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TITLE: BOREHOLE DILUTION FOR AMARGOSA
FARM CRITICAL GROUP: NEAR-FIELD FOCUS

PEOPLE: Randy Fedors
Gordon Withmeyer
Amit Armstrong

PROJECT:

This will be a detailed study of borehole dilution on the scale of individual wells or well-fields as in the area of Amargosa Farms agricultural district. This work is part of the ARDES KTI and is complementary to the larger scale study by Amit and Gordon to determine the likely fate and transport of radionuclides from the repository at Yucca Mountain to the critical group downgradient approximately 25 kilometers.

Preliminary scoping work has already been started for the near-field focus. Literature review and software scoping along with the collection of pertinent data from federal and state databases have focused the work plan. There is a workplan, a preliminary scoping report, and a reference list attached on subsequent pages. This format for the scientific notebook was determined per discussions with Bob Brient and as it became apparent that a software package has been identified and that scientific calculations would soon be going beyond a scoping effort.

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1. INTRODUCTION

The concept of borehole dilution in the literature addresses the areas of sampling bias and well design, effectiveness of pump & treat systems, and capture zone analysis. Our perspective is the latter. Borehole dilution is used to explain 1-2 orders of magnitude difference in concentrations between well samples and measured concentrations in the aquifer; either concentration value may be greater than the other. "Borehole dilution" is also the name of a procedure to estimate permeabilities in a single well bore through analysis of the dilution rate after release of a solute in the well bore. Borehole dilution in our work here refers to dilution of the aquifer concentrations of a solute in a wellbore due to pumping in a well which may capture both contaminated and uncontaminated portions of the aquifer.

Borehole dilution refers to near-field effects of pumping wells on the flow field and the capture of both contaminated and uncontaminated waters. In the vicinity of Amargosa Valley (previously Lathrop Wells) and Amargosa Farms (irrigated farmland area south of Amargosa Valley), dilution of the aquifer concentration in any wellbore may occur due to the creation of both vertical and horizontal gradients towards the actively pumping well or wellfield. An important feature of the wells in this area is that they partially penetrate the aquifer.

Five categories of influence which may significantly effect the borehole concentration are:

1. well pump rate and well distribution in the well field;
2. regional hydraulic gradient;
3. hydrostratigraphy and anisotropy;
4. well penetration depth and length of screen;
5. solute plume distribution, vertically & horizontally.

The last three lose significance if the plume is larger than the area of influence in a horizontal sense (capture area) and if the wells are fully penetrating an aquifer which is contaminated top to bottom. All 5 effects are inter-related, but it is convenient to group the first two and the last three. Analytical solutions can incorporate the effects of well pump rates, well spacing, and regional gradients under certain restrictions for a sensitivity analysis. Complex numerical models are generally required to analyze the effects of the hydrogeology, the plume configuration, and the well design especially if 3-dimensional effects are considered to be important. Modeling scales to consider are: 1) well field area of Amargosa Valley of approximately 100 square kilometers; and, 2) single well area of approximately 10-1000 meters capture zone.

2. BACKGROUND

Total System Performance (TSP) reports in 1995 (TRW) and 1996 (EPRI) put forth dilution factors as attributed to regional or far-field mixing and dispersion. TSP-95 focused on sub-basin contributions of water and lateral dispersion for a prediction of a centerline concentration dilution factor of 1×10^6 and a plume configuration of 7.7 km laterally and 2.9 km vertically. TSP-95 used a 3-dimensional solution of the advective-dispersive equation for a line source. Their sub-basin mixing model used large-scale basin estimates of flow rates to arrive at a dilution factor. TSP-96 (EPRI) used the Dominico-Robbins (1985) model which is for 1-dimensional flow and 3-dimensional transport with dispersion and first order kinetic loss. TSP-96 reported on a sensitivity analysis of lateral dispersivity as well as plume width and depth at 5 km. Instead of using an unbounded, scale-dependency model for dispersivity, TSP-96 used values approximately an order of magnitude less than the TSP-95 values. The base simulation plume width at 25 km was reported as 3.5 km wide with no reported depth. As compared with TSP-95, TSP-96 reported

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a more conservative 15x dilution factor prior to an uncertainty adjustment to +/- 2x dilution factor. Neither TSP incorporates near field (to Amargosa Valley wells) effects of borehole dilution as defined in the Introduction section.

The NRC HLW Annual Report of 1996 noted that TPA-95 estimates of dilution factor were optimistic. The scoping study in the 1996 annual report used the 2-dimensional flow model MAGNUM-2D along with the radionuclide transport code CHAINT.

The effect each category on borehole dilution can be described in qualitative terms. Determination can be separated into a two step process. First determine the effect on the capture area. Second analyze the spatial configuration of the plume in relation to the capture area. The effect of each category on the capture zone can be generalized. An increase in the pump rate will increase the capture area. An increase in the spacing of the wells may increase the capture zone horizontally but it may decrease the capture zone vertically and may introduce gaps in the capture zone between wells. An increase in the regional hydraulic gradient will act to decrease the capture area. An increase in the anisotropy will increase the capture zone horizontally but decrease it vertically. An increase in the horizontal variability of porous media will channelize the plume. However, wells may be preferentially placed the channels of higher permeability. In increase in the depth of a partially penetrating well will increase the vertical capture area but decrease the horizontal capture area. The position and distribution of the plume in relation to the capture zone will control the dilution of the solute in the well bore.

Before elaborating on the mathematical approximations to the physical system at Amargosa Springs area, it is useful to distinguish three concentration values. First is the concentration of a solute anywhere in the aquifer; this is a point value. A useful measure is the maximum concentration, $C_{AQ,MAX}$. A second type of value is the vertically averaged concentration for a column in the aquifer, C_{AQ} . The third type is the concentration in the well bore, C_{WELL} , which is usually taken as an average value since the well can be viewed as a CSTR (continuously stirred tank reactor).

2.1 Analytical Models

Analytical solutions are appropriate for quick estimates of simple hydrogeologic systems to determine capture zones for wells. These solutions are generally restricted to uniform (steady) flow in isotropic, homogeneous domains in a horizontal 2-dimensional plane. Vertical flow is ignored and vertical averaging of aquifer concentrations is required. Multiple stresses on the system (multiple wells, rivers, infiltration) utilize superposition.

Analytic solutions for capture zone estimates can be obtained for 2-dimensional scenarios (CZAEM; Strack, 1989) or for 3-dimensional scenarios incorporating the effects of a partially penetrating well. The analytic element method solves a form of the flow equation which uses hydraulic potential as the dependent variable. Superposition is used to model multiple stresses in study domain. CZAEM is the underlying code to the EPA wellhead capture zone code WhAEM (described in Strack, 1989; and in EPA, 1994 WhAEM User Manual). As a 2-dimensional code, CZAEM is applicable for isotropic, homogeneous domains where vertical flow can be ignored. It can be used to ascertain sensitivity to hydraulic conductivity as well as the distribution of wells and the magnitude of their pump rates. To address the effects of vertical flow near partially penetrating wells, another code must be used or written. Analytic solutions have been published for 3-dimensional flow fields for partially penetrating wells and estimation of their capture zones (Schafer, 1996; Faybishenko, et al., 1995; Grubb, 1993). Codes may be available for 3-dimensional capture zones from Hendrik Haitjema as related to his book "Analytic Element Method for Groundwater Modeling" (1995).

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Heterogeneous domains in vertical direction are incorporated by the approximation of a layered system with a single layer. Schafer (1996) describes an extension to 3-dimensional delineation of capture zones and incorporates a method to approximate a heterogeneous domain for partially penetrating wells. He illustrates the effect on a capture zone of anisotropy ratios, pumping rates, and well configuration. Strack (1989) suggests a transformation of the vertical axis and hydraulic conductivity. Analytical solutions which could incorporate the transformed conductivity are not included in the CZAEM model.

2.2 Numerical Models

Sensitivity analyses of effects which include vertical movement of water or solute in a heterogeneous domain require the use of numerical models. A good illustration of the influences which affect a capture zone is found in Bair & Lahm (1996). They simulated a well field and its effect on capture zone size and shape using a finite difference method for steady state analysis of flow along with a particle tracking scheme. They determined the magnitude of effect due to regional gradient, well penetration, pump rates, well configuration, and anisotropy of porous media all from the perspective of an idealized pump and treat design.

Three published articles on numerical simulation of 3-dimensional flow in and around a wellbore contain pertinent information for refined modeling in the vicinity of a single well. Chiang, et al. (1995) simulated 3-dimensional flow and solute transport (advection only) in the vicinity of a partially penetrating well in order to understand an order of magnitude difference between well samples and point aquifer samples. The concentration profile in the aquifer was known. The well bore was modeled as separate elements with a permeability in the range of that predicted for laminar flow in a tube. They attributed a majority of the difference to vertical contribution of clean water. They noted that their transient simulation results asymptotically approached the simple, mass balance-based result which assumes a flat water table. Therefore, concentration in the well is proportional the degree of penetration (the so-called "penetration factor") at long times.

Akindunni, et al. (1995) simulated 3-dimensional flow near a well for various screen positions and plume positions. They approximated the well with a neumann boundary condition at the edge of the domain by apportioning the discharge uniformly to the number of nodes along the screened length of the well. They compared vertically averaged values of concentration for both the wellbore and the aquifer. In there transient simulations, concentrations differed significantly in the well and aquifer. Dependent on the plume depth and the screened portion, the concentration in the wellbore was higher or lower than the vertically averaged aquifer value. However, over long times, the concentration in the wellbore asymptotically approached the vertically averaged aquifer value. In addition to screen position and plume position, they also looked at screen length and anisotropy. Again, initial concentrations differed significantly but long time concentrations appear to trend towards the vertically averaged aquifer value. As expected, simulations with large anisotropic ratios exhibited the less vertical mixing as compared low ratios.

Reilly, et al. (1989) also modeled the wellbore as a column of hydraulically connected cells. Their focus was on wellbore flow in a monitoring well with implications for sampling bias and cross-contamination. In a monitoring well, cross-contamination will act to dilute the plume. Of note was their conclusion that greater than half the aquifer-to-wellbore flow occurred in the top 10 percent of the screened length while greater than half the wellbore-to-aquifer flow occurred in the bottom 10 percent of the screened length. Hence, solute plumes approaching the top of the screened portion will enter the wellbore while plumes approaching the bottom will tend to flow around the well. This may be pertinent for Amargosa Springs area when irrigation wells are shut down but is probably irrelevant during periods of pumping.

3. NOTES ON WORK PLAN

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3.1 Data Availability

The pertinent area of Amargosa Desert is 25-30 km from the repository. Active pumping wells are located near and in the town of Amargosa Valley and the nearby irrigated fields. Saturated hydraulic conductivity, pumpage rates, well distributions, well construction, amount of irrigation (recharge), vertical and horizontal hydrostratigraphy not well documented, as per usual, are not well documented. Data may be available from the large scale USGS modeling projects or from various state and federal data bases.

The size of the plume as it enters the Amargosa Valley area is also unknown. Horizontal and vertical distributions as well as the concentration (uniform or non-uniform) estimates will have to be determined from other modeling efforts.

3.2 Ranges for Sensitivity Analyses

First phase of sensitivity analysis is to prioritize the features of Amargosa which affect borehole dilution. This will be accomplished by perturbations of each component individually. The ranges will be based on reasonable ranges. The categories listed in the Introduction section can be separated into perturbable (do not get them mad!) components:

- permeability, magnitude
- permeability, vertical variation
- anisotropic ratio
- regional hydraulic gradient
- well distribution (spatial, clusters)
- well pump rates (vary spatially, overall magnitude)
- well design (screen length and depth of screen)
- plume source concentration
- plume distribution (vertically and horizontally)

A second phase could be a more sophisticated perturbation selection procedure amongst the most significant components.

3.3 Analytical Model

Initial software evaluation led to the EPA WhAEM modeling environment. The underlying CZAEM model can be used for sensitivity analyses for well pump rates, well distributions spatially, and regional hydraulic gradients. In addition, an infiltration recharge from irrigation can be added. The number of stresses appears to be limited to approximately 150; total number of pumping wells and recharge areas. Quantitative output appears to be limited (check screen output during trace). Graphical output is simplistic, though I haven't explored the full utility of the GAEP program.

CZAEM

- calibrate
- sensitivity on K, Q, well distribution
- produce percentage of plume capture

3.4 Numerical Model

The real system is a transient flow field in a heterogeneous, uncertain domain with variable and uncertain stresses (well, recharge, etc...). Given the available data and the time frame to be simulated, what are some appropriate approximations. One approximation is to assume a steady state flow field. The flow field

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could then be used for particle tracking. This approach ignores dispersion as a first approximation and leads to a conservative estimate for dilution. A trial-and-error determination of number of particles to release is an approach towards determination of a meaningful concentration in the wellbore nodes/cells.

How a model handles flow and transport near a well is critical. Finite difference models may be extremely cumbersome for approximating each pumping well. Finite element models are preferable. Alternatives for modeling wellbore dilution using discretized flow field and particle tracking:

- point source (neumann b.c.) in one cell/node;
- line source (neumann b.c.) in multiple cells/nodes along a vertical column, apportion discharge between cells/nodes based on permeability of each strata;
- point source (neumann b.c.) with vertical column of hydraulically connected nodes (high K), avoid because of difficulties numerically;
- line source (dirichlet) in vertical column, heads chosen so as to get correct discharge at steady state.

The line source will better represent the system in terms of aquifer-wellbore interaction as well as screen lengths and depths in relation to plume distribution. The single point source in one cell/node is the simplest to implement and easiest in terms of post-processing.

MAGNUM-3D & PTM

- calibrate steady state flow;
- particle track; determine number of particles to release & assign mass;
- sensitivity on everything;
- output is percentage dilution factor:
(minimum dilution at any location, average for all wells);
- pre- and post-processing needed:
depends on how MAGNUM incorporates wells;
well-by-well concentration comparison with $C_{AQ,MAX}$ and C_{AQ} ;
- small scale focus on single or multiple wells (10 to 1000 meter):
well design versus plume stratification or configuration;
treat well as line source (multiple layer representation);
- larger scale (1000 sq.km.) appears to be on backburner:
does point source/sink for well approximate line source at this scale.

4. SUMMARY

There is a limited amount data for the Amargosa Valley and Amargosa Farms in terms of the hydraulic parameters, well design, and well usage parameters. In addition, the predicted plume magnitude and configuration are uncertain parameters obtained from larger scale modeling. A focus on well design and plume configuration may be justified based on the availability of data.

Acronyms

NRC	Nuclear Regulatory Commission
EPA	Environmental Protection Agency
CZAEM	Capture Zone Analytic Element Method
WhAEM	Wellhead Analytic Element Method
HLW	High Level Waste
USGS	U.S. Geological Survey

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Work plan per Gordon Wittmeyer after discussions with
NRC staff (McCartin, Caldwell, Leslie) is attached on this page.

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Borehole Dilution at the Amargosa Farms Critical Group Area

Dilution in individual boreholes depends in part on the fractions of water drawn from contaminated and uncontaminated production zones, which in turn depend on the depth of the well and the location, length, and number of screened and uncased intervals. A study will be undertaken to quantitatively assess the effects of borehole dilution on radionuclide doses in the Amargosa Farms critical group area. Fundamental questions to be addressed by this study include: (i) how variations in well construction practices (depth, screen placement, etc.), borehole spacing, and pumping rates affect capture of a radionuclide plume of specified shape; (ii) the magnitude of well-to-well variations in radionuclide doses; and (iii) for the purposes of computing doses, the reasonableness of assuming that all radionuclides released from the repository are completely mixed in all of the water pumped in the Amargosa Farms area.

Specific analyses to be conducted include:

- A detailed statistical analysis of borehole depths, well depths, screened or uncased section positions and lengths will be conducted for the Amargosa Farms area. An evaluation will also be conducted to determine if variations in well construction methods can be directly tied to hydrostratigraphic facies changes.
- A parametric study to evaluate the sensitivity of borehole dilution to reasonable variations in well depth, screening practices, and radionuclide plume depth.
- An assessment of the sensitivity of plume capture to reasonable variations in pumping rates and spatial arrangements of irrigation and domestic supply wells.
- An assessment of the magnitude of well-to-well variations in radionuclide doses for reasonable variations in pumping rates and spatial arrangements of irrigation and domestic supply wells.

Where effects of pumping on dose are quantitatively examined, reported numerical results will be relative to the normalized concentration for the radionuclide plume—no absolute radionuclide concentrations or doses will be reported.

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*Printout of references pertinent to Amargosa Farms & borehole
dilution for attached on this page; 4 pages included.*

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*Printout of references pertinent to Amargosa Forum & borehole
dilution in attached or this page; 4 pages included.*

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Status to date: (1) Software selection
(2) data collection

(1) Software Selection

At this stage in the project, an analytic element model with capture zone analysis is the chosen approach. Given the uncertainty of parameters, or the outright lack of data, a numerical model does not seem warranted for an initial phase sensitivity analysis.

Henk Hartjema's GFLOW model was chosen over other analytic element models due to its incorporation of partially penetrating wells and their associated vertical flow.

Other analytic element models include:

- CAPZONE (Scott Bair)
- AgModel (Wellware)
- QuickFlow (Geraghty-Miller)
- TWODPLUME (Stotta Engineering)
- WINFLOW } (ESI)
- WINTRAN }
- TWODAN (Charles Fitts)
- CZAEEM (Otto Strack)

(2) Data Collection

The following databases or tables will be used to develop reasonable hydraulic parameters, hydrostratigraphy, and well design and usage:

- a) The USGS GWIS database extraction for the Pucca Mountain area. The extraction was procured by Gordon Wittmayer at least 3 years ago. The file obtain from Gordon is stored in /home2/bren/rfedors/Bore/Data and is still called "gw2.fil"
- b) Xerox copy of well permits dating from 1905 to 1995 as obtained by Gordon from Pat LaPlante (CWRRA-Washington office). Presumably, the tables originated from the Nevada State Engineer's Office.
- c) Xerox copies of water use estimates for Amargosa Desert from the Nevada State Engineer's Office as obtained by

Chad Glenn (NRC - Las Vegas Office).

- d) Xerox copies of well driller's logs as obtained by Chad Glenn from the Nevada State Engineer's Office
- e) published literature specific to Amargosa Farms area which may or may not have used category a)-d) databases as a source.

All categories of data listed above are "existing" data per QAP-015

It is anticipated that a combination of Fortran (SUN Fortran 77) codes, awk scripts, & spreadsheets will be used to extract pertinent data and analyze on a statistical basis. Depending on machine availability, the spreadsheet program to be used is EXCEL either on an IBM-compatible DOS machine or on the WABI interface on the SUN workstation running SOLARIS

The analytic element model GFLOW will be installed and tested on IBM-compatibles which have a DOS overlay on OS/2, or which are running Windows 95. Preliminary work with CZAEEM code for delineation of capture zone suggest that GFLOW work will be successful. There are strong connections between the codes.

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Amargosa Desert = Hydrographic Basin 230



Well Permit & Water Use databases

xerox copies from Nevada Division of Water Resources
Bob Coache - Nevada State Engineers Office
(702) 486-2770

- ① Annual tables of water-use estimates made by state engineer. Chad Glenn xeroxed copies from 1983, 1985-1996 July 1997 and sent to SWRS.
- ② well permit table from 1905 to 1995 obtained from Pat Laplante (CNWRA) via Gordon Wittmayer

Both of these data tables are catalogued by well permit number. If approved permits are utilized 5 years, they become certificated. There has been a general rejection of new permits since the early 1990's due to aquifer mining. However, large industrial (mining) operation at Bullfrog (near Beatty) did not appear on ^{water-use} permit list but has apparently been extracting since 1987. Apparently, when the Annual Summary is prepared by the State Engineer, the large mining companies were not included in the detailed tables but they are in the summary page for the year. This is important to note if a spatial distribution of the water-use estimates is needed. The American Borate, IMV, and Bullfrog companies should be checked and added in if missing for any particular year. The location of each can be determined from the well permit database.

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American Borate

Since the water-use database will be used to spatial distribution and magnitude of pumpage in the Amargosa Farms area, the detailed information was entered into a computer file. Checks on data entry was accomplished by starting with the well permit database (itself entered into a computer file), verifying that the water-use database had the same permit number and location. The irrigated amount was then added to appropriate column. During this data entry, typos were noted in the Nevada State Engineers table of well permits: the location of a large groundwater user (American Borate) in the Amargosa Farms area was obscured and grossly misplaced. The reasonableness of the location for

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American Borate operations as listed in the water-use tables suggested that the well permit database was incorrect.

There are entries in the databases from Nevada Div of Water Resources which are in Amargosa Desert, but not near the Amargosa Farms area.

These are the ranges and townships which are being considered as Amargosa Farms area:

- R47E; T16S
- R48E; T15-17S
- R49E; T15-17S
- R50E; T15-17S

(predominantly western half of R50E)

Per this definition of the Amargosa Farms area, the following users of groundwater are removed from my computer file:

Permit #	section	Township	Range	Description
22140	8	17S	52E	irrigation
22141	7	17S	52E	irrigation
51841-51848				St. Joe's Bull Frog operation
58268		12S	46-47E	
61412		13S	46E	near Beatty
61413				U.S. Fish & Wildlife
53596	7	18S	51E	
54271	7	17S	52E	Nye Cty

NoPer = Not Permitted
AB = American Borate
IMV = Industrial Mineral Ventures
BF = St. Joe's Bull Frog operation
Other = domestic, municipal, commercial

The original and the adjusted values of annual water use are in the table below:

Summaries of Groundwater Pumpage - Nevada State Engineer's Office
Adjustments to State Engineers data removes non-Amargosa Farms wells.
Borehole Dilution ARDES KTI -- RFedors

RF Koffel 97

Year	Actual State Engineer Tabulation				Remove non-Amargosa Farms Wells				Total
	Irrigation Ac-Ft	Irr/NoPer Ac-Ft	AB/IMV/BF Ac-Ft	Other Ac-Ft	Irrigation Ac-Ft	Irr/NoPer Ac-Ft	AB/IMV Ac-Ft	Other Ac-Ft	
1996	9263	1780	2285	285	9253	1780	1019	253.8	12305.8
1995	10839	1515	2571	110	10839	1515	780	110	13244
1994	8892	1085	2508	110	8892	1085	717	110	10804
1993	8558.8	150	2481	110	8508.8	150	1007	110	9775.8
1992	5711	50	2292.5	110	5661	50	653.5	110	6474.5
1991	4716.5	225	1070	110	4716.5	225	450	110	5501.5
1990	4603.1	350	2719.29	135	4603.1	350	886.69	135	5974.79
1989	1266	300	2220	135	1266	300	1413	135	3114
1988	2666	312	996	135	2666	312	996	135	4109
1987	4500	1200	302	135	4500	1200	302	135	6137
1986	5552.9	1000	550	135	5552.9	1000	550	135	7237.9
1985	5807	2665	950	250	5807	2665	950	250	9672
1983	5893	3212	125	270	5893	3212	125	270	9500

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The 1996 Water Use data as added to the well permit data:

Well Permit & Estimated Water Use (data entry) RFedors
 Added Water Use data to permit spreadsheet file (permit.xls) 16Jul97
 Borehole Dilution for ARDES KTI
 add'l ==> PC=certificate & permit
 RFA,RFP=ready for action (protested)
 APP=application
 A1,A2,A3=special case of 3 permits same number

Water Use => entries are put under 1st permit number unless original.
 permits are split, then put under 2nd listed permit number.
 water use category not (!) modified from Well Permit database.

permit#	add'l	yr	qq	qtr	sec	tw	rng	cfs rate	irrig acres	use	1996 irrig acre-ft
15702	PC	54	ne	se	14	16	48	1	35	irr	175
15893	PC	54	ne	ne	23	16	48	3.5	160	irr	625
15929	PC	54	ne	ne	9	17	49	2.228	80	irr	700
16545	PC	55	ne	ne	28	16	49	2.5	21.98	ird	183.4
16562	PC	55	ne	ne	16	16	48	2.2	120	ird	125
17657	A3	58	ne	nw	15	16	48	0.04	2.5	irr	5
17657	A1	58	ne	nw	15	16	48	2.14	147.5	irr	7.5
17694	PC	58	ne	nw	15	17	49	2	38.2	irr	25
18222	PC	59	ne	nw	30	16	49	5.4	268	irr	665
18764	PC	60	ne	ne	8	16	48	4.01	71.4	irr	5
18772	PC	60	sw	nw	20	16	48	3.01	199	irr	17.5
19448	PC	61	sw	nw	7	16	48	0.63	37	ird	92.5
19916	PC	61	ne	ne	24	16	48	2.5	160	irr	227.5
19917	PC	61	ne	se	24	16	48	2.5	160	irr	625
20352	PC	62	xx	xx	36	16	48	3.5	233.9	ird	799.5
22233	PC	64	ne	ne	36	16	48	1	38	irr	25
22746	PC	65	ne	se	19	16	49	2.5	160	irr	625
24585	PC	68	se	sw	9	16	49	0.75	23.75	irr	105
24725	PC	68	se	nw	18	16	48	2.7	155.49	irr	657.75
24763	PC	68	ne	ne	8	16	49	0.59	26.69	irr	27.5
25009	PC	69	se	sw	10	16	48	1.22	3.5	irr	5
25742	PC	70	nw	sw	10	16	48	0.14	3.5	irr	17.5
25743	PC	70	nw	sw	10	16	48	0.14	3.5	irr	11.25
26152	PC	71	sw	se	8	16	48	1	12	irr	24
26283	PC	71	nw	nw	18	16	48	2.2	160	ird	400
26673	PC	72	nw	ne	24	15	49	0.004	0	qm	8
26718	PC	72	ne	se	8	16	49	0.1	3.78	irr	5
27812	PC	73	ne	nw	12	17	48	2.54	0	mm	272
28062	PC	74	se	sw	2	18	49	0.79	0	qm	16
28828	PC	74	se	nw	35	16	49	0.43	13.14	irr	26.28
29521	PC	75	se	sw	9	16	49	0.16	5	irr	25
29649	PC	75	ne	ne	9	17	49	1.32	125.6	irr	170
30411	PC	76	ne	se	23	16	49	2.67	151	irr	625
31727	PC	77	se	sw	9	16	49	0.16	5	irr	25
35592	PC	78	se	sw	1	17	48	0.5	0	qm	7.5
36584	PC	79	nw	nw	15	16	48	0.08	5	irr	12.5
38127	PC	79	se	nw	26	16	48	1.667	116.67	irr	583.5
38363	PC	79	se	ne	26	16	48	1.666	116.67	irr	233.4
40954	PC	80	se	se	22	16	49	0.178	9.54	irr	5

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 changed
 in
 pump
 file

continued

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permit#	add'l	yr	qq	qtr	sec	tw	rng	cfs rate	irrig acres	use	1996 irrig acre-ft
42171	PC	80	sw	se	8	16	48	0.275	60	irr	70.7
43524	PC	81	ne	ne	9	17	49	1.454	125.6	irr	628
43873	PC	81	sw	nw	24	16	48	1.667	116.67	irr	583.5
45162	PC	81	se	sw	2	17	49	0.446	0	qm	10
45740	PC	82	ne	nw	27	16	49	0.02	0	qm	3.4
46748	PC	83	sw	nw	15	16	48	0.16	8.42	irr	10
47205	PC	83	sw	se	31	16	49	0.2	0	qm	10.5
49885	PC	86	se	nw	12	17	48	0.25	13	irr	65
50385	PC	86	nw	ne	16	16	49	0.1	0	qm	20
53181	PC	89	sw	sw	2	18	49	0.08	0	qm	50
53189	PC	89	se	ne	16	16	48	0.3	0	com	2
59180	PC	93	xx	se	16	35	49	0.07	0	com	1
60433	PC	94	nw	nw	15	16	48	0.039	2.5	irr	12.5
60442	APP	94	ne	nw	15	16	48	0.023	1.5	irr	5
60443	APP	94	ne	nw	15	16	48	0.025	1.61	irr	1
60471	APP	94	nw	nw	15	16	48	0.016	1	irr	5
60474	APP	94	ne	nw	15	16	48	0.029	1.84	irr	1
48479	PC	84	xx	sw	36	17	49	.26	0	com	746.5
60450	APP	94	nw	nw	15	16	48	-999	1.5	irr	7.5
61080	PC	96	nw	ne	10	17	49	-999	0	com	50
61219	PC	96	sw	ne	3	18	50	-999	0	qm	2

The spreadsheet file Home2/ren/rfedors/Bore/Data/pump.xls (EXCEL format) includes all well permit entries. However, only a fraction of historical permits used groundwater (as estimated by Nevada State Engineers Office) during 1996. Only those with estimated usage are included in the table above.

qq = quarter-quarter section
 qtr = quarter section
 sec = section

tw = township south

rng = range east

cfs rate = cubic ft/second well rating (not actual use rate)

com = domestic

irr = irrigation

ird = irrigation (DLE)

qm = municipal and quasi-municipal

mm = milling & mining

com = commercial

RF 7/30/97

GFLOW analytic element model from Henk Haitjema

documentation includes:

(1) postscript file sent with disks & tutorial
chapters 1-7, appendix B, C(2) book \Rightarrow Analytic Element Modeling of Groundwater Flow
Henk Haitjema (1995)
Academic Press, New York
ISBN 0-12-316550-4
purchased for CNWRA library

The story of the diskettes:

An educational version comes with the book. However,
Henk Haitjema sent me the "basic" version 1.10

{	Henk Haitjema (Indiana University)
	Haitjema Software (812) 336-2464
	2738 Briggs Rd
	Bloomington IN 47401

The educational version has some of the capabilities turned off.

Installation testing

To install this windows 3.x executable on "c" drive in directory "GFlow":

(1) add following lines to autoexec.bat

c:\path... \mouse.com

set GFLOW = c:\GFLOW

set PATH = ... ; c:\GFLOW

(2) add to config.sys

DEVICE = c:\ANSI.SYS

(assuming ansi.sys in in root directory)

(3) Use install.exe which comes with package (on diskettes)

For the IBM's running OS/2, just make sure that the mouse
and the ansi.sys are installed for DOS overlay so that this
program will run in a full DOS window.It is anticipated that most of the simulations will be done on
the IBM running a DOS overlay on OS/2 (machine is PS/2 95)
This machine has the 32 bit extensions installed.The installation test will be done using data extracted from
a solution file (demo.sol) which comes with the package and
a solution created on my installed program version using the
input file "demo.dat". This is a complicated groundwater problem
which includes many of GFLOW's capabilities (43 line sinks without
resistance, 19 line sinks with resistance, and 16 line doublets for
inhomogeneities). The domain coverage for the plot is:

$$x_1 = -21522,$$

$$y_1 = -34509,$$

$$x_2 = 71832,$$

$$y_2 = 73526.$$

The plot of solutions appear
to be identical; Using the "sol 5"
command to create a solution, the
same max error 0.4416% for
line sinks w/ resistance results as
was stated in demo/tutorial text.Direct comparison between my solution & Henk's (distributed) solution
for location $x=0, y=0$ (middle of lower left quadrant)

	<u>x</u>	<u>y</u>	<u>z</u>		Henk's	My Solution
head	0	0	-	\Rightarrow	275.1672	275.2815
potential	0	0	-	\Rightarrow	56501.03	56685.03
discharge	0	0	-		$Q_x = 5.333770$	5.383546
					$Q_y = 0.3924446$	0.4011707
specific discharge	0	0	-		$q_x = 0.7095877E-1$	0.7150465E-1
					$q_y = 0.5220957E-2$	0.5328378E-2
					$q_z = 0.125312E-2$	-0.1257065E-2
velocity	0	0	-		$V_x = 0.3547938$	0.3575293
					$V_y = 0.2610478E-1$	0.2664189
					$V_z = -0.626560E-2$	-0.6285327E-2

Z locations automatically taken as water table; note that there is
a slight difference in heads at location (0,0). The differences in
the results are probably due to the 32 bit extension (prior to pentiums,
IBM-compatibles ran a 16 bit operating system & hardware). The differences are not
considered significant.

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GFlow simulations - Approach (mechanically speaking)

Data Entry (interactive mode)

> C:\GFlow\gflow to start program in full DOS screen mode

ACQ

- permeability K_{sat}
- porosity (use default) → not used for this work
- thickness 1000 meters
- base 0 meters
- reference $x=0$ $y=-10000$ $H=1000$ meters
- Uniform $Q_x = Kh$, $Q_y = 0$

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3/23/99

PPWELL

→ DISCHARGE

→ x y z1 z2, discharge radius

SOLVE

GRID

choose appropriate window

horizontal resolution of grid → 100

TRACE

→ direction (backward or forward)

→ contour on

→ cursor on

Notes on this process:

① after solving, checkarcy velocities in main menu for a point upgradient along centerline to determine reasonable window for gridding & tracing; There is a tradeoff between window size and mouse resolution (for location of releases).

For a range of problems, 1/2% difference between GFlow calculated q_x at upgradient point and $q_x = K \nabla h$ hand calculation seems to give a reasonable length at which the horizontal width of plume no longer varies.

② check reference point to make sure it is not impinging on solution (check head values across symmetry line, centerline)

③ Estimate area of capture by obtaining maximum height and maximum width, then assume elliptical cross-sectional shape at upgradient point where flow can be assumed to be 2-D (no significant vertical component due to partially penetrating well).

RF
3/23/99

TOP-018 for PATCHI

RF 13
8/6/97

See TOP-018 folder under QA control (Bruce Mabrito) for installation tests. A copy of the memo put into the QA folder is attached below for a background introduction.

Wexler, E.S. (1992). Analytical Solutions for One-, Two-, and Three-Dimensional solute Transport in Groundwater Systems with Uniform Flow; USGS Techniques of Water-Resources Investigations Chapter B7, Book 3.

TO: Bruce Mabrito
FROM: R. Fedors
SUBJECT: Modifications and Installation for PATCHI
DATE: August 6, 1997

RF
8/6/97

PATCHI is one of a series of Fortran source codes made available by the U.S. Geological Survey (USGS) for analytical solutions to the advection-dispersion transport equation. All of the codes are fully documented in Wexler (1992); pertinent pages are attached to the TOP-018 folder. The printout of a readme file which comes with the distribution is also included here. PATCHI is the solution for a 2-dimensional patch source of constant concentration perpendicular to a 1-dimensional flow field. The solution is for 1-dimensional advection and 3-dimensional dispersion along with decay and first order adsorption.

The floppy diskette contains the original source files in UNIX tar and gzip compression form as obtained from the USGS software internet web site: http://water.usgs.gov/software/ground_water.html. Also contained on the diskette are the modifications made to the make file and two of the source code modules (title.f and subs3.f). The modifications are necessary in order to compile the software on a CNWRA SUN workstation. The modifications to the source code are commented, dated, initialed, and described in the source code. The modifications are:

1. Edit the make file so that only the patchi code is compiled and add the compile option "-lv77" to the Fortran command to get the VMS extensions for date and time system calls;
2. Change the system calls for date and time in the "title.f" file;
3. Comment out the graphics call for DISSPLA in the pltn3 subroutine of the "subs3.f" file.

Note that CNWRA does not have a license for the DISSPLA program.

The installation test included here is "sample11" from the U.S. Geological Survey distribution. The input file is labeled sample11.dat, the USGS output file is labeled sample11.prt, and my installation test output is labeled sample11.out. The output files match exactly indicating a proper installation of the PATCHI code.

PATCHI is installed so that plume configuration bounds may be made for the Amargosa Farms wellbore dilution, especially limits on thickness and width at the 25 and 30 kilometer critical area. EPR's TSPA (1995) included width and depth for the plume at 25 km however their dispersivity values were poorly chosen. EPR's 1996 TSPA used better dispersivity values but did not report plume thicknesses.

RF
8/6/97

GFlow data inputs - Ranges for sensitivities

Assume 1000 meter thick aquifer

Screen Height & length - from statistics on well construction, database was the GWIS assembled by the U.S. Geol. Survey, Summary output table attached on following pages).

- 113 wells in Amargosa Farms area
- 52 = average length of screened portion (meters)
 - 33 = standard deviation of screen length (m)
 - 1 = minimum screen length (m)
 - 191 = maximum screen length (m)
- 11 = water table to top of screen distance (m), average
- 0 = " " " " , minimum
- 66 = " " " " , maximum

Regional Gradients range 0.001 to 0.01

These values for the range are reported in the literature. In addition, measurements were made on water table maps to verify this range as appropriate and to get a feel for the distribution within this range

Nichols & Alkers (1985) 10ft / (0.25cm)(4010ft/cm)

Plate 2 1984 map	{	near Hwy 29 \Rightarrow 0.01
		typical from north \Rightarrow 0.0017
		western edge, lowest \Rightarrow 0.0012
1962 map	{	near Hwy 29 \Rightarrow 0.01
		western edge, lowest \Rightarrow 0.0007

DOE Site Characterization 1988

Fig 3-9, p. 3-62 Yucca Mtn to Amargosa \Rightarrow 0.0032

Kilroy (1991)

- east of Hwy 29, off Specter Range area \Rightarrow 0.010
- into Amargosa Farms area (from north) \Rightarrow 0.0017
- within Amargosa Farms area \Rightarrow 0.0014

Literature \Rightarrow Bedinger et al (1989) \Rightarrow 0.003 generic basin fill Death Valley Region

Pump Rates

- domestic/municipal 2 - 200 gallons per day
1800 gpd/household (DOE Site Characteriz. 1988)
- irrigation 1 - 799.5 Ac-ft from 1996 water use table
State Engineer's Office

Transmissivity 10 - 400 m^2/d

Appears to be standard range reported for basin-fill alluvium (Plume 1996; Winograd & Thorndarson 1975; DOE Site Characterization Plan 1988). After extracting the specific capacity data and approximating the transmissivity (using chart from Ground Water Manual 1981), I can see where this range came from. The draft D. Agnese modeling report for the U.S.G.S. also contains a chart with ranges for two types of alluvium.

Since Amargosa Farm is more in the area of lower fans and lowlands (rather than the coarser sediments of the upper and middle fans), the K_{sat} should show a wider range and be more heterogeneous (layered, lenses) and better sorted compared to sediments close to the highland source.

- Plume 1996 $\Rightarrow K_{sat} = 0.02 - 1460 ft/day$
- DOE Site Charact(1988) $\Rightarrow K_{sat} = 0.21 - 2.9 m/d$

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1/16/97

Data Extraction from GWIS database (U.S.G.S)

Database was delivered by Gordon Wittmeyer who got them from a formal request to the U.S. Geol. Survey. The 3 files are

gw1.fil
gw2.fil
nts.fil

Only "gw2.fil" had any data from the Amargosa Farms area.

Gordon's search area 36.3480 to 36.5708 latitude

-116.3740 to -116.6190 longitude

Using Gordon's area; 182 wells were extracted from gw2.fil

Inspection of maps suggested a slightly larger area would be appropriate to capture all of the wells in the Amargosa Farms area; extending to the north & to the west.

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New area 36.3480 to 36.6694 latitude

⇒ 36°40'10" to 36°20'53"

-116.3594 to -116.6208 longitude

⇒ -116°21'34" to -116°37'15"

224 wells were extracted from gw2.fil

A description of the database can be found in the
U.S.G.S. Open-File Report 89-587

National Water Information System User's Guide Manual

Volume 2, Chapter 4, Ground-Water Site Inventory System

The program "amarg.f" (see next page) was written in Fortran 77. The program checks each record of the gw2.fil file, if location is within the bounds mentioned above, then information from that well is written to a new output file.

Two comments: ① since variables are re-used for each record, they must be reset to the flag value prior to reading the record; ② the records are read as characters, then divided up → thanks to Gordon's example. Otherwise, the comment lines should help in readability of code.

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"amarg.f" along with the GWSI (original) files, gw1.fil, gw2.fil, and nts.fil were put into ~/Archive/Bore for later copying to tape

RF 8/11/97

Printed by Randall S. Fedors

Jul 08, 97 16:37

amarg.f

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```

*****
*** Program reads data from the amarg.gwis file which was ***
*** Amargosa Farms extract of USGS GWSI database file "gw2.fil" ***
*** "amarg.gwis" ==> 36.3480 to 36.6694 and 116.3594 to 116.6208 ***
***
*** Modify as needed to reformat well log info. ***
*** RFedors (3July97) ***
*****
program amarg

implicit none
character record*80 , code*4 , wellid*2
character infile*12, outfile*12
integer*4 xdeg , xmin , xsec , ydeg , ymin , ysec
integer*4 numwells, screen
real*4 lat , long, land
real*4 dhole, dhole, dwater, dischg, dprod, dstatic
real*4 diam, diam2, diam3, diam4, dtop, dtop2
real*4 dtop3, dtop4, dbot, dbot2, dbot3, dbot4
logical start

infile = 'amarg.gwis'
outfile = 'amarg.all'
open(8,file=infile,status='unknown')
open(9,file=outfile,status='unknown')

c Start reading and processing records using internal files.
c Check first part of record for code.
c C001 = Well ID,
c C009 = latitude (deg,min,sec)
c C010 = Longitude (positive value) C083 = Depth to Top of Open Interval
c C024 = primary use(not in gw2.fil) C084 = Depth to Bottom of Open Interval
c C027 = Hole Depth (ft) C087 = diameter of opening (inches)
c C028 = Depth of Well (ft) C272 = specific capacity (gpm/ft)
c C030 = Depth to Water Level C153 = depth to production water level
c C016 = land elevation (ft) C154 = depth to static water level (ft)
call out(start,lat,long,land,dhole,dwell,dwater,dischg,dprod
& ,dstatic,diam,diam2,diam3,diam4,dtop,dtop2
& ,dtop3,dtop4,dbot,dbot2,dbot3,dbot4,wellid)

call reset(xdeg,ydeg,land,dhole,dwell,dwater,dischg,dprod
& ,dstatic,diam,diam2,diam3,diam4,dtop,dtop2
& ,dtop3,dtop4,dbot,dbot2,dbot3,dbot4)

start = .false.
numwells = 0
10 read(8,'(a80)',end=30) record
read(record(2:5),'(a4)') code
if(start .and. code .eq. 'C001') then
call out(start,lat,long,land,dhole,dwell,dwater,dischg,dprod
& ,dstatic,diam,diam2,diam3,diam4,dtop,dtop2
& ,dtop3,dtop4,dbot,dbot2,dbot3,dbot4,wellid)
call reset(xdeg,ydeg,land,dhole,dwell,dwater,dischg,dprod
& ,dstatic,diam,diam2,diam3,diam4,dtop,dtop2
& ,dtop3,dtop4,dbot,dbot2,dbot3,dbot4)
endif
if(code .eq. 'C001') then
read(record(25:26),'(a2)') wellid
screen = 1
start = .true.
endif
endif

c Chose which categories to add to data array.
if(code .ne. 'C001') then
if(code .eq. 'C009') then
read(record(13:18),'(3i2)') xdeg , xmin , xsec
lat = xdeg + xmin/60. + xsec/3600.
goto 20
endif
if(code .eq. 'C010') then

```

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amarg.f

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```

read(record(13:19),'(i3,2i2)') ydeg , ymin , ysec
long = ydeg + ymin/60. + ysec/3600.
goto 20
endif
if(code .eq. 'C016') then
read(record(12:19),'(g8)') land
goto 20
endif
if(code .eq. 'C027') then
read(record(12:19),'(g8)') dhole
goto 20
endif
if(code .eq. 'C028') then
read(record(12:19),'(g8)') dwell
goto 20
endif
if(code .eq. 'C030') then
read(record(12:19),'(g8)') dwater
goto 20
endif
if(code .eq. 'C083') then
if(screen .eq. 1) read(record(12:18),'(g8)') dtop
if(screen .eq. 2) read(record(12:18),'(g8)') dtop2
if(screen .eq. 3) read(record(12:18),'(g8)') dtop3
if(screen .eq. 4) read(record(12:18),'(g8)') dtop4
if(screen .gt. 4) write(6,*) 'el problema con screens'
goto 20
endif
if(code .eq. 'C084') then
if(screen .eq. 1) read(record(12:18),'(g8)') dbot
if(screen .eq. 2) read(record(12:18),'(g8)') dbot2
if(screen .eq. 3) read(record(12:18),'(g8)') dbot3
if(screen .eq. 4) read(record(12:18),'(g8)') dbot4
goto 20
endif
if(code .eq. 'C087') then
if(screen .eq. 1) read(record(12:18),'(g8)') diam
if(screen .eq. 2) read(record(12:18),'(g8)') diam2
if(screen .eq. 3) read(record(12:18),'(g8)') diam3
if(screen .eq. 4) read(record(12:18),'(g8)') diam4
screen = screen + 1
goto 20
endif
if(code .eq. 'C153') then
read(record(12:18),'(g8)') dprod
goto 20
endif
if(code .eq. 'C154') then
read(record(12:19),'(g8)') dstatic
goto 20
endif
if(code .eq. 'C272') then
read(record(12:19),'(g8)') dischg
numwells = numwells + 1
goto 20
endif
endif
endif

20 goto 10
30 continue
write(6,*) 'number of wells w/ spec. capacity= ', numwells

stop
end

C=====
subroutine reset(xdeg,ydeg,land,dhole,dwell,dwater,dischg,dprod
& ,dstatic,diam,diam2,diam3,diam4,dtop,dtop2
& ,dtop3,dtop4,dbot,dbot2,dbot3,dbot4)
c Resets all variables to -999. for next well to avoid carry-over.

```

RF
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"amarg.f" along with the GWS (original) files, gw1.fil, gw2.fil,
and ntr.fil were put into ~/Archive/Bore for later copying to tape

Printed by Randall S. Fedors

RF
8/11/97

```
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real*4 xdeg,ydeg, land, dhole, dwell, dwater, dischg
real*4 dprod, dstatic, diam, diam2, diam3, diam4
real*4 dtop, dtop2, dtop3, dtop4, dbot, dbot2, dbot3, dbot4

xdeg = -9.
ydeg = -9.
land = -9.
dhole = -9.
dwell = -9.
dwater = -9.
dstatic = -9.
dprod = -9.
dischg = -9.
diam = -9.
diam2 = -9.
diam3 = -9.
diam4 = -9.
dtop = -9.
dtop2 = -9.
dtop3 = -9.
dtop4 = -9.
dbot = -9.
dbot2 = -9.
dbot3 = -9.
dbot4 = -9.

return
end
=====
subroutine out(start,lat,long,land,dhole,dwell,dwater,dischg,dprod
& ,dstatic,diam,diam2,diam3,diam4,dtop,dtop2
& ,dtop3,dtop4,dbot,dbot2,dbot3,dbot4,wellid)
c Prints to file
character wellid*2
real*4 lat, long, land, dhole, dwell, dwater, dischg
real*4 dprod, dstatic, diam, diam2, diam3, diam4
real*4 dtop, dtop2, dtop3, dtop4, dbot, dbot2, dbot3, dbot4
logical start

if(start) then
write(9,111) long, lat, wellid, land, dhole, dwell
& , dwater, dstatic, dprod, dischg, diam, diam2, diam3, diam4
& , dtop, dtop2, dtop3, dtop4, dbot, dbot2, dbot3, dbot4
else
write(9,121)
endif

111 format(f9.4,f8.4,1x,a2,f6.0,5f7.1,5f6.2,8f7.1)
121 format('longitude latitude # land dhole dwell dwater dstat'
& ', dprod dschg diam diam2 diam3 diam4'
& ', dtop dtop2 dtop3 dtop4 dbot dbot2 dbot3 dbot4')
return
end
```

Monday August 11, 97

amarg.f

2/2

Notes on using GFLOW & defining capture zones for 3-D problems

① Calculation of a gradient

GFLOW uses discharge potential as a dependent variable. For the uniform regional gradient, or rather the potential due to the uniform regional gradient, the transmissivity is multiplied times the gradient. The gradient itself can be calculated assuming a confined or an unconfined aquifer (H or H^2 dependence) (H = head). However, since this is a thick aquifer (thickness = 1000 m), the difference is insignificant, hence just use $\Delta H = (H_2 - H_1) / (x_2 - x_1)$ where x is horizontal distance.

② The "specific velocity" in GFLOW is the darcy velocity. Hence, the further from the well, the closer this specific velocity should come to the velocity hand-calculated from the uniform regional gradient

$$|g| = |-K \Delta H| \text{ which ignoring vectors } \Rightarrow g = K \Delta H$$

This is the basis for the 1/2% error allowed in determining how far to go away from the well to delineate a capture zone. The particle traces are essentially going straight (in horizontal plane) by the time

$$\frac{q_{hand\ case} - q_{GFLOW}}{q_{GFLOW}} < \frac{1}{2}\%$$

In the vertical plane, the particle traces indicate that the vertical effect diminishes much sooner, approx. 1/2 to 1/3 the distance for the horizontal

Also note that the usual idiom of at 1-2 aquifer thickness, the effect of partial penetration is no longer present; i.e. the solution for a fully penetrating well is the same for a partially penetrating well at that distance. This idiom should not be used due to the extremes at which we are pumping, the thickness, and the small degree of partial penetration of the well.

③ The width may be more realistic of actual situation due to the layering having a profound effect.

RF 8/11/97
 Trial & error
 particle tracing led
 to choice of 1/2% error;
 this is when traces
 stopped significantly
 changing for a range
 of problems.

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GFlow Base Case

PF 3/23/99

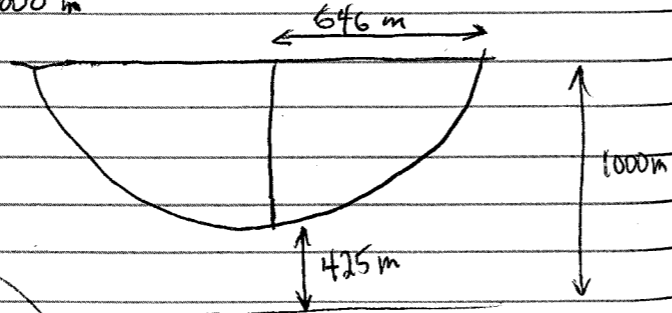
Parameters which typically will not be changed:
 porosity = use default (no time dependent analysis) = 0.2
 thickness = 1000 meters
 base = 0
 reference = $x=0, y=-10,000, head=1000m$
 well location = $x=0, y=0$
 well radius = 0.34 meters
 Base case parameters (those that will change in sensitivity analyses):
 permeability = 0.1 m/day
 uniform flow = 0.5 $\frac{m^2}{day}$ $T=100 \frac{m^2}{d}$ $\nu h=0.005$
 pump rate = 300 $\frac{m^3}{day}$ mid-range for irrigation
 Screen $\Rightarrow z_1=940m, z_2=1000m$

Head @ (0, 9000) = 999.9 m hence reference head is not signif. impacting
 $[q_{flow}]_{x=-6350} = .5075E-3 \%$ $\Rightarrow 1\frac{1}{2}\%$ difference

$[q_{gate}]_{uniform flow field} = .50E-3 \%$ $\Rightarrow q = K_{sat} \nu h$ ignoring vector's direction

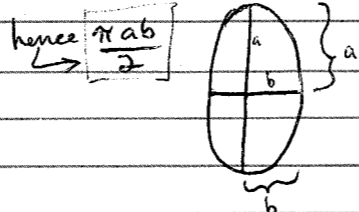
particle trace in horizontal plane, y-value not changing
 at $x=-6350m$ as suggested by $1\frac{1}{2}\%$ rule, confirmed
 vertical not changing at $x=-2000m$

half-width = 646 m
 elevation = 425 m



capture zone
 width = 1292 m
 thickness = 575 m

area of ellipse = $\pi \cdot a \cdot b$



cross-check [area * q] = Q pumping
 $\frac{\pi (646m)(575m)}{2} * [.5075E-3 \frac{m^3}{d}] = 300 \frac{m^3}{d}$
 $296 \frac{m^3}{d} \approx 300 \frac{m^3}{d}$

should use
 $q = .5 \times 10^{-3} \%$
 of 9/15/97

units = meters

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	half-width	elev	capture zone width	thick	Note
Base Case	646	425	1292	575	
Screen \Rightarrow 810-1000	619	400	1238	600	max screen length
Screen \Rightarrow 500-1000	470	248	940	752	artificial screen
fully penetrating well	287	0	574	1000	fully penetrating

defining a window (in which to delineate the capture zone) means that GFlow will calculate all parameters at the resolution (grid) requested (now using 100 nodes in horizontal plane). Hence, defining a window closer to the closer leads to better mouse resolution in releasing particles. The starting and ending points of each release are recorded at the top of the screen. If the window covers too much area (far-field), the mouse location resolution suffers. However, for strong wells and weak uniform regional gradients, large windows are needed to delineate the capture zone at the point where it becomes essentially 2-D

scoping for future reference (units are meters, days) radius = 534 m
 aquifer thickness = 1000 m

Screen	Q pump	Q uniform	dh	Trans.	K _{sat}	1/2 width	elev	capture
940-1000	1380	0.1	0.01	10	.01	6358	<16	entire capture
940-1000	1380	0.5	.005	100	0.1	1691	59	
940-1000	1380	2.0	.005	400	0.4	707	391	
880-940	690	0.5	.005	100	0.1	1046	203	

RF 228/10/97

RF 8/12/97
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GFlow simulation - Domestic Wells

1 Ac-ft/household or 1800 gal/day/household

This is DOE (Site Characterization 1988) estimate. Plus Nevada Division of Water Resources uses this value (personal communication via telephone) for their water use estimates. Thomas Buzo (1996) report acknowledges that this value is high, a more reasonable estimate is probably less than half that value based on some metering at selected wells.

Use range 1 - 6.625 m³/d [1, 2, 3, 4, 6.625 m³/d = Q_{pump}]

Base Case: Screen 940-1000 units meters, days
(domestic) Q_p = 3
radius = 0.34 partially penetrating well at x=0, y=0
Q_{uniform} = 0.5 aquifer thickness = 1000
K_{sat} = 0.1
Transmiss. = 100
∇h = 0.005
reference → x=0, y=10000 h=1000

	head at well	1/2 width	elev
1) Base Case window [-250 -75 50 50]	999.555	38	912.2
2) Screened at 930-940 thin layer 999.2-999.8 not captured	999.835	34.6	902.5 to 999.2
3) Q _{pump} = 2 (screen at 940-1000) window x=-200 (1/2 of q _{uniform})	999.703	27	918.5
4) Q _{pump} = 1 1/2 of q _{uniform} → x = -138 screen @ 940-1000	999.852	14.3	927.4
5) Q _{pump} = 4 1/2 of q _{uniform} → x = -389 ditto screen	999.406	48.7	904.4

	head @ well	1/2 width	elev	
6) Q _{pump} = 6.625 screen 940-1000 1 1/2 of q _{uniform} → x = -375	999.016	71.7 71.3	888.4 888.7	backward forward trace
7) K _{sat} = 0.1 ∇h = 0.001 Q _p = 3 1/2 of q _{uniform} → x = -575 Screen → 940-1000	999.555	124 123.4	848.8 849.2	backward forward
8) ditto case 7) K _{sat} = 0.01 ∇h = 0.005 (T=10) 1 1/2 of q _{uniform} → x = -855 Q _{uniform} = 0.05	995.54	184.5 183.4	796.9 798.1	backward forward
9) ditto case 8) K _{sat} = 0.05 (T=10 m ² /s) 1 1/2 of q _{uniform} → x = -357	999.109	66.6 66.1	891.8 892.1	backward forward
10) ditto case 8) K _{sat} = 0.4 (T=400 m ² /s) 1 1/2 of q _{uniform} → x = -120	999.889	10.9 10.88	929.7 929.8	backward forward
11) ditto case 8) ∇h = 0.01 (K _{sat} = 0.1) Q _{uniform} = 100 1 1/2 of q _{uniform} → x = -173	999.555	20.6 20.5	922.7 922.5	backward forward

q_{uniform} = darcy velocity
∇h = gradient of head

PATCHI Simulations (Analytic solution 3-D dispersion)

Parameter values needed for input

Concentration - C_0

particle velocity - v

dispersivity longitudinal - α_L

" transverse horizontal - α_{T_y}

" transverse vertical - α_{T_z}

retardation factor - R_d

half-life - $T_{1/2}$

z_1 & z_2 vertical coordinates of patch source

y_1 & y_2 horizontal coordinates of patch source

Dispersion = $v\alpha$

i.e.

$$D_x = v\alpha_L$$

$$D_y = v\alpha_{T_y}$$

$$D_z = v\alpha_{T_z}$$

The base values of these parameters used in the EPRI TSP (which used the Domenico-Robbins solution)

$$C_0 = 10,000$$

$$v = 1.7 \times 10^{-6} \text{ m/s}$$

$$\alpha_L = 20 \text{ m}$$

$$\alpha_T = 5 \text{ m}$$

$$R_d = 10 \quad (K_d = 0)$$

$$T_{1/2} = 1 \times 10^{20} \text{ s}$$

$$z_2 = 50 \text{ m}$$

$$y_2 = 800 \text{ m}$$

modeled from "accessible environment through alluvium"

The long half-life sets decay = 0 essentially

The distribution coef = 0 = K_d sets simulation to neglect adsorption

They defined the plume at 10^{-4} concentration

(which I guess means 8 orders of magnitude to define plume).

No, actually they use $10^{-4} * C_0$ to define the plume.

What are reasonable values for these parameters.

(1) For starters, just normalize the initial concentration to 1
 $C_0 = 1$

(2) Keep adsorption set to zero; decay as well.

(3) seepage velocity (v) $\Rightarrow \frac{q}{\phi}$ for saturated q = Darcy velocity

$$1.76 \times 10^{-6} \text{ m/s} \Rightarrow 55.4 \text{ m/yr}$$

Annual NRC report 1996 states ranges of velocities (Darcy)

$$\text{footprint tuff} \Rightarrow 0.5 - 1.9 \text{ m/yr}$$

$$\text{tuff} \Rightarrow 0.01 - 3.7 \text{ m/yr}$$

$$\text{alluvium} \Rightarrow 0.4 - 0.7 \text{ m/yr}$$

assuming porosity = 0.1 for tuffs
= 0.3 for alluvium

$$\text{footprint tuff } v \Rightarrow 5 - 19 \text{ m/yr}$$

$$\text{tuff } v \Rightarrow 0.1 - 37 \text{ m/yr}$$

$$\text{alluvium } v \Rightarrow 1.33 - 2.33 \text{ m/yr}$$

Based on these values, the EPRI study used a much larger value of velocity. This causes a longer time to breakthrough but increases the dispersion (thus larger dilution factors) as compared to using a smaller velocity.

Clearly a sensitivity will have to be done for seepage velocity.

There is another question about the choice of velocity which includes the length of the x-direction (principal direction of flow).

At what distance to calculate plume configuration

a) start from repository and go 30 km to Amargosa Valley (junction of highways, the town) and include flow through the tuffs as well as the alluvium.

- what should the patch size be?

- what value of velocity is representative of all units?

- what dispersivity values are representative of all units?

b) start from the "accessible environment" or fence and essentially only model the plume through the alluvium

- sensitivity on plume dimensions (EPRI did this)

- then it's only ~15 km to Amargosa Valley junction

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(4) What values of dispersivity to use for the 3 dispersion values needed

EPRI used a 4:1 ratio α_L/α_T with $\alpha_L = 20$ m for their base case; and they varied their α_T (horizontal dispersivity) from 2.5 to 10 meters.

Based on Gelhar ^{et al} 1992 (Water Resources Research 28(7) p. 1955-1974) a generic set of dispersivity values can be ascertained,

The popular modeling ratio $\frac{\alpha_L}{\alpha_T} = 3:1$ was not supported by the Gelhar et al work, his tabulations indicated:

$\frac{\alpha_L}{\alpha_T}$ range 1:1 to 50:1
mostly between 3:1 and 20:1

$\frac{\alpha_L}{\alpha_{Tz}}$ range 10:1 and 650:1

α_L generally between 0.01 and 1000 m } length scale dependence
 α_{Ty} " 0.005 and 100 m }

α_{Tz} generally between 0.003 and 0.06 m } no length scale dependence

most α_L values are less than 200 m; but for the "reliable" data
max $\alpha_L = 4$ for length scales less than 250 m
(no "reliable" data for larger length scales)

Gelhar's rule of thumb $\alpha_L : \alpha_{Ty} : \alpha_{Tz}$

use order of magnitude differences especially for $\alpha_{Ty} : \alpha_{Tz}$ ratio

Obviously we don't have any site-specific data for Amargosa Valley & Amargosa Farms area.

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Sample input files & methodology

Two sample input files are attached at the bottom of this page.

- (1) The 1st one is used to approximate the plume configuration. 10^{-4} cutoff is approximated from pairs of y values & z values from simulation results. Since a linear interpolation is used on this non-linear data set, a second simulation is used.
- (2) The second simulation attempts to input the exact point at which $C = 10^{-4}$ is reached, the results of simulation verify the guess (from interpolated estimate).

The 1st interpolations are done in a spreadsheet program (Excel, designed for business use!).

File: farms7.dat

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7th Run, scoping - Amargosa Farms; for new output file y=15 & only 1 time!
patchi code: aquifer of infinite width and height with a 'patch' source
Model Data: Y1=-250 m, Y2=250 m, Z1=0 m, Z2=25 m, V=10 m/yr
DX=1000, DY=100, DZ=10 m**2/yr, DK=1E-16 per yr, C0=1.0 mg/L

```
====
1 15 16 5 104 0
mg/l m/yr m**2/yr per yr meter yr 1.E-16
1.0 10.0 1000.0 100.0 10.0 1.E-16
-250.0 250.0 0.0 25.0
15000.0
0.0 1000.0 1500.0 2000.0 2400.0 2600.0 2800.0 3000.0
3200.0 3400.0 3600.0 3800.0 4000.0 4500.0 5000.0
0.0 200.0 400.0 600.0 800.0 1000.0 1200.0 1400.0
1600.0 1800.0 2000.0 2200.0 2400.0 2600.0 3000.0 4000.0
4000.0 5000.0 6000.0 8000.0 10000.0
```

file: f.dat

Detailed - Amargosa Farms
patchi code: aquifer of infinite width and height with a 'patch' source
Model Data: Y1=-250 m, Y2=250 m, Z1=0 m, Z2=25 m, V=10 m/yr
DX=1000, DY=100, DZ=10 m**2/yr, DK=1E-16 per yr, C0=1.0 mg/L

```
====
1 15 16 1 104 0
mg/l m/yr m**2/yr per yr meter yr 1.E-16
1.0 10.0 1000.0 100.0 10.0 1.E-16
-250.0 250.0 0.0 25.0
15000.0
0.0 1023.0 1024.0 1025.0 1026.0 1027.0 1430.0 1851.0
2683.0 2684.0 2685.0 2686.0 2500.0 2291.0 2292.0
0.0 295.0 296.0 297.0 298.0 299.0 300.0 450.0
260.0 763.0 653.0 654.0 685.0 850.0 1000.0 2000.0
5000.0
```


The file is called o/Bore/Analytic/Amarjosa/patchi.xls

At 3/22/89
The point of making 2 simulations (1st to get interpolated estimate, 2nd to verify) is that of reproducibility. Certainly, the ~~accuracy~~ precision is dependent on the grid chosen in the 1st simulation. The second simulation just removes the grid size choice as a dependant variable. With all of the guess-estimation on dispersivity and seepage velocity, the added precision in results is not warranted.

Also noted that some of the simulations pushed the method used to calculate the integrals of the analytic solution. The default value of Legendre quadrature points is 104. This had to be increased to 256 quadrature points when it was noted that oscillations occurred from time step to time step.

Form4.dat approximates the EPR1 implementation (Domencio - Robbins) by setting α_{Tz} to essentially zero. EPR1 actually set $\alpha_{Ty} = \alpha_{Tz} = 5 \text{ m}$ (for the base case) which leads to increased amount of dispersion.

			plume width	dilution factor
15 km	Patchi code	$\alpha_{Tz} = 0$	3250 m	4.1
25 km	"	$\rightarrow = 1 \times 10^{-6} \text{ m}$	4042 m	5.2
15 km	Patchi code	$\alpha_{Tz} = 0.5$	2846 m	25.6
25 km	"	"	3442 m	41.5
15 km	EPR1 results	$\alpha_{Tz} = \alpha_{Ty} = 5 \text{ m}$?	20
25 km	"	"	3.3 km	33

not included on table of previous page }
I could not reproduce EPR1's results (I got df=141 for 25 km case). Given the layering of the alluvial sediments, $\alpha_{Tz} = 5 \text{ m}$ does not seem reasonable. The choice of $\alpha_{Tz} = 0.5 \text{ m}$ (an order of magnitude less than horizontal transverse dispersivity) is the reasonable choice between the other two extremes.

30 8/21/97
RF

Water Use Estimates

Handwritten & computer tables were obtained from State Engineers Office (Nevada) of water use estimates for Basin 230 - Amargosa Desert, Chad Glean (NRC - Las Vegas office) made the xeroxes. Robert Coache (Bob) (702) - 486-2770 is now the chief engineer, he puts together the tables. The xeroxed tables will be in the CWRMA library system; the years included are 1983-1996; 1984 is not available. The engineer's annual summaries are tabulated below for the entire Amargosa Desert followed by a table which I removed non-Amargosa Farms wells. The wells which are

Summaries of Groundwater Pumpage - Nevada State Engineer's Office
Adjustments to State Engineers data removes non-Amargosa Farms wells.
Borehole Dilution ARDES KTI -- RFedors

Actual State Engineer Tabulation

Year	Irrigation Ac-Ft	Irr/NoPer Ac-Ft	AB/IMV/BF Ac-Ft	QM/COM Ac-Ft	QM/DOM Ac-Ft	Other Ac-Ft
1996	9263	1780	2285	205	50	30
1995	10839	1515	2571	10	100	0
1994	8892	1085	2508	10	100	0
1993	8558.8	150	2481	10	100	0
1992	5711	50	2292.5	10	100	0
1991	4716.5	225	1070	10	100	0
1990	4603.1	350	2719.29	10	125	0
1989	1266	300	2220	10	125	0
1988	2666	312	996	10	125	0
1987	4500	1200	302	10	125	0
1986	5552.9	1000	550	10	125	0
1985	5807	2665	950	20	230	0
1983	5893	3212	125	20	250	0

Remove non-Amargosa Farms Wells

Irrigation Ac-Ft	Ind-IVM/AB Ac-Ft	QM/COM Ac-Ft	Domestic Ac-Ft	Other Ac-Ft	Total Ac-Ft
11033	1019	203.8	50	0	12305.8
12354	780	10	100	0	13244
9977	717	10	100	0	10804
8658.8	1007	10	100	0	9775.8
5711	653.5	10	100	0	6474.5
4941.5	450	10	100	0	5501.5
4953.1	886.69	10	125	0	5974.79
1566	1413	10	125	0	3114
2978	996	10	125	0	4109
5700	302	10	125	0	6137
6552.9	550	10	125	0	7237.9
8472	950	20	230	0	9672
9105	125	20	250	0	9500

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part of Amargosa Desert, Basin 230 in state and federal nomenclature, are listed below

permit #	sec	Township	Range
22140	8	17 S	52 E
22141	7	17 S	52 E
51841-51848	}	12-13 S	46 E
58268			
61412			
61413	7	18 S	51 E
53596	7	18 S	51 E
54271	7	17 S	52 E

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There were no other non-pro water use estimates for wells outside of the Amargosa Farms area. For simplicity, I defined the Amargosa Farms area by range and township as Townships 15-18 S and Ranges 46-50 E.

Detailed tables listing water use by well permit followed each annual summary. According to the state engineer, the domestic wells are not tracked, only an annual estimate is given. Also, many of the wells are not metered; these are to be considered estimates, not actual pumpage. They use acreage under irrigation, type of crop to estimate.

The detailed water use information was entered into a spreadsheet (pump.xls) for years 1983, 1985-1986. A copy of the spreadsheet is attached to the following pages and it includes various averages and summations including a separate table on the page 33 of this notebook.

Notes: (1) "assumed # of wells" = the number of permits listed under 1 water use estimate, assumes 1 well/permit
(2) no domestic wells are listed in the tables, the state engineer said domestic wells are limited to 1800 gal/min, though often the actual use is less than half that.

RF
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RF

near Beatty

- (4.) unpermitted irrigation users have a deceptive word in place of a permit number
- (5.) The summary statistics tables \Rightarrow Ac-ft units, another table with m³/day units (spread over entire year of irrigation)
- (6.) State engineer says that water use on permit can change.

Water Use		pump rating		all years	1996Ac-ft	1995Ac-ft	1994Ac-ft	1993Ac-ft	1992Ac-ft	1991Ac-ft	1990Ac-ft	1989Ac-ft	1988Ac-ft	1987Ac-ft	1986Ac-ft	1985Ac-ft	1983Ac-ft	
	qm/mun	m ³ /d	cfs															
permitted acreage irrigation 4237		584	0.239	average	13													
		9	9	count		10	0	0	0	0	0	0	0	0	0	0	0	0
		10	0.004	sum		128	0	0	0	0	0	0	0	0	0	0	0	0
		1933	0.790	min		0.1												
com/mm		1266	0.517	average	332	153	390	359	372	327	225	443	707	332	101	184	475	255
		6	6	count		7	2	2	2	2	2	2	2	3	3	3	2	1
		46	0.019	sum		1072	780	717	744	654	450	887	1413	997	303	551	950	255
		6214	2.540	min		0.1	349	340	232	306	115	384	525	1	1	1	110	255
irr/d		3366	1.376	average	244	213	262	228	210	190	329	191	103	148	266	384	335	320
		60	60	count		55	51	44	41	30	15	26	15	20	20	17	25	26
		39	0.016	sum		11721	13344	10017	8604	5711	4942	4953	1541	2968	5314	6528	8372	8316
		13212	5.400	min		1.0	2	1	1	1	20	5	5	3	3	3	23	5
total		2864	1.171	average	248	179	266	233	217	199	317	209	174	172	244	354	345	317
		75	75	count		72	53	46	43	32	17	28	17	23	23	20	27	27
		10	0.004	sum		12920	14124	10734	9348	6365	5392	5840	2954	3965	5616	7079	9322	8571
		13212	5.400	min		0.1	2	1	1	1	20	5	5	1	1	1	23	5

RF
8/21/97

cubic meters/day		pump rating		all years	996 m3/d	1995m3/d	1994m3/d	1993m3/d	1992m3/d	1991m3/d	1990m3/d	1989m3/d	1988m3/d	1987m3/d	1986m3/d	198m3/d	1983m3/d	
	qm/mun	m ³ /d	cfs															
permitted acreage irrigation 4237		584	0.239	average	43													
		9	9	count		10	0	0	0	0	0	0	0	0	0	0	0	0
		10	0.004	sum		432	0	0	0	0	0	0	0	0	0	0	0	0
		1933	0.790	min		0.3												
com/mm		1266	0.517	average	1126	519	1321	1214	1260	1107	762	1501	2392	1125	341	622	1609	864
		6	6	count		7	2	2	2	2	2	2	2	3	3	3	2	1
		46	0.019	sum		3631	2641	2428	2519	2213	1524	3003	4785	3375	1024	1865	3217	864
		6214	2.540	min		0.3	1181.9	1151.4	785.6	1036.2	389.4	1299.0	1777.9	1.7	1.7	2.0	372.5	863.5
irr/d		3366	1.376	average	828	722	886	771	711	645	1116	645	348	503	900	1300	1134	1083
		60	60	count		55	51	44	41	30	15	26	15	20	20	17	25	26
		39	0.016	sum		39691	45188	33921	29137	19341	16734	16773	5218	10052	17995	22106	28352	28160
		13212	5.400	min		3.4	6.8	3.4	3.4	3.4	67.7	16.9	16.9	8.5	8.5	8.5	76.9	16.9
total		2864	1.171	average	841	608	902	790	736	674	1074	706	588	584	827	1199	1169	1075
		75	75	count		72	53	46	43	32	17	28	17	23	23	20	27	27
		10	0.004	sum		43754	47830	36349	31656	21554	18258	19776	10003	13426	19020	23971	31569	29023
		13212	5.400	min		0.3	6.8	3.4	3.4	3.4	67.7	16.9	16.9	1.7	1.7	2.0	76.9	16.9

- ⑧ some observations on comments column in xeroxed tables:
 - 5 Ac-ft \Rightarrow alfalfa, pasture, sod, garden, fruit trees, dairy
 - 2 1/2 Ac-ft \Rightarrow fruit trees, grapes, garden
 - 2 Ac-ft \Rightarrow grains, pistachio trees, fruit trees, pasture
 - 1 Ac-ft \Rightarrow wind breaks, gardens
 - 0.5 Ac-ft \Rightarrow mobile home / trailers (450 gpd)

⑨ The increased number of wells which are active increases in the mid-90's probably due to threat of losing water rights brought on by golf course / community development project which anticipated a need for 24,000 Ac-ft/yr pumped water (Valle de Sol development, Amargosa Resources, Inc.)

⑨ Highest pumpage listed 1162.5 Ac-ft apparently uses 1 well (there is only 1 permit); other high pumpage users have 2 or 3 wells (permits) \Rightarrow 600-700 Ac-ft range.

⑩ The "permitted acreage irrigation" = 4237 Acres is the sum of acres for all actual water users where the acres are ~~from~~ from the permit.

RF 312349

⑩ These tables are a more complete version of the tables listed on scientific notebook pages 6&7.

⑫ Permit database (Scientific Notebook pages 6&7)
Total permitted acreage for all active [certificated, ~~permitted~~ permitted (but not certificated), & application pending categories]

RF 312349

6757 Acres Irrigation for 176 permits

⑬ Bugo (consultant) report to Nye County 1996

Reports \Rightarrow Basin 230 28,600 Ac-ft/yr committed groundwater for irrigation; (total committed is 41,093 Ac-ft/yr).

```

Aug 04, 97 8:12      range.f      Page 1/2
*****
** Main purpose is to convert Range & Township locations to UTM **
** coordinates assuming the center of quarter-quarter setions. **
** Program reads data from the Well Permit & Water Use databases as **
** created from data entry spreadsheet files permit.xls & pump.xls **
** Xerox copies of tables obtained from Nevada Engineers Office. **
** **
** Should work for any Range & Township as long as lower left coord **
** are input and range() & twnsbp() dimensionings are changed. **
** RFedors (17July97) **
*****
*           1           2           3           4           5           6           7
*234567890123456789012345678901234567890123456789012345678901234567890123456789012
program rangee

implicit none
character qq*2, qtr*2
character infile*12, outfile*12
integer*4 ipermit, section, twn, rang, i, j, ir, numrec
integer*4 range(46:50,15:18), twnsbp(46:50,15:18)
real*4 dmile, dqtr, dqg, utmnorth, utmeast, water
real*4 x, xl, yl, xxl, yyn, sect
parameter ( numrec=60 )

infile = 'pump96.pm'
outfile = 'pump.dat'
open(8,file=infile,status='unknown')
open(9,file=outfile,status='unknown')

c Assume 6x6 square mile Range and Townships, hardcode in the
c lower left corner of each Range & Township in terms of UTM
c coordinates; hence, work in units of meters.
dmile = 5280 * .3048
dqtr = dmile * 0.25
dqg = dqtr * 0.25

range(47,15) = 524845
twnsbp(47,15) = 4050075
range(47,16) = 524892
twnsbp(47,16) = 4040442

range(48,15) = 534548
twnsbp(48,15) = 4050098
range(48,16) = 534548
twnsbp(48,16) = 4040422
range(48,17) = 534956
twnsbp(48,17) = 4030608

range(49,15) = 544172
twnsbp(49,15) = 4050188
range(49,16) = 544252
twnsbp(49,16) = 4040264
range(49,17) = 544607
twnsbp(49,17) = 4030608
range(49,18) = 544801
twnsbp(49,18) = 4021390

range(50,15) = 553516
twnsbp(50,15) = 4050250
range(50,16) = 553888
twnsbp(50,16) = 4040288
range(50,17) = 554457
twnsbp(50,17) = 4031046
range(50,18) = 554457
twnsbp(50,18) = 4021390

c Determine which Range and Township (most are in R48,49 E).
do 90 ir = 1,numrec
read(8,101) ipermit, qq, qtr, section, twn, rang, water
    
```

Monday August 04, 97

range.f

```

Aug 04, 97 8:12      range.f      Page 2/2
101  format(i8,1x,a2,2x,a2,1x,3i4,f7.3)

      utmnorth = twnsbp(rang,twn)
      utmeast = range(rang,twn)

c Sections.
      if(section.le.6) sect = 5.5 * dmile
      if(section.gt.6.and.section.le.12) sect = 4.5 * dmile
      if(section.gt.12.and.section.le.18) sect = 3.5 * dmile
      if(section.gt.18.and.section.le.24) sect = 2.5 * dmile
      if(section.gt.24.and.section.le.30) sect = 1.5 * dmile
      if(section.gt.30.and.section.le.36) sect = 0.5 * dmile
      utmnorth = utmnorth + sect

      x = dmile * ( 6. - 0.5 )
      do 40 j = 1,5,2
        do 30 i = 1,6
          if(section.eq.(j-1)*6+i) utmeast = utmeast + x
          x = x - dmile
30      continue
40      x = dmile * ( 6. - 0.5 )
      continue

      x = dmile * 0.5
      do 60 j = 2,6,2
        do 50 i = 1,6
          if(section.eq.(j-1)*6+i) utmeast = utmeast + x
          x = x + dmile
50      continue
60      x = dmile * 0.5
      continue

c Quarter sections and Quarter-Quarter; any other entry ('xx'), left at => 0.
      xl = 0.
      yl = 0.
      xxl = 0.
      yyn = 0.
      if(qtr.eq.'nw'.or.qtr.eq.'sw') xl = -dqtr
      if(qtr.eq.'ne'.or.qtr.eq.'se') xl = dqtr
      if(qtr.eq.'nw'.or.qtr.eq.'ne') yl = dqtr
      if(qtr.eq.'sw'.or.qtr.eq.'se') yl = -dqtr

      if(qq.eq.'nw'.or.qq.eq.'sw') xxl = -dqg
      if(qq.eq.'ne'.or.qq.eq.'se') xxl = dqg
      if(qq.eq.'nw'.or.qq.eq.'ne') yyn = dqg
      if(qq.eq.'sw'.or.qq.eq.'se') yyn = -dqg

      utmnorth = utmnorth + yl + yyn
      utmeast = utmeast + xl + xxl
      write(9,'(2f10.0,f10.3,i10)') utmeast, utmnorth, water, ipermit

90  continue

      stop
      end
    
```

RF
8/21/97

range.f

8/21/77
35 RF

In order to plot the water use data to illustrate spatial distribution, a conversion utility was used to go from Range & Township coordinates to UTM coordinates. This is used only for graphical purposes because the transformation is inexact

- (1) Lower left (SW) corner of each range & township is given an UTM coordinate (read/approximated from 7 1/2' and 15' topo maps)
- (2) assume 6 mile x 6 mile square range & townships.
- (3) assume well is in center of section, quarter section, or quarter-quarter section (this choice depends on the amount of information available).
- (4) other plotted data is also in the UTM coordinates (NAD 27 conversion); UTM coordinates for 7 1/2' quad map outline, coordinates for roads (highways 29 and 95); GWSI database in longitude and latitude converted to UTM; the streamtubes of Gordon Wittmeyer
- (5) output is ready for teplot by adding appropriate header line for ~~plotting~~ scattered data.

RF
3/23/99

The code to accomplish this conversion is attached to this page. It is used on SUN workstation & should also work on a PC, using fortran 77

Well Driller Reports

Xeroxed by Chad Glenn (NRC, Las Vegas office) at Nevada Division of Water Resources. Made arrangements to reduce usual \$100/reports plus 20¢ add'l pages of report (many reports are 2 pages) to free if Chad brings his own paper & does xeroxing himself. The logs can not leave the office.

535 Reports were xeroxed in Amargosa Farms area (Ranges 47-50E, Townships 15-17S)

27 Excluded as being in Ash Meadows (eastern half of Range 50E)

16 described as "test" wells

18 with no "use" category noted

Remaining = 474 wells drilled (since at least 1921)

		Domestic	Dom/Irrig	Irrigation	Indust/commercial	Mun
South	T 17 S	52	6	62	1	1
↕	T 16 S	199	18	111	1	3
North	T 15 S	12	0	5	2	1

Man to quasi-municipal

Discrepancies may occur due to changes from original use category on a permit to present day usage.

RK
3/22/99

current tables (Bao (Site Characterization 1988 DOE))

- 9 quasi-municipal
- 5 commercial
- 3 industrial

Also note dual use designations for 24 wells domestic & irrigation

Hot spots for domestic wells

Quantity	section	Township	Range
40	15	16 S	49 E
33	35	16 S	49 E
30	12	17 S	48 E
25	8	16 S	49 E
15	10	16 S	48 E
14	22	16 S	49 E

Distribution of Domestic wells (includes dual dom/irrigation wells)

	R47 S	R48 E	R49 E	R50 E
North	T 15 S	0	2	2
↕	T 16 S	1	105	110
South	T 17 S	0	27	17

Total domestic (plus dom/irrig) = 287 wells drilled

Total irrigation (plus dom/irrig) = 302 wells drilled

Comments on lithologies:

- ① well drillers are notoriously bad at logging core (understandable)
- ② most of the descriptions are variations of sand, gravel, clay
- ③ other noted types: limestone layers, cemented sands and/or gravels, boulder/gravel (3-4 ft thick) → streambeds?, sands with beds of clay, caliche; volcanic tuff, red clay, brown clay, loam
- ④ units vary from a few feet to tens of feet
- ⑤ numerous notations of multiple water-bearing units and numerous clay beds

8/26/97
38 RF

ARC-INFO

Ron Martin helped

Extraction of UTM coordinates for roads, state line, and for digitized range & township lines to aid perspective when plotting well locations or quantity & distribution of domestic wells drilled.

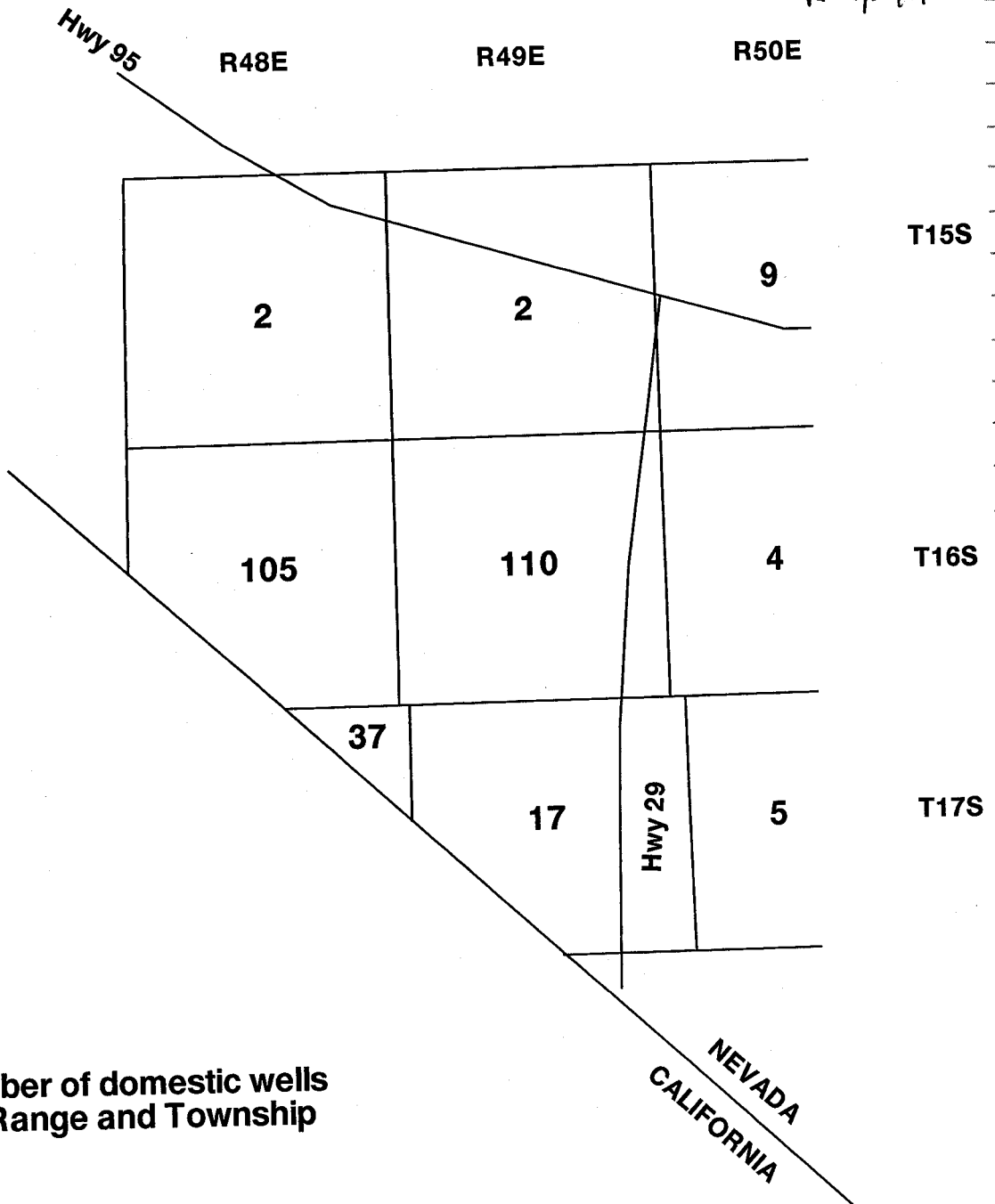
ARC-INFO, R. Martin has Beatty satellite image, and roads from DV junction coverage. Both files are kept in a library of databases directory for general staff usage.

We digitized the range & township (also roads, to check for reliability against their existing roads database) from Figure 1 of Oatfield & Czarniecki (1991).

I can then extract UTM coordinates for all of the features I want to plot in Tecplot to use a frame of references.

Here's an example of the result:

RF 8/26/97



Number of domestic wells by Range and Township

9/9/97
RF 39

STRIPI code → Put under TOP-018 control

In order to model horizontal transverse dispersion, the stripi.f code was compiled. Patchi.f code is designed to model 3-D dispersion. However, the plumes obtained were 300 m to 1 km or more thick. Since many existing plumes remain thin, but do spread out laterally (due to stratification of sediments), a code which simulated 2-D dispersion (α_x and α_y) from a line source was found. Stripi.f is one of codes found at the USGS web site

<http://water.usgs.gov/software/ground.html>

and documented in Wexler, E. J. (1992) → Analytical Solutions for One-, Two-, and Three-Dimensional Solute Transport in Ground-Water Systems with Uniform Flow; USGS Tech of Water-Resource Investigations Chapter B7, Book 3.

Installation: similar to that for patchi.f (see page 13 of this book) except changes to files sub2.f for the time stamp.

Sample problem 7 was used as verification of proper installation. Results of USGS generated output are identical to my output; paper copies are in TOP-018 folder

Stripi.f is used because of peculiarities in patchi.f results when vertical dispersion was set to something near zero (10^{-6} , relatively speaking). Stripi.f was compiled so as to verify adaptation of patchi to 2D, but then, heh, why not just use stripi.f for thin plumes where no vertical dispersion is occurring.

Sample input file:

```

Thin plume - Amargosa Farms; dispersivities 20:2 meters
stripi code: aquifer of infinite width with a finite width source (line)
Model Data: Y1=-250 m, Y2=250 m, V=10 m/yr
DX=200 , DY=20 m**2/yr, DK=1E-16 per yr, C0=1.0 mg/L
=====
 2 15 1 256 0
mg/l m/yr m**2/yr per yr meter yr
 1.0 10.0 200.0 20.0 1.E-16
-250.0 250.0
15000.0 25000.0
 0.0 1000.0 1100.0 1200.0 1400.0 1600.0 1800.0 2000.0
2200.0 2400.0 2600.0 2800.0 3000.0 3500.0 4000.0
5000.0

```

RF
9/9/97

40
9/10/97
RF

Plume Widths & Thicknesses (patchi & strip results)

[Spreadsheet File → o:\Bore\Analytic\Amargosa\patchi.xls]

Summary of scenarios included in report on Borehole Dilution.
Methods are described on pages 24-29 of this scientific notebook.
This chart supersedes (replaces) the chart on page 28; the differences are ① more entries; and, ② centerline concentrations properly account for water table boundary condition (spreading only in vertical direction).

patchi transport mini calculations, units=meters,years															
note that the results are simulated to steady state, thus results do not depend on velocity															
FILE.dat				y1	y2	z1	z2	v	Dx	Dy	Dz	Dk	L:Ty:Tz	dispersity	
farms4				-250	250	0	25	55	1100	275	1.00E-06	1.00E-16	20:5:0		
farms4b				-250	250	0	25	55	1100	275	27.5	1.00E-16	20:5:5		
farms4c				-250	250	0	25	55	1100	275	275	1.00E-16	20:5:5		
farms4d				-250	250	0	50	55	1100	275	275	1.00E-16	20:5:5		
farms5				-250	250	0	25	10	1000	200	20	1.00E-16	100:20:2		
farms6				-250	250	0	25	10	1000	200	10	1.00E-16	100:20:1		
farms7				-250	250	0	25	10	1000	100	10	1.00E-16	100:10:1		
farms8				-250	250	0	25	10	1000	100	1	1.00E-16	100:10:0.1		
farms9				-250	250	0	25	10	500	50	5	1.00E-16	50:5:5		
farms10				-250	250	0	25	10	200	20	2	1.00E-16	20:2:2		
note that the following results are not dependent on velocity in steady state case															
strip#20				-250	250			10	200	20		1.00E-16	20:2		
strip#21				-250	250			10	500	50		1.00E-16	50:5		
strip#22				-250	250			10	1000	100		1.00E-16	100:10		
Code: patchi.f	Code: patchi.f	Plume	Distance	Interpolated estimates				Final simulated estimates				Centerline	Centerline	dilution	
Dispersivities	Source Size			half width	range	thickness	range	half-width	thickness	half-width	thickness	width	half-conc.	conc	factor
	sq.meter	(m)	half width range	thickness range	half-width	thickness	half-width	thickness	half-width	thickness	width	half-conc.	conc	factor	
#4, 15 km	20:5:0	25x500	15	1500	2000	25	25	1611	25	1625	25	3250	2.41E-01	0.482	2.1
				3.19E-04	1.75E-06										
#4, 25 km	20:5:0	25x500	25	2000	2100	25	25	2021	25	2021	25	4042	1.92E-01	0.384	2.6
		25x500		1.17E-04	5.49E-05										
#4b, 15km	20:5:0.5	25x500	15	1000	1500	250	500	1410	421	1423	437	2846	3.90E-02	0.078	12.8
	20:5:0	25x500		2.09E-03	5.13E-05	5.99E-03	1.52E-05								
#4b, 25km	20:5:0.5	25x500	25	1625	2000	500	600	1714	532	1721	537	3442	2.41E-02	0.0482	20.7
	20:5:0	25x500		1.82E-04	1.47E-05	2.11E-04	2.05E-05								
#4c, 25km	20:5:5	25x500	25	1500	1625	1000	1500	1530	1483	1531	1485	3062	7.65E-03	0.0153	65.4
	20:5:0			1.19E-04	5.79E-05	1.08E-03	9.18E-05								
#4d, 25km	20:5:5	50x500	25	1625	2000	1500	2000	1647	1600	1649	1612	3298	1.53E-02	0.0306	32.7
	20:5:0			1.16E-04	9.30E-06	1.98E-04	6.45E-06								
delineate @	20:5:0	25x500	25	1625	2000	1500	2000	1750	1701	1759	1718	3518	1.53E-02	0.0306	32.7
	5.00E-04	25x500		1.16E-04	9.30E-06	1.98E-04	6.45E-06								
#5, 15 km	100:20:2	25x500	15	2400	2600	600	800	2405	757	2405	761	4810	1.04E-02	0.0208	48.1
	100:20:2	25x500		1.02E-04	4.69E-05	5.77E-04	6.20E-05								
#5, 20 km	100:20:2	25x500	20	2600	2800	800	1000	2676	845	2676	848	5352	7.38E-03	0.01476	67.8
	100:20:2	25x500		1.28E-04	6.70E-05	1.63E-04	1.88E-05								
#5, 25 km	100:20:2	25x500	25	2800	3000	800	1000	2905	918	2906	922	5812	6.27E-03	0.01254	79.7
	100:20:2	25x500		1.34E-04	7.68E-05	2.80E-04	4.88E-05								
#5, 30 km	100:20:2	25x500	30	3000	3200	800	1000	3107	986	3106	986	6212	5.23E-03	0.01046	95.6
		25x500		1.31E-04	7.90E-05	3.90E-04	9.02E-05								
#6, 15 km	100:20:1	25x500	15	2400	2600	400	600	2494	556	2495	562	4990	1.47E-02	0.0294	34.0
		25x500		1.44E-04	6.63E-05	1.18E-03	5.03E-05								
#6, 20 km	100:20:1	25x500	20	2600	2800	600	800	2783	625	2782	627	5564	1.11E-02	0.0222	45.0
	100:20:1	25x500		1.80E-04	9.46E-05	1.50E-04	5.50E-06								
#6, 25 km	100:20:1	25x500	25	3000	3200	600	800	3026	661	3027	683	6054	8.86E-03	0.01772	56.4
	100:20:1	25x500		1.08E-04	5.98E-05	2.08E-04	1.91E-05								
#6, 30 km	100:20:1	25x500	30	3200	3400	600	800	3242	726	3241	731	6482	7.39E-03	0.01478	67.7
		25x500		1.12E-04	6.55E-05	4.13E-04	4.31E-05								
#7, 15 km	100:10:1	25x500	15	1500	2000	400	600	1839	577	1852	580	3704	2.04E-02	0.0408	24.5

RF
9/10/97

9/10/97
41RF

Capture Zone Results (. /Boore/Data/capture.xlsx)

Summary of Results, previously discussed pages 10-12, 14-15, 20-23 This notebook.

In Report #ID	ID #	Description	input				output			not captured on top
			Screen	Qp	head grad	Transmis	Width	Thick		
1	1	dom base, Qp=1	940-1000	1	0.005	100	29	73		
2	2	dom base, Qp=2	940-1000	2	0.005	100	54	82		
3	3	dom base, Qp=3	940-1000	3	0.005	100	76	88		
4	4	dom base, Qp=4	940-1000	4	0.005	100	97	96		
5	5	dom base, Qp=6.815	940-1000	6.815	0.005	100	146	113		
6	6	dom, Qp=37.5, 11 well	940-1000	37.5	0.005	100	418	224		
7	7	dom, Qp=75, 11 well	940-1000	75	0.005	100	607	309		
8	8	irr base, Qp=300	940-1000	300	0.005	100	1292	575		
9	9	irr base, Qp=800	940-1000	800	0.005	100	2330	825		
10	10	irr base, Qp=1380	940-1000	1380	0.005	100	3382	941		
11	11	irr base, Qp=2000	940-1000	2000	0.005	100	4450	985		
12	12	dom, Ksat=.01	940-1000	3	0.005	10	369	203		
13	13	dom, Ksat=.05	940-1000	3	0.005	50	133	108		
14	14	dom, Ksat=.1	940-1000	3	0.005	100	76	88		
15	15	dom, Ksat=.4	940-1000	3	0.005	400	22	70		
16	16	dom, grad=.001	940-1000	3	0.001	100	248	151		
17	17	dom, grad=.0025	940-1000	3	0.0025	100	133	108		
18	18	dom, grad=.005	940-1000	3	0.005	100	76	88		
19	19	dom, grad=.01	940-1000	3	0.01	100	41	78		
20	20	dom, screen position a	940-1000	3	0.005	100	76	88		
21	21	dom, screen position b	930-990	3	0.005	100	69	98	0	
22	22	dom, screen position c	920-980	3	0.005	100	67	107	5	
23	42	dom, screen position d	900-960	3	0.005	100	68	127	21	
24	23	dom, screen length a	980-1000	3	0.005	100	115	65		
25	24	dom, screen length b	940-1000	3	0.005	100	76	88		
26	25	dom, screen length c	900-1000	3	0.005	100	51	122		
27	26	fully penetrating	0-1000	300	0.005	100	574	1000		
28	27	half penetration	500-1000	300	0.005	100	940	752		
29	28	max actual screen	810-1000	300	0.005	100	1238	601		
30	29	base screen length	940-1000	300	0.005	100	1292	575		
31	30	irrig Ksat=.05	940-1000	300	0.005	50	1944	751		
32	31	irrig, Ksat=.1	940-1000	300	0.005	100	1292	575		
33	32	irrig, Ksat=.2	940-1000	300	0.005	200	876	424		
34	33	irrig, Ksat=.3	940-1000	300	0.005	300	705	352		
35	34	irrig, Ksat=.4	940-1000	300	0.005	400	607	309		
36	35	irrig, Ksat=.2	940-1000	2116	0.005	200	2810	890		
37	36	irrig, Ksat=.3	940-1000	2116	0.005	300	2146	793		
38	37	irrig, Ksat=.4	940-1000	2116	0.005	400	1798	719		
39	38	irrig, grad=.001	940-1000	2116	0.001	400	5596	1000		
40	39	irrig, grad=.002	940-1000	2116	0.002	400	3282	934		
41	40	irrig, grad=.003	940-1000	2116	0.003	400	2486	850		
42	41	irrig, grad=.005	940-1000	2116	0.005	400	1798	719		
	42	see above								

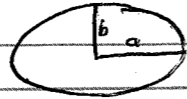
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Dilation Factor Calculations

Calculation of Areas, general comments:

(i) area of an ellipse = πab



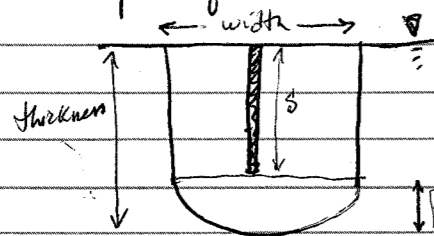
(ii) since plume shapes (3D-dispersed plumes) are approximated here as half ellipses as are capture areas for large pumpage wells

area half-ellipse = $\frac{\pi ab}{2}$
and width = $2a$, thickness = b

Hence capture area large pumpage wells & plumes (3D)

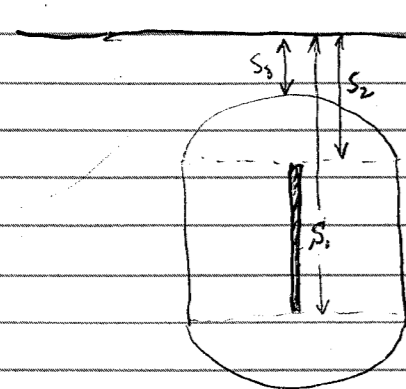
$$\frac{\pi}{2} \left[\frac{\text{width}}{2} \right] [\text{thickness}]$$

(ii) Domestic wells (small pumpage) are not approximated very well by an ellipse due to the relative size of the screened portion to the capture area (especially thickness). So, break apart the areas depending upon the depth of the screened portion



$$\text{area} = [\text{width} \times \text{thickness}] + \left[\frac{\pi}{2} \left(\frac{\text{width}}{2} \right) (\text{thick} - S) \right]$$

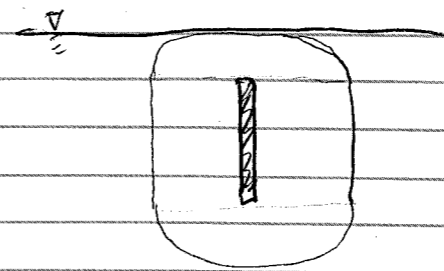
where S = screened length
= distance of bottom of screen from ground surface (water table)



For the case where the screen is significantly below the water table,
 S_3 = length not captured on top

$$\text{area} = [\text{width} \times \text{thickness}]$$

$$\text{area} = [\text{width} \times (S_1 - S_2)] + \left[\frac{\pi}{2} \left(\frac{\text{width}}{2} \right) (S_2 - S_3) \right] + \left[\frac{\pi}{2} \left(\frac{\text{width}}{2} \right) (\text{thickness} - S_1) \right]$$



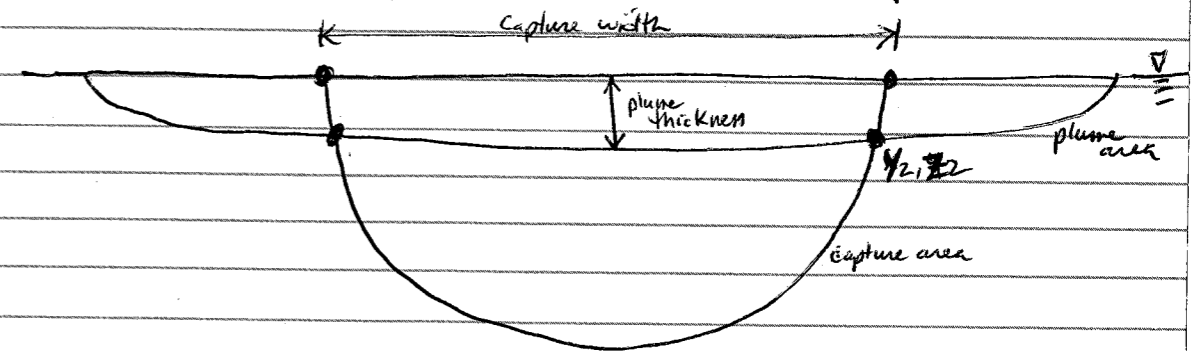
For domestic well case where screen is near but not at water table, the top portion may not be well approximated by an half ellipse nor a rectangle. So I used the average of those two shapes (their areas) for the top or portion of capture area above the screen. This is the "average" noted in the spreadsheet tables for domestic well capture areas

(2) scenarios for intersection of areas of plume and capture area

(i) For the thin plumes, the plume area is simply the width times the specified thickness. The thin plumes are defined as those modeled with no vertical dispersion, hence the thickness never changes (and is uniform across the width of the plume).

(ii) ~~3D plume~~ The intersection area of the thin plume with domestic wells is \Rightarrow plume thickness \times capture zone width. The intersection area of the thin plume with irrigation wells depends on which is wider \Rightarrow plume thickness \times Max [capture width, plume width]

(ii) 3D plume intersection with capture areas. This is typically a comparison of an ellipse which is wide and thin (plume) to an ellipse which is narrow and thick (capture). This intersection may be approximated as a rectangle



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Y2K compliance (change date on computer to greater than 2001)

Year 2001 compliance check for software packages

GFLOW ver 1.1
patchi ver 1.1
stripi ver 1.1

GFLOW pc-DOS based program, executable only

- ① has no date stamp for output or interactive on screen
- ② calculations verified before and after year change - okay.

patchi Fortran 77 code, currently compiled on UNIX, SUN platform

- ① I had to change the system calls to get a time stamp when I first compiled the program (USGS compiler has different system calls for the date) The change I made is not Y2K compliant. This is something I have to fix, not something wrong with the code as distributed by the USGS

- ② calculations are correct regardless of time stamp ~~and~~ indicated by running same problem before and after the year change.

Credits to IMS staff for changing the date for me since I do not have access (root).

Of course this caused WABI to be very slow until I found IMS staff to reboot the machine again after changing back the date (after they changed the date back).

stripi - ditto comments from patchi

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Source Term or Boundary Condition for Plume Configuration.

In response to Bob Baca's comment on Technical Review of report to account for dilution due to "passive transport" (dispersion during transport), additional approaches need to be determined. Baca wanted the concentration distribution within the plume to be accounted for in the dilution factor due to pumping wells.

However, Gordon & I had removed all mention of concentration in the plume (we had used centerline concentration as conservative representation of the plume) because Schwartz in the EPRJ TSPA-96 (Kessler and McGuire, 1996) had already analyzed the passive dispersion and this report was not intending to re-do Schwartz's analysis. We were only trying to obtain the plume shape & dimensions.

In the technical review, Baca also wanted to make a better connection with the TPA approach for dilution factor (df):

$$df = \frac{M}{Q}$$

The mass release rate from the repository (M) is divided by the largest of 3 possible volumetric fluxes

- ① infiltrating water through repository
- ② Q in the aquifer below the footprint in which the release is introduced
- ③ total pumping of the critical group (at 5 km or 30 km locations).

To make any connection with the TPA code, a mass release rate should be used as a source term for the advective-dispersive transport - not a constant concentration boundary as in Wexler (1992) used so far in this work (and as used by Schwartz in Kessler and McGuire (1996) in the EPRJ TSPA-96). Hence there is no reason to integrate a non-uniform plume and it's contribution within the capture zone. Rather, new solutions for advective-dispersive equations

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are needed. Analytical solutions of Codell and others (1982) in NUREG-0868 are for mass release rate as a source term. Then the dilution factors for passive transport and borehole (pumping) dilution would link the mass release of TPA to the pumping amount in Amargosa Farms. This is something which could not be done with Dirichlet boundary condition for advective-dispersive transport since it is comparing apples and oranges (Dirichlet b.c. to mass release rate; the mass release rate is similar to a flux boundary condition; just a conversion of mass to concentration at the source area of the domain).

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Codell and others (1982) NUREG-0868 analytical solutions use the approach of an instantaneous release of mass for a wide variety of point source, line source, depth averaged solution, and horizontal patch source. Any of these solutions can then use the convolution integral to integrate over time for a mass release rate. The mass release rate can be uniform (constant) or some function since a numerical integrator is used (Simpson's Rule).

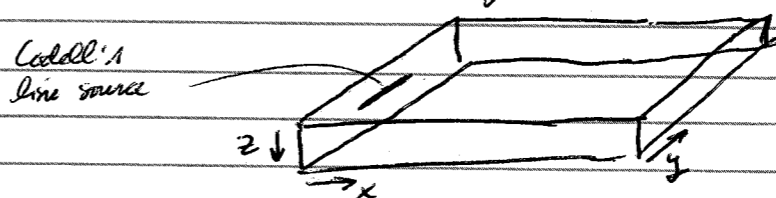
None of Codell's solutions are comparable in source configuration in terms of:

- ① my 3-D solution is for a vertical patch source oriented perpendicular to flow
- ② my 2-D solutions (really Wexler's) are a line source at the water table with no vertical dispersion

One possible usage is to assume Codell's horizontal patch source at the water table is similar to Wexler's line source at the water table. For long distances (x-distance from source), the line versus patch is no problem. However, Codell uses vertically averaged solution in z-direction (vertical). To use Codell's solution, I would have to assume that the aquifer is a unit thickness (=1) and that this would be the same as no vertical dispersion in my "thin" plumes from Wexler's 2-D line solutions.

The reason I am trying to mimic my previous source sizes (patch for 3-D dispersion problems and line for "thin" plume) is that I only want to model advective-dispersion from the "accessible environment or fence" which is about 5 km from repository. Somewhere beyond this point, the flow would enter the alluvial aquifer. To model advective-dispersive transport from this "accessible environment or fence", I would like to use a vertical patch.

Another possibility to utilize Codell's approach is to analytically or numerically integrate his line source



The numerical approach would be similar to the approach used by Domenico & Robbins (as used by Schwartz in TSPA-96 EPR). Since modifying Codell and others (1982) solution would mean more extensive TSP-088 work (code verification, validation) and not just installation testing, it would be much more efficient if an existing code could be used. Here's the collection of the primary references for analytical solutions as used in the groundwater field: (3-dimensional)

3D analytical solution for solute transport

G-T Yeh, 1981: AT123D: Analytical transient one-, two-, and three-dimensional simulation of waste transport in an aquifer system. ORNL-5602. OAK Ridge National Lab.

Chris Neville developed one 3-d analytical solution for transport from a patch boundary several years ago. See Zheng and Bennett (1995) "Applied Contaminant transport modeling", by Van Nostrand Reinhold. RF 2/29/97

Domenico and Schwartz 1990 "Physical and Chemical Hydrogeology", Chapter 17. The new edition (1997) has better solutions and examples.

Javandel et al., 1984 "Ground water Transport: Handbook of mathematical models" has some analytical solutions.

Wexler's (1992) technical publication for the USGS (my copy).

Codell's (1982) NUREG-0868 has instantaneous mass release solutions which he then uses the convolution integral (Simpson's Rule) to integrate over time to get a mass release rate source term.

Development of 2-D vertical patch source from
Codell's (NUREG-0868) line source

The solution for an instantaneous mass release solved using
Green's functions is (for the general case)

$$C_i = \frac{1}{n_e R_d} X(x,t) Y(y,t) Z(z,t)$$

C = concentration of species i at some downgradient point
 n_e = effective porosity
 R_d = retardation = $1 + \frac{\rho_s K_d}{n}$ $\left\{ \begin{array}{l} n = \text{porosity} \\ \rho_s = \text{bulk density} \\ K_d = \text{distribution coefficient} \end{array} \right.$

For a line source at depth z_s in an aquifer of infinite
~~lateral and depth extent thickness "h"~~ RF 9/29/97
 lateral extent and depth [p. 3.7, case (6) of NUREG-0868]

$$C_i = \frac{1}{n_e R_d} X_1 Y_2 Z_3 \text{ where}$$

$$X_1 = \frac{1}{\sqrt{4\pi E_x t/R_d}} \exp \left[-\frac{(x - \frac{ut}{R_d})^2}{4E_x t/R_d} - \lambda t \right]$$

$$Y_2 = \frac{1}{2b} \left\{ \operatorname{erf} \frac{(\frac{b}{2} + y)}{\sqrt{4E_y t/R_d}} + \operatorname{erf} \frac{(\frac{b}{2} - y)}{\sqrt{4E_y t/R_d}} \right\}$$

$$Z_3 = \frac{1}{\sqrt{4\pi E_z t/R_d}} \left\{ \exp \left(-\frac{[z - z_s]^2}{4E_z t/R_d} \right) + \exp \left(-\frac{[z + z_s]^2}{4E_z t/R_d} \right) \right\}$$

where exp = exponential

erf = error function

E_x, E_y, E_z = dispersion coefficients in x, y, z directions

t = time

b = entire width of line source in y -direction

u = velocity (from Codell's development, this has to
be seepage or particle velocity)

So far, nothing new has been developed. Everything on previous
page is from NUREG-0868

I would like to have a vertically-oriented patch source
instead of Codell's line source. All I have to do is integrate
the Z component (Green function) from a line at depth z_s to
a patch from depth z_{s1} to z_{s2} . Both line & patch are
of width b , but of course, we are not changing the X or
 Y components of the solution. Use Z_4 to denote patch solution.

$$\text{For the patch solution } C_i = \frac{1}{n_e R_d} X_1 Y_2 Z_4$$

where Z_4 is the integral of Codell's Z_3

$$Z_4 = \int_{z_{s1}}^{z_{s2}} \frac{1}{\sqrt{4\pi E_z t/R_d}} \left\{ \exp \left(-\frac{[z - z_s]^2}{4E_z t/R_d} \right) + \exp \left(-\frac{[z + z_s]^2}{4E_z t/R_d} \right) \right\} dz_s$$

which can be broken-down into

$$Z_4 = \frac{1}{\sqrt{4\pi E_z t/R_d}} \left\{ \int_{z_{s1}}^{z_{s2}} \exp \left(-\frac{[z - z_s]^2}{4E_z t/R_d} \right) dz_s + \int_{z_{s1}}^{z_{s2}} \exp \left(-\frac{[z + z_s]^2}{4E_z t/R_d} \right) dz_s \right\}$$

Now these are nice looking integrals (they are of the same form); but,
fortunately I can look up the result of the integration in integral tables
(according to Wexler (1992) reference to Abramowitz & Stegun (1964) p. 303, eq 7.4.32)

$$\int \exp[-(ax^2 + 2bx + c)] dx = \frac{1}{2} \sqrt{\frac{\pi}{a}} \exp \left[\frac{b^2 - ac}{a} \right] \operatorname{erf} \left(\sqrt{a} x + \frac{b}{\sqrt{a}} \right) + C^*$$

where C^* is an arbitrary integration constant
which I am dropping now by saying it's arbitrarily equal to zero.

note that

$$\frac{-[z - z_s]^2}{4E_z t/R_d} = \frac{-[z^2 - 2zz_s + z_s^2]}{4E_z t/R_d} = - \left[\frac{z^2}{4E_z t/R_d} - \frac{2zz_s}{4E_z t/R_d} + \frac{z_s^2}{4E_z t/R_d} \right]$$

Hence for this problem $x \Rightarrow z_s$ $a \Rightarrow \frac{1}{4E_z t/R_d}$ $b \Rightarrow \frac{-z}{4E_z t/R_d}$ $c \Rightarrow \frac{z^2}{4E_z t/R_d}$
 for simplicity, let $\eta = 4E_z t/R_d$ $a = 1/\eta$

Z_4 has been separated into two integrals, the result of the first integral

$$\int_{z_{s1}}^{z_{s2}} \exp\left(-\frac{[z-z_s]^2}{\eta}\right) dz_s = \frac{1}{2} \sqrt{\eta \pi} \exp\left[\frac{\left(\frac{z}{\eta}\right)^2 - \frac{1}{\eta} \frac{z^2}{\eta}}{\frac{1}{\eta}}\right] \operatorname{erf}\left[\frac{1}{\sqrt{\eta}} z_s + \frac{z/\eta}{\sqrt{\eta}}\right] + C^*$$

$$= \left\{ \frac{\sqrt{\eta \pi}}{2} \exp\left[\frac{(z^2 - z_s^2)}{\eta}\right] \operatorname{erf}\left[\frac{z_s}{\sqrt{\eta}} - \frac{z}{\sqrt{\eta}}\right] \right\} \Bigg|_{z_{s1}}^{z_{s2}}$$

↑
evaluated at

note:
 $\exp(0) = 1$

$$= \frac{\sqrt{\eta \pi}}{2} \operatorname{erf}\left[\frac{z_s - z}{\sqrt{\eta}}\right] \Bigg|_{z_{s1}}^{z_{s2}}$$

$$= \frac{\sqrt{4E_z \pi t/R_d}}{2} \left\{ \operatorname{erf}\left[\frac{z_{s2} - z}{\sqrt{4E_z t/R_d}}\right] - \operatorname{erf}\left[\frac{z_{s1} - z}{\sqrt{4E_z t/R_d}}\right] \right\}$$

changing to complementary error function $\Rightarrow \operatorname{erfc} = 1 - \operatorname{erf}$

$$\int_{z_{s1}}^{z_{s2}} \exp\left(-\frac{[z-z_s]^2}{4E_z t/R_d}\right) dz_s = \sqrt{\pi E_z t/R_d} \left\{ \operatorname{erfc}\left[\frac{z_{s1} - z}{2\sqrt{E_z t/R_d}}\right] - \operatorname{erfc}\left[\frac{z_{s2} - z}{2\sqrt{E_z t/R_d}}\right] \right\}$$

Now, similarly for the second integral

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$$\int_{z_{s1}}^{z_{s2}} \exp\left(-\frac{[z+z_s]^2}{4E_z t/R_d}\right) dz_s \quad \text{note that } \frac{(z+z_s)^2}{4E_z t/R_d} = \frac{z^2 + 2zz_s + z_s^2}{4E_z t/R_d}$$

then using the solution from the integral table, letting

$$x \Rightarrow z_s \quad a = \frac{1}{4E_z t/R_d} = \frac{1}{\eta} \quad b \Rightarrow \frac{z}{\eta} \quad c \Rightarrow \frac{z^2}{\eta}$$

then

$$\int_{z_{s1}}^{z_{s2}} \exp\left(-\frac{[z+z_s]^2}{4E_z t/R_d}\right) dz_s = \frac{1}{2} \sqrt{\eta \pi} \exp\left[\frac{\frac{z^2}{\eta} - \frac{1}{\eta} \frac{z^2}{\eta}}{(\frac{1}{\eta})}\right] \operatorname{erf}\left[\frac{1}{\sqrt{\eta}} z_s + \frac{z/\eta}{\sqrt{\eta}}\right] + C^*$$

letting integration constant C^* be equal to zero and noting that $\exp(0) = 1$

$$= \frac{\sqrt{\eta \pi}}{2} \cdot \exp(0) \cdot \operatorname{erf}\left[\frac{z_s}{\sqrt{\eta}} + \frac{z}{\sqrt{\eta}}\right] \text{ evaluated from } z_{s1} \text{ to } z_{s2}$$

evaluate at limits and use $\operatorname{erfc} = 1 - \operatorname{erf}$

$$= \sqrt{\pi E_z t/R_d} \left\{ \operatorname{erfc}\left(\frac{z_{s1} + z}{2\sqrt{E_z t/R_d}}\right) - \operatorname{erfc}\left(\frac{z_{s2} + z}{2\sqrt{E_z t/R_d}}\right) \right\}$$

Now combine all of the components

$$\text{note: } \frac{\sqrt{\pi E_z t/R_d}}{4 \sqrt{\pi E_z t/R_d}} = \frac{1}{4\sqrt{\pi E_z t/R_d}}$$

$$C_i = \frac{1}{n_e R_d} X_1 Y_2 Z_4$$

$$C(x, y, z, t) = \frac{1}{n_e R_d} \left[\frac{1}{\sqrt{4\pi E_x t/R_d}} \exp\left\{\frac{(x - \frac{ut}{R_d})^2}{(4E_x t/R_d)} - \lambda t\right\} \right]$$

$$\cdot \left[\frac{1}{2b} \left\{ \operatorname{erf}\left(\frac{b+y}{\sqrt{4E_y t/R_d}}\right) + \operatorname{erf}\left(\frac{b-y}{\sqrt{4E_y t/R_d}}\right) \right\} \right]$$

$$\cdot \left[\frac{1}{\sqrt{4\pi E_z t/R_d}} \left\{ \operatorname{erfc}\left(\frac{z_{s1} - z}{\sqrt{4E_z t/R_d}}\right) - \operatorname{erfc}\left(\frac{z_{s2} - z}{\sqrt{4E_z t/R_d}}\right) + \operatorname{erfc}\left(\frac{z_{s1} + z}{\sqrt{4E_z t/R_d}}\right) - \operatorname{erfc}\left(\frac{z_{s2} + z}{\sqrt{4E_z t/R_d}}\right) \right\} \right]$$

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coefficient "16" changed by RF 9/29/97

where the Z_4 term above is repeated below for clarity

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$$Z_4 = \left(\frac{1}{\sqrt{4\pi E_z t/R_d}}\right)^{-1/2} \left\{ \operatorname{erfc}\left(\frac{z_{s1} - z}{(4E_z t/R_d)^{1/2}}\right) - \operatorname{erfc}\left(\frac{z_{s2} - z}{(4E_z t/R_d)^{1/2}}\right) + \operatorname{erfc}\left(\frac{z_{s1} + z}{(4E_z t/R_d)^{1/2}}\right) - \operatorname{erfc}\left(\frac{z_{s2} + z}{(4E_z t/R_d)^{1/2}}\right) \right\}$$

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Switch back to Dirichlet boundary condition for analytical transport solution for plume delineation

Assume that dispersion component coming off source patch is negligible compared to advective flux off source, then

$$\dot{M} = \text{mass rate}$$

$$\dot{M} = C_0 q A_{\text{source}}$$

$$A_{\text{source}} = \text{source area} = [500 \text{ m} \times 25 \text{ m}] \times 2 = 25,000 \text{ m}^2$$

the 2 accounts for the mirroring at the water table

$$q = \left(2.4 \frac{\text{m}}{\text{yr}}\right) \phi \quad \text{for capture zone analysis}$$

$$\phi = 0.005$$

$$\Gamma = 400 \frac{\text{m}^2}{\text{d}} \Rightarrow K_{\text{sat}} = 0.4 \frac{\text{m}}{\text{d}}$$

$$\text{assume } \phi = 0.3$$

$$v = q/\phi$$

$$v = 2.4 \frac{\text{m}}{\text{yr}}$$

(used in Wexler transport runs patch, strip)

$$q = 1.7 \frac{\text{m}}{\text{yr}}$$

Hence, for $\dot{M} = 10 \frac{\text{Ci}}{\text{yr}}$

$$C_0 = \frac{\dot{M}}{q A_{\text{source}}} = \frac{10 \frac{\text{Ci}}{\text{yr}}}{\left(0.7 \frac{\text{m}}{\text{yr}}\right) (25000 \text{ m}^2)} \left(\frac{10^{-3} \text{ m}^3}{\text{l}}\right)$$

$$C_0 = 57.1 \times 10^{-8} \frac{\text{Ci}}{\text{l}} = 0.57 \frac{\text{mCi}}{\text{l}}$$

Hence the C_0 should be recalculated for changes in patch size, decay velocity, and desired mass release rate.

Note the dilution factor scale for scaling of C_0 & plume width & thickness.

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Note that the C_0

was incorrectly estimated here; but it doesn't matter since all results are presented as normalized (C/C_0) concentrations

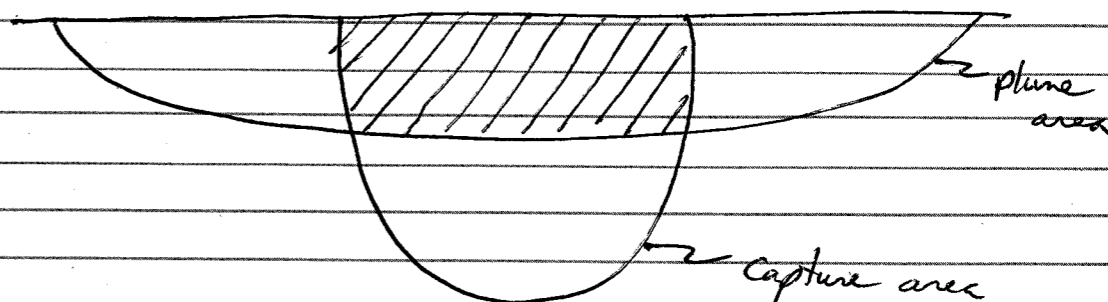
correction

$$C_0 = \frac{\dot{M}}{q A} = \frac{10 \frac{\text{Ci}}{\text{yr}} \left(\frac{10^{-3} \text{ m}^3}{\text{l}}\right)}{\left[0.7 \frac{\text{m}}{\text{yr}}\right] [500 \times 25] \text{ m}^2}$$

$$C_0 = 1.11 \times 10^{-6} \frac{\text{Ci}}{\text{l}}$$

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Program to calculate areal average of intercepted portion of plume captured by a pumping well



The shaded area has a concentration average, this average is used instead of the centerline concentration as used by Schwartz in EPRI-TSPA-96

Whereas the volumetric-flux based dilution factor is solely based on the comparison of the shaded area and the entire area of the capture, a more representative concentration than the centerline value is the areal average.

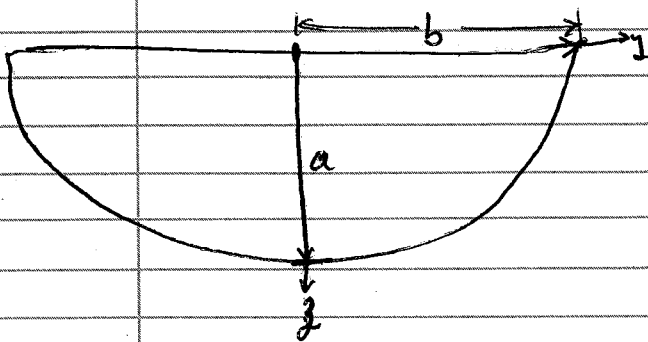
The postprocessor "itsec.f" was written ~~to~~ to calculate the areal average by discretizing the plume and capture areas into cells of area = 1 m² (dy=1, dz=1)

The modular post-processor includes

- a) reads input files for plume & capture information
- b) calls subroutines "interpol" and "domest" or "irrig"
- c) multiplies the capture matrix times the plume matrix and sums the results then divides by the area (or number of 1 m² cells which contributed to summation (this is not a matrix multiply!))
- d) prints results

(2) interpol subroutine - interpolates the input file of plume concentrations to every $1m^2$ cell of plume; the input file contains two header lines plus the output from Wexler simulations printed out for one x-value, the vertical plane perpendicular to flow (the y-z plane). Simple linear interpolation is used.

(3) domest. subroutine - creates a binary matrix where
 1 = inside capture area
 0 = outside capture area
 based on the input values of capture width and thickness and the equation for an ellipse.

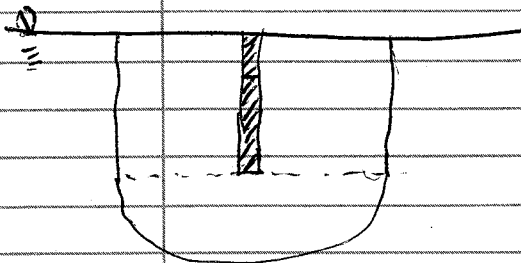


$$1 = \frac{z^2}{a^2} + \frac{y^2}{b^2}$$

rearranged to

$$y = \left[b^2 \left(1 - \frac{z^2}{a^2} \right) \right]^{1/2}$$

where $b =$ capture zone width divided by 2
 $a =$ capture zone thickness



The domest. subroutine accounts for multiple geometries used to get the area: a rectangle and an ellipse (half ellipse)

(4) irrig - creates binary matrix as does "domest" subroutine except only has to calculate for half-ellipse since screened portion is not significantly affecting shape as a half-ellipse

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pages 3&4 of itsec.f post-processor

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10  continue
   do 20 i = 0,ny-2
     ypts(i) = yp(i+1) - yp(i)
20  continue
c Do different calculation for thin plume versus 3D plume, if-then.
   if(iflag2.eq.1) then
     do 30 i = 0,nz-2
       zpts(i) = zp(i+1) - zp(i)
30  continue
c Interpolate z-columns where y-position is known.
   do 70 ky = 0,ny-2
     iy = nint( yp(ky) )
     iz = 0
     do 60 kz = 0,nz-2
       plume(iy,iz) = concp(ky,kz)
       a = (concp(ky,kz+1) - concp(ky,kz)) / (zp(kz+1) - zp(kz))
       b = concp(ky,kz) - a * zp(kz)
       do 50 i = 1,nint(zpts(kz))-1
         iz = iz + 1
         plume(iy,iz) = a * ( float(i) + zp(kz) ) + b
50  continue
     iz = iz + 1
60  continue
     iz = iz + 1
     plume(iy,iz) = concp(iy,ny-1)
70  continue
c Row by row, skipping appropriately.
   iy = 0
   iz = 0
   do 140 kz = 0,nz-2
     do 130 j = 1,nint(zpts(kz))
       do 120 ky = 0,ny-2
         ky2 = int(yp(ky+1))
         ky1 = int(yp(ky))
         a = (plume(ky2,iz) - plume(ky1,iz)) / (yp(ky+1) - yp(ky))
         b = plume(ky1,iz) - a * yp(ky)
         do 110 i = 1,nint(ypts(ky))-1
           iy = iy + 1
           plume(iy,iz) = a * ( float(i) + yp(ky) ) + b
110  continue
         iy = iy + 1
120  continue
         iz = iz + 1
         iy = 0
130  continue
140  continue
c Figure out plume width and zero-out remainder.
c Also calculate total mass in plume from concentrations.
c The variable "cPlume" is (concentration * area).
   do 150 j = 0,maxz
     do 150 i = 0,maxy
       if(plume(i,j).lt.threshld) plume(i,j) = 0.
150  continue
     concPlume = 0.
     do 160 j = 0,maxz
       do 160 i = 0,maxy
         concPlume = concPlume + plume(i,j)
160  continue
     concMid = 0.
     do 162 j = 0,maxz
       concMid = concMid + plume(0,j)
162  continue

```

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```

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cPlume = ( concPlume * 2. ) - concMid
do 170 i = 0,maxy
  if(plume(i,0).lt.threshld) then
    pwidth = float(i) * 2.
    goto 175
  else
    endif
170  continue
175  do 180 j = 0,maxz
    if(plume(0,j).lt.threshld) then
      pthickness = float(j)
      goto 300
    else
      endif
180  continue
else
  iy = 0
  do 210 ky = 0,ny-2
    plume(iy,0) = concp(ky,0)
    a = (concp(ky+1,0) - concp(ky,0)) / (yp(ky+1) - yp(ky))
    b = concp(ky,0) - a * yp(ky)
    do 210 i = 1,nint(ypts(ky))-1
      iy = iy + 1
      plume(iy,0) = a * ( float(i) + yp(ky) ) + b
210  continue
    plume(iy+1,0) = concp(ny-1,0)
c Figure out plume width and zero-out remainder.
c Also calculate total mass in plume from concentrations, after zeroing out.
c The variable "cPlume" is (concentration * area).
    pthickness = pthick
    do 220 i = 0,maxy
      if(plume(i,0).lt.threshld) plume(i,0) = 0.
220  continue
    ip = int(pthick)
    do 240 j = 1,ip
      do 240 i = 0,maxy
        plume(i,j) = plume(i,j-1)
240  continue
    concPlume = 0.
    do 250 i = 0,maxy
      concPlume = concPlume + plume(i,0)
250  continue
    concMid = plume(0,0) * pthick
    cPlume = ( concPlume * pthick * 2. ) - concMid
    do 260 i = 0,maxy
      if(plume(i,0).lt.threshld) then
        pwidth = float(i) * 2.
        goto 300
      else
        endif
260  continue
endif
300  write(10,*) 'Interpolated plume.'
c   do 400 j = 0,15
c     write(10,'(12e10.2)') ( plume(i,j), i=0,11 )
c400  continue
write(10,1100) pwidth, pthickness
write(10,1117)
1100  format(' plume width =',f7.0,' plume thickness =',f7.0)
1117  format('*****')
return
end
c=====

```

itsec.f

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pages 5 & 6 of
itsec.f post-processor

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RF
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```
Oct 20, 97 16:22          itsec.f          Page 5/6
      subroutine domest(cwidth2,cthick,capture,scntop,scnbot,ctop,icap)
c Calculates the number of nodes in the capture area of a domestic well
c assuming dy=dz=1 for extrapolation to a capture area.
      parameter (maxy=3400, maxz=2000)
      implicit real (a-h,o-z)
      implicit integer (i-n)
      dimension capture(0:maxy,0:maxz)

      do 10 iz = 0,maxz
        do 10 iy = 0,maxy
          capture(iy,iz) = 0.
10      continue
      iscnbot = nint(scnbot)
      iscntop = nint(scntop)

c Top of capture area (half-ellipse); mirror the half-ellipse to fill capture().
      icap1 = 0
      if(ctop.le.1.e-4) goto 50
      toptick = scntop - ctop
      itop = nint(toptick)
      izz = iscntop
      do 30 iz = 1,itop
        z = float(iz)
        if(iz.ge.iscntop) goto 50
        ytmp = sqrt( cwidth2**2 * ( 1. - z**2 / toptick**2 ) )
        izz = izz - 1
        do 20 iy = 0,maxy
          y = float(iy)
          if(y.le.ytmp) then
            capture(iy,izz) = 1.
            icap1 = icap1 + 1
          else
            goto 30
          endif
20      continue
30      continue
50      write(10,*) 'Top of domestic capture area, nodes = ', icap1

c Middle of capture area, screen elevation (rectangle).
      icap2 = 0
      do 130 iz = iscntop,maxz
        if(iz.gt.iscnbot) goto 150
        do 120 iy = 0,maxy
          if(float(iy).le.cwidth2) then
            capture(iy,iz) = 1.
            icap2 = icap2 + 1
          else
            goto 125
          endif
120      continue
125      continue
130      continue
150      write(10,*) 'Middle plus top domestic capture nodes = ', icap2

c Bottom of capture area (half-ellipse).
      icap3 = 0
      do 230 iz = iscnbot+1,maxz
        z = float(iz)
        if(z.gt.cthick) goto 250
        ytmp = sqrt( cwidth2**2 * ( 1. - z**2 / cthick**2 ) )
        do 220 iy = 0,maxy
          y = float(iy)
          if(y.le.ytmp) then
            capture(iy,iz) = 1.
            icap3 = icap3 + 1
          else
            goto 225
          endif
220      continue
```

```
Oct 20, 97 16:22          itsec.f          Page 6/6
225      continue
230      continue

250      write(10,*) 'Bottom half ellipse= ', icap3
      mirror = 0
      do 260 j = 1,maxz
        if(capture(0,j).gt.0.1) mirror = mirror + 1
260      continue
      icap = ( ( icap1 + icap2 + icap3 ) * 2 ) - mirror
      write(10,*) 'Domestic well capture area (all) = ', icap

c      do 300 j = 0,15
c      write(10, '(15f3.0)') ( capture(i,j), i=0,14 )
c300      continue

      return
      end

=====
      subroutine irrig(cwidth2,cthick,capture,icap)
c Calculates the number of nodes in an irrigation well assuming that
c dy=dz=1 for extrapolation to a capture area.
      parameter (maxy=3400, maxz=2000)
      implicit real (a-h,o-z)
      implicit integer (i-n)
      dimension capture(0:maxy,0:maxz)

      icap = 0
      do 10 iz = 0,maxz
        do 10 iy = 0,maxy
          capture(iy,iz) = 0.
10      continue

      do 30 iz = 0,maxz
        z = float(iz)
        if(z.gt.cthick) goto 50
        ytmp = sqrt( cwidth2**2 * ( 1. - z**2 / cthick**2 ) )
        do 20 iy = 0,maxy
          y = float(iy)
          if(y.le.ytmp) then
            capture(iy,iz) = 1.
            icap = icap + 1
          else
            goto 25
          endif
20      continue
25      continue
30      continue

50      icap = icap + icap - cthick
      write(10,*) 'Irrigation well capture area = ', icap

c      do 200 j = 0,15
c      write(10, '(15f3.0)') ( capture(i,j), i=0,14 )
c200      continue

      return
      end
```

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example input file \Rightarrow plume.dat

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Oct 16, 97 7:25

f8.25km

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15	22	0.00438														
20000.	0.	10.	200.	400.	600.	800.	900.	1100.	1300.	1500.	1700.	1900.	2100.	2300.	2500.	2700.
0.	0.317E-03	0.305E-03	0.271E-03	0.223E-03	0.170E-03	0.144E-03	0.982E-04	0.618E-04	0.361E-04	0.196E-04	0.985E-05	0.461E-05	0.201E-05	0.817E-06	0.310E-06	
60.	0.299E-03	0.288E-03	0.256E-03	0.211E-03	0.161E-03	0.136E-03	0.926E-04	0.583E-04	0.341E-04	0.185E-04	0.931E-05	0.436E-05	0.190E-05	0.773E-06	0.293E-06	
75.	0.264E-03	0.254E-03	0.226E-03	0.186E-03	0.142E-03	0.121E-03	0.819E-04	0.516E-04	0.302E-04	0.164E-04	0.825E-05	0.387E-05	0.169E-05	0.686E-06	0.261E-06	
100.	0.195E-03	0.188E-03	0.167E-03	0.138E-03	0.105E-03	0.891E-04	0.606E-04	0.382E-04	0.224E-04	0.122E-04	0.613E-05	0.288E-05	0.126E-05	0.513E-06	0.195E-06	
125.	0.128E-03	0.123E-03	0.109E-03	0.902E-04	0.689E-04	0.585E-04	0.398E-04	0.252E-04	0.147E-04	0.802E-05	0.406E-05	0.191E-05	0.837E-06	0.342E-06	0.131E-06	
150.	0.742E-04	0.714E-04	0.636E-04	0.525E-04	0.401E-04	0.341E-04	0.233E-04	0.147E-04	0.864E-05	0.471E-05	0.239E-05	0.113E-05	0.496E-06	0.203E-06	0.779E-07	
175.	0.383E-04	0.369E-04	0.329E-04	0.272E-04	0.208E-04	0.177E-04	0.121E-04	0.766E-05	0.451E-05	0.247E-05	0.125E-05	0.594E-06	0.262E-06	0.108E-06	0.415E-07	
200.	0.176E-04	0.170E-04	0.151E-04	0.125E-04	0.958E-05	0.816E-05	0.559E-05	0.355E-05	0.210E-05	0.115E-05	0.587E-06	0.279E-06	0.124E-06	0.512E-07	0.198E-07	
225.	0.722E-05	0.695E-05	0.620E-05	0.513E-05	0.394E-05	0.336E-05	0.231E-05	0.147E-05	0.871E-06	0.480E-06	0.246E-06	0.117E-06	0.523E-07	0.217E-07	0.845E-08	
250.	0.264E-05	0.254E-05	0.227E-05	0.188E-05	0.145E-05	0.124E-05	0.851E-06	0.544E-06	0.324E-06	0.179E-06	0.922E-07	0.443E-07	0.198E-07	0.829E-08	0.324E-08	
275.	0.866E-06	0.835E-06	0.746E-06	0.620E-06	0.478E-06	0.408E-06	0.282E-06	0.181E-06	0.108E-06	0.599E-07	0.310E-07	0.150E-07	0.675E-08	0.284E-08	0.112E-08	
300.	0.255E-06	0.246E-06	0.220E-06	0.183E-06	0.141E-06	0.121E-06	0.837E-07	0.539E-07	0.323E-07	0.181E-07	0.940E-08	0.456E-08	0.207E-08	0.878E-09	0.348E-09	
325.	0.676E-07	0.652E-07	0.584E-07	0.486E-07	0.377E-07	0.323E-07	0.224E-07	0.145E-07	0.873E-08	0.490E-08	0.257E-08	0.125E-08	0.573E-09	0.245E-09	0.979E-10	
350.	0.162E-07	0.156E-07	0.140E-07	0.117E-07	0.906E-08	0.778E-08	0.542E-08	0.352E-08	0.213E-08	0.120E-08	0.634E-09	0.312E-09	0.144E-09	0.618E-10	0.250E-10	
375.	0.350E-08	0.338E-08	0.304E-08	0.254E-08	0.198E-08	0.170E-08	0.119E-08	0.775E-09	0.472E-09	0.268E-09	0.142E-09	0.704E-10	0.327E-10	0.142E-10	0.577E-11	
400.	0.689E-09	0.665E-09	0.598E-09	0.501E-09	0.391E-09	0.337E-09	0.237E-09	0.155E-09	0.949E-10	0.542E-10	0.289E-10	0.145E-10	0.676E-11	0.296E-11	0.122E-11	
425.	0.124E-09	0.119E-09	0.107E-09	0.902E-10	0.706E-10	0.608E-10	0.429E-10	0.283E-10	0.174E-10	0.100E-10	0.538E-11	0.271E-11	0.128E-11	0.565E-12	0.234E-12	
450.	0.202E-10	0.196E-10	0.176E-10	0.148E-10	0.116E-10	0.101E-10	0.712E-11	0.472E-11	0.292E-11	0.169E-11	0.915E-12	0.464E-12	0.221E-12	0.986E-13	0.413E-13	
475.	0.304E-11	0.294E-11	0.265E-11	0.224E-11	0.176E-11	0.152E-11	0.108E-11	0.722E-12	0.449E-12	0.262E-12	0.143E-12	0.731E-13	0.351E-13	0.158E-13	0.669E-14	
500.	0.420E-12	0.406E-12	0.367E-12	0.310E-12	0.245E-12	0.213E-12	0.152E-12	0.102E-12	0.636E-13	0.373E-13	0.205E-13	0.106E-13	0.513E-14	0.233E-14	0.999E-15	
550.	0.634E-14	0.613E-14	0.556E-14	0.471E-14	0.375E-14	0.326E-14	0.235E-14	0.159E-14	0.101E-14	0.600E-15	0.335E-15	0.176E-15	0.868E-16	0.403E-16	0.176E-16	
600.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

RF

10/21/97

$X = 25 \text{ km}$

$C_0 = .438 \times 10^{-2} \text{ mg/l}$

$t_{\text{time}} = 20,000 \text{ yrs}$

$\alpha_L = 100 \text{ m}$

$\alpha_T = 10 \text{ m}$

$\alpha_B = 0.1 \text{ m}$

1st page of capture inputs (large pumping)
 (multiple capture areas can be run at one time).

10/21/97
 63 RF

Oct 15, 97 17:05		caps3D.input		Page 1/1
2	1292.	575.	.244	#8
0.	60.	0.		capture ID#
2	2330.	825.	.244	#9
0.	60.	0.		
2	3382.	941.	.244	#10
0.	60.	0.		
2	4450.	985.	.244	#11
0.	60.	0.		RF
2	1944.	751.	.244	#30
0.	60.	0.		10/21/97
2	1292.	575.	.244	#31
0.	60.	0.		
2	876.	424.	.244	#32
0.	60.	0.		
2	705.	352.	.244	#33
0.	60.	0.		
2	607.	309.	.244	#34
0.	60.	0.		
2	2810.	890.	.244	# 35
0.	60.	0.		
2	2146.	793.	.244	# 36
0.	60.	0.		
2	1798.	719.	.244	# 37
0.	60.	0.		
2	5596.	1000.	.244	# 38
0.	60.	0.		
2	3282.	934.	.244	# 39
0.	60.	0.		
2	2486.	850.	.244	# 40
0.	60.	0.		
2	1798.	719.	.244	# 41
0.	60.	0.		
99999				

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2nd page of capture.dat inputs (small pumping capture areas)

Oct 16, 97 8:19			caps2D.input			Page 1/1		
1								
76.	87.8	.244						
0.	60.	0.						
1								
69.	97.5	.244						
10.	70.	.2						
1								
67.	107.	.244						
20.	80.	4.7						
1								
68.	127.	.244						
40.	100.	20.5						
1								
28.6	72.6	.244						
0.	60.	0.						
1								
54.0	81.5	.244						
0.	60.	0.						
1								
76.0	87.8	.244						
0.	60.	0.						
1								
97.4	95.6	.244						
0.	60.	0.						
1								
146.	112.	.244						
0.	60.	0.						
1								
418.	224.	.244						
0.	60.	0.						
1								
607.	309.	.244						
0.	60.	0.						
1								
369.	203.	.244						
0.	60.	0.						
1								
133.	108.	.244						
0.	60.	0.						
1								
76.0	87.8	.244						
0.	60.	0.						
1								
21.8	70.3	.244						
0.	60.	0.						
1								
248.	151.	.244						
0.	60.	0.						
1								
133.	108.	.244						
0.	60.	0.						
1								
76.0	87.8	.244						
0.	60.	0.						
1								
41.2	77.5	.244						
0.	60.	0.						
99999								

RF
10/21/97

Thursday October 16, 97

caps2D.input

10/21/97
65 RF

test input files to check programs for proper operation; more complex domestic well is used here

Oct 16, 97 17:19		plume.dat.small					Page 1/1	
4	4	0.00438						
1	1	10.						
20000.	0.	5.	10.	20.				
0.	0.4E-03	0.4E-04	0.4E-05	0.4E-09				
5.	0.4E-04	0.4E-05	0.1E-06	0.1E-09				
12.	0.1E-06	0.1E-07	0.1E-08	0.1E-10				
30.	0.1E-08	0.1E-09	0.1E-10	0.1E-11				

RF
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Oct 16, 97 17:19		capture.dat.small			Page 1/1	
1						
20.	14.0	.244				
10.	12.	8.				
99999						

RF
10/21/97

66

RF
10/21/97

Output from test example from previous page.
Results as expected.

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Oct 20, 97 11:37

result3D.small

Page 1/1

Interpolated plume.

0.40E-03	0.33E-03	0.26E-03	0.18E-03	0.11E-03	0.40E-04	0.33E-04	0.26E-04	0.18E-04	0.11E-04	0.40E-05	0.36E-05
0.33E-03	0.27E-03	0.21E-03	0.15E-03	0.92E-04	0.33E-04	0.27E-04	0.21E-04	0.15E-04	0.91E-05	0.32E-05	0.29E-05
0.26E-03	0.21E-03	0.16E-03	0.12E-03	0.72E-04	0.26E-04	0.21E-04	0.16E-04	0.12E-04	0.71E-05	0.24E-05	0.22E-05
0.18E-03	0.15E-03	0.12E-03	0.85E-04	0.52E-04	0.18E-04	0.15E-04	0.12E-04	0.84E-05	0.50E-05	0.17E-05	0.15E-05
0.11E-03	0.92E-04	0.72E-04	0.52E-04	0.31E-04	0.11E-04	0.91E-05	0.71E-05	0.50E-05	0.29E-05	0.88E-06	0.79E-06
0.40E-04	0.33E-04	0.26E-04	0.18E-04	0.11E-04	0.40E-05	0.32E-05	0.24E-05	0.17E-05	0.88E-06	0.00E+00	0.00E+00
0.34E-04	0.28E-04	0.22E-04	0.16E-04	0.96E-05	0.34E-05	0.28E-05	0.21E-05	0.14E-05	0.75E-06	0.00E+00	0.00E+00
0.29E-04	0.23E-04	0.18E-04	0.13E-04	0.80E-05	0.29E-05	0.23E-05	0.17E-05	0.12E-05	0.63E-06	0.00E+00	0.00E+00
0.23E-04	0.19E-04	0.15E-04	0.11E-04	0.64E-05	0.23E-05	0.18E-05	0.14E-05	0.95E-06	0.50E-06	0.00E+00	0.00E+00
0.17E-04	0.14E-04	0.11E-04	0.79E-05	0.48E-05	0.17E-05	0.14E-05	0.10E-05	0.71E-06	0.00E+00	0.00E+00	0.00E+00
0.12E-04	0.94E-05	0.74E-05	0.53E-05	0.32E-05	0.12E-05	0.93E-06	0.70E-06	0.48E-06	0.00E+00	0.00E+00	0.00E+00
0.58E-05	0.48E-05	0.37E-05	0.27E-05	0.16E-05	0.58E-06	0.47E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

plume width = 38. plume thickness = 12.

Top of domestic capture area, nodes = 10

Middle plus top domestic capture nodes = 33

Bottom half ellipse= 5

Domestic well capture area (all) = 89

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	1.	1.	1.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	0.	0.	0.	0.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	0.	0.	0.	0.
1.	1.	1.	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

For capture zone 1 with width = 20. & thick = 14.

Representative concentration for intersection area 0.474E-05

trans df = 923.967 centerline df = 10.950

=====

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General instructions for itsec.f processing

- ① Run patchi or stripi to get distrib of concentration
- ② edit file.out from ① to add required header lines as described in top of itsec.f ; file-out is y-z cross-section created from patchi/stripi runs ; copy edit to file = plume.dat
- ③ copy caps3D.input or caps2D.input into a file called capture.dat
- ④ run itsec (type itsec at prompt, then carriage return)
- ⑤ results are put into a file called intersec.out
 $T-BDF = \text{dispersion based dilution factor} = C_0/C_c$
 $C_0/C_c = \text{inverse of normalized centerline concentration}$
 $V-BDF = \text{copy from previous pages of scientific notebook for capture zone vs intercepted portion of plume areas (see page 45-46)}$
- ⑥ Results in intersec.out have been transferred to table below
 The following pages are a table of the results

Plume Description	Capture Description	V-BDF	C_0/C_c	T-BDF
3D plume 1 P2 10/21/97				
20:2:0.2 m	#8, Q = 300	1.4	9.1	34
20:2:0.2 m	#9, Q = 800	2.6	9.1	55
20:2:0.2 m	#10, Q = 1,380	3.5	9.1	57
20:2:0.2 m	#11, Q = 2,000	4.8	9.1	57
Small irrigation well, 3D plume 1				
20:2:0.2 m	#31, T = 50	2.6	9.1	48
20:2:0.2 m	#32, T = 100	1.8	9.1	34
20:2:0.2 m	#33, T = 200	1.4	9.1	26
20:2:0.2 m	#34, T = 300	1.0	9.1	20
20:2:0.2 m	#35, T = 400	1.0	9.1	18
Large irrigation well, 3D plume 1				
20:2:0.2 m	#36, T = 200	2.8	9.1	57
20:2:0.2 m	#37, T = 300	3.0	9.1	52
20:2:0.2 m	#38, T = 400	2.4	9.1	45
20:2:0.2 m	#39, grad = 0.001	6.2	9.1	57.5
20:2:0.2 m	#40, grad = 0.002	3.4	9.1	57.5
20:2:0.2 m	#41, grad = 0.003	2.3	9.1	56.6
20:2:0.2 m	#42, grad = 0.005	1.0	9.1	45
Domestic wells, 3D plume 1				
20:2:0.2m	#21, 940-1,000	9.1	9.5	1
20:2:0.2 m	#22, 930-990	9.1	9.7	1
20:2:0.2 m	#23, 920-980	9.1	9.9	1
20:2:0.2 m	#24, 900-960	9.1	10.4	1
20:2:0.2 m	#1, Q = 1	9.1	9.36	1

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continued

Plume Description	Capture Description	V-BDF	C _o /C _c	T-BDF
20:2:0.2 m	#2, Q = 2	9.1	9.44	1
20:2:0.2 m	#3, Q = 3	9.1	9.5	1
20:2:0.2 m	#4, Q = 4	9.1	9.6	1
20:2:0.2 m	#5, Q = 6.8	9.1	9.9	1
20:2:0.2 m	#6, Q = 37.5	9.1	13	1
20:2:0.2 m	#7, Q = 75	9.1	18	1
20:2:0.2 m	#12, T = 10	9.1	12	1
20:2:0.2 m	#13, T = 50	9.1	9.8	1
20:2:0.2 m	#14, T = 100	9.1	9.5	1
20:2:0.2 m	#15, T = 400	9.1	9.3	1
20:2:0.2 m	#16, grad = 0.001	9.1	11	1
20:2:0.2 m	#17, grad = 0.0025	9.1	9.8	1
20:2:0.2 m	#18, grad = 0.005	9.1	9.5	1
20:2:0.2 m	#19, grad = 0.01	9.1	9.4	1
3D plume 2 PR 10/21/97				
100:10:0.1 m	#8, Q = 300	1.9	14	37
100:10:0.1 m	#9, Q = 800	2.7	14	47
100:10:0.1 m	#10, Q = 1,380	3.3	14	60
100:10:0.1 m	#11, Q = 2,000	4.1	14	73
Small irrigation well, 3D plume 2				
100:10:0.1 m	#31, T = 50	3.2	14	43
100:10:0.1 m	#32, T = 100	2.4	14	37
100:10:0.1 m	#33, T = 200	1.8	14	34
100:10:0.1 m	#34, T = 300	1.6	14	32
100:10:0.1 m	#35, T = 400	1.5	14	30

continued

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Plume Description	Capture Description	V-BDF	C _o /C _c	T-BDF
PR				
Large irrigation well, plume 2 10/21/97				
100:10:0.1 m	#36, T = 200	3.0	14	53
100:10:0.1 m	#37, T = 300	2.6	14	45
100:10:0.1 m	#38, T = 400	2.3	14	41
100:10:0.1 m	#39, grad = 0.001	4.3	14	—
100:10:0.1 m	#40, grad = 0.002	3.3	14	59
100:10:0.1 m	#41, grad = 0.003	2.8	14	49
100:10:0.1 m	#42, grad = 0.005	2.3	14	41
Thin plumes, Domestic wells at 25 km, 20:2 m dispersivity ratio				
25 m thick; 20:2 m	#21, 940-1,000	3.3	1.8	1.78
25 m thick; 20:2 m	#22, 930-990	4.3	1.8	1.77
25 m thick; 20:2 m	#23, 920-980	5.4	1.8	1.77
25 m thick; 20:2 m	#24, 900-960	4.3	1.8	1.76
10 m thick; 20:2 m	#21, S = 940-1,000	8.2	1.8	1.78
10 m thick; 20:2 m	#22, S = 930-990	10.3	1.8	1.77
10 m thick; 20:2 m	#23, S = 920-980	26	1.8	1.70
10 m thick; 20:2 m	#24, S = 900-960	N/A	1.8	N/A
25 m thick; 20:2 m	#1, Q = 1	2.8	1.8	1.76
25 m thick; 20:2 m	#2, Q = 2	3.1	1.8	1.77
25 m thick; 20:2 m	#3, Q = 3	3.3	1.8	1.78
25 m thick; 20:2 m	#4, Q = 4	3.5	1.8	1.78
25 m thick; 20:2 m	#5, Q = 6.8	4.0	1.8	1.80
25 m thick; 20:2 m	#6, Q = 37.5	7.6	1.8	1.90
25 m thick; 20:2 m	#7, Q = 75	10.2	1.8	2.01

Continued

Plume Description	Capture Description	V-BDF	C _o /C _c	T-BDF
10 m thick; 20:2 m	#1, Q = 1	7.0	1.8	1.76
10 m thick; 20:2 m	#2, Q = 2	7.7	1.8	1.77
10 m thick; 20:2 m	#3, Q = 3	8.2	1.8	1.78
10 m thick; 20:2 m	#4, Q = 4	8.8	1.8	1.78
10 m thick; 20:2 m	#5, Q = 6.8	10.1	1.8	1.80
10 m thick; 20:2 m	#6, Q = 37.5	19	1.8	1.90
10 m thick; 20:2 m	#7, Q = 75	26	1.8	2.01
25 m thick; 20:2 m	#12, T = 10	6.9	1.8	1.88
25 m thick; 20:2 m	#13, T = 50	3.9	1.8	1.80
25 m thick; 20:2 m	#14, T = 100	3.3	1.8	1.78
25 m thick; 20:2 m	#15, T = 400	2.7	1.8	1.76
25 m thick; 20:2 m	#16, grad = 0.001	5.3	1.8	1.84
25 m thick; 20:2 m	#17, grad = 0.0025	3.9	1.8	1.80
25 m thick; 20:2 m	#18, grad = 0.005	3.3	1.8	1.78
25 m thick; 20:2 m	#19, grad = 0.01	2.9	1.8	1.77
10 m thick; 20:2 m	#12, T = 10	17	1.8	1.88
10 m thick; 20:2 m	#13, T = 50	9.8	1.8	1.80
10 m thick; 20:2 m	#14, T = 100	8.2	1.8	1.78
10 m thick; 20:2 m	#15, T = 400	6.8	1.8	1.76
10 m thick; 20:2 m	#16, grad = 0.001	13.2	1.8	1.84
10 m thick; 20:2 m	#17, grad = 0.0025	9.8	1.8	1.80
10 m thick; 20:2 m	#18, grad = 0.005	8.2	1.8	1.78
10 m thick; 20:2 m	#19, grad = 0.01	7.4	1.8	1.77
Thin plumes irrigation wells @ 25 km				
25m thick; 20:2 m	#8, Q = 300	19	1.8	2.8

Continued

Plume Description	Capture Description	V-BDF	C _o /C _c	T-BDF
25m thick; 20:2 m	#9, Q = 800	26	1.8	4.8
25m thick; 20:2 m	#10, Q = 1,380	36	1.8	5.9
25m thick; 20:2 m	#11, Q = 2,000	49	1.8	5.9
25m thick; 50:5 m	#8, Q = 300	19	2.6	3.3
25m thick; 50:5 m	#9, Q = 800	26	2.6	4.8
25m thick; 50:5 m	#10, Q = 1,380	30	2.6	6.8
25m thick; 50:5 m	#11, Q = 2,000	33	2.6	8.8
25m thick; 100:10 m	#8, Q = 300	19	3.6	4.1
25m thick; 100:10 m	#9, Q = 800	26	3.6	5.2
25m thick; 100:10 m	#10, Q = 1,380	30	3.6	6.9
25m thick; 100:10 m	#11, Q = 2,000	32	3.6	8.9

RF
10/21/97Plot Files:

Data files plus xvgr "all" files (complete plot file with axis instructions)

Figures 4-2 to 4-13 /Bore/Data/XVGR/#

(data for 4-2 to 4-13 reported on page 41 and pages 45-46)

Figures 4-14 - 4-17 /Bore/Analytic/Intersect/XVGR/#

(data for figures 4-14 to 4-17 reported on pages 67-71)

Input Files for Plumes

All plume scenarios were re-run through Wexler's (1992) patchi and stripi programs. A new output file from ~~the~~ patchi program outputs the data in an y-z plane instead of an x-y plane. Corresponding data locations were checked between

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The 2 output files to ensure that my creation of a new output file had no effect on the calculated values at any point in the x-y-z area of the plume.

Note that a patch thickness of 50 m is used as input to obtain a patch source of 25 m thick at the water table (mirror the 25 m thick source to account for no flow boundary condition at water table). Dispersion coefficients are input values, note that $D_{x,y,z} = v\alpha$ where α is the appropriate dispersivity for that direction (x, y, or z) and v is the seepage or particle velocity ($v = Q/\phi$)

Input files for "stripi" simulations:

Oct 16, 97 8:43										wexler100Thin.dat										Page 1/1		
Thin plume - Amargosa Farms; dispersivities 20:2 meters																						
stripi code: aquifer of infinite width with a finite width source (line)																						
Model Data: Y1=-250 m, Y2=250 m, V=2.44 m/yr																						
DX= , DY= m**2/yr, DK=1E-16 per yr, C0=0.00438 mg/L																						
====																						
2	15	1	256	0																		
mg/l			m/yr		m**2/yr		per yr		meter		yr											
.00438			2.44		244.		24.4		1.E-16													
-250.0			250.0																			
15000.0			25000.0																			
0.0			200.0		300.0		400.0		500.0		600.0		800.0		1000.0							
1200.0			1500.0		1800.0		2100.0		2400.0		2700.0		3000.0									
15000.0																						

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Oct 16, 97 8:43										wexler50Thin.dat										Page 1/1		
Thin plume - Amargosa Farms; dispersivities 20:2 meters																						
stripi code: aquifer of infinite width with a finite width source (line)																						
Model Data: Y1=-250 m, Y2=250 m, V=2.44 m/yr																						
DX= , DY= m**2/yr, DK=1E-16 per yr, C0=0.00438 mg/L																						
====																						
2	15	1	256	0																		
mg/l			m/yr		m**2/yr		per yr		meter		yr											
.00438			2.44		122.		12.2		1.E-16													
-250.0			250.0																			
15000.0			25000.0																			
0.0			200.0		300.0		400.0		500.0		600.0		700.0		800.0							
900.0			1000.0		1200.0		1400.0		1700.0		2000.0		2300.0									
15000.0																						

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Oct 16, 97 8:32										wexler20Thin.dat										Page 1/1		
Thin plume - Amargosa Farms; dispersivities 20:2 meters																						
stripi code: aquifer of infinite width with a finite width source (line)																						
Model Data: Y1=-250 m, Y2=250 m, V=2.44 m/yr																						
DX= , DY= m**2/yr, DK=1E-16 per yr, C0=0.00438 mg/L																						
====																						
2	15	1	256	0																		
mg/l			m/yr		m**2/yr		per yr		meter		yr											
.00438			2.44		48.8		4.88		1.E-16													
-250.0			250.0																			
15000.0			25000.0																			
0.0			200.0		300.0		400.0		500.0		600.0		700.0		800.0							
900.0			1000.0		1200.0		1400.0		1600.0		1800.0		2000.0									
15000.0																						

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Sample output file for itsec.f preprocessor

Once the 2 headers have been added to one of the matrices in the Wexler (patch or strip) output files (bottom of previous page) the file renamed plume.dat. Below is an output file of itsec.f using "wexlertans10.dat" for the plume definition and caps3D.input for capture.dat.

Oct 20, 97 17:10	df-f10.25km.output	Page 1/2
f10.25km (100:10:0.1)		
Interpolated plume. plume width = 2586. plume thickness = 406. *****		
Irrigation well capture area = 584079 For capture zone 1 with width = 1292. & thick = 575. Intersect area = 584079 Representative concentration for intersection area 0.128E-03 qfactor= 1.245 trans df= 34.314 centerline df= 9.144		
Irrigation well capture area = 1510867 For capture zone 2 with width = 2330. & thick = 825. Intersect area = 1510867 Representative concentration for intersection area 0.802E-04 qfactor= 1.881 trans df= 54.629 centerline df= 9.144		
Irrigation well capture area = 2501163 For capture zone 3 with width = 3382. & thick = 941. Intersect area = 2501163 Representative concentration for intersection area 0.762E-04 qfactor= 2.959 trans df= 57.462 centerline df= 9.144		
Irrigation well capture area = 3444785 For capture zone 4 with width = 4450. & thick = 985. Intersect area = 3444785 Representative concentration for intersection area 0.762E-04 qfactor= 4.076 trans df= 57.462 centerline df= 9.144		
Irrigation well capture area = 1147589 For capture zone 5 with width = 1944. & thick = 751. Intersect area = 1147589 Representative concentration for intersection area 0.915E-04 qfactor= 1.639 trans df= 47.851 centerline df= 9.144		
Irrigation well capture area = 584079 For capture zone 6 with width = 1292. & thick = 575. Intersect area = 584079 Representative concentration for intersection area 0.128E-03 qfactor= 1.245 trans df= 34.314 centerline df= 9.144		
Irrigation well capture area = 292146 For capture zone 7 with width = 876. & thick = 424. Intersect area = 292146 Representative concentration for intersection area 0.172E-03 qfactor= 1.012 trans df= 25.532 centerline df= 9.144		
Irrigation well capture area = 195246 For capture zone 8 with width = 705. & thick = 352. Intersect area = 195246 Representative concentration for intersection area 0.215E-03 qfactor= 1.000 trans df= 20.333 centerline df= 9.144		
Irrigation well capture area = 147621 For capture zone 9 with width = 607. & thick = 309. Intersect area = 147621 Representative concentration for intersection area 0.249E-03 qfactor= 1.000 trans df= 17.593 centerline df= 9.144		
Irrigation well capture area = 1965590 For capture zone 10 with width = 2810. & thick = 890. Intersect area = 1965590 Representative concentration for intersection area 0.762E-04 qfactor= 2.326 trans df= 57.462 centerline df= 9.144		
Irrigation well capture area = 1337611 For capture zone 11 with width = 2146. & thick = 793. Intersect area = 1337611 Representative concentration for intersection area 0.848E-04		

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cont'd.

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Oct 20, 97 17:10	df-f10.25km.output	Page 2/2
qfactor= 1.764 trans df= 51.643 centerline df= 9.144 Irrigation well capture area = 1016213 For capture zone 12 with width = 1798. & thick = 719. Intersect area = 1016213 Representative concentration for intersection area 0.975E-04 qfactor= 1.555 trans df= 44.902 centerline df= 9.144		
Irrigation well capture area = 4397848 For capture zone 13 with width = 5596. & thick = 1000. Intersect area = 4397848 Representative concentration for intersection area 0.762E-04 qfactor= 5.203 trans df= 57.462 centerline df= 9.144		
Irrigation well capture area = 2409164 For capture zone 14 with width = 3282. & thick = 934. Intersect area = 2409164 Representative concentration for intersection area 0.762E-04 qfactor= 2.850 trans df= 57.462 centerline df= 9.144		
Irrigation well capture area = 1660822 For capture zone 15 with width = 2486. & thick = 850. Intersect area = 1660822 Representative concentration for intersection area 0.774E-04 qfactor= 1.994 trans df= 56.617 centerline df= 9.144		
Irrigation well capture area = 1016213 For capture zone 16 with width = 1798. & thick = 719. Intersect area = 1016213 Representative concentration for intersection area 0.975E-04 qfactor= 1.555 trans df= 44.902 centerline df= 9.144		

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Below is a list of files run through itsec.f
All of these files are in /Bore/Analytic/Intersec/*

plume.dat	capture.dat	output	comments
st100.25km	caps2D.input	df-st100.25km.10m	plume=10m thick
st100.25km	↓	df-st100.25km.25m	plume=25m thick
f8.25km	↓	df-f8.25km.dom	3D plume
st20.25km	caps2.input	df-st20.25km.10m	plume=10m thick
st20.25km	↓	df-st20.25km.25m	plume=25m thick
f10.25km	↓	df-f10.25km.dom	3D plume
f10.25km	caps3D.input	df-f10.25km.output	} 3D plume
f9.25km	↓	df-f9.25km.output	
f8.25km	↓	df-f8.25km.output	
st20.25km	caps3D.input	df-st20.25km.25m	} plume 25m thick
st50.25km	↓	df-st50.25km.25m	
st100.25km	↓	df-st100.25km.25m	

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QAP-014 Review (Memo)

Cont'd

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Memo

For: Dr. Robert Baca
 From: Jeff Bogan
 Subject: QAP-014 Review of Assessment of Dilution Effects Induced by Water Well Pumping in the Amargosa Farms Area and documentation in scientific notebook
 Date: Oct 21, 1997
 cc: R. Fedors

RF 10/24/97

This memo is to inform you of the review performed on the quality assessment (as specified in QAP-014) of the dilution effects induced by water well pumping in the Amargosa Farms area. There are three steps that are required to solve for the dilution effects. First the dilution of the nuclides as it exits the repository and the subsequent dispersal of the plume is computed. Next, the orthogonal capture zone is delineated by a trial and error process with GFLOW1 software. Lastly, the results from the previous two steps are used to determine the quantity of nuclides, drawn by the either an irrigation well or a domestic well. A review of the documentation in the scientific notebook and verification of the controlled and uncontrolled software used in each of these steps is given.

The dilution of the nuclides as it exits the repository, is computed by either patchi.exe or stripi.exe executable. These are based on analytical solutions of Wexler (1992). To produce a suitable range of values that include the most significant portion of the plume, several iteration of the program may be necessary. The boundary of the plume is delineated by the iso-cline that equals the concentration of nuclides at their introduction into the water table. A file is produced by the patchi executable that give the plume distribution at the critical points. The user is responsible for fitting this plume so that it boundaries are at the edges of the matrix given in this file.

As based on the QAP-014 Sect 3.1 a review of the documentation in the scientific notebook was performed. Input parameters (p27), name, version and justification for usage were included. However, some of the input parameters were not fully defined especially as formatted in the file, and no sample output file was included. As based on QAP-014 Sect 3.2 verification of the patchi executable was performed. Based on the sample parameters and parameters created by the reviewer, the software gave reasonable results.

The orthogonal capture zone was delineated with GFLOW, (Haitjema Software). Aquifer, partially penetrating well and region of interest characteristics were used as input for the software. Certain values were conjectural at this point as the true values based on data from Amargosa Valley are not available. A backwards particle trace was then performed with software. This procedure was to define the capture zone by determining with a trial and error basis, the extent of upstream particles that will be captured by the well. This defines the capture zone by determine particles on the boundary of the well capture area. This procedure was performed for both downward(z) and perpendicular(y) directions.

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As based on the QAP-014 a review of the documentation in the scientific notebook was performed. Input parameters(p12, 20, 21), name, version and justification for usage were included. 41 sample runs were included in the scientific notebook (p41). The reviewer checked Report ID #8, #18, #28 and #38 on this page against given results with good agreement in every case. However, on this table's header, a note might be included as to which columns are parameters and which are results. GFLOW is commercial software, and validation is given in its documentation. The purpose to which it was put is within its capabilities and the results were reasonable, as results from an internal error checking routine within the program were small.

An intersection calculation was determined with a program called itsec (R. Fedors) to combine the results of the previous two steps. To prepare the input files, output files from patchi must be edited and results from GFLOW entered into a second data file. Specifically the "file.out" file must be edited to include two lines at the head of the file for dimensions of the matrix, threshold concentration, flags for capture zone, and thickness. The name must be changed to "plume.dat". The second file is constructed of information derived from the GFLOW, This information includes dimensions of the capture zone, darcy velocity and well screen information. More than one well may be specified in this file. The program then postprocesses the information to determine the quantity of nuclides captured by the well.

The itsec source code is commented throughout. This includes a description of all of the input file and output file parameters. The development and rational for the model and its sources is documented in the scientific notebook. Input files and output is included. Several runs were done independent of the previous files to gage the performance of this program. For the most part it performed properly as described in the scientific notebook. There are some concerns, however, based on accuracy. These are detailed on the following page.

For the input file plume.dat:

3 3 0.00438
1 10.
80000. 0. 5. 10.
0. 0.688E-04 0.187E-04 0.267E-04
5. 0.410E-04 0.210E-04 0.457E-04
10. 0.210E-04 0.250E-04 0.367E-04

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and capture.dat:

1
5. 5. .244 c Width, Thick, Darcy
12. 12. 8. c Screen top, Screen bottom, C Top
99999

The following output file was outputted

intersec.out :

Interpolated plume.
0.69E-04 0.59E-04 0.49E-04 0.39E-04 0.29E-04 0.19E-04 0.15E-04 0.11E-04 0.75E-05 0.37E-05 0.00E+00 0.00E+00
0.63E-04 0.54E-04 0.46E-04 0.37E-04 0.28E-04 0.19E-04 0.15E-04 0.11E-04 0.77E-05 0.38E-05 0.00E+00 0.00E+00
0.58E-04 0.50E-04 0.42E-04 0.35E-04 0.27E-04 0.20E-04 0.16E-04 0.12E-04 0.78E-05 0.39E-05 0.00E+00 0.00E+00
0.52E-04 0.46E-04 0.39E-04 0.33E-04 0.26E-04 0.20E-04 0.16E-04 0.12E-04 0.80E-05 0.40E-05 0.00E+00 0.00E+00
0.47E-04 0.41E-04 0.36E-04 0.31E-04 0.26E-04 0.21E-04 0.16E-04 0.12E-04 0.82E-05 0.41E-05 0.00E+00 0.00E+00
0.41E-04 0.37E-04 0.33E-04 0.29E-04 0.25E-04 0.21E-04 0.17E-04 0.13E-04 0.84E-05 0.42E-05 0.00E+00 0.00E+00
0.37E-04 0.34E-04 0.31E-04 0.28E-04 0.25E-04 0.22E-04 0.17E-04 0.13E-04 0.87E-05 0.44E-05 0.00E+00 0.00E+00
0.33E-04 0.31E-04 0.29E-04 0.27E-04 0.25E-04 0.23E-04 0.18E-04 0.14E-04 0.90E-05 0.45E-05 0.00E+00 0.00E+00
0.29E-04 0.28E-04 0.27E-04 0.26E-04 0.25E-04 0.23E-04 0.19E-04 0.14E-04 0.94E-05 0.47E-05 0.00E+00 0.00E+00
0.25E-04 0.25E-04 0.25E-04 0.25E-04 0.24E-04 0.24E-04 0.19E-04 0.15E-04 0.97E-05 0.48E-05 0.00E+00 0.00E+00
0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
0.21E-04 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
plume width = 20. plume thickness = 10.

Top of domestic capture area, nodes = 9
Middle plus top domestic capture nodes = 3
Bottom half ellipse = 0

Domestic well capture area (all) = 19
0.
0.
0.
0.
0.
0.
0.
0.
0.
0.
1. 0.
1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

0.
0.
0.
For capture zone 1 with width = 5. & thick = 5.
Representative concentration for intersection area 0.249E-04
trans df = 172.441 centerline df = 62.500

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Because the value in the upper left most corner is used in this case to represent the total concentration for the block that is interpolated over (being an integer value) instead of interpolating to the center of each block, there may be some kind of error in the this respect. In addition there was a random number that showed up outside of the matrix in this case, which in itself is not that much of an innaccuracy, but may indicate some kind of other problem.

Jeff Bogan

Resolution of this QAP-014 review by Jeff Bogan is included on the following pages.

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Input instructions for patchi code

TECHNIQUES OF WATER-RESOURCES INVESTIGATIONS

Table 10.—Input data format for the program PATCHI

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| Data set | Columns | Format | Variable name | Description |
|-----------------|---------|--------|---------------|---|
| 1 | 1 - 60 | A60 | TITLE | Data to be printed in a title box on the first page of program output. Last line in data set must have an "=" in column 1. First four lines are also used as titles for plot. |
| 2 | 1 - 4 | I4 | NX | Number of x-coordinates at which solution will be evaluated. |
| | 5 - 8 | I4 | NY | Number of y-coordinates at which solution will be evaluated. |
| | 9 - 12 | I4 | NZ | Number of z-coordinates at which solution will be evaluated. |
| | 13 - 16 | I4 | NT | Number of time values at which solution will be evaluated. |
| | 17 - 20 | I4 | NMAX | Number of terms to be used in numerical integration technique (must be equal to 4, 20, 60, 104, or 256). |
| | 21 - 24 | I4 | IPLT | Plot control variable. Contours of normalized concentration will be plotted if IPLT is greater than 0. |
| 3 | 1 - 10 | A10 | CUNITS | Character variable used as label for units of concentration in program output. |
| | 11 - 20 | A10 | VUNITS | Units of ground-water velocity. |
| | 21 - 30 | A10 | DUNITS | Units of dispersion coefficient. |
| | 31 - 40 | A10 | KUNITS | Units of solute-decay coefficient. |
| | 41 - 50 | A10 | LUNITS | Units of length. |
| | 51 - 60 | A10 | TUNITS | Units of time. |
| 4 | 1 - 10 | F10.0 | CO | Solute concentration at inflow boundary. |
| | 11 - 20 | F10.0 | VX | Ground-water velocity in x-direction. |
| | 21 - 30 | F10.0 | DX | Longitudinal dispersion coefficient. |
| | 31 - 40 | F10.0 | DY | Transverse dispersion coefficient in y-direction. |
| | 41 - 50 | F10.0 | DZ | Transverse dispersion coefficient in z-direction. |
| | 51 - 60 | F10.0 | DK | First-order solute-decay coefficient. |
| 5 | 1 - 10 | F10.0 | Y1 | Y-coordinate of lower limit of finite width and height solute source. |
| | 11 - 20 | F10.0 | Y2 | Y-coordinate of upper limit of finite width and height solute source. |
| | 21 - 30 | F10.0 | Z1 | Z-coordinate of lower limit of finite width and height solute source. |
| | 31 - 40 | F10.0 | Z2 | Z-coordinate of upper limit of finite width and height solute source. |
| 6 | 1 - 80 | 8F10.0 | X(I) | X-coordinates at which solution will be evaluated (eight values per line). |
| 7 | 1 - 80 | 8F10.0 | Y(I) | Y-coordinates at which solution will be evaluated (eight values per line). |
| 8 | 1 - 80 | 8F10.0 | Z(I) | Z-coordinates at which solution will be evaluated (eight values per line). |
| 9 | 1 - 80 | 8F10.0 | T(I) | Time values at which solution will be evaluated (eight values per line). |
| ¹ 10 | 1 - 10 | F10.0 | XSCLP | Scaling factor by which to divide x-coordinate values are divided to convert them to plotter inches. |
| | 11 - 20 | F10.0 | YSCLP | Scaling factor used to convert y-coordinates into plotter inches. |
| | 21 - 30 | F10.0 | DELTA | Contour increment for plot of normalized concentration (must be between 0.0 and 1.0). |

¹Data line is needed only if IPLT (in data set 2) is greater than 0.

RF

Input instructions for stripi

ANALYTICAL SOLUTIONS FOR SOLUTE TRANSPORT IN GROUND-WATER SYSTEMS WITH UNIFORM FLOW 37

Table 5.—Input data format for the program STRIPI

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| Data set | Columns | Format | Variable name | Description |
|----------------|---------|--------|---------------|--|
| 1 | 1 - 60 | A60 | TITLE | Data to be printed in a title box on the first page of program output. Last line in data set must have an "=" in column 1. First four lines are also used as title for plot. |
| 2 | 1 - 4 | I4 | NX | Number of x-coordinates at which solution will be evaluated. |
| | 5 - 8 | I4 | NY | Number of y-coordinates at which solution will be evaluated. |
| | 9 - 12 | I4 | NT | Number of time values at which solution will be evaluated. |
| | 13 - 16 | I4 | NMAX | Number of terms used in the numerical integration techniques (must be equal to 4, 20, 60, 104, or 256). |
| | 17 - 20 | I4 | IPLT | Plot control variable. Contours of normalized concentration will be plotted if IPLT is greater than 0. |
| 3 | 1 - 10 | A10 | CUNITS | Character variable used as label for units of concentration in program output. |
| | 11 - 20 | A10 | VUNITS | Units of ground-water velocity. |
| | 21 - 30 | A10 | DUNITS | Units of dispersion coefficient. |
| | 31 - 40 | A10 | KUNITS | Units of solute-decay coefficient. |
| | 41 - 50 | A10 | LUNITS | Units of length. |
| | 51 - 60 | A10 | TUNITS | Units of time. |
| 4 | 1 - 10 | F10.0 | CO | Solute concentration at inflow boundary. |
| | 11 - 20 | F10.0 | VX | Ground-water velocity in x-direction. |
| | 21 - 30 | F10.0 | DX | Longitudinal dispersion coefficient. |
| | 31 - 40 | F10.0 | DY | Transverse dispersion coefficient. |
| | 41 - 50 | F10.0 | DK | First-order solute-decay coefficient. |
| 5 | 1 - 10 | F10.0 | Y1 | Y-coordinate of lower limit of finite-width solute source. |
| | 11 - 20 | F10.0 | Y2 | Y-coordinate of upper limit of finite-width solute source. |
| 6 | 1 - 80 | 8F10.0 | X(I) | X-coordinates at which solution will be evaluated (eight values per line). |
| 7 | 1 - 80 | 8F10.0 | Y(I) | Y-coordinates at which solution will be evaluated (eight values per line). |
| 8 | 1 - 80 | 8F10.0 | T(I) | Time values at which solution will be evaluated (eight values per line). |
| ¹ 9 | 1 - 10 | F10.0 | XSCLP | Scaling factor by which x-coordinate values are divided to convert them to plotter inches. |
| | 11 - 20 | F10.0 | YSCLP | Scaling factor used to convert y-coordinates into plotter inches. |
| | 21 - 30 | F10.0 | DELTA | Contour increment for plot of normalized concentration (must be between 0.0 and 1.0). |

¹Data line is needed only if IPLT (in data set 2) is greater than 0.

Input and output files for "patchi" and "stripi"
(see also pages 72 & 73) a/Bore/Analytic/Intersect/*

stripi input output itsec. input for plume.dat
wexler100Thin.dat file.out st100.15km (at 15 km)
($\alpha_L: \alpha_T \Rightarrow 100:10$ m) st100.25km (at 25 km)

(then edit plume.dat for 10 m or 25 m thick plume)
(also add 2 header lines as indicated in itsec.f comments)
(do 1 plume at a time [see matrix input])

wexler 50Thin.dat file.out st50.15km
($\alpha_L: \alpha_T \Rightarrow 50:5$ m) st50.25km

wexler 20Thin.dat file.out st20.15km
(20:2 m) st20.25km

wexler farms 10.dat file.out f10.15km
(20:2:0.2 m) f10.25km

wexler farms 8.dat file.out f8.15km
(100:10:0.1 m) f8.25km

The output files from itsec.f are descriptive of inputs

capture.dat = caps3D.input { df-st100.25km.10m.out (10 m thick plume)
df-st100.25km.25m.out (25 m thick plume)
df-f8.25km.dom.out
df-st20.25km.10m.out
df-st20.25km.25m.out

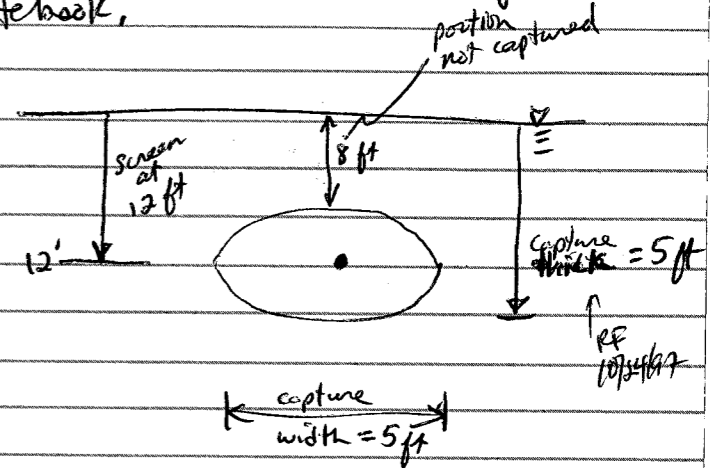
capture.dat = caps3D.input { df-f10.25km.out
df-f9.25km.out
df-f8.25km.out
df-st20.25km.large.out } 3-dimensional plume \Rightarrow "large"
df-st50.25km.large.out
df-st100.25km.large.out

Comments on test example of J. Bogan (in memo)

(1) capture description did not properly utilize the input instructions, specifically the meaning of capture width and capture thickness. See capture thickness as defined on page 42 of scientific notebook.

Test example \Rightarrow

screened portion is point
capture thickness (5ft) did not fit with screened portion of 12 ft depth



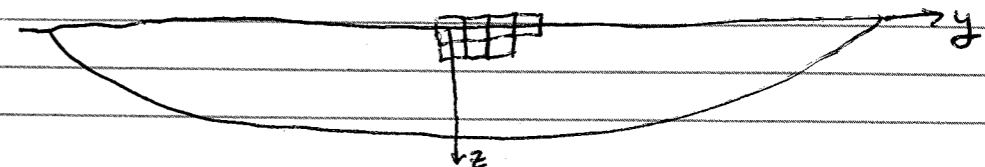
(2) Only a portion of the plume was entered; input instructions specifically specify that the entire plume be entered.

Other comments on memo

(1) Plume delineation is at $C_0 \times 10^{-4}$ not at C_0 iso-cline
(2) User does not have to "fitting this plume so that its boundaries are at edges of the matrix." Rather, just make sure that y and z values are large enough so that $C_0 \times 10^{-4}$ threshold is included somewhere within matrix. There is no reason to be accurate, just don't go too far so that interpolation is weakened, or don't cut it too short so that extrapolation is expected (there will be none!)

(3) GFlow "trial & error" basis included both forward and backward tracking.

(4) Account for top half-cells (above) water table, as illustrated below.



To: J. Bogan
 B. Baca
 From: R. Fedors
 Subject: Resolution of Items in QAP-014 Review by J. Bogan of Oct 21, 1997
 on Borehole Dilution Effects in the Amargosa Farms Area
 Date: October 25, 1997

R Fedors
10/25/97

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Item 1 (page 1 of QAP-014 review memo)

Input parameters for Wexler (1992) patchi and stripi codes were not fully defined especially as formatted in the file, and no sample output file was included in the scientific notebook.

Resolution:

Input parameters and formats are defined in Wexler (1992) page 56 for patchi and page 27 for stripi. Xerox copies of the input instructions are now added to the scientific notebook. Input and output files for the transport simulations are referenced by path/name. These will be tar'd to tape at the conclusion of the borehole dilution scoping report. A sample output file is now added to the scientific notebook so that a clear connection is evident with the patchi/stripi output and the input for the postprocessor itsec.f for which two header lines are added. A sample input file for the itsec.f postprocessor was already incorporated into the scientific notebook.

Item 2 (page 4 of QAP-014 review memo)

An extraneous value (non-zero) of concentration noted outside the plume may be indicative of some kind of other problem.

Resolution:

An error in the interpolation algorithm left a non-zero value of concentration outside the plume area as delineated by 1×10^{-4} times the source concentration. This error was indicative of an interpolation error at the edge of the plume which was magnified when only a small portion of the plume was input as in the test case of J. Bogan in his memo. The error was corrected and all of the cases were re-run with no significant changes (to the 4th significant figure or less) to the results. This was expected since the input criteria specified that the entire plume must be entered, the error at the outside edges (low concentration relative to the interior) was insignificant. The test case of J. Bogan was also re-run and the results included in the scientific notebook. In addition, input checks have been added to 'stop' the calculation if improper plume inputs are attempted.

Item 3 (page 4 of QAP-014 review memo)

There may be an error associated with the choice of the discretization grid.

R Fedors
10/25/97

Resolution:

J. Bogan is suggesting a shift of the grid placement. A grid refinement check as suggested by B. Baca was attempted. However since the code uses integer location values as pointers in matrices, the refinement most readily implemented is that by a factor of ten. This creates a problem size which is beyond the memory plus swap currently on the SUN server bigend. Rather than involving IMS staff or modifying the code significantly, J. Bogan concurred that accounting for the half-cells above the water table would sufficiently address his concerns. The accounting is literally a subtraction of the mass and area in the half-cells above the water table from the interpolated portion of the plume. The half-cells along the vertical mirror plane of the plume were already accounted for in the itsec.f code. In re-runs of 34 different combinations of plumes and capture zones, the results did not significantly change. Some results changed in the 3rd significant figure, however the results in the borehole dilution scoping report are generally reported to 2 significant figures. The conclusion is that the grid was sufficiently refined to avoid any grid configuration effects. Output from the itsec.f postprocessor for the 34 re-runs are included in the scientific notebook as is the printout of the itsec.f code.

Wexler, E.J. 1992. Analytic Solutions for One-, Two-, and Three-Dimensional Solute Transport in Ground-Water Systems with Uniform Flow. Techniques of Water-Resources Investigations of the USGS, Book 3, Chapter B7.

I CONSIDER THIS TO BE IN ACCORDANCE
WITH QAP 014 NOW.

JH Bogan
CONSULTANT.

10/25/97
RF

| Oct 24, 97 9:21 | df--f8.25km.out | Page 1/2 |
|---|-----------------|----------|
| Interpolated plume.
plume width = 5300. plume thickness = 293.
***** | | |
| Irrigation well capture area = 584079
For capture zone 1 with width = 1292. & thick = 575.
Representative concentration for intersection area 0.118E-03
trans df= 37.249 centerline df= 13.817
===== | | |
| Irrigation well capture area = 1510867
For capture zone 2 with width = 2330. & thick = 825.
Representative concentration for intersection area 0.930E-04
trans df= 47.089 centerline df= 13.817
===== | | |
| Irrigation well capture area = 2501163
For capture zone 3 with width = 3382. & thick = 941.
Representative concentration for intersection area 0.727E-04
trans df= 60.254 centerline df= 13.817
===== | | |
| Irrigation well capture area = 3444785
For capture zone 4 with width = 4450. & thick = 985.
Representative concentration for intersection area 0.596E-04
trans df= 73.508 centerline df= 13.817
===== | | |
| Irrigation well capture area = 1147589
For capture zone 5 with width = 1944. & thick = 751.
Representative concentration for intersection area 0.102E-03
trans df= 42.984 centerline df= 13.817
===== | | |
| Irrigation well capture area = 584079
For capture zone 6 with width = 1292. & thick = 575.
Representative concentration for intersection area 0.118E-03
trans df= 37.249 centerline df= 13.817
===== | | |
| Irrigation well capture area = 292146
For capture zone 7 with width = 876. & thick = 424.
Representative concentration for intersection area 0.130E-03
trans df= 33.817 centerline df= 13.817
===== | | |
| Irrigation well capture area = 195246
For capture zone 8 with width = 705. & thick = 352.
Representative concentration for intersection area 0.138E-03
trans df= 31.836 centerline df= 13.817
===== | | |
| Irrigation well capture area = 147621
For capture zone 9 with width = 607. & thick = 309.
Representative concentration for intersection area 0.146E-03
trans df= 29.977 centerline df= 13.817
===== | | |
| Irrigation well capture area = 1965590
For capture zone 10 with width = 2810. & thick = 890.
Representative concentration for intersection area 0.829E-04
trans df= 52.859 centerline df= 13.817
===== | | |
| Irrigation well capture area = 1337611
For capture zone 11 with width = 2146. & thick = 793.
Representative concentration for intersection area 0.972E-04
trans df= 45.056 centerline df= 13.817
===== | | |
| Irrigation well capture area = 1016213
For capture zone 12 with width = 1798. & thick = 719.
Representative concentration for intersection area 0.105E-03
trans df= 41.594 centerline df= 13.817
===== | | |
| Irrigation well capture area = 4397848
For capture zone 13 with width = 5596. & thick = 1000.
Representative concentration for intersection area 0.544E-04
trans df= 80.487 centerline df= 13.817
===== | | |
| Irrigation well capture area = 2409164 | | |

| Oct 24, 97 9:21 | df--f8.25km.out | Page 2/2 |
|--|-----------------|----------|
| For capture zone 14 with width = 3282. & thick = 934.
Representative concentration for intersection area 0.743E-04
trans df= 58.934 centerline df= 13.817
===== | | |
| Irrigation well capture area = 1660822
For capture zone 15 with width = 2486. & thick = 850.
Representative concentration for intersection area 0.896E-04
trans df= 48.897 centerline df= 13.817
===== | | |
| Irrigation well capture area = 1016213
For capture zone 16 with width = 1798. & thick = 719.
Representative concentration for intersection area 0.105E-03
trans df= 41.594 centerline df= 13.817
===== | | |
| <div style="text-align: right;">RF
10/25/97</div> | | |

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RF 10/25/97

Printed by Randall S. Fedors

| Oct 24, 97 9:43 | df-st100.25km.25m.dom.out | Page 1/2 |
|--|---------------------------|----------|
| Interpolated plume.
plume width = 5884. plume thickness = 25.

Domestic well capture area (all) = 5739
For capture zone 1 with width = 76. & thick = 88.
Representative concentration for intersection area 0.121E-02
trans df= 3.631 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 5591
For capture zone 2 with width = 69. & thick = 98.
Representative concentration for intersection area 0.121E-02
trans df= 3.630 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 5663
For capture zone 3 with width = 67. & thick = 107.
Representative concentration for intersection area 0.121E-02
trans df= 3.629 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 5969
For capture zone 4 with width = 68. & thick = 127.
Representative concentration for intersection area 0.121E-02
trans df= 3.625 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 1898
For capture zone 5 with width = 29. & thick = 73.
Representative concentration for intersection area 0.121E-02
trans df= 3.624 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 3875
For capture zone 6 with width = 54. & thick = 82.
Representative concentration for intersection area 0.121E-02
trans df= 3.628 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 5739
For capture zone 7 with width = 76. & thick = 88.
Representative concentration for intersection area 0.121E-02
trans df= 3.631 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 7765
For capture zone 8 with width = 97. & thick = 96.
Representative concentration for intersection area 0.121E-02
trans df= 3.634 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 13424
For capture zone 9 with width = 146. & thick = 112.
Representative concentration for intersection area 0.120E-02
trans df= 3.642 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 74122
For capture zone 10 with width = 418. & thick = 224.
Representative concentration for intersection area 0.119E-02
trans df= 3.684 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 147855
For capture zone 11 with width = 607. & thick = 309.
Representative concentration for intersection area 0.117E-02
trans df= 3.735 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 59343
For capture zone 12 with width = 369. & thick = 203.
Representative concentration for intersection area 0.119E-02
trans df= 3.676 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 11786
For capture zone 13 with width = 133. & thick = 108.
Representative concentration for intersection area 0.120E-02
trans df= 3.640 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 5739 | | |

| Oct 24, 97 9:43 | df-st100.25km.25m.dom.out | Page 2/2 |
|---|---------------------------|----------|
| For capture zone 14 with width = 76. & thick = 88.
Representative concentration for intersection area 0.121E-02
trans df= 3.631 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 1358
For capture zone 15 with width = 22. & thick = 70.
Representative concentration for intersection area 0.121E-02
trans df= 3.623 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 30013
For capture zone 16 with width = 248. & thick = 151.
Representative concentration for intersection area 0.120E-02
trans df= 3.657 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 11786
For capture zone 17 with width = 133. & thick = 108.
Representative concentration for intersection area 0.120E-02
trans df= 3.640 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 5739
For capture zone 18 with width = 76. & thick = 88.
Representative concentration for intersection area 0.121E-02
trans df= 3.631 centerline df= 3.620
===== | | |
| Domestic well capture area (all) = 2801
For capture zone 19 with width = 41. & thick = 78.
Representative concentration for intersection area 0.121E-02
trans df= 3.626 centerline df= 3.620
===== | | |

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Input files and output file for itsec.f run for Jc Bogan test case; illustrates that itsec.f is doing as expected.

Oct 22, 97 15:21 plume.dat.bogan
 3 3 0.00438
 1 10.
 20000. 0. 5. 10.
 0. 0.688E-04 0.187E-04 0.267E-04
 5. 0.410E-04 0.210E-04 0.457E-04
 10. 0.210E-04 0.250E-04 0.367E-04

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Oct 22, 97 14:55 capture.dat.bogan
 1
 5. 5. .244
 12. 12. 8.
 99999

RF

Oct 22, 97 16:20 intersec.out

```
Interpolated plume.
0.69E-04 0.59E-04 0.49E-04 0.39E-04 0.29E-04 0.19E-04 0.20E-04 0.22E-04 0.23E-04 0.25E-04 0.27E-04 0.00E+00
0.63E-04 0.54E-04 0.46E-04 0.37E-04 0.28E-04 0.19E-04 0.21E-04 0.24E-04 0.26E-04 0.28E-04 0.30E-04 0.00E+00
0.58E-04 0.50E-04 0.42E-04 0.35E-04 0.27E-04 0.20E-04 0.23E-04 0.25E-04 0.28E-04 0.31E-04 0.34E-04 0.00E+00
0.52E-04 0.46E-04 0.39E-04 0.33E-04 0.26E-04 0.20E-04 0.24E-04 0.27E-04 0.31E-04 0.34E-04 0.38E-04 0.00E+00
0.47E-04 0.41E-04 0.36E-04 0.31E-04 0.26E-04 0.21E-04 0.25E-04 0.29E-04 0.33E-04 0.38E-04 0.42E-04 0.00E+00
0.41E-04 0.37E-04 0.33E-04 0.29E-04 0.25E-04 0.21E-04 0.26E-04 0.31E-04 0.36E-04 0.41E-04 0.46E-04 0.00E+00
0.37E-04 0.34E-04 0.31E-04 0.28E-04 0.25E-04 0.22E-04 0.26E-04 0.31E-04 0.35E-04 0.39E-04 0.44E-04 0.00E+00
0.33E-04 0.31E-04 0.29E-04 0.27E-04 0.25E-04 0.23E-04 0.27E-04 0.30E-04 0.34E-04 0.38E-04 0.42E-04 0.00E+00
0.29E-04 0.28E-04 0.27E-04 0.26E-04 0.25E-04 0.23E-04 0.27E-04 0.30E-04 0.34E-04 0.37E-04 0.40E-04 0.00E+00
0.25E-04 0.25E-04 0.25E-04 0.25E-04 0.24E-04 0.24E-04 0.27E-04 0.30E-04 0.33E-04 0.36E-04 0.39E-04 0.00E+00
0.21E-04 0.22E-04 0.23E-04 0.23E-04 0.24E-04 0.25E-04 0.27E-04 0.30E-04 0.32E-04 0.34E-04 0.37E-04 0.00E+00
0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
plume width = 22. plume thickness = 11.
*****
Top of domestic capture area, nodes = 9
Middle plus top domestic capture nodes = 3
Bottom half ellipse= 0
Domestic well capture area (all) = 19
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
1.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
1.1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
1.1 1.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
1.1 1.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
1.1 1.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
For capture zone 1 with width = 5. & thick = 5.
Intersect area = 19
Representative concentration for intersection area 0.237E-04
qfactor= 2.111 trans df= 184.654 centerline df= 63.663
=====
```

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Code "itsec.f" as modified

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```
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*****
** Post-processor for Wexler output and capture area output.      **
**                                                                  **
** Calculates intersection of a plume and each capture zone      **
** for dilution factors. Assumes a grid where dy=1 and dz=1.    **
** Cells (1m^2) are centered around input data points to get    **
** representative concentration for each cell.                   **
** Code is written for clarity at the expense of efficiency.     **
** Compiled on SUN using: f77 -r8 -o itsec itsec.f                **
**                                                                  **
** Borehole Dilution for ARDES KTI                               **
**                                                                  **
** RFedors (Oct97)  CNWRA                                         **
*****
* INPUT FILES:
* Read plume input file, list concentrations from centerline to edge of plume.
* Format based on Wexler, 1992 output plus my headers (records 1&2).
*   1. ny, nz, conc_o  initial concentration      (2i5,f10.6)
*   2. flag for thin(=0) or 3D(=1) plume, thickness (i10,f10.3)
*   3. y-values          (*)
*   4-(nz+4). z-value and concentrations for each y-position. (*)
* For all measurements, assume that ground=0 and z-axis is vertical down.
*
* Read capture input file, 2 records each capture area;
* if flag=1 then domestic, if iflag=2 then irrigation, if iflag=99999, then stop
*   1. iflag          (i5)
*   2. width, thick, darcy velocity          (3f6.3)
*   3. screentop, screenbot, ctop          (3f6.3)
*   4-? repeat 1-3 for each capture area or just iflag=99999 to stop.
* For all measurements, assume that ground=0 and z-axis is vertical down.
*****
*   1   2   3   4   5   6   7
*23456789012345678901234567890123456789012345678901234567890123456789012
program itsec

parameter (max=100, maxy=3400, maxz=2000, maxny=50, maxnz=50)
implicit real (a-h,o-z)
implicit integer (i-n)
character infile*12, infile2*12, outfile*12
dimension capture(0:maxy,0:maxz), plume(0:maxy,0:maxz)
&      , concp(0:maxny,0:maxnz), yp(0:maxny), zp(0:maxnz)

infile = 'plume.dat'
infile2 = 'capture.dat'
outfile = 'intersec.out'
open(8,file=infile,status='unknown')
open(9,file=infile2,status='unknown')
open(10,file=outfile,status='unknown')

zero = 1.e-10
dy = 1.
dz = 1.
c Read plume input file.
read(8,'(2i5,f10.6)') ny, nz, conc_o
read(8,'(i10,f10.3)') iflag2, pthick
read(8,*) time, ( yp(j), j = 0,ny-1 )
do 20 k = 0,nz-1
  read(8,*) zp(k), ( concp(j,k), j = 0,ny-1 )
20 continue
close(8)
c Make sure entire plume is entered in the input file, else exit
if(concp(ny-1,0).gt.conc_o*1.e-4) then
  write(6,*) 'Inputs are incorrect, inputs must cover entire plume'
  stop
endif
if(iflag2.ne.0.and.concp(0,nz-1).gt.conc_o*1.e-4) then
  write(6,*) 'Inputs are incorrect, inputs must cover entire plume'
  stop
endif
```

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```
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endif
c Fill in plume matrix.
call interpol(plume,concp,yp,zp,ny,nz,iflag2,pthick,conc_o,cPlume)
c Read capture input file, 3 records for each capture area.
do 200 i = 1,max
  read(9,'(i5)') iflag
  if(iflag.eq.99999) stop
  read(9,'(3f6.3)') cwidth, cthick, darcy
  read(9,'(3f6.3)') scntop, scnbot, ctop
c Fill in capture matrices.

cwidth2 = cwidth * 0.5
if(iflag.eq.1)
&   call domest(cwidth2,cthick,capture,scntop,scnbot,ctop,icap)
if(iflag.eq.2)
&   call irrig(cwidth2,cthick,capture,icap)
c Calculate factors doing both mirrored sides of ellipse; account for extra
c half-cells along water table and along centerline vertical plane by
c looping through mirrored half from 1,maxy(z) instead of 0,maxy(z).
intersect = 0
conc = 0.
do 100 iz = 0,maxz
  do 100 iy = 0,maxy
    conc_tmp = capture(iy,iz) * plume(iy,iz)
    if(conc_tmp.gt.zero) then
      intersect = intersect + 1
      conc = conc + conc_tmp
    else
      endif
100 continue
do 110 iz = 1,maxz
  do 110 iy = 1,maxy
    conc_tmp = capture(iy,iz) * plume(iy,iz)
    if(conc_tmp.gt.zero) then
      intersect = intersect + 1
      conc = conc + conc_tmp
    else
      endif
110 continue

areaIntersect = float(intersect)
conc = conc / areaIntersect

write(10,1003) i, cwidth, cthick
write(10,1007) conc
transfactor = conc_o / conc
centerlinefactor = conc_o / concp(0,0)

write(10,1011) transfactor, centerlinefactor
write(10,1017)

write(6,*) 'done with capture ', i
200 continue

1003 format('For capture zone',i5, ' with width =', f7.0
&      , ' & thick =', f7.0)
1007 format('Representative concentration for intersection area',e11.3)
1011 format('trans df=',f8.3,' centerline df=',f8.3)
1017 format('=====')
stop
end
c=====
subroutine interpol(plume,concp,yp,zp,ny,nz,iflag2
&      ,pthick,conc_o,cPlume)
c Interpolates concentration values focussing on the plume area of matrix.
```

itsec.f

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Continued

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```

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c Uses row by row linear interpolation.
  parameter (maxy=3400, maxz=2000, maxny=50, maxnz=50)
  implicit real (a-h,o-z)
  implicit integer (i-n)
  dimension plume(0:maxy,0:maxz), concp(0:maxny,0:maxnz)
  &      , yp(0:maxny), zp(0:maxnz), ypts(0:maxny), zpts(0:maxnz)

  threshld = conc_o * 1.e-4
c Initial plume matrix
  do 10 iz = 0,maxz
    do 10 iy = 0,maxy
      plume(iy,iz) = 0.
10    continue

  do 20 i = 0,ny-2
    ypts(i) = yp(i+1) - yp(i)
20    continue

c Do different calculation for thin plume versus 3D plume, if-then.

  if(iflag2.eq.1) then

    do 30 i = 0,nz-2
      zpts(i) = zp(i+1) - zp(i)
30    continue
c Interpolate z-columns where y-position is known.
  do 70 ky = 0,ny-1
    iy = nint( yp(ky) )
    iz = 0
    do 60 kz = 0,nz-2
      plume(iy,iz) = concp(ky,kz)
      a = (concp(ky,kz+1) - concp(ky,kz)) / (zp(kz+1) - zp(kz))
      b = concp(ky,kz) - a * zp(kz)
      do 50 i = 1,nint(zpts(kz))-1
        iz = iz + 1
        plume(iy,iz) = a * ( float(i) + zp(kz) ) + b
50      continue
        iz = iz + 1
60      continue
        plume(iy,iz) = concp(ky,nz-1)
70      continue

c Row by row, skipping appropriately.
  iy = 0
  iz = 0
  do 140 kz = 0,nz-2
    do 130 j = 1,nint(zpts(kz))

      do 120 ky = 0,ny-2
        ky2 = int(yp(ky+1))
        ky1 = int(yp(ky))
        a = (plume(ky2,iz) - plume(ky1,iz)) / (yp(ky+1) - yp(ky))
        b = plume(ky1,iz) - a * yp(ky)
        do 110 i = 1,nint(ypts(ky))-1
          iy = iy + 1
          plume(iy,iz) = a * ( float(i) + yp(ky) ) + b
110        continue
          iy = iy + 1
120        continue
          iz = iz + 1
          iy = 0
130        continue
140        continue
c Added to get bottom edge of plume correct.
  iy = 0
  iz = int(zp(nz-1))
  do 146 ky = 0,ny-2
    ky2 = int(yp(ky+1))
    ky1 = int(yp(ky))

```

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itsec.f

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  a = (plume(ky2,iz) - plume(ky1,iz)) / (yp(ky+1) - yp(ky))
  b = plume(ky1,iz) - a * yp(ky)
  do 145 i = 1,nint(ypts(ky))-1
    iy = iy + 1
    plume(iy,iz) = a * ( float(i) + yp(ky) ) + b
145  continue
    iy = iy + 1
146  continue

c Figure out plume width and zero-out remainder.
c Also calculate total mass in plume from concentrations.
c The variable "cPlume" is (concentration * area).
  do 150 j = 0,maxz
    do 150 i = 0,maxy
      if(plume(i,j).lt.threshld) plume(i,j) = 0.
150  continue
      concPlume = 0.
      do 160 j = 0,maxz
        do 160 i = 0,maxy
          concPlume = concPlume + plume(i,j)
160  continue
          concMidY = 0.
          concMidZ = 0.
          do 170 i = 1,maxy
            concMidY = concMidY + plume(i,0)
170  continue
            do 175 j = 1,maxz
              concMidZ = concMidZ + plume(0,j)
175  continue
            cPlume = ( concPlume * 2. ) - concMidZ - concMidY
            do 180 i = 0,maxy
              if(plume(i,0).lt.threshld) then
                pwidth = float(i) * 2.
                goto 185
              else
                endif
180  continue
185  do 190 j = 0,maxz
            if(plume(0,j).lt.threshld) then
              pthickness = float(j)
              goto 300
            else
              endif
190  continue

          else

            iy = 0
            do 215 ky = 0,ny-2
              plume(iy,0) = concp(ky,0)
              a = (concp(ky+1,0) - concp(ky,0)) / (yp(ky+1) - yp(ky))
              b = concp(ky,0) - a * yp(ky)
              do 210 i = 1,nint(ypts(ky))-1
                iy = iy + 1
                plume(iy,0) = a * ( float(i) + yp(ky) ) + b
210  continue
                iy = iy + 1
215  continue
                plume(iy,0) = concp(ny-1,0)

c Figure out plume width and zero-out remainder.
c Also calculate total mass in plume from concentrations, after zeroing out.
c The variable "cPlume" is (concentration * area).
  pthickness = pthick
  do 220 i = 0,maxy
    if(plume(i,0).lt.threshld) plume(i,0) = 0.
220  continue
    ip = int(pthick)
    do 240 j = 1,ip

```

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      do 240 i = 0,maxy
        plume(i,j) = plume(i,j-1)
240    continue
      concPlume = 0.
      do 250 i = 0,maxy
        concPlume = concPlume + plume(i,0)
250    continue
      concMidY = cPlume
      concMidZ = plume(0,0) * pthick
      cPlume = ( concPlume * pthick * 2. ) - concMidY - concMidZ
      do 260 i = 0,maxy
        if(plume(i,0).lt.threshld) then
          pwidth = float(i) * 2.
          goto 300
        else
          endif
260    continue
      endif

300  write(10,*) 'Interpolated plume.'
c    do 400 j = 0,15
c      write(10,'(12e10.2)') ( plume(i,j), i=0,11 )
c400  continue

      write(10,1100) pwidth, pthickness
      write(10,1117)
1100  format(' plume width =',f7.0,' plume thickness =',f7.0)
1117  format('*****')
      return
      end
=====
      subroutine domest(cwidth2,cthick,capture,scntop,scnbot,ctop,icap)
c Calculates the number of nodes in the capture area of a domestic well
c assuming dy=dz=1 for extrapolation to a capture area.
      parameter (maxy=3400, maxz=2000)
      implicit real (a-h,o-z)
      implicit integer (i-n)
      dimension capture(0:maxy,0:maxz)

      do 10 iz = 0,maxz
        do 10 iy = 0,maxy
          capture(iy,iz) = 0.
10    continue
      iscnbot = nint(scnbot)
      iscntop = nint(scntop)

c Top of capture area (half-ellipse); mirror the half-ellipse to fill capture().
      icap1 = 0
      if(ctop.le.1.e-4) goto 50
      tophick = scntop - ctop
      itop = nint(tophick)
      izz = iscntop
      do 30 iz = 1,itop
        z = float(iz)
        if(iz.ge.iscntop) goto 50
        ytmp = sqrt( cwidth2**2 * ( 1. - z**2 / tophick**2 ) )
        izz = izz - 1
        do 20 iy = 0,maxy
          y = float(iy)
          if(y.le.ytmp) then
            capture(iy,izz) = 1.
            icap1 = icap1 + 1
          else
            goto 30
          endif
20    continue
30    continue
c50  write(10,*) 'Top of domestic capture area, nodes = ', icap1

```

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```

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50    continue

c Middle of capture area, screen elevation (rectangle).
      icap2 = 0
      do 130 iz = iscntop,maxz
        if(iz.gt.iscnbot) goto 150
        do 120 iy = 0,maxy
          if(float(iy).le.cwidth2) then
            capture(iy,iz) = 1.
            icap2 = icap2 + 1
          else
            goto 125
          endif
120    continue
125    continue
130    continue
c150  write(10,*) 'Middle plus top domestic capture nodes = ', icap2
150    continue

c Bottom of capture area (half-ellipse).
      icap3 = 0
      do 230 iz = iscnbot+1,maxz
        z = float(iz)
        if(z.gt.cthick) goto 250
        ytmp = sqrt( cwidth2**2 * ( 1. - z**2 / cthick**2 ) )
        do 220 iy = 0,maxy
          y = float(iy)
          if(y.le.ytmp) then
            capture(iy,iz) = 1.
            icap3 = icap3 + 1
          else
            goto 225
          endif
220    continue
225    continue
230    continue

c250  write(10,*) 'Bottom half ellipse = ', icap3
250    continue
      mirror = 0
      do 260 j = 1,maxz
        if(capture(0,j).gt.0.1) mirror = mirror + 1
260    continue
      icap = ( ( icap1 + icap2 + icap3 ) * 2 ) - mirror - nint(cwidth)
      write(10,*) 'Domestic well capture area (all) = ', icap

c    do 300 j = 0,15
c      write(10,'(15f3.0)') ( capture(i,j), i=0,14 )
c300  continue

      return
      end
=====
      subroutine irrig(cwidth2,cthick,capture,icap)
c Calculates the number of nodes in an irrigation well assuming that
c dy=dz=1 for extrapolation to a capture area.
      parameter (maxy=3400, maxz=2000)
      implicit real (a-h,o-z)
      implicit integer (i-n)
      dimension capture(0:maxy,0:maxz)

      icap = 0
      do 10 iz = 0,maxz
        do 10 iy = 0,maxy
          capture(iy,iz) = 0.
10    continue

      do 30 iz = 0,maxz
        z = float(iz)

```

itsec.f

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RF

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Continued

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itsec.f

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```

if(z.gt.cthick) goto 50
ytmp = sqrt( cwidth2**2 * ( 1. - z**2 / cthick**2 ) )
do 20 iy = 0,maxy
  y = float(iy)
  if(y.le.ytmp) then
    capture(iy,iz) = 1.
    icap = icap + 1
  else
    goto 25
  endif
20  continue
25  continue
30  continue

50  icap = icap + icap - nint(cthick) - nint(cwidth)
write(10,*) 'Irrigation well capture area = ', icap

c   do 200 j = 0,15
c   write(10,'(15f3.0)') ( capture(i,j), i=0,14 )
c200 continue

return
end

```

RF
10/25/97

12/10/97
93 PR

Tape (8mm) written of directories ~/Bore and ~/WP/Bore on SUN (bigband)
File listing on the tape is included below (bore.tar.gz is file on tape)

Printed by Randall S. Fedors

| Dec 10, 97 7:43 | tar.out | Page 1/11 |
|-----------------|---|-----------|
| a | Bore/ 0K | |
| a | Bore/Data/ 0K | |
| a | Bore/Data/nts.fil 11098K | |
| a | Bore/Data/gw1.fil 2463K | |
| a | Bore/Data/gw2.fil 6765K | |
| a | Bore/Data/CodesGordon/ 0K | |
| a | Bore/Data/CodesGordon/depth_form_log.f 3K | |
| a | Bore/Data/CodesGordon/depth_log.f 2K | |
| a | Bore/Data/CodesGordon/depth_log_gw.f 2K | |
| a | Bore/Data/CodesGordon/farms.f 3K | |
| a | Bore/Data/CodesGordon/form_log.f 3K | |
| a | Bore/Data/CodesGordon/form_log_2.f 3K | |
| a | Bore/Data/CodesGordon/lithval.f 4K | |
| a | Bore/Data/CodesGordon/ss_lith.f 2K | |
| a | Bore/Data/CodesGordon/ss_log.f 3K | |
| a | Bore/Data/CodesGordon/stufform.f 1K | |
| a | Bore/Data/CodesGordon/well_log.f 2K | |
| a | Bore/Data/CodesGordon/well_log_gw.f 2K | |
| a | Bore/Data/CodesGordon/nts.fil.gz 584K | |
| a | Bore/Data/CodesGordon/gw1.fil.gz 287K | |
| a | Bore/Data/CodesGordon/gw2.fil.gz 747K | |
| a | Bore/Data/permit.amg 11K | |
| a | Bore/Data/UTM/ 0K | |
| a | Bore/Data/UTM/zone1.dat 3K | |
| a | Bore/Data/UTM/zone2.dat 3K | |
| a | Bore/Data/UTM/zone3.dat 3K | |
| a | Bore/Data/UTM/zone4.dat 3K | |
| a | Bore/Data/UTM/zone5.dat 3K | |
| a | Bore/Data/UTM/Readme 1K | |
| a | Bore/Data/UTM/amgQuads.dat 1K | |
| a | Bore/Data/UTM/amg.water.dat 7K | |
| a | Bore/Data/UTM/pump96.dat 3K | |
| a | Bore/Data/UTM/quad_tube.lay 9K | |
| a | Bore/Data/UTM/tecplot.phy 1K | |
| a | Bore/Data/UTM/qm96.plt 1K | |
| a | Bore/Data/UTM/print.out 7K | |
| a | Bore/Data/UTM/locat_tmp.lay 12K | |
| a | Bore/Data/UTM/town.dat 1K | |
| a | Bore/Data/UTM/wateruse96.lay 10K | |
| a | Bore/Data/UTM/print1.out 22K | |
| a | Bore/Data/UTM/roadstate.dat 1K | |
| a | Bore/Data/UTM/comm96.plt 1K | |
| a | Bore/Data/UTM/irrig96.plt 3K | |
| a | Bore/Data/UTM/town1.lay 5K | |
| a | Bore/Data/UTM/town2.lay 6K | |
| a | Bore/Data/UTM/pump96.plt 4K | |
| a | Bore/Data/UTM/roadState.lay 10K | |
| a | Bore/Data/UTM/fig3-1.ps 7K | |
| a | Bore/Data/UTM/fig3-1.lay 7K | |
| a | Bore/Data/UTM/pump96.lay 12K | |
| a | Bore/Data/UTM/pumpageTR.lay 7K | |
| a | Bore/Data/UTM/fig3-2.ps 10K | |
| a | Bore/Data/UTM/fig3-3.lay 12K | |
| a | Bore/Data/UTM/print3-3.out 15K | |
| a | Bore/Data/UTM/newroad.lay 9K | |
| a | Bore/Data/UTM/fig3-2.lay 7K | |
| a | Bore/Data/UTM/print3-2.out 10K | |
| a | Bore/Data/UTM/fig4-1.lay 4K | |
| a | Bore/Data/UTM/print4-1.out 4K | |
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| a | Bore/Data/UTM/fig4-1.ps 4K | |
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| a | Bore/Data/UTM/new96Scaled.lay 12K | |
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| a | Bore/Data/gwis_ext.f 3K | |
| a | Bore/Data/zone 16K | |
| a | Bore/Data/tecplot.phy 1K | |

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|-----------------|---|-----------|
| a | Bore/Data/plt.csh 1K | |
| a | Bore/Data/amarg.f 8K | |
| a | Bore/Data/Spreadsheet_orig/ 0K | |
| a | Bore/Data/Spreadsheet_orig/amg.txt 38K | |
| a | Bore/Data/Spreadsheet_orig/amgg.txt 37K | |
| a | Bore/Data/amarg2.gwis 1308K | |
| a | Bore/Data/gwis.f 2K | |
| a | Bore/Data/wat.prn 16K | |
| a | Bore/Data/gwis 17K | |
| a | Bore/Data/amarg.gwis 2379K | |
| a | Bore/Data/amarg 26K | |
| a | Bore/Data/amarg.all 34K | |
| a | Bore/Data/amarg.all.wp 35K | |
| a | Bore/Data/amarg.all.blank 34K | |
| a | Bore/Data/amargQuads 3K | |
| a | Bore/Data/amarg.f.all 8K | |
| a | Bore/Data/permit.wq1 50K | |
| a | Bore/Data/Readme 2K | |
| a | Bore/Data/zone.ann 13K | |
| a | Bore/Data/amarg.f.short 8K | |
| a | Bore/Data/zone.f 2K | |
| a | Bore/Data/pump.amg 8K | |
| a | Bore/Data/amarg.water.meters 7K | |
| a | Bore/Data/amg.water.plt 7K | |
| a | Bore/Data/wat.plt 15K | |
| a | Bore/Data/amg_all.xls 180K | |
| a | Bore/Data/sys_call.f 1K | |
| a | Bore/Data/watlvl_reg.dat.gordon1993 19K | |
| a | Bore/Data/print.out 26K | |
| a | Bore/Data/pump.prn 26K | |
| a | Bore/Data/water93.lay 3K | |
| a | Bore/Data/is-2.ps 86K | |
| a | Bore/Data/pump.xls 126K | |
| a | Bore/Data/permit.xls 41K | |
| a | Bore/Data/ann_pump.xls 25K | |
| a | Bore/Data/pump96.xls 36K | |
| a | Bore/Data/pump96.prn 3K | |
| a | Bore/Data/range.f 5K | |
| a | Bore/Data/dataedit.xls 3982K | |
| a | Bore/Data/pump96.wq1 39K | |
| a | Bore/Data/range 19K | |
| a | Bore/Data/pump.dat 1K | |
| a | Bore/Data/amg_all.wq1 44K | |
| a | Bore/Data/pump.wq1 47K | |
| a | Bore/Data/intersect.nawk 2K | |
| a | Bore/Data/comm.prn 1K | |
| a | Bore/Data/irrig.prn 2K | |
| a | Bore/Data/capture.xls 45K | |
| a | Bore/Data/intersec.xls 77K | |
| a | Bore/Data/qm.prn 1K | |
| a | Bore/Data/capture.txt 11K | |
| a | Bore/Data/capture.prn 5K | |
| a | Bore/Data/XVGR/ 0K | |
| a | Bore/Data/XVGR/captureQ.dat 1K | |
| a | Bore/Data/XVGR/capQ.dat 1K | |
| a | Bore/Data/XVGR/Q-df.xvgr 1K | |
| a | Bore/Data/XVGR/capQ.ps 5K | |
| a | Bore/Data/XVGR/q300.xvgr 1K | |
| a | Bore/Data/XVGR/q300.parm 14K | |
| a | Bore/Data/XVGR/q300.allxvgr 15K | |
| a | Bore/Data/XVGR/domQ-df.ps 5K | |
| a | Bore/Data/XVGR/q300.ps 5K | |
| a | Bore/Data/XVGR/dom-10-25plume.xvgr 1K | |
| a | Bore/Data/XVGR/dom-10-25plume.ps 5K | |
| a | Bore/Data/XVGR/temp 5K | |
| a | Bore/Data/XVGR/q2116capture.xvgr 1K | |
| a | Bore/Data/XVGR/dom-10-25plume.parm 14K | |
| a | Bore/Data/XVGR/dom-10-25plume.allxvgr 14K | |
| a | Bore/Data/XVGR/q2116capture.parm 13K | |

tar.out

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12/10/97
93 PR

Tape (8mm) written of directories ~/Bore and ~/WP/Bore on SUN (bigband)
File listing on the tape is included below (bore.tar.gz is file on tape)

Printed by Randall S. Fedors

| Dec 10, 97 7:43 | tar.out | Page 3/11 |
|-----------------|--|-----------|
| a | Bore/Data/XVGR/q2116capture.allxvgr 14K | |
| a | Bore/Data/XVGR/q2116capture.ps 4K | |
| a | Bore/Data/XVGR/domCapture.xvgr 1K | |
| a | Bore/Data/XVGR/domCapture.ps 5K | |
| a | Bore/Data/XVGR/domCapture.parm 13K | |
| a | Bore/Data/XVGR/domCapture.allxvgr 14K | |
| a | Bore/Data/XVGR/domQ-df.xvgr 1K | |
| a | Bore/Data/XVGR/domQ-df.allxvgr 15K | |
| a | Bore/Data/XVGR/domQ-df.parm 14K | |
| a | Bore/Data/XVGR/domGrad-df.xvgr 1K | |
| a | Bore/Data/XVGR/domK-df.xvgr 1K | |
| a | Bore/Data/XVGR/domGrad-df.parm 13K | |
| a | Bore/Data/XVGR/domK-df.parm 14K | |
| a | Bore/Data/XVGR/domK-df.ps 5K | |
| a | Bore/Data/XVGR/domK-df.allxvgr 14K | |
| a | Bore/Data/XVGR/domGrad-df.allxvgr 14K | |
| a | Bore/Data/XVGR/domGrad-df.ps 5K | |
| a | Bore/Data/XVGR/capQ.parm 14K | |
| a | Bore/Data/XVGR/tecplot.phy 1K | |
| a | Bore/Data/XVGR/irr-20plume.xvgr 1K | |
| a | Bore/Data/XVGR/irr-25plume.ps 6K | |
| a | Bore/Data/XVGR/irr-25plume.xvgr 1K | |
| a | Bore/Data/XVGR/irr-25plume.parm 14K | |
| a | Bore/Data/XVGR/irr-25plume.allxvgr 14K | |
| a | Bore/Data/XVGR/Q-df.parm 13K | |
| a | Bore/Data/XVGR/capQ.allxvgr 14K | |
| a | Bore/Data/XVGR/Q-df.allxvgr 14K | |
| a | Bore/Data/XVGR/Q-df.ps 5K | |
| a | Bore/Data/XVGR/irr300-df.xvgr 1K | |
| a | Bore/Data/XVGR/irr300-df.parm 13K | |
| a | Bore/Data/XVGR/irr300-df.allxvgr 14K | |
| a | Bore/Data/XVGR/irr300-df.ps 5K | |
| a | Bore/Data/XVGR/q-grad-df.xvgr 1K | |
| a | Bore/Data/XVGR/q-grad-df.parm 13K | |
| a | Bore/Data/XVGR/q-grad-df.ps 5K | |
| a | Bore/Data/XVGR/q-grad-df.allxvgr 14K | |
| a | Bore/Data/intersec.xls.1 61K | |
| a | Bore/Analytic/ OK | |
| a | Bore/Analytic/wexler.ps 37K | |
| a | Bore/Analytic/analgwst.1/ OK | |
| a | Bore/Analytic/analgwst.1/src/ OK | |
| a | Bore/Analytic/analgwst.1/src/cntour.f 15K | |
| a | Bore/Analytic/analgwst.1/src/dgdiss.f 2K | |
| a | Bore/Analytic/analgwst.1/src/exerfc.f 4K | |
| a | Bore/Analytic/analgwst.1/src/finite.f 15K | |
| a | Bore/Analytic/analgwst.1/src/gauss.f 10K | |
| a | Bore/Analytic/analgwst.1/src/qlqpts.f 3K | |
| a | Bore/Analytic/analgwst.1/src/lenchr.f 1K | |
| a | Bore/Analytic/analgwst.1/src/ofile.f 2K | |
| a | Bore/Analytic/analgwst.1/src/patchf.f 13K | |
| a | Bore/Analytic/analgwst.1/src/patchi.f 12K | |
| a | Bore/Analytic/analgwst.1/src/plot1d.f 4K | |
| a | Bore/Analytic/analgwst.1/src/plot2d.f 5K | |
| a | Bore/Analytic/analgwst.1/src/point2.f 9K | |
| a | Bore/Analytic/analgwst.1/src/point3.f 10K | |
| a | Bore/Analytic/analgwst.1/src/rdplot.f 1K | |
| a | Bore/Analytic/analgwst.1/src/point3_mod.f 10K | |
| a | Bore/Analytic/analgwst.1/src/seminf.f 9K | |
| a | Bore/Analytic/analgwst.1/src/stripf.f 10K | |
| a | Bore/Analytic/analgwst.1/src/stripi.f 10K | |
| a | Bore/Analytic/analgwst.1/src/subs1.f 3K | |
| a | Bore/Analytic/analgwst.1/src/subs2.f 3K | |
| a | Bore/Analytic/analgwst.1/src/subs3.f 4K | |
| a | Bore/Analytic/analgwst.1/src/title.f 3K | |
| a | Bore/Analytic/analgwst.1/src/dimens.inc 1K | |
| a | Bore/Analytic/analgwst.1/src/pltdat.inc 1K | |
| a | Bore/Analytic/analgwst.1/src/units.inc 1K | |
| a | Bore/Analytic/analgwst.1/src/locsubs.DGUX.f 2K | |
| a | Bore/Analytic/analgwst.1/src/locsubs.SIG.f 2K | |

| Dec 10, 97 7:43 | tar.out | Page 4/11 |
|-----------------|--|-----------|
| a | Bore/Analytic/analgwst.1/src/locsubs.PRIMOS.f 3K | |
| a | Bore/Analytic/analgwst.1/src/locsubs.lahey.f 2K | |
| a | Bore/Analytic/analgwst.1/src/locsubs.DMY.f 2K | |
| a | Bore/Analytic/analgwst.1/src/locsubs.Solaris.f 3K | |
| a | Bore/Analytic/analgwst.1/src/stripi.o 14K | |
| a | Bore/Analytic/analgwst.1/src/tmp/ OK | |
| a | Bore/Analytic/analgwst.1/src/Orig/ OK | |
| a | Bore/Analytic/analgwst.1/src/Orig/Makefile 7K | |
| a | Bore/Analytic/analgwst.1/src/Orig/cntour.f 15K | |
| a | Bore/Analytic/analgwst.1/src/Orig/dgdiss.f 2K | |
| a | Bore/Analytic/analgwst.1/src/Orig/dimens.inc 1K | |
| a | Bore/Analytic/analgwst.1/src/Orig/exerfc.f 4K | |
| a | Bore/Analytic/analgwst.1/src/Orig/finite.f 15K | |
| a | Bore/Analytic/analgwst.1/src/Orig/gauss.f 10K | |
| a | Bore/Analytic/analgwst.1/src/Orig/qlqpts.f 3K | |
| a | Bore/Analytic/analgwst.1/src/Orig/lenchr.f 1K | |
| a | Bore/Analytic/analgwst.1/src/Orig/locsubs.DGUX.f 2K | |
| a | Bore/Analytic/analgwst.1/src/Orig/locsubs.DMY.f 2K | |
| a | Bore/Analytic/analgwst.1/src/Orig/locsubs.PRIMOS.f 3K | |
| a | Bore/Analytic/analgwst.1/src/Orig/locsubs.SIG.f 2K | |
| a | Bore/Analytic/analgwst.1/src/Orig/locsubs.Solaris.f 3K | |
| a | Bore/Analytic/analgwst.1/src/Orig/locsubs.lahey.f 2K | |
| a | Bore/Analytic/analgwst.1/src/Orig/ofile.f 2K | |
| a | Bore/Analytic/analgwst.1/src/Orig/patchf.f 13K | |
| a | Bore/Analytic/analgwst.1/src/Orig/patchi.f 11K | |
| a | Bore/Analytic/analgwst.1/src/Orig/plot1d.f 4K | |
| a | Bore/Analytic/analgwst.1/src/Orig/plot2d.f 5K | |
| a | Bore/Analytic/analgwst.1/src/Orig/pltdat.inc 1K | |
| a | Bore/Analytic/analgwst.1/src/Orig/point2.f 9K | |
| a | Bore/Analytic/analgwst.1/src/Orig/point3.f 10K | |
| a | Bore/Analytic/analgwst.1/src/Orig/point3_mod.f 10K | |
| a | Bore/Analytic/analgwst.1/src/Orig/rdplot.f 1K | |
| a | Bore/Analytic/analgwst.1/src/Orig/seminf.f 9K | |
| a | Bore/Analytic/analgwst.1/src/Orig/stripf.f 10K | |
| a | Bore/Analytic/analgwst.1/src/Orig/stripi.f 9K | |
| a | Bore/Analytic/analgwst.1/src/Orig/subs1.f 3K | |
| a | Bore/Analytic/analgwst.1/src/Orig/subs2.f 3K | |
| a | Bore/Analytic/analgwst.1/src/Orig/subs3.f 4K | |
| a | Bore/Analytic/analgwst.1/src/Orig/title.f 2K | |
| a | Bore/Analytic/analgwst.1/src/Orig/units.inc 1K | |
| a | Bore/Analytic/analgwst.1/src/patchi.f.orig 11K | |
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| a | Bore/Analytic/analgwst.1/src/rdplot.o 3K | |
| a | Bore/Analytic/analgwst.1/src/qlqpts.o 4K | |
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| a | Bore/Analytic/analgwst.1/src/lenchr.o 2K | |
| a | Bore/Analytic/analgwst.1/src/locsubs.Solaris.o 2K | |
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| a | Bore/Analytic/analgwst.1/README 21K | |
| a | Bore/Analytic/analgwst.1/NOTICE 3K | |
| a | Bore/Analytic/analgwst.1/data/ OK | |
| a | Bore/Analytic/analgwst.1/data/sample1a.dat 1K | |
| a | Bore/Analytic/analgwst.1/data/sample1a.prt 6K | |
| a | Bore/Analytic/analgwst.1/data/sample1b.dat 1K | |
| a | Bore/Analytic/analgwst.1/data/sample1b.prt 6K | |
| a | Bore/Analytic/analgwst.1/data/sample3a.dat 1K | |
| a | Bore/Analytic/analgwst.1/data/sample3a.prt 6K | |
| a | Bore/Analytic/analgwst.1/data/sample3b.dat 1K | |
| a | Bore/Analytic/analgwst.1/data/sample3b.prt 5K | |
| a | Bore/Analytic/analgwst.1/data/sample8a.dat 2K | |
| a | Bore/Analytic/analgwst.1/data/sample8a.prt 26K | |
| a | Bore/Analytic/analgwst.1/data/sample8b.dat 2K | |
| a | Bore/Analytic/analgwst.1/data/sample8b.prt 26K | |

12/10/97
93 PR

Tape (8mm) written of directories ~/Bore and ~/WP/Bore on SUN (bigend)
File listing on the tape is included below (bore.tar.gz is file on tape)

Printed by Randall S. Fedors

| Dec 10, 97 7:43 | tar.out | Page 5/11 |
|-----------------|--|-----------|
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| a | Bore/Analytic/analgwst.1/data/sample2.prt | 6K |
| a | Bore/Analytic/analgwst.1/data/sample4.dat | 1K |
| a | Bore/Analytic/analgwst.1/data/sample4.prt | 6K |
| a | Bore/Analytic/analgwst.1/data/sample5.dat | 1K |
| a | Bore/Analytic/analgwst.1/data/sample5.prt | 24K |
| a | Bore/Analytic/analgwst.1/data/sample6.dat | 2K |
| a | Bore/Analytic/analgwst.1/data/sample6.prt | 32K |
| a | Bore/Analytic/analgwst.1/data/sample7.dat | 2K |
| a | Bore/Analytic/analgwst.1/data/sample7.prt | 21K |
| a | Bore/Analytic/analgwst.1/data/sample9.dat | 1K |
| a | Bore/Analytic/analgwst.1/data/sample9.prt | 13K |
| a | Bore/Analytic/analgwst.1/data/sample10.dat | 2K |
| a | Bore/Analytic/analgwst.1/data/sample10.prt | 31K |
| a | Bore/Analytic/analgwst.1/data/sample11.dat | 2K |
| a | Bore/Analytic/analgwst.1/data/sample11.prt | 42K |
| a | Bore/Analytic/analgwst.1/data/sample9a.dat | 1K |
| a | Bore/Analytic/analgwst.1/data/sample9a.prt | 13K |
| a | Bore/Analytic/analgwst.1/doc/ | 0K |
| a | Bore/Analytic/analgwst.1/doc/finite.txt | 5K |
| a | Bore/Analytic/analgwst.1/doc/seminf.txt | 5K |
| a | Bore/Analytic/analgwst.1/doc/point2.txt | 5K |
| a | Bore/Analytic/analgwst.1/doc/stripf.txt | 5K |
| a | Bore/Analytic/analgwst.1/doc/stripi.txt | 5K |
| a | Bore/Analytic/analgwst.1/doc/gauss.txt | 5K |
| a | Bore/Analytic/analgwst.1/doc/point3.txt | 5K |
| a | Bore/Analytic/analgwst.1/doc/patchf.txt | 5K |
| a | Bore/Analytic/analgwst.1/doc/patchi.txt | 5K |
| a | Bore/Analytic/analgwst.1/doc/analgwst.txt | 5K |
| a | Bore/Analytic/analgwst.1/bin/ | 0K |
| a | Bore/Analytic/analgwst.1/bin/patchi | 1K |
| a | Bore/Analytic/analgwst.1/bin/stripi | 1K |
| a | Bore/Analytic/analgwst.1/bin/gauss | 1K |
| a | Bore/Analytic/analgwst.1/bin/point2 | 1K |
| a | Bore/Analytic/analgwst.1/bin/patchi.exe | 47K |
| a | Bore/Analytic/analgwst.1/bin/p3.tmp | 1K |
| a | Bore/Analytic/analgwst.1/bin/p6.tmp | 1K |
| a | Bore/Analytic/analgwst.1/bin/sample11.dat | 2K |
| a | Bore/Analytic/analgwst.1/bin/sample11.out | 42K |
| a | Bore/Analytic/analgwst.1/bin/print.ps | 57K |
| a | Bore/Analytic/analgwst.1/bin/patchi.exe.std | 45K |
| a | Bore/Analytic/analgwst.1/bin/qlq.pts | 10K |
| a | Bore/Analytic/analgwst.1/bin/stripi.exe | 44K |
| a | Bore/Analytic/analgwst.1/bin/patchi.exe.yz-15y | 47K |
| a | Bore/Analytic/analgwst.1/bin_data/ | 0K |
| a | Bore/Analytic/analgwst.1/bin_data/qlq.pts | 10K |
| a | Bore/Analytic/analgwst.1/test/ | 0K |
| a | Bore/Analytic/analgwst.1/test/test.sh | 4K |
| a | Bore/Analytic/analgwst.1/test/check.sh | 2K |
| a | Bore/Analytic/analgwst.1/test/clean.sh | 1K |
| a | Bore/Analytic/Amargosa/ | 0K |
| a | Bore/Analytic/Amargosa/patchi | 1K |
| a | Bore/Analytic/Amargosa/patchi.exe | 47K |
| a | Bore/Analytic/Amargosa/f.dat | 1K |
| a | Bore/Analytic/Amargosa/sample11.dat | 2K |
| a | Bore/Analytic/Amargosa/farms1.dat | 1K |
| a | Bore/Analytic/Amargosa/t10.dat | 1K |
| a | Bore/Analytic/Amargosa/farms11.dat | 1K |
| a | Bore/Analytic/Amargosa/patchi.exe.std | 45K |
| a | Bore/Analytic/Amargosa/ten10.dat | 1K |
| a | Bore/Analytic/Amargosa/file.out | 7K |
| a | Bore/Analytic/Amargosa/farms2.dat | 1K |
| a | Bore/Analytic/Amargosa/ten55.dat | 1K |
| a | Bore/Analytic/Amargosa/farms3.dat | 1K |
| a | Bore/Analytic/Amargosa/ten2.dat | 1K |
| a | Bore/Analytic/Amargosa/farms4.dat | 1K |
| a | Bore/Analytic/Amargosa/patchi.xls | 54K |
| a | Bore/Analytic/Amargosa/farms5.dat | 1K |
| a | Bore/Analytic/Amargosa/Gradient/ | 0K |

| Dec 10, 97 7:43 | tar.out | Page 6/11 |
|-----------------|---|----------------------------|
| a | Bore/Analytic/Amargosa/Gradient/t.dat | 1K |
| a | Bore/Analytic/Amargosa/Gradient/patchi | symbolic link to ../patchi |
| a | Bore/Analytic/Amargosa/Gradient/f10.dat | 1K |
| a | Bore/Analytic/Amargosa/Gradient/f10.prt | 15K |
| a | Bore/Analytic/Amargosa/Gradient/file.out | 5K |
| a | Bore/Analytic/Amargosa/farms4a.dat | 1K |
| a | Bore/Analytic/Amargosa/farms5a.dat | 1K |
| a | Bore/Analytic/Amargosa/farms11.prt | 70K |
| a | Bore/Analytic/Amargosa/f3000.800 | 1K |
| a | Bore/Analytic/Amargosa/STRIPI/ | 0K |
| a | Bore/Analytic/Amargosa/STRIPI/stripi | 1K |
| a | Bore/Analytic/Amargosa/STRIPI/stripi.exe | 44K |
| a | Bore/Analytic/Amargosa/STRIPI/sample5.dat | 1K |
| a | Bore/Analytic/Amargosa/STRIPI/sample5.prt | 24K |
| a | Bore/Analytic/Amargosa/STRIPI/s.dat | 1K |
| a | Bore/Analytic/Amargosa/STRIPI/s10.dat | 1K |
| a | Bore/Analytic/Amargosa/STRIPI/print.ps | 33K |
| a | Bore/Analytic/Amargosa/STRIPI/sample7.dat | 2K |
| a | Bore/Analytic/Amargosa/STRIPI/sample7.prt | 21K |
| a | Bore/Analytic/Amargosa/STRIPI/rfedors.sample7 | 21K |
| a | Bore/Analytic/Amargosa/STRIPI/s10.prt | 5K |
| a | Bore/Analytic/Amargosa/STRIPI/file.out | 1K |
| a | Bore/Analytic/Amargosa/STRIPI/s2.dat | 1K |
| a | Bore/Analytic/Amargosa/STRIPI/s55.dat | 1K |
| a | Bore/Analytic/Amargosa/STRIPI/n2.dat | 1K |
| a | Bore/Analytic/Amargosa/STRIPI/s.prt | 5K |
| a | Bore/Analytic/Amargosa/STRIPI/s2.prt | 5K |
| a | Bore/Analytic/Amargosa/STRIPI/new2.dat | 1K |
| a | Bore/Analytic/Amargosa/STRIPI/new2.prt | 5K |
| a | Bore/Analytic/Amargosa/STRIPI/n2.prt | 5K |
| a | Bore/Analytic/Amargosa/STRIPI/wexler50Thin.dat | 1K |
| a | Bore/Analytic/Amargosa/STRIPI/st20.prt | 5K |
| a | Bore/Analytic/Amargosa/STRIPI/wexler20Thin.dat | 1K |
| a | Bore/Analytic/Amargosa/STRIPI/wexler20Thin.prt | 5K |
| a | Bore/Analytic/Amargosa/STRIPI/wexler50Thin.prt | 5K |
| a | Bore/Analytic/Amargosa/STRIPI/wexler100Thin.dat | 1K |
| a | Bore/Analytic/Amargosa/STRIPI/wexler100Thin.prt | 5K |
| a | Bore/Analytic/Amargosa/farms6.dat | 1K |
| a | Bore/Analytic/Amargosa/t.dat | 1K |
| a | Bore/Analytic/Amargosa/test.plt | 8K |
| a | Bore/Analytic/Amargosa/farms7.dat | 1K |
| a | Bore/Analytic/Amargosa/farms10.prt | 39K |
| a | Bore/Analytic/Amargosa/farms8.dat | 1K |
| a | Bore/Analytic/Amargosa/patchi.xls.1 | 50K |
| a | Bore/Analytic/Amargosa/farms10.10.out | 3K |
| a | Bore/Analytic/Amargosa/farms9.dat | 1K |
| a | Bore/Analytic/Amargosa/farms8.prt | 39K |
| a | Bore/Analytic/Amargosa/farms10.dat | 1K |
| a | Bore/Analytic/Amargosa/farms10.2.out | 3K |
| a | Bore/Analytic/Amargosa/farms4b.dat | 1K |
| a | Bore/Analytic/Amargosa/farms4c.dat | 1K |
| a | Bore/Analytic/Amargosa/farms4d.dat | 1K |
| a | Bore/Analytic/Amargosa/intersect.lay | 2K |
| a | Bore/Analytic/Amargosa/farms4d.dat | 1K |
| a | Bore/Analytic/Amargosa/print.out | 7K |
| a | Bore/Analytic/Amargosa/plume8.lay | 4K |
| a | Bore/Analytic/Amargosa/tecplot.phy | 1K |
| a | Bore/Analytic/Amargosa/farms10.Co.out | 3K |
| a | Bore/Analytic/internet.solns | 2K |
| a | Bore/Analytic/analgwst.1.source.tar.gz | 111K |
| a | Bore/Analytic/Rood/ | 0K |
| a | Bore/Analytic/Rood/data.fil | 2K |
| a | Bore/Analytic/Rood/gwscreen.out | 8K |
| a | Bore/Analytic/Rood/rood.for | 106K |
| a | Bore/Analytic/Rood/rood.f | 103K |
| a | Bore/Analytic/Rood/rood.header | 3K |
| a | Bore/Analytic/Codell2/ | 0K |
| a | Bore/Analytic/Codell2/ground.f | 15K |
| a | Bore/Analytic/Codell2/out | 33K |
| a | Bore/Analytic/soln-3d.note | 1K |

PR

12/10/97
93 RF

Tape (8mm) written of directories ~/Bore and ~/wP/Bore on SUN (bigend)
File listing on the tape is included below (Bore.tar.gz is file on tape)

Printed by Randall S. Fedors

| Dec 10, 97 7:43 | tar.out | Page 7/11 |
|-----------------|---|-----------|
| a | Bore/Analytic/Codell/ 0K | |
| a | Bore/Analytic/Codell/ex2.inp 15K | |
| a | Bore/Analytic/Codell/ex2.out 97K | |
| a | Bore/Analytic/Codell/rfl.in% 1K | |
| a | Bore/Analytic/Codell/out 4K | |
| a | Bore/Analytic/Codell/grr 1K | |
| a | Bore/Analytic/Codell/gr.single 65K | |
| a | Bore/Analytic/Codell/codell.xls 20K | |
| a | Bore/Analytic/Codell/gr 49K | |
| a | Bore/Analytic/Codell/gr.double 49K | |
| a | Bore/Analytic/Codell/rf2.in 1K | |
| a | Bore/Analytic/Codell/rf2.in% 1K | |
| a | Bore/Analytic/Codell/final20.in 1K | |
| a | Bore/Analytic/Codell/rfl.in 1K | |
| a | Bore/Analytic/Codell/Orig/ 0K | |
| a | Bore/Analytic/Codell/Orig/gr.tar 40K | |
| a | Bore/Analytic/Codell/Orig/daught.f 2K | |
| a | Bore/Analytic/Codell/Orig/erff.f 1K | |
| a | Bore/Analytic/Codell/Orig/expf.f 1K | |
| a | Bore/Analytic/Codell/Orig/fun.f 5K | |
| a | Bore/Analytic/Codell/Orig/gather.f 2K | |
| a | Bore/Analytic/Codell/Orig/gr.f 1K | |
| a | Bore/Analytic/Codell/Orig/grdflx.f 19K | |
| a | Bore/Analytic/Codell/Orig/interp.f 4K | |
| a | Bore/Analytic/Codell/Orig/wlist.f 1K | |
| a | Bore/Analytic/Codell/Orig/Readme.email 1K | |
| a | Bore/Analytic/Codell/Orig/ex2.inp 15K | |
| a | Bore/Analytic/Codell/Orig/ex2.out 97K | |
| a | Bore/Analytic/Codell/Orig/rf.out 97K | |
| a | Bore/Analytic/Intersect/ 0K | |
| a | Bore/Analytic/Intersect/f10.dat 7K | |
| a | Bore/Analytic/Intersect/itsec.f 15K | |
| a | Bore/Analytic/Intersect/QAP/ 0K | |
| a | Bore/Analytic/Intersect/QAP/itsec.f 14K | |
| a | Bore/Analytic/Intersect/QAP/Grid/ 0K | |
| a | Bore/Analytic/Intersect/QAP/Grid/itsec_grid 39K | |
| a | Bore/Analytic/Intersect/QAP/Grid/f8.25km 4K | |
| a | Bore/Analytic/Intersect/QAP/Grid/caps3D.input 1K | |
| a | Bore/Analytic/Intersect/QAP/Grid/capture.dat 1K | |
| a | Bore/Analytic/Intersect/QAP/Grid/plume.dat 4K | |
| a | Bore/Analytic/Intersect/QAP/Grid/itsec_grid.f 14K | |
| a | Bore/Analytic/Intersect/QAP/Grid/f10.25km 4K | |
| a | Bore/Analytic/Intersect/QAP/Grid/its 39K | |
| a | Bore/Analytic/Intersect/QAP/Grid/output 1K | |
| a | Bore/Analytic/Intersect/QAP/Grid/itsd 39K | |
| a | Bore/Analytic/Intersect/QAP/f10.15km 4K | |
| a | Bore/Analytic/Intersect/QAP/f10.25km 4K | |
| a | Bore/Analytic/Intersect/QAP/f10.dat 7K | |
| a | Bore/Analytic/Intersect/QAP/f5.15km 4K | |
| a | Bore/Analytic/Intersect/QAP/f5.25km 4K | |
| a | Bore/Analytic/Intersect/QAP/f5.dat 7K | |
| a | Bore/Analytic/Intersect/QAP/f7.15km 4K | |
| a | Bore/Analytic/Intersect/QAP/f7.25km 4K | |
| a | Bore/Analytic/Intersect/QAP/f7.dat 7K | |
| a | Bore/Analytic/Intersect/QAP/f8.15km 4K | |
| a | Bore/Analytic/Intersect/QAP/f8.dat 7K | |
| a | Bore/Analytic/Intersect/QAP/f9.15km 4K | |
| a | Bore/Analytic/Intersect/QAP/f9.25km 4K | |
| a | Bore/Analytic/Intersect/QAP/f9.dat 7K | |
| a | Bore/Analytic/Intersect/QAP/st100.15km 1K | |
| a | Bore/Analytic/Intersect/QAP/st100.25km 1K | |
| a | Bore/Analytic/Intersect/QAP/st100.dat 1K | |
| a | Bore/Analytic/Intersect/QAP/st20.15km 1K | |
| a | Bore/Analytic/Intersect/QAP/st20.25km 1K | |
| a | Bore/Analytic/Intersect/QAP/st20.dat 1K | |
| a | Bore/Analytic/Intersect/QAP/st50.15km 1K | |
| a | Bore/Analytic/Intersect/QAP/st50.25km 1K | |
| a | Bore/Analytic/Intersect/QAP/st50.dat 1K | |
| a | Bore/Analytic/Intersect/QAP/caps2D.input 1K | |

| Dec 10, 97 7:43 | tar.out | Page 8/11 |
|-----------------|--|-----------|
| a | Bore/Analytic/Intersect/QAP/caps3D.input 1K | |
| a | Bore/Analytic/Intersect/QAP/itsec 38K | |
| a | Bore/Analytic/Intersect/QAP/capture.dat 1K | |
| a | Bore/Analytic/Intersect/QAP/plume.dat 1K | |
| a | Bore/Analytic/Intersect/QAP/df-st100.25km.25m.out 9K | |
| a | Bore/Analytic/Intersect/QAP/df-st100.25km.10m.out 9K | |
| a | Bore/Analytic/Intersect/QAP/df-f8.25km.dom.out 9K | |
| a | Bore/Analytic/Intersect/QAP/df-st100.25km.25m.large.out 5K | |
| a | Bore/Analytic/Intersect/QAP/df-f10.25km.out 5K | |
| a | Bore/Analytic/Intersect/QAP/df-st20.25km.10m.out 9K | |
| a | Bore/Analytic/Intersect/QAP/df-st20.25km.25m.out 9K | |
| a | Bore/Analytic/Intersect/QAP/df-f10.25km.dom.out 9K | |
| a | Bore/Analytic/Intersect/QAP/df-f9.25km.out 5K | |
| a | Bore/Analytic/Intersect/QAP/df-f8.25km.out 5K | |
| a | Bore/Analytic/Intersect/QAP/df-st20.25km.25m.large.out 5K | |
| a | Bore/Analytic/Intersect/QAP/df-st50.25km.25m.large.out 5K | |
| a | Bore/Analytic/Intersect/tecplot.phy 1K | |
| a | Bore/Analytic/Intersect/df-f8.25km.dom.output 10K | |
| a | Bore/Analytic/Intersect/plume.dat 1K | |
| a | Bore/Analytic/Intersect/capture.dat 1K | |
| a | Bore/Analytic/Intersect/intersec.out 4K | |
| a | Bore/Analytic/Intersect/plume.dat2 1K | |
| a | Bore/Analytic/Intersect/df-st100.25km.25m.output 10K | |
| a | Bore/Analytic/Intersect/XVGR/ 0K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-Q-irr.xvgr 1K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-T-irr.parm 13K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-Q-irr.parm 14K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-Q-irr.all 15K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-Q-irr.ps 6K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-T-irr.xvgr 1K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-T-irr.all 14K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-T-irr.ps 5K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-Q-dom.xvgr% 1K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-Q-dom.xvgr 1K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-T-dom.xvgr 1K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-Q-dom.all 14K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-Q-dom.parm 13K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-Q-dom.ps 5K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-T-dom.ps 5K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-T-dom.all 14K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-T-dom.parm 13K | |
| a | Bore/Analytic/Intersect/XVGR/tdf-Q-irr.xvgr.old 1K | |
| a | Bore/Analytic/Intersect/f9.dat 7K | |
| a | Bore/Analytic/Intersect/f7.dat 7K | |
| a | Bore/Analytic/Intersect/f8.dat 7K | |
| a | Bore/Analytic/Intersect/f5.dat 7K | |
| a | Bore/Analytic/Intersect/f10.15km 4K | |
| a | Bore/Analytic/Intersect/f10.25km 4K | |
| a | Bore/Analytic/Intersect/f9.15km 4K | |
| a | Bore/Analytic/Intersect/f9.25km 4K | |
| a | Bore/Analytic/Intersect/f5.15km 4K | |
| a | Bore/Analytic/Intersect/f5.25km 4K | |
| a | Bore/Analytic/Intersect/f7.15km 4K | |
| a | Bore/Analytic/Intersect/f8.15km 4K | |
| a | Bore/Analytic/Intersect/f7.25km 4K | |
| a | Bore/Analytic/Intersect/f8.25km 4K | |
| a | Bore/Analytic/Intersect/print.ps 17K | |
| a | Bore/Analytic/Intersect/plumes.output 2K | |
| a | Bore/Analytic/Intersect/caps3D.input 1K | |
| a | Bore/Analytic/Intersect/df-f10.25km.output 5K | |
| a | Bore/Analytic/Intersect/caps2D.input 1K | |
| a | Bore/Analytic/Intersect/st20.dat 1K | |
| a | Bore/Analytic/Intersect/df-f8.25km.output 7K | |
| a | Bore/Analytic/Intersect/wexlerfarms8.dat 1K | |
| a | Bore/Analytic/Intersect/wexler20Thin.dat 1K | |
| a | Bore/Analytic/Intersect/wexlerfarms10.dat 1K | |
| a | Bore/Analytic/Intersect/st50.dat 1K | |
| a | Bore/Analytic/Intersect/wexler100Thin.dat 1K | |
| a | Bore/Analytic/Intersect/wexler50Thin.dat 1K | |

12/10/97
93 RF

Tape (8mm) written of directories ~/bore and ~/WP/Bore on SUN (bigband)
File listing on the tape is included below (bore.tar.gz is file on tape)

Printed by Randall S. Fedors

| Dec 10, 97 7:43 | tar.out | Page 9/11 |
|-----------------|---|-----------|
| a | Bore/Analytic/Intersect/st20.15km 1K | |
| a | Bore/Analytic/Intersect/st20.25km 1K | |
| a | Bore/Analytic/Intersect/st50.15km 1K | |
| a | Bore/Analytic/Intersect/st50.25km 1K | |
| a | Bore/Analytic/Intersect/st100.dat 1K | |
| a | Bore/Analytic/Intersect/st100.15km 1K | |
| a | Bore/Analytic/Intersect/st100.25km 1K | |
| a | Bore/Analytic/Intersect/Readme 1K | |
| a | Bore/Analytic/Intersect/df-st20.25km.25m.output 10K | |
| a | Bore/Analytic/Intersect/tmp/ 0K | |
| a | Bore/Analytic/Intersect/tmp/itsec 38K | |
| a | Bore/Analytic/Intersect/tmp/f10.15km 4K | |
| a | Bore/Analytic/Intersect/tmp/f10.25km 4K | |
| a | Bore/Analytic/Intersect/tmp/f10.dat 7K | |
| a | Bore/Analytic/Intersect/tmp/f5.15km 4K | |
| a | Bore/Analytic/Intersect/tmp/f5.25km 4K | |
| a | Bore/Analytic/Intersect/tmp/f5.dat 7K | |
| a | Bore/Analytic/Intersect/tmp/f7.15km 4K | |
| a | Bore/Analytic/Intersect/tmp/f7.25km 4K | |
| a | Bore/Analytic/Intersect/tmp/f7.dat 7K | |
| a | Bore/Analytic/Intersect/tmp/f8.15km 4K | |
| a | Bore/Analytic/Intersect/tmp/f8.25km 4K | |
| a | Bore/Analytic/Intersect/tmp/f8.dat 7K | |
| a | Bore/Analytic/Intersect/tmp/f9.15km 4K | |
| a | Bore/Analytic/Intersect/tmp/f9.25km 4K | |
| a | Bore/Analytic/Intersect/tmp/f9.dat 7K | |
| a | Bore/Analytic/Intersect/tmp/st100.15km 1K | |
| a | Bore/Analytic/Intersect/tmp/st100.25km 1K | |
| a | Bore/Analytic/Intersect/tmp/st100.dat 1K | |
| a | Bore/Analytic/Intersect/tmp/st20.15km 1K | |
| a | Bore/Analytic/Intersect/tmp/st20.25km 1K | |
| a | Bore/Analytic/Intersect/tmp/st20.dat 1K | |
| a | Bore/Analytic/Intersect/tmp/st50.15km 1K | |
| a | Bore/Analytic/Intersect/tmp/st50.25km 1K | |
| a | Bore/Analytic/Intersect/tmp/st50.dat 1K | |
| a | Bore/Analytic/Intersect/tmp/plume.dat 4K | |
| a | Bore/Analytic/Intersect/tmp/caps2D.input 1K | |
| a | Bore/Analytic/Intersect/tmp/caps3D.input 1K | |
| a | Bore/Analytic/Intersect/tmp/capture.dat 1K | |
| a | Bore/Analytic/Intersect/tmp/intersec.out 7K | |
| a | Bore/Analytic/Intersect/result3D.small 4K | |
| a | Bore/Analytic/Intersect/df-f10.25km.dom.output 10K | |
| a | Bore/Analytic/Intersect/df-st20.25km.10m.output 10K | |
| a | Bore/Analytic/Intersect/plume.dat.small 1K | |
| a | Bore/Analytic/Intersect/capture.dat.small 1K | |
| a | Bore/Analytic/Intersect/results.small 2K | |
| a | Bore/Analytic/Intersect/df-f9.25km.output 7K | |
| a | Bore/Analytic/Intersect/df-st100.25km.10m.output 10K | |
| a | Bore/Analytic/Intersect/df-st50.25km.25m.large.output 7K | |
| a | Bore/Analytic/Intersect/df-st20.25km.25m.large.output 7K | |
| a | Bore/Analytic/Intersect/df-st100.25km.25m.large.output 7K | |
| a | Bore/Analytic/Intersect/plumes2.output 2K | |
| a | Bore/Analytic/Intersect/itsec.f.1 14K | |
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| a | Bore/Analytic/Intersect/plume.dat.bogan 1K | |
| a | Bore/Analytic/Intersect/df-f10.25km.output.old 7K | |
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| a | Bore/Analytic/Intersect/plume.dat.strip1.small 1K | |
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| a | Bore/Analytic/Intersect/QAP2/f7.15km 4K | |

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| a | Bore/Analytic/Intersect/QAP2/df-f8.25km.out 5K | |
| a | Bore/Analytic/Intersect/QAP2/df-st100.25km.25m.dom.out 5K | |
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RF

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93 RP 2

Tape (8mm) written of directories ~/Bore and ~/WP/Bore on SUN (big bend)
File listing on the tape is included below (bore.tar.gz is file on tape)

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|-----------------|------------------------------|------------|
| a | WP/Bore/plume.wp 16K | |
| a | WP/Bore/tecplot.phy 1K | |
| a | WP/Bore/pump.wp5 73K | |
| a | WP/Bore/plume.wp5 6K | |
| a | WP/Bore/dfactor.wp5 74K | |
| a | WP/Bore/dfactor.wp 84K | |
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| a | WP/Bore/qap-014 6K | |
| a | WP/Bore/tmp.wp6 19K | |
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| a | WP/Bore/insert.pag 3K | |