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TECHNICAL MEMORANDUM

TO: **Andrew Burns - Southern Nevada Water Authority** **HCI-1827**
Jim Watrus - Southern Nevada Water Authority

FROM: **Houmao Liu**

SUBJECT: **Preliminary Comments on *FEMFLOW3D* Documentation**

DATE: **May 5, 2006**

INTRODUCTION

Hydrologic Consultants Inc. (HCI) has completed a preliminary review of the document entitled "*FEMFLOW3D* – A Finite-Element Program for The Simulation of Three-Dimensional Groundwater Systems, Version 2" as requested by Southern Nevada Water Authority (SNWA). Hereafter, this document is referred to as "User Manual". This Technical Memorandum is prepared as a summary of our *preliminary* review. We hope this review arrives timely for SNWA to respond and meet the tight release schedule. As HCI completes further review of the User Manual, more comments related to the documentation may be provided.

GENERAL COMMENTS

In general, the User Manual is well structured and easy to follow. However, given the complicated problems that *FEMFLOW3D* is designed to solve, more examples are needed for the user to better understand and easily follow the User Manual without reading the entire source code. The following recommendations for a more "user friendly" manual are offered.

1. Provide sample problems related to specific features such as multi-compartments, faults, node collapsing, specified head, specified flux, and river. These sample problems will provide users with examples for setting up particular models using the special features of *FEMFLOW3D*.
2. Define the maximum dimension of each of the problems that *FEMFLOW3D* is designed to solve in the User Manual.
3. Clarify or recommend the approaches and software used to prepare the input files and to analyze the model results.

SPECIFIC COMMENTS

In addition to the general comments above, the following is a list of specific comments related to each section of the User Manual:

Table of Contents: add "Appendix" to Table of Contents

P1-1, second line in third paragraph: "confirm" should be "confined" and "unconfirmed" should be "unconfined"

P1-2, third line: the word "given" does not seem appropriate

P1-5, sixth line below Equation 1-2: K_j should be K_{ij}

P1-6, second to last line: there should be a comma between "…1-5" and "a wedge …"

P1-9, third sentence: "A fault also possesses conductive…into or from the fault plane" is not clear to the reader

P1-11, second paragraph, last sentence: "this feature…within a well" needs further explanation

P2-3, Equation 2-2: the left side of the equation should be $H_{I,t}^{(k+1)}$

P2-3, Equation 2-3: give users a recommended range of values for α, γ, ε

P2-3, last sentence: in ε = 0.01 feet, "feet" should be removed

P2-5, third paragraph below Equation 2-6: "= n x 1 vector" should be "= a n x 1 vector"

P2-6, first sentence: add "{" to "L_{11}…"

P2-7, first paragraph, last sentence: $C_{I,J}$ should be changed to C_I

P2-8, Equation 2-22: should be $X_I^{(k+1)} - X_I^{(k)}$, not $X_I^{(k)} - X_I^{(k-1)}$

P2-8, second line below Equation 2-22: $X_J^{(k+1)}$ should be changed to $X_I^{(k+1)}$

P2-9, third sentence below Equation 2-25: "n x 1 …." should be "a n x 1 …"

P2-11, first paragraph, seventh line: "efficiently" should be "efficiency"

P2-11, first paragraph, ninth line: "system of equations" should be the end of the sentence with a period

P2-11, first paragraph, tenth line: "with" should be "With"

P2-11, second paragraph, third line: "nodes reads" should be changed to "NODES reads"

P2-11, fourth paragraph, first line: "…NODES, adjustment…" should be "…NODES, mesh adjustment …"

P2-11, third to last line: "…position the node too close …" should be changed to "…Position of the node is too close…"

P2-16, for Equation 2-29: add explanation for Φ_I

P2-16, last sentence: not clear

P2-18, Equation 2-37: $\int_{\Omega} q$ should be $\int_{\Gamma} q$

P2-19, line above Equation 2-39: "the interpolating functions for the node I are…" should be changed to "the interpolating function for the node I is…"

P2-19, Equation 2-39: "d_I y" should be "d_I z"

P2-19: Add explanation of "z"

P2-19, third and fourth line below Equation 2-39: "triangular" should be "tetrahedron"

P2-23, second to last line: "Equation 2-62" should be "Equation 2-63"

P2-24, second paragraph, first line: "Equation 2-35" should be "Equation 2-36"

P2-24, third paragraph, second line: "Equations 2-63 and 2-64" should be "Equations 2-64 and 2-65"

P2-24, third paragraph, third line: "Equation 2-35" should be "Equation 2-36"

P2-25, tenth line of "Background" section: "Equations 2-34 and 2-35" should be "Equations 2-35 and 2-36"

P2-27, Equation 2-80: in the explanation, "the computed heat at node F" should be changed to "the computed head at node I"

P2-27, last paragraph in "Groundwater Storage" section: "2-43", "2-61", and "2-85" should be "2-44", "2-62", and "2-80"

P2-28, Equation 2-81: there should be an explanation and guidance for users on how to assign the weight factor to the node

P2-29, second to last line: "2-68" should be "2-67"

P2-30, third line below Equation 2-83: "… the context head-independent…" should be "… the context of head-independent…"

P2-31, last paragraph, first line: "Equation 2-89" should be "Equation 2-88"

P2-35, Equation 2-107: $H_j^{(t-1)}$ should be $H_j^{(t-\Delta t)}$

P2-36, line above Equation 2-110: "in to" should be "into"

P2-36, two lines above Equation 2-111: "can are" should be "can be"

P2-37, explanation of Q_w for Equation 2-114: "…injection for…" should be "…injection rate for…"

P2-41, Equation 2-129: "$q_{EI} = C_{EI} (C_{EI} - H_I)$" should be changed to "$q_{EI} = C_{EI} (H_{EI} - H_I)$"

P2-41, second to last line: "2-68" should be "2-67"

P2-43, third to last line: "Equation 2-131" should be "Equation 2-138"

P2-44, last sentence above Equation 2-143: is not very clear; if Cri equals zero, why do we still need the second term of the equation?

P2-46, second paragraph, second to last line: "Equation 2-68" should be "Equation 2-67"

P2-47, eighth line: "…assigning recharge of ..." should be "…assigning recharge or…"

P2-47, second line above Equation 2-150: "introduced by Equation…" should be "introduced by fault, Equation…"

P2-48, first paragraph, first and second line: "…Q_{IJ}…" should be "…q_J…"

P2-49, sixth line below Equation 2-157: "$[L^{-2}]$" should be "$[L^2]$"

P2-49, seventh and eighth line below Equation 2-157: "$[L^{-1}]$" should be "$[L^1]$"

P2-49, last line: "Equation 2-58" should be "Equation 2-157"

P3-1, Note 3: need to emphasize that the file type should be in Upper Case

P3-3, Note 4, line 3: "if ISLOVE = 1, records 7, 9 …" should be "if ISLOVE = 1, records 8, 9 …"

P3-3, Note 4, line 4: "if ISLOVE = 2, records 8, 9 …" should be "if ISLOVE = 1, records 7, 9 …"

P3-5, Note 7: should add "if NC()=0, then Record 8 is omitted"

P3-6, Record 4: explain "MAT()" in more detail

P3-9, for WSTART: why do we need both records 2 and 6?

P3-9: what is the format for Record 2, is it F10.0 or 5F15.0?

P3-9: the format for Record 6 should be 5F15.0 not 5F10.0

P3-7, Subroutine WOUTPUT: there should be more of an explanation on "hydrograph site" and on how to determine "nodal weight"

P3-12, Note 10: "CBASE()" should be "CHBASE()"

P3-12, Note 10: "CHTASB()" should be "CHTAB()"

P3-12, Note 10: not clear; why is the specific-head at a particular time the sum of CHBASE() and the transient head? For example, if CHBASE() = 300 and the transient head is 295, then the specified head is 595?

P3-13, Record 3: explain the actual meaning of "Number of well links"

P3-13, Records 4 and 7: specify the sign (+ ot -) for the input rate for injection and pumping

P3-14, Note 11: "specified head" should be replaced with "specified flux"

P3-16, Note 3: "Records 5 and 6 for" should be "Records 5 and 6 are repeated for"

P3-17, Record 4: IBREAK() is not included in the source code

P3-17, Record 5: RNODE() is not an array

P3-17, Records 7 and 9: clarify the sign (+ ot -) for the input of discharge QXTB and QTB()

P3-19, Record 1: need to explain that when "IMESH ≠ 0, then output …"

P3-19, Record 6: COL is an array

P3-20, Record 12: XLEAK() is not an array.

P4-7: the rotation direction in the input description is not consistent with the input data.

CLOSURE

HCI appreciates this opportunity to work with SNWA on this project. If you have any questions or require further clarification about these comments, please do not hesitate to contact me.