

# ***Excel for Hydrology***

## ***Section 5***



### ***Regression***

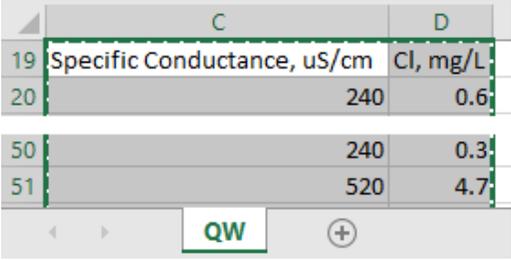
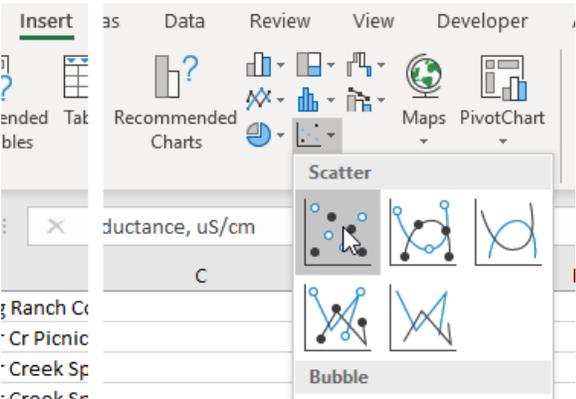
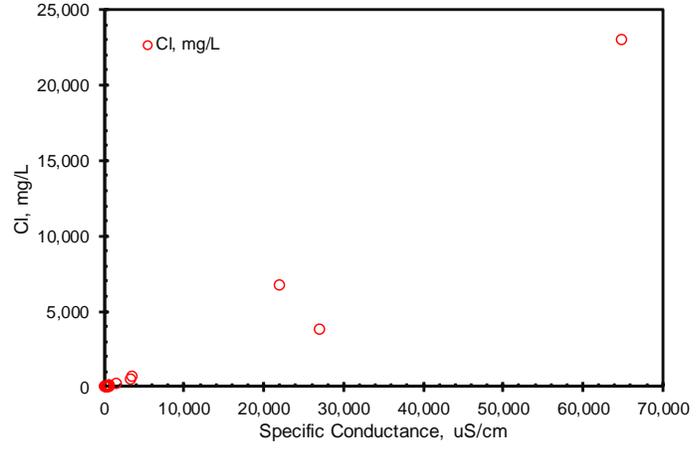
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## 05\_Regression

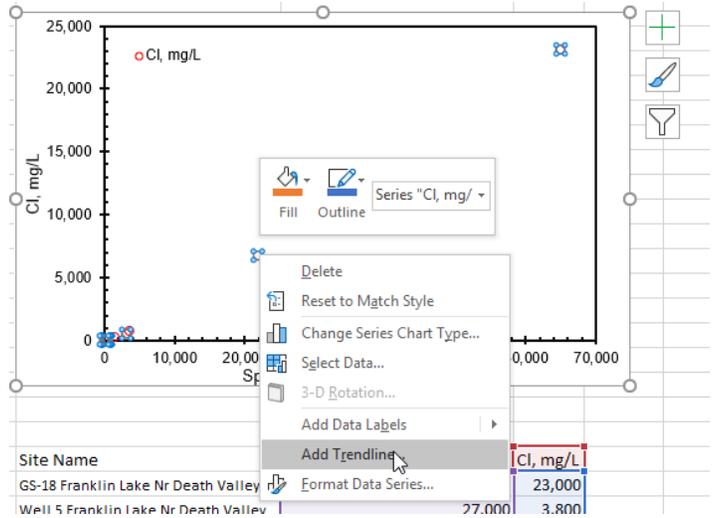
Linear and log-linear regressions are foundations of preliminary interpretations, which are computed quickly by adding trendlines to XY charts. This approach is fast, but estimated slope and intercept are not available for other equations. Alternatively, [SLOPE](#) and [INTERCEPT](#) are functions for linear regression, where estimated slope and intercept are available for other equations.

### 01\_linearQW.xlsx Regression – Specific Conductance and Chloride

Regression by Trendline																
<p>Select range <b>C19: D54</b>.</p>	 <table border="1"> <thead> <tr> <th></th> <th>C</th> <th>D</th> </tr> </thead> <tbody> <tr> <td>19</td> <td>Specific Conductance, uS/cm</td> <td>Cl, mg/L</td> </tr> <tr> <td>20</td> <td>240</td> <td>0.6</td> </tr> <tr> <td>50</td> <td>240</td> <td>0.3</td> </tr> <tr> <td>51</td> <td>520</td> <td>4.7</td> </tr> </tbody> </table>		C	D	19	Specific Conductance, uS/cm	Cl, mg/L	20	240	0.6	50	240	0.3	51	520	4.7
	C	D														
19	Specific Conductance, uS/cm	Cl, mg/L														
20	240	0.6														
50	240	0.3														
51	520	4.7														
<p>Add XY chart of Specific Conductance and Chloride. Select "Scatter."</p>																
<p>XY chart with formatting for clarity.</p>	 <table border="1"> <caption>Chart Data</caption> <thead> <tr> <th>Specific Conductance (uS/cm)</th> <th>Chloride (mg/L)</th> </tr> </thead> <tbody> <tr> <td>240</td> <td>0.6</td> </tr> <tr> <td>240</td> <td>0.3</td> </tr> <tr> <td>520</td> <td>4.7</td> </tr> </tbody> </table>	Specific Conductance (uS/cm)	Chloride (mg/L)	240	0.6	240	0.3	520	4.7							
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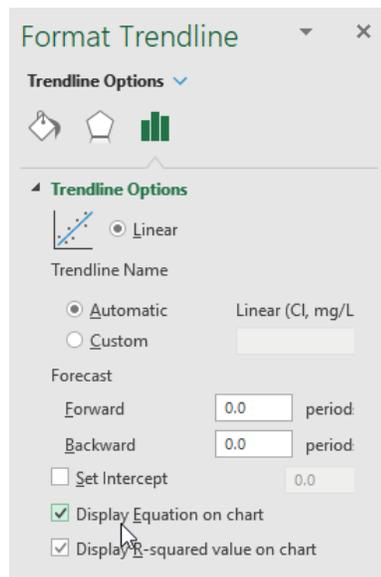
Select series.

Right-click and select "Add Trendline" from dialog.



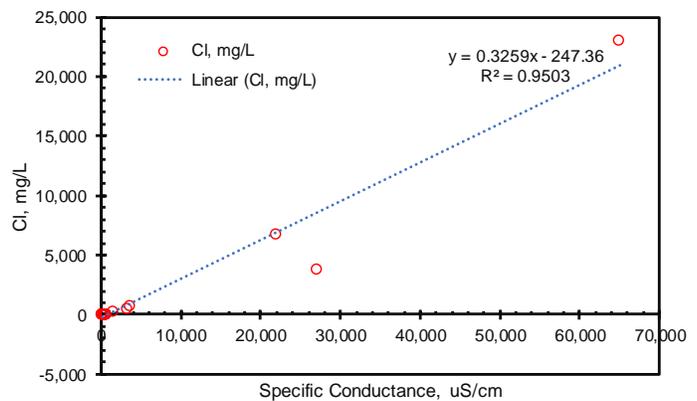
Select Trendline option, **Linear**.

Check options, "Display Equation on chart", and "Display R-squared value on chart".



$r^2 > 0.95$ , but equation is non-sensical.

Cl = -247 mg/L, negative concentration, where SC = 0  $\mu$ S/cm.



Format trendline and set intercept to 0.

Format Trendline

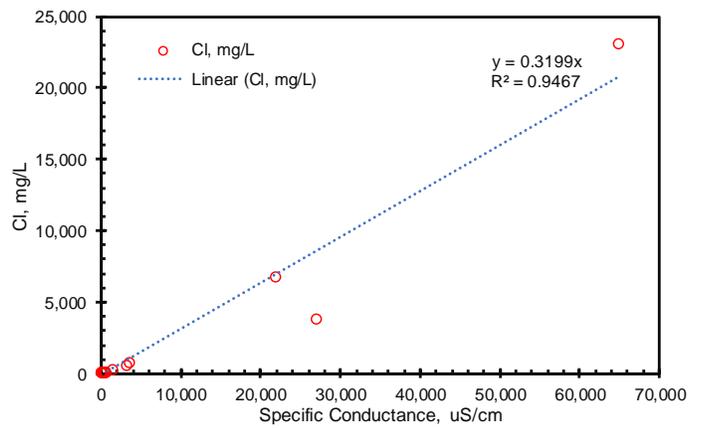
Trendline Options

Set Intercept

Display Equation on chart

Display R-squared value on chart

$r^2$  marginally less, but  
Results are physically possible.



## 01\_linearQW.xlsx Regression – Specific Conductance and Chloride

Regression by Functions SLOPE+INTERCEPT																																											
Enter labels “Slope =” and “Intercept =” in cells <b>D17</b> and <b>D18</b> .	<table border="1"> <thead> <tr> <th></th> <th>C</th> <th>D</th> <th>E</th> </tr> </thead> <tbody> <tr> <td>17</td> <td></td> <td>Slope =</td> <td></td> </tr> <tr> <td>18</td> <td></td> <td>Intercept =</td> <td></td> </tr> <tr> <td>19</td> <td>Specific Conductance, uS/cm</td> <td>Cl, mg/L</td> <td></td> </tr> <tr> <td>20</td> <td>65,000</td> <td>23,000</td> <td></td> </tr> <tr> <td>21</td> <td>27,000</td> <td>3,800</td> <td></td> </tr> </tbody> </table>		C	D	E	17		Slope =		18		Intercept =		19	Specific Conductance, uS/cm	Cl, mg/L		20	65,000	23,000		21	27,000	3,800																			
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Type function =SLOPE( into cell <b>E17</b> . after typing “(” a reminder appears that First range is <b>Ys</b> and Second range is <b>Xs</b> .	<table border="1"> <thead> <tr> <th></th> <th>C</th> <th>D</th> <th>E</th> <th>F</th> <th>G</th> </tr> </thead> <tbody> <tr> <td>17</td> <td></td> <td>Slope =</td> <td>=slope(</td> <td></td> <td></td> </tr> <tr> <td>18</td> <td></td> <td>Intercept =</td> <td>SLOPE(known_ys, known_xs)</td> <td></td> <td></td> </tr> <tr> <td>19</td> <td>Specific Conductance, uS/cm</td> <td>Cl, mg/L</td> <td></td> <td></td> <td></td> </tr> <tr> <td>20</td> <td>65,000</td> <td>23,000</td> <td></td> <td></td> <td></td> </tr> <tr> <td>21</td> <td>27,000</td> <td>3,800</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>		C	D	E	F	G	17		Slope =	=slope(			18		Intercept =	SLOPE(known_ys, known_xs)			19	Specific Conductance, uS/cm	Cl, mg/L				20	65,000	23,000				21	27,000	3,800									
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Complete equation with ranges, <b>\$D\$20:\$D\$54</b> and <b>\$C\$20:\$C\$54</b> .  Finished formula reads, “=SLOPE(\$D\$20:\$D\$54,\$C\$20:\$C\$54)”	<table border="1"> <thead> <tr> <th></th> <th>C</th> <th>D</th> <th>E</th> <th>F</th> <th>G</th> <th>H</th> </tr> </thead> <tbody> <tr> <td>17</td> <td></td> <td>Slope =</td> <td>=SLOPE(\$D\$20:\$D\$54,\$C\$20:\$C\$54)</td> <td></td> <td></td> <td></td> </tr> <tr> <td>18</td> <td></td> <td>Intercept =</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>19</td> <td>Specific Conductance, uS/cm</td> <td>Cl, mg/L</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>20</td> <td>65,000</td> <td>23,000</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>21</td> <td>27,000</td> <td>3,800</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>		C	D	E	F	G	H	17		Slope =	=SLOPE(\$D\$20:\$D\$54,\$C\$20:\$C\$54)				18		Intercept =					19	Specific Conductance, uS/cm	Cl, mg/L					20	65,000	23,000					21	27,000	3,800				
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<b>PLUS:</b> slope and intercept available.  <b>MINUS:</b> Intercept cannot be specified.	<table border="1"> <thead> <tr> <th></th> <th>D</th> <th>E</th> </tr> </thead> <tbody> <tr> <td>17</td> <td>Slope =</td> <td>0.325914</td> </tr> <tr> <td>18</td> <td>Intercept =</td> <td>-247.357</td> </tr> <tr> <td>19</td> <td>Cl, mg/L</td> <td></td> </tr> <tr> <td>20</td> <td>65,000</td> <td></td> </tr> <tr> <td>21</td> <td>27,000</td> <td></td> </tr> </tbody> </table>		D	E	17	Slope =	0.325914	18	Intercept =	-247.357	19	Cl, mg/L		20	65,000		21	27,000																									
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Can control reporting of estimated Cl with a threshold value.  Add Threshold Cl =, 100, mg/L to range <b>D16:F16</b> .	<table border="1"> <thead> <tr> <th></th> <th>D</th> <th>E</th> <th>F</th> </tr> </thead> <tbody> <tr> <td>16</td> <td>Threshold Cl =</td> <td>100</td> <td>mg/L</td> </tr> <tr> <td>17</td> <td>Slope =</td> <td>0.325914416</td> <td></td> </tr> </tbody> </table>		D	E	F	16	Threshold Cl =	100	mg/L	17	Slope =	0.325914416																															
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16	Threshold Cl =	100	mg/L																																								
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Add header equation to cell **E19**,  
="Estimated "&D19.

	D	E	F
16	Threshold Cl =	100	mg/L
17	Slope =	0.325914416	
18	Intercept =	-247.3570052	
19	Cl, mg/L	="Estimated "&D19	
20	23,000	20,937	
21	3,800	8,552	

Add censored estimate equation cell **E20**  
=IF(C20\*\$E\$17+\$E\$18>\$E\$16,  
C20\*\$E\$17+\$E\$18,  
"< "&TEXT(\$E\$16,"0")).

	C	D	E	F	G	H	I	J
16		Threshold Cl =	100	mg/L				
17		Slope =	0.325914416					
18		Intercept =	-247.3570052					
19	Specific Conduc	Cl, mg/L	Estimated Cl, mg/L					
20	65,000	23,000	=IF(C20*\$E\$17+\$E\$18>\$E\$16,C20*\$E\$17+\$E\$18,"< "&TEXT(\$E\$16,"0"))					
21	27,000	3,800						
22	22,000	6,700						

Copy cell **E20**.  
Paste to range **E20:E54**.  
Estimated Cl values less than the threshold  
are censored.

	C	D	E
19	Specific Conduc	Cl, mg/L	Estimated Cl, mg/L
20	65,000	23,000	20,937
21	27,000	3,800	8,552
22	22,000	6,700	6,923
23	3,600	690	926
24	3,300	480	828
25	1,570	200	264
26	700	41	< 100
27	670	1	< 100
28	630	16	< 100

## 02\_Example\_T-SC-DeathValley+OtherSCEqs.xlsx – Log-Log Regression

### Log-Log Regression by Functions SLOPE+INTERCEPT

Enter labels "Slope =" and "Intercept =" in cells **G16** and **G17**.

	G	H
16	Slope =	
17	Intercept =	
18	MEASURED	
19	SC, gpm/ft	

Add slope function in cell **H16**.

**Note:**

*Ys in column F and Xs in column G.*

	F	G	H	I	J
16		Slope =	=SLOPE(\$F\$20:\$F\$34,\$G\$20:\$G\$34)		
17		Intercept =			
18		MEASURED			
19	T-ft <sup>2</sup> /d	SC, gpm/ft			
20	5	0.04			

Add intercept function in cell **H17**.

Add header, T-estimated, ft<sup>2</sup>/d to cell **H19**.

	F	G	H	I	J
16		Slope =	1032.793876		
17		Intercept =	=INTERCEPT(\$F\$20:\$F\$34,\$G\$20:\$G\$34)		
18		MEASURED			
19	T-ft <sup>2</sup> /d	SC, gpm/ft	T-estimated, ft <sup>2</sup> /d		
20	5	0.04			

Estimate T with regression in cell **H20**.

With, =G20\*\$H\$16+\$H\$17

Copy cell **H20**.

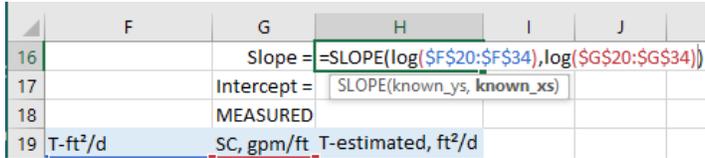
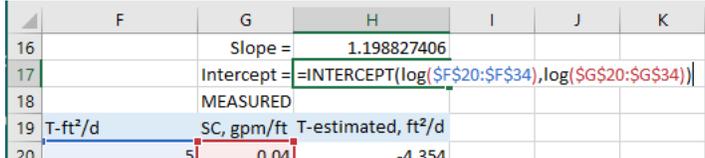
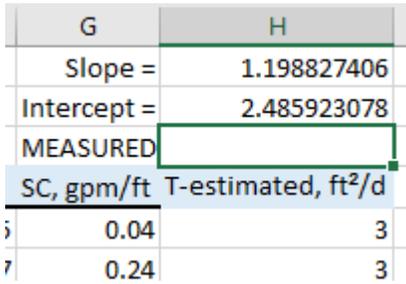
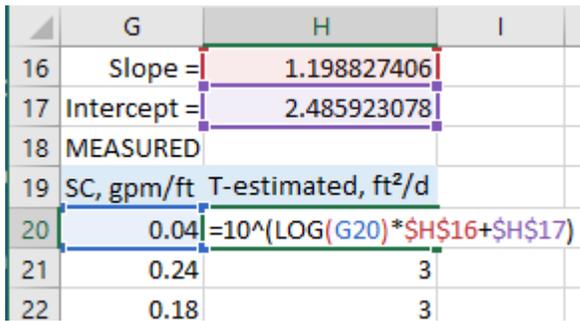
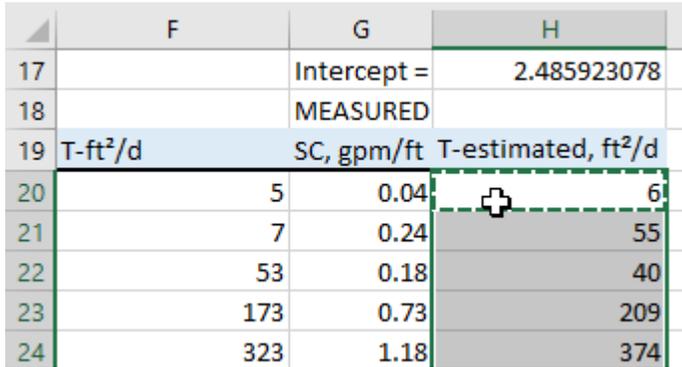
Paste to range **H20:H34**.

	F	G	H
16		Slope =	1032.793876
17		Intercept =	-4354.02532
18		MEASURED	
19	T-ft <sup>2</sup> /d	SC, gpm/ft	T-estimated, ft <sup>2</sup> /d
20	5	0.04	=G20*\$H\$16+\$H\$17
21	7	0.24	
22	53	0.18	

Whoa, Negative transmissivities,

Seriously wrong results because regressed SC vs. T rather than log(SC) vs. log(T).

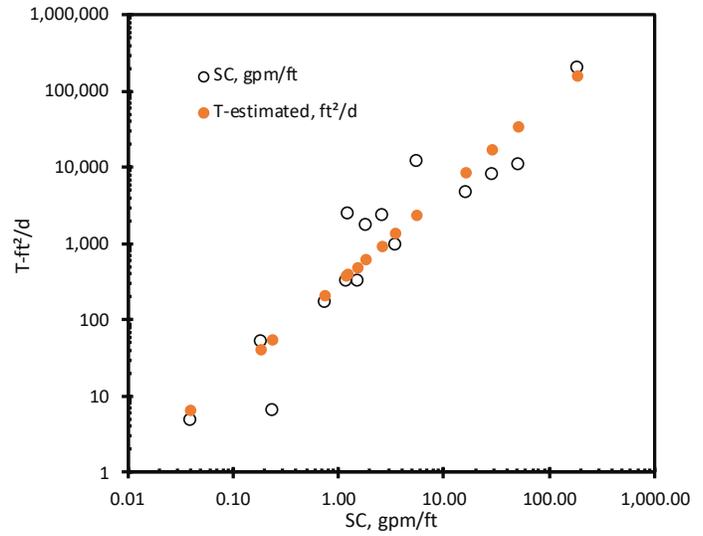
	F	G	H
16		Slope =	1032.793876
17		Intercept =	-4354.02532
18		MEASURED	
19	T-ft <sup>2</sup> /d	SC, gpm/ft	T-estimated, ft <sup>2</sup> /d
20	5	0.04	-4,313
21	7	0.24	-4,108
22	53	0.18	-4,165
23	173	0.73	-3,603
24	323	1.18	-3,132

<p>Open cell <b>H16</b> for editing with F2.</p> <p>Encapsulate each range with log, <b>log(range)</b>.</p> <p>Revised formula reads,  <code>"=SLOPE(log(\$F\$20:\$F\$34),log(\$G\$20:\$G\$34))"</code></p>	 <p>Excel spreadsheet showing the SLOPE formula in cell H16: <code>=SLOPE(log(\$F\$20:\$F\$34),log(\$G\$20:\$G\$34))</code>. The spreadsheet includes columns F, G, H, I, J and rows 16-19. Row 19 contains headers: T-ft<sup>2</sup>/d, SC, gpm/ft, T-estimated, ft<sup>2</sup>/d.</p>
<p>Open cell <b>H17</b> for editing with F2.</p> <p>Revise INTERCEPT equation by encapsulating each range with log, <b>log(range)</b>.</p>	 <p>Excel spreadsheet showing the INTERCEPT formula in cell H17: <code>=INTERCEPT(log(\$F\$20:\$F\$34),log(\$G\$20:\$G\$34))</code>. The spreadsheet includes columns F, G, H, I, J, K and rows 16-20. Row 20 contains values: 5, 0.04, -4,354.</p>
<p>Less wrong but still wrong.</p> <p>Equation is  <math>\log(T) = A \cdot \log(SC) + B</math>,  <math>T = 10^{[A \cdot \log(SC) + B]}</math>, or  <math>T = 10^B \cdot SC^A</math></p>	 <p>Excel spreadsheet showing the equation components in cells G and H. Cell G contains: Slope = 1.198827406, Intercept = 2.485923078, MEASURED, SC, gpm/ft, T-estimated, ft<sup>2</sup>/d. Cell H contains: 0.04, 3, 0.24, 3.</p>
<p>Revise estimate T in cell <b>H20</b> with  <math>T = 10^{[A \cdot \log(SC) + B]}</math></p> <p>Formula, <code>=10^(LOG(G20)*\$H\$16+\$H\$17)</code></p> <p>Copy cell <b>H20</b>.</p> <p>Paste to range <b>H20:H34</b>.</p>	 <p>Excel spreadsheet showing the formula in cell H20: <code>=10^(LOG(G20)*\$H\$16+\$H\$17)</code>. The spreadsheet includes columns G, H, I and rows 16-22. Row 20 contains values: 0.04, 6.</p>
<p>Estimated Ts seem plausible.</p> <p>Copy range <b>H19:H34</b>.</p>	 <p>Excel spreadsheet showing the final data table. The spreadsheet includes columns F, G, H and rows 17-24. Row 17 contains: Intercept = 2.485923078. Row 18 contains: MEASURED. Row 19 contains: T-ft<sup>2</sup>/d, SC, gpm/ft, T-estimated, ft<sup>2</sup>/d. Row 20 contains: 5, 0.04, 6. Row 21 contains: 7, 0.24, 55. Row 22 contains: 53, 0.18, 40. Row 23 contains: 173, 0.73, 209. Row 24 contains: 323, 1.18, 374.</p>

Select XY chart.

Paste special and add series, **T-estimated, ft<sup>2</sup>/d**.

Add legend.



Revise series, **T-estimated, ft<sup>2</sup>/d**, from markers to a solid line.

