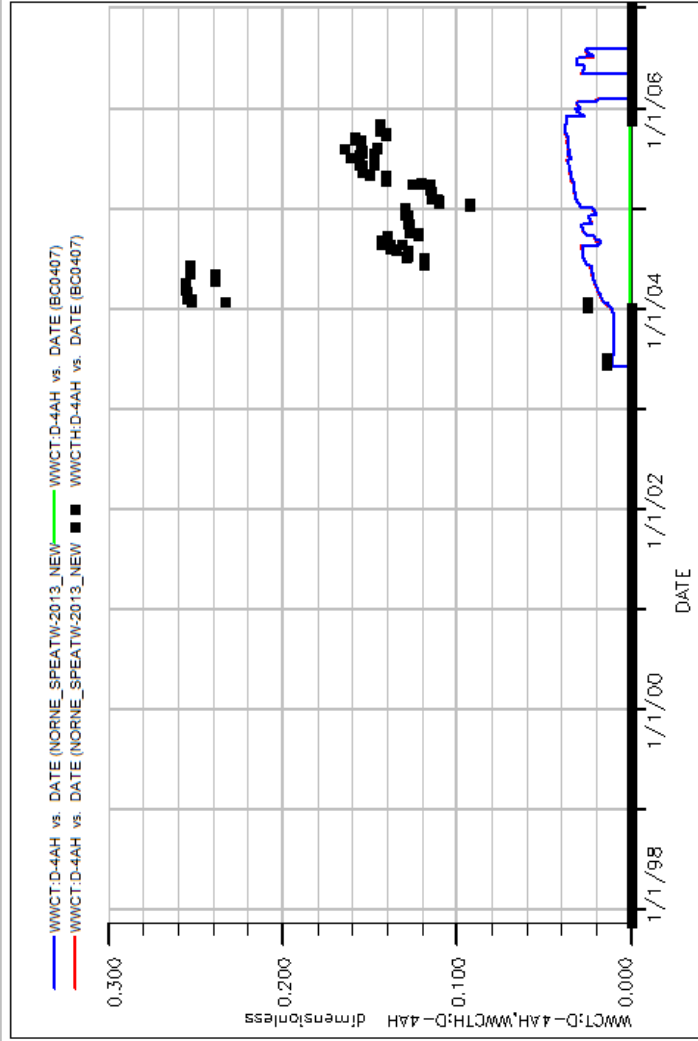
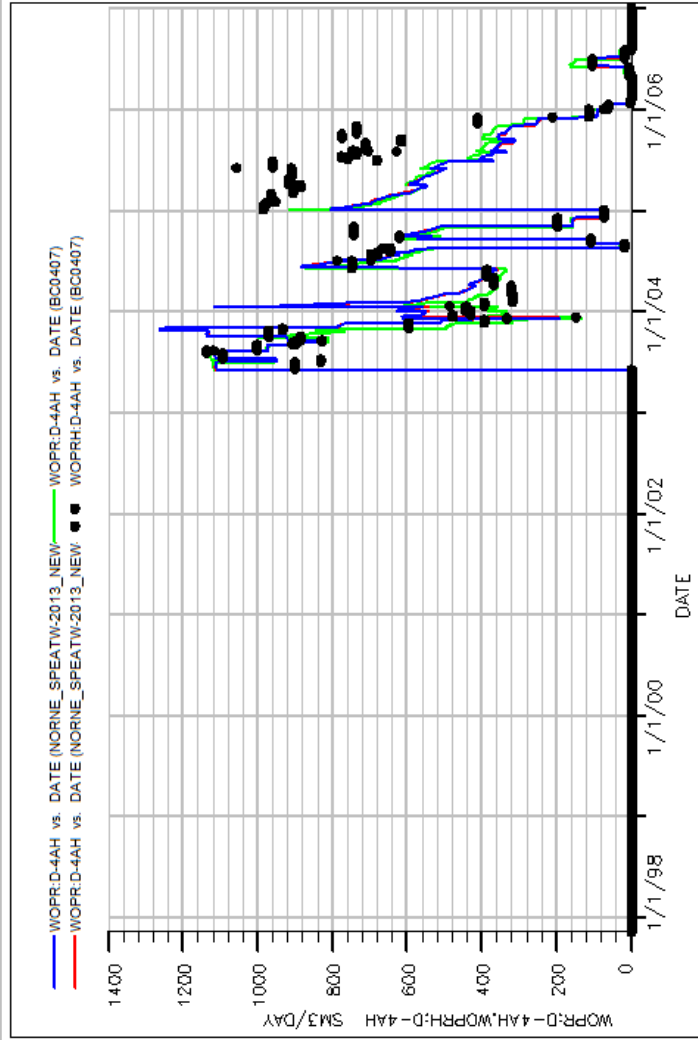


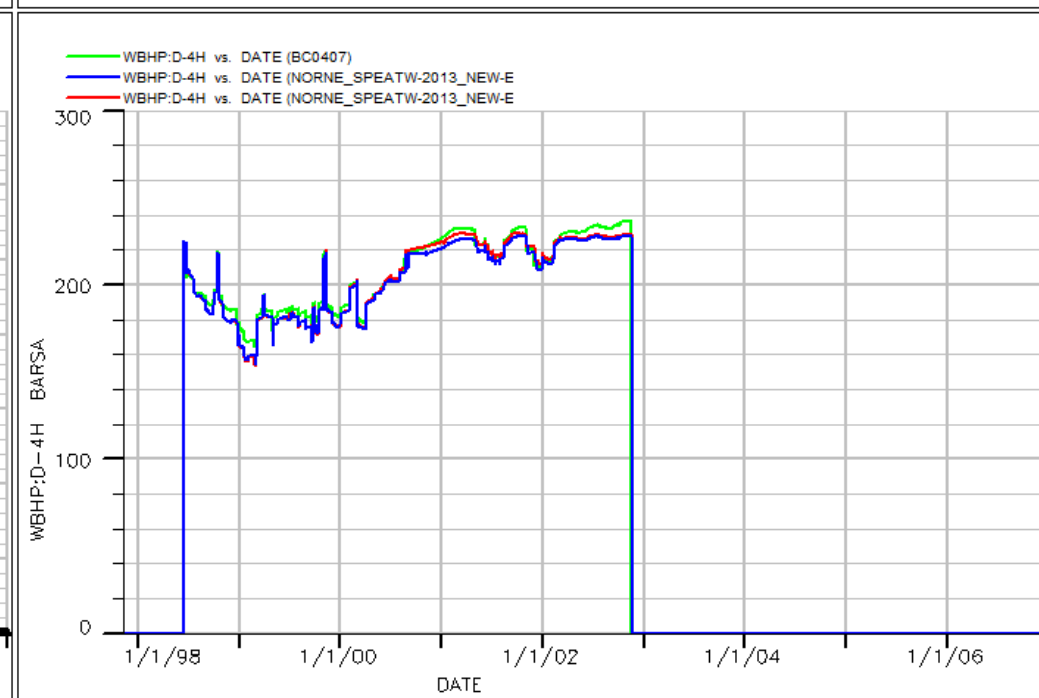
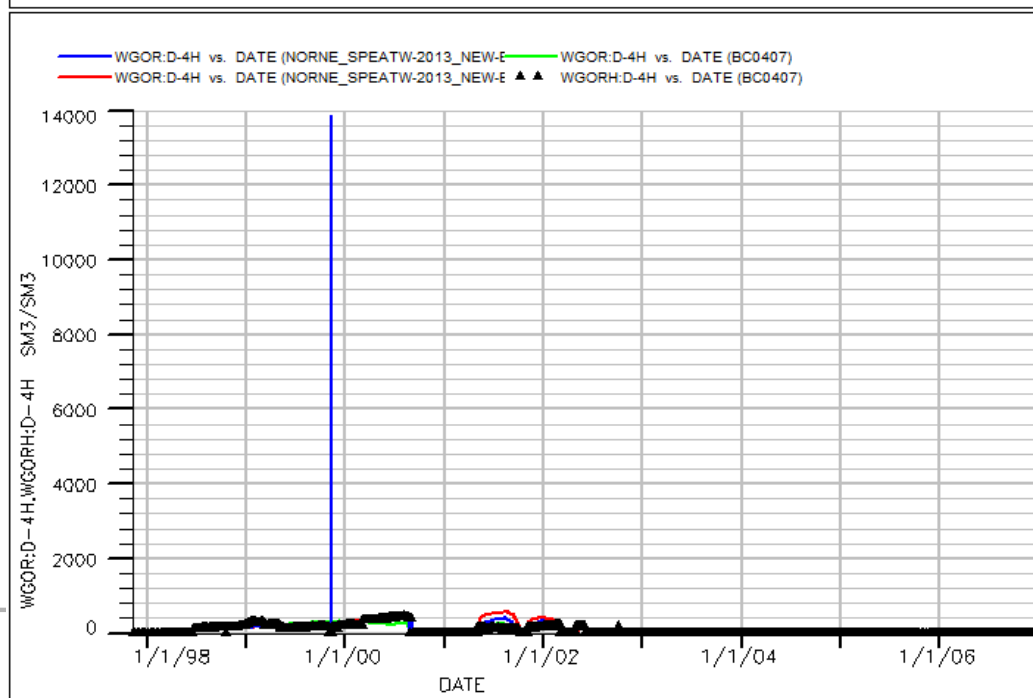
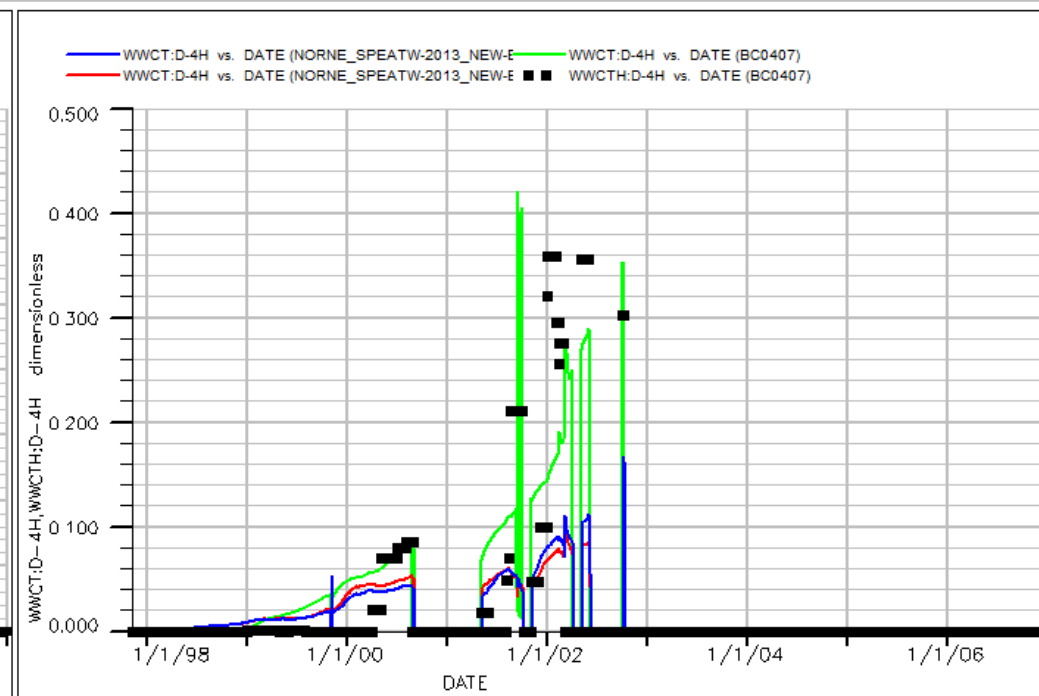
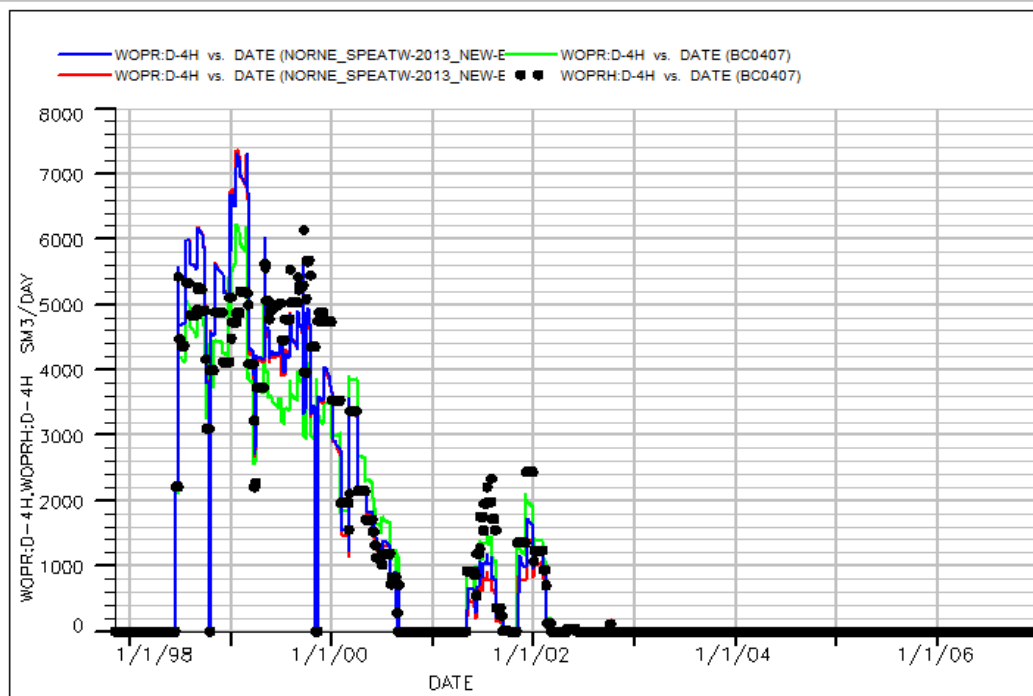


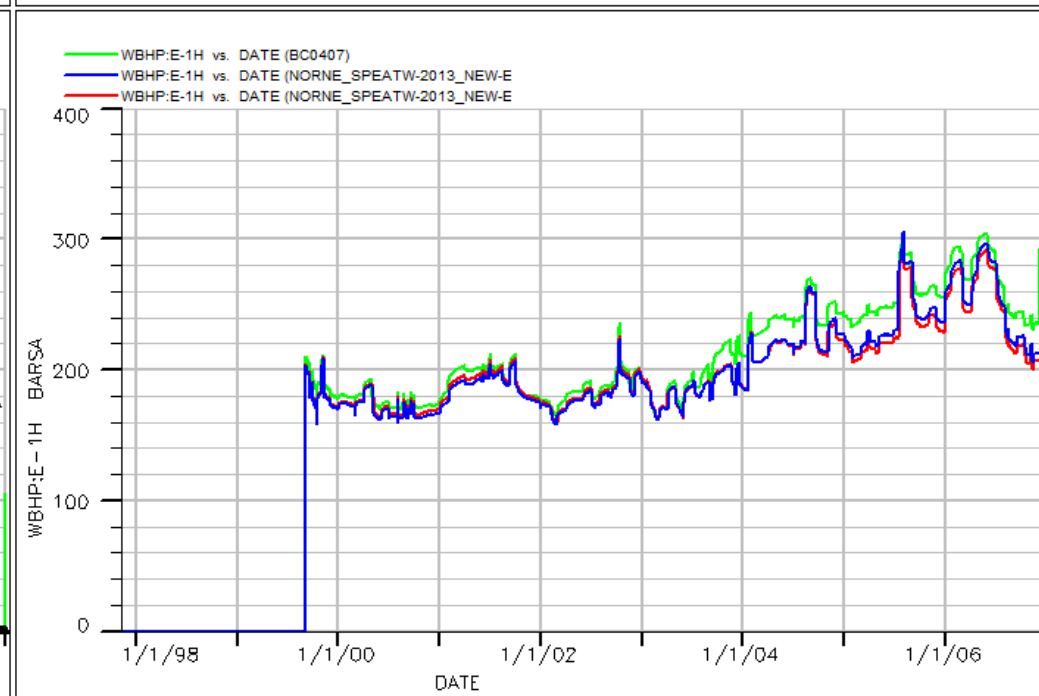
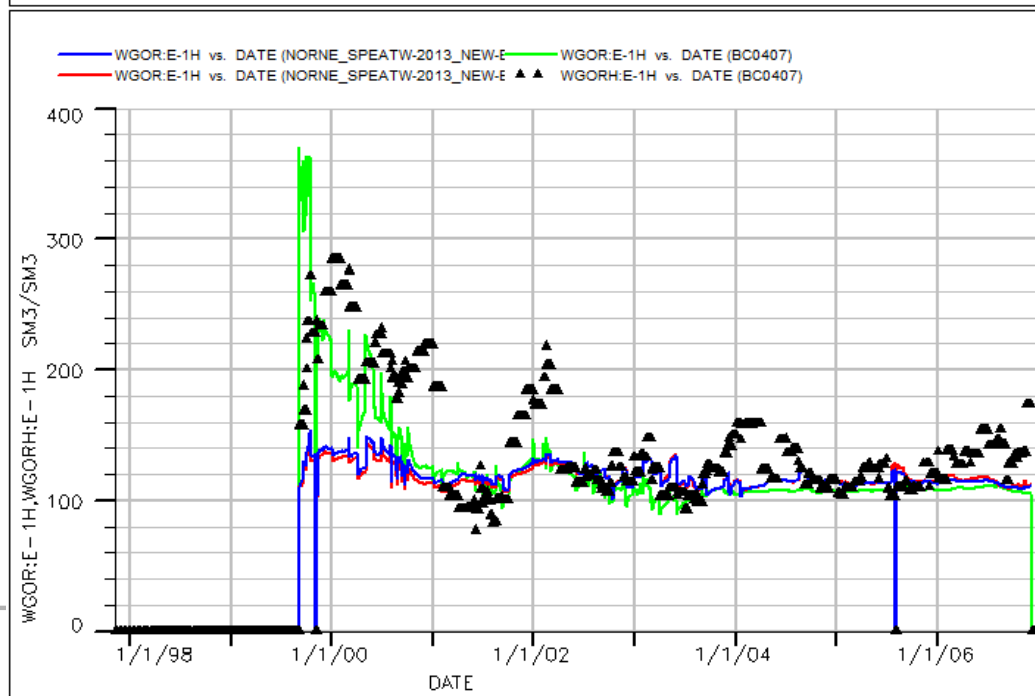
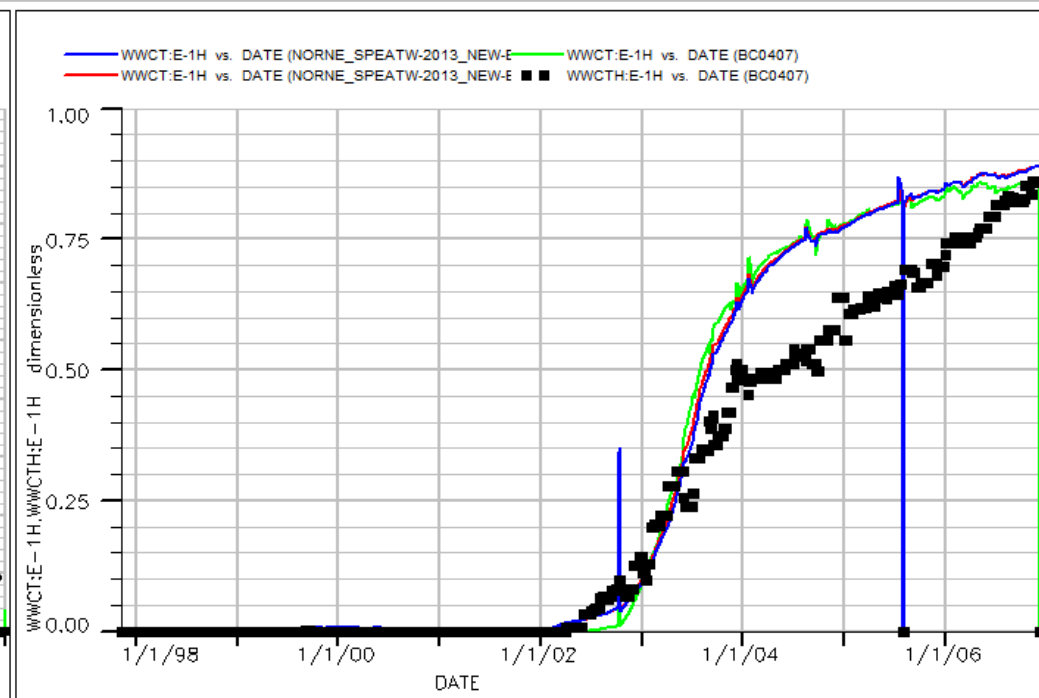
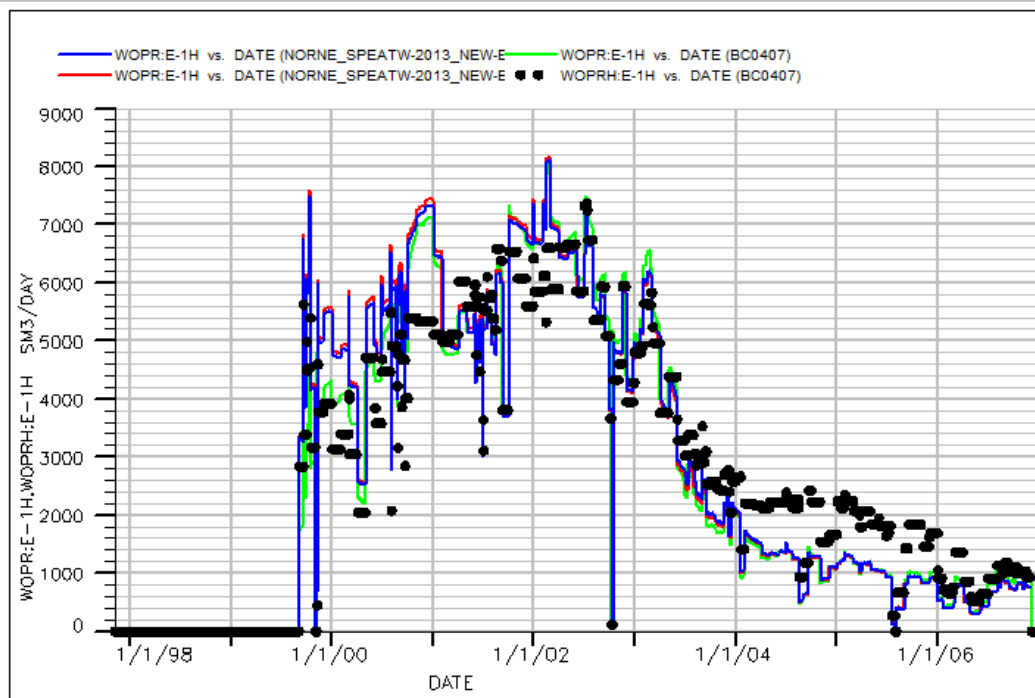


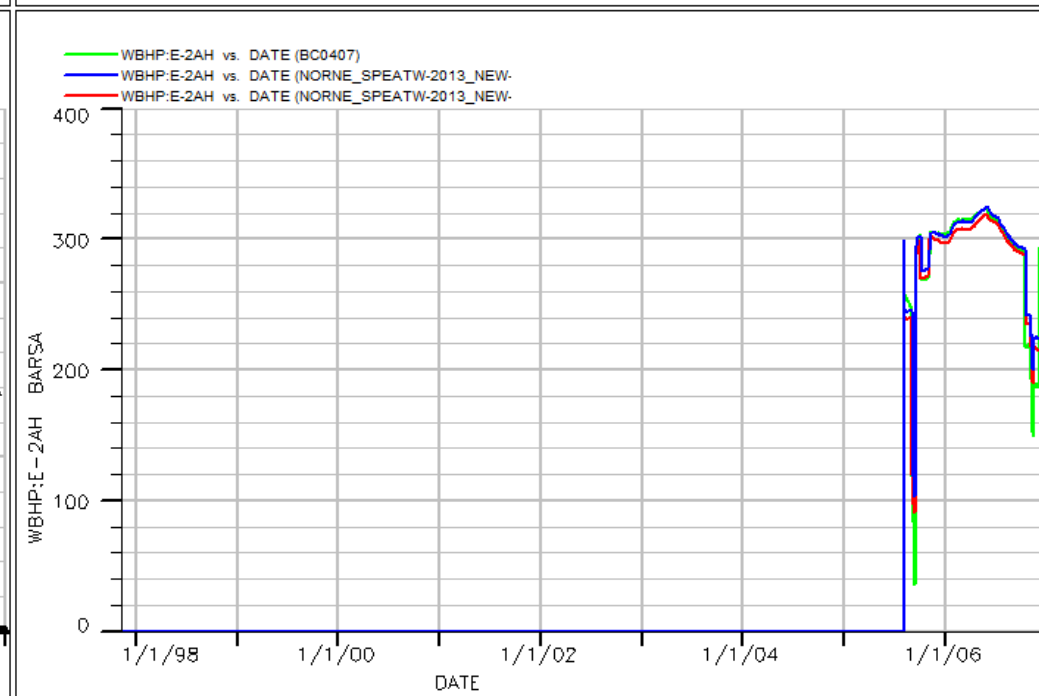
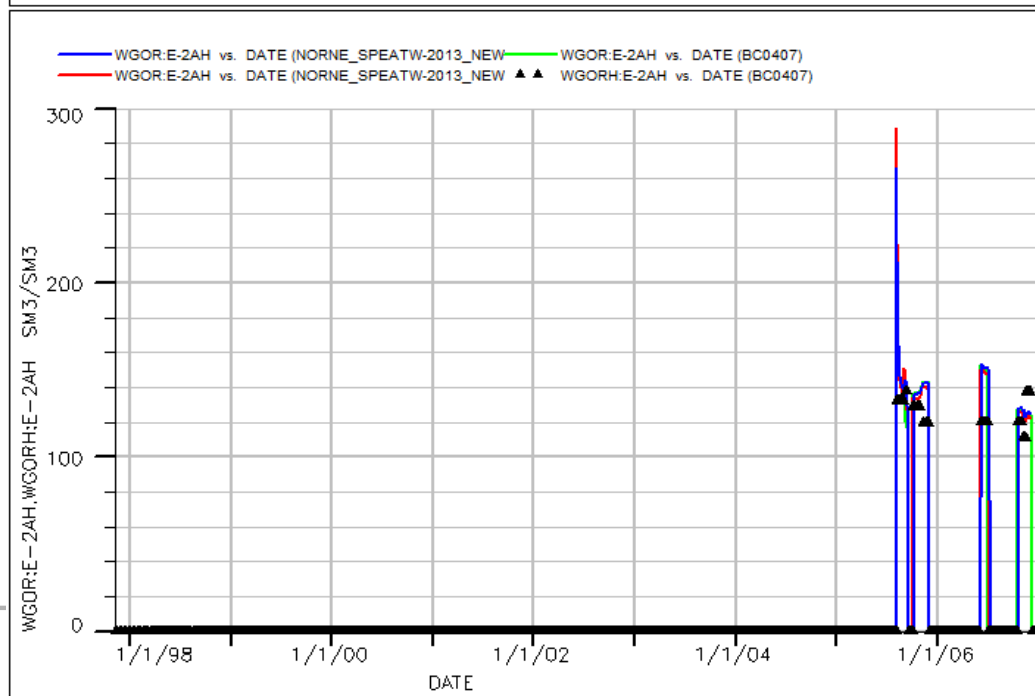
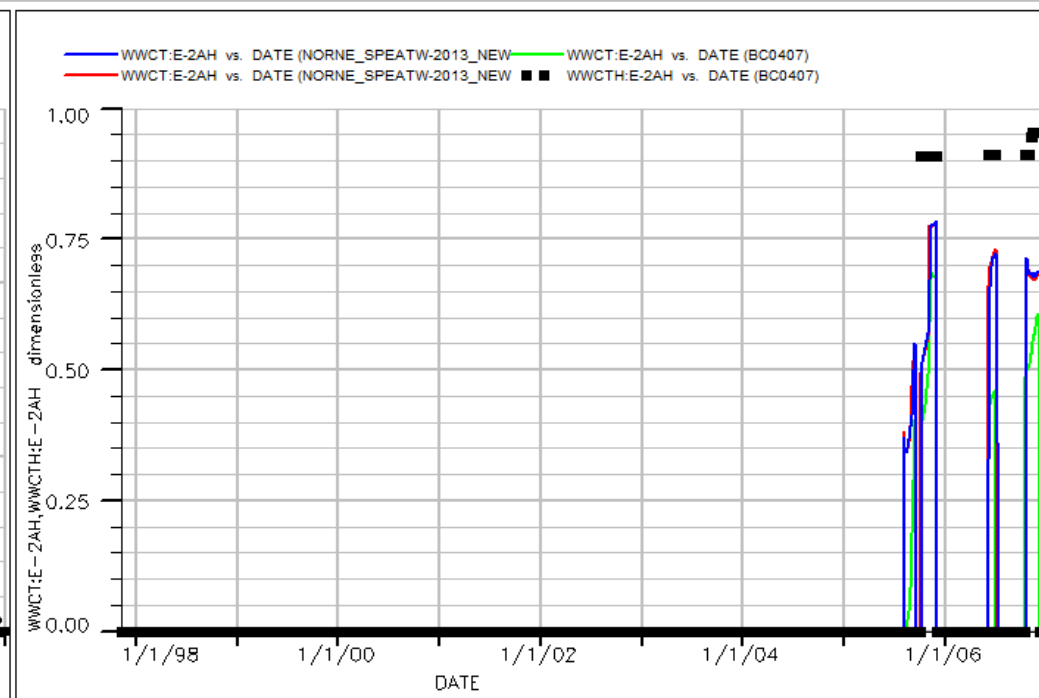
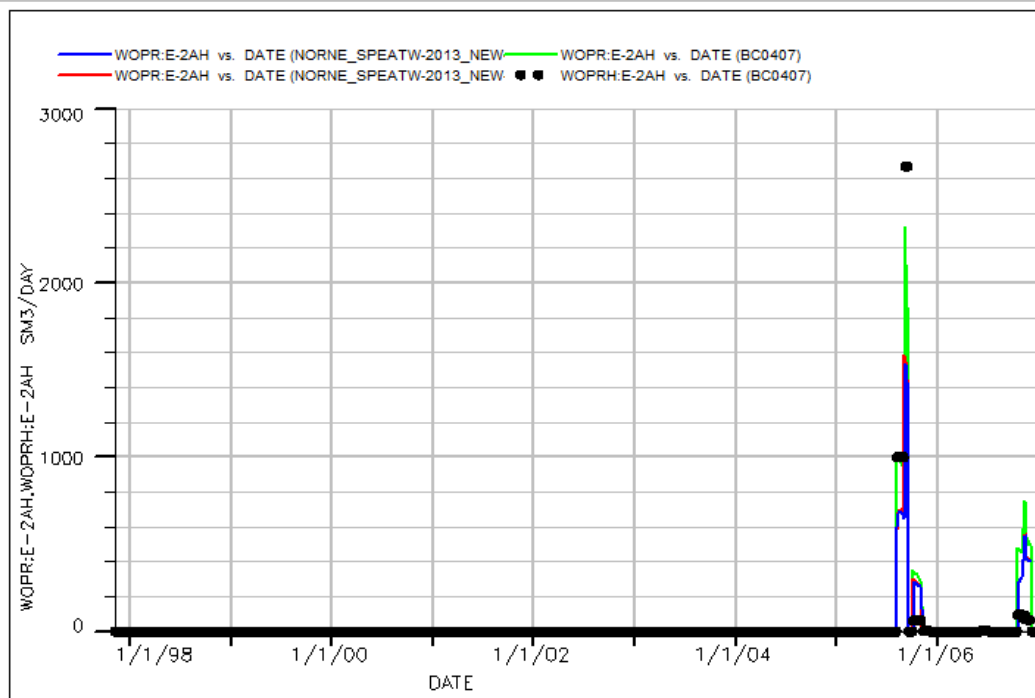


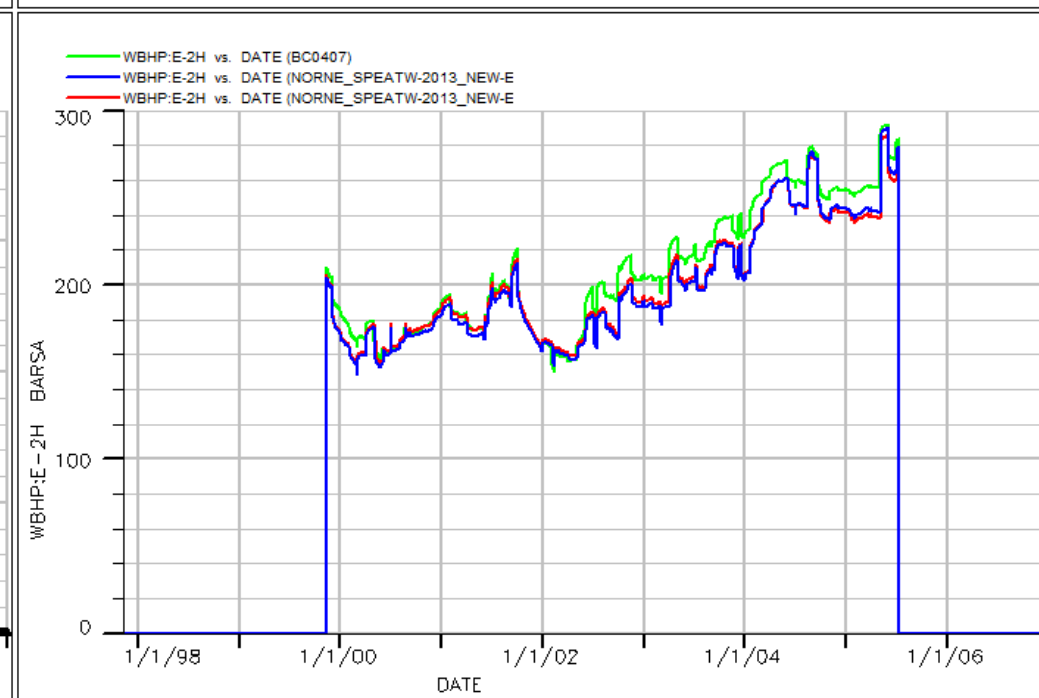
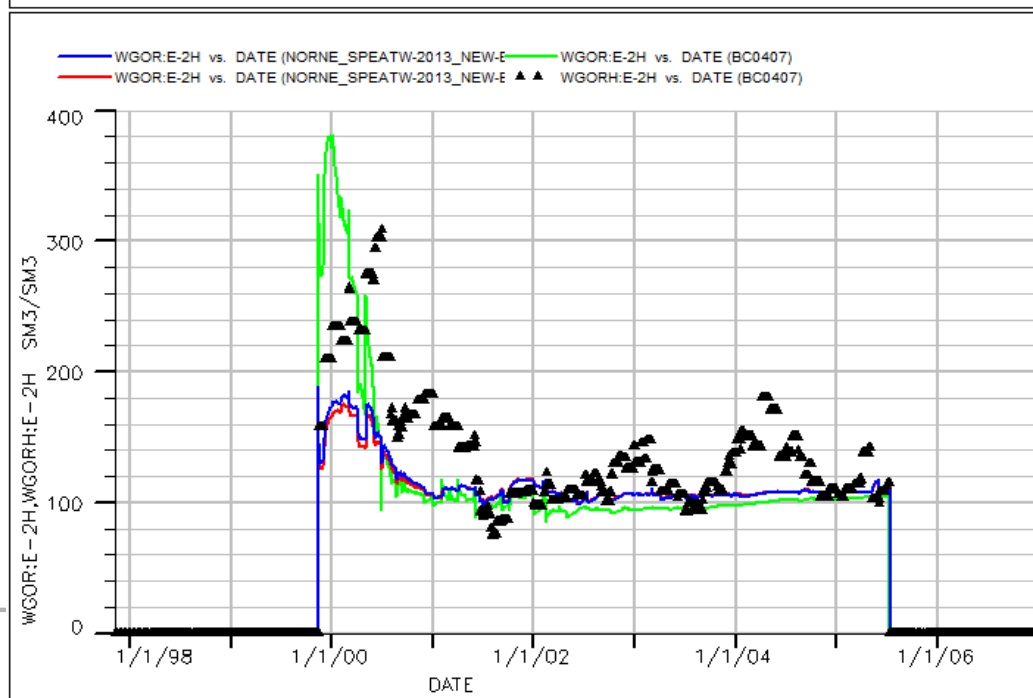
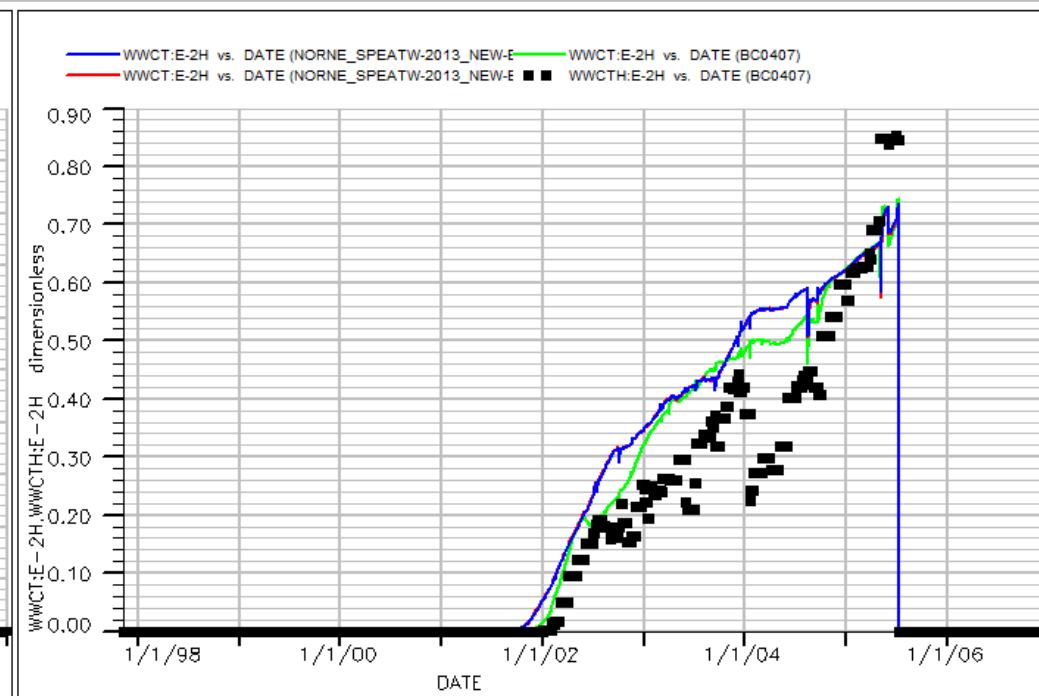
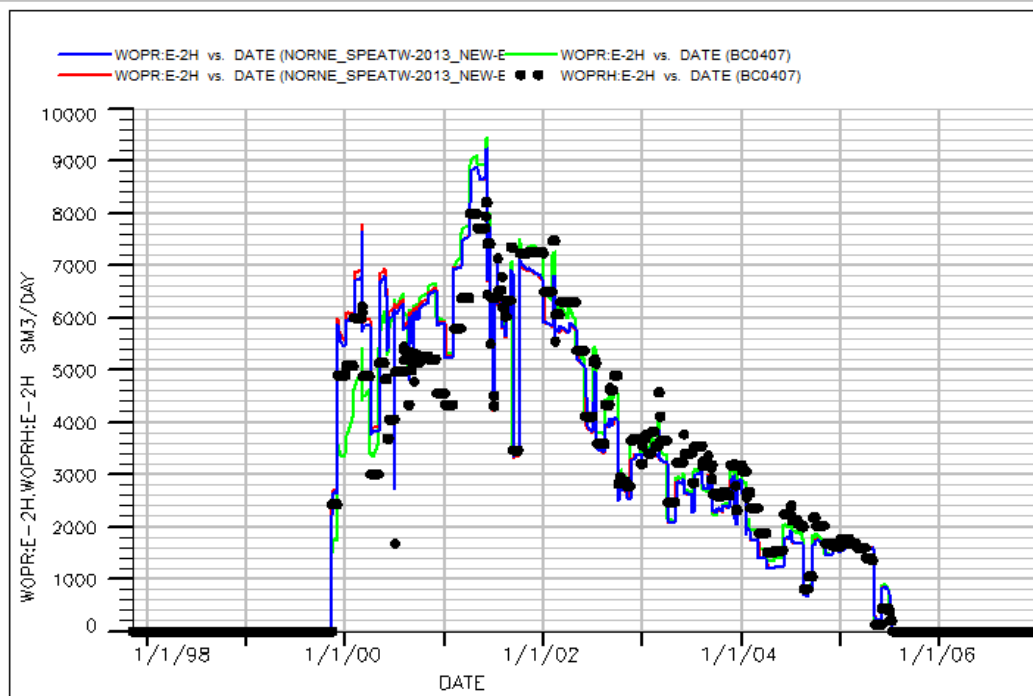


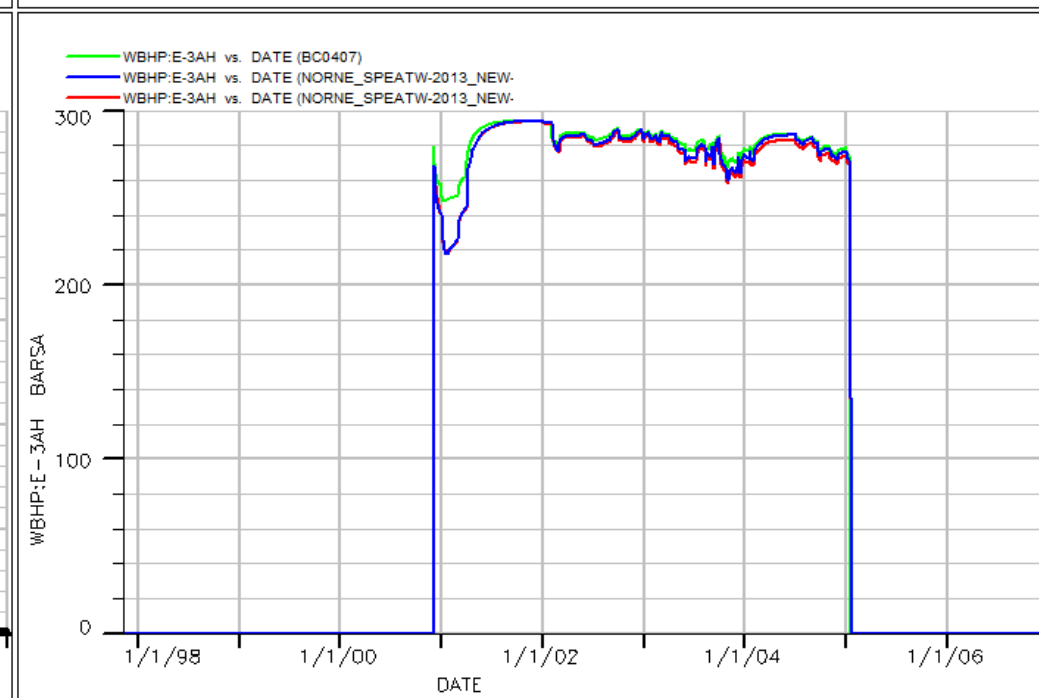
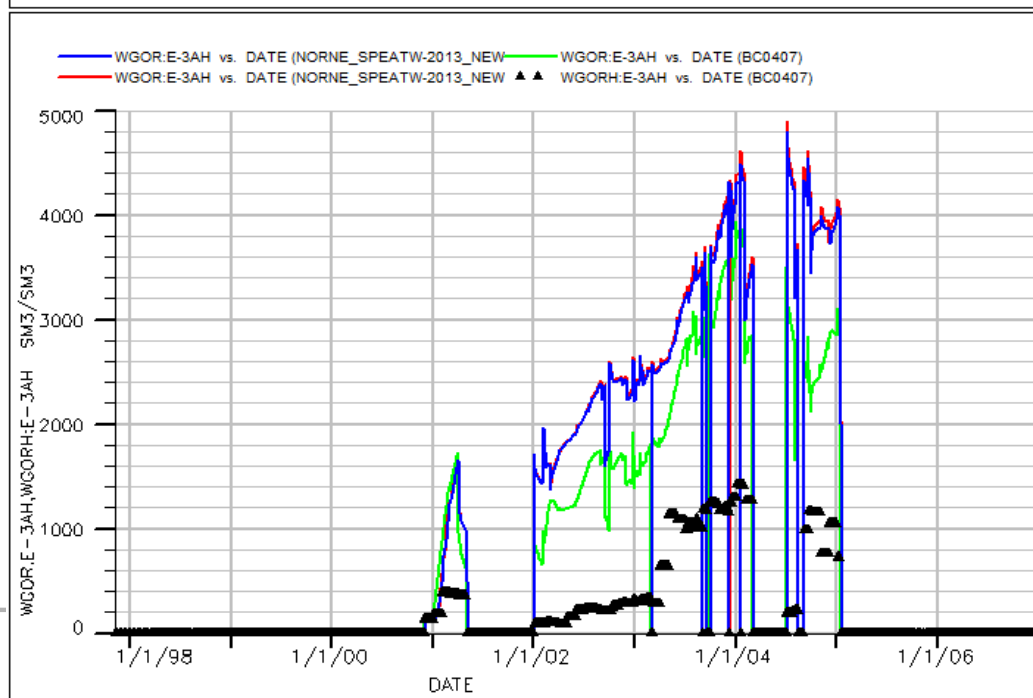
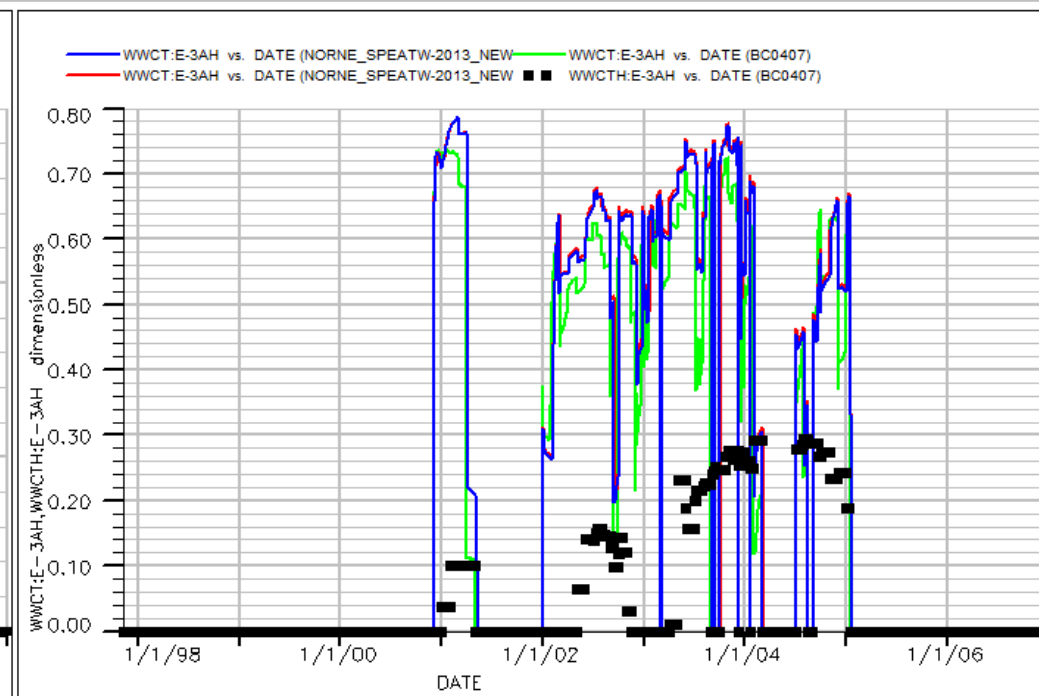
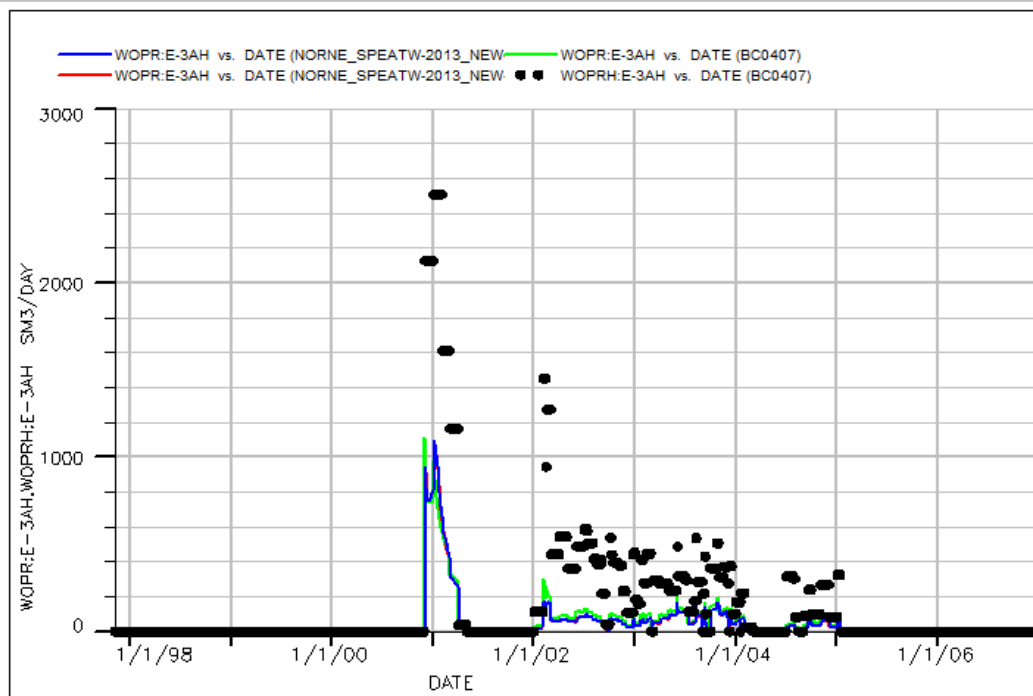


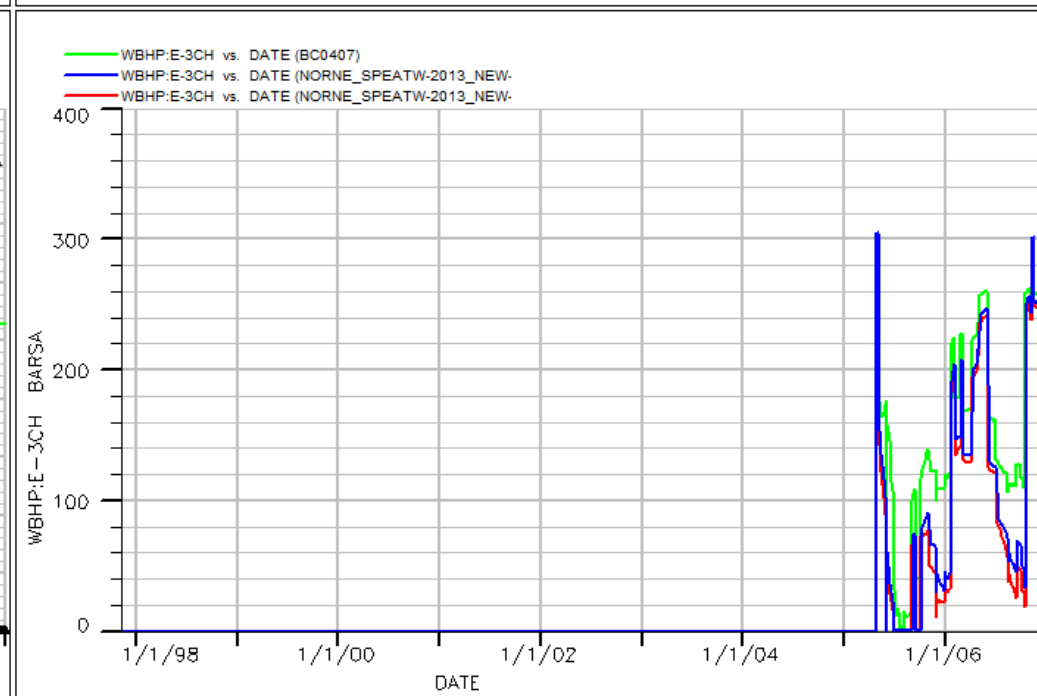
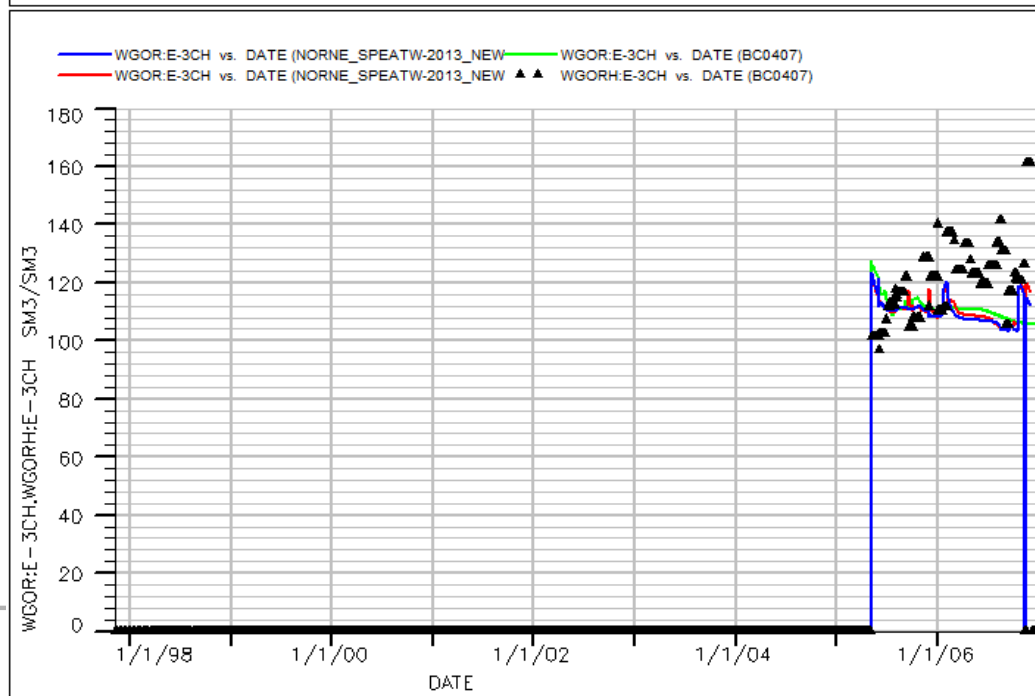
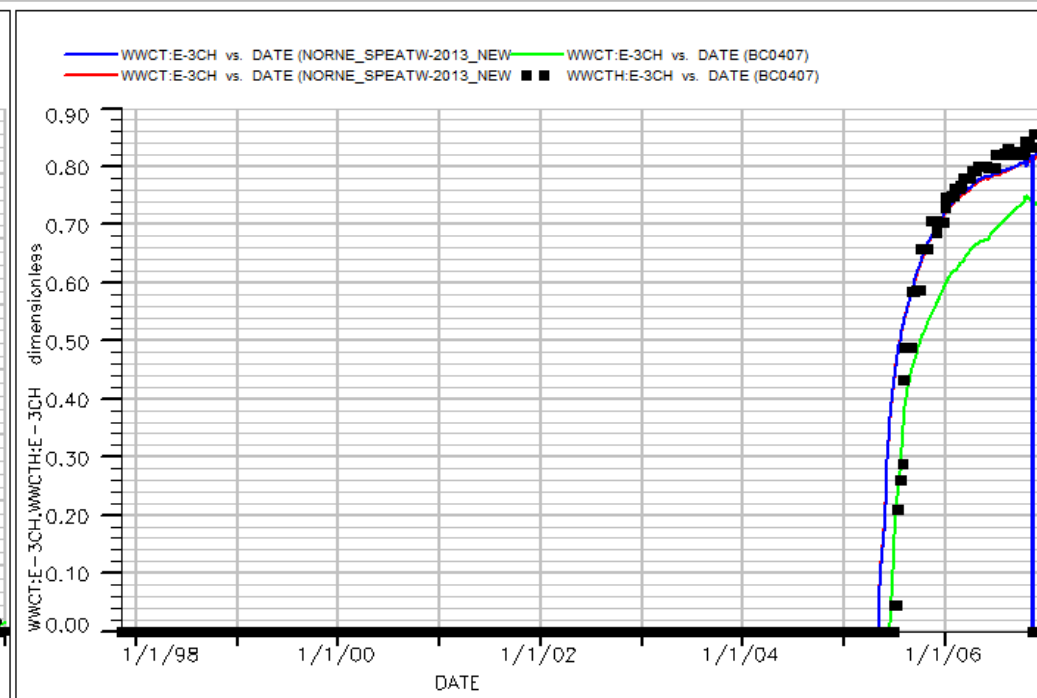
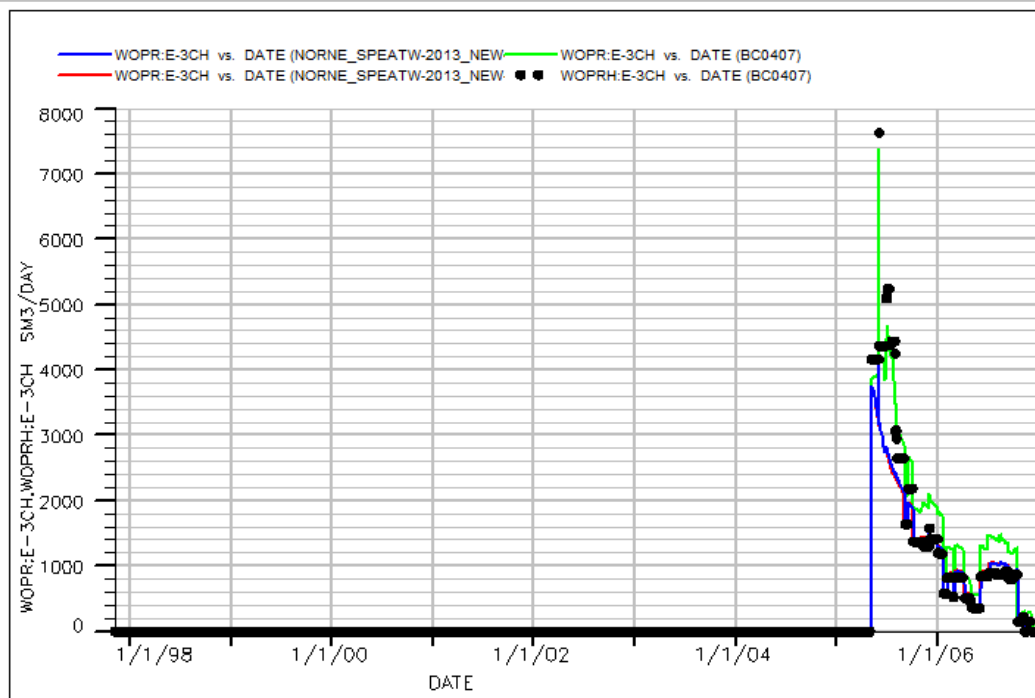


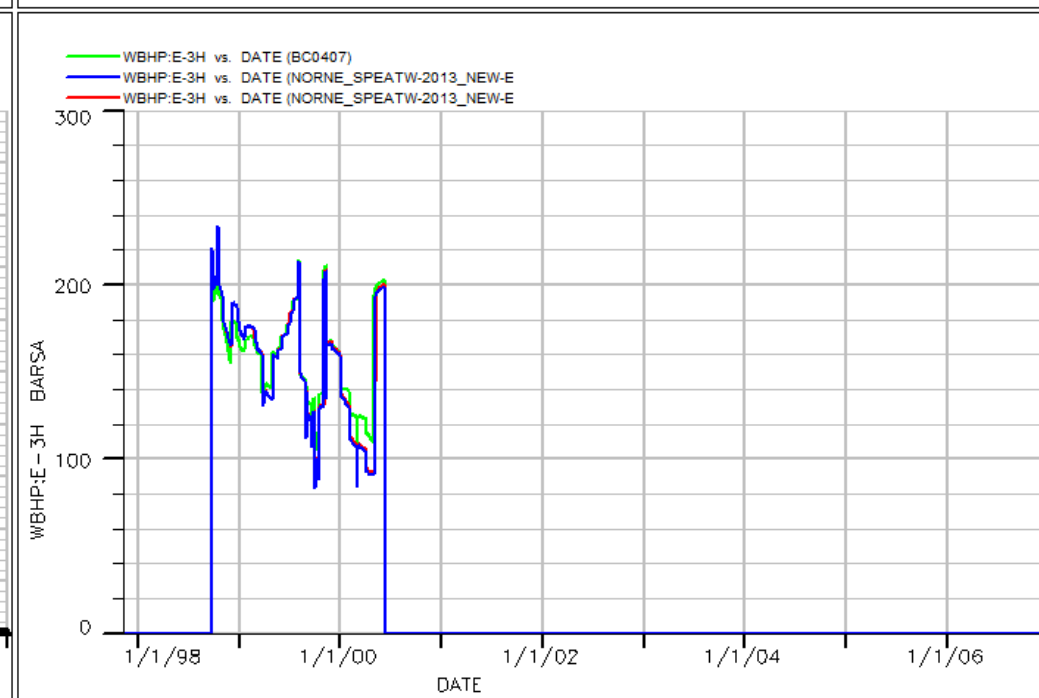
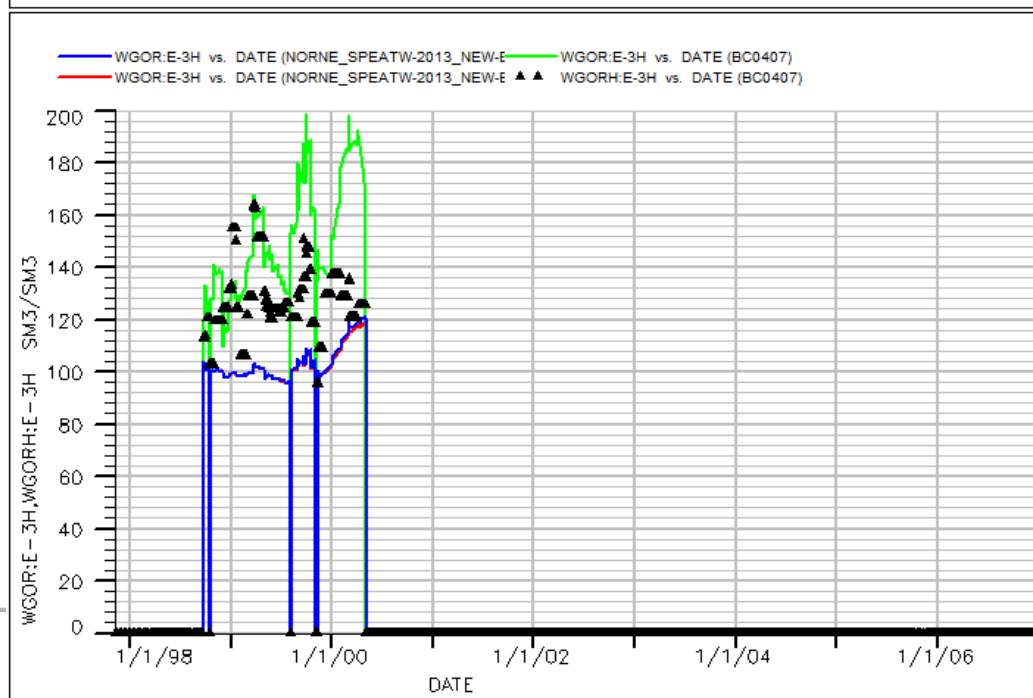
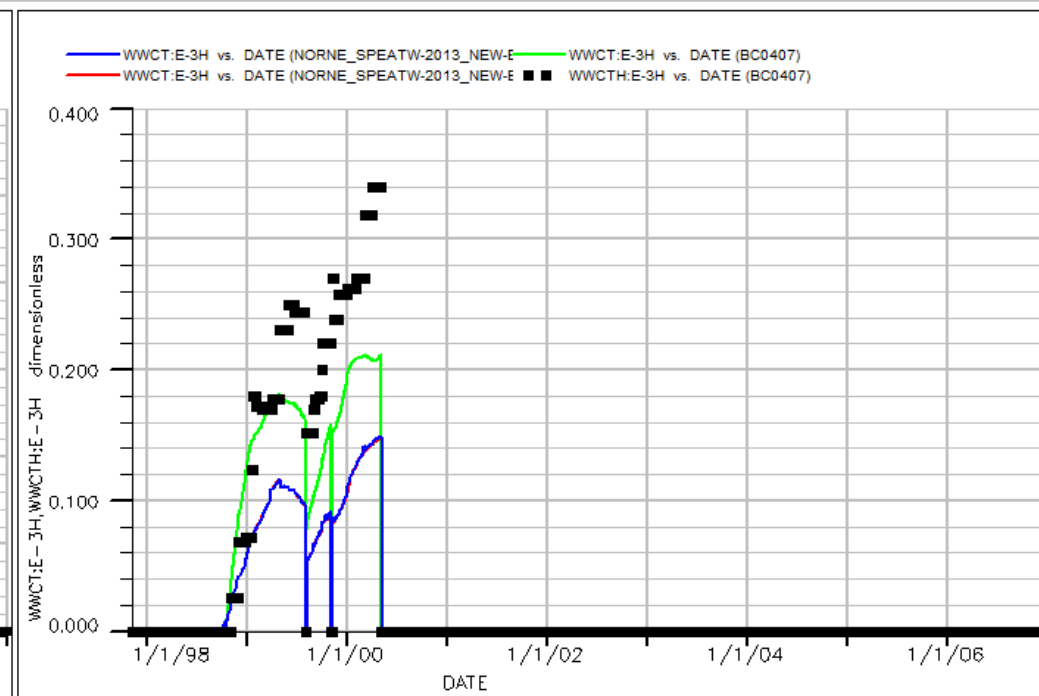
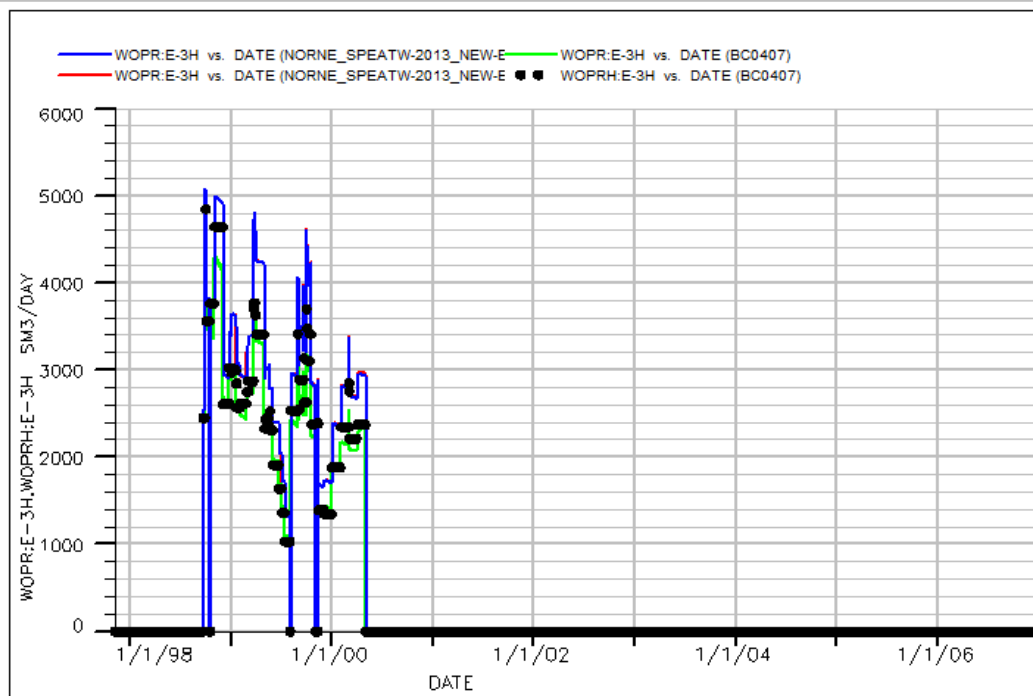


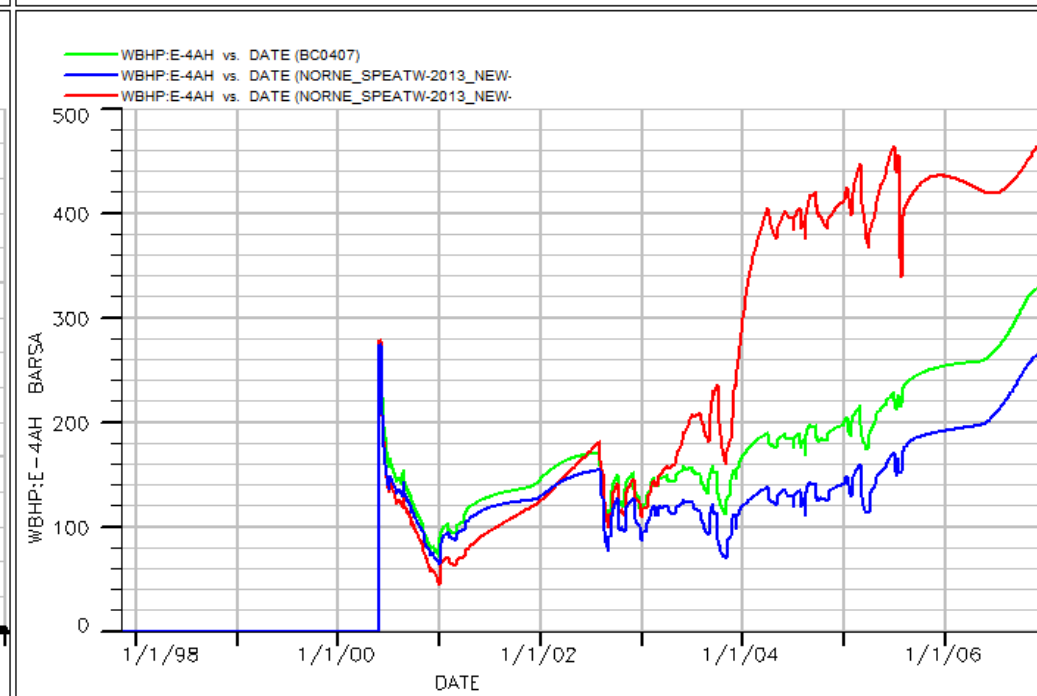
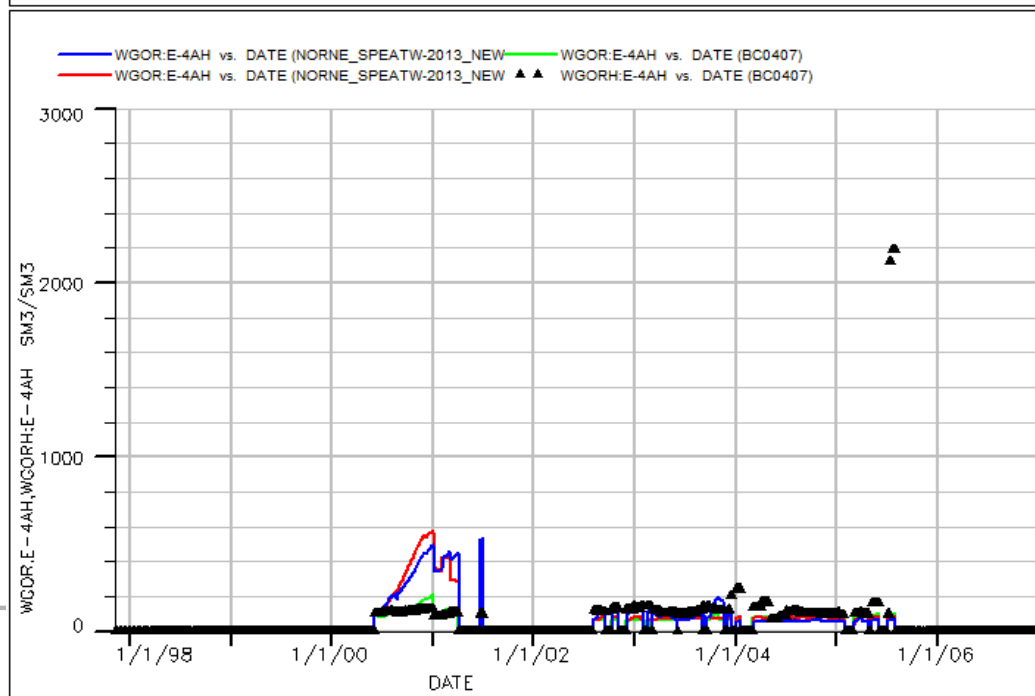
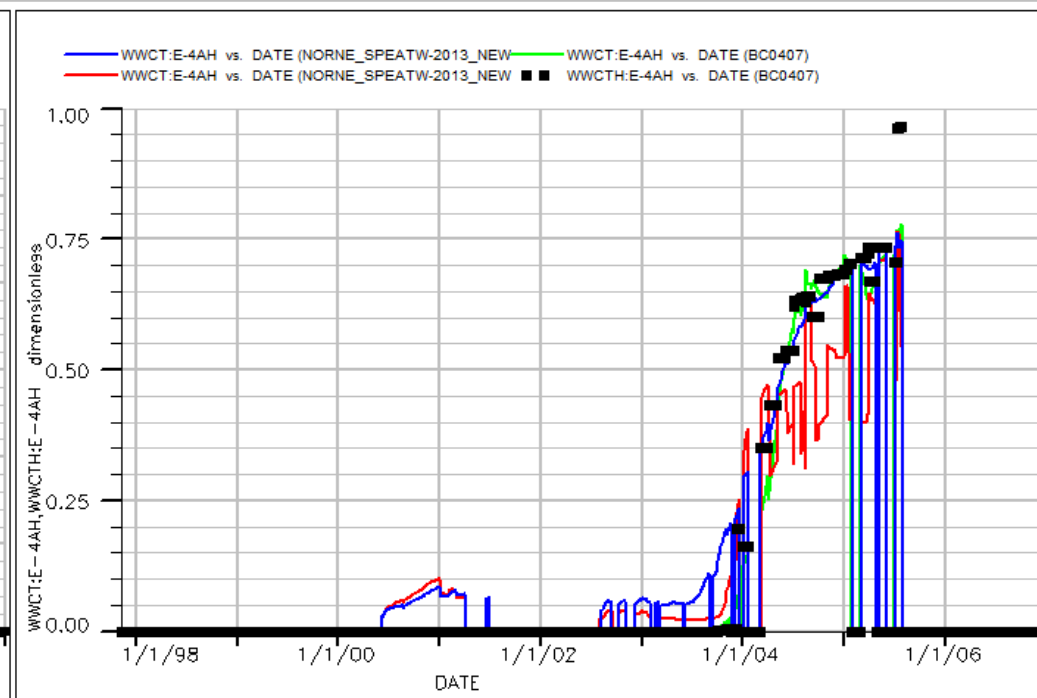
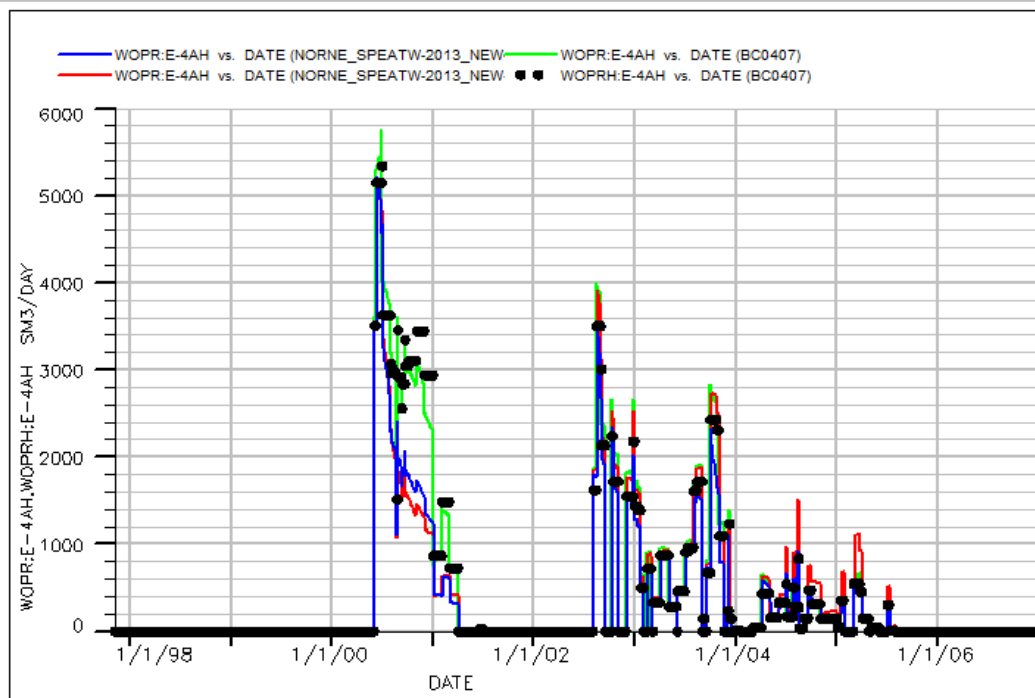


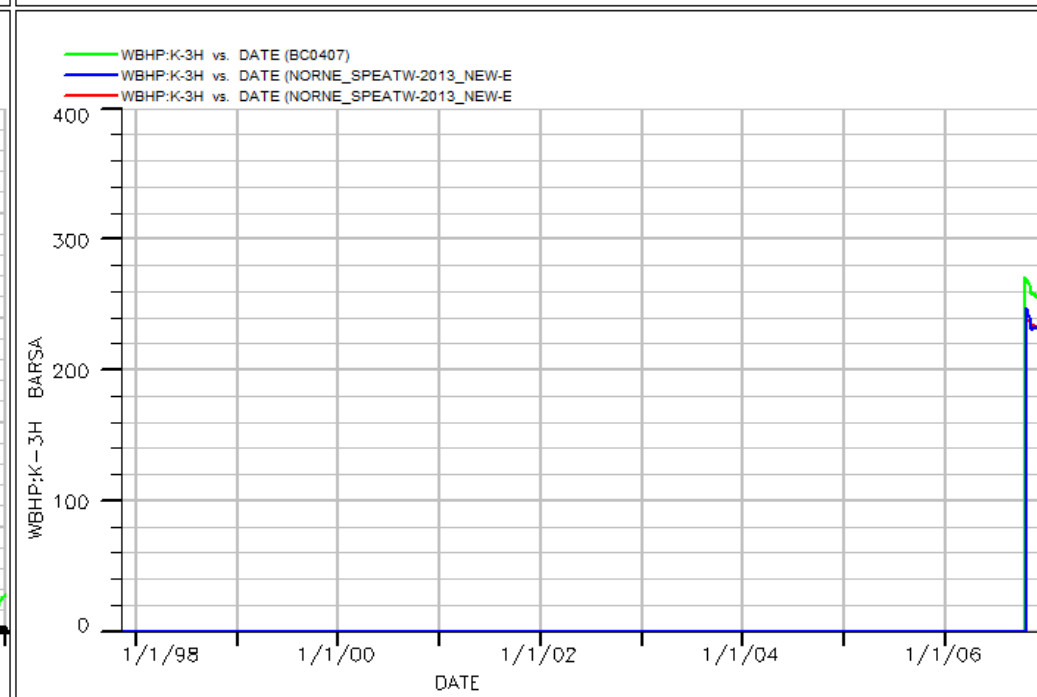
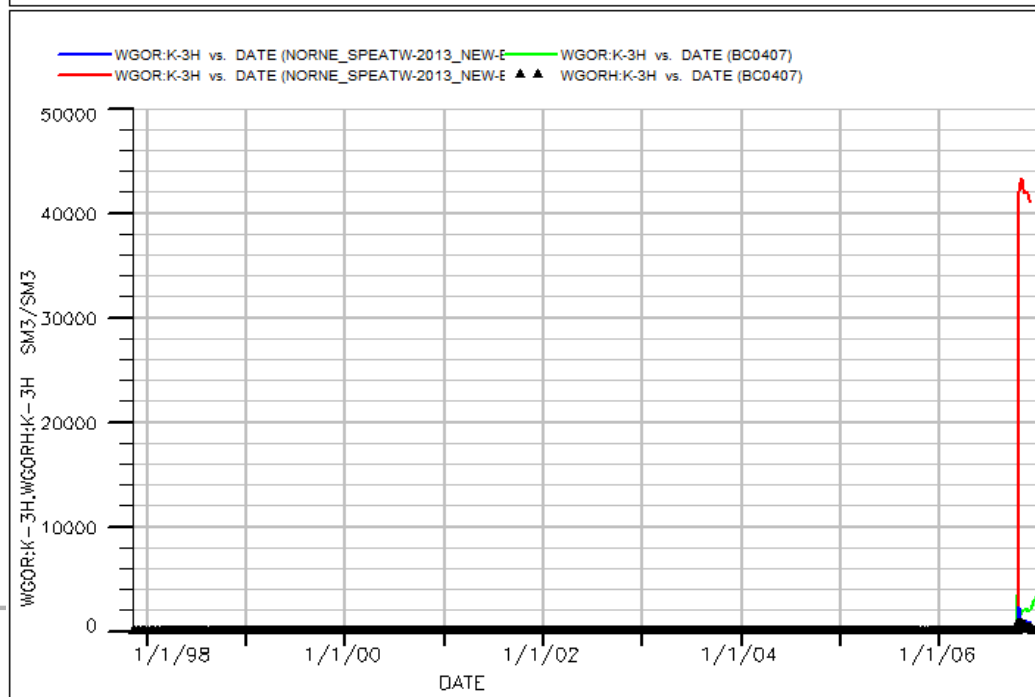
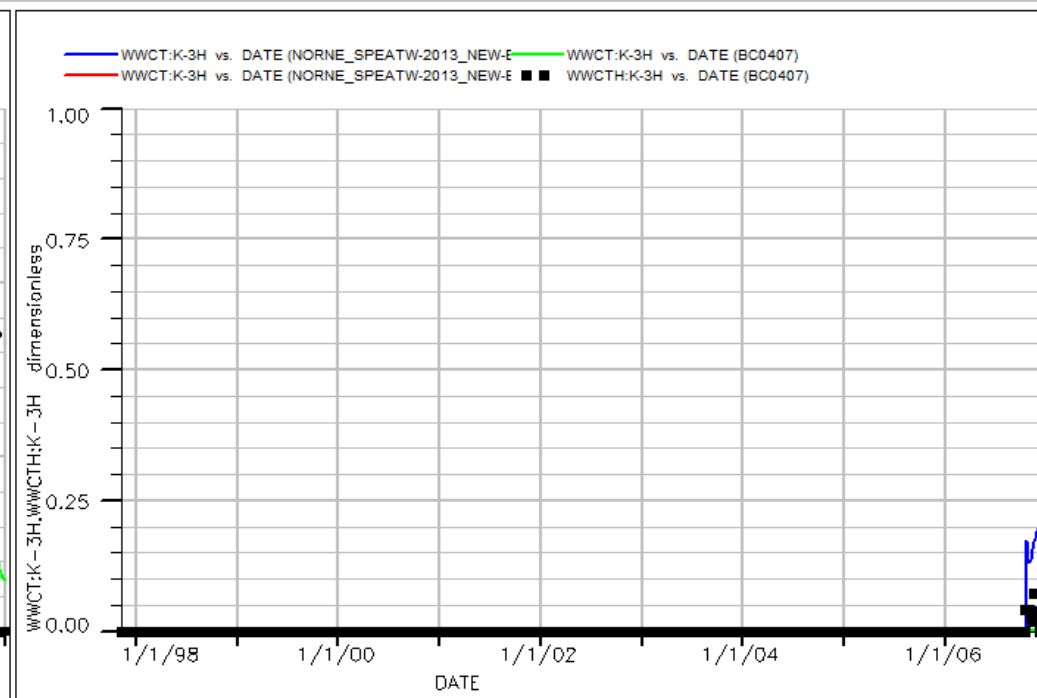
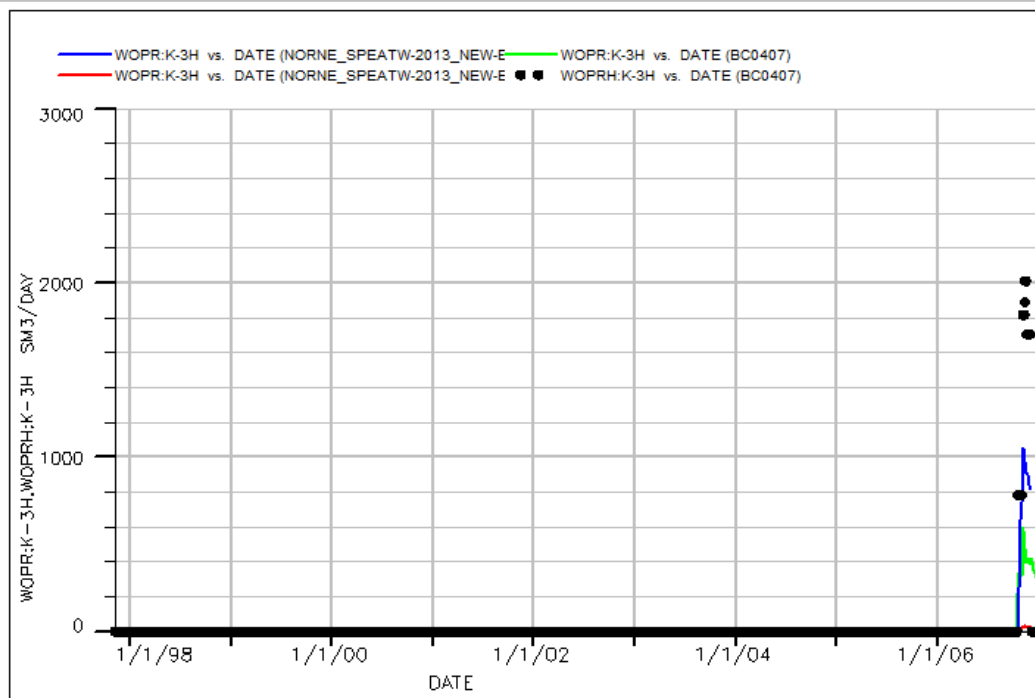




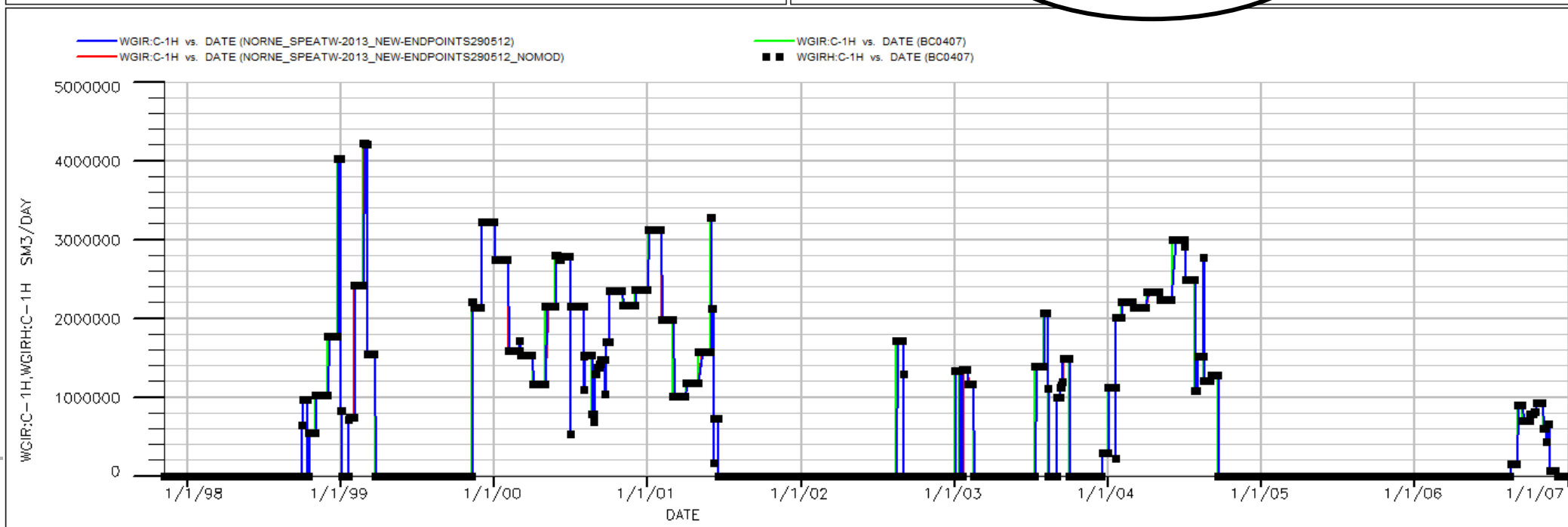
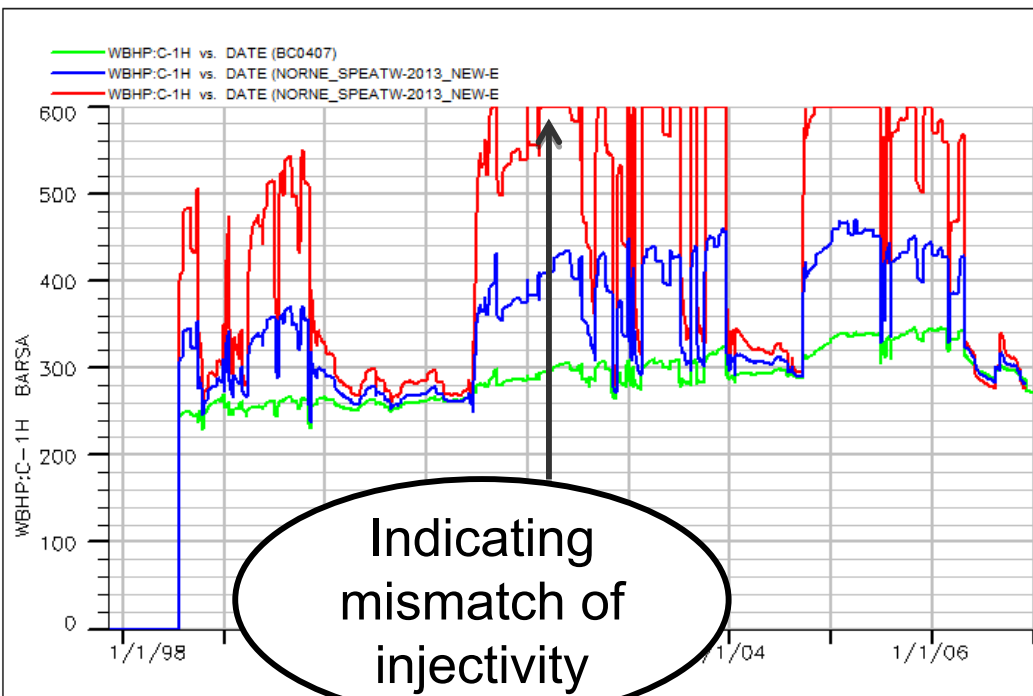
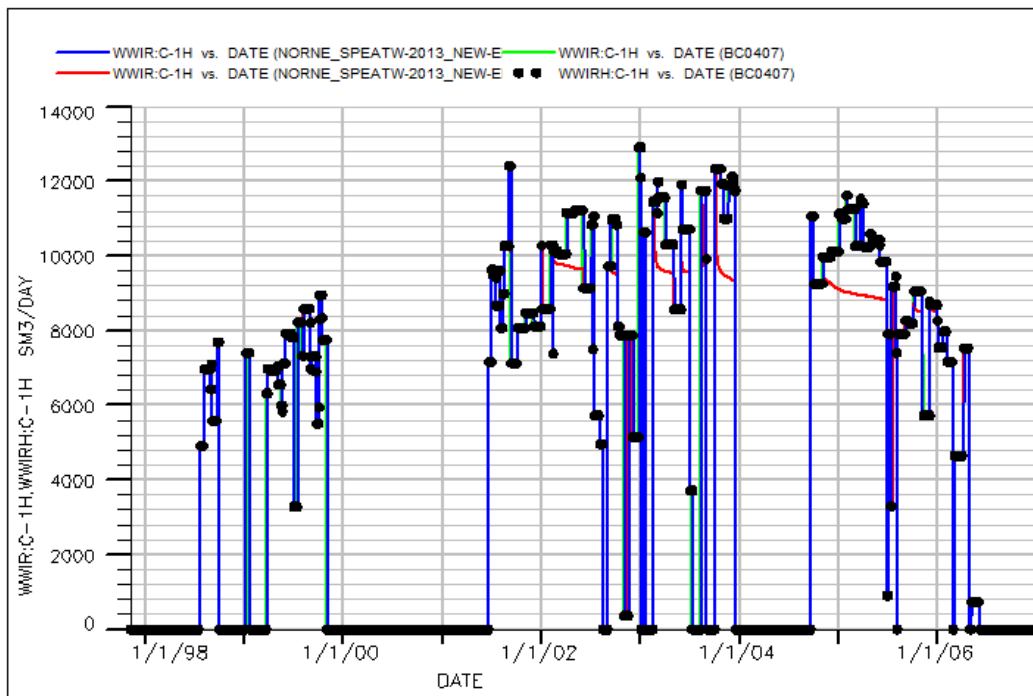


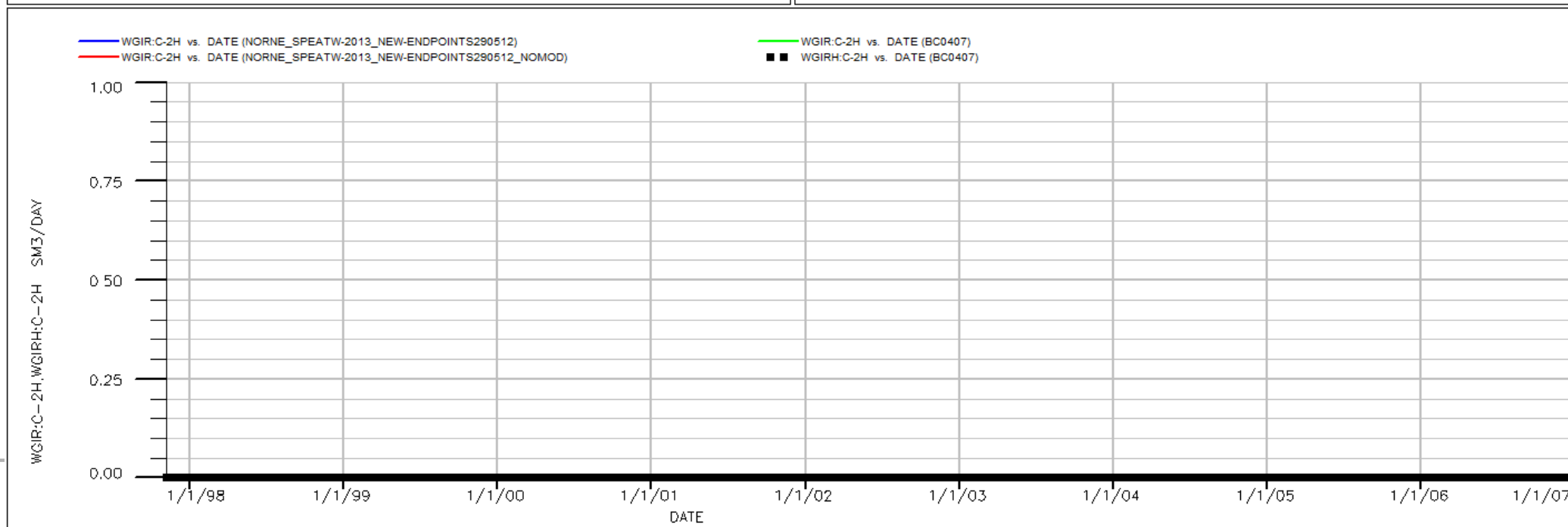
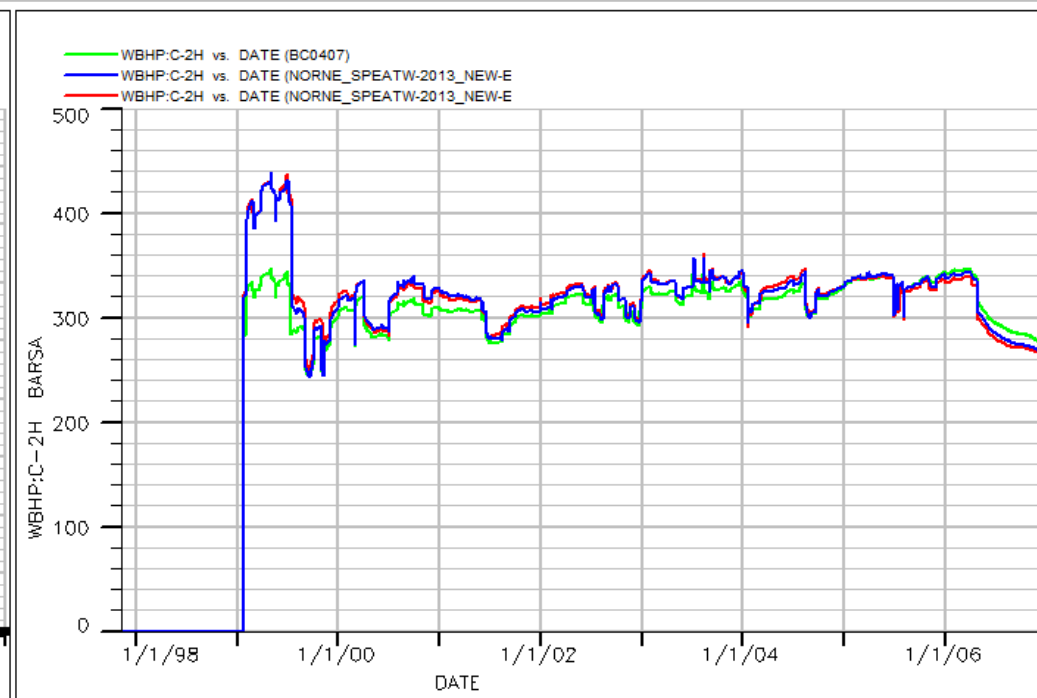
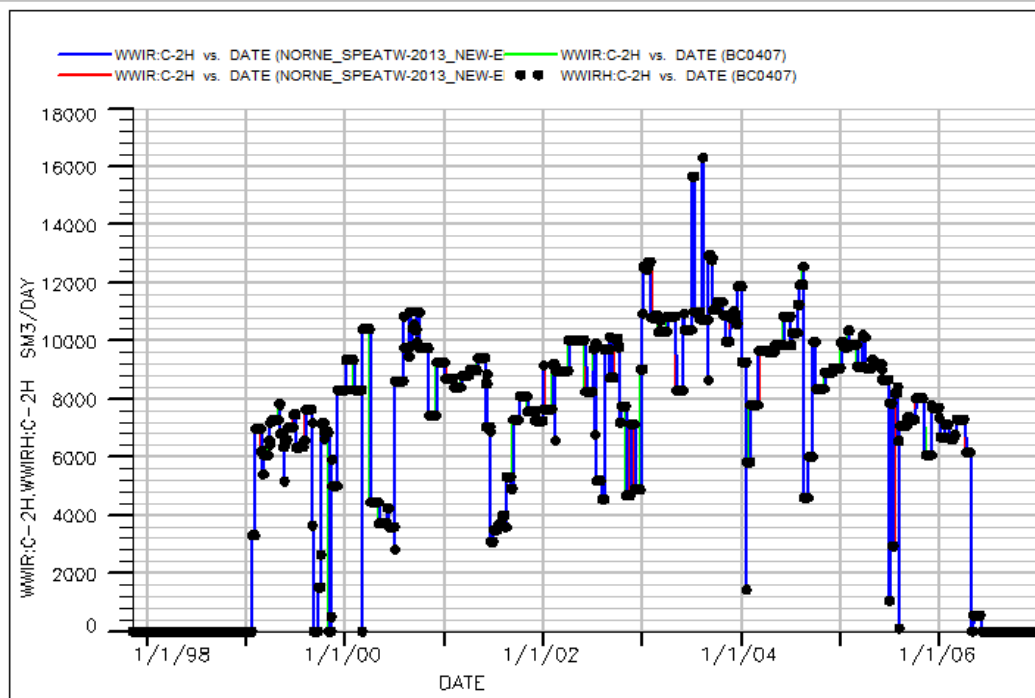


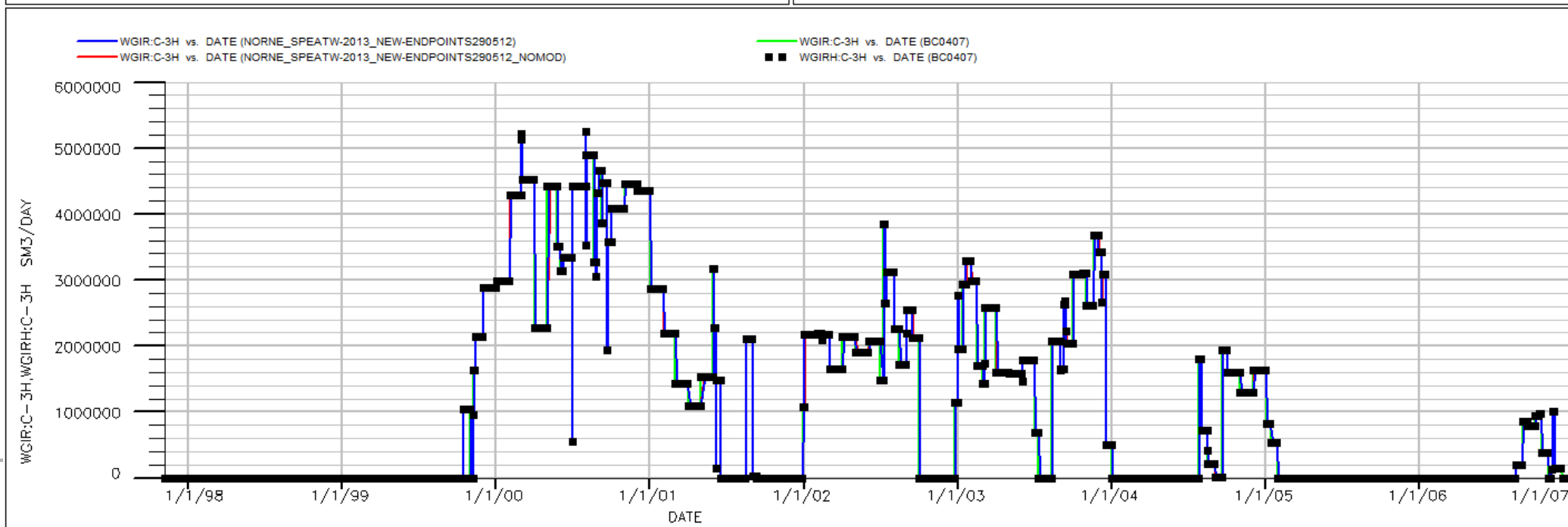
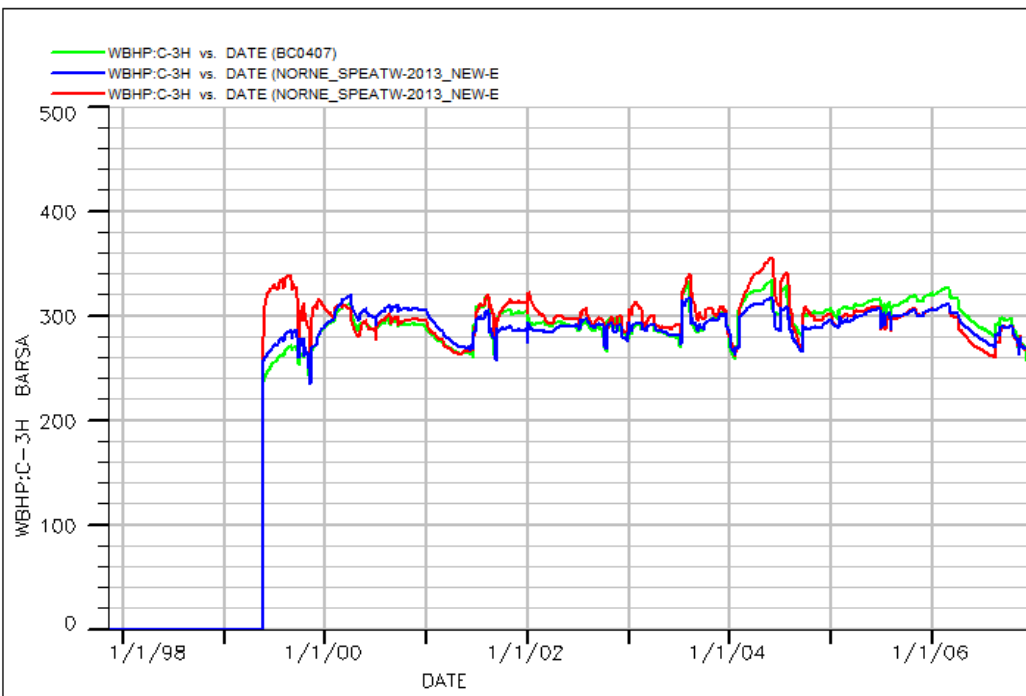
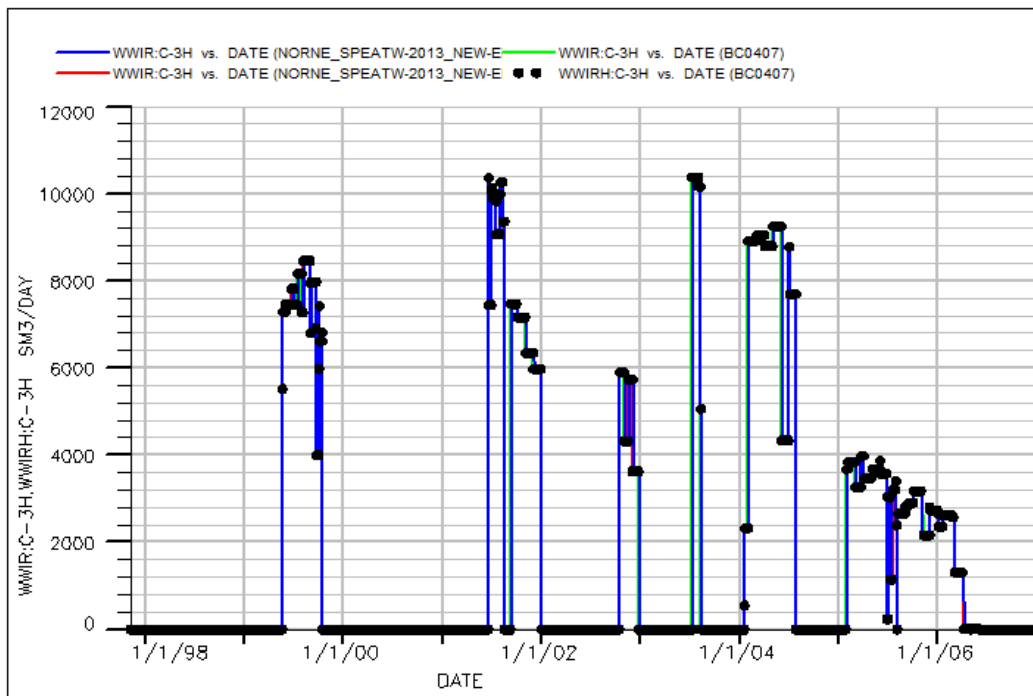


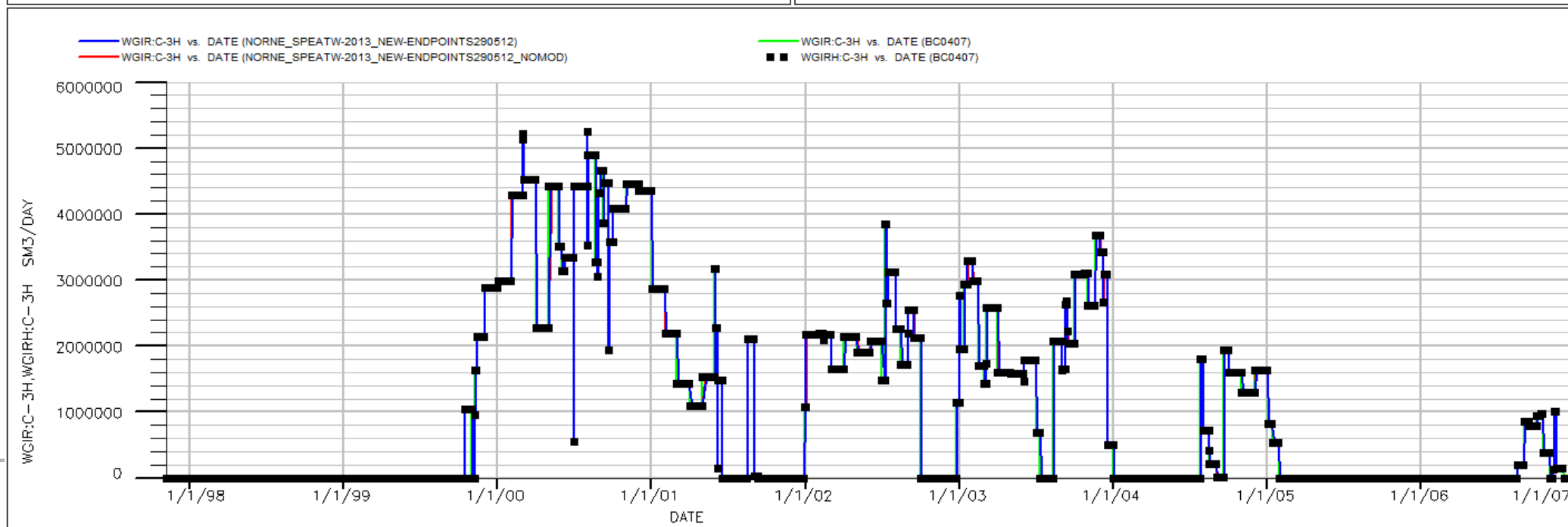
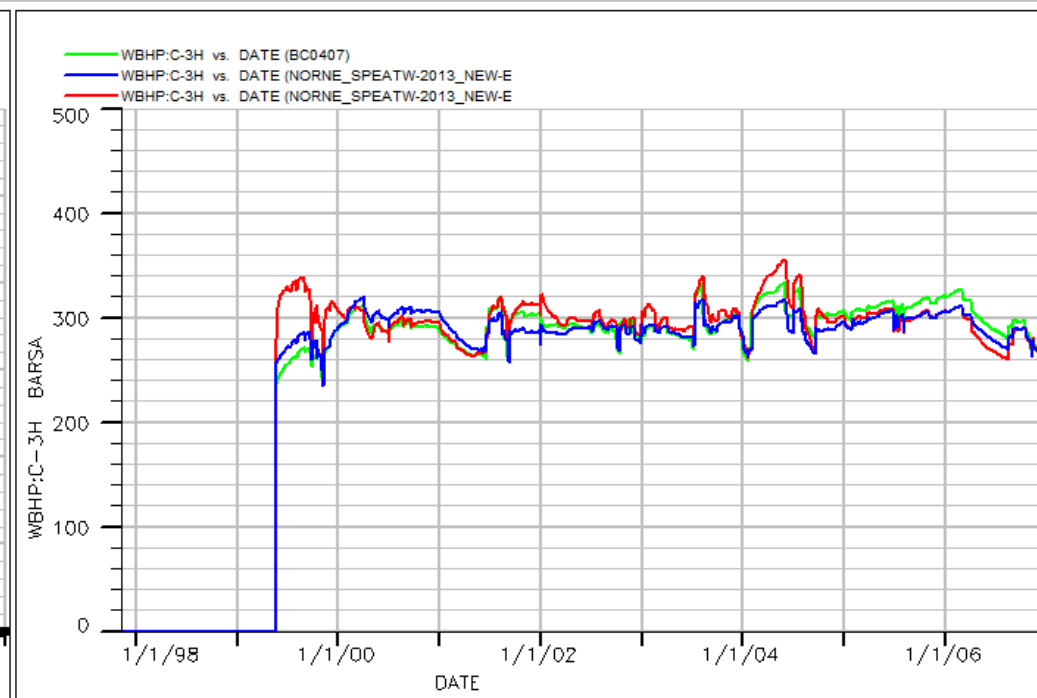
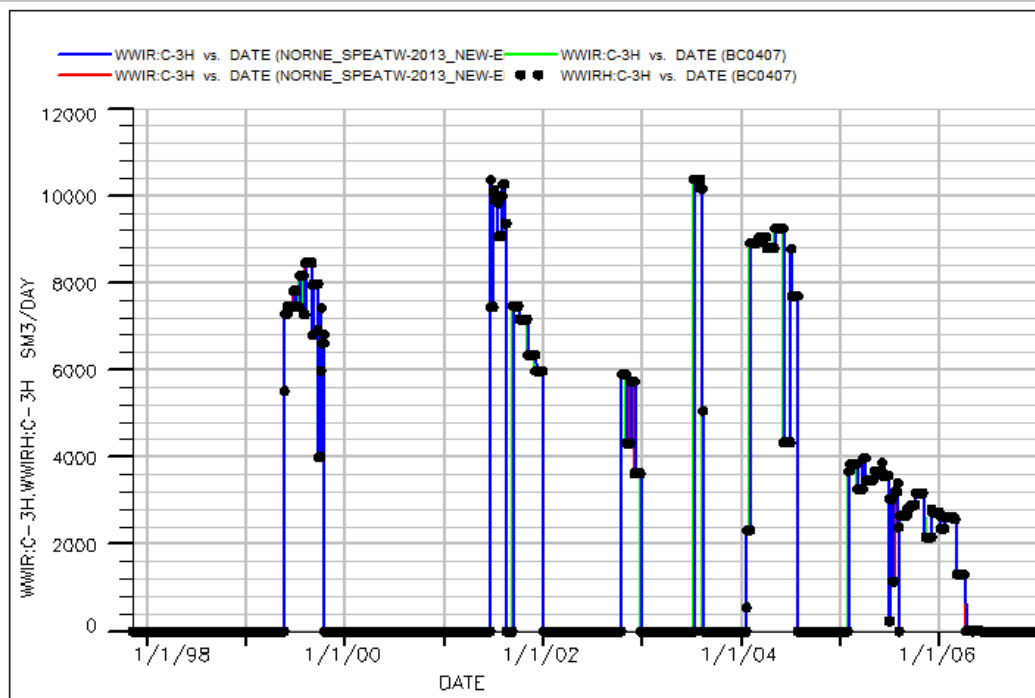


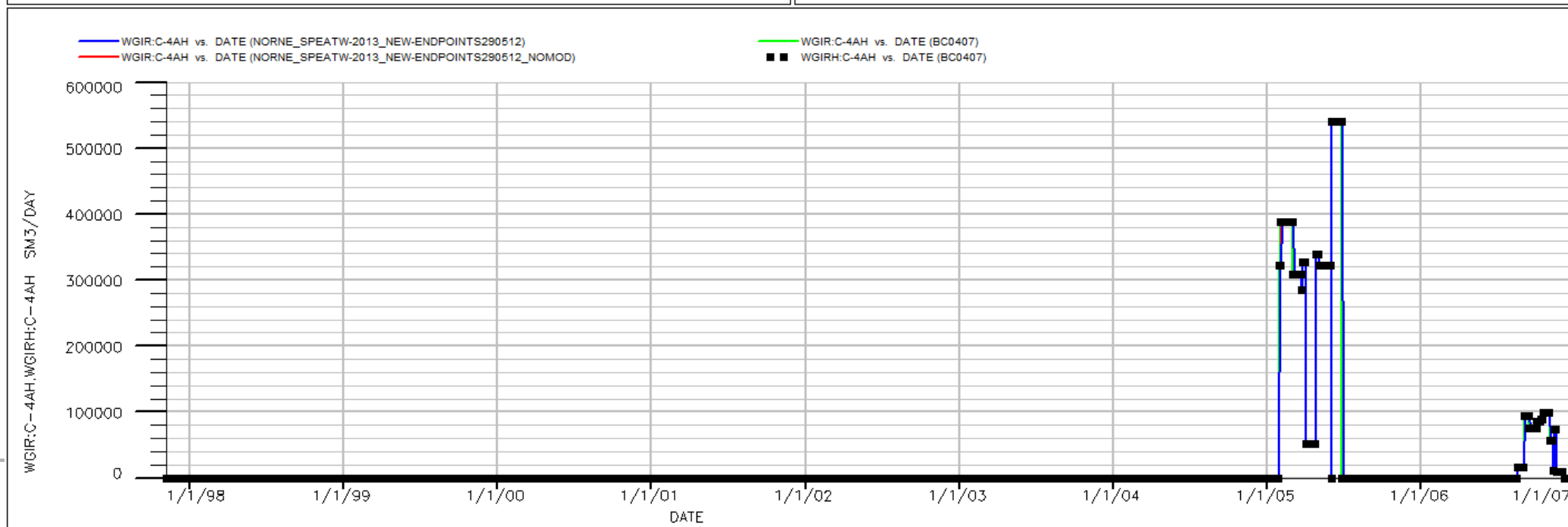
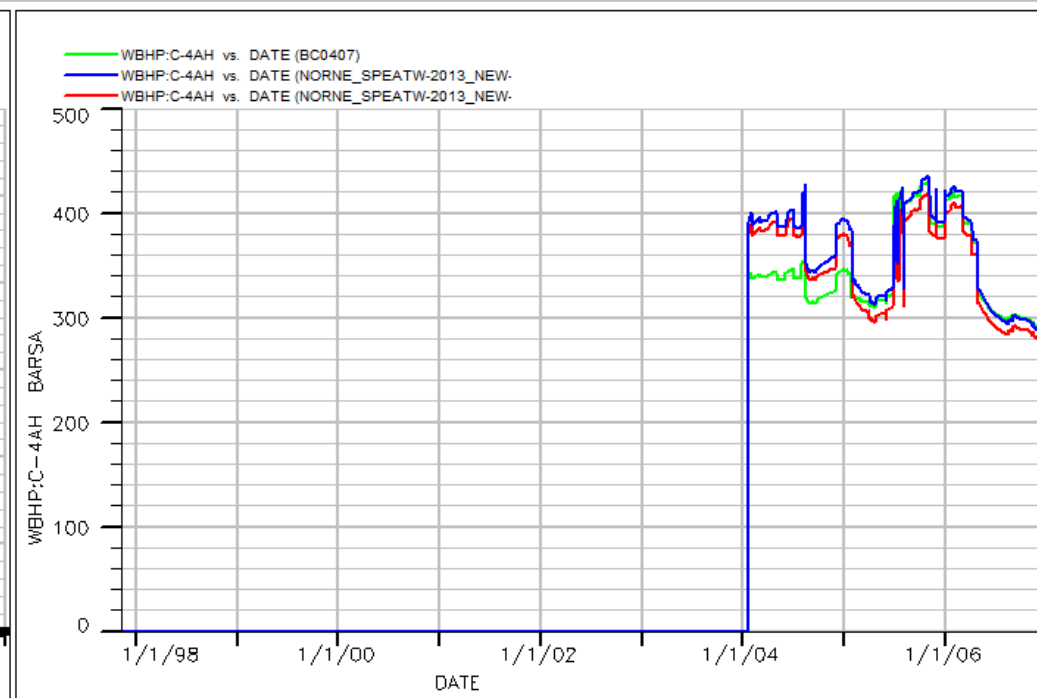
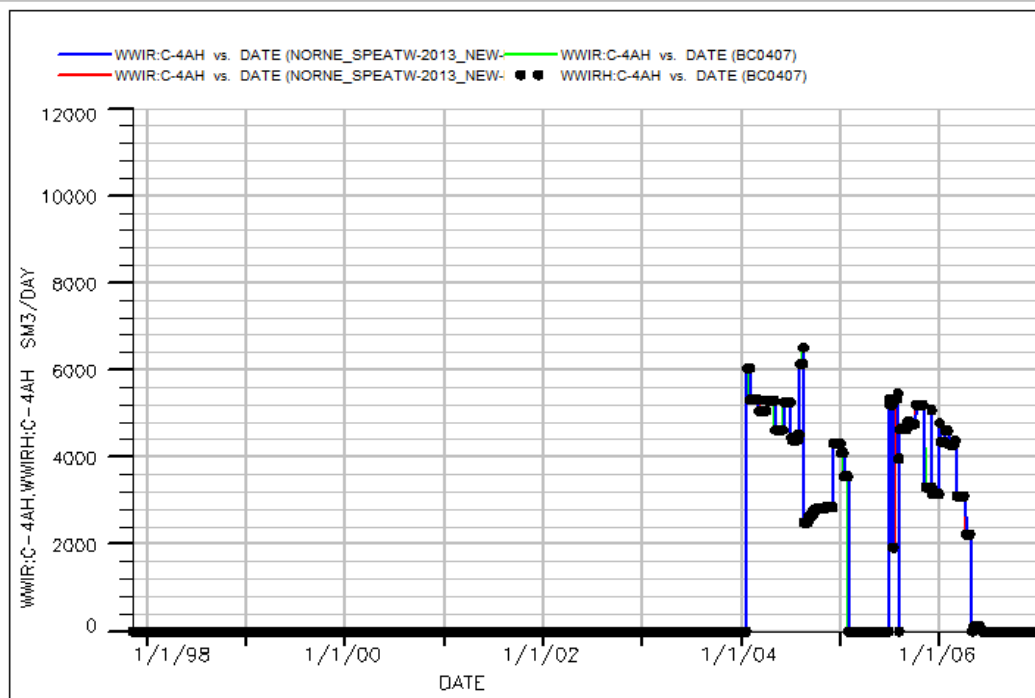
Injection wells

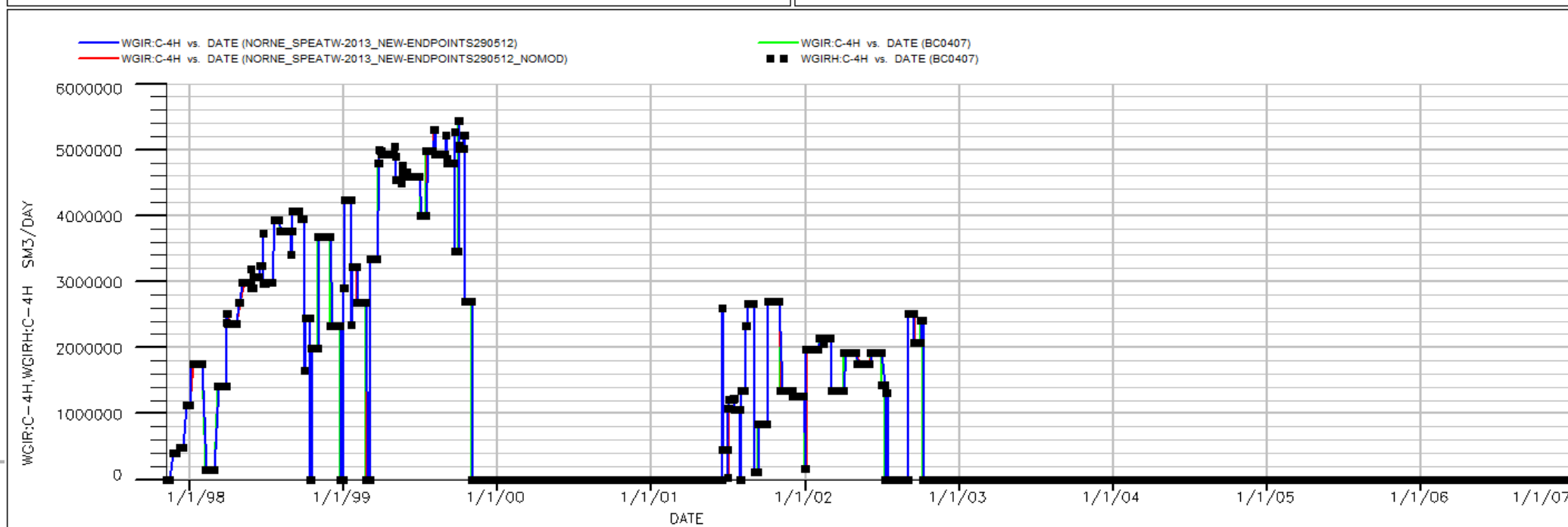
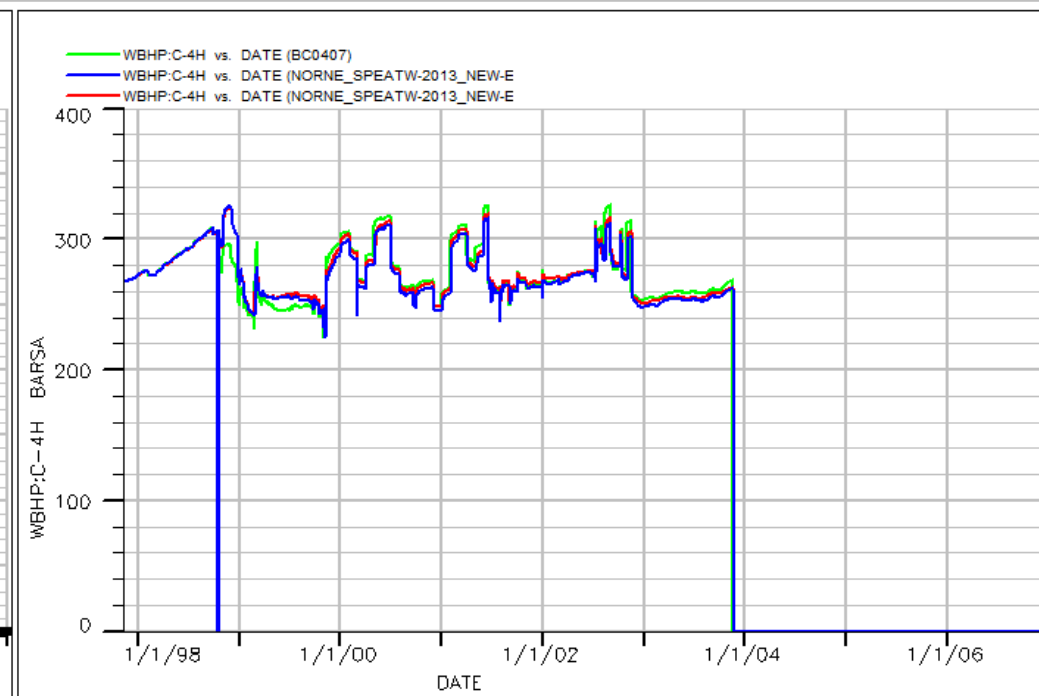
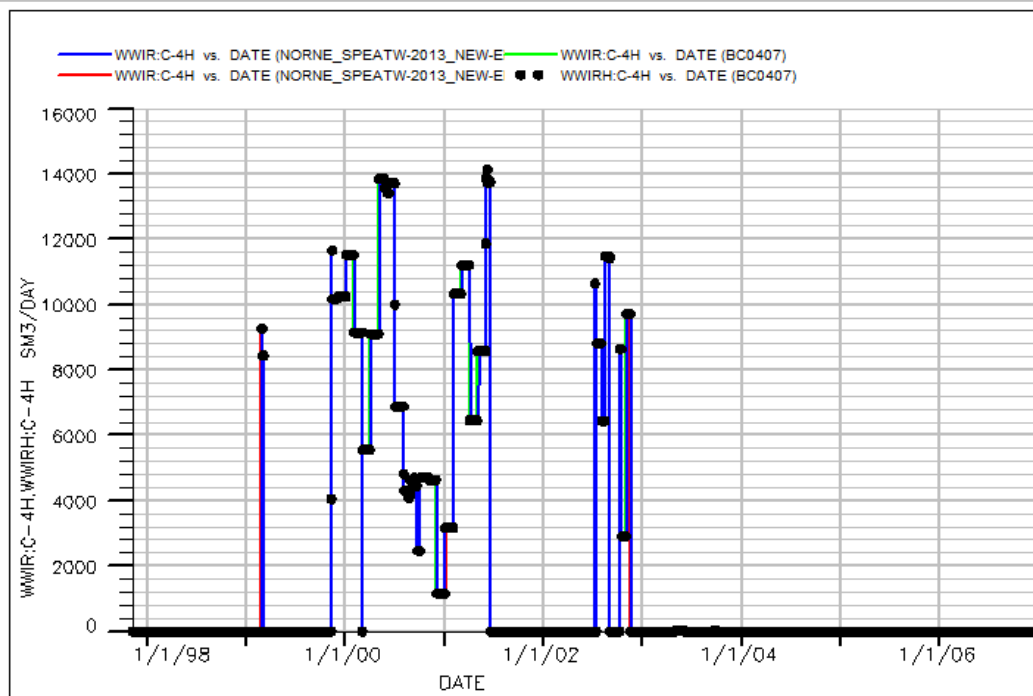


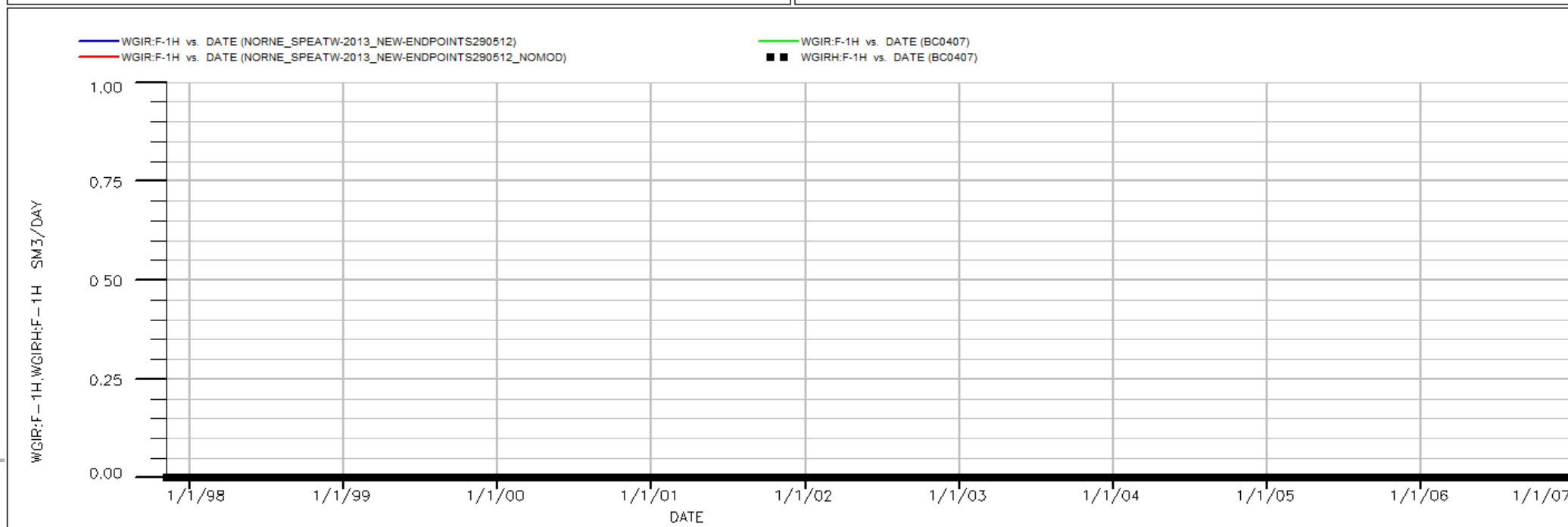
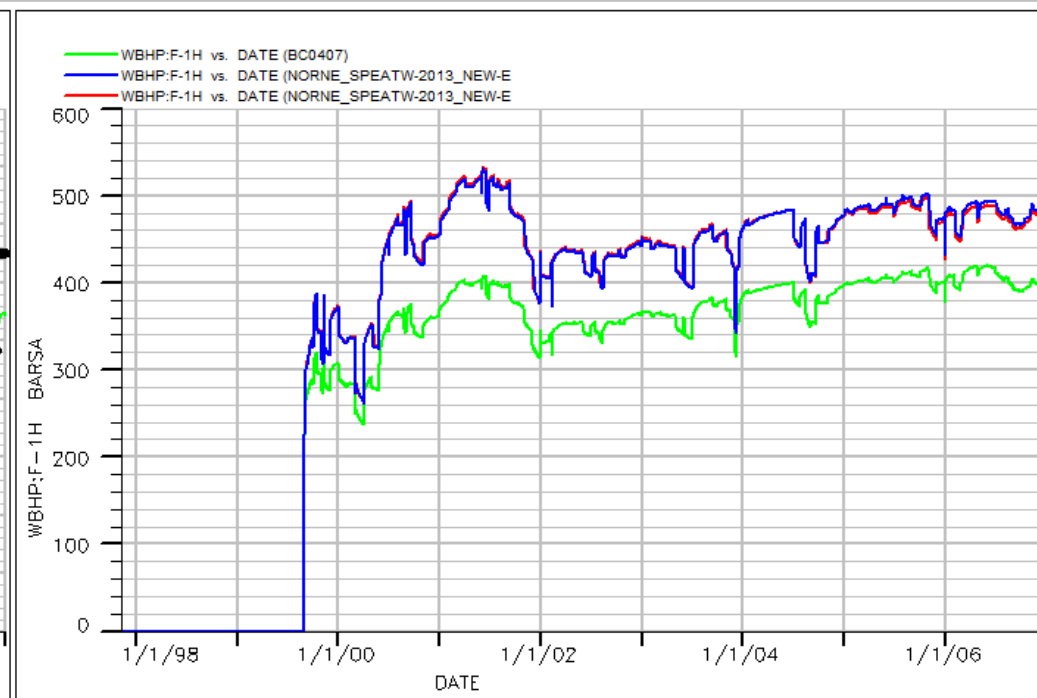
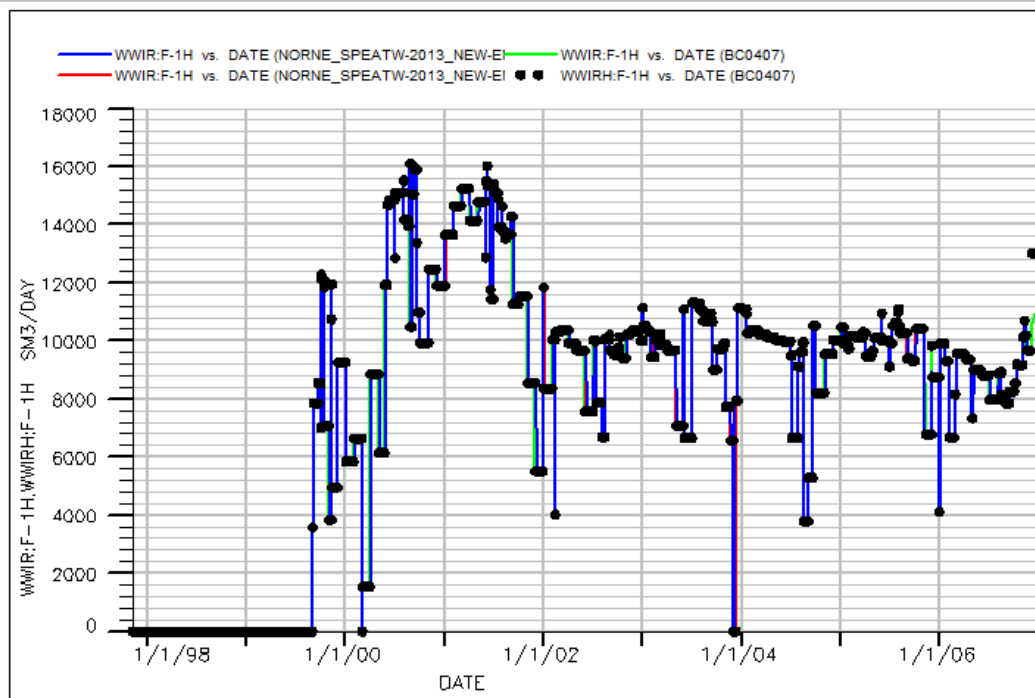


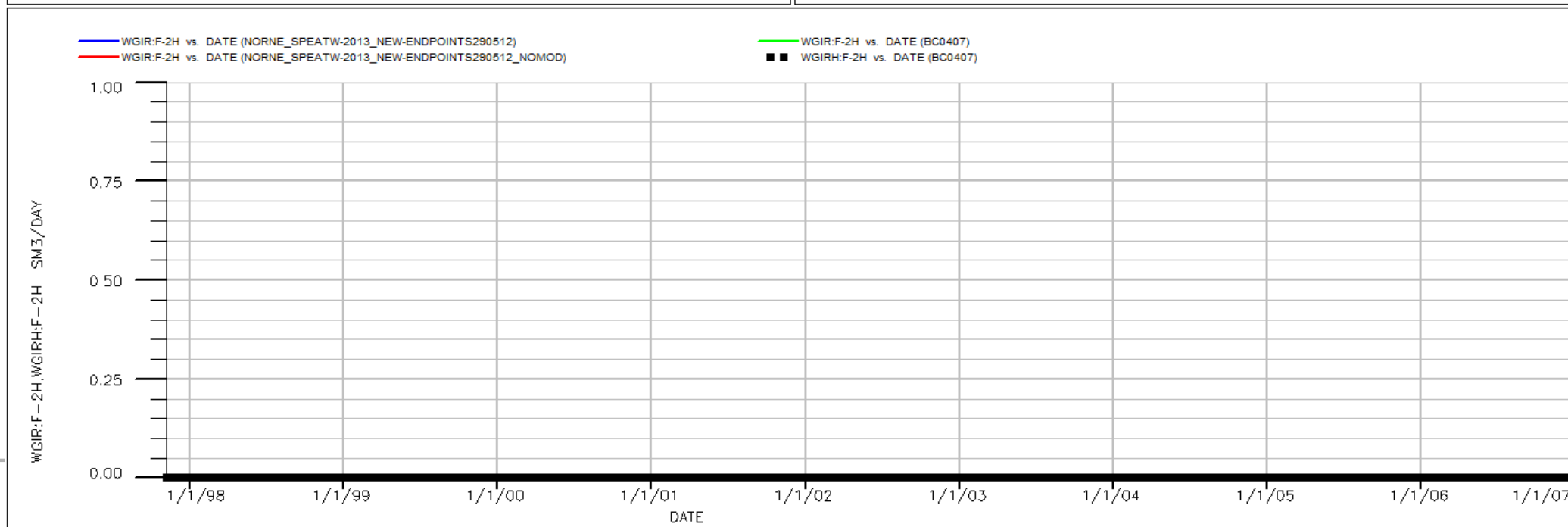
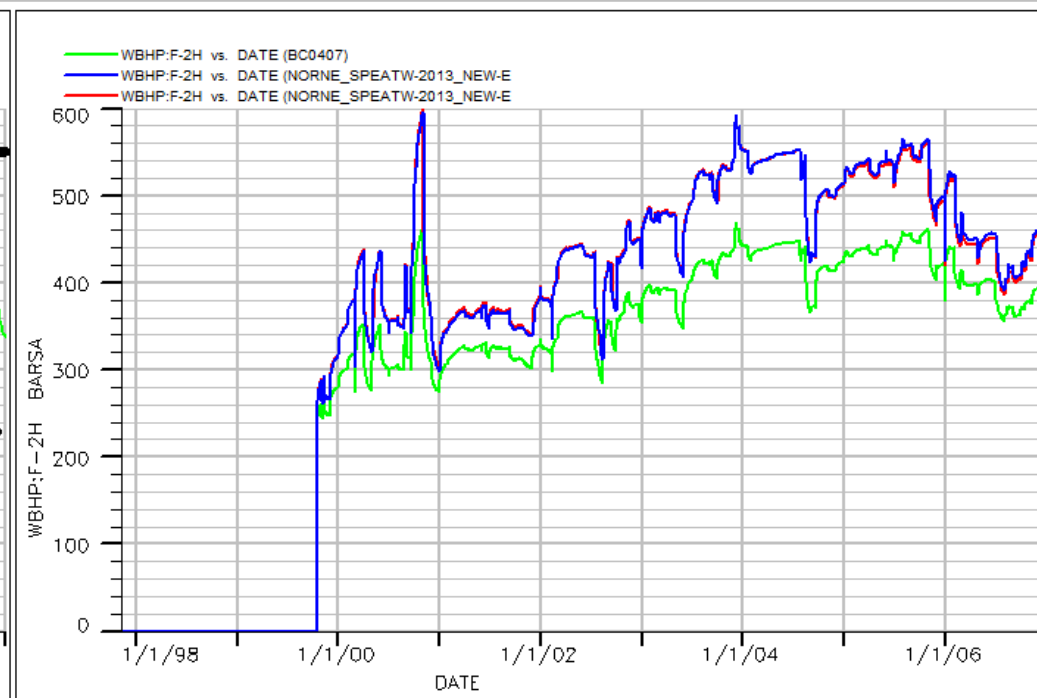
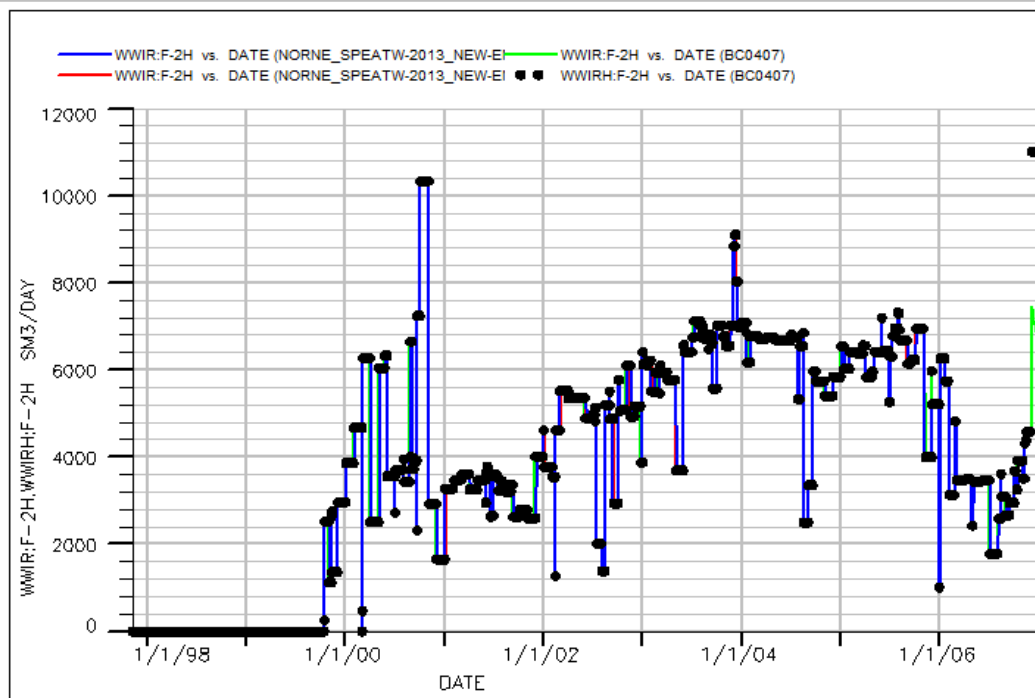


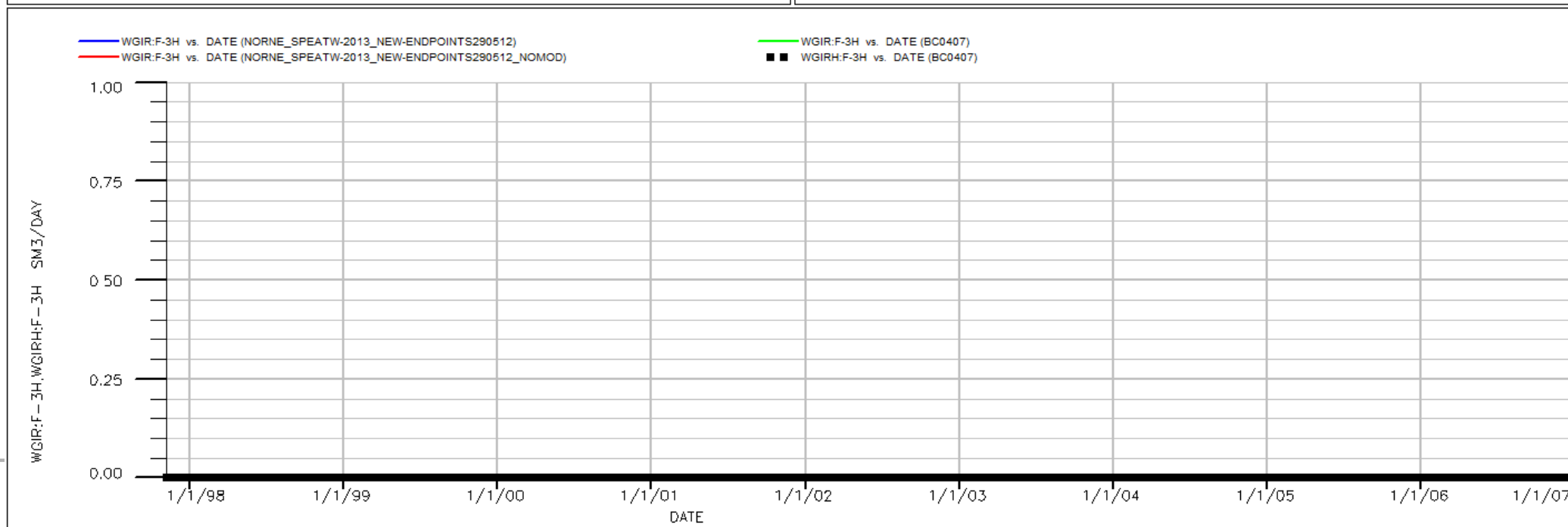
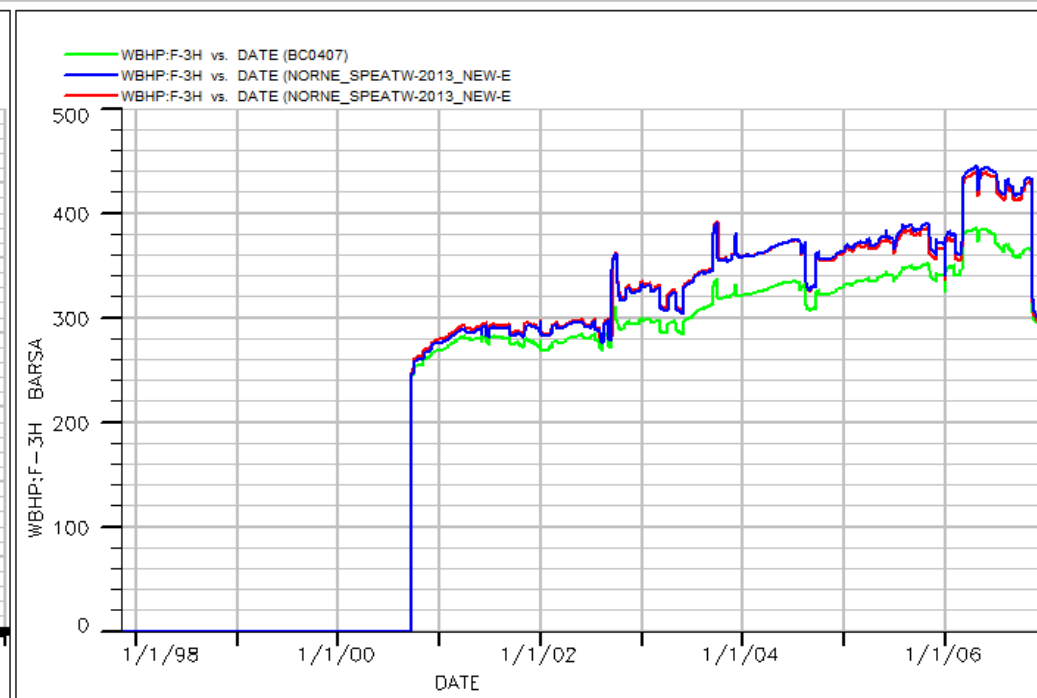
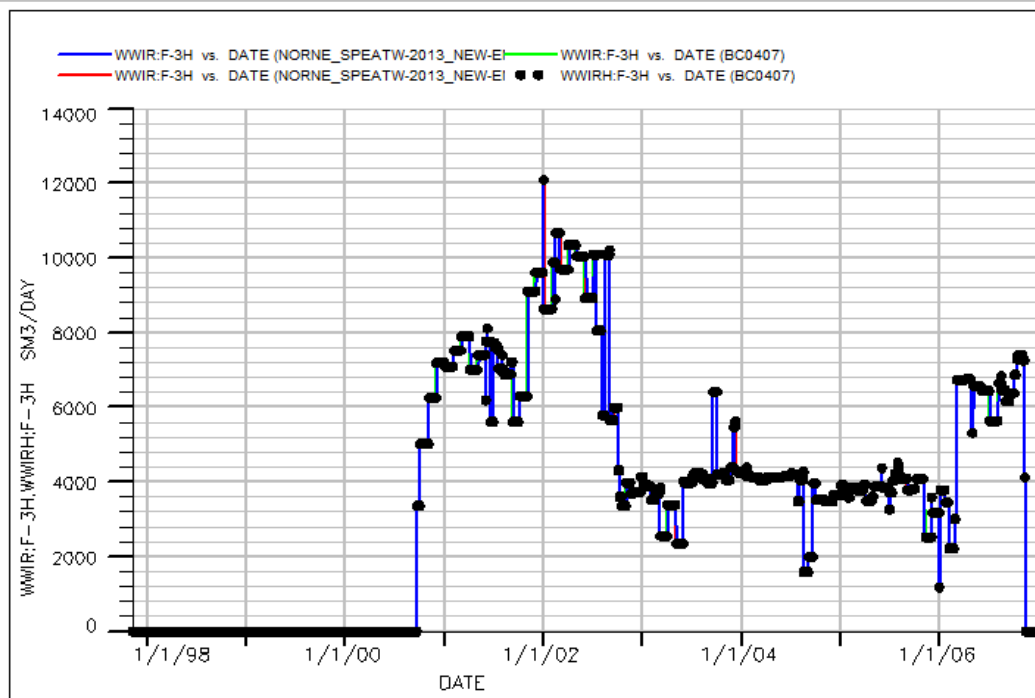


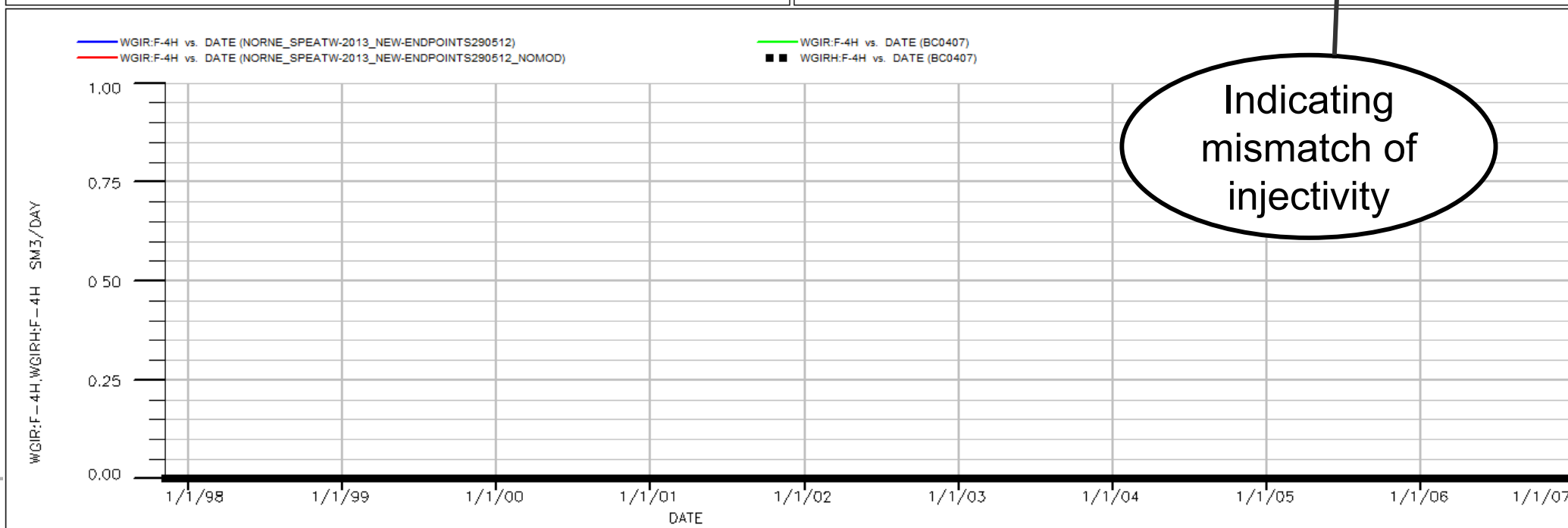
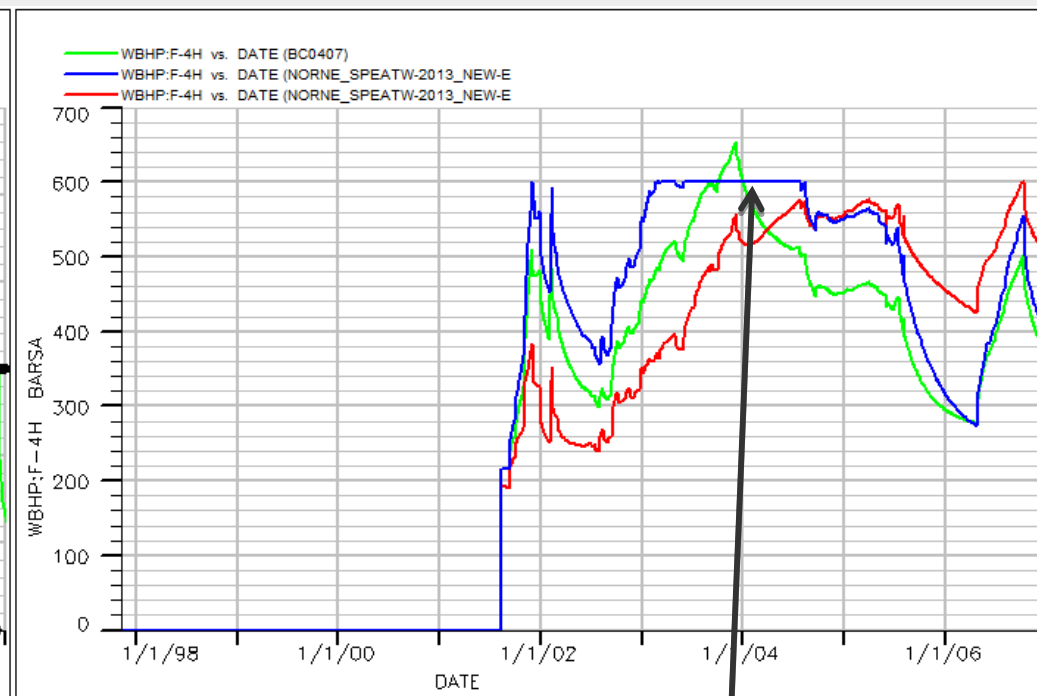
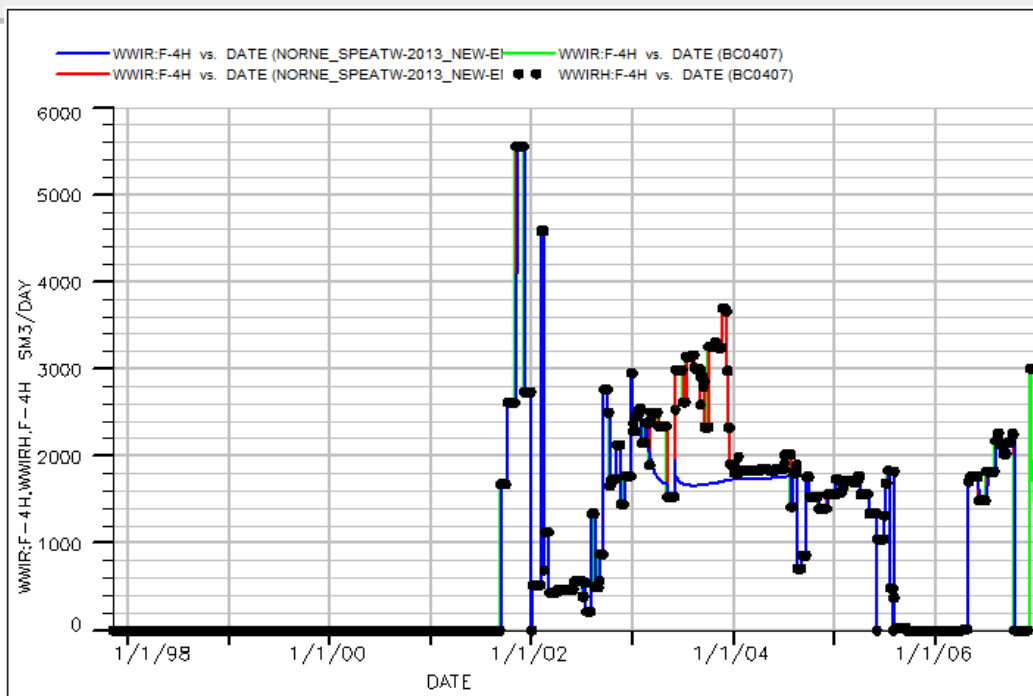












Indicating mismatch of injectivity

Summaries

- Key updates are the implementations of end-point scaling and singel set of saturation functions
- Saturation end-point vaules have uncertainties and may be used as history matching parameters
- Preserved fluid-in-place volumes - good match in fluid-in-place volumes
- Checked and corrected extreme non-physical values
- Improved model simulation performance - the updated model is much more efficient to run
- Clarified all comments in all files
- Excluded prediction Schedule