EXECUTIVE SUMMARY

A distinct relationship exists between land use and water quality. Knowledge of this relationship is necessary for both land use planning purposes and protection of water resources. To this end, this report provides an assessment of the correlation between water quality data as collected by the Wildlands Conservancy and existing land use for the Jordan Creek Watershed. The purpose for the correlation analysis is to identify whether any clear relationship exists between the monitored water quality in the creek and the land use pattern within the watershed. The impact of watershed geology on water quality is also evaluated. Key findings and recommendations based on the assessment are listed below.

Key Findings

- Significant trends, both increases and decreases, were identified for 11 of the 13 water quality parameters analyzed including alkalinity, ammonia, calcium hardness, conductivity, nitrates, phosphates, redox, total dissolved solids, temperature, total hardness and turbidity.
- All seven of the land use types within the watershed would appear to have significant water quality trends for certain water quality parameters. The land use types include open space, agricultural, residential, industrial, commercial, institutional and transportation.
- Limestone has a very significant impact on the water quality in the Jordan Creek. Six of thirteen water quality parameters have an increasing correlation with limestone. Alkalinity, ammonia, calcium hardness, conductivity, total dissolved solids and total hardness display this trend with limestone.
- Trends identified for residential, commercial and open space land uses may be used with more confidence than trends for other land use types because they have a larger range of land use percentage by sampling site.
- All “developed” land uses exhibit a strong correlation with limestone in terms of increasing land use percentage with increasing limestone in the drainage area. Agriculture has the opposite correlation with limestone.
- Agricultural and residential land uses represent the dominant future land uses in the watershed based on zoning.

Key Recommendations

- Identified trends should be substantiated through additional water quality sampling over a prolonged period of time.
- Future efforts to correlate land use and water quality should focus on continuing agricultural use, increased residential development as indicated by zoning and industrial land use.
- Measures to mitigate potential adverse impacts of land use activities on water quality should focus on preliminary trends identified and specific impacts of future residential and industrial development and continuing agricultural use.

Prepared by the Lehigh Valley Planning Commission
for the Wildlands Conservancy
July 2000
A distinct relationship exists between land use and water quality. Improperly or inadequately controlled land use activities can greatly impact both surface water and groundwater quality and aquatic life. The severity of the impacts depend on the physical and chemical characteristics of the receiving water, the properties of the pollutants involved and both the intensity and nature of the land use activity.

The types of pollutants generated vary with land use activity. Typically, a single pollutant seldom occurs individually. For example, sewage waste is a biodegradable organic substance that contains nutrients and may also contain pathogenic organisms or heavy metals. The combination of pollutants can have serious effects on water quality and aquatic life. However, the full impacts of combined pollutants are often difficult to determine.

Knowledge of the relationship between land use and water quality is necessary for both land use planning purposes and protection of water resources. By knowing the types of water pollution threats and associated land use activities, it may be possible to determine a more preferable location for any given activity. Further, implementation of appropriate management programs for existing activities can minimize any water quality degradation or even improve existing water quality.

The Wildlands Conservancy obtained water samples from a total of 15 sites within the Jordan Creek and tributaries. Figure 1 is a location map of the water quality monitoring points. (Note that the numbering system for the monitoring points is not consecutive.) Sampling occurred from June through August 1998 and June and July 1999. Laboratory analyses were completed for 13 water quality parameters. The Wildlands Conservancy is preparing an assessment of the water sampling data to identify any significant differences in the water quality by location and to identify possible explanations for monitored water quality based on geology, land use and other factors. Regarding land use, the Wildlands Conservancy analyses would attempt to identify a specific land use (i.e. specific industry) which might explain the finding of any unusually high pollutant level by location. The purpose for the analysis contained herein is to identify whether any clear correlation exists between the monitored water quality in the creek and the generalized land use pattern within the watershed. The method used to prepare this assessment was to determine the percent of a given land use upstream of a given monitoring point, the associated water quality data by parameter at that monitoring point and compare that relationship to the other monitoring points throughout the watershed. The final product will be an assessment of percent land use versus water quality to identify any strong linkages and to help determine any land use measures needed to protect water quality.

Prior to correlating land use and water quality, it was necessary to delineate the land areas and land use draining to each of the 15 sampling sites. Based on August 1999 land use as documented by the LVPC for the Jordan Creek Rivers Conservation Plan, the percentage of each of eight land use types within the delineated areas was determined. The August 1999 land use map is included as Plate 1.
FIGURE 1
JORDAN CREEK WATERSHED
WATER QUALITY MONITORING POINTS

- Water Quality Monitoring Point and Number
- △ Streams
- Municipal Boundaries
- Watershed Boundary
- Slate, Shale and Siltstone Areas
- Limestone Areas
located in a map pocket at the end of this report. The water quality sampling locations are also shown on Plate 1. Table 1 is a listing of the water quality sampling sites and their associated existing land use percentages. With this information, it was possible to graph average values of each parameter versus the percentage of each existing land use type across all sampling locations. An example of the land use/water quality graphs is included as Figure 2. The graph shows the percent of existing agricultural land use at each sampling location versus the nitrates concentration measured at that location. The water quality data at each station is shown with a diamond at the average value of all samples and with a bracket showing the range of sampling results. Graphing of the data has also included creation of a “best fit” straight line through the data representing a trend line. The best fit lines are based on mathematical equations which consider the data variations such that a best fit line is possible even if the data by eye doesn’t correspond to a straight line very well. The graphs and trend lines must be used cautiously. Only strong trends in the data which can be conceptually explained will be considered valid. The average water quality values (diamonds) are used to develop the trend lines. The graphs for all combinations of land use/water quality types are included in Appendix A. The best fit lines can be used to indicate water quality trends as the percentage of a land use increases. Trends identified for existing land use can also be projected into the future by evaluating development types guided by municipal zoning throughout the watershed. This aspect of the water quality/land use relationship will be discussed in more detail later in this report.

Note from Table 1 that there was not sufficient percent land use for big impervious areas or quarries within the watershed (values ranged from 0 to less than 1 percent by sampling location) such that no valid trends could be determined from the data. Big Impervious is a land use category for large paved areas such as the Penn State Campus near Fogelsville. Areas of water were not considered in the land use evaluation. Also note that the range of data for institutional, commercial and industrial land uses was between 0 and 3 percent and any identified trends may be misleading given such a small range in data. The transportation land use varies by about 4% and any identified trends should also be cautiously used. The data for residential, agricultural and open space land uses represent a larger range of percentages and any identified trends may be used with more confidence than for other land use types. For the Jordan Creek Watershed, agriculture and open space land uses represent a larger range of percentages and any identified trends may be used with more confidence than for other land use types. For the Jordan Creek Watershed, agriculture and open space land uses dominate the upstream areas and “developed” land uses dominate the downstream areas. As the water quality monitoring progresses downstream, the agricultural and open space land uses typically give way to increasing residential, commercial, industrial, institutional and transportation land uses. A major contributor to water quality, however, is watershed geology and specifically the presence or absence of limestone. Surface water and ground water in limestone areas would be expected to have elevated concentrations of hardness and alkalinity due to the solution of carbonate bedrock. Other water quality parameters such as conductivity, pH and total dissolved solids may also be affected by the presence of limestone. The limestone areas are located at the downstream portion of the Jordan Creek Watershed as shown in Figure 1. Monitoring point 8 is located essentially at the upstream end of the limestone and has only a very small fraction of drainage area in limestone. Monitoring points 1 through 7 have significant limestone. Points 10 through 19 have no limestone in their drainage areas. The key challenge in the assessment of land use/water quality trends for the Jordan Creek Watershed is to separate trends caused by land use from trends caused by geology.

All of the “developed” land uses exhibit a strong correlation with limestone in terms of increasing land use percentages with increasing limestone in the drainage area. Therefore, any identified trends for residential, industrial, commercial, institutional and transportation may not be associated with
<table>
<thead>
<tr>
<th>Sampling Site</th>
<th>Open Space</th>
<th>Agriculture</th>
<th>Residential</th>
<th>Industrial</th>
<th>Commercial</th>
<th>Institutional</th>
<th>Big Impervious</th>
<th>Transportation</th>
<th>Quarry</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32.30%</td>
<td>36.69%</td>
<td>17.13%</td>
<td>1.76%</td>
<td>1.94%</td>
<td>2.90%</td>
<td>0.19%</td>
<td>6.50%</td>
<td>0.19%</td>
<td>0.40%</td>
</tr>
<tr>
<td>2</td>
<td>33.78%</td>
<td>38.71%</td>
<td>15.96%</td>
<td>1.61%</td>
<td>1.30%</td>
<td>2.66%</td>
<td>0.09%</td>
<td>5.30%</td>
<td>0.20%</td>
<td>0.39%</td>
</tr>
<tr>
<td>4</td>
<td>34.71%</td>
<td>40.46%</td>
<td>14.81%</td>
<td>1.67%</td>
<td>0.55%</td>
<td>2.62%</td>
<td>0.07%</td>
<td>4.54%</td>
<td>0.21%</td>
<td>0.36%</td>
</tr>
<tr>
<td>5</td>
<td>35.19%</td>
<td>40.46%</td>
<td>14.93%</td>
<td>1.15%</td>
<td>0.55%</td>
<td>2.60%</td>
<td>0.08%</td>
<td>4.50%</td>
<td>0.22%</td>
<td>0.32%</td>
</tr>
<tr>
<td>7</td>
<td>36.91%</td>
<td>32.29%</td>
<td>22.67%</td>
<td>0.06%</td>
<td>0.14%</td>
<td>1.70%</td>
<td>0.70%</td>
<td>5.40%</td>
<td>0.00%</td>
<td>0.13%</td>
</tr>
<tr>
<td>8</td>
<td>35.50%</td>
<td>44.23%</td>
<td>12.87%</td>
<td>0.55%</td>
<td>0.52%</td>
<td>2.06%</td>
<td>0.00%</td>
<td>3.97%</td>
<td>0.00%</td>
<td>0.30%</td>
</tr>
<tr>
<td>10</td>
<td>34.71%</td>
<td>46.95%</td>
<td>12.34%</td>
<td>0.30%</td>
<td>0.51%</td>
<td>1.03%</td>
<td>0.00%</td>
<td>3.92%</td>
<td>0.00%</td>
<td>0.24%</td>
</tr>
<tr>
<td>11</td>
<td>25.40%</td>
<td>51.84%</td>
<td>16.88%</td>
<td>0.04%</td>
<td>0.49%</td>
<td>1.10%</td>
<td>0.01%</td>
<td>4.23%</td>
<td>0.00%</td>
<td>0.01%</td>
</tr>
<tr>
<td>11.5</td>
<td>35.92%</td>
<td>47.48%</td>
<td>11.02%</td>
<td>0.31%</td>
<td>0.52%</td>
<td>0.69%</td>
<td>0.00%</td>
<td>3.84%</td>
<td>0.00%</td>
<td>0.22%</td>
</tr>
<tr>
<td>12</td>
<td>39.53%</td>
<td>42.09%</td>
<td>12.20%</td>
<td>0.37%</td>
<td>0.48%</td>
<td>1.16%</td>
<td>0.00%</td>
<td>4.16%</td>
<td>0.00%</td>
<td>0.01%</td>
</tr>
<tr>
<td>13</td>
<td>32.88%</td>
<td>51.54%</td>
<td>10.48%</td>
<td>0.28%</td>
<td>0.30%</td>
<td>0.52%</td>
<td>0.00%</td>
<td>3.68%</td>
<td>0.00%</td>
<td>0.32%</td>
</tr>
<tr>
<td>14</td>
<td>29.61%</td>
<td>54.89%</td>
<td>10.44%</td>
<td>0.32%</td>
<td>0.34%</td>
<td>0.60%</td>
<td>0.00%</td>
<td>3.64%</td>
<td>0.00%</td>
<td>0.16%</td>
</tr>
<tr>
<td>15</td>
<td>25.85%</td>
<td>60.82%</td>
<td>8.13%</td>
<td>0.05%</td>
<td>0.10%</td>
<td>1.20%</td>
<td>0.00%</td>
<td>3.70%</td>
<td>0.00%</td>
<td>0.15%</td>
</tr>
<tr>
<td>17</td>
<td>44.90%</td>
<td>44.52%</td>
<td>7.51%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>3.05%</td>
<td>0.00%</td>
<td>0.02%</td>
</tr>
<tr>
<td>19</td>
<td>16.08%</td>
<td>67.88%</td>
<td>12.21%</td>
<td>0.03%</td>
<td>0.01%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>3.79%</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
</tbody>
</table>
the land use at all but simply mirror those caused by limestone. Agriculture has the opposite correlation with limestone showing a significant decline in percent of drainage areas with increasing limestone. Open space has no clear correlation by drainage area with limestone so these issues don’t have any discernable impact on identified trends. For the above reasons, water quality trends were evaluated with respect to limestone percentage of drainage area as well as land use percentage. Further, for each land use, possible trends were evaluated looking at all water quality data and also looking just at the monitoring points not affected by limestone. Trends were only considered valid if they appeared using all data and only non-limestone monitoring point data.

Significant trends are identified below based on strong upward or downward trends by land use or limestone where the data appears to support the trend line. The results are shown in Table 2. Note that Big Impervious and Quarries are not listed in Table 2 since insufficient data was available to establish trends.

From Table 2, significant trends, both increases and decreases, were identified for 11 of the 13 water quality parameters. They include alkalinity, ammonia, calcium hardness, conductivity, nitrates, phosphates, redox, total dissolved solids, temperature, total hardness and turbidity. All seven of the land use types with sufficient data appear to have significant water quality trends for certain water quality parameters.

Significant trend line decreases were identified for open space, agriculture and residential land uses for six water quality parameters. The six parameters include ammonia, nitrate, phosphate, redox, temperature and turbidity. Decreases in these parameters with increasing land use percentage is a positive water quality indicator.

Significant trend line increases for certain land uses were identified for all eleven of the water quality parameters which displayed strong trends. These increases took place with all seven land uses. Trend line increases for these parameters indicates a water quality concern.

Results for the specific water quality parameters are presented below.

**Alkalinity**

No significant trends were identified by land use percentage. A strong increasing trend was identified based on percent limestone, as expected. The highest concentration of alkalinity for the non-limestone monitoring points was 52 mg/l whereas the limestone points averaged 114 mg/l with a high of 190 mg/l. The strong limestone trend likely obscured any possible correlations with land use. The correlations were also influenced by a very low alkalinity at monitoring point 17 that, by itself, resulted in apparent increasing or decreasing trends by land use.

**Ammonia**

Ammonia concentrations decreased with increasing agricultural land use contrary to any correlation with pesticide or fertilizer usage. No trend was identified for open space. For all five other land uses and limestone a trend of increasing ammonia with increasing land use
percentage was identified. This represents an increase in ammonia with the urbanization of the watershed.

**Calcium Hardness**

A strong increasing trend of calcium hardness with increasing limestone percentage was found, again as expected. The solution of calcium ions in the surface and groundwater from limestone bedrock and soils creates “hard” water. The maximum hardness for the non-limestone monitoring points was 66 mg/l whereas the monitoring points influenced by limestone average 112 mg/l with a high of 169 mg/l. An increasing trend also occurred for residential land use although the very low hardness of 17 mg/l at monitoring point 17 significantly influenced this trend.

**Conductivity**

A strong increasing trend in conductivity was found with increasing limestone percentage, again as expected with the solution of calcium carbonate. Correlations were also found with residential and transportation land uses that again were strongly influenced by a very low conductivity at monitoring point 17. The conductivity trends basically mirrored those for total dissolved solids which both reflect dissolved materials in the water.

**Dissolved Oxygen**

No trends were identified for dissolved oxygen for the seven land uses or limestone.

**Nitrate**

Open space exhibited a decreasing impact on nitrates meaning for higher open space percentages the nitrate concentration was lower. This is an understandable trend if open space means lands not subject to fertilizer application. Both agriculture and commercial land uses showed the opposite, increasing trend. These trends would be reasonably traced to use of fertilizers. No strong trends were identified for the other land use types or limestone.

**pH**

No strong trends were identified for pH for the seven land uses or limestone. The data showed a weak trend of increasing pH with urbanized land uses contrary to an expected relationship.

**Phosphate**

A decreasing trend was identified for open space and phosphate concentration similar to nitrates. The same decreasing trend for agriculture is not expected and perhaps is more a function of the small range of phosphate concentrations between 0.15 mg/l and 0.35 mg/l than a land use trend. Increasing trends were identified for developed land uses (residential, industrial and institutional).
Redox

Redox potential is a measure of the oxidizing or reducing nature of the water. A decreasing trend was found for agriculture and increasing trends found for open space, residential, institutional and transportation. The significance of these correlations is not clear.

Total Dissolved Solids

Limestone percentage was found to have a strong increasing correlation with total dissolved solids. Residential, industrial, institutional and transportation land uses exhibited the same trend. Road wash-off and pesticide application represents the transportation land use runoff and possibly the residential and institutional trends are caused by road wash-off in addition to fertilizers. The industrial trend could be a combination of these plus the possibility of point source discharges.

Water Temperature

Agriculture displayed a decreasing trend with water temperature indicating more shaded streams in agricultural areas. Industrial, commercial and institutional land uses displayed an increasing trend indicating less shaded streams in urbanized areas.

Total Hardness

Limestone percentage had a strong increasing correlation with total hardness as it did with calcium hardness. Residential land use had increasing trends for both total and calcium hardness also. Transportation land use showed an increasing trend also.

Turbidity

Agriculture displayed a trend of increasing turbidity with increasing agricultural land use which would be expected if farmed lands are not protected from erosion. Open space yielded the opposite trend which would indicate vegetated areas less subject to erosion. Residential land use also shows a decreasing relationship which may simply be mirroring the inverse relationship with agriculture.

From Table 2, limestone has a very significant impact on water quality in the Jordan Creek Watershed. Six of thirteen water quality parameters have an increasing correlation with limestone. For these six parameters, the identified trends with land uses should be used cautiously because of the difficulty of screening out the limestone impact from the correlations. As stated previously, the trends for open space, agriculture and residential land uses may be more reliable than for other land uses since they have a wider range of occurrence throughout the watershed. For industrial, commercial, institutional and transportation, the correlations will be more sensitive to isolated water quality problems such as improperly controlled construction site runoff or other individual properties discharging contaminants. Total dissolved solids concentrations that quadruple between monitoring point 5 downstream to monitoring point 4 essentially defines the increasing correlation with industry. It also influences the trends with other land uses. All identified trends should be viewed as
### TABLE 2
**JORDAN CREEK WATERSHED**
**LAND USE AND GEOLOGY WATER QUALITY TRENDS**

<table>
<thead>
<tr>
<th>Land Use/Geology</th>
<th>Water Quality Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alkalinity</td>
</tr>
<tr>
<td>Open Space</td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>D</td>
</tr>
<tr>
<td>Residential</td>
<td>I</td>
</tr>
<tr>
<td>Industrial</td>
<td>I</td>
</tr>
<tr>
<td>Commercial</td>
<td>I</td>
</tr>
<tr>
<td>Institutional</td>
<td>I</td>
</tr>
<tr>
<td>Transportation</td>
<td>I</td>
</tr>
<tr>
<td>Limestone</td>
<td>I</td>
</tr>
</tbody>
</table>

**I** = Significant increase in water quality values with an increase in land use percentage.

**D** = Significant decrease in water quality values with an increase in land use percentage.
generalized and preliminary trends subject to further investigation. Identified trends should be substantiated through additional water quality sampling over a prolonged period of time. Point source discharges in the Jordan Creek Watershed will likely affect these results and have not been considered here.

Based on the municipal zoning throughout the Jordan Creek Watershed, agriculture, open space and residential land uses will continue to dominate the major part of the watershed upstream of South Whitehall Township. In the lower portion of the watershed, more urbanized land uses dominate the zoning. On a land use percentage basis, agriculture and residential uses represent the dominant land use types of concern for water quality purposes. Trends identified for these land uses should be priorities for addressing with pollutant management strategies. The remaining land uses will be only small percentages of the watershed for the near future. Of these, the predominant land use of concern is industrial and the potential for point source discharges of contaminants. Measures to mitigate the potential adverse impacts of land use activities on water quality should focus on the preliminary trends identified herein and the specific impacts of future residential and industrial development and continuing agricultural use.
APPENDIX A

Land Use / Water Quality Graphs

Graphs are grouped by water quality parameter such that the first set of graphs is for Alkalinity. Within each set the graphs are consistently ordered by land use type. The graph of % Limestone vs. water quality parameter is the last graph in each set. There are eight graphs in each set. The order of graphs by water quality parameter and land use (including limestone) is as follows:

<table>
<thead>
<tr>
<th>Water Quality Parameter</th>
<th>Land Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkalinity</td>
<td>Open Space</td>
</tr>
<tr>
<td>Ammonia</td>
<td>Agriculture</td>
</tr>
<tr>
<td>Calcium Hardness</td>
<td>Residential</td>
</tr>
<tr>
<td>Conductivity</td>
<td>Industrial</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>Commercial</td>
</tr>
<tr>
<td>Nitrate</td>
<td>Institutional</td>
</tr>
<tr>
<td>pH</td>
<td>Transportation</td>
</tr>
<tr>
<td>Phosphate</td>
<td>Limestone</td>
</tr>
<tr>
<td>Redox</td>
<td></td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
</tr>
<tr>
<td>Total Hardness</td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td></td>
</tr>
</tbody>
</table>

Note: The water quality parameters listed above are as shown in Table 2. Several parameters are shown with a slightly different name on the following graphs. They include specific conductance for conductivity and Ortho PO4 for phosphate.
% EXISTING AGRICULTURE VS. ALKALINITY

ALKALINITY

% AGRICULTURE
% EXISTING RESIDENTIAL VS. ALKALINITY

![Graph showing % Existing Residential vs. Alkalinity](image-url)
% EXISTING COMMERCIAL VS. ALKALINITY

- ALK AVG
- Linear (ALK AVG)
% EXISTING OPEN SPACE VS. AMMONIA

- AMMONIA AVG
- Linear (AMMONIA AVG)
% EXISTING RESIDENTIAL VS. AMMONIA

- AMMONIA AVG
- Linear (AMMONIA AVG)
EXISTING COMMERCIAL vs. AMMONIA

% COMMERCIAL

AMMONIA
% EXISTING INSTITUTIONAL VS. AMMONIA

[Graph showing the relationship between % Existing Institutional and Ammonia, with data points and a linear trend line.]
% EXISTING OPEN SPACE VS. C. HARDNESS

![Graph showing the relationship between existing open space and hardness. The graph includes a linear trend line and data points representing hardness averages.](image)
% EXISTING AGRICULTURE VS. C. HARDNESS
EXISTING RESIDENTIAL VS. C. HARDNESS

% RESIDENTIAL

% EXISTING RESIDENTIAL VS. C. HARDNESS

C. Hardness Avg

Linear (C. HardnessAvg)

C. Hardness

0.00%

5.00%

10.00%

15.00%

20.00%

25.00%

0.00%

20.00

40.00

60.00

80.00

100.00

200.00
% EXISTING INDUSTRIAL VS. C. HARDNESS

C. HARDNESS vs % INDUSTRIAL

- Red diamonds: C. Hardness Avg
- Black line: Linear (C. Hardness Avg)
Comparison of Existing Commercial vs. C. Hardness:

- Existing Commercial Avg:
  - 200.00%
  - 180.00%
  - 160.00%
  - 140.00%
  - 120.00%
  - 100.00%
  - 80.00%
  - 60.00%
  - 40.00%

- C. Hardness Avg:

Graph showing % Existing Commercial vs. C. Hardness.
% EXISTING TRANSPORTATION VS. C. HARDNESS

% TRANSPORTATION

C. HARDNESS

Series 1
Linear (Series1)
% EXISTING OPEN SPACE VS. SPECIFIC CONDUCTANCE

- specific conductance avg
- Linear (specific conductance avg)
% EXISTING AGRICULTURE VS. SPECIFIC CONDUCTANCE

- Specific conductance avg
- Linear (specific conductance avg)
% EXISTING RESIDENTIAL VS. SPECIFIC CONDUCTANCE

specific conductance avg
Linear (specific conductance avg)

% RESIDENTIAL

0.00% 5.00% 10.00% 15.00% 20.00% 25.00%

1200.00 1000.00 800.00 600.00 400.00 200.00

Specifc Conductance
% EXISTING INDUSTRIAL VS. SPECIFIC CONDUCTANCE

Specific conductance avg

Linear (specific conductance avg)
% EXISTING OPEN SPACE VS. DISSOLVED O2

y = -2.3925x + 10.129

Dissolved O2 Avg
Linear (Dissolved O2 Avg)
% EXISTING AGRICULTURE VS. DISSOLVED O2

\[ y = -1.1033x + 9.8582 \]
% EXISTING RESIDENTIAL VS. DISSOLVED O2

\[ y = 4.0284x + 8.8067 \]
% EXISTING INDUSTRIAL VS. DISSOLVED O2

\[ y = 78.664x + 8.8968 \]
% EXISTING COMMERCIAL VS. DISSOLVED O2

Dissolved O2 Avg

Linear (Dissolved O2 Avg)

\[ y = 148.81x + 8.5686 \]
% EXISTING INSTITUTIONAL VS. DISSOLVED O2

\[ y = 19.412x + 9.073 \]
% EXISTING TRANSPORTATION VS. DISSOLVED O2

\[ y = 61.745x + 6.6992 \]
LIMESTONE VS DISSOLVED O2

% LIMESTONE VS DISSOLVED O2

Dissolved O2 Avg — Linear (Dissolved O2 Avg)

% Limestone
% EXISTING OPEN SPACE VS. NITRATE

![Graph showing % existing open space vs. nitrate. The graph includes a linear trend line and data points.](graph.png)
% EXISTING AGRICULTURE VS. NITRATE

NITRATE AVG

Linear (NITRATE AVG)
% EXISTING RESIDENTIAL VS. NITRATE

NITRATE

% RESIDENTIAL
EXISTING COMMERCIAL VS. NITRATE
% EXISTING INSTITUTIONAL VS. NITRATE

INSTITUTIONAL

NITRATE AVG

Linear (NITRATE AVG)
% EXISTING AGRICULTURE VS. pH

pH AVG
Linear (pH AVG)
% EXISTING INDUSTRIAL VS. pH

% INDUSTRIAL

pH

- pH AVG
- Linear (pH AVG)
% EXISTING COMMERCIAL VS. pH

% COMMERCIAL

pH AVG

Linear (pH AVG)
% EXISTING TRANSPORTATION VS. pH

pH AVG

Linear (pH AVG)

Hd

0.00% 1.00% 2.00% 3.00% 4.00% 5.00% 6.00% 7.00%

0.00% 1.00% 2.00% 3.00% 4.00% 5.00% 6.00% 7.00%
% LIMESTONE VS pH

![Graph showing the relationship between % Limestone and pH. The graph plots pH values on the y-axis ranging from 7.20 to 8.80, and % Limestone on the x-axis ranging from 0 to 20. There are data points indicating pH AVG and a linear trend line representing the average pH values across different % Limestone concentrations.](image-url)
% EXISTING OPEN SPACE VS. ORTHO-PO4

% OPEN SPACE

ORTHO-PO4

P04 AVG
Linear (P04 AVG)
% EXISTING COMMERCIAL VS. ORTHO-PO4
% EXISTING TRANSPORTATION VS. ORTHO-PO4

% TRANSPORTATION

% ORTHO-PO4

- Linear (PO4 AVG)
- PO4 AVG
% LIMESTONE VS PO4

PO4 AVG - Linear (PO4 AVG)

% Limestone
% EXISTING OPEN SPACE VS. REDOX

- Redox Avg
- Linear
  (Redox Avg)
% EXISTING INDUSTRIAL VS. REDOX

- Redox Avg
- Linear (Redox Avg)
EXISTING INSTITUTIONAL VS. REDOX

% EXISTING INSTITUTIONAL VS. REDOX

Redox Avg
Linear (Redox Avg)
% EXISTING TRANSPORTATION VS. REDOX

![Graph showing % Existing Transportation vs. Redox with linear fit]

- Redox Avg
- Linear (Redox Avg)
% LIMESTONE VS REDOX

% Limestone

Redox Avg — Linear (Redox Avg)
EXISTING OPEN SPACE VS. TDS

% OPEN SPACE VS. TDS

TDS avg
Linear (TDS avg)
% EXISTING AGRICULTURE VS. TDS

![Graph showing the relationship between % existing agriculture and TDS](image-url)
% EXISTING COMMERCIAL VS. TDS

TDS

% COMMERCIAL

TDS avg
Linear (TDS avg)
% EXISTING OPEN SPACE VS. H2O TEMP

![Graph showing the relationship between % Existing Open Space and H2O Temp.](image)

- **Avg H2O Temp**
- **Linear (Avg H2O Temp)**

The graph illustrates the variation of H2O Temp (C) with different % Existing Open Space values, from 0.00% to 50.00%. The linear trend line indicates a possible correlation between these two variables.
% EXISTING INDUSTRIAL VS. H2O TEMP

![Graph showing the relationship between existing industrial percentage and H2O temperature. The graph includes a linear trend line and error bars for each data point, indicating variability. The x-axis represents the percentage of industrial, while the y-axis shows the H2O temperature in degrees Celsius.](image)
EXISTING COMMERCIAL VS. H2O TEMP

% COMMERCIAL

H2O TEMP (°C)

Avg H2O Temp
Linear (Avg H2O Temp)
% EXISTING INSTITUTIONAL VS. H2O TEMP

![Graph showing % Existing Institutional vs. H2O Temp with data points and a linear trend line.](image)
% EXISTING AGRICULTURE VS. TOTAL HARDNESS

- TOT HARD. AVG
- Linear (TOT HARD. AVG)
% EXISTING RESIDENTIAL VS. TOTAL HARDNESS

![Graph showing % Existing Residential vs. Total Hardness](image)

- Red diamonds: TOT HARD AVG
- Black line: Linear (TOT HARD AVG)
% EXISTING INDUSTRIAL VS. TOTAL HARDNESS

% INDUSTRIAL

TOT HARD. AVG
Linear (TOT HARD. AVG)
% EXISTING INSTITUTIONAL VS. TOTAL HARDNESS

% INSTITUTIONAL

0.00%  0.50%  1.00%  1.50%  2.00%  2.50%  3.00%

TOTAL HARDNESS

0.00  50.00  100.00  150.00  200.00  250.00  300.00  350.00  400.00  450.00

- Linear (TOT HARD. AVG)

- TOT HARD. AVG

% EXISTING INSTITUTIONAL VS. TOTAL HARDNESS

- Linear (TOT HARD. AVG)

- TOT HARD. AVG
% EXISTING TRANSPORTATION VS. TOTAL HARDNESS

- % TRANSPORTATION
- TOTAL HARDNESS

- Red diamonds represent TOT HARD. AVG
- Black line represents Linear (TOT HARD. AVG)
% LIMESTONE VS TOTAL HARDNESS

TOT HARTD. AVG — Linear (TOT HARTD. AVG)
% EXISTING OPEN SPACE VS. TURBIDITY (LAB)
% EXISTING INDUSTRIAL VS. TURBIDITY (LAB)

TURBIDITY (LAB)
Linear (TURBIDITY (LAB))

% INDUSTRIAL
% EXISTING COMMERCIAL VS. TURBIDITY (LAB)

The graph illustrates the comparison of existing commercial versus turbidity measured in the lab. The x-axis represents the percentage of commercial, while the y-axis shows the turbidity levels. The data points and a linear trend line are plotted to indicate the relationship between the two variables.
% EXISTING INSTITUTIONAL VS. TURBIDITY (LAB)
% EXISTING TRANSPORTATION VS. TURBIDITY (LAB)