CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

Title : Analysis of Escalante, Utah Permeability Data for High Velocity Flow Effects

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Task Objective: Nearly 500 sets of Permeability will be analyzed for evidence of high velocity flow effects. Differential pressure squared vs. flow rate ($\Delta(P^2)$ vs. Q) will be plotted at each data location, as well as log-log plots of the same, & $\Delta(P^2)/Q$ vs. Q, following procedures outlined in LeCain (1997, 1998), and Rousseau et al. (1999). Information gathered through these methods of examining the data will ultimately be used to interpret any role that high velocity flow effects may be playing with respect to calculated permeability values. Appropriate actions will then be taken. Discussions of the Escalante, Utah data collection may be found in Dinwiddie (2001), and Current (2001), and general discussions of instrumentation employed are in CNWRA SN 526, as are discussions of methodology.

RNM, 08/27/02

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References:

Current, C.L. Characterization of Geologic Controls on Permeability and their incorporation into a three dimensional Geologic Model of the Temblor Formation, Coalinga, CA., M.S. Thesis, Department of Geological Sciences, Clemson University, Clemson, South Carolina, December 2001.

Dinwiddie, C.L. A new small drillhole minipermeameter probe for in situ permeability measurement: Design, theoretical analysis, operation, and performance characteristics, Ph.D Dissertation, Department of Environmental Engineering & Science, Clemson University, Clemson, South Carolina, August, 2001.
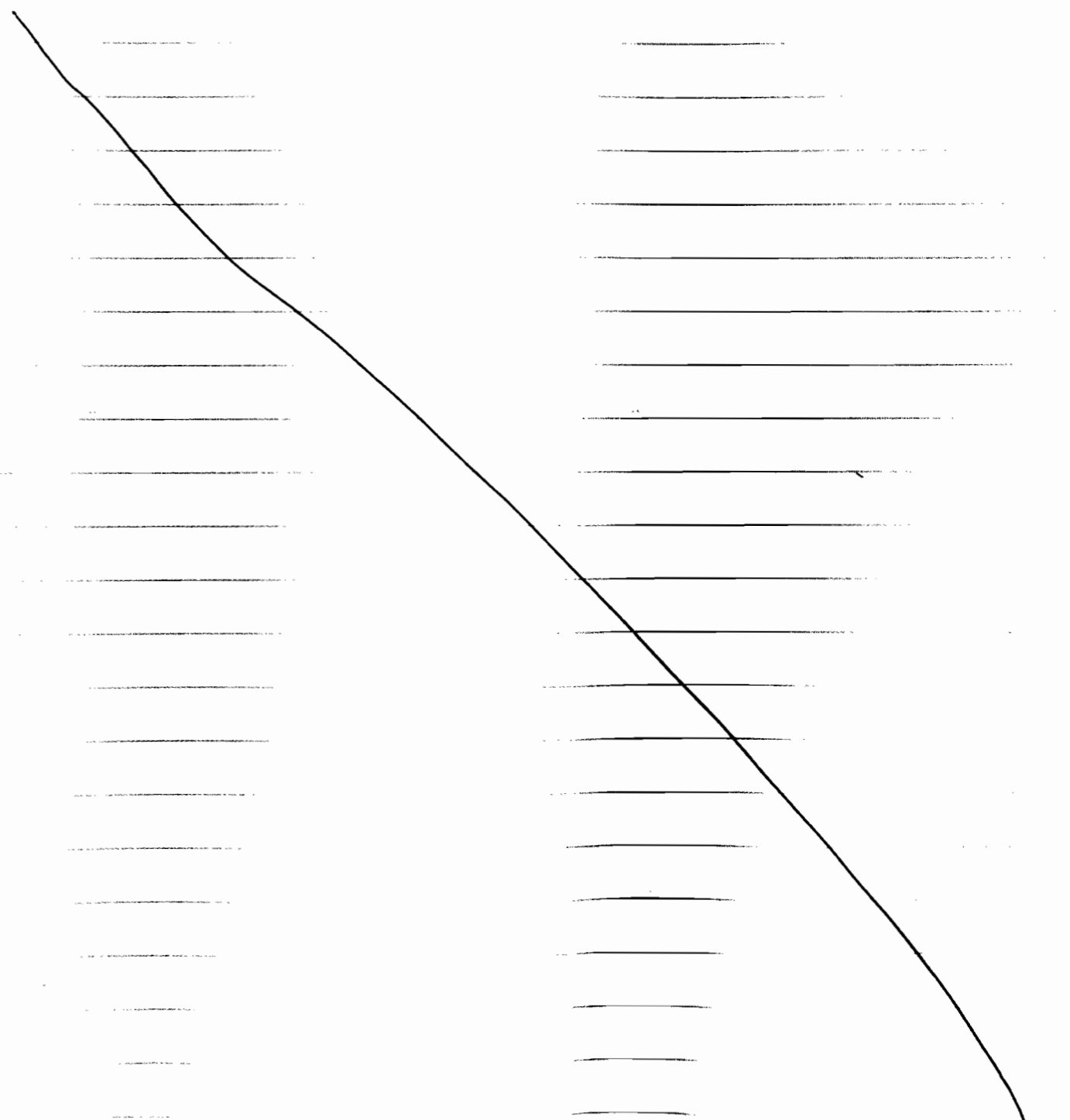
LeCain, G.D. 1997. Air-injection testing in vertical boreholes in welded and non-welded tuff, Yucca Mountain, Nevada. U.S. Geological Survey Water Resources Investigations Report 96-4262, Denver, CO.

LeCain, G.D. 1998. Results from air-injection and tracer testing in the Upper Tiva Canyon, Bow Ridge Fault, and Upper Paintbrush Contact Alcoves of the Exploratory Studies Facility, August 1994 through July, 1996, Yucca Mountain, Nevada US Geological Survey Water-Resources Investigations Report 98-4058, Denver, CO.

Rousseau, J.P., E.M. Kwicklis, and D.C Gillies. 1999. Hydrogeology of the unsaturated zone, North Ramp Area of the Exploratory Studies Facility, Yucca Mountain, Nevada. US-Geological Survey Water-Resources Investigations Report 98-4050, Denver, CO.

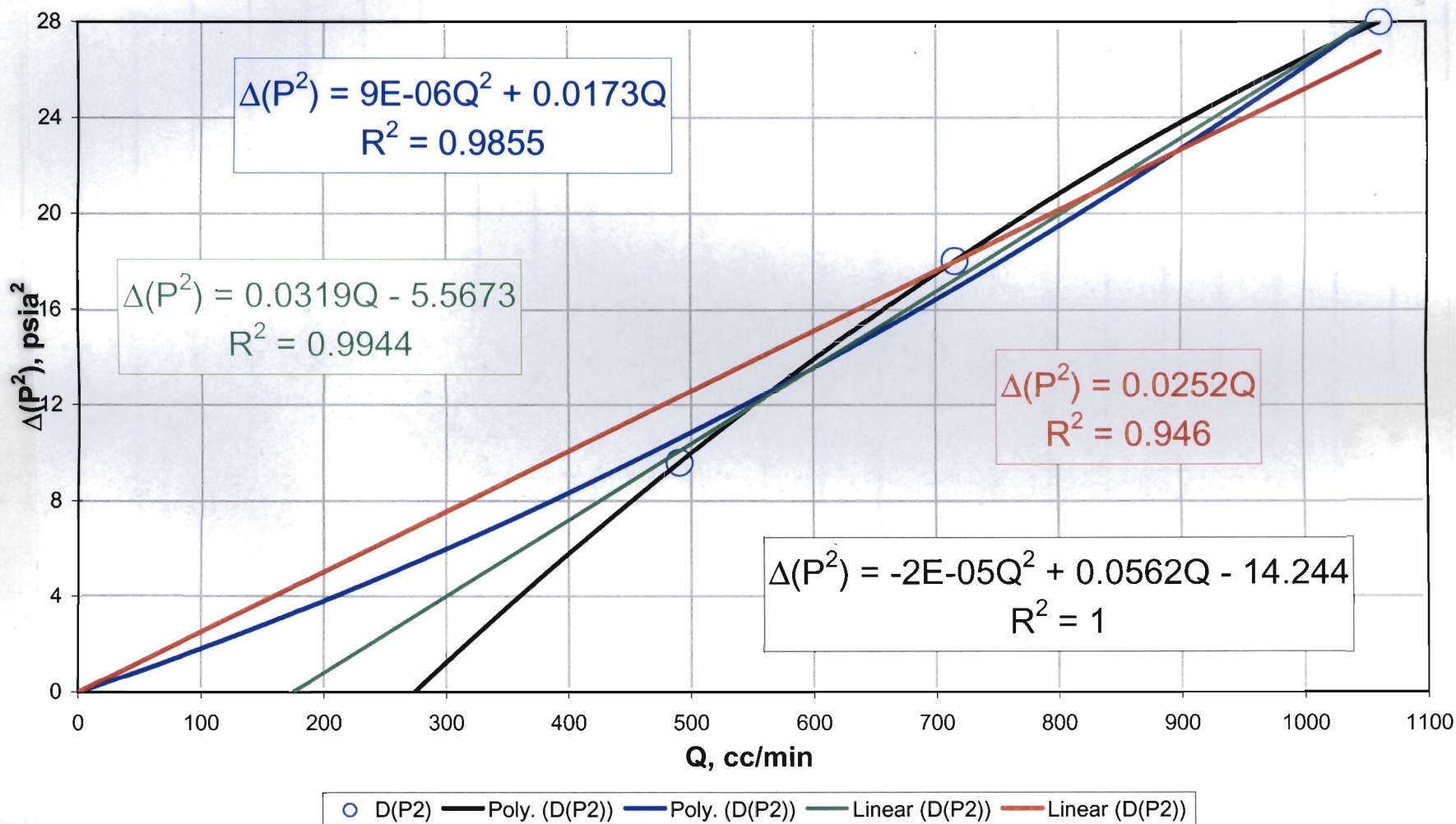RNM, 08/27/02

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Note: The following graphical information is a continuation of the CNWRA controlled scientific notebook #537. The methodology of this information can be explained on pages 41 through 44 of that notebook.

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RNM, 08/27/02

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 32

$$\Delta(P^2) = 9E\text{-}06Q^2 + 0.0173Q$$
$$R^2 = 0.9855$$

$$\Delta(P^2) = 0.0319Q - 5.5673$$
$$R^2 = 0.9944$$

$$\Delta(P^2) = 0.0252Q$$
$$R^2 = 0.946$$

$$\Delta(P^2) = -2E\text{-}05Q^2 + 0.0562Q - 14.244$$
$$R^2 = 1$$

Legend: ○ D(P2) ── Poly. (D(P2)) ── Poly. (D(P2)) ── Linear (D(P2)) ── Linear (D(P2))

Y-axis: $\Delta(P^2)$, psia^2
X-axis: Q, cc/min

Rnm, 08/27/08

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 32

$$\log_{10}(\Delta(P^2)) = 1.384\log_{10}(Q) - 2.7257$$
$$R^2 = 0.9865$$

> 1; CLD, 04/28/03

Y-axis: $\log_{10}(\Delta(P^2))$
X-axis: $\log_{10}(Q)$

Legend: ○ log(D(P2)) ── Linear (log(D(P2)))

Rnm, 08/27/08

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 32

$$\Delta(P^2)/Q = 1E\text{-}05Q + 0.0153$$
$$R^2 = 0.7795$$

slope is positive; CLD, 04/28/03

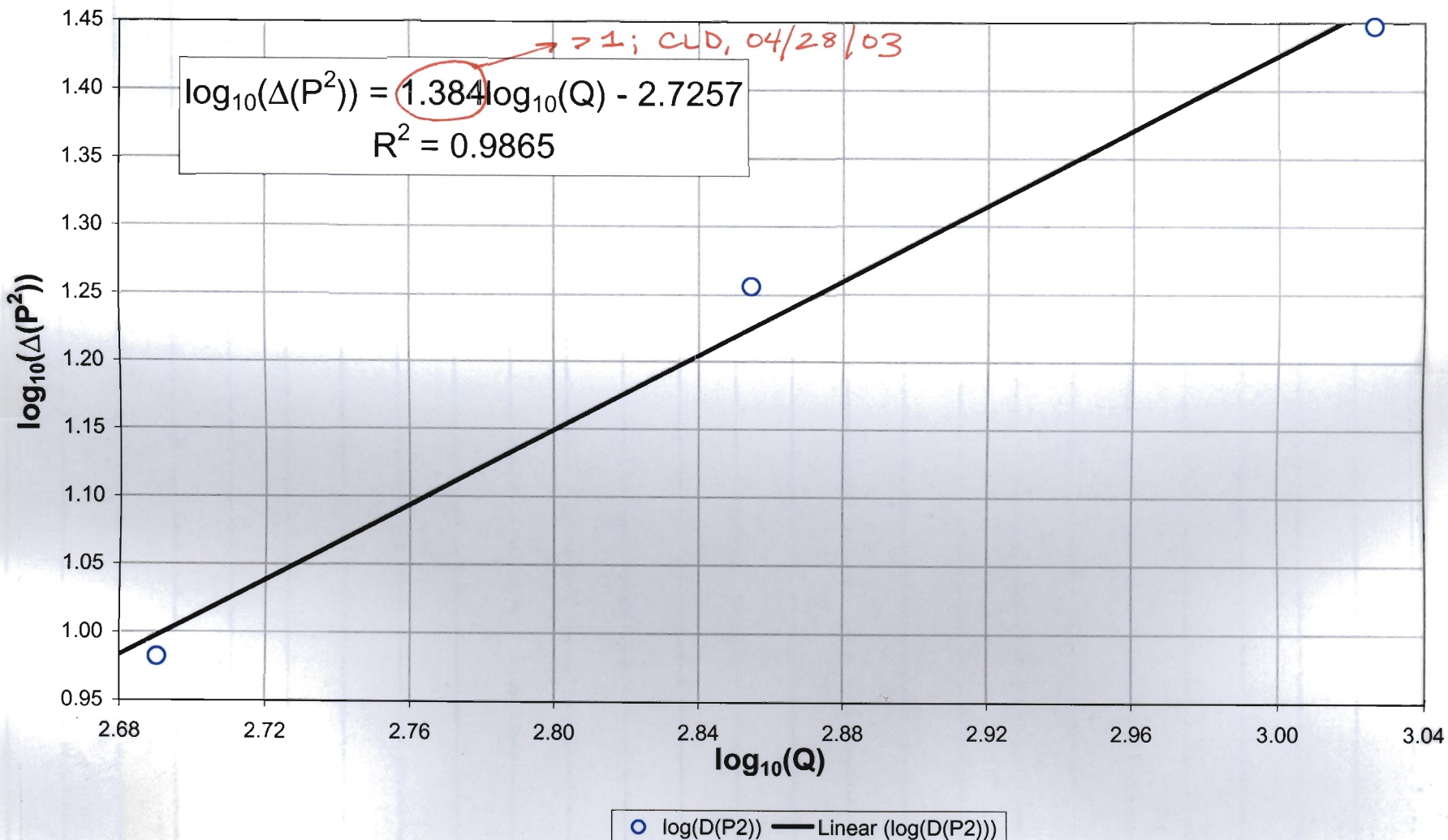Legend: O D(P2)/Q —— Linear (D(P2)/Q)

RNVM, 08/27/03

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 33

$$\Delta(P^2) = -4E\text{-}06Q^2 + 0.0164Q$$
$$R^2 = 0.9992$$

$$\Delta(P^2) = 0.0107Q$$
$$R^2 = 0.5884$$

$$\Delta(P^2) = 0.0067Q + 5.1676$$
$$R^2 = 0.9672$$

$$\Delta(P^2) = -5E\text{-}06Q^2 + 0.0181Q - 0.9798$$
$$R^2 = 1$$

Legend: O D(P2) —— Poly. (D(P2)) —— Poly. (D(P2)) —— Linear (D(P2)) —— Linear (D(P2))
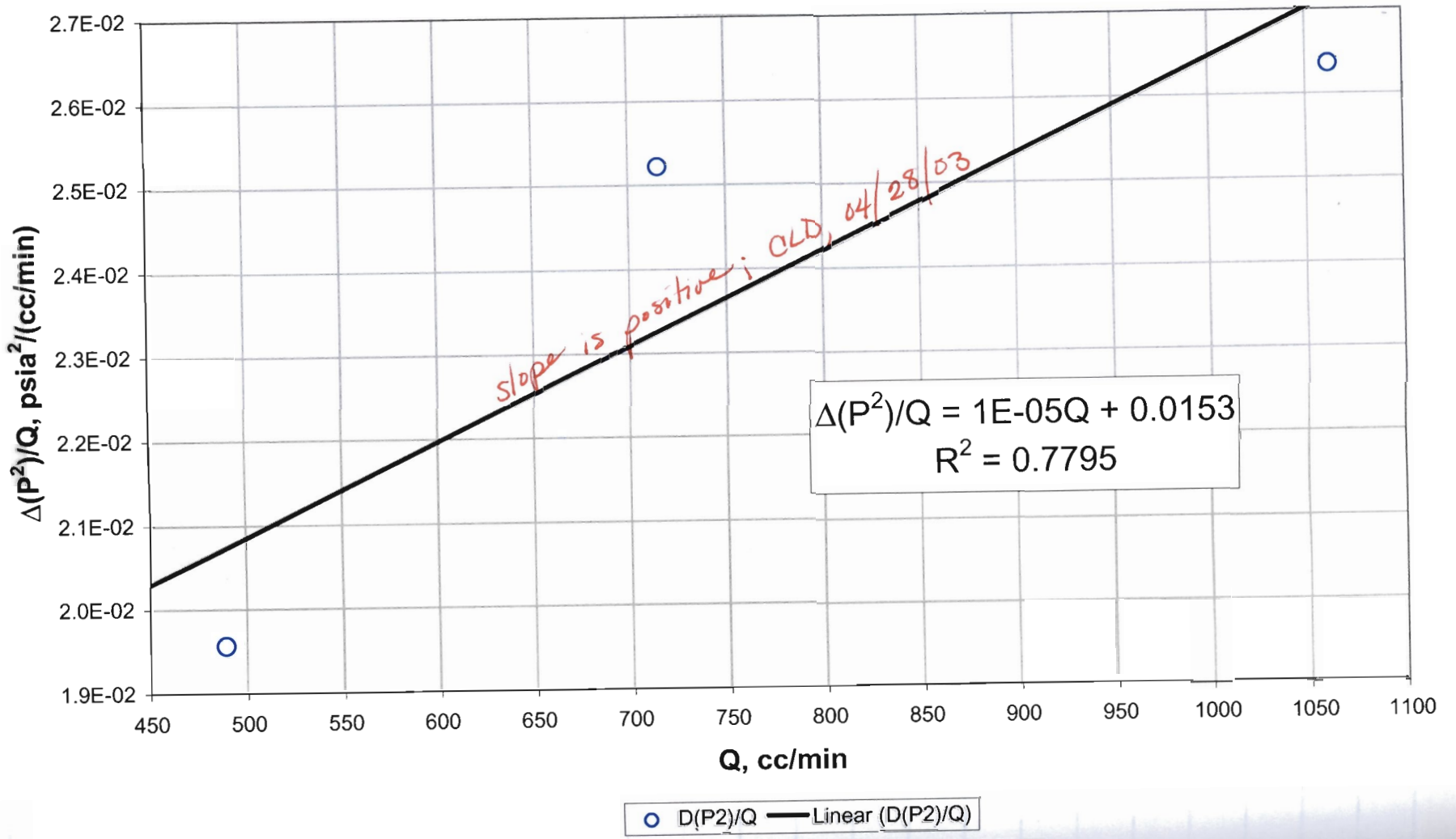
RNVM, 08/27/03

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 33

$$\log_{10}(\Delta(P^2)) = 0.6109\log_{10}(Q) - 0.7551$$
$$R^2 = 0.9836$$

X-axis: $\log_{10}(Q)$
Y-axis: $\log_{10}(\Delta(P^2))$

Legend: o log(D(P2)) —Linear (log(D(P2)))
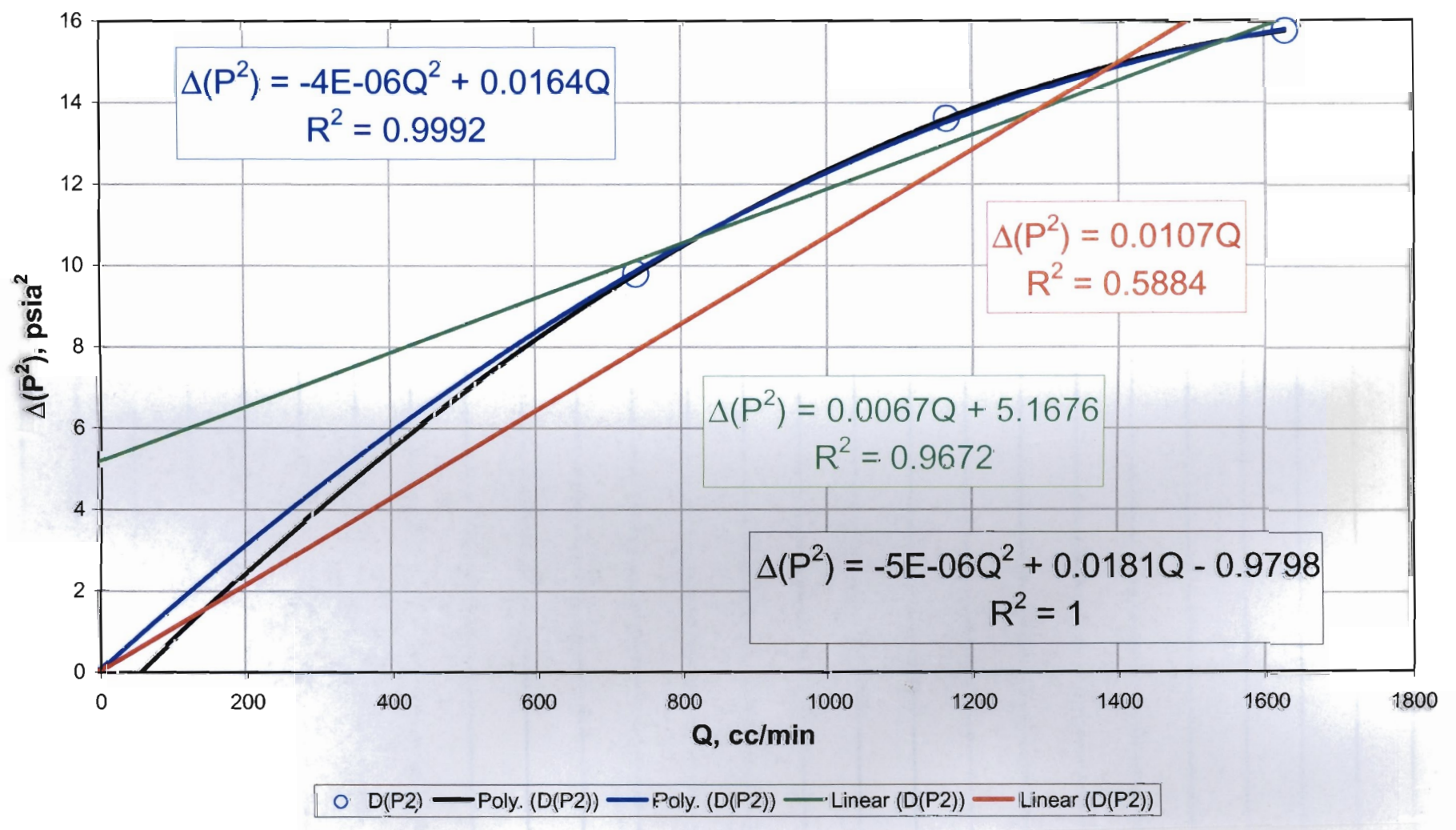
RNM, 08/27/02

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 33

$$\Delta(P^2)/Q = -4E\text{-}06Q + 0.0163$$
$$R^2 = 0.998$$

X-axis: Q, cc/min
Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)

Legend: o D(P2)/Q —Linear (D(P2)/Q)
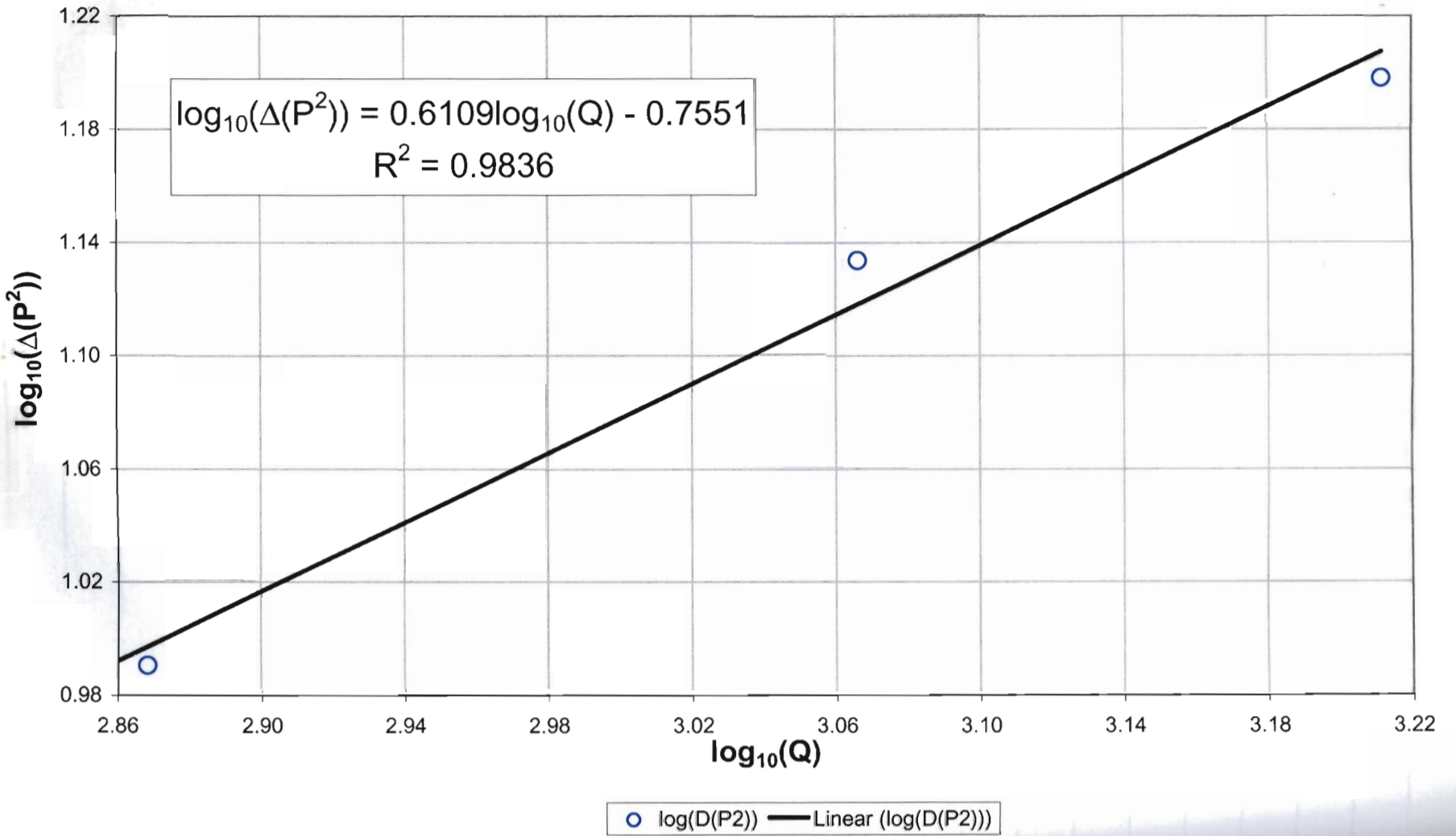
RNM, 08/27/02

RNM, 08/27/04

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero, there is no high velocity flow effect.
X Transect: Drillhole 34

$$\Delta(P^2) = -1E\text{-}05Q^2 + 0.0494Q - 10.065$$
$$R^2 = 0.9958$$

$$\Delta(P^2) = 0.0219Q$$
$$R^2 = 0.9308$$

$$\Delta(P^2) = -4E\text{-}06Q^2 + 0.0278Q$$
$$R^2 = 0.9677$$

$$\Delta(P^2) = 0.0198Q + 2.5853$$
$$R^2 = 0.9446$$

Y-axis: $\Delta(P^2)$, psia^2

X-axis: Q, cc/min

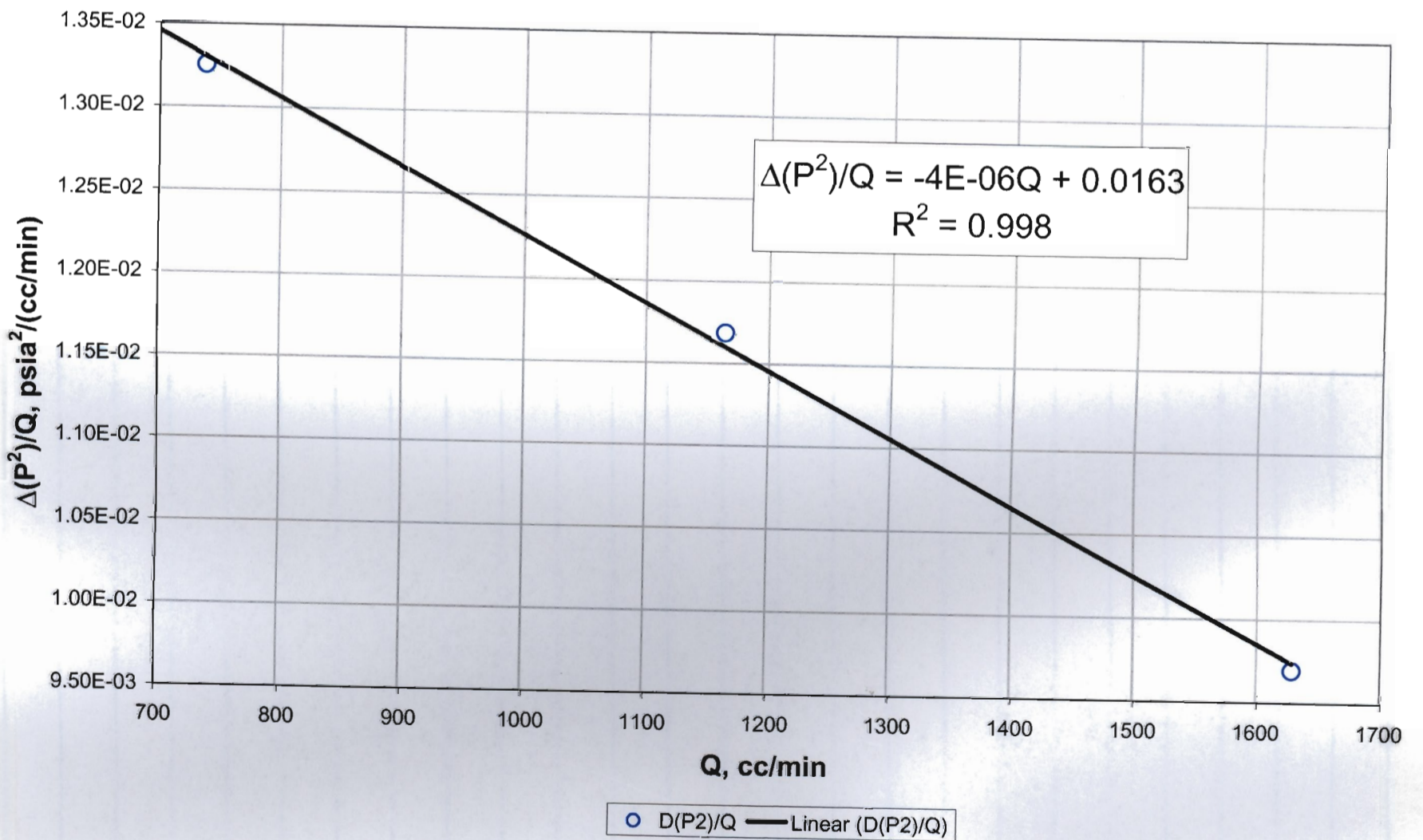Legend: O D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))
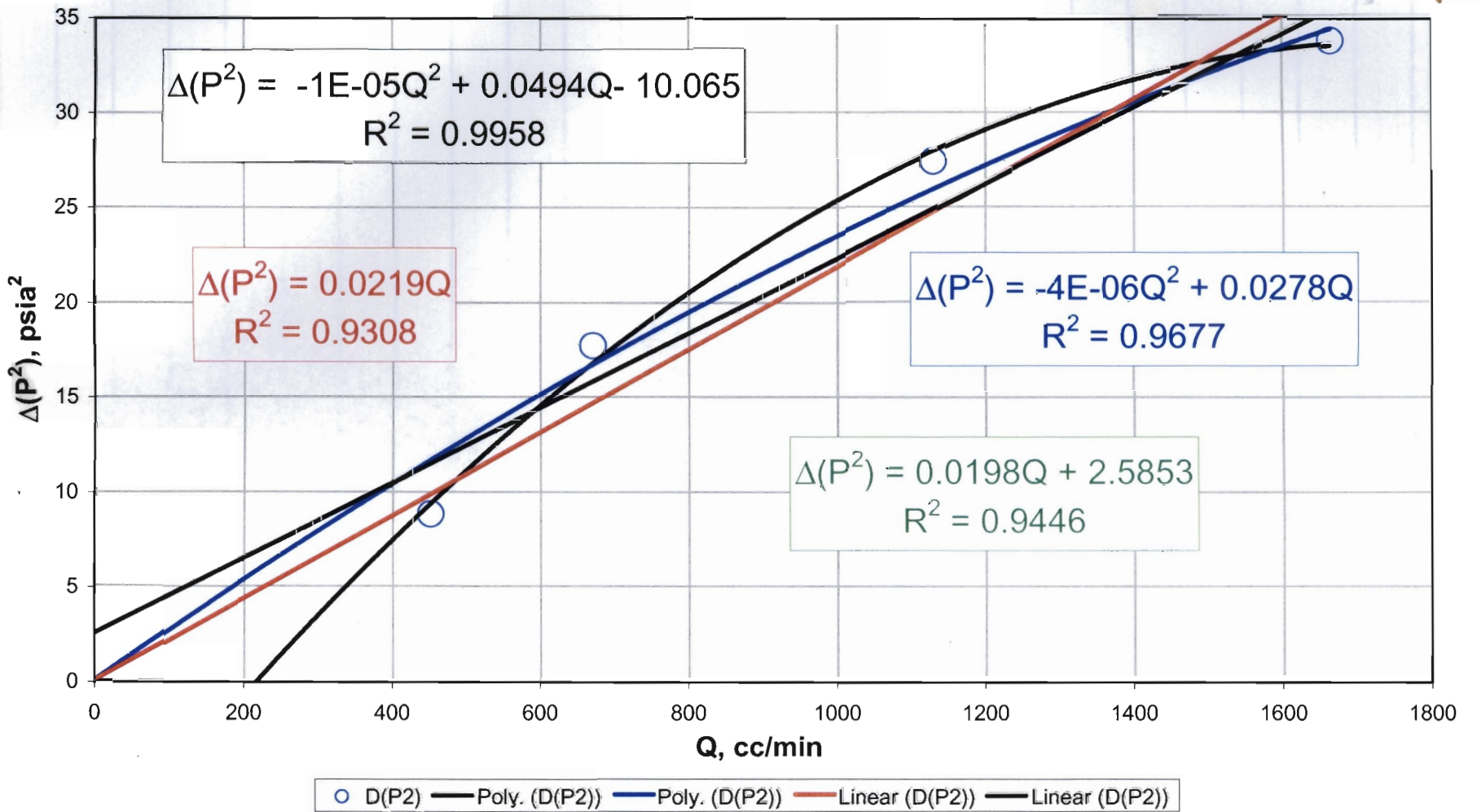
RNM, 08/27/04

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 34

$$\log_{10}(\Delta(P^2)) = 1.0001\log_{10}(Q) - 1.6487$$
$$R^2 = 0.9415$$

→ slope is unity
CLD, 04/29/03

Y-axis: $\log_{10}(\Delta(P^2))$

X-axis: $\log_{10}(Q)$

Legend: O log(D(P2)) — Linear (log(D(P2)))

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 34

$$\Delta(P^2)/Q = -1E\text{-}06Q + 0.0237$$
$$R^2 = 0.0332$$

Slope is negative – no HVF; CLD, 04/28/63

Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min) — from 2.0E-02 to 2.7E-02

X-axis: Q, cc/min — from 450 to 1750

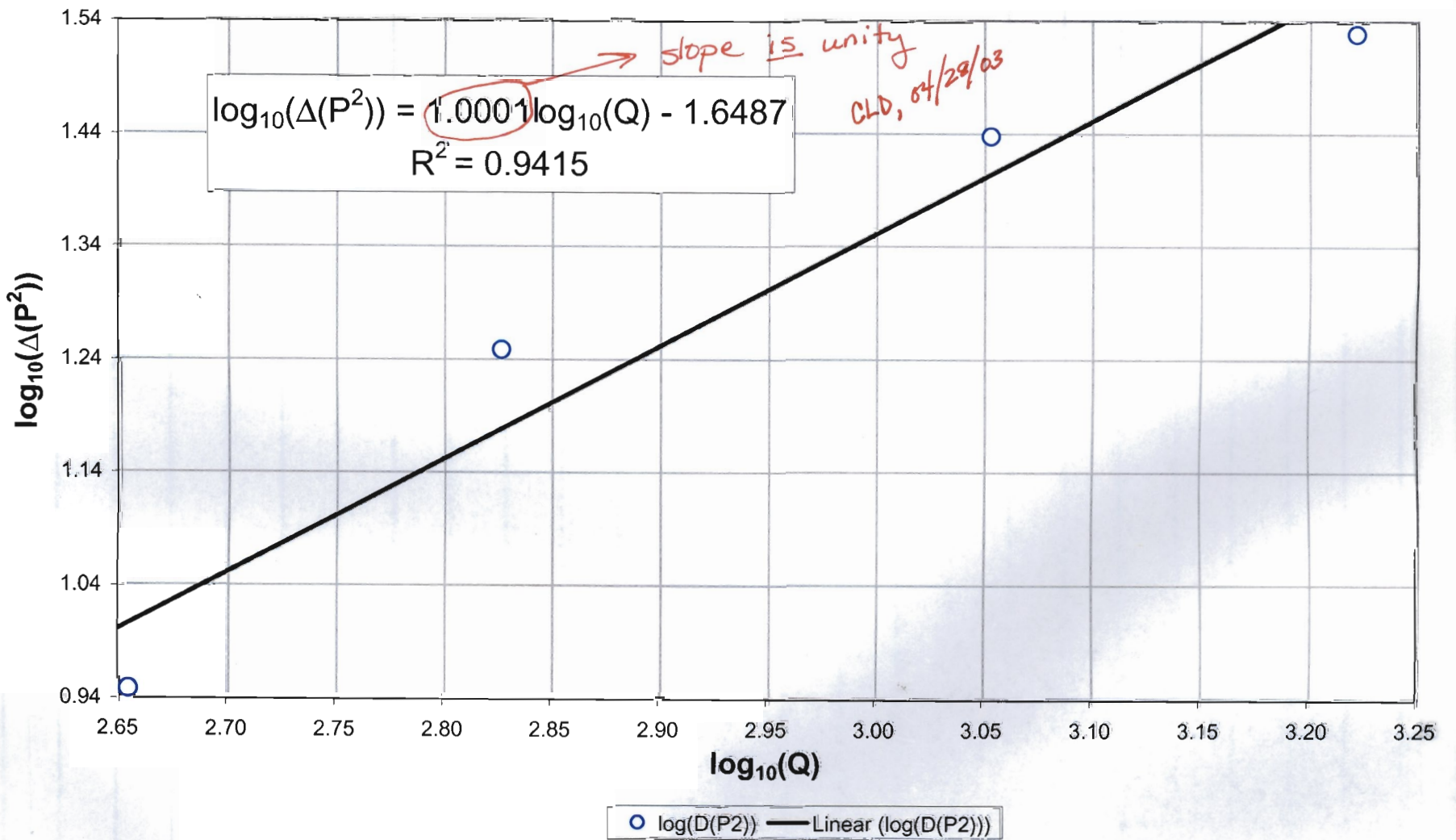Legend: ○ D(P2)/Q ——Linear (D(P2)/Q)

RNM, 08/27/02

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 35

$$\Delta(P^2) = -3E\text{-}05Q^2 + 0.0756Q - 17.829$$
$$R^2 = 1$$

$$\Delta(P^2) = 2E\text{-}06Q2 + 0.0256Q$$
$$R^2 = 0.9668$$

$$\Delta(P^2) = 0.0278Q$$
$$R^2 = 0.9639$$

$$\Delta(P^2) = 0.0307Q - 2.4439$$
$$R^2 = 0.9736$$

Y-axis: $\Delta(P^2)$, psia^2 — from 0 to 32

X-axis: Q, cc/min — from 0 to 1200

Legend: ○ D(P2) ——Poly. (D(P2)) ——Poly. (D(P2)) ——Linear (D(P2)) ——Linear (D(P2))
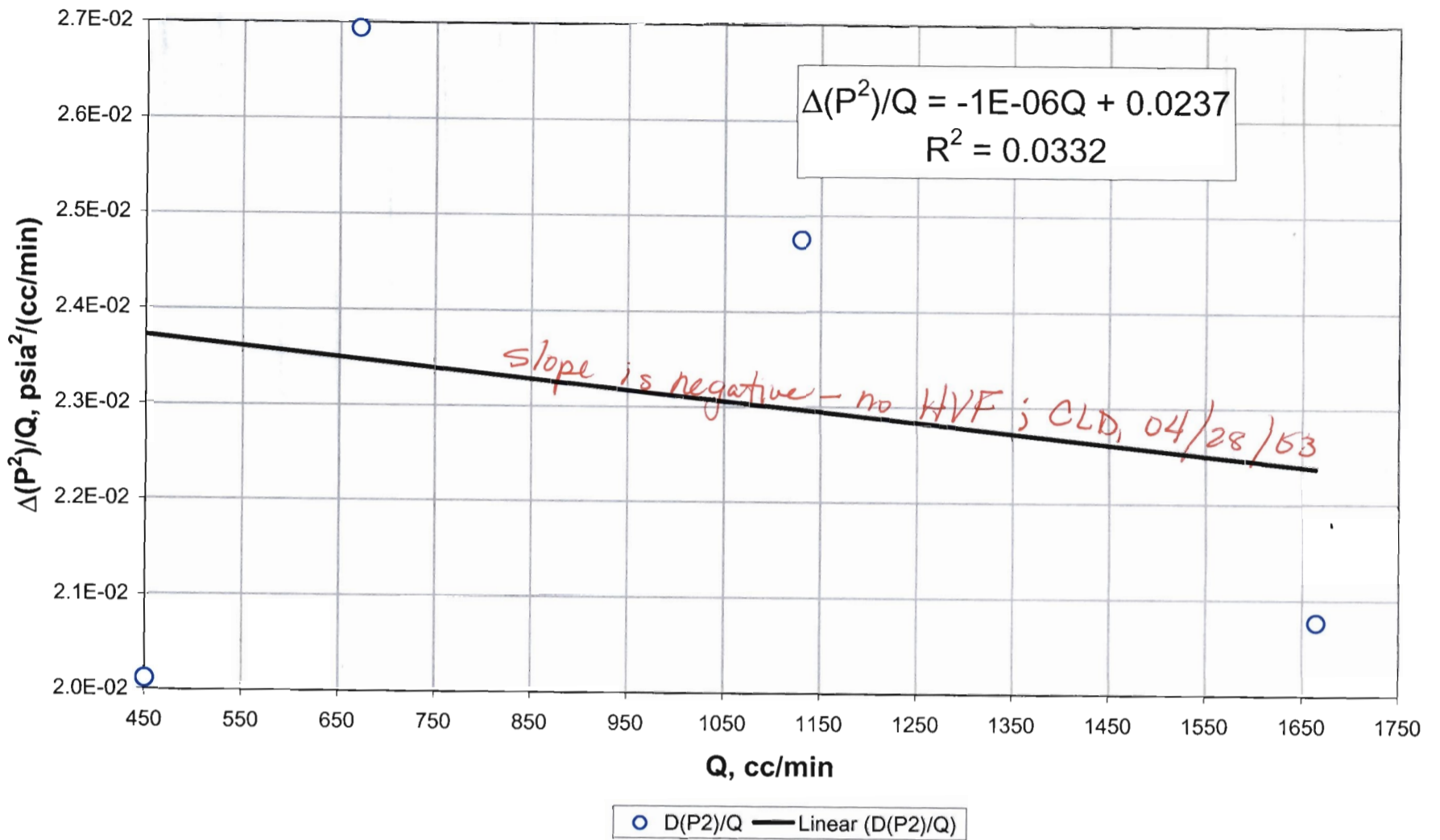
RNM, 08/27/02

RNM, 08/27/02

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
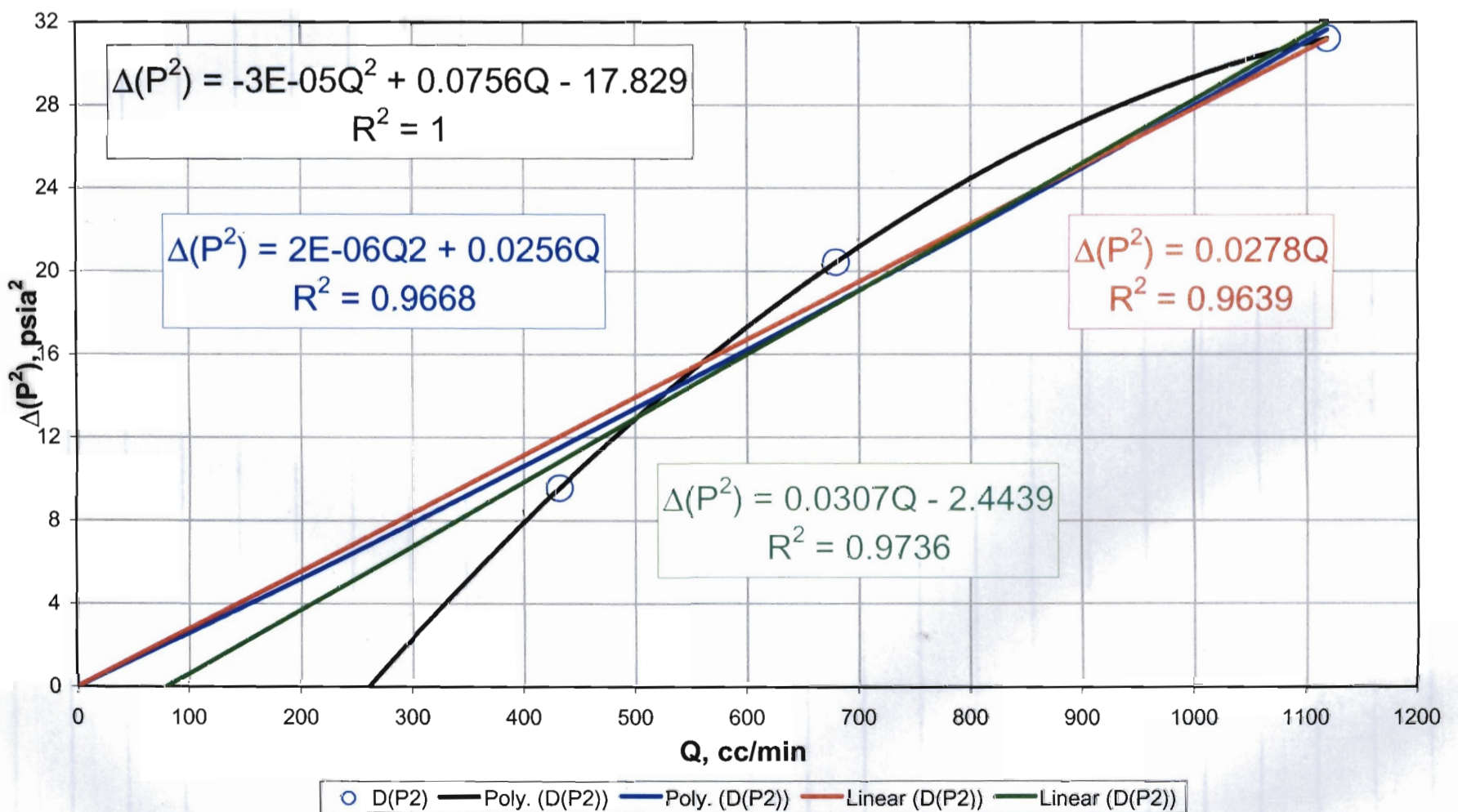**X Transect: Drillhole 35**

>1; CLD, 04/28/03

$$\log_{10}(\Delta(P^2)) = 1.2381\log_{10}(Q) - 2.2534$$
$$R^2 = 0.9639$$

y-axis: $\log_{10}(\Delta(P^2))$ — 0.95, 1.05, 1.15, 1.25, 1.35, 1.45, 1.55

x-axis: $\log_{10}(Q)$ — 2.60, 2.65, 2.70, 2.75, 2.80, 2.85, 2.90, 2.95, 3.00, 3.05

Legend: o log(D(P2)) —— Linear (log(D(P2)))

RNM, 08/27/02

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 35

slope is positive; CLD, 04/28/03

$$\Delta(P^2)/Q = 7E\text{-}06Q + 0.0216$$
$$R^2 = 0.3365$$

y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min) — 2.2E-02, 2.4E-02, 2.5E-02, 2.7E-02, 2.8E-02, 3.0E-02, 3.1E-02

x-axis: Q, cc/min — 350, 450, 550, 650, 750, 850, 950, 1050, 1150
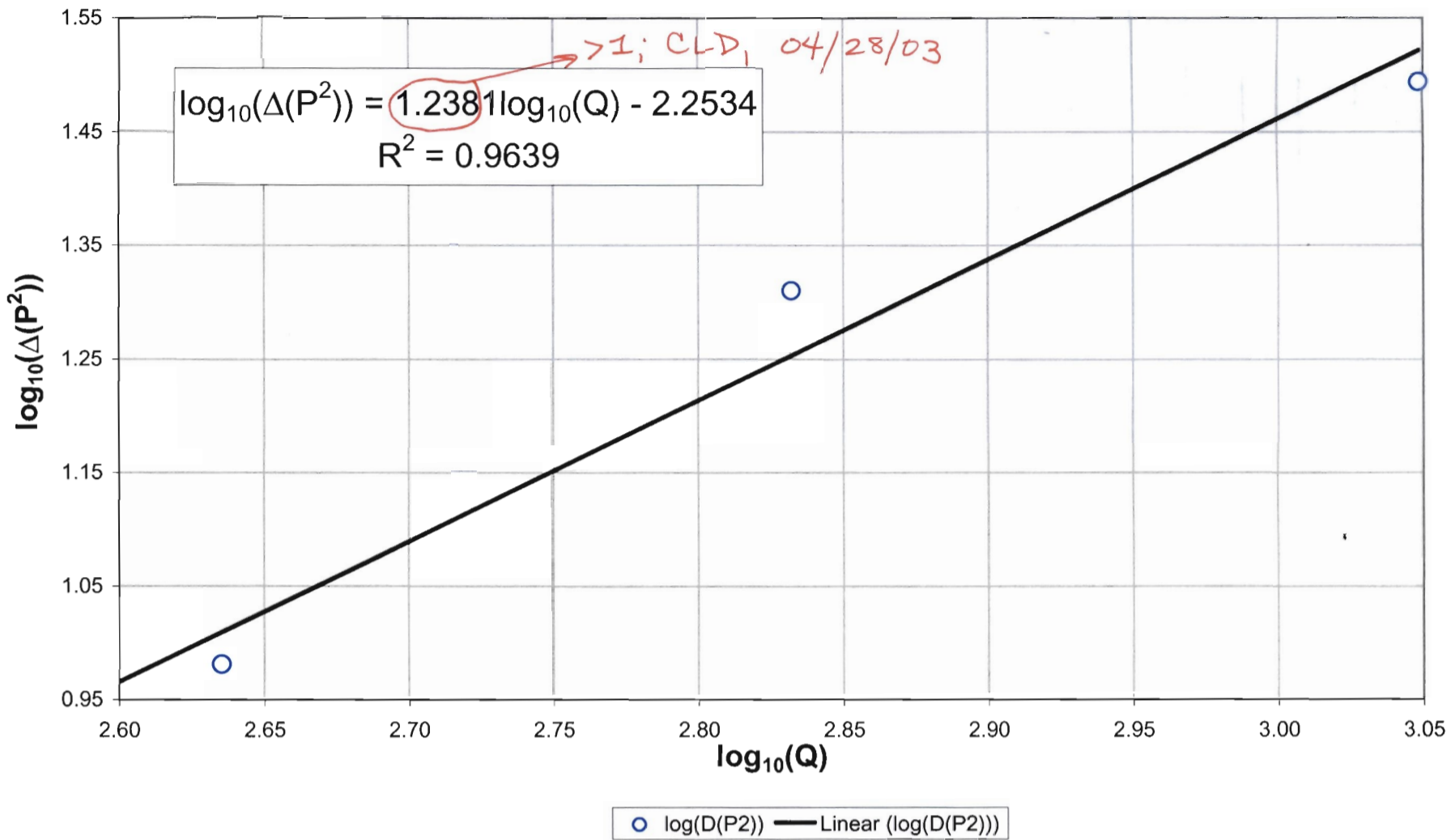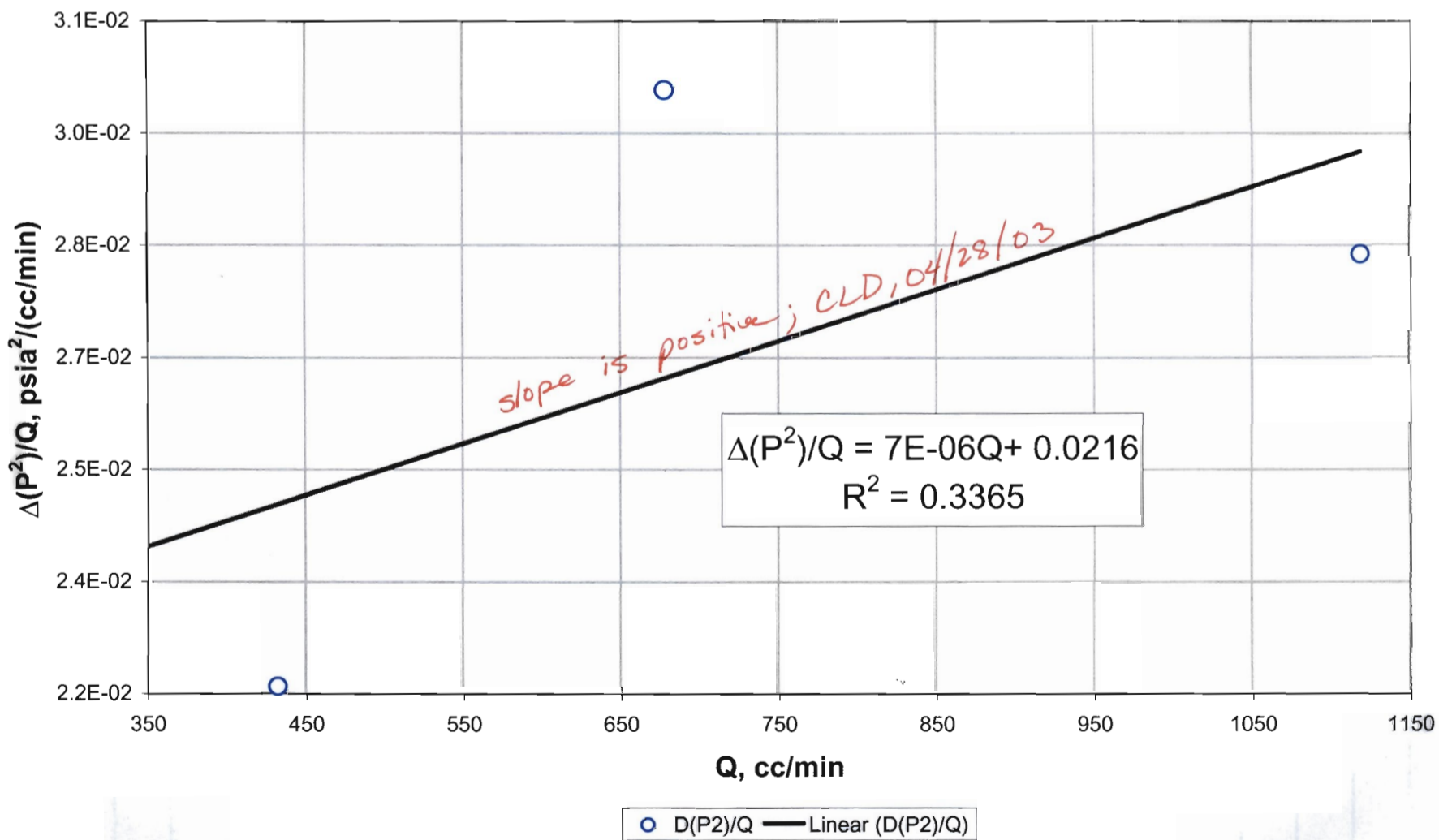
Legend: o D(P2)/Q —— Linear (D(P2)/Q)

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 36

$$\Delta(P^2) = -3E\text{-}05Q^2 + 0.079Q - 22.782$$
$$R^2 = 1$$

$$\Delta(P^2) = 2E\text{-}06Q^2 + 0.0184Q$$
$$R^2 = 0.9533$$

$$\Delta(P^2) = 0.0201Q$$
$$R^2 = 0.9497$$

$$\Delta(P^2) = 0.0221Q - 1.7615$$
$$R^2 = 0.959$$

y-axis: $\Delta(P^2)$, psia^2
x-axis: Q, cc/min

Legend: O D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))

RNM, 08/27/08

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
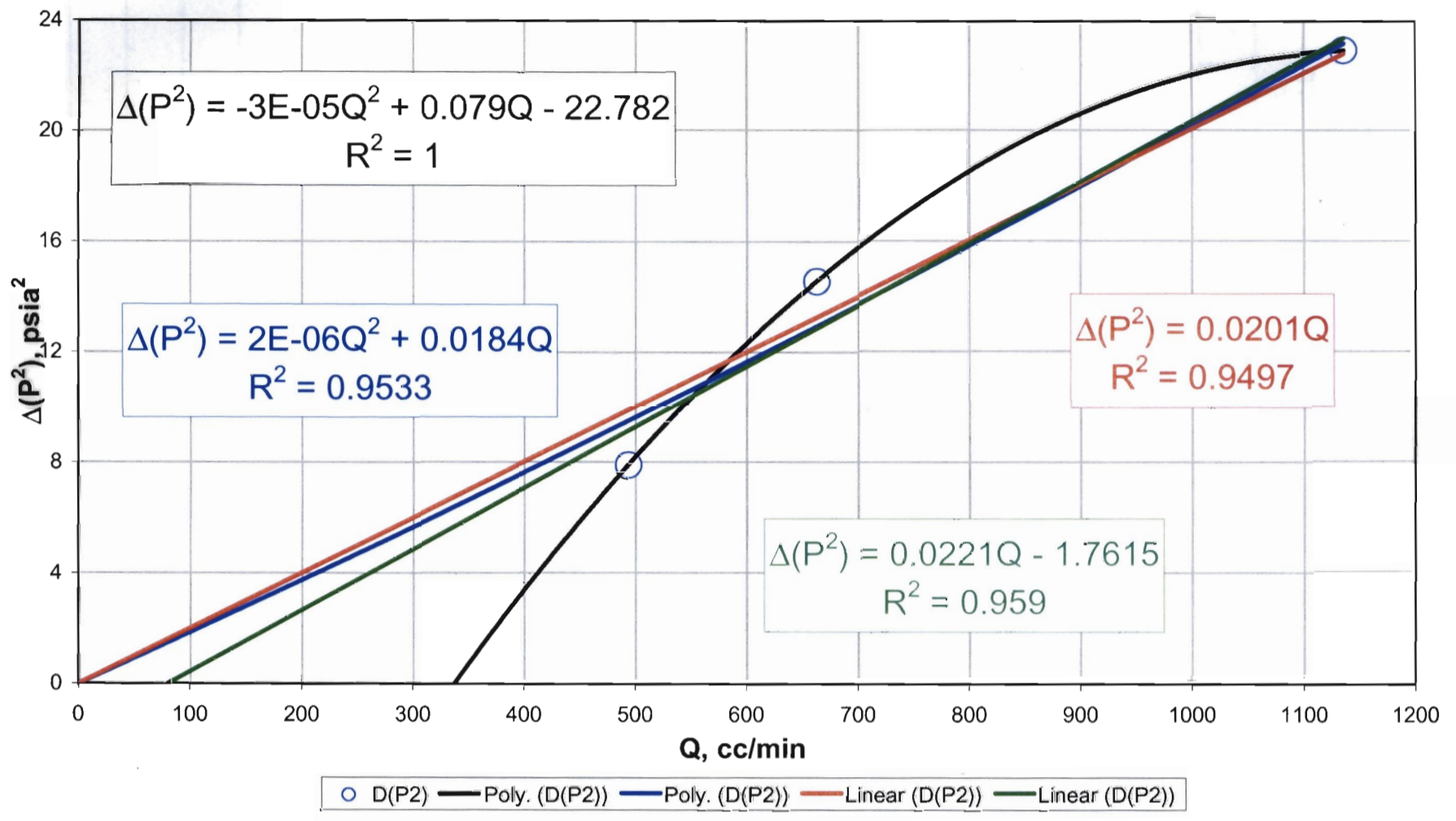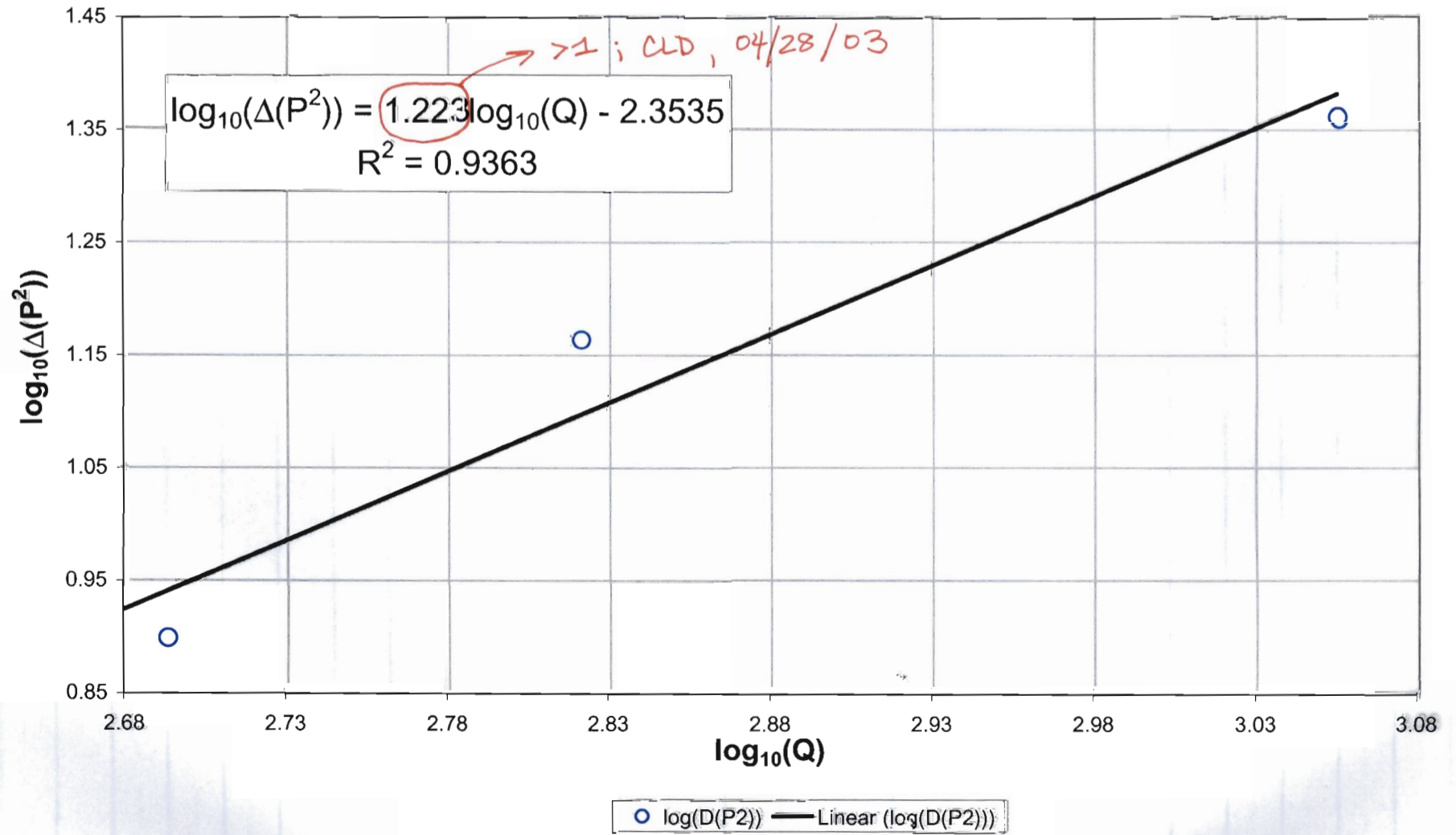**X Transect: Drillhole 36**

→ >1 ; CLD, 04/28/03

$$\log_{10}(\Delta(P^2)) = 1.223\log_{10}(Q) - 2.3535$$
$$R^2 = 0.9363$$

y-axis: $\log_{10}(\Delta(P^2))$
x-axis: $\log_{10}(Q)$

Legend: O log(D(P2)) — Linear (log(D(P2)))

RNM, 08/27/08

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 36

RNM . 08/27/02

slope is (+) ; CLD. 04/28/03

$$\Delta(P^2)/Q = 4E\text{-}06Q + 0.0162$$
$$R^2 = 0.2097$$

Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)
X-axis: Q, cc/min

Legend: ○ D(P2)/Q —— Linear (D(P2)/Q)

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 37

RNM, 08/27/02

$$\Delta(P^2) = -5E\text{-}05Q^2 + 0.1033Q - 29.574$$
$$R^2 = 1$$

$$\Delta(P^2) = E\text{-}06Q^2 + 0.0221Q$$
$$R^2 = 0.9481$$

$$\Delta(P^2) = 0.0258Q$$
$$R^2 = 0.9381$$

$$\Delta(P^2) = 0.0298Q - 3.3263$$
$$R^2 = 0.9577$$

Y-axis: $\Delta(P^2)$, psia^2
X-axis: Q, cc/min

Legend: ○ D(P2) —— Poly. (D(P2)) —— Poly. (D(P2)) —— Linear (D(P2)) —— Linear (D(P2))
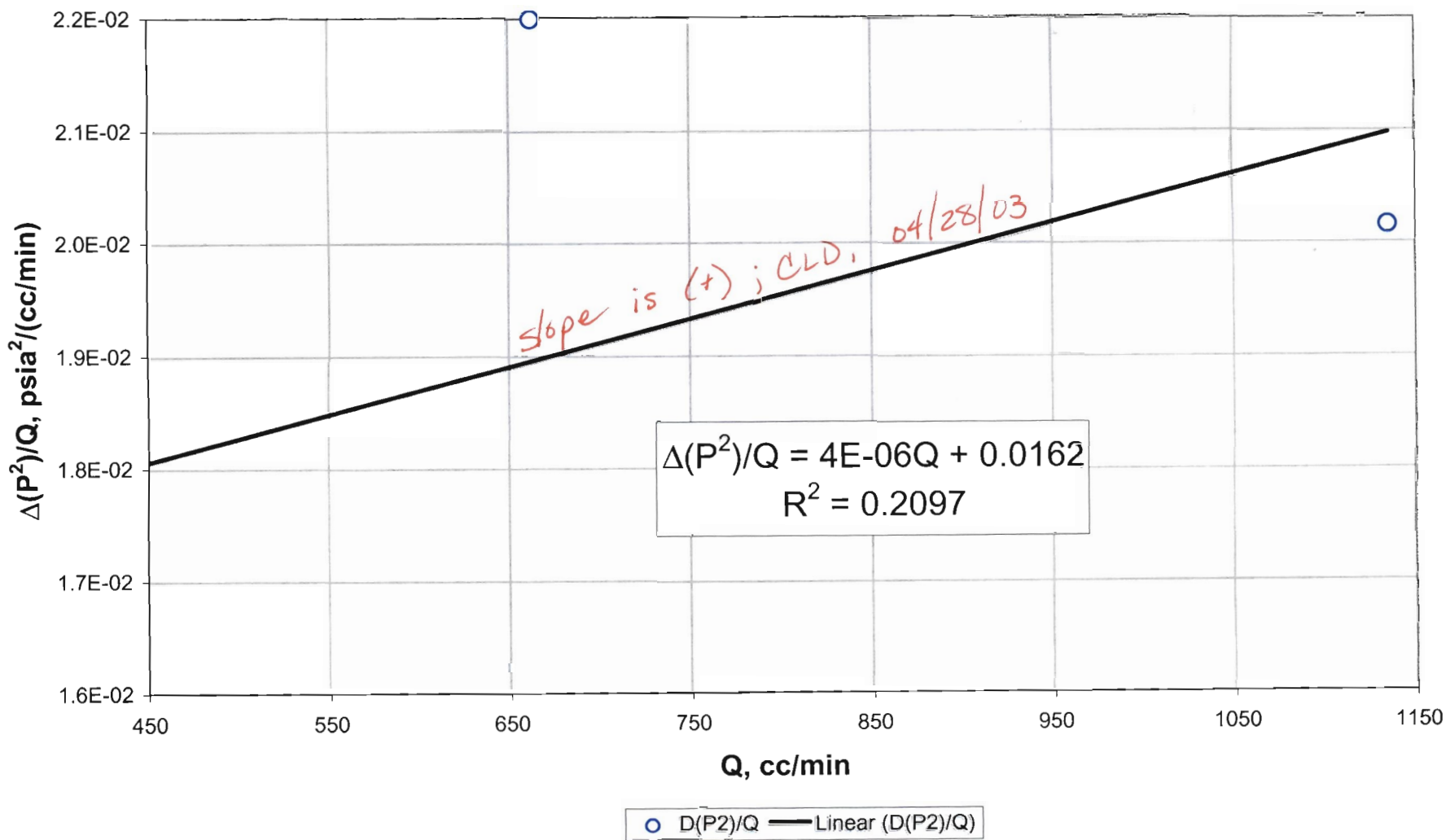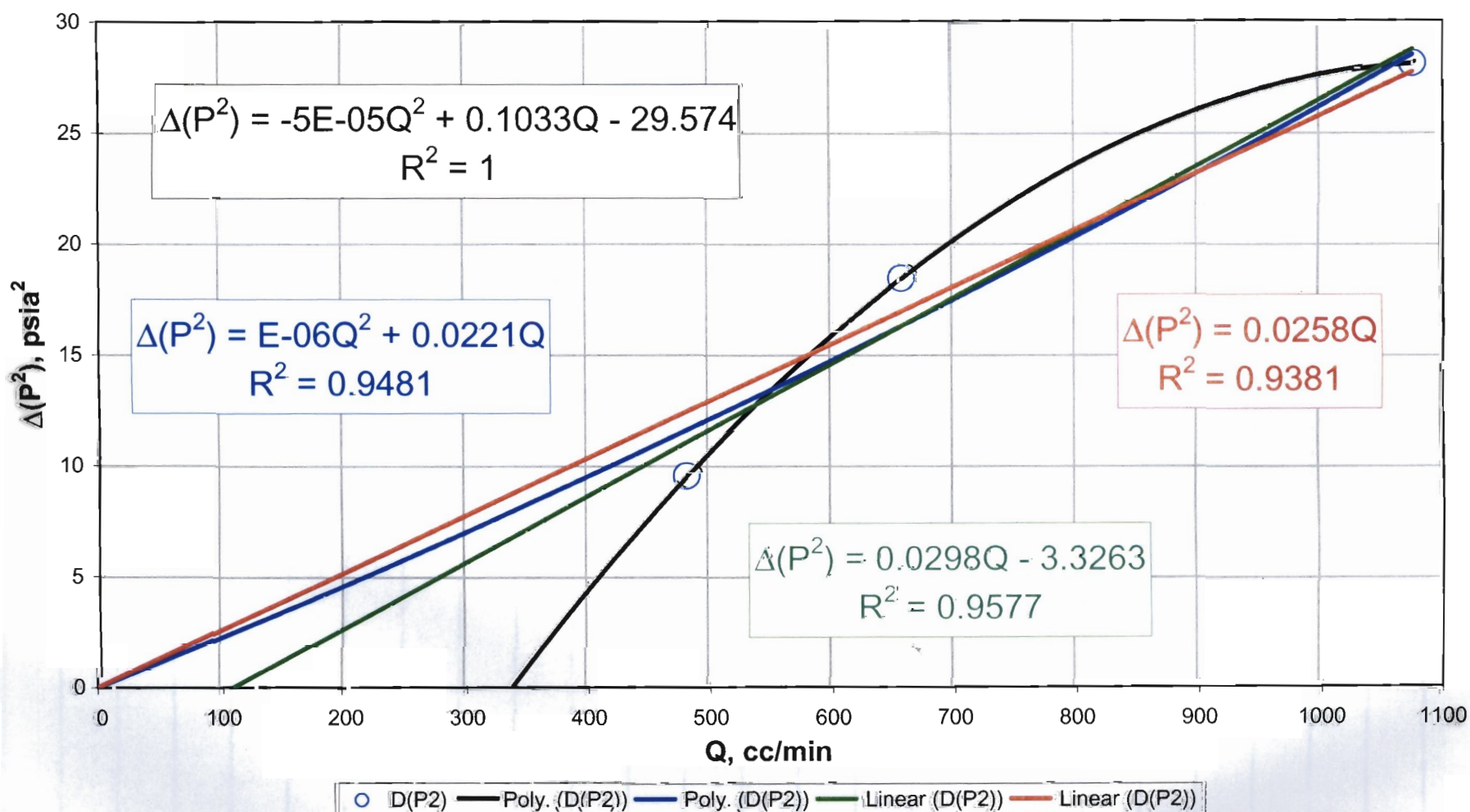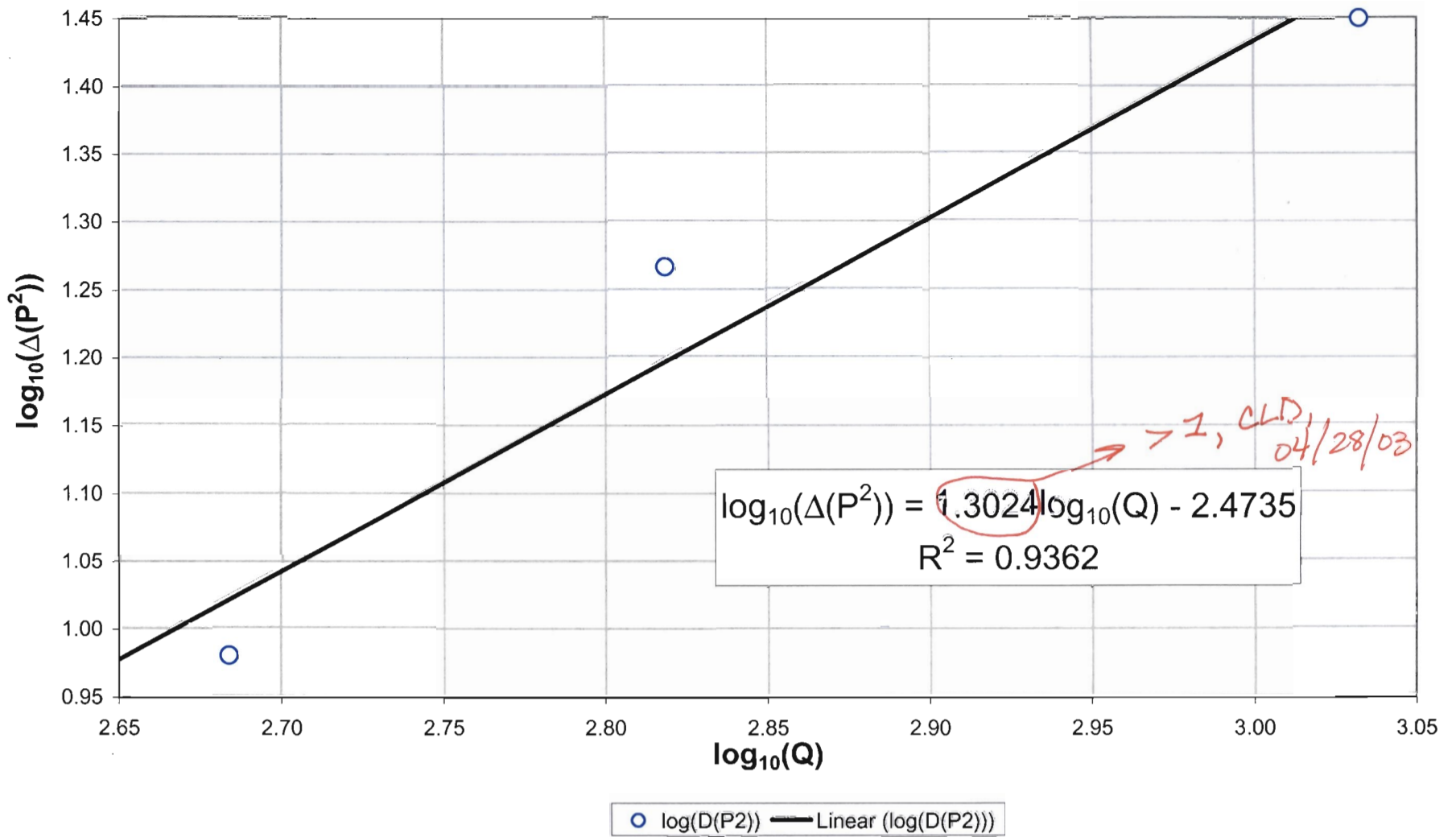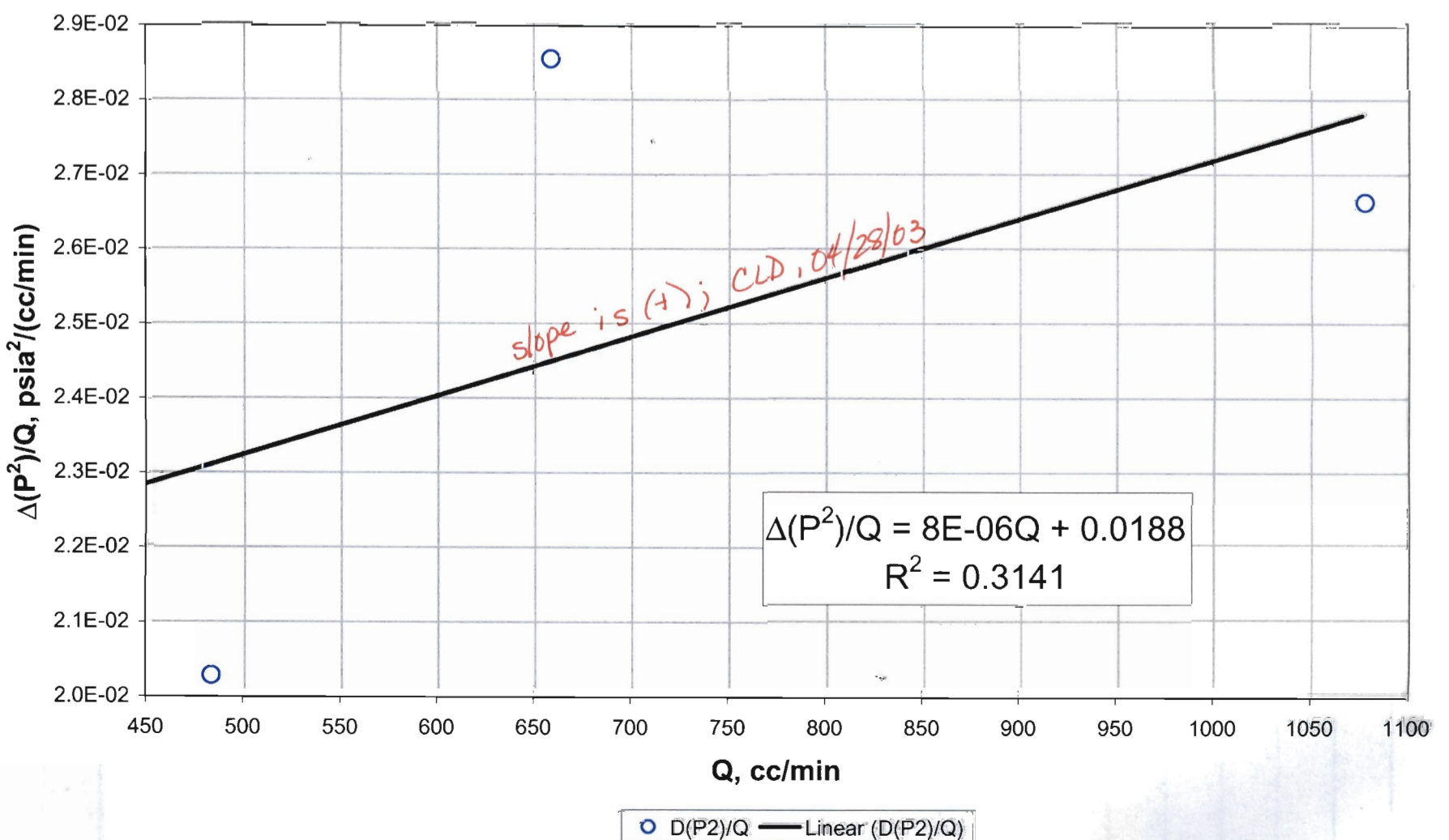
RMM, 08/27/02

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 37

$\log_{10}(\Delta(P^2)) = 1.3024 \log_{10}(Q) - 2.4735$
$R^2 = 0.9362$

> 1, CLD, 04/28/03

Axis label (y): $\log_{10}(\Delta(P^2))$
Axis label (x): $\log_{10}(Q)$

Legend: O log(D(P2)) —— Linear (log(D(P2)))

RMM, 08/27/02

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 37

slope is (+); CLD, 04/28/03

$\Delta(P^2)/Q = 8E\text{-}06Q + 0.0188$
$R^2 = 0.3141$

Axis label (y): $\Delta(P^2)/Q$, psia^2/(cc/min)
Axis label (x): Q, cc/min

Legend: O D(P2)/Q —— Linear (D(P2)/Q)

RNM, 08/27/02

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 38

$\Delta(P^2) = -3E\text{-}06Q^2 + 0.0383Q - 3.164$
$R^2 = 0.966$

$\Delta(P^2) = 4E\text{-}06Q^2 + 0.0281Q$
$R^2 = 0.9629$

$\Delta(P^2) = 0.0317Q$
$R^2 = 0.9584$

$\Delta(P^2) = 0.0343Q - 2.0879$
$R^2 = 0.9655$

Axis label (y): $\Delta(P^2)$, psia^2
Axis label (x): Q, cc/min

Legend: ○ D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))

RNM, 08/27/02

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
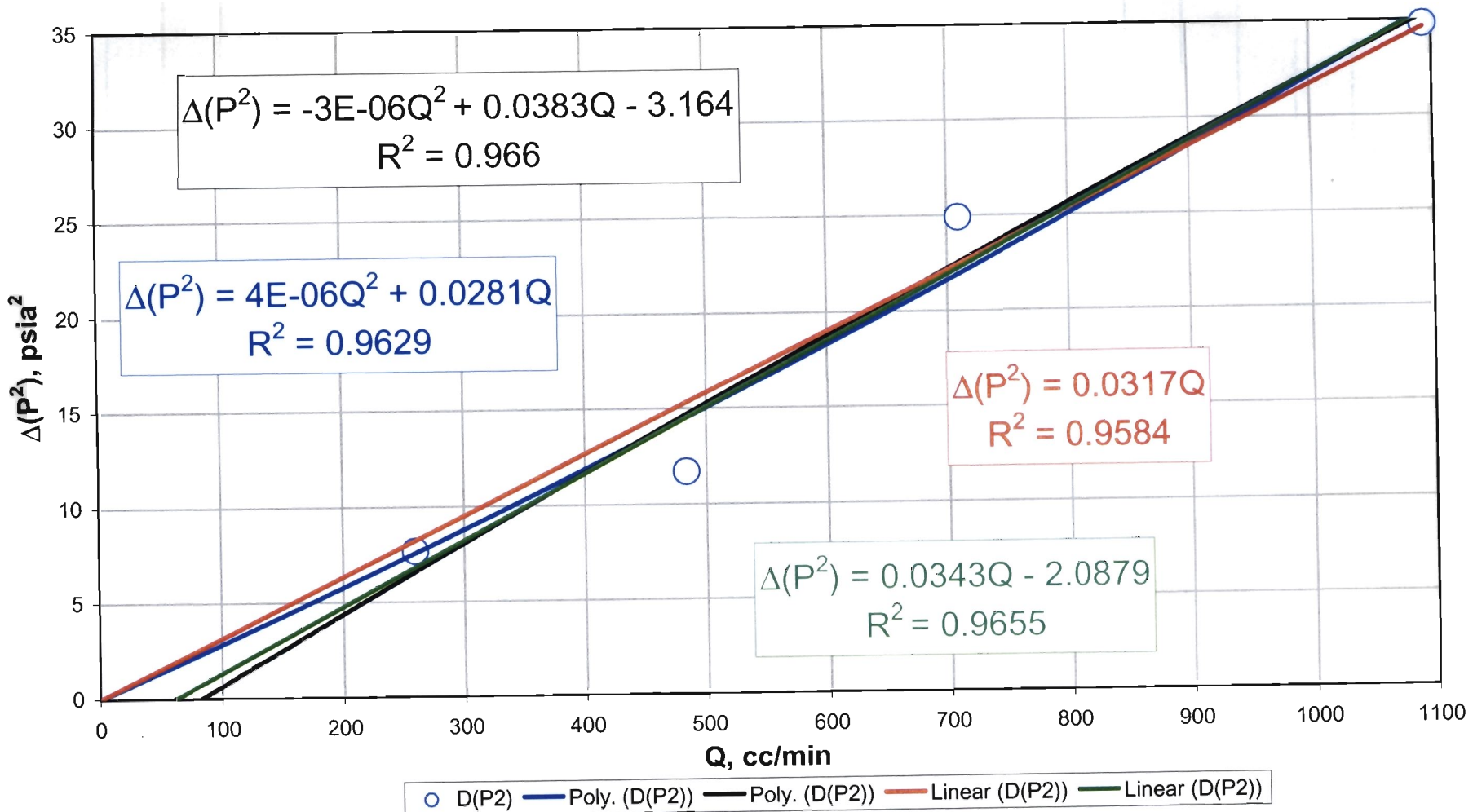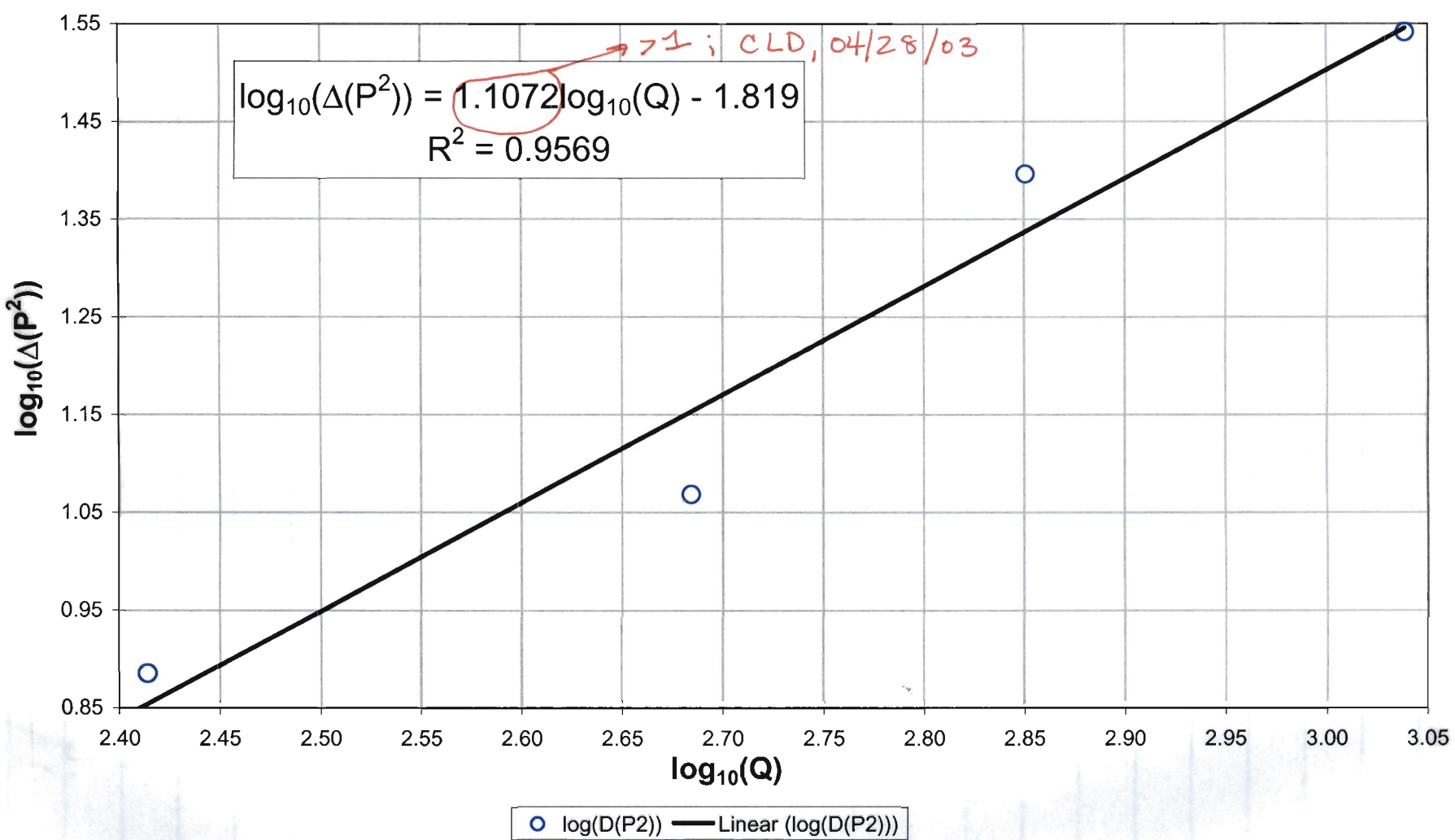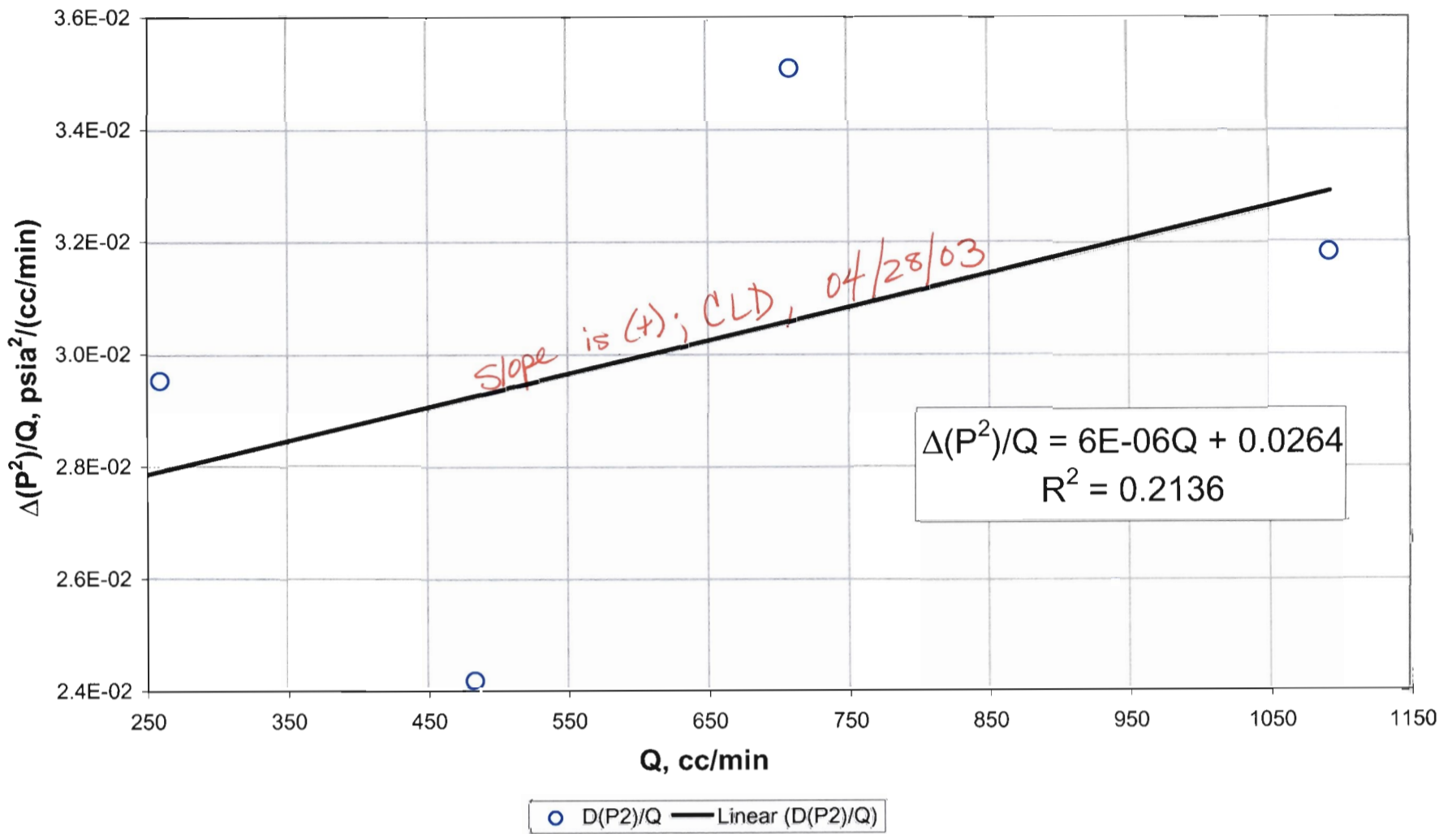**X Transect: Drillhole 38**

>1 ; CLD, 04/28/03

$\log_{10}(\Delta(P^2)) = 1.1072\log_{10}(Q) - 1.819$
$R^2 = 0.9569$

Axis label (y): $\log_{10}(\Delta(P^2))$
Axis label (x): $\log_{10}(Q)$

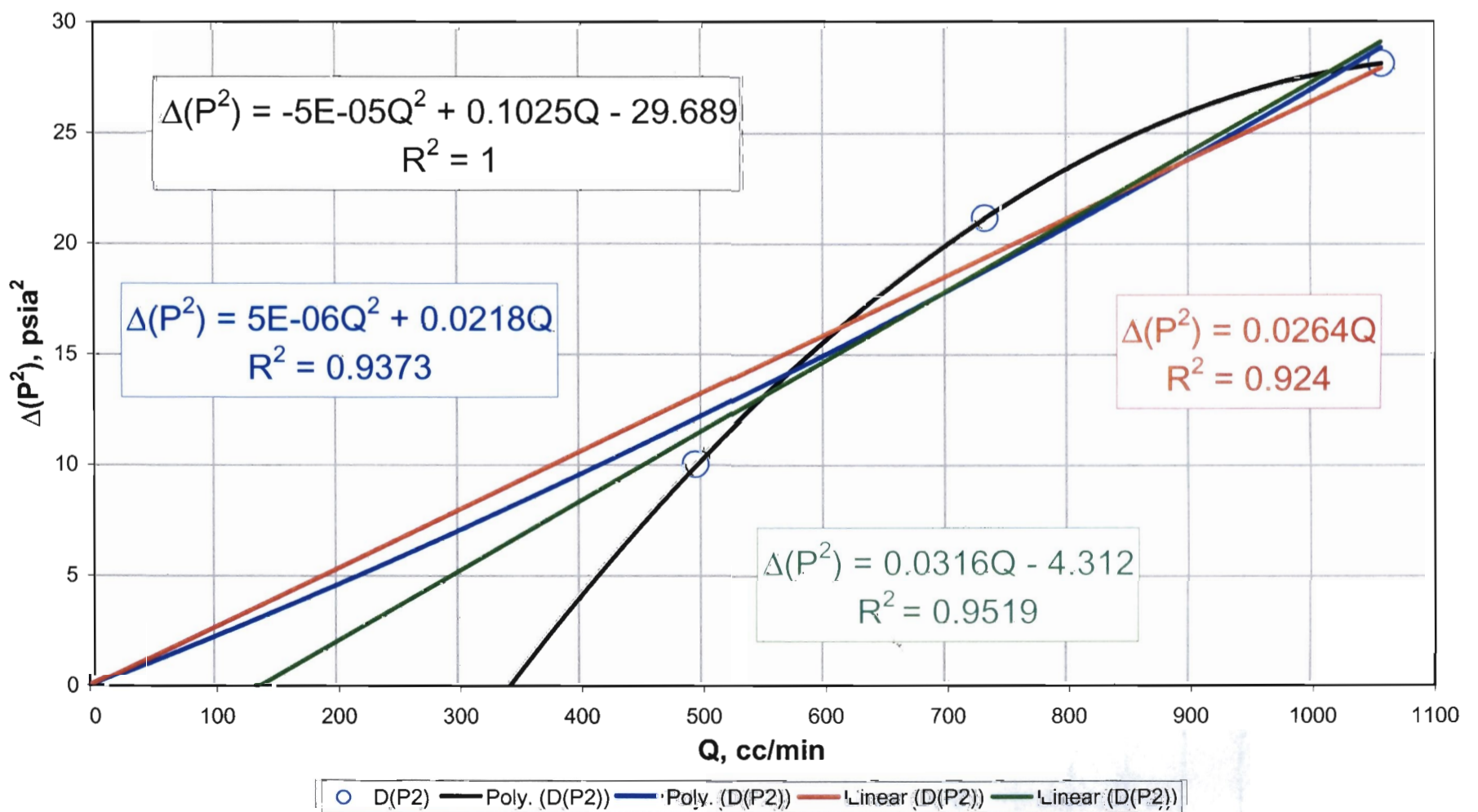Legend: ○ log(D(P2)) — Linear (log(D(P2)))

RnM, 08/27/03

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 38

$\Delta(P^2)/Q = 6E\text{-}06Q + 0.0264$

$R^2 = 0.2136$

Slope is (+); CLD, 04/28/03

Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)

X-axis: Q, cc/min

Legend: ○ D(P2)/Q —— Linear (D(P2)/Q)

RnM, 08/27/03

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 39

$\Delta(P^2) = -5E\text{-}05Q^2 + 0.1025Q - 29.689$

$R^2 = 1$

$\Delta(P^2) = 5E\text{-}06Q^2 + 0.0218Q$

$R^2 = 0.9373$

$\Delta(P^2) = 0.0264Q$

$R^2 = 0.924$

$\Delta(P^2) = 0.0316Q - 4.312$

$R^2 = 0.9519$

Y-axis: $\Delta(P^2)$, psia^2

X-axis: Q, cc/min

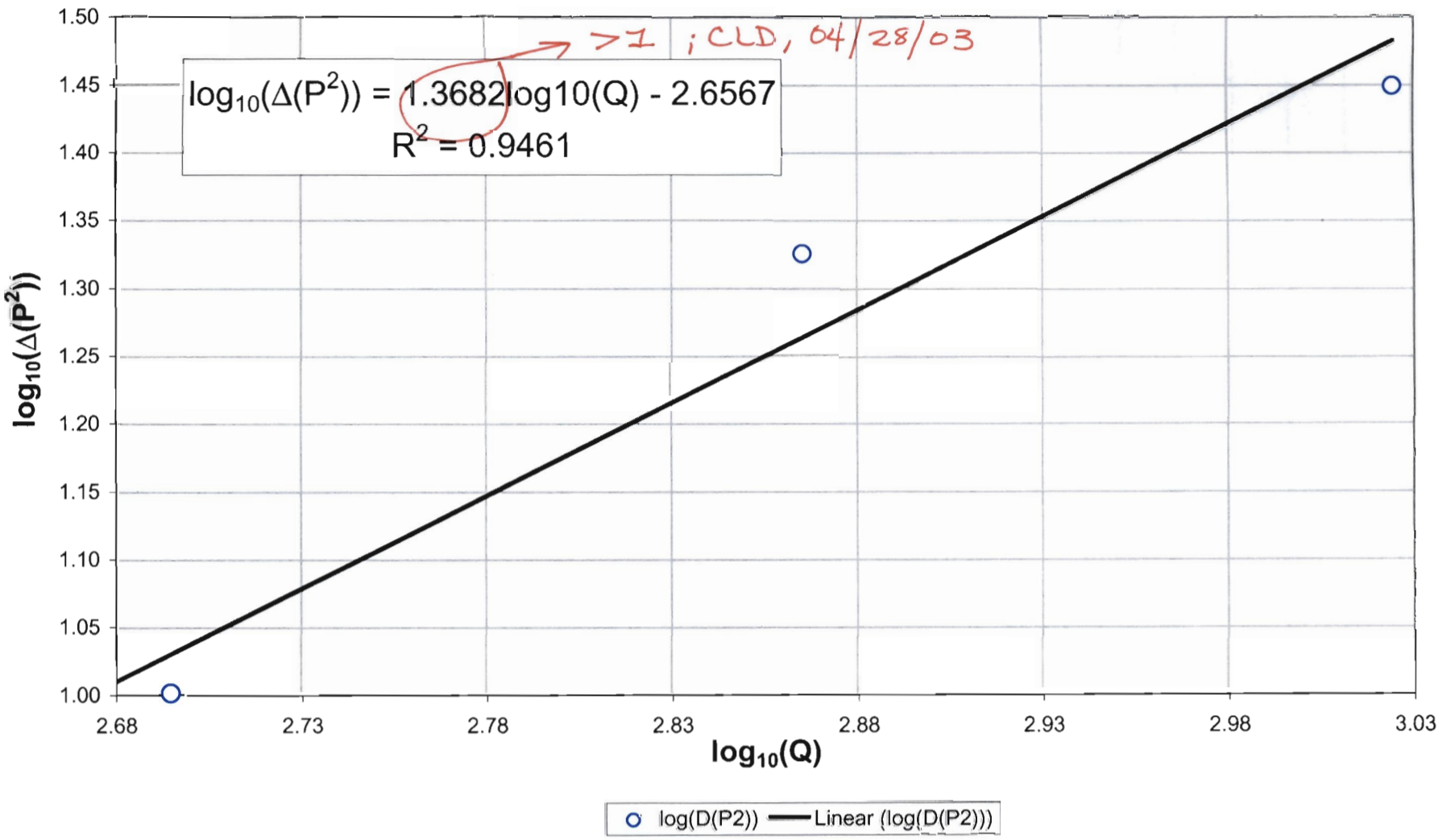Legend: ○ D(P2) —— Poly. (D(P2)) —— Poly. (D(P2)) —— Linear (D(P2)) —— Linear (D(P2))

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
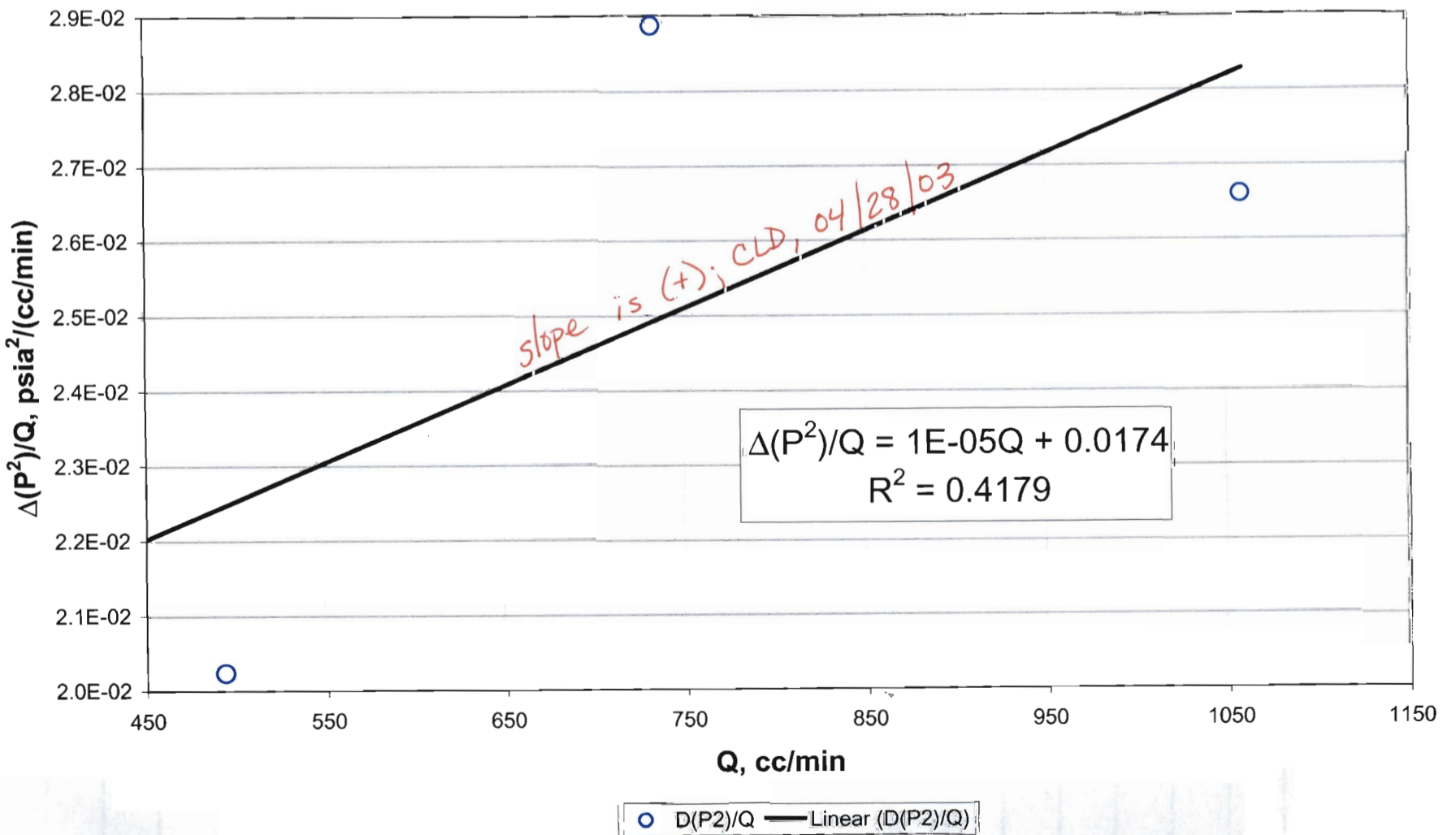### X Transect: Drillhole 39

$$\log_{10}(\Delta(P^2)) = 1.3682\log_{10}(Q) - 2.6567$$
$$R^2 = 0.9461$$

> 1 ; CLD, 04/28/03

Legend: o log(D(P2)) — Linear (log(D(P2)))
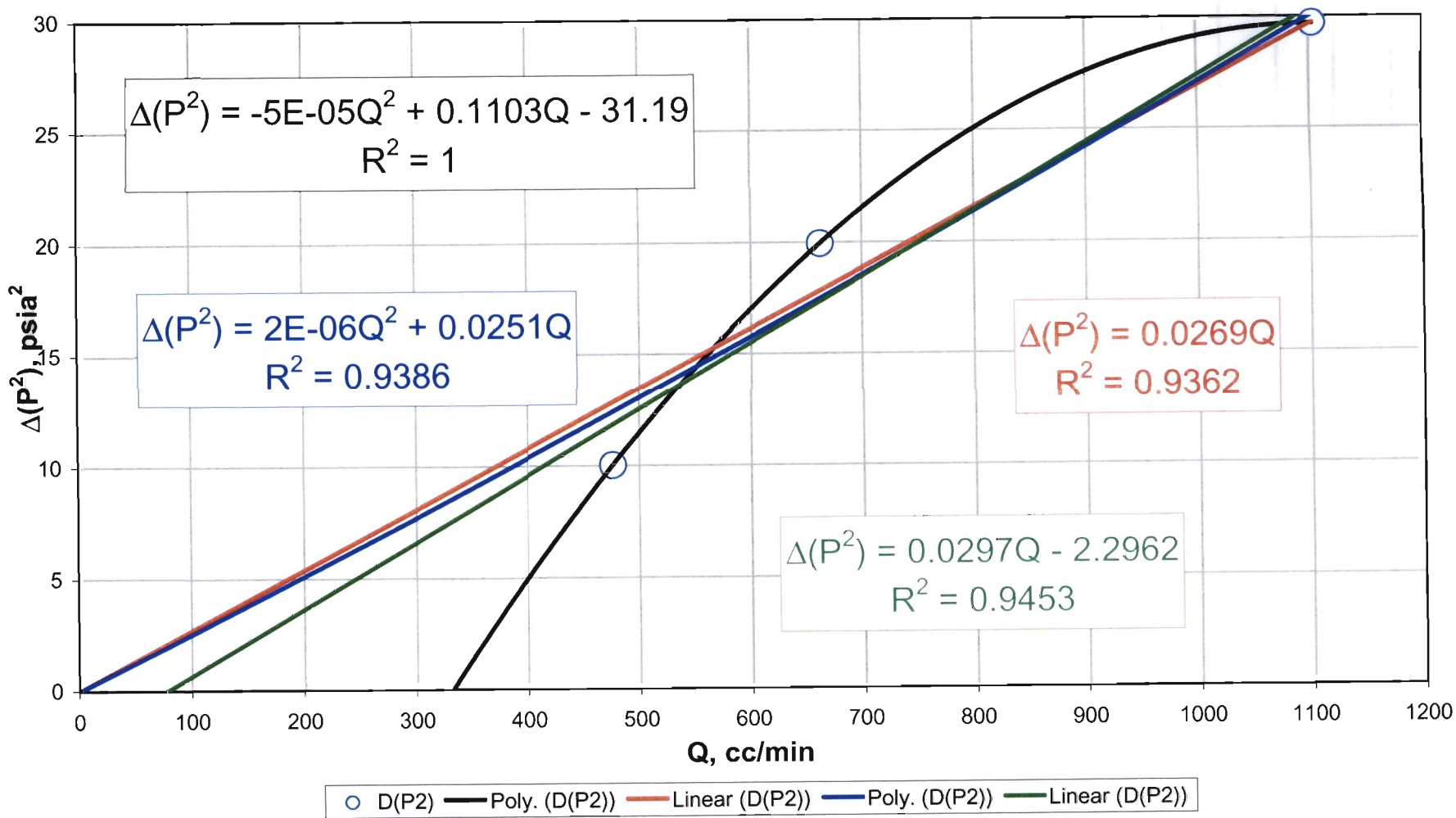
RNM, 08/27/02

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 39

slope is (+); CLD, 04/28/03

$$\Delta(P^2)/Q = 1E\text{-}05Q + 0.0174$$
$$R^2 = 0.4179$$

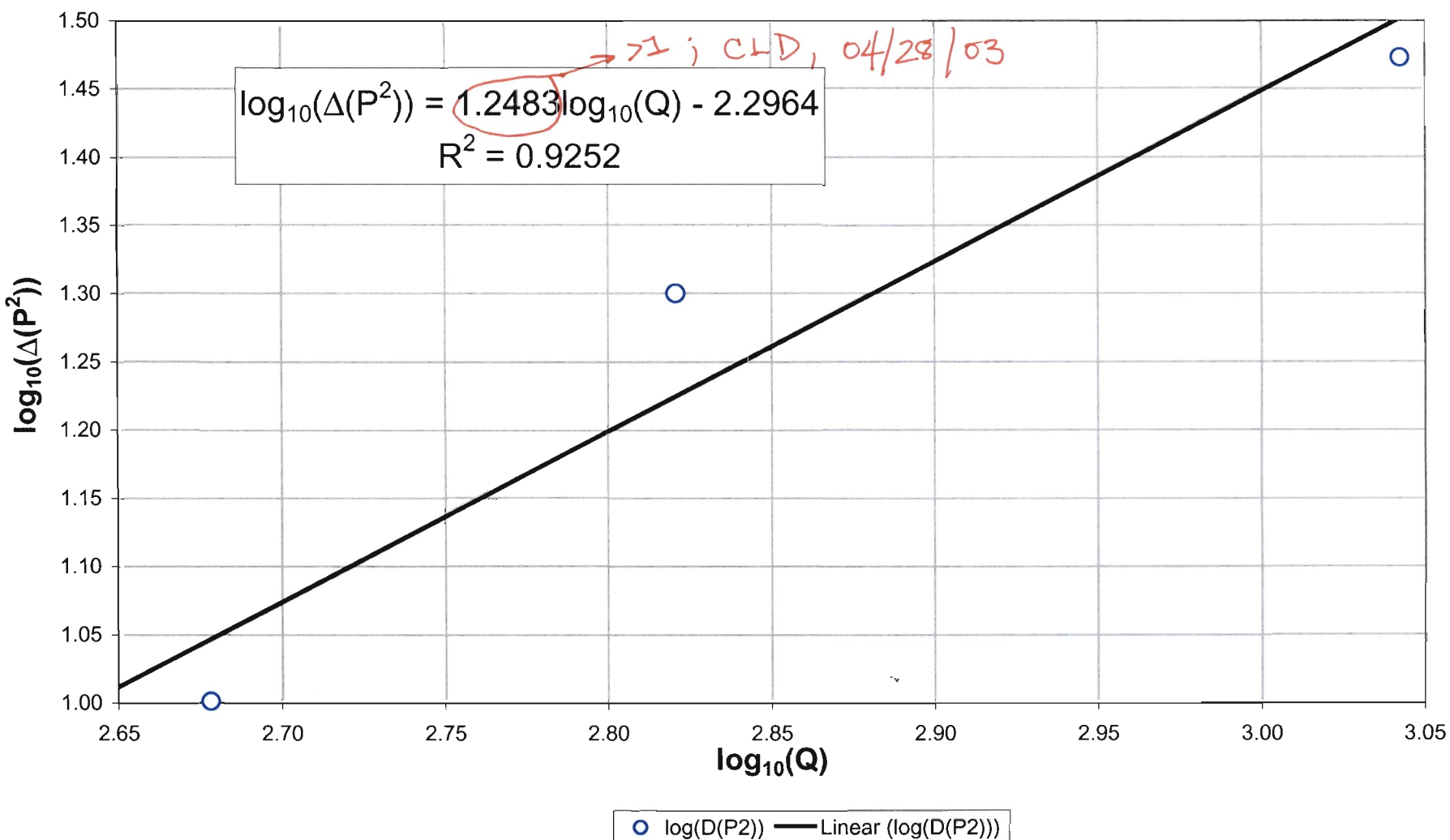Legend: o D(P2)/Q — Linear (D(P2)/Q)

RNM, 08/27/02

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 40

$\Delta(P^2) = -5E\text{-}05Q^2 + 0.1103Q - 31.19$
$R^2 = 1$

$\Delta(P^2) = 2E\text{-}06Q^2 + 0.0251Q$
$R^2 = 0.9386$

$\Delta(P^2) = 0.0269Q$
$R^2 = 0.9362$

$\Delta(P^2) = 0.0297Q - 2.2962$
$R^2 = 0.9453$

y-axis: $\Delta(P^2)$, psia^2
x-axis: Q, cc/min

Legend: O D(P2) — Poly. (D(P2)) — Linear (D(P2)) — Poly. (D(P2)) — Linear (D(P2))
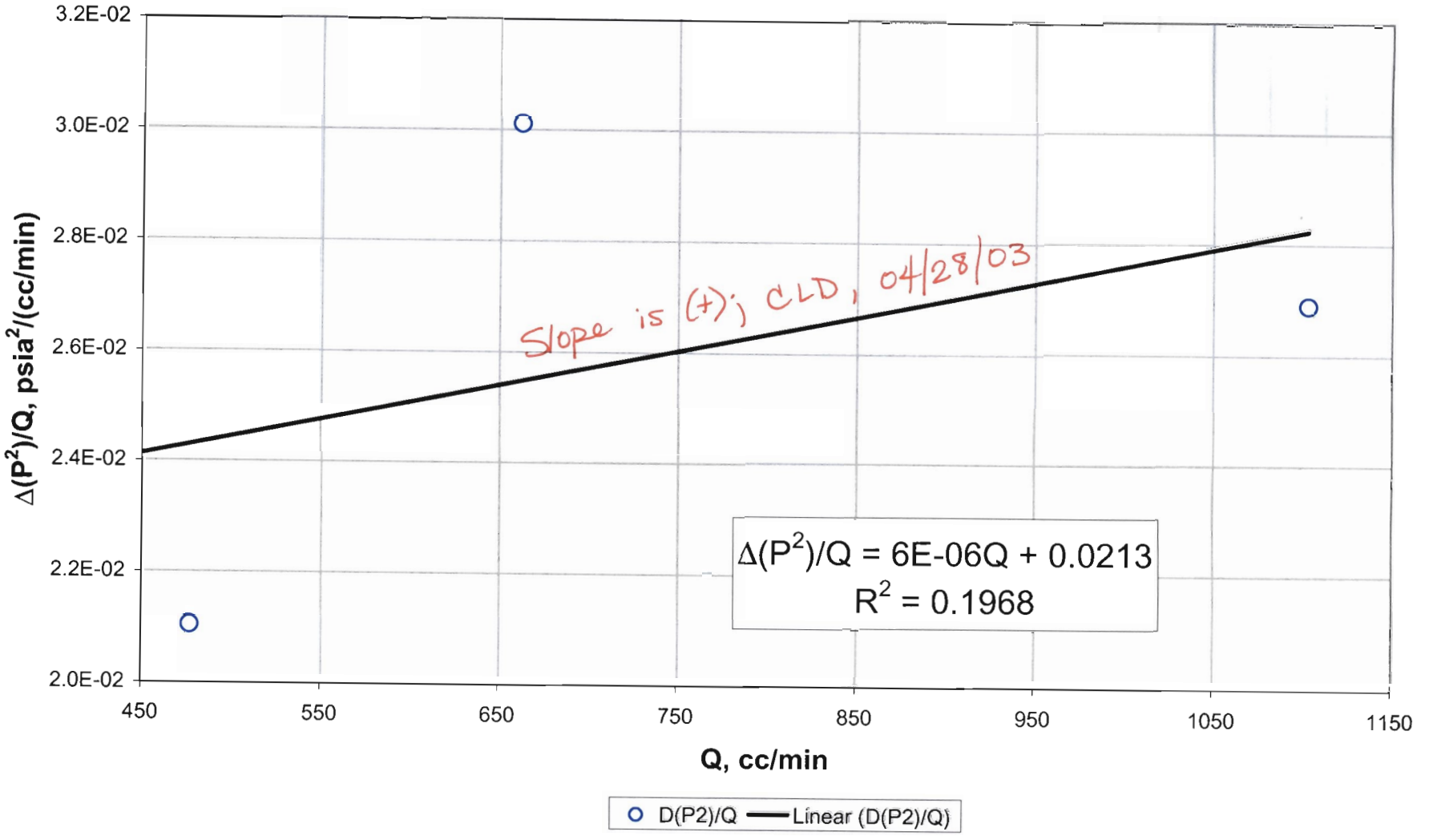
RNM / 08/27/02

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 40

$\log_{10}(\Delta(P^2)) = 1.2483\log_{10}(Q) - 2.2964$
$R^2 = 0.9252$

→ >1 ; CLD, 04/28/03

y-axis: $\log_{10}(\Delta(P^2))$
x-axis: $\log_{10}(Q)$

Legend: O log(D(P2)) — Linear (log(D(P2)))

RNM, 08/27/02

Final check for high velocity flow effects:
High velocity flow effects are present when when the slope is non-zero and positive.
X Transect : Drillhole 40

Slope is (+); CLD, 04/28/03 (handwritten)

$$\Delta(P^2)/Q = 6\text{E-}06Q + 0.0213$$
$$R^2 = 0.1968$$

Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)
X-axis: Q, cc/min

Legend: O D(P2)/Q — Linear (D(P2)/Q)

RNM, 08/27/04 (handwritten, left margin)

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 41

$$\Delta(P^2) = -4\text{E-}06Q^2 + 0.0193Q + 3.6895$$
$$R^2 = 1$$

$$\Delta(P^2) = 0.0103Q + 8.6579$$
$$R^2 = 0.9934$$

$$\Delta(P^2) = 0.0171Q$$
$$R^2 = 0.5175$$

$$\Delta(P^2) = -6\text{E-}06Q^2 + 0.0259Q$$
$$R^2 = 0.9965$$

Y-axis: $\Delta(P^2)$, psia^2
X-axis: Q, cc/min

Legend: O D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))

RNM 08/27/04 (handwritten, left margin)

RNM, 08/27/02

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
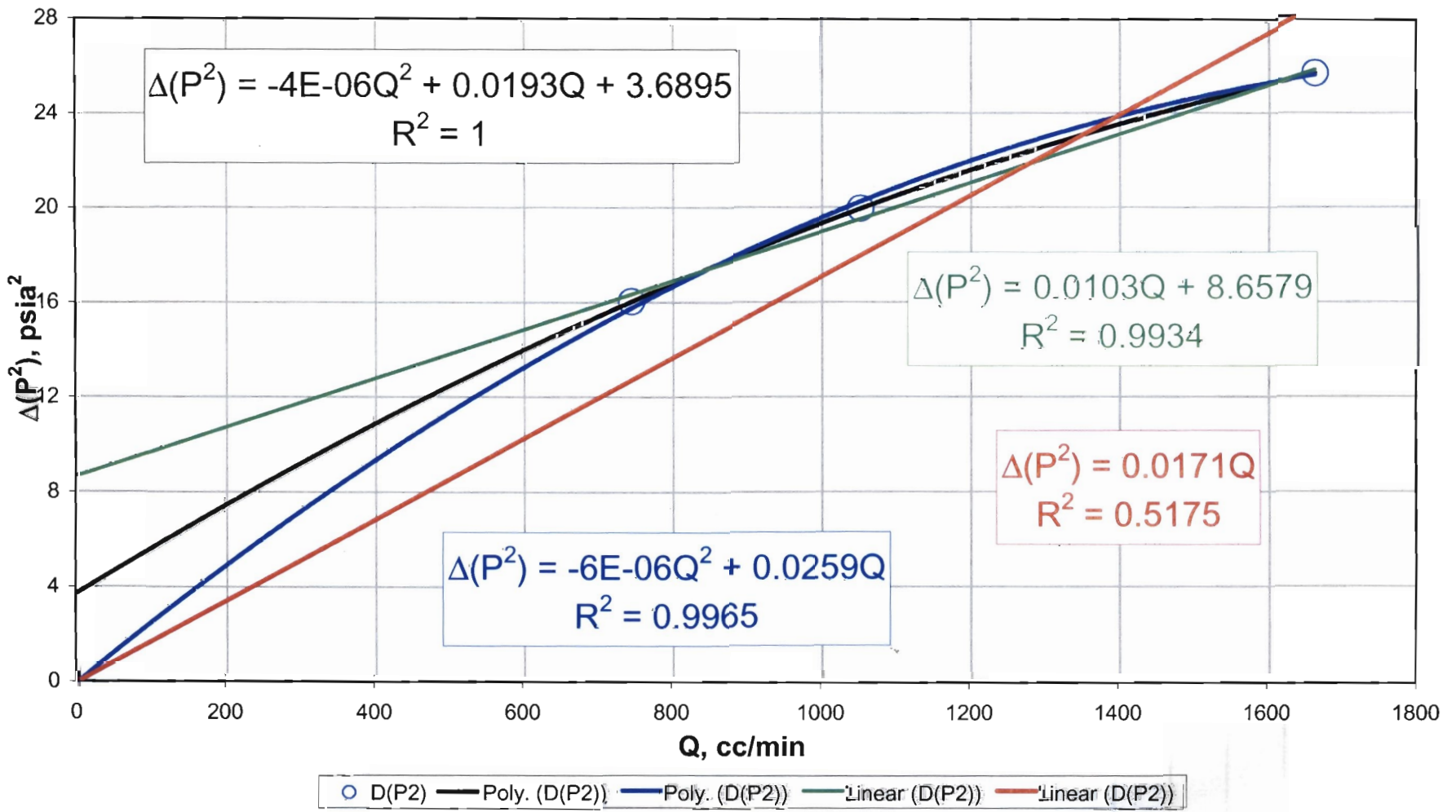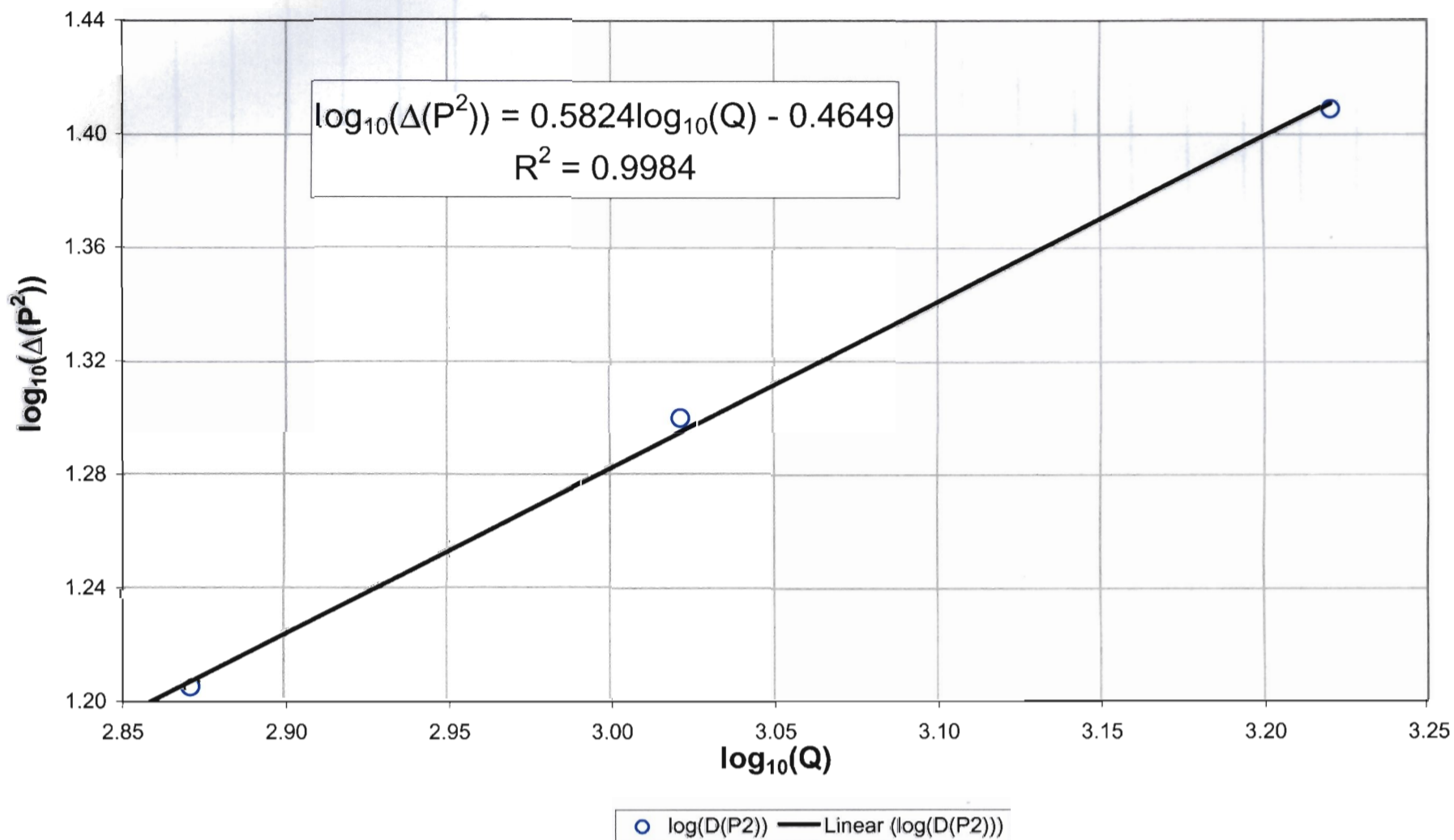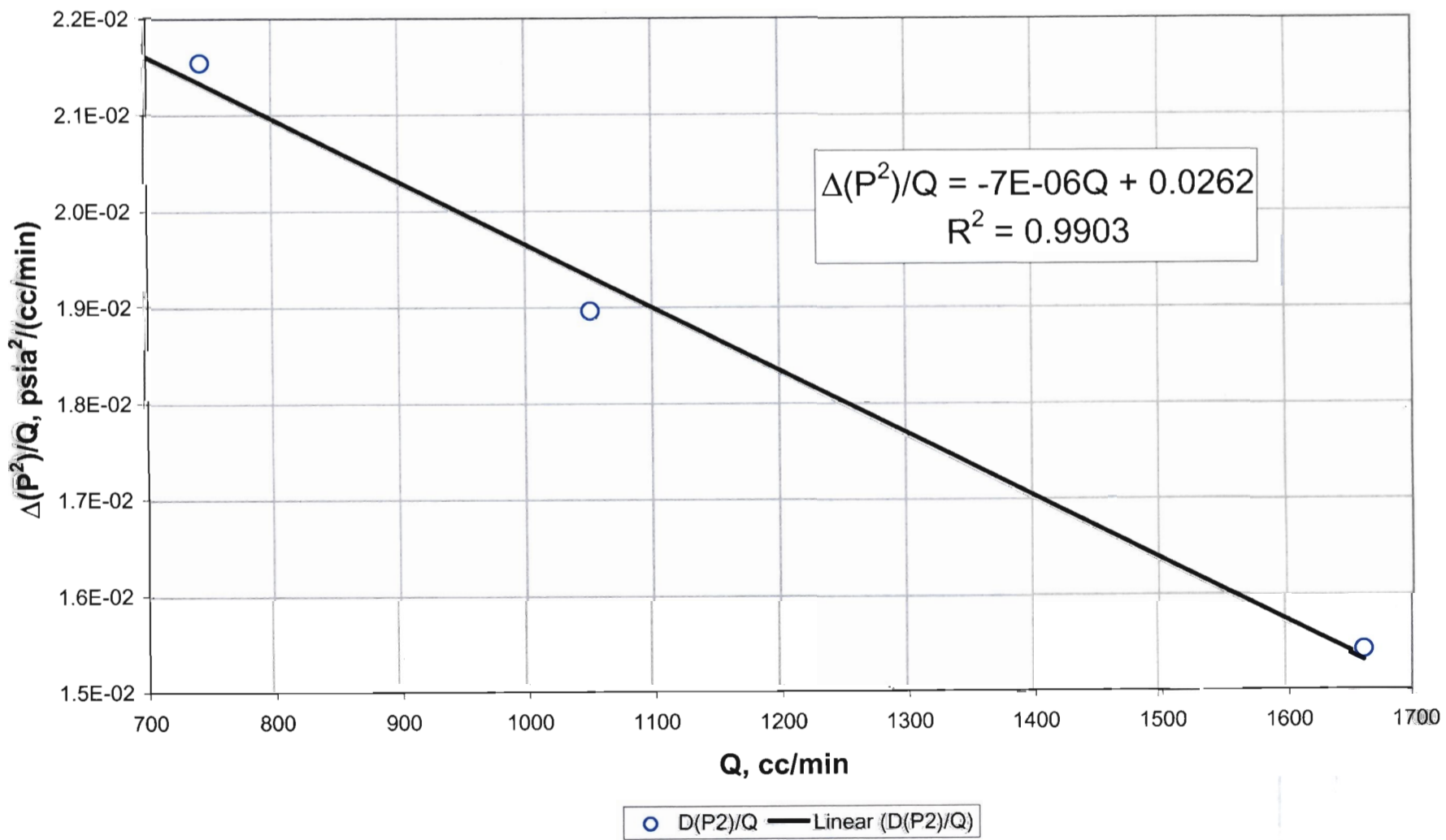**X Transect: Drillhole 41**

$$\log_{10}(\Delta(P^2)) = 0.5824\log_{10}(Q) - 0.4649$$
$$R^2 = 0.9984$$

y-axis: $\log_{10}(\Delta(P^2))$
x-axis: $\log_{10}(Q)$

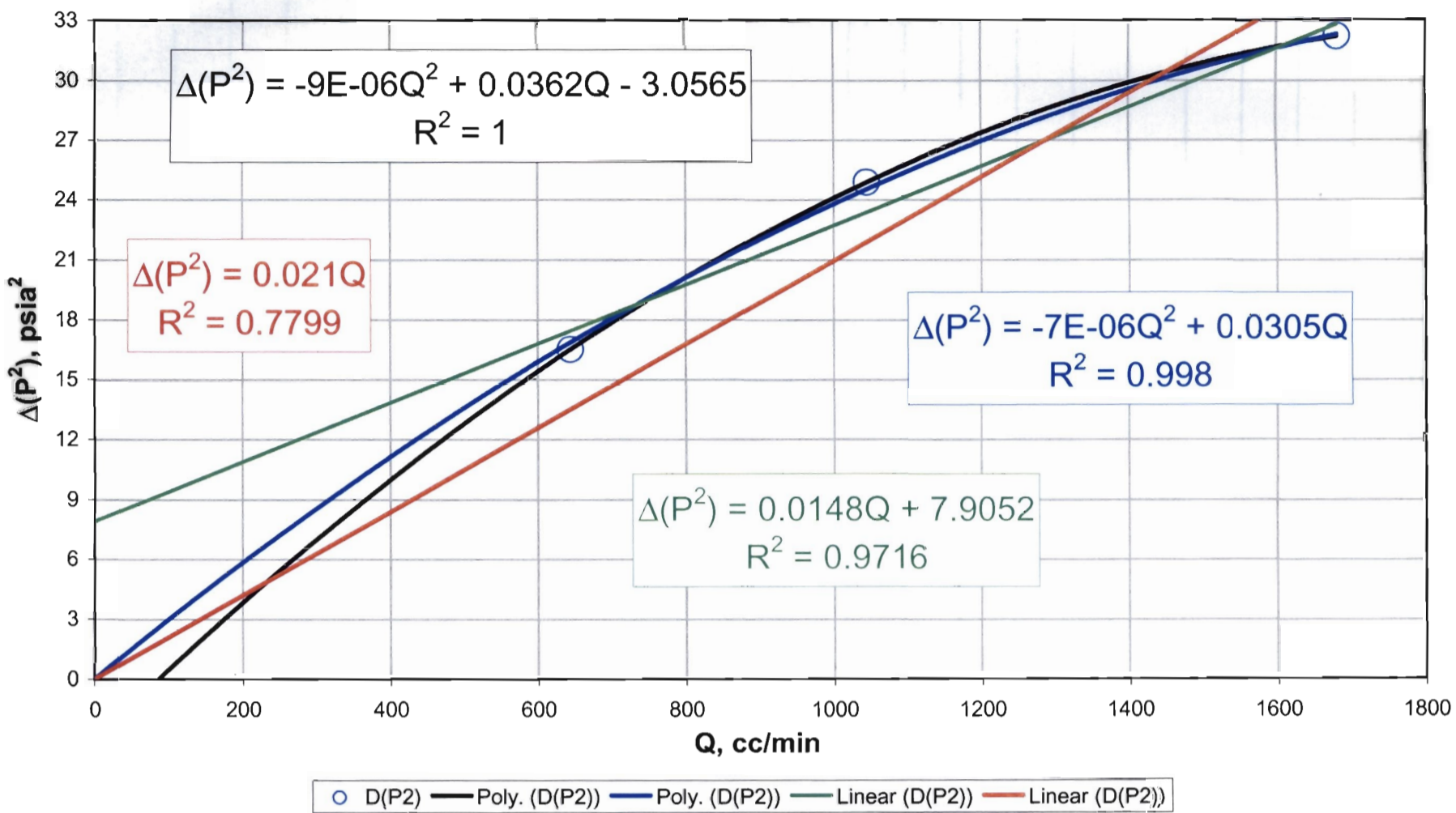Legend: o log(D(P2)) —— Linear (log(D(P2)))

RNM, 08/27/02

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 41

$$\Delta(P^2)/Q = -7E\text{-}06Q + 0.0262$$
$$R^2 = 0.9903$$

y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)
x-axis: Q, cc/min

Legend: o D(P2)/Q —— Linear (D(P2)/Q)

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 42

$$\Delta(P^2) = -9E\text{-}06Q^2 + 0.0362Q - 3.0565$$
$$R^2 = 1$$

$$\Delta(P^2) = 0.021Q$$
$$R^2 = 0.7799$$

$$\Delta(P^2) = -7E\text{-}06Q^2 + 0.0305Q$$
$$R^2 = 0.998$$

$$\Delta(P^2) = 0.0148Q + 7.9052$$
$$R^2 = 0.9716$$

Y-axis: $\Delta(P^2)$, psia^2
X-axis: Q, cc/min

Legend: ○ D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))

RNM, 08/27/02

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 42

$$\log_{10}(\Delta(P^2)) = 0.6969\log_{10}(Q) - 0.7293$$
$$R^2 = 0.9842$$

Y-axis: $\log_{10}(\Delta(P^2))$
X-axis: $\log_{10}(Q)$

Legend: ○ log(D(P2)) — Linear (log(D(P2)))

RNM, 08/27/02

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
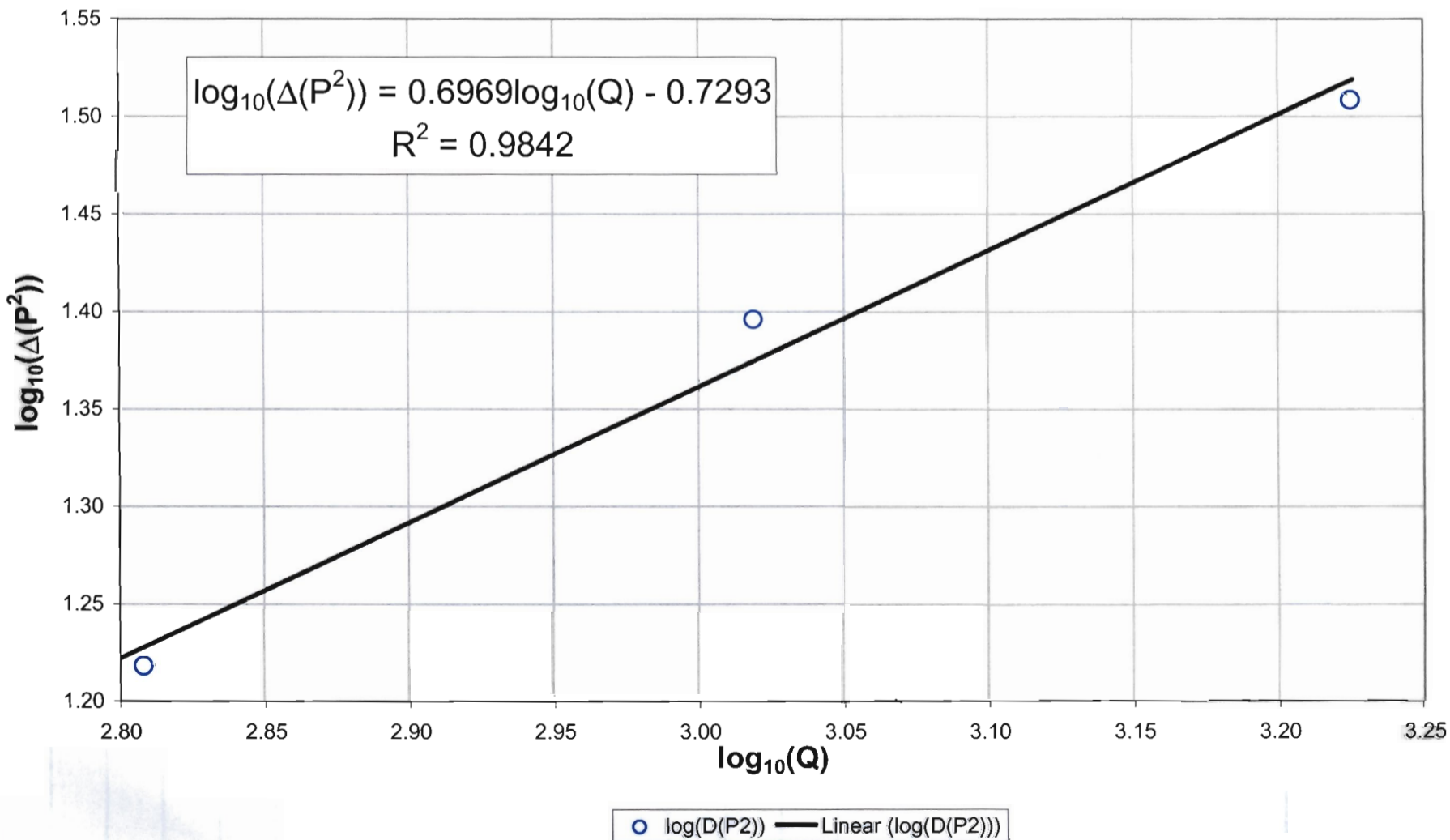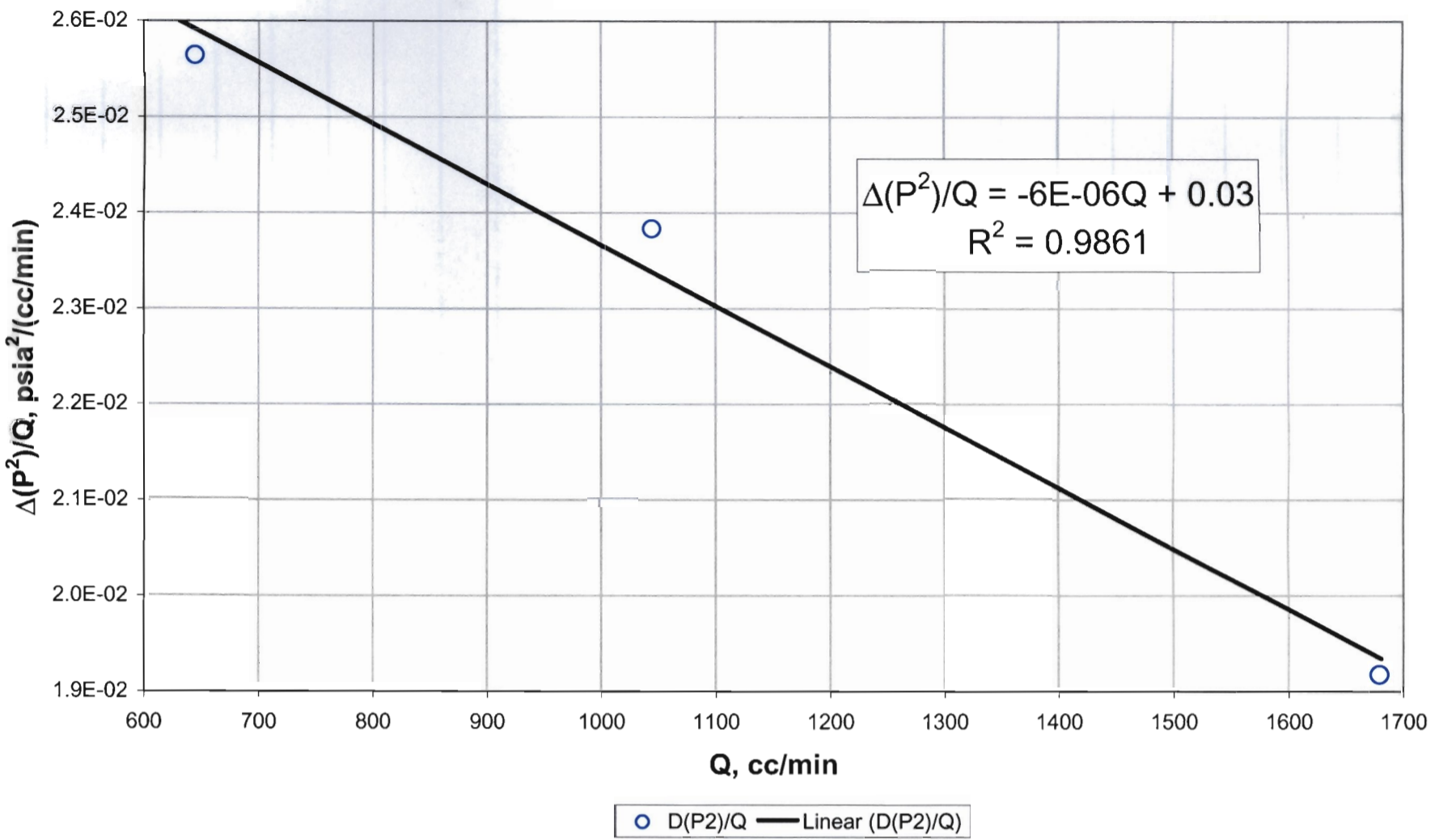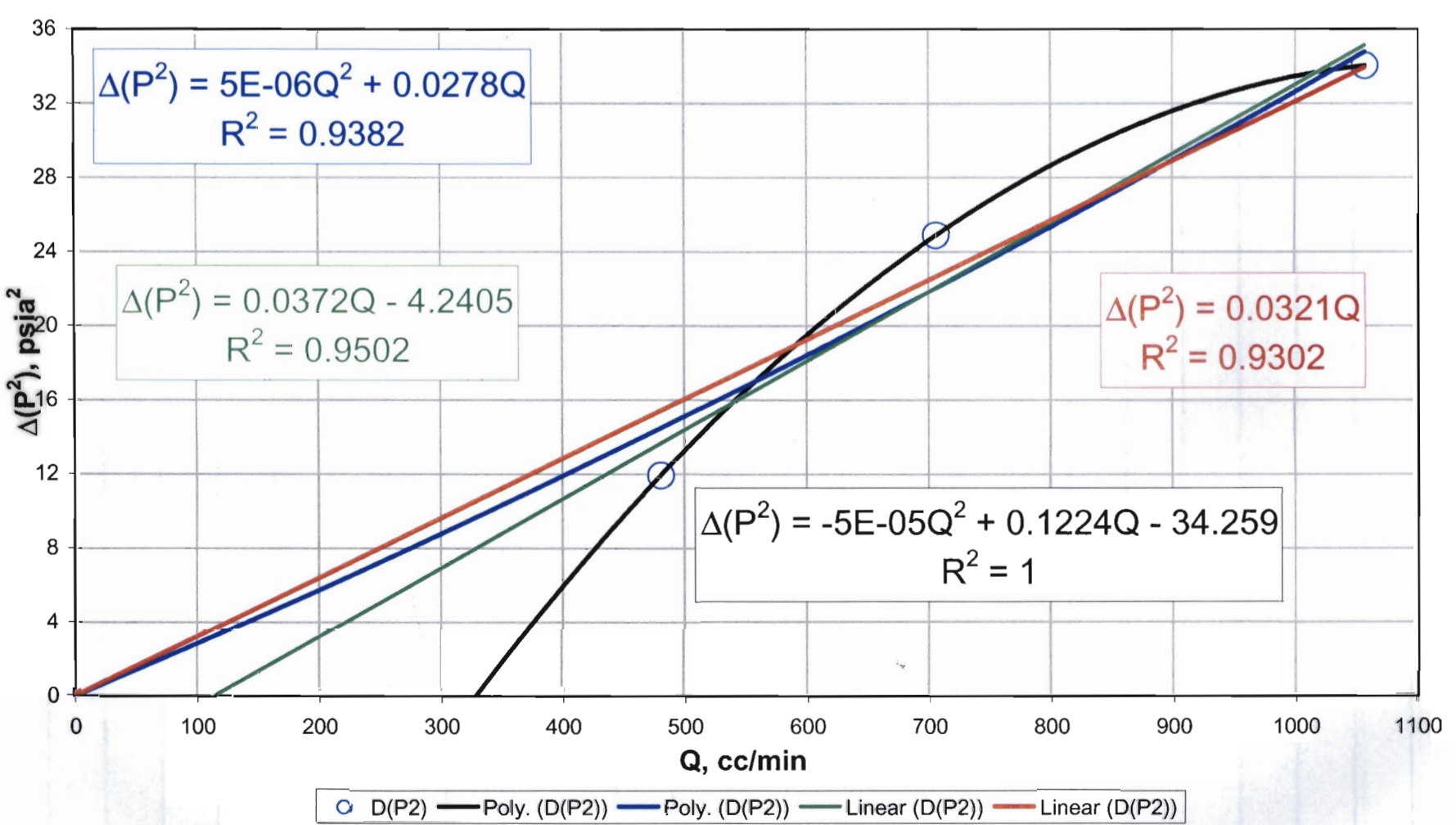**X Transect : Drillhole 42**

$$\Delta(P^2)/Q = -6E\text{-}06Q + 0.03$$
$$R^2 = 0.9861$$

Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)
X-axis: Q, cc/min

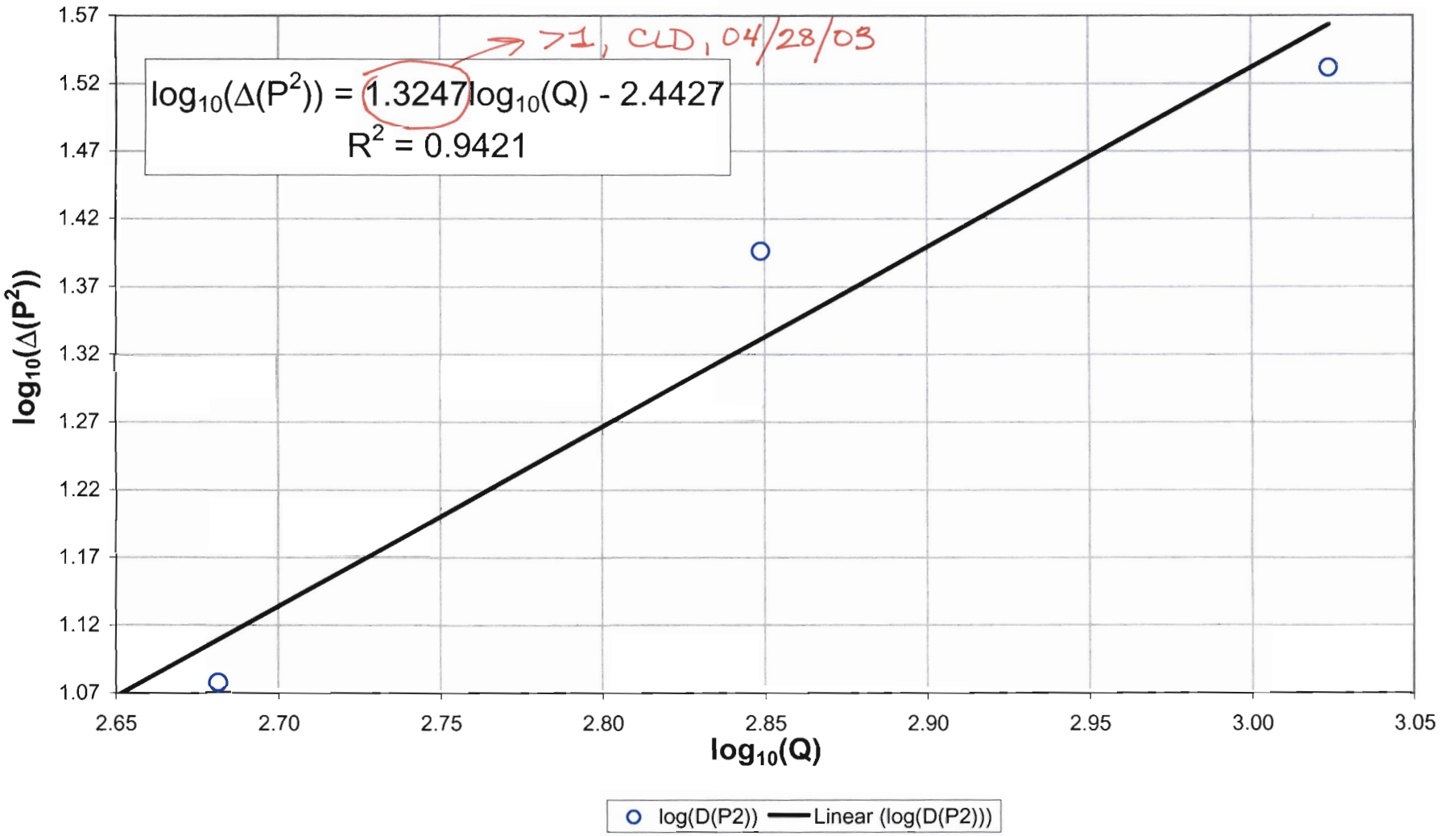Legend: ○ D(P2)/Q —— Linear (D(P2)/Q)

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 43

$$\Delta(P^2) = 5E\text{-}06Q^2 + 0.0278Q$$
$$R^2 = 0.9382$$

$$\Delta(P^2) = 0.0372Q - 4.2405$$
$$R^2 = 0.9502$$

$$\Delta(P^2) = 0.0321Q$$
$$R^2 = 0.9302$$

$$\Delta(P^2) = -5E\text{-}05Q^2 + 0.1224Q - 34.259$$
$$R^2 = 1$$

Y-axis: $\Delta(P^2)$, psia^2
X-axis: Q, cc/min

Legend: ○ D(P2) —— Poly. (D(P2)) —— Poly. (D(P2)) —— Linear (D(P2)) —— Linear (D(P2))
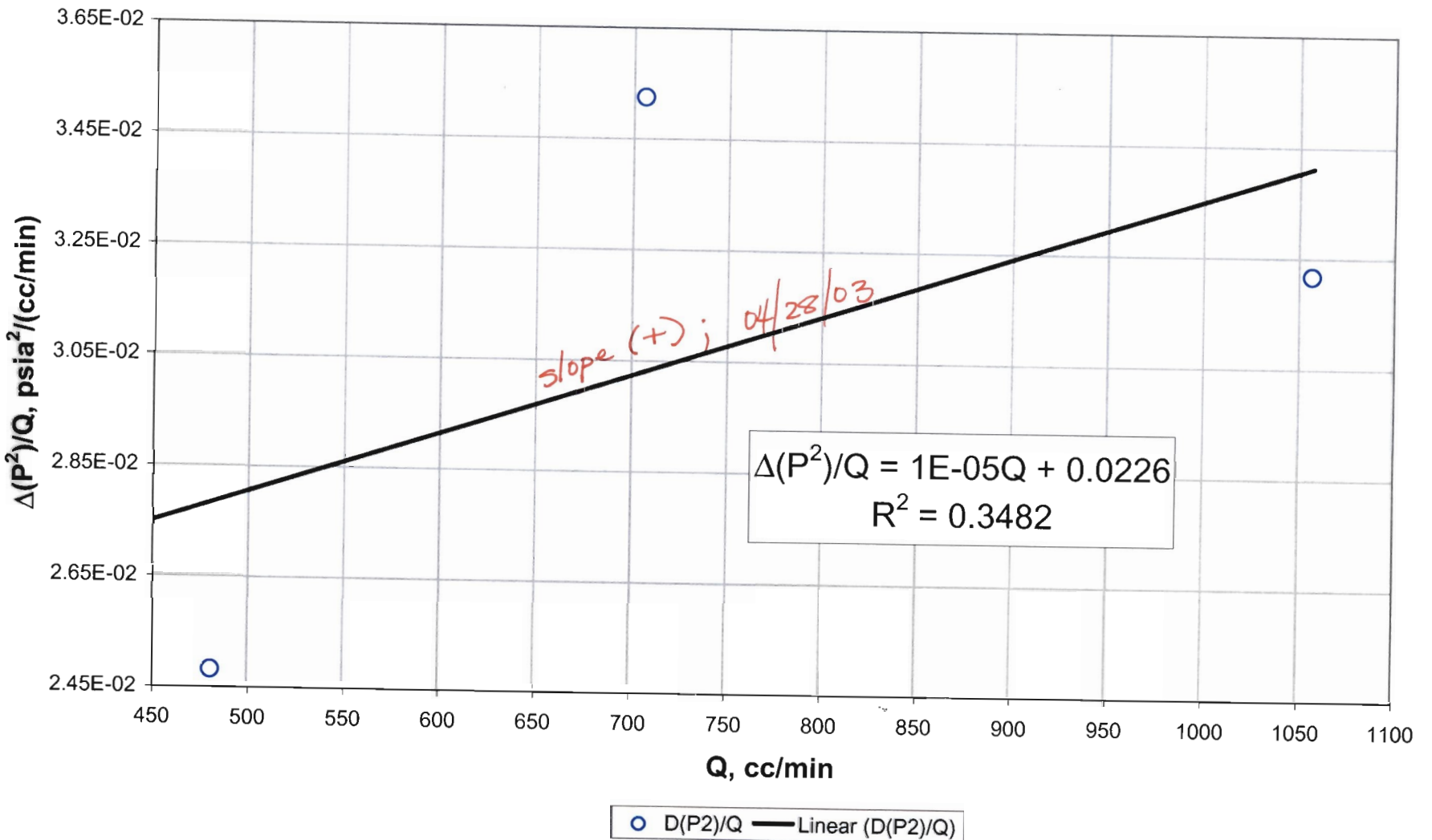
Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 43

→ >1, CLD, 04/28/03

$$\log_{10}(\Delta(P^2)) = 1.3247\log_{10}(Q) - 2.4427$$
$$R^2 = 0.9421$$

Y-axis: $\log_{10}(\Delta(P^2))$

X-axis: $\log_{10}(Q)$

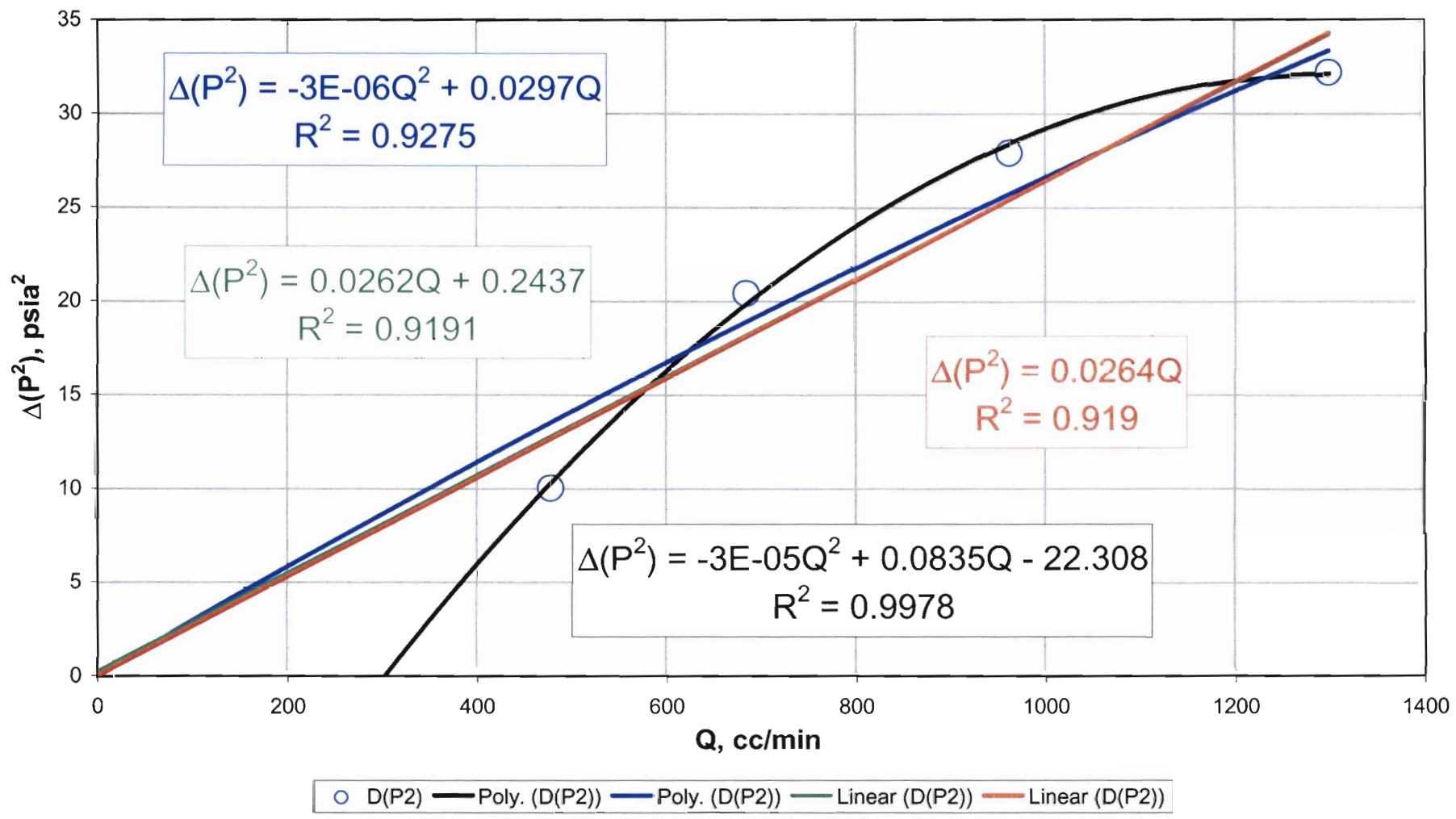Legend: ○ log(D(P2)) ——Linear (log(D(P2)))

RNM, 08/27/02

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 43

slope (+); 04/28/03

$$\Delta(P^2)/Q = 1E{-}05Q + 0.0226$$
$$R^2 = 0.3482$$

Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)

X-axis: Q, cc/min

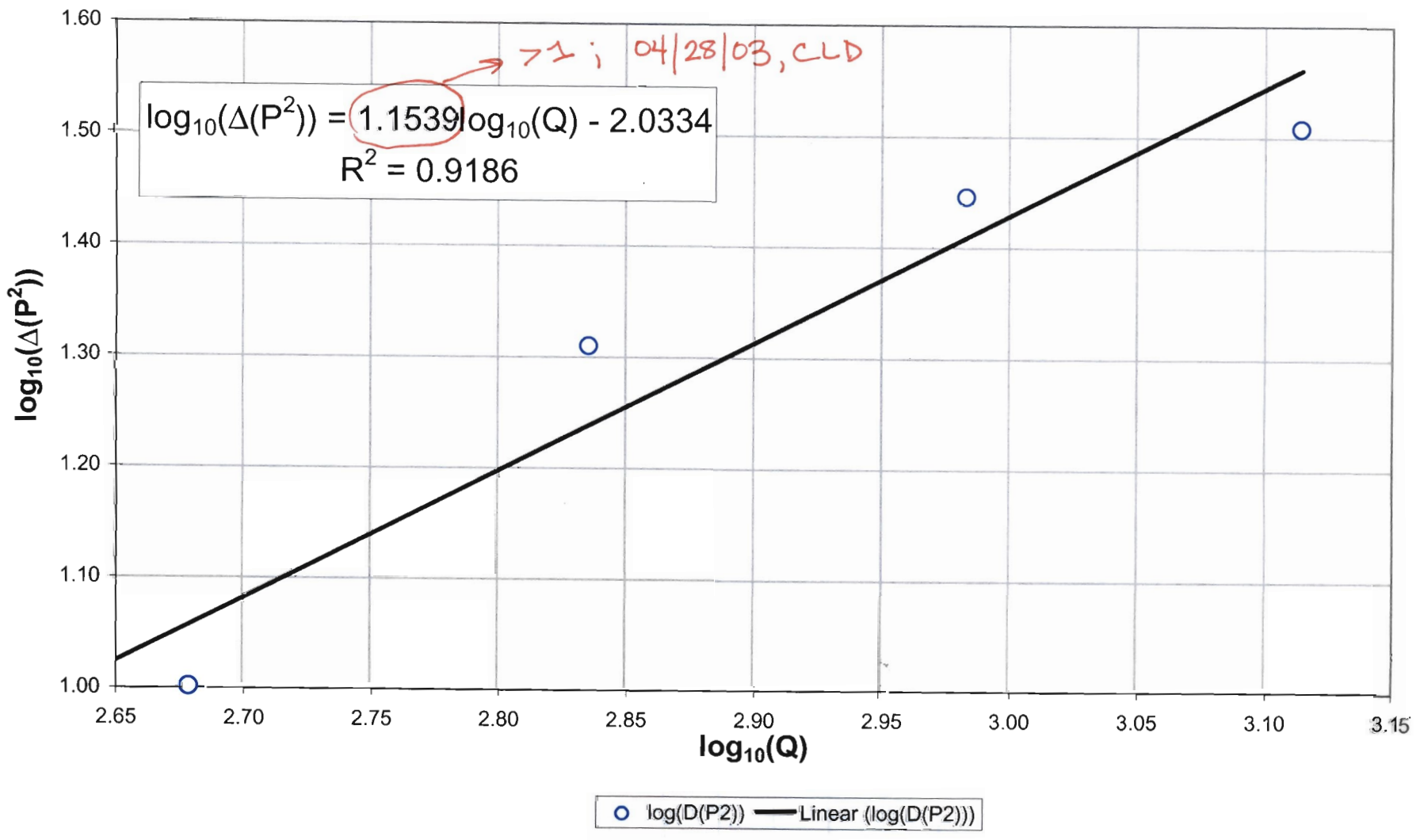Legend: ○ D(P2)/Q ——Linear (D(P2)/Q)

RNM, 08/27/02

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 44

$$\Delta(P^2) = -3E\text{-}06Q^2 + 0.0297Q$$
$$R^2 = 0.9275$$

$$\Delta(P^2) = 0.0262Q + 0.2437$$
$$R^2 = 0.9191$$

$$\Delta(P^2) = 0.0264Q$$
$$R^2 = 0.919$$

$$\Delta(P^2) = -3E\text{-}05Q^2 + 0.0835Q - 22.308$$
$$R^2 = 0.9978$$

Y-axis: $\Delta(P^2)$, psia^2

X-axis: Q, cc/min

Legend: O D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))
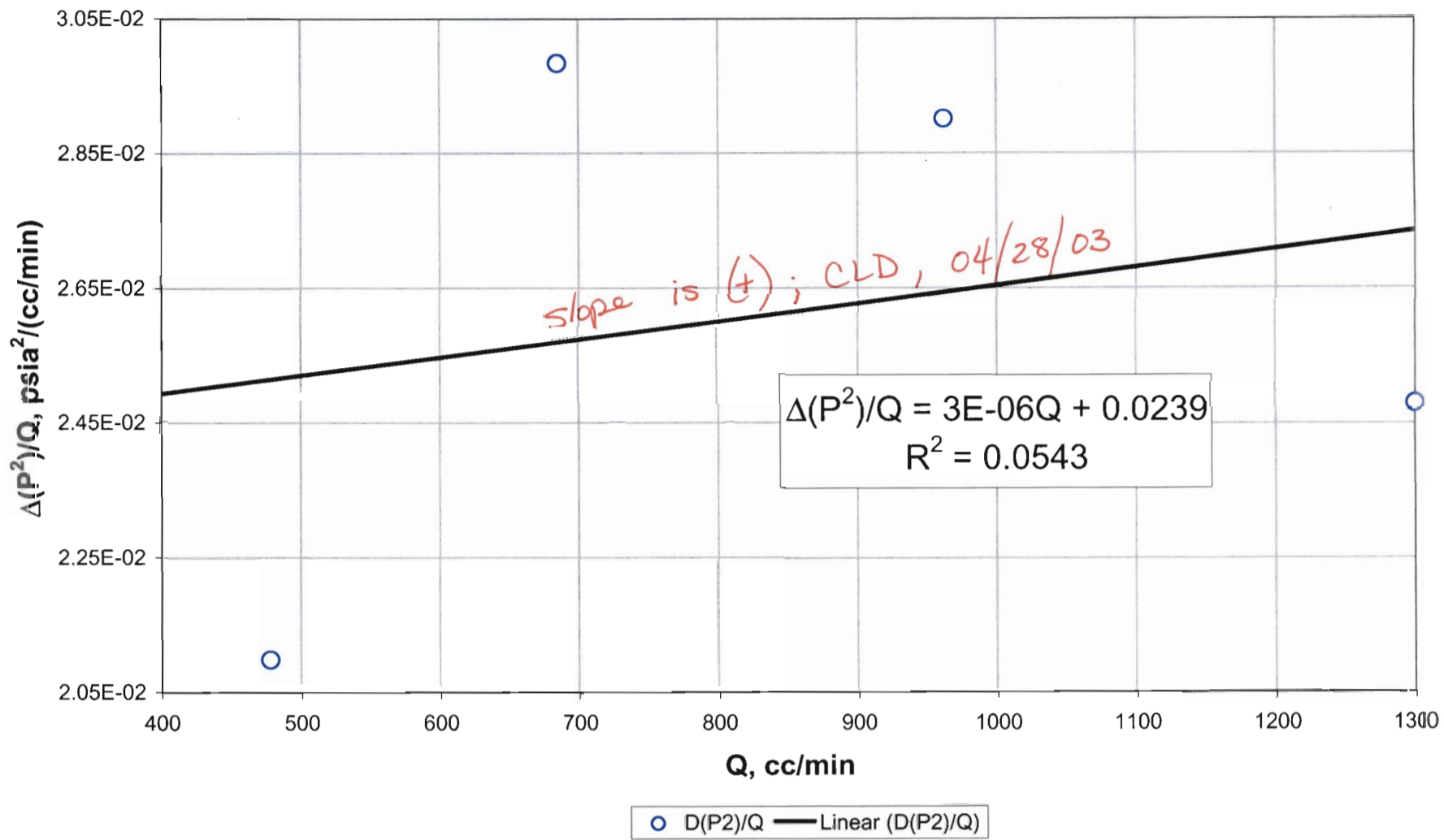
Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 44

→ >1 ; 04/28/03, CLD

$$\log_{10}(\Delta(P^2)) = 1.1539\log_{10}(Q) - 2.0334$$
$$R^2 = 0.9186$$

Y-axis: $\log_{10}(\Delta(P^2))$

X-axis: $\log_{10}(Q)$

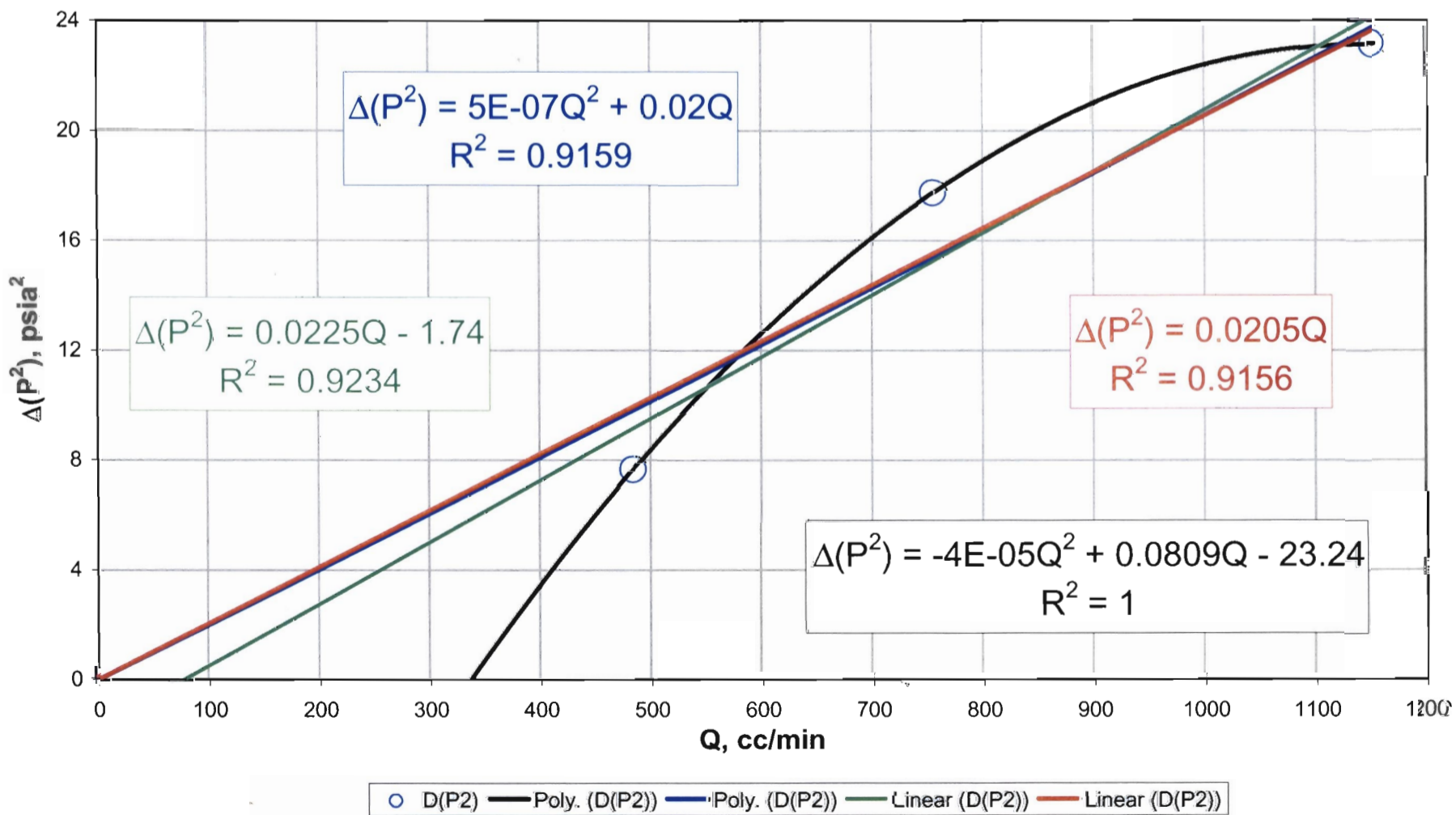Legend: O log(D(P2)) — Linear (log(D(P2)))

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 44

slope is (+); CLD, 04/28/03

$$\Delta(P^2)/Q = 3E\text{-}06Q + 0.0239$$
$$R^2 = 0.0543$$

Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)
X-axis: Q, cc/min

○ D(P2)/Q —— Linear (D(P2)/Q)

RNM, 08/27/02

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 45

$$\Delta(P^2) = 5E\text{-}07Q^2 + 0.02Q$$
$$R^2 = 0.9159$$

$$\Delta(P^2) = 0.0225Q - 1.74$$
$$R^2 = 0.9234$$

$$\Delta(P^2) = 0.0205Q$$
$$R^2 = 0.9156$$

$$\Delta(P^2) = -4E\text{-}05Q^2 + 0.0809Q - 23.24$$
$$R^2 = 1$$

Y-axis: $\Delta(P^2)$, psia^2
X-axis: Q, cc/min

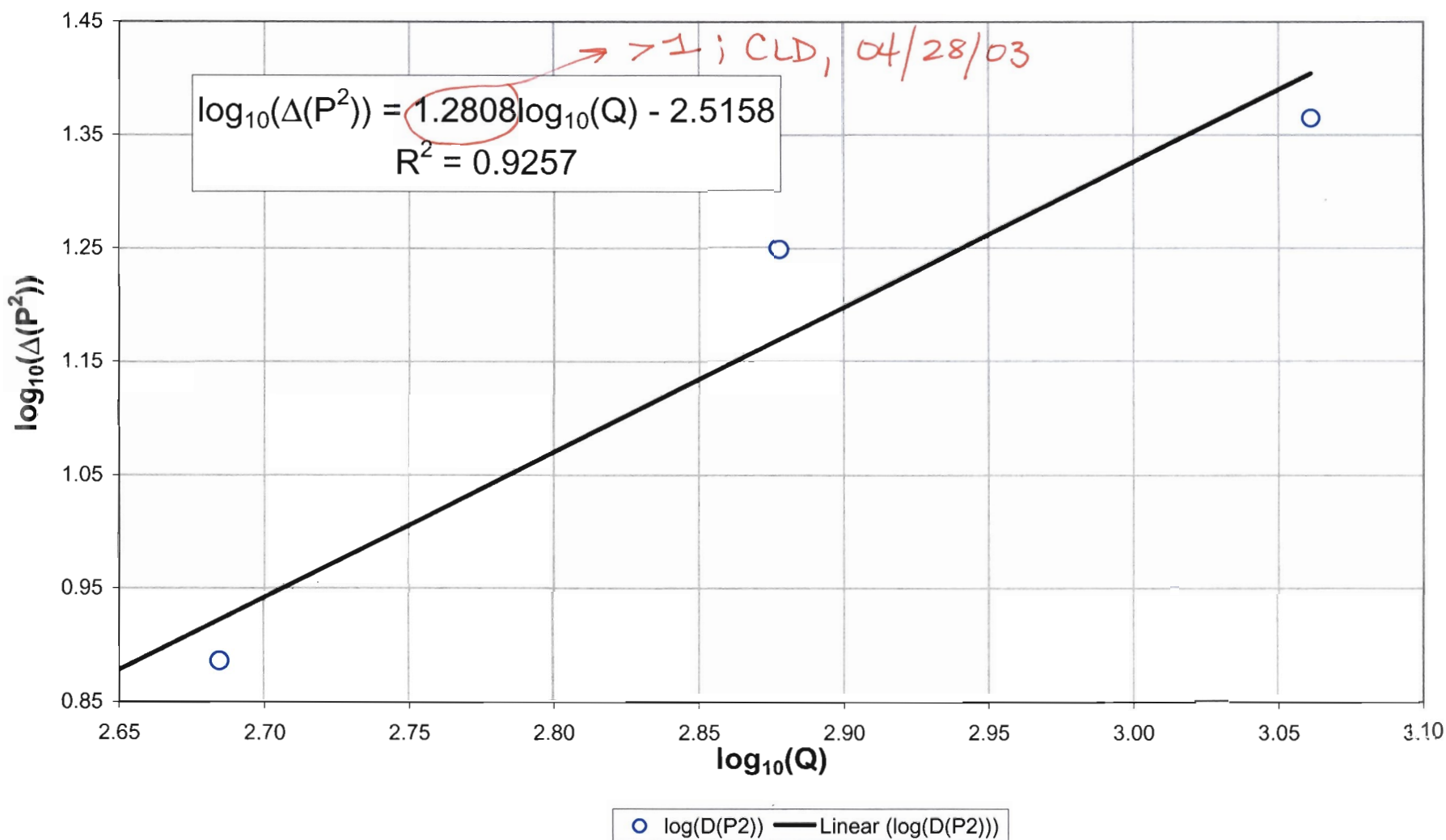○ D(P2) —— Poly. (D(P2)) —— Poly. (D(P2)) —— Linear (D(P2)) —— Linear (D(P2))

RNM, 08/27/02

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
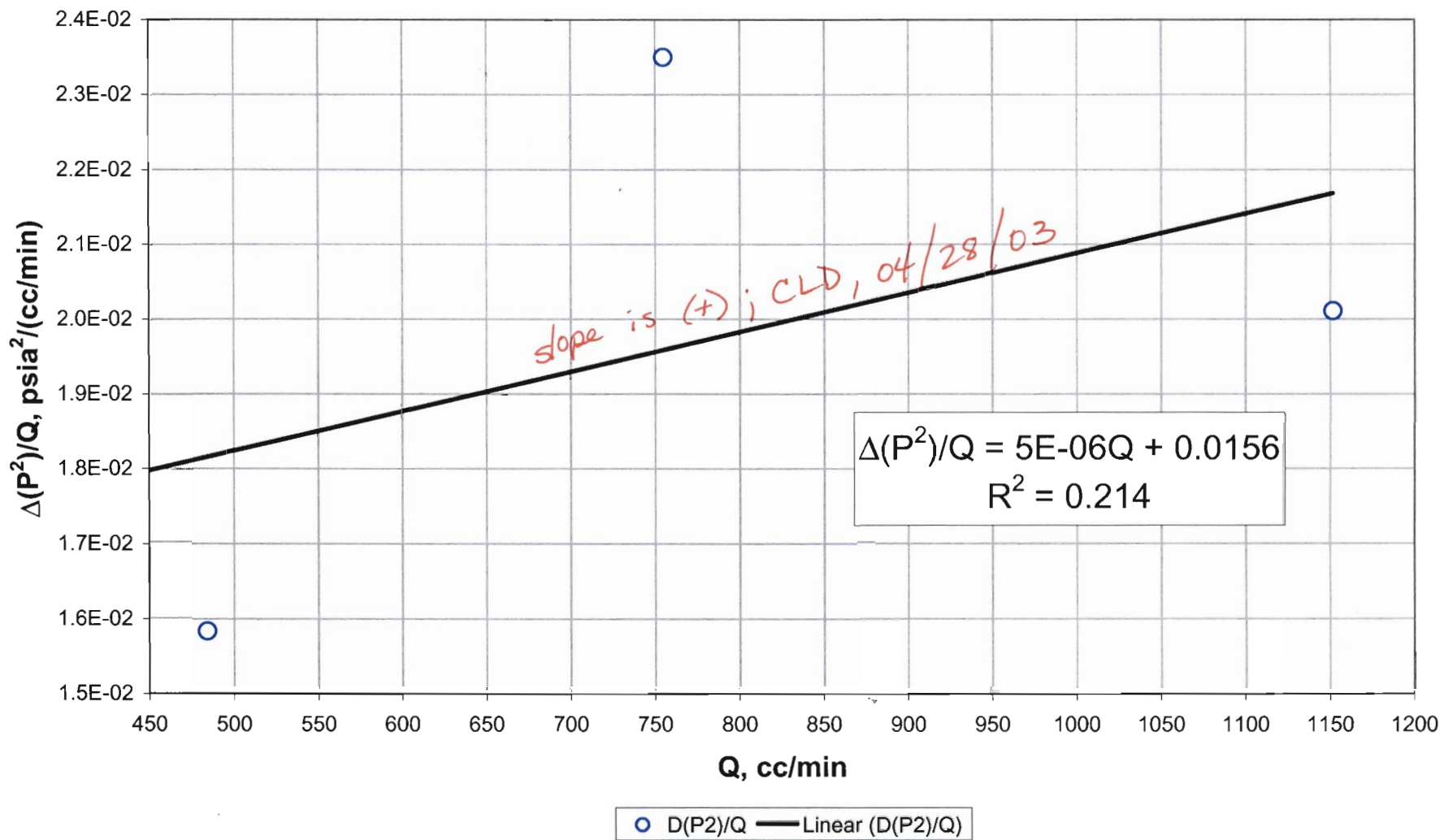### X Transect: Drillhole 45

RNM, 08/27/03

$$\log_{10}(\Delta(P^2)) = 1.2808\log_{10}(Q) - 2.5158$$
$$R^2 = 0.9257$$

> > 1 ; CLD, 04/28/03

Y-axis: $\log_{10}(\Delta(P^2))$
X-axis: $\log_{10}(Q)$

Legend: o log(D(P2)) —Linear (log(D(P2)))

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 45
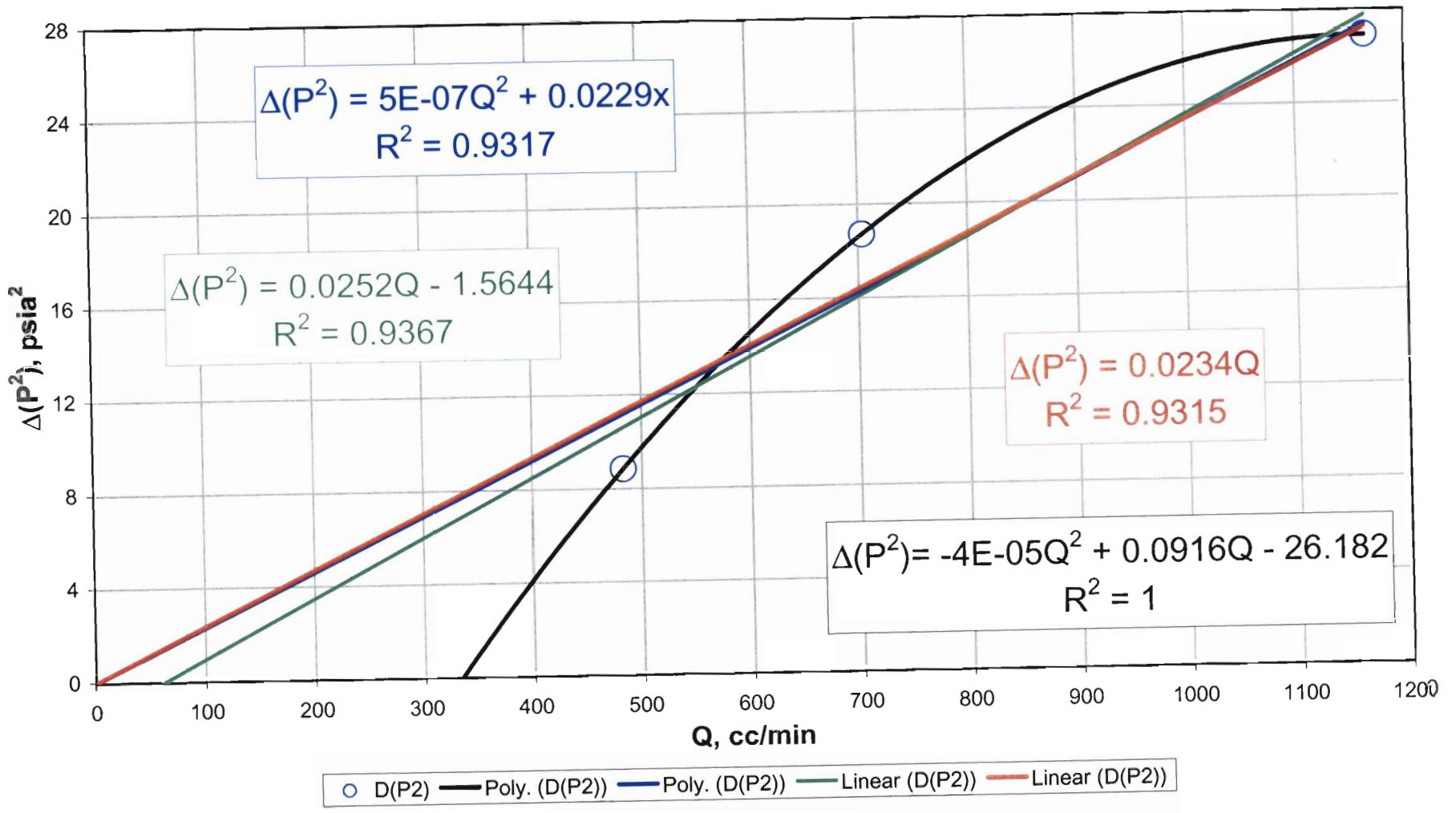
RNM, 08/27/03

slope is (+) ; CLD, 04/28/03

$$\Delta(P^2)/Q = 5E\text{-}06Q + 0.0156$$
$$R^2 = 0.214$$

Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)
X-axis: Q, cc/min
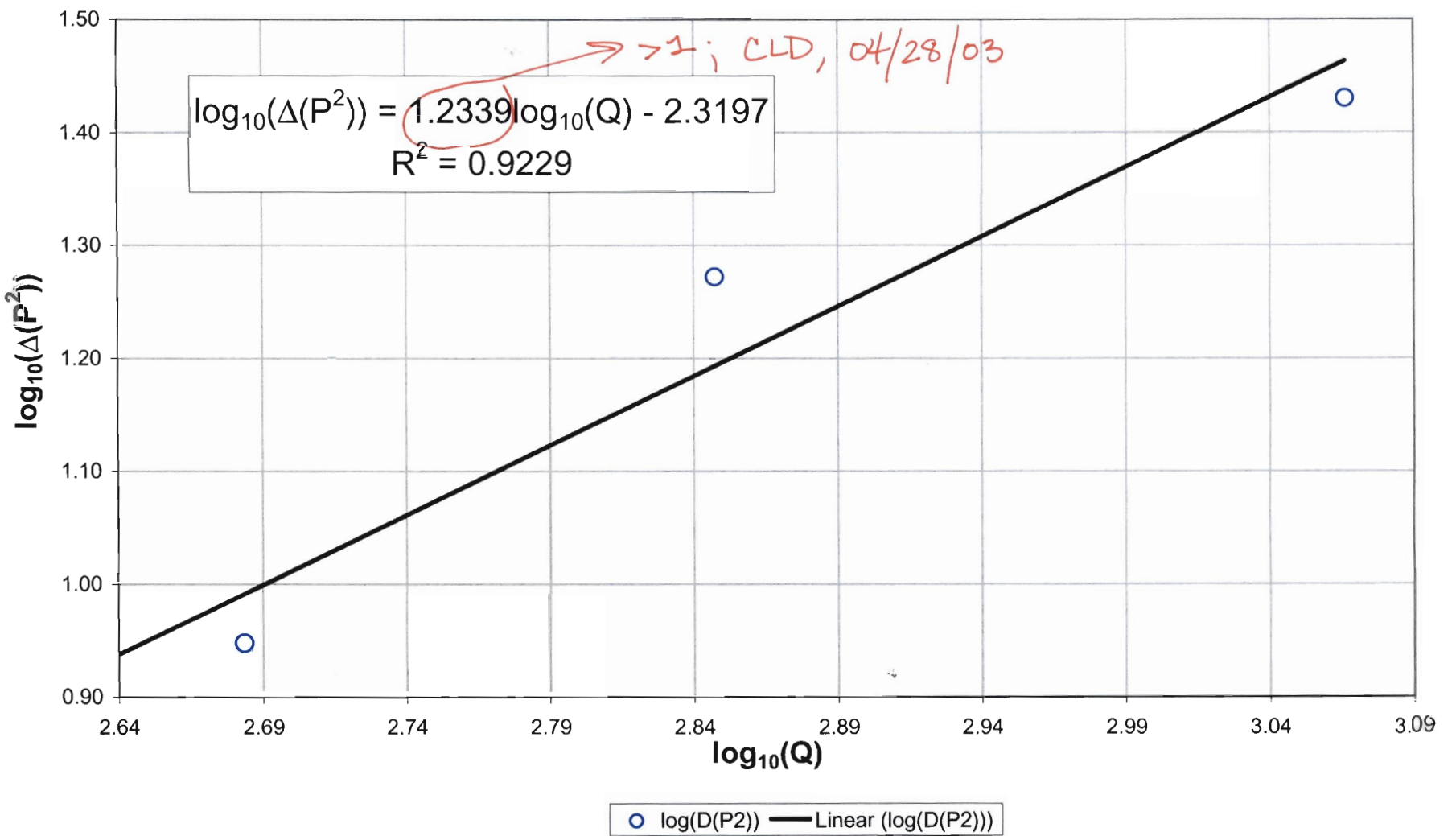
Legend: o D(P2)/Q —Linear (D(P2)/Q)

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 46

$$\Delta(P^2) = 5E\text{-}07Q^2 + 0.0229x$$
$$R^2 = 0.9317$$

$$\Delta(P^2) = 0.0252Q - 1.5644$$
$$R^2 = 0.9367$$

$$\Delta(P^2) = 0.0234Q$$
$$R^2 = 0.9315$$

$$\Delta(P^2) = -4E\text{-}05Q^2 + 0.0916Q - 26.182$$
$$R^2 = 1$$

Y-axis: $\Delta(P^2)$, psia^2

X-axis: Q, cc/min

Legend: ○ D(P2) —Poly. (D(P2)) —Poly. (D(P2)) —Linear (D(P2)) —Linear (D(P2))
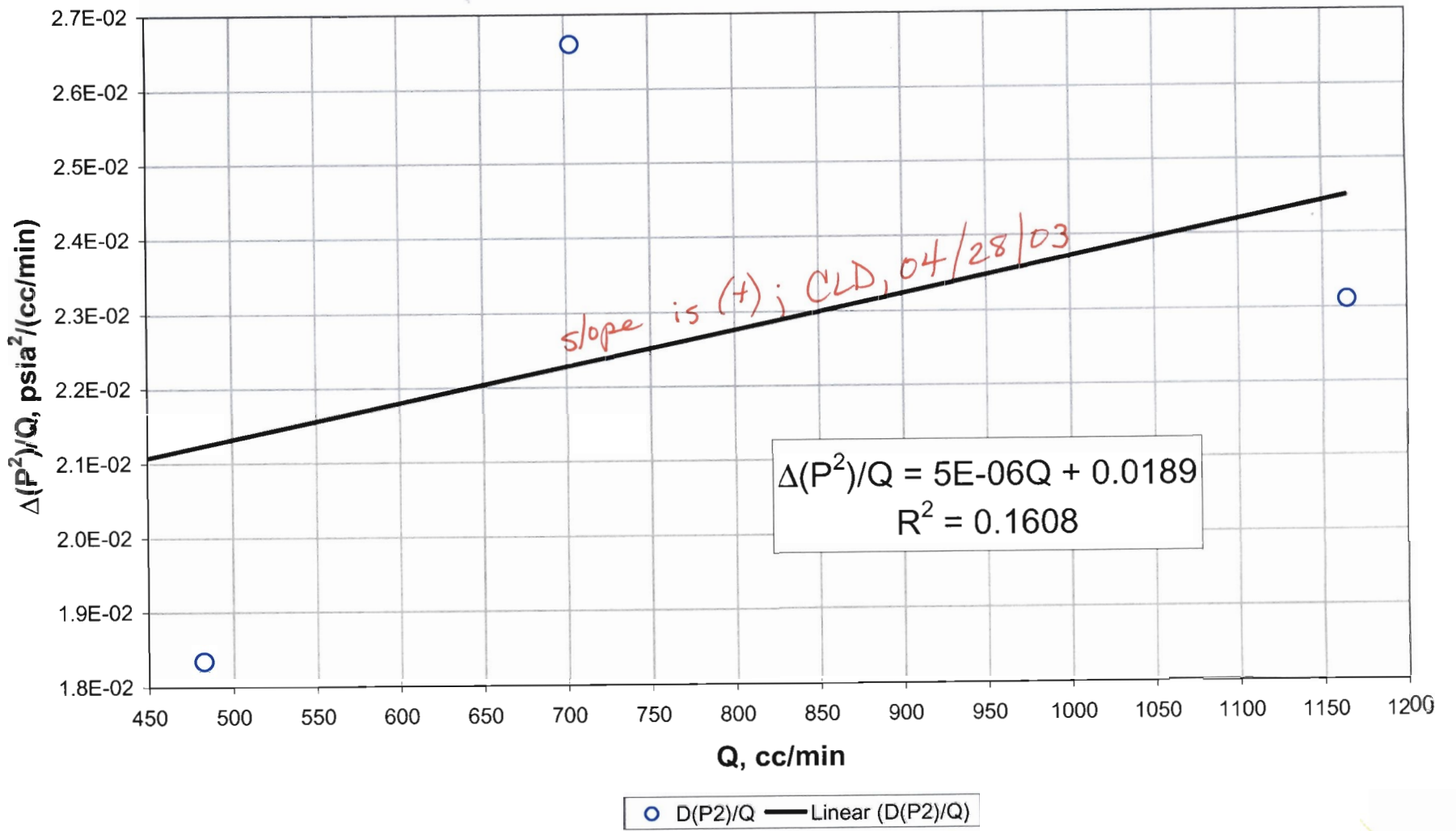
RNM, 08/27/02

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
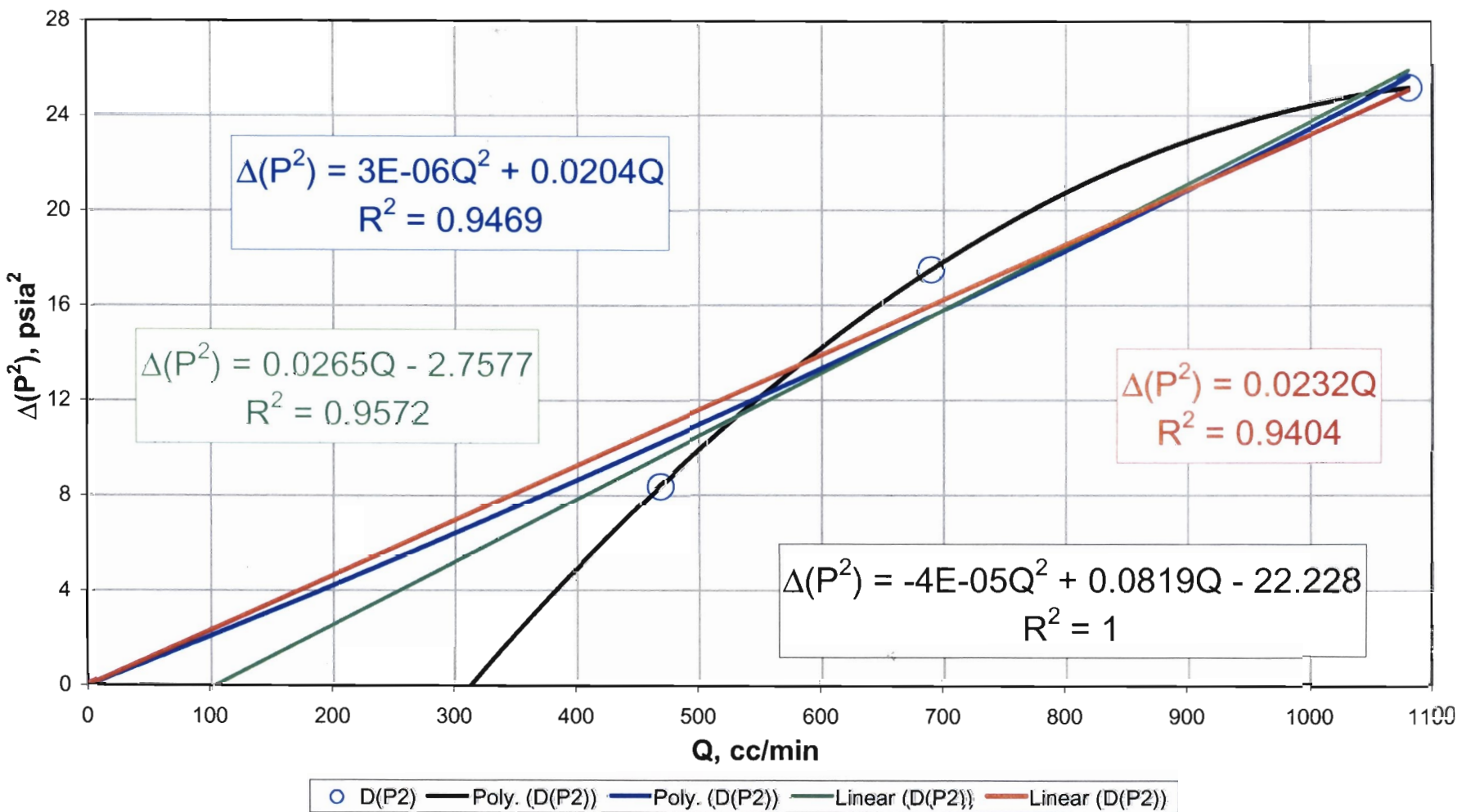**X Transect: Drillhole 46**

>1; CLD, 04/28/03

$$\log_{10}(\Delta(P^2)) = 1.2339\log_{10}(Q) - 2.3197$$
$$R^2 = 0.9229$$

Y-axis: $\log_{10}(\Delta(P^2))$

X-axis: $\log_{10}(Q)$

Legend: ○ log(D(P2)) —Linear (log(D(P2)))

RNM, 08/27/02

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 46

slope is (+) ; CLD, 04/28/03

$$\Delta(P^2)/Q = 5E\text{-}06Q + 0.0189$$
$$R^2 = 0.1608$$

Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)
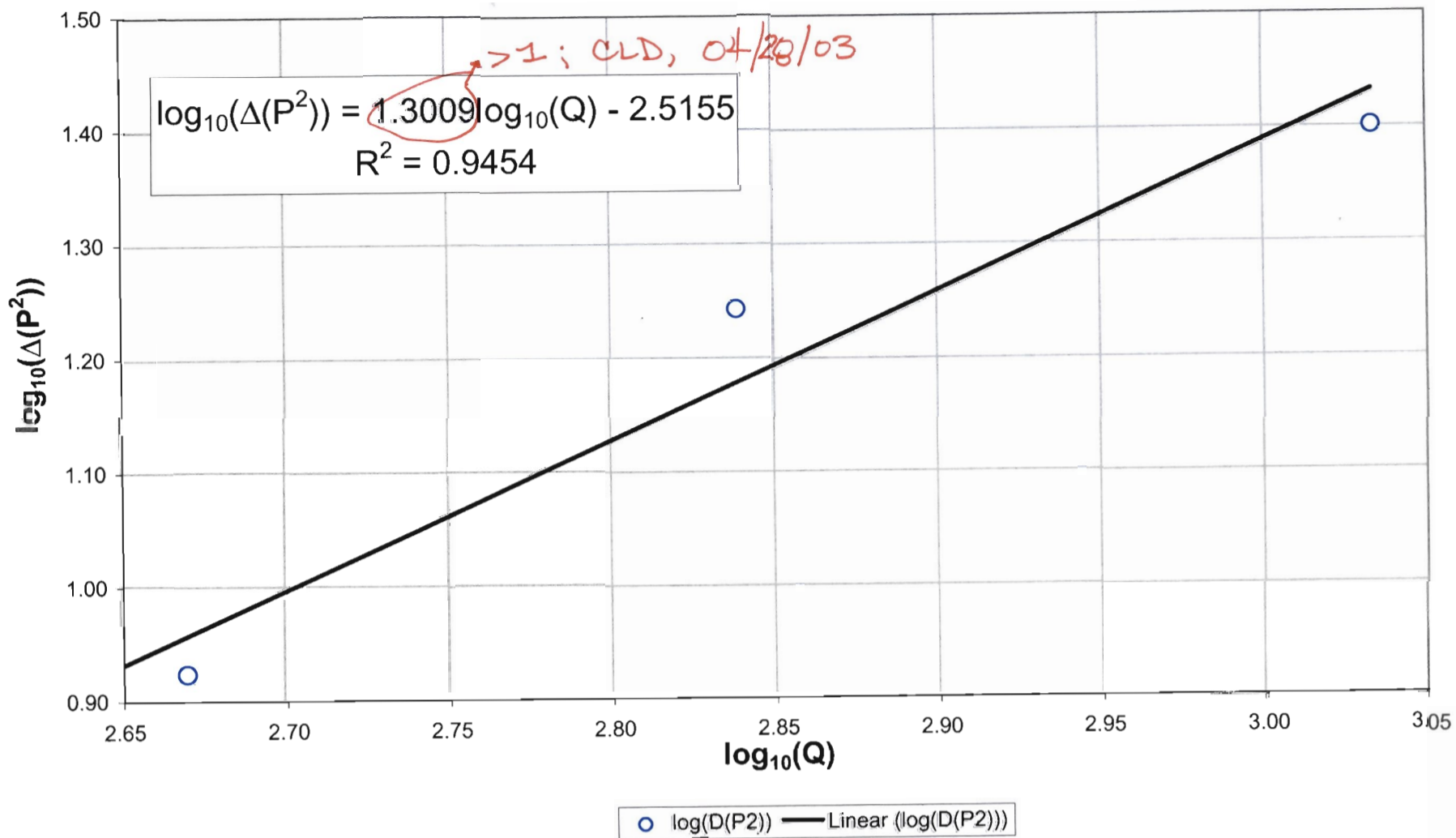X-axis: Q, cc/min

○ D(P2)/Q —— Linear (D(P2)/Q)

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 47

$$\Delta(P^2) = 3E\text{-}06Q^2 + 0.0204Q$$
$$R^2 = 0.9469$$

$$\Delta(P^2) = 0.0265Q - 2.7577$$
$$R^2 = 0.9572$$

$$\Delta(P^2) = 0.0232Q$$
$$R^2 = 0.9404$$

$$\Delta(P^2) = -4E\text{-}05Q^2 + 0.0819Q - 22.228$$
$$R^2 = 1$$

Y-axis: $\Delta(P^2)$, psia^2
X-axis: Q, cc/min

○ D(P2) —— Poly. (D(P2)) —— Poly. (D(P2)) —— Linear (D(P2)) —— Linear (D(P2))
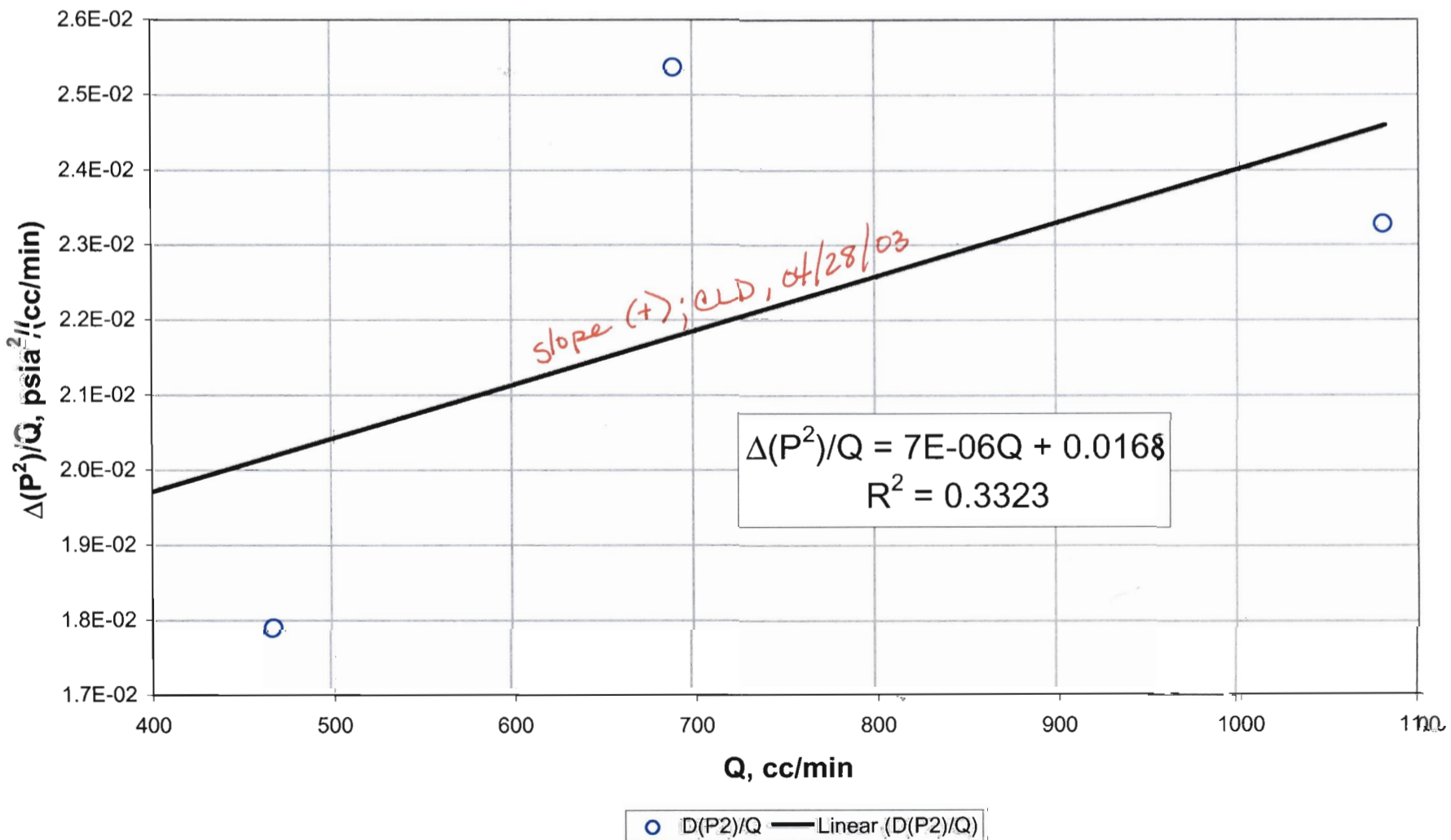
Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 47

>1; CLD, 04/28/03

$$\log_{10}(\Delta(P^2)) = 1.3009\log_{10}(Q) - 2.5155$$
$$R^2 = 0.9454$$

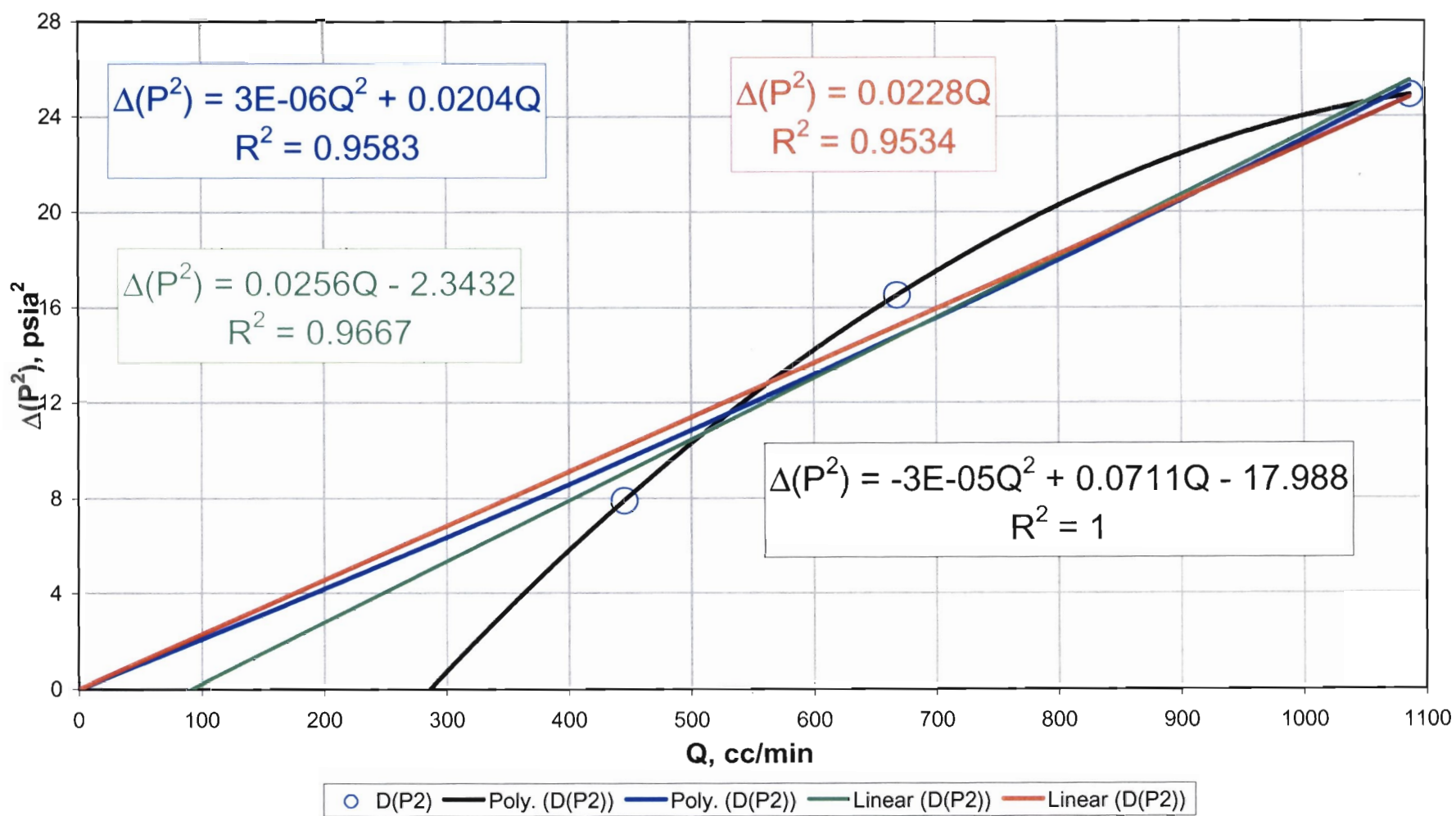RNM, 08/27/02

○ log(D(P2)) ——Linear (log(D(P2)))

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 47

slope (+); CLD, 04/28/03

$$\Delta(P^2)/Q = 7E{-}06Q + 0.0168$$
$$R^2 = 0.3323$$

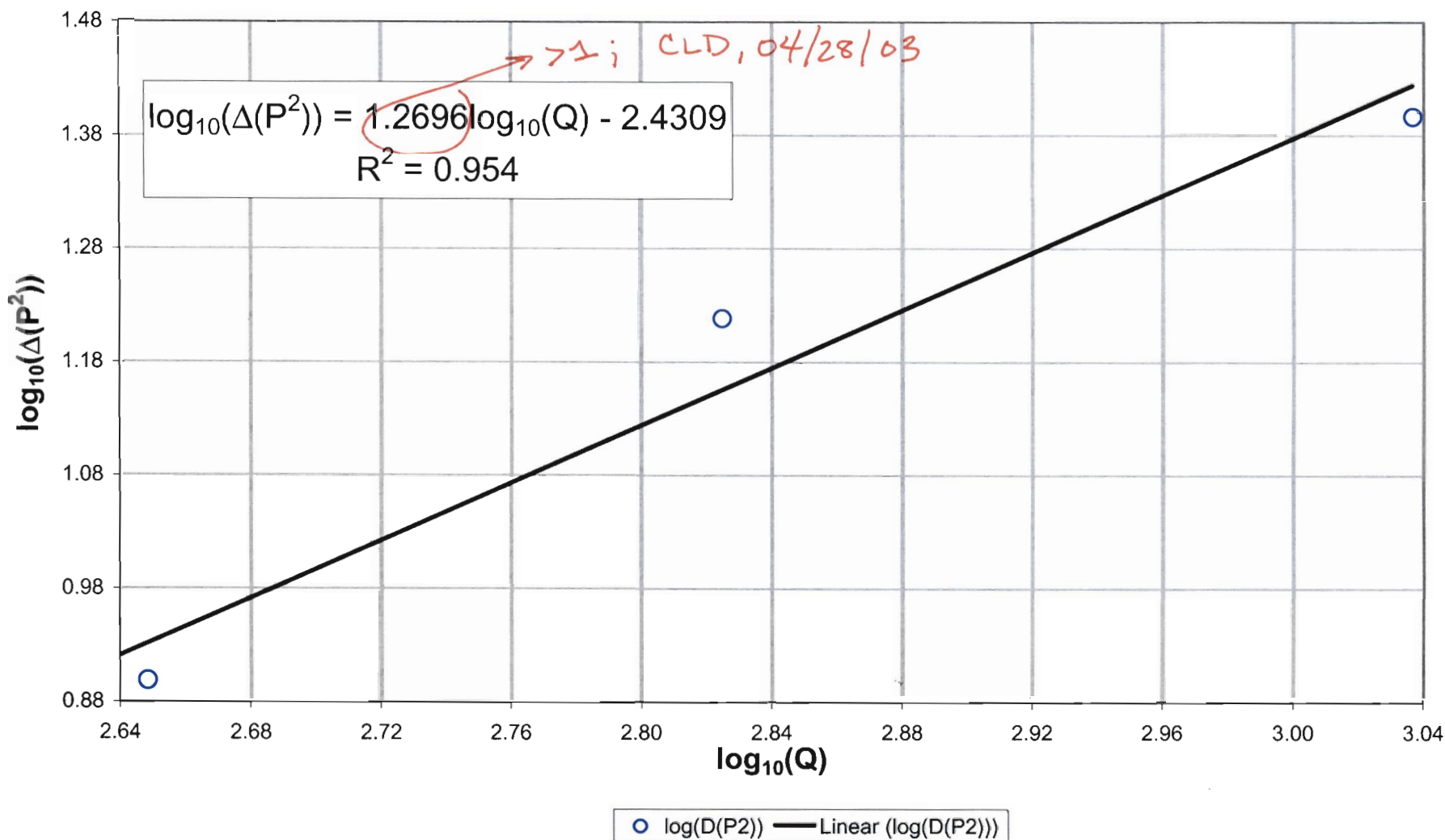RNM, 08/27/02

○ D(P2)/Q ——Linear (D(P2)/Q)

RnM, 08/27/09

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 48

$\Delta(P^2) = 3E\text{-}06Q^2 + 0.0204Q$
$R^2 = 0.9583$

$\Delta(P^2) = 0.0228Q$
$R^2 = 0.9534$

$\Delta(P^2) = 0.0256Q - 2.3432$
$R^2 = 0.9667$

$\Delta(P^2) = -3E\text{-}05Q^2 + 0.0711Q - 17.988$
$R^2 = 1$

Y-axis: $\Delta(P^2)$, psia^2
X-axis: Q, cc/min

Legend: O D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))
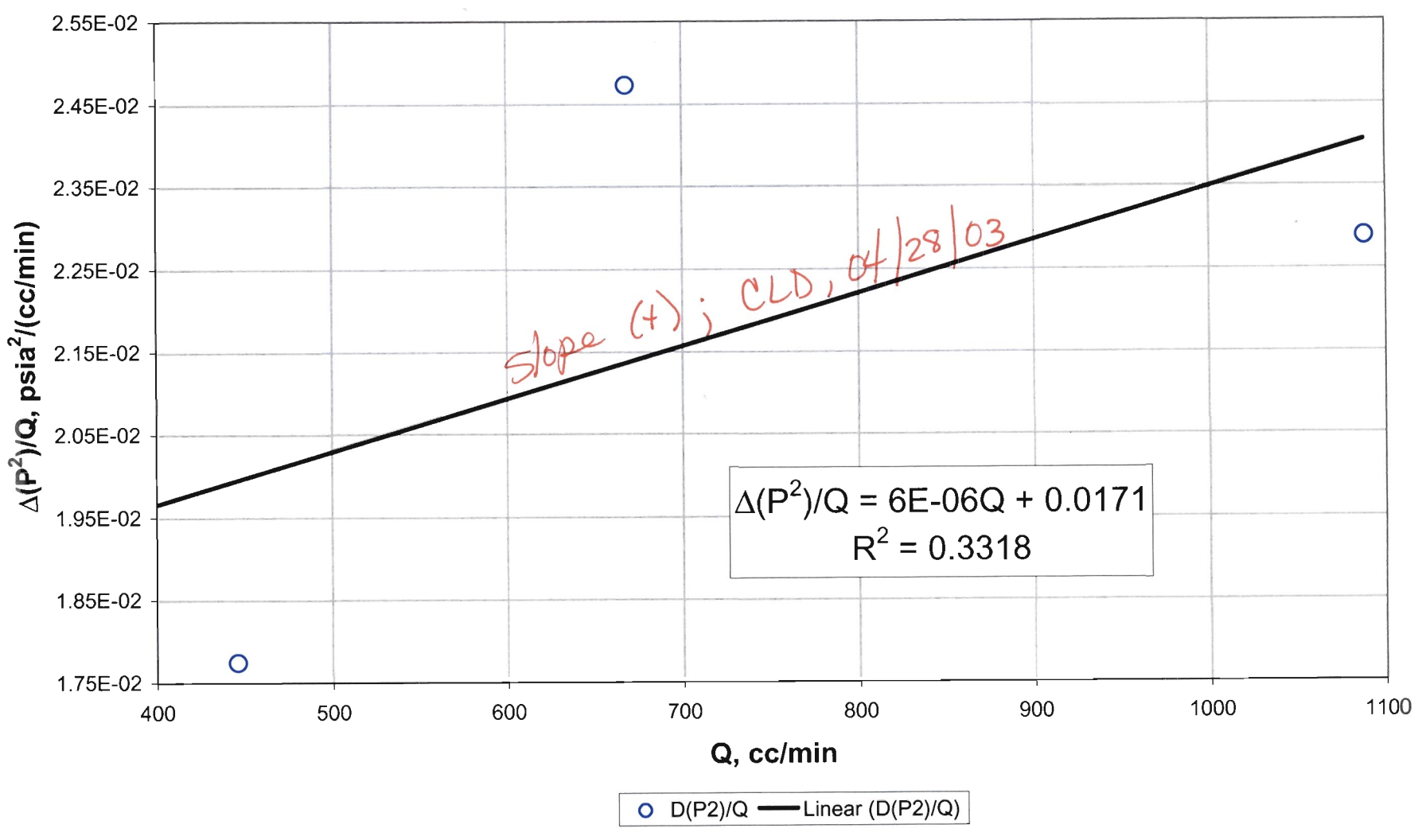
RnM, 08/27/09

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 48

→ >1; CLD, 04/28/03

$\log_{10}(\Delta(P^2)) = 1.2696\log_{10}(Q) - 2.4309$
$R^2 = 0.954$

Y-axis: $\log_{10}(\Delta(P^2))$
X-axis: $\log_{10}(Q)$

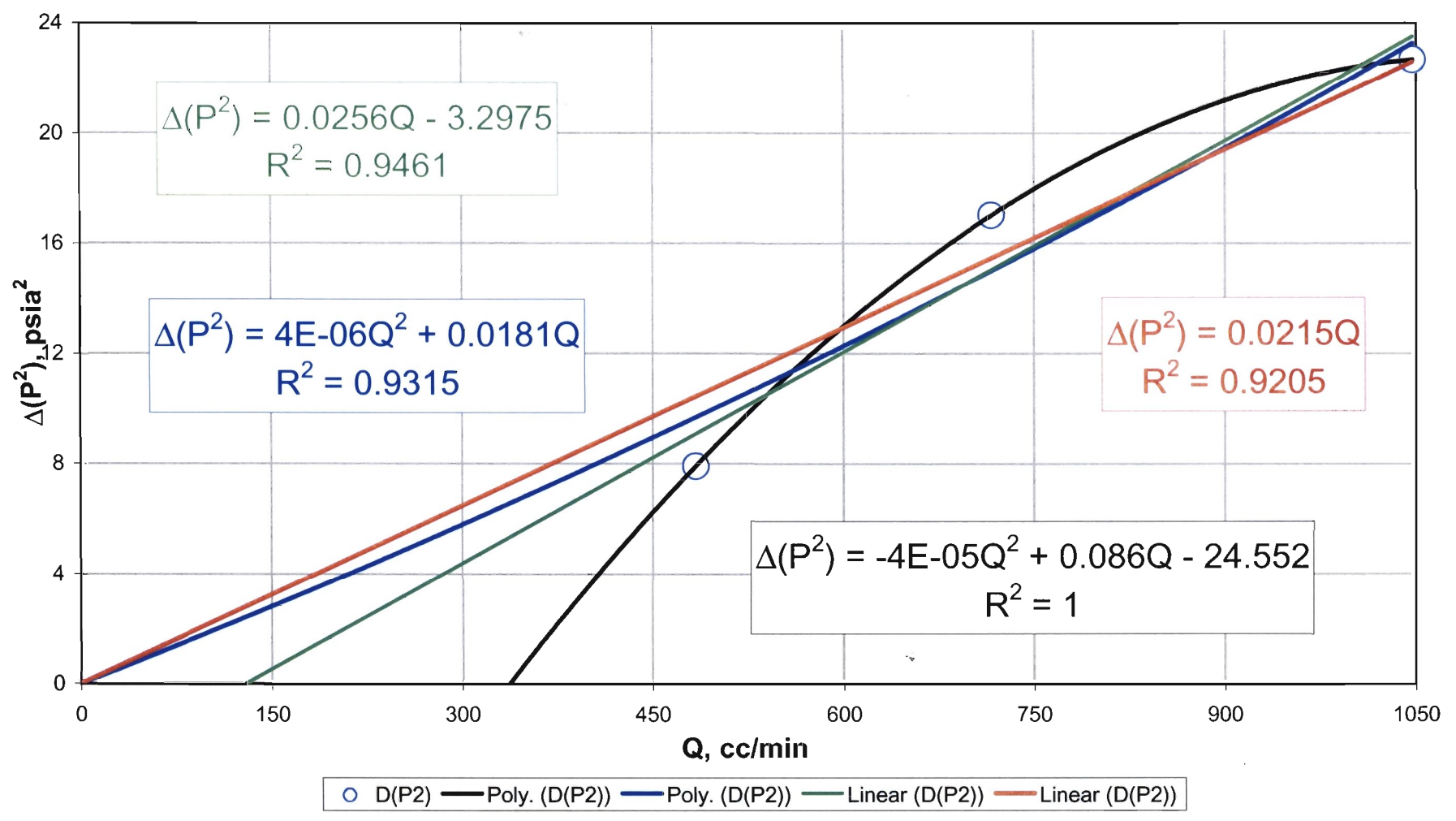Legend: O log(D(P2)) — Linear (log(D(P2)))

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 48

Slope (+); CLD, 04/28/03

$$\Delta(P^2)/Q = 6E\text{-}06Q + 0.0171$$
$$R^2 = 0.3318$$

Axis labels: $\Delta(P^2)/Q$, psia^2/(cc/min) vs Q, cc/min

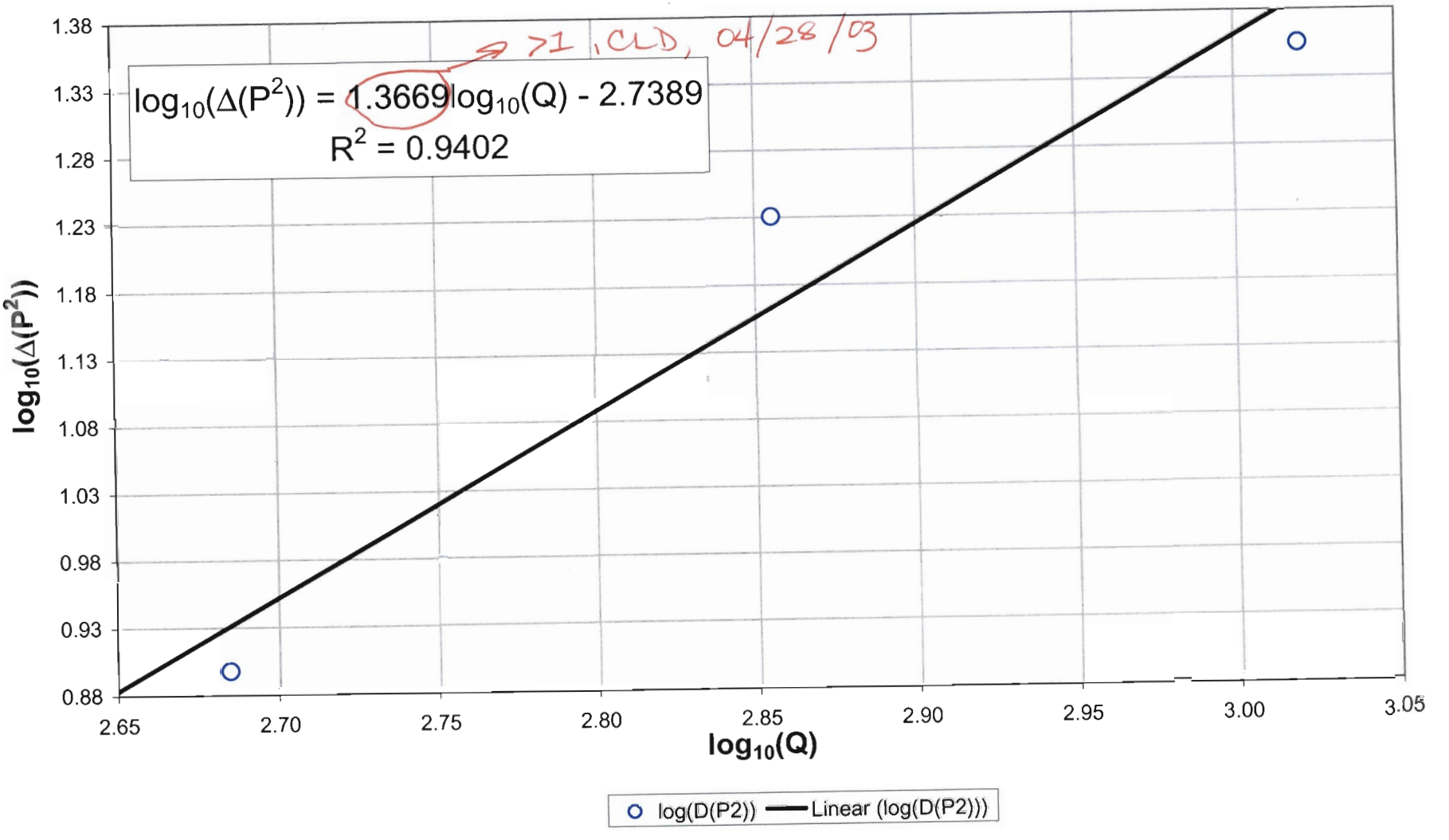Legend: o D(P2)/Q — Linear (D(P2)/Q)

RNM, 08/27/08

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 49

$$\Delta(P^2) = 0.0256Q - 3.2975$$
$$R^2 = 0.9461$$

$$\Delta(P^2) = 4E\text{-}06Q^2 + 0.0181Q$$
$$R^2 = 0.9315$$

$$\Delta(P^2) = 0.0215Q$$
$$R^2 = 0.9205$$

$$\Delta(P^2) = -4E\text{-}05Q^2 + 0.086Q - 24.552$$
$$R^2 = 1$$

Axis labels: $\Delta(P^2)$, psia^2 vs Q, cc/min

Legend: o D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))
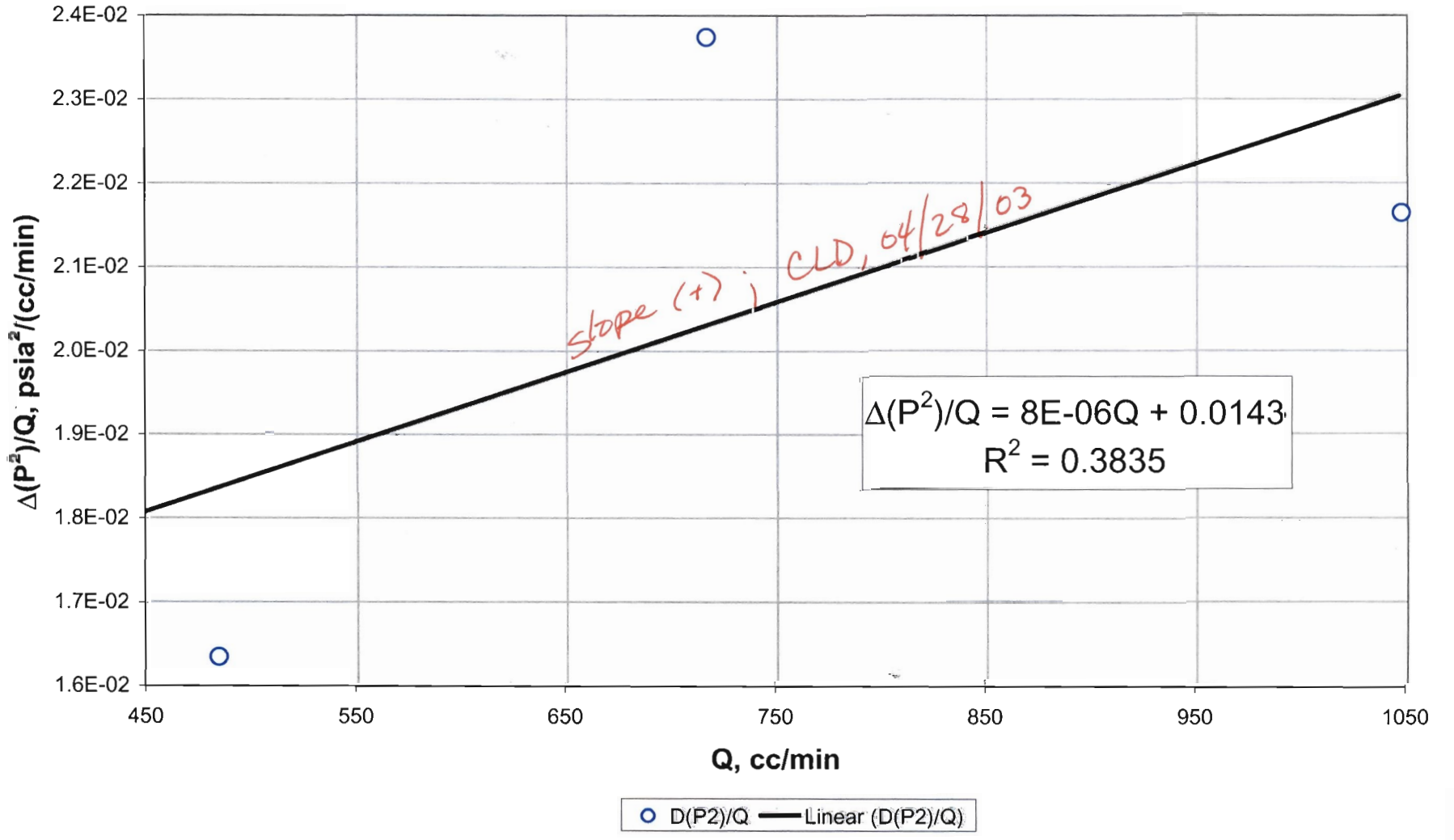
RNM, 08/27/08

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 49

→ >1 , CLD, 04/28/03

$$\log_{10}(\Delta(P^2)) = 1.3669 \log_{10}(Q) - 2.7389$$
$$R^2 = 0.9402$$

y-axis: $\log_{10}(\Delta(P^2))$
x-axis: $\log_{10}(Q)$

Legend: ○ log(D(P2)) ——Linear (log(D(P2)))
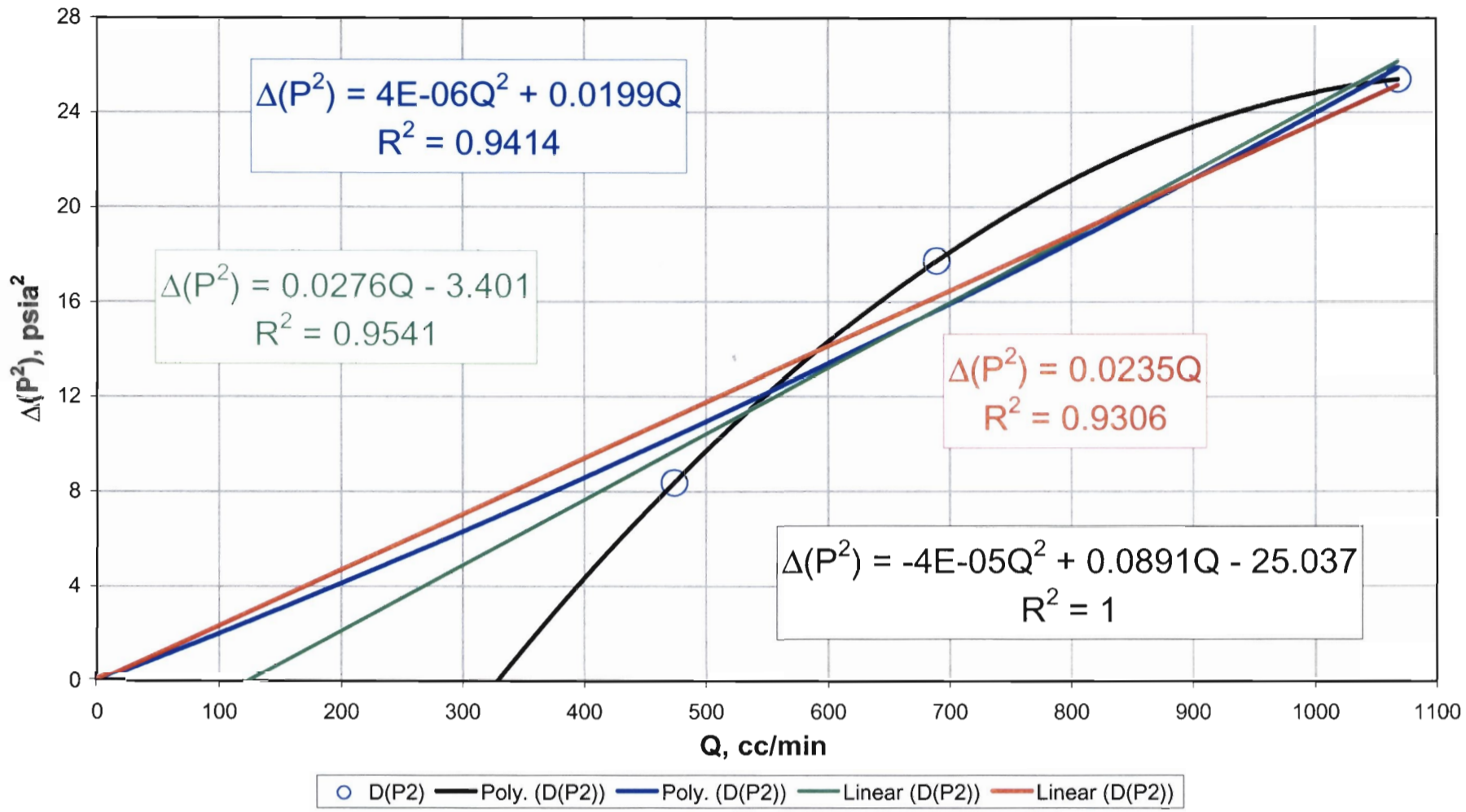
RNM, 08/27/02

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 49

slope (+) ; CLD, 04/28/03

$$\Delta(P^2)/Q = 8E\text{-}06Q + 0.0143$$
$$R^2 = 0.3835$$

y-axis: $\Delta(P^2)/Q$, psia²/(cc/min)
x-axis: Q, cc/min

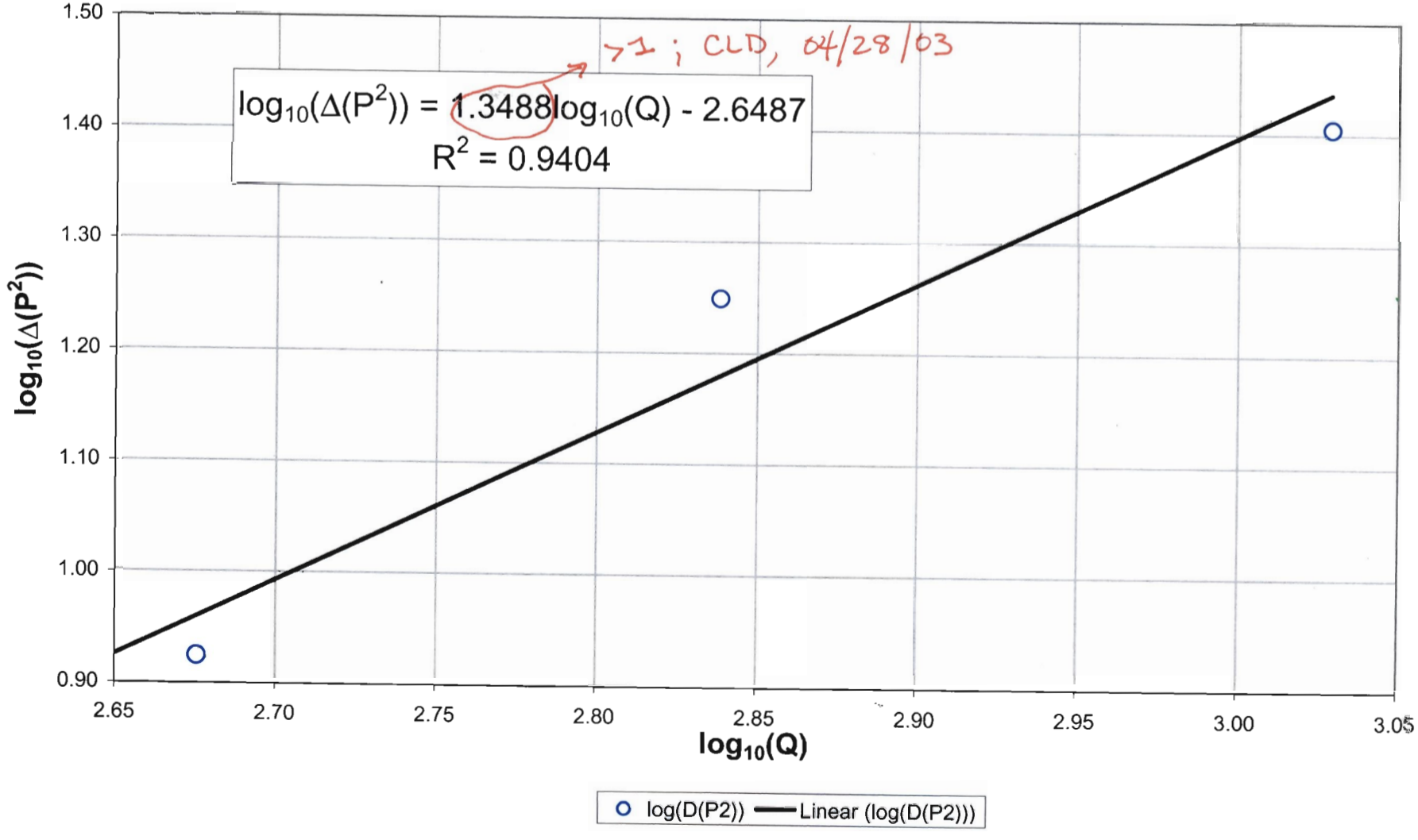Legend: ○ D(P2)/Q ——Linear (D(P2)/Q)

RNM, 08/27/02

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 50

$$\Delta(P^2) = 4E\text{-}06Q^2 + 0.0199Q$$
$$R^2 = 0.9414$$

$$\Delta(P^2) = 0.0276Q - 3.401$$
$$R^2 = 0.9541$$

$$\Delta(P^2) = 0.0235Q$$
$$R^2 = 0.9306$$

$$\Delta(P^2) = -4E\text{-}05Q^2 + 0.0891Q - 25.037$$
$$R^2 = 1$$

Y-axis: $\Delta(P^2)$, psia^2
X-axis: Q, cc/min

Legend: ○ D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))
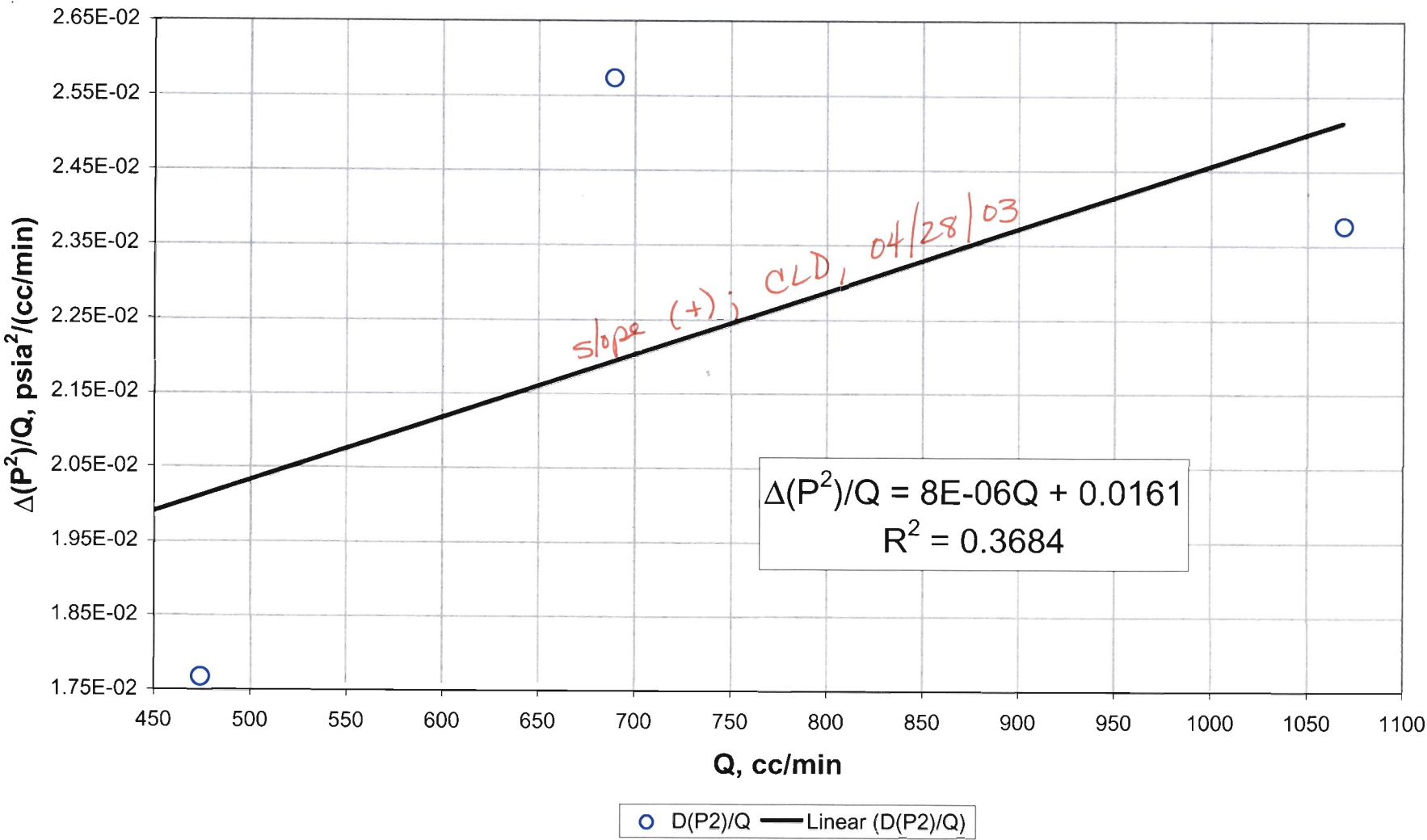
RNM, 08/27/02

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 50

→ >1 ; CLD, 04/28/03

$$\log_{10}(\Delta(P^2)) = 1.3488\log_{10}(Q) - 2.6487$$
$$R^2 = 0.9404$$

Y-axis: $\log_{10}(\Delta(P^2))$
X-axis: $\log_{10}(Q)$

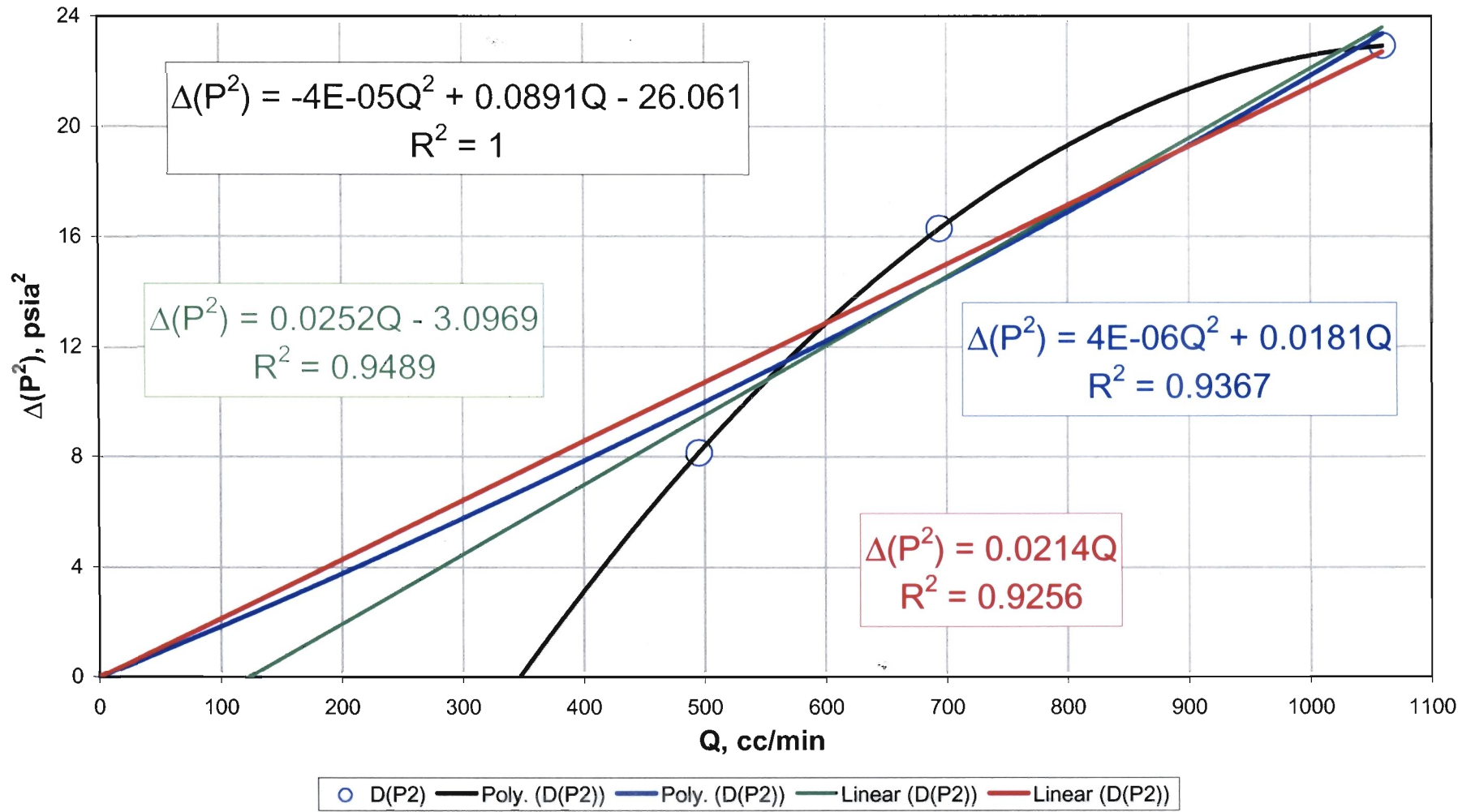Legend: ○ log(D(P2)) — Linear (log(D(P2)))

RNM, 08/27/02

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 50

$$\Delta(P^2)/Q = 8E\text{-}06Q + 0.0161$$
$$R^2 = 0.3684$$

slope (+); CLD, 04/28/03

X axis: Q, cc/min
Y axis: $\Delta(P^2)/Q$, psia^2/(cc/min)

Legend: D(P2)/Q — Linear (D(P2)/Q)

RWM, 08/27/03

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 51

$$\Delta(P^2) = -4E\text{-}05Q^2 + 0.0891Q - 26.061$$
$$R^2 = 1$$

$$\Delta(P^2) = 0.0252Q - 3.0969$$
$$R^2 = 0.9489$$

$$\Delta(P^2) = 4E\text{-}06Q^2 + 0.0181Q$$
$$R^2 = 0.9367$$

$$\Delta(P^2) = 0.0214Q$$
$$R^2 = 0.9256$$

X axis: Q, cc/min
Y axis: $\Delta(P^2)$, psia^2

Legend: D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))
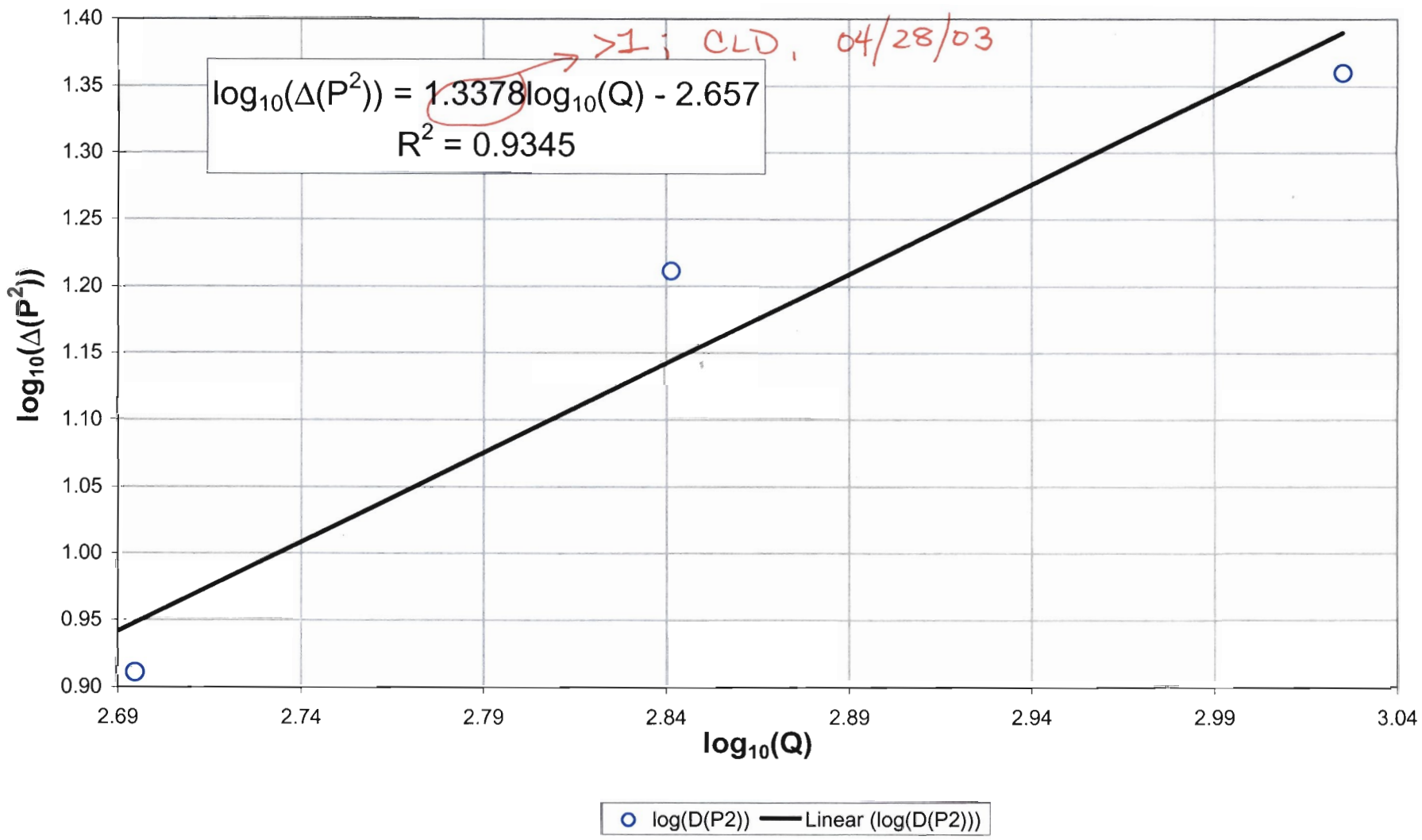
RWM, 08/27/03

RNM, 08/27/02

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 51

$\log_{10}(\Delta(P^2)) = 1.3378\log_{10}(Q) - 2.657$
$R^2 = 0.9345$

>1 ; CLD, 04/28/03
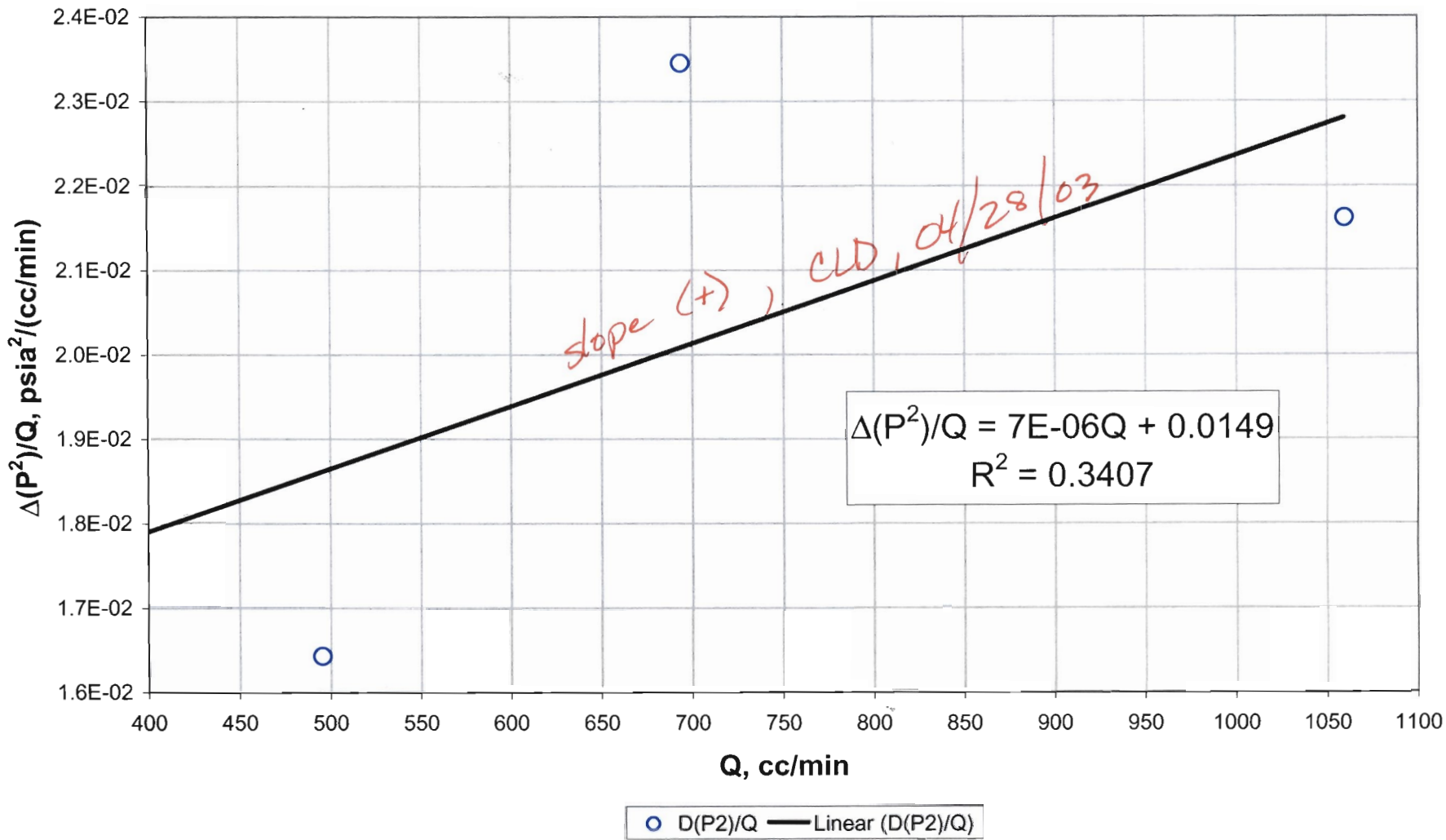
○ log(D(P2)) ——Linear (log(D(P2)))

Final check for high velocity flow effects:
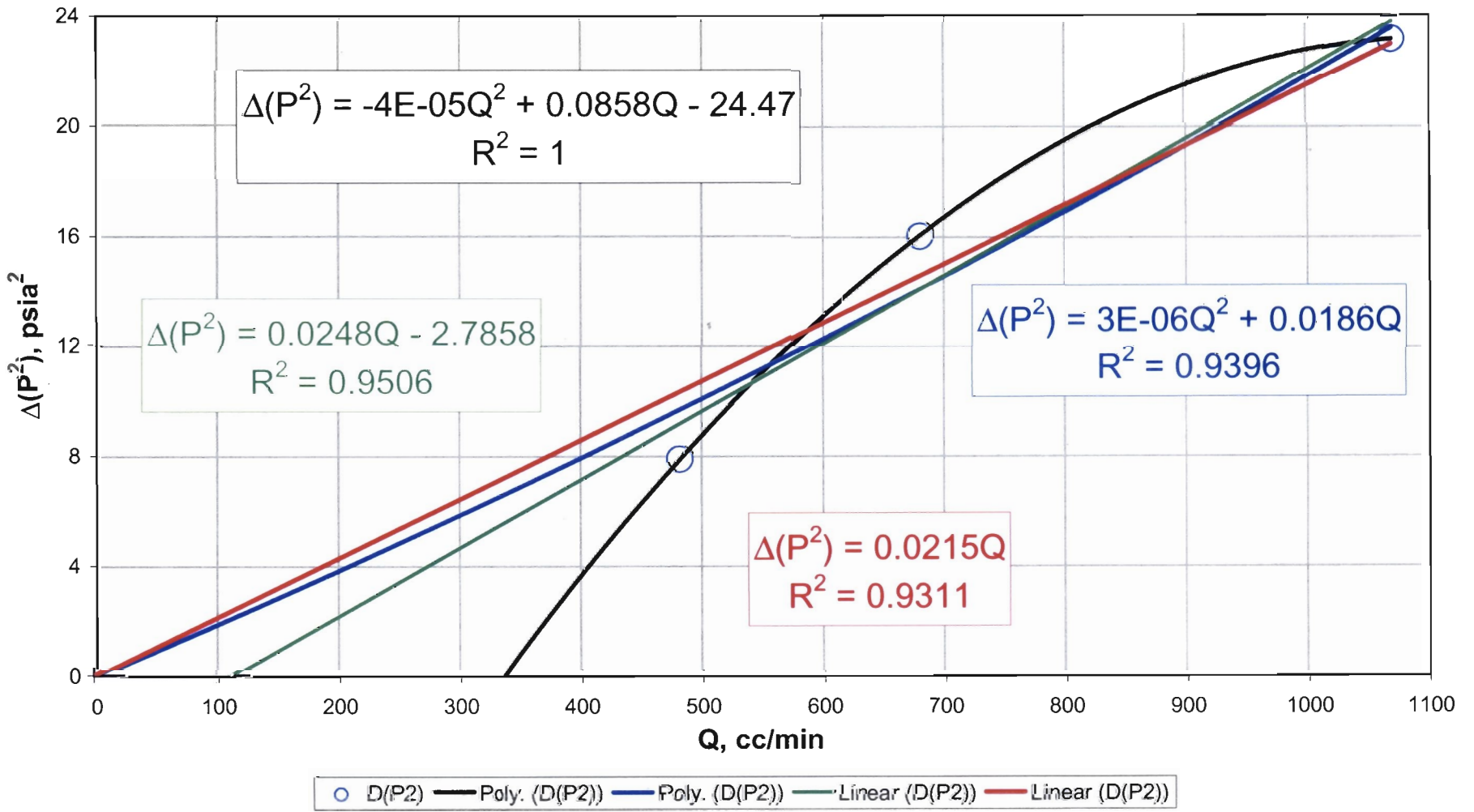**High velocity flow effects are present when the slope is non-zero and positive.**
X Transect : Drillhole 51

RNM, 08/27/02

slope (+), CLD, 04/28/03

$\Delta(P^2)/Q = 7E\text{-}06Q + 0.0149$
$R^2 = 0.3407$
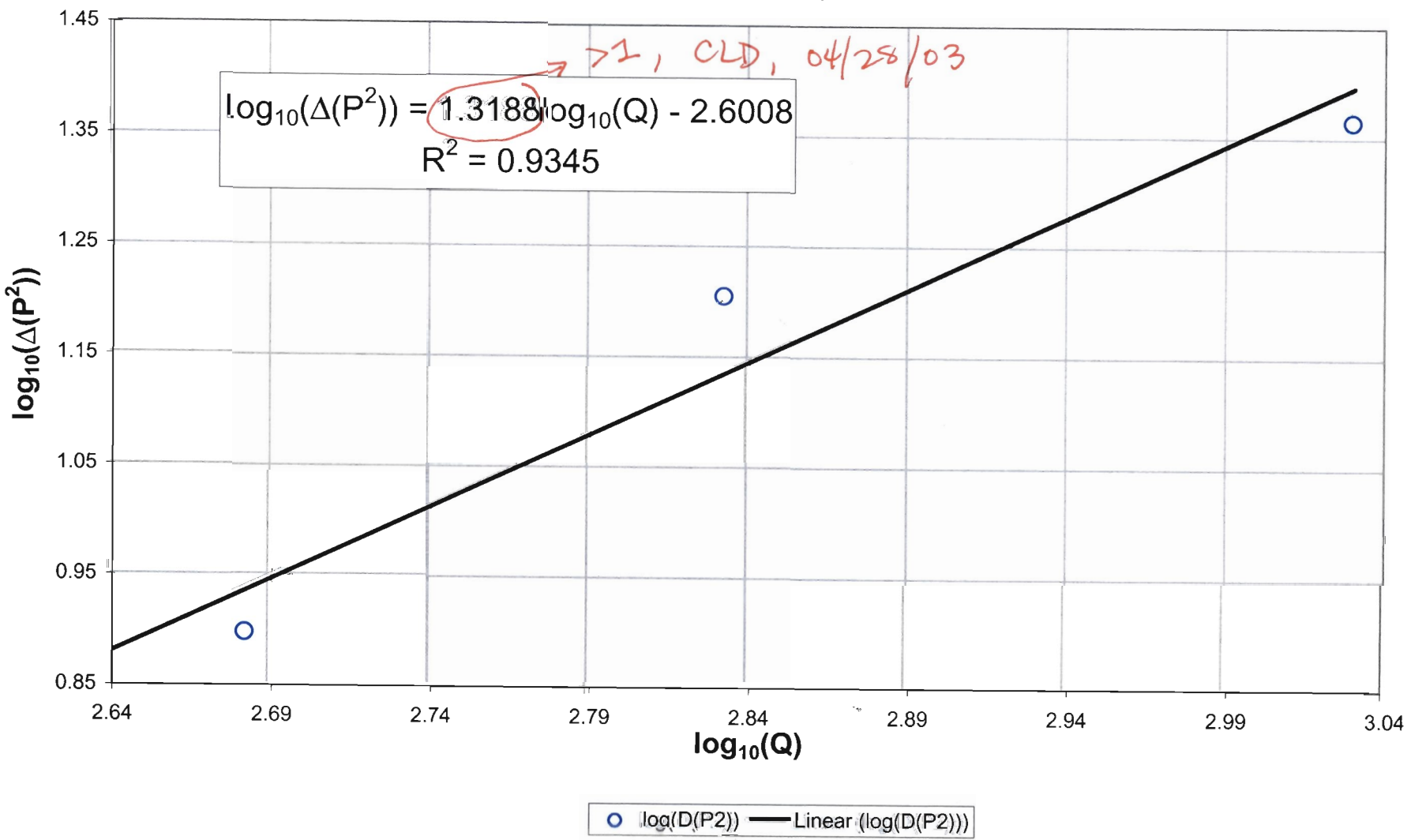
○ D(P2)/Q ——Linear (D(P2)/Q)

RNM, 08/27/04

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 52

$$\Delta(P^2) = -4E\text{-}05Q^2 + 0.0858Q - 24.47$$
$$R^2 = 1$$

$$\Delta(P^2) = 0.0248Q - 2.7858$$
$$R^2 = 0.9506$$

$$\Delta(P^2) = 3E\text{-}06Q^2 + 0.0186Q$$
$$R^2 = 0.9396$$

$$\Delta(P^2) = 0.0215Q$$
$$R^2 = 0.9311$$

Axis labels: $\Delta(P^2)$, psia^2 (ordinate); Q, cc/min (abscissa)

Legend: O D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))
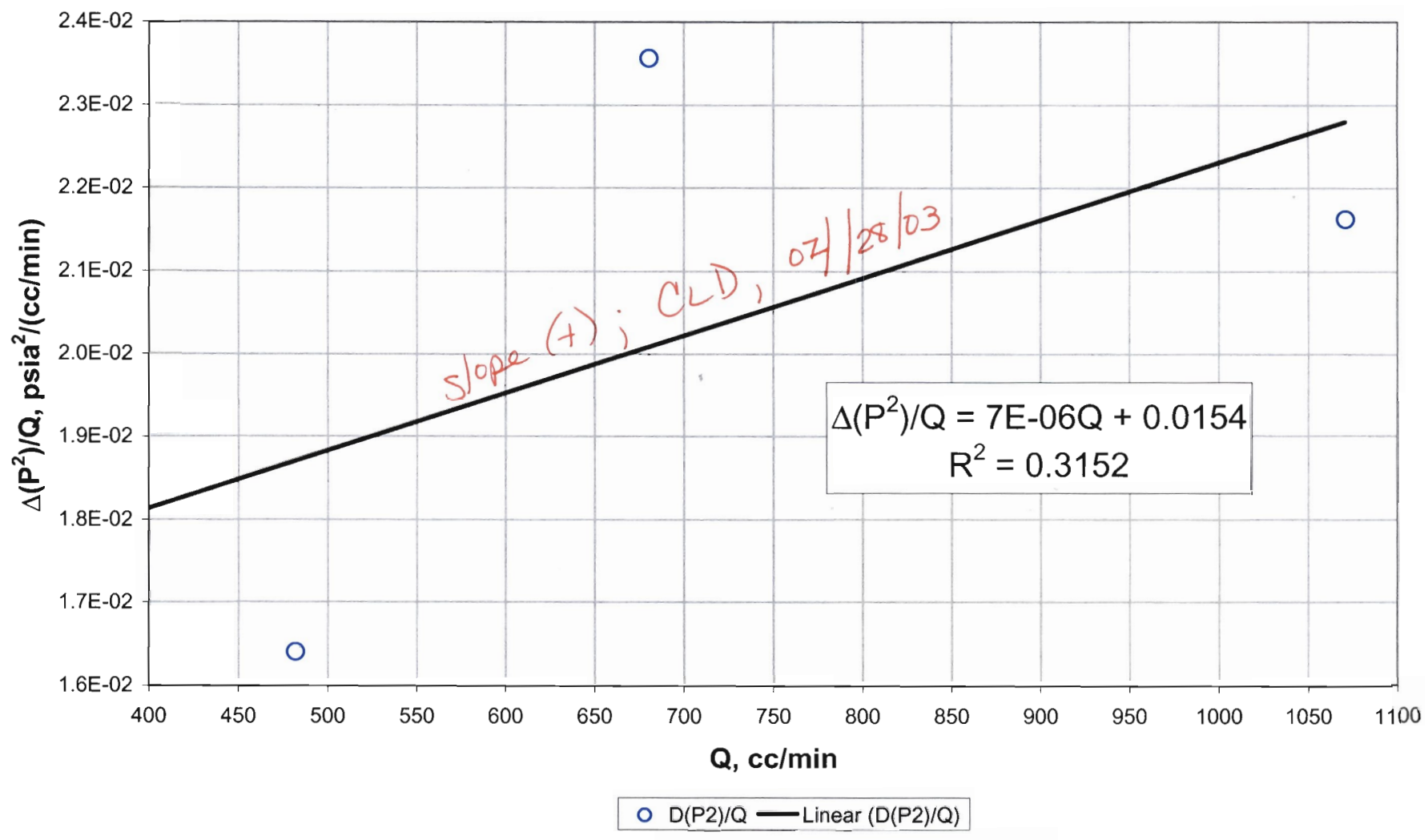
RNM, 08/27/04

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 52

➔ >1, CLD, 04/28/03

$$\log_{10}(\Delta(P^2)) = 1.3188\log_{10}(Q) - 2.6008$$
$$R^2 = 0.9345$$

Axis labels: $\log_{10}(\Delta(P^2))$ (ordinate); $\log_{10}(Q)$ (abscissa)

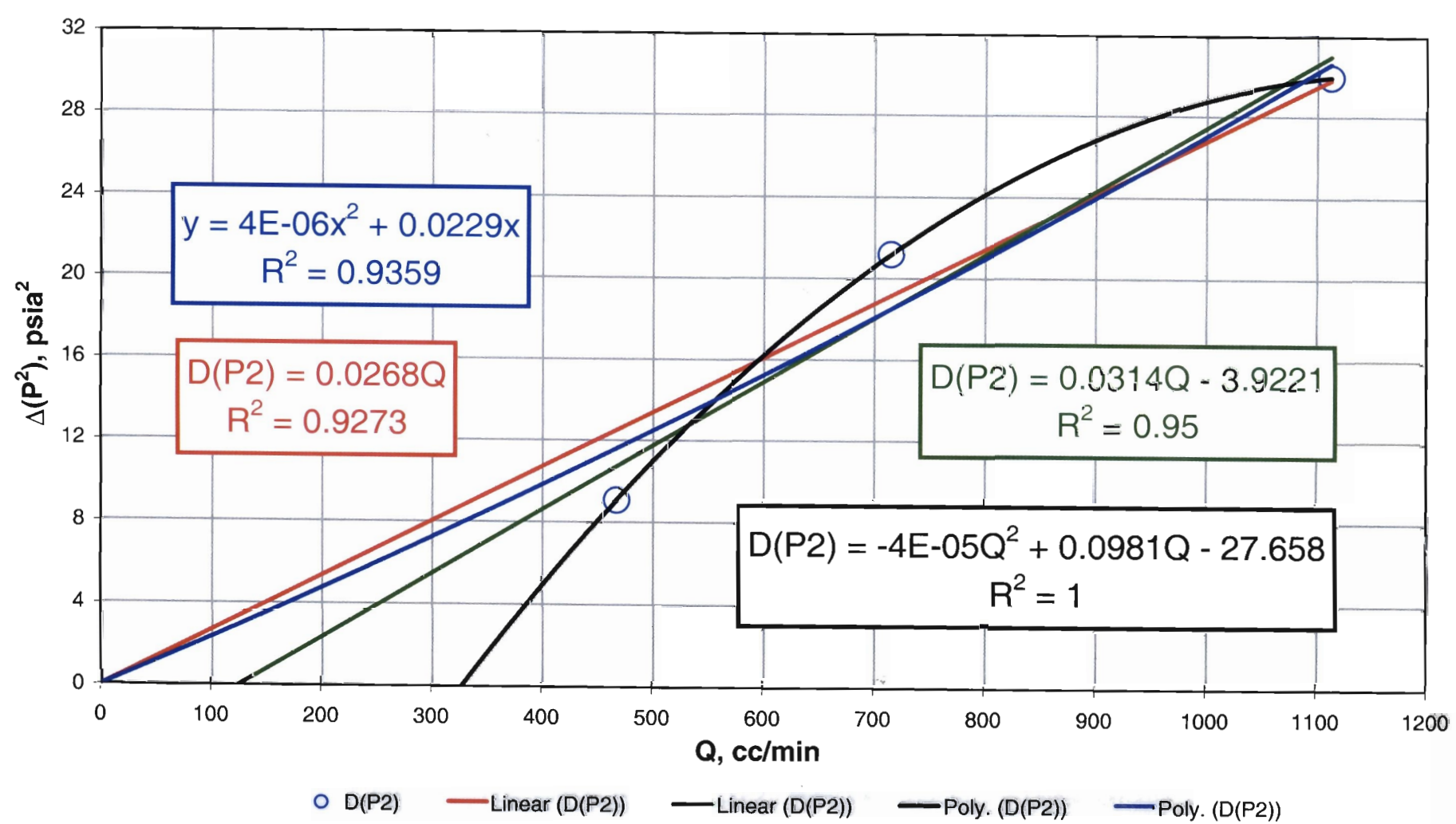Legend: O log(D(P2)) — Linear (log(D(P2)))

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 52

slope (+); CLD, 07/28/03

$$\Delta(P^2)/Q = 7E\text{-}06Q + 0.0154$$
$$R^2 = 0.3152$$

Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)
X-axis: Q, cc/min

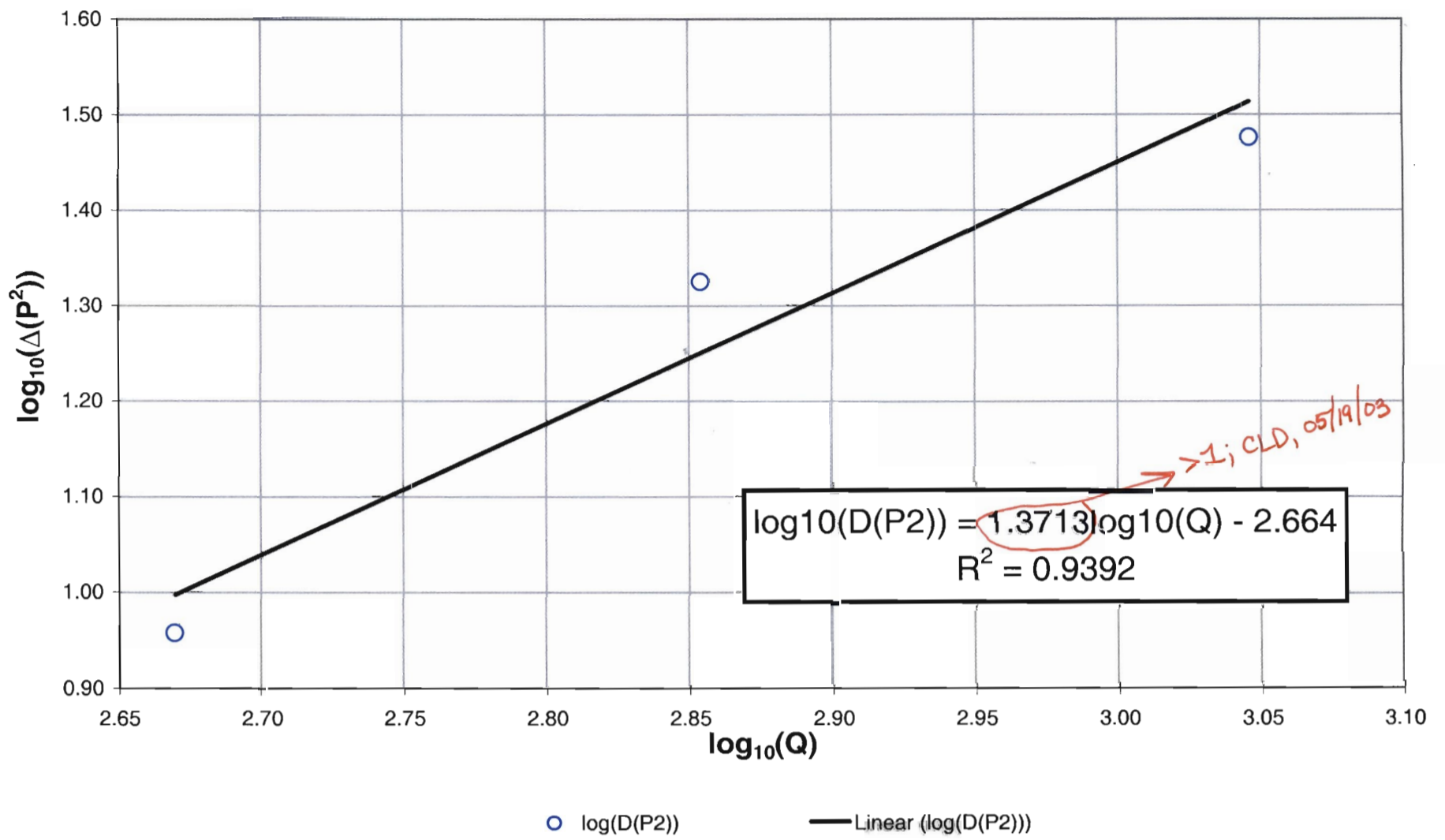Legend: ○ D(P2)/Q ── Linear (D(P2)/Q)

RNM, 08/27/08

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 53

$$y = 4E\text{-}06x^2 + 0.0229x$$
$$R^2 = 0.9359$$

$$D(P2) = 0.0268Q$$
$$R^2 = 0.9273$$

$$D(P2) = 0.0314Q - 3.9221$$
$$R^2 = 0.95$$

$$D(P2) = -4E\text{-}05Q^2 + 0.0981Q - 27.658$$
$$R^2 = 1$$

Y-axis: $\Delta(P^2)$, psia^2
X-axis: Q, cc/min

Legend: ○ D(P2) ── Linear (D(P2)) ── Linear (D(P2)) ── Poly. (D(P2)) ── Poly. (D(P2))
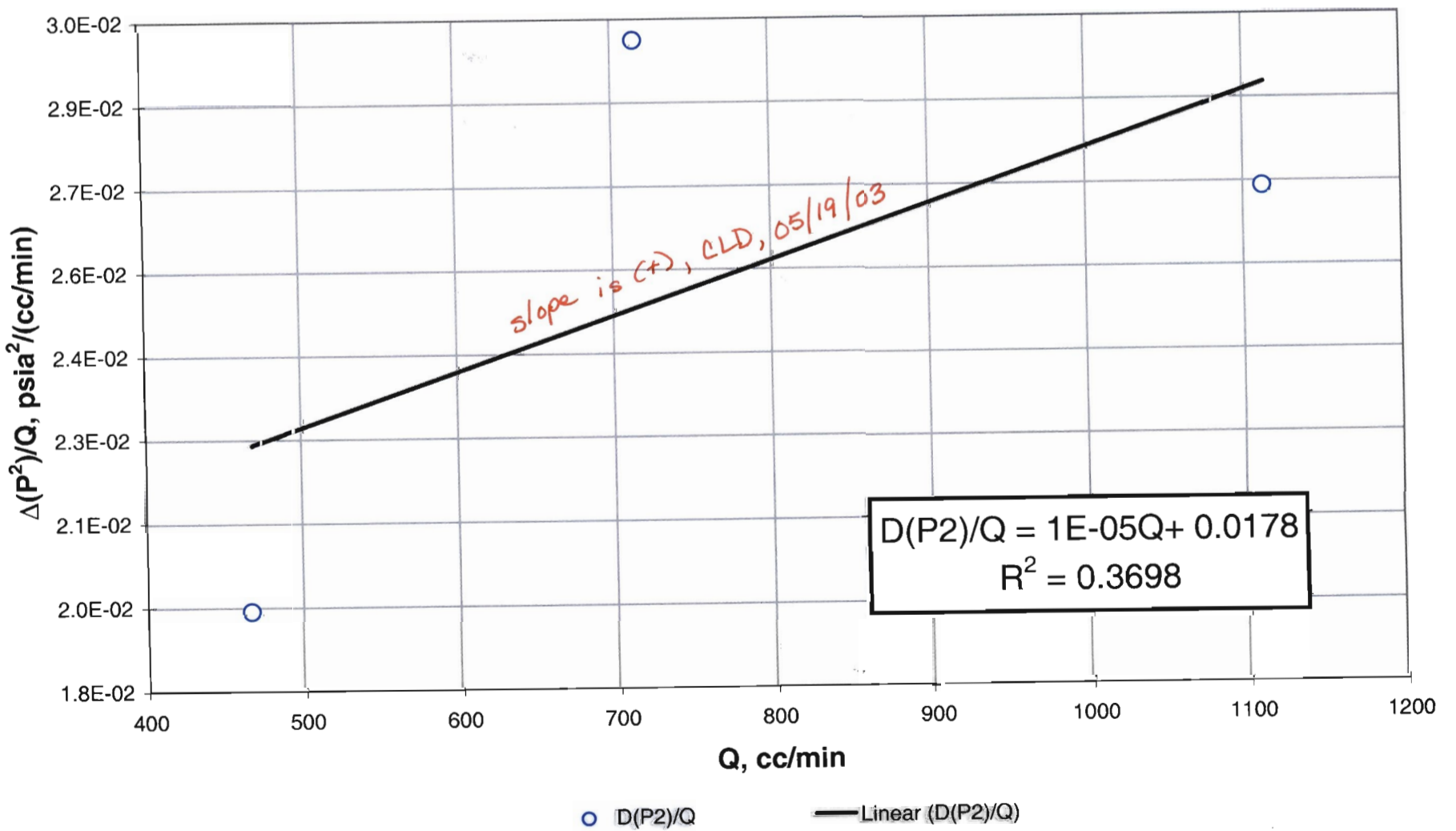
RNM, 08/27/08

This page is to replace the ~~previous~~ underlying, because the prior analysis incorrectly considered data from X-54 to be part of the data gathered at the X-53 drillhole. CLD, 05/19/03

RNM, 08/27/02

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 53

$$\log10(D(P2)) = 1.3713 \log10(Q) - 2.664$$
$$R^2 = 0.9392$$

> 1; CLD, 05/19/03

○ log(D(P2))   ——Linear (log(D(P2)))

This page is to replace the underlying page — see explanation on page 67.

RNM, 08/27/02

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 53

slope is (+), CLD, 05/19/03

$$D(P2)/Q = 1E-05Q + 0.0178$$
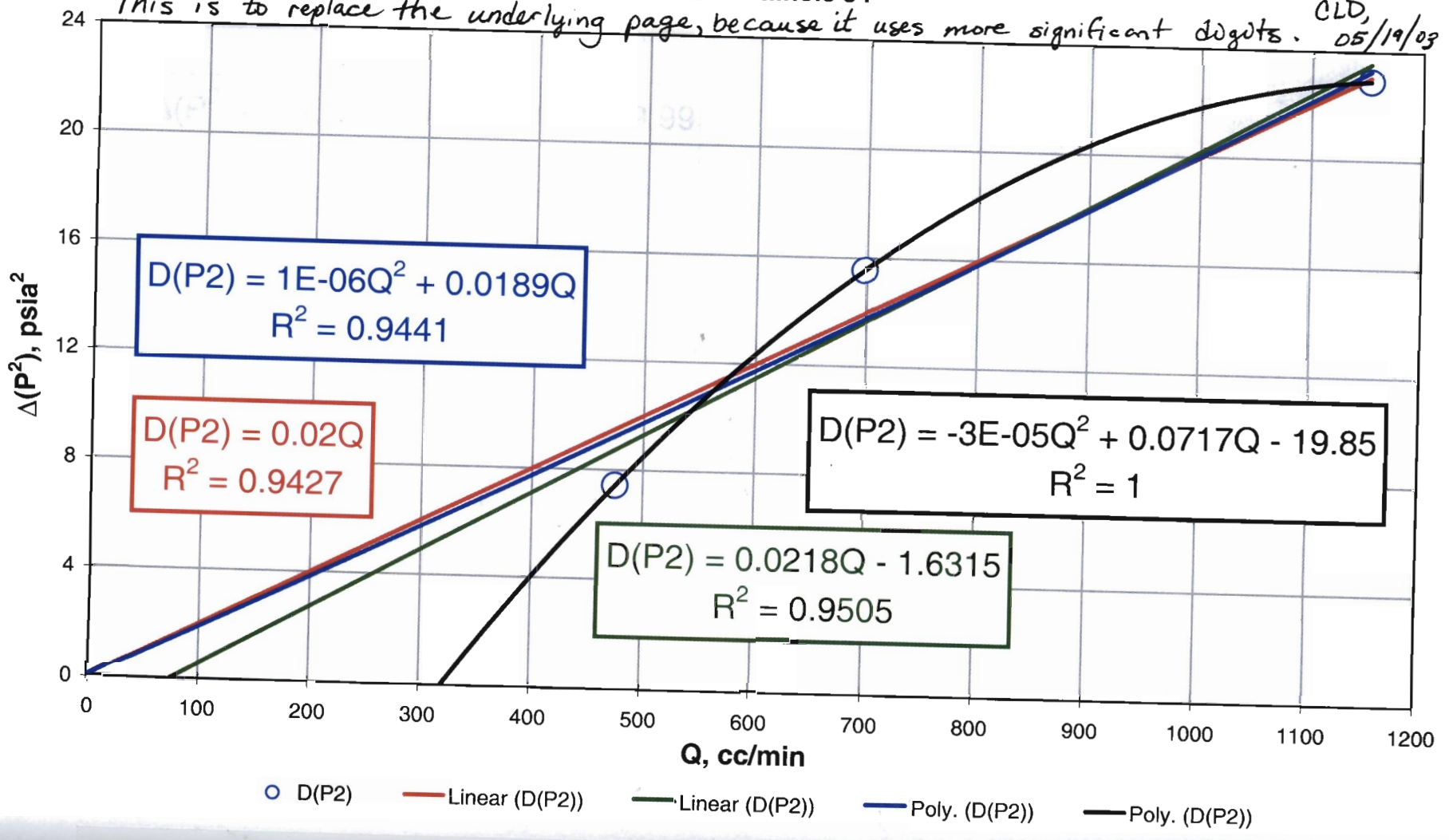$$R^2 = 0.3698$$

○ D(P2)/Q   ——Linear (D(P2)/Q)

This page is to replace the underlying page — see pg. 67 explanation. CLD, 05/19/03

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
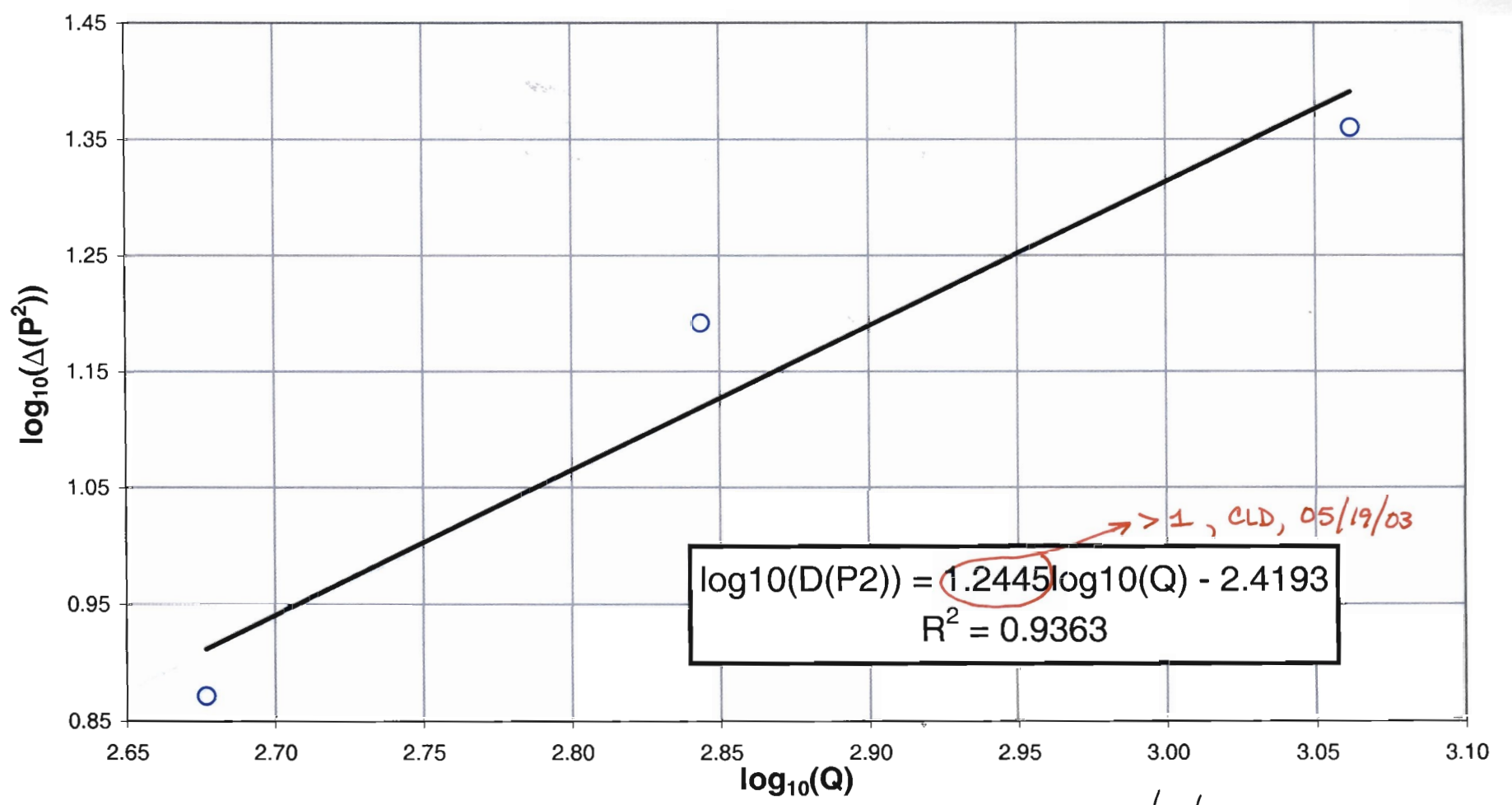X Transect: Drillhole 54

This is to replace the underlying page, because it uses more significant digits. CLD, 05/19/03

$D(P2) = 1E\text{-}06Q^2 + 0.0189Q$
$R^2 = 0.9441$

$D(P2) = 0.02Q$
$R^2 = 0.9427$

$D(P2) = -3E\text{-}05Q^2 + 0.0717Q - 19.85$
$R^2 = 1$

$D(P2) = 0.0218Q - 1.6315$
$R^2 = 0.9505$

Y-axis: $\Delta(P^2)$, psia^2
X-axis: Q, cc/min

○ D(P2)   —— Linear (D(P2))   —— Linear (D(P2))   —— Poly. (D(P2))   —— Poly. (D(P2))

RNM, 08/27/03

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 54

$\log10(D(P2)) = 1.2445 \log10(Q) - 2.4193$
$R^2 = 0.9363$

→ > 1, CLD, 05/19/03

Y-axis: $\log_{10}(\Delta(P^2))$
X-axis: $\log_{10}(Q)$

This page is to replace the underlying, see explanation page 70. CLD 05/19/03

○ log(D(P2))   —— Linear (log(D(P2)))

RNM, 08/27/03

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 54

slope → + is (+) CLD, 05/19/03

$$D(P2)/Q = 5E\text{-}06Q + 0.0158$$
$$R^2 = 0.2151$$

○ D(P2)/Q ——Linear (D(P2)/Q)

This page is to replace the underlying; see explanation page 70. CLD, 05/19/03

RNM, 08/27/03

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 55

$$\Delta(P^2) = -9E\text{-}06Q^2 + 0.0328Q - 4.4318$$
$$R^2 = 1$$

$$\Delta(P^2) = 0.0142Q + 3.5537$$
$$R^2 = 0.9686$$

$$\Delta(P^2) = -5E\text{-}06Q^2 + 0.0232Q$$
$$R^2 = 0.9914$$

$$\Delta(P^2) = 0.0172Q$$
$$R^2 = 0.9206$$

○ D(P2) ——Poly. (D(P2)) ——Poly. (D(P2)) ——Linear (D(P2)) ——Linear (D(P2))

RNM, 08/27/03

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
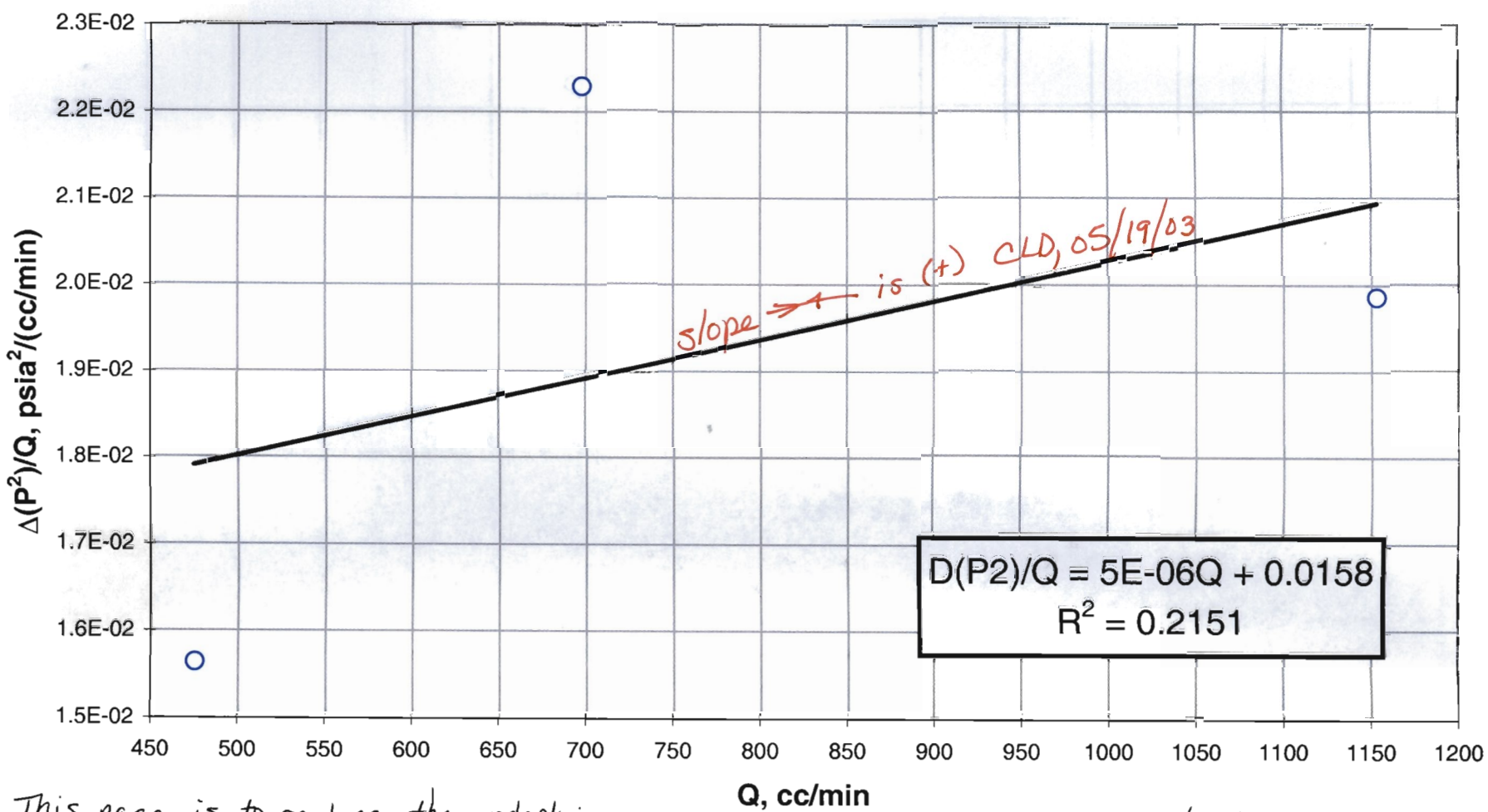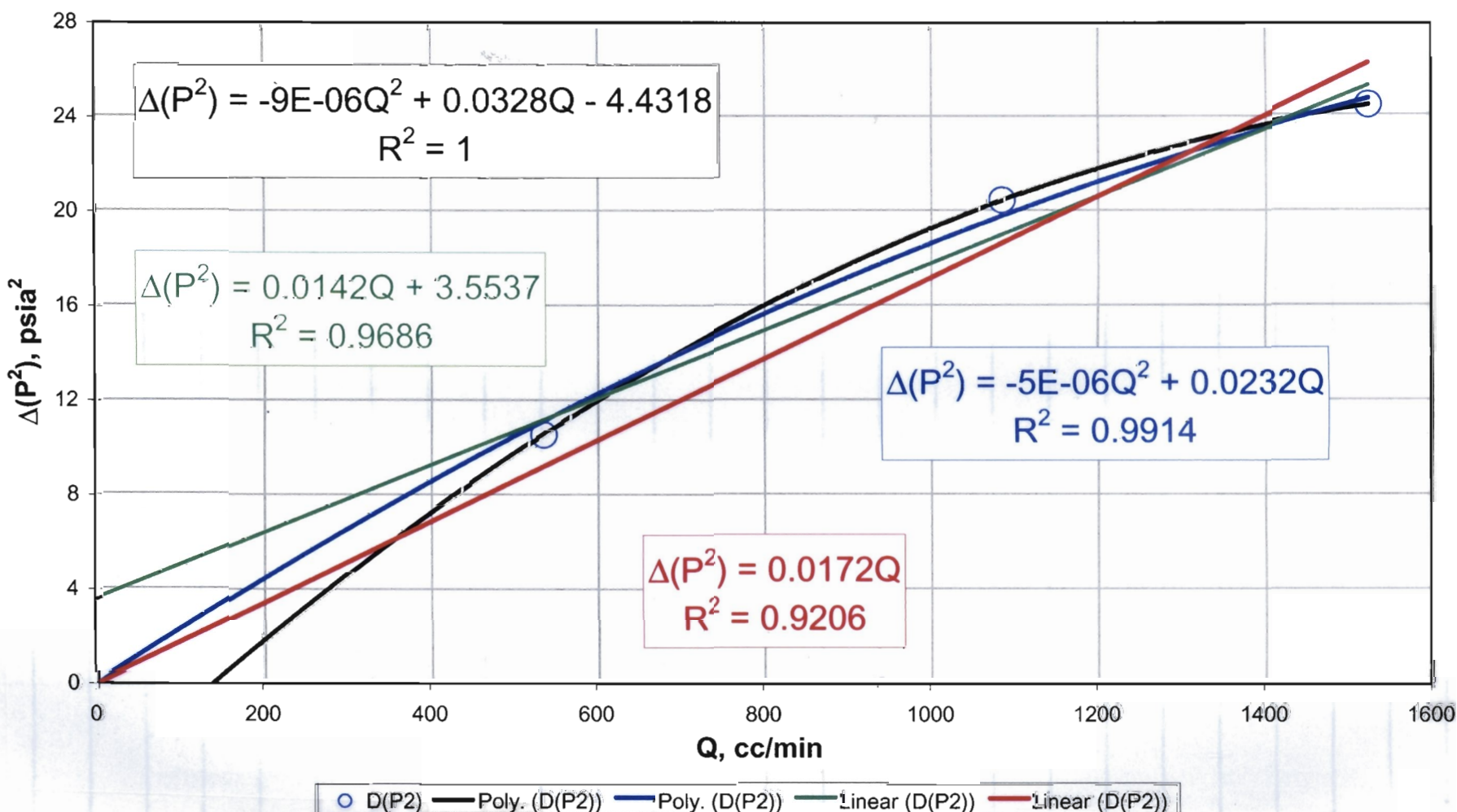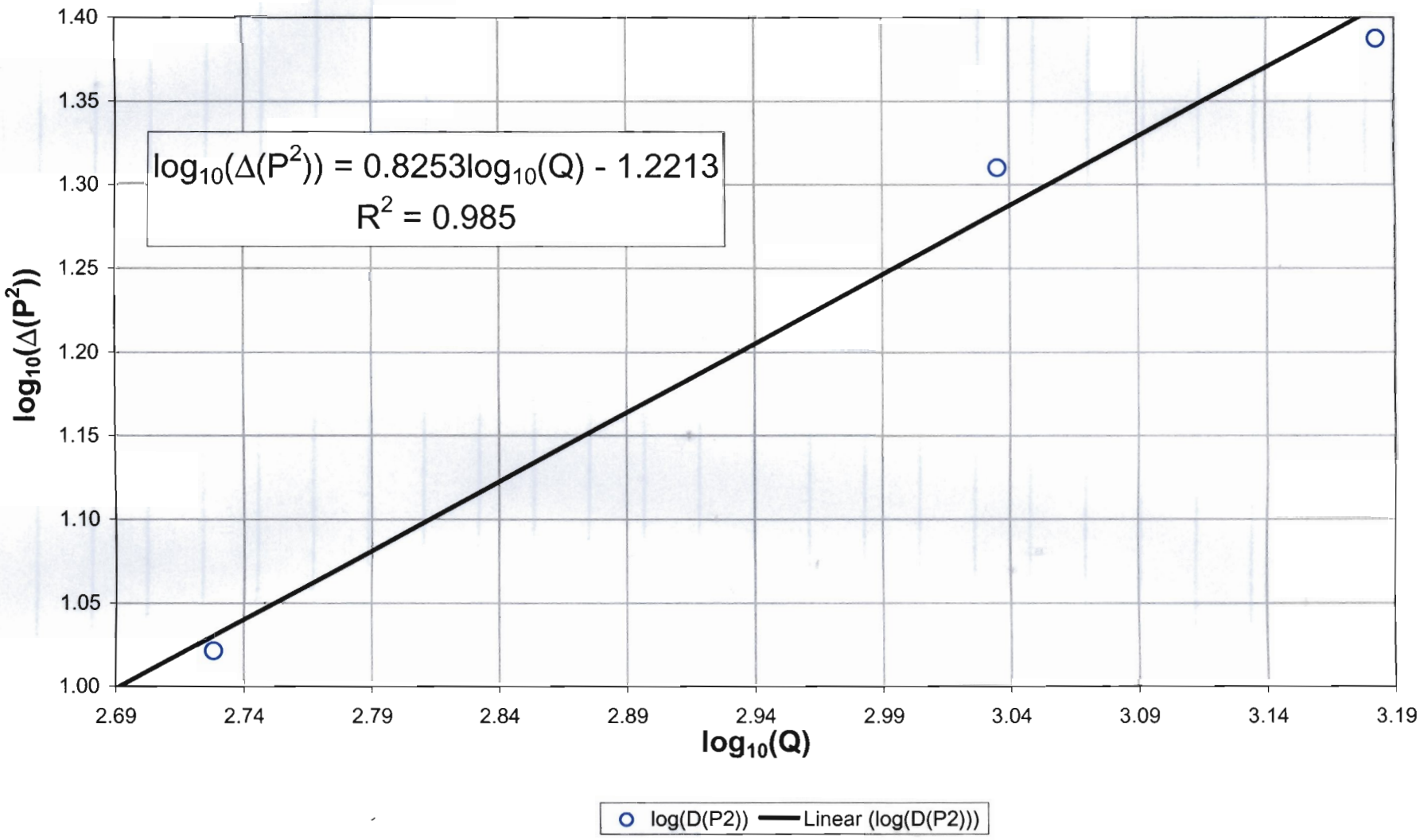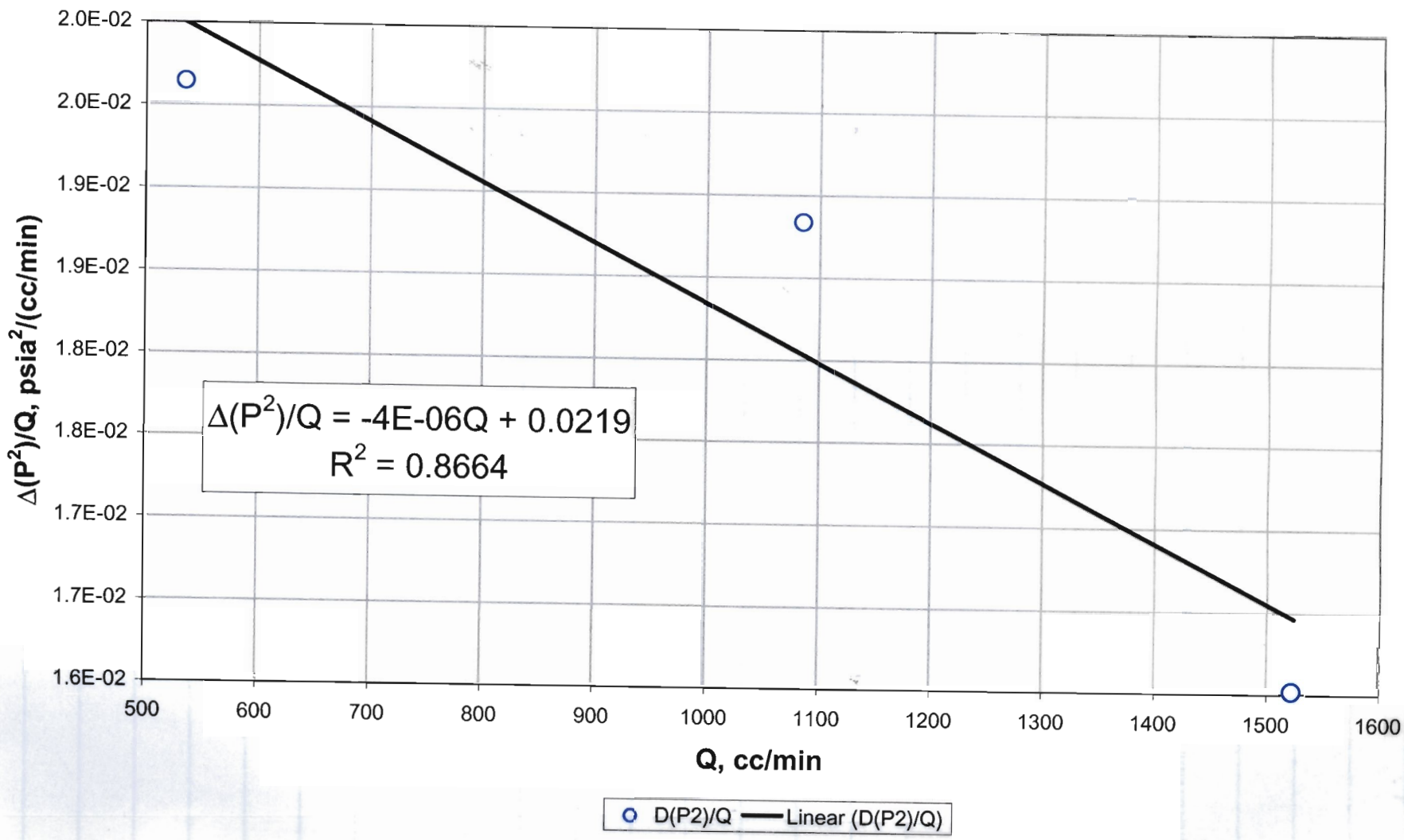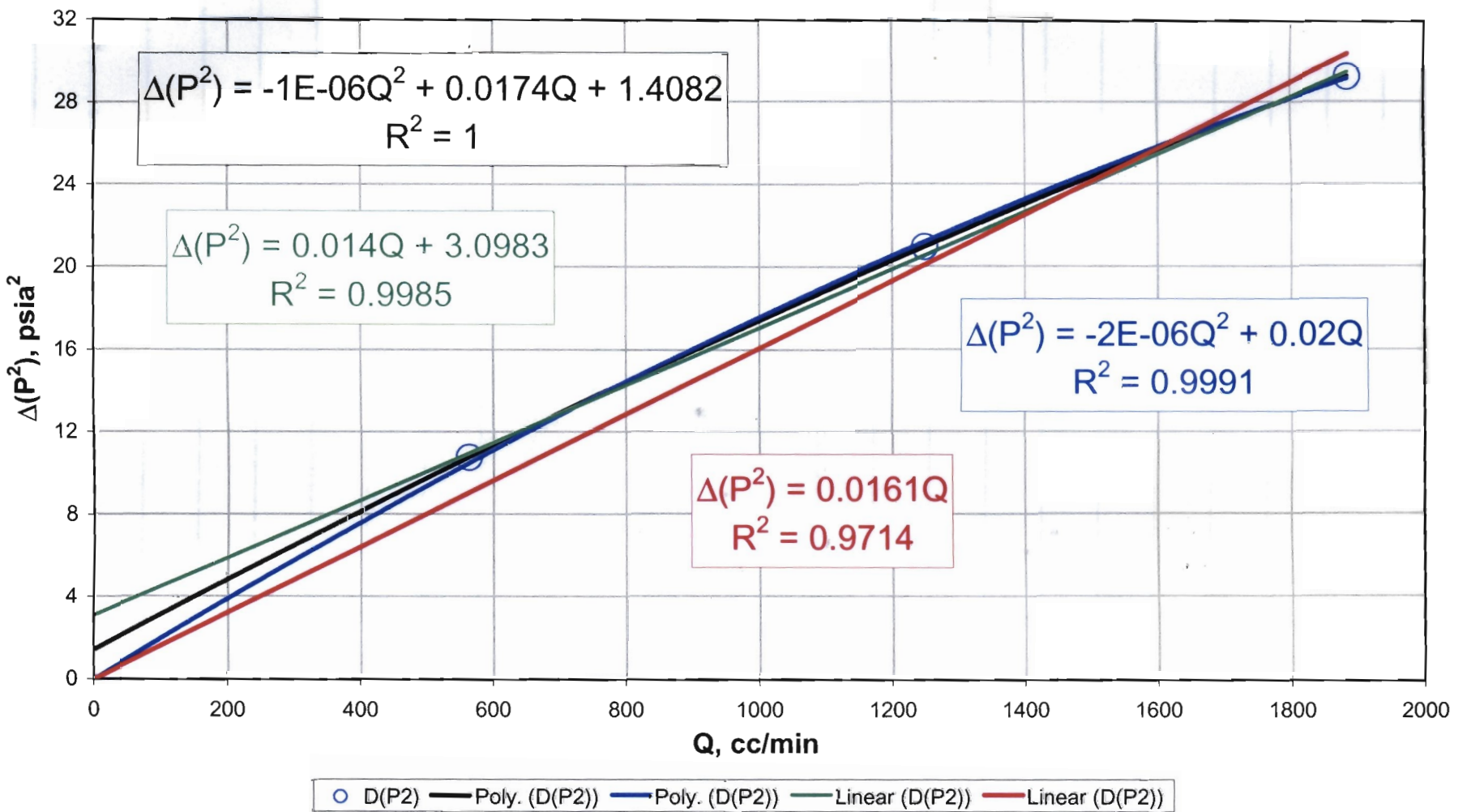**X Transect: Drillhole 55**

$$\log_{10}(\Delta(P^2)) = 0.8253\log_{10}(Q) - 1.2213$$
$$R^2 = 0.985$$

y-axis: $\log_{10}(\Delta(P^2))$ — 1.00, 1.05, 1.10, 1.15, 1.20, 1.25, 1.30, 1.35, 1.40

x-axis: $\log_{10}(Q)$ — 2.69, 2.74, 2.79, 2.84, 2.89, 2.94, 2.99, 3.04, 3.09, 3.14, 3.19

Legend: o log(D(P2)) —Linear (log(D(P2)))

RNM, 08/27/02

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 55

$$\Delta(P^2)/Q = -4E\text{-}06Q + 0.0219$$
$$R^2 = 0.8664$$

y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min) — 1.6E-02, 1.7E-02, 1.7E-02, 1.8E-02, 1.8E-02, 1.9E-02, 1.9E-02, 2.0E-02, 2.0E-02

x-axis: Q, cc/min — 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500, 1600
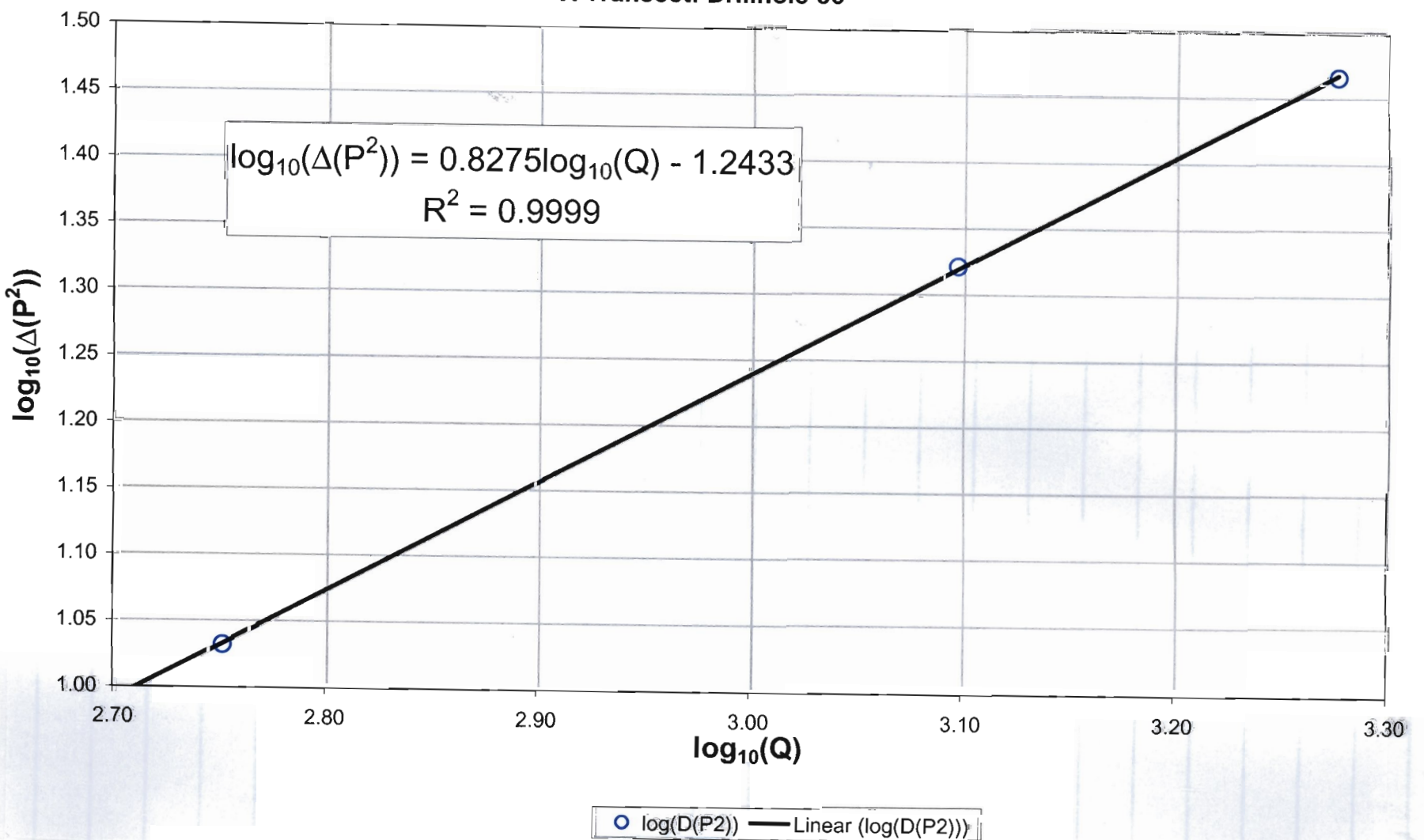
Legend: o D(P2)/Q —Linear (D(P2)/Q)

RNM, 08/27/02

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 56

$$\Delta(P^2) = -1\text{E-}06Q^2 + 0.0174Q + 1.4082$$
$$R^2 = 1$$

$$\Delta(P^2) = 0.014Q + 3.0983$$
$$R^2 = 0.9985$$

$$\Delta(P^2) = -2\text{E-}06Q^2 + 0.02Q$$
$$R^2 = 0.9991$$

$$\Delta(P^2) = 0.0161Q$$
$$R^2 = 0.9714$$

Y axis: $\Delta(P^2)$, psia^2
X axis: Q, cc/min

Legend: O D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))
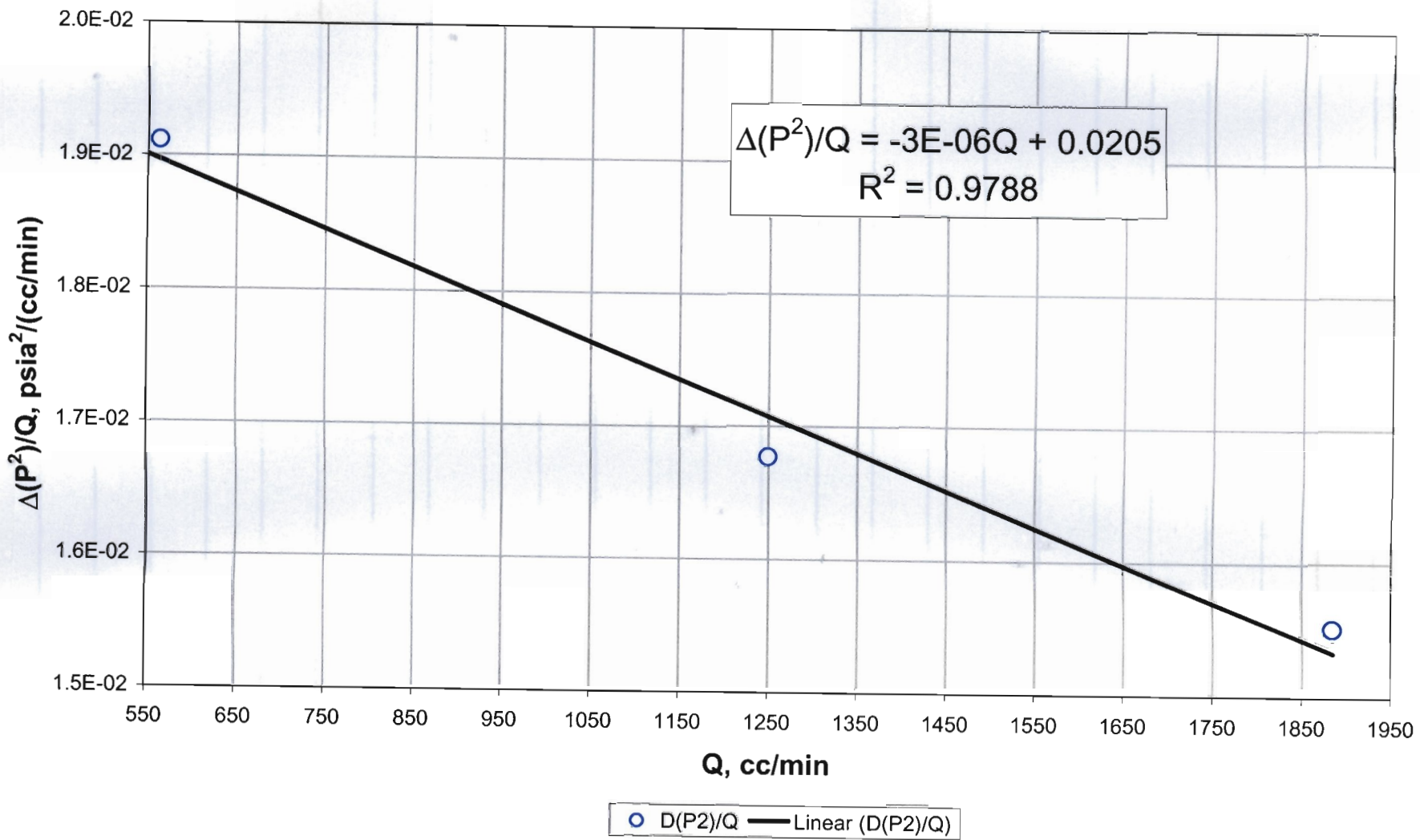

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 56

$$\log_{10}(\Delta(P^2)) = 0.8275\log_{10}(Q) - 1.2433$$
$$R^2 = 0.9999$$

Y axis: $\log_{10}(\Delta(P^2))$
X axis: $\log_{10}(Q)$

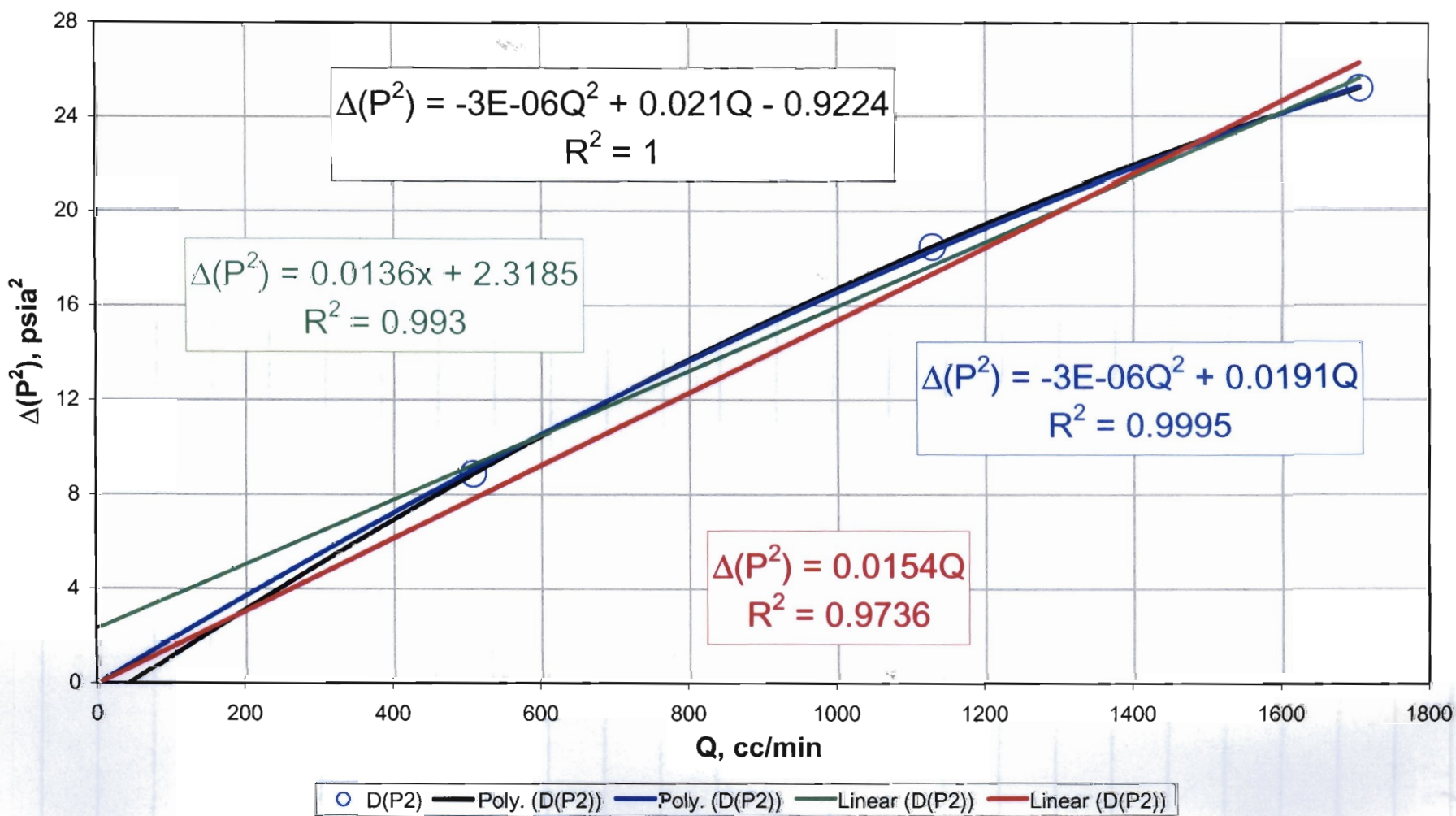Legend: O log(D(P2)) — Linear (log(D(P2)))

RNM, 08/27/02

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 56

$$\Delta(P^2)/Q = -3E\text{-}06Q + 0.0205$$
$$R^2 = 0.9788$$

Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)
X-axis: Q, cc/min

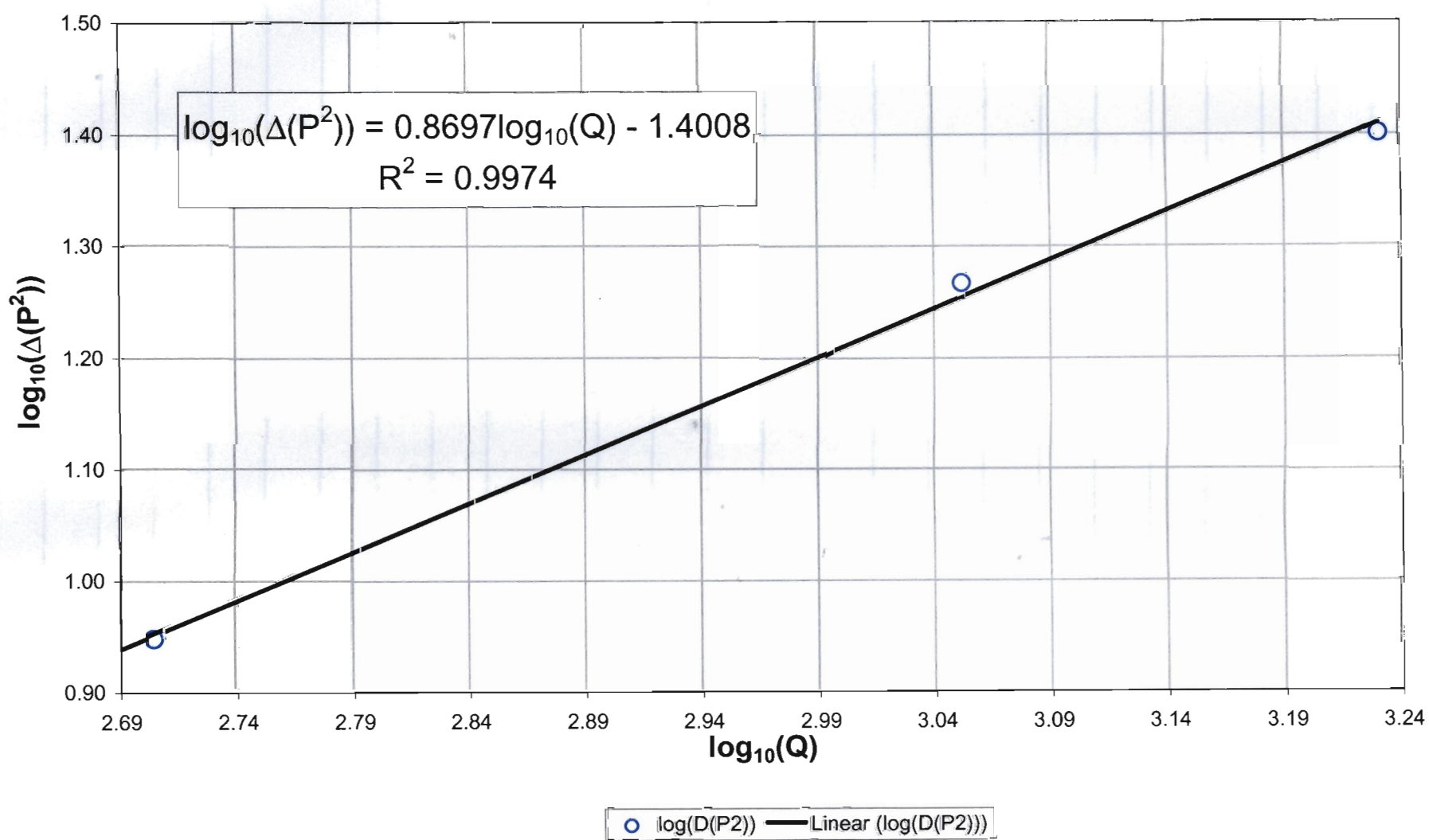Legend: ○ D(P2)/Q — Linear (D(P2)/Q)

RNM, 08/27/02

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 57

$$\Delta(P^2) = -3E\text{-}06Q^2 + 0.021Q - 0.9224$$
$$R^2 = 1$$

$$\Delta(P^2) = 0.0136x + 2.3185$$
$$R^2 = 0.993$$

$$\Delta(P^2) = -3E\text{-}06Q^2 + 0.0191Q$$
$$R^2 = 0.9995$$

$$\Delta(P^2) = 0.0154Q$$
$$R^2 = 0.9736$$

Y-axis: $\Delta(P^2)$, psia^2
X-axis: Q, cc/min

Legend: ○ D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))
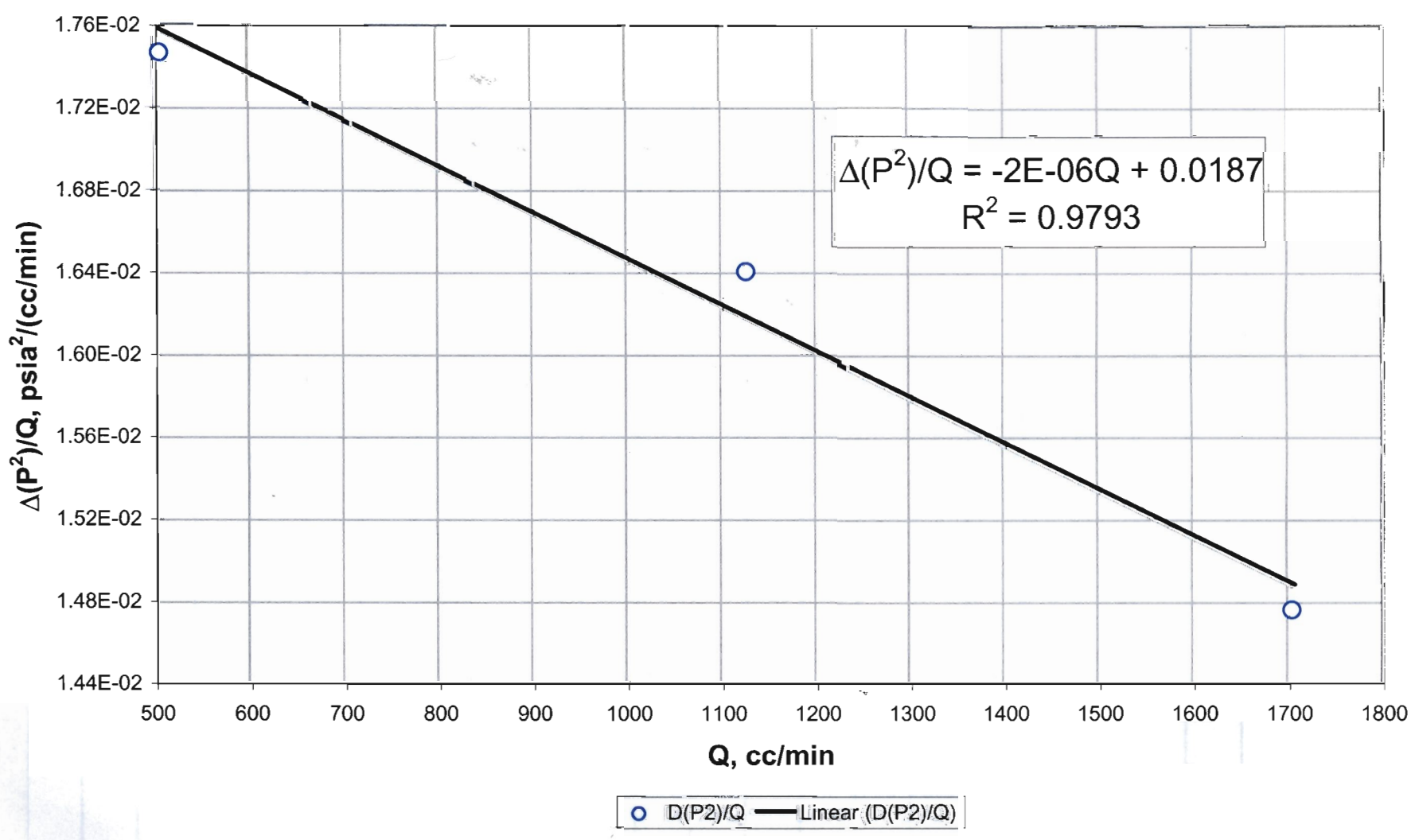
Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 57

$$\log_{10}(\Delta(P^2)) = 0.8697\log_{10}(Q) - 1.4008$$
$$R^2 = 0.9974$$

Legend: ○ log(D(P2)) —— Linear (log(D(P2)))

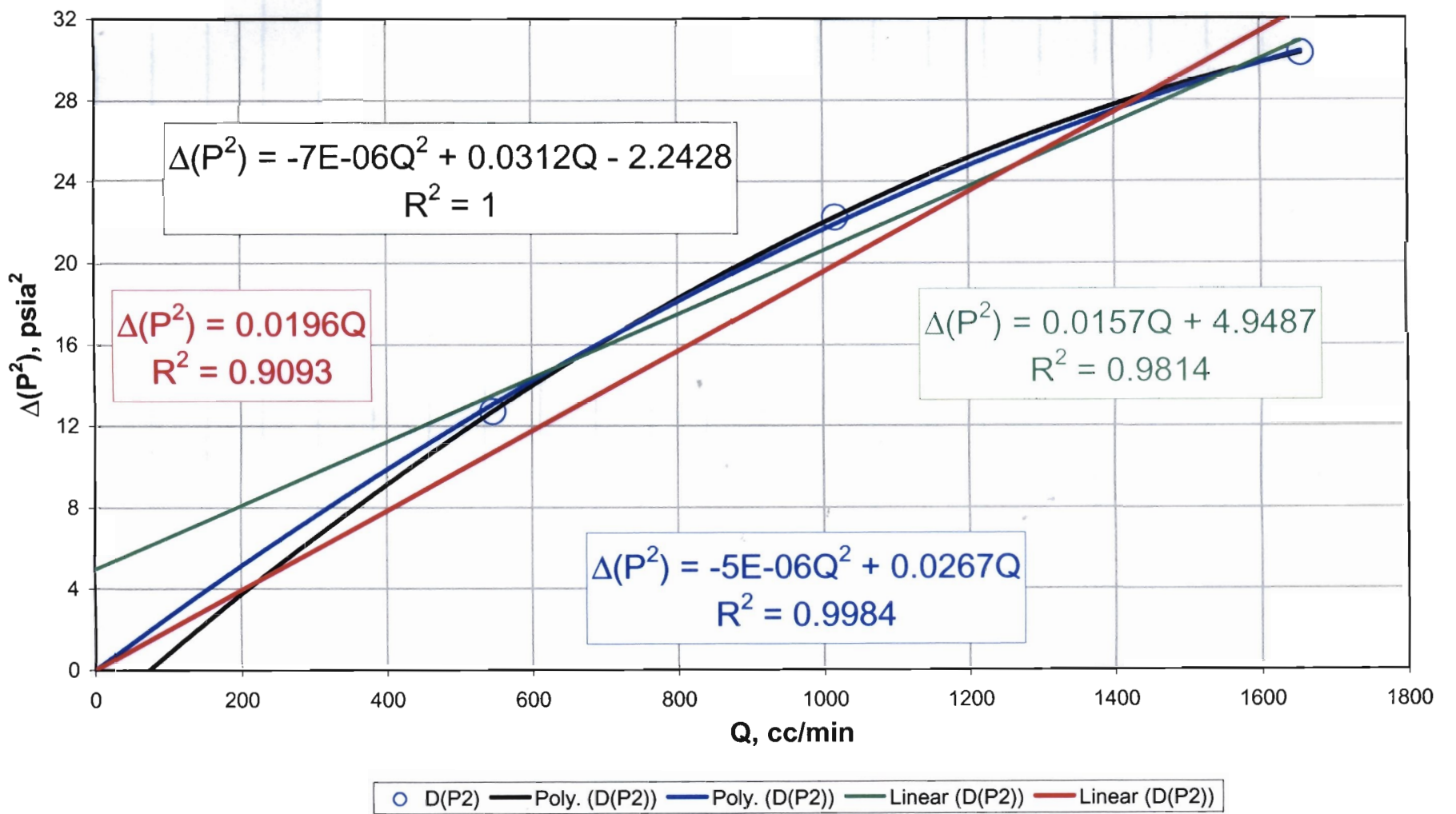Y-axis: $\log_{10}(\Delta(P^2))$
X-axis: $\log_{10}(Q)$

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 57

$$\Delta(P^2)/Q = -2E-06Q + 0.0187$$
$$R^2 = 0.9793$$

Legend: ○ D(P2)/Q —— Linear (D(P2)/Q)

Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)
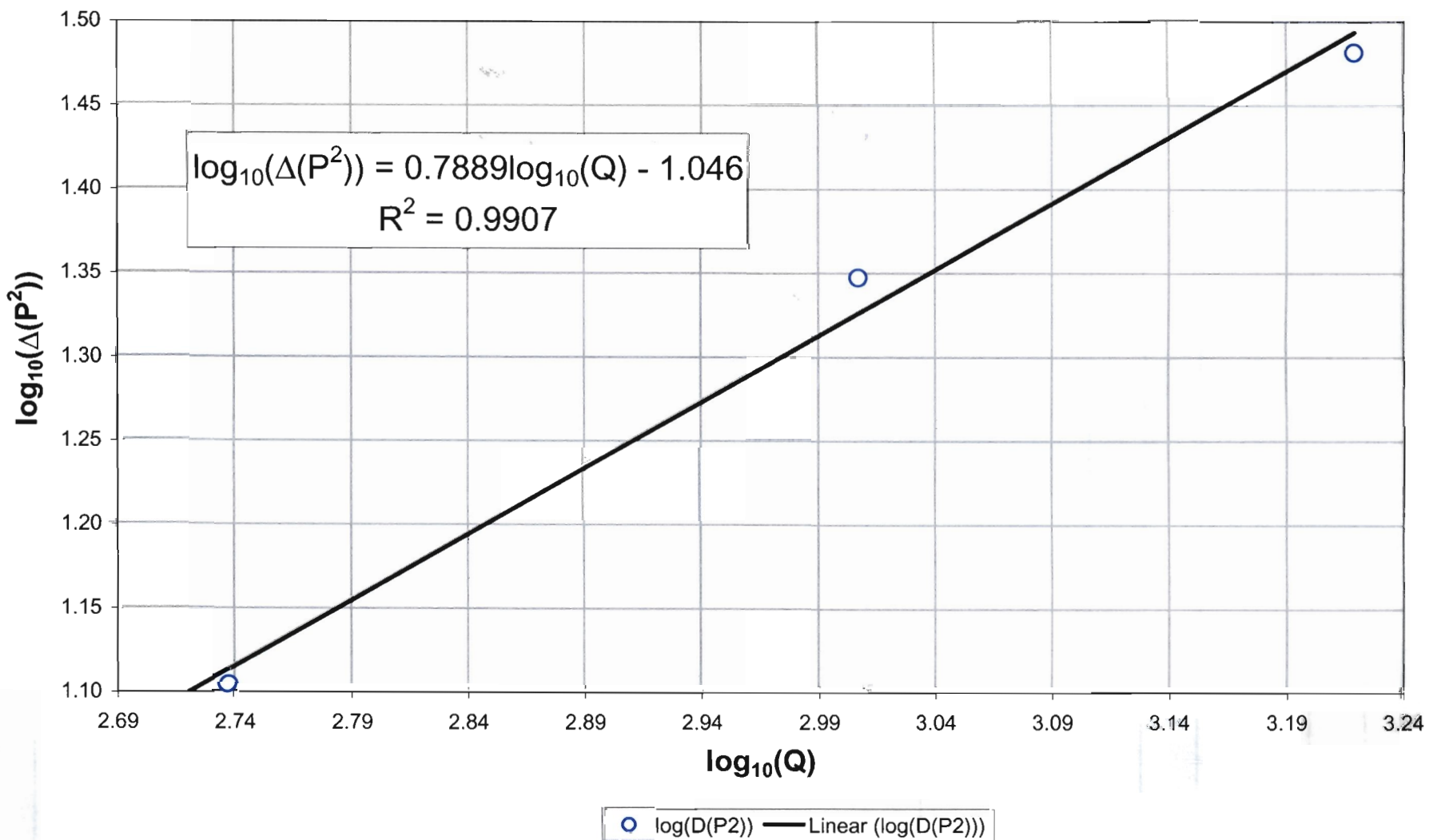X-axis: Q, cc/min

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero, there is no high velocity flow effect.
X Transect: Drillhole 58

$$\Delta(P^2) = -7E\text{-}06Q^2 + 0.0312Q - 2.2428$$
$$R^2 = 1$$

$$\Delta(P^2) = 0.0196Q$$
$$R^2 = 0.9093$$

$$\Delta(P^2) = 0.0157Q + 4.9487$$
$$R^2 = 0.9814$$

$$\Delta(P^2) = -5E\text{-}06Q^2 + 0.0267Q$$
$$R^2 = 0.9984$$

Y-axis: $\Delta(P^2)$, psia^2
X-axis: Q, cc/min

Legend: ○ D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))

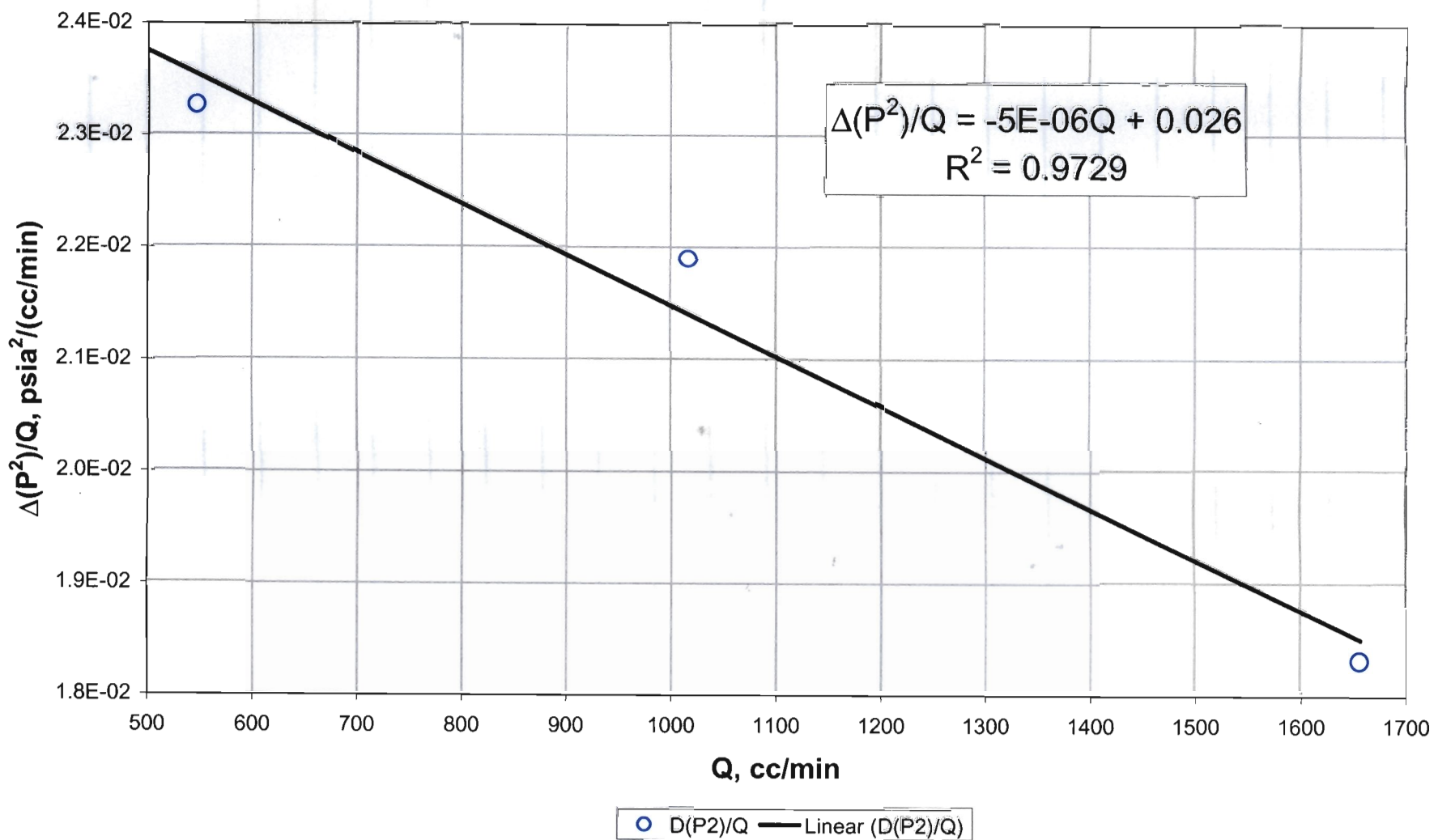## Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 58

$$\log_{10}(\Delta(P^2)) = 0.7889\log_{10}(Q) - 1.046$$
$$R^2 = 0.9907$$

Y-axis: $\log_{10}(\Delta(P^2))$
X-axis: $\log_{10}(Q)$

Legend: ○ log(D(P2)) — Linear (log(D(P2)))

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 58

$$\Delta(P^2)/Q = -5E\text{-}06Q + 0.026$$
$$R^2 = 0.9729$$

Axis: $\Delta(P^2)/Q$, psia^2/(cc/min) vs Q, cc/min

Legend: O D(P2)/Q —— Linear (D(P2)/Q)

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 59

$$\Delta(P^2) = -4E\text{-}06Q^2 + 0.0232Q - 1.0521$$
$$R^2 = 1$$

$$\Delta(P^2) = 0.0149Q + 2.7056$$
$$R^2 = 0.9931$$

$$\Delta(P^2) = -3E\text{-}06Q^2 + 0.0211Q$$
$$R^2 = 0.9995$$

$$\Delta(P^2) = 0.017Q$$
$$R^2 = 0.9695$$

Axis: $\Delta(P^2)$, psia^2 vs Q, cc/min

Legend: O D(P2) —— Poly. (D(P2)) —— Poly. (D(P2)) —— Linear (D(P2)) —— Linear (D(P2))

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
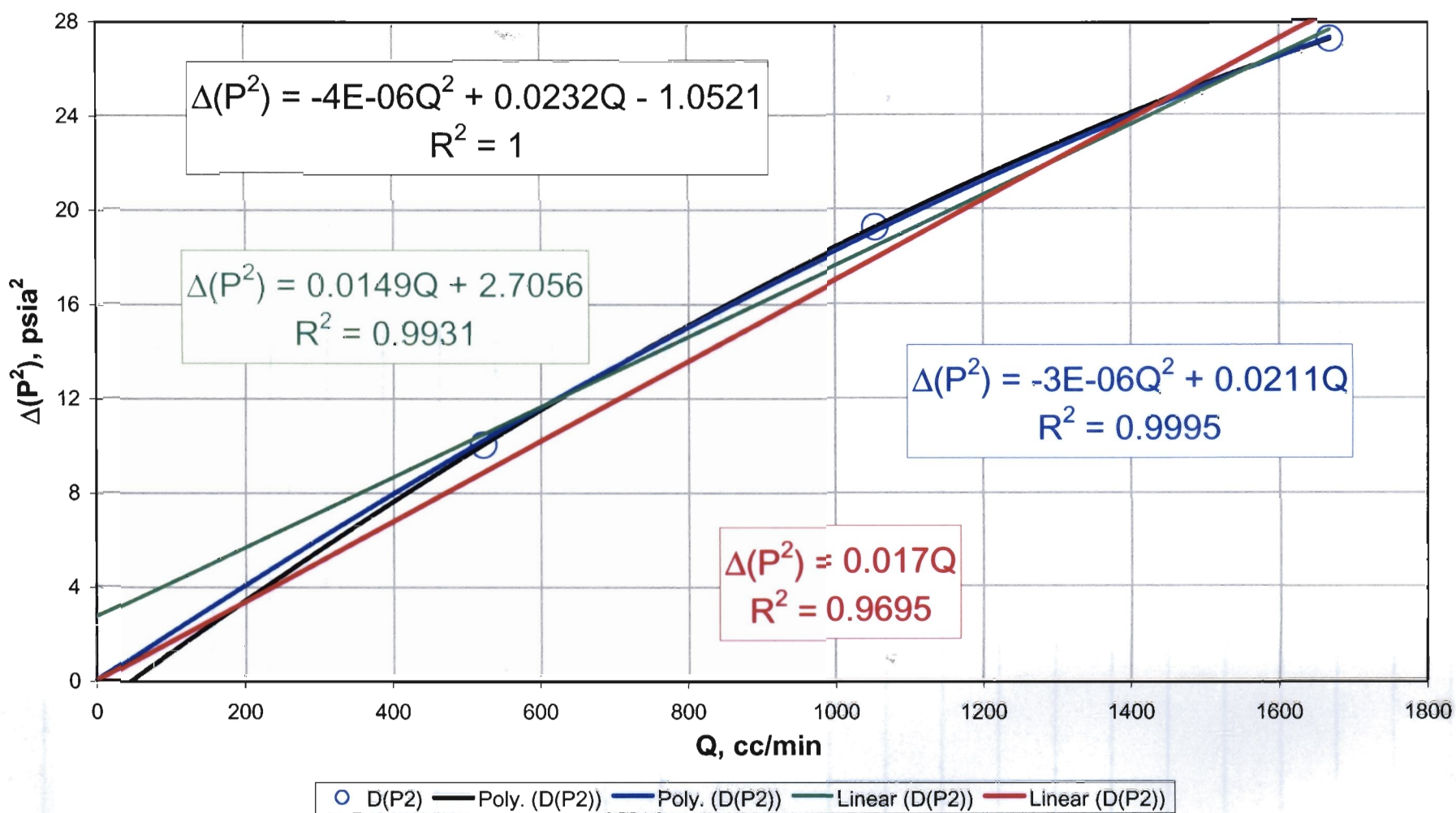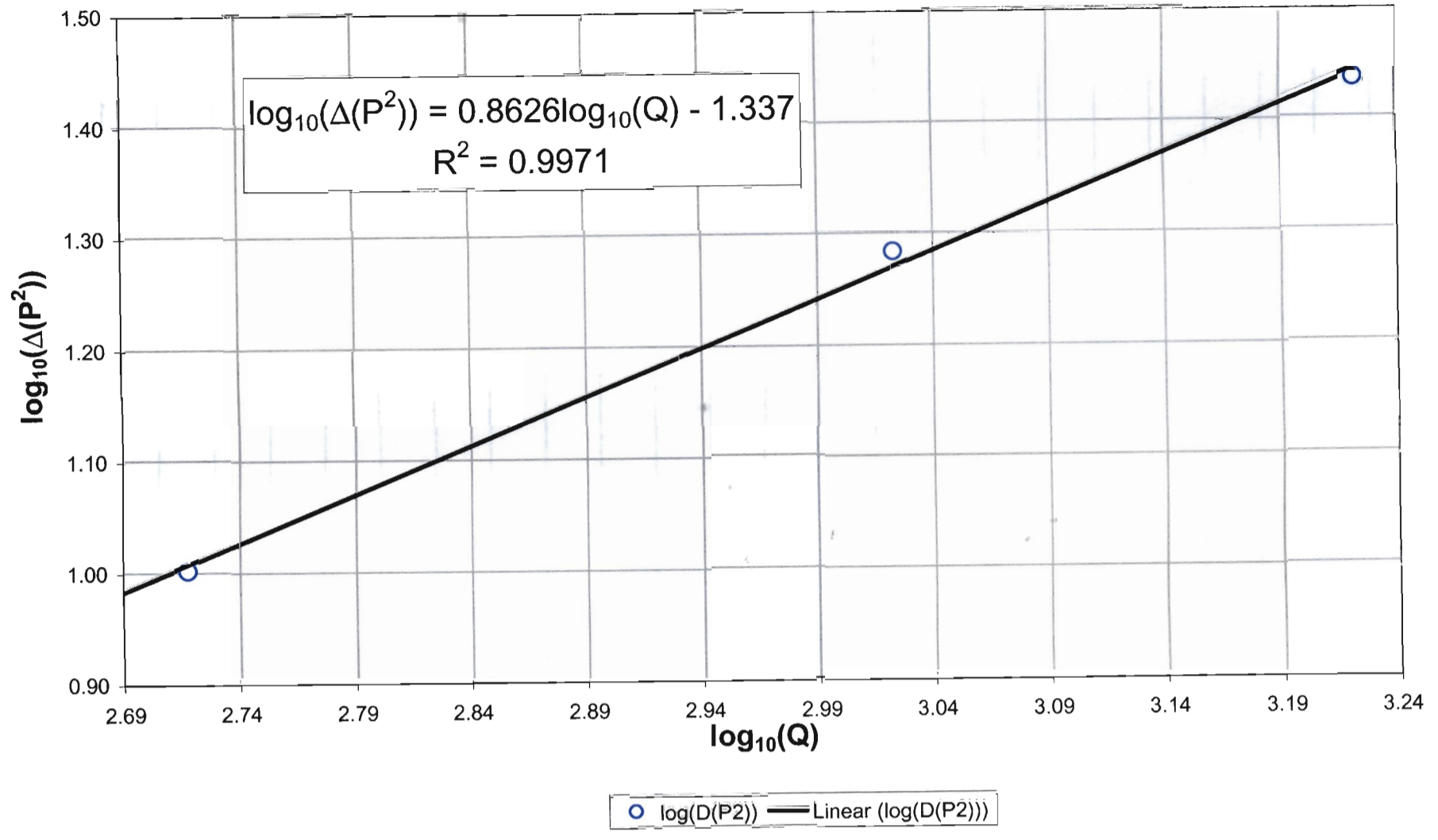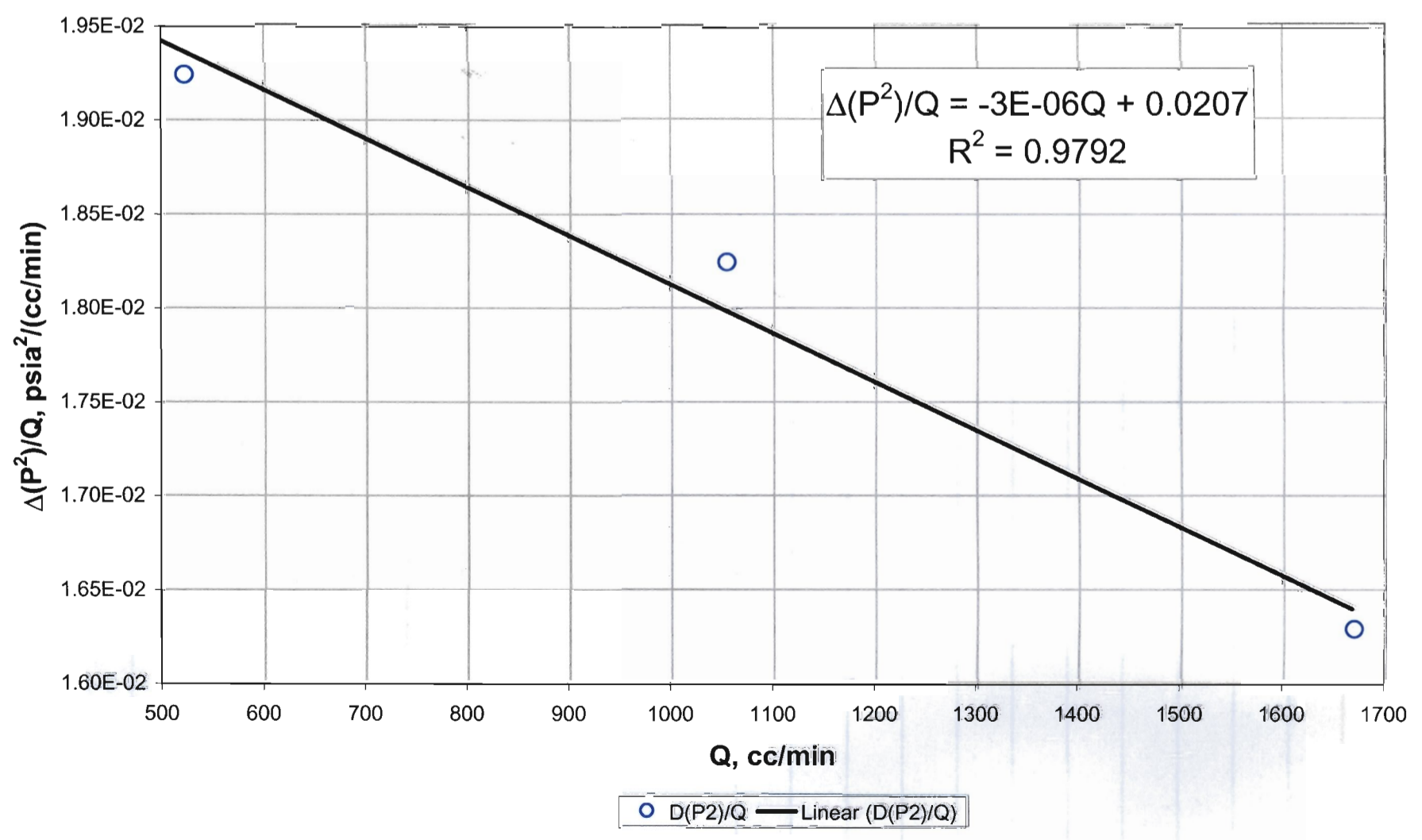**X Transect: Drillhole 59**

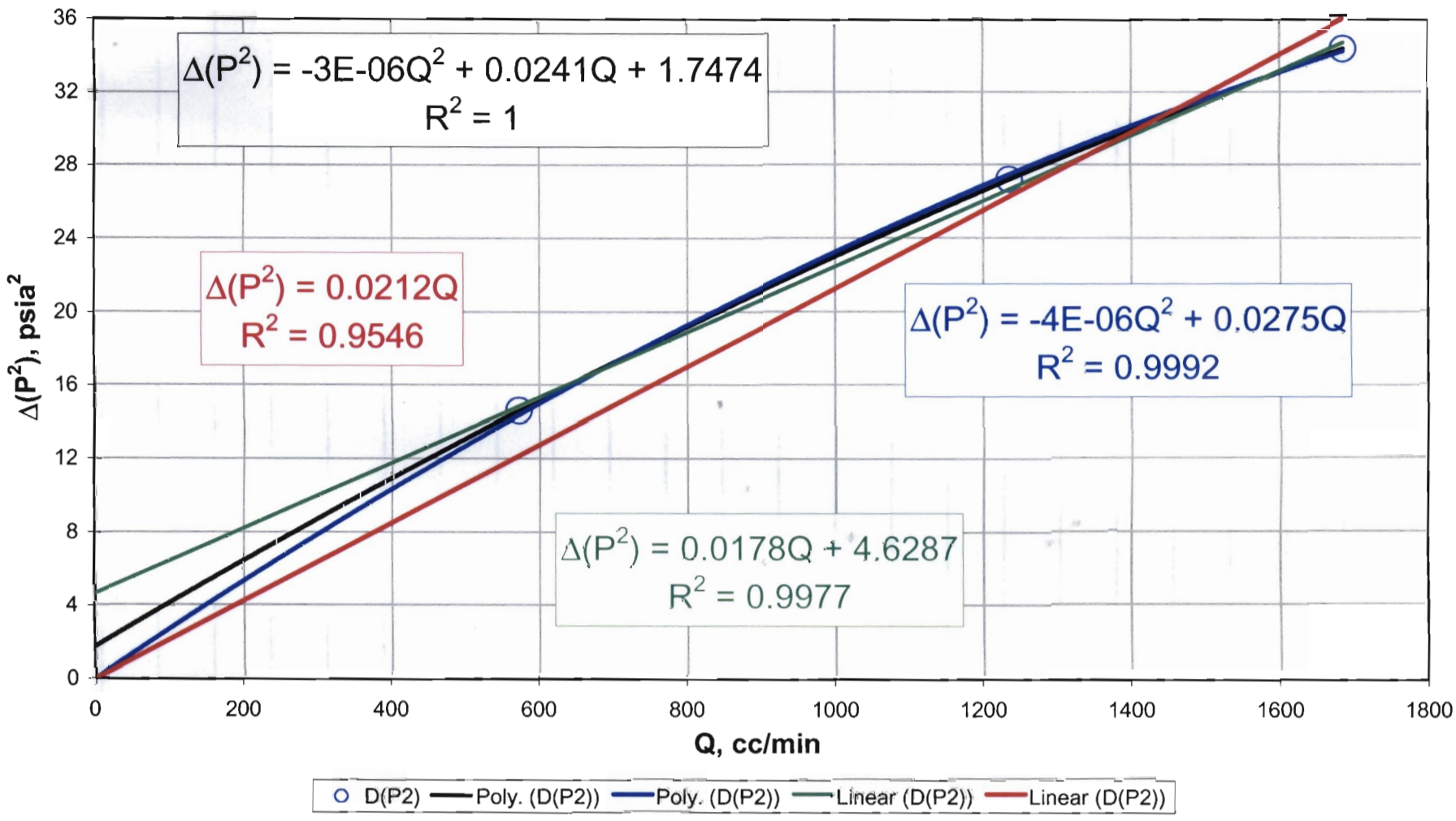$$\log_{10}(\Delta(P^2)) = 0.8626\log_{10}(Q) - 1.337$$
$$R^2 = 0.9971$$

Axis labels: $\log_{10}(\Delta(P^2))$ (y-axis), $\log_{10}(Q)$ (x-axis)

Legend: O log(D(P2)) —— Linear (log(D(P2)))

RNM, 08/27/08

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 59

$$\Delta(P^2)/Q = -3E-06Q + 0.0207$$
$$R^2 = 0.9792$$

Axis labels: $\Delta(P^2)/Q$, psia^2/(cc/min) (y-axis), Q, cc/min (x-axis)

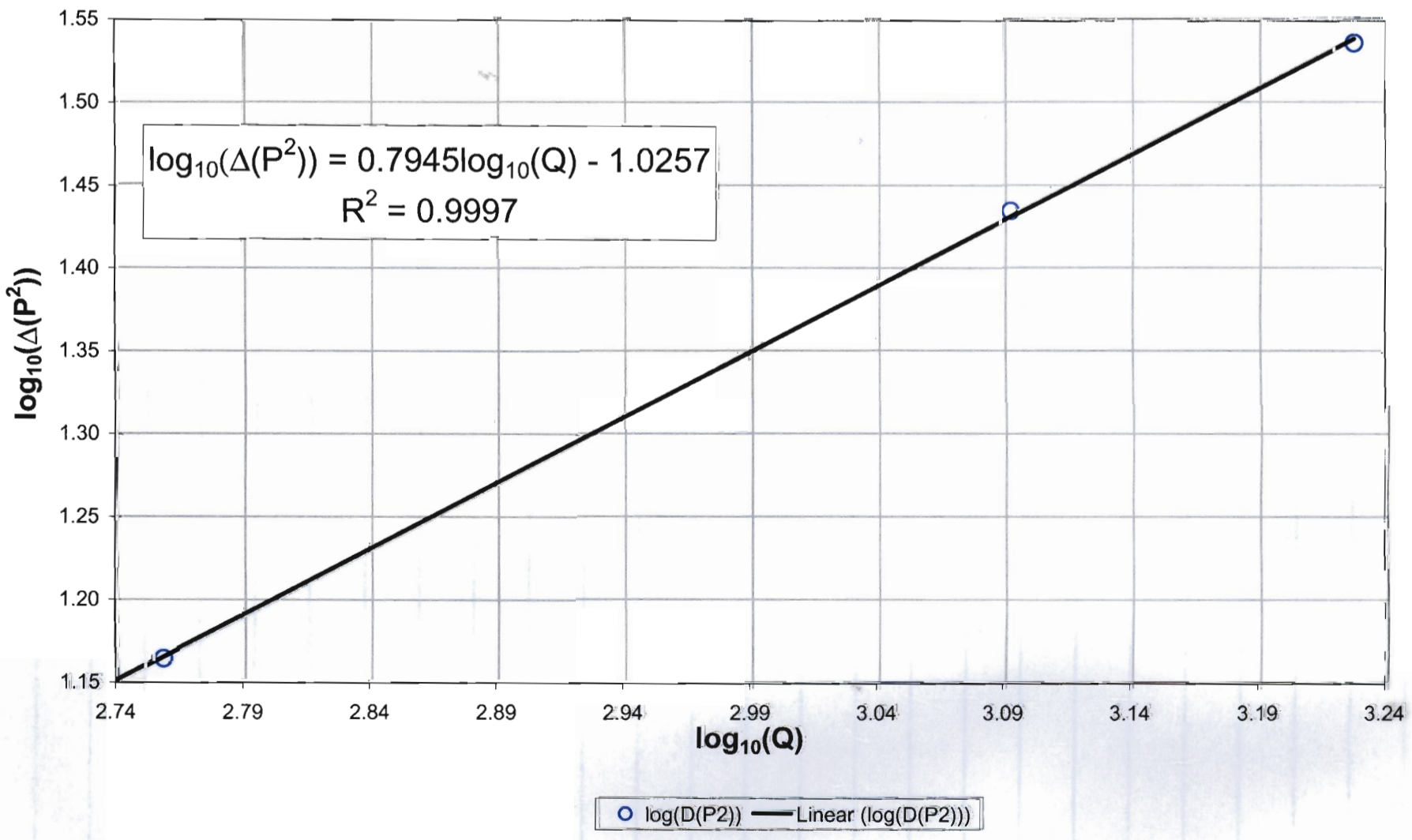Legend: O D(P2)/Q —— Linear (D(P2)/Q)

RNM, 08/27/08

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 60

$$\Delta(P^2) = -3E\text{-}06Q^2 + 0.0241Q + 1.7474$$
$$R^2 = 1$$

$$\Delta(P^2) = 0.0212Q$$
$$R^2 = 0.9546$$

$$\Delta(P^2) = -4E\text{-}06Q^2 + 0.0275Q$$
$$R^2 = 0.9992$$

$$\Delta(P^2) = 0.0178Q + 4.6287$$
$$R^2 = 0.9977$$

Y-axis: $\Delta(P^2)$, psia^2

X-axis: Q, cc/min

Legend: O D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))
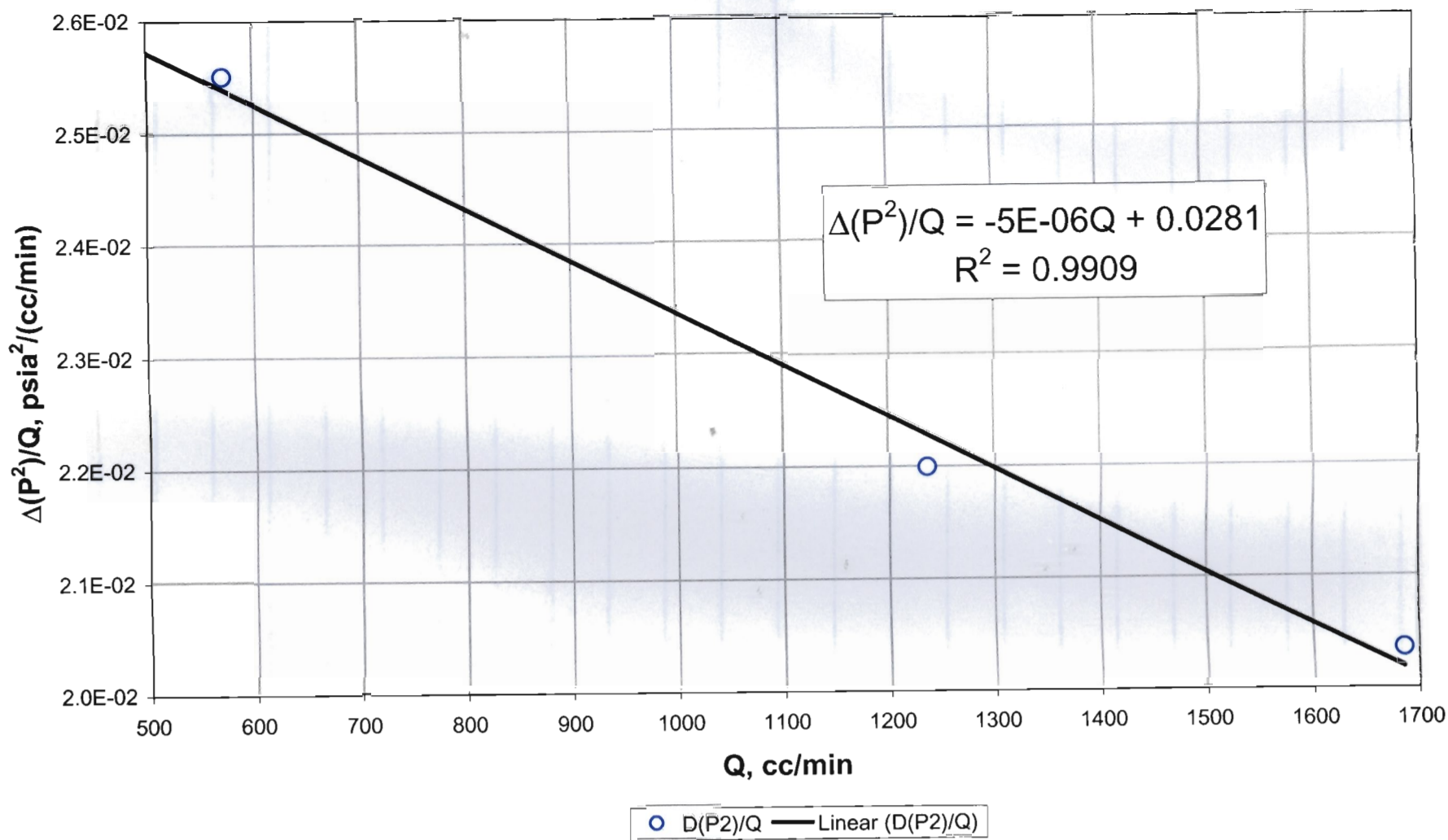
Handwritten: RmM. 08/27/08

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 60

$$\log_{10}(\Delta(P^2)) = 0.7945\log_{10}(Q) - 1.0257$$
$$R^2 = 0.9997$$

Y-axis: $\log_{10}(\Delta(P^2))$

X-axis: $\log_{10}(Q)$

Legend: O log(D(P2)) — Linear (log(D(P2)))
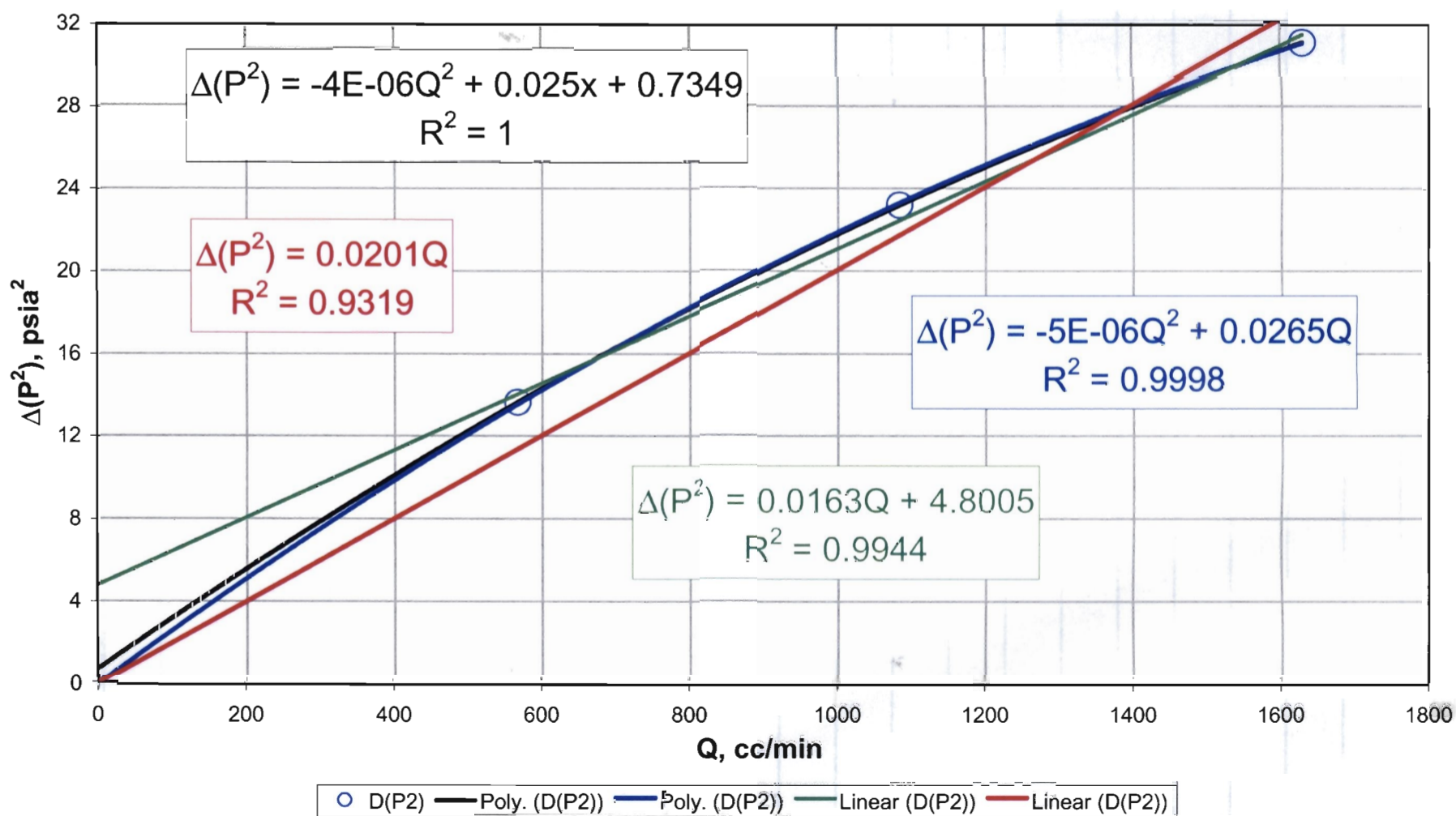
Handwritten: RmM, 08/27/08

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 60

$$\Delta(P^2)/Q = -5E\text{-}06Q + 0.0281$$
$$R^2 = 0.9909$$

Q, cc/min

$\Delta(P^2)/Q$, psia^2/(cc/min)
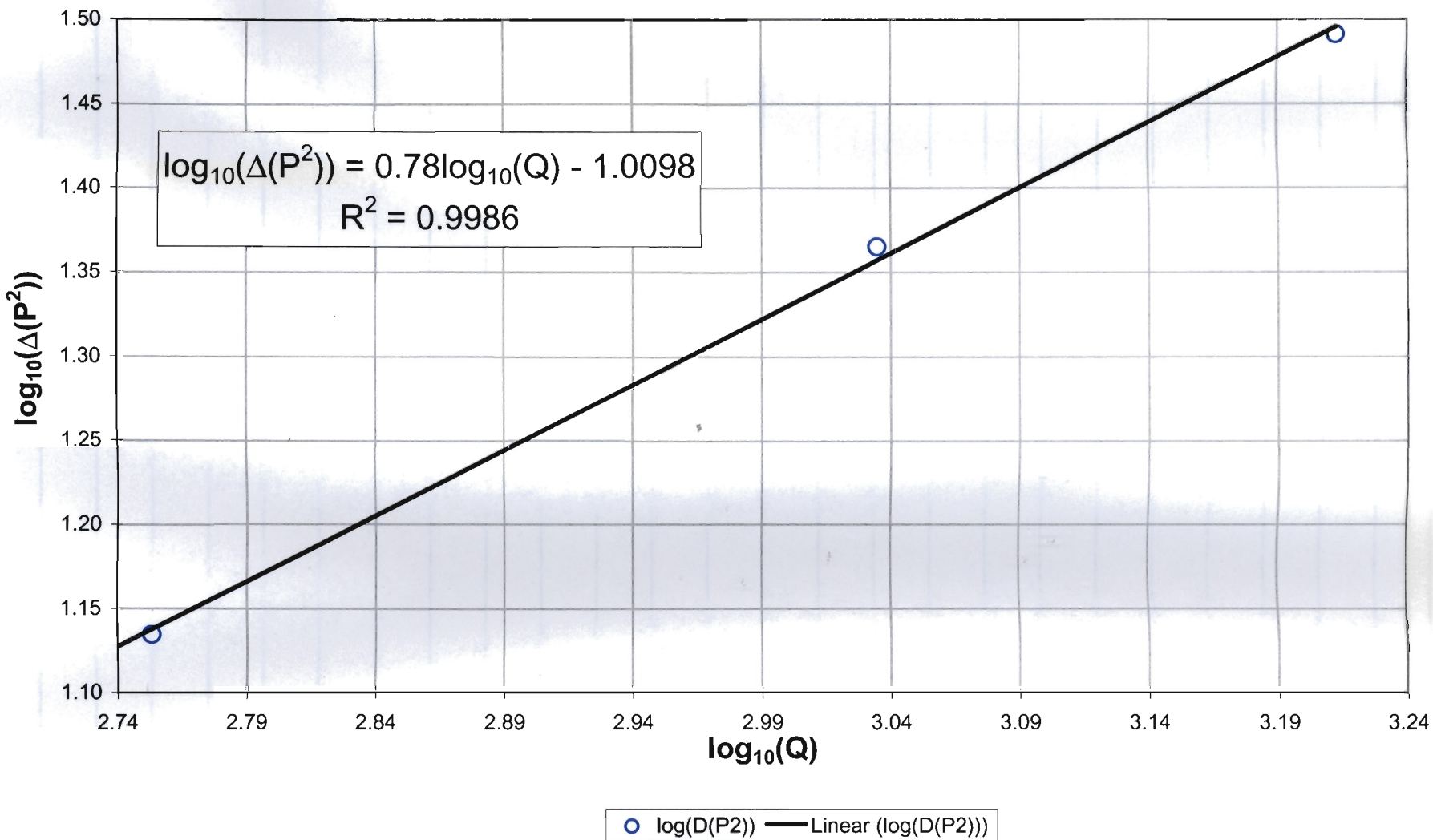
O D(P2)/Q —— Linear (D(P2)/Q)

RNM, 08/27/02

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 61

$$\Delta(P^2) = -4E\text{-}06Q^2 + 0.025x + 0.7349$$
$$R^2 = 1$$

$$\Delta(P^2) = 0.0201Q$$
$$R^2 = 0.9319$$

$$\Delta(P^2) = -5E\text{-}06Q^2 + 0.0265Q$$
$$R^2 = 0.9998$$

$$\Delta(P^2) = 0.0163Q + 4.8005$$
$$R^2 = 0.9944$$

$\Delta(P^2)$, psia^2

Q, cc/min

O D(P2) ——Poly. (D(P2)) ——Poly. (D(P2)) ——Linear (D(P2)) ——Linear (D(P2))

RNM, 08/27/02

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
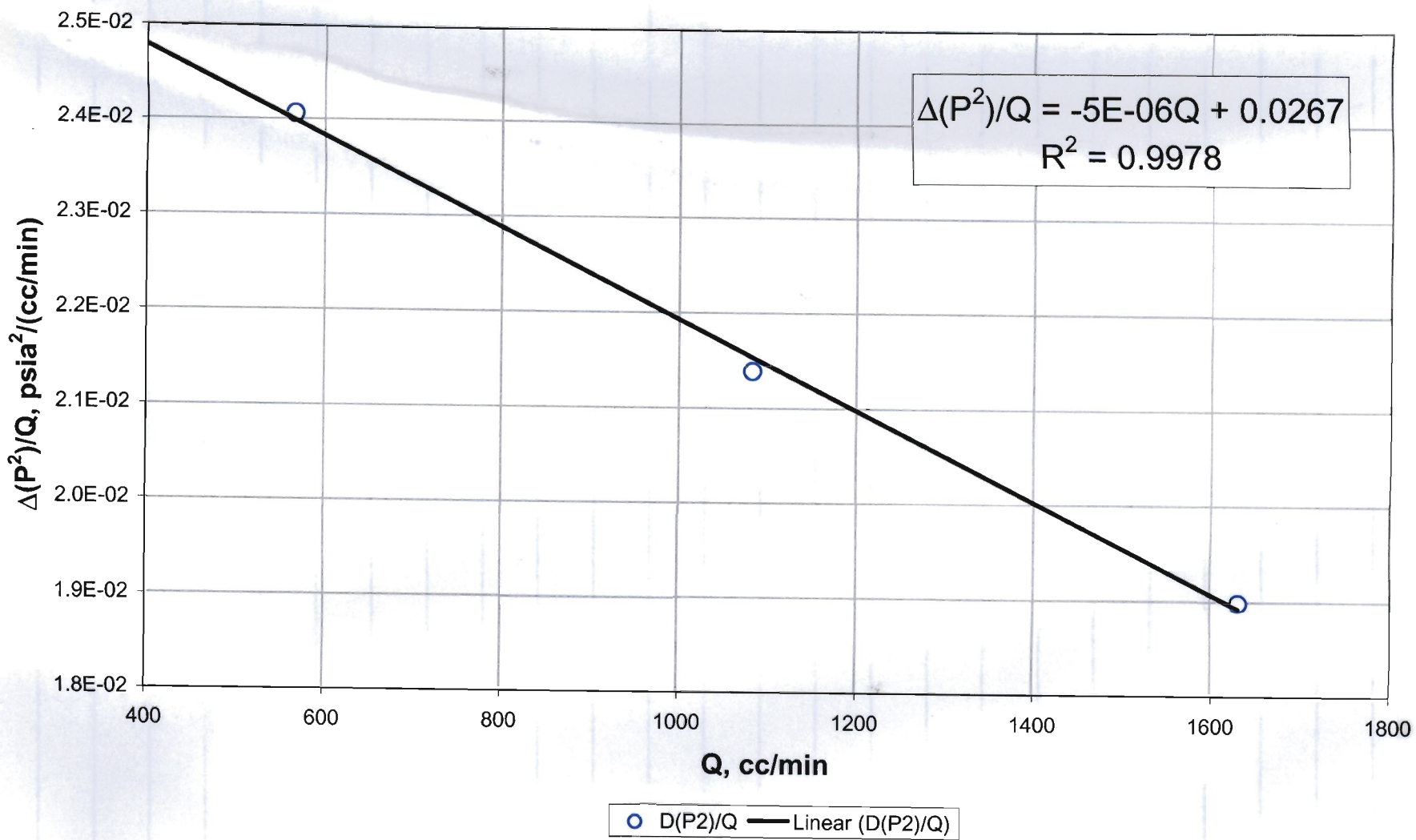**X Transect: Drillhole 61**

$$\log_{10}(\Delta(P^2)) = 0.78\log_{10}(Q) - 1.0098$$
$$R^2 = 0.9986$$

y-axis: $\log_{10}(\Delta(P^2))$
x-axis: $\log_{10}(Q)$

Legend: ○ log(D(P2)) ── Linear (log(D(P2)))

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 61
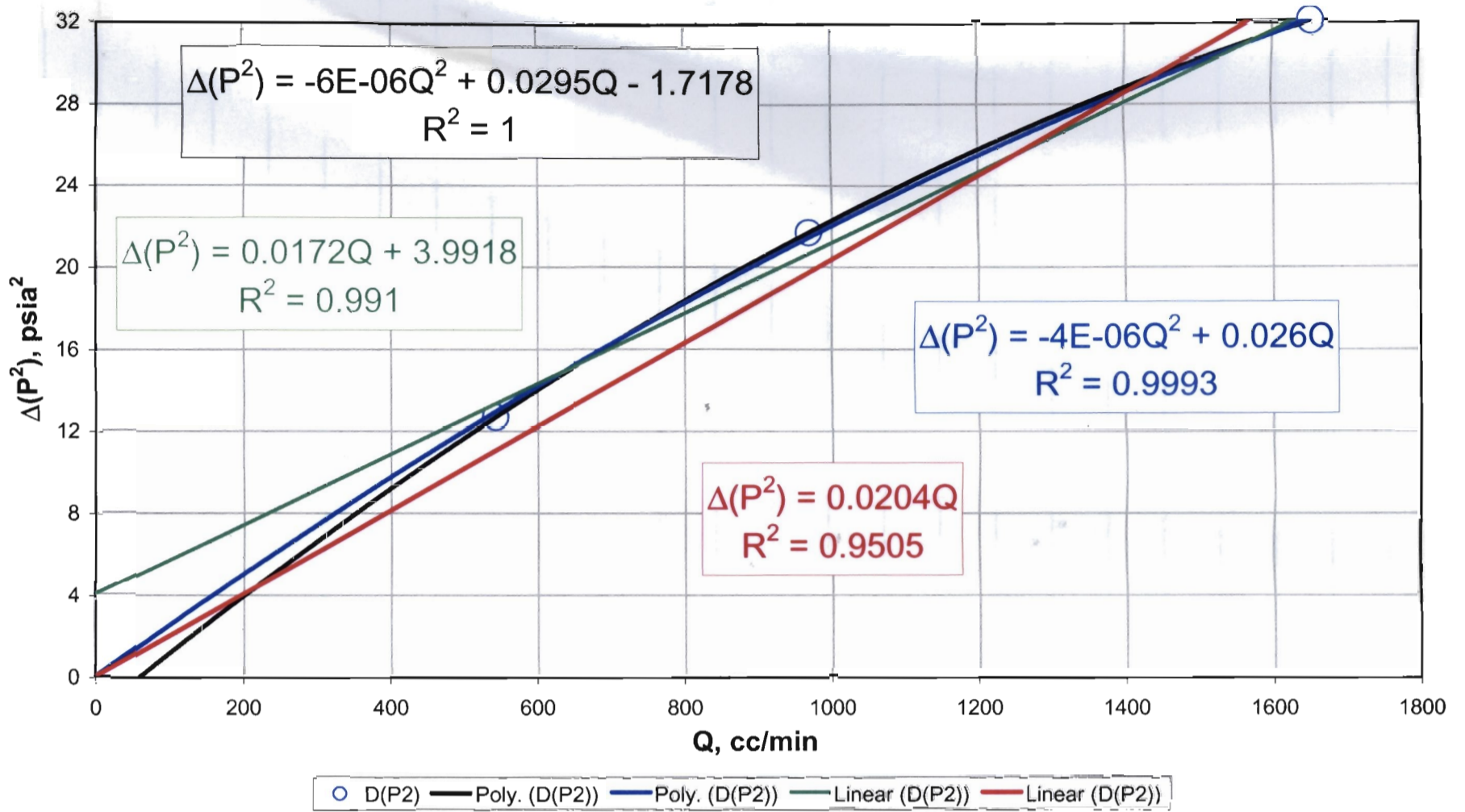

$$\Delta(P^2)/Q = -5E\text{-}06Q + 0.0267$$
$$R^2 = 0.9978$$

y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)
x-axis: Q, cc/min

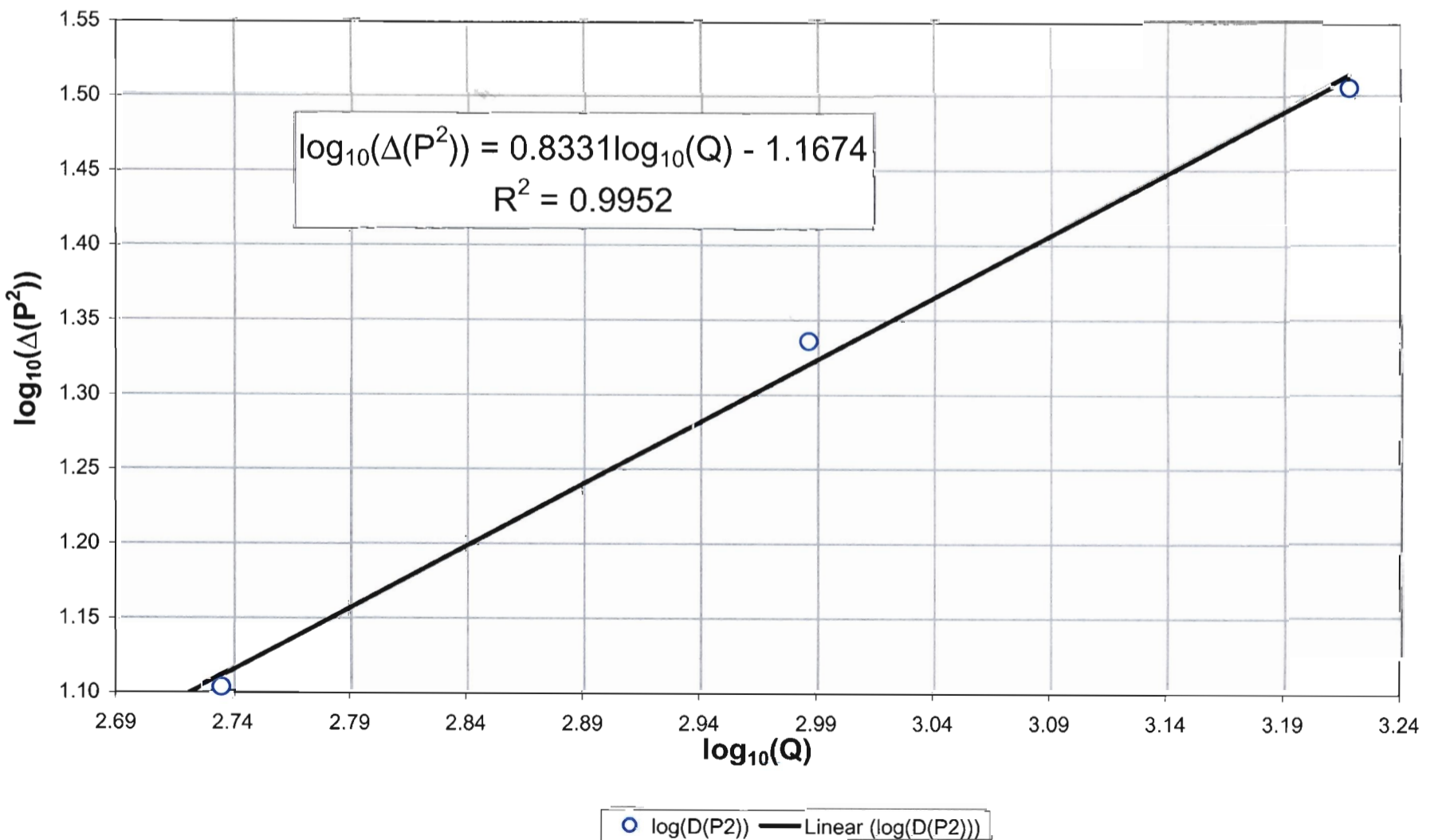Legend: ○ D(P2)/Q ── Linear (D(P2)/Q)

**Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 62**

$$\Delta(P^2) = -6E\text{-}06Q^2 + 0.0295Q - 1.7178$$
$$R^2 = 1$$

$$\Delta(P^2) = 0.0172Q + 3.9918$$
$$R^2 = 0.991$$

$$\Delta(P^2) = -4E\text{-}06Q^2 + 0.026Q$$
$$R^2 = 0.9993$$

$$\Delta(P^2) = 0.0204Q$$
$$R^2 = 0.9505$$

Y-axis: $\Delta(P^2)$, psia^2
X-axis: Q, cc/min

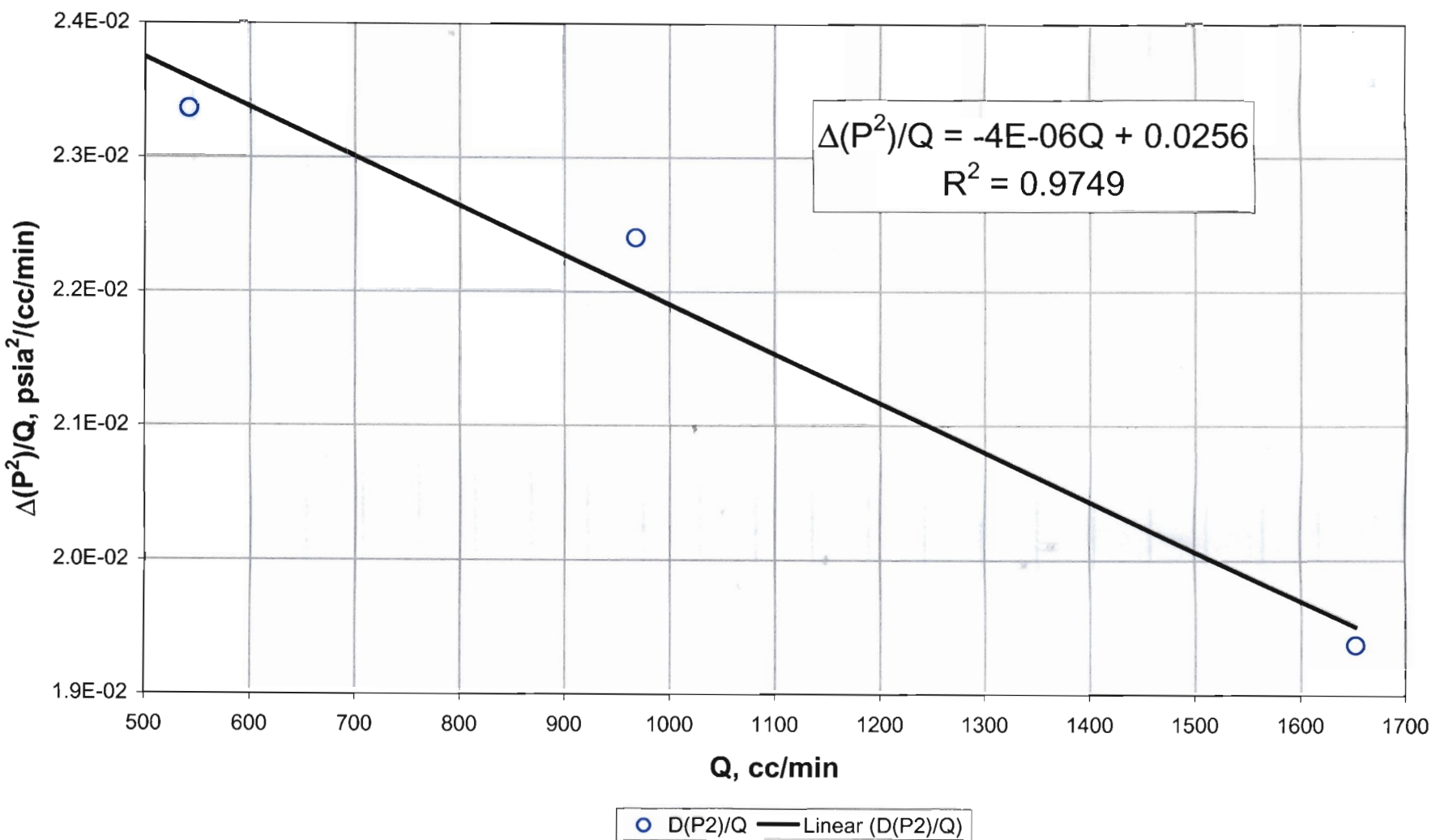Legend: O D(P2) — Poly. (D(P2)) — Poly. (D(P2)) — Linear (D(P2)) — Linear (D(P2))

**Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of
high-velocity flow effects (when the slope is greater than unity)
X Transect: Drillhole 62**

$$\log_{10}(\Delta(P^2)) = 0.8331\log_{10}(Q) - 1.1674$$
$$R^2 = 0.9952$$

Y-axis: $\log_{10}(\Delta(P^2))$
X-axis: $\log_{10}(Q)$

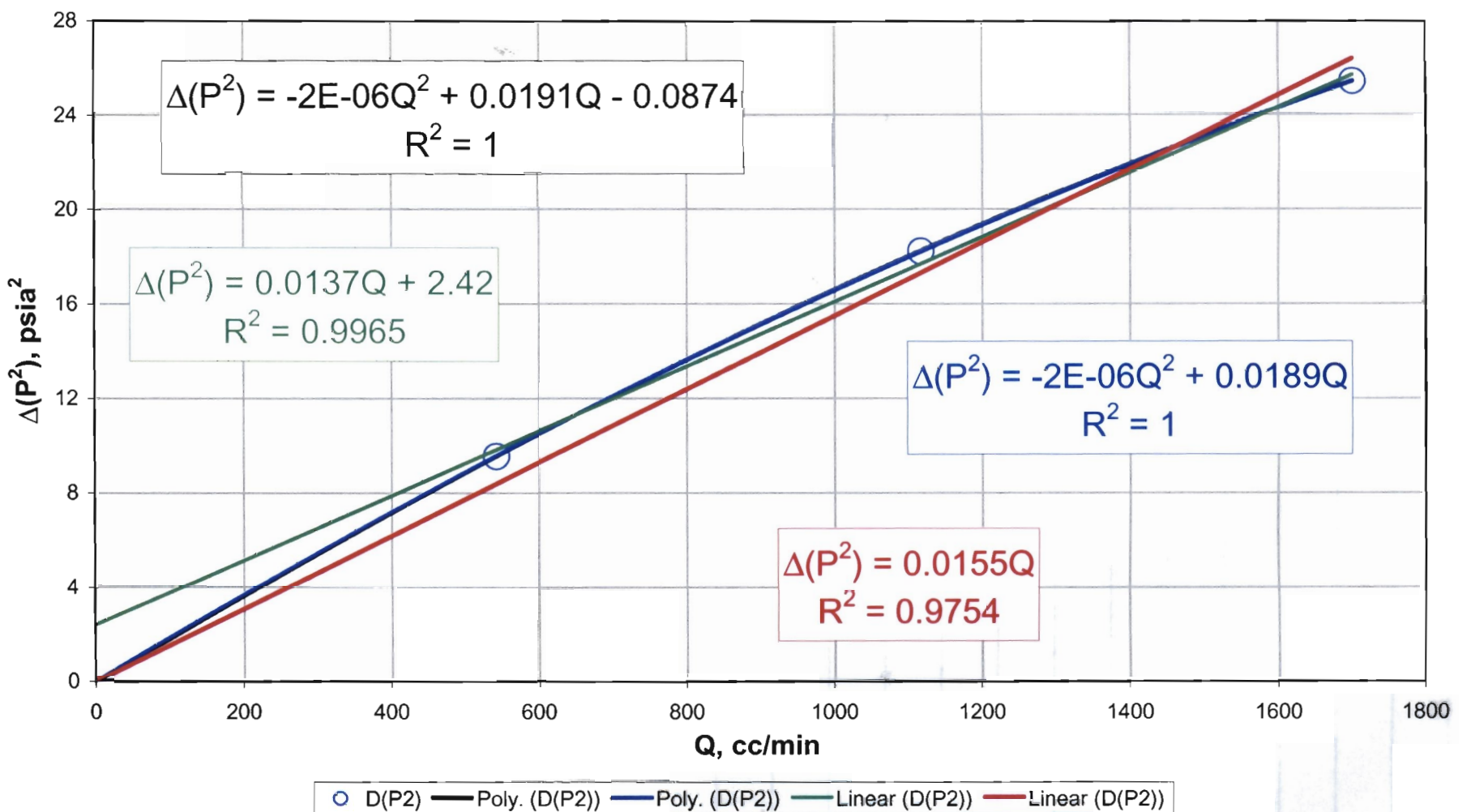Legend: O log(D(P2)) — Linear (log(D(P2)))

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 62

$\Delta(P^2)/Q = -4E\text{-}06Q + 0.0256$
$R^2 = 0.9749$

- Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min)
- X-axis: Q, cc/min

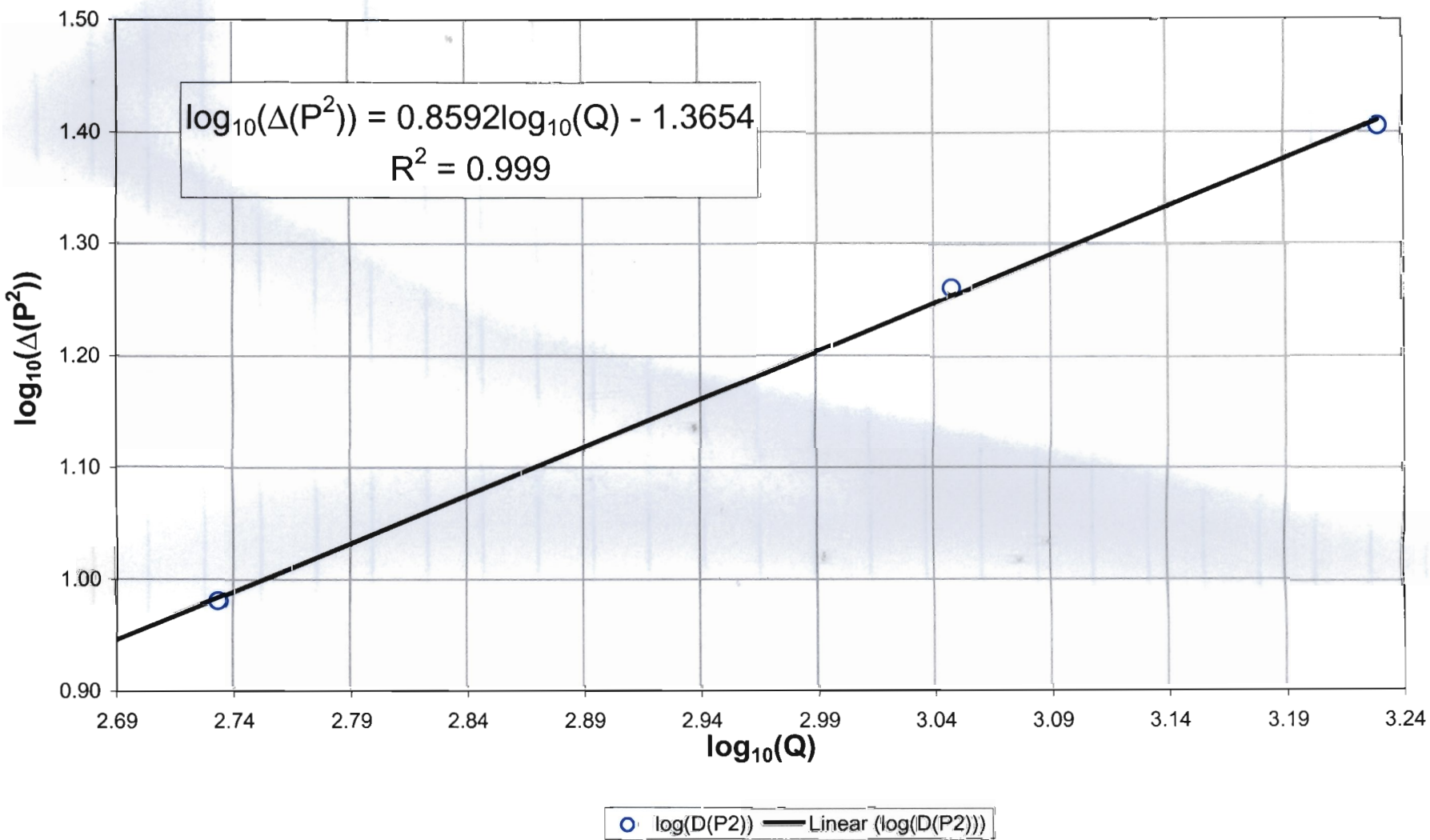Legend: ○ D(P2)/Q ── Linear (D(P2)/Q)

Rum, 08/27/02

Relationship between steady-state differential pressures squared and flowrate:
If relationship is linear, with the ordinate intercept nearly zero,
there is no high velocity flow effect.
X Transect: Drillhole 63

$\Delta(P^2) = -2E\text{-}06Q^2 + 0.0191Q - 0.0874$
$R^2 = 1$

$\Delta(P^2) = 0.0137Q + 2.42$
$R^2 = 0.9965$

$\Delta(P^2) = -2E\text{-}06Q^2 + 0.0189Q$
$R^2 = 1$

$\Delta(P^2) = 0.0155Q$
$R^2 = 0.9754$

- Y-axis: $\Delta(P^2)$, psia^2
- X-axis: Q, cc/min

Legend: ○ D(P2) ── Poly. (D(P2)) ── Poly. (D(P2)) ── Linear (D(P2)) ── Linear (D(P2))

Rum, 08/27/02

Log-Log plot of differential pressures squared vs. flowrate--used to identify the presence of high-velocity flow effects (when the slope is greater than unity)
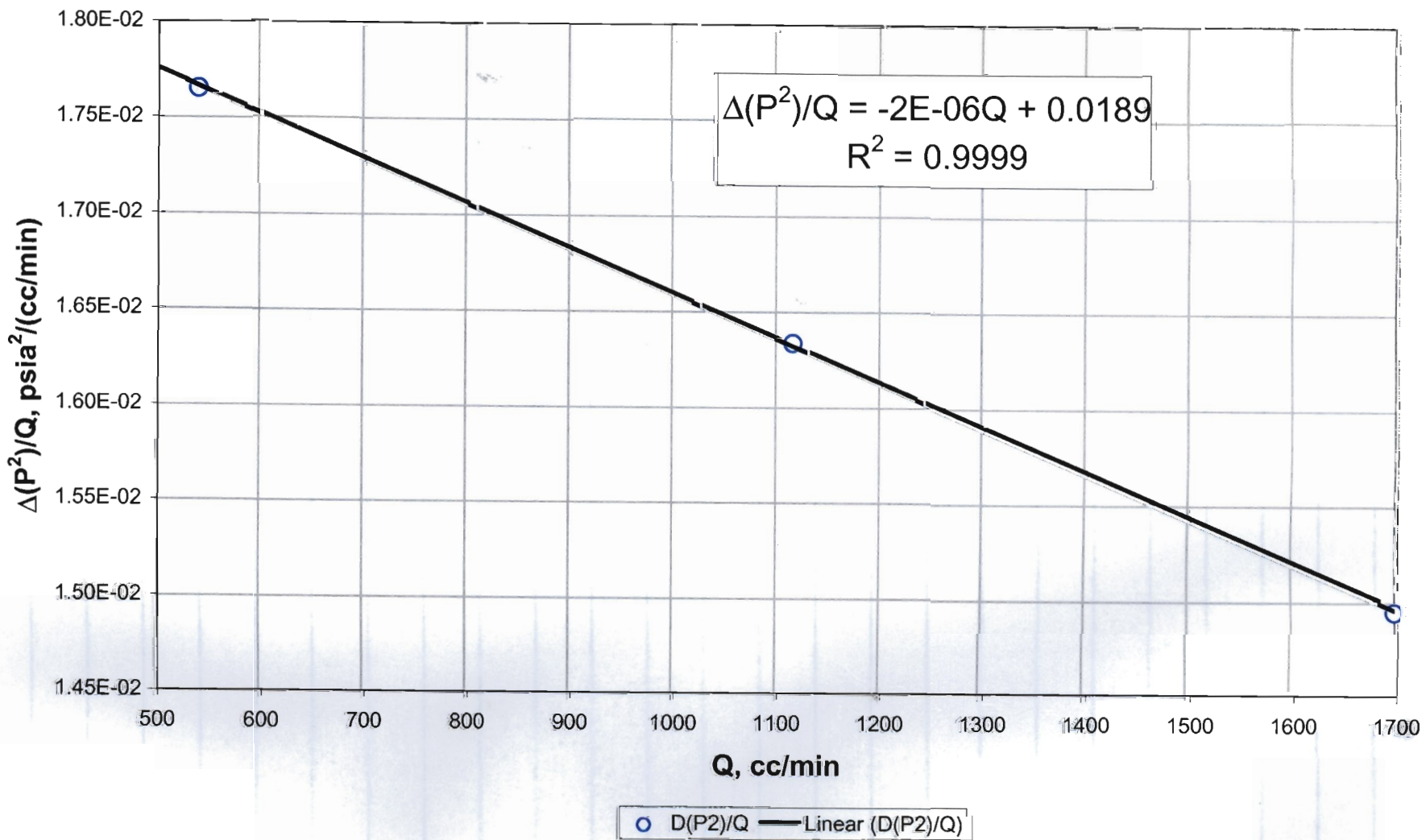**X Transect: Drillhole 63**

$$\log_{10}(\Delta(P^2)) = 0.8592\log_{10}(Q) - 1.3654$$
$$R^2 = 0.999$$

Y-axis: $\log_{10}(\Delta(P^2))$ — values: 0.90, 1.00, 1.10, 1.20, 1.30, 1.40, 1.50

X-axis: $\log_{10}(Q)$ — values: 2.69, 2.74, 2.79, 2.84, 2.89, 2.94, 2.99, 3.04, 3.09, 3.14, 3.19, 3.24

Legend: o log(D(P2)) —Linear (log(D(P2)))

Final check for high velocity flow effects:
High velocity flow effects are present when the slope is non-zero and positive.
X Transect : Drillhole 63

$$\Delta(P^2)/Q = -2E\text{-}06Q + 0.0189$$
$$R^2 = 0.9999$$

Y-axis: $\Delta(P^2)/Q$, psia^2/(cc/min) — values: 1.45E-02, 1.50E-02, 1.55E-02, 1.60E-02, 1.65E-02, 1.70E-02, 1.75E-02, 1.80E-02

X-axis: Q, cc/min — values: 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500, 1600, 1700

Legend: o D(P2)/Q —Linear (D(P2)/Q)