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WATER RESOURCES STUDY

Metropolitan Spokane Region

APPENDIX D

Wastewater Generation and Treatment

JANUARY 1976

METROPOLITAN SPOKANE REGION WATER RESOURCES STUDY

LIST OF REPORTS AND APPENDICES

REPORTS

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METROPOLITAN SPOKANE REGION WATER RESOURCES STUDY.

APPENDIX D.

WASTEWATER GENERATION AND TREATMENT.

JANUARY 1976

524 p.

Department of the Army
Corps of Engineers, Seattle District

Kennedy-Tudor Consulting Engineers

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The summary report was prepared by the Seattle District Corps of Engineers. The technical report and appendices were prepared for the Seattle District, Corps of Engineers by Kennedy-Tudor Consulting Engineers.

PREFACE

With the enactment of the Federal Water Pollution Control Act Amendment of 1972 (Public Law 92-500), new national goals have been established for the elimination of pollution discharges into our streams and lakes. This appendix is a part of the report prepared to assist local government in satisfying State and Federal Requirements relating to Public Law 92-500. The suggestions contained in this report are for implementation by local interests with available assistance from other local, State and Federal agencies. The study suggests a regional wastewater management plan for the metropolitan Spokane urban area and provides major input to Washington State Department of Ecology Section 303e plans for the Spokane River Basin in Washington State. Also included in the study are planning suggestions for urban runoff and flood control, and the protection of the area's water supply resources.

As listed on the inside front cover, documentation for this study consists of a Summary Report and a Technical Report with supporting Appendices A through J.

The Technical Report summarizes Appendices A through J, which contain 58 individual task section reports prepared during the study. These task sections are listed by title in Attachment I of the Technical Report. Generally, the numbering of appendix task sections reflects the following system:

Study Task Sections	Type of Study Activity
300's	Data Collection
400's	Data Evaluation and Projection
500's	Identification of Unmet Needs
600's	Development of Alternative Plans
700's	Evaluation Comparison and Selection of Plans
800's	Institutional Arrangements

Pages within each appendix are numbered by task section, as illustrated below:

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Task section identifier

Identifies page number, numbered consecutively from beginning of task section

APPENDIX D - WASTEWATER GENERATION AND TREATMENT

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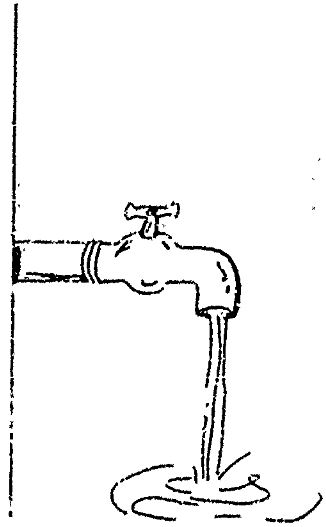
A detailed index for each task section precedes the respective section text.



SECTION 312

WASTE SOURCES (DOMESTIC AND INDUSTRIAL)

WATER RESOURCES STUDY

METROPOLITAN SPOKANE REGION

SECTION 312

WASTE SOURCES

26 July 1974

Department of the Army, Seattle District
Corps of Engineers
Kennedy-Tudor Consulting Engineers

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INTRODUCTION

The objective of this section is to create an inventory of all existing liquid waste sources in the study area and to evaluate the quantity and quality of these waste sources at the present time. The sources of wastewater to be inventoried and evaluated include sanitary sewage, industrial wastes, urban runoff, agricultural wastes, soil erosion, and leachate from solid waste disposal. Table 1 lists these general categories and shows how they have been further subdivided for analysis in this study. The pollution potential from soil erosion, solid waste disposal, agriculture and urban runoff are covered in separate subsections but are summarized herein.

Wastewater sources are inventoried recognizing the present disposal; that is, to surface waters, groundwaters or land. This is not meant to imply that these sources are permanently fixed to the present ultimate disposal but rather to summarize the present impact. Subsequent analysis considers alternative disposal for all sources in seeking an optimum solution.

This section does not include an evaluation of the chemical and biological constituents of natural rainwater washoff from undeveloped land. The simulation model addresses this subject.

There are no definitive records of the quantity and quality of most uncollected waste sources such as runoff or infiltration from agricultural lands. Also there are significant data gaps in the records of many operating entities. One of the objectives of this section and its separate subsections is to fill these data gaps with estimates of quantity and quality to arrive at a total wastewater evaluation for the study area. Where estimated data are used they are identified to distinguish them from recorded data.

DOMESTIC AND INDUSTRIAL WASTES TO
CITY OF SPOKANE SEWAGE TREATMENT PLANT

Volume of Waste Flows to City of Spokane System

General. Four recent reports for the City of Spokane have addressed the analysis of waste flows to the City of Spokane sewage collection and treatment facilities. These reports are the source of much of the data and data summaries cited in this subsection. The four reports are as follows and are cited as indicated.

Citation	Description
Esvelt (1972)	Esvelt & Saxton/Bovay. 1972. Action plan, Spokane wastewater study.
Bovay (1973)	Bovay Engineers. 1973. Report on additions and modifications to the wastewater treatment plant.
Bovay (1974a)	Bovay Engineers. 1974. Proposed system for user charges and industrial cost recovery.
Bovay (1974b)	Bovay Engineers. 1974. Report on excessive infiltration/inflow.

The components of the total sewage flow which arrives at the sewage treatment plant include the following:

1. Domestic sewage from residences.
2. Sanitary sewage from the normal complement of commercial, public service and transient populations found in any city.
3. Air conditioning cooling waters from residences, commercial, service and transient facilities.
4. Process and cooling water wastes from industry.
5. Sanitary sewage flow from industry.

6. Infiltration.

7. Urban runoff.

The objectives of this subsection are to present in summary form the quantity and quality of the dry weather components of the total waste flow, that is, of items one through six above. None of these components are directly measured and recorded. The overall total sewage flow as it reaches the sewage treatment plant is recorded and totalized. The above cited reports contain estimates of some of the components and an evaluation or check of others by difference from the total.

The data needs of this report are slightly different from those in the cited reports. The cited reports are directed toward providing information toward improvements to the City collection and treatment system. This report has, as an additional need, the requirement to develop a useful basis for projecting flow and quality data for areas outside the City for which there are no records.

Total Wastewater Flow. The total wastewater flow as recorded at the treatment plant includes the dry weather flow components plus that portion of the urban runoff which can be handled by the plant. Since there is no measure of the urban runoff component, compilation of annual and monthly averages which include days of rainfall are meaningless in the evaluation of the dry weather flow components. Bovay (1973), in Exhibit II-4, shows a complete one year record of recorded flows for 1972. This graph clearly shows the distortion of the record caused by urban runoff entering the plant in both overstatement and understatement of flow. A rainfall event causes a rise in plant flow to the range 50 to 60 mgd at which point the entire flow is bypassed so that the recorded flow drops to 10 mgd, the least reading on the recorder, although the actual plant throughput is zero.

The total year record does show that there is a distinct trend in the dry weather component from the order of 25 mgd in winter months to 30 mgd or more in summer months. This "summer" regime extends from mid-April to mid-September. Bovay (1973) gives 27.3 mgd as the yearly average observed dry weather flow. The range of dry weather flows is from minimum days of approximately 19 mgd to maximum days of approximately 40 mgd.

The available data for developing a breakdown of the recorded total flow into its components are the identifiable industrial component and the identified infiltration inflow. These components are discussed first, following which an analysis is made which develops a synthesis of the flow components on an annual basis.

Industrial Waste Component. Under the provisions of EPA requirements for User Charges and Industrial Cost Recovery* an industrial user is defined as any nongovernmental user falling in Divisions A, B, D, E and I of the Standard Industrial Classification Manual, 1972 but excluding those whose wastes are "primarily segregated domestic wastes or wastes from sanitary conveniences." Bovay (1974a) is prepared in response to this definition. Bovay (1974a) indicates that there are 493 candidates for classification as "industrial user" in accordance with the above defi-

*Federal Register, Volume 38, Number 161, August 21, 1973. Subsection 35.905-19.

nition. From this candidate list, 71 are selected for recommendation to be included in the cost recovery program.

Division I of the Standard Industrial Classification (SIC) covers "services" and includes businesses which are not normally considered industry in the sense that they produce process waste waters. It is the inclusion of businesses in Division I that swells the candidate list in Bovay (1974a) to 439 and from which most of the deletions were made to arrive at the recommended list of 71.

The flow data summarized in Bovay (1974a) are derived from city water use records augmented by private well supplies where applicable, converted to a work day basis rather than a calendar day basis.

Due to the specialized purpose of Bovay (1974a), the summaries are not abstracted directly. Rather, a recapitulation is made using data from Bovay (1974a) and backup data furnished by Bovay for the purpose of this report. Table 2 is compiled listing the largest industrial waste sources and includes but is not limited to those industries listed by Bovay (1974a). Table 3 is a compilation of industries from Table 2 which are deemed to contribute significant process waste flows. Businesses whose flows are essentially sanitary wastes such as hotels, hospitals, schools and commercial establishments are excluded. The flows shown in Table 3 are estimated average calendar date flows. Note that 23 listed industries have or have had waste discharge permits. Table 3 also shows the estimated components of each industrial flow by segregation of sanitary, cooling and process portions.

Table 3 indicates that the major industries with process wastes contributing to the city sewer system include a total of approximately 3.2 mgd of which only about 3 percent is sanitary flow and, therefore, can be neglected in compiling a balance between components. From a pollution load standpoint it is significant that approximately 750,000 gpd or 25 percent of the major industrial component is waste cooling water.

Bovay (1973a) indicates that there are numerous small industries in the food processing field and others that, although small individually, represent a significant flow. An allowance is made for these small industries not specifically identified in arriving at a total industrial flow component of 3.5 mgd.

Infiltration Inflow Component. A significant dry weather infiltration and inflow to the Spokane sewage collection systems has been identified and reported in Bovay (1974b). These identified dry weather inflows are all in the sewered area south of the Spokane River, as might be expected, since the only large portions of the sewer system not in dry highly permeable soils are south of the river. The identified inflows and infiltration as reported by Bovay (1974b) are estimated to be a minimum of 1.7 mgd and as high as 3.8 mgd.

Bovay uses the words inflow and infiltration to recognize that there are two types of nonsewage flow invading the system in dry weather. One type is groundwater which enters through poor joints and cracks in pipe and manholes and is commonly designated infiltration. The other type, which is unusual, is the deliberate connection of springs, streams and swamps for the purpose of drainage and has been termed inflow. The infiltration quantities are estimated to be more or less constant all year but the inflow quantities are probably strongly seasonal. The infiltration-inflow data in Bovay (1974b) do not represent a full year of sampling but are limited to December 1973 through May 1974. Hence, the seasonal variation is unknown.

There are other suspected dry weather non-sewage additions to flow such as basement pumpage in the downtown area at high river stage. These have not been specifically identified or measured.

The collection of streams, springs and swamps into the combined sewer system is an historical fact that is not expected to be changes unless it proves cost-effective to do so. Therefore, although these inflow sources are identified, some of them may remain as dry weather flow components in the future.

Summer flow from single pass heat exchangers in air conditioning equipment in major commercial buildings is not regarded as or included in the infiltration inflow study, Bovay (1974b).

Identificatification of the Domestic Component in Previous Reports. The referanced reports have presented increasingly detailed efforts to identify the domestic sewage component of the total sewage flow reaching the treatment plant. The most recent and the one which has had the benefit of the industrial analysis in Bovay (1974a) and the infiltration inflow in Bovay (1974b) is shown in Bovay (1974a) as follows:

Component	Dry Weather Flow, mgd
Estimated Infiltration-Inflow	8.50
Estimated Industrial	4.25
Estimated Industrial Commercia	2.75
Domestic	14.00
Total to STP in 1973	29.50

From the domestic breakdown at 14.0 mgd, the per capita contribution is calculated at 76 gpcd based on 55,000 services and estimated 3.5 persons per service. (The service population developed from 55,000 services and 3.5 persons per service is 192,000 persons which is in excess of the 1973 City population estimated at 173,000.)

The figure of 8.5 mgd for infiltration-inflow is retained from development in Bovay (1973) and carried over after the completion of the infiltration inflow report which identifies a maximum of 3.8 mgd. This apparently indicates an opinion on the part of the report writers that substantial infiltration-inflow exists that has not and cannot be specifically identified.

The 8.5 mgd figure is developed in Bovay (1973) as follows: The equivalent per capita water use from metered city records is computed at 137 gpcd including water used by industry and commercial customers. This computation is made for the time of year when there is no landscape irrigation. Sewage flow is estimated at 82 percent of water use making the equivalent per capita sewage flow 113 gpcd. For a sewered population of 166,000, a dry weather flow of 18.8 mgd is developed. Comparison of the total dry weather flow based on water use at 18.8 mgd with the observed 1972 average flow of 27.3 mgd indicated an unaccounted increment of 8.5 mgd which was designated infiltration.

Synthesis of Flow Components. Typical winter STP flow rates for extended periods without rain average around 26.0 mgd on week days and 22.5 mgd on Saturdays and Sundays for a week-long average of 25.0 mgd. If average industrial flows are taken at 3.5 mgd and identified winter infiltration-inflow at 3.5 mgd average then the net domestic plus commercial (which includes so called "dry" industry) is 25 - (3.5 + 3.5) = 18 mgd. For a service population of 166,000, the per capita equivalent is 108 gpcd. The gross per capita including industrial is 130 gpcd.

A typical July week day without rain gives STP flows of 32 mgd and weekend flows of 27.5 mgd for a week-long average of 30.7 mgd. If the average industrial flow is taken at 3.5 mgd, the summer infiltration-inflow at 2.0 mgd, and the domestic plus commercial at 18 mgd, then the accounted flows total 23.5 mgd. This would appear to indicate a summer extra water flow of 30.7 - 23.5 = 7.2 mgd. The composition of this extra summer flow is probably divided between single pass air conditioning heat exchangers, excessive irrigation runoff which reaches stormwater inlets and additional domestic use.

A flow recorder was installed at the interim treatment facility for Northwest Terrace by the consultant for the purpose of collecting data on the largely residential component of sewage flow. The results indicate per capita flows of the order of 90 gpcd. This appears to be in substantial agreement with the results developed above, which gave 108 gpcd including commercial and 130 gpcd including industry and commercial.

Based on the foregoing analysis, a 12 month dry weather flow pattern is synthesized in Table 4 and compared with the actual recorded sewage treatment plant flows for 1972-73. The synthesized total dry weather flow for the year is 27.68 mgd as compared with the measured total of 28.98 mgd. This indicates an average stormwater flow passing through the treatment plant of 1.30 mgd or 475 mg per year. Actually, more stormwater passes through the plant and less dry weather sanitary since, when stormwater is reaching the plant, some sanitary is being displaced through overflows. If the rough approximation is made that the apparent storm water quantity arriving at the plant is actually double since an equal volume of dry weather sanitary was displaced to overflows, a result is obtained which is in very close agreement with that shown in Esvelt (1972). The results are compared below:

Annual Flows, Million Gallons

	Per Above Without Adjustment	Per Above Adjusted for Displacement	Esvelt (1972)
Dry weather sanitary flow	10,103	9,628	10,040
Storm flow through treatment	475	950	920
Total Plant Flow	10,578	10,578	10,960
Untreated sanitary to overflows	--	475	160

The annual average for the residential plus commercial is 21.3 mgd which yields an annual average per capita of 128 gpcd. This includes the additional summer flow increment.

The above derived value for the per capita residential commercial component represents the probably maximum which can be developed from the available data. The probable minimum value would result from adopting the 8.5 mgd infiltration-inflow of Bovay (1973). The minimum value would be 94 gpcd annual average including the excess summer component or 78 gpcd for a winter dry weather average. The range of values is summarized below:

	Per Capita Residential-Commercial Flow, gpcd	
	Probable Maximum	Probable Minimum
Annual Average	128	94
Winter Dry Weather	108	78

When compared with the values found for the largely residential Northwest Terrace and with other cities having plentiful low cost water, the probable maximum values appear to be the more valid.

Quality of Raw Waste Flows to City of Spokane System

Total Flow Quality. The data sources for quality of raw sewage arriving at the City sewage treatment plant are: (1) the file of plant operating records, (2) a survey made by EPA in 1970 and 1972, (3) a special sampling and analysis for nitrogen and phosphorus only by an independent laboratory, and (4) a raw waste survey by Bovay in connection with pilot plant studies in 1973 (Bovay, 1973).

The raw sewage data available from plant records include the following:

Parameter	Frequency of Reporting
1. Temperature	Daily
2. Dissolved oxygen	Weekly (approximately)
3. BOD	Biweekly (approximately)
4. pH	Daily
5. Suspended solids	Each week day
6. Turbidity	Irregular

Bovay (1973) shows that the plant BOD records prior to July 1972 are of questionable accuracy and that similar precautions are necessary regarding suspended solids prior to January 1973.

The EPA raw waste surveys were conducted on two dates, September 19, 1970 and September 18, 1972, and included COD, BOD and suspended solids.

The special analyses of nitrogen and phosphorus content were run in two periods, June 1971 to April 1972 and February 1973 to April 1973. The forms analyzed were total Kjeldhal nitrogen, ammonia, total phosphorus and total dissolved phosphorus.

The sampling and analyses in connection with Bovay pilot plant studies were conducted on three dates in 1973, January 24, January 29 and February 1, and included COD, BOD, suspended solids and N and P nutrients.

All of the above described sources were utilized in evaluating and selecting representative values in Bovay (1973). Subsequently, in Bovay (1974a) additional data became available in the 1973 plant records which were used to supersede the selected values from Bovay (1973) for BOD, SS and total phosphorus. The final selected values from Bovay (1973) and, where superseded, from Bovay (1974a) are summarized in Table 5.

The originally selected BOD results were 54,000 pounds per day based on plant records for the last half of 1972. This was superseded by a value of 51,100 from analysis of 1973 records. The originally selected SS results were 38,000 pounds per day from plant records January through March 1973. This was revised to 38,100 pounds per day based on the entire year. All nitrogen data are from statistical analysis of the special sampling by an independent laboratory. The original phosphorus results were from statistical analysis of the data collected in connection with the pilot plant operation. The total phosphorus data were superseded in Bovay (1974a) by plant record data for 1973. The original total P value was 1750 pounds per day. The revised value is 2040 pounds per day. Bovay (1973) also arrives at an evaluation of total grease loading, based on plant removals, of 3,500 to 5,000 gallons per week.

Industrial Component. Bovay (1974a) develops total pollution load for industrial and commercial components for the parameters BOD, suspended solids and phosphorus. The industrial component is defined as essentially the same as the categories shown in Table 3. Commercial includes commercial, hotels, motels, hospitals, schools and the remainder of the service industry. The Bovay (1974a) results are summarized below:

	Pollution Load, Pounds per Work Day		
Component	BOD	SS	P
Industrial	21,400	14,700	320
Commercial	5,000	4,000	290
Total	26,400	18,700	610

Table 6 summarizes estimated pollution load for the industries shown in Table 3 based on an independent calculation made for this study. Table 6 is expanded to include other parameters than covered by Bovay. Table 6 is in terms of average pounds of pollutant per calendar day. There is substantial agreement for the parameters reported for industrial in Bovay (1974a). Table 6 values for BOD, SS, and P are 20,243, 13,518 and 307 pounds per day respectively. When comparing, it must be recognized that Bovay (1974a) is in terms of loading per work day rather than per calendar day as in Table 6.

Residential-Commercial Component. Table 7 shows the estimated residential-commercial component as determined by difference, subtracting the industrial from the total plant influent load. Table 7 also shows the residential-commercial component as converted into per capita loading for a service population of 166,000.

Other Sources. Urban runoff quality is treated in detail in another subsection. One aspect of urban runoff deserves special mention here since the pollution load does not necessarily occur simultaneously with precipitation.

During periods of winter icing the City streets are sanded for traffic safety. The sand placed on the streets contains salt. Occasionally the temperature will hover at a range where the only snow and ice that melts is that which has been sanded. This street runoff enters the storm sewers and causes the influent flow at the plant to have a high chloride ion concentration. High chloride concentrations are corrosive to equipment and toxic to the anaerobic organisms in the digesters. Plant operating policy requires that, when the influent chloride concentration reaches 1,000 mg/l, the influent be totally bypassed.

Raw sewage flows to the City of Spokane exhibit characteristics indicating the need for source control. The plant operation records contain numerous references to such conditions. Table 8 is a summary of incidents reproduced from this source.

Quality of Treated Effluent from City Sewage Treatment Plant

Present Conditions. The following data sources are available:

1. Plant operating records.

2. EPA surveys of 9-19-70 and 9-18-72.

3. Pilot plant studies by Bovay on 1-24-73, 1-29-73 and 2-1-73.

4. Sampling and analysis by Soltero monthly from 5-6-72 to date.

5. Sampling and analysis for simulation model calibration in this study, September 1973.

Plant operating records provide effluent quality data as follows:

Parameter	Frequency of Reporting
1. Dissolved Oxygen	Weekly (approximately)
2. BOD	Biweekly (approximately
3. pH	Daily
4. Suspended Solids	Each week day
5. Turbidity	Irregular
6. Chlorine Residual	Daily
7. Total Coliform	Two days per week
8. Fecal Coliform	Two days per week

Table 9 presents a summary by months of flow, BOD and suspended solids for the period April 1972 through March 1973.

The EPA and Pilot Plant survey data includes values for COD, BOD and suspended solids which are shown in Table 10.

The Soltero data include a wide spectrum of parameters including nutrients but not including the usual BOD, COD and SS. The nutrient data are abstracted and re[illegible]ced in Table 11. For complete data on all parameters analyzed see Soltero, Gasperino and Graham (1973).

The sampling period in September 1973 for calibration of the simulation model covered the usual parameters plus nutrients and heavy metals. The mean values from this sampling are summarized in Table 12. For complete results at 4 hour intervals, refer to Section 607 of the report. Selected representative values considering all available data sources are shown in Table 13.

DOMESTIC WASTE SOURCES
OUTSIDE THE CITY OF SPOKANE

Introduction

Communities having municipal sewage collection and treatment facilities are listed in Table 1 of Section 311. The object of the following paragraphs is to create an inventory of the available data on the quantity and quality of the treated sanitary sewage effluent being discharged to the environment from these communities. In the absence of specific data for each community, the objective is to select and apply appropriate criteria that will permit estimation of the total existing waste load from these communities.

The basic sources of data on municipal waste flows are the following where available:

a. Monthly reports to the Department of Social and Health Services.
b. Applications for NPDES permits.
c. Efficiency study reports by DOE.
d. Report by Bovay, 1972, Comprehensive Water and Sewerage Planning Study.
e. EPA Maintenance and Operation Report.

The minimum desirable data for each community includes the following:

a. Population served.
b. Average dry weather flow.
c. Peak wet weather flow.
d. Effluent quality parameters
    1. pH
    2. BOD
    3. Settleable solids
    4. Temperature.

Inventory

Table 14 shows the compilation of available data for the nine communities outside the City of Spokane which have municipal sewage collection and treatment. Additional quality parameters beyond the minimum are included as available. Each community is discussed briefly below.

City of Cheney. The waste load of the City of Cheney is complicated by the variable tributary population. The permanent population in 1970 census is 6,358. The estimated permanent population in 1972 is 6,500. The resident population of students attending Eastern Washington State College varies through the year as follows, using the school year 72-73 as an example:

School Quarter	Period	Enrollment
Fall	Sept. 27-Dec. 15 '72	6,775
Winter	Jan. 3-Mar. 16 '73	6,465
Spring	Mar. 27-June 8 '73	6,109
Summer	June 18-Aug. 17 '73	3,300 (est.)

A large proportion of students, faculty and staff commutes from Spokane and other areas outside the service area of the Cheney sewerage system. Estimates of commuters are between 60 and 75 percent for students and faculty and about 50 percent for staff. The estimated full time equivalent for the average Fall or Winter quarter condition is approximately 9,254. A figure of 8,400 is found in documents referring to this plant, presumably on a year-round basis.

The following per capita dry weather flow contributions are developed from plant flow records and analysis of population data:

Population Component	Dry Weather Flow Gallons per Capita per Day
Permanent residents	73
Students living in Cheney	55
Commuting students	11
Commuting faculty and staff	22

Based on the above per capita flows and the annual pattern of population, the synthesized annual dry weather flow is estimated at 220 million gallons or .602 mgd. The observed 1972-73 annual flow including storm inflow events is .638 mgd. The synthesized annual flow of .602 mgd is equal to an average year round equivalent full time population of 8,150 persons.

The flow records indicate a significant storm water inflow concurrent with rainfall events. Prior to the 1973-74 winter season, these peak wet weather flows were of the order 1.3 mgd. No particular concern was caused by these modest peaks. The past winter, however, with unusually heavy rains, resulted in three consecutive days of peak flow over 4 mgd rate culminating in overflow and breaking of one of the lagoon dikes. Subsequent investigation indicated that a significant number of roof drains and area drains, particularly within the college, are connected to the sanitary system.

Table 14 shows available water quality data from the plant effluent based on plant monthly reports. There are no records of the flow which actually reaches surface water from the treatment lagoons. The ultimate receiving surface water is Hangman Creek via Marshall and Minnie Creeks. In dry weather, the flow of Minnie Creek is alleged to disappear into a hayfield. At other times it presumably reaches

Hangman Creek.

When the last addition to the lagoons was made in 1972, the design was based on a population equivalent of 8,400 and a BOD loading of 1,420 pounds per day (0.17 pounds per capita per day). The lagoon design loading is 40 pounds of BOD per acre per day.

City of Deer Park. The 1970 population of Deer Park is 1,295. Essentially, the entire community is served by the sewage collection system and the current tributary population is estimated to be 1,300. Measured average daily flow for the period January 1972 through December 1973 is 150,000 gpd. The estimated average dry weather flow, based on July through September 1972 is 143,000 gpd. This indicates that the storm inflow is relatively small, however, it does not necessarily mean that there is not a significant year round infiltration flow. The maximum daily flow recorded is 200,000 gpd, also indicative of little storm water inflow. The apparent per capita dry weather flow of 110 gpd is high for a small municipality, indicating possible infiltration.

Only one industry in Deer Park holds a waste discharge permit, namely the Deer Park Creamery. The permitted flow is 7,500 gallons per day which would be equivalent to 6 gpcd.

The receiving water is Dragoon Creek, a branch of the Little Spokane River. The available effluent quality data from monthly DOE reports is shown in Table 14. The treatment facility is a secondary plant utilizing trickling filters and has a nominal capacity of 1,500 persons according to an EPA efficiency report. The efficiency report added no analytical data to that in the monthly reports which are inadequate to evaluate performance. The report did indicate a turbid effluent. Sludge is disposed to drying beds.

Fairchild Air Force Base. Three treatment facilities serve the base, a main collection system and plant and two systems which serve outlying areas. None of the data reported below is official. All data reported are estimates of doubtful reliability.

The main collection system and plant serve an estimated equivalent full time population of 6,700. There are believed to be no significant industrial type flows in addition to domestic waste flows. The average daily flow, April 1970 to March 1973, was 1.06 mgd with peak flows of the order 1.7 mgd. Dry weather flow is reported to be of the order 800,000 gpd. The apparent per capita flow of 120 gpd is high and may include significant infiltration even in dry weather. Winter flows are known to contain significant infiltration as distinguished from storm inflow. The past wet winter resulted in day long flows of the order 1.5 mgd for extended periods.

The reported sewage strength of 222 mg/l settleable solids and 269 mg/l BOD is high. These high levels were reported to have been reached following the extensive installation of garbage grinders.

The main treatment plant is a secondary type utilizing trickling filters, rated 1.5 mgd. The final effluent is disposed of by seepage and evaporation. There is no discharge to surface waters. In summer, the treated effluent is discharged to a lagoon for disposal by evaporation and seepage. In winter, the treated effluent is discharged to a drain field. The treated effluent quality is reported to be 13 mg/l settleable solids and 22 mg/l BOD indicating removal efficiencies in excess of 90 percent.

The Survival School and Ammunition Storage Areas are currently served by a separate collection and treatment facility. A contract has been let to construct facilities which will permit the separate plant to be abandoned and provide for pumping the untreated waste to the main plant. The tributary population is highly variable and unknown. There are no measuring devices at the existing plant. The estimated average population is 700 or less and the flow 80,000 to 90,000 gallons per day or less. The existing plant is a secondary plant utilizing trickling filters discharging to a non-overflow lagoon for disposal by seepage and evaporation. There is no discharge to surface waters.

The Geiger Heights housing area is and will continue to be served by a separate collection and treatment facility. The estimated tributary population is 1,000. No flow data are available, but flow is estimated to be less than 100,000 gpd. The treatment facility consists of two lagoons in series. Ultimate disposal is by evaporation and seepage. There is no discharge to surface waters.

No quality data are available for either the Survival School or Geiger Heights system. Both are assumed to be typical domestic sanitary sewage.

Town of Fairfield. The 1970 census population is 469. Substantially the entire town is served by the sewage collection system. The present estimated population is 480. There are no recorded flow measurements. A flow measurement device exists on the downstream side of the two lagoons which comprise the treatment facility. The flow indicated at the measuring device, estimated at 15,000 gallons per day, would not include seepage and evaporation losses from the lagoons. The indicated flow is equivalent to 31 gpcd (gallons per capita per day). Lagoon influent is estimated to be at least equal to 60 gpcd (29,000 gpd) dry weather flow. Infiltration is reported to be a major problem in Fairfield sewers but no measurement of wet weather flow is available. The EPA Operation and Maintenance Report of 1972 states that the major infiltration problem is caused by a spring drained into the collection system.

Fairfield's treatment facilities consist of lagoons and a chlorine contact chamber with discharge to a tributary of Hangman Creek. It is reported that the receiving stream, Rattlers Run Creek, goes dry most of the year before reaching Hangman Creek. Effluent quality is not routinely measured. Only the Cl_2 residual is monitored. On December 11, 1973, DOE conducted a treatment plant efficiency study yielding the results shown in Table 15. Flow was not measured.

Town of Medical Lake. Population per 1970 census is 3529 but this figure includes the 2,000 residents of Eastern State Hospital and an unknown number in Lakeland Village, both of which have their own separate sewage collection and disposal facilities. The 1972 DSHS water facilities report gives a water service population for Medical Lake alone of 1872 and the EPA operations and maintenance report of 1972 gives 580 homes as the sewerage service area (which at 3.2 persons per home checks the 1872 figure). The sewage collection system serves almost the entire community. The estimated service population is 1800 persons.

Medical Lake's sewage treatment facilities consist of lagoons. Most of the year, the lagoons function as a non-overflow system with total inflow lost to evaporation and percolation. The chlorination facility and effluent ditch are used only when there is an effluent, usually about 10 days per year. The effluent ditch carries the effluent four miles to Deep Creek, a tributary of the Spokane River.

The quantity of wastewater is not accurately measured. The lift station pump capacity and operating hours indicate the flow is about 135,000 gallons per day according to the operator. The estimated flow fluctuates from about 130,000 gpd during dry weather to about 150,000 gpd during peak wet weather periods. The average dry weather per capita flow is 73 gpcd.

Available quality data appears to be limited to the results from a DOE efficiency report of May 16, 1973 which are shown in Table 16.

Town of Millwood. The Town of Millwood had a 1970 census population of 1,770. The sewerage service area, however, covers only a small part of the town, primarily the central business area. Approximately 90 connections are reported. Since the service area has relatively few full time residents, the full time equivalent population is impossible to estimate on the basis of the number of connections alone. The service population is estimated by the town to be 15 percent of the total population, which would be approximately 270 persons or an average of 3 per connection. The EPA Maintenance and Operation Report of 1972 gives 500 as the service population. The NPDES application shows between 200 and 500. A full time equivalent service population of around 200 is estimated.

Both the EPA M & O report and the monthly reports indicate an average flow of 10,000 gpd. The EPA figure is from one measurement only and the monthly reports show the same figure every day and hence probably do not represent measurements. Infiltration is not reported as a problem.

The treatment facility is a package unit, extended aeration type, which discharges directly to the Spokane River. The plant is rated 17,000 gpd. Effluent quality in terms of pH, dissolved oxygen and chlorine residual are available from monthly reports. The pH and DO are shown in Table 14. The chlorine residual is 0.6 ppm.

Town of Rockford. Rockford had a 1970 census population of 327. The entire community is reportedly served by the sewage collection system and treatment facility. A figure of 350 is reported in the EPA efficiency report of 1972 and 367 in the 1972 DSHS water facilities report. A service population of 340 is selected from this data.

The Rockford treatment facilities consist of lagoons which discharge into Rock Creek, a tributary of Hangman Creek. There is no measuring device for flow entering the lagoons. There is a 60° V-notch weir at the lagoon effluent which measures the net discharge after losses by seepage and evaporation. No records are kept of the flow through the weir but the annual average is reported to be "1 1/2 to 2" depth" in the weir. A 2" depth corresponds to a flow of 11,200 gpd or 33 gpcd. Infiltration is reported to be a problem during spring thaw (EPA report June 29, 1972) resulting in flows 3 1/2" to 5 1/2" deep in the weir. A 5 1/2" depth corresponds to a flow of 135,000.

The NPDES application gives 30,000 gpd as average flow and 80,000 gpd as peak wet weather flow. The application further states that there is zero discharge to Rock Creek for 10 months of the year and that lagoons overflow to Rock Creek only 2 months per year. This information regarding period of overflow appears to be in disagreement with the EPA efficiency report.

There are no reported wastewater quality data for Rockford. The NPDES application indicates 85-95 percent BOD removal.

City of Tekoa. Tekoa had a 1970 census population of 808. Current service populations reported are 950 per EPA operation and maintenance report of June 1972, and "over 1000" per NPDES application. The "reported" population appears to exceed the 1970 census by an unjustified amount. A service population of 850 is selected.

There do not appear to be any reliable wastewater flow records. The EPA report shows 200,000 gpd. The few entries available from monthly reports show 100,000 gpd. The consultant engaged to update the treatment facilities estimates the average flow at 120,000 gpd. Infiltration is alleged to be no problem.

There are no wastewater quality data. There are physical facilities for secondary treatment using trickling filters, with discharge to Hangman Creek. The plant site is subject to flooding. Currently the plant is essentially inoperable and the flow discharged is estimated as equal to poorly operated primary treatment.

Wellpinit (Bureau of Indian Affairs). The sewerage system does not include the entire community. According to Woodward (1971) the treatment facility serves 50 residents and a school population of 220 for a total full time equivalent of 80 persons.

The only estimate of flow is likewise from Woodward (1971) at 8,000 gpd. This is equal to 100 gpcd which appears to be high for a small isolated community.

The existing treatment facility consists of package extended aeration plant rated 7500 gpd which discharges into a non-overflow lagoon for ultimate disposal by seepage and evaporation. The Woodward report gives BOD of influent as 54 mg/l and effluent 34 mg/l.

Summary

Table 17 lists all the above described municipal facilities and provides an estimate of the total untreated waste load generated by each community. The nine communities (counting the Fairchild Air Force Base facilities as a single community) serve a total equivalent population of 20,622 and generate a total flow of 1.87 million gallons per day. The estimated total pollution loads in pounds per day before treatment are: BOD-3174, N-535 and P-149. The most flagrant deficiency is lack of meaningful records.

INDUSTRIAL WASTE SOURCES OUTSIDE THE CITY OF SPOKANE

General

There are 21 industries listed by DOE as having waste discharge permits for release of their waste flows directly to the environment rather than via a municipal collection and treatment system. These industries are listed in Table 8 of Section 311. This list can be refined by elimination of industries no longer active and by elimination of conditional permits which do not constitute an active source but rather a potential source of unspecified nature.

These dischargers are categorized by the ultimate receiving waters, first into those to surface waters and those to groundwater, and secondly to refine the groundwater group by potentially receiving aquifer.

The primary available data sources for quantity and quality of wastes are the application for waste discharge permits and the waste discharge permit itself. These sources are referred to as the "application" and "permit" respectively. Where the discharge is to "navigable waters and their tributaries," a discharge permit is required from the Corps of Engineers. The application for such permits also provides quantity and quality data similar to DOE permits.

Dischargers to Surface Waters

Industries which discharge directly to surface waters are listed in Table 18. There are only five industries that fall in this category including Soft Water Service which has plans to relocate and discharge to City sewers.

Hillyard Processing. Hillyard Processing holds permit number 3841, which expires in 1976, for its Sullivan Road operation. The Hillyard facility at Wellesley Road no longer creates liquid industrial wastes due to a change in operation and is not included as an existing or potential waste source although still holding an unexpired permit, number 3603. Hillyard (Sullivan) discharges an average of 545,000 gallons per day of treated wastes to the Spokane River at approximate River Mile 87.1. The plant operates three shifts per day, normally on a 5 day week, that is for 251 days per year, making the average annual flow 137 million gallons. The waste waters are from washing of aluminum dross. The treatment process essentially consists of settling to prevent carryover of the dross and adjustment of pH.

The waste discharge permit contains the following limitations on the quality of the effluent associated with a volume of flow not to exceed 720,000 gpd:

a. Range of pH to be between 6.5 and 8.5.
b. Suspended solids not to exceed 75 mg/1.
c. Total solids not to exceed 3,750 mg/1.
d. Chlorides not to exceed 3,000 mg/1.

The application contains quality data designated as "average" and "complete analysis." The "complete analysis" is for a grab sample made 23 June 1971 and analyzed by ABC Laboratories. The computation of the so called "average" is unknown but may include a "factor of safety." The two sources are not compatible. The most recently available data, in 1974, are likewise different.

Parameter	Units	1971 Application Aver-age	1971 Application Complete Analysis	1974 Data Low	1974 Data High	1974 Data Aver-age
pH		8.5		6.7	7.4	7.0
Suspended Solids	Mg/1	14	3	0.9	2.8	2.0
Total Solids	Mg/1	907	337	730	2792	1500
Chlorides	Mg/1	661	79	288	866	400

The process is substantially unchanging so that the wide range is not expected. The recent change in pH is the result of treatment change as explained below. The values adopted for Table 18 are composed of the 1974 data for parameters available and "complete analysis" data for all other parameters. In any case, the evidence is that the performance is within the permit limits. The actual flow reported at 545,000 gpd is 76 percent of the permit flow of 720,000 gpd.

Experience with a fish kill in 1973 raised the issue of toxicity due to ammonium hydroxide in small concentrations when combined with relatively high pH. The observed 8.5 mg/1 of ammonia nitrogen approaches the 10 mg/1 cited by DOE as potentially fatal for 24 hour exposures. Subsequent pH adjustment has sought to keep pH near 7.0 rather than the high range of the permit at 8.5

The most significant component of the Hillyard waste flow other than pH control is the high chloride content. Fluoride content of 3.2 mg/1 is also significant.

Inland Empire Paper. Inland holds permit number T-3835 which expires in December 1976. This permit provides for waste flows, exclusive of cooling waters, at an average flow of 4.8 mgd and not to exceed 5.5 mgd to be discharged to the Spokane River at River Mile 83 with the following quality limitations:

a. No visible oil or grease.

b. pH and zinc shall be limited subject to Condition No. 7 of this permit.

c. Beginning January 1, 1973 the total waste water discharge shall be limited to a biochemical oxygen demand (BOD) of 6 pounds per ton of pulp and 6 pounds per ton of paper produced up to a maximum of 1400 pounds of BOD per day. The suspended combustible solids (SCS) shall be limited to 8 pounds of SCS per ton of pulp and paper produced up to a maximum of 1200 pounds per day. These values are to be an average of daily measurements for any consecutive 30 day period.

The referenced Condition No. 7 is:

The permittee shall investigate treatment and/or inplant control which will provide a total mill effluent with a pH range of 6.5 to 8.5 and a total zinc concentration not to exceed that of the receiving water. The mill effluent shall comply with this criteria by January 1, 1973 provided these criteria cannot be met without waste water treatment. If treatment is necessary to comply with the pH or zinc criteria, then compliance shall be achieved by September 1, 1973 for such parameter requiring treatment. The results of these investigations shall be submitted to the Department of Ecology by January 1, 1973.

The implementation of these conditional aspects of the permit is shown in the following material quoted from a letter of December 15, 1972 from Inland Empire Paper Company to DOE:

"In our Waste Discharge Permit T-3835, paragraph 2(c) and 7 have compliance dates of January 1, 1973.

Paragraph 2(c) lists limitations of BOD and SCS (suspended combustible solids). Our monthly reports show our history of being within the limits on BOD, but on several occasions, over the maximum on SCS. We have employed several methods during the past months to reduce the amount of SCS going to our primary facility and feel we can stay within limits.

It should be pointed out that we are using extensive amounts reclaimed fiber in the interest of the total waste reduction concept. This is additional fiber which enters our system and increases our total "pulp" usage.

Paragraph 7 was answered in our August 11, 1972 letter by notifying you of our elimination of the use of zinc in our bleaching process by the change to sodium. Tests by outside labs indicate no measurable amount of zinc in our effluent. These test results will be included in our monthly report to comply with paragraph 5."

The Inland Empire operation is continuous, 24 hours per day 7 days per week, except for certain holidays and occasional machine down time.

The permit also provides for discharge of an average of 0.8 and maximum of 1.0 mgd of cooling water.

Actual waste flow is averaging 3.3 mgd, resulting in an annual flow of 1203 million gallons. (Note that there was a prolonged strike in 1973 which resulted in a complete shutdown from June 22 to October 17, 1973.) Included in this 3.3 mgd is approximately 1 mgd of cooling water.

A requirement of the permit is that certain water quality measurements be made. These requirements are:

1. Continuously recording meters to monitor and record:

   a. pH.
   b. Temperature.
   c. Flow.

2. A report of the effluent characteristics is to be submitted monthly to the Department of Ecology based upon the analysis of effluent samples composited daily or analyses which were obtained by continuous monitoring. This report shall contain the following information for each day of operation as well as an average for each report period:

   a. Production of pulp and paper in tons.
   b. Waste water flow in gallons.
   c. SCS in pounds per day.
   d. BOD in pounds per day.

e. pH; maximum, minimum and average.
f. Temperature; maximum, minimum and average.

3. The total zinc in a composited 24-hour sample shall be measured for one day each month and submitted with the monthly report.

The average values from these reports for the period January '72 to June '73 are reported in Table 19 and summarized in Table 18. An application to the Corps of Engineers made in 1971 listed additional parameters not covered in the required report to DOE. These are included in Table 18 also but should be recognized as possibly being out-of-date due to changes in process and treatment since 1971.

Kaiser (Mead). Kaiser Aluminum and Chemical Corporation Mead Works has permit number 3812 which expires August 1976. The flow quantities given in the permit were confirmed and refined in a letter from Kaiser to the consultant as being substantially correct estimates of the actual flow as follows:

16,000 gpd water softener regeneration
185,000 gpd sanitary waste
2,450,000 gpd courtyard cooling sprinklers
1,780,000 gpd rectifier cooling
700,000 gpd ingot cooling.

The three components of cooling water add up to 4,930,000 gpd as compared with 5,280,000 in the permit. The sanitary flow is identical with the permit flow. The water softener flow at 16,000 gpd is less than the 21,000 gpd allowed for process flow in the permit.

The Mead works is a continuous operation, 24 hours per day, 365 days per year. Total employees per day is given as 1710 in the application. The process and sanitary flows are uniform throughout the year. The cooling water use varies seasonally, only the rectifier and ingot cooling uses are year-round and the courtyard sprinklers are operated only May through September.

Effluent quality requirements from the permit are as follows:

2. The effluent quality of the total plant discharge shall be limited to the following:

   a. pH of 6.5 to 8.5 with an induced variation of less than 0.5 units.
   b. No visible oils and/or 10 ppm maximum.
   c. A turbidity not to exceed 5 JUT over natural conditions.

3. Sanitary wastes are to receive secondary treatment and adequate disinfection before they are mixed or discharged with any other plant water or discharge.

Process wastes which are discharged are entirely from regeneration of zeolite water softeners. These wastes are discharged without treatment. Presumably this flow is high in chloride. There are no chloride data for the effluent. There is no chloride limitation in the permit.

There is a closed circuit process flow associated with a wet scrubber to prevent air pollution from the pot line atmosphere. The discharge of these wastes is prohibited by the permit. Kaiser indicates that the wet scrubber system is scheduled to be replaced by a dry system in 1974. The existing wet system results in the production of a sludge containing calcium fluoride, calcium sulfate, alumina and carbon produced by lime precipitation. Both the lime and the sludge are covered by the permit requirements as follows:

5. Solid wastes, including the sludges from the air pollution control facilities shall be handled in such a manner that they, or leachates from them, do not enter state waters.

6. Lime shall be handled in such a manner as to prevent its entry into a storm sewer or state water.

The sludge is disposed of to an evaporation pond. This sludge will not be produced when the wet scrubber is replaced.

Sludge from the sanitary treatment plant is also disposed of by drying beds.

The combined flow of untreated process waste, treated sanitary waste and untreated cooling water are combined and discharged to Peone Creek, a tributary of the Little Spokane River. The point of discharge is located just south of Highway 2 (Newport) and approximately two miles from the confluence with the Little Spokane River.

The permit requires monthly reports of the following water quality parameters:

1. Flow
2. pH
3. Conductivity
4. Settleable Solids
5. Chlorine Residual
6. Temperature.

Summary data from the reports of these parameters for the period May 1972 through November 1973 are shown in Table 18. Data for other parameters are available from a Corps of Engineers permit application of 1971 which are also shown in Table 18. Due to the changes in operation since 1971, these latter data may not be currently representative.

The two most significant parameters based on the waste sources are chlorides and temperature. Limits are not established for either in the permit. The average conductivity of 334 micromhos per square centimeter in the effluent is between the observed values for adjacent well waters at around 300 for the Department of Game spring and 390 for the Wandermere spring. The high dilution of the process waste in the cooling water flow would be expected to make any total change in conductivity small. The average temperature of 20°C in the effluent indicates an approximate 9°C rise over average well water temperatures. Water temperatures of Peone Creek upstream from the Kaiser discharge are not available.

Kaiser (Trentwood). Kaiser Aluminum and Chemical Corporation has on file for its Trentwood Works an application for NPDES permit dated August 1973. This application is in effect a temporary permit under current DOE procedures which give this status to applications where the prior permit has expired and DOE has taken no action on the application within 60 days. The prior permit for the Trentwood Works, number T-3960, expired on February 28, 1973.

The application proposed a maximum discharge of 27 mgd and an average of 24 mgd to the Spokane River at River Mile 86 through a submerged diffuser. The following breakdown is given for these total flows:

Sanitary Wastes	4,100	5,200
Industrial Wastewater	6,198,100	7,003,853
Cooling Water Discharge	17,497,000	19,218,647
Water Incorporated into Product	n/a	n/a
Evaporative Loss	200,000	272,300
Other (Specify) Irrigation	100,000	500,000
TOTAL	24,000,000	27,000,000

The Trentwood operation is essentially a continuous one, 24 hours per day, 7 days per week for an average of 360 days of the year. Total employment is of the order 2600* per day. This level of employ-

*Revised to 2600 from 2000 in application by letter to consultant.

ment would indicate that the sanitary waste flow shown in the application is not the total sanitary flow. The reported 4,100 gpd average appears to be based on the volume of the potable water supply. It is possible that river water is used for toilet flushing and is thus not reported.

The source of all waters except the above mentioned potable water supply from an on-site well is the Spokane River.

All waste waters from the Trentwood facility, including storm drainage from roofs and parking lots, is routed through the final treatment lagoon before discharge to the Spokane River through the single river bed diffuser.

Current flow measurements are not available. Using the application data, the net average discharge of all wastes is 23.7 mgd or 8532 million gallons per year, exclusive of storm water. The areas drained of storm water are unknown but are estimated at 200 acres from aerial photographs.

The application describes the sources of pollutants entering the industrial wastewater component as follows:

> Oil "The principal sources of oil in the effluent from the Kaiser Trentwood Plant are the remelt casting stations, hot line coolants and aluminum washing operations. Relatively minor sources are the automotive garage, air compressor accumulator tank blowdown and the roll grind shop. The hot line oil is an emulsified oil."

Approximately 750 gallons of Mobil Prosol 46 rolling oil are used per day.

> "Spent hot line rolling oil is processed at the new Industrial Waste Water Treatment (I.W.W.T.) Facility. The emul-

sion is broken with the addition of acid and heat. Free oil is collected in storage tanks and removed by outside businesses. Water effluent from this system received additional chemical treatment and then is discharged thru the clarifier and lagoon for final clean-up."

Phosphate "Phosphate enters the waste water as a result of metal cleaning operations. All phosphate bearing effluents are collected in a common collection system and drained to the I.W.W.T. Facility. These waters consist of lime and poly (polyelectrolyte) additions to form a floc which drops out in the clarifier."

Approximate quantities of phosphate chemicals reported are 50 pounds per day of Oakite trisodium phosphate and 240 pounds per day of Oakite poly trisodium phosphate.

Chromium "Chromium-bearing waste waters originate primarily from the paint line, alodizer and the conversion coating processes. Chromium in the waste exists in two (2) ionic forms, the hexavalent state and the trivalent state. These waters are collected in a common collection system and drained to the I.W.W.T. Facility. The treatment consists of reducing the hexavalent chromium to a trivalent state. With pH adjustment and addition of polymers, the contaminates will floc out in the clarifier."

Reported use of chromium containing chemicals is 120 pounds per day of Oakite 264 phosphoric, chromic hydrofluor acid.

The volumes of the above components waste flows are as follows, from a Kaiser letter of December 30, 1973 to the consultant:

Oil emulsion waste	40 gpm =	58,000 gpd
Phosphate bearing waste	160 gpm =	230,000 gpd
Chrome bearing waste	100 gpm =	144,000 gpd
TOTAL		432,000 gpd

This accounts for 14 percent of the 6.2 mgd classified as industrial waste flow as distinguished from cooling water.

There are no quality measurements available to the consultant for the effluent under current operating conditions other than the table shown in the application which is reproduced in Table 20. Available data in STORET are for the period September 13-14, 1972 when two separate discharges were operating.

For an evaluation of DOE concerns and limits, the only available source is the expired permit. The permit focused on the following parameters:

1. Temperature

Temperature of Receiving Water Measured at a Point Above the South Outfall	Allowable Induced Temperature Increase Outside the Dilution Zone Below Either the South or West Outfall
32° - 36°	4°
36° - 46°	3°
46° - 61°	2°
61° - 64°	1°
64° and above	0°

2. Chromium

"A chromium removal system shall be installed, which shall result in a maximum allowable instantaneous concentration of chromium of 0.2 ppm, with a total discharge of less than 3.5 lbs/day. Furthermore, the wastewaters will contain no measurable hexavalent chromium."

3. Phosphorus

"A phosphorus removal system shall be installed,...the wastewaters shall contain an average phosphate concentration of less than 0.03 ppm.

4. Oil

"A new oil recovery system will be installed which will result in a wastewater containing no visible oils with a maximum instantaneous concentration of 10 ppm."

5. Coliforms

"A chlorine contact chamber will be added to the domestic sewage treatment facilities. This chamber will provide for

15 minutes contact time at peak flow or 1 hour contact time at average flow, whichever is greater."

Comparison of the above requirements with Table 20 indicates the following:

1. No check can be made on temperature compliance since the river temperature above and below the outfall are not given.

2. The total chromium level at .04 mg/l is below the instantaneous limit of 0.2 ppm but would result in 8.0 pounds per day which exceeds the daily limit of 3.5 pounds per day. The .01 mg/l of hexavalent chromium is 10 times greater than normal spectrophotometer limits of 0.00. mg/l.

3. The phosphate level at 0.30 mg/l exceeds by 10 times the stated limit of 0.03 mg/l.

4. The oil level at 3.7 mg/l is less than the required instantaneous maximum of 10 mg/l but exceeds the required average of 1.5 mg/l.

5. No coliform data are reported.

The expired permit contained the following requirements for monitoring and reporting:

"A report is to be submitted each month to indicate the following maximum and average effluent characteristics: pH, total chrome, grease, total solids, daily volume, temperature and phosphates."

Soft Water Service. Soft Water Service Company held expired permit number T-3939. The application made prior to issuance of permit T-3939 is available, but there does not appear to be a subsequent NPDES application.

Soft Water Service (SWS) is located in the City of Spokane and discharges its sanitary waste to the City sewer system, but discharges its process waste directly to the Spokane River. The point of discharge is between the Monroe Street Dam and the Monroe Street Bridge. It is understood that SWS plans to relocate to another site within the City sometime in 1974 or 1975. The expired permit called for elimination of the direct discharge to the Spokane River and diversion of the process waste to the City sewers. This has not been done but it is understood that the relocated SWS plant will discharge process wastes to the City sewers.

The permit calls for a discharge volume not to exceed 35,000 gpd. The plant is supplied from the City water system whose records indicate an annual use of 10 million gallons which is equal to 27,500 gallons per calendar day or 40,000 gallons per work day, 5 days per week.

The process waste flows are primarily from regeneration of water softeners, but there is also regeneration of deionizer media. No treatment is provided for the softener regeneration waste in which the significant pollutants are chloride salts of calcium, magnesium and sodium. The application indicated use of 3000 pounds per day of sodium chloride. The deionizer regeneration wastes are treated by passing through a calcium carbonate filter for pH control of acid and caustic flows.

The permit contained no specific discharge requirements or monitoring and reporting requirements.

An analysis of the waste flow was made August 21, 1973 by the City staff, with results as follows:

Parameter	Units	Concentration
Grease	mg/l	--
Suspended Solids	mg/l	637
Chlorine Demand	lb/mg	--
BOD	mg/l	*
pH		9.2
COD	mg/l	*
PO_4	mg/l	4.1
Total Solids		1.66%

The flow at time of test is not recorded. The observed 1.66% total solids, less City Water solids or approximately .20% makes net addition 1.46%. This is equal to 4900 pounds per day in a flow of 40,000 gallons. Considering that the actual flow is unknown, this is reasonable agreement with the stated use of sodium chloride, at 3,000 pounds per day, which converted to calcium chloride would be 4000 pounds per day.

Spokane Industrial Park. Spokane Industrial Park (SIP) is a privately developed and operated industrial park on the site of the old U.S. Naval Supply depot east of Trentwood. The facility is owned and operated by Washington Water Power Company and leases sites to sixty four tenant industries. The sanitary and industrial waste flows from these tenants are collected and treated for discharge in a single system.

The majority of the tenants have no process wastes, only sanitary sewage. The total estimated population is 3500 employees per day. Four tenants have industrial waste discharge permits. These are:

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*Salt content of waste interfered with test.

Name	Permit Number	Expiration Date
A-M Manufacturing	3482	12/15/75
Columbia Lighting	3065	10/10/73
General Aluminum Corp.	2990	6/19/73
Suntex Veneer	3955	4/10/77

The Chembond Corporation is located in SIP and has a waste discharge permit. The Chembond Corporation is not included in the above list because its industrial waste flows, which are entirely uncontaminated cooling waters, are discharged to dry wells rather than to the SIP system. See discussion under dischargers to land and groundwater.

The Spokane Industrial Park itself does not hold a DOE waste discharge permit and has not made application for an NPDES permit. SIP has made application for a permit from the Corps of Engineers under Section 13 of the Rivers and Harbors Act of 1899. To avoid duplication of paper effort, Section 13 applications are being given recognition under current DOE procedures as an interim permit. This application is referred to below as the Corps application. The Corps application was made in June 1971 so it cannot reflect current conditions, since the existing treatment plant was completed in December 1971.

The Corps application reports an expected average daily flow of .545 mgd and the expected discharge quality for a broad spectrum of parameters. However, the reported quality was based on analysis made before the existing treatment facilities were completed. More recent data for the period September 1972 are available from STORET. Where available, the more recent data are shown in Table 18, otherwise the data in Table 18 are taken from the Corps application.

The waste flow of .545 mgd is not in agreement with average daily water use reported at 1.9 mgd in 1971.

An EPA inspection was made on June 27, 1972 which reports an average flow of .6 mgd. No analyses were made. The effluent was reported highly turbid.

Following are descriptions of the operations of those tenants holding waste discharge permits. In all cases, the sanitary wastes are to be discharged to the SIP system. Hence, the discussion is restricted to industrial flows other than sanitary.

A-M Manufacturing has a permit to discharge not in excess of 21,500 gpd to the SIP sewer system. A-M Manufacturing's wastes include those from irrigation equipment manufacture and zinc plating operations. Their application gives a breakdown of the total flows as follows:

	Average gpd	Maximum gpd
Industrial Processing	11,040	.14,000
Cooling Water	4,608	7,500
	15,648	21,500

The plant normally operates 2 shifts per day for 260 days per year. This would make the average annual flow approximately 4.1 million gallons.

Requirements of the permit include the following:

"2. Concentrated chemical solutions from the muriatic acid tanks are to be disposed of in such a manner as to prevent their entry into a State waterway. At no time are these concentrated chemical solutions to be discharged to any sewer system.

3. No waste solvents are to be discharged to any sewer system.

4. Overflow rinse waters from the metal plating line shall be discharged to the Spokane Industrial Park sewers. The com-

bined effluent from the metal plating line rinse water tanks shall not exceed the following concentrations:

a. A pH range between 6.5 and 8.5;
b. 3.0 parts per million of zinc or .5 pound per day;
c. Less than 0.5 parts per million of cyanide.

5. Chemical sludges or sludges containing oils, or sludges havein high or low pH values must be disposed of in such a manner as to prevent their entry into a State waterway."

The permit also has the following monitoring and reporting requirement:

"6. For each day of operation of the metal plating line, daily samples of the plant effluent shall be tested for the following parameters: zinc, cyanide, and pH. The results of those tests shall be submitted to the Department of Ecology on a monthly basis. The data upon which this report is based shall be made available for inspection and study by members of the staff of the Department of Ecology upon request."

Columbia Lighting, Incorporated holds permit 3065 which expired October 10, 1973. There is no record of a subsequent reapplication or a renewal. The expired permit was for a discharge not to exceed 432,000 gallons per day to SIP system. Limitations specified in the permit are for pH between 6.5 and 8.5 and total chrome less than 1 mg/l. The permit also contains prohibitions and precautions regarding materials not to be discharged to the SIP system, including chemical and oil sludges, paints, thinners and solvents. Unspecified dip tank chemicals are to be neutralized before discharge to SIP. The monitoring and reporting requirements are for monthly reports showing results of daily pH measurements and biweekly total chrome.

General Aluminum holds permit 2990 which expired June 19, 1973. No reapplications or renewals were found. This permit was for 200 gpd of uncontaminate cooling water to SIP system. The permit prohibits discharge to the SIP system of quench tank solids, metal plating wastes, chemical and oil sludges.

Suntex Veneer holds permit 3955 which is currently valid and will expire in 1979. The permit provides for discharge not to exceed 74,000 gpd to the SIP system. There are no stated requirements for the quality of discharge except indirectly by prohibition of discharge of wood solids and glue. The permit also prohibits the discharge of uncontaminated cooling water, requiring that such flows be discharged to storm sewers. Hence, it is not clear what pollutants, if any, are expected in the discharge to the SIP system. The application by Suntex indicated that the flow breakdown was 49,000 gpd of industrial processing waste and 25,000 gpd of compressor cooling water, matching the total of 74,000 in the permit. If the cooling water is excluded, however, the net waste to the SIP system must be 49,000 gpd maximum. Following is the list of chemicals used as shown in the application. The resin (glue) is prohibited from the discharge and it is not known which of the remaining chemicals have potential for appearing in the discharge.

Brand Name	Chemical Scientific or Actual Name	Quantity Used Per Day Average	Maximum
Mogul CE-105	Morpholine & Cyclohexaline	1 1/2 qts	
Mogul CE-171	Phosphate & Lignosulphonate	3#	
Mogul CE-15	Sodium Sulphite & Lignosulphonate	2#	
Chem Bond	Cerax 303 Phenolic Resin	2100#	2800#
FMC	Grade 100 Soda Ash	180#	240#
Pennwalt	Liquid Caustic Soda 50%	690#	920#
US Borax	5 Mol Granulated Borax	18#	24#
764	EDTA	1/4 #	

Dischargers to Land or Groundwaters

Industries which discharge to land for disposal by evaporation or by percolation to groundwater are listed in Table 21. These industries are further classified into those which discharge into the surface of the primary Spokane Valley aquifer and those which discharge to other land surfaces throughout the study area. There is an expired permit to Simmons Egg Farm which would fall in this category, but it is not listed since the business no longer operates.

Discharges to the surface of the primary aquifer are listed in Table 22 and discussed below.

ASC Industries holds waste discharge permit 3872 which expires in 1976. The permit, which provides for discharge not in excess of 90,000 gpd, specifically calls for disposal of both waste flows and cooling waters by means of drainfields on the plant site. The only quality limitations are prevention of excess solids carryover and oils to 10 mg/l or less. The application form indicates that the flow is primarily cooling water at an average rate of 45,000 gpd and that the business is highly seasonal, being carried on in conjunction with the irrigation season. Sanitary wastes for an average of 35 employees per day are disposed of by septic tank. The relation of the septic tank drainfield to the industrial waste drainfield is not known.

Ace Concrete holds permit number 3693 which expires June 1976. The permit covers discharges up to 75,000 gpd to either a lagoon or abandoned gravel pit for ultimate disposal to groundwater by seepage. No quality requirements are specified but the discharge is limited to plant operation (sand and gravel washing) waters and non-toxic and non-putrescible material. The application indicates that the 75,000 gpd is an average flow figure and that the operation is seasonal, being limited to 160 to 200 days per year.

Acme Concrete has expired permit number 2908. The not to exceed flow is 10,000 gpd to be disposed to gravel pit areas. The application indicates that the waste flow is settled wash water and that the operation is seasonal to the extent that the level of operation is very low in winter months.

Central Premix holds permit number 3879, which expires October 1976, for their Ft. Wright operation. Central Premix also has ready-mix facilities at two other locations, Division Street and Yardley, where sand and gravel wash wastes are also disposed of by lagooning. These operations do not appear to be part of the permit. The permit provides for discharge not to exceed 322,640 gpd to a lagoon or gravel pit for ultimate seepage disposal. The permit mentions that the ultimate point of disposal by seepage is the Spokane River but, since the route is necessarily via groundwater, this discharger is classified as groundwater rather than surface water oriented. The application shows that the average flow is 288,000 gpd from sand and gravel washing and that the operation is seasonal, ranging from 197 to 220 days per year. Observations of the lagoon indicated a very turbid brown discharge.

Chembond Corporation has expired permit number 2826. Chembond is a resin manufacturer located in the Spokane Industrial Park. The permit provided for discharge of up to 108,000 gpd of uncontaminated cooling water to dry wells rather than to the SIP sewer system. The application indicates that the average discharge of cooling water is 36,000 gpd.

Ideal Cement holds permit number 3869 which expires September 1976. The permit provides for discharge of up to 9,600 gpd of uncontaminated cooling water to a dry well on the site. Discharge of process waters to the dry well are prohibited. The application indicates that the average flow is 4,800 gpd.

Kaiser (South Mead Works) has changed function since the issuance of permit 3129 which expired February 7, 1974. The current status was described to the consultant in a letter from Kaiser Aluminum and Chemical Corporation dated March 7, 1974. The following is quoted from the referenced letter: (The letter is in answer to number questions from the consultant. Where the question is not self-evident from the answer, the question is inserted in parentheses.)

"Mead South Plant

Note: The Mead South Plant is now occupied primarily by R.A. Hanson Co., a heavy construction equipment manufacturer. Kaiser operates one coke kiln on the site and provides domestic and cooling water supply. The following answers pertain to Kaiser's operation and the on-site Hanson operations.

1. Average number of employees including number reported by R.A. Hanson:

Day	Night	Swing
115	3	8

2.

Product	Production Rate
Calcined Fluid Coke	225 TPD Avg.
Heavy Construction Equipment	Not applicable

3. Water Use

	Gallons Per Day	
	Average	Maximum
Domestic Service	1,000	1,500
Cooling Water	311,000	413,000
Total	312,000	414,000

All figures are estimates and no seasonal fluctuation is known.

4. No process water other than cooling water is used and there are no water treatment facilities.

5. There is no recycling and no future plans for recycling.

6. There are no solid wastes generated by the calcination operation. Sewage is treated in a small activated sludge-type treating plant. Solids from the sewwage plant are disposed of in a sludge bed.

7. There are no process liquid wastes except cooling water and no treatment is provided.

8. None. (Treatment facility serves how many employees?)

9. Waste water volume estimate: Average 644 MGPD*--includes excess pump capacity flow through.

   Evaporation loss estimate: Average 76 MGPD

10. None maintained. (What effluent quality testing is done?)

11. No changes anticipated. (What is anticipated production growth?)"

The expired permit, which was for flows up to 7.7 mgd, called for industrial wastes to discharge to lagoons. Presumably the current flows, approximately 7 percent of the permit level, continue to disposal via the lagoon.

Statement 9 in Kaiser's letter is interpreted to mean that pump

*MGPD = thousands of gallons per day.

capacity exceeds the capacity of the using equipment and that part of the flow goes to waste without going through the equipment. Thus, the actual flow to the lagoons is 644,000 gpd less the estimated evaporation at 76,000 gpd or a net waste flow of 568,000 gpd. According to the Kaiser letter, the entire waste flow other than sanitary use is either uncontaminated cooling water and uncontaminated well water that bypasses the equipment.

Triple "E" Meats holds permit number 3878 which expires November 1976. The permit provides for discharge of up to 2200 gpd of cooling and process waters to an on-site drainfield. The permit does not contain any specific quality limitations other than a maximum of 150 mg/l of grease. The limitations are described as follows, referring to the process operation associated with meat packing:

> "3. Floors are to be dry cleaned prior to washdown to prevent excessive loss of grease and meat particles to the disposal system.
>
> 4. Waste process and washdown waters are to be passed through an adequate grease retention unit prior to discharge to the drainfield. This facility is to be properly maintained such that not more than 150 PPM of grease will be contained in the waste discharged."

The application indicates that the average total discharge is 1600 gpd composed of 1500 gpd of process flow and 100 gpd of cooling waters.

Dischargers to the land surface or groundwater in areas other than over the primary aquifer are listed in Table 23 and are described below.

Dawn Mining Company holds permit number 3216 which expires

October 22, 1974. The permit covers the cooling and process waste discharge from a uranium ore concentration facility located 3/4 mile west of Ford in the Spokane Indian Reservation, Stevens County. A maximum discharge of 650,000 gallons per day is permitted with the requirement that disposal be to a lagoon for ultimate disposal by evaporation and seepage. There are no specific quality restrictions of the discharge to the lagoon. There is a monitoring and reporting requirement for weekly pH readings on Chamokane Creek below the mill, with the further stipulation that pH below 6.5 is to be reported immediately.

According to the application, the lagoon is located approximately 1000 feet from the south bank of Chamokane Creek. Plant operation is non-seasonal and averages 300 days per year. Daily consumption of chemicals for average production of 2500 pounds of ammonium diuranate is given as follows:

Chemical	Average Use Per Day
Sulphuric Acid	25 tons
Ammonium Nitrate	1 ton
Liquid Ammonia	1 ton
Calcium Hydroxide	15 tons

Average process water use is given as 514,000 gallons per day plus 28,800 gpd of cooling water for a total of 542,800 gpd. No data are available on the quality of effluent to the lagoon. (1)

Northwest Tungsten holds permit number 3915, expiring November 1976, for discharge of 9,600 gallons per day to groundwater in connection with production of 50 tons per day of tungsten ore. The location is in the Blue Grouse Mountains in the upper Dragoon Creek watershed. The

(1) Subsequent to completion of this section, there was news of the proposed reopening of the Sherwood Mine, an uranium mine also on the Spokane Indian Reservation.

operation is seasonal, being open only 160 days per year between May and December. The system is described in the application as being essentially a closed cycle. Water used in the mill is discharged to a settling pond from which water is recycled through the mill. The net discharge is the seepage loss from the settling pond. The quantity 9,600 gpd is interpreted as being the net system loss to seepage. An analysis of the water in the settling pond is not available.

Rockford Grain Growers had expired permit number 2875 for discharge of 1000 gallons per day to groundwater. The application indicates that the wastes are generated from washing truck and storage tanks and application equipment for handling fertilizers and agricultural chemicals. The operation is indicated to be seasonal, being from 60 to 120 days per year.

The nature of the fertilizers and agricultural chemicals listed in the application are as follows:

Ammonium fertilizers containing phosphates, nitrates, and sulfur.
Liquid urea.
Potash.
Herbicides and insecticides, primarily phenoxy and organic phosphate types.

The permit required all tank and tank yard washing wastes and spoiled batches of chemicals or toxic chemicals be discharged to a lagoon. The application indicated that ultimate disposal from the lagoon was to be by seepage and evaporation. The facility is located adjacent to Rock Creek, a tributary of Hangman Creek. Quality of the lagooned wastes is unknown.

United Paving had expired permit number 3111 for discharge of not to exceed 40,000 gpd to a pond for ultimate disposal by seepage and evaporation. The wastes flow results from sand and gravel washing and is seasonal, averaging 155 to 165 days per year. The permit contained a requirement to keep the pond dredged of fines so that seepage will continue and overflow be prevented.

<u>Summary</u>

Table 24 presents a summary of all industrial waste dischargers other than those which discharge to the City of Spokane sewage treatment plant. The industries are categorized into three groups, those that discharge to surface waters, those that discharge to land on the surface of the primary aquifer and those that discharge to other land surfaces.

The most significant dischargers are to surface waters. The total average daily flow is 31.9 mgd and it is estimated that these flows carry 1362 pounds per day (ppd) of BOD, 212 ppd of nitrogen (N) and 114 ppd of phosphate (P). Inland Empire Paper represents practically all of the BOD content of this group. Kaiser (Mead) and Kaiser (Trentwood) account for most of the N and P. Kaiser (Trentwood) accounts for 24 mgd or 75 percent of the flow volume, of which 17 mgd are waste cooling water.

Dischargers to land surface of the primary aquifer total 0.825 mgd with negligible amounts of the primary pollutants BOD, N and P. Most flows are either cooling waters or sand and gravel wash waters. Kaiser (South Mead) has a small sanitary component in the much larger cooling flow.

The industrial dischargers to other aquifers are very small in volume except for Dawn Mining at .543 mgd. There is negligible content of the primary pollutants BOD, N and P. The Rockford Grain Growers discharge, although very small in volume, deserves notice for its potential content of fertilizer and pesticide wastes and location in an inhabited area.

SANITARY WASTE SOURCES IN AREAS WITH INTERIM AND INDIVIDUAL ON-SITE DISPOSAL SYSTEMS

Introduction

The study area is categorized as follows for the purpose of compiling an evaluation of sanitary waste sources not served by central collection and treatment facilities:

1. Areas served by interim facilities
   a. Inside the City of Spokane.
   b. Suburban (within the urban planning area but outside the City limits).
   c. Outside of the urban planning area.

2. Areas served by individual on-site disposal
   a. Inside the City of Spokane.
   b. Suburban.
   c. Outside the urban planning area
      (1) In communities served by a public water system.
      (2) Other.

It is the objective of this subsection to delineate these areas, estimate the present tributary population and estimate the total present waste load attributable to these sources.

For the purpose of determining units of waste load represented by individual on-site disposal and interim treatment, the urban planning area is subdivided into the geographical unit areas as shown on Plate 312-1. The area outside the urban planning area is regarded as a single unit.

Areas Served by Interim Facilities

Locations of interim facilities are shown on Plate 311-2 and are tabulated in Table 25. Note that the Fairchild AFB Survival School interim facility is listed but not included in totals since current construction will phase out the interim plant and deliver the waste flow to the main plant at Fairchild AFB. Table 25 is arranged to provide service population totals by geographical units in which the facilities are located.

The summary in Table 25 shows that approximately 14,500 persons in the study area are served by interim facilities. The word approximately is inserted to point out that firm population data were unobtainable for many of these service areas so that the data had to be estimated. The facilities located in each geographic unit are discussed below.

North Spokane. There are nine interim facilities in this geographical unit servicing approximately 7142 persons both inside and outside the City of Spokane. Approximately half of the persons served by interim facilities in the study area are in this unit.

North Spokane represents the largest concentration of interim facilities in the study area. Not only is this the largest concentration but it is made up on the largest elements, both inside and outside the City. All of the interim facilities serving more than 400 persons are, with one exception, in the North Spokane Area. Some of the largest are:

Name	Service Population
Fairwood Addition	3157
Lidgerwood (Cozza-Calkins)	1500
Northwest Terrace	900
Whitworth College	1200

Fairwood Addition is operated by Washington Water Power who also provides water service in the area. Not only does this system serve a significant population, it is associated with an extensive collection system serving an area of single family dwellings. The service area is outside the City and north of a suburban area served by individual on-site disposal. The service area adjoins the south bank of the Little Spokane River. The service population equivalent includes schools and commercial.

Lidgerwood or Cozza-Calkins facility is located in the south half of the tongue of City land between Division and Nevada Streets north of Francis Avenue. It is the largest interim facility inside the City limits. Approximately 1500 persons are served by the lagoons which were placed in service in 1972. The planned capacity of the system is 2300 persons.

The next largest interim facility in the City is the Northwest Terrace plant. This plant is located at the west city limits above Riverside State Park and the Spokane River, north of Francis Avenue. The facility is reported to serve 900 now and is to serve an ultimate population of 1800. See below for revised present service population. Northwest Terrace is an extended aeration plant with disposal to the Spokane River. Northwest Terrace and the Police Academy are the only two interim plants that discharge to surface waters.

A recording device was installed at the effluent weir of the Northwest Terrace treatment facility from June 14 to June 25, 1974 to obtain some representative flow data for a suburban area. The results are summarized as follows:

Average daily flow	67,092 gpd
Instantaneous peak	246,816 gpd
Instantaneous minimum	7,776 gpd

A house count of the service area from aerial photographs indicates 212 dwellings. This gives a service population of 742 persons at 3.5 persons per dwelling unit. The estimate of 900 appears to be too high. The calculated average contribution is 90 gallons per capita per day. The service area is new and essentially all residential. The indicated per capita flow then is representative of residential dry weather flow with little, if any, infiltration.

Whitworth College is outside the City near the northeast edge of Five Mile Prairie and is located in a residential area served by individual on-site disposal.

The North Spokane geographical unit contains all of the interim facilities inside the City of Spokane except the Spokane Police Academy. In addition to the interim facilities listed in Table 25, there are two interim facilities currently under construction inside the City limits in the North Spokane area. These new facilities are known as Pacific Park and Sundance Hills. The interim facilities inside the City are summarized in Table 26.

In addition to Lidgerwood and Northwest Terrace, described above, the other interim facilities in the City requiring a brief description are Panorama Terrace and the two facilities under construction.

Panorama Terrace is located on the southeast corner of Five Mile Prairie and serves only 18 persons but the area is reported to have potential for 210. Topographically, Panorama Terrace drains to an area outside the City presently unsewered and served by individual on-site disposal.

The two interim facilities under construction in 1974, Pacific Park and Sundance Hills, are in the northwest extremity of the City between Five Mile Prairie and the Spokane River. Both areas drain toward the river which is separated from the City limits by unincorporated area. The Pacific Park facility has an estimated ultimate capacity of 140 persons and Sundance Hills, 480 persons.

In summary, by reference to Table 26, the present population served by interim facilities inside the City is 2425 of which 2418 are in the North Spokane unit. The remaining 7 are accounted for by the Police Academy near the west end of Felts Field.

Peone Prairie. There are no interim facilities in this unit.

Spokane Valley, Near. The next largest concentration of interim facilities is the Near Valley unit with 3628 persons so served. Here, as contrasted with North Spokane, there are 29 facilities involved, all relatively small, for an average of 125 persons per facility indicating limited collection systems associated with each. The facilities are closely clustered in some parts of the Near Valley. There is a cluster of 5 in the vicinity of Sprague Avenue and University Road and another cluster of 7 in the vicinity of Broadway Avenue and Bowdish Road. The remainder are scattered throughout the unit. Most of the interim facilities in the Near Valley unit are located in the midst of large areas served by concentrated individual on-site disposal.

Spokane Valley, East. The East Valley unit contains six facilities serving 1713 persons, an average of 286 per interim facility, in widely scattered locations. In contrast to the Near Valley unit, most of the interim facilities in the East Valley unit are isolated and not in the midst of areas served by individual on-site disposal.

Moran Prairie. The Moran Prairie unit contains only three interim facilities serving 330 persons. Glennaire Terrace with 270 persons represents most of the service population and is isolated from the area served by individual on-site disposal which is concentrated in the southeast corner of the City and due south of the City boundary.

Southwest. The Southwest unit contains only two facilities totaling service for 1,098 persons, 1030 of whom are in Geiger Heights, a housing development operated by Fairchild AFB. Geiger Heights is relatively isolated, in the vicinity of Hallet Road and Grove Road. The nearest significant concentrations of other housing in the urban planning area are about three miles away.

West Plateau. The West Plateau unit contains only one facility now that the Survival School facility is being combined with the Fairchild AFB main plant. This single facility serves a mobile home park in Airways Heights. Airways Heights, approximately 5 miles west of Spokane and 2 miles east of Fairchild AFB is a community of approximately 1197 persons served by individual on-site disposal, except for the 68 served by the interim facility at the mobile home park.

Outside the Urban Planning Area. The seven interim facilities which are outside the urban planning area units described above serve 474 persons. In general, these facilities are so remote and so small individually that they have little potential for near future incorporation in other systems. They are not "interim" facilities in the sense of being temporary solutions pending incorporation in a larger contiguous or surrounding system. Five of the seven facilities are for institutional use and only two serve residences.

In summary, the population served by interim facilities in the urban planning area are shown in Table 27.

Areas Served by Individual On-Site Disposal

The estimated total population of suburban geographic units shown on Plate 312-1 are tabulated in Table 28. Also shown in Table 28, to complete the service populations in the urban planning area, are the service population of the sewered area of the City of Spokane and of Fairchild AFB.

The populations shown in Table 28 are developed from SMATS zone and district populations as developed for population allocation in Section 402 interpolated to 1973. To further break down the populations in the geographical units between those served by individual on-site facilities and those served by interim facilities, the interim facility service populations by geographical unit from Table 27 are inserted in Table 28 and the on-site service population subsequently determined by difference. There is no known compilation of housing served by individual on-site disposal. Table 28 shows that there are almost 79,000 persons served by individual disposal in the urban planning area.

Areas Within the City. Only an estimated 3164 persons with individual disposal are located within the City. These areas are concentrated in three locations, the northeast corner of the City in the North Spokane unit, the southeast corner of the City in the Near Valley unit and the southwest corner of the City in the Southwest unit.

Of the 1160 shown to be in the North Spokane unit, approximately 900 are accounted for by the area in the northeast corner of the city. This area is separated from the rest of the City by the Burlington-Northern railroad yards and topographically drains to the northwest, away from the central collection system. The remaining 200 are scattered through the northern edge of the City where the topography, in general, has begun to slope north away from the central collection system. Note that almost all of the City population in the North Spokane unit, other than the northeast corner, is served by interim facilities.

There are 1526 persons allocated to the Near Valley unit in the southeast corner of the City. This part of the City is traversed by a swale that drains in a northwesterly direction, taking the natural direction of drainage outside the city and away from the central sewered area. The natural drainage is to the Spokane Valley east of the City.

The 478 persons allocated to the Southwest unit are in the southwest corner of the City west of Hangman Creek and, in general, south of 17th Avenue. These unsewered areas are substantially lower than the sewered areas to the north and are naturally tributary to Hangman Creek.

Suburban Areas Outside the City. There are 78,608 persons outside the City but in the suburban area who are served by individual disposal systems. The largest concentration is in the Spokane Valley with a total of 56,492, 50,519 of whom are in the Near Valley unit, that is west of Sullivan Road. The remaining 5,973 in the East Valley unit includes all those from Sullivan Road to the State line and around both Newman and Liberty Lakes.

The next largest concentration is in the North Spokane unit which includes 14,332 persons. The greatest concentration is immediately north of the City limits and east of Five Mile Prairie.

Similarly, the concentrations in the Moran Prairie and Southwest units, totaling 1854 and 1394 respectively are adjacent to the City limits and adjacent to unsewered areas of the City.

Of the 2364 persons in the West Plateau unit, approximately 700 are in and around the community of Airways Heights. There are no other large concentrations.

The Peone Prairie unit accounts for only 534 persons. These appear to be widely scattered without any significant concentrations.

Outside the Urban Planning Area there are two categories served by individual on-site disposal, communities served by a public water system and all others. The population of communities outside the urban area served by public water systems and using individual disposal are listed in Table 29. The total population in this category is approximately 1992.

Individual homes, motels, and resorts make up the category not served by public water supply and using individual disposal. The population in this category is not enumerated. The individual population units are so small and so widely scattered that they have no possibility of becoming elements in any centralized plan. Furthermore, there is no direct method for estimating this population.

There are only seven communities out of 31 outside the urban area that involve 100 or more persons. None contains over 300 persons. Refer to Plate 311-3 for location of these communities. There are three significant groupings. One, along the shores of Long Lake just northwest of the urban planning area, contains four communities totaling 322 persons. A second group of five is also located on Long Lake, but further northwest in the vicinity of Tumtum. This second group contains 208 persons. Another group of four is between Colbert and Chatteroy, north of the urban planning area and contains 104 persons. The remainder are widely scattered throughout the study area, from Diamond Lake in the north to Latah in the south and westward to the gorge west of Little Falls Dam.

Summary

Table 30 summarizes the enumeration of interim and individual service populations including those outside the urban planning area. This total count shows that there are over 95,000 persons in the service area using interim or individual on-site disposal. Of these, 84 percent or 80,000 use individual disposal and 16 percent or 14,400 are served by interim facilities.

Evaluation of Waste Load Represented by Flows to Interim and Individual Disposal

There are no flow or quality data representing these services specifically. The flows and quality must be estimated from data from sewered systems, where available, and from the literature. Unit values have been selected for flow, BOD, total N, Ortho P and total suspended solids as shown in Table 31. Table 31 also shows the application of these unit flow and quality parameters to the populations served to arrive at estimated waste loads of the raw sanitary flows. For the study area as a whole, the estimated flow to interim and individual disposal 2,466 million gallons, or an average of 6.6 mgd. This flow is the equivalent of dry weather flow without infiltration for a sewered system. Over 97 percent of this flow and the associated pollutants are associated with populations living in the urban planning area.

SUMMARY OF WASTE SOURCES

Scope

The foregoing portion of this section presents detailed data on waste sources in the following categories:

1. Sanitary flows to the City of Spokane STP.
2. Industrial flows to the City of Spokane STP.
3. Sanitary flows to communities other than the City of Spokane having collection and treatment facilities.
4. Industrial flows which discharge to the environment other than through the City of Spokane STP.
5. Sanitary flows to interim and individual on-site disposal facilities.

Separate subsections contain detailed data on the potential for wastewater flow from the following sources:

1. Leachate from solid waste disposal.
2. Nutrients carries by soil erosion.
3. Nonpoint and point sources associated with agriculture.
4. Urban runoff.

The purpose of this summary is to combine the findings from this section and the listed subsections to provide an overview of waste sources for the study area.

The subsection on solid waste disposal shows that there is negligible threat to surface waters from solid waste disposal practices. There is some potential for groundwater pollution but the threat cannot be evaluated quantitatively. Therefore, there are no figures for solid waste leachate in any of the summary tables. Similarly, the subsection on agricultural sources, other than soil erosion, shows that there are a few minor threats to surface and groundwater, none of which are quantifiable. Therefore, there are no figures for these small indefinite potentials in the summary tables. A brief summary description of the pollution potential from these sources is included at the close of this summary.

The waste sources associated with soil erosion and urban runoff, although not directly measured for this specific area, are quantified by correlation. These results are included in the summary tables.

The basic summarization data are included in the following tables which are discussed below:

Table Number	Title
32	Summary of Untreated Waste Sources
33	Summary of Waste Flows Currently Reaching Surface Waters, Annually
34	Summary of Waste Flows Currently Reaching Surface Waters, June Through September
35	Summary of Net Discharges to Surface Water Assuming Spokane to Have Secondary Treatment and Phosphorus Removal, Annual, and June Through September
36	Summary of Waste Flows to the Surface of the Primary Aquifer

Total Wastewater Generation

The total average daily wastewater generation for the study area, including all sanitary and industrial sources, is 70.9 mgd. This total does not include urban runoff. Of the 70.9 mgd, 34.1 mgd or 48 percent is of sanitary origin and 36.9 mgd or 52 percent is from industrial sources.

The sanitary component, which includes not only residential flows but sanitary flows from commercial, hospital, hotels, service and other sources, is made up of 24.18 mgd to the City of Spokane STP, 1.87 mgd to other municipalities with collection and treatment facilities, 1.22 mgd to interim facilities and 6.81 mgd to individual on-site disposal. Thus, the flows to the City STP represent 71 percent of the study area sanitary flows. Ninety seven percent of the interim facilities are located in the urban planning area and 97.5 percent of the individual on-site disposal units are in the urban planning area. Therefore, the total sanitary flow within the urban planning area represents 32 mgd or 94 percent of the study area total.

The industrial flow component is dispersed to the environment by four principal routes, through the City STP, through the Spokane Industrial Park STP, by individual facilities to surface waters and by individual facilities to land disposal. Only 3.5 mgd or less than 10 percent of the flow is to the City STP. The pollution load associated with this flow is, as discussed below, proportionately much more significant. The 3.5 mgd to the City STP includes approximately 25 percent uncontaminated cooling water and 5 percent sanitary wastes. The 31.36 mgd of industrial flow that reaches surface waters through individual disposal is dominated by four industries, all of which have large quantities of cooling water in addition to their process wastes. These industries are summarized below:

Industry	Average Annual Basis Total Flow mgd	Cooling Water Component mgd
Hillyard (Sullivan Road)	.545	--
Inland Empire Paper	3.297	1.000
Kaiser (Mead)	3.500	3.310
Kaiser (Trentwood)	24.000	17.497
Other	.027	--
TOTAL	31.363	21.807

This shows that 70 percent of the average annual industrial waste flow individually discharged to surface waters is made up of cooling water.

Industrial waste disposal to land at 1.39 mgd is made up of two components, one of .825 mgd to the surface of the primary aquifer and 0.564 mgd to other areas. The dischargers to the primary aquifer are all in the urban planning area. The dischargers to other land surfaces are remote from the urban planning area. Of the total flow to the surface of the primary aquifer in the urban planning area, more than two thirds is represented by the Kaiser South Mead discharge of 0.568 mgd which is almost entirely cooling water. Other flows in this category which are all or predominantly cooling water include Chembond Corporation at 0.036 mgd, Ideal Cement at .005 mgd. The remainder are predominantly sand and gravel wash waters. Therefore, this category includes a total of approximately .60 mgd of cooling water out of a total of .825 mgd or 73 percent.

The industrial dischargers to land surfaces in remote areas are widely scattered. From a quantity standpoint, Dawn Mining at 0.543 mgd accounts for 97 percent of the total .564 mgd.

Relatively little is known of composition of the flows to the Spokane Industrial Park STP except that the flows include all of the sanitary wastes from the sixty four tenant industries, most of which have no process flows. The cooling water content is unknown and assumed to be negligibly small.

The other major waste bearing flow component shown in Table 32 is urban runoff flows which are collected in City of Spokane combined and separate storm sewers and discharge to the Spokane River. No attempt has been made to evaluate other urban runoff flows collected by the few county storm sewer systems and by the numerous dry wells which percolate into the surface of the primary aquifer. An annual discharge of 2430 million gallons from 20,000 served acres is the estimated present urban runoff discharge to the Spokane River.

For comparison with other flows expressed as an average daily flow, this annual discharge is equal to 6.66 mgd spread over 365 days. That is, the sewered urban runoff from the City is estimated to be approximately 27 percent of the dry weather sanitary discharge from the same area. A very rough estimate could be made of the presently uncollected urban runoff associated with areas served by individual on-site disposal on the basis of this percentage. On this basis, the uncollected urban runoff would be equal to an annual average flow of 2.0 mgd.

The total study area waste flow without urban runoff as shown in Table 32 is 70.93 mgd. Adding the estimated collected and uncollected urban runoff, the study area total becomes 79.59 mgd of which 8.4 percent is presently collected urban runoff and 2.5 percent is uncollected, for a total of 10.9 percent collected and uncollected urban runoff.

If industrial cooling waters are put into a separate category from other industrial waste flows, the summary breakdown of waste flows in the study area shows that sanitary sources are the major pollution bearing flows.

Component	Average Annual Flow, mgd	Percent of Waste Bearing
Sanitary, all sources	34.08	71.5
Industrial waste bearing	13.57	28.5
SUBTOTAL, WASTE BEARING	47.65	
Industrial cooling water	23.28	
TOTAL	70.93	

If this same comparison is made for sanitary, industrial and urban runoff flows presently reaching surface waters, that is excluding all flows presently going to land disposal, the sanitary flows are still the predominant waste bearing flows:

Component	Average Annual Flow, mgd	Percent of Waste Bearing
Sanitary to surface waters	26.05	57
Industrial waste bearing to surface waters	12.78	28
Urban runoff to surface waters	6.66	15
SUBTOTAL, WASTE BEARING	45.49	
Industrial cooling flows to surface waters	22.68	
TOTAL	68.17	

Total Pollution Load

Table 32 summarizes the total waste load of the study area prior to treatment except for certain categories of industrial waste dischargers. The industrial flows to the City of Spokane STP are expressed in terms of the wastes as discharged to the City sewers which is, at present, essentially untreated except for grease traps and similar minor treatment. All of the other industrial flows are as presently discharged to the environment, which may be either treated or untreated.

Table 32 shows that for BOD the predominant load is in the sanitary flows which represent 67 percent of the total. The industrial component is next in importance at 29 percent and urban runoff follows at 4 percent. The industries which are tributary to the City sewer represent practically all of the industrial BOD load although representing less that 10 percent of the total industrial flow. The high BOD inside the City is due to the prevalence of food processing type industries. Outside of the City, the only significant industrial BOD load is Inland Empire Paper.

The nitrogen and phosphorus loads follow a pattern similar to that for BOD with sanitary sources accounting for 86 percent and 84 percent respectively of the totals, exclusive of those contributed by soil erosion. Again, like BOD, the majority of the N and P load is in those industries tributary to the City sewers. On an annual basis, the nitrogen load associated with soil erosion is approximately 42 percent of the load potential from sanitary, industrial and urban runoff combined. The phosphorus potential represented by the annual load from soil erosion is proportionately much lower, being less than 6 percent of the other potential.

The sanitary component that is presently directed to interim facilities and individual on-site disposal is a significant part of the total sanitary waste load. These two elements of the sanitary potential represent approximately 31 percent of the total sanitary.

Current Pollution Load to Surface Waters

Table 33 summarizes the pollution load from all sources presently reaching surface waters on an annual basis. Table 34 presents the same summary restricted to the months of June through September. The June through September period is significant to the performance of Long Lake since this is the period of low flow, following the annual flush by high spring flows, in which temperature stratification and its accompanying phenomena take place. For this reason, summaries are presented for this period under both existing conditions and for conditions which assume proposed secondary treatment and phosphorus removal are acting on current discharges from the City STP.

Tables 33, 34 and 35 are all based on an estimated division of flows through treatment and bypassed without treatment, developed previously in this section. Thus, for both elements of flow which are normally directed to the City of Spokane STP there are two entries in Tables 33, 34, and 35, one for treated flows and one for untreated flows. The estimated removals for the City of Spokane existing primary plant are based on plant records for BOD and upon literature and private communication sources for nitrogen and phosphorus. The estimated loads and removals for the three other municipal facilities that presently discharge significant portions of their annual flow to surface waters are entirely from literature values. Industrial discharges to surface water are from Table 24, converted to annual loads.

Table 33 shows that although separate industrial flows represent 48 percent of the present annual discharge to surface waters, they represent only 3.4 percent of the BOD, 1.8 percent of the N and 4.4 percent of the P reaching surface waters on an annual basis. The largest share of pollution load comes from the treated and untreated sanitary and industrial flows directed to the City of Spokane STP; these flows accounting for 90 percent of the BOD, 53 percent of the N and 84 percent of the P. Urban runoff, both treated and untreated, accounts for 6 percent BOD, 2.5 percent N and 2.5 percent P. Soil erosion, on an annual basis, brings into the Spokane River an estimated 42 percent of the total N load and 9 percent of the total P load. The impact of the three small municipalities is negligible compared with the totals. These results are summarized below:

	Percent of Total Annual Load			
Component	Flow	BOD	N	P
Treated and untreated sanitary and industrial to City STP	42.0	90.3	53.1	83.6
Treated and untreated urban runoff	10.1	6.0	2.6	2.5
Small municipalities	0.3	0.3	0.4	0.6
Separate industrial discharges	47.6	3.4	1.8	4.4
Soil erosion	N.A.	--	42.1	8.9
Totals	100.0	100.0	100.0	100.0

The untreated portion of the sanitary and industrial component due to bypasses and overflows is not a significant proportion of the pollutants BOD, N and P but is a very significant contributor of coliforms. This is not readily quantified, but it would be generally correct to conclude that every time there is a rain event which causes overflow or bypass of combined sewage, coincident with summer flow in the Spokane River, the coliform count in the river will exceed Class A requirements.

Table 34 presents a summary of present loads reaching surface waters in the June through September season. The most notable difference from the annual basis is the elimination of soil erosion as a significant contributor. The net result is an increase in the significance of the sanitary and industrial flows to the City system. A summary by percent of the June-September totals is presented below.

	Percent of June-September Load			
Component	Flow	BOD	N	P
Treated and untreated sanitary and industrial to City STP	45.4	91.7	85.2	91.7
Treated and untreated urban runoff	7.5	4.6	2.9	2.3
Small municipalities	0.3	0.3	0.7	0.5
Separate industrial discharger	46.8	3.4	3.0	5.0
Soil erosion	N.A.	--	8.2	0.5
Totals	100.0	100.0	100.0	100.0

Estimated Pollution Load Due to Present Flows Assuming Secondary Treatment and Phosphorus Removal at City of Spokane STP.

Table 35 summarizes the expected loads that would reach surface waters on an annual and June through September basis for current flow rates assuming the proposed improvements are made to the City of Spokane STP. The secondary treatment removals of BOD and N are from literature values and P removal is taken as 85 percent, the goal set in the proposed improvements. In this analysis, no difference in bypass and overflow occurrence is assumed.

On an annual basis, this proposed improvement will reduce the phosphorus load from the City STP to the point where separate industrial discharges and soil erosion are 38 percent of the total P load. But, on a June through September basis, the City system remains the principal but greatly reduced contributor at 55 percent for the treated portion and 23 percent for the untreated portions. The bypassed and overflowed discharges, although only 6.7 percent of the June-September flow, will contribute 23 percent of the P. The percent contribution of pollutants for the June-September season are summarized below. Because of their increased significance, the bypassed and overflowed portions are listed separately:

	Percent of June-September Load			
Component	Flow	BOD	N	P
Treated sanitary and industrial to City STP	43.3	48.4	75.6	55.5
Untreated sanitary and industrial to City sewers	2.1	23.9	5.6	19.0
Treated urban runoff to City STP	2.9	0.8	1.1	--
Untreated urban runoff to City sewers	4.6	12.4	2.4	4.8
Other municipalities	0.3	1.2	.9	1.6

Component	Flow	BOD	N	P
	Percent of June-September Load			
Separate industrial discharges	46.8	13.3	3.8	55.5
Soil erosion	N.A.	--	10.6	1.6
Totals	100.0	100.0	100.0	100.0

For BOD, when the City sanitary and industrial are treated to secondary level, the untreated urban runoff component begins to have a greater proportionate impact, but is still only 25 percent of the treated sanitary and industrial component. The BOD content of the overflowed sanitary and industrial component contains twice the BOD of the untreated urban runoff.

The treated sanitary and industrial flow from the City STP remains the most significant source of N at 75.6 percent.

Synthesized Phosphorus Content of the Spokane River

From the above summaries, the synthesized phosphorus enrichment of the Spokane River by the effluent of the City of Spokane STP and its associated overflows and bypasses is 206,000 pounds for the June through September period and 620,000 pounds per year, both expressed as total P. These values are equal to 1,689 pounds per day rate for the June through September period and 1,699 pounds per day on a year round basis.

In the September 1973 sampling program, the phosphorus content of the Spokane River upstream from the City of Spokane STP was found to be 82.6 pounds per day average throughout the 48 hour sampling period. Downstream from the City of Spokane STP, during this same sampling period the content was found to be 2,104.4 pounds per day average. The measured daily enrichment was, therefore, 2,022 pounds per day. There were 6 hours of complete bypass and 7 hours of partial bypass caused by stormwater inflows to the combined sewers which should make the measured phosphorus addition higher than the dry weather average. These synthesized values of approximately 1,700 pounds per day appear to be of the correct order of magnitude compared with this data.

A further check is available from the data published by Soltero et al. (1973). Soltero gives average daily total phosphorus content of the Spokane River above, at Fort Wright Bridge and below, at Seven Mile Bridge, of 2.11 and 5.09 tons per day as phosphate. This converts to an average daily addition between this station of 1,945 pounds per day or 710,000 pounds per year as P. Soltero also gives the orthophosphate content of the enrichment as 1.67 tons per day or 398,000 pounds per year. These results also tend to confirm the synthesized values.

The synthesized enrichment for present conditions for the June through September period at 206,000 pounds when applied to the corresponding flow of the Spokane River for the same period results in an average concentration of 0.056 mg/l. If the measured concentration upstream from the City STP at 0.015 mg/l per the September 1973 sampling program or the Soltero yearly average of 0.036 are added, the total contents entering Long Lake would be of the order .071 to .092 mg/l. This is of the same order as Soltero's flow weighted average for Long Lake influent for total organic plus inorganic phosphorus at 0.264 mg/l as PO_4 or 0.086 mg/l as P.

Making a corresponding calculation for the forecast condition after installation of secondary treatment and phosphorus removal by the City of Spokane, the synthesized June through September enrichment is reduced to 50,000 pounds as total P or an average concentration of 0.014. Again adding the upstream concentrations of 0.015 to 0.036 gives synthesized totals reaching Long Lake of from 0.029 to 0.050 mg/l.

The forecast concentrations appear to be above the value of 0.01 mg/l given in the literature as the minimum to trigger nuisance algal blooms.

With the forecast City enrichment reduced to the same order as the apparent upstream contribution, the makeup of the upstream load becomes significant. The industrial contribution estimated at 11,000 pounds for the June through September period is approximately one fifth of the reduced City load of 50,000. It would therefore account for only .003 mg/l of the upstream total of 0.015 to 0.036.

Turning again to the September 1973 sampling program, the phosphorus content at the stateline as the Spokane River enters the study area is found to have an average concentration of 0.021 mg/l. From the USGS-EPA well water sampling program, the average total phosphate content of all primary aquifer wells is found to be 0.017 mg/l. Thus, both the river water as it crosses the state line and the ground waters which add to the river flow have phosphorus concentrations of the same order and which are also of the same order that appear upstream from the City sewage treatment plant outfall. The separate industrial discharges appear to make an addition that is of the order of 20 percent of the background quality.

The estimated total phosphorus content of summer flows entering

Long Lake under present and projected treatment conditions is approximated as follows:

	Present		Projected	
	mg/l	percent	mg/l	percent
Influent river and groundwater	.017	22.3	.017	50.0
Industrial flows	.003	4.0	.003	8.8
City of Spokane STP effluent and overflows	.056	73.7	.014	41.2
TOTAL TO LONG LAKE	.076	100.0	.034	100.0

Summary of Findings on Agricultural Sources

Nonpoint Sources. The only significant nonpoint source in the study area is that associated with soil erosion from the Palouse soil region. This source is quantified and is included in the foregoing summary tables.

Irrigation return flow to surface water is negligible. Percolation to groundwater from irrigated lands is rated a moderate pollution threat in the Spokane Valley and the Little Spokane Valley.

The most significant nonpoint threat from grazing is in actual encroachment into stream waterways by cattle. This condition is most prevalent in the Hangman Creek and Dragoon Creek watersheds.

Point Sources. Animal concentrations in the study area are, with the exception of one egg producer, less than the minimum number requiring an NPDES permit. The larger dairy concentrations are minor threats to surface and groundwater, depending upon the quality of compliance with disposal guidelines being encouraged by the County Health District. The two largest feeder operations are located away from surface waters. In general, there is low potential for significant pollution from animal point sources.

Summary of Findings on Solid Waste Disposal Sites as Potential Pollution Sources

General Municipal Sites. The municipal solid waste disposal sites receiving general refuse offer moderate to low potential for water pollution based on consideration of location relative to hydrogeologic formation, size and method of operation. When these characteristics are combined with the low annual rainfall, the potential is reduced still further.

Industrial Sites. There are five industrial solid waste disposal sites of which three are located on the glacial outwash gravels over the primary aquifer: Kaiser Mead, Kaiser Trentwood, and Spokane Industrial Park.

The gravel pits over the primary aquifer are particularly vulnerable to pollution potential and the primary protection must be in exclusion of materials with putrescible, toxic or bacterially contaminated properties. The Spokane Industrial Park site which is in a gravel pit is rated at moderately high potential. The Kiaser Trentwood site, which is not in a pit, is rated at moderate. No data are available on the Kaiser Mead operation.

Demolition Sites. All four of the sites which receive demolition wastes are in abandoned gravel pits over the primary aquifer and two of the pits extend into the groundwater. All gravel pits are highly vulnerable, and those that extend into the water table could not have a higher potential. The demolition sites rely on control of the materials placed for protection of the groundwater. All four sites and particularly those two extending below groundwater are rated as having high pollution potential.

Septic Tank Pumpage Sites. This material has high pollution potential from oxygen demand, taste and odor, chemical and bacteriological aspects. The septic tank sludge disposal sites are licensed and controlled by the Spokane County Health District.

None of the five specific septic tank sludge sites is over the primary aquifer. The only site to have received some septic tank sludge that is over the primary aquifer is the City's Indian Trail site. The pollution potential from present septic tank disposal sites is rated low.

TABLE 1

WASTE SOURCES CATEGORIES

1. Domestic Wastes

   a. To community sewerage facilities

      1. City of Spokane
      2. Other than Spokane

   b. Not on community sewerage facilities

      1. Discharge to surface waters
      2. Discharge to groundwater

2. Industrial Wastes

   a. On City of Spokane system
   b. Not on City of Spokane system

      1. Discharge to surface water
      2. Discharge to groundwater

3. Urban Runoff

   a. Discharge to combined sewer systems
   b. Separate stormwater systems

      1. Discharge to surface waters
      2. Discharge to groundwater

4. Agricultural Wastes

   a. Diffused or nonpoint sources

      1. From irrigated cropland
      2. From dry cropland
      3. Soil erosion
      4. From pasture operations

   b. Point sources

      1. Animal concentrations
      2. Agricultural processing

TABLE 1 (continued)

5. Miscellaneous Man-Created Wastes

   Solid waste leachates
   Air pollution fallout
   Construction disturbance
   Animal pet wastes

6. Natural Waste Sources

   Vegetation decay
   Animal decay and waste
   Erosion sediments
   Mineral leachates
   Rainfall

TABLE 2

MAJOR INDUSTRIES THAT DISCHARGE TO CITY OF SPOKANE SEWERS

Name of Industry	Kind of Industry: Description	SIC Division	SIC No.	Waste Discharge Permit No.	Listed in Bovay (1974a)
Alladin Metalcraft	Plating	D	3471		No
Alsco Linen Service	Commercial laundry	I	7218	3067	Yes
American Bumper Service	Plating	D	3471		No
American Sign and Indicator	Electric sign manufacturing	D	3699	3075	No
Arden Farms	Dairy products distribution	D	2026		No
Babyland Diaper Service	Diaper service	I	7214		Yes
Beacon Cleaners	Laundry	I	7211		Yes
Becwar Meat Packing	Meat packing	D	2011	3039	Yes
Benewah Creamery	Dairy products	D	2026	3847	No
Bonanza Packing Co.	Meat packing	D	2013		Yes
Burlington-Northern R.R.	Railroad yards	E	4011	3101 & 3964	No
Carnation Company	Dairy products	D	2020	3902	Yes
Centennial Mills (Sprague)	Wheat starch and gluten	D	2046	T-4040	No
Centennial Mills (Trent)	Wheat flour	D	2041		No
Central Heating	Heating plant	E	4961		No
Central Premix Concrete	Concrete redi-mix	D	3273		No
Commercial Creamery	Poultry and egg processing	D	2017	3647	Yes
Crystal Linen	Laundry	I	7213	3066	Yes
Culligan Soft Water Service	Water softener regeneration	I	7399	T-3939	Yes
Darigold (Inland Empire Dairy)	Dairy products	D	2020	3849	Yes

TABLE 2 (continued)

Name of Industry	Kind of Industry: Description	SIC Division	SIC No.	Waste Discharge Permit No.	Listed in Bovay (1974a)
GAF Photo Service	Photo development	I	7395		Yes
Hallstone Dairy	Dairy products	D	2026	3800	No
Heath Eggleston	Food products (salad dressing, etc.)	D	2099		Yes
Hillyard Laundry	Laundry	I	7213		Yes
Hillyard Laundry	Laundry	I	7213		Yes
Holiday Inn	Motel	I	7011		Yes
Hollister Stier Laboratory	Pharmaceuticals	D	2831		Yes
Hygrade Meats	Meat packing	D	2011	2846	Yes
Inland Empire Bottling (Coca Cola)	Soft drink bottling	D	2086		Yes
Inland Empire Plating.	Plating	D	3471		No
ITT Continental Bakery	Bakery	D	2051		Yes
Lilac City Laundry	Laundry	I	7213		Yes
Metallic Arts	Plating	D	3479		Yes
Milky Way Dairy	Dairy products	D	2026		Yes
Mr. Klean Carwash	Car wash	I	7542		Yes
Nalley's	Potato chip manufacturing	D	2099	3191	Yes
Olympic Corn Products	Corn dog manufacturing	D	2099		Yes
Poultry Processors	Poultry processing	D	2016	3454	No
Produce Supply Company	Vegetable washing and preparation	D	2099	4023	Yes
Ralston Purina Company	Animal feed manufacturing	D	2048		Yes

TABLE 2 (continued)

Name of Industry	Kind of Industry			Waste Discharge Permit No.	Listed in Bovay (1974a)
	Description	SIC Division	SIC No.		
S & P Meats	Meat packing	D	2013		Yes
Sacred Heart Medical Center	Hospital	I	8062		Yes
Service Soft Water Cond.	Water softener regeneration	I	7399		Yes
Seven-Up Bottling Company	Soft drink bottling	D	2086		Yes
Smith Nielsen Equipment Co.	Saw grinding and equipment sales	D	3541	3725	No
Speed Queen Laundromats	Laundromat	I	7215		Yes
Spokane Rendering	Rendering plant	D	2077	T-3397	Yes
Spokane Stove Repair	Metal fabrication	D	3444	3074	No
Spokesman Review	Newspaper publisher	D	2711		No
St. Lukes Hospital	Hospital	I	8062		Yes
Troy Laundry	Laundry	I	7218	3102	Yes
Union Pacific R.R.	Railroad yards	E	4011	3599	No
United Dressed Meats	Meat packing	D	2011	3103	No
U.S. Macaroni	Macaroni manufacturing	D	2098		Yes
Victory Plating	Plating	D	3471		No
Washington Water Power	Power distributor	E	4911		Yes
Wayne Photo	Photo development	I	7395		Yes
Western Bottling Company	Soft drink bottling	D	2086		Yes
Western Soap Company	Soap manufacturing	D	2841	3870	No

TABLE 3

COMPONENTS OF THE INDUSTRIAL WASTE FLOW
TO CITY OF SPOKANE SEWERS

Industry	Average Daily Flow, gpd			
	Domestic Flow	Cooling Flow	Process Flow	Total Flow
Alladin	60	400	5,540	6,000
Alsco	3,850	--*	35,330	39,180
American Bumper	30	20	250	300
Arden	300	17,050	13,160	30,510
Babyland	60	--	2,420	2,480
Beacon Cleaners	60	--	3,140	3,200
Becwar	1,050	24,325	24,325	49,700
Benewah Creamery	570	8,000	7,000	15,570
Bonanza	1,200	11,800	75,200	88,200
Burlington	30,300	--	520,200	550,500
Carnation	2,200	11,100	11,400	24,700
Centennial (SP)	450	115,100	365,050	480,600
Centennial (TR)	2,400	--	17,200	19,600
Central Heat	540	--	86,460	87,000
Central Premix	290	--	22,860	23,150
Commercial Creamery	1,110	1,800	17,950	20,860
Crystal	1,500	--	41,560	43,060
GAF	600	--	5,920	6,520
Hallstone	120	570	110	800
Heath Eggleston	240	--	1,820	2,060
Hillyard Laundry	180	--	2,370	2,550
Hillyard Laundry	60	--	560	620
Hollister	2,850	--	34,150	37,000
Hygrade	1,460	295,900	87,300	384,700
Inland Empire Bottling	1,500	--	19,600	21,100
Inland Empire Dairy	1,200	191,000	63,200	255,400
Inland Empire Plating	380	2,540	35,080	38,000
ITT Bakery	4,200	4,490	17,310	26,000
Lilac City Laundry	300	--	3,400	3,700
Metallic Arts	60	400	5,540	6,000

TABLE 3 (continued)

Industry	Average Daily Flow, gpd Domestic Flow	Cooling Flow	Process Flow	Total Flow
Milky Way Dairy	150	18,360	1,890	20,400
Mr. Klean	30	--	5,520	5,550
Nalleys	1,650	--	78,250	79,900
Olympic Corn	240	--	820	1,060
Poultry Processors	1,200	--	150,000	151,200
Produce	750	6,050	24,200	31,000
Ralston Purina	1,500	--	2,640	4,140
S & P Meats	1,470	17,450	8,550	27,470
Servi-Soft	90	--	4,940	5,030
Seven-Up	2,670	4,300	50,700	57,700
Smith & Nielsen	210	--	1,500	1,710
Spokane Rendering	660	--	128,340	129,000
Spokane Stove	500	--	2,700	3,200
Spokesman	54,500	27,000	40,400	121,900
Troy Laundry	330	--	15,550	15,880
Union Pacific	1,800	--	140,550	142,350
United Dressed Meats	1,800	4,000	90,000	95,800
U.S. Macaroni	510	--	4,380	4,890
Victory Plating	30	67	903	1,000
Wayne Photo	630	--	10,890	11,520
Western Bottling	430	--	38,800	39,200
Western Soap	30	1,610	760	2,400
TOTAL	130,300	763,330	2,327,690	3,221,320

*A hyphen (--) means zero or essentially zero.

TABLE 4

SYNTHESIZED ANNUAL DRY WEATHER SEWAGE FLOW FOR THE CITY OF SPOKANE STP

Month	Flow Components, mgd Residential and Commercial	Industrial	Infiltration Inflow	Synthesized Total	Actual Measured STP Flows*
January	18.0	3.5	3.5	25.0	28.12
February	18.0	3.5	3.5	25.0	28.03
March	18.0	3.5	3.5	25.0	28.00
April	21.5	3.5	3.0	28.0	26.21
May	23.5	3.5	2.5	29.5	29.81
June	25.2	3.5	2.0	30.7	30.35
July	25.2	3.5	2.0	30.7	30.65
August	25.2	3.5	2.0	30.7	30.73
September	23.5	3.5	2.5	29.5	29.95
October	21.5	3.5	3.0	28.0	29.17
November	18.0	3.5	3.5	25.0	28.53
December	18.0	3.5	3.5	25.0	28.24
Annual Average	21.3	3.5	2.88	27.68	28.98

*From STP records April 1972 through March 1973 including storm waters that passed through the plant but excluding all bypass flows which are not measured.

TABLE 5

REPRESENTATIVE RAW SEWAGE QUALITY
AT CITY OF SPOKANE STP FROM ALL SOURCES

Parameter	Loading Pounds per Day	Calculated per Capita Pounds per Day[3]	Calculated Concentration Mg/1[4]
BOD	51,100[2]	0.308	221
Suspended Solids	38,100[2]	0.230	165
Total Kjeldahl Nitrogen-N	5,500[1]	0.033	24
Ammonia Nitrogen-N	2,780[1]	0.017	12
Total Phosphorus-P	2,040[2]	0.012	8.8
Filterable Phosphorus-P	1,072[1]	0.006	4.6
Grease	4,000[1,5]	0.024	17.3

[1]Source: Bovay (1973).
[2]Source: Bovay (1974a).
[3]Based on service population of 166,000.
[4]Based on annual average dry weather flow 27.7 mgd.
[5]Based on 4,000 gallons per week at 7 pounds per gallon.

TABLE 6

ESTIMATED POLLUTION LOAD OF INDUSTRIES TRIBUTARY TO (

Industry	Industry Type	Average Daily Waste Flow Gpd	BOD5 Mg/l	BOD5 #/day	COD Mg/l	COD #/day
Alladin	Plating	6,000	8*	0.40*	20*	1.00*
Alsco	Laundry	39,180	485	259	2,707	885
American Bumper	Plating	300	8*	0.02*	20*	0.05*
Arden	Dairy Products	30,510	903*	230*	1,511*	355*
Babyland	Laundry	2,480	430	8 89	1,0[illegible]*	22.33*
Beacon Cleaners	Cleaners	3,200	225	6.00	530	14.14
Becker	Meat Packing	49,700	748	310	2,055	852
Benewah	Dairy Products	15,570	891*	115.7*	1,791*	232*
Bonanza	Meat Packing	88,200	197	145	389	286
Burlington	Railroad	550,500	11.1*	51.0*	27.7*	127*
Carnation	Dairy Products	24,700	795	164	1,050	216
Centennial (SP)	Wheat Starch	480,600	2,500	10,017	4,900	1[illegible],633
Centennial (TR)	Flour	[illegible],600	24.5*	4.01*	61.1*	10.0*
Central Heating	Steam Generation	87,000	1.24*	0.90*	3.10*	2.25*
Central Premix	Redi-Mix Concrete	23,150	2.48*	0.48*	6.26*	1.21*
Commercial Creamery	Dairy Products	20,860	125	21 74	227*	3[illegible].48*
Crystal	La[illegible]ry	43,060	873	314	1,933	695
G.A.F.	[illegible]to Developing	6,520	433	23.0	478	26.0
Hallstone	Dairy Products	800	891*	5.94*	1,791*	11.95*
Heath Eggleston	Food Processing	2,060	33	0.57	97*	1.67*
Hillyard Laundry	Laundry	2,550	331	7.04	83[illegible]*	17.69*
Hillyard Laundry	Laundry	620	49	0.25	123*	0.64*
Hollister	Pharmaceuticals	37,000	250	7[illegible].2	364	112
Hygrade	Meat Packing	384,700	819	2,624	2,055*	6,596*
Inland Empire Bottling	Soft Drinks	21,100	130	22.9	164	28.9
Inland Empire Dairy	Dairy Products	255,400	1,011	2,154	1,972	4,202
Inland Empire Plating	Plating	38,000	8*	2.54*	20*	6.34*
ITT Bakery	Bakery	26,000	399	86.6	1,257	273
Lilac City Laundry	Laundry	3,700	963	29.7	1,438	44.36
Metallic Arts	Plating	6.000	8	0.[illegible]0	20*	[illegible].00*
Milky Way Dairy	Dairy Products	20,400	291	49.49	419	71.26
Mr. Klean	Car Wash	5,550	35	1.62	[illegible]*	4.07*
Malley's	Potato Chips	79,900	515	343	1,287*	858*
Olympic Corn	Corn Dogs	1,060	265	2.34	779*	6.88*
Poultry Processors	Poultry	151,200	680*	857*	741*	934*
Produce Supply	Vegetables	31,000	572	148	1,694	433
Ralston Purina	Animal Feed	4,140	308	10.63	906*	31.27*
S & P Meats	Meat Packing	27,470	166	38.02	374*	85.65*
Servi-Soft	Water Softener	5,030	0	0	0*	0*
Seven-Up	Soft Drink	57,700	772	131	344	166
Smith & Nielsen	Plating and Saw Grinding	1,710	8*	0.11*	20*	0.29*
Spokane Rendering	Rendering	129,000	812	874	2,992	3,221
Spokane Stove	Plating	3,200	8*	0.21*	20*	0.53*
Spokesman	News Paper Publisher	121,900	155*	158*	389*	396*
Troy Laundry	Laundry	15,880	460	61.0	1,222	162
Union Pacific	Railroad	142,350	48.7*	57.9*	122*	145*
United Dressed Meats	Meat Packing	95,800	680*	543*	741*	592*
U.S. Macaroni	Macaroni	4,890	330	13.45	858	34.98
Victory Plating	Plating	1,000	8*	0.07*	20*	0.17*
Wayne Photo	Photo Developing	11,520	119	11.43	134*	12.87*
Western Bottling	Soft Drinks	39,200	690	226	1,020	334
Western Soap	Soap Manufacturing	2,400	200*	4.01*	500*	10.0*
TOTALS		3,221,320		20,243*		42,227*

[1]Figures marked with an asterisk (*) are synthesized based on literature, comparable industries and judgment.
Figures not marked with an asterisk are from available recorded data.

TABLE 6

UTION LOAD OF INDUSTRIES TRIBUTARY TO CITY OF SPOKANE STP

	COD		Waste Parameters[1] Suspended Solids		Total Kjeldahl-N		Phosphate-P		Grease		pH
	Mg/l	#/day	Mg/l	#/day	Mg/l	#/day	Mg/l	#/day	Mg/l	#/day	
10*	20*	1.00*	19*	0.95*	--*	--*	0.08*	0.004*			6.9*
	2,707	385	860	281	22.0	7.17	22.54	7.37	2,370	775	9.7
12*	20*	0.05*	19*	0.05*	--*	--*	0.08*	0.002*			6.9*
	1,511*	355*	134*	34.1*	45.2*	11.50*	14.44*	3.68*			8.2*
39	1,080*	22.33*	84	[illegible]	86.6*	1.79*	31.3	0.647	2,370*	49*	9.1
00	530	14.14	138	3.68	--*	--*	22.9	0.611			10.2
	2,055	852	478	198	75.7*	31.38*	17.84	7.40	25*	10.4*	7.0
*	1,791*	232*	136*	17.65*	44.6*	5.79*	12.09*	1.57*			8.1*
	389	286	112	82.4	20.3*	14.33*	20.46	15.1	25*	18.4*	8.0
0*	27.7*	127*	11.1*	51.0*	2.4*	19.9*	0.60*	2.55*	100*	459*	
	1,050	216	117	24.1	39.8*	8.2*	15.97	3.29			8.7
	4,900	13,633	1,650	6,611	49.9*	200*	0.009*	0.035*			
1*	61.1*	10.0*	24.5*	4.01*	5.3*	86*	1.22*	0.200*			
0*	3.10*	2.25*	1.24*	0.90*	--*	--*	0.06*	0.045*			
8*	6.26*	1.21*	398*	76.8*	--*	--*	0.124*	0.024*			
4	227*	33.48*	42	7.30	8.3*	1.45*	4.0	0.696			9.5
	1,933	695	424	152	19.0*	6.82*	6.35	2.28	2,370*	852*	10.2
	478	26.0	152	8.27	4.0*	.22*	19.6	1.07			7.8
4*	1,791*	11.95*	136*	0.91*	45.0*	.30*	1,209	0.08			8.1*
7	97*	1.67*	10	0.17	--*	--*	0.6	0.010	49*	0.8*	8.0
4	832*	17.69*	169	3.59	6.6*	.14*	6.8	0.145	2,370*	50.4*	9.8
5	123*	0.64*	16	0.17	--*	--*	0.5	0.005	2,370*	12.3*	8.8
	364	112	52	16.1	15.9*	4.89*	1.84	0.57			8.0
	2,055*	6,596*	422	1,355	82.0*	263.0*	8.1	26.0	25*	80.2*	7.8
	164	28.9	593	104	5.7*	1.00*	1.24	0.22			9.5
	1,972	4,202	152	324	50.8*	108.13*	12.91	27.5			7.8
4*	20*	6.34*	19*	6.02*	--*	--*	0.08*	0.025*			6.9*
	1,257	273	411	89.2	14.9*	3.24*	11.50	2.49			8.4
	1,438	44.36	32.8	10.12	19.1	.59	82.4	2.542	2,370*	73.1*	10.1
0	20*	1.00*	19	0.95	--*	--*	0.08	0.004			8.4
9	419	71.26	50	8.50	14.5*	2.47*	5.4	0.918			9.1
2	80*	4.07*	163	7.54	--*	--*	0.6	0.028			8.1
	1,287*	458*	372	248	11.2*	7.45*	0.207*	0.138*	49	32.7	8.4
4	779*	6.88*	140	1.24	--*	--*	1.4	0.012	49*	0.4*	8.0
	741*	934*	365*	460*	68.3*	86.11*	10.88*	13.71*	25*	31.51*	7.8*
	1,694	435	733	190	11.5*	2.96*	4.14	1.07	49*	12.7*	7.7
3	906*	31.27*	93	3.21	31.0*	1.07*	4.3	0.148	49*	1.7*	9.4
2	374*	85.65*	184	42.14	32.2*	[illegible]	6.5	1.489	25*	5.7*	9.2
	0*	0*	44	1.85	--*	--*	0.1	0.004			7.4
	344	166	10	4.81	7.4*	3.58*	1.76	0.85			8.6
1*	20*	0.29*	19*	0.27*	--*	-*	0.08*	.001*			7.0*
	2,992	3,221	2,327	2,505	40.6*	43.7*	7.37	7.93	100*	107.5*	7.1
1*	20*	0.53*	19*	0.51*	--*	--*	0.08*	0.002*			
	389*	396*	155*	158*	19.3*	19.6*	7.79*	7.92*			
	1,222	162	327	43.3	11.3*	1.5*	22.95	3.04	2,370*	314*	11.1
*	122*	145*	48.7*	57.9*	1.5*	1.8*	2.44*	2.90*	50*	59.4*	
	741*	592*	365*	292*	68.8*	54.95*	10.88*	8.69*	25*	20.0*	7.8*
5	858	34.98	343	13.98	12.3*	.5*	1.7	0.069	49*	2.0*	8.1
7*	20*	0.17*	19*	0.16*	--*	--*	0.08*	0.0007*			6.9*
3	134*	12.87*	6	0.58	--*	--*	1.3	0.125			7.6
	1,020	334	29	9.49	6.1*	2.0*	0.81	0.26			9.0
1*	500*	10.0*	200*	4.01*	20.0*	.4*	7,590*	152*			
		42,227*		13,518*		917.78*		307*		2,968*	

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army, Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	ESTIMATED POLLUTION LOAD OF INDUSTRIES TRIBUTARY TO CITY OF SPOKANE STP	TABLE 6

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TABLE 7

ESTIMATED COMPONENTS OF TOTAL RAW WASTE QUALITY, CITY OF SPOKANE STP

Parameter	Total Raw Waste[1] Pounds per Day	Identified Industrial[2] Pounds per Day	Residential Commercial by Difference	
			Daily Load[3] Pounds per Day	Per Capita[4] Pounds per Capita per Day
BOD	51.100	20,200	30,900	0.19
Suspended Solids	38,100	13,500	24,600	0.15
Total Kjeldahl Nitrogen-N	5,500	900	4,600	0.028
Total Phosphorus-P	2,040	310	1,730	0.014
Grease	4,000	3,000	1,000	0.006

[1]From Table 5.
[2]From Table 6 except as noted.
[3]Computed by difference between total and identified industrial.
[4]Computed on the basis of a population of 166,000.

TABLE 8

EXAMPLES OF RAW WASTE PROBLEMS
FROM CITY OF SPOKANE STP RECORDS

Date		Description from "Remarks" Column of Plant Records
March	1, 1973	Heavy black oil--24 hours
	2	Heavy black oil mixed with diesel--most of day
	5	Small quantity black grease--night shift
	6	Small quantity black oil
April	1	Medium quantity of solvent--8 pm
	12	Oil in influent--11:30
May	24	Blood in influent
June	13	Blood or dye--8 pm
	19	Strong solvent odor--8 am
July	4	Green colored influent--9 am
August	3	Diesel oil in influent--6:00
	8	Blood in influent
	21	Strong petroleum odor--7:30
	31	Blood in influent--8 am
September	5	Large quantities of potatoes and green coloring in influent
	6	More potatoes and blood

TABLE 8 (continued)

Date		Description from "Remarks" Column of Plant Records
September	10, 1973	Blood in influent--10:15 pm
	12	Blood in influent--early morning
	15	Blood in influent--4 to 6 am
	19	Blood in influent--8 pm
	27	Blood in influent--7 am
October	2	Gasoline in influent--4 pm
	23	Heavy blood in influent--6 am
	30	Blood in influent--2:15 am
	31	Animal fat in influent--8 am
November	1	Large quantities of blood--2:30 am
	3	Large quantities of blood--6 am and 7:30 am
	7	Blood in influent--2:15 am
	15	Blood in influent--5:15 am
	21	Blood and guts in influent--5 am
December	4	Small quantity of blood
	8	Animal parts in influent--12 mn to 8 am
	12	Fish in bar screen
January	4, 1974	Grease, animal fat, and animal parts in influent--24 hours
	8	Heavy grease--all day shift
	9	Heavy grease--graveyard shift
	10	Heavy grease--all day
	11	Animal fat and grease

TABLE 8 (continued)

Date		Description from "Remarks" Column of Plant Records
January	12, 1974	Animal fat and grease
	13	Animal fat
	21	Solvent odor in influent--pm
	23	Heavy blood in influent--12 mn
	24	Light grease in influent
February	2	Blood and grease in influent--2:15 am
	4	Strong solvent in influent--am
	7	Large quantities of blood, meat and fat--3rd shift
	8	Medium quantities of blood--1st shift
	15	Potatoes and animal fat--6 pm
	16	Grease in influent--12 midnight
	20	Petroleum odor in influent--4 pm
	21	Strong petroleum odor--6 pm
	24	Light blood in influent--8 am
	26	Light blood and animal tissue--12 mn

TABLE 9

EFFLUENT QUALITY, CITY OF SPOKANE STP FROM PLANT RECORDS — MARCH, 1973 TO FEBRUARY, 1974

Month	Flow MGD	BOD_5 Mg/l	BOD_5 Lbs/day	Suspended Solids Mg/l	Suspended Solids Lbs/day	Influent Temp. °F	Total Coliform No./100 ml	Fecal Coliform No./100 ml
March	27.72	174	40,210	65	15,020	58	84,037	49,916
April	27.95	117	27,260	63	14,680	59	56,037	34,600
May	28.70	136	32,540	49	11,720	63	49,700	42,500
June	28.73	121	28,980	53	12,690	67	80,323	32,942
July	33.03	102	28,090	56	15,420	67	111,087	60,152
August	34.15	124	35,300	76	21,640	70	--	--
September	29.68	152	37,610	79	19,550	68	102,050	4,233
October	26.35	205	45,030	85	18,670	64	5,000	3,510
November	27.13	145	32,800	97	21,940	58	2,100	430
December	32.84	102	27,930	77	21,080	54	102,083	13,943
January	28.70	126	30,150	74	17,710	53	70,483	105
February	25.85	171	36,850	75	16,160	54	27,358	2,204
Annual Average	29.24	140	34,130	71	17,310	61	62,751	22,230
Annual Total	10,673 MG*	-	12,460,000 lbs.	—	6,318,000 lbs.	--	--	—

*Million gallons.

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	EFFLUENT QUALITY, CITY OF SPOKANE STP FROM PLANT RECORDS — MARCH, 1973 TO FEBRUARY, 1974	TABLE 9

TABLE 10

EFFLUENT QUALITY, CITY OF SPOKANE STP FROM EPA AND PILOT PLANT SURVEYS*

Source	EPA		Pilot Plant Surveys		
Parameters / Date	9-19-70	9-18-70	1-24-73	1-29-73	2-1-73
Flow, mgd	25.7	26.8	27.9	28.2	27.2
COD, pounds per day	45,386	50,112	—	53,934	41,553
BOD, pounds per day	21,836	22,832	27.689	—	17,313
Suspended Solids, pounds per day	—	16,110	20,476	18,370	22,623

*From Bovey (1973).

TABLE 11

EFFLUENT QUALITY
CITY OF SPOKANE STP
FROM SOLTERO[1]

Parameter	Mean Concentration[2], mg/l
Nitrate-N	0.65
Nitrite-N	0.061
Ammonia-N	10.76
Soluble Organic NH_3-N	0.69
Particulate NH_3-N	3.15
Orthophosphate-PO_4	3.43[3]
Soluble Organic-PO_4	0.78[3]
Particulate-PO_4	0.89[3]

[1]From Soltero, Gasperini and Graham (1973).

[2]Mean of 22 samples taken from 5-6-72 to 3-15-73.

[3]Reported as PO_4 in the referenced report, converted to P here.

TABLE 12

EFFLUENT QUALITY, CITY OF SPOKANE STP
FROM SAMPLING PROGRAM OF SEPTEMBER 18-20, 1973

Parameter	Units	Valve*
Flow	MGD	34.39
Temperature	°C	19.1
Dissolved Oxygen	Mg/1	3.5
BOD_5	Mg/1	71
TDS	Mg/1	381.4
Ortho PO_4 as P	Mg/1	3.46
Total PO_4 as P	Mg/1	5.84
NO_3	Mg/1	0.64
NO_2	Mg/1	0.129
NH_3	Mg/1	13.36
Total N	Mg/1	20.0
Total Coliform	No./100 ml	2,140
Fecal Coliform	No./100 ml	1,009

*Flow weighted means for the period September 18 through September 20, 1973.

TABLE 13

REPRESENTATIVE EFFLUENT QUALITY, CITYOF SPOKANE STP -

Month	Flow		Temperature		Dissolved Oxygen	BOD		Suspended Solids		Total Dissolved Solids		Orthophosph as P	
	MGD	CFS	°F	°C	Mg/1	Mg/1	#/day	Mg/1	#/day	Mg/1	#/day	Mg/1	#/
January	25.0	38.7	53	12	5.0	144	30,000	72	15,000	408	85,000	3.84	8
February	25.0	38.7	54	12	4.8	144	30,000	72	15,000	408	85,000	3.84	8
March	25.0	38.7	58	14	4.7	144	30,000	72	15,000	408	85,000	3.84	8
April	28.0	43.3	59	15	4.5	129	30,000	64	15,000	365	85,000	3.44	8
May	29.5	45.6	63	17	3.6	122	30,000	61	15,000	345	85,000	3.25	8
June	30.7	47.5	67	19	3.4	117	30,000	58	15,000	331	85,000	3.12	8
July	30.7	47.5	67	19	3.2	117	30,000	58	15,000	331	85,000	3.12	8
August	30.7	47.5	70	21	3.1	117	30,000	58	15,000	331	85,000	3.12	8
September	29.5	45.6	68	20	3.5	122	30,000	61	15,000	345	85,000	3.25	80
October	28.0	43.3	64	18	3.8	129	30,000	64	15,000	365	85,000	3.44	80
November	25.0	38.7	58	14	4.5	144	30,000	72	15,000	408	85,000	3.84	80
December	25.0	38.7	54	12	4.8	144	30,000	72	15,000	408	85,000	3.84	80
Annual Average	27.68	42.83	61	16	4.1	130	30,000	65	15,000	368	85,000	3.47	80
Annual Total	10,103*	1,351**	--	--	--	--	10,950,000 lbs.	--	5,475,000 lbs.	--	31,025,000 lbs.	--	292,00

*Million gallons.
**Million cubic feet.

TABLE 13

TIVE EFFLUENT QUALITY, CITYOF SPOKANE STP — DRY WEATHER BASIS

Total Dissolved Solids		Orthophosphate as P		Total Phosphorus as P		Nitrate and Nitrite as N		Ammonia as N		Total Organic Nitrogen as N		Total Coliforms	Fecal Coliforms
Mg/1	#/day	Mg/1	#/day	Mg/1	#/day	Mg/1	#/day	Mg/1	#/day	Mg/1	#/day	Org/100ml	Org/100ml
408	85,000	3.84	800	6.00	1,250	0.77	160	12.5	2,600	8.64	1,800	20,000	10,000
408	85,000	3.84	800	6.00	1,250	0.77	160	12.5	2,600	8.64	1,800	20,000	10,000
408	85,000	3.84	800	6.00	1,250	0.77	160	12.5	2,600	8.64	1,800	20,000	10,000
365	85,000	3.44	800	5.38	1,250	0.69	160	11.2	2,600	7.74	1,800	20,000	10,000
345	85,000	3.25	800	5.08	1,250	0.65	160	10.6	2,600	7.32	1,800	20,000	10,000
331	85,000	3.12	800	4.88	1,250	0.62	160	10.1	2,600	7.02	1,800	20,000	10,000
331	85,000	3.12	800	4.88	1,250	0.62	160	10.1	2,600	7.02	1,800	20,000	10,000
331	85,000	3.12	800	4.88	1,250	0.62	160	10.1	2,600	7.02	1,800	20,000	10,000
345	85,000	3.25	800	5.08	1,250	0.65	160	10.6	2,600	7.32	1,800	20,000	10,000
365	85,000	3.44	800	5.38	1,250	0.69	160	11.2	2,600	7.74	1,800	20,000	10,000
408	85,000	3.84	800	6.00	1,250	0.77	160	12.5	2,600	8.64	1,800	20,000	10,000
408	85,000	3.84	800	6.00	1,250	0.77	160	12.5	2,600	8.64	1,800	20,000	10,000
368	85,000	3.47	800	5.42	1,250	0.69	160	11.3	2,600	7.80	1,800	20,000	10,000
--	31,025,000 lbs.	--	292,000 lbs.	--	456,250 lbs.	--	58,400 lbs.	--	949,000 lbs.	--	657,000 lbs.	--	--

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army, Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	REPRESENTATIVE EFFLUENT QUALITY, CITY OF SPOKANE STP -- DRY WEATHER BASIS	TABLE 13

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TABLE 14

SANITARY WASTE FLOWS FROM MUNICIPAL FACILITIES OTHER THAN THE CITY OF SPOKANE

	Population		Reported Flows, gpd		Estimated Flows, gpd[16]		Available Effluent Qua			
Community	1970 Census	Current Estimated Tributary	Annual Average (AA) or Dry Weather (DW)	Peak Wet Weather	Average Dry Weather	Peak Wet Weather	pH	BOD mg/1	DO mg/1	Settleable Solids mg/1
City of Cheney	6358[3]	8,150[2]	638,000AA	4,500,000	602,000	4,500,000	7.	48	7.3	--
City of Deer Park	1295	1,300	150,000AA 143,000DW	200,000	143,000[4]	200,000	7.2	--	5.3	0.0
Fairchild Air Force Base Main Plant	--	6,700[5]	1,060,000AA 800,000DW	1,500,000	800,000[4]	1,700,000	--	22	--	13
Fairchild Air Force Base Survival School	--	700[6]	NA[15]	NA	39,000[13]	100,000	--	--	--	--
Fairchild Air Force Base Geiger Heights	--	1,000	NA	NA	74,000[14]	150,000	--	--	--	--
Town of Fairfield	469	480	NA	NA	53,000[14,7]	75,000	7.6	20	--	--
Town of Medical Lake	1527[9]	1,800	135,000AA 130,000DW	150,000	130,000	150,000	10.4	29	--	0.1
Town of Millwood	1770[11]	150[11]	10,000AA	15,000	10,000	15,000	7.2	--	1.0	--
Town of Rockford	327	340	NA	135,000	25,000[14]	135,000	--	--	--	--
City of Tekoa	808	850	NA	NA	63,000	100,000	--	--	--	--
Wellpinit Bureau of Indian Affairs	--	80[12]	8,000AA	NA	5,600	10,000	--	36	--	--
TOTALS		21,622			1,945,000					

1. HC=Hangman Creek, LRS=Little Spokane River, SR=Spokane River, NOF=Non-overflow to surface waters, NNOF=Normally non-overflow, but can overflow to designated surface water.
2. Year around average full time equivalent for 6500 permanent residents, plus live-in students at EWSC and student, faculty and staff commuters.
3. Permanent residents only.
4. Containing existing infiltration estimated at equivalent to 35 gpcd.
5. Includes full time equivalent allowance for commuters.
6. Subject to wide fluctuation.
7. Includes allowance for infiltration at 35 gpcd.
8. Flow from lagoons dissipates in receiving stream percolation most of year.
9. Census of Medical Lake without hospital but including Lakeland Village.
10. Overflow reported about 10 days per year to Deep Creek.
11. Less than 15% of to
12. Full time equivalen
13. Estimated 55 gpcd.
14. Estimated 74 gpcd.
15. NA=not available.
16. Selected values ba

WATER RESOURCES STUDY
METROPOLITAN SPOKANE REGIO
Dept. of the Army, Seattle District
Corps of Engineers
Kennedy - Tudor Consulting Enginee

CITY OF SPOKANE

	Estimated Flows, gpd[16]		Available Effluent Quality Data							
ak Wet eather	Average Dry Weather	Peak Wet Weather	pH	BOD mg/l	DO mg/l	Settleable Solids mg/l	COD mg/l	Other Available	Remarks	Ultimate Receiving Waters[1]
500,000	602,000	4,500,000	7.	48	7.3	--	173	Yes	Quality from monthly reports	NNOF-HC[4]
200,000	143,000[4]	200,000	7.2	--	5.3	0.0	--	No	Quality from monthly reports	LSR
500,000	800,000[4]	1,700,000	--	22	--	13	--	No	Quality data from plant operator	NOF
NA	39,000[13]	100,000	--	--	--	--	--	--	No quality data available	NOF
NA	74,000[14]	150,000	--	--	--	--	--	--	No quality data available	NOF
NA	53,000[14,7]	75,000	7.6	20	--	--	70	Yes	See Table 15 for additional quality data	NNOF-HC[8]
150,000	130,000	150,000	10.4	29	--	0.1	196	Yes	See Table 16 for additional quality data	NNOF-SR[10]
15,000	10,000	15,000	7.2	--	1.0	--	--	Yes	Quality data from monthly reports. Chlorine resid.	SR
135,000	25,000[14]	135,000	--	--	--	--	--	--	No quality data available	HC
NA	63,000	100,000	--	--	--	--	--	--	No quality data available	HC
NA	5,600	10,000	--	36	--	--	--	No	All data from Woodward (1971)	NOF
	1,945,000									

erflow to surface waters, NNOF=

lus live-in students at EWSC

r.

11. Less than 15% of town estimated to be served by sewers.
12. Full time equivalent for 50 residents and 220 students.
13. Estimated 55 gpcd.
14. Estimated 74 gpcd.
15. NA=not available.
16. Selected values based on judgment.

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army, Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	SANITARY WASTE FLOWS FROM MUNICIPAL FACILITIES OTHER THAN THE CITY OF SPOKANE	TABLE 14

TABLE 15

TOWN OF FAIRFIELD -- EFFLUENT QUALITY

	Composited Lab Results* (unless otherwise noted)		
	Influent	Effluent	Remarks
Temperature °C*	19.0	23	Field Test
pH*	7.1	7.3	Field Test
Conductivity* umhos/cm	350	400	Field Test
Settleable Solids* ml/l	2.5	0.0	Field Test
pH	7.2	7.6	
Conductivity umhos/cm	640	690	
BOD_5 mg/l	100	20	
COD mg/l	62	70	
T.S. mg/l	398	399	
T.N.V.S. mg/l	265	284	
T.S.S. mg/l	92	37	
N.V.S.S. mg/l	23	3	
Turbidity JTU	40	30	
Total Coliform #/100ml	--	400	
Fecal Coliform #/100ml	--	200	
NH_3-N mg/l	--	6.3	
Total Kjeldahl-N mg/l	--	8.8	

*Source: DOE efficiency report December 11, 1973.
Flow was not measured.

TABLE 16

MEDICAL LAKE -- WASTE FLOW QUALITY*

	Field Data	
	Influent	Effluent
Temperature °C	14.2	22
pH	7.8	10.4
Settleable Solids ml/1	7.9	0.1

	Composited Lab Results	
	Influent	Effluent
BOD_5 mg/1	158	29
COD mg/1	376	196
T.S. mg/1	625	458
T.N.V.S. mg/1	358	265
T.S.S. mg/1	203	128
N.V.S.S. mg/1	21	24
pH	7.4	10.6
Conductivity umhos/cm	850	460
Turbidity JTU	70	56
Total Coliform #/100ml	400**	400**
Fecal Coliform #/100ml	400**	400**

*Source: DOE efficiency report May 16, 1973.
Flow was not measured.

**Coliform count taken without benefit of Cl_2.

TABLE 17

ESTIMATED UNTREATED WASTE LOAD TO MUNICIPAL SEWAGE TREATMENT PLANTS

Community	Service[1] Population	Dry Weather Flow gpcd[3]	Dry Weather Flow mgd[1]	BOD ppcd[6]	BOD #/day	N ppcd[6]	N #/day	P ppcd[6]	P #/day
City of Cheney	8,150[4]	74	0.602	0.15	1,222	.025	204	.007	57
City of Deer Park	1,300	110	0.143[5]	0.15	195	.025	33	.007	9
Fairchild AFB-Main	6,700[4]	119	0.800[5]	0.17	1,139	.029	194	.008	54
Fairchild AFB-Survival	700[4]	55	0.039	0.11	77	.020	14	.005	4
Fairchild AFB-Geiger	(2)								
Town of Fairfield	480	74	0.053	0.14	67	.022	11	.006	3
Town of Medical Lake	1,800	72	0.130	0.15	270	.025	45	.007	13
Town of Millwood	150[4]	66	0.010	0.12	18	.020	3	.005	1
Town of Rockford	340	74	0.025	0.14	48	.022	8	.006	2
City of Tekoa	850	74	0.063	0.15	128	.025	21	.007	6
Wellpinit, BIA	80[4]	70	0.006	0.12	10	.020	2	.005	-
TOTALS	20,622	90.7	1.871	0.153	3,174	.0259	535	.0072	149

[1]From Table 14.
[2]Included with interim plants for summarization.
[3]From Table 14 or calculated from Table 14 values.
[4]Full time equivalent populations allowing for part time residents and commuters as applicable.
[5]Includes existing infiltration.
[6]Literature values modified by judgment.

TABLE 18

WASTEWATER QUALITY DATA FOR INDUSTRIES THAT DISCHARGE TO SURFACE WATERS

	Hillyard (Sullivan)	Inland Empire Paper	Kaiser (Mead)	Kaiser (Trentwood)	Soft Water Service	Spokane Industrial Park
Discharge Location	Spokane River	Spokane River	Deadman (Peone) Creek	Spokane River	Spokane River	Spokane River
Average Daily Discharge GPD	545,000[5]	3,297,000[6]	3,868,000[2]	24,000,000[8]	27,000[9]	545,000[1]
PARAMETERS						
pH	8.5[3]	6.7[6]	8.0[2]	7.2[8]	9.2[10]	8.3[1]
Temperature °C	14[4]	18[6]	23[2]	19[8]	10[1]	12[1]
Conductivity						
Spec umhos/cm	-	403[7]	--	-	-	-
umhos/cm[3]	-	-	344[2]	-	-	-
BOD_5						
mg/1	0.25[4]	47.3	0.39	-	-	5.3[1]
#/day	1.14	1,301[6]	12.6	-	-	24.1
COD						
mg/1	24[4]	132[7]	--	-	-	0[1]
#/day	109	3,630	--	-	-	0
TS						
mg/1	907[3]	125[7]	165[1]	51[8]	16,600[10]	277[1]
#/day	4,123	3,437	5,323	10,208	3,737	1,259
TDS						
mg/1	334[4]	97[7]	164[1]	-	-	250[1]
#/day	1,518	2,667	5,290	-	-	1,136

TABLE 13 (continued)

PARAMETERS	Hillyard (Sullivan)	Inland Empire Paper	Kaiser (Mead)	Kaiser (Trentwood)	Soft Water Service	Spokane Industrial Park
SS						
mg/l	14[3]	28[7]	1.00[1]	-	637[10]	26[1]
#/day	63.6	770	32.3	-	143	118
NH_3-N						
Mg/l	8.0[4]	0[7]	1.46[1]	-	-	3.4[1]
#/day	36.4	0	47.1	-	-	15.5
Kjeldahl N						
mg/l	-	1.21[7]	-	-	-	6.8[1]
#/day	-	33.3	-	-	-	30.9
NO_2-N						
mg/l	-	-	-	-	-	0.20[1]
#/day	-	-	-	-	-	0.91
NO_3						
mg/l	0.8[4]	0.1[7]	1.20[1]	-	-	1.42[1]
#/day	3.64	2.75	38.7	-	-	6.45
PO_4-P						
mg/l	0.02[4]*	0.69[7]*	0.23[1]*	0.30[8]	4.1[10]	5.9[1]*
#/day	0.09	18.9	7.42*	60	0.92	26.8*
Ortho PO_4-P						
mg/l	0[4]*	-	0.22[1]	-	-	-
#/day	0	-	7.10	-	-	-
SO_4						
mg/l	-	47.5[7]	-	-	-	15.7[1]
#/day	-	1307	-	-	-	71.4
Cl						
mg/l	79[4]	16[7]	15.4[1]	-	-	23[1]
#/day	359	440	497	-	-	105

TABLE 18 (continued)

PARAMETERS	Hillyard (Sullivan)	Inland Empire Paper	Kaiser (Mead)	Kaiser (Trentwood)	Soft Water Service	Spokane Industrial Park
CN						
mg/l	-	-	-	-	-	0.01[1]
#/day	-	-	-	-	-	0.05
Total Al						
ug/l	40[4]	-	2[1]	-	-	375[1]
#/day	0.18	-	.06	-	-	1.70
Cr^{+6}						
ug/l	-	-	-	10[8]	-	-
#/day	-	-	-	2.00	-	-
Total Cr						
ug/l	0[4]	10[7]	10[1]	40	-	76[1]
#/day	0	.27	.32	8.01	-	0.35
Total Cu						
ug/l	-	10[7]	30[1]	-	-	128[1]
#/day	-	.27	.97	-	-	0.58
Total Fe						
ug/l	-	-	-	-	-	675[1]
#/day	-	-	-	-	-	3.07
Total Pb						
ug/l	0[4]	10[7]	10[1]	-	-	282
#/day	0	.27	.32	-	-	1.28
Total Mn						
ug/l	-	-	-	-	-	15[1]
#/day	-	-	-	-	-	0.07
Total Hg						
ug/l	0[4]	0.5[7]	5[1]	-	-	0[1]
#/day	0	0.14	.16	-	-	0

TABLE 18 (continued)

PARAMETERS	Hillyard (Sullivan)	Inland Empire Paper	Kaiser (Mead)	Kaiser (Trentwood)	Soft Water Service	Spokane Industrial Park
Total Zn						
ug/1	0[4]	440[6]	100[1]	-	-	165[1]
#/day	0	12.1	3.2	-	-	0.75
Oil & Grease						
mg/1	1.3[4]	-	2.1[1]	3.7[8]	-	6.4[1]
#/day	5.91	-	67.7	741	-	29.1

*Data represents total phosphorus as P.

Note: Whenever parameter concentration and flow were given, mass emission rate was calculated. Whenever mass emission rate and flow were given, parameter concentration was calculated.

Source of Information.

[1]1971 Corps of Engineers permit.
[2]Plant effluent report to DOE (May 1972-November 1973), as specified by DOE Permit 3812 (August 2, 1971).
[3]1971 DOE permit application: average analysis.
[4]1971 DOE permit application: complete analysis.
[5]1971 DOE permit application.
[6]Plant effluent report to DOE (January 1972-June 1973), as specified by DOE Permit T-3835 (April 7, 1972).
[7]1971 Corps of Engineers permit (discharge 002 only).
[8]August 1973 DOE permit application.
[9]From City water records and estimate of process wastes.
[10]City testing.

TABLE 19

WASTE DISCHARGE CHARACTERISTIC REPORTED BY INLAND EMPIRE PAPER[1]

Month	Average Daily Flow mgd[3]	SCS[2] (lb/day)	BOD (lb/day)	pH	Temperature °F	Zn mg/l
January 1972	3.437	772	845			
February	2.762	947	1078			
March	2.919	904	1276			
April	3.209	827	1648	7.2		
May	3.595	1260	1713	6.8		
June	3.895	636	1953	6.7		
July	3.258	894	1253	6.4		
August	3.862	1449	846	6.3	65	0.25
September	3.483	1227	1037	6.5	64	
October	3.183	890	1201	6.5	65	
November	3.215	1177	1383	6.7	64	
December	3.188	673	1536	6.7	63	
January 1973	3.198	645	1486	6.7	63	0.225
February	3.531	894	1493	6.5	64	0.5
March	3.664	1023	1416	6.7	64	0.25
April	3.230	1121	1116	6.7	67	0.06
May	3.242	825	1154	6.6	68	1.158
June	2.472	907	992	6.8	68	0.625
Average	3.297	948	1301	6.7	67	0.44

Average Conc. SCS $= \frac{(948)}{(8.34)(3.297)} = 34.5$ mg/l   Average Conc. BOD $= \frac{(1301)}{(8.34)(3.297)} = 47.3$ mg/l

[1]Source: Reports to DOE.
[2]SCS = Suspended combustible solids.
[3]Average per calendar day for the month, not per working day.

TABLE 20

KAISER TRENTWOOD[1]
ANALYSES OF EFFLUENT DISCHARGED INTO
THE SPOKANE RIVER MAY 23, 1973

Parameter	Quantity	Analytical Method
Total Cr	0.04 ppm	Hach
Cr +6	0.01 ppm	Hach
Grease & Oils	3.7 mg/1	Hexane Extraction
Total Solids	51 ppm	Evaporation
pH	7.2	pH Meter
Temperature	66°F	Thermometer
Flow	16,800 gpm[2]	Flow Transmitter
Phosphate	0.30 ppm	Hach

The above is a typical effluent analysis. The 24-hour composite sample is taken bi-monthly.

[1]Source: Application for discharge permit.

[2]Equal to 24.2 mgd.

TABLE 21

INDUSTRIAL WASTE DISCHARGES TO
LAND OR GROUNDWATER

Name	Type	Location: Surface of Primary Aquifer	Location: Other Areas
ASC Industries, Inc.	Irrigation Pipe	X	
Ace Concrete	Sand & Gravel Readymix	X	
Acme Concrete	Readymix	X	
Central Premix	Sand & Gravel Readymix	X	
Chembond Corp.	Resin Manufacture	X	
Dawn Mining	Uranium Ore Processing		X
Ideal Cement	Cement Distribution	X	
Interpace	Clay Products		X
Kaiser (South Mead)	Coke & Equipment Mfg.	X	
Northwest Tungsten Corp.	Mill		X
Rockford Grain Growers	Grain Storage		X
Triple "E" Meats	Meat Packing	X	
United Paving	Sand & Gravel, Asphalt		X

TABLE 22

INDUSTRIAL WASTE DISCHARGES TO THE SURFACE OF THE PRIMARY AQUIFER

Industry	Location	Waste Discharge Permit		Industry Type	Waste Flows		Characteristics of Waste Flows	Estimated Annual Mass Emission	
		Number	Expiration Date		Max gpd	Aver gpd		Flow mg[3]	Pollutants Pounds[3]
ASC Industries	N. 800 Fancher Way, Spokane	3872	10/26/76	Plastic irrigation pipe mfr.[2]	90,000[1]	45,000[2]	Process wastes limited to 10 mg/1 oil and cooling water.[1] Seasonal operation est. Apr-Sept.[2]	5.94	248 Max. Ext.[6]
Ace Concrete	N. 302 Park Road Spokane 25/44-SW 1/4 18	3693	6/28/76	Sand and gravel readymix [2]	75,000[1]	75,000[2]	From sand and gravel washing. seasonal-160 to 200 days per year[2]	13.5	Unknown turbidity
Acme Concrete	E. 5203 Broadway Spokane 25/43-4	2908	2/ 1/73	Readymix[2]	10,000[1]	10,000[3]	Settled wash water seasonal. Low level in winter[2]	1.8	Unknown turbidity
Central Premix	Ft. Wright 25/42-NW 1/4 14	3879	10/13/76	Sand and gravel readymix[2]	322,640[1]	288,000[2]	From sand and gravel washing. Seasonal 195-220 days per year[2]	57.6	Unknown turbidity
Chembond Corp	Spokane Industrial Park	2826	11/ 3/72	Resin manufacture[2]	108,000[1]	36,000[2]	Cooling water	9.36	None[5]
Ideal Cement	E. 12207 Empire Millwood 25/44-4	3869	9/27/76	Cement distribution terminal[2]	9,600[1]	4,800[2]	Cooling water	1.25	None[5]

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	INDUSTRIAL WASTE DISCHARGES TO THE SURFACE OF THE PRIMARY AQUIFER	TABLE 22

TABLE 22 (continued)

Industry	Location	Waste Discharge Permit		Industry Type	Waste Flows		Characteristics of Waste Flows	Estimated Annual Mass Emission	
		Number	Expiration Date		Max gpd	Aver gpd		Flow mg	Pollutants Pounds
Kaiser (South Mead)	Mead 26/43-21	3129	2/ 7/74	Coke and heavy equipment mfr[4]	7,700,000[1]	568,000[4]	Cooling water	204.5	None[5]
Triple "E" Meat	E. 10420 Jackson Spokane	3878	11/10/76	Meat Packing[2]	2,200[1]	1,600[2]	Washdown water limited to 150 mg/l grease	0.42	350 Hex. Ext.[6] 700 BOD

[1]Source, DOE permit.

[2]Source, application for DOE permit.

[3]Estimated.

[4]Letter, Kaiser to Kennedy-Tudor 7 March '74.

[5]None except temperature rise which is unknown.

[6]Hexane extractable oil and grease.

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army, Seattle District Corps of Engineers Kennedy – Tudor Consulting Engineers	INDUSTRIAL WASTE DISCHARGES TO THE SURFACE OF THE PRIMARY AQUIFER	TABLE 22 (cont.)

TABLE 23

INDUSTRIAL WASTE DISCHARGES TO LAND ABOVE BASALT AND OTHER AQUIFERS

Industry	Location	(4)	Waste Discharge Permit		Industry Type	Waste Flows		Characteristics of Waste Flows	Estimated Annual Mass Emission	
			Number	Expiration Date		Max gpd	Aver gpd		Flow Mg^3	Pollutants Pounds
Dawn Mining	3/4 mile west of Ford 28/39-25	CH	3216	10/22/74	Uranium[2] ore concentration plant	650,000[1]	542,800[2]	Unknown	163	Unknown
Northwest Tungsten	North of Clayton 30/42-16	LS	3915	11/26/76	Metals mill[2]	9,600[2]	9,600[2]	Unknown	1.5	Unknown
Rockford Grain Growers	Rockford	B	2875	11/22/72	Fertilizer and agricultural chemical salts[2]	1,000[1]	1,000	Contains unknown amounts of fertilizer and pesticides	.06	Unknown
United Paving	Near Geiger Field 25/42-28 and 33	B	3111	2/ 9/74	Sand and gravel	40,000[1]	Unknown	Containing silt and other fines from sand and gravel washing	4.8	Unknown,

[1]Source: DOE permit.
[2]Source: Application for DOE permit.
[3]Estimated.
[4]B = Basalt Aquifer, CH = Chamokane Watershed, LS = Little Spokane Watershed.

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	INDUSTRIAL WASTE DISCHARGES TO LAND ABOVE BASALT AND OTHER AQUIFERS	TABLE 23

TABLE 24

SUMMARY OF ESTIMATED INDUSTRIAL WASTE DISCHARGES OTHER THAN TO CITY OF SPOKANE STP

Present Disposal	Industry	Flow Average Mgd	BOD Average Pounds per Day	N Average Pounds per Day	P Average Pounds per Day	Remarks
Surface Waters	Hillyard (Sullivan)	.545	neg.	40	neg.	(1)
	Inland Empire Paper	3.297	1,301	33	20	
	Kaiser (Mead)	3.500[2]	12	85	7	(3)
	Kaiser (Trentwood)	24.0	25	15	60	
	Soft Water Service	.027	—	—	—	(4)
	SUBTOTAL	31.363	1,338	173	87	
	Spokane Industrial Park	.60	24	39	27	
SUBTOTAL		31.963	1,362	212	114	
Land-Primary Aquifer	ASC Industries	.014[5]	—	—	—	
	Ace Concrete	.037[6]	—	—	—	
	Acme Concrete	.005[7]	—	—	—	
	Central Premix	.158[8]	—	—	—	
	Chembond Corp	.036	—	—	—	(9)
	Ideal Cement	.005	—	—	—	(9)
	Kaiser (South Mead)	.568	—	—	—	(10)
	Triple E Meat	.002	neg.	—	—	
SUBTOTAL		.825				
Land-Other	Dawn Mining	.543	—	—	—	
	Northwest Tungsten	.004[11]	—	—	—	
	Rockford Grain Growers	—[12]	—	—	—	(13)
	United Paving	.017[14]	—	—	—	
SUBTOTAL		.564				
TOTAL		33.352	1,362	212	114	

[1]Other important parameters are chloride and fluoride

[2]Annual average based on 5.0 mgd mid-May to mid-September and 2.7 mgd remainder.

[3]Also high chlorides and temperature.

[4]Primarily a high chloride waste.

[5]Annual average. 45,000 gpd rate when operating May through September.

[6]Annual average. 75,000 gpd in 180 day season.

[7]Annual average. 10,000 gpd in 180 day season.

[8]Annual average. 288,000 gpd in 200 day season.

[9]All cooling water

[10]All cooling water except minor sanitary component.

[11]Annual average for 9,600 gpd in 160 day season

[12]Annual average is negligible. 1,000 gpd for 180 day season.

[13]Wastes from washing fertilizer and pesticide tanks.

[14]Annual average for 40,000 gpd for 160 day season.

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army, Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	SUMMARY OF ESTIMATED INDUSTRIAL WASTE DISCHARGES OTHER THAN TO CITY OF SPOKANE STP	TABLE 24

TABLE 25

INTERIM FACILITIES INVENTORY

ID No.	Name	Geographical Units							
		North Spokane	Peone Prairie	Near Valley	East Valley	Moran Prairie	South-west	West Plateau	Out-side
1	Aloha Addition			126					
2	Balfour Apartments			126					
3	Belle Terre			42					
4	Camelot Addition	114							
5	Camlu Apartments			45					
6	Castle Addition			123					
7	Chattaroy Valley Mobile Estates								42
8	Conifer Village			192					
9	Crescent at University City			150					
10	Fairwood Additions	3,157							
11	Geiger Heights Housing						1,030		
12	Glennaire Terrace					270			
13	Golden Acres North Mobile Home Park			48					
14	Good Samaritan Home				350				
15	Hangman Hills								21

TABLE 25 (continued)

ID No.	Name	Geographical Units							
		North Spokane	Peone Prairie	Near Valley	East Valley	Moran Prairie	South-west	West Plateau	Out-side
16	Hill View Estates			348					
17	Holiday Hills (Recreation)				356				
18	Holiday Hills (Ski)				400				
19	Hutton Settle., Inc.			55					
20	Kraft Apartments			114					
21	Lamplighter Lodge			440					
22	La Petite Ville Mobile Home Park	85							
23	Liberty High School								196
24	Liberty Lake Utilities				280				
25	Lidgerwood	1,500[2]							
26	Manorville Apartments			102					
27	Mater Cleri Seminary								40
28	Mica Peak AFS								15
29	Mt. Spokane Chair Lifts								10
30	N. Cedar Drive-In Theater	18							

TABLE 25 (continued)

ID No.	Name	Geographical Units							
		North Spokane	Peone Prairie	Near Valley	East Valley	Moran Prairie	South-west	West Plateau	Out-side
31	Northwest Terrace	900[2]							
32	Opportunity Convalescence Center			150					
33	Opportunity Terrace Estate			90					
34	Painted Hills Subdivision			105					
35	Panorama Terrace	18[2]							
36	Pines Manor			100					
37	Pines Terra			108					
38	Pines Townhouses			64					
39	Pine Villa Apartments	150							
40	Ponderosa Apartments			291					
41	Regal Village					50			
42	Rainbow Heights Mobile Home Park							68	
43	River Rose Mobile Home Park				235				
44	Rooney's Mobile Home Park						68		
45	S & J Apartments			75					

TABLE 25 (continued)

ID No.	Name	Geographical Units: North Spokane	Peone Prairie	Near Valley	East Valley	Moran Prairie	South-west	West Plateau	Out-side
46	Sandy Beach Resort				92				
47	Spokane Police Academy			7					
48	Stoneridge Apartments			135					
49	Stoneridge Apartments			123					
50	Survival School Fairchild AFB							750[1]	
51	Sunrise North Apartments			144					
52	Ted Gunning Apartments			50					
53	Timberlane Developments			87					
54	University City Shopping Center			30					
55	Upper Columbia Academy								150
56	Valley Commons Apartments			153					
57	Valumart Store			5					
58	Whitworth College	1,200							
59	Young Shopping Center					10			
	TOTAL	7,142	0	3,628	1,713	330	1,098[1]	68[1]	474

[1]Survival School of Fairchild AFB is listed but not included in totals since it is currently being transferred to Fairchild AFB main plant.

[2]Facilities inside the City of Spokane.

TABLE 26

INTERIM FACILITIES INSIDE THE CITY OF SPOKANE

Number	Name	Population Present	Population Design	Ultimate Disposal
25	Lidgerwood	1,500	2,300	NOF
31	Northwest Terrace	900	1,800	SR
	Pacific Park	*	140	NOF
35	Panorama Terrace	18	210	NOF
	Sundance Hills	*	480	
Subtotal--North Spokane Area		2,418	4,930	
47	Spokane Police Academy	7	7	SR
	TOTALS	2,425	4,937	

*Under construction in 1974.

TABLE 27

SUMMARY OF POPULATIONS SERVED BY INTERIM FACILITIES

Geographical Unit	Number of Facilities	Population Served: Inside the City	Outside the City	Total
North Spokane	9	2,418	4,724	7,142
Peone Prairie	0	0	0	0
Near Valley	29	7	3,621	3,628
East Valley	6	0	1,713	1,713
Moran Prairie	3	0	330	330
Southwest	2	0	1,098	1,098
West Plateau	1	0	68	68
Subtotal, Suburban	50	2,425	11,554	13,979
Outside Urban Area	7	0	474	474
	57	2,425	12,028	14,453

TABLE 28

ESTIMATED POPULATION OF AREAS SERVED BY INDIVIDUAL ON-SITE DISPOSAL AND INTERIM FACILITIES IN URBAN PLANNING AREA

Area	Total Population			Population Served by Interim Facilities			Population Served by Individual On-Site Facilities		
	Within City Limits	Outside City Limits	Total	Within City Limits	Outside City Limits	Total	Within City Limits	Outside City Limits	Total
North Spokane	3,578	19,056	22,634	2,418	4,724	7,142	1,160	14,332	15,492
Peone Prairie	0	534	534	0	0	0	0	534	534
Near Valley	1,533	52,614	54,147	7	3,621	3,628	1,526	48,993	50,519
East Valley	0	7,686	7,686	0	1,713	1,713	0	5,973	5,973
Moran Prairie	0	2,184	2,184	0	330	330	0	1,854	1,854
Southwest	478	2,492	2,970	0	1,098	1,098	478	1,394	1,872
West Plateau	0	3,432	2,432	0	68	68	0	2,364	2,364
Subtctal Unsewered	5,589	86,998	92,587	2,425	11,554	13,979	3,164	75,444	78,608
City Sewered Area	168,804	0	168,804						
Fairchild AFB	0	5,500	5,500						
Subtotal Sewered	168,804	5,500	174,304						
Total, Urban Area	174,393	92,498	266,891						

TABLE 29

COMMUNITIES OUTSIDE THE URBAN PLANNING AREA
SERVED BY INDIVIDUAL DISPOSAL SYSTEMS

Identification Number	Community	Approximate Service Population
1	Airway Heights	(1)
2	Balmer Gardens	30
3	Bunch Estates (Stevens County)	60
4	Camp Diamond (Pend Oreille County)	150
5	Carmel Estates	16
6	Cayuse Cove (Lincoln County)	42
7	Cedar Knolls	7
8	Chattaroy Hills	244
9	Conrad's Development (Lincoln County)	56
10	Elk	20[2]
11	Fairway Addition	(1)
12	Feltons Addition	20
13	Four Lakes	200
14	Glenrose	27
15	Glines	12
16	Half Moon Ranchos	21
17	Koontz's Squaw Canyon Development (Lincoln County)	40
18	Latah	169
19	Marshall	74
20	North Glen Estates	25
21	North Mountain View	18
22	Panorama Acres	40
23	Peace Farm (commune)	50
24	Prairie Pines	10
25	Rivilla	(1)
26	Spangle	212
27	Spokane Lake Park	6
28	Stonelodge (Stevens County)	140
29	Stonelodge 1st Addition (Stevens County)	158
30	Strong and Turosky (Stevens County)	22

TABLE 29 (continued)

Identification Number	Community	Approximate Service Population
31	Sunshine Shores (Stevens County)	80
32	Velview Estates	(1)
33	Waterview Terrace	16
34	Waverly	9[2]
35	West Shore	18
36	Deborah Addition[3]	
37	Hidden Hollow[3]	
38	Loughbon Bay[3]	
39	Rinker-Bolenus Development (Lincoln County)[3]	
	TOTAL	1,992

[1]Accounted as suburban in Table 28.

[2]Public water system serves only portion of community.

[3]New developments intended to have public water supply, but no data available, population negligible in 1973.

TABLE 30

SUMMARY OF POPULATIONS SERVED BY INTERIM FACILITIES AND INDIVIDUAL ON-SITE DISPOSAL

Kind of Facility	Area Served	Service Population	
INTERIM FACILITY	Within City of Spokane	2,425	
	North Spokane	4,724	
	Spokane Valley	5,334	
	Other suburban	1,496	
	Outside the urban area	474	
	Subtotal Interim		14,453
INDIVIDUAL ON-SITE	Within City of Spokane	3,164	
	North Spokane	14,332	
	Spokane Valley	54,966	
	Other suburban	6,146	
	Communities outside the urban planning area	1,992	
	Isolated rural	Not evaluated	
	Subtotal Individual		80,600
TOTAL INTERIM AND INDIVIDUAL ON-SITE			95,053

TABLE 31

ESTIMATED UNTREATED WASTE LOAD TO INTERIM AND INDIVIDUAL ON-SITE DISPOSAL

Element	Criteria		Units	Interim			Individual			Interim Plus Individual		
	Inside UPA	Outside UPA		Inside UPA	Outside UPA	Subtotal	Inside UPA	Outside UPA	Subtotal	Inside UPA	Outside UPA	Total
Population				13,979	474	14,453	78,608	1,992	80,600	92,587	2,466	95,053
Flow	85 gpcd	65 gpcd	mgd	1.188	.031	1.219	6.682	.129	6,811	7.870	.160	8.030
BOD	0.16 pcd	0.14 pcd	#/day	2,237	66	2,303	12,577	279	12,856	14,814	345	15,159
Total Organic-N	0.030 pcd	0.028 pcd	#/day	419	13	432	2,358	56	2,414	2,777	69	2,846
Total Phosphate-P	0.008 pcd	0.007 pcd	#/day	112	3	115	629	14	643	741	17	758
Total Suspended Solids	0.15 pcd	0.13 pcd	#/day	2,097	62	2,159	11,791	259	12,050	13,888	321	14,209

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	ESTIMATED UNTREATED WASTE LOAD TO INTERIM AND INDIVIDUAL ON-SITE DISPOSAL	TABLE 31

TABLE 32

SUMMARY OF UNTREATED WASTE SOURCES

Component	Average Daily Basis				Annual Basis			
	Flow	Pollutants Pounds Per Day			Flow	Pollutants Thousands of Pounds		
	mgd	BOD	N	P	Millions of Gallons	BOD	N	P
Sanitary Sewage								
To City of Spokane STP	24.18[1]	30,900[2]	4,600[2]	1,730[2]	8,826	11,279	1,679	631
To Other Municipal STP	1.87[3]	3,174[3]	535[3]	149[3]	683	1,159	195	54
To Interim Facilities	1.22[4]	2,303[4]	432[4]	115[4]	445	841	158	42
To Individual Disposal	6.81[4]	12,856[4]	2,414[4]	643[4]	2,486	4,692	881	235
SUBTOTAL SANITARY	34.08	49,233	7,981	2,637	12,440	17,971	2,913	962
Industrial Wastes								
To City of Spokane STP	3.5[1]	20,200[2]	900[2]	310[2]	1,278	7,373	329	113
To Spokane Industrial Park STP	.60[5]	24[5]	39[5]	27[5]	219	9	14	10
Individual to Surface Water	31.36[5]	1,338[5]	173[5]	87[5]	11,446	488	63	32
Individual to Land Disposal	1.39[5]	—	—	—	507	—	—	—
SUBTOTAL INDUSTRIAL	36.85	21,562	1,112	424	13,450	7,870	406	155
SUBTOTAL SANITARY PLUS INDUSTRIAL	70.93	70,795	9,093	3,061	25,890	25,841	3,319	1,117

TABLE 32 (continued)

Component	Average Daily Basis				Annual			
	Flow	Pollutants Pounds Per Day			Flow Millions of	Pollutants Thousands of Pounds		
	mgd	BOD	N	P	Gallons	BOD	N	P
Urban Runoff								
To City Collection Systems					2,430[6]	1,000[7]	90[7]	20[7]
SUBTOTAL SANITARY, INDUSTRIAL AND URBAN RUNOFF					28,320	26,841	3,409	1,137
Soil Erosion								
Hangman Creek and Deep Creek-Coulee Creek					N.A.[8]	N.A.[8]	1,440[9]	64[10]
TOTAL ALL SOURCES						26,841	4,849	1,201

[1]From Table 4. Infiltration of 2.88 mgd included in sanitary component.
[2]From Table 7.
[3]From Table 17.
[4]From Table 31.
[5]From Table 31.
[6]From Table 14 of Urban Runoff.
[7]From Table 13 of Urban Runoff.
[8]Not applicable.
[9]From Table SE-6 of Soil Erosion increased 15% to include Deep Creek-Coulee Creek.
[10]From Table SE-6 of Soil Erosion converted to as P rather than PO_4 and increased 15% to include Deep Creek-Coulee Creek.

TABLE 33

SUMMARY OF WASTE FLOWS CURRENTLY REACHING SURFACE WATERS, ANNUALLY

Component	Allocations				Net to Surface Waters			
	Flow MG[1]	Pollutants, TP[2]			Flow MG[1]	Pollutants, TP[2]		
		BOD	N	P		BOD	N	P
Total dry weather sanitary and industrial to City collection system	10,104	18,652	2,008	744				
Portion that is treated	9,628	17,773	1,913	708				
Estimated removals, primary	—	31.4%	10%	20%				
Net treated to surface waters	9,628	12,192	1,722	566	9,628	12,192	1,722	566
Portion that goes to surface waters untreated	476	879	95	36	476	879	95	36
Total urban runoff to combined and separate sewers	2,430	1,000	90	20				
Portion that is treated	950	391	35	8				
Estimated removals, primary	—	31.4%	10%	20%				
Net treated to surface waters	950	268	32	6	950	268	32	6
Portion that goes to surface waters untreated	1,480	609	55	12	1,480	609	55	12

TABLE 33 (continued)

Component	Allocations				Net to Surface Waters			
	Flow	Pollutants, TP			Flow	Pollutants, TP		
	MG	BOD	N	P	MG	BOD	N	P
Total other municipal to surface waters[3]	79	124	21	6				
Estimated removals	—	67%	29%	33%				
Net to surface waters	79	41	15	4	79	41	15	4
Industrial wastes to surface waters					11,446	488	63	32
SUBTOTAL					24,059	14,477	1,982	656
Soil Erosion					—	—	1,440	64
TOTAL					24,059	14,477	3,422	720

[1]MG = millions of gallons.

[2]TP = thousands of pounds

[3]Includes Deer Park, Millwood and Tekoa only.

TABLE 34

SUMMARY OF WASTE FLOWS CURRENTLY REACHING SURFACE WATERS, JUNE THROUGH SEPTEMBER

Component	Allocations				Net to Surface Waters			
	Flow	Pollutants, TP[2]			Flow	Pollutants, TP[2]		
	MG[1]	BOD	N	P	MG[1]	BOD	N	P
Total dry weather sanitary and industrial to City collection system	3,700	6,217	669	248				
Portion that is treated	3,526	5,925	638	236				
Estimated removals, primary	—	31.4%	10%	20%				
Net treated to surface waters	3,526	4,065	574	189	3,526	4,065	574	189
Portion that goes to surface waters untreated	174	292	31	12	174	292	31	12
Total urban runoff to combined sewers	608	250	22	5				
Portion that is treated	238	98	9	2				
Estimated removals, primary	—	31.4%	10%	20%				
Net treated to surface waters	238	67	8	2	238	67	8	2
Portion that goes to surface waters untreated	370	152	13	3	370	152	13	3
Total other municipal to surface waters[3]	26	41	7	2				
Estimated removals	—	67%	29%	33%				
Net to surface waters	26	14	5	1	26	14	5	1

TABLE 34 (continued)

Component	Allocations Flow MG	Allocations Pollutants, TP BOD	N	P	Net to Surface Waters Flow MG	Net to Surface Waters Pollutants, TP BOD	N	P
Industrial wastes to surface waters					3,815	163	21	11
SUBTOTAL					8,149	4,753	652	218
Soil erosion					--	--	58	1
TOTAL					8,149	4,753	710	219

[1]MG = millions of gallons.

[2]TP = thousands of pounds.

[3]Includes Deer Park, Millwood, and Tekoa only.

TABLE 35

SUMMARY OF NET DISCHARGES TO SURFACE WATER
ASSUMING SPOKANE TO HAVE SECONDARY TREATMENT AND PHOSPHORUS REMOVAL
ANNUAL AND JUNE THROUGH SEPTEMBER

Component	Annual Discharge				Discharge June-September			
	Flow MG[1]	Pollutants, TP[2]			Flow MG[1]	Pollutants, TP[2]		
		BOD	N	P		BOD	N	P
City sanitary and industrial flow								
Net treated to surface waters	9,628	1,777	1,243	106	3,526	592	415	35
Portion that goes to surface waters untreated	476	879	95	36	174	292	31	12
Total urban runoff to combined sewers								
Net treated to surface waters	950	39	23	1	238	10	6	0
Portion that goes to surface waters untreated	1,480	609	55	12	370	152	13	3
Total other municipal to surface waters[3]	79	41	15	4	26	14	5	1
Industrial wastes to surface waters	11,446	488	63	32	3,815	163	21	11
SUBTOTAL	24,059	3,833	1,494	191	8,149	1,223	491	62
Soil erosion	—	—	1,440	64	--	--	58	1
TOTAL	24,059	3,833	2,934	255	8.149	1,223	549	63

[1]MG = millions of gallons.
[2]TP = thousands of pounds.
[3]Includes Deer Park, Millwood, and Tekoa only.

LIST OF REFERENCES

Bovay Engineers, Inc. 1972. Comprehensive water and sewerage planning study, Spokane County Washington.

Bovay Engineers, Inc. 1974a. Proposed system for user charges and industrial cost recovery. City of Spokane, Washington, wastewater treatment plant expansion. K-T #566

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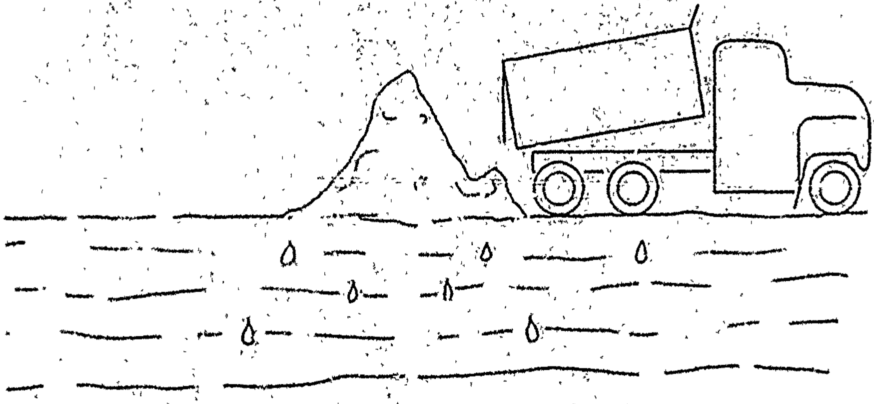
Soltero, R., Gasperino, A., and Graham, W. 1973. An investigation of the cause and effect of eutrophication in Long Lake, Washington. Eastern Washington State College, Cheney. K-T #88



SECTION 312.5

SOLID WASTE DISPOSAL SITES AS POTENTIAL POLLUTION SOURCES

WATER RESOURCES STUDY

METROPOLITAN SPOKANE REGION

SECTION 312.5

SOLID WASTE DISPOSAL SITES AS POTENTIAL POLLUTION SOURCES

25 April 1974

Department of the Army, Seattle District
Corps of Engineers
Kennedy-Tudor Consulting Engineers

INDEX

SOLID WASTE DISPOSAL SITES AS
POTENTIAL POLLUTION SOURCES

Objectives

The objective of this section is to collect those facts about present solid waste disposal practice in the study area which will form the background for evaluation of existing or potent al effect on water quality. Specific steps toward this objective include preparation of an inventory of existing solid waste disposal sites, both active and inactive, and relating those sites to geological formations and groundwater occurrence. Also included are descriptions of present methods of disposal, particularly as they relate to the access of water to and from the solid wastes.

The scope of this section includes a survey of state law governing solid waste disposal and the steps being taken by county and city governments in the service area to implement that law and formulate policy for future solid waste management.

The evaluation of solid wastes storage, service areas, collection and transportation are not within the scope of this study.

Overview of Solid Waste Disposal Practice in the Study Area

Except for minor amounts of salvage for reuse or recycling, solid waste disposal in the study area is by landfill, in all classifications ranging from controlled sanitary landfills to uncontrolled open dumps. Until air pollution control requirements prohibited open burning or uncontrolled incineration, most solid waste disposal in the study area involved a combination of burning combustibles and landfill of the residue and incombustibles.

The State Solid Waste Management Act, discussed in more detail below, was passed in 1971. In general, only the planning phase of the requirements of this legislation have been met at this date. All counties in the study area except Lincoln County have prepared comprehensive solid waste management reports which include descriptions of the practices at the time of report preparation as well as plans and policy for the future. Some changes in practice have been made since the preparation of these reports, and the near future will see more as the counties move toward implementation of the new plans. This state of transition should be kept in mind in referring to the comprehensive plan reports listed below:

Area	Report Coverage
Spokane County including City of Spokane	Spokane County Engineer, Spokane City Engineer, 1971: Spokane County Coordinated Comprehensive Solid Waste Management Plan.
Pend Oreille and Stevens Counties	Trico Economic Development District, 1972: A Comprehensive Solid Waste Management Plan Prepared for Ferry County, Pend Oreille County, Stevens County.
Whitman County	Environmental Data Center, 1971: A Comprehensive Solid Waste Management Plan for Whitman County, Washington.

Reference should be made to the above reports for those aspects of solid waste management that are not within the scope of this study such as storage, service areas, collection, transportation and financial management. For discussion of the future plans in these reports, see the paragraph below titled Solid Waste Management Policy.

Since over 99 percent of the population of the study area resides in Spokane County, the summary of solid waste volume for Spokane County is essentially that of the study area. The following paragraph from Plan of Action, Appendix (Spokane River Drainage Policy Committee, 1972) summarizes the solid waste generation for Spokane County within the study area:

> "The total solid wastes produced in the zone is estimated at over 1,800,000 cubic yards (or 270,000* tons) annually. Wastes from homes, businesses, and institutions constitute the largest single source, accounting for 82% of the total. The remaining 18% is generated by industry. About three-fourths of the solid wastes from residential/commercial comes from the City of Spokane, with the rest divided equally between the East Valley area and the remainder of the county. About 36% of the industrial solid waste total is generated in the city, 36% in the valley, and 28% in the rest of the county."

Relation of Solid Waste Disposal to Water Quality

Land disposal of solid wastes in the study area ranges from uncontrolled open refuse dumps to well operated and maintained sanitary landfill constructed to strict standards. The potential impact on water quality, therefore, can have a correspondingly wide range.

Open refuse dumps can result in direct contamination of rainfall runoff on its way to surface waters. Buried disposal can

*This number is shown in Plan of Action as 720,000 which appears to be a typographical error since a density of 300 pounds/cubic yard is called out by footnote.

result in contaminated leachate reaching either surface or groundwater. The quantity and quality of the leachate will depend on many variables including the soil cover thickness and type, the depth and degree of compaction of the solid wastes, the annual precipitation amount and pattern, the depth to groundwater and the permeability of the foundation material between the wastes and the water table.

For a solid waste disposal site to produce leachate, there must be some source of water moving through the fill material. Possible sources include (1) precipitation, (2) moisture content of the refuse, (3) surface water infiltrating into the fill, (4) percolating water entering the fill from adjacent land area or (5) groundwater in contact with the fill (Tempco, 1973). Exclusion of the above listed possible sources of moisture is one of the most important features of the design and operation of a properly constructed sanitary landfill. The production of leachate in a well designed and managed landfill can be effectively eliminated (Tempco, 1973).

Improperly designed and operated refuse dumps, however, can be producers of leachate. Fills without adequate cover or compaction, fills in contact with groundwater and fills in canyons are particularly vulnerable to production of leachate.

The quantity and quality of leachate vary over an extremely wide range, although the overall composition of municipal refuse is remarkably consistent. The causes for wide variation in quantity are obviously associated with the water supply needed to produce the leachate. Less obvious are the causes for the wide range in concentration of pollutants found in the leachate. The age of the fill and existance of aerobic or anaerobic conditions are known to be major factors. Although leachate composition is impossible to quantify in exact terms without monitoring of each specific site, some generalizations are possible from the literature on municipal refuse. The California State Water Pollution Control Board measured leachate composition as follows from existing landfills (Temco, 1973).

COD	8,000-10,000 mg/l
BOD	2,500 mg/l
Iron	600 mg/l
Chloride	250 mg/l

There appears to be general agreement that the concentrations observed in leachate from new fills are extremely high, but that concentrations decrease and stabilize with age.

Currently, an evaluation effort is being made in the study area through the selection of wells for sampling in the USGS-EPA ongoing monitoring program. This program gives special attention to the possibility of groundwater pollution by solid waste disposal in landfill. Well 26/42 27N1 is sampled to monitor the effect of the City disposal site at Indian Trails. Well 25/43 14K1 is to monitor solid waste disposal in East Spokane. Wells 25/44 1J1 and 25/44 2Q1 are monitored to evaluate industrial disposal in the Trentwood area. Wells 25/45 16K1 and 25/45 15D1 are monitored to evaluate the effect of the old County site at Greenacres, recently made inactive. Three analyses of samples from these wells are available to date.

Examination of the available data from all of the above listed wells except 25/45 16K1 indicates that there is no evidence of groundwater pollution from leachate at this time in the primary aquifer. The water quality exhibited by 25/45 16K1 is anomalous with respect to many parameters so that no conclusion, either affirmative or negative, can be drawn for this well. Further investigation will be required to understand the evidence from well 25/45 16K1.

The only documented evidence of water quality degradation from solid waste disposal in the primary aquifer of the study area is the following incident resulting from industrial wastes, reported by Esvelt and Saxton (1964). This incident involved leaching of sodium and potassium salts from an old dump by a subsequent flow of percolating water from a nearby gravel washing operation.

There has been no corresponding effort to monitor solid waste disposal sites in other aquifers.

Inventory of Solid Waste Disposal Sites

Categories. The inventory of solid waste disposal sites is assembled in four categories: general, industrial, demolition and septic tank pumpage. The general category includes municipal and county disposal sites which provide for general solid waste disposal including household, commercial, industrial and agricultural or landscape materials. The industrial category is restricted to private operations serving industry only and not handling household or similar type wastes. Demolition sites include those handling both combustible and incombustible demolition wastes and excluding household and other general type wastes. The last category includes sites devoted entirely to disposal of pumpage from septic tanks.

The inventory of disposal sites for all categories is shown in Table SW-1 and in Plate 312- . Table SW-1 includes, where available, those features of each disposal site likely to affect water quality such as the topographic and geological properties, whether operated as a sanitary landfill, covered dump or open dump, and the extent, kind and volume of wastes.

General Sites. There are 23 general solid waste disposal sites in the study area of which 7 are presently inactive. Eleven of the 16 active sites are in Spokane County serving the urban concentration of the City and its suburbs. The most important active sites from the standpoint of size and volume handled are the County sites at Mica, Marshall and Colbert and the City of Spokane sites at Indian Trail and Moran. Until its recent closure and replacement by the Mica site, the Greenacres site was the largest of the County sites.

Mica. This site was opened in 1972 by the County to replace the Greenacre site which was full. The site contains 160 acres, located on the pretertiary formation near Mica approximately 5 miles south of Sprague Avenue. Approximately 320,000 cubic yards per year are expected and the site is expected to last for ten years or more. The operation is a controlled sanitary landfill.

The potential for water reaching the solid wastes is minimized by sanitary landfill operation. The potential for groundwater contamination is minimized by the location on the most impervious formation in the area. Surface drainage is remote from a major water course. The overall potential for this site as a source of water quality degradation is very low.

Marshall. The site is approximately six miles southwest of the City and is located on the Columbia Plateau formation in the vicinity of the town of Marshall. The site has been in use since 1965 and is expected to have 15 years remaining usefulness. The site is currently operated as a controlled sanitary landfill but it is believed that the earlier material was not placed to current standards. In general, the groundwater of the basalt formations in this area is isolated from the surface by the impervious layers of latah materials. The exact conditions at this site are unknown. Considering the operation as a controlled sanitary landfill and the hydrogeology of the area, the pollution potential of this site is rated low.

Colbert. This site serves the County areas north of the City of Spokane and is located on the glacial outwash materials of the Little Spokane Valley. The site is operated as a sanitary landfill and is expected to have only 5 years remaining usefulness. Due to the permeable nature of the glacial outwash materials that extend from groundwater to the surface, this site has higher potential for pollution than the other principal County sites. The primary protection at this site must be provided by reliance upon cover and compaction to exclude the rainfall percolation. The pollution potential of this site is rated moderate.

Greenacres. This site was the primary County site for disposal of materials from the East Valley for approximately 20 years.

The Greenacres site covers 53 acres located on the pretertiary formation immediately south of the edge of the glacial valley fill. The estimated volume of waste added in the last four years before closure of the site is one million cubic yards. The materials are covered but most of the materials were placed under conditions substantially below those which would qualify it as a sanitary landfill. The impermeable foundation, cover and age of the fill combine to rate its pollution potential as low.

Indian Trail. This is the City of Spokane's primary solid waste disposal site. It occupies 360 acres on sandy eolian materials overlaying the basic glacial outwash materials at the toe of the southwest corner of Five Mile Prairie. The surface materials are described as a sandy loam. The site is operated by the City as a controlled sanitary landfill and is believed to have a remaining usefulness of from 10 to 15 years. In addition to general solid wastes, this site is also the recipient of all of the sludge and other solid wastes such as screenings from the City of Spokane Sewage Treatment Plant. Specific figures on volume of wastes at the City site are not available from referenced reports but the annual volume to both City sites together is estimated to be of the order 1.5 million cubic yards or more.

The fine grained surface materials in which the fill is located provide a limited barrier over the highly permeable gravels to any moisture that may reach the solid wastes. The southwest corner of the fill extends outside the area covered by the eolian materials into the area of glacial outwash sand, gravel and boulders. The entire site is steep and has natural surface drainage to the nearby Spokane River.

Considering all factors, this site is rated moderate with regard to pollution potential.

Moran. The City site known as Moran is located on the Columbia Plateau formation approximately three miles south of the City center in the Hangman Creek Valley. This site receives all of the City solid wastes from south of Sprague Avenue. The site is in a ravine and is operated as a sanitary landfill. The surface soils are described as very sandy. Only five years of remaining useful life are estimated. The ravine location opens the possibility ot pollution due to surface drainage. The possibility of leaching to the basalt aquifer is rated low. The overall pollution potential of this site is rated low.

The remaining general sites other than the Fairchild AFB site are small in areal extent and in population served. A significant proportion of the remaining small sites are located on either the pretertiary or Columbia Plateau formation where groundwater pollution potential is small. These include Tekoa, Diamond Lake, Sacheen Lake and Wellpinit on pretertiary and Fairchild, Espanola and Reardon on Plateau. The groundwater pollution potential of these sites is estimated to be small. There are some on the outwash gravels of the Little Spokane Valley, including Deer Park, Milan, Colbert Township (inactive), Elk (inactive) and one on the Chamokane outwash gravel at Ford. These have a moderate pollution potential where not operated as a sanitary landfill.

In summary, the solid waste disposal sites receiving general refuse offer moderate to low potential for water pollution based on consideration of location relative to hydrogeologic formation, size and method of operation. When this is combined with the low annual rainfall, the potential is reduced still further.

Industrial Sites. There are five industrial solid waste disposal sites listed in Table SW-1. Three are located on the glacial outwash gravels over the primary aquifer: Kaiser Mead, Kaiser Trentwood, and Spokane Industrial Park. Two are located in the glacial outwash gravels of the Chamokane Valley: Suntex Veneer and Dawn Mining.

Of those over the primary aquifer, data are available only for two. The Spokane Industrial Park site is in an abandoned gravel pit and accepts only incombustible materials. The gravel pit does not extend down into groundwater. The Kaiser Trentwood site is not in a gravel pit but on level ground operated as a sanitary landfill and excludes autos, large appliances, tires, dead animals, waste oil and sewage solids. The gravel pits over the primary aquifer are particularly vulnerable to pollution potential and the primary protection must be in exclusion of materials with putrescible, toxic or bacterially contaminated properties. The Spokane Industrial Park site is rated at moderately high potential and the Kaiser Trentwood site at moderate. No data are available on the Kaiser Mead operation.

Little data is available on the two sites in the Spokane

Indian Reservation, Suntex Veneer and Dawn Mining. It is understood that the Dawn Mining wastes are from a uranium mining operation. The following is quoted from Trico (1972):

> "The uranium mill near Ford has a waste disposal program which is monitored by the State Division of Health's Radiation Control Section and the U.S. Atomic Energy Commission. The tailing area is fenced, posted and screened with trees. Future production will probably not exceed that of the present."

Demolition Sites. All four of the sites which receive demolition wastes are in abandoned gravel pits over the primary aquifer and two of the pits extend into the groundwater. These sites are alleged to receive only "inert" or "inorganic" materials except that the Cunningham site receives both organic and inorganic material including waste oils. As stated above under industrial sites, all gravel pits are highly vulnerable, and those that extend into the water table could not have a higher potential. All of the demolition sites rely on control of the materials placed for protection of the groundwater. All four sites and particularly those two extending below groundwater are rated as having high pollution potential.

Septic Tank Pumpage Sites. The sludge periodically pumped from septic tanks is not a solid but rather a liquid with a very high solids content. This material has high pollution potential from oxygen demand, taste and odor, chemical and bacteriological aspects. Sewage sludge is defined as a solid waste by the regulations of the Spokane County Health District.

The septic tank sludge disposal sites are licensed and controlled by the Spokane County Health District (SCHD). SCHD estimates that over 4.5 million gallons per year of septic tank sludge are hauled to disposal. The disposal sites are to be covered daily and dosed with lime.

Five controlled septic tank sludge disposal sites are listed in Table SW-1. There was, in the past, some disposal of septic tank sludge at the City of Spokane Indian Trail site. Also in the past there had been some disposal to the City of Spokane sewage treatment plant but this practice has been discontinued.

None of the five specific septic tank sludge sites is over the primary aquifer. The only site to have received some septic tank sludge that is over the primary aquifer is the City's Indian Trail site.

Unauthorized Solid Waste Disposal. Even before the enactment of the most recent legislation, there were County statutes designed to prohibit unauthorized and illegal dumps. Despite legal prohibitions, the Spokane County Coordinated Comprehensive Solid Waste Management Plan Report described the situation at the time of its writing in 1970 as follows:

> "...illegal dumping continues throughout the County. Plate VI shows locations of several hundred illegal dumping violations reported in 1968 and 1970. ... In addition to these sites, there are probably hundreds of sites located off the county roadways in farmers' and ranchers' fields. ... None of these sites have been identified. ... Some illegal dumps have been located adjacent to streams, even within high water marks of streams. ... It has been estimated that over 50% of the violations reported to the Utilities Department are corrected as required by law enforcement proceedings..."

Solid Waste Criteria

The available volumes of solid waste arriving at various legal disposal sites is summarized in Table SW-2. This table represents an update of a similar table, shown in Plan of Action Appendix. This table shows that the County exclusive of the City is sending 485,000 cubic yards to legal disposal sites. Adding to this, a volume of 132,000 cubic yards estimated in Plan of Action as the illegal and private component, a total of 617,000 cubic yards is obtained for the County exclusive of the City. The total reported for the two City disposal sites is given as 1.5 million cubic yards per year. Illegal and private dumping inside the City are believed to be negligible. Added to the remainder of the County, a countywide total of 2,117,000 cubic yards per year is obtained.

These figures are in terms of truck cubic yards which are taken to have an average density of 300 pounds per cubic yard. Converting the annual volume to weight on this basis, and dividing by the estimated populations in the respective service areas, per capita waste contributions are calculated as follows:

Service Area	Per Capita Solid Wastes Pounds Per Capita Per Day
County exclusive of City	4.3
City only	7.2
Countywide including City	6.1

These figures bracket the national average of 5.3 pounds per capita per day.

The compactions being achieved in sanitary landfill in the study area are unknown. Assuming "good practice" achievement of 1000 pounds per cubic yard, the annual study area requirement for in place volume is of the order 640,000 cubic yards.

Solid Waste Management Policy

State Legislation. Chapter 70.95 Revised Code of Washington (RCW) provides the basic state legislation establishing solid waste management policy. The purpose of this legislation is described as follows:

> "70.95.020 PURPOSE. The purpose of this chapter is to establish a comprehensive state-wide program for solid waste handling which will prevent land, air, and water pollution and conserve the natural and economic resources of this state. To this end it is the purpose of this chapter:
>
> (1) To assign primary responsibility for adequate solid waste handling to local government, reserving to the state, however, those functions necessary to assure effective programs throughout the state;
>
> (2) To provide for adequate planning for solid waste handling by local government;
>
> (3) To provide for the adoption and enforcement of basic minimum performance standards for solid waste handling;
>
> (4) To provide technical and financial assistance to local governments in the planning, development, and conduct of solid waste handling programs."

To meet the above described goals, the legislation provides that:

1. Each county shall develop a comprehensive solid waste management plan and that each city in each county shall participate in this planning effort by submitting to the county its own plan or joining with the county in a joint plan.

2. Each county, or any city, or jurisdictional board of health shall adopt regulations or ordinances governing solid waste handling implementing the comprehensive solid waste management plan covering storage, collection, transportation, treatment, utilization, processing and final disposal including the issuance of permits.

3. No solid waste disposal site or disposal site facilities shall be maintained, established, substantially altered, expanded or improved until the county, city, or other person operating such site has obtained a permit from the jurisdictional health department.

4. Each county, city or jurisdictional board of health shall monitor compliance with the regulations and ordinance adopted for solid waste management.

The general requirements of 70.95 RCW are further elaborated by Washington State Department of Ecology in their Regulation Relating to Minimum Functional Standards for Solid Waste Handling in Chapter 173-301 WAC. The most significant requirments of these standards relative to potential water quality degradation from solid waste disposal are quoted as follows:

WAC 173-301-183 POLLUTION CONTROL. Adequate pollution control measures shall be provided.

(1) Surface runoff water from around the disposal site and from roof drains shall be intercepted and directed around or under the disposal site.

(2) Surface runoff from the disposal operation itself shall not cause violation of applicable receiving water standards.

(3) Groundwater pollution controls shall be provided as needed. The detailed plans for such controls shall be provided.

WAC 173-301-300 SANITARY LANDFILL, LEACHATE CONTROL. Plans for a sanitary landfill shall include provisions for interception and treatment of leachate at all sites where the average annual precipitation is 25 inches or more. Interception and treatment may be required at other sites. A sampling and testing program for the leachate and its treated effluent may be required.

WAC 173-301-301 POLLUTION PREVENTION.

(1) The distance separating the bottom of a sanitary landfill disposing of a readily decomposable organic waste and hazardous wastes shall be determined on a case by case basis. Generally, a separation equivalent to four (4) feet of impervious soil shall be the minimum separation between the bottom of the fill and the highest groundwater.

(2) Inert materials can be disposed of at landfill sites which afford little or no protection to the ground and surface waters.

(3) Septic tank pumpings and sewage treatment plant sludge disposal shall be determined on a case-by-case basis. Generally, a ratio of sludge or pumpings to other solid waste of 1 to 4 or 1 to 5, such that the moisture content does not exceed 40% will give satisfactory disposal results.

(4)*

(5) Medical wastes should be deposited above the groundwater dependent on a case-by-case basis and covered as soon as possible after deposition.

(6)*

WAC 173-301-303 SINGLE LAYER COMPACTION. Each layer of incoming solid waste shall be spread, preferably uphill, in layers of not more than two (2) feet and thoroughly compacted before succeeding layers are added. The slopes of the face preferably shall not exceed thirty (30) degrees nor be less than twenty (20) degrees, or between the slopes of two (2) and three (3) horizontal to one (1) vertical.

WAC 173-301-304 DAILY COVER. The compacted solid waste shall be compacted and covered fully with at least six (6) inches of compacted soil after each day of operation, or as specified by the jurisdictional health department, and department of ecology.

WAC 173-301-305 FINAL COVER. As soon as possible after reaching the final lift of a given area of a site, the area shall

*Inapplicable portions are omitted.

be covered with an equivalent of two (2) feet of compacted soil adequately sloped to allow surface water to run off.

WAC 173-301-306 FINAL SURFACE. The finished surface of the filled area shall be covered with adequate tillable soil and seeded with native grasses or other suitable vegetation immediately upon completion, or as soon as conditions permit. If necessary, slopes shall be covered with straw or other mulch to prevent erosion, both before and after seeding.

WAC 173-301-610 NONCONFORMING SITES AND FACILITIES. Modification of existing sites, facilities, and operating procedures for conformance with the requirements of this chapter shall be accomplished as promptly as possible and in conformance to the county or regional solid waste management plan. When the degree of necessary improvement is of such an extent that immediate compliance cannot be accomplished, special approval shall be requested from the jurisdictional health department. Such a request shall set forth a program for compliance with this chapter along with a time schedule for the commencement and completion of necessary improvements.

WAC 173-301-611 ABANDONED DISPOSAL SITES. All abandoned nonconforming sites shall be compacted, covered and reseeded by the owner as soon as feasible.

WAC 173-301-625 ENFORCEMENT. The jurisdictional health department shall determine compliance with this chapter, with any local ordinances or regulations and with approved management plans promulgated for satisfactory solid waste storage, collection, transportation and disposal.

Compliance by Local Agencies. Each county in the study area except Lincoln County has completed its comprehensive plan as required by state legislation. The general provisions of these plans are as follows:

Pend Oreille County. The Trico Economic Development District presents a comprehensive solid waste management plan for Ferry, Stevens, and Pend Oreille Counties. The plans, although under one cover, are essentially separate for each county.

For Pend Oreille County, the study proposes an interim system using a modified landfill concept. Ultimately, a transfer station system is proposed and one central sanitary landfill. The interim system proposes that landfills be located at five sites, three of which are within the study area. These are near Newport, Diamond Lake, and Sacheen Lake. In the "ultimate" system, the proposed central sanitary landfill site is not located within the basin study area.

No progress has been made in plan implementation to date, and the county sanitarian is evaluating additional alternatives. These alternatives are not expected to affect the ultimate plan which utilizes a central sanitary landfill located outside the study area.

Stevens County. The plan proposed for Stevens County in the Trico study is similar to the ultimate plan proposed for Pend Oreille County. There are to be two sanitary landfills. The major portion of the population is to be served for disposal purposes by transfer stations, including four or five within the study area.

Planning has subsequently been revised and proposes one centrally located sanitary landfill between Chewelah and Colville, outside the study area. Transfer stations would be designed for mobility, so that relocation to better sites would be possible. Plans are to begin implementation of the program in two years.

Whitman County. The solid waste management plan for Whitman County was completed in 1971, but has not been implemented. Engineering studies are underway. The final plan will essentially follow the comprehensive plan which includes elimination of the existing Tekoa dump. A transfer station would be located serving Tekoa and nearby communities. A centrally located sanitary landfill is proposed outside the study area which will provide for county-wide final disposal. Existing sites are expected to be phased out over the next two years.

Spokane County. State requirements for planning were met with the completion of a joint City-County comprehensive solid wastes plan in 1971. Although under one cover, the plans for the City and County are not integrated.

The County plan proposes shifting to a transfer station system, eliminating most of the disposal facilities existing in 1971. Some of these facilities have been closed and other landfill sites acquired, but in general the timetable developed in the plan has not been achieved. The County subsequently proposed a variation to this plan and applied for state aid. The proposed revised plan utilizes seven rural transfer facilities. The Deer Park, Milan, and Colbert landfills together with three other open dumps are to be closed. Only the Mica and Marshall sanitary landfills are to continue in operation. Details of the system configuration and operation would be established in an engineering study. The preliminary schedule calls for completion of the system by late 1976 or early 1977. The application was recently funded. The engineering study had not begun as of April, 1974.

City of Spokane. Present planning by the City of Spokane proposes continued reliance on sanitary landfills for the next several years. Search is underway for a site to replace the Moran sanitary landfill. Estimates on the life of Spokane's major site, Indian Trail, vary from 8 to 15 years. Long range plans are uncertain, but there is continuing interest in the possible return to incineration for volume reduction.

Spokane County Health District. The instrument for regulation, control and surveillance of solid waste operations in Spokane County in compliance with RCW 70.95.160 is the resolution passed August 28, 1973 by the Spokane County Health District Board of Health.

Possible Future Joint City-County Disposal. Among the recommendations contained in the City portion of the Coordinated Comprehensive Solid Waste Management Plan is one that consideration be given to a joint City-County landfill operation, both on the north and south sides of the City. Estimates of the City requirements are 200 acres in the north and 60 acres in the south.

There are also recommendations for continued cooperation with the Inland Empire Waste Conservation Association on long range plans for recycling and heat energy utilization.

TABLE [illegible]

[illegible]

Ident. No.	Site Name	Location, County	Type	Owner-Operator	Site Characteristics	Class[1]	Area, Acres	Annual Quantity	Year Opened	Remaining Life Years[6]	Mode of Wastes: Allowed[2]	Mode of Wastes: Prohibited[3]	Geology[4]	Remarks
D-1	[illegible]	Spokane	Demolition	Private	Gravel Pit	OD					Inert		Pr. Glacial	Excavate below water
D-2	Appleway Motors	Spokane	Demolition	Private	Gravel Pit	OD					Inert		Pr Glacial	
D-3	Central Premix	Spokane	Demolition	Private	Gravel Pit	OD					Inert & Wood (9)		Pr. Glacial	Excavate below water
D-4	Cunningham	Spokane	Demolition	Private	Gravel Pit	OD				1			Pr. Glacial	
G-1	Colbert	Spokane	General	County-Private[5]	Level	SL	40	50,C cy	60	3	H,C,I,A,X	Autos	S. Glacial	
G-2	Colbert Township	Spokane	General	Township									S. Glacial	Inactive
G-3	Deer Park	Spokane	General	Town-County	Level	SL	10	10,000 cy	60	4	H,C,I,A,X	SO	S. Glacial	
G-4	Elk	Spokane	General	Township									S Glacial	Inactive
G-5	Espanola	Spokane	General	Township	Level	CD	3	206 cy	67	4	H,A	Autos,DA	Plateau	
G-6	Fairchild AFB	Spokane	General	Air Force	Quarry	SL	40	30,000 cy	60	15	I X	T,G	Plateau	
G-7	Greenacres	Spokane	General	County	Hillside	CD	33	(19)	Prior to 56	0			P. Tertiary	Inactive
G-8	Indian Trail	Spokane	General	City of Spokane	Ravine-Hillside	SL	360	(11)	30±	10-15	(12)		Pr. Glacial	
G-9	[illegible]	Spokane	General	Private[5]	Hillside	SL	50	70,000 cy	55	15	H,C,I,A,X	Autos	Plateau	
G-10	Mead	Spokane	General	Township									Pr Glacial	Inactive
G-11	Mica	Spokane	General	County-Private[5]	Ravine-Hillside	SL	160	320,000 cy	72	>10	H,C I,A,X	Autos	P Tertiary	
G-12	[illegible]	Spokane	General	County	Level	CD	3	2,700 cy	60	3	H,C,I,A,X	Autos	S Glacial	
G-13	[illegible]	Spokane	General	City of Spokane	Ravine	SL	40	(11)	62	3	(13)		Plateau	
G-14	[illegible] Mile	Spokane	General	Township	Level	CD	12	800 cy	64	6	H,A X	Autos,DA,SS	Pr Glacial	
G-15	Spangle	Spokane	General	Town	Quarry	CD	9	444 cy	43	0	H,A,X	Autos DA,SS	Plateau	Inactive
G-16	Valleyford	Spokane	General	Township	Quarry	CD	8	80 cy	42	11	H,A	Autos,DA,SS	Plateau	Inactive
G-17	Diamond Lake	Pend Oreille	General	County	—	—	—	—			H	—	P Tertiary	
G-18	Sacheen Lake	Pend Oreille	General	County	—	—	—	—			H	—	P Tertiary	
G-19	Wellpinit	Stevens	General	Reservation	—						H	—	P Tertiary	
G-20	Ford	Stevens	General	County	—						H	—	S Glacial	
G-21	Suicide Hill	Stevens	General	Reservation	—								Plateau	Inactive
G-22	Tekoa	Whitman	General	Town	Hillside	OD	13	—			H C,A	—	P. Tertiary	
G-23	Reardan	Lincoln	General	Town	Ravine-Level						H,C,A		Plateau	
I-1	Kaiser Mead	Spokane		Private		OD							Pr Glacial	
I-2	Kaiser Trentwood	Spokane	Industrial	Private	Level	SL	30	2,444 cy	41	25	C,I	Autos,LA,T,DA,WO,SS	Pr Glacial	
I-3	Spokane Ind Park	Spokane	Industrial	Private	Gravel Pit	OD	10	3,000 cy	60	10	I	(7)	Pr. Glacial	
I-4	[illegible] Veneer	Stevens	Industrial	Private	—						I		S Glacial	
I-5	[illegible] Mining	Stevens	Industrial	Private	—						M		S Glacial	
S-1	Appleway [illegible]	Spokane	Septic Tank[8]	Private				882 000 gal					Plateau	T26-R44-S26
S-2	Country [illegible]	Spokane	Septic Tank	Private				300,000 gal					P Tertiary	T26-R44-S32
S-3	[illegible] Pay-less A	Spokane	Septic Tank	Private									Plateau	Near Espanola
S-4	[illegible] Pay-less B	Spokane	Septic Tank	Private									Plateau	Near Marshall
S-5	Metropolitan Services	Spokane	Septic Tank	Private									Lacustrine	T23-R43-S11

[1] Classified as SL=Sanitary Landfill, CD=Covered Dump and OD=Open Dump.
[2] Categories H=Household, C=Commercial, I=Industrial, A=Agricultural, X=Institutional, M=Mine Tailings.
[3] NS=Not Specified, Autos=Junked Autos, SS=Sewage Solids, DA=Dead Animals, F=All Putrescibles, G=Garbage, WO=Waste Oil, LA=Large Appliances, T=Tires
[4] Categories Pr Glacial=Primary Aquifer Glacial Outwash, S Glacial=Other Glacial Outwash Aquifer, Plateau=Columbia Plateau Basalt-Loess Interlayered, P Tertiary=Pre-Tertiary Igneous and Metamorphic Rock, Lacustrine=Sandy Lake Deposits
[5] Under contract to the County
[6] Remaining life from 1971
[7] All except noncombustibles
[8] Indicates septic tank pumpage.
[9] Allowed waste includes both organic and inorganic wastes and oils
[10] One million cubic yards in the last four years
[11] Two city sites together receive 1.5 million cy annually, mostly to Indian Trail (breakdown not available).
[12] All kinds are accepted, municipal and industrial. Public access.
[13] All kinds of municipal and industrial as delivered by city collection. No public access

TABLE SW-2

ESTIMATED ANNUAL VOLUME OF SOLID
WASTES FOR SPOKANE COUNTY

Category	Description		Annual Cubic Yards
Spokane County General Outside City	G-1	Colbert	50,000
	G-2	Colbert Township	Closed
	G-3	Deer Park	10,000
	G-4	Elk	Closed
	G-5	Espanola	300
	G-6	Fairchild AFB	50,000
	G-7	Greenacres	Closed
	G-9	Marshall	70,000
	G-10	Mead	Closed
	G-11	Mica	320,000
	G-12	Milan	2,700
	G-14	Nine Mile	800
	G-15	Spangle	500
	G-16	Valley Ford	800
	Subtotal Identified Dumps		485,100
	Allowance for illegal and private dumps		132,000
	Total Spokane County outside of City		617,100
City General	G-9	Indian Trail	1,500,000
	G-13	Moran	
	Total City		1,500,000
TOTAL SPOKANE COUNTY INCLUDING CITY			2,117,100

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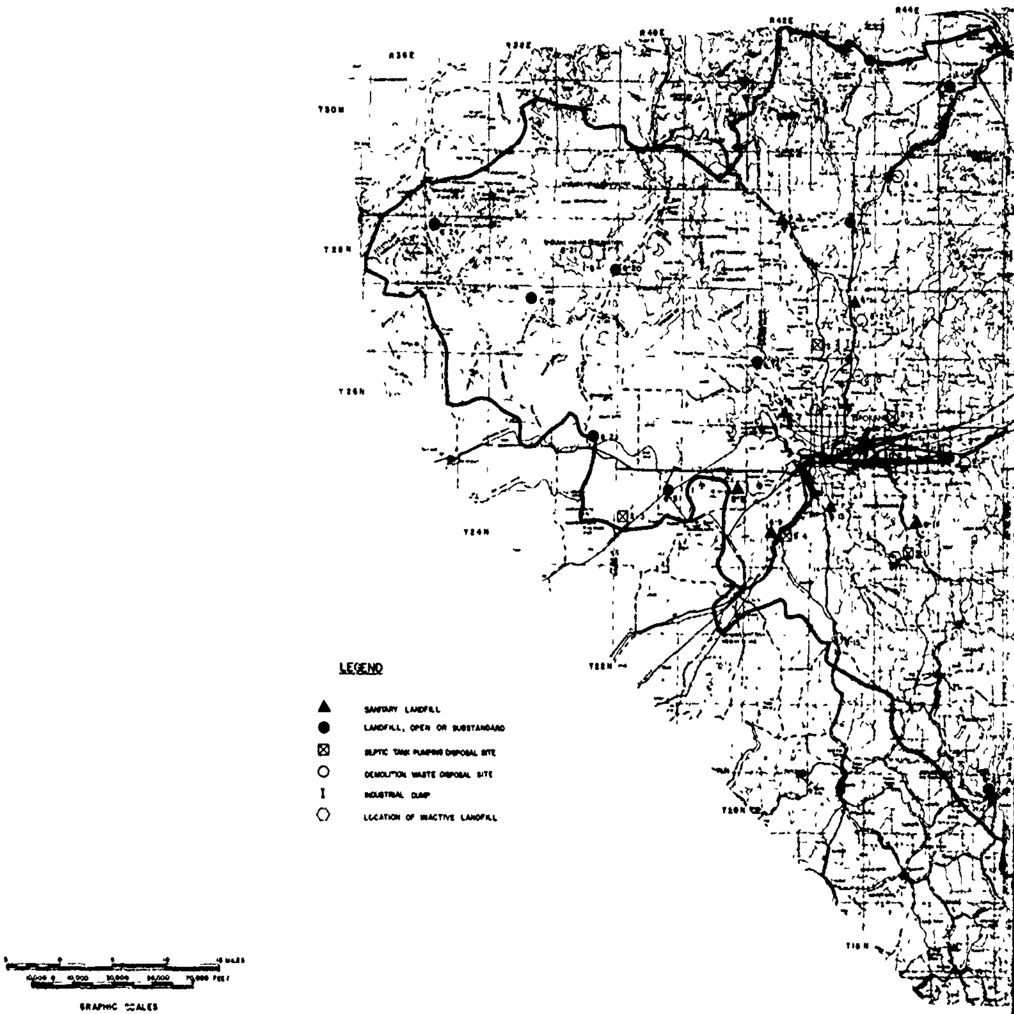
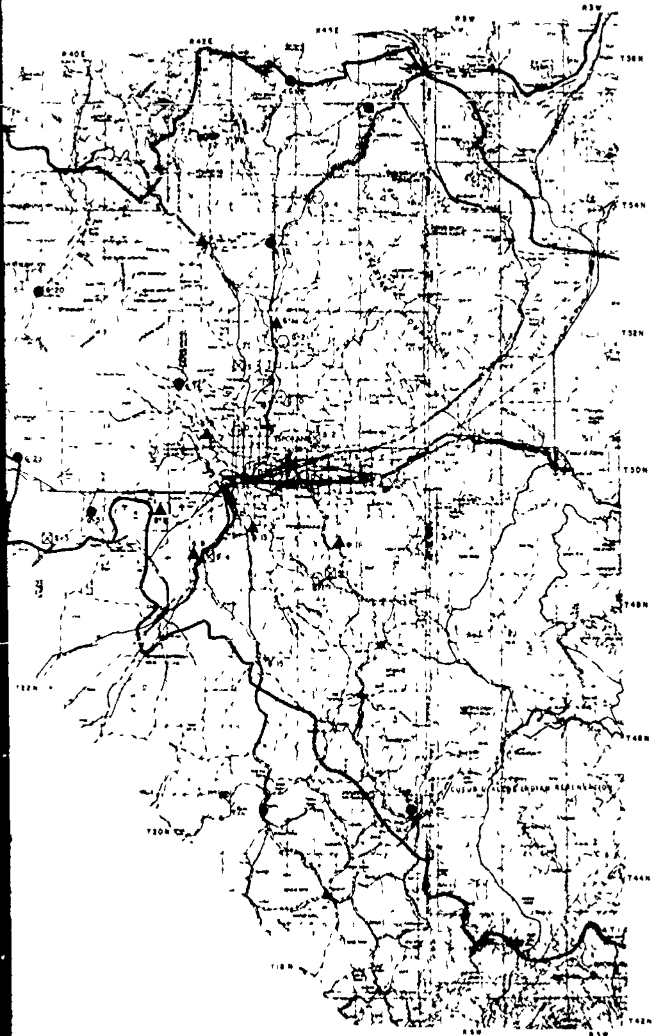


REVISIONS			
SYMBOL	DESCRIPTION	DATE	BY



MAP SOURCE PREPARED FROM USGS UNITED STATES TOPOGRAPHIC SERIES
SANDPOINT 1958 RITZVILLE 1958 SPOKANE 1958 OKANOGAN 1954

SITE IDENTIFICATION

IDENTIFICATION NUMBER	SITE NAME
G 1	COLBERT
G 2	COLBERT TOWNSHIP
G 3	DEER PARK
G 4	ELK
G 5	ESPANOLA
G 6	FAIRCHILD AIR FORCE BASE
G 7	GREENACRES
G 8	INDIAN TRAIL
G 9	MARSHALL
G 10	MEAD
G 11	MICA
G 12	MILAN
G 13	MORAN
G 14	NINE MILE
G 15	SPANGLE
G 16	VALLEY FORD
G 17	DIAMOND LAKE
G 18	SACHEEN LAKE
G 19	WELLPINIT
G 20	FORD
G 21	SUICIDE HILL
G 22	TEKOA
G 23	REARDAN
G 24	McCOY LAKE
D 1	ACE CONCRETE
D 2	APPLEWAY MOTORS
D 3	CENTRAL PREMIX
D 4	CUNNINGHAM
I	KAISER MEAD
I 2	KAISER TRENTWOOD
I 3	SPOKANE INDUSTRIAL PARK
I 4	SUNTEX VENEER
I 5	DAWN MINING
S 1	APPLEWAY FUEL
S 2	COUNTRY AIR
S 3	BOBERS PAYLESS A
S 4	GOBERS PAYLESS
S 5	METROPOLITAN SERVICES

KENNEDY TUDOR
CONSULTING ENGINEERS
SEATTLE WASHINGTON

U S ARMY
ENGINEER DISTRICT SEATTLE
CORPS OF ENGINEERS
SEATTLE WASHINGTON

WATER RESOURCES STUDY
METROPOLITAN SPOKANE REGION

SOLID WASTE DISPOSAL SITES

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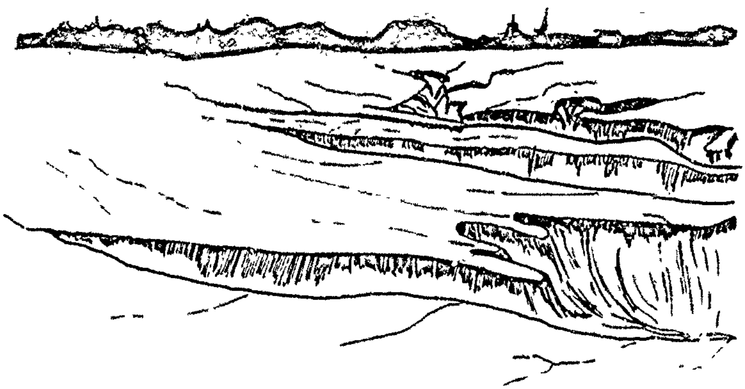

SECTION 312.6

SOIL EROSION

WATER RESOURCES STUDY

METROPOLITAN SPOKANE REGION

SECTION 312.6

SOIL EROSION

4 June 1974

Department of the Army, Seattle District
Corps of Engineers
Kennedy-Tudor Consulting Engineers

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TABLE INDEX

SOIL EROSION

Introduction

Soil erosion in certain parts of the study area has long been recognized, not only as an agricultural problem, but as a pollution problem. The erosion problem is significant throughout that part of the study area covered by Palouse soils and subject to dry farming with wheat as the primary crop. Practically the entire Hangman Creek watershed is in the Palouse soil area. Other areas with Palouse soils are the Deep Creek-Coulee Creek basin, adjoining Hangman Creek to the northwest, and that part of Lincoln County along the south bank of the Spokane River. The Hangman Creek and the Deep Creek-Coulee Creek watersheds are the areas of greatest significance to water pollution from erosion within the study area.

The Hangman Creek and the Deep Creek-Coulee Creek watersheds are only part of a much larger area of Eastern Washington and Idaho which comprise the Palouse area. Since the Palouse River watershed represents the largest part of this area, it has been subject to more extensive and more specific study than the portions within the study area. Therefore, facts about the Palouse soil erosion problem in the study area must be largely derived by extrapolation from available data on the Palouse River and other watersheds.

The severity of the erosion problem is indicated by the following quotation from the foreword to a Soil Conservation Service report of 1968 titled, "To Control Water Erosion, Runoff and Sedimentation, and Water Pollution in the Nonirrigated Grainlands of the Palouse Region in Eastern Washington:"

> "As noted in the Department of Agriculture's 'Resources in Action, Agriculture/2000,' the Nation is faced with a conservation crisis. At stake is the quality of the Nation's total environment. Nowhere is this problem more sharply etched than in the nonirrigated grain lands of the Palouse Region of the Pacific Northwest. Here, at a rate not exceeded anywhere in the United States, soil is being wasted by erosion; water is being polluted by silt, rendering it unfit for human consumption, undesirable for fish and wildlife, and destroying its recreational values; and the air is being polluted by dust from the unprotected, wind-whipped fields."

The problem within the study area specifically has been recognized most recently by a special committee formed in conjunction with preparation for Expo '74 to study environmental conservation in the Hangman Creek Watershed. A draft report by this committee concludes that "the paramount need of the watershed is conservation in ways which will at the same time control erosion and enable farmers to make a living."

Description of the Erosion Problem

The erosion problem is the product of the interaction of a number of factors including the soil type, topography, climate and agricultural practices.

The Palouse soils are described in the Geology section of this study as being loess materials, that is, windblown silt and sand deposits, with a fine grained texture. These deposits rest on layers of basalt and are highly irregular in depth, varying from 3 to

20 feet. These soils are further characterized as having low permeability and being highly susceptible to wind and water erosion.

Slopes of cultivated land in the Palouse region typically range from 15 to 25 percent (Soil Conservation Service, 1968).

Although total annual rainfall is low, the rainfall is concentrated largely in the winter months and frequently occurs on frozen ground.

Farming practices including summer fallow (Kelsey, 1968) and the use of heavy mechanical equipment are factors which combine with the soil, steep slopes and rainfall pattern to cause heavy erosion. The process has been described by Soil Conservation Service (1968) as follows:

> "Three factors interrelate to cause water erosion in this area. They are (1) soil and slope characteristics, (2) climate characteristics, and (3) man's treatment of the land. In virgin condition under perennial grass cover, the soil resisted erosion quite well. It had a deep moisture storage profile, and the surface soil absorbed water readily because the high content of organic materials made a desirable physical condition. In seventy years of cultivation about half the original organic matter has been destroyed, and the resulting soil surface is less permeable, more subject to freezing, and is eroded more easily by runoff....
>
> Steep slopes not only accentuate the runoff problem, but the rough, hilly topography makes difficult the application of many time-proven erosion control practices, such as contour farming, stripcropping, and terraces or diversions.
>
> Frost in the ground at the time of heavy precipitation or snow melt increases runoff and erosion. Research indicates that in silt loam soils, little or no water penetrates the soil when temperatures are 28°F or lower. Ice crystals fill the air space in the soil and block water movement...
>
> With frozen ground, runoff will occur from rain on practically all slopes and practically every treatment."

This same reference summarizes the consequences of these combinations of factors by citing the results in Whitman County:

> "The detailed soil surveys of Whitman County indicate that in 70 years of farming, all of the original topsoil has been eroded from about 10 percent of the land, and from one-fourth to three-fourths of the original soil has been removed from an additional 60 percent of the cultivated area. Many fertile bottomlands are covered with silt deposits up to 5 or 6 feet deep."

The Soil Conservation Service (1968) has quantified the problem in a map by evaluating the areas throughout the Palouse region in terms of a scale of erosion from slight to very severe. The portion of the map applicable to the study area is reproduced in Plate 312-SE1. A substantial part of the Palouse formation in the study area is rated moderate and severe with annual soil losses estimated at 5 to 10 and 10 to 20 tons per acre. Plate 312-SE1 indicates some areas outside the Hangman Creek and Deep Creek-Coulee Creek watersheds with moderate erosion potential. Outside the Hangman Creek and Deep Creek-Coulee Creek watersheds, however, this soil erosion potential is not combined with dry farming but with other agricultural uses that do not aggravate the problem.

The Palouse River basin, from which the entire region with similar characteristics gets its name, adjoins the Hangman Creek watershed on its southwest side. The validity for transferring generalization and specific data from the Palouse River basin to Hangman Creek is in their many similarities extending from soil, topography and rainfall to crops and farming practices.

Relation of Erosion to Water Pollution

The consequences of erosion for water pollution are (1) the potential silt load with its impact on fishery and wildlife habitat, reduced recreation potential and aesthetic loss; (2) the nutrients carried with the silt which impact on the eutrophication problem; and (3) the potential for carry-off of pesticides to form a toxic threat.

There are no available studies which quantify these water pollution threats for the study area as a whole or for either of the principal subareas involved in this problem, namely Hangman Creek and the Deep Creek-Coulee Creek watersheds. Data from other parts of the Palouse region are applied below to the Hangman Creek watershed in detail. The data developed for Hangman Creek are extrapolated to the smaller Deep Creek-Coulee Creek in proportion to area to arrive at an estimate of study area total.

The Hangman Creek watershed includes approximately 460,000 acres of which approximately 155,000 acres are in Idaho and the remaining 305,000 acres are in Washington and therefore inside the study area. Since the pollution load does not recognize the political boundary, the pollution estimates developed herein are for the entire watershed including the Idaho portion. It is estimated that there are 297,000 acres of cropland, range, pasture and forest subject to significant erosion based on the Soil Conservation Service (SCS) mapping. Applying SCS average annual erosion rates to the elements of this area, an average annual soil loss of 2,900,000 tons is developed for the entire Hangman Creek Watershed. See Table SE-1. This is equal to an average rate of 10 tons per acre per year for the area subject to significant erosion or 6.3 tons per acre for the entire watershed. These figures compare reasonably with the overall average of 9.5 tons per acre per year for Palouse region cropland given by Soil Conservation Service (1968).

The foregoing estimate of erosion is an estimate of the movement of soil from its native location but is not indicative of the quantity that may reach a watercourse as a sediment. A recent publication of the U.S. Environmental Protection Agency titled "Methods for Identifying and Evaluating the Nature and Extent of Non-point Sources of Pollutants" presents a number of methods for quantifying the sediment yield. In general, the data required for the methods are not available for Hangman Creek except the method for correlation to a similar basin. The statement is made that "Sediment yield curves can be constructed... from watersheds having similar climatic, topographic, and geologic properties...The relationship, sediment yield is proportioned to drainage area to the 0.8 power, appears to be valid for several basins with similar characteristics."

Sediment yield in the Palouse River Basin has been investigated by the U.S. Geological Survey in "Sediment Transport by Streams in the Palouse River Basin, Washington and Idaho, July 1961-June 1965" published in 1970. These results are abstracted in Table SE-2. Analysis of the Palouse River watershed data indicates that the expected sediment yield from a watershed of the size of Hangman Creek, approximately 720 square miles, is of the order 0.4 acre feet per square mile per year or 1.1 tons per acre per year as compared with the 9.5 tons per acre per year expressed in terms of erosion loss. That is, approximately 12 percent of the total erosion loss appears as stream sediment.

Applying an annual sediment yield rate of 1.1 tons per acre per year to the 460,000 acres in Hangman Creek watershed gives a value of 505,000 tons per year of sediment discharged to the Spokane River. The developed rate of 1.1 tons per acre per year is in substantial agreement with the low range in the very generalized sediment yield map shown in Volume 1 of Appendix VIII of the Comprehensive Framework Study by the Pacific Northwest River Basins Commission. In this document, the Hangman Creek area is classified in the range of 0.5 to 1.5 acre feet per year per square mile sediment yield. The low end of the range, 0.5 acre feet per square mile, is equal to 1.4 tons per acre and the high 4.2 tons per acre.

The result is also in agreement for the annual sediment yield for the Pine Creek-Rock Creek portion of the Palouse River watershed as developed by Futrell-Redford-Saxton (1973). This report shows a range of 500 to 1000 tons per year per square mile for the Pine Creek-Rock Creek subbasin which is the part of the Palouse basin adjoining Hangman Creek. The developed figure for Hangman Creek at 1.1 tons per acre equal 700 tons per square mile is in the middle of the 500-1000 range.

The Deep Creek-Coulee Creek watershed has a total area of 96,000 acres or approximately 21 percent of the Hangman Creek watershed.

The annual runoff per unit area in the Deep Creek-Coulee Creek watershed has not been measured except for some partial year data by USGS (Broom, 1951) but it is estimated to be not more than 50 percent of the yield per unit area for Hangman Creek. The size of the Deep Creek-Coulee Creek watershed applied to the 0.8 power relationship indicates a sediment yield rate of twice that of Hangman Creek. A number of factors in addition to the lower rate of water runoff indicate that such a high figure should not be used. These factors include rainfall, land slope, land use and location of cropland relative to streams. On a judgement basis, the Deep Creek-Coulee Creek basin is estimated to have a sediment yield of the order 15 percent of that for Hangman Creek or 75,000 tons per year.

The total estimated annual sediment load entering the Spokane River above Long Lake from the Hangman Creek and Deep Creek-Coulee Creek watersheds is 580,000 tons per year.

The annual pattern of the sediment load is shown in data compiled by the U.S. Geological Survey in their report "Palouse River Basin Hydrological Investigation." These data are abstracted in Table SE-3. Analysis of these data indicate that over 99 percent of the sediment discharge in the Palouse region occurs from October through May, with peaks in January and February.

Nutrients from the Erosion Problem

Water quality measurements of Hangman Creek for nutrient are relatively meager. The total availability appears to consist of 10 sampling dates in STORET and the one year bimonthly cycle of samplings made by Soltero et al. (1973). These data are assembled and summarized in Tables SE-4A and SE-4B. The limited data from STORET indicates winter season concentrations of the order 2.0 mg/l for all forms of nitrogen and 0.40 mg/l for phosphorus. The Soltero data indicate winter season concentrations of 2.35 mg/l for ammonia plus nitrate nitrogen and 0.47 mg/l for ortho plus soluble organic phosphate. The variation in strength of observed nutrients in the summer season is substantially lower from both sources.

Also available is a more extensive program of sampling made on the Palouse River Basin in the report "Surface Water Quality in Palouse Dryland Grain Region" by Johnson, Carlile, Johnstone and Cheng, 1973. The selected data for locations which drain cropland are abstracted and summarized in Table SE-5. These data for the Palouse River Basin indicate winter season nutrient concentrations as follows:

Nitrogen, $NH_3 + NO_3$ as N	7.24 mg/l
Phosphorus, Ortho + Poly as PO_4	0.32 mg/l.

Summer season concentrations are summarized as follows:

Nitrogen, $NH_3 + NO_3$ as N	1.48 mg/l
Phosphorus, Ortho + Poly as PO_4	0.29 mg/l.

The Palouse River Basin data indicate substantially higher winter season concentrations of nitrogen than the Hangman Creek data. The phosphorus data for the winter season is in agreement. The summer values for nitrates on the Palouse are in agreement with Hangman Creek data whereas the summer phosphate values on the Palouse are substantially higher than Hangman Creek.

Mass emission rates of nitrogen and phosphorus nutrients are estimated in Table SE-6 based on mean monthly discharge of Hangman Creek and concentrations selected to be representative of the available Hangman Creek data. The available data require the assumption that uniform concentration be used throughout each season. This must be recognized as a very crude approximation of what must actually be true for an extremely "flashy" stream like Hangman Creek which has extremes of flow range throughout the runoff season. The known mechanism of erosion indicates that the concentration should change significantly with the rate of runoff. Hence, the mass emissions herein calculated should be recognized as an approximation for this reason in addition to the inherent weakness of limited available data.

The possibility should also be recognized that more detailed data on Hangman Creek might show values closer to the extensive Palouse studies on similar lands.

Note that 96 percent of the total annual emission of nitrogen and 98 percent of phosphorus takes place between December and June. Only 4 percent of the nitrogen and 2 percent of the phosphorus are released into the Spokane river from June through November which includes the season of active biological growth in Long Lake. The primary unknown, particularly with regard to phosphorus which may be closely bound with soil particles, is how much of the winter emission is deposited with sediment in Long Lake and how much of the deposit may be made available by subsequent benthic activity.

Recognized Unmet Needs and Proposed Programs for Erosion Control

The need for erosion control in the Palouse region has been widely recognized at federal, state and local levels. The Hangman Creek Task Force draft report paraphrases the needs of Hangman Creek as follows:

> "The 1970 National Inventory of Soil and Water Conservation Needs points to the problems of the basin. This inventory shows that of the area's 224,500 acres of cropland, 50 percent need sod forming crops in rotation, 22 percent need stripcropping or diversions, and only 20 percent are adequately treated. Of the 78,000 acres of range and pastureland, 37 percent need grazing protection only, 17 percent need re-establishment of cover, 16 percent need improvement of present plant cover, and 24 percent have adequate treatment. On 139,000 acres of forestland in the basin, 60 percent needs better management, 6 percent needs reforestation, and the ballance is being treated adequately. The present condition of pasture and rangeland in the watershed is closely associated with attempts by farmers to improve their economic status. Most pasture and rangeland have some erosion, but the situation has been improved over the past few years through better range management. To the extent that farmers have removed brush from pastures and along stream channels, their efforts have been detrimental to wildlife. Overgrazing on streambanks contributes to accelerated erosion, sloughing, and water pollution."

The Spokane County total conservation needs were enumerated in broad terms in the U.S. Soil Conservation Service 1970 publication, "Washington Soil and Water Conservation Needs Inventory." This source indicates that, of a total of approximately 439,000 acres of non-irrigated cropland, 338,000 acres are in need of some form of conservation treatment. Obviously, a large part of this need is in the Hangman Creek watershed.

The U.S. Soil Conservation Service (SCS) is the agency with primary interest and responsibility in the field of land treatment. The role of SCS is primarily one of technical assistance offered to local Soil Conservation Districts or to individual farmers. At present, implementation of land treatment is largely possible only through voluntary action by private individuals. There are no methods to enforce mandatory compliance or to provide financial assistance for compliance. (Public Law 566, which provides for cost sharing with locals on group action projects in the fields of flood control, recreation, drainage, etc., also administered by SCS, is not applicable to land treatment.)

The potential change and direction in future soil conservation activity is expressed in the following quotation from an article by David Unger, Assistant Executive Secretary of the National Association of Conservation Districts:

> Sediment control is not a new topic to conservation districts. It has been a principal concern of ours for 35 years. What is new is that today when we consider sediment control we deal with it in terms of pollution control as well as the preservation of soil as a productive resource.
>
> What has been happening in recent years to deal with the problem? First, there has been action by municipal and county governments. In many places across the country, local governments have enacted ordinances requiring builders and developers to reduce erosion on construction sites in cooperation with conservation districts. Second, the Federal Highway Administration has issued standards which require use of various erosion prevention techniques in the construction of new federal-aid highways. And third, several states have enacted laws providing for various kinds of accelerated and intensified sediment control programs, all of them to be carried out with the assistance of soil and water conservation districts and their cooperating agencies.
>
> There are three trends exemplified in these legislative approaches. The first is that soil and water conservation districts are given greater authority to deal with the problem. The second is that although the early laws deal primarily with construction-type erosion, the newer laws are concerned with erosion from farm and forest lands as

well. And the third trend is toward an increasing degree of mandatory control in comparison to voluntary action. Slowly but surely, soil erosion is becoming illegal in this country.

In March 1972, the Environmental Protection Agency and the Council of State Governments prepared to develop a model state sediment control law for submission to the state legislatures. We helped put together a task force representing the Department of Agriculture, EPA, state governments, and the NACD to draft a model law.

The model law is premised on two basic recommendations:

1. Responsibility for an erosion and sediment control regulatory program should be placed in the conservation districts which have the responsibility under the laws of all fifty states for the control of erosion and sediment deposition. This responsibility would be in conjunction with, but would not replace, those state and local regulatory programs concerned with the quality of soil and water resources and pollution abatement activities.

2. Suggested state erosion and sediment control legislation should be drafted in the form of an amendment to existing conservation districts' enabling laws.

Principal authorities and requirements of the model law include:

1. Establishment of a comprehensive state soil erosion and sediment control program applicable to different types of land use and soil conditions, with identification of areas having critical soil erosion and sediment problems; and adoption of statewide guidelines including conservation standards for the control of erosion and sediment resulting from land disturbing activities.

2. Establishment of district soil erosion and sediment control programs and conservation standards consistent with the state program and guidelines.

3. Prohibition of certain land disturbing activities unless conducted in accordance with approved soil erosion and sediment control plans with special requirements applicable to land disturbing activities resulting from normal agricultural and forestry activities.

4. Use of existing regulatory mechanisms, such as building,

grading, and other permits applicable to land disturbing activities to implement erosion and sediment control plan requirements.

5. Inspection, monitoring, and reporting requirements. Provision for modification of approved plans by mutual agreement.

6. Penalties, injunctions, and other enforcement provisions.

7. Provisions for cost-sharing.

8. Appropriations to carry out the act.

TABLE SE-1

ESTIMATED EROSION IN THE
HANGMAN CREEK WATERSHED

Land Use	Class[1]	Acreage[2]	Average Unit Erosion[1] (Tons/Acre)	Average Annual Soil Erosion[2] (Tons)
Cropland	Very Severe	12,000	20.0	240,000
	Severe	135.400	15.0	2,031,000
	Moderate	50,800	7.5	381,000
	None	23,600	2.5	59,000
Range and Pasture	Moderate	25,600	2.5	64,000
Forest	Moderate	49,900	2.5	125,000
TOTAL		297,300		2,900,000

[1]Source: U.S. Soil Conservation Service (1968).

[2]Developed by the consultant.

TABLE SE-2

REPRESENTATIVE SEDIMENT YIELDS
FOR THE PALOUSE REGION
1961-1965

Sampling Station or Drainage Reach	General Use Character of Drainage	Average Sediment Loss (Tons)	Drainage Area (Square Miles)	Sediment Yield Tons/ Sq. M.	Sediment Yield Acre-Feet Sq. M.
Palouse River-Palouse to Colfax	Excellent Cropland	180,000	99	1800	1.0
South Fork Palouse River-Pullman to Colfax	Primarily Excellent Cropland	86,000	69	1200	0.7
Pine Creek at Pine City	Excellent Cropland	160,000	302	600	0.3
TOTALS		426,000	470		

Source: U.S. Geological Survey. 1970. Sediment transport by streams in the Palouse River Basin, Washington and Idaho, July 1961-June 1965. Washington, D.C.

TABLE SE-3

ANNUAL PATTERN OF SEDIMENT DISCHARGE
FOR THE PALOUSE RIVER AT HOOPER
1962-1971

Month	Average Sediment Discharge (Tons)	Percent of Annual
October	1,063	0.01
November	7,010	0.05
December	1,138,956	10.25
January	3,289,143	29.59
February	4,213,809	37.91
March	1,738,165	15.64
April	472,233	4.25
May	228,573	2.06
June	23,622	0.21
July	1,813	0.02
August	527	+
September	1,21[illegible]	0.01

Source: U.S. Geological Survey. 1973. Palouse River Basin hydrological investigation. Tacoma, Washington.

TABLE SE-4A

AVAILABLE NUTRIENT WATER QUALITY DATA
ON HANGMAN CREEK FROM STORET[1]

Date		Concentrations mg/1					
			Nitrogen Parameters			Phosphorus Parameters	
		NH_3-N	NO_2-N	NO_3-N	Tot. Kjeld-N	Phos-T	Phos-D
9/12/72				0.58	0.66	0.050	
10/10/72		0.24	0.009	0.39	0.69	0.048	0.002
10/31/72		0.07	0.011	0.57	0.37	0.046	0.009
11/19/72		0.11	0.010	0.54	0.44	0.051	0.008
11/29/72		0.06	0.008	0.77	0.22	0.046	0.030
12/27/72		0.92			1.90	1.100	0.012
1/18/73		0.36	0.020	0.60	0.90	0.230	0.093
2/ 6/73		0.85	0.050	1.60	0.91	0.560	0.075
June-Nov.	Low	0.06	0.009	0.39	0.22	0.046	0.002
	High	0.24	0.011	0.77	0.69	0.051	0.030
	Mean	0.12	0.010	0.57	0.48	0.048	0.012
Dec.-May	Low	0.36	0.020	0.60	0.90	0.230	0.012
	High	0.92	0.050	1.60	1.90	1.100	0.093
	Mean	0.71	0.035	1.10	1.24	0.630	0.060

[1]Station 12-4240.

TABLE SE-4B

AVAILABLE NUTRIENT WATER QUALITY DATA
FOR HANGMAN CREEK FROM SOLTERO

		Concentrations mg/1				
	Parameter	Low	High	Mean of Total Record[1]	Mean Dec-May	Mean June-Nov
NITROGEN FORMS	NH_3-N	0.07	0.5	0.22	0.544	0.120
	NO_2-N	0.001	0.041	0.015	0.022	0.013
	NO_3-N	0.81	3.54	1.58	1.808	1.509
	Soluble Organic NH_3-N	0.0	0.92	0.49	0.360	0.550
	Particulate Organic NH_3-N	0.0	2.37	0.42	1.078	0.291
PHOSPHORUS FORMS	Ortho-PO_4	0.01	0.55	0.1	0.316	0.042
	Soluble Organic PO_4	0.0	0.2	0.05	0.055	0.053
	Particulate PO_4	0.08	1.56	0.32	1.085	0.161

[1]For the period 5/6/72 to 3/15/73.

TABLE SE-5

TYPICAL WATER QUALITY DATA FOR CROPLAND RUNOFF IN THE PALOUSE RIVER BASIN[3]

Sampling Point		Nitrogen Concentration[1]			Phosphorus Concentration[2]		
		Mean Dec-May	Mean June-Nov	Mean Annual	Mean Dec-May	Mean June-Nov	Mean Annual
1a	On the Palouse	5.14	1.42	3.28	0.25	0.33	0.29
7a	On Missouri Creek	6.89	0.59	5.49	0.24	0.16	0.22
9a	On Staley Creek	7.83	1.51	4.91	0.26	0.34	0.30
10a	On Ewartsville	7.20	1.33	3.68	0.27	0.29	0.28
11b	Wilbur Creek	9.22	--	9.22	0.84	--	0.84
12a	Spring Flat Creek	7.00	1.93	5.02	0.28	0.25	0.27
13a	Armstrong Creek	8.95	1.66	5.02	0.25	0.25	0.25
ALL POINTS COMBINED		7.24	1.48	4.47	0.32	0.29	0.30

[1]Nitrogen concentration expressed as mg/l of NH_3-N plus NO_3-N.

[2]Dissolved phosphate concentration expressed as mg/l of ortho plus poly phosphate.

[3]Source: Surface water quality in the Palouse dryland grain region. 1973. Washington Agricultural Experimental Station, Washington State University, Bulletin 779.

TABLE SE-6

ESTIMATED MASS EMISSION OF NUTRIENTS
FROM HANGMAN CREEK WATERSHED

Month	Mean Discharge cfs	Nitrogen Mg/1	Nitrogen Tons	Phosphorus Mg/1	Phosphorus Tons
December	197	2.5	41.13	0.35	5.76
January	494	2.5	103.14	0.35	14.44
February	803	2.5	151.43	0.35	21.20
March	821	2.5	171.41	0.35	24.00
April	401	2.5	81.02	0.35	11.34
May	250	2.5	52.20	0.35	7.31
Subtotal			600.33		84.05
June	95.3	1.5	11.55	0.09	0.69
July	22	1.5	2.76	0.09	0.17
August	13.4	1.5	1.68	0.09	0.10
September	13.9	1.5	1.69	0.09	0.10
October	18.4	1.5	2.30	0.09	0.14
November	44.7	1.5	5.42	0.09	0.32
Subtotal			25.40		1.52
TOTAL			625.73		85.57

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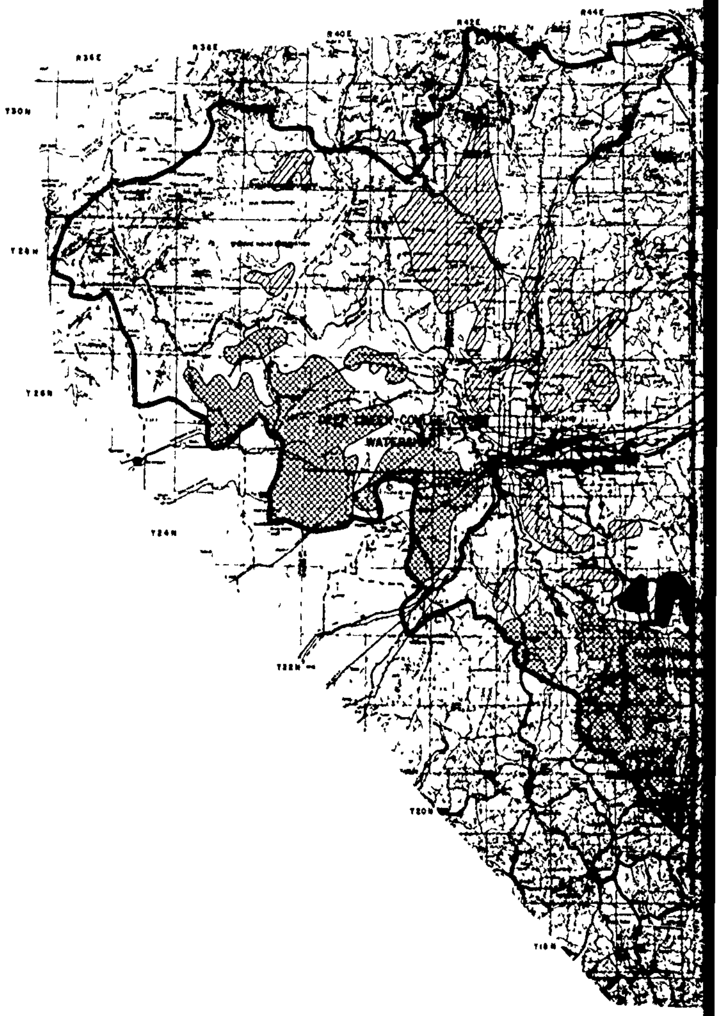
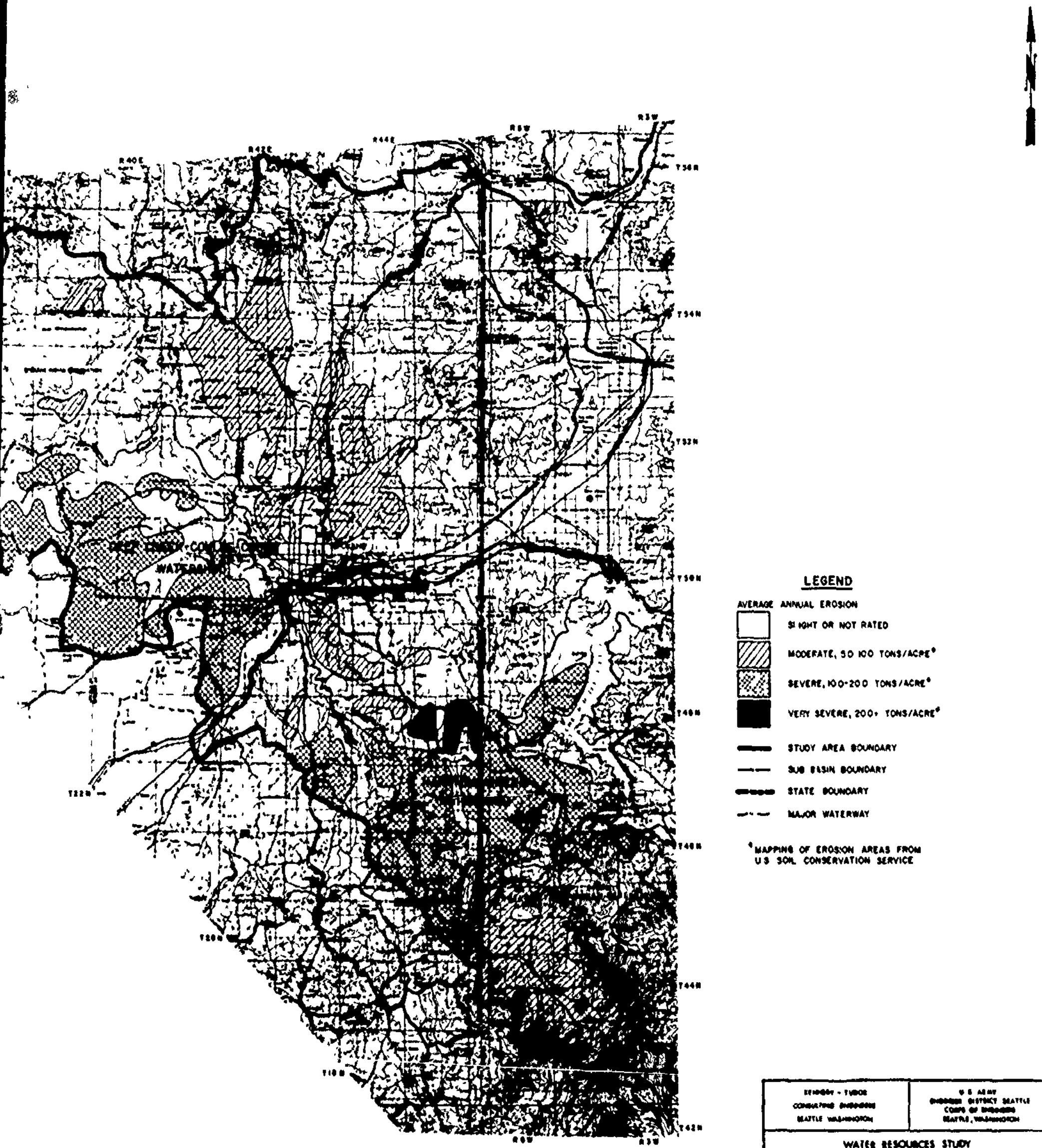


GRAPHIC SCALES

	DESCRIPTION	DATE	BY

MAP SOURCE PREPARED FROM USGS, UNITED STATES TOPOGRAPHIC SERIES, SANDPOINT 1958 RITZVILLE 1963 SPOKANE 1963, OKANOGAN 1964



MAP SOURCE PREPARED FROM USGS, UNITED STATES TOPOGRAPHIC SERIES, SANDPOINT 1958, RITZVILLE 1953, SPOKANE 1965, OKANOGAN 1964

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WATER RESOURCES STUDY
METROPOLITAN SPOKANE REGION

SOIL EROSION POTENTIAL

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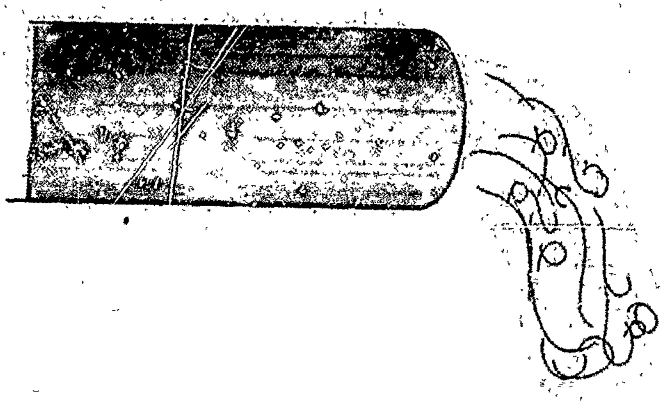

SECTION 312.7

URBAN RUNOFF

WATER RESOURCES STUDY

METROPOLITAN SPOKANE REGION

SECTION 312.7

URBAN RUNOFF

20 June 1974

Department of the Army, Seattle District
Corps of Engineers
Kennedy-Tudor Consulting Engineers

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URBAN RUNOFF

Goals of Urban Runoff Evaluation

If there were neither data gaps nor limitations of developed practical calculation methodology, it would be desirable to present the following findings:

1. Total annual volume of urban runoff reaching surface water under present conditions.

   a. Through combined sewers
      1) Treated
      2) Overflowed.

   b. Through separate storm sewers.

2. Total annual mass emission of the following pollutants associated with each of the volumes under 1 above.

   a. BOD and/or COD.
   b. Total dissolved solids.
   c. Total coliform.
   d. Fecal coliform.
   e. Orthophosphate.
   f. Total phosphorus.
   g. Nitrate.
   h. Total Kjeldahl nitroten.
   i. Any significant heavy metal.
   j. Hexane extractables.
   k. Pesticides.

3. A breakdown of both volume and mass emission of pollutants seasonally between June through September and the remainder of the year.

4. Accumulation rates, accumulation limits and washoff constants for the above listed pollutants that would permit modeling of a runoff pollutograph for any rainfall event.

As will be demonstrated below, there are both data gaps and lack of practical calculation methodology not only for the study area specifically, but for urban runoff in general where mass emission of pollutants is concerned. Despite an avalanche of research papers on this subject in the last ten years, any calculation made from the currently available data and methodology must be recognized as a very rough approximation.

The extreme complication created by the existing system of combined sewer overflows to evaluation of what pollution load actually is reaching surface waters under current conditions is addressed only to the extent of reporting available estimates. The present system of overflow is inevitably subject to revision and the current upgrade of the City sewage treatment plant will change the bypass condition there. The exact calculation of what has been happening would not be useful to evaluation of the problem. Therefore, the concentration herein is toward evaluation of the total urban runoff pollution load before any treatment.

The hydrology of urban runoff, in contrast to the evaluation of the pollution load, is a well developed art. Several alternative methods are available depending upon the purpose to which the calculated flows are to be put and whether the calculation is to be made manually or by computer. Where the shape of the hydrograph for a particular rainfall event is not required, the rational formula is useable and is suitable for manual calculation. Synthetic hydrograph methods are available for more refined calculations and the simulation techniques are available for use in conjunction with computers.

For the purpose of determining the annual or seasonal volume of urban runoff, it is not necessary to know the shape of the hydrograph for various rainfall events. Likewise, if the annual or seasonal pollution volume is to be calculated on the basis of average runoff quality, only the runoff volume is necessary. The more advanced methods of determining total pollutional load due to runoff are based on the interaction between the rainfall-runoff increments and the pollutional load available on the surface. The use of this method requires the simulation technique.

Since the hydrologic techniques are commonly known and available, they are not included in the literature search part of this section. The literature search is devoted to pollutant data and evaluation.

Present Extent of Urban Drainage.

Within the urban planning area, with a few small exceptions, all storm water drainage from urban areas that reaches surface waters does so through City of Spokane sewers. The suburban area outside the City of Spokane is drained almost entirely by taking advantage of the natural permeability of the valley soils to dispose of storm waters through dry wells or simply onto the surface. Hence, in addressing the urban runoff problem in the City of Spokane in detail, the urban runoff to surface waters of the urban area is being substantially covered.

Existing Storm Water Collection in the City of Spokane

Table 1 summarizes the tributary areas relative to urban runoff in the City of Spokane. This table was prepared from mapping in Esvelt & Saxton/Bovay (1972) but the numbers themselves are not available in the referenced report. There are four kinds of runoff collection situations in the Esvelt & Saxton/Bovay study area:

1. Areas drained by combined sewers, 15,871 Ac.

2. Areas drained by separate storm drains, 3,511 Ac.

3. Unsewered areas topographically tributary to a separate stormwater outfall, 639 Ac.

4. Unsewered areas which are not served by any runoff collection or outfall, 3,213 Ac.

The Esvelt & Saxton/Bovay sewer study area covers 23,230 acres which does not include the entire area inside the city limits. The entire area inside the city limits is 32,848 acres or 51 square miles. Table IV-A from Esvelt & Saxton/Bovay (1972) is reproduced in abbreviated form herein as Table 2. This table covers the entire City and gives a breakdown by land use. An exact parallel cannot be drawn between Tables 1 and 2 since unknown amounts of Public and Semi Public and Parks from Table 2 are included in the various sewered categories of Table 1. Furthermore, there are significant residential and industrial areas without sewered drainage. The tables are roughly checked by comparing the subtotal of "combined sewered," "separately sewered" and "unsewered but tributary" at 20,021 acres from Table 1 with the subtotal of 20,283.65 acres from Table 2.

In summary, urban runoff is shown to be currently collected into sewers for disposal to surface waters from a total of approximately 20,000 acres of which approximately 650 acres are unsewered land which drains overland to contiguous sewers or outfalls. The composition of land use in the drained area is approximately as follows:

Classification	Area, Acres
Residential	8,000
Business and Commercial	990
Industrial	1,360
Street Pavements	7,000
Public and Semi Public	2,000
Parks	650
	20,000

Combined Sewers in the City of Spokane

Eighty two percent of the City area from which surface drainage is collected in sewers is served by a combined system. A combined system is one in which storm and sanitary wastes are conveyed in a common pipe. As indicated in the section describing facilities, the historical pattern of sewer construction resulted in a system of combined sewers with multiple outlets to the river. When these many trunks were gathered in interceptor sewers to convey the sanitary flow to the treatment plant, the result was a large number of overflows where each combined trunk was connected into the interceptor. These overflows are mapped in Figure 10 in Section 311 and are listed in Table 3 herein.

Each of these overflows is a unique situation with regard to frequency and volume of overflow. Both storm and sanitary wastes are conveyed to the treatment plant up to the hydraulic capacity of the interceptor. When flow at any point exceeds the interceptor capacity, the excess flow is automatically overflowed to the river without treatment. Since the combined sewer is carrying both sanitary and storm flows, that which overflows is likewise a mixture of storm and sanitary waste. The proportions of storm and sanitary waste are unique at each overflow and at each point the composition of the overflow varies with time as the volume of storm flow changes relative to the sanitary flow.

Even if the quality of the sanitary and storm wastes were known precisely for each, the determination of the quality of the overflow at each point would be complex. The complexity is further compounded by the unique service area and hydraulic conditions at each overflow. Nevertheless, evaluations have been made of the mass emission of the overflow which are reported below.

Conclusions from the Esvelt and Saxton/Bovay Report

The report by Esvelt & Saxton/Bovay (1972) presented the following conclusions relative to the volume, quality and significance of the annual emission due to urban runoff in the City of Spokane.

> "Table X-A shows that on an annual basis, runoff waters contain negligible amounts of the nutrients, nitrogen and phosphorus, compared to the sanitary sewage flow. Runoff waters contain approximately 10 percent as much BOD as the treatment plant effluent. System overflows contain less than 8 percent as much BOD as the sewage treatment plant effluent. Runoff waters carry nearly as much suspended solids as are discharged to the river annually in the treatment plant effluent. Those carried in the runoff are more inert, however, consisting of sand and grit."

The applicable parts of the referenced Table X-A are reproduced below:

ANNUAL EMISSION RATES FROM THE SPOKANE SEWER SYSTEM

	Flow Million Gallons	SS Thousand Pounds	BOD Thousand Pounds	TKN Thousand Pounds	P Thousand Pounds
Raw Sewage Flow*	10,200	10,700	12,200	1,700	510
Primary Effluent*	10,200	3,760	5,290	1,700	470

	Flow Million Gallons	SS Thousand Pounds	BOD Thousand Pounds	TKN Thousand Pounds	P Thousand Pounds
Total Runoff	1,500	3,300	620	50	6.3
Combined Sewer Overflows**	740	1,400	430	46	10.5
Sanitary Sewage in Overflows	160	170	190	27	8

*1970-1971 average at Spokane Sewage Treatment Plant.
**Computed based on assumption that interception capacity = 2 x dry weather flow.

The total annual storm water runoff shown above at 1,500 million gallons is equal to approximately 3.45 inches of runoff (about 20% of annual rainfall of 17 inches) from the approximately 16,000 acres which are drained to the combined sewer system. (Note that the annual yield of runoff from separate storm sewers is not included in the above.)

The referenced report concluded that average quality of storm water runoff was as follows, based on literature search and limited testing.

BOD	50 mg/l
Suspended Solids	260 mg/l
Total Kjeldahl N	4 mg/l
Total P	0.5 mg/l
Total Coliform	100,000 per 100 ml

The above values were used in calculating annual emissions shown in referenced Table X-A.

The Esvelt & Saxton/Bovay report qualifies its conclusions about the importance of runoff by pointing out the potential short term problems caused by storm runoff and overflow at low river stages as follows:

> "The short term problems created by overflow may be of more importance than the annual emissions, as transient reductions in water quality then occur. Exhibit VII-1 shows storm runoff frequency for Spokane. From this figure, a runoff rate of about 600 cfs can be expected one hour each year. A one-hour flow at this rate would discharge about 17 tons of suspended solids to the river and nearly 4 tons of BOD. If the river were flowing at 1,000 cfs entering Spokane, this amount of runoff evenly mixed would provide nearly 100 mg/l of suspended solids and 20 mg/l BOD.
>
> Runoff amounting to 300 cfs can be expected about eight times each year for a one hour duration. This runoff would discharge 8 tons of suspended solids and 1 1/2 tons of BOD during one hour. This would provide about 60 mg/l SS and 10 mg/l BOD to the river, assuming the same discharge and mixing."

The referenced Exhibit VII-1 is not reproduced herein. It shows that the above quoted paragraph applies to frequencies expected in the period April to October which is coincident with low flows.

The referenced report does not make the following computation but it appears to be implied. If the total combined overflow is 740 mg* of which 160 mg is sanitary sewage, then 580 mg must be runoff. Hence, the net emissions must be:

Primary treated sanitary sewage	10,040 mg
Primary treated runoff	920 mg
Untreated sanitary in overflows	160 mg
Untreated runoff in overflows	580 mg
TOTAL	11,700 mg

This checks the sum of total sanitary at 10,200 mg plus total runoff at 1500 mg.

The report does not state whether the overflows shown in reproduced Table X-A include bypasses at the sewage treatment plant or not. The table on Exhibit VII-4 of the same report indicates average

*mg = million gallons.

annual volume of overflow as 447 mg and specifically excludes the STP bypass.

The table from Exhibit VII-4 of the Esvelt & Saxton/Bovay report is reproduced herein as Table 3. The referenced report also shows a development of the frequency and volume of overflow at each overflow location in the combined sewer system.

The quality sampling made as part of the Esvelt & Saxton/Bovay report was limited to two grab samples from a storm sewer at Nine Mile Road and Assembly Street and to one sequence of samples through a rainfall event from the storm sewer at Superior and Cataldo. These data are reproduced herein as Table 4.

Summary from City NPDES Application for Permit

The City of Spokane has filed NPDES application for permits for 36 overflows and 8 bypasses. The data from these applications is summarized in Tables 5 and 6 respectively. The data given in this source indicates an annual average discharge from overflows of 567 million gallons plus a discharge of 70 million gallons from bypasses, making a total of 637 million gallons.

The overflow numbering system used by Esvelt & Saxton/Bovay, as shown in Table 3, are shown in a column headed ESB number in Tables 5 and 6 for coordination. Both the ESB and NPDES numbers are shown in the location plan Figure 10 of Section 311.

The NPDES permits were prepared by the City subsequent to the ESB report and represent the more recent evaluation.

Literature Search

The only presently available evaluations of the mass emission pollution load of urban runoff for the City of Spokane are the foregoing data and referenced tables. A literature search is undertaken here to supplement the available information on present runoff conditions and provide a basis for evaluation of projected conditions.

There have been a significant number of papers released on urban runoff as a pollution source since 1964. Refer to the Bibliography in Section 302 and the List of References in this section. The early data gathering efforts were directed toward correlation with the obvious factors which effect quality and quantity of runoff such as land use, climate and street cleaning practices. The data were not being gathered toward implementing any particular uniform or recognized technique for waste load computation. Practically all were directed toward development of a possible technique based on correlation.

The literature reviews are presented below and in referenced tables. The Metcalf & Eddy (1971) and Lombardo and Franz (1972) citations are presented first because they demonstrate the recognized methodology, an understanding of which is necessary to evaluate the appropriateness of raw data gathered by others. Following these first two citations, the remainder are presented in alphabetical order.

Metcalf & Eddy (1971). In this citation titled "Storm water management model," a simulation approach is developed. The mechanism de-developed in this simulation approach indicates why the correlative approach was experiencing so much difficulty. The mechanism shows that a sampling program that does not recognize the physcial processes involved in build up of pollutants and their subsequent wash off is impossible to interpret by correlation alone.

The mechanism given mathematical expression in the Metcalf and Eddy simulation is as follows: The pollutant load builds up on the urban surfaces as a time function but with a limiting characteristic. The pollutant load on the surface at any time is a function of the length of time since last washoff (or sweeping), the amount left by the last washoff (or sweeping), the rate of accumulation and the limiting value of accumulated material. The pollutants are then washed off by the rainfall event at a rate proportional to the amount of pollutant present on the surface and to the rainfall.

If the mechanism is a fair approximation of the actual physical process, and it has recognition and acceptance of being the case, then it is obvious why there is difficulty in correlation of data that does not include time since the rain event began or since the antecedant cleaning regime. It also points out the inherent risk in attempting to evaluate the mass emission of pollutants based on applying average pollutant concentrations to total runoff.

The development of the Metcalf and Eddy simulation of urban runoff did not include any data gathering. Hence, the application and testing reported in the referenced work relied on previous studies which had not gathered their data with this mechanism in mind. The application and testing were based on data from Weibel, Anderson and Woodward (1963) and the American Public Works Association (1969) for conditions in Cincinnati and Chicago respectively. See reviews below.

Lombardo and Franz (1972). Hydrocomp Inc. includes in their quality simulation model the accumulation-washoff mechanism described by Metcalf and Eddy. Their methodology is described in Lombardo and Franz (1972) as follows:

> "The accumulation process is modeled by a daily rate of accumulation and a limiting value of accumulation for each constituent...The limiting value is approached asymptotically if no washoff occurs. Factors which effect the limiting value are frequency and efficiency of street cleaning, natural decay processes and removal by wind action.
>
> The relationship between these factors and the limiting load value has not been clearly established. However, the following methodology can be used to estimate the limiting value. First assume that the total of all removal processes (other than washoff by runoff) is represented by R, where R is expressed as the fraction removed per day. The load on an area, in pounds per day, is given by L(t) where t represents the time. We also assume the daily addition to the load is Y pounds per acre per day. Therefore, the load at any time t (assuming no washoff) would be:
>
> $$L(t) = L(t-1)\cdot(1-R) + Y \qquad (15.3)$$
>
> The limiting value of L(t) as t become large is simply Y/R. Thus, an estimate of the removal efficiency expressed as an average...will give an estimate of the limiting value..."

That is, the accumulated load, L, at any time, t, can be established if, in addition to knowing the accumulation rate, Y, one also knows either the efficiency of all removal processes, R, or the limiting value of accumulations Y/R. Lombardo and Franz (1972) then goes on to show how, in the absence of test data, R can be estimated. They arrive at a typical value of R = 0.086 which makes the limiting value 11.5 times the rate of daily addition.

Thus to perform the accumulation calculation for any specific parameter for any specific locality, an accumulation rate and a limiting value or removal efficiency must be adopted, either from specific test data or from the literature.

Lombardo and Franz (1972) explain the washoff methodology as follows:

> "The water quality model computes the quality of surface runoff by assuming the amount of constituents washed off in any time interval dt is proportional to the amount of constituent on the surface. This leads to the equation:
>
> $$X_1 - X = X_o(1 - e^{-k\ t})* \quad (15.1)$$
>
> where:
>
> X_o - initial constituent load, lbs. = L(t) from (15.3).
>
> X - constituent load after time interval, t.
>
> t - time interval, hr.
>
> k - constant of proportionality.
>
> Assuming that k is proportional to runoff rate r in inches per hour, and that 90% of constituents on impervious areas and 50% on pervious areas are washed off at a runoff rate of 0.5 in/hr, the value of k is determined as 4.6r for impervious areas and 1.4r for pervious areas. Thus the equation is (for impervious areas):
>
> $$X_o - X = X_o(1 - e^{-4.6rt}) \quad (15.2)$$
>
> Dividing by the total volume of runoff during the time interval, one obtains the average pollutant concentration during the time interval. The calculation is performed for each time interval with Po reduced by the amount of pollutant washed off in the preceding interval."

Thus, to perform the washoff calculation for any specific locality, the

*For derivation see Metcalf and Eddy. Also, the letter symbols used in Equations 15.1 and 15.2 have been changed from the source to make them consistent.

required data are the rainfall data as a time function and the solution to the accumulation calculation is dependent upon the previous calculation for its starting point. To carry out this type of calculation for a period of time is a tedious task best done by computer.

The primary prerequisite to making such a calculation for any specific locality is selection of accumulation rates and limiting values of accumulation for each parameter required and for both pervious and impervious surfaces. Lacking specific data for Spokane except as noted above, the literature search is directed toward filling this gap.

The American Public Works (1969) report approaches the urban runoff pollution potential via analysis of dry dust and dirt collected from selected areas in Chicago. These areas included single family, multiple family and commercial land use. The collected material were all dust and dirt that would pass a 1/8 inch mesh. The dust and dirt samples were blended with water and analyzed. Analytical results are expressed in mg/g of dust and dirt. Since the amount of dust and dirt were developed in terms of accumulation in pounds per day per 100 feet of curb, the analized pollutant potential could be converted to the same basis. The APWA report does not attempt to convert these potential street loadings to urban runoff mass emission. The parameters included in the analysis of dust and dirt infusions included water soluble, volatile water soluble, BOD, COD, PO_4, N, total plate counts, confirmed coliforms and fecal enterococci.

Avco Economic Systems (1970) presents results of sampling and analytical work done on urban runoff flows from 15 test areas in the City of Tulsa, Oklahoma. The 15 areas were selected to be representative of various types of land use. Samples were collected for 30 events and the parameters reported include total coliform, fecal coliform, fecal streptococci, BOD, COD, TOC, Kjeldahl nitrogen, soluble orthophosphate, total, suspended and dissolved solids, pH, chloride and specific conductance. These extensive data are reported in a variety of forms including: (1) summary of means and ranges for all test areas, (2) means and standard deviations for each parameter for each individual test area, (3) average daily load of pollutants per mile of street and (4) calculated average yearly pollution loads, pounds per acre, for each test area.

The summary results are reproduced herein as Tables 7, 8 and 9.

Black, Crow and Eidsness (1971) is devoted primarily to seeking a solution to the impact of combined sewer overflows for six urban drainage basins in Atlanta, George. Runoff quality data was collected for three separately sewered areas, however, as part of the overall program. The parameters sampled include total suspended solids, volatile suspended solids, conductivity, pH, alkalinity, phosphate, and chemical oxygen demand (COD). The number and frequency of sampling are not given nor is the method of averaging given except for volatile suspended solids, phosphate and COD. Much of the data is reported as having been taken under "dry weather flow conditions." Storm condition data was apparently extended by use of best fit equations. Values of COD/BOD and VSS/TSS are given rather than the separate values. The data appear to be of doubtful value for comparison or extrapolation and are not reproduced herein.

In addition to the analytical results shown in the table, a computation was made based on the results which derived an annual BOD yield of 253 pounds per acre.

Bryan (1972) presents results of storm water runoff sampling and analysis for a 1069 acres area of mixed land use in Durham, North Carolina. The tributary area held an average population density of 9.7 persons per acre and land use was distributed as follows: 59.5% residential, 18.6% commercial and industrial, 11.8% public and institutional and 10.1 % unused. Surface characteristics were distributed as follows: 20.2% paved streets and parking, 9.1% roofs, 3.4% unpaved streets, 67.3% lawns, parks and undeveloped. Results of analysis from sampling 17 storms containing a total of 10.64 inches of rainfall, expressed as flow weighted means, are tabulated below:

Parameter	Mean Concentration	Annual Yield Pounds per Acre
Biochemical Oxygen Demand	14.5 mg/l	84
Chemical Oxygen Demand	179 mg/l	1,040
Total Solids	2,730 mg/l	15,900
Volatile Total Solids	298 mg/l	1,730
Chloride as NaCl	12.6 mg/l	73
Total Phosphate	0.58 mg/l	3.4
Lead	0.32 mg/l	1.9
Fecal Coliform	30,000 per 100 ml	

Envirogenics Company (1971) contains urban runoff data for one location in Sacramento, California, for six storm events in December, 1968 through April 1969. For each storm event, an analysis is reported for the beginning of runoff, 3 hours after and 12 to 18 hours after. Parameters reported include total suspended solids, volatile suspended solids, settleable solids, BOD, COD, pH and fecal coliforms. The flow rate was not measured. The characteristics and the size of the tributary area are not reported. A large size is indicated by the pipe size given as 84 inch.

This report subsequently makes a calculation of storm water runoff quality based on the accumulation-washoff method using a quality simulation model. The pollution quantities were generated from an 18 year long record of hourly rainfall data using the following accumulation and washoff relationship:

> $L = P - k_1L - k_2LQ$, where L is accumulation of pollutant over the area, $\dot{L}$ is hourly increase (or decrease) in pollutant accumulation, P is production rate of pollutant, k_1 is decay constant, k_2 is wash-off constant, and Q is storm water runoff flow. The mass flow of pollutant in the runoff is k_2LQ.

Values for the three parameters, P, k_1 and k_2 were selected for the specific study area based on the above described sampling and three sources from the literature, APWA (1969); Weibel, Anderson and Woodward (1964); and Engineering-Science (1967). The method of selection is not shown. Note that two of the data sources are the same as those relied upon by Metcalf and Eddy.

The calculated mean quality of the stormwater runoff is given as follows:

Suspended Solids	250 mg/l
BOD	125 mg/l
Fecal Coliform	6.3×10^4 organisms/l

The Envirogenics Co. report takes advantage of the 18 year rainfall record which was used as a data base to develop a statistical evaluation of the pollution load and presents data in terms of "percent of time pollution is less than given value."

McElroy and Bell (1974). In addition to a complete literature review covering all of the titles reviewed herein, this report presents the results of sampling and analysis of urban runoff for two areas in West Lafayette, Indiana. The two test areas are an urban area and a semi-urban rural area.

The urban area consists of 29 acres of fully developed residential area with an estimated population of 252 persons and having 38 percent impervious surfaces, about half of which are pavement and half roofs. The sampling periods consisted of four closely spaced successive rainfall events between October 27 and November 13 of 1972. Samples and analyses at half hour intervals are reported for BOD and suspended solids concentrations and for concurrent flow. Rainfall is not reported. The time from the last rain preceding the first sampling period is not given.

The yield of pollutants in pounds per acre per storm event are summarized below. The values in the table below are computed from the raw data in the report. The results do not appear in this form in the report.

RUNOFF POLLUTANTS

Storm Event	Length Hours	Inches Depth on Gross Area	Mean Concentration mg/1		Yield pounds/acre	
			BOD	SS	BOD	SS
Oct. 27	5 1/2	0.0052	11.89	29.7	0.014	0.035
Oct. 31	11	0.0073	20.57	26.0	0.034	0.043
Nov. 1	11 1/2	0.1379	5.45	18.6	0.170	0.582
Nov. 13	3	0.0851	12.25	32.7	0.236	0.630

The large yield on November 1, not a full 24 hours later than the

October 31 event, indicates that the October 31 event removed only a small part of the surface accumulation existing at that date.

Mische and Dharmadhikari (1971) presents results of urban run-off quality measurements made for three drainage areas in Tucson, Arizona. The sampling program took samples at five minute intervals on the rising limb of the runoff hydrograph and at 20 minute intervals after the peak discharge was passed. The results presented, however, do not reflect this detail and show only average quality. The averages are described as simple average unweighted for flow. This, combined with the sample frequency pattern, would heavily weight the average toward the "first flush" concentrations. The parameters analyzed include turbidity, suspended solids, total dissolved solids, COD, total coliform, fecal coliform and fecal streptococci. The results obtained are reproduced herein on Table 10.

From the fact that the stormwater collection in the sampled areas was all in open drainageways and that there were open refuse dumps on the banks of the channels would indicate other than typical urban practice. As the authors point out, their results are consistently higher than the Cincinnati and Tulsa results. These facts, and the average method used, indicate that the reported results are of doubtful value for analysis or extrapolation to other areas.

Oblas (1973) includes both an extensive literature search and original pollution measurements. The literature review includes the reports reviewed herein except for Envirogenics Company (1971), Sartor and Boyd (1973), and Black, Crow and Eidsness (1971). Data are also summarized from a number of additional sources to form a table comparing twenty one sources. Portions are reproduced as part of Table 12.

The original runoff quality data developed in this report is for a six month period on a 147 acre area on Mercer Island including residential, commercial, institutional and undeveloped sections. The runoff samples were analyzed for 10 pollution parameters: temperature, pH, nitrate, orthophosphate, DO, alkalinity, color, turbidity, suspended solids, BOD, and COD. Non-concurrent tests were made subsequently for coliforms. Flows were also measured and recorded.

Sartor and Boyd (1973) approaches the potential pollution from urban runoff on the basis of analysis of the materials found on streets collected by a variety of artificial means rather than by analysis of natural rainfall runoff. This investigation was confined solely to street areas and does not include other areas such as sidewalks, driveways, roofs, parking lots or landscaped areas that normally participate in natural urban runoff.

Data were collected from sampling streets in eight cities, two of which were sampled twice at different seasons of the year. The pollutant materials investigated include: total solids, volatile solids, BOD, COD, Kjeldahl nitrogen, soluble nitrate, phosphates, heavy metals (chromium, copper, zinc, nickel, mercury, lead and cadmium) and both chlorinated hydrocarbon and organic phosphate pesticide compounds.

Street areas representing nine classifications of land use were selected in each study city. These land use categories included four types of residential, three types of industrial and two kinds of commercial. Most summaries, however, are given in terms of the three basic categories of residential, industrial and commercial and a mean representing all three.

The sample collection methods ranged from application of artificial rainfall at rates of 0.2 and 0.8 inches per hour for 2 1/4 hours to hand sweeping followed by hand washdown with a hose. The majority of the data were collected by the hand sweeping and hand spray washdown method.

The sampling program was designed to determine the standing load of pollutants at a single point in time without preplanned relation to the last cleaning by either sweeping or natural rainfall. This was apparently recognized as a defect of the program after the sampling had been completed. To attempt to fill the need for specific data on the rate of accumulation and the shape of the accumulation curve, the data were analyzed statistically. The analysis was performed in terms of total solids loading only. The report does not develop the accumulation rate data for any of the pollution parameters such as BOD. The report is cautious in presenting the results of the analysis since the data collection was not planned for this purpose. The results are presented graphically and in terms of "best fit" equations.

Since the data for each pollutant in terms of the total solids is available in the report, it could be implied that the accumulation of each constituent pollutant can be computed by ratio to total solids. This report also shows that such a procedure would lead to incorrect results since it was demonstrated that at least two parameters, BOD and

COD, appear to accumulate at different rates. The significant result of the analysis appears to be that the accumulation rate falls off after 1 to 3 days and is practically asymptotic in 11 or 12 days.

The report also covers discussions of the source of the contaminants that appear on streets and the effectiveness of current public works practices for street cleaning. It also makes some comparisons of instantaneous urban runoff pollution with sanitary sewage pollution but does not compare annual mass emissions.

Results of the street loading investigations are available in five forms:

1. The basic observations in terms of mean loading intensities as pounds per 1000 square feet or pounds per curb mile.

2. The loading intensity in pounds per day since the last rainfall.

3. The loading intensity in pounds per day since the last sweeping or major rainfall.

4. The concentration of pollutants in the solids loading.

5. The solids accumulation rate from analysis as "best fit" equations.

The results for selected parameters in terms of observed loadings in pounds per day per curb mile as weighted average for all cities and [illegible] land areas is reproduced in Table 11. Similar data for observed loading per day since last cleaning by rain, sweeping and both are also included.

The results of analysis of solids accumulation produced the following "best fit" curves where:

X = elapsed time since last clean (days)

Y = solids loading on streets (lb/curb mile)

Residential land-use category:

$$Y = 426\ (e^{0.0565X});$$

Industrial land-use category:

$$Y = X/(0.00187 + 0.000601X);$$

Commercial land-use category:

$$Y = 694 - 519/X;$$

All land-use areas combined:

$$Y = 296\ (X^{0.511});$$

Weibel, Anderson and Woodward (1963). This reference is the "Cincinnati study" as referred to above. The Cincinnati study reports the results of urban runoff sampling for a period July 1962 through September 1963 for a 27 acre residential and light commercial area. The area is estimated to have 37 percent impermeable area.

Samples were taken continuously throughout the rainfall events manually (July to October) and automatically October through September. Flow hydrographs were taken simultaneously. Samples were selected for analysis on the basis of observed hydrograph. Basis, however, is not stated. Parameters reported are: turbidity, color, pH, alkalinity, hardness, chlorides, suspended solids, volatile suspended solids, COD, BOD, NO_2, NO_3, NH_3, Organic N and soluble PO_4. Mean and range for the year are reported and with breakdown of means by season. Bacterial counts for total and fecal coliform and fecal streptococci are reported counts exceeding in percent of samples.

Tables are also presented for:

1. Mean concentrations observed as function of time after start of runoff.

2. Stormwater runoff loads in pounds per year per acre compared with raw sanitary sewage loads.

The values given in the Cincinnati report for annual emission in urban wastewater are as follows:

Constituent	Annual Emission Pounds per Acre per Year
SS	730
VSS	160
COD	240
BOD	33
PO_4	2.5
Total N	8.9

Evaluation of the Literature Sources

The literature presents the development of a methodology for quality evaluation in Metcalf & Eddy (1971). At the time that Metcalf & Eddy made their study, there were no adequate raw data for application of the method. Their attempts to apply the method using the data from APWA (1969) and Weibel, Anderson, and Woodward (1963) were not satisfactory. The literature search indicates that there are still no fully satisfactory data sources for application of the Metcalf & Eddy methodology of surface accumulation and washoff.

The effort reported in Sartor and Boyd (1973), although limited to only the street surface portion of urban runoff, recognized the need for determining the shape of the pollutant accumulation curve but did not produce a satisfactory end product that allows quantitative expression of these curves for the significant parameters. Further manipulation of their results may be the best data source to date for application of the simulation method.

Envirogenics Co. (1971) is the only reference found which showed application of the simulation method to a specific problem. It also demonstrated one of the significant advantages of the simulation method when applied to a long term precipitation record, namely statistical analysis of the pollution potential. Unfortunately, this application appears to have been made on the basis of weak basic data.

Only three data sources are sufficiently intensive in number of observations and parameters analyzed to give confidence to evaluation of mass emission rates based on mean concentrations or on computed pollution yield per unit of time. These are the Cincinnati, Tulsa and Durham studies reported in Weibel, Anderson and Woodward (1963), Avco Economics Systems (1970) and Bryan (1972) respectively. The results from these three reports for key parameters are tabulated for comparison in Table 12. Also shown in Table 12 are results from two other cities, Lubbock, Texas and Ann Arbor, Michigan, quoted from Oblas (1973) and the simulation computed results from Envirogenics Co. (1971) for Sacramento, California.

Heading Table 12 are the Spokane evaluations from Esvelt & Saxton/Bovay (1972) The various sources give their results in two forms:

1. As mean concentration of pollutant in runoff waters which does not recognize the volume of runoff waters.

2. As annual yield of pollutant per acre of tributary area which does recognize the volume of runoff waters.

The three cities, Cincinnati (C), Tulsa (T), and Durham (D) have roughly comparable annual rainfalls that are approximately twice that of Spokane. To compare the reported results in the two alternative forms, the annual pollutant load for the presently combined sewer service area in Spokane is computed in each case. Where the data are given as mean concentration of the pollutant, it is converted to annual load on the basis of 1,500 million gallons per year estimated volume of runoff for Spokane per Esvelt & Saxton/Bovay. Where the data are given as annual pounds yield of pollutant per acre of tributary area, the annual load is computed on the basis of the 16,000 acres tributary to the Spokane combined sewer system.

Considering BOD, Durham and Tulsa report comparable concentrations at 14.5 and 11.8 mg/l respectively. For these two cities, the annual yield per acre is also reported. Here, Durham shows 84 pounds per acre as compared with 30 for Tulsa, showing that the difference in runoff exaggerates the difference in concentration. For Cincinnati only, the annual yield is given at 33 pounds per acre. When these values are applied to Spokane runoff and area, the results based on concentration become small compared with those based on yield per acre. Note that the concentration is high as developed by simulation for Sacramento, which has low annual rainfall which is comparable to Spokane. Keeping in mind the mechanism of accumulation to an asymptotic limit, the annual yield expressed in pounds per acre appears to be a more valid basis for extrapolation than mean concentration. The equivalent of 39 pounds per acre per year developed by Esvelt & Saxton/Bovay appears to be consistent with the range of 30 to 84 pounds per acre per year from C, T and D.

Several investigators have expressed concern that BOD results may be invalid due to interference by toxic heavy metals and have advocated inclusion of COD data as an alternative. COD data for C, T and D are available and are equal to 240, 226 and 1040 pounds per acre per year respectively. The ratios of COD to BOD are 7.3 and 7.5 to 1 for C and T but over 12 for D. The Durham ratio seems excessive. The C and T values are in close agreement.

Nitrogen nutrients are reported only for C and T. D contained no nitrogen analysis. The results for C in terms of annual yield are given only for total nitrogen but details in the report give a breakdown into components as follows:

Nitrites	1.7%
Nitrates	13.6%
Ammonia	21.4%
Organic	63.3%

The nitrogen results for T are given only in terms of organic Kjeldahl nitrogen. (Presumably only the organic fraction of the total Kjeldahl analysis is referred to and does not include ammonia.) The comparative values for C and T as organic nitrogen are 5.6 and 2.1 pounds per acre per year. The concentration selected by Esvelt & Saxton/ Bovay is equal to 3.1 pounds per acre when applied to Spokane, falling between the C and T values.

All three, C, T and D, report phosphates on an annual yield basis. C reports as "total soluble PO_4," T as "soluble orthophosphate," and D as "total phosphate." Values given are in close agreement being 2.5, 3.4 and 3.0 pounds per acre per year respectively for C, T and D. The concentration value selected by Esvelt & Saxton/Bovay is equal to 0.4 pounds per acre per year which is only about one eighth of the average for C, T and D.

Heavy metals are not compared in Table 12 since only D reports values. The annual yield of lead reported for D is 1.9 pounds per acre per year. Sartor and Boyd (1972) also report heavy metals but in terms of found street loadings. For lead, Sartor and Boyd report 0.57 and 0.65 pounds per curb mile for lead and zinc respectively, the two most significant heavy metals found. For Spokane as a whole there are approximately 0.06 curb miles per acre. Therefore, the Sartor and Boyd data mean that, at the random times they observed, .034 pounds of lead per acre are available to be washed off. Thirty rainfall events in a year finding this loading would yield 1.0 pounds per acre per year which checks the order of magnitude reported for Durham. The Sartor and Boyd ratio of zinc to lead provides a means for estimating the yield of zinc.

None of the reports attempted to develop coliform pollution in terms of yield. All data are in terms of observed mean concentration. Total coliforms are reported for both C and T at 58,000 and 87,000 organisms per 100 ml respectively. Esvelt & Saxton/Bovay selected 100,000 for their Spokane evaluation. The reported values for fecal coliforms are 10,900, 420 and 30,000 organisms per 100 ml for C, T and D respectively. In addition, there is a value of 6,300 organisms/100 ml used by Envirogenics Co. for Sacramento.

The Tulsa report gives solids in three forms, total, suspended and dissolved. Durham is in terms of total and volatile total. Cincinnati is in terms of suspended and volatile suspended. Since the Esvelt & Saxton/Bovay values for Spokane estimate are in terms of suspended solids, and two of the references include this data, suspended solids is selected for basis of comparison in Table 12. There is supplemental data from Envirogenics for Sacramento and from Lubbock, Texas and Ann Arbor, Michigan. All except the Cincinnati results are available only in concentration form. The Tulsa data is converted to yield on the basis of ratios shown in the report between total and suspended. Expressed as concentration, the suspended solids values range from 210 to 1370 mg/l, with the stronger evidence in the range around 300 mg/l which is in substantial agreement with the 260 mg/l selected by Esvelt & Saxton/Bovay. As annual yields there are only two examples for comparison but both give much higher values, of the order 3 to 5 times greater than that indicated by concentration applied to Spokane runoff.

McElroy and Bell (1974) data cover only four storms closely spaced for West Lafayette. Hence, the data do not yield a check in terms of annual yield for the two parameters tested. The observed weighted mean concentrations of BOD ranging from 5 to 21 mg/l are similar to the results reported for Tulsa, Durham and Lubbock. The suspended solids in the range of 18 to 33 mg/l are, however, about one tenth of those reported for these same above cited locations. There is a potential check of accumulation rate between the November 1 event, which appeared to be intense enough to remove a large part of the accumulation, and the November 13 event. The indicated accumulation rate is .02 pounds of BOD per acre per day. This converts to approximately 0.33 pounds per curb mile per day which is only one sixth of the rate observed by Sartor and Boyd (1973).

Estimate of the Present Urban Runoff Mass Emission

Based on the foregoing literature evaluation as summarized in Table 12, a selection is made of unit rates of annual yield to arrive at an approximation of the present mass emission from the 20,000 acres total presently sewered to surface waters in Spokane. Note that Table 12 is in terms of 16,000 (actually 16,510 per Table 1) acres tributary area which represents the combined sewer system which drains to the sewage treatment plant.

The selected unit yield and the total annual yield for 20,000 acres are shown in Table 13. Table 13 also includes an estimation of the summer season yield, between June 1 and September 30. The basis for estimation of summer season yield is a factor of .25 applied to the total annual to reflect an interaction between 0.33 of the accumulation time and 0.20 of the available precipitation for washoff.

The selected values shown in Table 13 are intended to be on the high side to evaluate the maximum potential impact.

A check of the total annual runoff volume for the 20,000 acres presently served is shown in Table 14 The breakdown of areas is an estimate based on the city wide breakdown shown in Table 2. Streets as defined in Table 2 means the easement in which the street is located rather than the paved area itself. Impervious is defined as impervious areas connected to the street or sewer by pipe or impervious conveying surface. Roof areas which discharge onto the ground are "pervious" by this definition. The estimated total annual runoff from the 20,000 acres presently sewered is 2,430 million gallons. This is in substantial agreement with 1,500 million gallons from 16,000 acres tributary to the combined sewers as developed by Esvelt & Saxton/Bovay. The summer season runoff volume is estimated to be twenty percent of the annual or 490 million gallons.

Accompanying these annual runoff volumes, the yields for the three most significant parameters are estimated as follows:

Parameter	Total Annual Yield Pounds	Summer Yield Pounds
BOD	1,000,000	250,000
Total N	90,000	22,500
Ortho P	20,000	5,000

In addition to annual and seasonal quantity and quality of the present urban runoff, there is one more characteristic of importance to evaluation of impact and treatment possibilities. This characteristic is the total volume of individual storm events. Bovay (1973) presents an evaluation of this characteristic in terms of a 2,000 acre element on a statistical basis. Based on a statistical analysis of rainfall events, Bovay (1973) concludes that the volume of runoff from 2,000 acres with a return period of 6 months is 14 million gallons or 42 acre feet. Extending this to the presently combined sewer service area of 16,000 acres, the storm event runoff volume for 6 month return frequency is 336 acre feet. For the total of combined and separate storm sewers which serves approximately 20,000 acres, the volume is 420 acre feet. The site layout for the proposed treatment plant enlargement and upgrade contains provision for approximately 14 million gallons on 42 acre feet of storm water storage.

TABLE 1

CITY OF SPOKANE SEWERAGE SYSTEM AREAS[1]

	Area, Acres				
	Combined	Separate	Unsewered		
Zone	Sewers	Sewers[2]	(3)	(4)	Total[5]
1	1,047	668	15	862	2,592
2	1,655	280	79	688	2,702
3	1,475	125	12	155	1,767
4	648	20	31	92	791
5	2,190	189	107	257	2,743
6	785	21	4	62	872
7	1,329	789	21	588	2,727
8	4,472	0	324	67	4,863
9	807	327	46	385	1.565
10	1,463	1,092	0	57	2,612
Total	15,871	3,511	639	3,213	23,234

Total City Area = 32,845 acres.

[1]As measured from mapping contained in Esvelt & Saxton/Bovay (1972) not including Spokane River surface area.

[2]Sewers collecting storm drainage only and discharging directly to surface waters. Not connected to the combined sewer system.

[3]Unsewered but topographically tributary to an adjoining area drained by sewers which connect to the combined system.

[4]Unsewered and topographically not tributary to any sewered area.

[5]Total within the Esvelt & Saxton/Bovay study area which does not include the entire City of Spokane.

TABLE 2

LAND USE CATEGORIES IN CITY OF SPOKANE[1]

Land Use	Area, Acres	
Residential	8,713.65	
Business and Commercial	991.79	
Industry	1,437.05	
Streets and Alleys	7,098.63	
Public and Semi Public Other than Parks	2,042.53	
Subtotal		20,283.65
Parks	1,778.38	
Agricultural	307.49	
Undeveloped	9,937.27	
Water	543.00	
Subtotal		12,566.14
TOTAL		32,847.79

[1]From Table IV-A of Esvelt & Saxton/Bovay 1972, abbreviated.

TABLE 3

ESTIMATED OVERFLOW QUANTITIES, AVERAGE YEAR, CITY OF SPOKANE

Overflow Point No.	Location	Acres Contributing Storm Runoff	Peak Flow Rate CFS	Average Duration Per O.F. Hrs.	Average Volume Per O.F. M.G.	Total Volume Per Year M.G.	No. of Overflows Per Year	Remarks
1	Surro at S. Riverton	64	0.76	0.35	0.01	0.01	3	
2	Rebecca at Upriver Dr.	100	3.90	1.56	0.03	0.45	17	
3	Regal at S. Riverton	51	2.18	2.73	0.02	1.25	75	
4	Altamont at S. Riverton	49	1.21	0.83	0.01	0.05	5	
5	Magnolia at S. Riverton	60	2.70	1.56	0.02	0.31	17	
6	Sharp at Perry	121	6.89	9.50	0.28	13.30	47	
7	Desmet at B.N. R.R.	0	0	0	0	0	0	Sanitary only
8	Mallon at Perry	187	8.97	3.15	0.09	0.43	59	
9	Front at Erie	1,975	74.65	1.72	0.55	10.91	20	
10	Front at Erie	276	3.94	0.63	0.03	0.08	3	
11	5th at Arthur	64	2.49	1.59	0.02	0.26	17	
12	3rd at Perry	1,170	41.16	1.98	0.39	10.53	27	
13	3rd at Arthur	38	2.75	1.98	0.02	0.61	27	
14	Front at Erie	112	0	0	0	0	0	Restricted flow
15	Highdrive near 33rd	529	11.90	0.61	0.07	0.30	4	
16	Cedar at Riverside	1,537	35.96	1.80	0.39	8.90	23	
17	Cedar at Riverside	17	0	0	0	0	0	
18	Lincoln at Trent	588	56.44	2.02	0.42	15.68	37	
19	Havermale at Howard	0	0	0	0	0	0	
20	Astor at Desmet	34	1.17	1.08	0.01	0.08	10	
21	N. End of Wash. St. Br.	645	23.22	1.72	0.24	5.75	23	
22	N. End of Howard St. Br.	79	1.87	1.95	0.08	2.90	37	
23	Monroe at Bridge St.	86	10.44	1.72	0.08	1.53	20	
24	Cedar at Ide	181	3.93	1.95	0.03	2.97	37	
25	Cedar at Main	35	1.47	1.80	0.01	0.25	22	

312.7-34

TABLE 3 (continued)

Overflow Point No.	Location	Acres Contributing Storm Runoff	Peak Flow Rate CFS	Average Duration Per O.F. Hrs.	Average Volume Per O.F. M.G.	Total Volume Per Year M.G.	No. of Overflows Per Year	Remarks
26	Main at Oak	0	0	0	0	0	0	Restricted flow
27	1st at "A" St.	20	0.32	1.70	0.01	0.10	17	
28	"A" St. at Linton	243	9.11	1.66	0.09	0.85	10	
29	Under Freeway Bridge	49	1.32	0.87	0.01	0.05	4	
30	"A" St. at Linton	50	1.95	1.56	0.01	0.23	16	
31	"A" St. at Linton	0	0	0	0	0	0	Sanitary Only
32	Clarke at Linton	0	0	0	0	0	0	Restricted Flow
33	Sherwood at Summit	74	2.99	1.74	0.02	0.43	20	
34	Nettleton at Ohio	135	6.65	9.32	0.15	6.88	46	
35	Nora at Pettet	394	18.91	2.12	0.12	8.26	69	
36	Cochran at Grace	5,185	182.00	9.21	6.03	283.60	47	
37	Cochran at Buckeye	86	4.51	4.84	0.07	4.42	66	
38	Columbia Circle	129	6.19	2.12	0.04	2.70	69	
39	Kiernan at NW Blvd.	635	16.00	1.80	0.17	3.96	23	
40	NW Blvd. at Assembly	1,140	25.22	9.40	1.24	58.46	47	
41	NW Blvd. at Assembly	0	0	0	0	0	0	Albi Stadium-San only
42	NW Blvd. at Hartley	84	1.35	1.57	0.02	0.37	17	
43	NW Blvd. at Assembly	17	0.63	0.62	0.01	0.02	4	
44	Assembly at A.L. White	0	0	0	C	0	0	Restricted flow
45	STP Headworks	n/a	n/a	n/a	n/a	n/a	n/a	Manual gate
	Totals	16,239	575.15			446.88		

Source: Esvelt & Saxton/Bovay (1972).

TABLE 4

URBAN RUNOFF QUALITY DATA FROM ESVELT & SAXTON/BOVAY

Grab Samples from Storm Sewer
at Nine Mile Road and Assembly Street

Parameter	Units	June 2, 1971	August 22, 1971
BOD	mg/l	14	41
Total Phosphorus	mg/l	0.26	0.35
Total Kjeldahl Nitrogen	mg/l	1.5	23.6
Suspended Solids	mg/l		100
Volatile Suspended Solids	mg/l		58

Time Interval Sampling for a Rainfall Event
August 22, 1971 at Superior and Cataldo Streets

		Time After Start of Flow					
Parameter	Units	5 min	1/4 hr	1/2 hr	1 hr	2 hrs	3 hrs
BOD	mg/l	100	50	45	40	30	15
Suspended Solids	mg/l	1900	1600	1450	1200	650	50
Total Phosphorus	mg/l	2	1.8	1.8			
Kjeldahl Nitrogen	mg/l	14	10	8			

TABLE 5

CITY OF SPOKANE SEWER SYSTEM OVERFLOWS[1]

Overflow Structure Name	NPDES Outfall Number	Average Number of Overflow Occurrances/Year		Average Duration of Overflow Occurrances (hours/occurrance)		Average Overflow Volume (1000 gal/occurrance)		Average Yearly Overflow Quantity (gallons)[2]	
		Wet Weather	Dry Weather	Wet Weather	Dry Weather	Wet Weather	Dry Weather	Wet Weather	Dry Weather
Hartley St. Outfall	002	17	0	1.57	0	20	0	340,000	0
Hollywood Outfall	004	47	0	9.40	0	1,250	0	58,750,000	0
Garland Ave Relief O.	006	23	0	1.80	0	170	0	3,910,000	0
Columbia Circle O	007	69	0	2.12	0	40	0	2,760,000	0
Rivercrest Pump Sta. O.	008	1	1	8	8	8	8	8,000	8,000
TJ Meenach Dr. O.	010	66	0	9.15	0	6,100	0	402,600,000	0
Ft. Geo. Wright Pump Sta Overflow	011	1	1	8	8	5	5	5,000	5,000
Nora & Pettet Dr. O.	012	60	0	2.12	0	120	0	7,200,000	0
Natorium Pk. Pump Sta.	013	1	1	8	8	15	15	15,000	15,000
Sherwood & Summit O.	014	20	0	1.74	0	20	0	400,000	0
Ohio Ave. O.	015	46	0	9.32	0	150	0	6,900,000	0
High Br. Park O	016	17	0	1.65	0	110	0	1,870,000	0
Westgrove Sewer Syphon Overflow	017	1	1	8	8	10	10	10,000	10,000
Seventh Ave & Cannon hill Overflow	019	4	0	0.87	0	10	0	40,000	0
So. Manito Relief Sewer Overflow	020	4	0	0.61	0	70	0	280,000	0
Clark Ave. O.	021	1	1	8	8	10	10	10,000	10,000
Elm St. Outfall	022	1	1	8	8	10	10	10,000	10,000
Cedar & Ide St. O.	023	37	0	1.95	0	80	0	2,960,000	0
Cedar & Riverside O.	024	23	0	1.80	0	390	0	8,970,000	0
Cedar & Main Ave O.	025	22	0	1.80	0	10	0	220,000	0

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	CITY OF SPOKANE SEWER SYSTEM OVERFLOWS	TABLE 5

TABLE 5 (continued)

Overflow Structure Name	NPDES Outfall Number	Average Number of Overflow Occurrences/Year		Average Duration of Overflow Occurrences (hours/occurrance)		Average Overflow Volume (1000 gal/occurrance)		Average Yearly Overflow Quantity (gallons)	
		Wet Weather	Dry Weather	Wet Weather	Dry Weather	Wet Weather	Dry Weather	Wet Weather	Dry Weather
Lincoln & Trent Ave. O.	026	37	0	2.02	0	420	0	15,540,000	0
Monroe St. O.	027	20	0	1.72	0	80	0	1,600,000	0
Howard St. O.	029	37	0	1.95	0	80	0	2,960,000	0
Washington St. O.	030	23	0	1.72	0	240	0	5,520,000	0
Astor & Desmet O.	031	10	0	1.08	0	10	0	100,000	0
Erie St. Overflow	032	2	0	0.63	0	30	0	90,000	0
Erie St. Outfall	033	27	0	1.96	0	430	0	11,610,000	0
Front Ave. O	034	20	0	1.72	0	550	0	11,000,000	0
Mallon St. O.	035	59	0	3.15	0	90	0	5,310,000	0
Desmet Ave. O.	036	1	0	1	0	5	0	5,000	0
Sharp Ave. O.	037	47	0	9.5	0	280	0	13,160,000	0
Magnolia St. O.	038	17	0	1.56	0	20	0	340,000	0
Altamount St. O.	039	5	0	0.83	0	10	0	50,000	0
Regal St. O.	040	75	0	2.73	0	20	0	1,500,000	0
Rebecca St. O.	041	17	0	1.56	0	30	0	510,000	0
Surro Drive O.	042	3	0	0.35	0	10	0	30,000	0
TOTALS								556,583,000	58,000

[1]Source: City of Spokane application to DOE for NPDES Permit, November 1973.
[2]This column = (Average Number Occurrances/Year) X (Average Overflow Volume).

TOTAL YEARLY FLOW = 566,641,000 Gallons = 75,750,000 Cu. Ft. = 1,739 Acre-Ft.

Average Wet Weather Flow = 1.55 MGD (= 566,583,000 ÷ 365)
Average Dry Weather Flow = 158 GPD
Average Total Flow for Year = 1.55 MGD = 2.40 CFS = 4.76 Acre-Ft./Day.

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army Seattle District Corps of Engineers Kennedy – Tudor Consulting Engineers	CITY OF SPOKANE SEWER SYSTEM OVERFLOWS	TABLE 5 (cont.)

TABLE 6

CITY OF SPOKANE SEWER SYSTEM BYPASSES[1]

Bypass Structure Name	NPDES Outfall Number	Average Number of Bypass Occurrances/Year		Average Duration of Bypass Occurrances (hours/occurrance)		Average Bypass Volume (1000 gal/occurrance)		Average Yearly Bypass Quantity (gallons)	
		Wet Weather	Dry Weather	Wet Weather	Dry Weather	Wet Weather	Dry Weather	Wet Weather	Dry Weather
Spokane STP Bypass	005	60	0	3	0	750	0	45,000,000	0
Ft. Geo. Wright Syphon Blowoff	009	1	1	8	8	5	5	5,000	5,000
Federal Sewer Syphon Blowoff	018	1	1	8	8	10	10	10,000	10,000
Elm St O	022	1	1	168	168	400	400	400,000	400,000
Div "D" Interceptor Syph Blowoff	028	1	1	8	8	20	20	20,000	20,000
Erie St Overflow	032	1	0	3-4 Mo.	0	24,000	0	24,000,000	0
Front Ave Outfall	034	1	0	3-4 Mo.	0	See 032	--	--	--
Mallon St. O	035	1	0	3-4 Mo.	0	Unknown	--	Unknown	--
TOTAL								69,435,000	435,000

[1]Source City of Spokane application to DOE for NPDES Permit, November 1973.

TOTAL YEARLY FLOW = 69,870,000 Gal. = 934,000 Cu. Ft. = 21.44 Acre-Ft.

Average Wet Weather Flow = 190,232 GPD (= 69,435,000 ÷ 365)
Average Dry Weather Flow = 1,192 GPD
Average Total Flow for Year = 0.191 MGD = 0.296 CFS = 0.59 Acre-Ft./Day

Total Yearly Overflow + Bypass Quantity = 636,511,000 Gal. = 85,095,000 Cu. Ft. = 1,954 Acre-Ft.
Average Total Daily Overflow + Bypass Flow for Year = 1.74 MGD = 2.70 CFS = 5.35 Acre-Ft./Day

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept of the Army Seattle District Corps of Engineers Kennedy – Tudor Consulting Engineers	CITY OF SPOKANE SEWER SYSTEM BYPASSES	TABLE 6

TABLE 7

AVERAGE YEARLY POLLUTANT LOADS FOR 15 TEST AREAS IN TULSA, OKLAHOMA

Test Area	Classification	Acres	Pollution Load: lbs/acre/year BOD	COD	Organic Kjeldahl Nitrogen	Soluble Ortho-Phosphate	Total Solids
1	Light Industrial	686	30	250	2.5	8.0	5,100
2	Commercial-Retail	272	27	150	3.3	2.9	920
3	Residential	550	14	110	2.6	3.3	1,200
4	Med. Ind.-Residential	938	44	320	3.0	3.3	1,900
5	Residential	507	33	250	1.3	1.6	490
6	Medium Industrial	368	21	160	1.1	1.5	600
7	Residential	197	15	90	1.5	1.3	790
8	Residential	211	33	250	1.5	2.5	840
9	Residential	64	20	230	1.3	2.0	830
10	Commercial (Office)	206	48	470	3.6	3.1	1,900
11	Residential-Com. Mix	815	35	290	1.7	2.1	1,400
12	Open Land-Runways	223	25	140	1.2	1.7	630
13	Residential	212	25	150	2.4	2.0	780
14	Recreation (Golf)	263	12	60	1.1	1.1	660
15	Residential	74	25	90	0.8	1.7	570
	WEIGHTED AVERAGE	372	30	225	2.1	3.0	1,630

Source: Avco Economic Systems (1970).

TABLE 8

SUMMARY OF ANALYTICAL RESULTS FROM
15 TEST AREAS IN TULSA, OKLAHOMA

Parameter	Mean of the Test Areas	Range of the Test Area Means
Bacterial (number/100 ml)*		
Total Coliform	87,000	5,000 - 400,000
Fecal Coliform	420	10 - 18,000
Fecal Streptococcus	6,000	700 - 30,000
Organic (mg/1)		
BOD	11.8	8 - 18
COD	85.5	42 - 138
TOC	31.8	15 - 48
Nutrients (mg/1)		
Organic Kjeldahl Nitrogen	0.85	0.36 - 1.48
Soluble Orthophosphate	1.15	0.54 - 3.49
Solids (mg/1)		
Total	545	199 - 2,242
Suspended	367	84 - 2,052
Dissolved	178	89 - 400
Other Parameters		
pH	7.4	6.8 - 8.4
Chloride (mg/1)	11.5	2 - 46
Specific conductance (micromhos/cm)	108	36 - 220

*Geometric mean.

Source: Avco Economic Systems (1970).

TABLE 9

AVERAGE DAILY LOADS PER MILE OF STREET FROM THE 15 TEST AREAS IN TULSA, OKLAHOMA

Test Area No.	Classification	Total Acres	Total Street Miles[1]	Total Street Acres	Average Load (lbs/day/mile of street) BOD	COD	Total Solids	Organic Kjeldahl Nitrogen	Soluble Ortho-Phosphate
1	Light Industrial	686	11.46	101	4.85	41.1	838	0.41	1.30
2	Commercial-Retail	272	7.41	56	2.54	15.1	92	0.32	0.29
3	Residential	550	14.87	105	1.41	11.5	120	0.26	0.34
4	Med. Ind.-Residential	938	28.40	214	3.98	29.3	175	0.28	0.30
5	Residential	507	16.32	100	2.80	21.4	43	0.11	0.13
6	Medium Industrial	368	12.24	85	1.70	12.7	49	0.09	0.13
7	Residential	197	6.84	47	1.20	7.2	63	0.12	0.10
8	Residential	211	6.97	60	2.72	20.9	69	0.12	0.21
9	Residential	64	3.11	24	1.12	13.1	47	0.07	0.11
10	Commercial (Office)	206	12.99	104	2.10	20.4	82	0.16	0.13
11	Residential-Com. Mix	815	49.05	340	1.60	13.3	66	0.08	0.15
12	Open Land-Runways	223	3.39[2]	103[2]	4.53	25.5	113	0.22	0.30
13	Residential	212	5.58	42	2.58	15.2	81	0.25	0.20
14	Recreation (Golf)	263	2.07	20	4.26	20.5	23	0.37	0.38
15	Residential	74	2.06	16	2.47	8.7	56	0.07	0.17
	MEAN	372	12.18	94	2.60	18.4	128	0.20	0.28

[1]Adjusted value based on width of streets and easements.
[2]Miles and acres of airport runways.

Source: Avco Economic Systems, Inc. (1970).

TABLE 10

AVERAGE URBAN RUNOFF WATER QUALITY FOR THREE LAND AREAS IN TUCSON, ARIZONA

	Drainage Area Type		
	Fully Developed Residential	Partly Developed Residential, Commercial	Partly Developed Residential and Industrial
Watershed Area, sq. mi.	0.90	3.50	1.90
Turbidity, JTU	624	1,059	1,734
Suspended Solids mg/l	777	1,394	1,876
Total Dissolved Solids mg/l	189	173	264
COD mg/l	230	185	497
Total Coliform/100 ml	590,000	420,000	420,000
Fecal Coliform/100 ml	1,030,000	820,000	190,000
Fecal Streptococci/ 100 ml	130,000	7,270,000	60,000

Source: Mische and Dharmadhikari (1971).

TABLE 11

POTENTIAL URBAN RUNOFF POLLUTANTS MEASURED AS LOADINGS ON STREET SURFACES -- AVERAGE FOR EIGHT CITIES

Parameter	Units	Surface Loadings, Per Curb Mile			
			Apparent Accumulations		
		Observed at Random Times[1]	Since Last Sweep[2]	Since Last Major Rain[3]	Since Last Rain or Sweep[4]
BOD	Pounds	14	4.5	1.9	5.5
COD	Pounds	95	16	10	22
Phosphates	Pounds	1.1	0.17	0.29	0.21
Nitrate	Pounds	.094	0.058	0.047	0.066
Kjeldahl N	Pounds	2.2	0.44	0.31	0.67
Lead	Pounds	0.57	0.13	0.22	0.30
Zinc	Pounds	0.65	0.17	0.30	0.53
Total Heavy Metal	Pounds	1.7			1.1
Total Coliform	10^9 Organisms	99	8.0	15.0	22.0
Fecal Coliform	10^6 Organisms	5600	800	800	1100
Total Pesticides	10^{-6} Pounds	1300			2400

[1]Weighted average for 8 cities.
[2]Numerical mean for 5 cities.
[3]Numerical mean for 8 cities.
[4]Numerical mean for 7 cities.

Source: Sartor and Boyd (1973).

TABLE 12

COMPARISON OF URBAN RUNOFF POLLUTION YIELDS FROM LITERATURE APPLIED TO CITY OF SPOKANE

Reference	BOD Concentration Average Conc.[1]	BOD Concentration Annual Load[2]	BOD Area Loading Area Load[3]	BOD Area Loading Annual Load[4]	COD Concentration Average Conc.[1]	COD Concentration Annual Load[2]	COD Area Loading Area Load[3]	COD Area Loading Annual Load[4]	Total Kjeldahl Nitrogen Concentration Average Conc.[1]	Total Kjeldahl Nitrogen Concentration Annual Load[2]	Total Kjeldahl Nitrogen Area Loading Area Load[3]	Total Kjeldahl Nitrogen Area Loading Annual Load[4]	Phosphates Concentration Average Conc.[1]	Phosphates Concentration Annual Load[2]	Phosphates Area Loading Area Load[3]	Phosphates Area Loading Annual Load[4]	Suspended Solids Concentration Average Conc.[1]	Suspended Solids Concentration Annual Load[2]	Suspended Solids Area Loading Area Load[3]	Suspended Solids Area Loading Annual Load[4]	Total Coliforms Conc. Organisms/100 ml	Fecal Coliforms Conc. Organisms/100 ml
SPOKANE Kevelt & Benton/Bovey (1972)	50*[5]	620*	39	620*	—	—	—	—	6*	50*	3.1	50*	0.5*	6.3	0.4	6.5*	260*	3,300*	206	3,300*	100,000*	—
CINCINNATI Weibel, Anderson & Woodward (1963)	—	—	33*	330	—	—	260*	3,840	—	—	5.4[6]	96	—	—	2.5*	40	210*	2,625	730*	11,600	58,000*	10,500*
TULSA Area Economic Systems (1970)	11.0*	130	30*	400	85.5*	1,075	226*	3,610	0.85*	10.6	2.1*	36	1.15*	14.4	3.0*	48	367*	4,300	1,000[7]	17,360	67,000*	620*
DURHAM Bryan (1972)	14.5*	180	7.6*	1,340	179*	2,230	1,040*	16,640	—	—	—	—	0.50*	7.3	3.4*	54	—	—	—	—	—	36,000*
SACRAMENTO Environgenetics Company (1971)	125*	1,560	—	—	—	—	—	—	—	—	—	—	—	—	—	—	250*	3,125	—	—	—	6,300*
LUBBOCK TEXAS ANN ARBOR MICHIGAN Weibel (1973) quoting other references	25* 67*	310 530	— —	— —	— —	— —	— —	— —	— 0.5*	— 6.3	— —	— —	— 3.0*	— 47.5	— —	— —	530* 1,370*	6,625 17,125	— —	— —	— —	— —

[1]Average concentration in mg/l except as otherwise noted

[2]Annual load in thousands of pounds based on calculation from mean concentration and annual runoff of 1500 million gallons (12.5 × mg/l = 1000's of pounds/year).

[3]Average yield of the pollutant in pounds per acre per year

[4]Annual load in thousands of pounds calculated for an area of 16,000 acres (16 × lb/acre/year = 1000's of pounds/year).

[5]An asterisk (*) indicates value from cited reference—all other values are calculated.

[6]Kjeldahl N estimated at 0.63 of total given as 8.7 pounds per acre per year

[7]Computed from values given for total solids and ratio of 80 to total shown in referenced report.

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	COMPARISON OF URBAN RUNOFF POLLUTION YIELDS FROM LITERATURE APPLIED TO CITY OF SPOKANE	TABLE 12

TABLE 13

ESTIMATED MASS EMISSION OF URBAN RUNOFF FROM
20,000 ACRES OF PRESENTLY SEWERED AREA IN SPOKANE

Parameter	Annual Loading: Unit Rate Pounds per Acre	Annual Loading: Total Load Pounds	Seasonal Load June 1-Sept 30 Pounds
Suspended Solids	500	10,000,000	2,500,000
BOD	50	1,000,000	250,000
COD	240	4,800,000	1,200,000
Nitrite	0.08	1,600	400
Nitrate	0.61	12,200	3,050
Ammonia	0.96	19,200	4,800
Organic Nitrogen	2.85	57,000	14,250
Total Nitrogen	4.5	90,000	22,500
Orthophosphate	1.0	20,000	5,000
Lead	0.5	10,000	2,500
Zinc	0.6	12,000	3,000

TABLE 14

ESTIMATE OF IMPERVIOUS AREA IN THE
PRESENTLY SEWERED AREA OF 20,000 ACRES

	Area Acres	Percent Impervious	Impervious Area, Acres
Residential	8,453	.15	1,268
Business & Commerical	961	.60	577
Industry	1,437	.25	359
Streets	6,885	.67	4,613
Public & Semi Public	1,940	.35	679
Parks & Other Open	324	.05	16
Total Service Area	20,000		7,512

$$7512 \text{ Acres} \times 0.7 \text{ runoff coef.} \times \frac{17 \text{ inches annual rainfall}}{12} =$$

7,450 acre feet = 2,430 million gallons

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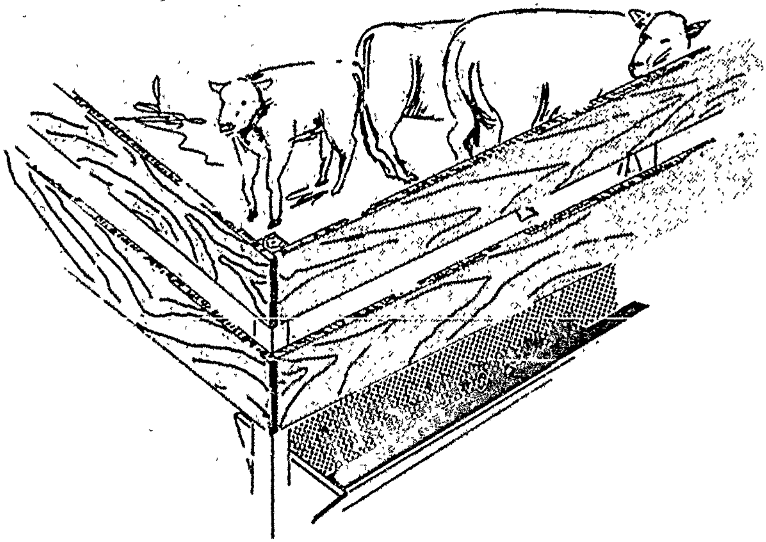

SECTION 312.8

POTENTIAL AGRICULTURAL WASTEWATER SOURCES

WATER RESOURCES STUDY

METROPOLITAN SPOKANE REGION

SECTION 312.8

POTENTIAL AGRICULTURAL WASTEWATER SOURCES

25 June 1974

Department of the Army, Seattle District
Corps of Engineers
Kennedy-Tudor Consulting Engineers

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POTENTIAL AGRICULTURAL WASTEWATER SOURCES

Scope and Objectives

Agriculture covers a wide range of activities, many of which may adversely affect water quality. These include feedlots, dairies, poultry farms, irrigated agriculture, dryland agriculture, logging, and farmsteads. Pollutants derived from such agricultural operations include sediment, oxygen-demanding wastes, nutrients, pesticides and other chemical and mineral substances.

It is the purpose of this subsection to determine the kind, extent and location of the various agricultural activities within the study area with the objective of evaluating the pollution potential from these activities. Most agricultural pollution potential is categorized as non-point source. As such, the pollution load reaching surface or groundwaters is usually not subject to direct measurement. Therefore, the evaluation must be inferred either from the measurable effect on the receiving waters or from observation of the source itself. Except for nutrient loads that have been measured during the runoff season on Hangman Creek, there are practically no water quality data directly linked to agricultural activities. Therefore, the burden of this investigation falls on description of the agricultural activities themselves.

The recognized categories of agricultural waste sources for which evaluations are sought in the process of inventorying the agricultural activities of the area are as follows:

1. Constituents of natural rainfall on croplands:

a. In surface runoff.

1. Nutrients from fertilizers.
2. Nutrients from decay of plant materials.
3. Pesticides.
4. Sediment from erosion.

b. In percolation and seepage to groundwater.

(Same pollutants as to surface except that sediment is not usually a problem)

2. Constituents from irrigation of croplands:

a. Surface return flows containing the pollutants listed under 1 above.

b. Percolation to groundwater. In addition to the pollutants listed above for natural rainfall, there is the added potential for salt buildups.

3. Constituents from natural rainfall on pasture lands and animal concentration areas:

a. Oxygen demanding putrescible material.

b. Nutrients and salts in animal excreta.

c. Chemicals and pesticides.

4. Leachate from agricultural solids waste disposal.

Agricultural Activity in the Study Area

An overview of agricultural activity in the study area is presented below based on two criteria: 1. Agricultural land use, and 2. Farm animal populations. The basic data source for agricultural land use is the U.S. Soil Conservation Service (SCS) compilations titled "Small Watershed Reconnaissance Data" and the SCS mapping of soil conservation needs. The basic data source for farm animal populations is the U.S. Department of Commerce 1969 Census of Agriculture. (1969 is the latest census. The next scheduled is 1974.)

Agricultural Land Use

Figure 1 identifies the subdivisions of the study area used in the SCS inventory of land use. Table 1 shows the acreage for various categories of agricultural land use within the subdivision of the study area and summarized for the entire study area. Note that approximately one tenth of one percent of the study area drains into Idaho. This small area is almost entirely in forest land with negligible agricultural pollution potential. The discussion which follows does not include the Idaho drainage and is confined to lands tributary to the Spokane River.

The totals for the study area tributary to the Spokane River show that the overall land use breakdown is as follows:

Land Use	Approximate Area Acres	Percent of Total
Croplands of all kinds	390,000	27
Grazed forest and pasture	529,000	37
Ungrazed forest	395,000	27
Other	132,000	9
Total	1,446,000	100

Of the 390,000 acres in cropland, 252,000 acres or 65 percent are in the three areas southwest of the Spokane River made up as follows:

Subarea	Area, Acres
Hangman Creek	161,000
Deep Creek-Coulee Creek	46,000
Lower Spokane-South	45,000
	252,000

The primary crop in these three areas is wheat raised by dry farming methods on the Palouse soils. Irrigated agriculture represents less than 0.7 percent of the cropland in these three areas.

The next largest segment of cropland is the 92,000 acres in the Little Spokane Valley, representing 24 percent of the study area total. Of this 92,000 acres, 68,000 acres, or more than two thirds, are in hay and pasture. The Lower Spokane-North has only 17,000 acres of cropland and, like the Little Spokane Valley, more than two thirds are in hay and pasture. Irrigated agriculture represents 5,000 acres or 5.5 percent of the total cropland in the Little Spokane, ninety percent of which is irrigated hay and pasture. A similar situation exists for the Lower Spokane-North where the irrigated portion is 5.3 percent and all in hay and pasture. To summarize, for the Little Spokane Valley and Lower Spokane-North subregions, the croplands are predominantly hay and pastures of which about five percent are irrigated.

Cropland in the Spokane Valley covers 29,000 acres and accounts for 7 percent of the study area cropland. This area has the largest proportion and the largest absolute amount of irrigated agriculture. Approximately 13,000 acres or 45 percent are irrigated. This area is also unique for the diversity of crops, both dry farmed and irrigated. An approximate breakdown is as follows:

Crop	Approximate Area, Acres: Dry	Irrigated
Grain	10,023	1,660
Hay	5,444	470
Grass Seed	500	7,500
Truck Crops	--	2,000
Orchard	--	1,000
	15,967	12,630

Considering the categories other than cropland, the various subareas are characterized as follows, based on the distribution shown in Table 1.

Hangman Creek. The proportion of land not involved in agriculture is small. Range and pasture at 74,000 acres or 24 percent of the subarea ranks second only to cropland. Together with grazed forest, there are 100,000 acres devoted to grazing animals.

Deep Creek-Coulee Creek. This subarea is similar to Hangman Creek but has an even larger proportion of land in agriculture. The amount in grazing, at 60,000 acres, exceeds cropland area.

Spokane Valley. Approximately 35 percent of this subarea is in urban and other nonagricultural use. Of the land not devoted to cropland and urban use, the remainder is divided approximately evenly between grazing land and unused forest. The grazing land, at 29,000 acres, is significant.

Little Spokane Valley. This subarea contains half of the ungrazed forest in the study area. These ungrazed forest lands are in the highlands that ring the valley. Grazed lands occupy 119,000 acres making this subregion second to Lower Spokane-North. However, this area has a much higher proportion of range and pasture which has a higher animal capacity per unit of area.

Lower Spokane-North. This subregion is almost entirely in the Spokane Indian Reservation. Cropland is almost negligible and is all in dry hay and pasture. The remainder of the subregion is divided almost evenly between grazed and ungrazed forest. (In fact, the numbers reported look suspiciously as if they were divided in two by judgment rather than by measurement.)

Lower Spokane-South. Almost the entire subregion, except for cropland, is in grazing land, and over 80 percent of that is in grazed forest.

Animal Population

Table 2 shows the livestock and poultry population of Spokane County from the 1969 Census of Agriculture. The agricultural animal population fluctuates with season, market conditions and weather. Up to date populations are not available, but the census figures given in Table 2 are considered to be representative present populations for current conditions. Most of Spokane County is within the study area, and most of the important livestock and poultry operations in Spokane County were also within the study area.

The census data are not broken down below the county-wide level. Therefore it is not possible to compile populations more exactly conforming to the study area boundary. For the same reason, the Stevens County census cannot be subdivided to obtain the number of animals in the upper Dragoon Creek and Chamokane Creek Areas. As shown above under land use, the areas devoted to grazing in Lower Spokane-North and Lower Spokane-South are 129,000 and 92,500 acres respectively. Lower Spokane-North is entirely in Stevens County and Lower Spokane-South is practically all in Lincoln County. Therefore, significant cattle populations in the study area are not represented in Table 2 which is for Spokane County alone.

At 17 head per 1000 acres grazing intensity, the number of cattle in the Stevens and Lincoln portions of the study area are estimated at 2,200 and 1,600 respectively.

The following generalizations about the size and distribution of dairy herds are based on information obtained from various local agricultural offices. These figures are in general agreement with the distribution by herd size shown in the 1969 census of agriculture for Spokane County which is summarized in Table 3. Table 3 includes all cattle herds, and is not restricted to dairy herds.

Dairies in the Spokane River basin are numerous, but tend to be smaller than those encountered near western Washington metropolitan areas. Health District and Extension Service personnel provided estimates indicating that the total number of dairy herds in the study area is probably between 100 and 120. The largest dairy has approximately 400 head, with the next largest having less than 200. Both are located near urban areas, the larger being just south of Cheney and the other southeast of Spokane. According to the most recent agricultural census in 1969, the major portion of the dairy animals (approximately 70 percent) are in herds numbering more than 20 and less than 100 head. The largest concentration of dairy herds is in the Deer Park area in Spokane and Stevens Counties. Smaller concentrations are in the Cheney-Medical Lake and the Milan areas. The remaining herds are scattered, primarily in Spokane County. The 1969 census shows that in Spokane County 118 farmers reported sales of milk to processors.

The distribution of non-intensive cattle raising, other than dairy herds, can be inferred from the land use inventory. Feed lots and other intensive concentrations must be located on an individual basis.

Poultry and hog farms in the study area are not large relative to those in other parts of the U.S. Again, the best source of data on numbers is the 1969 Census of Agriculture. The major portion of both poultry and hogs in the study area is in Spokane County. In 1969, there were less than 5,000 hogs and pigs in the county and over 600,000 poultry. The majority of the poultry (over 584,000) were on only nine farms. Six farms reported over 200 hogs and pigs and had a total population of 1,734. In addition to the above, there were in 1969 in excess of 3,000 sheep and 3,000 horses plus small numbers of other animals. These latter animals are not in significant concentrations.

Fertilizer Use

Fertilizers are used in all subregions of the study area and on most crops. The 1969 Census of Agriculture indicates that use ranges from less than 0.10 tons per acre per year for pasture, hay and grain to over 0.20 tons per acre per year for grass seed production. The most widely used fertilizing element is nitrogen and its most widely used form is liquid ammonia. The largest fertilizer use in the area is for wheat. All wheatland is fertilized with nitrogen but there is a growing use of phosphates and sulfur. Local agriculture officials estimate that 35 to 40 percent of wheatland now receives phosphate and 5 percent sulfur.

Most nitrogen fertilizers are highly water soluble and tend to re- [illegible] so. One of the advantages of liquid ammonia, now widely used, is its ability in dry cool soils to react with the soil to form non-leaching compounds which slowly release nitrogen to the root zone.

All phosphate fertilizers react with the soil to form relatively insoluble compounds that cling to the soil particles. There is little tendency for phosphate to move by leaching.

The recent EPA publication (1963) on Methods and Practices for Controlling Water Pollution from Agricultural Nonpoint Sources is quoted as follows on the factors affecting nutrient losses from croplands:

> The composition of phosphorus and nitrogen substances in the soil/water system and the way they are lost from soils differ greatly, as do control practices. Most of the phosphorus in soil, whether it comes from organic or inorganic sources, is contained within, or is tightly attached to, soil particles. Soluble phosphate content of surface runoff is usually very low, but concentrations may be significant in runoff from dead vegetation. Most of the phosphorus lost from land is associated with sediment. Thus, control of phosphate pollution depends largely on control of soil erosion.
>
> Organic or humus nitrogen lost from soils into water is associated with sediment, and erosion control is, again, an important control mechanism. However, most nitrogen lost from the soil is in the form of nitrate, which is not absorbed into the soil particles. It is completely soluble in water and moves where water moves. Control of nitrate movement to surface water or to aquifers depends on the control of runoff and leaching.

It continues with reference to the effect of type of crop:

> The type of crop or land use has a major effect on nutrient losses through erosion and leaching. Erosion of soil and loss of phosphorus and organic nitrogen associated with sediment are much lower for sod crops such as pasture and range grasses, than for row crops such as corn and soybeans..

<u>Pesticide Use</u>

Herbicides are the most widely used pesticide in the study area.

The 1969 Census of Agriculture indicates that 77 percent of the dollars spent for pesticides in Spokane County is for herbicides and only 17 percent for insect control on crops. Insect control on livestock and poultry is minor compared to other pesticide use in the study area. The largest single use is herbicides for weeds or grass in crops. About 75 percent of the herbicide used is 2,4-D. The most common insecticides used are malathion and chlordane.

The importance of erosion as a potential vehicle for pesticide pollution is indicated by the following quotation from the "Mrak Report" (U.S. Department of Health, Education and Welfare, 1969):

> "Because of the tight binding characteristics of pesticide residues to soil particles, it is suggested that the general pollution of waters by pesticides occurs through the transport of soil particles to which the residues are attached."

The pollution path is not limited to erosion, however. The following is quoted from EPA (1973):

> "Pesticides also enter waterways through surface runoff and groundwater supplies. As a group, pesticides have low solubility in water, but small amounts are transported in solution. Herbicides are generally more water soluble than insecticides, and a few are freely soluble."

The hazard from pesticide use for livestock pest control is evaluated by EPA (1973) as follows:

> "Insecticides used to control livestock pests are applied by various means, such as feed additives, backrubbers, sprays, pour-ons, liquid dips, or barn fumigations. Pesticide exposure to the environment is minimal with correct use. Barring dumping or accidental spillage, the potential for environmental pollution from this source is minimal."

Evaluation of Nonpoint Source Pollution Potential

The evaluation of agricultural pollution potential is discussed below in the categories listed at the beginning of this subsection and as summarized in the matrix shown in Table 4.

1. Constituents of natural rainfall runoff from croplands which reach surface waters.

The significance of the pollution problem associated with erosion from the dry farmed Palouse soils has had long standing recognition in this and adjoining watersheds. The inventory of croplands and their use presented above shows that this problem is confined almost exclusively to three subregions in the study area: The Hangman Creek, Deep Creek-Coulee Creek and Lower Spokane-South. The problem in these three subregions has a combination of the pollutional threats outlined above including:

a. Largest use of fertilizer in the study area.

b. Largest use of herbicides in the study area.

c. A crop and soil combination that is vulnerable to erosion.

The problem is centered on the unique combination of factors in the Palouse cropland area which evolves from its vulnerability to erosion. The subject is treated separately in a subsection titled "Soil Erosion."

Where erosion is not a problem, the low annual rainfall tends to minimize runoff pollution from croplands. Other factors which tend to minimize the threat in the remainder of the study area are the type of crops and the land slope and permeability. Except for the Spokane Valley, the only significant kinds of cropland are hay and pasture. For all of these reasons, the pollution potential from rainfall runoff from croplands to surface waters is rated low for Little Spokane Valley and Lower Spokane-North. The Spokane Valley is likewise rated low, although other crops are raised, because the ground slopes are very low and the soils are highly permeable. There is little evidence that significant surface runoff reaches surface water from the Spokane Valley.

2. Constituents of natural rainfall which percolate from croplands to groundwater.

Throughout the subregions which are on the Columbia Plateau formations, namely Hangman Creek, Deep Creek-Coulee Creek and Lower Spokane-South, the potential for percolation to the basalt groundwater aquifer is very small due to the impermeable nature of the surface formations. Groundwater pollution potential from cropland percolation is estimated to be very small for these subregions.

As stated above for flows to surface waters, the low annual rainfall reduces all pollutional threats of rainfall origin. In contrast to the surface water situation, where permeable soils reduce the threat, for groundwater pollution the threat is increased.

In the Little Spokane Valley, there are extensive croplands on relatively permeable soils which extend to the aquifers of the subregion. Of the 92,384 acres of cropland in this subregion, 60,677 acres, or two thirds are in hay and pasture and one third in other crops such as grain and grass seed. There appears to be some potential for groundwater contamination with nitrates from fertilizers even with low rainfall. The threat is probably lower in the Dragoon Creek part of the subregion where the cropland is hay and pasture which are fertilized at lower levels. In the Deadman Creek part of the subregion, the crops are predominantly grain and grass seed which have higher rates of fertilizer application.

In the Spokane Valley, most of the area is on the surface of the highly permeable primary aquifer. The predominant crops are grain and grass seed which take heavy fertilizer applications. Here the depth to groundwater in the agricultural areas is about 70 feet. The Bureau of Reclamation has estimated that 15 to 20 percent of applied irrigation water percolates beyond the root zone. The extent to which percolation from the lesser volume of natural rainfall penetrates the 70 feet of unsaturated gravel above the aquifer is unknown. The threat is rated as slight for the Spokane Valley due to rainfall.

The Lower Spokane North has relatively little cropland compared with the Little Spokane Valley, where the physical conditions are similar. The pollution potential is rated low.

3. Constituents of irrigation return flow to surface waters.

Irrigation of cropland is insignificant in all subregions except Little Spokane Valley and Spokane Valley. In the Little Spokane Valley practically all irrigation is to hay and pasture and is by sprinkler irrigation. The total area irrigated is small. The potential for surface return is rated slight. In the Spokane Valley most irrigation is by sprinklers but there is some ditch and furrow type remaining. Here the highly permeable soils prevent any surface returns.

4. Constituents of excess irrigation water percolating to groundwater.

The permeable soils in the Little Spokane Valley provide a slight threat from the relatively small irrigated area. The large irrigated area in the Spokane Valley with highly permeable soil and crops which take heavy fertilizer application are evaluated as a moderate threat although the percolation mechanism beyond the root zone is largely unknown.

5. Constituents from rainfall acting on animal pasture land.

The evaluation discussed in this paragraph is limited to pasture and forest grazing of livestock and does not cover animal concentrations such as feedlots or milking confinements at dairies. These latter situations are regarded as point sources and are covered separately from nonpoint sources. In general, pasture production of livestock inherently provides land disposal of animal wastes. Providing that the land is not overgrazed to the point of creating an erosion problem, runoff quality should approach that from natural grass and forest lands. The primary threat from pasture occurs as a result of concentration at feeding, watering and resting sites. Natural streams through grazing land attract these undesirable concentrations. This concentration of animals in stream beds is the primary threat from grazing lands in the study area. These situations are observed most often in the Hangman Creek area and the Dragoon Creek areas.

The potential for groundwater contamination from grazing is minimal except where the above cited stream concentrations occur in conjunction with a stream that interchanges with an accompanying ground-water body. The only sites in the study area with this type of potential are in the Little Spokane Valley.

Evaluation of Point Source Pollution Potential

Animal and poultry concentrations are the primary threats of agricultural point source pollution. Except for one egg producer, the animal and poultry concentrations in the study area are in general far smaller than the size limit for which NPDES permits are required. The concentrations above which NPDES permits are required are as follows:

a. 1000 slaughter and feeder cattle
b. 700 head or more of dairy cattle
c. 2500 swine over 55 pounds
d. 10,000 head of sheep
e. 55,000 turkeys
f. 100,000 laying hens or broilers
g. 30,000 laying hens or broilers with liquid manure handling systems
h. 5000 ducks
i. combinations of animals per schedule

The largest concentrations of dairy cattle are a herd of 385 in the Cheney area and one of 125 in the Deer Park area. (The Early Dawn Dairy, a major herd listed in publications, is no longer in existance.) In addition to these two largest there are other dairy herds concentrated in the Cheney and Deer Park areas as well as southeast of Spokane, around Milan and the Medical Lake vicinity. The average herd size in Spokane County is 75 head. Refer to Dairy Herd Improvement Association Annual Report for 1973.

Dairy operations are under the surveillance of the Spokane

County Health District. The Health District reports a recognizable threat of water pollution in a number of cases and, in one instance, the operation is subject to periodic flooding. The Health District reports that these threats are being eliminated.

There are two cattle feeder operations of modest size, the Morrison in the Moab Junction area with 600 to 800 head and the Dosser near Salese Lake with 250 to 400 head. Two slaughtering operations, Stockland and Hygrade, have holding facilities for cattle awaiting processing, both in the east Trent area.

It is understood that dairy and cattle concentrations are in general following the guidelines published by Washington State University for waste disposal. See Washington State University publication EM 3479.

The largest hog operation in the study area is a concentration of 60 to 80 on the Latah area.

Poultry production in the study area is currently off from the levels indicated in the census due to unfavorable feed and price levels. There is essentially no broiler production at present, only eggs. The largest egg producer is in the Deer Park area with approximately 200,000 hens. The next levels are 20,000 hens or less, with producers in Glenrose, Greenacres and Hutton Settlement.

In summary, there is a low potential for significant water pollution from agricultural point sources associated with animal and poultry production in the study area.

TABLE 1

SUMMARY OF AGRICULTURAL LAND USE

Study Area Element	SCS Area Inventory Numbers	Total Element Area	Forest Grazed	Forest Ungrazed	Range and Pasture	Other Than Agric.	Cropland Dry	Cropland Irrigated Hay and Pasture	Cropland Irrigated Other	Remarks
Little Spokane River	5b-1	187,366	22,688	113,567	25,392	9,892	14,907	920	--	
Deadman Creek	5b-2	105,120	22,291	44,582	744	5,674	31,369	350	110	Other irrigation is grass seed and orchard
Dragoon Creek	5b-3	102,150	25,965	32,582	--	3,938	36,745	2,920	--	
Wandermere	5b-4	46,500	11,474	17,211	10,845	1,907	4,353	400	300	Other irrig. is grass seed
LITTLE SPOKANE VALLEY		441,136	82,418	207,942	36,981	21,411	87,384	4,590	410	
Spokane Valley	5-[illegible]	92,797	6,019	18,057	2,114	46,168	8,439	--	12,000	Other irrig. is grass seed, truck, grain & orchards
Saltese Flats	5-[illegible]-1	15,520	6,246	694	2,926	494	4,880	220	60	Other irrigation is grain
Newman Lake	5-4	26,698	9,952	9,952	1,959	1,837	2,648	250	100	Other irrigation is grain
SPOKANE VALLEY		135,015	22,217	28,703	6,999	48,499	15,967	470	12,160	
Hangman Creek	5-5	227,863	22,075	15,107	70,522	25,377	94,782	130	570	
Rock Creek	5-4	78,880	3,143	5,277	3,820	1,765	65,190	--	--	
HANGMAN CREEK		307,758	25,218	20,384	74,342	27,142	159,972	130	570	
Deep Creek	5-6	97,002	17,775	10,000	29,900	6,397	32,730	200	--	
Coulee Creek	5-6-1	26,545	8,000	--	4,070	1,275	13,185	15	--	
DEEP CREEK-COULEE CREEK		123,547	25,775	10,000	33,970	7,672	45,915	215	--	
Spokane River South	5-8	156,950	71,609	6,000	16,800	20,181	41,725	--	635	12,440 Acre of other land use is water area
Bockmuehl Canyon	5-8-1	6,700	4,090	--	--	110	2,400	--	100	
LOWER SPOKANE SOUTH		163,650	75,699	6,000	16,800	20,291	44,125	--	735	

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	SUMMARY OF AGRICULTURAL LAND USE	TABLE 1

TABLE 1 (continued)

Study Area Element	SCS Area Inventory Numbers	Area in Acres: Total Element Area	Forest: Grazed	Forest: Ungrazed	Range and Pasture	Other Than Agric.	Cropland: Dry	Cropland: Irrigated: Hay and Pasture	Cropland: Irrigated: Other	Remarks
Spokane River North	5-7	112,210	45,000	46,030	8,000	5,070	7,710	400	--	
Chamokane Creek	5-9	163,120	75,000	75,600	1,000	2,740	8,280	500	--	
LOWER SPOKANE NORTH		275,330	[illegible]	121,630	9,000	7,810	15,990	900		
SUBTOTAL TRIBUTARIES TO SPOKANE RIVER		1,446,436	351,327	394,659	178,092	132,825	369,353	6,305	13,875	
TRIBUTARIES TO IDAHO	5-1 5a-1	9,873	5,167	3,086	280	100	—	1,240	—	
STUDY AREA TOTAL		1,456,309	356,494	397,745	178,372	132,925	369,353	7,545	13,875	

Source: Compiled from U.S. Soil Conservation Service, "Small Watershed Reconnaissance Data."

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	SUMMARY OF AGRICULTURAL LAND USE	TABLE 1 (cont.)

TABLE 2

1969 LIVESTOCK AND POULTRY
POPULATION -- SPOKANE COUNTY

	Farms Reporting	Number
Cattle and Calves	1,171	39,988
Hogs and Pigs	178	4,830
Sheep and Lambs	92	3,036
Horses and Ponies	672	3,180
Chickens (3 mon. plus)	309	620,489

Source: U.S. Bureau of the Census, 1972. Census of Agriculture, 1969. Volume 1. Area Reports, Part 46, Washington.

TABLE 3

1969 POPULATION DISTRIBUTION
FOR CATTLE AND CALVES
SPOKANE COUN.

Farm Category By Range of Herd Size	Number of Farms Reporting per Category*	Number of Cattle in Size Category
1-19	260	2,467
20-49	230	7,486
50-99	156	10,501
100-199	21	7,226
200-499	16	4,216
500 and over	5	3,010
		34,906

*Includes only farms with sales of $2,500 and over. Numbers also include both dairy and beef animals.

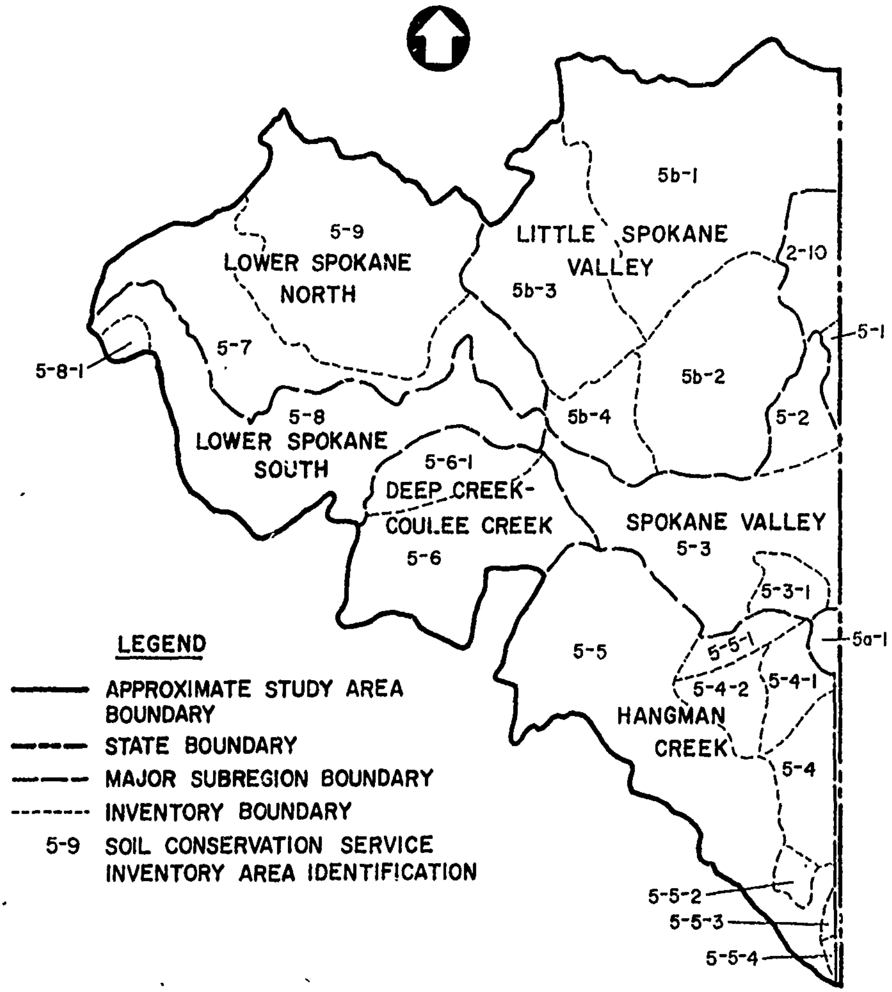
Source: Census of Agriculture, 1969.

TABLE 4

EVALUATION MATRIX OF AGRICULTURAL NONPOINT POLLUTION POTENTIAL

Study Area Subregion	Estimated Pollution Potential from Various Sources					
	From Rainfall on Cropland		From Irrigation of Cropland		From Rainfall on Animal Pastures	
	To Surface Water	To Ground-water	To Surface Water	To Ground-water	To Surface Water	To Ground-water
Little Spokane Valley	Low	Moderate	Slight	Slight	Moderate	Slight
Spokane Valley	Low	Slight	Low	Moderate	Low	Low
Hangman Creek	High*	Low	Low	Low	Moderate	Low
Deep Creek-Coulee Creek	High*	Low	Low	Low	Moderate	Low
Lower Spokane South	High*	Low	Low	Low	Moderate	Low
Lower Spokane North	Low	Low	Low	Low	Sligh*	Low

*For details, refer to the section, "Soil Erosion."



WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army, Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	AGRICULTURAL LAND INVENTORY AREAS	FIGURE 1

LIST OF REFERENCES

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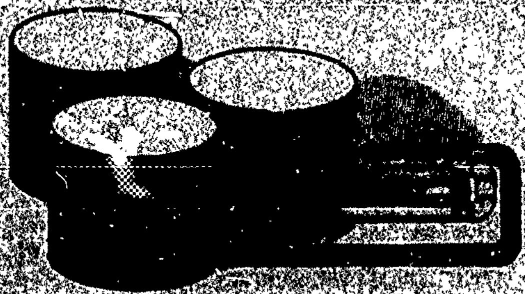

SECTION 311

EXISTING WASTEWATER COLLECTION AND TREATMENT FACILITIES

WATER RESOURCES STUDY

METROPOLITAN SPOKANE REGION

SECTION 311

EXISTING WASTEWATER COLLECTION AND TREATMENT FACILITIES

3 June 1974

Department of the Army, Seattle District
Corps of Engineers
Kennedy-Tudor Consulting Engineers

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PLATE INDEX

Plate Number	Title
311-1*	Sewerage Service Areas, Urban Planning Area
311-2*	Individual Disposal and Interim Treatment, Urban Planning Area
311-3*	Sewerage Service Areas, Outside the Urban Planning Area

* All plates are large drawings bound at the end of this section.

EXISTING WASTEWATER COLLECTION AND TREATMENT FACILITIES

Introduction

The objective of this section is to create an inventory of existing facilities for the collection, treatment and disposal of wastewater within the study area. The inventory of facilities includes, where available, the areal extent of collection systems, size and capacity of principal trunks, the location, description, size and nominal capacity of treatment facilities, and the location of the point of release to the environment.

Where there is no central collection and disposal facility, and disposal is by individual disposal systems, the inventory consists of a delineation of the areas served by this type of facility and an estimation of the population so served. Where there is no central collection and disposal facility, and the policy of local agencies has discouraged individual disposal systems in favor of group interim facilities, the inventory consists of listing and locating these facilities and an estimation of the population served.

Collection systems inventoried include separate storm water systems, combined storm and sanitary systems and separate sanitary systems. The overflow locations of the City of Spokane combined sewer system are mapped. The evaluation of the frequency, volume and quality of spills from their overflows is covered under the section dealing with waste sources.

Overview

Within the urban planning area only the City of Spokane, Fairchild Air Force Base, the Spokane Industrial Park and a portion of the Town of Millwood are served by sewerage collection systems and centralized treatment facilities. The extensive suburban areas east and north of the City of Spokane are served by individual septic tank and drainfield disposal systems and interim treatment and disposal facilities serving groups of homes or commercial buildings.

Industrial waste collection and disposal in the urban planning area shows a similar pattern. Industries within the City of Spokane dispose of their wastes through the City collection system and treatment plant. Industries outside the City are served by individual treatment facilities.

Urban runoff collection and disposal repeats the pattern. Urban runoff in the City of Spokane is collected mostly in a combined sewer system but with some separately sewered portions. The ultimate point of disposal for these collected wastes is the Spokane River. Outside the City, there is little urban runoff collection. In general, disposal is to local dry wells or to the naturally free draining land surface.

Outside the urban planning area, central sewerage collection and disposal systems are provided in the communities of Wellpinit, Deer Park, Cheney, Rockford, Fairfield and Tekoa. All other communities and isolated dwellings are served by individual septic tank and drainfield disposal systems. There is no significant source of industrial waste outside the urban planning area. Collection systems for urban runoff and storm drainage are, in general, provided by the same communities that have sanitary sewer systems.

For the urban planning area, the service areas of the existing sewage collection systems, the location of centralized treatment facilities and ultimate points of discharge for both municipal and industrial facilities are shown on Plate 311-1. Also shown on Plate 311-1 are the outlying communities with public water systems but without sewage collection systems. The areas within the urban planning area where individual on-site disposal systems and interim facilities are used, are shown on Plate 311-2.

Plate 311-3 shows the location of communities outside the urban planning area having collection systems and centralized treatment facilities. Also shown on Plate 311-3 are concentrations of 50 or more persons not served by a collection system.

Of the present study area population of 289,000, approximately 185,000 or 64 percent are estimated to be served by collection systems and centralized treatment, 91,000 or 31 percent are estimated to be using individual disposal facilities and 13,000 or 5 percent are estimated to be served by interim treatment facilities.

Sanitary Sewerage and Treatment Facilities Other Than the City of Spokane

General. There are nine communities other than the City of Spokane that are served by a sewage collection system and centralized treatment. They are:

- City of Cheney
- City of Deer Park
- Fairchild Air Force Base
- Town of Fairfield
- Town of Medical Lake
- Town of Millwood
- Town of Rockford
- City of Tekoa
- Wellpinit (Bureau of Indian Affairs)

The location of these facilities is shown on Plates 311-1 and 3. The general characteristics of each system are summarized in Table 1 and the characteristics of the respective collection systems are summarized in Table 2.

These relatively small systems are described in detail below. The City of Spokane system is treated separately. These nine systems serve a total population of approximately 21,500 and handle a total average daily flow of 2.176 mgd. The City of Spokane system serves 167,000 persons plus a significant industrial flow and handles 29 mgd average daily flow.

City of Cheney. The municipal sewerage system of the City of Cheney serves the entire contiguous business and residential districts of the City and the campus of Eastern Washington State College, an area of approximately one square mile. The population of this service area varies from about 6,500 to 10,000 depending on the resident college enrollment, but normally is about 8,400.

The wastewater collection system consists of approximately 35 miles of gravity sewers in sizes ranging from 6 to 24 inches. An average dry weather flow of about 500,000 gallons of domestic wastewater is conveyed to the treatment facility each day. The average wet weather peak flow is about 4.5 million gallons per day.

The wastewater treatment system utilized at Cheney is a conventional facultative lagoon system. Pretreatment is provided by solids comminution with bypass bar screens. Three lagoons are utilized, one of which is divided into two cells. Chlorination of final effluent is provided.

A schematic diagram of the Cheney wastewater treatment system is shown in Figure 1. The lagoons are basically operated in parallel with each lagoon normally receiving screened raw sewage.

Lagoon 2 receives raw sewage from the headworks and discharges to its separate chlorination contact chamber. This lagoon is 13.2 million gallons in volume with 9.0 acre surface area. The chlorine contact chamber following Lagoon 2 has a volume of 15,800 gallons and is constructed of concrete.

Lagoons 1a, 1b and 3 receive raw sewage from the headworks and discharge to a common chlorination facility. Lagoon 1a is 9.7 million gallons in volume with a surface area of 6.6 acres, and 1b has a volume of 8.8 million gallons with a surface area of 6.0 acres. Lagoon 3 has a volume of 27.3 million gallons and an area of 14.0 acres. The chlorine contact basin serving these three lagoons is an earthan basin with a volume of 31,000 gallons.

Effluent from Lagoons 1a, 1b and 3 drains into a pond formed by this flow trapped against an embankment topping the Burlington Northern (SP&S) cut. The sewage percolates through the embankment and down into the cut which it follows for about one quarter of a mile to where Minnie Creek enters the cut. Lagoon 2 discharges into Minnie Creek upstream from this point. Minnie Creek, including the effluent from all the lagoons, continues in the railroad cut for about 1.7 miles, then leaves the cut to continue 5.5 miles to juncture with Hangman Creek.

City of Deer Park. The entire community of approximately 1300 residents is served with a sanitary sewerage system. This system consists of gravity sewers, a pump station, and a treatment facility. Wastewater from approximately 85% of the service area flows by gravity directly to the treatment facility with about 15% of the area depending on a pump station. The average flow to the treatment facility is 149,000 gallons per day.

The collection system serves an area of approximately 0.53 square miles and contains 9.1 miles of sewers ranging in size from 8 to 12 inches.

The treatment plant is of the secondary type. The processes utilized are solids comminution with bar screen bypass, primary clarification, trickling filter with recirculation, secondary clarification, and chlorination. Sludge from the primary clarifier is digested anaerobically. A schematic flow diagram of this system is shown in Figure 2.

The treatment elements are sized as follows:

Primary clarifier, 26 feet diameter by 7 feet SWD
Trickling filter, 40 feet diameter by 3 feet rock depth
Secondary clarifier, 26 feet diameter by 7 feet SWD
Digester, 20 feet diameter by 14.5 feet SWD

The effluent is chlorinated and delivered by gravity flow in a pipeline to Dragoon Creek, a tributary of the Little Spokane River.

Fairchild Air Force Base. Fairchild Air Force Base is served by three domestic wastewater treatment facilities. The main sewage treatment plant serves most of the base. The weapons storage area and Deep Creek Survival School are served by the Deep Creek Station treatment plant. The Geiger Heights Housing area is served by the Geiger Heights Lagoon system.

The Deep Creek Station treatment plant and the Geiger Heights Housing Lagoon system are interim facilities. The plant at Deep Creek Station is scheduled to be phased out. The wastewater from this area will then be piped to the collection system of the main sewage treatment plant. The existing Deep Creek and Geiger Heights facilities are described under interim facilities.

The main sewage treatment plant serves about 6,700 people. This figure includes about 5,500 residents and 1,200 day employees. The extent of the service area of the collection system is roughly shown on Plate 311-1 and covers about 2.3 square miles. The collection system contains approximately 32 miles of sewers in sizes from 6 inches through 30 inches.

The main sewage treatment plant provides secondary treatment. A schematic flow diagram is shown in Figure 3. The influent to this plant passes through headworks consisting of comminutors, overflow bar screens, and a Parshall flume in which the flow is continuously recorded. The water flows then to primary clarifiers, primary trickling filters, and to the primary wet well. This well functions to recycle the flow back to the primary clarifiers. Overflow from the primary well goes to the secondary wet well, to the secondary trickling filters, and to the secondary clarifiers. From the secondary clarifiers, part of the flow is recycled and part becomes effluent. The recycled water from the secondary clarifiers returns to the secondary well.

Sludge from the primary and secondary clarifiers is processed in a two stage anaerobic digester. The supernatant from the first stage digester is recycled to the headworks. Processed sludge from the secondary digester is placed on drying beds. The drying beds have tile underdrains and filtrate is recycled back to the primary well. Dried solids are contracted to local agriculturists.

Effluent from the plant goes to drainfields during winter months or to a 1.4 acre pond during summer months. Plant effluent is also utilized for plant grounds irrigation. No chlorination is provided. No request for this process has been made because the effluent does not discharge to a surface watercourse. The capacity of the plant is rated at 1.5 mgd. The plant can hydraulically handle as much as 2 mgd at low removal efficiency. During periods of wet weather, the flow at the plant has reached 1.7 mgd.

The sizes of the treatment plant elements are as follows:

Element	No of Units	Diameter Feet	Depth Feet	Volume, Each Gallons
Primary Clarifier	4	60	10.7	226,000
Trickling Filter	4	68	4 rock	
Primary Digester*	1	60	10.4	220,000
Secondary Digester*	1	60	11.5	243,000

*The primary and secondary digestion tanks are in a single structure, one over the other.

Town of Fairfield. There are about 480 residents in the town, all of whom are served by a gravity sewerage system and the wastewater treatment facility. The service area is approximately 0.18 square miles and the collection system contains approximately 3.9 miles of sewers in sizes 4 inches to 12 inches.

The treatment facility is a series of two conventional facultative lagoons. A schematic flow diagram is shown on Figure 4. Pond No. 1 has a surface area of 2.4 acres; Pond No. 2 has a surface area of 1.4 acres. The effluent from Pond No. 1 feeds Pond No. 2. The effluent from the secondary lagoon is chlorinated as it enters a 93,000 gallon contact chamber from which the treated waste is discharged into a ditch known as Rattler's Run Creek, a tributary of Hangman Creek.

The influent is not measured. The effluent from the secondary lagoon passes through a 12" sharp crested rectangular weir in the effluent level control structure upstream of the chlorination pond. The flow measured at this point averages about 15,000 gallons per day. Influent to the primary lagoon would be somewhat more than this due to losses from evaporation and possible percolation.

Town of Medical Lake. Municipal sewerage facilities of the

Town of Medical Lake serve nearly the entire town. This service area of approximately 0.55 square miles includes about 1,800 people. Plans are pending to introduce a small additional residential section of town into the system. The collection system contains approximately 9.4 miles of sewers in sizes from 6 to 14 inches. The collection system delivers the wastewater to a pumping station near the treatment facility.

The treatment facility consists of three lagoons. Two of the lagoons act as primary facultative lagoons and the other as a secondary or polishing lagoon. The primary lagoons have four and five acre surface areas, respectively, and the polishing lagoon has a surface area of three acres. The polishing lagoon has been sealed with a light oil.

A schematic flow diagram of the Medical Lake Lagoons is shown in Figure 5. The normal flow is shown from Lagoons 1 and 2 in parallel to Lagoon 3. Other flow patterns between the lagoons are available, as shown, and are used in preparation for winter operation, and at other occasions. There is an overflow ditch at the perimeter of Lagoons 2 and 3 which, in case of excess flows, discharges to the effluent channel as shown. Most of the year, the lagoons function as a non-overflow system with total inflow lost to evaporation and percolation. The chlorination facility and effluent ditch are used only when there is an effluent, usually about 10 days per year. The effluent ditch carries the effluent four miles to Deep Creek, a tributary of the Spokane River.

The quantity of wastewater is not accurately measured. The lift station pump capacity and operating hours indicate the flow is about 135,000 gallons per day according to the operator. The estimated flow fluctuates from about 130,000 gpd during dry weather to about 150,000 gpd during peak wet weather periods.

The state hospital which adjoins the town of Medical Lake has its own separate sewage disposal facilities which discharge to West Medical Lake outside the study area.

Town of Millwood. About six blocks of residential-commercial area of the town of Millwood are sewered. There are about 90 connections in this service area. The domestic wastewater from this service area is conducted by approximately one half mile of 6 inch sewer to the treatment facility.

Treatment at Millwood is achieved by package Smith & Loveless "Oxigest" activated sludge, extended aeration plant. The extended aeration process does not consistently consume the entirety of the solids. Sludge that is not consumed is placed in a holding tank which is taken to a sanitary landfill for disposal about twice a year. Flow to the plant averages about 10,000 gallons per day, according to the operator. The plant has a capacity of 17,500 gallons per day.

Effluent from the plant is chlorinated. There is a small contact chamber. The effluent then is discharged to the Spokane River. The small service area and package treatment facility are on the same scale as systems classified as "interim" elsewhere in this report. This system is unique in being operated by a municipality and discharging to surface water rather than to a leaching field.

Town of Rockford. The domestic wastewater of the 350 residents of the Town of Rockford is collected by approximately 5 miles of 8 to 10 inch sewers which discharge to the Town of Rockford Sewage Lagoons.

There are two lagoons operated in series, one primary and one polishing lagoon, each having one acre of surface area. A schematic flow diagram of Rockford's treatment facilities is shown in Figure 6.

Flow into the plant is not measured, but the effluent is measured in a V notch weir. Flow at this point average two inches of depth in the notch, or about 11,200 gallons per day. The effluent discharges into Rock Creek, a tributary of Hangman Creek.

City of Tekoa. The wastewater collection and treatment facilities of the City of Tekoa serve about 1,000 residents. The collection system is designed to handle only sanitary domestic wastewater and consists of approximately 7.9 miles of sewers size 6 to 10 inches.

The existing treatment facilities include a comminutor, primary clarifier, trickling filter, secondary clarifier, chlorinator, digester and an outfall in Hangman Creek. A schematic flow diagram is shown in Figure 7. Current operation bypasses the trickling filter. The comminutor is inoperable. Actual current treatment consists of primary and secondary clarification and chlorination prior to dilution in Hangman Creek. Flow is not measured but is estimated to be about 120,000 gallons per day.

Sizes of the treatment elements are as follows:

Primary clarifier, 24 feet diameter by 10',3" depth
Trickling filter, 38 feet diameter by 5',8" rock depth
Secondary clarifier, 24 feet diameter by 9',5" depth
Digester, 24 feet diameter, volume 8670 cubic feet

Tekoa has engaged a consulting engineer for the purpose of selecting and designing treatment plant improvements to be completed by 1975.

Bureau of Indian Affairs, Wellpinit. Wellpinit is located on the Spokane Indian Reservation in Stevens County. Wellpinit is an unincorporated community center where the Spokane Tribe of Indians, the U.S. Bureau of Indian Affairs, and the Public Health Service have offices and community buildings. There are about 20 houses, a store, a school, and the complex of community buildings that are connected to the wastewater collection system. About 50 people reside in the houses in the service area, about 210 students attend the school, and about 50 people work in the office complex. The other residents of Wellpinit live outside the service area and have individual treatment and disposal.

The system is owned and operated by the Bureau of Indian Affairs. The sewer system collects domestic wastewater from the limited service area and delivers it to the treatment plant.

The treatment plant is a Yeomens Brothers "Cavitator" with a rated nominal capacity of 7500 gallons per day. It is an activated sludge extended aeration plant. A bar rack at the head of the plant is hand cleaned. Effluent from the plant enters a non-overflow polishing lagoon. The lagoon has a surface area of about 0.3 acre. A schematic flow diagram is shown in Figure 8. The estimated flow to the Wellpinit disposal facility is 8,000 gallons per day as reported by Woodward (1969).

City of Spokane

Overview. With a few minor exceptions, the incorporated area of the City is served by sanitary sewage collection systems. Most of the sewered area delivers the waste flows to a single central treatment plant, but some small portions are sewered by separate interim treatment facilities.

The sewage collection system and central treatment plant process not only the sanitary wastes from the residential and commercial elements, but also the waste flows from industries within the City.

The City of Spokane sewerage system consists of about 24 miles of separate sanitary sewers, about 20 miles of separate storm sewers, and about 569 miles of combined sanitary and storm sewers. This is the only system in the study area of which the major portion is designed as a combined sanitary and storm system. The population of the service area is estimated to be 167,000. The population equivalent of the industrial waste component, expressed in terms of BOD loading, is estimated at an additional 100,000 by the plant operating staff.

The central treatment plant is located on the bank of the Spokane River in the northwest part of the City. The existing plant provides primary treatment of waste flows prior to discharge to the Spokane River. The City has been ordered to upgrade treatment to the secondary level plus 85 percent phosphorus removal. This commitment to upgrading is firm and final and the projected upgrading is accepted as fact for this study.

Four small areas are served by separate treatment facilities.

These are: Northwest Terrace, the Spokane Police Academy, Panorama Terrace, and the Cozza-Calkins area. The facilities at the Cozza-Calkins area are referred to in the City documents as the "Cozza-Calkins Lagoon System," but these facilities are also generally known as "Lidgerwood." In documents submitted to the Department of Ecology, the facilities are known as "Lidgerwood Sewage Lagoon."

Collection System. The configuration of the existing collection system is best understood in historical perspective. There was no treatment until 1958. Prior to 1958, sewers were constructed in the most expeditious route to the nearest point on the banks of the Spokane River for direct discharge to the River. The other historical fact which imprints the existing system is that practically all sewers built prior to 1958 were constructed as combined sewers, that is, sewers to conduct sanitary wastes and storm water runoff in the same conduit. When the central treatment plant was built in 1958, it became necessary to gather up the multiple separate river discharges with a system of interceptor mains paralleling the river. The interceptor mains were sized with less capacity than the combined sewers being intercepted. The result is a number of overflows located at each previously existing combined sewer river discharge.

The interceptor mains and overflow points are shown in Figure 10. The size, slope and capacity of the interceptor mains are shown in Table 3. There are no pump stations on the primary interceptor mains. Only one station is associated with the interceptor system, Number 11 at Clarke and Linton. The remainder of the pump stations, as listed in Table 4, are located throughout the collection system.

The collection system does not have the capacity to deliver the total amount of collected wastewater to the treatment plant during all flow conditions. Forty overflow points in the system were reported in November 1973, in the City application to the Department of Ecology for a National Pollution Discharge Elimination System Permit. The location of these overflow points is shown in Figure 10. Tabulation of the overflows by location and NPDES number is contained in the section on waste sources where the volume and strength of overflows is also discussed. There are also 8 points within the system where bypasses can occur, the largest of which is at the Spokane Sewage Treatment Plant. These bypass points are also described in the section on waste sources.

Description of Existing Central Treatment Plant. The Spokane Sewage Treatment Plant receives all the wastewater generated in the City, except that which is handled by the four separate interim facilities and isolated areas with individual systems. The plant is located on the Spokane River which receives the treated effluent and bypassed wastewater of the plant. The plant was initially constructed in 1958 and expanded in 1962. The facility is a primary type treatment plant for which a schematic flow diagram is shown in Figure 9. Treatment operations consist of screening, degritting, preaeration, settling and flotation, chlorination and sludge digestion. The average daily flow currently treated (1973) is 29 million gallons per day (mgd). The nominal treating capacity is 50 mgd and the hydraulic capacity is approximately 60 mgd.

The influent diversion structure provides two facilities for bypassing influent directly to the river. The primary bypass is a 48" x 72" motor operated sluice gate through which flow can be diverted to the river via a 48 inch outfall. A secondary bypass is provided downstream from the primary bypass and consists of a 24" x 24" hand operated sluice gate.

The screening facility consists of three parallel paths. The normal path is through a comminuting bar rack (Barminutor) with a nominal capacity of 65 mgd. The alternative paths consist of two mechanically cleaned bar racks with separate manually fed grinders.

Provision is made for prechlorination by a point of application downstream from the screening facility and upstream from the grit chambers.

Two aerated grit chambers are provided, each 13 feet wide and 12 feet deep by 51 feet long with rectangular cross section and without baffles. Grit is removed by bucket type collectors and transferred to trunk loading by screw conveyors. The rate of aeration is not metered.

The preaeration basins were not part of the original plant construction that was completed in 1958, but were added in the 1961-62 expansion. Not all of the wastewater flows to the preaeration basins. About 10 to 20 percent of the flow bypasses the basins by leaping a submerged weir. This weir diverts the rest of the flow to the basins.

Each of the two basins is 40 feet by 80 feet, and 14 1/2 feet deep. A drain to the plant bypass is provided for periodic removal of settled solids. A skimming device at the outlet provides for removal of floating accumulations. Compressed air for the preaeration basins and grit chambers is supplied by two gas engine driven blowers rated 2500 cubic feet per minute.

The settling and flotation of the solids is accomplished in the four clarifiers. These clarifiers are operated in parallel. A diversion box combines the flow from the preaeration basins with the recycled flows from downstream operations and distributes the flow to each of the four clarifiers. Each clarifier is circular, 125 feet in diameter. This provides a surface overflow rate of 1000 gallons per square foot per day at nominal capacity of 50 mgd. The clarifiers are the limiting element in the existing treatment plant. Grease and scum are skimmed from clarifiers to storage for subsequent truck disposal. Settled solids are conveyed to the sludge thickeners.

Effluent from the clarifiers is chlorinated prior to disposal in the Spokane River. There are two manually controlled chlorinators, each with 6,000 pounds per day capacity. Liquid chlorine is purchased in one ton containers. The chlorine is applied to the wastewater flow between the clarifiers and the Parshall metering flume. Downstream of the flume are the contact chambers. There are four contact basins, each about 20 feet by 60 feet, 11.5 feet deep. Effluent from the contact chambers goes to the 36 inch outfall on the right bank of the Spokane River.

The sludge processing and disposal path begins at the sludge thickeners where the raw sludge is delivered from the clarifiers. There are two thickeners, each 35 feet in diameter. The supernatant overflow from the thickeners is returned to the diversion box ahead of the clarifiers.

The thickened sludge is pumped to two high rate primary anaerobic digesters, each 55 feet diameter by 37 feet side water depth. Each digester is provided with a floating cover having approximately 7 feet vertical travel range. Sludge mixing is performed with compressed recycled digestive gas. Sludge heating is accomplished in external heat exchangers.

Sludge is pumped from the primary digesters to the two secondary digesters. These are fixed cover digesters and are unheated. One of the two secondary digesters is equipped with mixing apparatus and the other is operated as a holding tank. The secondary digesters are 45 feet in diameter with 26 feet of side water depth.

Digested secondary sludge is prepared for dewatering by elutriation. Elutriation is an operation in which the sludge is washed with water to remove a portion of the bicarbonate alkylinity to improve the efficiency of chemical coagulation and dewatering. The sludge is elutriated in two tanks. Each has a 100 cubic foot mixing compartment and a settling compartment. The settling compartments are each about 12 feet by 19 feet. The wash water is effluent water from the clarifiers. The elutriate is recycled back to the diversion box. Washed solids from the elutriation tanks are conditioned with ferric chloride in the chemical conditioning tanks. The sludge is then filtered on either of two rotating vacuum filters. Each has a surface of 250 square feet. One of the filters has a stainless steel surface, the other has nylon cloth. The dewatered sludge filter cake is stored for truck disposal. The filtrate is recycled to the diversion box.

Sludge gas utilization facilities include compressors for recycling to digester mixing, boilers to supply heat for sludge heating, gas engines for blower drive and waste gas burners. An auxiliary gas supply is provided to make up any deficiency of supply from digestive gas.

The disposal of side waste streams enumerated above are summarized as follows:

Side Waste Streams	Disposal
Heavy grit in diversion structure	Bypass to river
Grit from grit chamber	Truck haul to landfill
Skimmings from preaeration	Truck haul to landfill
Skimmings from clarifiers	Truck haul to landfill
Sludge cake	Truck haul to landfill
Screenings (when comminutor is not in operation)	Truck haul to landfill

Proposed Expansion of City of Spokane Sewage Treatment Plant

Acting under a directive of the Department of Ecology (DOE), the City of Spokane is currently implementing a plan for upgrading sewage treatment for city wastewater flows. The proposed facilities to comply with the DOE directive are described in a report submitted to the City in June 1973 by Bovay Engineers, Inc. titled "Report on Additions and Modifications to the Wastewater Treatment Plant." Concurrence to the recommended plan in this report has been given by DOE and the revised implementation schedule (as of May, 1974) calls for completion by June 30, 1976. Plans are to be completed by Fall 1974 and contract awarded by January 1, 1975.

The referenced report concludes that the most cost effective regional solution in compliance with the DOE directive is to expand and upgrade the City treatment plant at the site of the existing plant, sizing the expansion with some allowance for possible future inclusion of some contiguous areas.

An expanded first stage treatment capacity of 40 mgd is recommended to provide capacity to the year 2000 from design population of 211,000. The design population is selected from a year 2000 forecast tributary City population of 205,000 and a potential tributary contiguous population of 66,000. The second stage of expansion is proposed in the year 2000 to increase capacity to 60 mgd for an ultimate design population of 289,000. The ultimate design population is selected from a year 2025 forecast tributary City population of 211,000 and a forecast potential contiguous population of 87,000.

The recommended form of treatment is secondary treatment by the activated sludge process plus phosphorus removal by a chemical process using either alum or ferric chloride. A recommendation is also made for land disposal of liquid sludge following pilot plant trials. Continuation of sludge disposal by dewatering and truck haul to landfill is recommended for initial operation and standby.

The proposed sewage treatment plant expansion does not address the problem of combined sewers, combined sewer overflows or possible separate treatment of urban runoff.

Interim Facilities

There are a significant number of interim wastewater systems within the Study Area which provide service outside the primary municipal systems on the assumption that these facilities will eventually be consolidated into a regional wastewater management plan. These facilities vary substantially with regard to population served and with regard to types of treatment afforded. Typically, interim wastewater facilities are small systems providing for collection, treatment, and disposal of liquid wastes and are not considered to be permanent. These facilities are operated by both local governmental agencies and private ownerships.

About 13 thousand people, or about five percent of the populace of the study area are served by interim wastewater treatment facilities. These facilities are found predominantly in the urban planning area, the locations of which are shown on Plate 311-2. A summary of information of interim facilities is shown in Table :. This table indicates the operators of the facility and population and process data. The identification number corresponds to those shown on Plate 311-2, on which the approximate locations of the interim facilities are shown.

There are 59 interim treatment facilities in the study area. These plants handle the domestic wastewater generated locally at apartment complexes, shopping areas, mobile home parks, developments, educational institutions, hotels, recreational areas, and military installations.

An important characteristic of the interim facilities is that the collection systems are usually not designed to handle more than the particular local need. That is if an area is developed upstream in the watershed of any particular interim facility, that facility would probably not have the hydraulic capacity to collect the additional generated wastewater, or the process capability to provide adequate additional treatment.

The processes utilized by interim facilities in the study area are activated sludge, both extended aeration and conventional, and stabilization lagoons, some of which are provided with supplemental mechanical aeration. Forty of the 59 interim facilities are activiated sludge package plants. Four are aerated lagoons, twelve are lagoons without mechanical aeration.

The plants are operated by various public and private entities as well as by the individual owners. Four facilities are operated by Spokane County, four by the City of Spokane, three by Vera Irrigation District, three by Fairchild Air Force Base, and one each by School District No. 362 and Whitworth Water District. Forty-two of the 59 interim facilities are operated privately. The superintendent of the Spokane Sewage Treatment Plant acts as a consulting operator and periodically inspects thirteen of the facilities in addition to those which are operated by the City.

The service areas of the facilities vary from one that serves over three thousand residents, to one that serves only a caretaker. The facilities known as Fairwood and Lidgerwood are important because of their size and location.

Fairwood. Fairwood is a lagoon system that is operated by the Whitworth Water District in North Spokane. It serves several residential developments, two schools, two apartment buildings, and a retreat facility. The Fairwood sewerage system serves a population in excess of three thousand. The facility was constructed in 1968. It consists of a system of gravity collection sewers which drain to a pump station. The pump station contains two 160 gpm pumps. The pump station lifts the wastewater to three lagoons for treatment. The wastewater enters Lagoon 1 which contains a series of diffused air aerators evenly distributed in the lagoons. There are two additional aerators located near the inflow to Lagoon 2. There is considerable evaporative loss in Lagoons 1 and 2 resulting in minimal flow to Lagoon 3 which results in parts of this lagoon being dry. The lagoon bottoms have been sealed to minimize seepage to groundwater. The bank of the Little Spokane River parallels the lagoons about 50 feet from the dikes.

The facility was designed for a capacity of 150,000 gallons per day, and pump operation data indicates that the present average flow is about 150,000 gpd. Plans are pending for an expansion of the lagoon system. A 17 acre shopping center is proposed to be constructed in 1974 which will generate additional wastewater loading of the Fairwood lagoons.

Lidgerwood. The Lidgerwood or Cozza-Calkins Sewage Lagoons are owned and operated by the City of Spokane. The lagoons handle domestic wastes from a population of about 1,500 persons. The system was placed in operation in July 1972. There are 24.7 acres of lagoons, with four equally sized cells. The design of the facility intended a sequential batch operation of the lagoon cells. Cell 1 was proposed to be totally filled to be followed by filling of Cell 2, etc. Each cell would then, in sequence, be permitted to evaporate at which time dried sludge could be removed prior to repeating the filling cycle. Subsequent experience with the lagoons since placing them in operation in 1972 has indicated that evaporative disposal is inadequate to permit cell No. 1 to evaporate dry prior to the complete filling of Cell No. 4. As an emergency measure to meet this evaporative capacity deficiency, the infiltration sealing membrane on one cell has been ruptured in order to augment the inadequate evaporative disposal by permitting pond leakage into the ground. This supplemental discharge by infiltration is also apparently inadequate to meet flow capacity and City of Spokane operations personnel have reported that they anticipate that the treatment system capacity will prove inadequate to handle existing flow demands.

Ultimate Disposal. Forty of the 59 interim facilities discharge their effluent to drainfields. Most of the facilities utilizing this form of disposal are package type rated aeration plants. There are 17 facilities that use a combination of evaporation and seepage as final disposal. All except three of these facilities are lagoons. One of the exceptions is the Liberty Lakes Utilities treatment plant which discharges to a seepage ditch that could ultimately reach Liberty Lake.

Only two facilities discharge directly to a surface water course. These are Northwest Terrace and Spokane Police Academy, both of which discharge to the Spokane River.

Individual Disposal

Extent and Significance. A significant portion of the study area is not served by community sewers. Residents within these unsewered areas must dispose of their domestic wastewater on an individual basis. About 30 percent of the populace of the study area live within unsewered areas. The unsewered areas within the urban planning area are shown on Plate 311-2. Unsewered communities outside the urban planning area are shown on Plates 311-2 and 3 and are listed in Table 6A. Note that Table 6A is limited to communities and developments with public water supplies. There are an undetermined number of homes, groups of homes, motels and the like which have individual water supplies as well as individual disposal systems. An incomplete listing of communities and developments in this group is shown in Table 6B.

Table 6C lists the public water supply systems and their population within the urban planning area which are unsewered and rely on individual disposal systems. This compilation indicates that there are approximately 84,000 persons in the urban planning area served by individual (and interim*) disposal facilities. Of this number, approximately 62,000 are in the valley east of the City of Spokane extending to include

*Some interim facilities are intermingled geographically with individual on-site disposal areas.

Range 44 east. In the most easterly part of the valley, in Range 45 east, there are an additional 6,000. The suburban area north of the City of Spokane accounts for the remaining 16,000.

Table 6A shows that there are approximately 3,300 persons outside the urban planning area served by public water systems and using individual disposal systems. Of these communities outside the urban planning area, the most significant concentrations of over 100 persons are found in the following localities:

Airways Heights
Four Lakes
Spangle
Latah
Camp Diamond
Chatteroy Hills
Stonelodge

For more detailed accounting of numbers and locations of individual disposal systems refer to the section on waste sources.

The numbers and concentration of individual disposal systems in the study area, and more particularly in the urban planning area, demonstrate the importance of these systems.

Kinds of Individual Systems. There are three basic methods of individual treatment and disposal employed. These are cesspools, septic tanks and drainfields, and aerobic treatment units with drainfields.

Cesspools are defined in the Public Health Service Manual of Septic Tank Practice as "A lined and covered excavation in the ground which receives the discharge of domestic sewage and other organic wastes from a drainage system, so designed as to retain the organic matter and solids, but permitting the liquids to seep through the bottom and sides." No estimate is available of the number of cesspools currently in use in the study area. In 1964, the then existing City Health Department made a survey and arrived at a figure of 2,000 cesspools in use in the City. It is not known, however, how many of these have been subsequently replaced by septic tanks or connected to the City sewerage system. No estimate has been made available as to the number of cesspools currently in use in Spokane County outside the City, but similar development patterns in the County areas would indicate, by correlation, that there are probably several thousand cesspools currently in operation in Spokane County.

There is a similar lack of detailed information concerning the extent of utilization of individual aerobic treatment units. These units are relatively much more expensive, employ mechanical devices which require maintenance, and need a continuous supply of electrical power to operate. Because of these disadvantages it is assumed that the number of these units being utilized in the study area is small.

The great majority of individual disposal facilities rely on septic tanks with drainfields. Septic tanks are underground chambers where grease, scum, and settleable solids are separated by gravitational force and by flotation. The liquid effluent flows by gravity to disposal, usually to a subsurface drainfield. The settled solids in the septic tank undergo anaerobic digestion which results in a portion of the settled material being converted to liquid or gas. Periodic removal of the residual solids is required. Typical construction for this most prevalent individual disposal system is covered below under description of current requirements.

Current Regulation of Individual Disposal Systems has rested with local planning and health agencies rather than state agencies as is the case for municipal or industrial waste sources. The currently responsible agencies, the statute under which they are operating and the effective dates are shown in Table 9. These regulations provide a guide to recent and current construction and surveillance. The great growth in individual disposal systems, particularly in the urban planning area, has taken place since World War II. Undoubtedly many of the existing individual disposal systems which were constructed in the 1950's and 1960's are below current standards.

The ordinances vary considerably in detail but are in substantial agreement on general principals. They generally provide for a permit procedure, enforcement, inspection during installation or alteration, and certain design and construction requirements. These latter requirements are by reference to some standard or are stated in an adopted regulation. Permits are required for both new work and any major alteration or repair. An exception to this is in Whitman County where permits are not required and residences more than 1/4 mile from the nearest habitation are totally exempt from the ordinance.

Special permits are required for commercial installers of septic tank-soil absorption systems in Spokane County and Lincoln County. Septic tank pumpers are regulated in all except Stevens County. All ordinances except Lincoln County's specifically prohibit the use of cesspools for disposal of human excreta, except by special permit. The Spokane County regulations forbid cesspools entirely for new construction.

<u>Design and Construction Standards for Septic Tank-Soil Absorption Systems</u>. The standards of design and construction of septic tank-soil absorption systems as stipulated directly or by reference in environmental health regulations in force in the study area are largely taken from Public Health Service Publication No. 526, "Manual of Septic-Tank Practice." In some instances, Washington State Department of Social and Health Services Bulletin ES No. 1, "A Septic Tank System for Your Home," is referenced, but this in turn is based upon the above publication as well as upon the "Federal Housing Administration Minimum Property Requirements."

<u>Regulations of the Spokane County Health District</u>. The regulations for on-site disposal systems in Spokane County are of great significance to the study area and are, therefore, presented in more detail. The current rules and regulations were adopted by the Board of the Spokane County Health District, December 21, 1971. These regulations make extensive reference to U.S. Public Health Service Bulletin No. 526. Important features included in the regulations are the following:

a. Requires a permit.
b. Specifies minimum clearance around septic tanks.
c. Specifies minimum clearance around drainfields.
d. Specifies minimum capacity of septic tanks.
e. Specifies minimum length of drain trenches plus reserve for replacement trenches.
f. Prohibits use of cesspools.

g. Permits drywells for disposal of wastes from sinks, floor drains, showers and tubs.
h. Requires inspection.
i. Regulates pumpage and disposal of residual solids.

A feature not covered is minimum lot size.

The typical installation of an on-site disposal facility in Spokane County for a three bedroom residence would be as follows:

a. 900 gallon septic tank.

b. A drainfield consisting of 180 lineal feet of drain trench plus space for 180 lineal feet of future replacement.

c. The drainfield would probably be in three 60 foot long trenches 10 feet apart with space for two future lines between the originals and one five feet beyond one of the originals.

d. The drainfield would be in an area without pavement above and 10 feet from any other use.

The above requirements coupled with current setback requirements and typical house and garage would result in a requirement for a 14,000 square foot lot.

Proposed Legislation for Regulation of Individual Disposal Systems. There is currently under consideration by the State Board of Health a set of proposed rules and regulations for on-site sewage disposal systems which would provide a uniform framework for regulation in this field by local Boards of Health. These proposed regulations would establish minimum requirements throughout the State and would require that local Boards of Health adopt local regulations and guidelines consistent with the State.

Some of the important features of the proposed state regulations are as follows:

a. "WAC 248.96.050(3). Subsurface on-site sewage disposal systems shall not be permitted in areas of fractured rock or excessively permeable material where it is likely that action of the soil profile will be ineffective in retaining and removing substances having an adverse effect on groundwaters."

b. "WAC 248.96.070(1). When subdivisions or multiple housing units are designed to have gross densities that exceed 3.5 housing units or 12 people/acre or waste flows of 1200 gallons/acre/day, on-site sewage disposal systems shall not be permitted unless the perpetual maintenance and management of the sewage disposal systems are under the responsibility of an approved management system..."

c. WAC 248.96.090. (Establishes minimum lot sizes depending on whether served from a public or private water supply and on soil characteristics. Requirements range from minimum of 12,500 square feet to 2 acres.)

d. WAC 248.96.110(2). (Provides that "all" sanitary sewage be served by the system, described as a septic tank and drainfield. This, presumably, would prohibit the use of dry wells for certain plumbing fixtures as now permitted by some county standards.)

Urban Drainage Facilities

Systems for transporting and disposing of urban runoff water are maintained by all of the local governments in the study area. Nowhere in the study area are there treatment facilities specifically for urban runoff. Only in the City of Spokane is treatment provided for a portion of the urban runoff incidental to domestic waste flows which are transported in combined sewers and then only to the extent that flows can be accomodated hydraulically. Two other minor exceptions are Fairchild Air Force Base which provides grease removal and solids settling for a portion of storm runoff and Wellpinit which combines certain local runoff with the sanitary flow.

A brief description of the existing drainage facilities outside the urban planning area follows:

The City of Cheney has a storm water collection system that delivers the runoff to rural areas outside of the residential-commercial area. The storm sewers are not mapped. City ordinances prohibit the connection of roof drains and area drains to the separate sanitary sewers.

The City of Deer Park utilizes an abandoned irrigation water distribution network to carry the urban runoff to agricultural lands outside of the residential-commercial area. City ordinances prohibit the connection of roof drains and garage drains to the sanitary sewerage system. The storm drains are not mapped.

Fairchild Air Force Base has an extensive system of storm water collection. This system consists of underground sewers, surface ditches and swales. This system delivers the collected storm water to an open ditch which leads to agricultural lands outside the base. At one point in the system is a facility for gravity separation of grease and oils from the storm water and for solids settling.

The Town of Fairfield has a separate storm drain system which delivers urban runoff to Rattler's Run Creek.

The Town of Medical Lake has a separate storm drain system. This system empties the collect runoff into Medical Lake. There are City ordinances which prohibit connection of drains to the sanitary sewerage system.

The Town of Rockford has storm sewers only in the commercial part of the town. These storm drains discharge storm runoff to Rock Creek.

The City of Tekoa has some storm drains in the commercial section of town. These sewers which discharge to Hangman Creek are not mapped.

The Bureau of Indian Affairs at Wellpinit maintains a runoff collection system in the vicinity of the Agency compound. The collected storm water is discharged to the sanitary sewerage system.

Within the urban planning area, the separate and combined systems of the City of Spokane, County facilities and State Highway drainage are the significant urban runoff facilities.

The City of Spokane has a combined storm and sanitary waste collection system that serves most of the City. Within the City, there also are some areas that are served by separate storm drainage systems.

This system includes about 569 miles of combined sewers and about 20 miles of separate storm drains. Many of the separate storm drains discharge to the combined system before reaching the river. Other storm sewers discharge to the Spokane River in 13 outfalls and to Hangman Creek in 3 outfalls.

The State Department of Highways maintains drainage facilities on all the State roads in the Study Area and on the Interstate 90 freeway. Cross culverts are on all the roads where applicable. On Trent Road, drywells are used for runoff disposal outside the City of Spokane. Within the City, a portion of Trent Avenue is served by storm drains which discharge to the City system. In Division Street, Route 395, storm sewers collect the runoff to about the Newport Highway wye. North of this point an open channel carries the runoff to an outfall that discharges to the Little Spokane River at Dartford. Drywells are located in SR27, and also are along the Interstate 90 freeway, except that portion of the freeway in the City of Spokane where the freeway is an elevated viaduct. Stormwater inlets on the viaduct drain the runoff to an underground storm sewer which discharges to Hangman Creek under the freeway bridge.

Spokane County has facilities for road drainage on all the major arterial roads in the County not previously mentioned. The principal method of County road drainage is by the use of drywells. The County also maintains some limited stormwater sewerage systems. A few residential developments in the Spokane Valley have storm sewers and in the north Spokane suburban area, there is a system of storm drainage.

This system, mostly tributary to Country Homes Boulevard, consists of an intercepting open ditch which carries the runoff to the Little Spokane River. The drywells on County roads do not consistently alleviate the problem of road flooding, particularly during intense storms. Plans for the construction of a more adequate and comprehensive storm drainage system in the County are pending.

Industrial Facilities

Most significant industrial development in the study area is concentrated in the urban planning area and much is further concentrated within the City of Spokane. Table 7 lists all industries known to have been issued waste discharge permits by the State Department of Ecology. Of these 51 permittees, 25 are for discharges to the City of Spokane sewer systems and treatment at the City sewage treatment plant. Four permits are for discharge to the Spokane Industrial Park sewer system and subsequent treatment in that treatment facility. One permit is for discharge to the Town of Deer Park facilities. That is, 30 out of 51 permits are for discharges to central collection and treatment facilities and 21 are for individual disposal to the environment.

Industries which discharge to the centralized collection and treatment systems can be further categorized by separating those who release their wastes untreated to the central system from those who provide some form of pretreatment. There are nine industries which provide pretreatment as described below:

Alsco Linen Service discharges its wastewater to the City*

*City indicates City of Spokane throughout the following.

sewer. The wastewater is generated by washing laundry. Pretreatment of the wastes includes screening and settling. There are 8 to 10, 6 feet by 4 feet fixed screens in series. The screens are manually cleaned every 8 hours. The screenings are collected by City solid waste disposal trucks. The solids which are settled are taken to a sanitary landfill about once a year. This is a non-consumptive industry so the quantity of waste generated is approximated by the quantity of influent water. This amounts to about 39,000 gallons per day.

Becwar Packing Company discharges its wastewater to the City sewers. About half of Becwar's average of 51,100 gpd is used for air conditioning cooling water. The other half is used for domestic purposes and for washdown. The washdown wastes are from meat packing operations and from animal holding pens. Screening, sedimentation and grease skimming facilities are provided for the packing operations. Part of the bovine solid waste that is generated in the animal holding pens is collected and sold to fertilizing firms. The remaining bovine waste and all of the procine waste is washed into a sewer manhole.

Burlington Northern discharges about 700,000 gpd to the City sewer from their Hillyard operation. This water is used to wash down machinery, floors, rolling stock, and for domestic purposes. Part of the domestic waste is included in the discharge to the sewer, and part is disposed of in two cesspools, one with three toilets, one with four. The industrial waste passes through grease separators, of which about 300 gallons of oil per week are collected and sold.

Centennial Mills at Sprague Avenue discharges its wastewater to the City sewer. About 481,000 gallons per day are used in the production of gluten and starch. Presently unsatisfactory pretreatment is attempted with an anaerobic filter, but a Unitech thermocompression evaporator is being tested for waste treatment. If the evaporator functions as planned, almost all of the wastewater will be recovered and effluent discharge will be virtually eliminated.

Crystal Linen discharges its wastewater to the City sewer. The water is used for laundry washing and steam generation. Pretreatment of the washwater consists of passing the water through a screen that removes rags, and through a shaker screen that removes lint. In this screen, acid is added to help dissolve grease. The water continues through three settling tanks in series prior to entry to the sewer. Each of the settling tanks is 10 feet by 10 feet by 12 feet. The laundry does not estimate its waste flow or evaporation so the actual waste flow must be approximated by the influent water flow which amounts to about 54,500 gallons per day.

Hollister Stier Laboratories discharge their wastewater to the City rewer. The wastes are generated in the research labs, the dishwashers, and air conditioning compressors. The waste is not pretreated prior to disposal, except that the liquid bacteria cultures to waste are sterilized.

Hygrade Food Products discharges its wastewater to the City sewer. The wastes are generated by meat washing, and domestic purposes. The collected wastewater passes through a single sedimentation tank that has a grease and scum skimmer. The skimmings are rendered. About

385,000 gallons per day are handled in this fashion.

Nalley's Fine Foods discharges its waste to the City sewer. Water is used to wash sliced potatoes to remove starch, to wash unpealed potatoes, and in general plant washdown. The water passes through a shaker screen and two clarifiers in series. The skimmings from the primary clarifier go to a grease trap. The water recovered from the grease trap is recycled to the headworks of the pretreatment facility. The solids that are settled in the primary clarifier are slurried to a third clarifier. The supernatant from the third clarifier is disposed of at a landfill. The waste flow is not metered. The influent of water to the plant averages about 80,000 gallons per day.

Spokane Rendering discharges its wastewater to the City sewer. The wastewater is generated from moisture extracted from raw materials, cooling water for condensing cooker gases, the odor scrubbing tower, plant wash down, truck wash down, and domestic uses. All of the wastewater passes through a screened catch basin and sweep arm clarifier. The City of Spokane estimates that Spokane Rendering generates 129,000 gallons of wastewater per day.

Spokane Industrial Park. Of the industries which discharge their wastes to the Spokane Industrial Park (SIP) treatment facility, only one performs any pretreatment. This one exception is Columbia Lighting which provides facilities for pH adjustment.

Spokane Industrial Park treatment facility serves sixty four industries from which both sanitary and industrial wastes are collected in a privately owned sewer system. Spokane Industrial Park, a subsidiary of Washington Water Power Company, provides leased industrial sites complete with utility services on the site of the old U.S. Naval Supply Depot in the east valley area.

The SIP collection system consists of approximately 2.7 miles of sewers in sizes 6 inches through 10 inches and a .75 mile 10 inch and 12 inch outfall sewer to the treatment plant site. The treatment facility consists of a two stage "Pasveer" oxidation ditch, a clarifier, and chlorine contact chamber. The oxidation ditch functions as an extended aeration plant. Each stage of the oxidation ditch is aerated by two mechanical rotors. Effluent from the oxidation ditch goes to the clarifier and effluent from the clarifier goes to two chlorine contact chambers prior to disposal in a submerged outfall in the Spokane River.

The dimensions of the oxidation ditch are: total width 30 feet, 15 feet per channel, depth 6 feet, and centerline circuit length approximately 650 feet. The clarifier is 40 feet in diameter and the two chlorine contact chambers are each 13 feet by 23 feet.

Industries with Separate Discharges. There are 21 industries listed by DOE as having waste discharge permits for release of their waste flows directly to the environment rather than via a municipal system. These industries and their facilities, if any, are listed in Table 8 and described below:

A.S.C. Industries has a permit to discharge 90,000 gallons per day to groundwater via drainfield. The permit requires treatment of wastes to eliminate excessive solids and oils before disposal.

Ace Concrete has a permit to discharge 75,000 gallons per day untreated wastes from gravel operations to the gravel pit.

Acme Concrete has a permit to discharge 10,000 gallons per day to groundwater via a gravel pit or settling basin.

Central Premix has a permit to discharge 332,640 gallons per day to a lagoon or gravel pit. Central Premix recycles all of the water used in their redimix operation. This operation consists of washing down the insides of concrete trucks. The washwater passes through a sand screw solids classifier, two ponds in series, and enters a holding tank for reuse. The gravel washing water is not reclaimed but is discharged to the gravel pit. These operations amount to a daily use of about 559,000 gallons.

Chembond Corporation has a permit to discharge 108,000 gallons per day untreated cooling water to drywells. Chembond is in the Spokane Industrial Park and discharges sanitary wastes only to their sewers.

Dawn Mining Co. has a permit to discharge not exceeding 650,000 gallons per day of process waters containing fines and tailings from uranium ore to a lagoon for seepage and evaporative disposal. No treatment is provided before lagoon disposal.

Gothman Produce Co. has a permit to discharge not to exceed 500 gallons per day of cooling and other wastes to groundwater. Blood and solid wastes from chicken processing are to be otherwise disposed of. Other liquid process wastes are to be treated by grease trap and septic tank.

Hillyard Processing has two locations, one at Sullivan Road and one at Wellesley Avenue and waste discharge permits for each. The actual operation has changed since the issuance of the permits. There is no longer any liquid industrial waste operation at Wellesley.

Hillyard Processing at Sullivan Road discharges its industrial process water to the Spokane River in a submerged outfall and domestic waste in a septic tank. The quantity of waste generated is about 528,000 gallons per day. The water is used in milling aluminum drosses. After washing the drosses, the water is acidified with sulfuric acid to maintain a pH below 8.5. Then the water passes through a sand screw solids classifier. Coagulants are added to the water prior to entry to the settling basins. The water travels about 0.1 mile in an open top flume to a box which gravity feeds the diffused submerged outfall. Biweekly tests are made for suspended solids, total solids, and chloride ion. Tests for pH are made every 4 hours. The aluminum concentrates are trucked to the Hillyard Processing operation on Wellesley Street. At the Wellesley Street location the aluminum is cast into ingots.

Ideal Cement has a permit to discharge not to exceed 9600 gallons per day of cooling water to groundwater by seepage. Industrial process waters are specifically excluded from this permit.

Inland Empire Paper Co. has a waste discharge permit to discharge an average of 4.0 million gallons per day of industrial waste and 0.8 million gallons per day of cooling water to the Spokane River. The following is quoted from the permit as descriptive of the industrial waste treatment facility:

"All process waters from entire paper mill and process waters from screenings and cleaning of pulp is collected at one central location. These waters have been recycled and put through a flotation separator and mechanical screen before collecting. The composite waters are then pumped through a mechanical screen separator and then to a thickener (clarifier) for Primary Treatment. The clarified water is then monitored and discharged continuously into a foam tank and then through a submerged outfall to the Spokane River. The thickened material is pumped over a vacuum filter and dewatered. It is then disposed of on land."

Domestic wastes are treated in septic tank and drain fields.

Kaiser Mead works has a waste discharge permit for the following quantities:

21,000 gpd process waste water
185,000 gpd sanitary waste
5,280,000 gpd cooling water

These quantities were confirmed as "estimates" in a letter from Kaiser to the consultant on March 7, 1974.

The cooling waters which are used for summer ambient air cooling (2.45 mgd), rectifier cooling (1.78 mgd) and ingot cooling (0.70 mgd) are discharged without treatment.

The sanitary wastes are treated in a facility consisting of primary clarifier, first and second filters (presumably trickling filters), secondary clarifier, chlorinator, sludge digester and sludge drying beds.

The process waste water is entirely from regeneration of Zeolite water softeners. No treatment is mentioned for this process waste.

Combined flows of treated sanitary sewage effluent, untreated cooling coater and untreated process waste are discharged to the surface waters of Peone Creek.

The only process water treating facility is on a closed circuit wet scrubber system for the pot liner. The treatment facility is described as neutralization with lime to precipitate calcium fluoride. The calcium fluoride sludge is conducted to an evaporation pond. This wet scrubbing system is understood to be in the process of being phased out for replacement by a dry system in 1974.

Kaiser South Mead works has a waste discharge permit that reports flows as follows:

300,000 gpd sanitary use
1,500,000 gpd industrial use
4,500,000 gpd cooling use

In a letter to the consultant dated March 7, 1974, Kaiser has revised these figures as follows, reflecting the current use of the facility:

1,000 gpd sanitary use
311,000 gpd cooling use

No process use other than cooling is currently reported and there are no process water treatment facilities. Sanitary waste flows are treated in a small activated sludge type unit. The ultimate disposal method listed in the permit is groundwater via a pond. Presumably this is still the case. No data are available on size or lining of the pond.

Kaiser Trentwood. This major industrial complex has a discharge permit for all of its liquid wastes, domestic, industrial and stormwater, at river mile 86 on the Spokane River. The following summary of data on treatment facilities is from the application for interim waste discharge permit dated August 17, 1973.

All waste flows, treated domestic waste, treated industrial waste and untreated storm water, are routed through a lagoon before discharge to the river through a submerged diffuser. The lagoon has provision for skimming of floating materials. The size of the lagoon is not given. There is no statement as to whether the lagoon is lined or not. The total flow throughput of the lagoon is as follows:

Treated domestic waste, 4,100 gpd*
Treated industrial waste, 6.2 mgd
Untreated cooling water, 17.5 mgd
Untreated storm water, not stated

The domestic treatment facility upstream from the lagoon consists of the elements of a secondary facility and includes primary clarifier, trickling filter, secondary clarifier, chlorine contact chamber, sludge digester and sludge drying beds.

The industrial waste treatment facilities upstream from the lagoon consist of an oil removal unit, a chromium and phosphate processing unit and a clarifier. Supplemental data on the capacity of these facilities, as follows, is from a letter from Kaiser to the consultant dated December 30, 1973.

Process	Waste Treatment Capacity
Chrome bearing waste	100 gpm
Phosphate bearing waste	160 gpm
Oil emulsion waste	40 gpm

The lagoon is reported as having a volume of approximately 4 million gallons and the river outfall and diffuser as having capacity in excess of 40,000 gpm.

*The domestic flow appears to be too low for a reported employment of over 2000 persons.

Materne Bros. has a permit to discharge not to exceed 300, 000 gallons per day of gravel wash wastes to an unspecified state waterway. This appears to have been a permit subject to activation at specific times and locations by prior notice to authorities.

McAtee and Heath has a permit to discharge not to exceed 72, 000 gallons per day of waste waters associated with asphalt plant operation to state waters. The permit is not for a specific time or location and required prior notice to DOE prior to activation, at which time treatment criteria are to be established.

Rockford Grain Growers has a permit to discharge 1000 gallons per day of cooling and other wastes to a lagoon. Wastes appear to be from washing tanks. No treatment is provided. Sanitary wastes are discharged to the Town of Rockford sewers.

Simmons Egg Farm. This former holder of a waste discharge permit is no longer operating.

Soft Water Service (Culligan) discharges approximately 27,000 gallons per day of process water to the Spokane River resulting primarily from recharge of water softeners and to a small extent from recharge of deionizers. No treatment is provided for the softener recharge wastes. A calcium carbonate filter is provided for pH adjustment of the caustic and acid wastes from the deionizer process. Sanitary wastes are sent to the City sewer. The entire operation is subject to being moved to a new location in the City where the total process discharge will be to the City sewers rather than to the Spokane River.

Triple E Meats has a permit to discharge not to exceed 2200 gallons per day cooling water and defrost water to ground seepage. There is no treatment prior to discharge.

United Paving has a permit to discharge 40,000 gallons per day of cooling and other waters by seepage and evaporation from pond disposal. There is no treatment prior to disposal.

Reference to the foregoing and to Table 8 indicates that, of the 20 permittees, only 5 are known to be operating treatment facilities any more elaborate than lagoons from which wastes are disposed of by seepage and evaporation. Only the following six have both significant flows and/or treatment facilities:

Dawn Mining Co.
Hillyard, Sullivan Road Plant
Inland Empire Paper Co.
Kaiser, Mead
Kaiser, South Mead
Kaiser, Trentwood

TABLE 1

GENERAL CHARACTERISTICS OF MUNICIPAL SEWERAGE FACILITIES

Community	Population[1]	Categories of Facilities Provided: Sanitary Sewers	Wastewater Treatment	Storm Sewers	Treatment Method	Estimated Sanitary ADWF[2] (GPD)	Discharge To	Approximate Sanitary Sewer Service Area Sq. Mi.
City of Cheney	6358	X	X	X	Lagoon	638,000	Minnie Creek	0.98
City of Deer Park	1295	X	X	X	Trickling Filter	142,000	Dragoon Dreek	0.53
Fairchild AFB	6700[4]	X	X	X	Trickling Filter	1,065,000	(8)	2.30
Town of Fairfield	469	X	X	X	Lagoon	28,000	Rattler Run Creek	0.18
Town of Medical Lk	3529	X	X	X	Lagoon	135,000	Non-overflow[9]	0.55
Town of Millwood	1770	X	X		Activated Sludge	10,000	Spokane River	0.04
Town of Rockford	327	X	X	X	Lagoon	30,000	Rock Creek	0.11
City of Spokane	170516	X	X[3]	X	Sedimentation	29,000,000	Spokane River	43.60
City of Tekoa	808	X	X	X	Sedimentation[6]	120,000	Hangman Creek	0.39
Wellpinit (BIA)	310[5]	X	X	X	Activated Sludge[7]	8,000	Non-overflow	0.02

1 1970 Census.
2 ADWF=Average Dry Weather Flow; MGD=Million Gallons Per Day.
3 Interim treatment facilities are also provided.
4 5500 residents, 1200 day employees--1973
5 50 residents, 210 students, 50 day employees--1973.
6 Trickling filter is available but not presently used.
7 A.S plant discharges to non-overflow polishing lagoon.
8 Discharge is to drainfield about half of year and to non-overflow lagoon for remainder.
9 Lagoon overflows to Deep Creek an estimated 10 days per year.

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	GENERAL CHARACTERISTICS OF MUNICIPAL SEWERAGE FACILITIES	TABLE 1

TABLE 2

COLLECTION SYSTEM CHARACTERISTICS

	Sanitary Sewers									Storm Sewers					
Community	Availability of System Mapping[1]	Total Length Miles	Size Range Inches	Pipe Materials	Joint Type	Number Siphons	Dist. Rock Cuts	M.H. Spacing	M.H. Materials	Availability of System Mapping	Length	Materials	Size Range	Joints	M H Spacing Typ
Town of Cheney	Yes	35	6-24	.1 mi C I 20 mi Conc 8 mi Rein Conc. 5 mi V C P	Mostly rubber gasket	1	50%	300'-400'	1/3 brick 1/3 block 1/3 precast	None	15 miles	100% concrete	12"-18"	rubber ring	300'-400'
City of Deer Park	2Z	9 1	8-12	100% Conc	5% rubber gasket 95% cement	0	0	300'-400'	100% precast	None	900' sewer 900' ditches	100% concrete	30"	cement	300'
Fairchild AFB	Yes[3]									Yes					
Town of Fairfield	BE	3 9	4-12	70% V C.P 30% A C P	30% rubber gasket 70% cement	●	0	300'-400'	100% block	None	900'	V C.P.	12"	cement	No M H
Town of Medical Lake	BE	9 4	6-14	10% Conc. 90% A C P.	100% rubber gasket	0	95%	300'-400'	60% precast 40% block	None	3000'	concrete	6"-12"	50% rubber ring 50% cement	300'-400'
Town of Millwood	—	0 57	6	100% V C P	100% cement	●	0	300'-400'	100% brick	None	None				
Town of Rockford	BE	5	8-10	100% Conc.	100% rubber gasket	●	10%	100'-400'	5% precast 95% block	None	Unknown (1500' ditch)	concrete	10"-12"	cement	300'-400'
City of Spokane	Yes[3]			See Table 3 for size and length of principal interceptors						Yes[3]					
Town of Tekoa	(2)	7.9	6-10	.5 Conc. .5 V.C P	10% rubber gasket 90% cement	0	5%	200'-600'	90% brick 10% block	None	1 mile 1 mile ditch	V.C P	8"-12"	cement	300'-400'

[1] BE indicates that a system plan is available in Bovay Engineers (1972).
[2] No reproducible map available
[3] Complete mapping available in Kennedy-Tudor files.

TABLE 3

CITY OF SPOKANE INTERCEPTOR SEWERS -- SIZE AND CAPACITY

Segment Designation	Pipe Diam. Inches	Slope Feet Per Foot	Approximate Length, Feet	Capacity[1]		Remarks
				cfs	mgd	
A-1	72	.002	--	162	105	Plant influent
A-2	60	.006	720	174	112	
A-3	54	.0105	3300	172	111	
A-4	60	.007	1050	188	121	
A-5	54	.011	1650	180	115	
A-6	60	.0065	2550	181	117	
A-7	60	.00686	430	185	120	Siphon
A-8	60	.0045	1350	151	97	
A-9	72	.0016	6200	146	94	
AA-1	24	.0025	700	9.6	6.2	
AA-2	21	.0025	600	6.8	4.4	
AA-3	14	--	600	6.7[2]	--	Force Main
AA-3.1	15	.002	100	2.5	1.6	
AA-3 2	15	.0084	250	5.0	3.2	
AA-3.3	15	.0043	1700	3.6	2.3	
AA-4	18	.0025	2300	4.5	2.9	
B-1	72	.00165	4250	149	95	
B-2	60	.0042	400	146	94	

TABLE 3 (continued)

Segment Designation	Pipe Diam. Inches	Slope Feet Per Foot	Approximate Length, Feet	Capacity		Remarks
				cfs	mgd	
BB-1	27	.006	350	20.5	13.1	
BB-2	24	.0109	1450	21.0	13.4	Siphon
BB-3	27	.0025	560	13.1	8.5	
BB-4	42	.0024	1900	43	27	30" Overflow @ junction 42" & 27"[3]
C-1	54	.006	480	131	85	
C-2	60	.003	500	120	77	
CC-1	42	.004	400	55	35	
CC-2	66	.0065	380	235	150	48" Overflow @ junction 66" & 42"[3]
CC-3	30	.0038	2050	21.7	13.9	
D-1	54	.0022	6500	80	52	
D-2	60	.0015	1800	86	55	
D-3	42	.00195	1800	38	24.3	
D-4	42	.0009	900	25.7	16.5	
D-5	42	.0008	180	24.1	15.6	
DD-1	12	.0073	350	2.6	1.6	Siphon
DD-1.1	10	.002	650	0.8	0.54	
DD-2	15	.003	450	3.0	1.9	

TABLE 3 (continued)

Segment Designation	Pipe Diam. Inches	Slope Feet Per Foot	Approximate Length, Feet	Capacity		Remarks
				cfs	mgd	
E-1	42	.0008	2900	24.1	15.6	
E-2	36	.0008	1000	16.0	10.3	
E-3	36	.0009	3100	17.0	11.0	
EE-1	--	Siphon	350	—	--	
EE-2	24	.002	1600	8.6	5.6	
EE-3	15	.014	1000	6.4	4.1	
EE-4	18	.004	950	5.6	3.6	
F-1	24	.0009	800	5.7	3.7	
F-2	18	.0012	4050	3.1	2.0	
F-3	15	.0012	1850	1.9	1.2	
F-4	12	.016	570	3.8	2.4	
F-5	10	.006	1400	1.4	0.9	

[1]Flowing full at Mannings 'n' = 0.0155.

[2]Flow at velocity of 6.3 fps.

[3]Overflows noted only at locations where downstream pipe size is significantly reduced.

TABLE 4

CITY OF SPOKANE SEWAGE PUMP STATIONS

Identification Number	Location Name	Number of Units	Pumping Equipment Capacity Each Unit gpm	Total Capacity gpm	Remarks
1	Springfield Station	1 1	300 gpm pump 400 gpm pump	700	Designed to accomodate 1 500 gpm pump at a future date
2	Assembly & Francis	2	300 gpm pumps	600	
3	Francis & Cannon	2 1	750 gpm pumps 450 gpm pump	1950	Space for 1 additional pump in future
4	Panorama Terrace	2	60 gpm pumps	120	Serves lagoon
5	Continental City	2	300 gpm pumps	600	
6	N. Ferral Street	2	750 gpm pumps	1500	
7	Ferris High School	2	300 gpm pumps	600	
8	45th & Regal (44th & Regal)	2	200 gpm pumps	400	
9	46th & Cook	2	200 gpm pumps	400	Overflows during storms

TABLE 4 (continued)

Identification Number	Location Name	Pumping Equipment: Number of Units	Pumping Equipment: Capacity Each Unit gpm	Total Capacity gpm	Remarks
10	35th & Helena	2	600 gpm pumps	1200	
11	Clarke & Linton			2700	
12	Elm Street	2	400 gpm pumps	800	
13	San Souci West	2	150 gpm pumps	300	Natatorium Park area
14	Spokane Falls Community College	2	100 gpm pumps	200	
15	Rivercrest Hospital	1	75 gpm	75	Ejector type, hospital only

TABLE 5

INTERIM FACILITIES

No. (10)	Name	Grid No.[9]	Treatment: A/S[1]	Treatment: Lagoon	Treatment: AER Lagoon	Treatment: Other	Treatment: Cl_2	Capacity (GPD) or Size	Effluent: Drain-field	Effluent: Non-over-flow	Effluent: Water-course	Service[8] Present Pop.	Present Units	Ultimate Pop.	Ultimate Units	Operation
1	Aloha Addition	H-3	X				X	20,000	X			126		174		Spokane Co.
2	Balfour Apartments	G-3	X					7,500	X			126		126		Owner
3	Belle Terre	I-2		X				1.42Ac.		X		42		138		Vera Irr.Dist.
4	Camelot Addition	E-7			X			26,000	X			114		507		Spokane Co.
5	Camlu Apartments	H-4	X				X	5,000	X			45		180		Owner
6	Castle Addition	G-2	X					70,000	X			123		303		Spokane Co.
7	Chattaroy Valley Mobile Estates	--				X[2]		3,000 gal.	X			42		42		Owner
8	Conifer Village	H-4	X					15,000	X			192		192		Owner
9	Crescent & Univ City	G-4	X					15,000	X			150		150		Owner
10	Fairwood Additions	D-7			X			150,000		X[5]		3,157[3]				Whitworth Water Dist.
11	Geiger H s. Housing	--		X				7 Ac.		X		1,030		1,800		Air Force
12	Glennaire Terrace	F-2			X			150,000		X		270		306		Owner
13	Golden Acres N. Mobile Home Park	F-4	X					3,000	X			48		48		Owner
14	Good Samaritan Home	J-3	X[4]					100,000	X			350		350		Owner
15	Hangman Hills	--	X					25,000	X			21		519		Owner
16	Hill V Estates	H-3	X				X	75,000	X			348		1,275		Owner
17	Holiday Hills (Recreation)	K-4	X				X	30,000	X				178		178	Owner
18	Holiday Hills (Ski)	K-4	X					30,000	X				200		200	
19	Hutton Settle., Inc.	G-5		X				0.5 Ac.		X		55		200		Owner
20	Kraft Apartments	G-4	X					8,000	X			114		114		Owner
21	Lamplighter Lodge	I-4	X					18,000	X				120		120	Owner
22	La Petite Ville Mobile Home Park	E-7	X					20,000	X			[illegible]		85		Owner
23	Liberty High School	--	X				X			X[5]		196		200		School Dist. #362
24	Liberty Lk Utilities	K-3				X[6]	X	150,000		X[6]		280		1,400		Liberty Lk. Utilities
25	Lidgerwood	D-6		X				24.7 Ac.		X		1,500		2,300		City of Spokane

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INTERIM FACILITIES

TABLE 5

TABLE 5 (continued)

No.	Name	Grid No.	Treatment: A/S	Treatment: Lagoon	Treatment: AER Lagoon	Treatment: Other	Cl_2	Capacity (GPD) or Size	Effluent: Drain-field	Effluent: Non-over-flow	Effluent: Water-course	Service: Present Pop.	Service: Present Units	Service: Ultimate Pop.	Service: Ultimate Units	Operation
26	Manorville Apartments	C-4	X					10,000	X			102		114		Owner
27	Mater Cleri Seminary	—		X				0.72Ac.		X		40		100		Owner
28	Mica Peak AFS	—	X							X[5]		15		15		Air Force
29	Mt. Spokane Chair Lifts	—	X					20,000	X				10		60	Spokane Co.
30	N Cedar Drive-In Thtr	D-6	X					15,000	X				900		900	Owner
31	Northwest Terrace	B-6	X				X	300,000			X	900		1,800		City of Spokane
32	Opportunity Convalescence Center	H-4	X				X	35,000	X			150		150		Owner
33	Opportunity Ter. Est.	H-4	X				X	15,000	X			90		156		Vera Irr. Dist.
34	Painted Hills Subd.	H-2		X				0.6 Ac.		X		105		159		Owner
35	Panorama Terrace	C-6		X				1.0 Ac.		X		18		210		City of Spokane
36	Pines Manor	H-4	X				X	7,500	X			100[11]	50			Owner
37	Pines Terra	H-4	X					8,000	X			108[11]	54			Owner
38	Pines Townhouses	F-4	X					15,000	X			64[11]	32			Owner
39	Pine Villa Apartments	D-7	X					15,000	X			150		150		Owner
40	Ponderosa Apartments	G-4	X					31,000	X			291		387		Owner
41	Regal Village	E-2		X				0.75Ac.		X						Owner
42	Rainbow Hts Mobile Home Park	--				X[2]			X			68		68		Owner
43	River Rose Mobile Home Park	J-5	X					5,000	X			235		235		Owner
44	Rooney's Mobile Home Park	--		X				0.95Ac.		X		68		68		Owner
45	S&J Apartments	G-4	X					5,300	X			75		81		Owner
46	Sandy Beach Resort	L-3	X					12,500	X				46		46	Owner
47	Spokane Policy Acad.	F-4		X				50 ft.sq.			X	7		7		City of Spokane
48	Stoneridge Apts	H-4	X					8,000	X			135		135		Owner
49	Stoneridge Apts	G-4	X					8,000	X			123		135		Owner
50	Survival School Fairchild AFB	--		X		X[7]		160,000		X		750		1,000		Air Force

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INTERIM FACILITIES

TABLE 5 (Cont.)

TABLE 5 (continued)

No.	Name	Grid No.	Treatment: A/S	Treatment: Lagoon	Treatment: AER Lagoon	Treatment: Other	Treatment: Cl_2	Capacity (GPD) or Size	Effluent: Drain-field	Effluent: Non-over-flow	Effluent: Water-course	Service: Present Pop.	Service: Present Units	Service: Ultimate Pop.	Service: Ultimate Units	Operation
51	Sunrise N. Apartments	H-5	X					10,000	X			144		144		Owner
52	Ted Gunning Apartments	H-4	X					8,000	X							Owner
53	Timberlane Devpts	I-3	X					17,000	X			87		180		Vera Irr. Dist.
54	University City Shopping Center	H-4	X					33,000	X							Owner
55	Upper Columbia Acad.	--		X				35,000		X				300		Owner
56	Valley Commons Apts.	G-4	X					12,000	X			153		165		Owner
57	Valumart Store	F-3	X					5,000	X							Owner
58	Whitworth College	D-7			X			2.3 Ac.		X		1,200		1,200		
59	Young Shopping Ctr	E-2	X					9,000	X							
	TOTALS		40	12	4	4	10		40	17	2	13,320				

1 Activated sludge.
2 Community septic tank.
3 Population equivalents to include schools and commercial.
4 To replace existing lagoon in Spring, 1974.
5 Effluent to evapo-infiltration pond.
6 Trickling filter S.T.P.; effluent to seepage ditch.
7 Imhoff tank and trickling filter also used in process.
8 Assumed 3.0 persons/unit for apartments and subdivisions and 2.5 persons/unit for mobile homes.
9 Refers to 400 scale map area.
10 Refers to identification on Plate 311-3.
11 Estimated two persons per unit for retirement community.

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	INTERIM FACILITIES	TABLE 5 (Cont.)

TABLE 6A

COMMUNITIES OUTSIDE THE URBAN PLANNING AREA SERVED BY PUBLIC WATER SUPPLIES WHICH HAVE INDIVIDUAL DISPOSAL SYSTEMS

Identification Number	Community	Approximate Service Population	Average Daily Water Use Gallons
1	Airway Heights	1197	153,000
2	Balmer Gardens	30	500
3	Bunch Estates (Stevens Co.)	60	6,000
4	Camp Diamond (Pend Oreille Co.)	140-175	26,100
5	Carmel Estates	16	3,000
6	Cayuse Cove (Lincoln Co.)	42	4,200
7	Cedar Knolls	7	560
8	Chatteroy Hills	244	230,000
9	Conrad's Develop. (Lincoln Co.)	56	5,600
10	Elk	20[1]	2,500
11	Fairway Addition	4	400
12	Feltons Addition	20	2,000
13	Four Lakes	200	8,000
14	Glenrose	27	3,375
15	Glines Addition	12	1,200
16	Half Moon Ranchos	21	3,900
17	Koontz's Squaw Canyon Development (Lincoln Co.)	40	4,000
18	Latah	169	52,500
19	Marshall	74	4,400
20	North Glen Estates	25	5,000
21	North Mt. View	18	3,000
22	Panorama Acres	40	7,400
23	Peace Farm (commune)	50	5,000
24	Prairie Pines	10	1,250
25	Rivilla[2]	97	15,000
26	Spangle	212	53,000
27	Spokane Lake Park	6	600
28	Stonelodge (Stevens Co.)	140	17,500
29	Stonelodge 1st Add. (Stevens Co.)	158	19,625
30	Strong and Turosky (Stevens Co.)	22	2,200

TABLE 6A (continued)

Identification Number	Community	Approximate Service Population	Average Daily Water Use Gallons
31	Sunshine Shores (Stevens Co.)	80	8,000
32	Velview Estates	50	5,000
33	Waterview Terrace	16	800
34	Waverly	9[1]	1,000
35	West Shore	18	260
36	Deborah Addition[3]		
37	Hidden Hollow[3]		
38	Loughbon Bay[3]		
39	Rinker-Bolenus Development (Lincoln Co.)[3]		

[1]Public water system serves only portion of community.

[2]Name of water company used to designate area name.

[3]New developments intended to have public water supply, but no data available.

TABLE 6B

COMMUNITIES OUTSIDE THE URBAN PLANNING AREA NOT SERVED BY PUBLIC WATER SUPPLIES WHICH HAVE INDIVIDUAL DISPOSAL SYSTEMS

Identification Number	Community
1	A & M Woodland Park
2	Arrow Park Tracts
3	Ballard's Addition
4	Bartlesons Addition
5	Blair Addition
6	Cheney Ponderosa Addition
7	Daltons Addition
8	Dragoon Estates
9	Four Lakes Golf & Country Club
10	Glasgow Park
11	Hildenbrandt's Little Spokane Sub'd.
12	Lake Forest
13	McCleary's Tracts
14	Meadow Lake Additions
15	Mt. View Orchard
16	Olsens Lakeside Addition
17	Paradise Pines Additions
18	Reflection Lake Additions
19	River Terrace Estates
20	Sunwest Acres
21	Teresa Terrace Addition
22	Waterview Terrace 1st Addition
23	Wildrose

TABLE 6C

PUBLIC WATER SUPPLY SERVICE AREAS IN THE URBAN PLANNING AREA WHICH HAVE INDIVIDUAL DISPOSAL SYSTEMS

Name of Water System	Service Population	General Location
CID Carder	210	East Valley R44
Carnhope	1,400	"
Dishman	500	"
East Spokane	3,200	"
Hutchinson	2,100	"
Irvin	1,650	"
Millwood	1,530*	"
Model	4,075	"
Modern	14,588	"
Orchard Avenue	3,500	"
Pasadena	2,000	"
Trentwood	3,400	"
Vera	11,000	"
Wash. Water Power-1	3,872	"
Wash. Water Power-2	4,737	"
Subtotal	62,262	
CID Corbin	2,500	East Valley R45
CID East Farms	660	"
CID Orchards	1,000	"
CID West Farms	850	"
Greenacres	790	"
Moab	167	"
Subtotal	5,967	
North Spokane	1,900	North Spokane
Wash. Water Power-3A	3,824	"
Wash. Water Power-3B	1,205	"
Wash. Water Power-3BP	475	"
Wash. Water Power-3C	223	"
Whitworth	8,908	"
Subtotal	16,535	
TOTAL	84,264	

*Not including the 270 persons on Millwood's limited sewer system.

TABLE 7

INDUSTRIAL WASTE DISCHARGE PERMITS

Name	Permit Number	Expiration Date	Maximum Daily Flow	Point of Discharge: To City Sewers	Point of Discharge: To STP	Point of Discharge: Separate Surface Water	Point of Discharge: Separate Groundwater	Point of Discharge: Other	Remarks
A-M Manufacturing	3482	12/15/75	21,500		X				
A.S.C. Industries	3872	10/26/76	90,000				X		
Ace Concrete	3593	6/28/76	75,000				X		
Acme Concrete	2908	2/ 1/73	10,000				X		
Alsco Linen	3067	12/19/73	70,000	X					
American Sign & Indicator	3075	12/ 6/73	250,000	X					
Becwar Meat Packing Co.	3039	8/ 1/73	60,000	X					
Benewah Creamery	3847	9/ 7/76	17,000	X					
Burlington-Northern	3964	2/23/77	350,000	X					
Carnation Company	3902	11/ 4/76	60,000	X					
Centenial Mills (Sprague)	T-4040	6/12/73	250,000	X					
Central Pre-mix	3879	10/13/76	332,640						
Chembond Corp	2826	11/ 3/72	108,000				X	Lagoon or Gravel Pit	
Columbia Lighting	3065	10/10/73	432,000		X				
Commercial Creamery	3647	3/26/76	40,000	X					
Crystal Laundry	3066	12/19/73	100,000	X					
Dawn Mining Company	3216	10/22/74	650,000						
Deer Park Creamery	3568	1/27/76	7,500					Lagoon-Evap. & Seepage	
General Aluminum Corp.	2990	6/19/73	200		X			Deer Park STP	
Gothmann Produce	2669	12/15/71	500				X		
Hallstone Dairy	3800	8/ 2/76	1,000	X					
Hillyard Processing (Sullivan)	3841	8/24/76	720,000			X			To Spokane Ri er
Hillyard Processing (Wellesley)	3603	5/17/76	300,000			X			To Spokane River
Hygrade Food Products	2846	11/22/72	50,000	X					
Ideal Cement	3869	9/27/76	9,600				X		

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army, Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	INDUSTRIAL WASTE DISCHARGE PERMITS	TABLE 7

TABLE 7 (continued)

Name	Permit Number	Expiration Date	Maximum Daily Flow	Point of Discharge: To City Sewers	To SIP	Separate: Surface Water	Separate: Groundwater	Other	Remarks
Inland Empire Dairy (Darigold)	3849	9/ 7/76	5,000	X					
Inland Empire Paper Co.	T-3835	12/31/76	5,500,000			X			To Spokane River
Kaiser, Mead Works	3812	8/ 2/76	5,486,000			X			To Peone Creek
Kaiser, South Mead	3129	2/ 7/ 74	7,700,000				X		
Kaiser, Trentwood	T-3960	2/28/73	27,000,000			X			To Spokane River
Materne Bros.	3043	7/27/73	300,000					Unspecified	Provisional Permit
McAtee & Heath	3452	8/ 7/75	72,000					Unspecified	Provisional Permit
Nalley's Fine Food	3191	7/29/74	210,000	X					
Northern Pacific RR	3101	1/12/74	28,000	X					Now part of Burlington-North.
Pacific Hide & Fur	3542	1/12/76	150	X				And land disposal	
Poultry Processors	3454	10/ 9/75	200,000	X					
Produce Supply	4023	8/24/77	2,700	X					
Rockford Grain Growers	2875	11/22/72	1,000				X		
Simmons Egg Farm	3052	8/29/73	50,000				X		No longer operating
Smith-Nielsen Equip. Co.	3725	6/30/76	3,750	X					
Soft Water Service (Culligan)	T-3939	6/ 1/73	35,000			X			Permit requires change to City Sewers
Spokane Rendering	T-3397	7/29/71	100,000	X					
Spokane Stove Repair	3074	1/22/74	3,000	X					
Suntex Veneer, Inc.	3955	4/10/77	74,000		X				
Triple "E" Meats, Inc.	3878	11/10/76	2,200				X		
Troy Laundry	3102	3/11/74	10,000	X					
Union Pacific RR	3599	1/12/76	164,000	X					
United Dressed Meats	3103	12/19/73	120,000	X					
United Paving	3111	2/ 9/74	40,000					Pond-Evap. & Seepage	
Western Linens	T-3360	2/11/77	25,000	X					
Western Soap	3870	9/27/76	3,000	X					

TABLE 8

INDUSTRIES WITH WASTE DISCHARGE PERMITS FOR DISPOSAL TO OTHER THAN CITY SEWERS

Permit No. and Expiration Date	Name and Address	Not to Exceed Flow gpd	Disposal: Location R/T-S[1]	Disposal: Kind	Treatment Provided Before Disposal	Remarks	Sanitary[2]
3872 10/26/76	A.S.C. Industries N. 800 Fancher Way Spokane	90,000		Groundwater via drainfields	Excessive solids and oil removal required		ST
3693 6/28/76	Ace Concrete Co. N. 320 Park Rd. Spokane	75,000	25/44-18	Lagoon or Gravel Pit	None	Not to enter GW directly-only by seepage	ST
2908 2/1/73	Acme Concrete E. 5203 Broadway Spokane	10,000		Lagoon or Gravel Pit	None		ST
3879 10/13/76	Central Premix Concrete Co. Terminal Annex Box 3366 Spokane	332,640	25/42-14	Lagoon or Gravel	None	Not to enter Spokane R except by seepage. This permit supercedes # 2555 to Union Sand and Gravel	ST
2826 11/ 3/72	Chembond Corp. Building 3 Spokane Ind. Park	108,000		Groundwater	None	Disch. restricted to uncontaminated cooling water and wash water from lab glassware	MS
3216 10/16/74	Dawn Mining Co. P.O. Box 25 Ford	650,000	28/39-25	Lagoon for evap. and seepage	None	Fines and tailings from uranium mining	ST

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	INDUSTRIES WITH WASTE DISCHARGE PERMITS FOR DISPOSAL TO OTHER THAN CITY SEWERS	TABLE 8

TABLE 8 (continued)

Permit No. and Expiration Date	Name and Address	Not to Exceed Flow gpd	Disposal Location R/T-S	Disposal Kind	Treatment Provided Before Disposal	Remarks	Sanitary
2669 12/15/71	Gothmann Produce Co. S. 2130 Inland Empire Highway Spokane	500		Groundwater	Unknown	Other than cooling required to be treated by grease trap and septic tank	ST
3841 8/24/76	Hillyard Processing Co. P.O. Box 6051 Spokane, Sullivan Road Plant	720,000	25/44-11	Spokane River	Coagulation and sedimentation	Waste from milling aluminum dross	ST
3603 5/17/76	Hillyard Processing Co. P.O. Box 6055 Spokane, Wellesley Avenue Plant	300,000		Spokane River via B-N sewer	Not operating No liquid waste	Called for sedimentation. Dry process change at this site results in no liquid	ST
3869 8/27/76	Ideal Cement Co. E 12207 Empire St. Millwood	9,600		Ground	None	Industrial process wastes are specifically excluded	ST
T-3835 12/31/76	Inland Empire Paper Company P.O. Box 686 Millwood	6,500,000		Spokane River River Mile 83	Yes. See Text		ST
3812 8/ 2/76	Kaiser Aluminum & Chemical Corp. Mead Works P.O. Box 6217 Hillyard Sta., Spokane	5,486,000		Peone Creek	Yes. See Text		TR

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	INDUSTRIES WITH WASTE DISCHARGE PERMITS FOR DISPOSAL TO OTHER THAN CITY SEWERS	TABLE 8 (Cont.)

TABLE 8 (continued)

Permit No. and Expiration Date	Name and Address	Not to Exceed Flow gpd	Disposal: Location R/T-S	Disposal: Kind	Treatment Provided Before Disposal	Remarks	Sanitary
3129 2/ 7/74	Kaiser A & C Corp. Mead South Plant	7,700,000		Groundwater	None. Cooling water only to lagoon	Present flows greatly reduced from permit. See text	TR
T-3960 2/28/73	Kaiser A & C Corp Trentwood Works	27,000,000	50/44-10&11	Spokane River	Yes. See Text		TR
3043 7/27/73	Materne Bros. W. 1204 Frances Ave. Spokane	300,000	Not specified	Not specified	See remarks	This is a conditional permit. Requirements to be spelled out if activated	NS
3452 7/ 7/75	McAtee & Heath P.O. Box 4187 Station B Spokane	72,000	Not specified	Not specified	See remarks	This is a conditional permit. Requirements to be spelled out if activated	NS
2875 11/22/72	Rockford Grain Growers, Inc. Rockford	1,000		Groundwater via lagoon	None	Prohibits release to surface water	NS
3052 8/29/73	Simmons Egg Farm N. 2406 Barker Rd. Greenacres	50,000		Groundwater via lagoon	See remarks	Company no longer operating	NS
T-3939 6/ 1/73	Soft Water Service 913 W. Bridge Ave. Spokane	35,000	25/43-18	Spokane River via City storm sewer	Yes. See text	Requires future connection to city sewer	NS

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	INDUSTRIES WITH WASTE DISCHARGE PERMITS FOR DISPOSAL TO OTHER THAN CITY SEWERS	TABLE 8 (Cont.)

TABLE 8 (continued)

Permit No. and Expiration Date	Name and Address	Not to Exceed Flow gpd	Disposal Location R/T-S[1]	Disposal Kind	Treatment Provided Before Disposal	Remarks	Sanitary[2]
3878 11/10/76	Triple E Meats, Inc. E. 1040 Jackson St. Spokane	2,200		Groundwater	Grease trap and septic tank	Limits untreated discharge to cooling and defrost water	ST
3111 2/9/74	United Paving Co., Inc. Geiger Field	40,000	25/42-28&33	Groundwater via pond	None		NS

[1]Location given by Township/Range-Section.

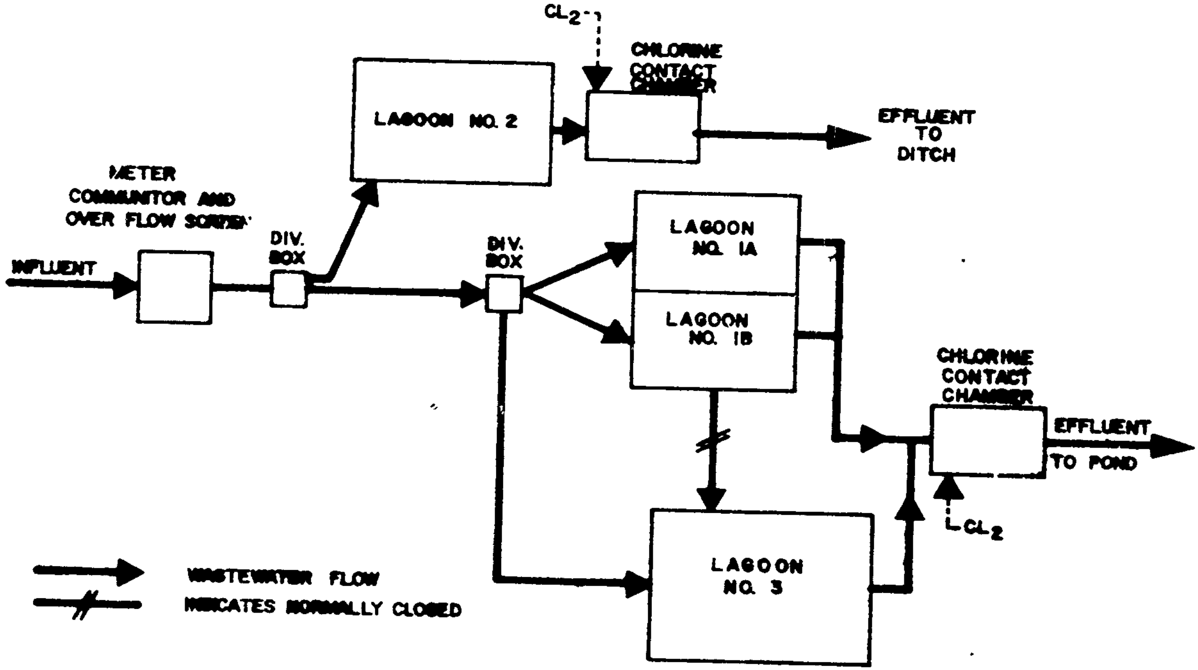
[2]Sanitary disposal by code: MS=Municipal sewers, ST=Septic tank and leach field, TR=Treated for disposal with the industrial stream, NS=Not specified

WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	INDUSTRIES WITH WASTE DISCHARGE PERMITS FOR DISPOSAL TO OTHER THAN CITY SEWERS	TABLE 8 (Cont.)

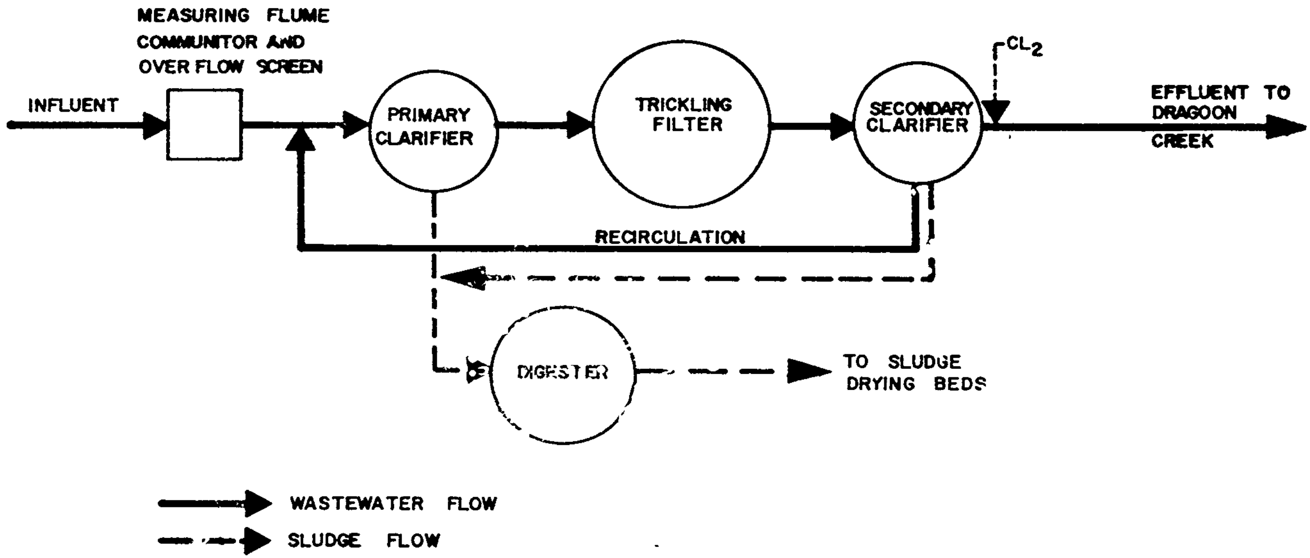
TABLE 9

REGULATION OF INDIVIDUAL WASTE DISPOSAL

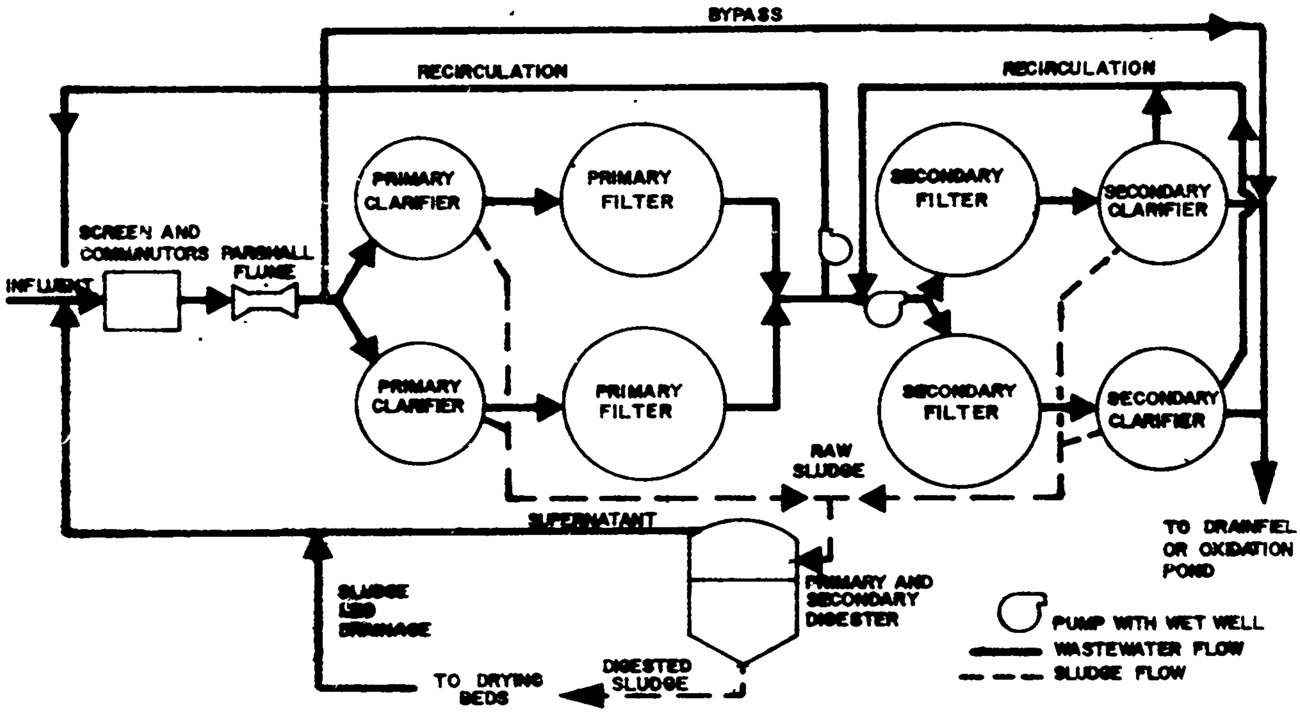
Jurisdictional Agency	Governing Ordinance or Code	Effective Date
Lincoln County Health Department	Health and Sanitary Code	July 5, 1966*
Pend Oreille County Health Department	Ordinance Number 70-4	November 23, 1970
Spokane County Health District	Title I. Environmental Health, Chapter 4. Rules and Regulations for Wastewater Disposal Systems	December 21, 1971
Stevens County Health Department	Ordinance No. 71-1966	June 13, 1966
Whitman County Health Department	Ordinance "Regulating Sewage Disposal in Unincorporated Areas in Whitman County."	February 15, 1960



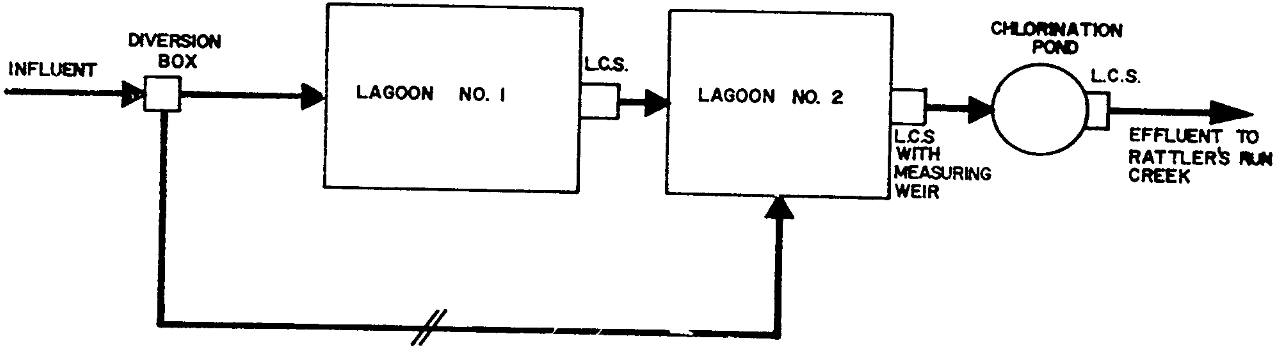
WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept of the Army, Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	SCHEMATIC FLOW DIAGRAM CITY OF CHENEY	FIGURE 1



WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army, Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	SCHEMATIC FLOW DIAGRAM CITY OF DEER PARK	FIGURE 2



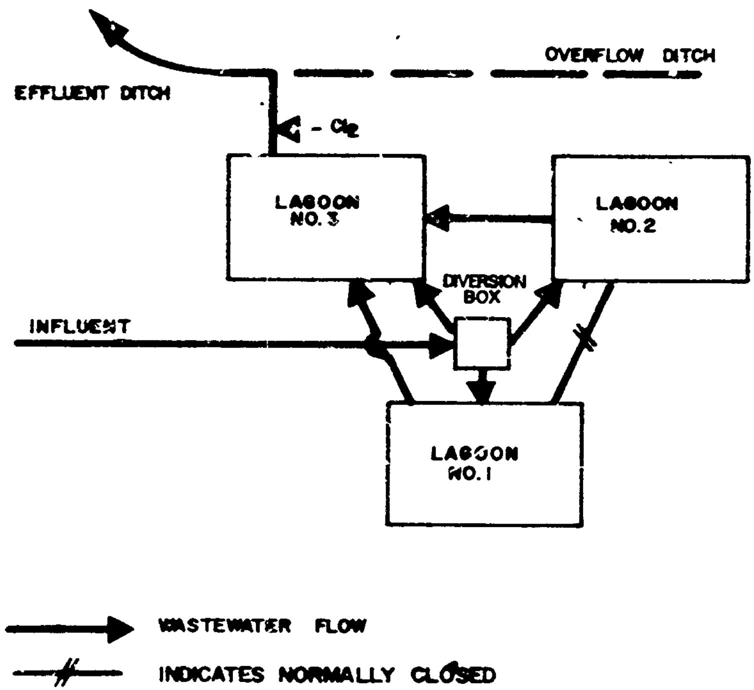
WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept of the Army, Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	SCHEMATIC FLOW DIAGRAM FAIRCHILD A.F.B	FIGURE 3



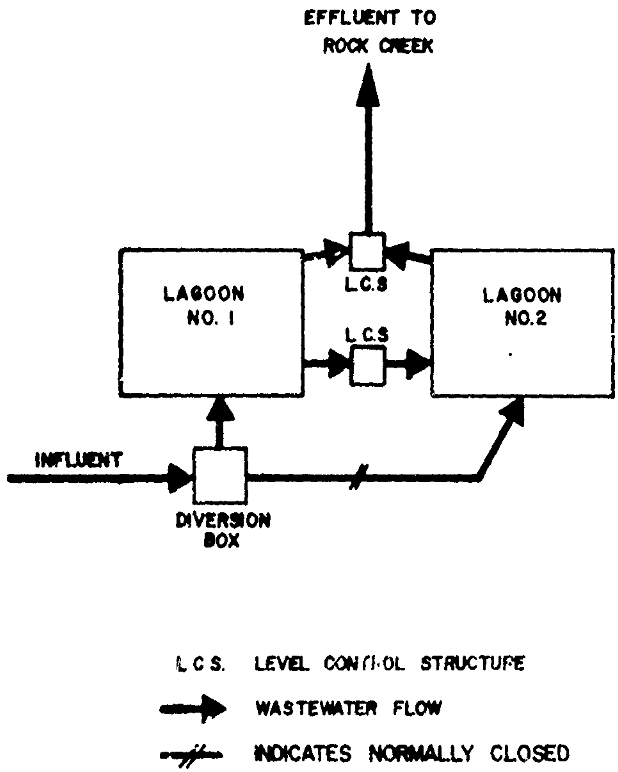
NOTE:

1. —//— INDICATES LINE IS NORMALLY CLOSED.
2. L.C.S LEVEL CONTROL STRUCTURE.

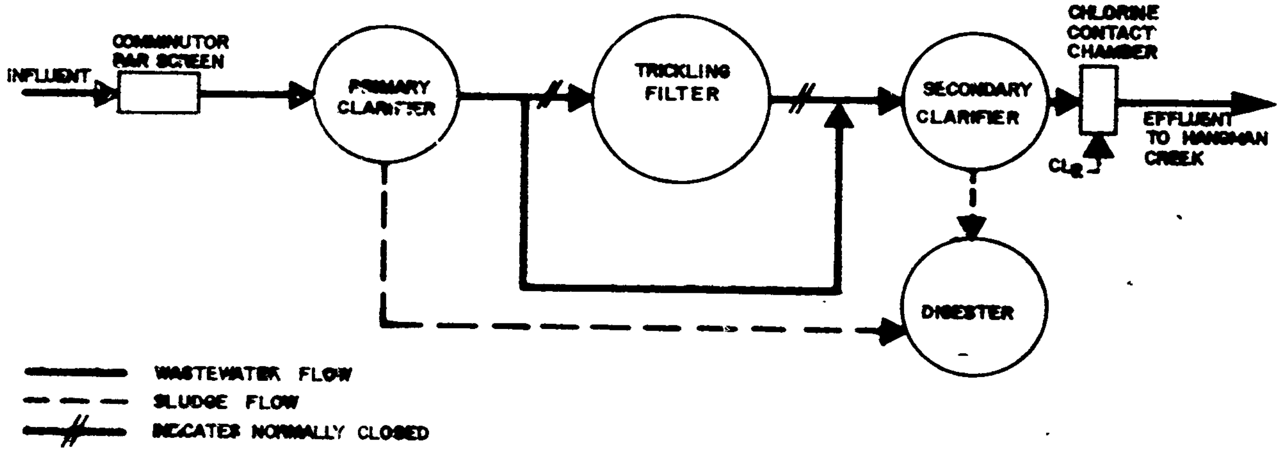
WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept of the Army, Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	SCHEMATIC FLOW DIAGRAM TOWN OF FAIRFIELD	FIGURE 4



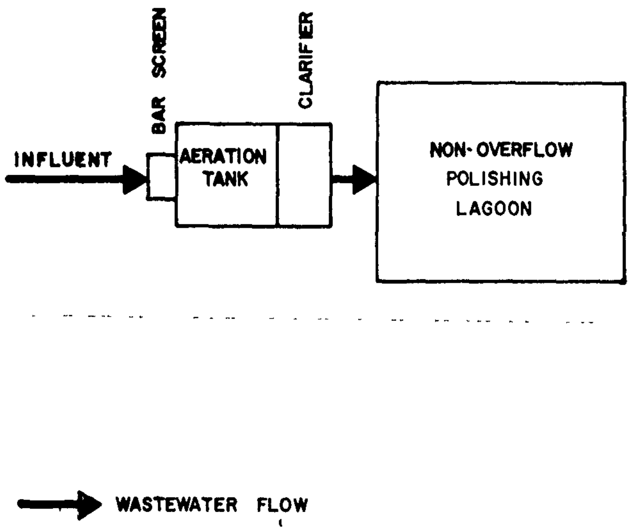
WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army, Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	SCHEMATIC FLOW DIAGRAM TOWN OF MEDICAL LAKE	FIGURE 5



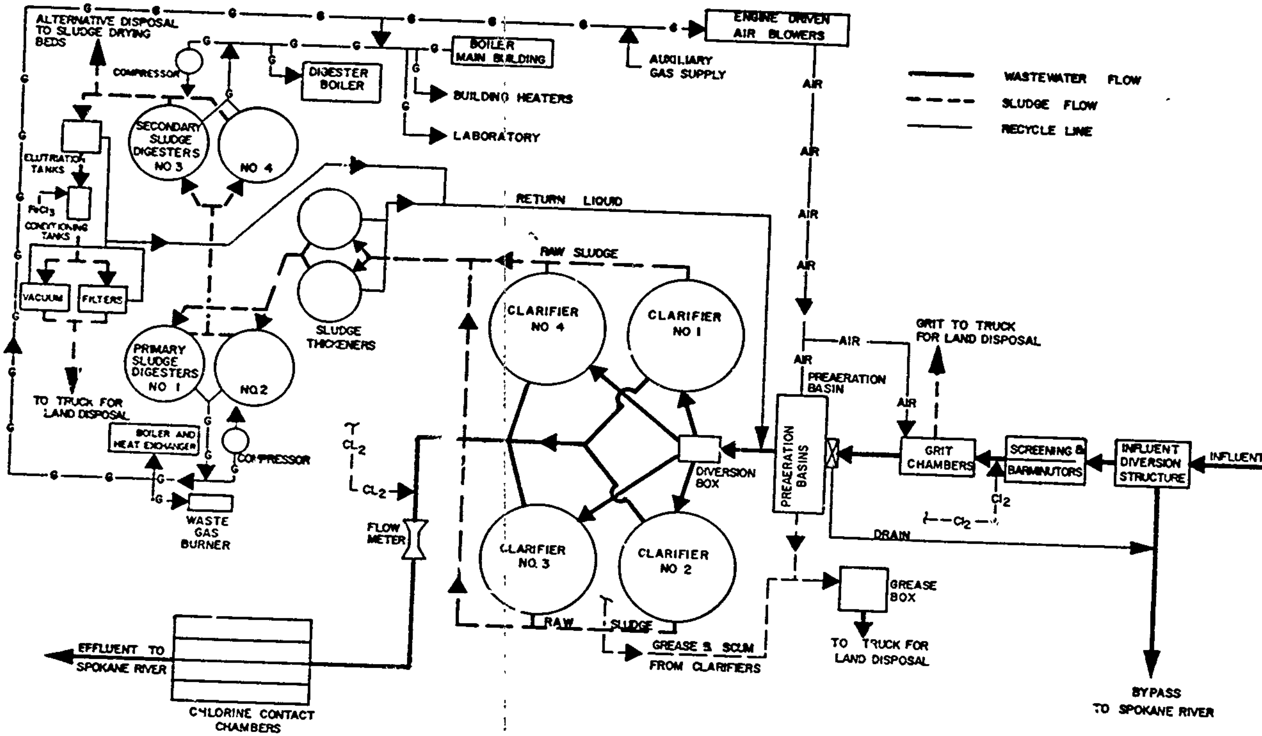
WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army, Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	SCHEMATIC FLOW DIAGRAM TOWN OF ROCKFORD	FIGURE 6



WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept. of the Army, Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	SCHEMATIC FLOW DIAGRAM CITY OF TEKOA	FIGURE 7



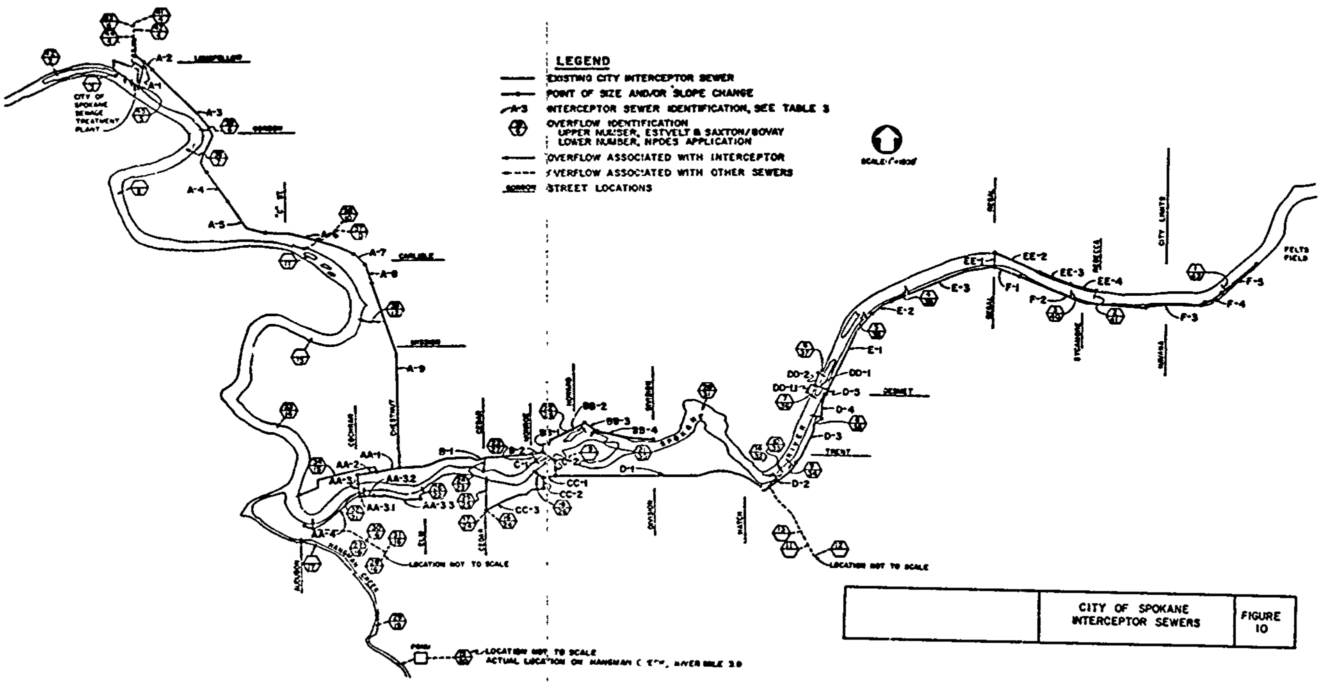
WATER RESOURCES STUDY METROPOLITAN SPOKANE REGION Dept of the Army Seattle District Corps of Engineers Kennedy - Tudor Consulting Engineers	SCHEMATIC FLOW DIAGRAM BIA, WELLPINIT	FIGURE 8



WATER RESOURCES STUDY
METROPOLITAN SPOKANE REGION
Dept. of the Army Seattle District
Corps of Engineers
Kennedy - Tudor Consulting Engineers

SCHEMATIC FLOW DIAGRAM
CITY OF SPOKANE

FIGURE 9



	CITY OF SPOKANE INTERCEPTOR SEWERS	FIGURE 10

LIST OF REFERENCES

Bovay Engineers, Inc. 1973. Report on additions and modifications to the wastewater treatment plant, City of Spokane, Washington. K-T #365

U.S. Department of Health, Education and Welfare. 1967. Manual of septic tank practice. Public Health Service. K-T #410

Washington State Department of Social and Health Services. 1974. Proposed rules and regulations of the State Board of Health for on-site sewage disposal systems. Draft. K-T #545

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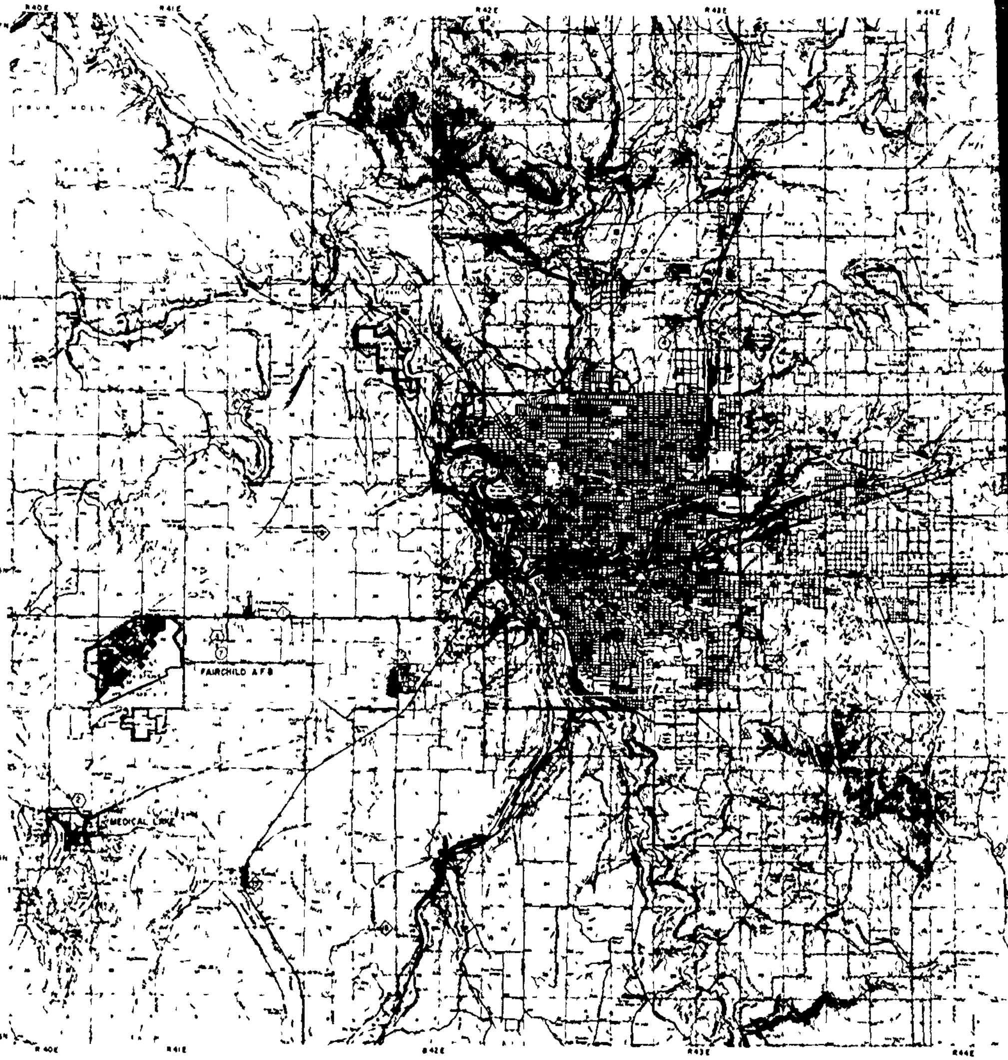


MAP SOURCE USGS 15 MINUTE QUADRANGLE SERIES, CLAYTON WASH 1950 DEER PARK WASH 1949 MT SPOKANE WASH IDAHO 95 MEDICAL LAKE WASH 1954 SPOKANE WASH 1950, GREENACRES WASH-IDAHO 1949

GRAPHIC SCALES

GENERAL LOCATION OF AREAS SERVED BY SPOKANE CO. STORM RUNOFF COLLECTION SYSTEMS

- △ COUNTRY HOMES BLVD
- △ FAIRWOOD PARK NO 1
- △ FAIRWOOD CREST NO 1 & 2
- △ WALL ST
- △ WEDGEWOOD DR
- △ DEARBORN DR

TREATMENT PLANT IDENTIFICATION

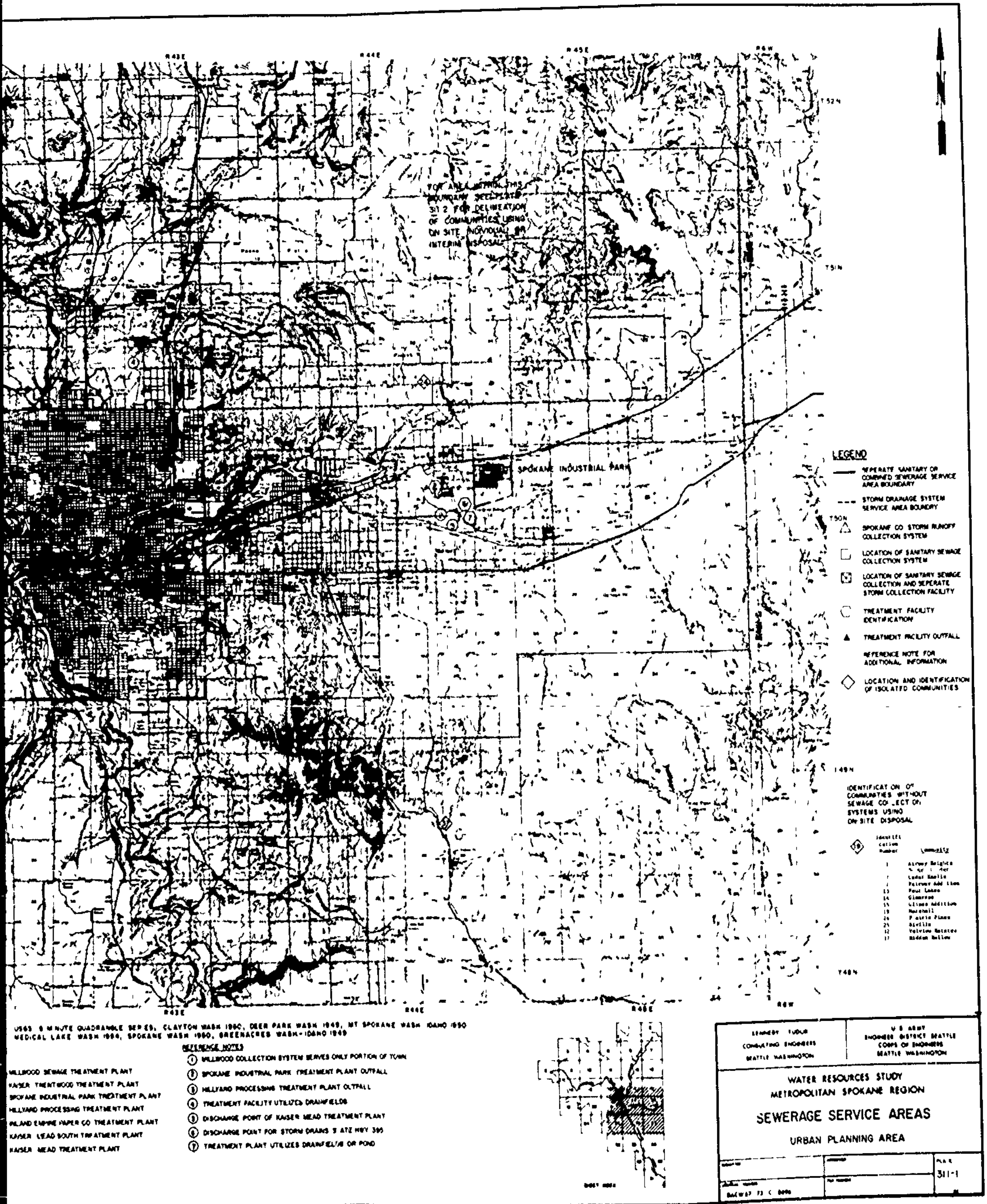
1. CITY OF SPOKANE SEWAGE TREATMENT PLANT
2. MEDICAL LAKE SEWAGE TREATMENT PLANT
3. FAIRCHILD A F B SEWAGE TREATMENT PLANT
4. MILLWOOD SEWAGE TREATMENT PLANT
5. KAISER TRENTWOOD TREATMENT PLANT
6. SPOKANE INDUSTRIAL PARK TREATMENT PLANT
7. HILLYARD PROCESSING TREATMENT PLANT
8. INLAND EMPIRE PAPER CO TREATMENT PLANT
9. KAISER-MEAD SOUTH TREATMENT PLANT
10. KAISER MEAD TREATMENT PLANT

REFERENCE NOTES

1. MILLWOOD COLLECTION SYSTEM SERVES ONLY PORTION OF TOWN
2. SPOKANE INDUSTRIAL PARK TREATMENT PLANT OUTFALL
3. HILLYARD PROCESSING TREATMENT PLANT OUTFALL
4. TREATMENT FACILITY UTILIZES DRAINFIELDS
5. DISCHARGE POINT OF KAISER MEAD TREATMENT PLANT
6. DISCHARGE POINT FOR STORM DRAINS STATE HWY 395
7. TREATMENT PLANT UTILIZES DRAINFIELDS OR POND

REVISIONS

SYMBOL	DESCRIPTION	DATE	BY



FOR AREA WITHIN THIS BOUNDARY SEE PLATE 311-2 FOR DELINEATION OF COMMUNITIES USING ON SITE INDIVIDUAL OR INTERIM DISPOSAL
SPOKANE INDUSTRIAL PARK
LEGEND
SEPERATE SANITARY OR COMBINED SEWERAGE SERVICE AREA BOUNDARY
STORM DRAINAGE SYSTEM SERVICE AREA BOUNDRY
SPOKANE CO STORM RUNOFF COLLECTION SYSTEM
LOCATION OF SANITARY SEWAGE COLLECTION SYSTEM
LOCATION OF SANITARY SEWAGE COLLECTION AND SEPERATE STORM COLLECTION FACILITY
TREATMENT FACILITY IDENTIFICATION
TREATMENT FACILITY OUTFALL
REFERENCE NOTE FOR ADDITIONAL INFORMATION
LOCATION AND IDENTIFICATION OF ISOLATED COMMUNITIES
IDENTIFICATION OF COMMUNITIES WITHOUT SEWAGE COLLECTION SYSTEMS USING ON SITE DISPOSAL
REFERENCE NOTES
1 MILLWOOD COLLECTION SYSTEM SERVES ONLY PORTION OF TOWN
2 SPOKANE INDUSTRIAL PARK TREATMENT PLANT OUTFALL
3 HILLYARD PROCESSING TREATMENT PLANT OUTFALL
4 TREATMENT FACILITY UTILIZES DRAINFIELDS
5 DISCHARGE POINT OF KAISER MEAD TREATMENT PLANT
6 DISCHARGE POINT FOR STORM DRAINS STATE HWY 395
7 TREATMENT PLANT UTILIZES DRAINFIELDS OR POND
MILLWOOD SEWAGE TREATMENT PLANT
KAISER TRENTWOOD TREATMENT PLANT
SPOKANE INDUSTRIAL PARK TREATMENT PLANT
HILLYARD PROCESSING TREATMENT PLANT
INLAND EMPIRE PAPER CO TREATMENT PLANT
KAISER MEAD SOUTH TREATMENT PLANT
KAISER MEAD TREATMENT PLANT
USGS 7.5 MINUTE QUADRANGLE SERIES, CLAYTON WASH 1950, DEER PARK WASH 1949, MT SPOKANE WASH IDAHO 1950 MEDICAL LAKE WASH 1964, SPOKANE WASH 1950, GREENACRES WASH-IDAHO 1949
KENNEDY TUDOR
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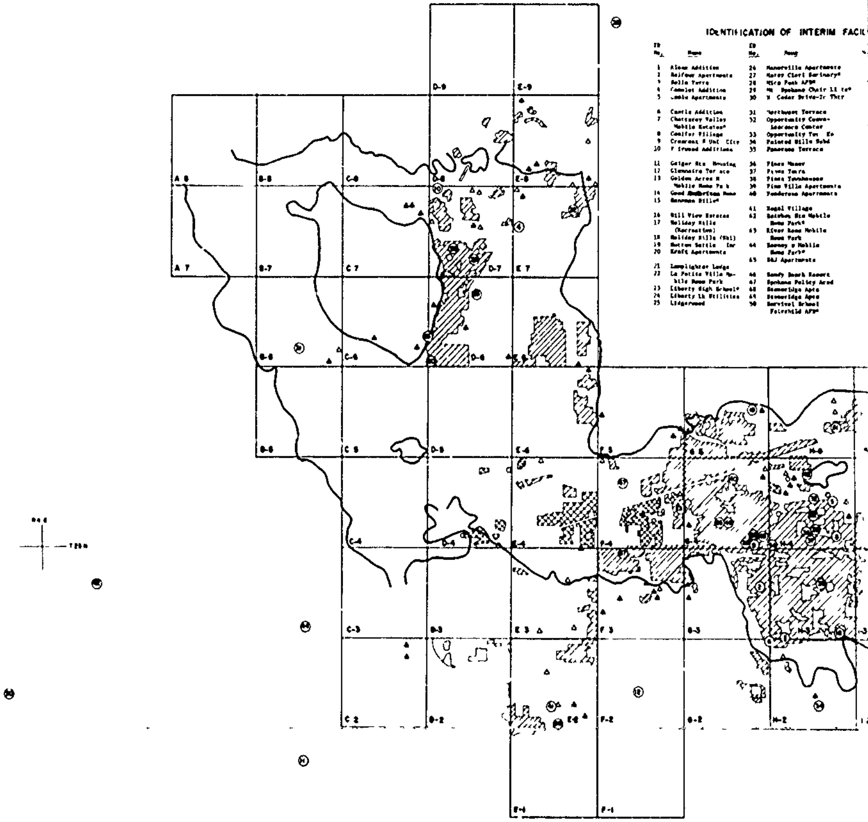
SEATTLE WASHINGTON
U S ARMY
ENGINEER DISTRICT SEATTLE
CORPS OF ENGINEERS
SEATTLE WASHINGTON
WATER RESOURCES STUDY
METROPOLITAN SPOKANE REGION
SEWERAGE SERVICE AREAS
URBAN PLANNING AREA
311-1



IDENTIFICATION OF INTERIM FACIL

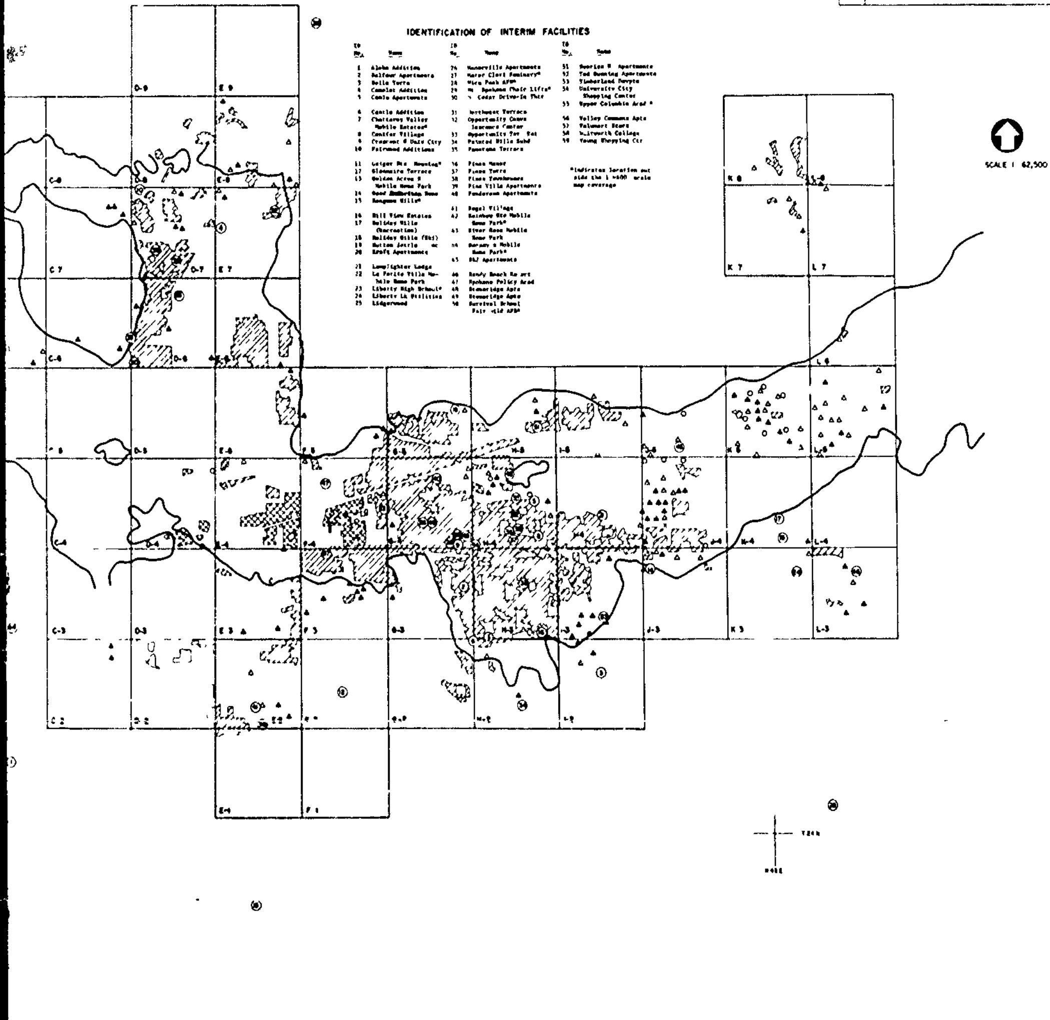
ID No.	Name	ID No.	Name
1	Alban Addition	26	Manorville Apartments
2	Balfour Apartments	27	Mater Cleri Seminary*
3	Bella Terra	28	Mica Peak AFB*
4	Camelot Addition	29	Mt. Spokane Chair Lift*
5	Cable Apartments	30	N. Cedar Drive-In Thtr
6	Castle Addition	31	Northwest Terrace
7	Chattaroy Valley Mobile Estates*	32	Opportunity Convalescence Center
8	Conifer Village	33	Opportunity Twn. Ho
9	Crossroads # Unit City	34	Painted Hills Subd
10	F Stroud Additions	35	Panorama Terrace
11	Geiger Hts. Housing	36	Pines Manor
12	Glennaire Terrace	37	Pines Terra
13	Golden Acres M Mobile Home Park	38	Pines Townhouses
14	Good Samaritan Home	39	Pine Villa Apartments
15	Gunsman Hills*	40	Ponderosa Apartments
		41	Regal Village
16	Hill View Estates	42	Rainbow Acs Mobile Home Park*
17	Holiday Hills (Recreation)	43	River Bend Mobile Home Park
18	Holiday Hills (Ski)	44	Rooney's Mobile Home Park*
19	Hutton Settle. Inc	45	S&J Apartments
20	Kraft Apartments		
21	Lamplighter Lodge		
22	La Petite Villa Mobile Home Park	46	Sandy Beach Resort
23	Liberty High School*	47	Spokane Police Acad
24	Liberty Lk Utilities	48	Stoneridge Apts
25	Lidgerwood	49	Stoneridge Apts
		50	Survival School Fairchild AFB*

LEGEND

DOMESTIC WATER SUPPLY

INDUSTRIAL AREAS SERVED BY SEPTIC TANKS

AREAS SERVED BY SEPTIC TANKS
LOCALIZED AREAS SERVED BY SEPTIC TANKS
LOCATIONS OF INTERIM TREATMENT PLANTS
LOCALIZED INDUSTRIAL AREAS SERVED BY SEPTIC TANKS
PRINCIPLE AQUIFER BOUNDARY (SHANNON & WILSON)
GRID OF 1:400 SCALE MAPPING
GRID IDENTIFICATION NUMBER



IDENTIFICATION OF INTERIM FACILITIES

ID No.	Name	ID No.	Name	ID No.	Name
1	Aloha Addition	26	Mansfield Apartments	51	Sunrise Apartments
2	Balfour Apartments	27	Mater Cleri Seminary*	52	Ted Dunning Apartments
3	Bella Terra	28	Fire Peak AFB*	53	Timberland Dwyte
4	Camelot Addition	29	Mt. Spokane Chair Lifts*	54	University City Shopping Center
5	Camlo Apartments	30	Cedar Drive-In Thtr	55	Upper Columbia Acad *
6	Castle Addition	31	Northwest Terrace	56	Valley Commons Apts
7	Chattaroy Valley Mobile Estates*	32	Opportunity Comm. Insurance Center	57	Valumart Store
8	Conifer Village	33	Opportunity Ter. Est	58	Whitworth College
9	Crescent & Dale City	34	Painted Hills Subd	59	Young Shopping Ctr
10	Fairwood Additions	35	Panorama Terrace		
11	Geiger Mil. Housing*	36	Pines Manor		
12	Glennaire Terrace	37	Pines Terra		
13	Golden Acres & Mobile Home Park	38	Pines Townhouses		
14	Good [illegible] Home	39	Pine Villa Apartments		
15	Hangman Hills*	40	Ponderosa Apartments		
16	Hill View Estates	41	Regal Village		
17	Holiday Hills (Recreation)	42	Rainbow Mobile Home Park*		
18	Holiday Hills (Ski)	43	River Rose Mobile Home Park		
19	Hutton Settlement	44	Mobile Home Park*		
20	Kraft Apartments	45	S&J Apartments		
21	Lamplighter Lodge	46	Sandy Beach Resort		
22	La Fonta Villa Mobile Home Park	47	Spokane Policy Acad		
23	Liberty High School*	48	Stonebridge Apts		
24	Liberty Lk Utilities	49	Stonebridge Apts		
25	Lidgerwood	50	Survival School Fairchild AFB*		

*Indicates location outside the 1:400 scale map coverage

LEGEND

DOMESTIC WATER SUPPLY

INDUSTRIAL AREAS SERVED BY SEPTIC TANKS

AREAS SERVED BY SEPTIC TANKS

LOCALIZED AREAS SERVED BY SEPTIC TANKS

LOCATIONS OF INTERIM TREATMENT PLANTS

LOCALIZED INDUSTRIAL AREAS SERVED BY SEPTIC TANKS

PRINCIPLE AQUIFER BOUNDARY (SHANNON & WILSON)

GRID OF 1:400 SCALE MAPPING

GRID IDENTIFICATION NUMBER

KENNEDY TUDOR
CONSULTING ENGINEERS
SEATTLE WASHINGTON

U S ARMY
ENGINEER DISTRICT SEATTLE
CORPS OF ENGINEERS
SEATTLE WASHINGTON

WATER RESOURCES STUDY
METROPOLITAN SPOKANE REGION

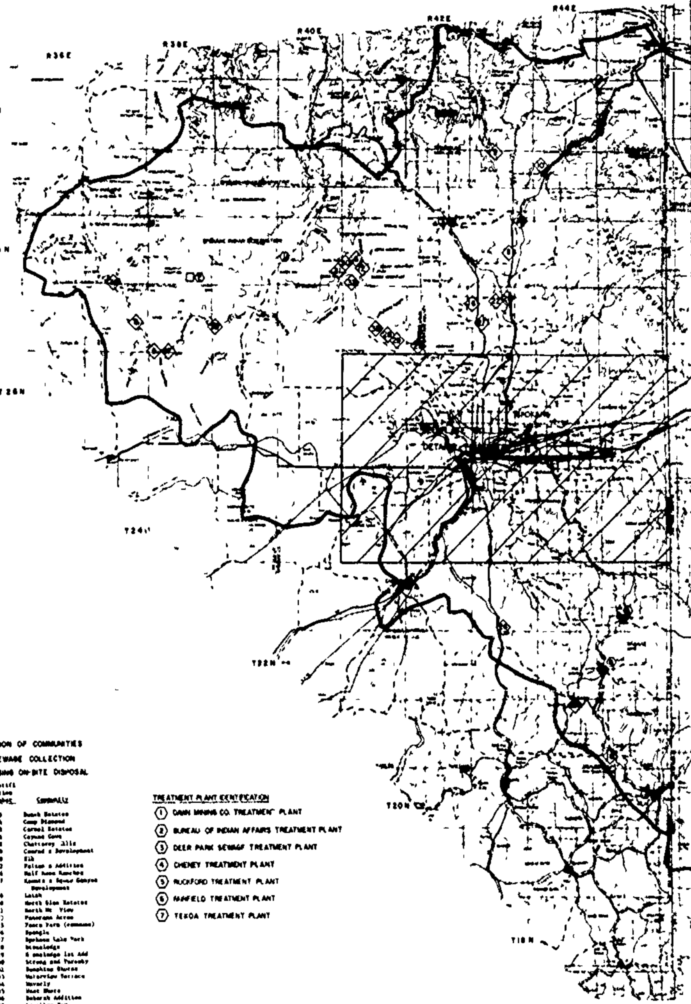
INDIVIDUAL DISPOSAL AND INTERIM FACILITIES

URBAN PLANNING AREA

DACW67 73 C 0096

PLATE 311-2

2



IDENTIFICATION OF COMMUNITIES WITHOUT SEWAGE COLLECTION SYSTEMS USING ON-SITE DISPOSAL

Identification Number	Community
3	[illegible] Estates
4	Camp Diamond
5	Carmel Estates
6	Coyote Cove
8	Chattaroy Hills
9	Conrad's Development
10	Elk
12	Folsom's Addition
16	Half Moon Ranches
17	[illegible] Canyon Development
18	Latah
20	[illegible] Estates
21	North Mt. View
22	Panorama Acres
25	[illegible]
26	Spangle
27	Spokane Lake Park
28	Stoneledge
29	[illegible] 1st Add
30	[illegible]
31	[illegible]
33	[illegible] Terrace
34	Waverly
35	[illegible]
36	[illegible] Addition
38	[illegible] Bay
39	[illegible] Development

TREATMENT PLANT IDENTIFICATION

1. DAWN MINING CO. TREATMENT PLANT
2. BUREAU OF INDIAN AFFAIRS TREATMENT PLANT
3. DEER PARK SEWAGE TREATMENT PLANT
4. CHENEY TREATMENT PLANT
5. ROCKFORD TREATMENT PLANT
6. FAIRFIELD TREATMENT PLANT
7. TEKOA TREATMENT PLANT

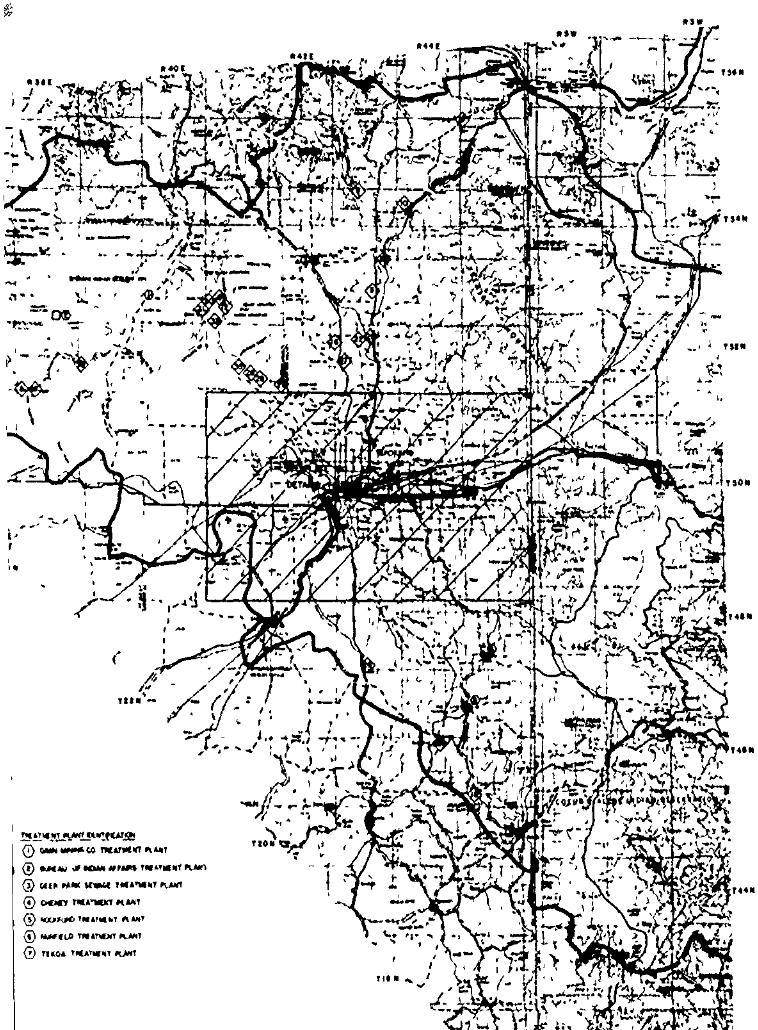
5 0 5 10 15 MILES

10,000 0 10,000 20,000 30,000 75,000 FEET

GRAPHIC SCALES

MAP SOURCE: PREPARED FROM USGS UNITED STATES TOPOGRAPHIC SERIES SANDPOINT 1958, RITZVILLE 1953, SPOKANE 19[illegible]5, OKANOGAN 1954

REVISIONS			
SYMBOL	DESCRIPTION	DATE	BY



LEGEND

- ☐ LOCATION OF SANITARY SEWAGE COLLECTION SYSTEM
- ⊠ LOCATION OF SANITARY SEWAGE COLLECTION AND SEPERATE STORM COLLECTION FACILITY
- ○ LOCATION AND IDENTIFICATION OF TREATMENT FACILITY
- ▲ TREATMENT OUTFALL TO SURFACE WATERS
- ◇ LOCATION AND IDENTIFICATION OF UNSEWERED COMMUNITY WITH PUBLIC WATER SUPPLY USING ON SITE INDIVIDUAL DISPOSAL

TREATMENT PLANT IDENTIFICATION

1. DAWN MINING CO. TREATMENT PLANT
2. BUREAU OF INDIAN AFFAIRS TREATMENT PLANT
3. DEER PARK SEWAGE TREATMENT PLANT
4. CHENEY TREATMENT PLANT
5. ROCKFORD TREATMENT PLANT
6. FAIRFIELD TREATMENT PLANT
7. TEKOA TREATMENT PLANT

MAP SOURCE: PREPARED FROM USGS, UNITED STATES TOPOGRAPHIC SERIES, SANDPOINT 1958 RITZVILLE 1953 SPOKANE 1953, OKANOGAN 1954

KENNEDY TUDOR CONSULTING ENGINEERS SEATTLE WASHINGTON	U S ARMY ENGINEER DISTRICT SEATTLE CORPS OF ENGINEERS SEATTLE WASHINGTON

WATER RESOURCES STUDY
METROPOLITAN SPOKANE REGION

SEWERAGE SERVICE AREAS
OUTSIDE THE URBAN PLANNING AREA

CONTRACT NUMBER: DACW67 71 C 0096

PLATE: III-3

SECTION 406.1

CRITERIA FOR PROJECTION OF WASTE LOADS

Each of the two basins is 40 feet by 80 feet, and 14 1/2 feet deep. A drain to the plant bypass is provided for periodic removal of settled solids. A skimming device at the outlet provides for removal of floating accumulations. Compressed air for the preaeration basins and grit chambers is supplied by two gas engine driven blowers rated 2500 cubic feet per minute.

The settling and flotation of the solids is accomplished in the four clarifiers. These clarifiers are operated in parallel. A diversion box combines the flow from the preaeration basins with the recycled flows from downstream operations and distributes the flow to each of the four clarifiers. Each clarifier is circular, 125 feet in diameter. This provides a surface overflow rate of 1000 gallons per square foot per day at nominal capacity of 50 mgd. The clarifiers are the limiting element in the existing treatment plant. Grease and scum are skimmed from clarifiers to storage for subsequent truck disposal. Settled solids are conveyed to the sludge thickeners.

Effluent from the clarifiers is chlorinated prior to disposal in the Spokane River. There are two manually controlled chlorinators, each with 6,000 pounds per day capacity. Liquid chlorine is purchased in one ton containers. The chlorine is applied to the wastewater flow between the clarifiers and the Parshall metering flume. Downstream of the flume are the contact chambers. There are four contact basins, each about 20 feet by 60 feet, 11.5 feet deep. Effluent from the contact chambers goes to the 36 inch outfall on the right bank of the Spokane River.

WATER RESOURCES STUDY

METROPOLITAN SPOKANE REGION

SECTION 406.1

CRITERIA FOR PROJECTION OF WASTE LOADS

7 October 1974

Department of the Army, Seattle District
Corps of Engineers
Kennedy-Tudor Consulting Engineers

INDEX

TABLE INDEX

SECTION 406.1
CRITERIA FOR PROJECTION OF
WASTE LOADS

Objectives

The objectives of this section are to develop the basis for forecasts of waste sources in terms of both quality and quantity throughout the study period. The study period is defined as the period from the present to the year 2020 with specific landmarks at 1985, 2000 and 2020. For the part of the study period over which cost effectiveness analyses are to be made, namely the twenty year* period from 1980 to the year 2000, additional detail is developed at five year intervals.

The goal in developing forecasts of waste water sources is to provide the basis for sizing the elements and determining the capital cost and associated operation and maintenance costs making up structural alternative plans for the management of these wastes.

The basic data sources to be utilized are the existing waste load data and the forecast population and land use of the study area. Evaluation of the existing waste source data is the first step undertaken with the object of developing unit waste characteristics specific to the study area. Where the evaluation indicates incompleteness or unreliability of available data specific to the study area, the data are supplemented from the literature. Since the forecast extends 45 years into the future from this date, it is necessary to also evaluate trends tending to modify

* See Federal Register Vol. 38 Number 127, July 3, 1973.

unit criteria and to adopt reasonable values for future dates. The final step in the projection is to combine the selected unit criteria with the forecast population to produce total waste loads for planning units.

Selection of planning units is developed in another section. Planning units are elements of land area selected to lend themselves to assembly in various combinations as required by alternative plans and as possible building blocks in staged construction. It is advantageous to make these elements as large as possible but still avoid the necessity for later subdividing the unit to suit an unforeseen analysis.

The basis for projection of waste loads due to urban runoff are developed in a separate subsection.

Definition of the Flow Elements

The waste flow elements are defined as follows for the purpose of evaluation and projection.

Sanitary Wastes. The wastewaters from sanitary conveniences in residences, commercial operations, private and public service establishments and from industrial facilities.

Industrial Wastes. The total non-sanitary waste flow from an industrial facility including both process wastes and uncontaminated cooling waters. Industrial wastes are considered both as a separate category and, under certain circumstances as defined below, as a part of municipal wastes.

Process Wastes. That part of waste flow from an industrial facility that is a consequence of and contains contamination from an industrial process. Waters which serve a cooling function only and are uncontaminated by the process are not included.

Cooling Waters. Waste waters from industry, commercial, service or residential sources that are used only for cooling and are uncontaminated in the process.

Municipal Wastes. Sanitary wastes and that part of industrial wastes from minor industry in an urban area not singled out for identification and quantification as major industrial wastes.

Infiltration. Groundwaters that enter the collection system through defects in the collection system such as poor joints, cracked pipe and leaky manholes.

Inflow. Storm waters that enter the collection system through unplanned or illegal entries such as flooded manhole covers, roof leaders, foundation drains, etc.

Urban Runoff. Storm drainage from street pavements, roofs and the general land surface caused by rainfall or snowmelt.

Dry Weather Flow. Municipal and/or industrial flow plus infiltration but exclusive of inflow, except in the special case of the existing City of Spokane. For the existing City of Spokane system certain flows referred to in Bovay (1974b) as inflow have the characteristics of infiltration in that they occur continuously and not only concurrent with rain. These continuous "inflow" elements are regarded in this sense as part of dry weather flow. Average dry weather flow is abreviated ADWF.

Peak Dry Weather Flow is the highest instantaneous flow rate of the combined municipal and/or industrial components. This is to be distinquished from the highest average daily flow rate which is computed from the day with the largest flow volume. Peak Dry Weather flow is abbreviated PDWF.

Peak Wet Weather Flow is the sum of peak dry weather flow plus inflow and is abreviated PWWF.

Design Flow, Sewage Treatment Works. Annual average dry weather flow ADWF in the case of plants which do not have combined sewers or are not otherwise committed to processing storm flows. The design flow for plants handling combined flows or storm flows from storage, must be specified in terms of the additional flow above ADWF which is intended to be processed with the same degree of treatment as the ADWF.

Design Flow, Pump Stations, Force Mains and Hydraulic Capacity of Treatment Works. Peak wet weather flow PWWF for separate systems and PWWF plus urban runoff for combined systems.

Definitions of Quality Elements

The parameters which are evaluated for all wastes as a measure quality are BOD, TDS, total suspended solids, total nitrogen and total phosphorus. These parameters are defined as follows:

BOD. Five day biochemical oxygen demand.

TDS. Total dissolved solids equal to filterable residue 178 - 181°C per Standard Methods, APWA (1971).

TSS. Total suspended solids equal to nonfilterable residue per Standard Methods, APWA (1971).

N. Total nitrogen in all its forms expressed as N, including nitrates, nitrite, ammonia and organic nitrogen.

P. Total phosphorus in all its forms expressed as P, including orthophosphates, polyphosphates and organic phosphates.

Existing Dry Weather Flows, Urban Planning Area

Actual per capita dry weather flow data, unclouded by unknown amounts of stormwater, infiltration or industrial components, is practically unavailable for the study area. There are three pieces of evidence which indicate the magnitude of per capita flow in the City of Spokane water service area. These are the synthesis of the components of total observed flow to the City of Spokane sewage treatment plant, the winter season water use rate, and the measured flow at the Northwest Terrace facility. The indicated per capita flow from the synthesis is 108 gpcd in winter and 152 gpcd in summer, both of which include the commercial, service and minor industrial components as well as the purely residential components of flow. Infiltration and major identified industrial contributors are excluded. The measured winter rate of water consumption as calculated by Bovay (1973) is 121 gpcd excluding major industrial consumption (which is equal to about 16 gpcd according to this same source). The synthesized sewage rate is approximately 90 percent of estimated water rate. The measured flow for the purely residential area, Northwest Terrace is 90 gpcd. This value is believed to be higher than areas with multiple units and smaller houses.

Thus, a reasonable synthesis of present winter weather flows is 80 gpcd for the residential component and 28 gpcd for the commercial, service and minor industrial component for a total of 108 gpcd. The increased summer use is known to include single pass air conditioning heat exchangers, excess landscape irrigation that reaches the storm inlets of the combined sewer system and increased residential use engendered by the warm climate. There is no record by which these components of the summer excess can be specifically evaluated. A single major air conditioning use that can be identified is equal to 5 gpcd. This single source is estimated to be one fourth of the total, making about 20 gpcd, say, 50 percent of the summer excess of 44 gpcd. The pattern of use in other areas indicate an increase in domestic flow of 10 to 15 gpcd during summer which would account for 30 percent of the observed summer excess. The remaining 20 percent or equivalent of 9 gpcd is assigned to excess irrigtion flows and other outdoor uses that reach the combined sewer system. In summary, the total per capita excess of 44 gpcd is allocated 22 gpcd to air conditioning, 9 gpcd to excess irrigation and 13 gpcd to increased residential use. These increases extend from mid May through September but are exerted at full value only from June through August. For the purpose of applying this data to other than the City of Spokane, the air conditioning portion is believed to be largely commercial and would apply in corresponding amount only where there was a comparable level of commercial and service development. The excess landscape irrigation component would apply only in combined sewer areas.

The City of Spokane wastewater flow experience is estimated to extend to suburban areas with comparable water abundance and rates as reflected in their water consumption, but must be modified for commercial-service content and separate sewers. On this basis, the present dry weather sewage flows for suburban areas are estimated as follows:

	Winter	Summer	Annual Average
City as a whole with combined sewers	108	152	123
City as a whole with separate sewers	108	143	120
Suburban with significant commercial	98	125	107
Suburban with moderate commercial	90	111	97
Suburban with negligable commercial	85	102	91

The difference in winter flow for suburban areas is due to the different estimated content of the 28 gpcd known to be from commercial and minor industrial flows. For example, the suburban with minimum commercial content is assigned only 5 gpcd of the 28 gpcd found in Spokane.

Existing Dry Weather Flows, Outside Urban Planning Area

For areas outside the suburban area the availability of firm data on per capita sanitary flows is even less than for the City and suburban areas. Since, in general, water is less abundant outside the urban planning area, the per capita water use is less. What little data there is, appears to substantiate this. For the three largest communities outside the urban planning area the per capita dry weather sewage flows are estimated to be 73 gpcd for Cheney, 110 gpcd for Deer Park and 73 gpcd for Medical Lake. Deer Park exhibits an unusually low peak to average ratio and high per capita flow which are indicative of infiltration. These flows include whatever commercial and service additions may exist in these communities.

A dry weather flow of 78 gpcd is selected as representative for communities of 500 or more outside the urban planning area. For smaller communities, 75 gpcd is selected to reflect lower proportions of commercial and service in the smaller communities. The actual flow for these smaller communities may well be less than 75 gpcd but federal standards[1] recommend a minimum of 75 gpcd unless otherwise supported by strong data.

Forecast Trends in Dry Weather Flow

Two levels of existing water use exist in the study area, a far above national average use in the urban planning area where water is abundant and low cost, and a normal to subnormal use per capita use in the areas outside the urban planning area where water is in relatively short supply. Future trends in water use, and consequently in wastewater flow are judged to be significantly different for these two situations.

A leveling out and even a decrease in per capita water use and wastewater flow is foreseen nationally as indicated by data developed by the USPHS and shown in Metcalf and Eddy (1972), Table 2.4 pg. 25. These overall figures include major industrial as well as domestic and commercial use. There are strong economic, social and environmental forces at work toward decreasing overall water consumption. The technology for reducing domestic use by up to 35 percent is estimated to be presently available through such devices as dual cycle flush toilets and flow control valves (EPA 1969). In spite of these pressures and technology,

(1) U.S. Dept. of Housing and Urban Development 1963, Minimum Design Standards for Community Sewerage Systems.

there appears to be no evidence of the predicted leveling out or downtrend as yet. Table 1 shows the trend in per capita water use for the City of Spokane is upward, approximately 10 percent in 10 years. Based on this trend, but modified by the general pressures to level out or decrease use, the forecast for the urban planning area is selected to continue the upward momentum but at a decreasing rate to be a total of 10 percent additional by year 2000 with no further increase thereafter.

For the areas outside the City of Spokane and the remainder of the urban planning area with comparable present water use, abundance and low rates, the forecast is tempered by the potential of improved water supply. These areas as a whole, have present average water use in the range of from 30 to 60 percent of City use. Black and Veatch (1973), in their report on Spokane Plain Water Supply forecast water consumption increasing to the level of the City of Spokane if an improved water supply is made available. Experience in other localities indicates that areas with subnormal water use and wastewater flows exhibit contained growth in per capita use until normal levels are reached. Therefore, in areas outside the urban planning area where present wastewater flows are in the range 75 - 85 gpcd, an increase is forecast, asymtotically approaching 100 gpcd at the end of the study period.

Forecast per capita flows on the above described basis are shown in Table 2.

Historical Peak Flow Data

The only reliable peaking factor data for the study area are from the records of the City of Spokane sewage treatment plant. In this combined system, only peak dry weather flow data are obtainable since storm flow peaks are bypassed without measurement. The measured peak day dry weather flows are of the order 40 mgd and the annual average dry weather flow is 27.3 mgd. The calculated peak day to average day ratio is 1.47 to 1.00. Peak hourly dry weather flows are of the order 50 mgd for which the peak to average ratio is 1.83.

Selection of Peak Flow Criteria

The variation in peak to average ratio with size of the service population is a well developed fact of sewerage flow characteristics and is reflected in curves published in the literature. The manual for "Design and Construction of Sanitary and Storm Sewers" jointly authored and published by the American Society of Civil Engineers and the Water Pollution Control Federation (ASCE and WPCF, 1969) summarizes a number of these curves. The envelope of curves shown in Fig. 4 and the curve from Figure 5 of ASCE and WPCF (1969) were evaluated together with the curve from Figure 2.6 of Metcalf and Eddy Inc. (1972) and a curve developed by Kennedy Engineers based on data for the Puget Sound Region. The curve from Figure 2.7 of Metcalf and Eddy Inc. (1972) is identical with the curve from Figure 5 of A.S.C.E. and W.P.C.F. and is the curve cited by Bovay (1973). All of these curves purport to show dry weather peak hourly to average daily flow rates for municipal systems.

The single piece of data from the City of Spokane experience when plotted with the above referenced data shows close agreement with the low range of the envelope of curves from Figure 4 from ASCE and WPCF (1969), with Figure 2.6 of Metcalf and Eddy Inc. (1972) and with the Kennedy Engineer's curve. The curve from Figure 5 of A.S.C.E. and WPCF (1969) and Figure 2.7 of Metcalf and Eddy Inc. (1972) is higher, giving a ratio of approximately 2.25 at 27 mgd or 23 percent above the City point.

The Kennedy Engineer's curve for Washington experience, Figure A, is selected for peak flow forecasting based on substantial agreement with the available data and specific applicability to the region. The curve is applied to the total municipal dry weather flow without infiltration and the infiltration is added to the computed peak to form the PDWF or the infiltration plus inflow is added to form the PWWF.

Infiltration

Two factors affect the amount of infiltration, the availability of ground water to penetrate the sewer and the construction and condition of the sewers and manholes themselves.

Within the study area, there are three general groundwater conditions relative to infiltration. There are areas of highly permeable material of great depth where perched groundwater is virtually impossible. There are areas of high groundwater in both permeable and semi-permeable soil. And finally, there are areas of average permeability that do not normally have free groundwater at sewer depth but can contain water under unusually wet surface conditions. The occurrence of these conditions must be given recognition in combination with sewer construction to arrive at infiltration quantities. The classification of areas into low, high, and intermittant infiltration potential is shown in Table 4 for communities outside the urban planning area and shown in Table 3 for the urban planning area. Plate 406-1 shows the locations of these conditions in the urban planning area.

The infiltration experience of the City of Spokane sewage collection system as a whole is not useful as a basis for forecasting infiltration to be expected if other areas are sewered in the Spokane area. The reasons that its overall experience is not a valid basis include:

1. The City sewered area covers at least two distinct soil types, one where there is no groundwater at sewer depths and one where it is possible in varying degrees.
2. The City sewers are in general old and represent types of joints and materials not currently used.
3. The City sewers are mostly combined sewer and are of very large size compared with what would be required for separate sanitary sewers.
4. According to Bovay (1974 b) certain springs and swamps are directly connected into the sewer contributing volumes that are not completely identified.

In Bovay (1973) the overall infiltration was estimated at 8.5 mgd which, when compared with the sewered area of the City at 17,000 acres, appeared to give a reasonable overall infiltration rate of 425 gallons per acre per day. Subsequently, in Bovay (1974b) as noted above, it was found that a significant amount of infiltration could be specifically identified as being due to drainage of springs and swamps.

Due to the extremely permeable soil and absence of groundwater at sewer depth throughout most of the City north of the Spokane River, and the age of the sewers, it is more likely that this area suffers from exfiltration than infiltration. The area south of the river, according to Bovay (1974b), is the site of practically all of the identified infiltration. This identified infiltration is shown to be a maximum 3.8 mgd. Pending action to the contrary by the City of Spokane, these identified infiltration quantities are included essentially undiminished in forecast flows for the City sewage collection system by adoption of 3.5 mgd infiltration.

For presently unsewered areas in the urban planning area, the assumption is made that any collection system constructed will conform to good practice and materials which will result in sewers that approach current specification standards for sewer construction. Current infiltration specification allowance is of the order 500 gallons per day per inch of pipe diameter per mile with compression joint pipe. (A.S.C.E. and W.P.C.F. 1969). Bovay (1973) indicates that there are approximately 500 miles of street sewers in the 17,000 acre service area or an average of 0.03 miles per acre. For separate collection systems, the average pipe size is 12 inch which would make the specified infiltration allowance of the order 180 gallons per acre per day. It is not prudent to expect sewers and manholes to maintain their new integrity throughout their useful life. A prudent infiltration allowance in recognition of the potential deterioration with time is usually selected larger than the specification rate.

Typical design allowances recognizing the effect of future deterioration as cited by A.S.C.E. and W.P.C.F. (1969) are 30,000 gpd/mile for systems with 24 inch and smaller pipe. On an area basis, this is equal to 900 to 1000 gallons per acre per day, or five times the specification level. This level appears to include an allowance for wet weather inflow as well as for infiltration.

A curve given in Metcalf and Eddy (1972) suggests that infiltration rates should be a function of the total area served as well as the condition of the sewers. This curve for new sewers shows 1000 gallons per acre per day (gpad) for areas to 100 acres, decreasing to 500 gpad at 1000 acres and 250 gpad at 10,000 acres.

Due to the extreme range of infiltration potential in the study area caused by variations in soil and groundwater, infiltration allowances are selected to meet a corresponding range of conditions. In all cases, current sewer construction standards as cited above are assumed.

	Infiltration Allowance Gallons/Acre/Day
High - known groundwater at sewer depth	500
Moderate - occasional groundwater at sewer depth	200
Low - well drained soil with groundwater below sewer depth	100

Although the "low" condition is actually more conducive to exfiltration, the nominal allowance is included to account for occasional perched groundwater caused by trench backfill and other local conditions.

The criteria for infiltration are customarily cited as above in terms of area rather than per capita. This is to reflect the fact that the length of the collection system and consequently its degree of exposure to infiltration is a function of population density.

The definition of "service area" with which to apply the criteria when stated in area terms presents some difficulties in this particular case due to the way in which housing has developed in the presently unsewered areas. This is further complicated for the forecast condition in which the location of the future housing is uncertain. The way in which housing has developed in both North Spokane and the Spokane Valley gives low overall densities when the area is considered in large increments but the development is actually more dense when viewed as isolated clusters or as strip development. Neither measurement would reflect a correct "service area." To overcome this difficulty the area criteria are converted to a percapita basis utilizing a range of equivalent development densities, low in the early years and increasing toward saturation at the close of the study period.

The areas in which sewerage service is being considered in the urban planning area are predominatly zones single family residential and areas of future expansion are predominatly agricultural suburban. The maximum density possible under Spokane County Zoning Ordinance for single family residential is 3.5 units per acres of land exclusive of that set aside for churches and schools and similar uses. The maximum density under agricultural suburban is higher, going to as much as 6 units per acre. Presumably the Agricutral Suburban will be rezoned to single family residential or other use before the level of utilization approaches the theoretical maximum or even, overall exceeds the single family residential rate. For 3.5 units per acre and 3.2 persons per unit, the maximum density is 11 per acre. This is approximately the same order of density as the 10 persons per acre overall average for the City of Spokane sewer service area. The weighted average densities of developed areas now and forecast for the year 2020 in the North Spokane and Spokane Valley are as follows:

Planning Area	Population Density Persons Per Acre 1975	2020
Spokane Valley	6.6	8.3
North Spokane	7.3	11.1

To represent the changing conditions throughout the study period, a range of equivalent densities from 6 persons per acre at present to 10 persons per acre at year 2000 are selected to convert the criteria to per capita basis. Table 3 shows infiltration allowances for planning units in the urban planning area calculated on this basis.

For isolated communities outside the urban planning area, a correlation can be found between average length of sewer per person served and the total size of the community. For the presently sewered communities in the study area, the fitted trend is as shown below.

Total Community Population	Miles of Sewer Per 100 Persons Served
300	1.4
500	1.0
800	0.79
1,000	0.71
2,000	0.58
5,000	0.49
10,000	0.44

The average sewer size for communities of this size range is 8 inch. At current specification infiltration rates of 500 gpd per inch diameter per mile, a new 8 inch sewer has maximum allowable infiltration of 4000 gallons per day per mile. In terms of per capita for a community of 500 with 1 mile of sewer per 100 served, the infiltration could be equal to 40 gpcd. This would occur only where the entire sewer was in groundwater.

To allow for deterioration with age, new sewer infiltration rates for small communities are assumed to range from 8,000 gpd per mile for worst groundwater conditions to 500 gpd per mile for least groundwater potential. The corresponding range for existing sewers is selected at 16,000 gpd per mile to 1,000 gpd per mile.

Table 4 shows selected infiltration rates for communities outside the urban planning area in terms of both average gallons per day per mile and the equivalent per capita basis computed from miles of sewer per person 100 persons served. Actual lengths are used where available and values from fitted trend are used for presently unsewered areas.

Inflow

During rainfall and snow melt, there is always opportunity for direct inflow into separate sanitary collection systems through manhole covers and illegal roof and area drains connected to the sanitary sewers on the customers property. This flow is additive to the wastewater and infiltration components to determine the peak wet weather flow. An overall average value of 300 gpad is selected for all locations inside and outside the urban planning area. Tables 3 and 4 show this data converted to per capita basis for the areas inside and outside the urban planning area respectively. The selected value is based on the difference between design "inflow plus infiltration" factors of the order 1000 gpad used by many jurisdictions and the part ascribed to purely infiltration phenomena of around 500 gpad. The apparent difference of around 500 gpad assignable to inflow on a nationwide basis is further reduced to 300 gpad for the study area to reflect the lower rainfall of the study area. If half the inflow is assumed to be attributable to leakage into manholes and half due to illegal or faculty construction on the property of the served residence, the manhole leakage is equal to 0.38 gpm per manhole, at 0.3 manholes per acre of service area, and 25 gpcd, at 6 persons per acre.

For communities outside the urban planning area where infiltration and inflow are expressed in terms of miles of sewer per person served, the above inflow rate is applied as an allowance of 25 gpcd plus 7,000 gallons per day per mile of sewer.

Forecast of Industrial Waste Flows

Existing industrial waste sources have been identified in two categories, those tributary to the City of Spokane STP and those not. Those tributary to the City of Spokane STP are shown to be numerous and individually small, there being over 50 making up a flow of approximately 3.5 million gallons per day. These industries are dominated by food processing and service type enterprises with practically no heavy manufacturing. Those not tributary to the City of Spokane STP are relatively few in number with several individual plants accounting for practically all of the flow. Refer to Table 5. Five industrial plants involving only three ownerships and two products account for 95 percent of the 32.7 mgd discharged by industries in the urban planning area not tributary to the City of Spokane STP. All five industries are in manufacturing, four in aluminum production or processing and one in paper manufacture. Of the 32.7 mgd, 22.4 or 68 percent are cooling waters, and 10.3 mgd or 32 percent are process wastes. The above cited five industries are the largest contributors in both categories.

The large industries which make up most of the industrial waste load anticipate no change, either increase or decrease, in waste flows or production. A growth forecast related to specific large industries is not possible based on commitments by these industries.

For both large and small industry forecast growth must be based on the overall forecasts for population employment and economic growth in the study area. The risk inherent in making such a forecast for the large industries is obvious considering the heavy reliance on one industry.

Forecast industrial employment by planning units is shown in Table 6. Industrial employment includes those associated with both waste producing industries and non waste producing industries. It is assumed that the ratio of waste producing to non waste producing will be essentially constant throughout the study period so that the total industrial employment is a valid index of industrial wastewater production.

From Table 6 it can be seen that the Southwest, West Plateau, Moran Prairie and Peone Prairie units have negligible industrial employment at present and are forecast to remain areas of very minor industrial employment. These areas contain no known waste sources of any significance at this time. The Southwest and Moran Prairie units are so located that it is highly probable that if any waste sources do develop from forecast employment, they would be sewered to the City of Spokane system. Therefore, from 1980 onward, these populations are incorporated into the City for load forecasting West Plateau and Peone Prairie forecasts are so small that no industrial waste forecast for these units is included.

The City as a whole has 17,139 employees or 65 percent of the total industrial employment. As shown above, this large share of industrial employment is associated with approximately 3.5 mgd of current industrial waste flow. Of this total, approximately 25 percent is estimated to be cooling water and the remaining 75 percent process wastes. The total waste flow is equivalent to an average discharge of 204 gallons per day per industrial employee. The proportion of total industrial employees within the urban planning that are forecast to be within the City at the end of the study period in the year 2020 is 62 percent, only slightly lower than the present level of 65 percent.

The Spokane Valley and North Spokane planning units contain 24 and 11 percent respectively of the present industrial employment. These proportions are forecast to become 26 and 11 percent respectively at year 2020, again indicating a continuation of established proportions similar to that shown above for industrial employment inside the City.

The forecast trends in the type of industrial employment developed in another section shows that the share of employment in primary industry will decrease in comparison with the share in secondary type industries are typified by those inside the City and the primary type by those in the Spokane Valley and North Spokane area. The share of employment in primary manufacturing is expected to be 10 percent less in the future than at present. Furthermore, the character of the primary manufacturing is expected to change from that which is related to a national market, like aluminum and paper, to those responsive to regional needs, like food processing. As regards waste flow production, these primary industries for regional needs are more similar to the existing secondary industry as characterized by the City and less like the 5 dominant primary industries in North Spokane and Spokane Valley. Therefore, rather than refer to the future industrial makeup as primary and secondary, it is referred to as heavy and light wherein heavy indicates primary manufacturing in large units for a national market and light indicates diversified smaller units producing products for local and regional markets.

To reflect these trends in the forecast of industrial waste flows the following assumptions are made:

1. Industry within the City will continue to be similar in character to that already there and the waste flows will increase in proportion to industrial employment.
2. Industry in the Spokane Valley and North Spokane units will have a continuing heavy type base similar to their present major components which will experience relatively small growth. The existing relatively small component of light type industry in these areas will have a proportionately higher rate of growth. The overall growth rate in the Spokane Valley and North Spokane units will be in proportion to forecast industrial employment, as for the City, but with different rates for each component type.

Of the present total industrial employment in the Spokane Valley of approximately 6550, about 2900 or 44 percent are employed in the primary manufacturing sector. Of the present total industrial employment in North Spokane of approximately 2500, about 1900 or 66 percent are in the primary sector. The overall forecast increase from 1975 to 2020 of industrial employment is 49.3 percent for Spokane Valley and 46.7 percent for North Spokane. It is estimated that the corresponding increase in the heavy component will be approximately one half of the overall rate or 25 percent and to take place in 2 1/2 percent steps at 1980, 1985, 1990, 1995, 2000, and a final 10 percent step 2000 to 2020. This is the basis of the "heavy" component forecast shown in Table 7. The corresponding forecast "light" industrial employment is determined by subtracting the above determined "heavy" component from the total forecast.

The present equivalent unit flow per industrial employee in the City for the diverse collection of smaller industries is developed above at 204 gpcd. Similar unit figures for the present conditions in the Spokane Valley and North Spokane are as follows:

Spokane Valley - 2900 employed in heavy with flow of 27.84 mgd equivalent to 9,600 gpcd. 3,653 employed in light with flow of .77 mgd equivalent to 212 gpcd.

North Spokane - 1900 employed in heavy with flow of 4.15 mgd equivalent to 2200 gpcd. There are no data for flow from the 823 employed in light.

From thse data unit flows are selected for forecasting as follows:

1. For light type in all areas, historical value or 200 gpcd

in 1975 with increases to 220 at 1980, 230 at 1985, 240 at 1990 and 250 at 1995 and later, said increases to reflect probable result of more are larger industries in regional type production.

2. For heavy in Spokane Valley, 9600 gpcd with small increases reaching 10,000 gpcd by year 2000 as shown in Table 7.
3. For heavy in North Spokane, 1,900 gpcd with small increases reaching 2000 gpcd by year 2000 as shown in Table 7.

The breakdown of total flow into process and cooling components is assumed to follow the historical patterns:

1. For all light, 25 percent cooling and 75 percent process.
2. For heavy in Spokane Valley, 35 percent cooling and 65 percent process.
3. For heavy in North Spokane, 90 percent cooling and 10 percent process.

The forecast of industrial waste flows for the three major planning units, City of Spokane, Spokane Valley and North Spokane are shown in Table 7. The resultant overall flow increases are compared with the overall industrial employment projection as below:

	Percent Increase 1975 to 2020	
	Industrial Employment	Industrial Waste Flow
City of Spokane	38.8	70.0
Spokane Valley	49.3	29.5
North Spokane	46.9	36.6

Assembly of Flow Components

The elements of total forecast wastewater flow covered in the preceeding paragraphs include:

1. Residential-Commercial flow criteria
2. Industrial flows
3. Infiltration
4. Inflow
5. Peak to average ratios

To arrive at the total forecast flow for the various planning units it is necessary to apply these criteria to the service population forecast and other characteristics of the individual planning units. This calculation is developed in another section.

Forecast Quality of the Residential-Commercial Component

The historical raw waste quality data for the City of Spokane sewage collection system do not permit the precise identification of the residential-commercial component. Approximate per capita values computed from estimated residential-commercial components of the total raw waste load are as follows:*

	Pollutant Load Pounds Per Capita Per Day
BOD	0.19
Suspended Solids	0.15
Nitrogen (Total Kjeldahl)	0.028
Phosphorus (Total as P)	0.014

Although these values appear reasonable when compared with literature values, they are not considered to be more valid than literature values because of the approximations required to separate the residential-commercial component from the total measured load. For this reason, a literature search is reported below. The results of the search are evaluated with the above to arrive at selected values for the study period.

The references are reported below in chronological order.

Babbitt and Baumann (1958) give typical sanitary sewage analysis as having the following range of values:

	Concentration mg/1		
	Strong	Medium	Weak
BOD	300	200	100
Suspended Solids	500	300	100
Total Nitrogen	85	50	25
Organic N	35	20	10
Ammonia N	50	30	15

* From Table 7 of Section 312.

When the above "medium" values are converted to per capita contributions based on 80 gpcd flow rate the results are:

	Pollutant Load Pounds Per Capita Per Day
BOD	0.13
TSS	0.20
Organic N	0.033
Ammonia N	0.020

Babbit and Baumann (1958) also quotes an old source (1937 ASCE report) for per capita contributions as follows:

	Load, Pounds Per Capita Per Day
BOD	0.22
Suspended Solids	0.21
Organic N	0.018
Ammonia N	0.012

ASCE (1959) gives 0.20 pounds per capita per day suspended solids and 0.17 pounds per capita BOD without the influence of garbage grinding. The estimate given of full use of garbage grinders is to increase solids by 60 percent and BOD by 30 percent. Note that Watson et al (1967) gives data that is contrary to these large increases.

Mackenthun (1965) lists 8 references on the content of nitrogen and phosphorus in sewage as follows:

a. From Engelbrecht and Morgan, 1959

Quotes Rudolfs (1947) that per capita contribution of phosphorus to domestic sewage is between 3.3×10^{-3} to 7.5×10^{-3} pounds per day as P_2O_5

Quotes Sawyer (1944) that detergents are equal to per capita contributions of 12 x 10^{-3} pounds per day as P_2O_5.

b. From McGauhey, 1963

Gives design factors for domestic wastes at Lake Tahoe as follows at flows of 90 gpcd:

BOD mg/1	250
Phosphate mg/1 P	8
Total Nitrogen mg/1 N	45

c. From Owen, 1953

Gives average per capita phosphorus contribution for Minnesota communities at 1.9 pounds per year.

d. From Parker, 1962

Gives nitrogen concentrations in raw sewage as 26.3 mg/1 organic and 32.4 mg/1 ammonia.

e. From Rudolfs, 1947

Gives phosphorus content of raw sewage as in the range of 1.7 to 4.0 mg/1 with average 2.3 mg/1 as P. On per capita basis for domestic sewage, range given as 0.53 to 1.20 pounds per year.

f. From Sawyer, 1952

Gives range of domestic sewage concentrations of 15 to 35 mg/1 nitrogen and 2 to 4 mg/1 phosphorus. (This Sawyer data may be from Rudolfs, 1947)

g. From Stumm and Morgan, 1962

Says that the content of sewage is 3 to 4 times what it was before the advent of detergents and that contained rise is expected. Gives 7 mg/1 as typical phosphorus content.

h. From Van Vuran, 1948

Gives nitrogen and phosphorus content of human excreta at 11.4 pounds N per year and 2.6 pounds of phosphoric acid.

Clarsen (1967). This source presents the results of a survey made of raw sewage characteristics reported by over 700 communities in Texas. The overall average per capita contributions were found to be as follows: BOD - .157 ppcd, TSS - 0.209 ppcd. A large number of the communities reporting were of 5000 or less persons and hence probably did not contain significant commercial or light industrial contributions. If only those communities of 10,000 or more are considered, the results are: BOD = .161 ppcd, TSS = 0.185 ppcd.

Watson et al (1967). This source reports results of original work on demestic wastes as they originate at single family residences. The wastes analyzed were completely free of groundwater, storm water, commercial and industrial flows. One of the primary objectives was to evaluate the effect of garbage grinders. Results are reported before and after installation of garbage grinders as follows:

	Per Capita Contributions, Pounds Per Day	
	Without Garbage Grinders	With Garbage Grinders
BOD	0.201	0.201
Suspended Solids	0.164	0.194
Total N	0.034	0.036
Ammonia N	0.026	0.027
Total P	0.009	0.007
Ortho P	0.006	0.005

No explanation offered of why there was no change or decrease in BOD, N and P accompanying the use of garbage grinders while the suspended solids showed a significant increase.

Loehr (1968). This source reports the results of a study made of 73 cities in 27 states on raw sewage characteristics. The results at the 50 percentile level for communities in the 20,000 to 50,000 and 50,000 to 150,000 size range are as follows:

	20,000 to 50,000	50,000 to 150,000
BOD ppcd	0.18	0.19
Suspended Solids ppcd	0.17	0.25

Considering cities of all sizes, the average per capita values are flow 135 gpcd, BOD 0.20 ppcd, and TSS 0.23 ppcd.

Imhoff et al (1971) gives the following values for residential sewage, without industrial or storm inflow:

Constituent	Contribution Pounds Per Capita Per Day
BOD	0.12

Fair, Geyer and Okun (1971) present domestic wastewater composition in only the broadest terms, that is BOD, COD and mineral and organic solids. Average BOD is given as 140 mg/l and average total suspended solids as 235 mg/l.

Black & Veatch (1971) give 3.5 pounds per capita per year as the mean annual domestic contribution of phosphorus exclusive of any allowance for industrial. This is expressed as total elemental phosphorus as P. Expressed in pounds per capita per day this is equal to .00958 or in terms of concentration for 100 gpcd flow 11.5 mg/l. Of this total, the estimated contribution from detergents is 50 percent or more. Consequently, any reduction achieved in use of phosphorus in detergents will have a significant effect on the quantity of phosphorus in domestic sewage.

Brown & Caldwell (1972) selected the following per capita contributions as representative of 2020 conditions for the domestic wastewater component in their Contra Costa County (California) Water Quality Study.

Waste Parameter	Unit Load pcd
BOD	0.18
Total suspended solids	0.20
Nitrogen	0.036
Phosphorus	0.010

The trending expressed in support of the above includes some increase in BOD and TSS for continued expansion in use of home garbage grinders and increases in nitrogen and phosphorus to correspond with the increase in BOD. Brown and Caldwell (1972) conclude that there will be no reduction in phosphorus from either a ban on phosphorus in detergents or through successful voluntary substitution.

Metcalf and Eddy (1972) presents a table of domestic sewage composition in terms of Strong, Medium and Weak that is almost identified with Babbitt and Baumann (1958).

	Concentration mg/l		
	Strong	Medium	Weak
BOD	300	200	100
Suspended Solids	350	200	100
Total N	85	40	20
Organic N	35	15	8
Ammonia	50	25	12
Total P	20	10	6

The foregoing data are summarized for comparison in Table 8. Before selecting final values for the study area, two considerations are recognized. First, the unit loads sought should include both the residential and the commercial component. Since only major industrial has been singled out for separate evaluation, commercial here means all other contributors except purely residential and major industrial. Secondly, the effect of the commercial load varies with the size of the community; the larger the community, the larger the commercial component. For this reason, one set of values is selected for the urban planning area with large commercial impact and one for communities outside the urban planning area with small commercial impact.

For the urban planning area, BOD is selected at the value estimated from City data and a growth of 15 percent is forecast over the study period. This small increase is selected to reflect a continuation of the trend in recent years toward increased sewage strength. This has been attributed to use of domestic and commercial garbage grinders (Metcalf and Eddy, 1972) notwithstanding Watson et al (1967). Refer also to the reported experience of Fairchild AFB in Section 312. For the Spokane urban planning area, the forecast trend of small industry into food processing is believed to be another cause for providing for some future increase in sewage strength.

The total settleable solids from estimated City data appears to be too low in relation to BOD and other experience. A value of 0.18 ppcd is selected for present conditions with a growth through the study period corresponding to that for BOD. The total nitrogen value from estimated City data is in good agreement with most sources. This pollutant appears to have the most consistent evaluation from all sources. The breakdown into organic and ammonia proportions is taken from Babbitt and Baumann. The total phosphorus indicated by estimated City data appears to be excessively high. Value selected is based primarily on Black and Veach supported by Watson. For both nitrogen and phosphorus, minor growth is forecast through the study period in parallel with BOD and TSS. Selected values by years through the study period are shown in Table 9.

For areas outside the urban planning area, values are selected ten percent lower than the urban planning area to reflect lower impact of commercial. Selected values by years through the study period are shown in Table 10.

Mass emissions for each planning unit or community or groupings of planning units and communities are computed on the same format as Tables 11 and 12 by multiplying the per capita loads by the appropriate service population at each year.

Forecast Industrial Pollution Load in City of Spokane

As stated above under forecast of flow, the expected character of industry in the City is consistent with the present experience. Therefore, the forecast pollution load would be expected to be similar to the present and in proportion to the forecast industrial employment. There is, however, a new consideration for industrial waste discharges inside the City which will tend to modify the concentration of pollutants which actually reach the City sewers. This new consideration is the EPA requirement relative to user charges and industrial cost recovery.

EPA regulations* for the determination of user charges and industrial cost recovery require that a surcharge be added to the base charge when BOD, suspended solids or other pollutant concentrations from a use exceed the range of concentration of these pollutants in normal domestic sewage. Bovay (1974a) has determined the levels of concentration for proposed surcharges in the City of Spokane as follows:

	Pollutant Concentration mg/l		
	BOD	Suspended Solids	Phosphorus
Concentration above which surcharge applies	260	215	15.2
Concentration below which credit applies	160	125	9.6

* Federal Register, Vol. 38 No. 161 Tuesday, August 21, 1973.

The mean concentrations of BOD and suspended solids are far above the levels for which a surcharge will be made. This will be an incentive for pretreatment by industry to avoid the surcharge where economically feasible. Since the treatment means for gross BOD and suspended solids reduction are, in general, uncomplicated and relatively inexpensive, it is assumed that at least part of industry will find pretreatment economically attractive compared with the surcharge. For some industries, especially small facilities, it probably will be more economical to pay the surcharge. It is doubtful if many would find it attractive to pretreat to the level of being eligible for a credit.

The phosphate load is close to the "no surcharge" level. Also, the technology of phosphate removal is more complex and more costly than BOD or SS removal. Therefore, the broad spectrum of industries in the City probably would not find it economically advantageous to reduce their phosphorus output by pretreatment. There could be individual exceptions but they would not be expected to effect the overall industrial output.

Due to the requirements for user charges and industrial cost recovery, it is estimated that the net BOD and SS load to the City sewers will be reduced to a level more closely approaching the "no surcharge" level than at present. It is estimated that the BOD and SS level will approach 350 mg/1 and 250 mg/1 respectively by 1980 and 225 mg/1 and 150 mg/1 by 1985 remaining constant thereafter. It is estimated that the phosphorus and nitrogen levels will experience some reduction incidental to the removal of BOD and SS. Thus, the phosphorus and nitrogen are expected to decrease from 10.5 and 31.5 mg/1 in 1975 to 7.5 and 22.5 mg/1 respectively by 1985. All above concentrations are expressed in terms of total flow including both process and cooling water components as is the case for Bovay (1974a). The criteria are summarized as follows in terms of the process flow component which is estimated to be 75 percent of total existing and forecast flow:

	Pollutant Concentration mg/1		
	1975	1980	1985 & beyond
BOD	925	466	300
Suspended Solids	618	333	200
Nitrogen	42	38	30
Phosphorus	14	13	10

Total forecast pollution load for industries tributary to the City STP is shown in Table 11.

Forecast Industrial Pollution Load Outside the City of Spokane.

The industry outside of the City as contrasted with that inside the City is expected to experience some change in make up in the future with decreasing emphasis on "heavy" industry and increasing emphasis on "light" industry more similar to that inside the City. These segregations are recognized in the flow forecast.

The heavy component will probably continue to provide either treatment or pretreatment similar to that currently being provided so that the net pollution load leaving the industrial property is expected to be a continuation of the present trends. For the Spokane Valley, exclusive of Spokane Industrial Park, these loads in terms of the process flows of 9.74 mgd are as follows:

	Daily Pollution Load Pounds	Pollutant Concentration mg/l
BOD	1326	16.34
Suspended Solids	951*	11.72
Kjeldahl Nitrogen	88	1.08
Phosphorus (as P)	66#	0.81

The pollution load for the "light" category in Spokane Valley at present is represented primarily by Spokane Industrial Park (SIP). The present concentrations of pollutants from SIP are as follows, based on estimated process flow of 0.55 mgd:

	Daily Pollution Load Pounds	mg/l
BOD	24	5.24
Suspended Solids	118	25.76
Kjeldahl Nitrogen	39	8.51
Phosphorus	27	5.90

These are not considered to be a valid basis for forecasting the "light" component in the Spokane Valley since these are treated effluent values and are an excessively small sample. The data developed for forecast conditions in the City are therefore adapted for the Spokane Valley as follows, for all years:

* Does not include the high solids waste of soft water service assumed diverted from separate surface discharge.

Assumes Kaiser Trentwood cut back to level of 0.10 mg/l to approach in their waste discharge permit at 0.03 mg/l.

	Pollution Loading mg/l Based on Process Flow Component*
BOD	300
Suspended Solids	200
Nitrogen	30
Phosphorus	10

It is assumed that any alternative plan which proposes centralized municipal and industrial treatment will result in the same pressures to reduce industrial pollution load as with the City in accordance with the requirements for user charges and industrial cost recovery.

For the North Spokane planning unit the present pollution loads for the process flows of 0.19 mgd, the "heavy" components are as follows:

	Daily Pollution Load Pounds	Pollutant Concentration mg/l
BOD	12	7.59
Suspended Solids	32	20.25
Nitrogen	85	53.80
Phosphorus	7	4.43

The load associated with the existing 0.19 mgd is expected to continue with the above concentrations. Future additions to the "heavy" component are not expected to follow the existing pattern with its unusually high nitrogen content and the high suspended solids

* Process Flow equal to 75% of total forecast flow.

relative to BOD. Future "heavy" component pollutant load, associated with process flows above and beyond the existing 0.19 mgd are expected to have a more conventional pattern as estimated below at one-tenth of the "light" concentrations:

	Pollutant Concentration mg/1
BOD	30
Suspended Solids	20
Nitrogen	3
Phosphorus	1

For North Spokane planning unit the forecast loadings for the "light" component, whose present existence in this area is negligible, are estimated to be the same as for comparable industry in the City and in the Spokane Valley.

Total forecast pollution loads for industrial flows in the Spokane Valley and North Spokane planning unit are developed in Tables 12 and 13 respectively.

TABLE 1

PER CAPITA WATER CONSUMPTION

CITY OF SPOKANE

FOR MONTHS NOVEMBER THROUGH MARCH 1963 TO 1973

YEAR	POPULATION	WATER USE (NOV. TO MAR.) MILLION GAL. (3)	PER CAPITA CONSUMPTION gpcd
1963 - 1964	177,615 (1)	3530.346	132
1964 - 1965	176,506 (1)	3801.891	143
1965 - 1966	175,397 (1)	3551.744	134
1966 - 1967	174,288 (1)	3650.663	139
1967 - 1968	173,178 (1)	3741.301	143
1968 - 1969	172,069 (1)	3739.678	144
1969 - 1970	170,960 (1)	3708.852	144
1970 - 1971	172,904 (2)	3538.998	136
1971 - 1972	174,606 (2)	3909.101	148
1972 - 1973	175,250 (2)	4067.738	154

(1) Based on 1960 and 1970 Census Population Interpolation

(2) Based on Reported City Water Records

(3) Estimated, Based on Annual Metered Flow

TABLE 2

FORECAST PER CAPITA MUNICIPAL FLOWS

1975 - 2020

Type of Tributary Area	1975	1980	1985	1990	1995	2000	2020
	Gallons Per Capita Per Day (gpcd)						
City of Spokane with combined sewers	123	127	131	133	134	135	135
City of Spokane with separate sewers	120	124	128	130	131	132	132
Suburban with significant commercial	107	111	114	116	117	118	118
Suburban with moderate commercial	97	100	103	105	106	107	107
Suburban with negligible commercial	91	94	97	98	99	100	100
Communities outside the UPA, population > 500	78	83	86	88	90	92	94
Communities outside the UPA, population < 500	75	80	83	85	87	89	90

TABLE 3
INFILTRATION AND INFLOW ALLOWANCES
IN THE URBAN PLANNING AREA

Planning Unit	Percent of Buildable Area in Category: High 500 gpad	Medium 200 gpad	Low 100 gpad	Weighted Infiltration Rate gpad	1975	1980	1985	1990	1995	2000	2020
				Equivalent Density of Service Population, Persons per Acre	6	7	8	9	9.5	10	10
					INFILTRATION ALLOWANCE, Gallons per Capita per Day						
Spokane Valley											
SV – 1			100	100	17	14	12	11	11	10	10
2			100	100	17	14	12	11	11	10	10
3			100	100	17	14	12	11	11	10	10
4		10	90	110	18	16	14	12	12	11	11
5		10	90	110	18	16	14	12	12	11	11
6		10	90	110	18	16	14	12	12	11	11
7	10	30	60	170	28	24	21	19	18	17	17
8	10	10	80	150	25	21	19	17	16	15	15
9		10	90	110	18	16	14	12	12	11	11
10		20	80	120	20	17	15	13	13	12	12
North Spokane											
NS – 1			100	100	17	14	12	11	11	10	10
2		100		200	33	29	25	22	21	20	20
3			100	100	17	14	12	11	11	10	10
4			100	100	17	14	12	11	11	10	10
5			100	100	17	14	12	11	11	10	10
6	10	10	80	150	25	21	19	17	16	15	15
7	25	10	65	210	35	30	26	23	22	21	21
8	10	10	80	150	25	21	19	17	16	15	15
9	20		80	180	30	26	22	20	19	18	18
Southwest		90	10	190	32	27	24	21	20	19	19
Moran Prairie		40	60	140	23	.	18	16	15	14	14
Peone Prairie		80	20	180	30	26	22	20	19	18	18
West Plateau		100		200	33	29	25	22	21	20	20
					INFLOW ALLOWANCE, Gallons per Capita per Day						
All Areas				25 gpcd plus 150 gpad	50	46	44	42	41	40	40

TABLE 4

INFILTRATION AND INFLOW ALLOWANCES

OUTSIDE THE URBAN PLANNING AREA

Community	Weighted Infiltration Rate, gpd Per Mile of Sewer	Precently Sewered?	Miles of Sewer Per 100 Persons Served	Equivalent Per Capita Infiltration gpcd	Equivalent Per Capita Inflow * gpcd
Airways Heights	1,000	No	0.68	7	73
Chattaroy Hills	1,000	No	1.5	16	130
Cheney	3,000	Yes	0.58	17	66
Deer Park	4,500	Yes	0.70	31	74
Fairchild AFB	4,000	Yes	0.48	19	59
Fairfield	3,000	Yes	0.82	25	83
Latah	1,000	No	1.5	15	130
Medical Lake	3,000	Yes	0.52	16	71
Rockford	1,500	Yes	1.48	22	128
Spangle	1,000	No	1.5	15	130
Tekoa	2,000	Yes	0.93	18	90

* Based on 25 gpcd plus the equivalent per capita of 7,000 gallons per day per mile.

TABLE 5

PRESENT INDUSTRIAL WASTEWATER FLOWS IN

NORTH SPOKANE AND SPOKANE VALLEY PLANNING UNITS

Industry	Industrial Wastewater Components, mgd		
	Process	Cooling	Total
SPOKANE VALLEY			
Hillyard	.545	--	.545
Inland Empire	2.297	1.000	3.297
Kaiser (Trentwood)	6.503	17.497	24.000
Spokane Ind. Park	.550	.050	.60
ASC Industries	.001	.013	.014
Ace Concrete	.037	--	.037
Acme Concrete	.005	--	.005
Central Premix (1)	.279	--	.279
Chembond Corp.	--	.036	.036
Ideal Cement	--	.005	.005
Triple E Meat	.002	--	.002
Subtotal Spokane Valley	10.219	18.601	28.820
NORTH SPOKANE			
Kaiser (Mead)	.190	3.310	3.500
Kaiser (South Mead)	.068	.500	.568
Subtotal North Spokane	.258	3.810	4.068
TOTALS - Spokane Valley plus North Spokane	10.477	22.411	32.888

(1) Does not include plant in West Plateau unit.

TABLE 6

FORECAST INDUSTRIAL EMPLOYMENT

Planning Unit	1975	1980	1985	1990	1995	2000	2020
City of Spokane	17,139	17,622	18,342	19,151	20,113	21,026	23,573
Southwest	29	29	30	31	32	33	36
Moran Prairie	134	138	143	148	154	160	176
SUBTOTAL	17,302	17,789	18,515	19,330	20,299	21,219	23,785
North Spokane	2,923	3,007	3,138	3,302	3,502	3,697	4,295
Spokane Valley	6,553	6,750	7,067	7,444	7,919	8,392	9,781
West Plateau	140	143	148	153	154	155	167
Peone Prairie	26	29	37	38	46	59	65
TOTAL	26,944	27,718	28,905	30,267	31,920	33,522	38,093

TABLE 7

FORECAST INDUSTRIAL WASTE FLOWS

		Units	1975	1980	1985	1990	1995	2000	2020
SPOKANE VALLEY	Forecast Industrial Employment	persons	6553	6750	7067	7444	7919	8392	9781
	Employment in Primary Ind.	persons	2900	2973	3046	3119	3192	3265	3555
	" " Other "	persons	3653	3777	4021	4325	4727	5127	6226
	Unit flow, primary ind.	gpcd	9600	9600	9700	9800	9900	10,000	10,000
	Total " " "	mgd	27.84	28.54	29.55	30.57	31.60	32.65	35.50
	Process portion @35%	mgd	9.74	9.99	10.34	10.70	11.06	11.43	12.42
	Cooling portion @65%	mgd	18.10	18.55	19.21	19.87	20.54	21.22	23.08
	Unit flow, other ind.	gpcd	212	220	230	240	250	250	250
	Total " " "	mgd	.77	.83	.92	1.04	1.18	1.28	1.56
	Process portion @75%	mgd	.58	.62	.69	.78	.89	.96	1.17
	Cooling portion @25%	mgd	.19	.21	.23	.26	.29	.32	.39
	Total all industrial	mgd	28.61	29.37	30.47	31.61	32.78	33.93	37.06
	Process portion of all	mgd	10.32	10.61	11.03	11.48	11.95	12.39	13.59
	Cooling portion of all	mgd	18.29	18.76	19.44	20.13	20.83	21.54	23.47
CITY OF SPOKANE	Forecast Industrial Employment	persons	17,139	17,789*	18,515	19,330	20,299	21,219	23,785
	Unit flow	gpcd	204	220	230	240	250	250	250
	Total Flow	mgd	3.50	3.91	4.26	4.64	5.07	5.30	5.95
	Process portion @75%	mgd	2.63	2.93	3.20	3.48	3.80	3.98	4.46
	Cooling portion @25%	mgd	.87	.98	1.06	1.16	1.27	1.32	1.49
NORTH SPOKANE	Forecast Industrial Employment	persons	3072	3256	3406	3584	3799	4023	4700
	Employment in primary type	"	1836	1946	2036	2142	2270	2404	2809
	" " other "	"	1236	1310	1370	1442	1529	1619	1891
	Unit flow, primary	gpcd	1900	1900	1900	1950	1950	2000	2000
	Total flow, primary	mgd	3.488	3.697	3.868	4.177	4.426	4.808	5.618
	Process Portion of primary @10%	mgd	0.349	0.370	0.387	0.418	0.443	0.481	0.562
	Cooling Portion of primary @90%	mgd	3.139	3.327	3.481	3.759	3.983	4.327	5.056
	Unit flow, other	gpcd	200	220	230	240	250	250	250
	Total flow, other	mgd	0.247	0.288	0.315	0.346	0.382	0.405	0.473
	Process portion of other @75%	mgd	0.185	0.216	0.236	0.260	0.287	0.304	0.355
	Cooling portion of other @25%	mgd	0.062	0.072	0.079	0.086	0.095	0.101	0.118
	Total all	mgd	3.735	3.985	4.183	4.523	4.808	5.213	6.091
	Process portion of all	mgd	0.534	0.586	0.623	0.678	0.730	0.785	0.917
	Cooling portion of all	mgd	3.201	3.399	3.560	3.845	4.078	4.428	5.174

* From 1980 on, City employment includes planning units Southwest and Moran Prairie

TABLE 8
COMPARISON OF PER CAPITA POLLUTANT
CRITERIA

Parameter	Estimated From City Data	ASCE Manual	Imhoff et al	Babbitt & Baumann (1)	Babbitt & Baumann (2)	Black & Veach EPA	Brown & Caldwell (3)	(4)	(5)	Loehr (6)	Classen (7)	McGauhey (8)	Mackenthun Owen (9)	Parker (10)	Rudolfs	Sawyer (11)	Van Vuren	Selected for the Urban Planning Area 1975	Selected for the Urban Planning Area 2020
BOD	0.19	0.17	0.12	0.13	0.22		0.18	0.201	0.201	0.20	0.157	0.157						0.19	0.22
TSS	0.15	0.20		0.20	0.21		0.20	0.164	0.194	0.23	0.209							0.18	0.22
Total N	0.028			0.033			0.036	0.034	0.036			0.034				.010 to .023	.0312	0.030	0.035
Org. N				0.013	0.018									0.020				0.012	0.014
Amm. N				0.020	0.012			0.026	0.027					0.024				0.018	0.021
Total P	0.014					0.00958	0.010	0.009	0.007			0.006	0.0052		.00145 to .00329	.0013 to .00329		0.010	0.012
Ortho P								0.006	0.005									0.006	0.008

(1) For medium strength sewage and 80 gpcd
(2) Quotation from old 1937 ASCE Data
(3) Recommended levels for year 2020
(4) Without garbage grinders
(5) With garbage grinders
(6) For 73 cities throughout the U.S.
(7) For over 700 communities in Texas
(8) At Lake Tahoe
(9) For Minnesota communities
(10) Concentrations converted at 90 gpcd
(11) Concentrations converted at 80 gpcd

TABLE 9

FORECAST PER CAPITA POLLUTANT

LOADING IN URBAN PLANNING AREA

Loadings, Pounds Per Capita Per Day (ppcd)

Pollutant	1975	1980	1985	1990	1995	2000	2020
BOD	0.19	0.19	0.20	0.20	0.21	0.21	0.22
Suspended Solids	0.18	0.19	0.19	0.20	0.20	0.21	0.22
Total N	0.030	0.031	0.032	0.033	0.034	0.035	0.035
Organic N	0.012	0.012	0.012	0.013	0.013	0.014	0.014
Ammonia N	0.018	0.019	0.020	0.020	0.020	0.021	0.021
Total P	0.010	0.010	0.010	0.011	0.011	0.012	0.012
Ortho P	0.006	0.006	0.006	0.007	0.007	0.008	0.008

TABLE 10

FORECAST PER CAPITA POLLUTANT

LOADING OUTSIDE THE URBAN PLANNING AREA

Loadings, Pounds Per Capita Per Day (ppcd)

Pollutant	1975	1980	1985	1990	1995	2000	2020
BOD	0.17	0.17	0.18	0.18	0.19	0.19	0.20
Suspended Solids	0.16	0.17	0.17	0.18	0.18	0.19	0.20
Total N	0.027	0.028	0.029	0.030	0.031	0.032	0.032
Organic N	0.011	0.011	0.011	0.012	0.012	0.013	0.013
Ammonia N	0.016	0.017	0.018	0.018	0.019	0.019	0.019
Total P	0.009	0.009	0.009	0.010	0.010	0.011	0.011
Ortho P	0.005	0.005	0.005	0.006	0.006	0.007	0.007

TABLE 11
INDUSTRIAL WASTE LOAD FORECAST
FOR INDUSTRIES IN CITY OF SPOKANE

	Units	1975	1980	1985	1990	1995	2000	2020
Forecast Process Flow	mgd	2.63	2.93	3.20	3.48	3.80	3.98	4.46
BOD Concentration	mg/1	925	466	300	300	300	300	300
BOD Daily Load	pounds/day	20,280	11,380	8,000	8,700	9,500	9,950	11,150
Suspended Solids, Concentration	mg/1	618	333	200	200	200	200	200
" " , Daily Load	pounds/day	13,550	8,130	5,340	5,800	6,340	6,640	7,440
Nitrogen, Concentration	mg/1	42	38	30	30	30	30	30
" , Daily Load	pounds/day	921	928	800	870	950	995	1,115
Phosphorus, Concentration	mg/1	14	13	10	10	10	10	10
" , Daily Load	pounds/day	307	318	267	290	317	332	372
Forecast Cooling Flow	mgd	0.87	0.98	1.06	1.16	1.27	1.32	1.49
Forecast Total Flow	mgd	3.50	3.91	4.26	4.64	5.07	5.30	5.95

TABLE 12

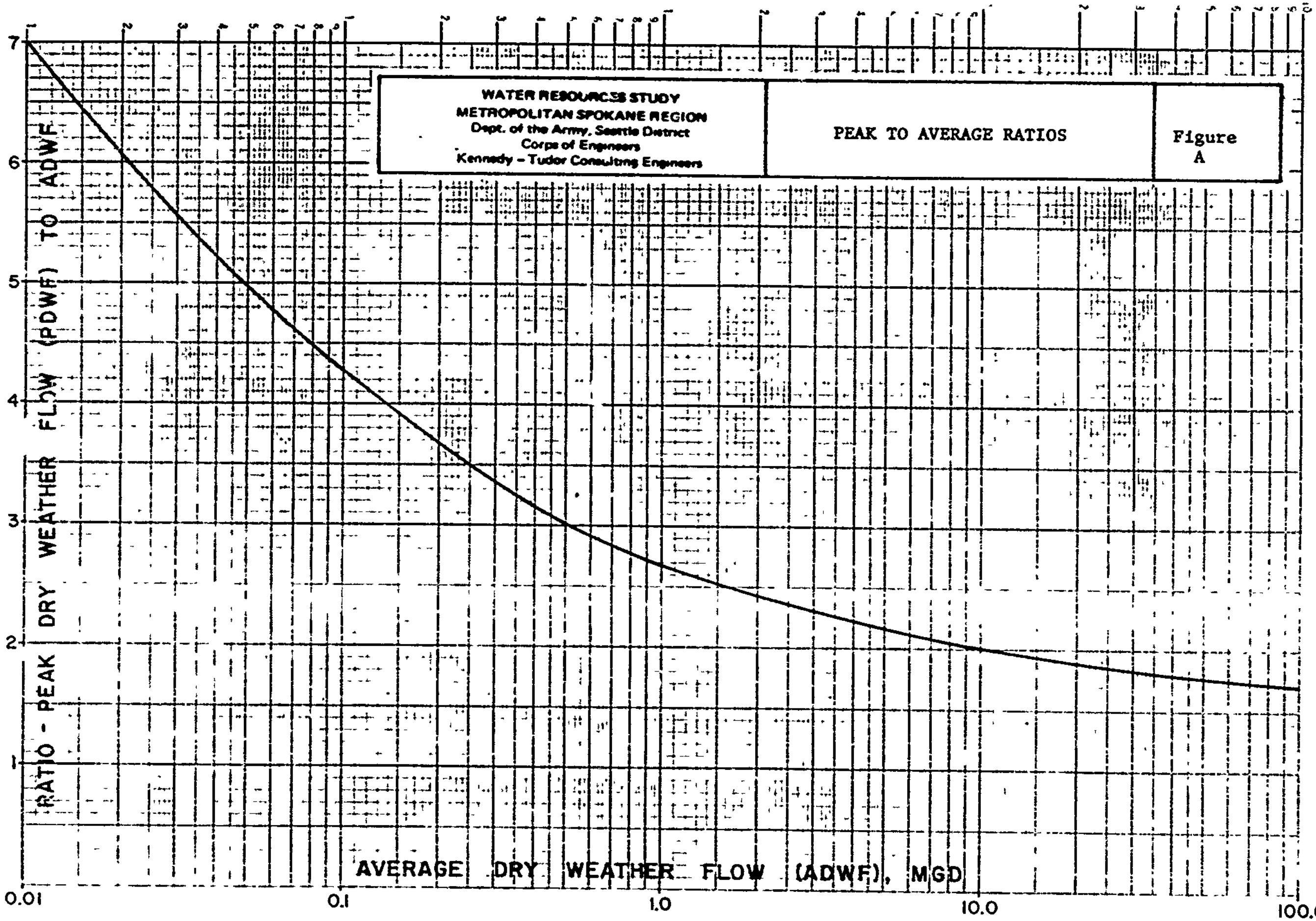
INDUSTRIAL WASTE LOAD FORECAST
SPOKANE VALLEY UNIT

	Units	1975	1980	1985	1990	1995	2000	2020
HEAVY COMPONENT								
Forecast Process Flow	mgd	9.74	9.99	10.34	10.70	11.06	11.43	12.42
BOD, Concentration	mg/1	16.34	16.34	16.34	16.34	16.34	16.34	16.34
BOD, Daily Load	pounds	1326	1360	1407	1456	1505	1556	1691
Suspended Solids, Concentration	mg/1	11.72	11.72	11.72	11.72	11.72	11.72	11.72
" " , Daily Load	pounds	951	975	1009	1045	1080	1116	1213
Nitrogen, Concentration	mg/1	1.08	1.08	1.08	1.08	1.08	1.08	1.08
" , Daily Load	pounds	88	90	93	96	100	103	112
Phosphorus, Concentration	mg/1	0.81	0.81	0.81	0.81	0.81	0.81	0.81
" , Daily Load	pounds	66	67	70	72	75	77	84
Forecast Cooling Flow	mgd	18.10	18.55	19.21	19.87	20.54	21.22	23.08
" Total "	mgd	27.84	28.54	29.55	30.57	31.60	32.65	35.50
LIGHT COMPONENT								
Forecast Process Flow	mgd	0.58	0.62	0.69	0.78	0.89	0.96	1.17
BOD, Concentration	mg/1	300	300	300	300	300	300	300
BOD, Daily Load	pounds	1449	1549	1724	1949	2224	2399	2923
Suspended Solids, Concentration	mg/1	200	200	200	200	200	200	200
" " , Daily Load	pounds	966	1033	1150	1299	1483	1599	1949
Nitrogen, Concentration	mg/1	30	30	30	30	30	30	30
" , Daily Load	pounds	145	155	172	195	222	240	292
Phosphorus, Concentration	mg/1	10	10	10	10	10	10	10
" , Daily Load	pounds	48	52	57	65	74	80	97
Forecast Cooling Flow	mgd	0.19	0.21	0.23	0.26	0.29	0.32	0.39
Forecast Total Flow	mgd	0.77	0.83	0.92	1.04	1.18	1.28	1.56

TABLE 13
INDUSTRIAL WASTE LOAD FORECAST
NORTH SPOKANE UNIT

	Units	1975	1980	1985	1990	1995	2000	2020
HEAVY COMPONENT								
Forecast Process Flow	mgd	0.35	0.37	0.39	0.42	0.44	0.48	0.56
BOD, Concentration	mg/1	7.59(1)	30(2)	30	30	30	30	30
BOD, Daily Load	pounds/day	22	27	32	39	44	5[illegible]	74
Suspended Solids, Concentration	mg/1	20.25(1)	20(2)	20	20	20	20	20
" " , Daily Load	pounds/day	59	62	66	71	74	81	94
Nitrogen Concentration	mg/1	53.80(1)	3(2)	3	3	3	3	3
" , Daily Load	pounds/day	157	157	158	159	159	160	162
Phosphorus, Concentration	mg/1	4.43(1)	1(2)	1	1	1	1	1
" , Daily Load	pounds/day	13	13	13	14	14	14	15
Forecast Cooling Flow	mgd	3.14	3.33	3.48	3.76	3.98	4.33	5.06
" Total Flow	mgd	3.49	3.70	3.87	4.18	4.42	4.81	5.62
LIGHT COMPONENT								
Forecast Process Flow	mgd	0.18	0.22	0.24	0.26	0.29	0.30	0.36
BOD, Concentration	mg/1	300	300	300	300	300	300	300
BOD, Daily Load	pounds/day	450	550	600	650	725	750	900
Suspended Solids, Concentration	mg/1	200	300	300	300	300	300	300
" " , Daily Load	pounds/day	300	367	400	433	483	500	600
Nitrogen Concentration	mg/1	30	30	30	30	30	30	30
" " , Daily Load	pounds/day	45	55	60	65	72	75	90
Phosphorus, Concentration	mg/1	10	10	10	10	10	10	10
" , Daily Load	pounds/day	15	18	20	22	24	25	30
Forecast Cooling Flow	mgd	0.06	0.07	0.08	0.09	0.10	0.10	0.12
" Total "	mgd	0.24	0.27	0.32	0.35	0.39	0.40	0.48

(1) Applies to 1975 and the first 0.35 mgd of flow thereafter.
(2) Applies to excess of process flow over the first 0.35 mgd.


WATER RESOURCES STUDY
METROPOLITAN SPOKANE REGION
Dept. of the Army, Seattle District
Corps of Engineers
Kennedy – Tudor Consulting Engineers
PEAK TO AVERAGE RATIOS
Figure A
RATIO - PEAK DRY WEATHER FLOW (PDWF) TO ADWF
AVERAGE DRY WEATHER FLOW (ADWF), MGD
0.01
0.1
1.0
10.0
100.0
1
2
3
4
5
6
7

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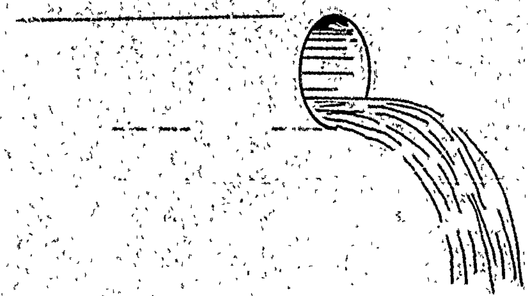

SECTION 406.2

PROJECTED WASTE FLOWS AND POLLUTION LOADS, URBAN PLANNING AREA

WATER RESOURCES STUDY

METROPOLITAN SPOKANE REGION

SECTION 406.2

PROJECTED WASTE FLOWS AND POLLUTION LOADS URBAN PLANNING AREA

23 October 1974

Department of the Army, Seattle District
Corps of Engineers
Kennedy-Tudor Consulting Engineers

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SECTION 406.2
PROJECTED WASTE FLOWS AND POLLUTION LOADS,
URBAN PLANNING AREA

Introduction

The objectives of this section are to combine the elements developed in two other sections to arrive at projected waste flows and pollution loads for the various planning units and subunits of the urban planning area. The two sections on which this section builds directly are:

Section No.	Title
406.1	Criteria for Projection of Waste Loads
602	Wastewater Planning Areas

Forecast Service Population

In Section 602 the total populations in the various planning units and subunits are developed. The total forecast population at a given date is not necessarily the population that can feasibly be served by a sewage collection system. This is especially true of areas which have been built up on the basis of individual on-site disposal since, under this kind of development, there is little incentive to group dwellings to minimize collection sewers.

The problem of when, if ever, any particular existing on-site disposal should be replaced by a central collection and disposal system is the subject of another section. The findings of that section will determine whether a collection system need be built and when. The objective of this section is to provide information on the total feasible sewerable population at each date without regard to the need for implementation or its timing.

The feasible service population for existing conditions is determined by evaluation of the housing pattern in each planning unit and subunit. The forecast service population is based on the existing service population, the amount of growth forecast, and the extent to which the forecast growth approaches saturation of the area.

For the City of Spokane, Esvelt & Saxton/Bovay (1972) estimate that 2450 dwellings in the sewered area are not presently served by the collection system. This is equal to about 7500 persons. Based on this data, the service population of the sewered area of the city is estimated to be 95 percent of the total residents in the sewered area. The forecast population growth in the area defined by the existing collection system is approximately 10 percent to the year 2020. Most of this will probably be in higher density housing which will undoubtedly be sewered. Since there will probably be little fill-in to cause extension of the system to serve those presently unserved, it is estimated that most will remain in this condition. On this basis the net sewered is estimated to increase to approximately 98.5 percent by 2020.

For areas presently unsewered, an individual evaluation is made for each area based on the pattern of existing housing. The criterion selected for judging the feasibility of sewering existing dwellings is that an individual dwelling or group of dwellings will be served if they can be connected to the system with 200 feet of sewer or less per dwelling . For example, an isolated group of 5 dwellings, the nearest of which is 500 feet from the collection trunk, would be picked up if they could be served as a group with no more than 1000 feet of additional sewer.

For future dwellings in an area in which collection for disposal has become available, there will be both regulatory and financial pressure to locate additional units within feasible sewage connection. Therefore, most added dwelling units can be assumed feasibly located for service by extensions of the basic sewer system. As the area is filled in between those feasibly sewered and those not, many of the existing dwellings not connected at first will be connected in the future. The extent to which this is possible is a function of present distribution and the degree to which saturation is approached as future additions are made.

Tables 1 through 5 summarize the results of evaluations of presently feasibly sewered populations and forecasts of future feasibly sewered populations. Some entire sub units are regarded as infeasible for a central collection system at present and for some years of forecast population increase. This is true of sub units NS-1, 2, 7, 8 and 9 in North Spokane and sub units SV-7 and 8 in the Spokane Valley.

Spokane Valley sub units SV-7 and 8 deserve special mention. In Table 2 they are shown as having zero feasible sewered population throughout the study period. This is true in the sense that the centers of population will remain remote from other development in the valley and there is not a forecast fill in between. The existing development in these units is actually quite concentrated around the shores of Liberty Lake and Newman Lake respectively and do represent feasibly sewered but isolated communities. For this reason and for the unique problems associated with the lakes, these two communities are treated separately. Feasibly sewered populations and waste load forecasts are developed below for both the Liberty Lake and Newman Lake communities.

The kind of development which takes place could affect the assumptions regarding feasibly sewered populations in NS-1 and NS-2. The kind of development taking place in NS-1, which is largely inside the City of Spokane, is being sewered in groups to "interim" facilities. It may become desirable to gather up these isolated sewered groups to one of the larger systems prior to 1985. The classification of NS-1 as zero in 1980 and 1985 is more an indication of the probable limit in development beyond which these isolated separate facilities are feasible. Note that in 1990, when added to the served group, NS-1 comes in at a high level reflecting the existence of these sewered concentrations. Five Mile Prairie, which makes up all of sub unit NS-2, has an existing diffuse development. If development continues in the same manner, it is unlikely that there will be significant sewerable concentrations at an early date. If, however, the future development is centered around extensions of City water service, it could be concentrated and, in an area generally unsuited to on-site disposal, require earlier incorporation into a sewered system.

Table 3 shows service populations for the City and areas potentially associated with the City of Spokane collection and treatment system. The population designated "City" in Table 3 and in summary Table 5 refers to the geographical area served by the present sewage collection system and not to the City political boundary. Moran Prairie and Southwest planning units contain areas both inside and outside the City limits. The parts of the Moran Prairie and Southwest units inside the City are areas not presently served by the City sewage collection system but are served by City water. Moran Prairie and Southwest, as a whole, are grouped with the City in a subtotal on Table 3 because these two areas are logical and probable additions to the City service area and are so considered in initial alternative formulations for which these data are developed.

Four of the North Spokane sub-units include areas which are inside the City limits but are not within the existing sewer service area for topographic reasons. These areas are potentially served by addition to the City system through pumping or may be left to be served by another system serving the North Spokane Area as a whole. To provide totals for the alternative of joining these areas to the City, populations are developed for areas designated NS-1A, 2A, 3A and 4A, which are the City area populations corresponding to sub units NS-1, 2, 3 and 4 respectively.

Table 1 provides populations of North Spokane sub units including City areas and Table 3 for portions of certain sub-units inside the City. For alternatives that combine the City areas of the North Spokane unit with the City, there is a corresponding reduction in the North Spokane unit when considered by itself. Table 4 presents populations, gross and service, for the North Spokane units with City areas deducted.

Table 5 in addition to presenting a summary of gross and service populations shown in Tables 1, 2 and 3, shows developments for Orchard Prairie, West Plateau and Fairchild AFB plus special developments for the Liberty Lake and Newman Lake areas of SV-7 and SV-8. The present density of Orchard Prairie is very low and is forecast to remain low to the year 2020. At year 2020, Orchard Prairie will be far below the level for a sewage collection system. On a gross area basis, the West Plateau unit is also very low, but, unlike Orchard Prairie, it does contain a sewerable concentration in the Airways Heights vicinity. Fairchild AFB is presently essentially all sewered and is forecast to have no significant growth.

Very large growths are forecast for both Liberty Lake and Newman Lake. The development is fairly concentrated now. It is expected that future development will be contingent upon being sewerable. Hence, high percentages of service populations are shown for both.

The total on Table 5 shows that the maximum potential service population for the urban planning area will be approximately 256,000 in 1980 out of a gross population of 292,000 or 88 percent. The forecast growth to 2020 is for a potential service population of approximately 368,000 out of a gross of 405,000 or 91 percent served. The forecast growth of service population from 1980 to 2020 is 44 percent.

The uncertainties regarding minor portions of the potentially served populations do not adversely affect the decision making process based on alternative evaluations using these data. Capital expenditures are based on sizing of facilities to provide capacity to the end of the comparison period, by which time most of these uncertainties are resolved. The service populations at early years only partially determine operating costs.

Forecast Wastewater Flows

The elements of forecast wastewater flows are the service population forecasts as developed above and criteria and industrial flows developed in Section 406.1. The objective of this section is to develop the average dry weather flow (ADWF) and the peak wet weather flow (PWWF) for all of the elements and combinations of forecast municipal wastewater flow that are needed to evaluate alternative wastewater plans. The basic work sheets for these calculations are contained in Appendix I. There is one sheet for each planning unit or sub unit which develops the ADWF and PWWF. For combinations of these elements the ADWF is obtained by simple addition of the ADWF for each element in the combination. The PWWF cannot be obtained in this way since the peak to average ratio is a non linear function of the size of service population. A specific calculation for each proposed combination is required as developed in Appendix II.

Forecast wastewater flows major planning elements in alternative combinations are summarized in Tables 6 through 15.

For the City of Spokane, two bases for flow projection are developed in Section 406.1, one for the case which assumes that the existing combined sewer system will continue in service and one in which a sewer separation is assumed to have been carried out. There are minor differences in annual average per capita flow due to cooling and excess irrigation waters reaching the combined sewers in the summer. The important difference is in the infiltration assigned to the existing system at 3.5 mgd based on existing experience. For separated sewers, infiltration criteria are assigned as for new construction in the rest of the urban planning area. When extended, these different criteria are found to result in only minor differences in total ADWF, especially at forecast conditions. Therefore, this refinement is dropped and the figures for combined sewers, which give 2 percent higher flows, are adopted in Tables 9 and 10.

Calculation proceedure for individual units. The proceedure used in computation of waste flows is as follows by reference to the line numbers in Appendix I. Referenced tables and figures from other sections are identified by the section number in parenthesis.

Line 1. Gross populations of planning units and sub units are from Table 1 (602).

Line 2. Percent served is based on individual evaluations of feasibly sewered portions of population as described above in this section.

Line 3. Computed from Line 1 and Line 2. Lines 1 and 3 are summarized in Tables 1 through 5 of this section.

Line 4. Evaluation of the sub unit in terms of degree of commercial development in three broad categories for the purpose of selecting appropriate per capita flows accounting for the commercial component. See Table 2 (406.1).

Line 5. Per capita flow criteria for the appropriate location and category as selected from Table 2 (406.1)

Line 6. Computed from Lines 3 and 5.

Line 7. Industrial flow component from Table 7 (406.1) for "other" industry allocated to sub-units in proportion to the allocation of industrial employment per SMATS zones as developed in Table 12 (402) applying the zone in each planning unit as shown in Appendix I (602). Note that primary or heavy industries, which are assumed to continue providing separate treatment and disposal for their wastes, are not included. This industrial component is for light industry comparable to that which is presently served by the City of Spokane system.

Line 8 is the sum of the residential commercial component in Line 6 and the light industrial component in Line 7. Line 8 represents the average dry weather flow without infiltration.

Line 9 is the ratio of peak dry weather flow to average dry weather flow read from Figure A (406.1) as a function of average dry weather flow, before infiltration , as read from Line 8.

Line 10 is the peak dry weather wastewater flow computed as the product of Lines 8 and 9.

Line 11 is the appropriate infiltration flow allowances, expressed as gpcd from Table 3 (406.1).

Line 12 is the infiltration flow computed as the product of Lines 3 and 11.

Line 13. The average dry weather flow (ADWF) is the sum of Lines 8 and 12, the municipal wastewater component and the infiltration allowance.

Line 14. The peak dry weather flow (PDWF) is the sum of Lines 10 and 12.

Line 15 is the wet weather inflow allowance expressed as gpcd from Table 3 (406.1).

Line 16 is the inflow quantity computed as the product of Lines 3 and 15.

Line 17, the peak wet weather flow (PWWF), is the sum of PDWF, Line 14, and the wet weather inflow, Line 16.

Calculation procedure for PWWF of combinations. The procedure for computation is as follows by reference to line numbers in Appendix II.

Lines a are developed from Lines 3, 8 and 12 of Appendix I, as sources for service population, average municipal flow, and infiltration allowance respectively.

Lines b, c and d are subtotals of the three components listed under Lines a.

Line e is the peak ratio read from Figure A(406.1) for the subtotal municipal flow at Line c.

Line f is the peak municipal flow without infiltration computed from the product of Lines c and e.

Line g is the PDWF including infiltration computed as the sum of Lines d and f.

Line h is the inflow allowance computed from the per capita values from Table 3 (406.1) multiplied by the service population subtotal from Line b.

Line i is the PWW flow computed from the sum of Lines g and h.

Line j, the ADWF, is computed from the sum of Lines c and d.

Forecast Pollutant Loads

The elements of pollutant loads are those of residential commercial origin and those from light industry tributary to municipal sewers. Forecast per capita pollutant loadings for the residential-commercial are developed in Table 9 (406.1). Forecast light industrial components of pollutant load for the City, Spokane Valley and North Spokane are developed in Tables 11, 12 and 13 (406.1) respectively. These components are assembled for major planning units and alternative combinations in Appendix III. Pollutant loads are computed for BOD, suspended solids, total nitrogen and total phosphorus in terms of both daily loading in pounds per day and concentration mg/l in the forecast volume of wastewater flow.

Forecast pollutant loads and concentrations are summarized in Table 6 through 15. Where it is necessary to know the breakdown of total nitrogen and phosphorus in the raw waste flows the following factors are applied:

Ammonia as fraction of total N	0.60
Organic N as " " " "	0.40
Ortho phosphate as fraction of total P	0.65

The method of calculation as shown in Appendix III is as follows by reference to the table line numbers:

Lines 1, 2, 3 and 5 are summarized from Lines 3, 6, 7 and 13 of Appendix I.

Line 4, the process flow component of the total industrial flow as distinguished from the cooling water component, is calculated at 0.75 of the total flow based on current conditions.

Line 5. Note that Line 5 is not the sum of Lines 2 and 3 since ADWF includes the additional component of infiltration. The forecast concentrations computed in Appendix III are in terms of ADWF, comparable to the strength which would arrive at treatment facility.

Lines 6, 10, 14 and 18 are computed as the product of Line 1 with the appropriate per capita loading from Table 9 (406.1).

Lines 7, 11, 15 and 19 are computed as the product of Line 4 and the appropriate pollutant concentration from Tables 11, 12 and 13 (406.1).

Lines 8, 12, 16 and 20 are the total pollutant load computed as the sum of the residential-commercial components (Lines 6, 10, 14 and 18) and the light industrial component (Lines 7, 11, 15 and 19).

Lines 9, 13, 17 and 21 are pollutant concentrations computed from Lines 8, 12, 16 and 20 associated with the ADWF from Line 5.

Summary for the Urban Planning Area

Table 15 is developed to give an overall picture of the elements of wastewater flow and accompanying pollutant load at two forecast levels, 1980 and 2000 for the entire urban planning area.

TABLE 1
FORECAST SERVICE POPULATIONS
NORTH SPOKANE SUBUNITS

	1980		1985		1990		1995		2000		2020	
Subunits	Gross	Served	Gross	Served	Gross	Served	Gross	Served	Gross	Served	Gross	Served
NS-1	1,507	0	3,093	0	4,759	4,045	6,375	5,610	8,000	7,200	13,922	12,808
NS-2	896	0	1,666	0	2,474	1,484	3,282	2,462	4,097	3,073	7,189	6,111
NS-3	14,555	14,409	16,257	16,094	18,044	18,044	19,693	19,693	21,358	21,358	25,120	25,120
NS-4	2,754	1,377	2,785	1,392	2,818	1,409	2,863	1,432	2,910	1,455	3,146	2,202
NS-5	1,139	342	1,156	347	1,174	352	1,216	426	1,261	504	1,437	647
NS-6	2,730	1,092	4,411	1,985	6,177	4,015	7,919	6,335	9,670	8 413	12,669	12,036
NS-7	165	0	187	0	209	84	243	122	277	152	397	238
NS-8	312	0	374	0	441	0	509	0	579	290	887	532
NS-9	2,113	0	2,286	0	2,465	0	2,686	0	2,910	2,182	3,718	2,788
TOTAL	26,171	17,220	32,215	19,318	38,561	29,433	44,786	36,080	51,062	44,627	68,485	62,482

TABLE 2

FORECAST SERVICE POPULATIONS
SPOKANE VALLEY

Subunits	1980 Gross	1980 Served	1985 Gross	1985 Served	1990 Gross	1990 Served	1995 Gross	1995 Served	2000 Gross	2000 Served	2020 Gross	2020 Served
SV-1	2,431	1,993	2,774	2,413	3,136	2,885	3,406	3,236	3,677	3,493	5,082	4,828
SV-2	8,742	7,868	9,102	8,374	9,479	9,005	9,754	9,461	10,034	10,034	11,500	11,500
SV-3	32,947	28,071	34,237	29,663	35,604	31,691	36,852	33,288	38,129	34,245	43,830	38,996
SV-4	13,198	9,898	15,510	12,408	17,864	14,291	20,429	17,365	22,818	20,080	20,929	27,836
SV-5	2,440	1,708	2,530	1,898	2,625	1,969	2,714	2,036	2,806	2,104	3,267	2,450
SV-6	1,113	556	1,142	571	1,173	586	1,228	614	1,286	643	1,575	945
SV-7	1,963	0	2,205	0	2,459	0	2,631	0	2,808	0	3,560	0
SV-8	2,523	0	2,805	0	3,102	0	3,421	0	3,745	0	5,190	0
SV-9	1,574	472	1,716	601	1,864	746	2,022	910	2,182	982	2,837	1,418
SV-10	2,373	1,661	2,512	1,809	2,657	1,993	2,877	2,244	3,100	2,480	3,586	3,048
TOTAL	69,304	52,227	74,533	57,737	79,963	63,166	85,334	69,154	90,585	74,061	111,356	91,021

TABLE 3
FORECAST SERVICE POPULATIONS
CITY SEWERED AREA, MORAN PRAIRIE, SOUTHWEST, AND
NORTH SPOKANE INSIDE CITY LIMITS

Subunits	1980 Gross	1980 Served	1985 Gross	1985 Served	1990 Gross	1990 Served	1995 Gross	1995 Served	2000 Gross	2000 Served	2020 Gross	2020 Served
City	177,660	174,107	179,101	175,519	180,639	177,026	182,328	178,681	184,073	180,392	192,962	191,032
Moran Prairie	5,530	3,097	6,404	3,714	7,320	4,392	8,307	5,515	9,298	7,438	12,949	11,007
South West	3,088	741	3,547	887	4,029	1,088	4,433	1,241	4,839	1,452	6,504	2,276
Subtotal	186,278	177,945	189,052	180,120	191,988	182,506	195,068	185,437	198,210	189,282	212,415	204,315
NS-1A	986	0	2,135	0	3,341	2,967	4,540	4,100	5,743	5,259	10,048	9,325
NS A	53	0	278	0	514	334	789	631	1,065	852	2,020	1,818
NS-3A	2,493	2,493	2,954	2,954	3,686	3,686	3,884	3,884	4,335	4,335	6,109	6,109
NS-4A	953	0	925	0	894	0	864	0	834	0	757	0
Subtotal NS	4,485	2,493	6,292	2,954	8,435	6,987	10,077	8,615	11,977	10,446	18,934	17,252
TOTAL CITY	190,763	180,438	195,344	183,074	200,423	189,493	205,145	194,052	210,187	199,728	231,349	221,567

TABLE 4
FORECAST SERVICE POPULATIONS
NORTH SPOKANE UNIT EXCLUSIVE OF
AREAS INSIDE CITY

	1980		1985		1990		1995		2000		2020	
Subunits	Gross	Served	Gross	Served	Gross	Served	Gross	Served	Gross	Served	Gross	Served
NS-1 less 1A	521	0	958	0	1,418	1,078	1,835	1,510	2,257	1,941	3,874	3,483
NS-2 less 2A	843	0	1,388	0	1,960	1,150	2,493	1,831	3,032	2,221	5,169	4,293
NS-3 less 3A	12,062	11,916	13,303	13,140	14,358	14,358	15,809	15,809	17,023	17,023	19,011	19,011
NS-4 less 4A	1,801	1,377	1,860	1,392	1,924	1,409	1,999	1,432	2,076	1,455	2,389	2,202
Subtotal	15,227	13,293	17,509	14,532	19,660	17,995	22,136	20,582	24,388	22,640	30,443	28,989
NS 5 thru 9	6,459	1,434	8,414	2,332	10,466	4,451	12,573	6,883	14,697	11,541	19,108	16,241
TOTAL	21,686	14,727	25,923	16,864	30,126	22,446	34,709	27,465	39,085	34,181	49,551	45,230

TABLE 5
FORECAST SERVICE POPULATIONS
SUMMARY

	1980		1985		1990		1995		2000		2020	
	Gross	Served	Gross	Served	Gross	Served	Gross	Served	Gross	Served	Gross	Served
SPOKANE VALLEY	69,304	52,227	74,533	57,737	79,963	63,166	85,334	69,154	90,585	74,061	111,356	91,021
NORTH SPOKANE	26,171	17,220	32,215	19,818	38,561	29,433	44,786	36,080	51,062	44,627	68,485	62,482
CITY	177,660	174,107	179,101	175,519	180,639	177,026	182,328	178,681	184,073	180,392	192,962	191,032
MORAN PRAIRIE	5,530	3,097	6,404	3,714	7,320	4,392	8,307	5,515	9,298	7,438	12,949	11,007
SOUTH WEST	3,088	741	3,547	887	4,029	1,088	4,433	1,241	4,839	1,452	6,504	2,276
SUBTOTAL	281,753	247,392	295,800	257,675	310,513	275,105	325,188	290,671	339,856	307,970	392,256	357,818
ORCHARD PRAIRIE	645	0	674	0	707	0	747	0	787	0	940	0
WEST PLATEAU	2,608	1,807	2,833	1,993	3,074	2,187	3,364	2,401	3,657	2,614	5,084	3,532
FAIRCHILD AFB	6,700	6,700	6,700	6,700	6,700	6,700	6,700	6,700	6,700	6,700	6,700	6,700
SUBTOTAL	9,953	8,507	10,207	8,693	10,481	8,887	10,811	9,101	11,144	9,314	12,724	10,232
TOTAL	291,706	255,899	306,007	266,368	320,993	283,992	335,999	299,772	351,001	317,284	404,980	368,050
NEWMAN LAKE	162	147	311	286	468	435	630	592	792	752	1,493	1,418
LIBERTY LAKE	982	953	1,164	1,141	1,356	1,342	1,467	1,467	1,580	1,580	2,097	2,097

TABLE 6
FORECAST RAW WASTEWATER FLOW
AND POLLUTION LOAD SUMMARY
NORTH SPOKANE

Parameter	Units	1980	1985	1990	1995	2000	2020
Service Population	Persons	17,220	19,818	29,433	36,080	44,627	62,482
ADWF	mgd	2.392	2.754	3.913	4.760	5.795	7.957
PWWF	mgd	6.291	7.129	9.763	11.619	13.887	18.358
BOD	pounds/day	3,797	4,536	6,507	8,254	10,099	14,571
	mg/l	191	198	200	208	209	220
Suspended Solids	pounds/day	3,622	4,147	6,300	7,667	9,857	14,296
	mg/l	182	181	193	193	204	216
Total N	pounds/day	586	691	1,033	1,295	1,635	2,269
	mg/l	29.4	30.1	31.7	32.7	33.9	34.2
Total P	pounds/day	189	217	345	420	560	777
	mg/l	9.5	9.5	10.6	10.6	11.6	11.7

TABLE 7
FORECAST RAW WASTEWATER FLOW
AND POLLUTION LOAD SUMMARY
SPOKANE VALLEY

Parameter	Units	1980	1985	1990	1995	2000	2020
Service Population	Persons	52,227	57,737	63,166	69,154	74,061	91,021
ADWF	mgd	7.025	7.793	8.544	9.407	10.030	12.188
PWWF	mgd	16.631	18.103	19.807	21.295	22.716	27.068
BOD	pounds/day	11,437	13,201	14,452	16,536	17,672	22,474
	mg/l	195	203	203	211	212	221
Suspended Solids	pounds/day	10,933	12,073	13,846	15,174	16,946	21,658
	mg/l	187	186	195	194	203	213
Total N	pounds/day	1,770	2,013	2,266	2,552	2,804	3,431
	mg/l	30.2	31.0	31.8	32.6	33.6	33.8
Total P	pounds/day	572	632	756	828	960	1,174
	mg/l	9.8	9.7	10.6	10.6	11.5	11.6

TABLE 8
FORECAST RAW WASTEWATER FLOW
AND POLLUTION LOAD SUMMARY
NORTH SPOKANE EXCLUSIVE OF AREAS WITHIN THE CITY

Parameter	Units	1980	1985	1990	1995	2000	2020
Service Population	Persons	14,727	16,864	22,445	27,465	34,181	45,230
ADWF	mgd	2.081	2.382	3.081	3.731	4.553	5.913
PWWF	mgd	5.258	6.263	7.940	9.241	11.080	14.118
BOD	pounds/day	3,323	3,945	5,109	6,445	7,905	10,776
	mg/l	192	199	199	207	208	219
Suspended Solids	pounds/day	3,148	3,586	4,902	5,944	7,663	10,501
	mg/l	182	181	191	191	202	213
Total N	pounds/day	509	597	803	1,002	1,269	1,665
	mg/l	29.4	30.1	31.3	32.2	33.5	33.8
Total P	pounds/day	164	188	268	325	434	570
	mg/l	9.5	9.5	10.4	10.5	11.4	11.6

TABLE 9
FORECAST RAW WASTEWATER FLOW
AND POLLUTION LOAD SUMMARY
CITY PLUS MORAN PRAIRIE AND SOUTHWEST

Parameter	Units	1980	1985	1990	1995	2000	2020
Service Population	Persons	177,945	180,120	182,506	185,437	189,282	204,315
ADWF	mgd	30.026	31.354	32.386	33.367	34.250	36.855
PWWF	mgd						
BOD	pounds/day	45,369	44,149	45,336	48,587	49,841	56,254
	mg/1	181	169	168	175	175	183
Suspended Solids	pounds/day	42,068	39,646	42,391	43,524	46,484	52,492
	mg/1	168	152	157	157	163	171
Total N	pounds/day	6,459	6,576	6,907	7,269	7,634	8,281
	mg/1	25.8	25.2	25.6	26.2	26.8	27.0
Total P	pounds/day	2,102	2,072	2,302	2,362	2,608	2,829
	mg/1	8.4	7.9	8.5	8.5	9.1	9.2

TABLE 10
FORECAST RAW WASTEWATER FLOW
AND POLLUTION LOAD SUMMARY
CITY INCLUDING CITY AREAS IN NS PLUS MP AND SW

Parameter	Units	1980	1985	1990	1995	2000	2020
Service Population	Persons	180,438	183,074	189,493	194,052	199,728	221,567
ADWF	mgd	30.337	31.726	33.218	34.396	35.492	38.894
PWWF	mgd						
BOD	pounds/day	45,842	44,730	46,734	50,396	52,035	60,050
	mg/l	181	169	169	176	176	185
Suspended Solids	pounds/day	42,541	40,207	43,789	45,247	48,678	56,288
	mg/l	168	152	158	158	165	174
Total N	pounds/day	6,537	6,670	7,137	7,562	7,999	8,885
	mg/l	25.9	25.2	25.8	26.4	27.1	27.4
Total P	pounds/day	2,127	2,102	2,378	2,457	2,734	3,036
	mg/l	8.4	8.0	8.6	8.6	9.2	9.4

TABLE 11
FORECAST RAW WASTEWATER FLOW
AND POLLUTION LOAD SUMMARY
WEST PLATEAU

Parameter	Units	1980	1985	1990	1995	2000	2020
Service Population	Persons	1807	1993	2187	2401	2614	3532
ADWF	mgd	0.233	0.255	0.278	0.305	0.332	0.449
PWWF	mgd	0.814	0.896	0.968	1.040	1.109	1.422
BOD	pounds/day	343	399	437	504	549	777
	mg/l	177	188	189	198	198	208
Suspended Solids	pounds/day	343	377	437	480	549	777
	mg/l	177	177	189	189	198	208
Total N	pounds/day	56	64	72	82	91	124
	mg/l	29	30	31	32	33	33
Total P	pounds/day	18	20	24	26	31	42
	mg/l	9.3	9.4	10.4	10.2	11.2	11.2

TABLE 12
FORECAST RAW WASTEWATER FLOW
AND POLLUTION LOAD SUMMARY
FAIRCHILD AFB

Parameter	Units	1980	1985	1990	1995	2000	2020
Service Population	Persons	6700	6700	6700	6700	6700	6700
ADWF	mgd	0.800	0.800	0.800	0.800	0.800	0.800
PWWF	mgd	1.700	1.700	1.700	1.700	1.700	1.700
BOD	pounds/day	1273	1273	1273	1273	1273	1273
	mg/l	191	191	191	191	191	191
Suspended Solids	pounds/day	1273	1273	1273	1273	1273	1273
	mg/l	191	191	191	191	191	191
Total N	pounds/day	208	208	208	208	208	208
	mg/l	31	31	31	31	31	31
Total P	pounds/day	67	67	67	67	67	67
	mg/l	10.1	10.1	10.1	10.1	10.1	10.1

TABLE 13
FORECAST RAW WASTEWATER FLOW
AND POLLUTION LOAD SUMMARY
NEWMAN LAKE

Parameter	Units	1980	1985	1990	1995	2000	2020
Service Population	Persons	147	286	435	592	752	1418
ADWF	mgd	0.017	0.033	0.050	0.068	0.086	0.163
PWWF	mgd	0.101	0.175	0.244	0.316	0.379	0.632
BOD	pounds/day	27.9	57.2	87.0	124	158	312
	mg/l	196	208	209	219	221	230
Suspended Solids	pounds/day	27.9	54.3	87.0	118	158	312
	mg/l	196	197	209	208	221	230
Total N	pounds/day	4.6	9.2	14.4	20.1	26.3	49.6
	mg/l	32	33	35	36	37	37
Total P	pounds/day	1.5	2.9	4.8	6.5	9.0	17.0
	mg/l	12.9	10.5	11.5	11.5	12.6	12.5

TABLE 14
FORECAST RAW WASTEWATER FLOW
AND POLLUTION LOAD SUMMARY
LIBERTY LAKE

Parameter	Units	1980	1985	1990	1995	2000	2020
Service Population	Persons	953	1141	1342	1467	1580	2097
ADWF	mgd	0.113	0.135	0.157	0.171	0.185	0.246
PWWF	mgd	0.463	0.540	0.609	0.652	0.690	0.876
BOD	pounds/day	181	228	268	308	332	461
	mg/1	192	203	205	216	215	225
Suspended Solids	pounds/day	181	217	268	293	332	461
	mg/1	192	193	205	206	215	225
Total N	pounds/day	29.5	36.5	44.3	49.9	55.3	73.4
	mg/1	31	32	34	35	36	36
Total P	pounds/day	9.5	11.4	14.8	16.1	19.0	25.2
	mg/1	10.1	10.1	11.3	11.3	12.3	12.3

TABLE 15
SUMMARY-ELEMENTS OF FORECAST WASTEWATER
POTENTIAL FOR URBAN PLANNING AREA

Elements of Total Wastewater Potential	1980 Population Gross	1980 Population Service	1980 Waste Flow mgd	1980 BOD Load Pounds/Day	1980 Phosphorus Load Pounds/Day	2000 Population Gross	2000 Population Service	2000 Waste Flow mgd	2000 BOD Load Pounds/Day	2000 Phosphorus Load Pounds/Day
Primary Municipal Elements										
North Spokane	26,171	17,220	2.4	3,797	189	51,062	44,627	5.8	10,099	560
Spokane Valley	69,304	52,227	7.0	11,437	572	90,585	74,061	10.0	17,672	960
City plus Moran Prairie & Southwest	186,278	177,945	30.0	45,369	2,102	198,210	189,282	34.3	49,841	2,608
SUBTOTAL	281,753	247,392	39.4	60,603	2,863	339,856	307,970	50.1	77,612	4,128
Heavy Industrial Elements										
Process Flows										
North Spokane			0.4	27 (4)	13 (4)			0.5	54 (4)	14 (4)
Spokane Valley			10.0	1,360 (4)	67 (4)			11.4	1,556 (4)	77 (4)
Cooling Flows										
North Spokane			3.3	0	0			4.3	0	0
Spokane Valley	—	—	18.6	0	0	—	—	21.2	0	0
SUBTOTAL			32.3	1,387	80			37.4	1,610	91
Isolated Municipal Elements										
Fairchild AFB	6,700	6,700	.80	1,273	67	6,700	6,700	.80	1,273	67
Airways Heights	(1)	1,807	.23	343	18	(1)	2,614	.33	549	31
Liberty Lake	(2)	953	.11	181	10	(2)	1,580	.19	332	19
Newman Lake	(2)	147	.02	28	2	(2)	752	.09	158	13
SUBTOTAL	6,700	9,607	1.16	1,825	97	6,700	11,646	1.41	2,312	130
SUBTOTAL	288,453	256,999	72.86	63,815	3,040	346,556	319,616	88.9	81,534	4,349
Other Elements										
Orchard Prairie	645	0				787	0			
West Plateau	2,608	(3)	—	—	—	3,657	(3)	—	—	—
SUBTOTAL	3,253					4,444				
TOTAL URBAN PLANNING AREA	291,706	256,999	72.86	63,815	3,040	351,001	319,616	88.9	81,534	4,349

(1) Included in West Plateau
(2) Included in Spokane Valley
(3) Included in Airway Heights
(4) Treated effluent at present level

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PLANNING AREA NS-1

ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	1507	3093	4759	6375	8000	13,922
(2)	Percent Served	percent	0	0	85	88	90	92
(3)	Service Population	persons	0	0	4045	5610	7200	12,808
(4)	Commercial Category	—	NEG.	NEG.	NEG	NEG	NEG.	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res-Comm Flow	mgd	0	0	0.396	0.555	0.720	1.281
(7)	Aver. Industrial	mgd	0	0	0	0	0	0
(8)	Aver. Municipal (6)+(7)	mgd	0	0	0.396	0.555	0.720	1.281
(9)	Peak ratio	—	0	0	3.2	3.0	2.8	2.6
(10)	Peak Wastewater (8)x(9)	mgd	0	0	1.267	1.665	2.016	3.331
(11)	Infiltration Rate	gpcd	14	12	11	11	10	10
(12)	Infiltration Flow	mgd	0	0	0.044	0.062	0.072	0.128
(13)	ADWF (8)+(12)	mgd	0	0	0.440	0.617	0.792	.409
(14)	PDWF (10)+(12)	mgd	-	-	1.3[illegible]	[illegible]	2.088	3.459
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0	0	0.170	0.230	0.288	0.512
(17)	PWWF (14)+(16)	mgd	0	0	1.481	1.957	2.376	3.971

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PLANNING AREA NS-2
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	896	1666	2474	3282	4097	7189
(2)	Percent Served	percent	0	0	60	75	75	85
(3)	Service Population	persons	0	0	1484	2462	3073	6111
(4)	Commercial Category	—	MOD.	MOD.	MOD.	MOD.	MOD.	MOD.
(5)	Per Capita Flow	gpcd	100	103	105	106	107	107
(6)	Aver. [illegible] Flow	mgd	0	0	0.156	0.261	0.329	0.654
(7)	Aver. Industrial	mgd	0	0	0	0	0	0
(8)	Aver Municipal (6)+(7)	mgd	0	0	0.156	0.261	0.329	0.654
(9)	Peak ratio	—	0	0	3.9	3.5	3.[illegible]	2.9
(10)	Peak Wastewater (8)x(9)	mgd	0	0	0.608	0.914	1.086	1.897
(11)	Infiltration Rate	gpcd	29	25	22	21	20	20
(12)	Infiltration Flow	mgd	0	0	0.033	0.052	0.061	0.122
(13)	ADWF (8)+(12)	mgd	0	[illegible]	0.189	0.313	0.390	0.776
(14)	PDWF (10)+(12)	mgd	0	[illegible]	0.641	0.966	1.147	2.019
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0	0	0.062	0.101	0.123	0.244
(17)	PWWF (14)+(16)	mgd	0	0	0.703	1.067	1.270	2.263

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PLANNING AREA NS-3
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	14,555	16,257	18,044	19,693	21,358	25,120
(2)	Percent Served	percent	99	99	100	100	100	100
(3)	Service Population	persons	14,409	16,094	18,044	19,693	21,358	25,120
(4)	Commercial Category	—	SIG.	SIG.	SIG.	SIG	SIG.	SIG.
(5)	Per Capita Flow	gpcd	111	114	116	117	118	118
(6)	Aver Res-Com Flow	mgd	1.599	1.835	2.093	2.304	2.520	2.964
(7)	Aver. Industrial	mgd	0.035	0.037	0.039	0.044	0.045	0.050
(8)	Aver Municipal (6)+(7)	mgd	1.634	1.872	2.132	2.348	2.565	3.014
(9)	Peak ratio	—	2.5	2.5	2.4	2.4	2.4	2.4
(10)	Peak Wastewater (8)x(9)	mgd	4.085	4.680	5.117	5.635	6.156	7.234
(11)	Infiltration Rate	gpcd	14	12	11	11	10	10
(12)	Infiltration Flow	mgd	0.202	0.193	0.198	0.217	0.214	0.251
(13)	ADWF (8)+(12)	mgd	1.836	2.065	2.330	2.565	2.779	3.265
(14)	PDWF (10)+(12)	mgd	4.287	4.873	5.315	5.852	6.370	7.485
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.663	0.708	0.758	0.807	0.854	1.005
(17)	PWWF (14)+(16)	mgd	4.950	5.581	6.073	6.659	7.224	8.490

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PLANNING AREA NS-4
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	2754	2785	2818	2863	2910	3146
(2)	Percent Served	percent	50	50	50	50	50	70
(3)	Service Population	persons	1377	1392	1409	1432	1455	2202
(4)	Commercial Category	—	NEG	NEG.	NEG.	NEG	NEG.	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver Res-Comm Flow	mgd	0.129	0.135	0.138	0.142	0.146	0.220
(7)	Aver. Industrial	mgd	0.203	0.222	0.241	0.261	0.274	0.308
(8)	Aver Municipal (6)+(7)	mgd	0.332	0.357	0.379	0.403	0.420	0.528
(9)	Peak ratio	—	3.3	3.3	3.2	3.2	3.2	3.0
(10)	Peak Wastewater (8)x(9)	mgd	1.096	1.178	1.213	1.290	1.344	1.584
(11)	Infiltration Rate	gpcd	14	12	11	11	10	10
(12)	Infiltration Flow	mgd	0.019	0 017	0.015	0.016	0 015	0.022
(13)	ADWF (8)+(12)	mgd	0.351	0.374	0.394	0.419	0.435	0.550
(14)	PDWF (10)+(12)	mgd	1.115	1.195	1.228	1.306	1.359	1.606
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.063	0.061	0.059	0.059	0 058	0.088
(17)	PWWF (14)+(16)	mgd	1.178	1.256	1.287	1.365	1.417	1694

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PLANNING AREA NS-5
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	1139	1156	1174	1216	1261	1437
(2)	Percent Served	percent	30	30	30	35	40	45
(3)	Service Population	persons	342	347	352	426	504	647
(4)	Commercial Category	—	NEG.	NEG	NEG	NEG	NEG.	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res-Comm Flow	mgd	0.032	0.034	[illegible]	0.042	0.050	0.065
(7)	Aver. Industrial	mgd	0.042	0.046	0.051	0.056	0.060	0. 72
(8)	Aver. Municipal (6)+(7)	mgd	0.074	0.080	0.085	0.098	0.110	0.137
(9)	Peak ratio	—	4.6	4.5	4.4	4.3	4.2	4.0
(10)	Peak Wastewater (8)x(9)	mgd	0.340	0.360	[illegible]	0.421	0.462	0.548
(11)	Infiltration Rate	gpcd	14	12	11	11	10	10
(12)	Infiltration Flow	mgd	0.005	0.004	0.004	0.005	0.005	0.006
(13)	ADWF (8)+(12)	mgd	0.079	0.084	0.089	0.103	0.115	0.143
(14)	PDWF (10)+(12)	mgd	[illegible]	0.364	[illegible]	0.426	0.467	0.554
(15)	Inflow Rate	gpcd	46	41	42	41	40	40
(16)	Inflow Quantity	mgd	0.016	0.015	0.015	0.017	0.020	0.026
(17)	PWWF (14)+(16)	mgd	0.361	0.379	0.393	0.443	0.487	0.580

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PLANNING AREA NS-6
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	2730	4411	6177	7919	9670	12,669
(2)	Percent Served	percent	40	45	65	80	87	95
(3)	Service Population	persons	1092	1985	4015	6335	8413	12,036
(4)	Commercial Category	—	NEG.	NEG.	NEG.	NEG.	NEG.	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res-Comm. Flow	mgd	0.103	0.193	0.393	0.627	0.841	1.204
(7)	Aver. Industrial	mgd	0	0	0	0	0	0
(8)	Aver. Municipal (6)+(7)	mgd	0.103	0.193	0.393	0.627	0.841	1.204
(9)	Peak ratio	—	4.2	3.7	3.2	2.9	2.75	2.6
(10)	Peak Wastewater (8)x(9)	mgd	0.433	0.714	1.258	1.818	2.313	3.130
(11)	Infiltration Rate	gpcd	21	19	17	16	15	15
(12)	Infiltration Flow	mgd	0.023	0.038	0.068	0.101	0.126	0.181
(13)	ADWF (8)+(12)	mgd	0.126	0.231	0.461	0.728	0.967	1.385
(14)	PDWF (10)+(12)	mgd	0.456	0.752	1.326	1.919	2.439	3.311
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.050	0.087	0.169	0.260	0.337	0.481
(17)	PWWF (14)+(16)	mgd	0.506	0.839	1.495	2.179	2.776	3.792

PLANNING AREA NS-7
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	165	187	209	243	277	397
(2)	Percent Served	percent	0	0	40	50	55	60
(3)	Service Population	persons	0	0	84	122	152	238
(4)	Commercial Category	—	NEG.	NEG.	NEG.	NEG.	NEG.	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res.-Comm. Flow	mgd	0	0	0.008	0.012	0.015	0.024
(7)	Aver. Industrial	mgd	0	0	0	0	0	0
(8)	Aver. Municipal (6)+(7)	mgd	0	0	0.008	0.012	0.015	0.024
(9)	Peak ratio	—	0	0	10	8.3	7.9	6.8
(10)	Peak Wastewater (8)x(9)	mgd	0	0	0.080	0.100	0.118	0.163
(11)	Infiltration Rate	gpcd	30	26	23	22	21	21
(12)	Infiltration Flow	mgd	0	0	0.002	0.003	0.003	0.005
(13)	ADWF (8)+(12)	mgd	0	0	0.010	0.015	0.018	0.029
(14)	PDWF (10)+(12)	mgd	0	-	0.082	0.103	0.121	0.168
(15)	Inflow Rate	gpcd	46	44	42	41	[illegible]	[illegible]
(16)	Inflow Quantity	mgd	0	0	0.004	0.005	0.006	0.010
(17)	PWWF (14)+(16)	mgd	0	0	0.086	0.108	0.127	0.178

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PLANNING AREA NS-8
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	312	374	441	509	579	887
(2)	Percent Served	percent	0	0	0	0	50	60
(3)	Service Population	persons	0	0	0	0	290	532
(4)	Commercial Category	—	NEG.	NEG.	NEG.	NEG.	NEG.	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res-Comm. Flow	mgd	0	0	0	0	0.029	0.053
(7)	Aver. Industrial	mgd	0	0	0	0	0	0
(8)	Aver. Municipal (6)+(7)	mgd	0	0	0	0	0.029	0.053
(9)	Peak ratio	—	0	0	0	0	6.4	5.1
(10)	Peak Wastewater (8)x(9)	mgd	0	0	0	0	0.186	0.270
(11)	Infiltration Rate	gpcd	21	19	17	16	15	15
(12)	Infiltration Flow	mgd	0	0	0	0	0.004	0.008
(13)	ADWF (8) + (12)	mgd	0	0	0	0	0.033	0.061
(14)	PDWF (10) + (12)	mgd	0	0	0	0	0.190	0.278
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0	0	0	0	0.012	0.021
(17)	PWWF (14)+(16)	mgd	0	0	0	0	0.202	0.299

PLANNING AREA NS-9
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	2113	2286	2465	2686	2410	3817
(2)	Percent Served	percent	0	0	0	0	75	75
(3)	Service Population	persons	0	0	0	0	2182	2788
(4)	Commercial Category	—	NEG.	NEG.	NEG.	NEG.	NEG.	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res-Comm. Flow	mgd	0	0	0	0	0.218	0.279
(7)	Aver. Industrial	mgd	0	0	0	0	0.009	0.010
(8)	Aver. Municipal (6)+(7)	mgd	0	0	0	0	0.227	0.289
(9)	Peak ratio	—	0	0	0	0	3.6	3.4
(10)	Peak Wastewater (8)x(9)	mgd	0	0	0	0	0.817	0.983
(11)	Infiltration Rate	gpcd	26	22	20	19	18	18
(12)	Infiltration Flow	mgd	0	0	0	0	0.039	0.050
(13)	ADWF (8)+(12)	mgd	0	0	0	0	0.266	0.339
(14)	PDWF (10)+(12)	mgd	0	0	0	0	0.856	1.033
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0	0	0	0	0.087	0.112
(17)	PWWF (14)+(16)	mgd	0	0	0	0	0.943	1.145

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PLANNING AREA NS-1 EXCLUDING NS-1A
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	521	958	1418	1835	2257	3874
(2)	Percent Served	percent	0	0	76	82	86	90
(3)	Service Population	persons	0	0	1078	1510	1941	3483
(4)	Commercial Category	—	NEG	NEG	NEG	NEG	NEG	NEG
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res.-Comm. Flow	mgd	0	0	0.106	0.149	0.194	0.348
(7)	Aver. Industrial	mgd	0	0	0	0	0	0
(8)	Aver. Municipal (6)+(7)	mgd	0	0	0.106	0.149	0.194	0.348
(9)	Peak ratio	—	0	0	4.2	3.9	3.7	3.3
(10)	Peak Wastewater (8)x(9)	mgd	0	0	0.445	0.581	0.718	1.148
(11)	Infiltration Rate	gpcd	14	12	11	11	10	10
(12)	Infiltration Flow	mgd	0	0	0.012	0.017	0.019	0.035
(13)	ADWF (8)+(12)	mgd	0	0	0.118	0.166	0.213	0.383
(14)	PDWF (10)+(12)	mgd	0	0	0.457	0.598	0.737	1.183
(15)	Inflow Rate	gpcd	46	44	42	41	40	46
(16)	Inflow Quantity	mgd	0	0	0.045	0.062	0.078	0.139
(17)	PWWF (14)+(16)	mgd	0	0	0.502	0.660	0.815	1.322

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PLANNING AREA: NS-2 EXCLUDING NS-2A

ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	843	1388	1960	2493	3032	5169
(2)	Percent Served	percent	0	0	59	73	73	83
(3)	Service Population	persons	0	0	1150	1831	2221	4293
(4)	Commercial Category	—	MOD.	MOD.	MOD.	MOD.	MOD.	MOD.
(5)	Per Capita Flow	gpcd	100	103	105	106	107	107
(6)	Aver. Res-Comm. Flow	mgd	0	0	0.121	0.194	0.238	0.459
(7)	Aver. Industrial	mgd	0	0	0	0	0	0
(8)	Aver. Municipal (6)+(7)	mgd	0	0	0.121	0.194	0.238	0.459
(9)	Peak ratio	—	0	0	4.1	3.7	3.5	3.1
(10)	Peak Wastewater (8)x(9)	mgd	0	0	0.496	0.718	0.833	1.423
(11)	Infiltration Rate	gpcd	29	25	22	21	20	20
(12)	Infiltration Flow	mgd	0	0	0.025	0.038	0.044	0.086
(13)	ADWF (8)+(12)	mgd	0	0	0.146	0.232	0.282	0.545
(14)	PDWF (10)+(12)	mgd	0	0	0.521	0.756	0.877	1.509
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0	0	0.048	0.075	0.089	0.172
(17)	PWWF (14)+(16)	mgd	0	0	0.569	0.831	0.966	1.681

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BY BP DATE Aug '74 SUBJECT APPENDIX I.b. SHEET NO. 12 OF ____
TASK NO. 406.2 REV. DATE North Spokane NS-3 less 3A FILE NO. ____

PLANNING AREA NS-3 EXCLUDING NS-3A
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	12,062	13,303	14,358	15,809	17,023	19,011
(2)	Percent Served	percent	99	99	100	100	100	100
(3)	Service Population	persons	11,916	13,140	14,358	15,809	17,023	19,011
(4)	Commercial Category	—	SIG.	SIG.	SIG.	SIG	SIG.	SIG.
(5)	Per Capita Flow	gpcd	111	114	116	117	118	118
(6)	Aver. Res.-Comm. Flow	mgd	1.323	1.498	1.666	1.850	2.009	2.243
(7)	Aver. Industrial	mgd	0.035	0.037	0.039	0.044	0.045	0.045
(8)	Aver. Municipal (6)+(7)	mgd	1.358	1.535	1.705	1.894	2.054	2.288
(9)	Peak ratio	—	2.55	2.5	2.5	2.5	2.45	2.4
(10)	Peak Wastewater (8)x(9)	mgd	3.463	3.838	4.262	4.735	5.032	5.491
(11)	Infiltration Rate	gpcd	14	12	11	11	10	10
(12)	Infiltration Flow	mgd	0.167	0.158	0.158	0.174	0.170	0.190
(13)	ADWF (8)+(12)	mgd	1.525	1.693	1.863	2.068	2.224	2.478
(14)	PDWF (10)+(12)	mgd	3.630	3.996	4.420	4.909	5.202	5.681
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.548	0.578	0.603	0.648	0.681	0.760
(17)	PWWF (14)+(16)	mgd	4.178	4.574	5.023	5.557	5.883	6.441

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BY BP DATE Aug '74 SUBJECT APPENDIX Ib SHEET NO. 13 OF

TASK NO. 406.2 REV. DATE North Spokane NS-4 less 4A FILE NO.

PLANNING AREA: NS-4 excluding NS-4A

ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	1801	1860	1924	1999	2076	2387
(2)	Percent Served	percent	76	75	73	72	70	92
(3)	Service Population	persons	1377	1392	1409	1432	1455	2202
(4)	Commercial Category	—	NEG.	NEG.	NEG.	NEG.	NEG.	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res.-Comm. Flow	mgd	0.129	0.135	0.138	0.142	0.146	0.220
(7)	Aver. Industrial	mgd	0.203	0.222	0.241	0.261	0.274	0.308
(8)	Aver. Municipal (6)+(7)	mgd	0.332	0.357	0.379	0.403	0.420	0.528
(9)	Peak ratio	—	3.3	3.3	3.2	3.2	3.2	3.0
(10)	Peak Wastewater (8)x(9)	mgd	1.096	1.178	1.213	1.290	1.344	1.584
(11)	Infiltration Rate	gpcd	14	12	11	11	10	10
(12)	Infiltration Flow	mgd	0.019	0.017	0.015	0.016	0.015	0.022
(13)	ADWF (8)+(12)	mgd	0.351	0.374	0.394	0.419	0.435	0.550
(14)	PDWF (10)+(12)	mgd	1.115	1.195	1.228	1.306	1.359	1.606
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.06[illegible]	0.061	0.059	0.059	0.058	0.088
(17)	PWWF (14)+(16)	mgd	1.178	1.256	1.287	1.365	1.417	1.694

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BY B.P DATE 8/14/74 SUBJECT APPENDIX Ic SHEET NO. 14 OF
TASK NO. 406.2 REV. DATE Spokane Valley SV-1 FILE NO.

PLANNING AREA SV-1
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	2431	2774	3136	3406	3677	5082
(2)	Percent Served	percent	82	87	92	95	95	95
(3)	Service Population	persons	1993	2413	2885	3236	3493	4828
(4)	Commercial Category	—	NEG.	NEG.	NEG.	NEG.	NEG.	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res-Comm. Flow	mgd	0.187	0.234	0.283	0.320	0.349	0.483
(7)	Aver. Industrial	mgd	0.000	0.000	0.000	0.000	0.000	0.000
(8)	Aver. Municipal (6)+(7)	mgd	0.187	0.234	0.283	0.320	0.349	0.483
(9)	Peak ratio	—	3.7	3.6	3.4	3.4	3.3	3.1
(10)	Peak Wastewater (8)x(9)	mgd	0.692	0.842	0.962	1.088	1.152	1.497
(11)	Infiltration Rate	gpcd	14	12	11	11	10	10
(12)	Infiltration Flow	mgd	0.028	0.029	0.032	0.036	0.035	0.048
(13)	ADWF (8)+(12)	mgd	0.215	0.263	0.315	0.356	0.384	0.531
(14)	PDWF (10)+(12)	mgd	0.720	0.871	0.994	1.124	1.187	1.545
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.092	0.106	0.121	0.133	0.140	0.193
(17)	PWWF (14)+(16)	mgd	0.812	0.977	1.115	1.257	1.327	1.738

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BY MP DATE 8/14/74 SUBJECT APPENDIX Ic SHEET NO. 15 OF ____
TASK NO. 406.2 REV. DATE ____ Spokane Valley SV-2 FILE NO. ____

PLANNING AREA SV-2
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	8742	9102	9479	9754	10,034	11,500
(2)	Percent Served	percent	90	92	95	97	100	100
(3)	Service Population	persons	7868	8374	9005	9461	10,034	11,500
(4)	Commercial Category	—	MOD.	MOD.	MOD.	MOD.	MOD.	MOD.
(5)	Per Capita Flow	gpcd	100	103	105	106	107	107
(6)	Aver. Res.-Comm. Flow	mgd	0.787	0.863	0.946	1.003	1.074	1.230
(7)	Aver. Industrial	mgd	0.249	0.272	0.298	0.328	0.343	0.391
(8)	Aver. Municipal (6)+(7)	mgd	1.036	1.135	1.244	1.331	1.417	1.621
(9)	Peak ratio	—	4.3	4.2	4.1	4.0	3.9	3.8
(10)	Peak Wastewater (8)x(9)	mgd	4.455	4.767	5.100	5.324	5.526	6.160
(11)	Infiltration Rate	gpcd	14	12	11	11	10	10
(12)	Infiltration Flow	mgd	0.110	0.100	0.099	0.104	0.100	0.115
(13)	ADWF (8)+(12)	mgd	1.146	1.235	1.343	1.435	1.517	1.736
(14)	PDWF (10)+(12)	mgd	4.565	4.867	5.199	5.428	5.626	6.275
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.362	0.368	0.378	0.388	0.401	0.460
(17)	PWWF (14)+(16)	mgd	4.927	5.235	5.577	5.816	6.027	6.735

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BY BP DATE Aug '74 SUBJECT APPENDIX Ic SHEET NO. 16 OF

TASK NO. 40612 REV. DATE Spokane Valley SV-3 FILE NO.

PLANNING AREA SV-3
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	32,947	34,237	35,064	36,852	38,129	43,830
(2)	Percent Served	percent	85	87	90	90	90	90
(3)	Service Population	persons	28,071	29,663	31,691	33,288	34,245	38,996
(4)	Commercial Category	—	SIG.	SIG.	SIG.	SIG.	SIG.	SIG.
(5)	Per Capita Flow	gpcd	111	114	116	117	118	118
(6)	Aver. Res-Comm Flow	mgd	3.116	3.382	3.676	3.895	4.041	4.602
(7)	Aver. Industrial	mgd	0.500	0.548	0.604	0.671	0.711	0.833
(8)	Aver. Municipal (6)+(7)	mgd	3.616	3.930	4.280	4.566	4.752	5.435
(9)	Peak ratio	—	2.3	2.3	2.2	2.2	2.2	2.2
(10)	Peak Wastewater (8)x(9)	mgd	8.317	9.039	9.416	10.045	10.454	11.957
(11)	Infiltration Rate	gpcd	14	12	11	11	10	10
(12)	Infiltration Flow	mgd	0.393	0.356	0.349	0.366	0.342	0.390
(13)	ADWF (8)+(12)	mgd	4.009	4.286	4.629	4.932	5.094	5.825
(14)	PDWF (10)+(12)	mgd	8.710	9.395	9.765	10.411	10.796	12.347
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	1.291	1.305	1.331	1.365	1.370	1.560
(17)	PWWF (14)+(16)	mgd	10.001	10.700	11.096	11.776	12.166	13.907

PLANNING AREA SV-4
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	13,198	15,510	17,864	20,429	22,818	30,929
(2)	Percent Served	percent	75	80	80	85	88	90
(3)	Service Population	persons	9898	12,408	14,291	17,365	20,080	27,836
(4)	Commercial Category	—	NEG.	NEG.	NEG.	NEG.	NEG.	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res-Comm. Flow	mgd	0.930	1.204	1.401	1.719	2.008	2.784
(7)	Aver. Industrial	mgd	0.029	0.031	0.033	0.036	0.037	0.037
(8)	Aver. Municipal (6)+(7)	mgd	0.959	1.235	1.434	1.755	2.045	2.821
(9)	Peak ratio	—	2.7	2.6	2.5	2.5	2.5	2.4
(10)	Peak Wastewater (8)x(9)	mgd	2.589	3.211	3.585	4.388	5.112	6.770
(11)	Infiltration Rate	gpcd	16	14	12	12	11	11
(12)	Infiltration Flow	mgd	0.158	0.174	0.171	0.208	0.221	0.306
(13)	ADWF (8)+(12)	mgd	1.117	1.409	1.605	1.963	2.266	3.127
(14)	PDWF (10)+(12)	mgd	2.747	3.385	3.756	4.596	5.333	7.076
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.455	0.546	0.600	0.712	0.803	1.113
(17)	PWWF (14)+(16)	mgd	3.202	3.931	4.356	5.308	6.136	8.189

PLANNING AREA SV-5
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	2440	2530	2625	2714	2806	3267
(2)	Percent Served	percent	70	75	75	75	75	75
(3)	Service Population	persons	1708	1898	1969	2036	2109	2450
(4)	Commercial Category	—	MOD.	MOD.	MOD.	MOD.	MOD.	MOD.
(5)	Per Capita Flow	gpcd	100	103	105	106	107	107
(6)	Aver. Res-Comm. Flow	mgd	0.171	0.195	0.207	0.216	0.225	0.262
(7)	Aver. Industrial	mgd	0.008	0.009	0.010	0.011	0.011	0.014
(8)	Aver. Municipal (6)+(7)	mgd	0.17?	0.204	0.217	0.227	0.236	0.276
(9)	Peak ratio	—	3.7	3.7	3.6	3.6	3.6	3.4
(10)	Peak Wastewater (8)x(9)	mgd	0.662	0.755	0.781	0.817	0.850	0.938
(11)	Infiltration Rate	gpcd	16	14	12	12	11	11
(12)	Infiltration Flow	mgd	0.027	0.027	0.024	0.024	0.023	0.027
(13)	ADWF (8)+(12)	mgd	0.206	0.231	0.241	0.251	0.259	0.303
(14)	PDWF (10)+(12)	mgd	0.689	0.782	0.805	0.841	0.873	1.241
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.079	0.084	0.083	0.083	0.084	0.098
(17)	PWWF (14)+(16)	mgd	0.768	0.866	0.888	0.924	0.957	1.339

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BY BP DATE Aug '74 SUBJECT APPENDIX Ic SHEET NO. 19 OF
TASK NO. 406.2 REV. DATE Spokane Valley SV-6 FILE NO.

PLANNING AREA SV-6
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	1113	1142	1173	1228	1286	1575
(2)	Percent Served	percent	50	50	50	50	50	60
(3)	Service Population	persons	556	571	586	614	643	945
(4)	Commercial Category	—	NEG.	NEG.	NEG.	NEG.	NEG.	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res-Comm Flow	mgd	0.052	0.055	0.057	0.061	0.064	0.094
(7)	Aver. Industrial	mgd	0.022	0.023	0.025	0.028	0.028	0.031
(8)	Aver. Municipal (6)+(7)	mgd	0.074	0.078	0.082	0.089	0.092	0.125
(9)	Peak ratio	—	4.7	4.6	4.5	4.4	4.4	4.0
(10)	Peak Wastewater (8)x(9)	mgd	0.348	0.359	0.369	0.392	0.405	0.500
(11)	Infiltration Rate	gpcd	16	14	12	12	11	11
(12)	Infiltration Flow	mgd	0.009	0.008	0.007	0.007	0.007	0.010
(13)	ADWF (8)+(12)	mgd	0.083	0.086	0.089	0.096	0.099	0.135
(14)	PDWF (10)+(12)	mgd	0.357	0.367	0.376	0.399	0.504	0.51
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.026	0.025	0.025	0.025	0.026	0.038
(17)	PWWF (14)+(16)	mgd	0.383	0.392	0.401	0.424	0.530	0.548

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PLANNING AREA SV-7
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	1963	2205	2459	2631	2808	3560
(2)	Percent Served	percent	0	0	0	0	0	0
(3)	Service Population	persons	0	0	0	0	0	0
(4)	Commercial Category	—	NEG.	NEG.	NEG	NEG.	NEG.	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res.-Comm. Flow	mgd	0	0	0	0	0	0
(7)	Aver. Industrial	mgd	0	0	0	0	0	0
(8)	Aver. Municipal (6)+(7)	mgd	0	0	0	0	0	0
(9)	Peak ratio	—	0	0	0	0	0	0
(10)	Peak Wastewater (8)x(9)	mgd	0	0	0	0	0	0
(11)	Infiltration Rate	gpcd	24	21	19	18	17	17
(12)	Infiltration Flow	mgd	0	0	0	0	0	0
(13)	ADWF (8)+(12)	mgd	0	0	0	0	0	0
(14)	PDWF (10)+(12)	mgd	0	0	0	0	0	0
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0	0	0	0	0	0
(17)	PWWF (14)+(16)	mgd	0	0	0	0	0	0

BY BP DATE Aug '74 SUBJECT APPENDIX Ic SHEET NO. 21 OF
TASK NO. 40612 REV. DATE Spokane Valley SV-8 FILE NO.

PLANNING AREA SV-8
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	2523	2805	3102	3421	3745	5190
(2)	Percent Served	percent	0	0	0	0	0	0
(3)	Service Population	persons	0	0	0	0	0	0
(4)	Commercial Category	—	NEG.	NEG.	NEG.	NEG.	NEG.	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res.-Comm. Flow	mgd	0	0	0	0	0	0
(7)	Aver. Industrial	mgd	0	0	0	0	0	0
(8)	Aver. Municipal (6)+(7)	mgd	0	0	0	0	0	0
(9)	Peak ratio	—	0	0	0	0	0	0
(10)	Peak Wastewater (8)x(9)	mgd	0	0	0	0	0	0
(11)	Infiltration Rate	gpcd	21	19	17	16	15	15
(12)	Infiltration Flow	mgd	0	0	0	0	0	0
(13)	ADWF (8)+(12)	mgd	0	0	0	0	0	0
(14)	PDWF (10)+(12)	mgd	0	0	0	0	0	0
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0	0	0	0	0	0
(17)	PWWF (14)+(16)	mgd	0	0	0	0	0	0

PLANNING AREA SV-9
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	1574	1716	1864	2022	2182	2837
(2)	Percent Served	percent	30	35	40	45	45	50
(3)	Service Population	persons	472	601	746	910	982	1418
(4)	Commercial Category	—	MOD.	MOD.	MOD.	MOD.	MOD.	MOD.
(5)	Per Capita Flow	gpcd	100	103	105	106	107	107
(6)	Aver. Res.-Comm. Flow	mgd	0.047	0.062	0.078	0.096	0.105	0.152
(7)	Aver. Industrial	mgd	0	0	0	0	0	0
(8)	Aver. Municipal (6)+(7)	mgd	0.047	0.062	0.078	0.096	0.105	0.152
(9)	Peak ratio	—	5.0	4.8	4.6	4.3	4.2	3.9
(10)	Peak Wastewater (8)x(9)	mgd	0.235	0.298	0.359	0.413	0.441	0.593
(11)	Infiltration Rate	gpcd	16	14	12	12	11	11
(12)	Infiltration Flow	mgd	0.008	0.008	0.009	0.011	0.011	0.016
(13)	ADWF (8)+(12)	mgd	0.055	0.070	0.087	0.107	0.116	0.168
(14)	PDWF (10)+(12)	mgd	0.243	0.306	0.368	0.424	0.452	0.609
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.022	0.026	0.031	0.037	0.039	0.057
(17)	PWWF (14)+(16)	mgd	0.265	0.332	0.399	0.461	0.491	0.666

PLANNING AREA SV-10
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	2373	2512	2657	2877	3100	3586
(2)	Percent Served	percent	70	72	75	78	80	85
(3)	Service Population	persons	1661	1809	1993	2244	2480	3048
(4)	Commercial Category	—	MOD.	MOD.	MOD.	MOD.	MOD.	MOD.
(5)	Per Capita Flow	gpcd	100	103	105	106	107	107
(6)	Aver. Res.-Comm. Flow	mgd	0.166	0.186	0.209	0.238	0.265	0.326
(7)	Aver. Industrial	mgd	0	0	0	0	0	0
(8)	Aver. Municipal (6)+(7)	mgd	0.166	0.186	0.209	0.238	0.265	0.326
(9)	Peak ratio	—	3.8	3.7	3.7	3.6	3.5	3.4
(10)	Peak Wastewater (8)x(9)	mgd	0.631	0.688	0.773	0.857	0.928	1.108
(11)	Infiltration Rate	gpcd	17	15	13	13	12	12
(12)	Infiltration Flow	mgd	0.028	0.027	0.026	0.029	0.030	0.037
(13)	ADWF (8)+(12)	mgd	0.194	0.213	0.235	0.267	0.295	0.363
(14)	PDWF (10)+(12)	mgd	0.659	0.715	0.799	0.886	0.958	1.145
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.076	0.080	0.084	0.092	0.099	0.122
(17)	PWWF (14)+(16)	mgd	0.735	0.795	0.883	0.978	1.057	1.267

KENNEDY-TUDOR
CONSULTING ENGINEERS
WATER RESOURCES STUDY — METROPOLITAN SPOKANE REGION

BY BP DATE Aug '74 SUBJECT APPENDIX Id SHEET NO. 24 OF
TASK NO. 406.2 REV. DATE City plus Moran Prairie & Southwest FILE NO.
(City combined sewers)

Combined Sewers

PLANNING AREA City, Moran Prairie & Southwest

ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	186,278	189,052	191,988	195,068	198,210	212,415
(2)	Percent Served	percent	96	95	95	95	96	96
(3)	Service Population	persons	177,945	180,120	182,506	185,437	189,282	204,315
(4)	Commercial Category	—						
(5)	Per Capita Flow	gpcd						
(6)	Aver. Res.-Comm. Flow	mgd	22.472	23.439	24.081	24.612	25.242	27.125
(7)	Aver. Industrial	mgd	3.972	4.327	4.712	5.147	5.376	6.033
(8)	Aver. Municipal (6)+(7)	mgd	26.444	27.766	28.793	29.759	30.618	33.158
(9)	Peak ratio	—	1.85	1.80	1.80	1.80	1.80	1.80
(10)	Peak Wastewater (8)x(9)	mgd	48.921	49.979	51.827	53.566	55.112	59.684
(11)	Infiltration Rate	gpcd						
(12)	Infiltration Flow	mgd	3.582	3.588	3.593	3.608	3.632	3.697
(13)	ADWF (8)+(12)	mgd	30.026	31.354	32.386	33.367	34.250	36.855
(14)	PDWF (10)+(12)	mgd	52.503	53.567	55.420	57.174	58.744	63.381
(15)	Inflow Rate	gpcd						
(16)	Inflow Quantity	mgd						
(17)	PWWF (14)+(16)	mgd						

KENNEDY-TUDOR
CONSULTING ENGINEERS

WATER RESOURCES STUDY — METROPOLITAN SPOKANE REGION

BY: BP DATE: Aug '74 SUBJECT: APPENDIX Ie SHEET NO. 25 OF

TASK NO. 406.2 REV. DATE: City plus Moran Prairie & Southwest (City separate sewers) FILE NO.

SEPARATE SEWERS

PLANNING AREA: CITY, MORAN PRAIRIE & SOUTHWEST

ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	186,278	189,052	191,988	195,068	198,210	212,415
(2)	Percent Served	percent	96	95	95	95	96	96
(3)	Service Population	persons	177,945	180,120	182,506	185,437	189,282	204,315
(4)	Commercial Category	—						
(5)	Per Capita Flow	gpcd						
(6)	Aver. Res-Comm. Flow	mgd	21.950	22.913	23.550	24.076	24.701	26.544
(7)	Aver. Industrial	mgd	3.972	4.327	4.712	5.147	5.376	6.033
(8)	Aver. Municipal (6)+(7)	mgd	25.922	27.240	28.262	29.223	30.077	32.577
(9)	Peak ratio	—	1.85	1.80	1.80	1.80	1.80	1.80
(10)	Peak Wastewater (8)x(9)	mgd	47.956	49.032	50.872	52.601	54.139	58.639
(11)	Infiltration Rate	gpcd						
(12)	Infiltration Flow	mgd	3.582	3.588	3.593	3.608	3.632	3.697
(13)	ADWF (8)+(12)	mgd	29.504	30.828	31.855	32.831	33.709	36.274
(14)	PDWF (10)+(12)	mgd	51.538	52.620	54.465	56.209	57.771	62.336
(15)	Inflow Rate	gpcd						
(16)	Inflow Quantity	mgd						
(17)	PWWF (14)+(16)	mgd						

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CONSULTING ENGINEERS
WATER RESOURCES STUDY — METROPOLITAN SPOKANE REGION

BY BP DATE Aug '74 SUBJECT APPENDIX If SHEET NO. 26 OF
TASK NO. 406.2 REV. DATE City plus North Spokane areas inside City, Moran Prairie and Southwest (City combined sewers) FILE NO.

WITH COMBINED SEWERS

CITY (INCLUDING PORTION IN NORTH SPOKANE ZONE WITHIN CITY LIMITS)
MORAN PRAIRIE
SOUTHWEST

PLANNING AREA SOUTHWEST
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	190,763	195,344	200,423	205,145	210,187	231,349
(2)	Percent Served	percent	95	94	95	95	95	96
(3)	Service Population	persons	180,438	183,074	189,493	194,052	199,728	221,567
(4)	Commercial Category	—						
(5)	Per Capita Flow	gpcd						
(6)	Aver. Res.-Comm. Flow	mgd	22.748	23.776	24.833	25.539	26.370	28.974
(7)	Aver. Industrial	mgd	3.972	4.327	4.712	5.147	5.376	6.033
(8)	Aver. Municipal (6)+(7)	mgd	26.720	28.103	29.545	30.686	31.746	35.007
(9)	Peak ratio	—	1.85	1.85	1.80	1.80	1.80	1.75
(10)	Peak Wastewater (8)x(9)	mgd	49.432	51.991	53.181	55.235	57.143	61.262
(11)	Infiltration Rate	gpcd						
(12)	Infiltration Flow	mgd	3.617	3.623	3.673	3.710	3.746	3.887
(13)	ADWF (8)+(12)	mgd	30.337	31.726	33.218	34.396	35.492	38.894
(14)	PDWF (10)+(12)	mgd	53.049	55.614	56.854	58.945	60.889	65.149
(15)	Inflow Rate	gpcd						
(16)	Inflow Quantity	mgd						
(17)	PWWF (14)+(16)	mgd						

KENNEDY-TUDOR
CONSULTING ENGINEERS
WATER RESOURCES STUDY — METROPOLITAN SPOKANE REGION

BY BP DATE Aug '74 SUBJECT APPENDIX Ig SHEET NO. 27 OF ____
TASK NO. 406.2 REV. DATE City plus North Spokane Areas inside City, Moran Prairie and Southwest (City separate sewers) FILE NO. ____

WITH SEPARATE SEWERS

CITY (INCLUDING PORTION IN NORTH SPOKANE ZONE WITHIN CITY LIMITS)
MORAN PRAIRIE
PLANNING AREA SOUTHWEST

ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	190,763	195,344	200,423	205,145	210,187	231,349
(2)	Percent Served	percent	95	94	95	95	95	96
(3)	Service Population	persons	180,438	183,074	189,493	194,052	199,728	221,567
(4)	Commercial Category	—						
(5)	Per Capita Flow	gpcd						
(6)	Aver. Res.-Comm. Flow	mgd	22.226	23.250	24.302	25.003	25.829	28.393
(7)	Aver. Industrial	mgd	3.972	4.327	4.712	5.147	5.376	6.003
(8)	Aver. Municipal (6)+(7)	mgd	26.198	27.577	29.014	30.150	31.205	34.396
(9)	Peak ratio	—	1.85	1.85	1.80	1.80	1.80	1.75
(10)	Peak Wastewater (8)x(9)	mgd	48.466	51.018	52.225	54.270	56.169	60.193
(11)	Infiltration Rate	gpcd						
(12)	Infiltration Flow	mgd	3.617	3.623	3.673	3.710	3.746	3.887
(13)	ADWF (8)+(12)	mgd	29.815	31.200	32.687	33.860	34.951	38.283
(14)	PDWF (10)+(12)	mgd	52.083	54.641	55.898	57.980	59.915	64.080
(15)	Inflow Rate	gpcd						
(16)	Inflow Quantity	mgd						
(17)	PWWF (14)+(16)	mgd						

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PLANNING AREA **MORAN PRAIRIE**
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	5530	6409	7320	8307	9298	12,949
(2)	Percent Served	percent	56	58	60	66	80	85
(3)	Service Population	persons	3097	3714	4392	5515	7438	11,007
(4)	Commercial Category	—	NEG.	NEG.	NEG.	NEG.	NEG.	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res.-Comm. Flow	mgd	0.291	0.360	0.430	0.546	0.744	1.101
(7)	Aver. Industrial	mgd	0.030	0.033	0.036	0.038	0.040	0.044
(8)	Aver. Municipal (6)+(7)	mgd	0.321	0.393	0.466	0.584	0.784	1.145
(9)	Peak ratio	—	3.4	3.2	3.1	2.95	2.80	2.6
(10)	Peak Wastewater (8)x(9)	mgd	1.091	1.258	1.445	1.723	2.195	2.977
(11)	Infiltration Rate	gpcd	20	18	16	15	14	14
(12)	Infiltration Flow	mgd	0.062	0.067	0.070	0.083	0.104	0.154
(13)	ADWF (8)+(12)	mgd	0.383	0.460	0.536	0.667	0.888	1.299
(14)	PDWF (10)+(12)	mgd	1.153	1.325	1.515	1.806	2.299	3.131
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.142	0.163	0.184	0.226	0.298	0.440
(17)	PWWF (14)+(16)	mgd	1.295	1.488	1.699	2.032	2.597	3.571

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WATER RESOURCES STUDY — METROPOLITAN SPOKANE REGION

BY BP DATE Aug '74 SUBJECT APPENDIX Ic SHEET NO. 29 OF
TASK NO. 406.2 REV. DATE Southwest FILE NO.

PLANNING AREA SOUTHWEST
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	3088	3547	4029	4433	4839	6504
(2)	Percent Served	percent	24	25	27	28	30	35
(3)	Service Population	persons	741	887	1088	1241	1452	2276
(4)	Commercial Category	—	NEG	NEG	NEG	NEG	NEG	NEG
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res-Comm. Flow	mgd	0.070	0.086	0.107	0.123	0.145	0.228
(7)	Aver. Industrial	mgd	0.006	0.007	0.007	0.008	0.008	0.009
(8)	Aver. Municipal (6)+(7)	mgd	0.076	0.093	0.114	0.131	0.153	0.237
(9)	Peak ratio	—	4.6	4.4	4.1	4.0	3.9	3.6
(10)	Peak Wastewater (8)x(9)	mgd	0.350	0.409	0.467	0.524	0.597	0.853
(11)	Infiltration Rate	gpcd	27	24	21	20	19	19
(12)	Infiltration Flow	mgd	0.020	0.021	0.023	0.025	0.028	0.043
(13)	ADWF (8)+(12)	mgd	0.096	0.114	0.137	0.156	0.181	0.280
(14)	PDWF (10)+(12)	mgd	0.370	0.430	0.490	0.549	0.778	1.133
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.034	0.039	0.046	0.051	0.058	0.091
(17)	PWWF (14)+(16)	mgd	0.404	0.469	0.536	0.600	0.836	1.224

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WATER RESOURCES STUDY — METROPOLITAN SPOKANE REGION

BY: BP DATE: Oct. 74 SUBJECT: APPENDIX I-j SHEET NO. 30 OF
TASK NO. 406.2 REV. DATE: West Plateau FILE NO.

PLANNING AREA: West PLATEAU
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	2608	2833	3074	3364	3657	5084
(2)	Percent Served	percent	69	70	71	71	72	70
(3)	Service Population	persons	1807	1993	2187	2401	2614	3532
(4)	Commercial Category	—	MOD.	MOD.	MOD.	MOD.	MOD	MOD
(5)	Per Capita Flow	gpcd	100	103	105	106	107	107
(6)	Aver. Res-Comm. Flow	mgd	0.181	0.205	0.230	0.255	0.280	0.378
(7)	Aver. Industrial	mgd	0	0	0	0	0	0
(8)	Aver. Municipal (6)+(7)	mgd	0.181	0.205	0.230	0.255	0.280	0.378
(9)	Peak ratio	—	3.75	3.70	3.60	3.50	3.40	3.20
(10)	Peak Wastewater (8)x(9)	mgd	0.679	0.758	0.828	0.892	.952	1.210
(11)	Infiltration Rate	gpcd	29	25	22	21	20	20
(12)	Infiltration Flow	mgd	0.052	0.050	0.048	0.050	0.052	0.071
(13)	ADWF (8)+(12)	mgd	0.233	0.255	0.278	0.305	0.332	0.449
(14)	PDWF (10)+(12)	mgd	0.731	0.808	0.876	0.942	1.004	1.281
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.083	0.088	0.092	0.098	0.105	0.141
(17)	PWWF (14)+(16)	mgd	0.814	0.896	0.968	1.040	1.109	1.422

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WATER RESOURCES STUDY — METROPOLITAN SPOKANE REGION

BY BP DATE Oct '74 SUBJECT APPENDIX I-K SHEET NO. 31 OF ____
TASK NO. 406.2 REV. DATE ____ Liberty Lake FILE NO. ____

PLANNING AREA: LIBERTY LAKE
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	982	11.4	1356	1467	1580	2097
(2)	Percent Served	percent	97	98	99	100	100	100
(3)	Service Population	persons	953	1141	1342	1467	1580	2097
(4)	Commercial Category	—	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res.-Comm. Flow	mgd	0.090	0.111	0.132	0.145	0.158	0.210
(7)	Aver. Industrial	mgd	0	0	0	0	0	0
(8)	Aver. Municipal (6)+(7)	mgd	0.090	0.111	0.132	0.145	0.158	0.210
(9)	Peak ratio	—	4.4	4.2	4.0	3.9	3.8	3.6
(10)	Peak Wastewater (8)x(9)	mgd	0.396	0.466	0.528	0.566	0.600	0.756
(11)	Infiltration Rate	gpcd	24	21	19	18	17	1.7
(12)	Infiltration Flow	mgd	0.023	0.024	0.025	0.026	0.027	0.036
(13)	ADWF (8)+(12)	mgd	0.113	0.135	0.157	0.171	0.185	0.246
(14)	PDWF (10)+(12)	mgd	0.419	0.490	0.553	0.592	0.627	0.792
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.044	0.050	0.056	0.060	0.063	0.084
(17)	PWWF (14)+(16)	mgd	0.463	0.540	0.609	0.652	0.690	0.876

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CONSULTING ENGINEERS
WATER RESOURCES STUDY — METROPOLITAN SPOKANE REGION

BY: BP   DATE: Oct '74   SUBJECT: APPENDIX I/   SHEET NO. 32 OF ____
TASK NO. 406.2   REV. DATE: Newman Lake   FILE NO. ____

PLANNING AREA **NEWMAN LAKE**
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	162	311	468	630	782	1493
(2)	Percent Served	percent	91	92	93	94	95	95
(3)	Service Population	persons	147	286	435	592	752	1418
(4)	Commercial Category	—	NEG.	NEG.	NEG.	NEG.	NEG	NEG.
(5)	Per Capita Flow	gpcd	94	97	98	99	100	100
(6)	Aver. Res.-Comm. Flow	mgd	0.014	0.028	0.043	0.059	0.075	0.142
(7)	Aver. Industrial	mgd	0	0	0	0	0	0
(8)	Aver. Municipal (6)+(7)	mgd	0.014	0.028	0.043	0.059	0.075	0.142
(9)	Peak ratio	—	6.5	5.6	5.1	4.8	4.5	3.9
(10)	Peak Wastewater (8)x(9)	mgd	0.091	0.157	0.219	0.283	0.338	0.554
(11)	Infiltration Rate	gpcd	21	19	17	16	15	15
(12)	Infiltration Flow	mgd	0.003	0.005	0.007	0.009	0.011	0.021
(13)	ADWF (8)+(12)	mgd	0.017	0.033	0.050	0.068	0.086	0.163
(14)	PDWF (10)+(12)	mgd	0.094	0.162	0.226	0.292	0.349	0.575
(15)	Inflow Rate	gpcd	46	44	42	41	40	40
(16)	Inflow Quantity	mgd	0.007	0.013	0.018	0.024	0.030	0.057
(17)	PWWF (14)+(16)	mgd	0.101	0.175	0.244	0.316	0.379	0.632

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PLANNING AREA FAIRCHILD A.F.B
ASSEMBLY OF FLOW COMPONENTS

Line	Component	Units	1980	1985	1990	1995	2000	2020
(1)	Gross Population	persons	6700	6700	6700	6700	6700	6700
(2)	Percent Served	percent	100	100	100	100	100	100
(3)	Service Population	persons	6700	6700	6700	6700	6700	6700
(4)	Commercial Category	—	MOD.	MOD.	MOD.	MOD.	MOD.	MOD.
(5)	Per Capita Flow	gpcd	86	86	86	86	86	86
(6)	Aver. Res.-Comm. Flow	mgd	0.579	0.579	0.579	0.579	0.579	0.579
(7)	Aver. Industrial	mgd	0	c	0	0	0	0
(8)	Aver. Municipal (6)+(7)	mgd	0.579	0.579	0.579	0.579	0.579	0.579
(9)	Peak ratio	—	1.98	1.98	1.98	1.98	1.98	1.98
(10)	Peak Wastewater (8)x(9)	mgd	1.144	1.144	1.144	1.144	1.144	1.144
(11)	Infiltration Rate	gpcd	33	33	33	33	33	33
(12)	Infiltration Flow	mgd	0.221	0.224	0.221	0.221	0.221	0.221
(13)	ADWF* (8)+(12)	mgd	0.800	0.800	0.800	0.800	0.800	0.800
(14)	PDWF (10)+(12)	mgd	1.365	1.365	1.365	1.365	1.365	1.365
(15)	Inflow Rate	gpcd	50	50	50	50	50	50
(16)	Inflow Quantity	mgd	0.335	0.335	0.335	0.335	0.335	0.335
(17)	PWWF* (14)+(16)	mgd	1.700	1.700	1.700	1.700	1.700	1.700

* BASED ON DATA IN SECTION 3.2

TUDOR ENGINEERING COMPANY

BY BP DATE Aug '74 SUBJECT APPENDIX II a SHEET NO. 34 OF
CHKD. BY DATE North Spokane JOB NO. 406.2

AGGREGATION OF PWWF FROM PLANNING SUBUNITS

Line — NORTH SPOKANE	Units	1980			1985			1990			1995			2000			2020		
		Service Pop. Line (3)	Avg. Manuf. Line (8)	Infil. Line (12)	(3)	(8)	(12)	(3)	(8)	(12)	(3)	(8)	(12)	(3)	(8)	(12)	(3)	(8)	(12)
(a1) Subunit # NS-1		0	0	0	0	0	0	4045	0.396	0.044	5610	0.555	0.062	7200	0.720	0.072	12,808	1.281	0.128
(a2) NS-2		0	0	0	0	0	0	1484	0.156	0.033	2962	0.261	0.052	3073	0.329	0.061	6111	0.654	0.122
(a3) NS-3		14,409	1.634	0.202	16,094	1.872	0.193	16,044	2.132	0.178	19,693	2.348	0.217	21,358	2.565	0.214	25,100	3.014	0.251
(a4) NS-4		1377	0.332	0.019	1392	0.357	0.017	1409	0.379	0.015	1432	0.403	0.016	1455	0.420	0.015	2202	0.528	0.022
(a5) NS-5		342	0.074	0.005	347	0.080	0.004	3521	0.085	0.004	4261	0.098	0.005	504	0.110	0.005	647	0.137	0.006
(a6) NS-6		1092	0.103	0.023	1985	0.193	0.038	4015	0.393	0.068	6335	0.627	0.101	8413	0.841	0.126	12,036	1.204	0.181
(a7) NS-7		0	0	0	0	0	0	84	0.008	0.002	122	0.012	0.003	152	0.015	0.003	238	0.024	0.005
(a8) NS-8		0	0	0	0	0	0	0	0	0	0	0	0	240	0.029	0.004	532	0.053	0.008
(a9) NS-9		0	0	0	0	0	0	10	0	0	0	0	0	2102	0.727	0.039	2788	0.289	0.050
(a10)																			
(b) Total Service Pop	persons	17,220			18,818			29,933			36,080			44,627			62,482		
(d) Total Manu. Flow	mgd		2.143			2.502			3.549			4.304			5.256			7.184	
(e) Total Infiltra. Flow	mgd			0.249			0.252			0.364			0.456			0.539			0.773
(c) Peak Ratio	—	2.45			2.40			2.30			2.25			2.20			2.10		
(f) Peak WW (b)x(c)	mgd	5.250			6.005			8.163			9.684			11.563			15.086		
(g) PDWF (f)+(d)	mgd	5.499			6.257			8.527			10.140			12.102			15.859		
(h) Inflow (b)x	mgd	0.792			0.872			1.236			1.479			1.785			2.499		
(i) PWWF (g)+(h)	mgd	6.291			7.129			9.763			11.619			13.887			18.358		
(j) ADWF	mgd	2.392			2.754			3.913			4.760			5.795			7.957		

TUDOR ENGINEERING COMPANY

BY BP DATE 9/6/74 SUBJECT APPENDIX II 6 SHEET NO. 35 OF
CHKD. BY DATE Spokane Valley JOB NO. 406.2

AGGREGATION OF PWWF FROM PLANNING SUBUNITS

Line	SPOKANE VALLEY	Units	1980			1985			1990			1995			2000			2020		
			Service Pop. Line (3)	Aver. Munic. Line (8)	Infil. Line (12)	(3)	(8)	(12)	(3)	(8)	(12)	(3)	(8)	(12)	(3)	(8)	(12)	(3)	(8)	(12)
(a1)	Subunit # SV-1		1993	0.187	0.028	2413	0.234	0.029	2885	0.283	0.032	3236	0.320	0.036	3493	0.349	0.035	4828	0.483	0.048
(a2)	SV-2		7868	1.026	0.110	8374	1.135	0.100	9005	1.244	0.099	9461	1.331	0.104	10,034	1.417	0.100	11,500	1.621	0.115
(a3)	SV-3		28,071	3.616	0.393	29,663	3.930	0.356	31,691	4.280	0.349	33,288	4.566	0.366	34,295	4.752	0.342	38,996	5.435	0.390
(a4)	SV-4		9898	0.959	0.158	12408	1.235	0.174	14,291	1.434	0.171	17,365	1.755	0.208	20050	2.045	0.221	27,836	2.821	0.306
(a5)	SV-5		1708	0.179	0.027	1898	0.204	0.027	1969	0.217	0.024	2036	0.227	0.024	2104	0.236	0.023	2450	0.276	0.027
(a6)	SV-6		556	0.074	0.009	571	0.078	0.008	586	0.082	0.007	614	0.087	0.007	643	0.092	0.007	945	0.125	0.010
(a7)	SV-7		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(a8)	SV-8		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(a9)	SV-9		472	0.047	0.008	601	0.062	0.008	746	0.078	0.009	910	0.096	0.011	952	0.105	0.011	1418	0.152	0.016
(a10)	SV-10		1661	0.166	0.028	1809	0.186	0.027	1993	0.209	0.026	2249	0.238	0.029	2480	0.265	0.030	3048	0.326	0.037
(b)	Total Service Pop	persons	52,227			57,737			63,166			69,154			74,061			91,021		
(c)	Total Munic. Flow	mgd		6.264			7.064			7.827			8.622			9.261			11.239	
(d)	Total Infiltr. Flow	mgd			0.701			0.729			0.717			0.785			0.769			0.949
(e)	Peak Ratio	—	2.15			2.1			2.1			2.05			2.05			2.0		
(f)	Peak WW (c)x(e)	mgd	13.468			14.834			16.437			17.675			18.985			22.478		
(g)	PDWF (f)+(d)	mgd	14.229			15.563			17.154			18.460			19.754			23.427		
(h)	Inflow (b)x	mgd	2.402			2.540			2.653			2.835			2.962			3.641		
(i)	PWWF (g)+(h)	mgd	16.631			18.103			19.807			21.295			22.716			27.068		
(j)	ADWF	mgd	7.025			7.793			8.544			9.407			10.030			12.188		

TUDOR ENGINEERING COMPANY

BY: BP DATE: Aug '74 SUBJECT: APPENDIX IIc SHEET NO. 26 of 66

CHKD. BY: ____ DATE: ____ North Spokane Exclusive of City Portions JOB NO. 406.2

AGGREGATION OF PWWF FROM PLANNING SUBUNITS

Line	North Spokane Excluding Areas within City Limits	Units	1980 Service Pop. Line (3)	1980 Aver. Munic. Line (8)	1980 Infil. Line (12)	1985 (3)	1985 (8)	1985 (12)	1990 (3)	1990 (8)	1990 (12)	1995 (3)	1995 (8)	1995 (12)	2000 (3)	2000 (8)	2000 (12)	2020 (3)	2020 (8)	2020 (12)
(a1)	Subunit # NS-1		0	0	0	0	0	0	1078	0.106	0.012	1510	0.149	0.017	1941	0.194	0.019	3483	0.348	0.035
(a2)	NS-2		0	0	0	0	0	0	1150	0.121	0.025	1831	0.194	0.038	2221	0.238	0.044	4293	0.459	0.076
(a3)	NS-3		11,916	1.358	0.167	13,140	1.535	0.158	19,358	1.765	0.158	15,809	1.899	0.174	17,023	2.054	0.170	[illegible]11	2.258	0.170
(a4)	NS-4		1377	0.332	0.019	1392	0.357	0.017	1409	0.379	0.015	1432	0.403	0.016	1455	0.420	0.015	2202	0.528	0.022
(a5)	NS-5		342	0.074	0.005	347	0.080	0.009	352	0.085	0.004	426	0.098	0.005	504	0.110	0.005	647	0.137	0.006
(a6)	NS-6		1092	0.103	0.023	1785	0.173	0.038	4015	0.393	0.068	6335	0.627	0.101	8413	0.841	0.126	12,036	1.204	0.181
(a7)	NS-7		0	0	0	0	0	0	84	0.008	0.002	122	0.012	0.003	152	0.015	0.003	238	0.024	0.005
(a8)	NS-8		0	0	0	0	0	0	0	0	0	0	0	0	290	0.029	0.004	532	0.053	0.008
(a9)	NS-9		0	0	0	0	0	0	0	0	0	0	0	0	2182	0.227	0.039	2788	0.289	0.050
(a10)																				
(b)	Total Service Pop.	persons	14,727			16,864			22,496			27,465			37,181			45,230		
(c)	Total Munic. Flow	mgd		1.867			2.165			2.797			3.377			4.128			5.330	
(d)	Total Infiltr. Flow	mgd			0.214			0.217			0.284			0.354			0.425			0.583
(e)	Peak Ratio	—	2.50			2.45			2.40			2.30			2.25			2.20		
(f)	Peak WW (c) x (e)	mgd	4.367			5.304			6.713			7.767			9.288			11.726		
(g)	PDWF (f) + (d)	mgd	4.581			5.521			6.997			8.121			9.713			12.309		
(h)	Inflow (b) x	mgd	0.677			0.742			0.943			1.120			1.367			1.809		
(i)	PWWF (g) + (h)	mgd	5.258			6.263			7.940			9.241			11.080			14.118		
(j)	ADWF	mgd	2.081			2.382			3.081			3.731			4.553			5.913		

TUDOR ENGINEERING COMPANY

BY BP DATE Aug '74 SUBJECT APPENDIX IId SHEET NO. 37 OF

CHKD. BY DATE City plus Moran Prairie & Southwest JOB NO. 406.2

(city combined sewers)

AGGREGATION OF PWWF FROM PLANNING SUBUNITS

City (Combined Sewers) Moran Prairie Southwest		1980			1985			1990			1995			2000			2020		
Line	Units	Service Pop. Line (3)	Aver. Munic. Line (8)	Infil. Line (12)	(3)	(8)	(12)	(3)	(8)	(12)	(3)	(8)	(12)	(3)	(8)	(12)	(3)	(8)	(12)
(a1) Subunit #																			
(a2)																			
(a3)																			
(a4)																			
(a5)																			
(a6)																			
(a7)																			
(a8)																			
(a9)																			
(a10)																			
(b) Total Service Pop	persons	177,945			180,120			182,506			185,437			189,282			209,315		
(c) Total Munic. Flow	mgd		26.444			27.766			28.793			29.759			30.618			33.158	
(d) Total Infiltra. Flow	mgd			3.582			3.588			3.593			3.608			3.632			3.697
(e) Peak Ratio		1.85			1.80			1.80			1.80			1.80			1.80		
(f) Peak WW (c) x (e)	mgd	48.921			49.979			51.827			53.566			55.112			59.684		
(g) PDWF (f) + (d)	mgd	52.503			53.567			55.420			57.174			58.744			63.381		
(h) Inflow (b) x	mgd																		
(i) PWWF (g) + (h)	mgd																		
(j) ADWF	mgd	30.026			31.354			32.386			33.367			34.250			36.855		

TUDOR ENGINEERING COMPANY

BY BP DATE Aug '74 SUBJECT APPENDIX II e SHEET NO. 38 OF ____
CHKD. BY ____ DATE ____ City plus Moran Prairie & Southwest JOB NO. 406.2
(city separate sewers)

AGGREGATION OF PWWF FROM PLANNING SUBUNITS

City (Separate Sewers)
Moran Prairie
Southwest

Line	Units	1980 Service Pop. Line (3)	1980 Aver. Munic. Line (8)	1980 Infil. Line (12)	1985 (3)	1985 (8)	1985 (12)	1990 (3)	1990 (8)	1990 (12)	1995 (3)	1995 (8)	1995 (12)	2000 (3)	2000 (8)	2000 (12)	2020 (3)	2020 (8)	2020 (12)
(a1) Subunit #																			
(a2)																			
(a3)																			
(a4)																			
(a5)																			
(a6)																			
(a7)																			
(a8)																			
(a9)																			
(a10)																			
(b) Total Service Pop	persons	177,945			180,120			182,506			185,437			187,282			204,315		
(c) Total Munic. Flow	mgd		25.922			27.240			28.262			29.223			30.077			32.577	
(d) Total Infiltra. Flow	mgd			3.582			3.588			3.593			3.608			3.632			3.677
(e) Peak Ratio	—	1.85			1.80			1.80			1.80			1.80			1.80		
(f) Peak WW (c)x(e)	mgd	47.956			49.032			50.872			52.601			54.139			58.639		
(g) PDWF (f)+(d)	mgd	51.538			52.620			64.465			56.209			57.771			62.336		
(h) Inflow (b)x	mgd																		
(i) PWWF (g)+(h)	mgd																		
(j) ADWF	mgd	29.504			30.828			31.855			32.831			33.709			36.274		

TUDOR ENGINEERING COMPANY

BY BP DATE Aug '74 SUBJECT APPENDIX II F SHEET NO. 39 OF

CHKD. BY DATE City incl. City portions of NS plus MP & SW JOB NO.

(city combined sewers)

AGGREGATION OF PWWF FROM PLANNING SUBUNITS

Line / City (combined sewers) including portion in N. Spokane, Moran Prairie, Southwest	Units	1980 Service Pop. Line (3)	1980 Aver. Munic. Line (8)	1980 Infil. Line (12)	1985 (3)	1985 (8)	1985 (12)	1990 (3)	1990 (8)	1990 (12)	1995 (3)	1995 (8)	1995 (12)	2000 (3)	2000 (8)	2000 (12)	2020 (3)	2020 (8)	2020 (12)
(a1) Subunit #																			
(a2)																			
(a3)																			
(a4)																			
(a5)																			
(a6)																			
(a7)																			
(a8)																			
(a9)																			
(a10)																			
(b) Total Service Pop	persons	180,436			183,014			189,413			194,252			199,728			221,567		
(c) Total Munic. Flow	mgd		26.720			28.103			29.545			30.686			31.746			35.007	
(d) Total Infiltra. Flow	mgd			3.617			3.623			3.673			3.710			3.746			3.887
(e) Peak Ratio	—	1.85			1.85			1.80			1.80			1.80			1.75		
(f) Peak WW (c) x (e)	mgd	49.432			51.991			53.181			55.235			57.143			61.262		
(g) PDWF (f) + (d)	mgd	53.049			55.614			56.854			58.945			60.889			65.149		
(h) Inflow (b) x	mgd																		
(i) PWWF (g) + (h)	mgd																		
(j) ADWF	mgd	30.337			31.726			33.218			34.396			35.492			38.894		

TUDOR ENGINEERING COMPANY

BY BP DATE Aug '74 SUBJECT APPENDIX IIg SHEET NO. 40 OF

CHK'D BY DATE City incl. City portions of NS plus MP & SW JOB NO. 406.2

(city separate sewers)

AGGREGATION OF PWWF FROM PLANNING SUBUNITS

Line City (separate sewers) including portion in N. Spokane, Moran Prairie, Southwest	Units	1980 Service Pop. Line (3)	1980 Aver. Munic. Line (8)	1980 Infil. Line (12)	1985 (3)	1985 (8)	1985 (12)	1990 (3)	1990 (8)	1990 (12)	1995 (3)	1995 (8)	1995 (12)	2000 (3)	2000 (8)	2000 (12)	2020 (3)	2020 (8)	2020 (12)
(a1) Subunit #																			
(a2)																			
(a3)																			
(a4)																			
(a5)																			
(a6)																			
(a7)																			
(a8)																			
(a9)																			
(a10)																			
(b) Total Service Pop	persons	180,763			195,349			200,423			205,185			210,187			231,349		
(c) Total Munic. Flow	mgd		26.198			27.577			29.014			30.150			31.205			34.396	
(d) Total Infiltra. Flow	mgd			3.617			3.623			3.673			3.710			3.746			3.887
(e) Peak Ratio	—	1.85			1.85			1.80			1.80			1.80			1.75		
(f) Peak WW (c) x (e)	mgd	48.466			51.018			52.225			54.270			56.169			60.193		
(g) PDWF (f) + (d)	mgd	52.083			54.641			55.898			57.980			59.915			64.080		
(h) Inflow (b) x	mgd																		
(i) PWWF (g) + (h)	mgd																		
(5) ADWF	mgd	29.815			31.200			32.687			33.860			34.951			38.283		

KENNEDY-TUDOR
CONSULTING ENGINEERS

WATER RESOURCES STUDY — METROPOLITAN SPOKANE REGION

BY BP DATE Aug '74 SUBJECT APPENDIX III a SHEET NO. 41 OF

TASK NO. 406.2 REV. DATE North Spokane FILE NO.

AVERAGE WASTE LOAD FORECAST — NORTH SPOKANE

LINE	PARAMETER	UNITS	1980	1985	1990	1995	2000	2020
(1)	SERVICE POP.	PERSONS	17,220	19,818	29,433	36,080	44,627	62,482
(2)	RES. + COMM. FLOW	MGD	1.863	2.197	3.218	3.943	4.868	6.744
(3)	IND. TOTAL FLOW	MGD	0.280	0.305	0.331	0.361	0.388	0.440
(4)	IND. PRO. FLOW (3)X.75	MGD	0.210	0.229	0.248	0.271	0.291	0.330
(5)	ADWF	MGD	2.392	2.754	3.913	4.760	5.795	7.957
(6)	BOD - RES + COMM	LBS/DAY	3272	3964	5887	7577	9372	13,746
(7)	BOD - IND PRO.	LBS/DAY	525	572	620	677	727	825
(8)	BOD - ADWF (6)+(7)	LBS/DAY	3797	4536	6507	8254	10,099	14,571
(9)	BOD - ADWF	mg/l	191	198	200	208	209	220
(10)	SS - RES. + COMM	LBS/DAY	3272	3765	5887	7216	9372	13,746
(11)	SS - IND. PRO.	LBS/DAY	350	382	413	451	485	550
(12)	SS - ADWF (10)+(11)	LBS/DAY	3622	4147	6300	7667	9857	14,296
(13)	SS - ADWF	mg/l	182	181	193	193	204	216
(14)	N - RES + COMM.	LBS/DAY	534	634	971	1227	1562	2187
(15)	N - IND. PRO.	LBS/DAY	52	57	62	68	73	82
(16)	N - ADWF (14)+(15)	LBS/DAY	586	691	1033	1295	1635	2269
(17)	N - ADWF	mg/l	29.4	30.1	31.7	32.7	33.9	34.2
(18)	P - RES. + COMM	LBS/DAY	172	198	324	397	536	750
(19)	P - IND. PRO.	LBS/DAY	17	19	21	23	24	27
(20)	P - ADWF (18)+(19)	LBS/DAY	189	217	345	420	560	777
(21)	P - ADWF	mg/l	9.5	9.5	10.6	10.6	11.6	11.7

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AVERAGE WASTE LOAD FORECAST – SPOKANE VALLEY

Line	Parameter	Units	1980	1985	1990	1995	2000	2020
(1)	Service Pop.	Persons	52,227	57,737	63,166	69,154	74,061	91,021
(2)	Res.+Comm. Flow	MGD	5.456	6.181	6.857	7.548	8.131	9.933
(3)	Ind. Total Flow	MGD	0.808	0.883	0.970	1.074	1.130	1.306
(4)	Ind. Pro Flow (3)x.75	MGD	0.606	0.662	0.728	0.806	0.848	0.980
(5)	ADWF	MGD	7.025	7.793	8.544	9.407	10.030	12.188
(6)	BOD - Res + Comm	LBS/DAY	9923	11,547	12,633	14,522	15,553	20,025
(7)	BOD - Ind. Pro.	LBS/DAY	1514	1654	1819	2014	2119	2449
(8)	BOD-ADWF (6)+(7)	LBS/DAY	11,437	13,201	14,452	16,536	17,672	22,474
(9)	BOD - ADWF	mg/l	195	203	203	211	212	221
(10)	SS - Res. + Comm	LBS/DAY	9923	10,970	12,633	13,831	15,533	20,025
(11)	SS - Ind. Pro.	LBS/DAY	1010	1103	1213	1343	1413	1633
(12)	SS - ADWF (10)+(11)	LBS/DAY	10,933	12,073	13,846	15,174	16,946	21,658
(13)	SS - ADWF	mg/l	187	186	195	194	203	213
(14)	N - Res. + Comm.	LBS/DAY	1619	1848	2084	2351	2592	3186
(15)	N - Ind. Pro.	LBS/DAY	151	165	182	201	212	245
(16)	N - ADWF (14)+(15)	LBS/DAY	1770	2013	2266	2552	2804	3431
(17)	N - ADWF	mg/l	30.2	31.0	31.8	32.6	33.6	33.8
(18)	P - Res. + Comm	LBS/DAY	522	577	695	761	889	1092
(19)	P - Ind. Pro.	LBS/DAY	50	55	61	67	71	82
(20)	P - ADWF (18)+(19)	LBS/DAY	572	632	756	828	960	1174
(21)	P - ADWF	mg/l	9.8	9.7	10.6	10.6	11.5	11.6

KENNEDY-TUDOR
CONSULTING ENGINEERS
WATER RESOURCES STUDY — METROPOLITAN SPOKANE REGION

BY BP DATE Aug '74 SUBJECT APPENDIX IIIc SHEET NO. 43 OF
TASK NO. 406.2 REV. DATE North Spokane Exclusive of Areas inside City FILE NO.

AVERAGE WASTE LOAD FORECAST – NORTH SPOKANE EXCLUDING REGION WITHIN CITY LIMITS

Line	Parameter	Units	1980	1985	1990	1995	2000	2020
(1)	Service Pop.	Persons	14,727	16,864	22,446	27,465	34,181	45,230
(2)	Res. + Comm. Flow	MGD	1.587	1.860	2.466	3.016	3.740	4.890
(3)	Ind. Total Flow	MGD	0.280	0.305	0.331	0.361	0.388	0.440
(4)	Ind. Pro. Flow (3)x.75	MGD	0.210	0.229	0.248	0.271	0.291	0.330
(5)	ADWF	MGD	2.081	2.382	3.081	3.731	4.553	5.913
(6)	BOD - Res + Comm	LBS/DAY	2798	3373	4489	5768	7178	9951
(7)	BOD - Ind. Pro.	LBS/DAY	525	572	620	677	727	825
(8)	BOD - ADWF (6)+(7)	LBS/DAY	3323	3945	5109	6445	7905	10,776
(9)	BOD - ADWF	mg/l	192	199	199	207	208	219
(10)	SS - Res. + Comm	LBS/DAY	2798	3204	4489	5493	7178	9951
(11)	SS - Ind. Pro.	LBS/DAY	350	382	413	451	485	550
(12)	SS - ADWF (10)+(11)	LBS/DAY	3148	3586	4902	5944	7663	10,501
(13)	SS - ADWF	mg/l	182	181	191	191	202	213
(14)	N - Res. + Comm.	LBS/DAY	457	540	741	934	1196	1583
(15)	N - Ind. Pro.	LBS/DAY	52	57	62	68	73	82
(16)	N - ADWF (14)+(15)	LBS/DAY	509	597	803	1.002	1.269	1.665
(17)	N - ADWF	mg/l	29.4	30.1	31.3	32.2	33.5	33.8
(18)	P - Res. + Comm	LBS/DAY	147	169	247	302	410	543
(19)	P - Ind Pro.	LBS/DAY	17	19	21	23	24	27
(20)	P - ADWF (18)+(19)	LBS/DAY	164	188	268	325	434	570
(21)	P - ADWF	mg/l	9.5	9.5	10.4	10.5	11.4	11.6

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BY BP DATE Aug '74 SUBJECT APPENDIX III d SHEET NO. 44 OF
TASK NO. 406.2 REV. DATE City plus Moran Prairie & Southwest (city combined sewers) FILE NO.

AVERAGE WASTE LOAD FORECAST - CITY (COMBINED SEWERS), MORAN PRAIRIE & SOUTHWEST

LINE	PARAMETER	UNITS	1980	1985	1990	1995	2000	2020
(1)	SERVICE POP.	PERSONS	177,945	180,120	182,506	185,437	189,282	204,315
(2)	RES. + COMM. FLOW	MGD	22.472	23.439	24.081	24.612	25.242	27.125
(3)	IND. TOTAL FLOW	MGD	3.972	4.327	4.712	5.147	5.376	6.033
(4)	IND. PRO. FLOW (3)x.75	MGD	2.976	3.250	3.534	3.858	4.037	4.522
(5)	ADWF	MGD	30.026	31.354	32.386	33.367	34.250	36.855
(6)	BOD - RES + COMM	LBS/DAY	33,810	36,024	36,501	38,942	39,749	44,949
(7)	BOD - IND. PRO.	LBS/DAY	11,559	8125	8835	9645	10,092	11,305
(8)	BOD - ADWF (6)+(7)	LBS/DAY	45,369	44,149	45,336	48,587	49,841	56,254
(9)	BOD - ADWF	mg/l	181	169	168	175	175	183
(10)	SS - RES. + COMM	LBS/DAY	33,810	34,223	36,501	37,087	39,749	44,949
(11)	SS - IND. PRO.	LBS/DAY	8258	5423	5810	6437	6735	7543
(12)	SS - ADWF (10)+(11)	LBS/DAY	42,068	39,646	42,391	43,524	46,484	52,492
(13)	SS - ADWF	mg/l	168	152	157	157	163	171
(14)	N - RES. + COMM.	LBS/DAY	5516	5764	6023	6305	6625	7151
(15)	N - IND. PRO.	LBS/DAY	943	812	884	964	1009	1130
(16)	N - ADWF (14)+(15)	LBS/DAY	6459	6576	6907	7269	7634	8281
(17)	N - ADWF	mg/l	25.8	25.2	25.6	26.2	26.8	27.0
(18)	P - RES. + COMM.	LBS/DAY	1779	1801	2008	2040	2271	2452
(19)	P - IND. PRO.	LBS/DAY	323	271	294	322	337	377
(20)	P - ADWF (18)+(19)	LBS/DAY	2102	2072	2302	2362	2608	2829
(21)	P - ADWF	mg/l	8.4	7.9	8.5	8.5	9.1	9.2

AVERAGE WASTE LOAD FORECAST City (Separate Sewers) Moran Prairie & Southwest

Line	Parameter	Units	1980	1985	1990	1995	2000	2020
(1)	Sewered Pop.	Persons	177,945	180,120	182,506	185,437	189,282	204,315
(2)	Res. & Comm. Flow	MGD	21.950	22.913	23.550	24.076	24.701	26.544
(3)	Ind. Total Flow	MGD	3.972	4.327	4.712	5.147	5.376	6.033
(4)	Ind. Pro Flow (3)x.75	MGD	2.976	3.250	3.534	3.858	4.037	4.522
(5)	ADWF	MGD	29.504	30.828	31.855	32.831	33.709	36.274
(6)	BOD - Res & Comm	LBS/DAY	33,810	36,024	36,501	38,942	39,749	44,949
(7)	BOD - Ind Pro.	LBS/DAY	11,559	8125	8835	9645	10,092	11,305
(8)	BOD - ADWF (6)+(7)	LBS/DAY	45,369	44,149	45,336	48,587	49,841	56,254
(9)	BOD - ADWF	mg/l	185	172	171	178	177	186
(10)	SS - Res. & Comm	LBS/DAY	33,810	34,223	36,501	37,087	39,749	44,999
(11)	SS - Ind. Pro.	LBS/DAY	8258	5423	5890	6437	6735	7543
(12)	SS - ADWF (10)+(11)	LBS/DAY	42,068	39,646	42,391	43,524	46,484	52,492
(13)	SS - ADWF	mg/l	171	154	160	159	166	174
(14)	N - Res. & Comm.	LBS/DAY	5516	5764	6023	6305	6625	7151
(15)	N - Ind. Pro.	LBS/DAY	943	812	884	964	1009	1130
(16)	N - ADWF (14)+(15)	LBS/DAY	6459	6576	6907	7269	7634	8281
(17)	N - AiWF	mg/l	26.3	25.6	26.0	26.6	27.2	27.4
(18)	P - Res. & Comm	LBS/DAY	1779	1801	2008	2040	2271	2452
(19)	P - Ind Pro.	LBS/DAY	323	271	294	322	337	377
(20)	P - ADWF (18)+(19)	LBS/DAY	2102	2072	2302	2362	2608	2829
(21)	P - ADWF	mg/l	8.6	8.1	8.7	8.6	9.3	9.4

KENNEDY-TUDOR
CONSULTING ENGINEERS
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BY BP DATE Aug '74 SUBJECT APPENDIX III f. SHEET NO. 46 OF ____
TASK NO 406.2 REV. DATE City incl. City portions of North Spokane FILE NO. ____
plus Moran-Prairie and Southwest
(city combined sewers)

AVERAGE WASTE LOAD FORECAST — City (Combined Sewers) Moran Prairie, Southwest & Portion in N Spokane within City Limits

Line	Parameter	Units	1980	1985	1990	1995	2000	2020
(1)	Service Pop.	Persons	180,438	183,074	189,493	194,052	199,728	221,567
(2)	Res. + Comm. Flow	MGD	22.748	23.776	24.833	25.539	26.370	28.974
(3)	Ind. Total Flow	MGD	3.972	4.327	4.712	5.147	5.376	6.033
(4)	Ind. Pro. Flow (3) x .75	MGD	2.976	3.250	3.534	3.858	4.037	4.522
(5)	ADWF	MGD	30.337	31.726	33.218	34.396	35.492	38.894
(6)	BOD - Res + Comm	LBS/DAY	34,283	36,615	37,899	40,751	41,943	48,745
(7)	BOD - Ind. Pro.	LBS/DAY	11,559	8125	8835	9645	10,092	11,305
(8)	BOD - ADWF (6)+(7)	LBS/DAY	45,842	44,730	46,734	50,396	52,035	60,050
(9)	BOD - ADWF	mg/l	181	169	169	176	176	185
(10)	SS - Res. + Comm	LBS/DAY	34,283	34,784	37,899	38,810	41,943	48,745
(11)	SS - Ind. Pro.	LBS/DAY	8258	5423	5890	6437	6735	7543
(12)	SS - ADWF (10)+(11)	LBS/DAY	42,541	40,207	43,789	45,247	48,678	56,288
(13)	SS - ADWF	mg/l	168	152	158	158	165	174
(14)	N - Res. + Comm.	LBS/DAY	5594	5858	6253	6598	6990	7755
(15)	N - Ind. Pro.	LBS/DAY	943	812	884	964	1009	1130
(16)	N - ADWF (14)+(15)	LBS/DAY	6537	6670	7137	7562	7999	8885
(17)	N - ADWF	mg/l	25.9	25.2	25.8	26.4	27.1	27.4
(18)	P - Res. + Comm	LBS/DAY	1804	1831	2084	2135	2397	2659
(19)	P - Ind. Pro.	LBS/DAY	323	271	294	322	337	377
(20)	P - ADWF (18)+(19)	LBS/DAY	2127	2102	2378	2457	2734	3036
(21)	P - ADWF	mg/l	8.4	8.0	8.6	8.6	9.2	9.4

KENNEDY-TUDOR
CONSULTING ENGINEERS
WATER RESOURCES STUDY — METROPOLITAN SPOKANE REGION

BY BP DATE Aug '74 SUBJECT APPENDIX III g SHEET NO. 47 OF ___
TASK NO 406.2 REV. DATE City incl. City portions of North Spokane plus Moran Prairie and Southwest (city separate sewers) FILE NO. ___

AVERAGE WASTE LOAD FORECAST

City (Separate Sewers); Moran Prairie, Southwest, & Portion in N. Spokane Within City Limits

Line	Parameter	Units	1980	1985	1990	1995	2000	2020
(1)	Service Pop.	Persons	180,438	183,074	189,493	194,052	199,728	221,567
(2)	Res. + Comm. Flow	MGD	22.226	23.250	24.302	25.003	25.829	28.393
(3)	Ind. Total Flow	MGD	3.972	4.327	4.712	5.147	5.376	6.003
(4)	Ind Pro Flow (3)X.75	MGD	2.976	3.250	3.534	3.858	4.037	4.522
(5)	ADWF	MGD	29.815	31.200	32.687	33.860	34.951	38.283
(6)	BOD - Res & Comm	LBS/DAY	34,283	36,615	37,899	40,751	41,943	48,745
(7)	BOD - Ind. Pro.	LBS/DAY	11,559	8125	8835	9645	10,092	11,305
(8)	BOD-ADWF (6)+(7)	LBS/DAY	45,842	44,730	46,734	50,396	52,035	60,050
(9)	BOD - ADWF	mg/l	185	172	172	179	179	188
(10)	SS - Res. & Comm	LBS/DAY	34,283	34,784	37,899	38,810	41,943	48,745
(11)	SS - Ind. Pro.	LBS/DAY	8258	5423	5890	6437	6735	7543
(12)	SS - ADWF (10)+(11)	LBS/DAY	42,541	40,207	43,789	45,247	48,678	56,288
(13)	SS - ADWF	mg/l	171	155	161	160	167	177
(14)	N - Res & Comm.	LBS/DAY	5594	5858	6253	6598	6990	7755
(15)	N - Ind. Pro.	LBS/DAY	943	812	884	964	1009	1130
(16)	N - ADWF (14)+(15)	LBS/DAY	6537	6670	7137	7562	7999	8885
(17)	N - ADWF	mg/l	26.3	25.7	26.2	26.8	27.5	27.9
(18)	P - Res. & Comm	LBS/DAY	1804	1831	2084	2135	2397	2659
(19)	P - Ind Pro.	LBS/DAY	323	271	294	322	337	377
(20)	P - ADWF (18)+(19)	LBS/DAY	2127	2102	2378	2457	2734	3036
(21)	P - ADWF	mg/l	8.6	8.1	8.7	8.7	9.4	9.5

406.2-74

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WATER RESOURCES STUDY — METROPOLITAN SPOKANE REGION

BY BP DATE Oct. '74 SUBJECT APPENDIX III-h SHEET NO. 48 OF

TASK NO. 406.2 REV. DATE West Plateau FILE NO.

AVERAGE WASTE LOAD FORECAST WEST PLATEAU

LINE	PARAMETER	UNITS	1980	1985	1990	1995	2000	2020
(1)	SERVICE POP.	PERSONS	1807	1993	2187	2401	2619	3532
(2)	Res. + Comm. FLOW	MGD	0.181	0.205	0.230	0.255	0.280	0.378
(3)	IND. TOTAL FLOW	MGD	0	0	0	0	0	0
(4)	IND. PRO. FLOW (3)X.75	MGD	0	0	0	0	0	0
(5)	ADWF	MGD	0.233	0.255	0.278	0.305	0.332	0.449
(6)	BOD - Res + Comm	LBS/DAY	343	399	437	504	549	777
(7)	BOD - IND PRO.	LBS/DAY	0	0	0	0	0	0
(8)	BOD - ADWF (6)+(7)	LBS/DAY	343	399	437	504	549	777
(9)	BOD - ADWF	mg/l	177	188	189	198	198	208
(10)	SS - Res. + Comm	LBS/DAY	343	377	437	480	549	777
(11)	SS - IND. PRO.	LBS/DAY	0	0	0	0	0	0
(12)	SS - ADWF (10)+(11)	LBS/DAY	343	377	437	480	549	777
(13)	SS - ADWF	mg/l	177	177	189	189	198	208
(14)	N - Res. + Comm.	LBS/DAY	56	64	72	82	91	124
(15)	N - IND. PRO.	LBS/DAY	0	0	0	0	0	0
(16)	N - ADWF (14)+(15)	LBS/DAY	56	64	72	82	91	124
(17)	N - ADWF	mg/l	29	30	31	32	33	33
(18)	P - Res. + Comm	LBS/DAY	18	20	24	26	31	42
(19)	P - IND. PRO.	LBS/DAY	0	0	0	0	0	0
(20)	P - ADWF (18)+(19)	LBS/DAY	18	20	24	26	31	42
(21)	P - ADWF	mg/l	9.3	9.4	10.4	10.2	11.2	11.2

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WATER RESOURCES STUDY — METROPOLITAN SPOKANE REGION

BY BP DATE Oct. '74 SUBJECT APPENDIX III i SHEET NO. 49 OF
TASK NO 406.2 REV. DATE Newman Lake FILE NO.

AVERAGE WASTE LOAD FORECAST NEWMAN LAKE

LINE	PARAMETER	UNITS	1980	1985	1990	1995	2000	2020
(1)	SERVICE POP.	PERSONS	147	286	435	592	752	1418
(2)	RES. + COMM. FLOW	MGD	0.014	0.028	0043	0.059	0.075	0.142
(3)	IND. TOTAL FLOW	MGD	0	0	0	0	0	0
(4)	IND. PRO FLOW (3)X.75	MGD	0	0	0	0	0	0
(5)	ADWF	MGD	0.017	0.033	0.050	0.068	0.086	0.163
(6)	BOD - RES + COMM	LBS/DAY	27.9	57.2	87.0	124	158	312
(7)	BOD - IND PRO.	LBS/DAY	0	0	0	0	0	0
(8)	BOD - ADWF (6)+(7)	LBS/DAY	27.9	57.2	87.0	124	158	312
(9)	BOD - ADWF	mg/l	196	208	209	219	221	230
(10)	SS - RES. + COMM	LBS/DAY	27.9	54.3	87.0	118	158	312
(11)	SS - IND. PRO.	LBS/DAY	0	0	0	0	0	0
(12)	SS - ADWF (10)+(11)	LBS/DAY	27.9	54.3	87.0	118	158	312
(13)	SS - ADWF	mg/l	196	197	209	208	221	230
(14)	N - RES. + COMM.	LBS/DAY	4.6	9.2	14.4	20.1	26.3	49.6
(15)	N - IND. PRO.	LBS/DAY	0	0	0	0	0	0
(16)	N - ADWF (14)+(15)	LBS/DAY	4.6	9.2	14.4	20.1	26.3	49.6
(17)	N - ADWF	mg/l	32	33	35	36	37	37
(18)	P - RES. + COMM	LBS/DAY	1.5	2.9	4.8	6.5	9.0	17.0
(19)	P - IND. PRO.	LBS/DAY	0	0	0	0	0	0
(20)	P - ADWF (18)+(19)	LBS/DAY	1.5	2.9	4.8	6.5	9.0	17.0
(21)	P - ADWF	mg/l	12.9	10.5	11.5	11.5	12.6	12.5

AVERAGE WASTE LOAD FORECAST LIBERTY LAKE

LINE	PARAMETER	UNITS	1980	1985	1990	1995	2000	2020
(1)	SERVICE POP.	PERSONS	953	1141	1342	1467	1580	2097
(2)	RES. + COMM. FLOW	MGD	0.090	0.111	0.132	0.145	0.158	0.210
(3)	IND. TOTAL FLOW	MGD	0	0	0	0	0	0
(4)	IND. PRO FLOW (3)X.75	MGD	0	0	0	0	0	0
(5)	ADWF	MGD	0.113	0.135	0.157	0.171	0.185	0.246
(6)	BOD - RES + COMM	LBS/DAY	181	228	268	308	332	461
(7)	BOD - IND. PRO.	LBS/DAY	0	0	0	0	0	0
(8)	BOD - ADWF (6)+(7)	LBS/DAY	181	228	268	308	332	461
(9)	BOD - ADWF	mg/l	192	203	205	216	215	225
(10)	SS - RES. + COMM	LBS/DAY	181	217	268	293	332	461
(11)	SS - IND. PRO.	LBS/DAY	0	0	0	0	0	0
(12)	SS - ADWF (10)+(11)	LBS/DAY	181	217	268	293	332	461
(13)	SS - ADWF	mg/l	192	193	205	206	215	225
(14)	N - RES. + COMM.	LBS/DAY	29.5	36.5	44.3	49.9	55.3	73.4
(15)	N - IND. PRO.	LBS/DAY	0	0	0	0	0	0
(16)	N - ADWF (14)+(15)	LBS/DAY	29.5	36.5	44.3	49.9	55.3	73.4
(17)	N - ADWF	mg/l	31	32	34	35	36	36
(18)	P - RES. + COMM	LBS/DAY	9.5	11.4	14.8	16.1	19.0	25.2
(19)	P - IND. PRO.	LBS/DAY	0	0	0	0	0	C
(20)	P - ADWF (18)+(19)	LBS/DAY	9.5	11.4	14.8	16.1	19.0	25.2
(21)	P - ADWF	mg/l	10.1	10.1	11.3	11.3	12.3	12.3

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WATER RESOURCES STUDY — METROPOLITAN SPOKANE REGION

BY BP DATE Oct. '74 SUBJECT APPENDIX III K SHEET NO. 51 OF

TASK NO. 406.2 REV. DATE Fairchild AFB FILE NO.

AVERAGE WASTE LOAD FORECAST FAIRCHILD A.F.B.

LINE	PARAMETER	UNITS	1980	1985	1990	1995	2000	2020
(1)	SERVICE POP.	PERSONS	6700	6700	6700	6700	6700	6700
(2)	RES. + COMM. FLOW	MGD	0.579	0.579	0.579	0.579	0.579	0.579
(3)	IND. TOTAL FLOW	MGD	0	0	0	0	0	0
(4)	IND. PRO. FLOW (3) X .75	MGD	0	0	0	0	0	0
(5)	ADWF	MGD	0.800	0.800	0.800	0.800	0.800	0.800
(6)	BOD - RES + COMM	LBS/DAY	1273	1273	1273	1273	1273	1273
(7)	BOD - IND PRO.	LBS/DAY	0	0	0	0	0	0
(8)	BOD - ADWF (6)+(7)	LBS/DAY	1273	1273	1273	1273	1273	1273
(9)	BOD - ADWF	mg/l	191	191	191	191	191	191
(10)	SS - RES. + COMM	LBS/DAY	1273	1273	1273	1273	1273	1273
(11)	SS - IND. PRO.	LBS/DAY	0	0	0	0	0	0
(12)	SS - ADWF (10)+(11)	LBS/DAY	1273	1273	1273	1273	1273	1273
(13)	SS - ADWF	mg/l	191	191	191	191	191	191
(14)	N - RES. + COMM.	LBS/DAY	208	208	208	208	208	208
(15)	N - IND. PRO.	LBS/DAY	0	0	0	0	0	0
(16)	N - ADWF (14)+(15)	LBS/DAY	208	208	208	208	208	208
(17)	N - ADWF	mg/l	31	31	31	31	31	31
(18)	P - RES. + COMM	LBS/DAY	67	67	67	67	67	67
(19)	P - IND. PRO.	LBS/DAY	0	0	0	0	0	0
(20)	P - ADWF (18)+(19)	LBS/DAY	67	67	67	67	67	67
(21)	P - ADWF	mg/l	10.1	10.1	10.1	10.1	10.1	101