

App. I: DCF, Prudhoe Bay

7 - IV - 79

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Dear Prof Gaffney, I thoroughly enjoyed our chat on the 'phone this afternoon. I enclose my cheque for \$30 payable to the University of Wisconsin for "Extractive Resources & Taxation". As I said, I would be grateful for reprints of your "Allocation of land among farms" Univ of Missouri Research Bulletin no 810 ed F. MILLER and your "Tax-Induced Slow Turnover of Capital" in the 1970 Am. J. of Econ. & Sociology.

The article by Gaffney in the ET has only been in the last couple of years - I think the title was "Leon Walras: An Economic Adviser Manqué" and he discusses Walras view on commutative (governed by free market) justice and distributive justice (governed by allocation of factor endowments e.g. church manors?). It all sounds very Physiocratic in Max Beer's natural law sense ("An Inquiry into Physiocracy").

Royalties vs Rents. It seems to me that a royalty is "rent-in-advance?" for the use of a natural object in perpetuity, just as a fee simple payment for land is - they are both PV's of future services. Hence, I suspect an ad valorem property tax must be neutral or non-neutral in both cases - its a tax on PV.

Thus, I think the questions of:

- (1) SVT and premature development (Pigan)
- (2) forestry & deferred yield bias
- (3) exhaustion by overgrazing (allegedly due to land tax)
- (4) premature mineral exhaustion

are all facets of the one question: Does ^{recurrent} ap , ad valorem tax on the PV of a natural resource alter the time disposition of its usage? (as compared with a no tax situation).

I think the answer in all cases is no. Consider the case of a ton of ore sitting on the ground. If we are in equilibrium in the no-tax situation then optimization requires that in each time period the % change in PV equals the rate of interest. If less, better to mine it; if more, leave it for future users. So, pre tax we would have ($i = 10\%$)

Beginning of Year 1 PV of ton = NRV (Net Realizable Value)
\$10

2 \$11

3 \$12-10

Suppose now an ad valorem tax of 5% is introduced payable at the beginning of each year. As soon as the tax is announced capitalization takes place

If t were a recurrent tax then V' (the after tax value) of the resource would be related to V (the pre tax value) according to the normal formula

$$V' = \frac{ER - tV'}{i}$$

$$\Rightarrow V' = \frac{i}{i+t} V$$

$$= \$6.67$$

$$(V=10)$$

But, of course, an ad valorem property tax on a severable resource can be dodged by ~~sale~~ severance - only the first year's levy has to be paid, so the NRV drops by 5% of \$10 to \$9.50 (NOT \$6.67). (This is not quite right: 5% of \$9.50 + \$9.50 $\neq$ \$10. We need an

analogous tax capitalization formula - the value of the resource to the consumer is unchanged (rent & capitalized rent are demand-determined values). The formula is

$$V' + tV' = V \quad \text{where } V \text{ is pre-tax value}$$

$$V' = \frac{V}{1+t} \quad \text{because } t \text{ is not necessarily recurrent}$$

So the value of the ore in
Year 1 is $\frac{\$10}{1.05} = \$9.52 = \text{NRV}$

Now we have a choice (1) leave it in the ground to appreciate & pay another tax or (2) get it out and get interest

Choice (1) leave it in

Choice (2) get it out

Value at beginning of year 2

$$\text{NRV} = \$11$$

$$\frac{1}{1+t}$$

$$= \$10.48$$

$$(\text{= } \$10.47619048)$$

$$\text{NRV}$$

$$= \$9.52(1+i)$$

$$= \$10.48$$

$$(\text{= } \$10.47619048)$$

So the introduction of the ad valorem property tax has not affected a marginal decision. Why? Because the appreciation compounds on the pre-tax values which offsets the recurrence of the tax if you choose to face it. Those who have argued the recurrent tax biases to exhaustion seem to me to have ignored the change in NRV in first period - they relate \$10.48 to \$10 not to \$9.52.

A general formulation is set out below

		Econ Value of One	NRV after tax (τ levied BOY)
BOYear	t	V_t	$\frac{V_t}{1+\tau}$
BOYear	$t+1$	V_{t+1}	$\frac{V_{t+1}}{1+\tau}$

Choices (1) take out beginning of this year
 (2) " " " Next year

$$\text{FV choice (1)} = \frac{V_t (1+i)}{(1+\tau)}$$

$$\text{FV choice (2)} = \frac{V_{t+1}}{(1+\tau)}$$

But in pre tax equilibrium $V_{t+1} = V_t (1+i)$

$$\therefore \text{FV choice (2)} = \text{FV choice (1)}$$

Is there anything wrong with this? It seems a bit too simple but I can't see what's wrong with it.

P.S. This seems to be related to PASOUR & HOLLEY

("Economic Analysis of Case against Ad valorem property taxation") NTJ v 29 No 2 (1976)

Also, the reasoning above would seem to be OK if the resource can't be got out at once - most mines couldn't be exhausted at once, but if that's so, then PV would be less anyway for pre tax equilibrium.

Hence, question arises - why not tax mineral properties by a self-assessed declaration of PV which government then uses as a tax base (or if dissatisfied, buys mine - owner out at, with compensation at written down replacement cost for improvements).

Well this is a bit much for a letter, so I'd better stop here. Please let me know what you think. Yours faithfully
 Gerald Dwyer

Appendix I

Sensitivity of Discounted Cash Flow (DCF) to Production

Rates and Interest Rates, Sadlerochit Formation

Table I-1 shows two alternative schedules of the flow of production from the Sadlerochit Formation. These are taken from the Van Poolen report, "Prediction of Reservoir Fluid Recovery, Sadlerochit Formation, Prudhoe Bay Field," Tables XVII and XIX. Both runs result in almost exactly the same ultimate recovery. The difference is that Run 18 starts faster and ends slower than Run 16. Run 18 would require a greater investment in lessee's capital to allow the faster starting rate of production to occur. This is compensated by the higher present value. Table I-2 shows the increase in present value or DCF at different rates of discount. Several points stand out.

DCF is sensitive to production rates. The gain in DCF from choosing Run 18 over Run 16 is a present value increment of \$5.4 billion at a 10 percent rate of discount. This is the maximum gain: it declines in both directions from 10 percent. However, it does not decline very sharply and is surprisingly insensitive to the rate of interest.

DCF is sensitive to the discount rate. For Run 18 it declines from \$47.8 billion down to \$16.1 billion as we go from a 3 percent to a 28 percent discount rate.

Run 16 is more sensitive to the discount rate than is Run 18. This is because Run 16 is slower and therefore more weighted towards the future, where discount factors are more sensitive to the choice of a discount rate.

The third row, which is Run 18 minus Run 16, is not very sensitive to the discount rate. This last point is quite significant. The amount of capital we can justify investing to speed up the flow of production is limited by the gain in DCF that results. Normally, with other kinds of investments, a higher rate of discount means a lesser gain from any investment that increases future production. In this case it means a greater gain, at least until the discount rate reaches 10 percent, after which the gain tapers off again.

Note how this bears on the concern that a higher ad valorem charge (AVC) would cause the last barrel of oil to be extracted too rapidly. When the discount rate rises above 10 percent, the addition of an ad valorem charge will slow down rather than speed up production by limiting the number of wells that may be drilled.

There appear to be two countervailing forces at work here. As we raise the discount rate both series of DCF's become smaller, which tends to bring them closer together, but Run 16 is more sensitive to the discount rate, which tends to pull them farther apart. Between 3 and 10 percent, the second force overpowers the first, and above 10 percent vice versa.

We leave further investigation of this interesting phenomenon to future study. The present point is that the application of an ad valorem charge would not contain much net bias either in the direction of speeding up or slowing down production.

Another important implication is that we may live in a world of uncertainty about future interest rates, but that does not prevent our

scheduling flows with some assurance that our scheduling will be optimal in case future interest rates change. Because future interest rates may change a good deal without changing the optimal application of capital.

Table I-1

Runs 16 and 18 from the Van Poolen Report

<u>Year</u>	<u>Run 16</u> <u>MMB/D</u>	<u>Run 18</u> <u>MMB/D</u>
1	1.4	1.40
2	1.2	1.80
3	1.2	1.80
4	1.2	1.80
5	1.2	1.80
6	1.2	1.80
7	1.2	1.80
8	1.2	1.31
9	1.2	1.10
10	1.2	.91
11	1.2	.89
12	1.2	.87
13	.99	.58
14	.75	.48
15	.56	.35
16	.47	.24
17	.35	.17
18	.27	.16
19	.22	.15
20	.17	.13
21	.13	.12
22	.11	.10
23	.10	.08
24	.08	.06
25	.07	.05
26	.05	--

Table I-2

Present Values at Different Rates of Discount,

Runs 16 and 18, Van Poolen Report

Discount Rate	.03	.05	.08	.10	.15	.20	.28
Run 18	47.8	42.3	35.6	32.7	25.6	21.0	16.1
Run 16	43.5	37.5	30.7	27.3	21.0	16.8	12.6
Run 18-Run 16	4.3	4.8	4.9	5.4	4.6	4.2	3.5
Run 18/Run 16	1.098	1.127	1.160	1.196	1.22	1.25	1.28

Van Poolen Rpt.

Fig. 1. They ran 29 models, various combos., to see effect of various assms. on oil recovery, cum. over time.

Time distribn. is ~~vague~~ but inferable from "Max. Sustained Oil Rate" in MM B/D. They have 3 rates: 1.2, 1.6, & 1.8.
(Tables give detail)

Ult. recovery is not rate-sensitive, particularly.

U.R. is sensitive to Gas Sales. There is a big Trade-off.

Selling gas reduces recovery.

(Can they reinject some other gas, like air?)

Another vble. is date of beginning gas sales. By lagging gas sales behind oil prodn. by 1 yr, you recover nearly as much oil as by no gas sales.

Loss from wrong opn. is substantial, ~~ca. 1/4~~, from 8b.

to 7, or ca. $\frac{1}{8}$. But re-injection uses 8% or so each time, of the gas, so you lose lots of gas by re-injecting it.

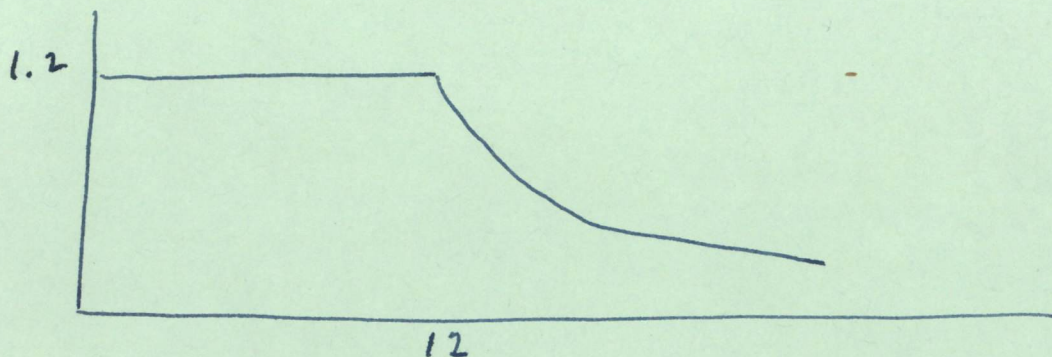
Water injection, raises recovery from 7 to 8 b.bl.

Re rate-sensitivity, they give you 3 rates for each set of assms. re gas sales & wtr. injn. Ult. R. rises w. rate for some assms.

and falls for others. The most likely assm. is

Runs 16-18, and 25-27. U.R. rises w. rate, Runs 16-18; and is nearly const., Runs 25-27.

Their produ. rates are flat-topped, so:



Followed by ca. 25% decline rates, but irregular.

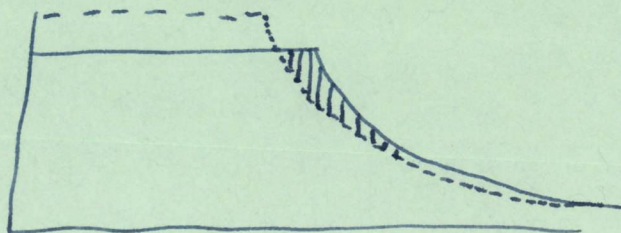
This suggests capacity choke in no. of wells, etc. Yet they get one yr. of 1.4 in Run 16, before dropping to 1.2.

They recover $\frac{5.271}{7.020} = 75\%$ of U.R. in 12 yrs. at 1.2.

" " $\frac{6.228}{7.322} = 85\%$ of U.R. in 12 yrs. at 1.8

Use flat-top in my graphs, anyway. It makes sense, combines capital limit with land limit.

Effect of new well:



Shifts its pre-decline flow to present. Advances inc. stream ca. 10 yrs.

Van P. - 3 -

A well yields ~~1,000~~ 1,000 B/d now, ^{for 12 years,} and reduces flow by 1,000 B/d for 2d 12 yrs.

$$\text{Gain} = 365 \text{ MB/d} \cdot P_{whd} \frac{1 - e^{-12i}}{i}$$

$$\text{Loss} = 365 \text{ MB/d} \cdot P_{whd} \left[\frac{1 - e^{-24i}}{i} - \frac{1 - e^{-12i}}{i} \right]$$

$$\text{Gain} - \text{Loss} = 365 \text{ MB/d} \cdot P_{whd} \left[\frac{1 - e^{-12i}}{i} - \frac{1 - e^{-24i}}{i} + \frac{1 - e^{-12i}}{i} \right]$$

$$= 365 \text{ MB/d} \cdot P \left[2 \frac{1 - e^{-12i}}{i} - \frac{1 - e^{-24i}}{i} \right]$$

$$= 365 \text{ MB/d} \cdot P \left[\frac{1 - 2e^{-12i} + e^{-24i}}{i} \right]$$

$$\text{Values of } \left[\frac{1 - 2e^{-12i} + e^{-24i}}{i} \right] = \Theta$$

$$i = .06 \quad .10 \quad .13 \quad .16$$

$$e^{-12i} = .50 \quad .319 \quad .231 \quad .168$$

$$2e^{-12i} = 1.00 \quad .638 \quad .462 \quad .336$$

$$e^{-24i} = .25 \quad .102 \quad .053 \quad .028$$

$$1 - 2e^{-12i} + e^{-24i} = .25 \quad .464 \quad .591 \quad .692$$

$$\Theta = ~~1.25~~ \quad ~~2.83~~ \quad 4.546 \quad 4.325$$

$$4.167 \quad 4.64$$

$$\frac{1 - e^{-12i}}{i} = 8.333 \quad 6.81 \quad 5.915 \quad 5.200$$

Van P. - 5-

$$R16 = .438 \text{ MMM B/a for 12 yrs}$$

$$R18 = .657 \quad \dots \quad 7 \text{ yrs.}$$

$$\text{Gain is } 50\% \left[\frac{1.8 - 1.2}{1.2} = \frac{.6}{1.2} \right]$$

$$\text{Gain is } .219 \text{ MMM B/y for 7 years}$$

Say for 8 years

Loss is spread over 13 years, 9-21 incl.

Say it is smoothed to $8/13$ of the gain

$$8/13 \text{ of } .219 = .135$$

$$\text{Gain is PV of } .219 \frac{1 - e^{-8i}}{i} = .219 \cdot 5.75 = 1.259$$

$$\text{Loss is PV of } .135 \left[\frac{1 - e^{-21i}}{i} - \frac{1 - e^{-8i}}{i} \right] = .135(10.0 - 5.75) \\ = .135 \cdot 4.25 = .574$$

Use 8%

$$\frac{1 - e^{-8 \cdot .08}}{.08} = \frac{1 - .54}{.08} = 5.75$$

$$\frac{1 - e^{-21 \cdot .08}}{.08} = \frac{1 - .20}{.08} = 10.0$$

$$\text{Net gain} = 1.259 - .574 = .685$$

Van P. - 6 -

Gain is PV of .685 MM Bbls. of oil

$$.685 \text{ MM} \times \$10/\text{bbl} = \$6.85 \text{ billion}$$

The cost of the extra wells is not estd. in report.
It cd. not be nearly that hi, however.

1. How does 20% prop. tax affect return on invt?

It As the return to devent. wells. Tabulate a few,
cfz. runs 16 & 18.

2. How much incentive is created to deplete "too fast"? Only as
much as there is incentive to add devent. wells. That is
mild, and is easily controllable if desired by adding royalties
or using existing regs.

3. arbitrary? Alaska Interstate on Jan. 6 '77 ^{Muller's Fuel Co. for \$45.8m;}
A corp. recently acquired another & ~~to~~ by agreement
the price depended on appraisal of reserves by 2 indep. engineers. They
raised price from 39.4 to \$45.8m, by 6.4m = 16%. WSJ 1/6/77 p.7
Other investors assume same risk (at lower rate, however)

Pardhall

I may have proven that the economy of speeding up
prodn. is very insensitive to Δi . - Van P. notes, p. 7.

Gain - loss from new well = $a \Theta$

a = annual cf. of well

$$\Theta = \frac{1 - 2e^{-12i} + e^{-24i}}{i} \approx 4.2 \text{ to } 4.6$$

Thus the gain is $4\frac{1}{2} \times$ annual flow, regardless of i .

So higher i will not change opt. schedule much, (at least in the range I looked at)

Be wary treating ΔP by lowering i . Antic. ΔP slows schedule; Δi affects cost of K as well as holding cost of oil, and has little effect.

App. I: Sensitivity of DCF to prodn. rates & i.r., S.Factor.

— Faster start, slower finish. Same w/o. acc.

— DCF is sensitive to prodn. rates. Gain in DCF is \$5.4 b at 10%, and declines both ways from there, but not very much. ~~to the~~

— Gain in DCF not ^{very} sensitive to disc. rate. Max. at 10%, lower to rt. & left.

— DCF sens. to disc. r.

— Slower run, DCF is more sens.

tot

AVC is part of disc. r. Can go to hi AVC w/o much effect on prodn sched.

App. H Computing the AUC

- a 20% rate is not so hi, bcs. it's capd.
- A hi rate does not take more income than there is, bcs. if ~~value~~ it did there wd. be no base, $DCF < 0$.
A balance is reached when the hi rate & the low base produce a middling figure. T. H-1 shows how base is reduced, & tax arrived at.
- Hi rate doesn't cause early shutdown, bcs. base drops -- from $\$166$ to $.1$, or 6/10 % of initial base
- The base is arrived at by discounting future cash flow at 28%. Thus the last cash comes Dec. 31, yr. 25, and value Jan 1 is $\frac{1}{1.28}$ of that: $.109 = \frac{.140}{1.28}$
- Lessee always gets 8% of the base; Lessor gets 20% (Lessor not guaranteed this, ^{\$} but is protected vs. external risks)
or
- The split is 20% to 8%, or 2.5 to 1, each yr. after deducting deprec. of value
- The last bbl is taxed 25 times at 20% before being lifted. That might seem too much, but ^{going to} base is

near zero for first 20 yrs.

$$\$8 \cdot 1.28^{-25} = 8 \cdot .0021 = \$0.17 = 1.7¢$$

(It rises in value 28% each yr.,) ~~compensating owner for holding it.~~

— This might seem to force early prodn. But that requires more K, lasting full life of prodn. I only used part of time. Have to look at process as a whole, not just one bbl. App. I does, I finds not very sensitive

In addition, last bl. probly not confirmed for 1st several yrs. ~~Ass~~ Greater weakness is under asmt.

Tech. notes, by column

(2) Daily flows in B/D from Run 18 in "Prediction..."

I. XIX. Gas recovery excluded. Rounded to 2 places.

(3) X 365

(4) C7 x \$8. Purely to show method, price assumed const.; & net of opj costs. current expenses.

(5) DCF. $\sum_{t=a}^{25} (CF_t) \times (1.28)^{-(n-a\frac{1}{2}+1)}$

n is (1): a is yr. of DCF.

A process where ea. individ. yr. is disc. ^{at 28%} then added to cum. sum. Assume CF rec'd Dec. 31; value is pres'd Jan. 1.

T. H-2 shows process for 2 of the figs

As run down column, DCF changes ~~for~~ as result of 2 things: one less yr; & later yrs. move on yr. nearer to present (or v.v.) & rise 28%.

Usually comes fall, but not in yr. 1

$$DCF_2 = DCF_1 - CF_1 + .28 \cdot DCF_1$$

$$= DCF_1 (1.28) - CF_1$$

Note bottom figs. .109 + 28% = .14

(6) 20% of DCF, (due at Dec. 31)

(7) Cash after tax

(8) Δ DCF, True depletion

(Add extend column to yrs before prodn, Δ is +, unrealized gain.)

(9) Share of CF.

(10) Lessee income

- (11) Lema inc., always 8% of ~~unrecovered~~ DCF
DCF is also unrecovered balance of DCF,
He always gets 8% of that, & we get 20%.

p. 52 (pencil)

Is my figure 1,846 \$? or other unit.

Value of 700 in bbls, @ \$8 = \$5.66

p. 8. in the r. of r.

1.32

$$i = .08 \quad t = .20$$

Run 18

n yr.	(2) Z low (at end of yr)	(3) PV _{yr} Jan. 1	.20 PV							$\frac{t}{i}$	$\frac{t}{t+i}$
			T	F-T	ΔPV	T/F	T/F-T	F-T+APR	$\frac{(9)}{PV}$	$\frac{T}{(9)}$	$\frac{T}{T+(9)}$
(1)			(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	1.40	5.52	1.10	.30	+.14	.79	3.67	.44	.08	2.5	.714
2	1.80	5.66	1.13	.67	+.21	.63	1.69	.46	.08		
3	1.80	5.45	1.09	.71	-.28	.61	1.54	.43	.08		
4	1.80	5.17	1.03	.77	-.35	.57	1.34	.42	.08		
5	1.80	4.82	.966	.83	-.45	.54	1.16	.38	.08		
6	1.80	4.37	.874	.93	-.58	.48	.94	.35	.08		
7	1.80	3.79	.758	1.04	-.74	.42	.73	.30	.08		
8	1.31	3.05	.610	.70	-.45	.47	.87	.25	.08		
9	1.10	2.60	.520	.58	-.38	.47	.89	.20	.08		
10	.91	2.22	.444	.47	-.28	.49	.94	.19			
11	.89	1.94	.388	.50	-.35	.44	.78	.15			
12	.87	1.59	.318	.55	-.43	.37	.58	.12			
13	.58	1.16	.232	.35	-.25	.40	.66	.10			
14	.48	.911	.182	.30	-.24	.38	.60	.06			
15	.35	.686	.137	.21	-.14	.39	.65	.07			
16	.24	.528	.106	.13	-.09	.44	.82	.04			
17	.17	.436	.087	.08	-.05	.51	1.09	.03			
18	.16	.388	.078	.08	-.05	.48	.98	.03			
19	.15	.337	.067	.08	-.06	.45	.84	.02			
20	.13	.281	.056	.07	-.05	.43	.80	.02			
21	.12	.230	.046	.07	-.06	.38	.66	.01			
22	.10	.174	.035	.07	-.03	.35	.50	.04			
23	.08	.123	.025	.05	-.04	.31	.50	.01			
24	.06	.077	.015	.04	-.04	.26	.38	.00			
25	.05	.039	.008	.042	-.039	.16	.19	.003	.08	2.5	.714

$$PV_n = PV_1 - \frac{F_1}{1.28} + .28 \left(PV_1 - \frac{F_1}{1.28} \right) = 1.28 \left(PV_1 - \frac{F_1}{1.28} \right) = 1.28 PV_1 - F_1$$

$$PV_{n+1} = 1.28 PV_n - F_n$$

You put in taxes plus interest, and take out F_n .

$$PV_n = \frac{PV_{n+1} + F_n}{1.28}$$

Table H-1: ~~Calculating~~ The ad valorem change (AVC)

Year	Current Flow $\rightarrow$ B/Y	DCF \$ of IV	AVC Change \$ / Y	Cash to Lessee Change \$	Change in DCF
(1)	(2)	(3)	(4)		(6)

- Flow assumed concentrated at ^{Dec. 31 of given} ~~year~~ year. This simplifies without significant error.
- Discounted Cash Flow, in dollars of present value. Price assumed at \$10 per bbl. Future flows are discounted to the present at 28%, the sum of 8% interest rate and 20% tax rate. Date is Jan. 1 of given year.
- Tax is 20% of DCF

Table I-2

Present Values at different rates of ~~discount~~ ^{interest} (or $i+t$), Runs 16 & 18,
Van Poolen Report.

~~For Runway Tax, Am. was cap. rate = .18 - Huber, p. 47.~~

Discount rate
($i+t$) or (i) | .03 .05 .08 .10 .15 .20 .28

~~PV~~							
~~Run 18~~	~~16.37~~	~~14.48~~	~~12.19~~	~~11.20~~	~~8.77~~	~~7.19~~	~~5.52~~
~~Run 16~~	~~14.90~~	~~12.85~~	~~10.51~~	~~9.36~~	~~7.18~~	~~5.75~~	~~4.32~~
~~Run 18 - Run 16~~	~~1.47~~	~~1.63~~	~~1.68~~	~~1.84~~	~~1.59~~	~~1.44~~	~~1.20~~
~~Run 18 / Run 16~~	~~1.098~~	~~1.127~~	~~1.160~~	~~1.196~~	~~1.22~~	~~1.25~~	~~1.28~~

~~Falls~~
~~Falls~~
Rises, then falls
~~Rises~~

Run 18	47.8	42.3	35.6	32.7	25.6	21.0	16.1
Run 16	43.5	37.5	30.7	27.3	21.0	16.8	12.6
Run 18 - Run 16	4.3	4.8	4.9	5.4	4.6	4.2	3.5
Run 18 / Run 16	1.098	1.127	1.160	1.196	1.22	1.25	1.28

Table H-1: An ad valorem change of 20%, showing capitalization of change into DCF

Year n	Daily flow	Yearly flow	Cash flow	DCF	AVC	Cash to Lessee	True depletion, or change in	State's Income	Return	AVC/		
			@ \$8/B		.20 DCF	CF-AVC	in	Share of cash flow AVC/CF	to Lessee	on lessee	Income to lessee	
		(2).365			.20(5)	(4)-(6)	DCF	(6)/(4)	less true depletion (7)+(8)	(10)/(5)	(6)/(10)	
	MM B/D	MM B/4	MMM \$/Y	MMM \$	MMM \$	MMM \$	MMM \$	90	90	90		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
1	1.40	511	4.1	16.1	3.21	.88	+.41	79%	1.28	.08	2.5	
2	1.80	657	5.3	16.5	3.30	1.96	-.61	63	1.34	.08	2.5	
3	1.80	657	5.3	15.9	3.18	2.07	-.82	61	1.26	.08	2.5	
4	1.80	657	5.3	15.1	3.01	2.25	-1.02	57	1.23	.08	2.5	
5	1.80	657	5.3	14.1	2.82	2.42	-1.31	54	1.11	.08	2.5	
6	1.80	657	5.3	12.8	2.55	2.72	-1.69	48	1.02	.08	2.5	
7	1.80	657	5.3	11.1	2.21	3.04	-2.16	42	.876	.08	2.5	
8	1.31	478	3.8	8.9	1.78	2.04	-1.31	47	.730	.08	2.5	
9	1.10	401	3.2	7.6	1.52	1.69	-1.11	47	.584	.08	2.5	
10	.91	332	2.7	6.5	1.30	1.37	-.818	49	.555	.08	2.5	
11	.89	325	2.6	5.7	1.13	1.46	-1.02	44	.438	.08	2.5	
12	.87	318	2.5	4.6	.929	1.61	-1.26	37	.350	.08	2.5	
13	.58	212	1.7	3.4	.677	1.02	-.730	40	.292	.08	2.5	
14	.48	175	1.4	2.66	.531	.876	-.660	38	.216	.08	2.5	
15	.35	128	1.0	2.00	.400	.613	-.450	39	.163	.08	2.5	
16	.24	88	.70	1.54	.310	.380	-.263	44	.117	.08	2.5	
17	.17	62	.50	1.27	.254	.234	-.140	57	.094	.08	2.5	
18	.16	58	.46	1.13	.228	.234	-.146	48	.088	.08	2.5	
19	.15	55	.44	.984	.196	.234	-.163	45	.071	.08	2.5	
20	.13	47	.38	.821	.163	.220	-.146	43	.068	.08	2.5	
21	.12	44	.35	.672	.134	.216	-.164	38	.052	.08	2.5	
22	.10	36	.29	.508	.102	.188	-.149	35	.039	.08	2.5	
23	.08	29	.23	.359	.073	.146	-.117	31	.029	.08	2.5	
24	.06	22	.18	.225	.044	.135	-.117	26	.018	.08	2.5	
25	.05	18	.14	.109	.022	.118	-.109	16	.009	.08	2.5	

Table I - 1

Text on Cartridge 7A

326 - 480 or so

Runs 16 and 18 from the Van Poolen Report

<u>Year</u>	<u>Run 16</u> <u>MMB/D</u>	<u>Run 18</u> <u>MMB/D</u>
1	1.4	1.40
2	1.2	1.80
3	1.2	1.80
4	1.2	1.80
5	1.2	1.80
6	1.2	1.80
7	1.2	1.80
8	1.2	1.31
9	1.2	1.10
10	1.2	.91
11	1.2	.89
12	1.2	.87
13	.99	.58
14	.75	.48
15	.56	.35
16	.47	.24
17	.35	.17
18	.27	.16
19	.22	.15
20	.17	.13
21	.13	.12
22	.11	.10
23	.10	.08
24	.08	.06
25	.07	.05
26	.05	