

## Paradise Creek Watershed, Summary of Water Quality Statistical Analysis.

The following worksheets show results of statistical comparisons between water quality sampling stations in the Paradise Creek watershed. Data analyses were conducted in June 2004 by Robert Limbeck, Watershed Scientist, Delaware River Basin Commission.

Statistical analyses were completed using Analyse-It, a statistical add-on package for Microsoft Excel, using the Paradise Creek water quality database provided by Debra Brady, project manager, as of June 2004.

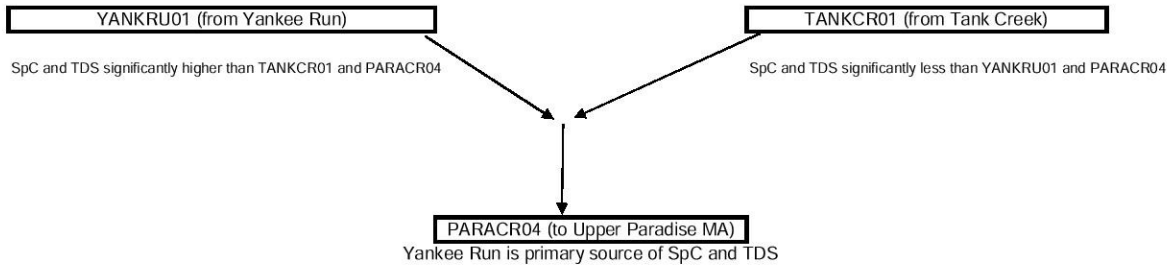
A separate (very thick) document prepared for a July 2004 meeting contains descriptive and comparative statistics for each parameter. That document also contains gauge height vs. discharge regression analyses for all water quality stations.

Data are summarized from 12 monthly samples taken at each site. Values are annual averages for each parameter. Insufficient data exist to consider seasonal changes. Missing data may significantly influence annual average values.

Overall water quality in the Paradise Creek watershed is excellent, considering annual avg DO, pH, %DO saturation, and temperature. Conductivity and TDS were the most sensitive parameters, able to detect influences of human activity upon water quality.

Since there were insufficient data to determine seasonal effects, this analysis does not show the numerous temperature violations detected during summer months. Additional and regular temperature, TDS and SpC monitoring is recommended.

## Tank Creek / Yankee Run Management Area



*Results: Yankee Run is the primary source of TDS and SpC delivered to PARACR04 and to the Upper Paradise Creek MA. Further downstream, Devils Hole Creek significantly improves SpC and TDS concentrations. Reason for high SpC and TDS concentrations observed in Yankee Run are unknown.*

## Water Quality Data and Results of Statistical Comparisons

Note: < symbol denotes that upstream concentration is significantly less than downstream station (p=0.05).

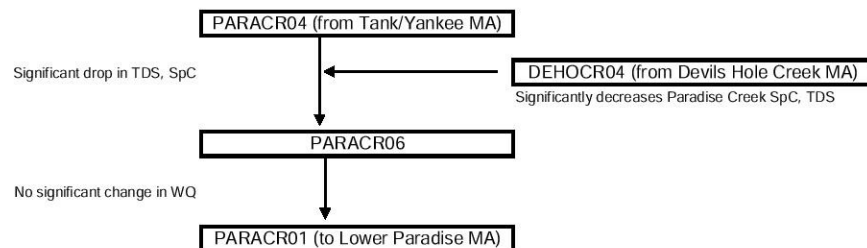
Note: = symbol denotes that upstream concentration is statistically equal to downstream station (p=0.05).

Note: > symbol denotes that upstream concentration is significantly greater than downstream station (p=0.05).

Note: \* / \* symbol denotes two statistical comparisons: tributary site vs. receiving stream upstream of confluence / trib vs. downstream of confluence.

Station		Field Specific Conductance	DO	pH	DO % saturation	TDS	Lab Conductivity	Water Temp (C)
TANKCR01		80.8	11.2	7.3	96.8	52.5	56.2	9.3
	vs YANKRU01 / vs PARACR04	< / <	= / =	= / =	= / =	< / <	< / <	= / =
YANKRU01		410.5	11.0	7.5	97.4	266.6	294.7	10.2
	vs PARACR04	>	=	=	=	>	>	=
PARACR04 (to Upper Paradise MA)		162.9	11.1	7.4	95.4	105.8	113.1	9.0

## Upper Paradise Management Area



*Result: Devils Hole Creek significantly improves TDS and SpC concentrations in Paradise Creek. Devils Hole Creek is heavily forested, with significantly lower concentrations of SpC and TDS than upstream and downstream stations on Paradise Creek, the receiving stream. Devils Hole Creek may serve as the water quality reference stream for the Paradise Creek watershed.*

## Water Quality Data and Results of Statistical Comparisons

Note: < symbol denotes that upstream concentration is significantly less than downstream station (p=0.05).

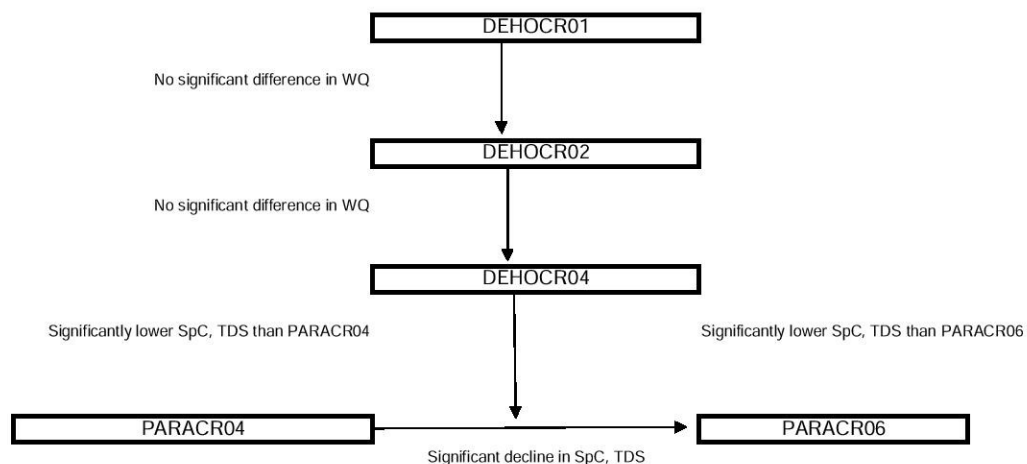
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Note: \* / \* symbol denotes two statistical comparisons: tributary site vs. receiving stream upstream of confluence / trib vs. downstream of confluence.

Station	Field Specific Conductance	DO	pH	DO % saturation	TDS	Lab Conductivity	Water Temp (C)
PARACR04 (WQ from Tank/Yankee MA)	162.9	11.1	7.4	95.4	105.8	113.1	9.0
vs DEHOOCR04 / vs PARACR06	> / >	= / =	= / =	= / =	> / >	> / >	= / =
DEHOOCR04 (WQ from Devils Hole Cr MA)	46.3	11.1	7.5	96.1	30.3	32.5	9.3
vs PARACR06	<	=	=	=	<	<	=
PARACR06	97.0	11.2	7.8	96.2	63.2	67.7	9.1
vs PARACR01	=	=	=	=	=	=	=
PARACR01 (to Lower Paradise MA)	99.8	11.0	7.6	96.0	64.9	71.8	9.9

## Devils Hole Creek Management Area



*Result: Excellent water quality in Devils Hole Creek has a significant influence upon Paradise Creek, mitigating elevated levels of SpC and TDS contributed by Yankee Run and causing a significant drop in SpC and TDS levels between Paradise Creek stations PARACR04 and PARACR06. Devils Hole Creek can serve as a water quality reference stream for future management efforts in the Paradise Creek watershed.*

## Data

Note: < symbol denotes that upstream concentration is significantly less than downstream station (p=0.05).

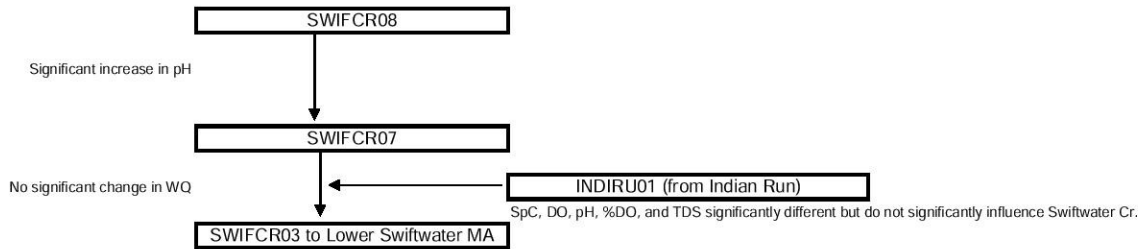
Note: = symbol denotes that upstream concentration is statistically equal to downstream station (p=0.05).

Note: > symbol denotes that upstream concentration is significantly greater than downstream station (p=0.05).

Note: \* / \* symbol denotes two statistical comparisons: tributary site vs. Paradise Cr upstream of confluence / trib vs. downstream of confluence.

Station		Field Specific Conductance	DO	pH	DO % saturation	TDS	Lab Conductivity	Water Temp (C)
DEHOCR01		53.4	9.8	7.1	91.9	34.4	40.4	12.5
	vs DEHOCR02	=	=	=	=	=	=	=
DEHOCR02		45.5	11.2	7.3	97.7	29.7	31.9	9.4
	vs DEHOCR04	=	=	=	=	=	=	=
DEHOCR04		46.3	11.1	7.5	96.1	30.3	32.5	9.3
	vs PARACR04 / vs PARACR06	< / <	= / =	= / =	= / =	< / <	< / <	= / =
PARACR04 (WQ from Tank/Yankee)		162.9	11.1	7.4	95.4	105.8	113.1	9.0
	vs PARACR06	>	=	=	=	>	>	=
PARACR06 (to Upper Paradise MA)		97.0	11.2	7.8	96.2	63.2	67.7	9.1

## Upper Swiftwater Management Area



*Results: A significant rise in pH was observed between SWIFCR08 and SWIFCR07, possibly due to natural changes in landscape and vegetation characteristics. With decreasing proximity to low gradient, tannic and swampy headwaters where low pH is common, pH at downstream stations rises to become similar to levels observed in most of the lower Paradise Creek watershed. Water quality of Indian Run is significantly different from upstream and downstream stations on Swiftwater Creek, the receiving stream, but Indian Run does not significantly influence water quality of Swiftwater Creek. Reasons are unknown for observed high concentrations of SpC, TDS and low pH, dissolved oxygen, and % DO saturation in Indian Run.*

## Water Quality Data and Results of Statistical Comparisons

Note: < symbol denotes that upstream concentration is significantly less than downstream station (p=0.05).

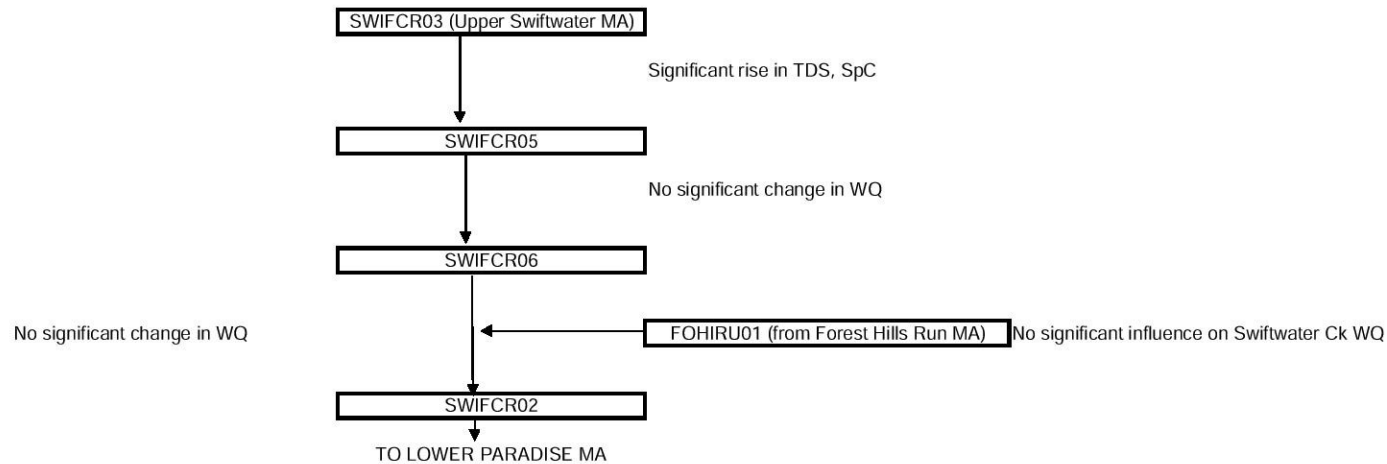
Note: = symbol denotes that upstream concentration is statistically equal to downstream station (p=0.05).

Note: > symbol denotes that upstream concentration is significantly greater than downstream station (p=0.05).

Note: \* / \* symbol denotes two statistical comparisons: tributary site vs. receiving stream upstream of confluence / trib vs. downstream of confluence.

Station		Field Specific Conductance	DO	pH	DO % saturation	TDS	Lab Conductivity	Water Temp (C)
SWIFCR08		128.2	10.5	6.4	93.5	83.4	91.4	10.1
	vs SWIFCR07	=	=	<	=	=	=	=
SWIFCR07		102.3	11.5	7.2	98.4	66.5	70.0	8.9
	vs INDIRU01 / vs SWIFCR03	< / =	> / =	> / =	> / =	< / =	< / =	= / =
INDIRU01		232.8	9.8	6.1	85.8	151.4	147.3	9.6
	vs SWIFCR03	>	<	<	<	>	>	=
SWIFCR03 (to Lower Swiftwater MA)		123.7	11.2	7.6	96.4	80.0	86.0	9.1

## Lower Swiftwater Management Area



*Result: Between stations SWIFCR03 and SWIFCR05, significant increases in concentrations of specific conductance and total dissolved solids were observed. Both the Sanofi Pasteur plant and a stretch of Rt. 611 are located within this reach, and may be contributing to the rise in these parameters. Elevated levels of SpC and TDS remain at all downstream stations, and cause significant changes to Paradise Creek (see Lower Paradise Management Area, comparison of SWIFCR02 to PARACR01 and PARACR07). Forest Hills Run does not significantly influence water quality of Swiftwater Creek, but combined high concentrations of SpC and TDS from Swiftwater Creek and Forest Hills Run significantly influence downstream concentrations in Paradise Creek.*

## Water Quality Data and Results of Statistical Comparisons

Note: < symbol denotes that upstream concentration is significantly less than downstream station (p=0.05).

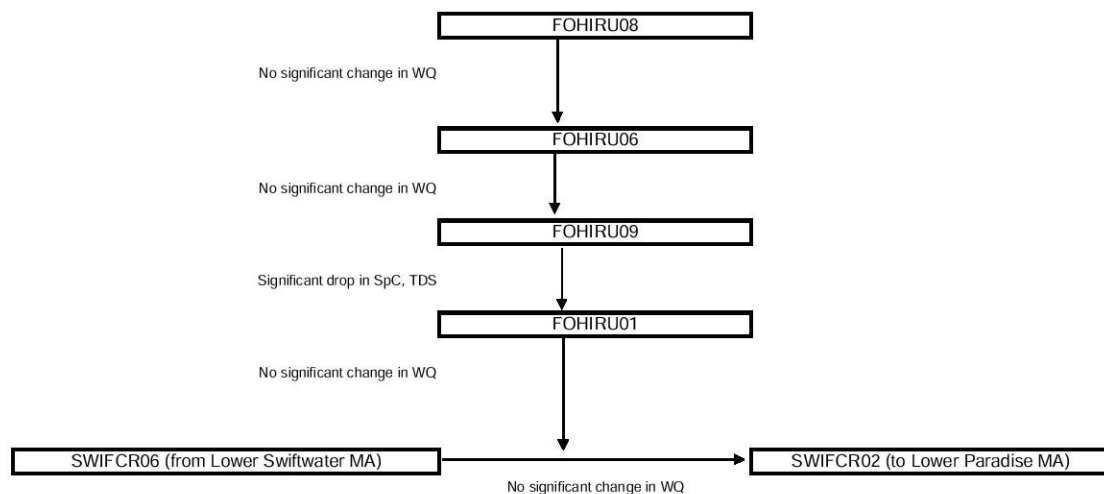
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Note: > symbol denotes that upstream concentration is significantly greater than downstream station (p=0.05).

Note: \* / \* symbol denotes two statistical comparisons: tributary site vs. receiving stream upstream of confluence / trib vs. downstream of confluence.

Station	Field Specific Conductance	DO	pH	DO % saturation	TDS	Lab Conductivity	Water Temp (C)
SWIFCR03 (WQ from Upper Swiftwater MA)	123.7	11.2	7.6	96.4	80.0	86.0	9.1
vs SWIFCR05	<	=	=	=	<	<	=
SWIFCR05	164.6	11.4	7.5	99.3	107.0	115.2	9.5
vs SWIFCR06	=	=	=	=	=	=	=
SWIFCR06	169.8	11.1	7.7	97.2	110.4	121.7	10.3
vs FOHIRU01 / vs SWIFCR02	= / =	= / =	= / =	= / =	= / =	= / =	= / =
FOHIRU01 (WQ from Forest Hills Run MA)	164.9	10.9	7.7	96.1	105.7	127.5	10.4
vs SWIFCR02	=	=	=	=	=	=	=
SWIFCR02 (to Lower Paradise MA)	166.3	11.0	7.7	97.1	108.0	119.7	10.3

## Forest Hills Run Management Area



*Results: Along Forest Hills Run, conductivity and TDS start high and gradually fall in concentration from headwaters to confluence with Swiftwater Creek, significantly decreasing concentration between stations FOHIRU09 and FOHIRU01. Forest Hills Run does not significantly change the water quality of Swiftwater Creek, though the combined water quality of Forest Hills Run and Swiftwater Creek significantly decreases water quality of Paradise Creek by elevating levels of SpC and TDS. High concentrations from Forest Hills Run may be attributable to runoff from Rt. 611, discharge from the Mt. Pocono Municipal Authority sewage treatment plant, and runoff from urban areas and golf courses.*

## Water Quality Data and Results of Statistical Comparisons

Note: < symbol denotes that upstream concentration is significantly less than downstream station (p=0.05).

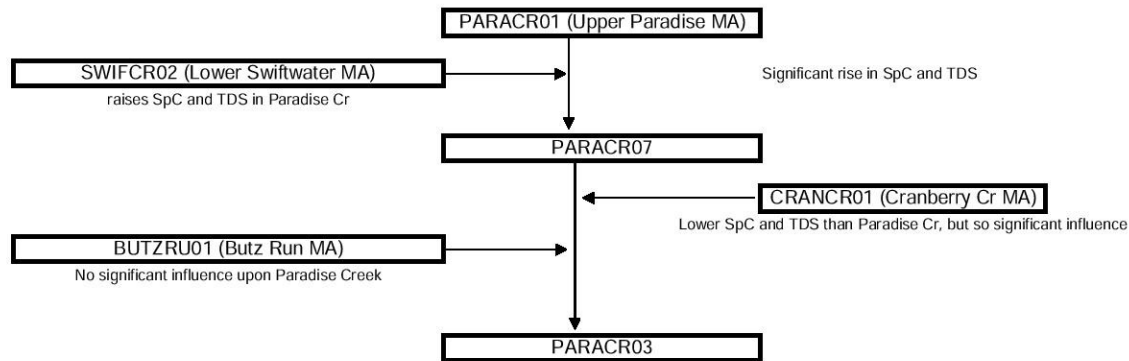
Note: = symbol denotes that upstream concentration is statistically equal to downstream station (p=0.05).

Note: > symbol denotes that upstream concentration is significantly greater than downstream station (p=0.05).

Note: \* / \* symbol denotes two statistical comparisons: tributary site vs. receiving stream upstream of confluence / trib vs. downstream of confluence.

Station		Field Specific Conductance	DO	pH	DO % saturation	TDS	Lab Conductivity	Water Temp (C)
FOHIRU08		248.8	11.2	7.4	97.4	161.8	175.3	9.5
	vs FOHIRU06	=	=	=	=	=	=	=
FOHIRU06		228.6	11.5	7.7	99.8	148.7	160.5	9.4
	vs FOHIRU09	=	=	=	=	=	=	=
FOHIRU09		204.6	10.8	7.7	96.8	133.1	151.4	11.3
	vs FOHIRU01	>	=	=	=	>	=	=
FOHIRU01		164.9	10.9	7.7	96.1	105.7	127.5	10.5
	vs SWIFCR06 / vs SWIFCR02	= / =	= / =	= / =	= / =	= / =	= / =	= / =
SWIFCR06 (Upstream from Lower Swiftwater MA)		169.8	11.1	7.7	97.2	110.4	121.7	10.3
	vs SWIFCR02	=	=	=	=	=	=	=
SWIFCR02 (Downstream to Lower Paradise MA)		166.3	11.0	7.7	97.1	108.0	119.7	10.3

## Lower Paradise Management Area



*Result: Between PARACR01 and PARACR07, conductivity and TDS rise significantly, attributable to elevated concentrations from Swiftwater Creek and Forest Hills Run. Water quality inputs from Cranberry Creek and Butz Run have no significant impact upon Paradise Creek, though Cranberry Creek conductivity and TDS concentrations are significantly lower than those of Paradise Creek.*

## Water Quality Data and Results of Statistical Comparisons

Note: < symbol denotes that upstream concentration is significantly less than downstream station (p=0.05).

Note: = symbol denotes that upstream concentration is statistically equal to downstream station (p=0.05).

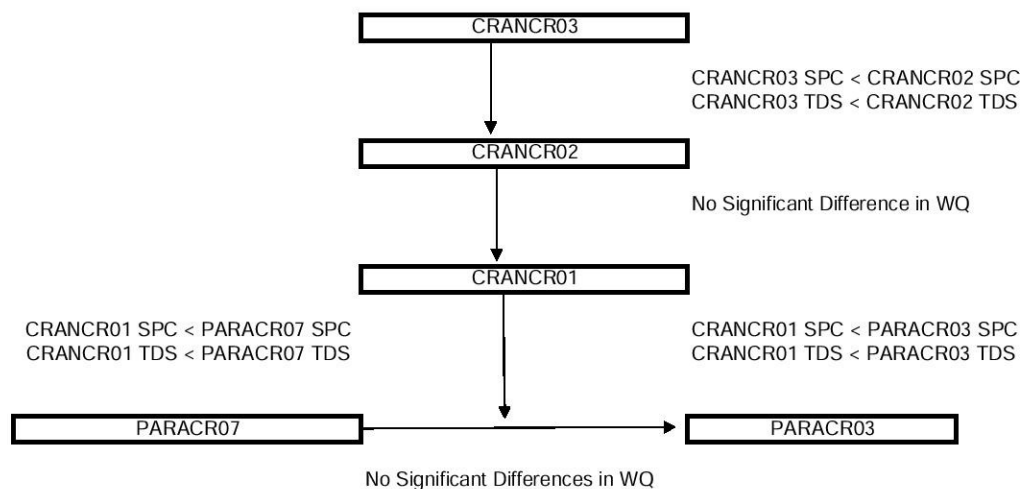
Note: > symbol denotes that upstream concentration is significantly greater than downstream station (p=0.05).

Note: \* / \* symbol denotes two statistical comparisons: tributary site vs. receiving stream upstream of confluence / trib vs. downstream of confluence.

Station	Field Specific Conductance	DO	pH	DO % saturation	TDS	Lab Conductivity	Water Temp (C)
PARACR01 (WQ from Upper Paradise MA)	99.8	11.0	7.6	96.0	64.9	71.8	9.9
vs SWIFCR02 / vs PARACR07	< / <	= / =	= / =	= / =	< / <	< / <	= / =
SWIFCR02 (WQ from Lower Swiftwater MA)	166.3	11.1	7.7	97.1	108.0	119.7	10.3
vs PARACR07	>	=	=	=	>	>	=
PARACR07	128.9	11.4	7.7	99.0	83.8	91.8	9.8
vs CRANCR01 / vs BUTZRU01 / vs PARACR03	= / = / =	= / = / =	= / = / =	= / = / =	> / = / =	> / = / =	= / = / =
CRANCR01 (WQ from Cranberry Creek MA)	80.6	11.4	7.7	98.7	52.4	58.1	9.5
vs BUTZRU01	=	=	=	=	=	=	=
BUTZRU01 (WQ from Butz Run MA)	104.2	11.2	7.8	97.1	67.4	75.2	10.1
vs PARACR03	=	=	=	=	=	=	=
PARACR03	123.5	11.3	8.0	99.0	80.2	88.8	10.1



## Cranberry Creek Management Area



*Result: The mining operation in the headwaters of Cranberry Creek produces a spike in conductivity and TDS at station CRANCR03 that declines significantly between stations CRANCR03 and CRANCR02. No further changes in water quality were observed along Cranberry Creek. Though Cranberry Creek's water quality is significantly different from Paradise Creek, Cranberry Creek does not change Paradise Creek's water quality.*

## Data

Note: < symbol denotes that upstream concentration is significantly less than downstream station (p=0.05).

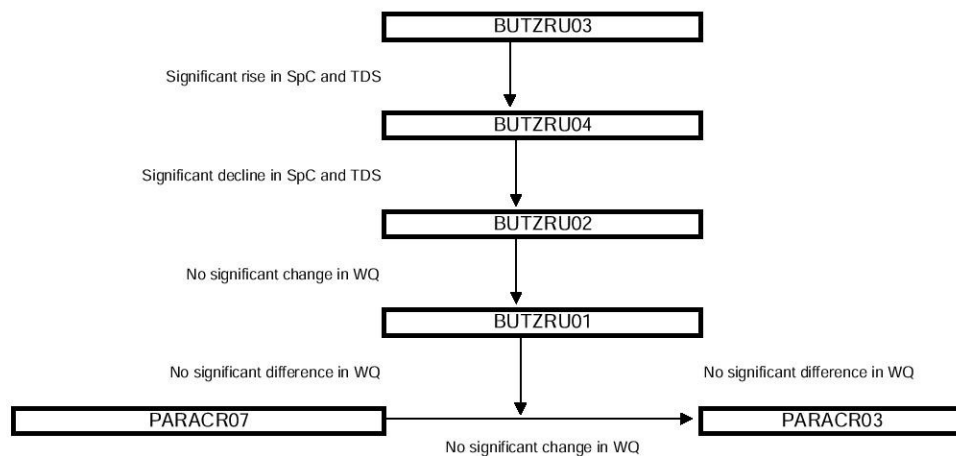
Note: = symbol denotes that upstream concentration is statistically equal to downstream station (p=0.05).

Note: > symbol denotes that upstream concentration is significantly greater than downstream station (p=0.05).

Note: \* / \* symbol denotes two statistical comparisons: tributary site vs. Paradise Cr upstream of confluence / trib vs. downstream of confluence.

Station		Specific Conductance	DO	pH	DO % saturation	TDS
CRANCR03		142.0	10.7	7.5	94.1	92.3
	vs CRANCR02	>	=	=	=	>
CRANCR02		78.3	11.4	7.4	97.9	50.9
	vs CRANCR01	=	=	=	=	=
CRANCR01		80.6	11.4	7.7	98.7	52.4
	vs PARACR07 / vs PARACR03	< / <	= / =	= / =	= / =	< / <
PARACR07 (upstream)		128.9	11.4	7.7	99.0	83.8
	vs PARACR03	=	=	=	=	=
PARACR03 (downstream)		123.5	11.3	8.0	99.0	80.1

## Butz Run Management Area



*Result: Though Butz Run does not significantly influence the water quality of Paradise Creek, an unknown source causes a large spike in concentration of SpC and TDS at station BUTZRU04. Downstream concentrations at station BUTZRU02 decrease significantly, ultimately becoming statistically similar to concentrations observed at Paradise Creek stations PARACR07 (upstream of Butz Run confluence) and PARACR03 (downstream of Butz Run confluence.)*

## Data

Note: < symbol denotes that upstream concentration is significantly less than downstream station (p=0.05).

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Note: > symbol denotes that upstream concentration is significantly greater than downstream station (p=0.05).

Note: \* / \* symbol denotes two statistical comparisons: tributary site vs. Paradise Cr upstream of confluence / trib vs. downstream of confluence.

Station		Field Specific Conductance	DO	pH	DO % saturation	TDS	Lab Conductivity	Water Temp (C)
BUTZRU03		79.9	10.1	7.6	90.3	52.1	60.8	12.1
BUTZRU04	vs BUTZRU04	<	=	=	=	<	<	=
BUTZRU04		253.9	10.0	7.4	90.0	165.1	191.3	12.7
BUTZRU02	vs BUTZRU02	>	=	=	=	>	>	=
BUTZRU02		116.6	10.8	7.8	95.5	75.8	84.8	10.9
BUTZRU01	vs BUTZRU01	=	=	=	=	=	=	=
BUTZRU01		104.2	11.2	7.8	97.1	67.4	75.2	10.1
PARACR07	vs PARACR07 / vs PARACR03	= / =	= / =	= / =	= / =	= / =	= / =	= / =
PARACR07		128.9	11.4	7.7	99.0	83.8	91.8	9.8
PARACR03	vs PARACR03	=	=	=	=	=	=	=
PARACR03		123.5	11.3	8.0	99.0	80.2	88.8	10.1