Genre Unit 4
WATER DISTRIBUTION ANALYSIS REPORT

What is a water distribution analysis report? Why do engineers use them?

A water distribution analysis report is a common document in water resources engineering. In these reports, an engineer certifies that the design for an extension of an existing water distribution system meets all required state and local agency criteria. Having calculated how to meet those criteria, the engineer recommends minimum pipe diameters and other system components.

Every habitable structure needs water for two reasons: consumption and fire protection. Every new home or neighborhood, pharmacy or shopping center either develops its own water supply, such as a well, or, more commonly, connects to an existing water system. When a new development is connecting to an existing system, the proposed system expansion must meet consumption demands, state public health codes, and fire protection standards, and it must comply with the standards of the existing water system (set by the local water utility or government agency tasked with managing the system). Fire and water agencies, as well as state code, require a licensed engineer to certify the proposed water distribution system meets all applicable criteria. Therefore, the audience for a water distribution analysis report is engineers and technicians who review reports for the water or fire protection agencies. They may be engineers or trained technical staff from a variety of backgrounds. (If a new development creates its own new system, such as developing a new well, then a different kind of report is submitted to state boards. That kind of report is not covered here.)

A water distribution analysis report describes the reason for the water system addition, summarizes local system requirements, and makes recommendations for the distribution system. If the new development is simple, then the report can be written as a short memo (plus tables summarizing results and figures displaying the existing and proposed water systems). A new development is simple if the project:

- comprises a single land use
- lies within one political jurisdiction
- is serviced by one water pressure zone or storage tank
- is serviced by an existing water agency with established system design guidelines
- is constructed all at once – i.e., there is no phasing to the project construction.

What does a water distribution analysis report look like?

A water distribution report is usually short. Most are less than five pages of text, although complicated projects require longer reports. A water distribution analysis memo is often two or three pages. Accompanying the report or memo are a few tables along with figures showing the location of the project site and the layout of the water distribution system.

The exact contents and formatting of a water distribution analysis depend upon the requirements of the water agency reviewing the document and the report template used by the engineer's consulting firm. This unit describes a typical case, but you should remain flexible to adjust your writing to meet the requirements of specific agencies, firms, or instructors.

What goes in each section of a water distribution analysis report?

In general, a water distribution analysis report follows the same order as discussed in Language Unit 6, Sequence of Information in a Report. The content is specific to the water distribution analysis, such as the source of the water, the estimated water demand, and the recommendations for the system components. Memos follow the same order as reports.

Water Distribution Analysis Report	General Sequencing of Information from Language Unit 6
Project Description, including Project Phasing (if required)	Introduction Background
Input Data - Water Supply, Water Storage and Pumping (if required)	Data (especially Data Sources)
Analysis Data - Scenario, Criteria, Unit Demand	Data (Sources, Reporting of Data, and Interpretation of Data)
Analysis Results	Engineering Analysis or Evaluation
Conclusions and Recommendations	Conclusion Recommendations
(No limitations section)	Limitations
Figures and Tables	(Not covered in Language Unit 6)
References	
Appendix	

The following descriptions provide specific information about what is contained in each section.

1. Project Description (Introduction)

This section serves to summarize the project itself. It covers the name of the project, its owner, the total area of the project site (acres), the number of residential units, the type of structure, and the maximum square footage. The type of structure is a classification provided by the building code in force at the project site. This classification, coupled with maximum structure square footage, may determine the minimum amount of fire flow demand for the project site. However, some local agencies use other information for fire flow. In that case, structure classification and square footage data may be replaced with other relevant information.

The introduction should also clearly describe the location of the project site and include a location map. The introduction should include a reference to the location map (e.g., “See Figure 1 for the location of the project site”). Then the map should appear on the following page in the report. If a new system requires pumping or storage facilities, then these should also appear on the map even if they are not contained within the project site. Grammar & Mechanics Lesson 10 in the Civil Engineering Writing Project provides guidance on including figures and tables in reports.

Project Phasing (Optional)

Larger projects cannot be constructed all at once. As a result, it is important to describe which part of the project will be installed first, second, third, and so on. We refer to the order in which a project is built as project phasing. Project phasing can impact the performance of the system during the "interim condition" when one phase is complete but the entire project is unfinished. “Interim condition”

represents a separate analysis scenario that affects the hydraulic performance of the network and operation of the proposed storage tank and pump (if included as part of the project).

Example project descriptions for a residential housing sub-division
Project Description Autumn Hills Units 4 & 5, developments by Sheraton Homes, are located southeast of the intersection of Stetson and Rocky Road in Eagleton, Nevada. The project consists of 71 single family residential units on 10.11 acres in unit 4 and 21 additional units on 2.5 acres in unit 5. The entire project covers approximately 12.61 acres. Figure 1 shows the project site and its vicinity.
Project Description Westerly Ridge, a development by Sheraton Homes, in Anderson's Edge Pod 104C, is located southwest of the intersection of Story Road and Sorrano Road in Eagleton, Nevada. The project consists of two phases. Phase 1 will consist of 8 single-family residential units on 1.35 acres, and Phase 2 includes 161 additional units on approximately 19.1 acres for a total of 169 units on 20.45 acres for the entire site. Figure 1 shows the project site and its vicinity. The initial phase will consist of Phase 1 only. Buildout will consist of Phases 1 and 2. *NOTE: the final sentence describes the project phasing. Nothing more was needed because Figure 1 clearly showed Phases 1 and 2.*
Commentary: Project Description
Key items to note: 1. Project name and owner 2. Location of the project site relative to existing roadways or some other known landmarks 3. The size of the project including both the area and number of dwelling units 4. A reference to the Location map (e.g., Figure 1)

2. Input Data

Water Supply. A key piece of a water distribution analysis report is identifying the source of the water. The water source is the connection point to the existing water system. This connection point may be a well, pump, or storage tank, or an existing transmission pipeline located at a street intersection. The water supply description should include the pressure zone elevation for future comparison with the finished floor elevation of the proposed structures.

Water Storage and Pumping (Optional)

Most new water systems are simple additions to existing water infrastructure, but larger additions may require the installation of new pumping and storage facilities. When describing the water supply, include a description of the proposed pump and storage facilities. This description should include the elevations of the water source, the pump impeller eye, and the storage tank operating elevation (high water level and low water level).

Example descriptions of a water supply
Water Supply The project is served by the Las Vegas Valley Water District's (LVVWD's) 2975 Pressure Zone. The hydraulic grades are taken at the intersection of Story Road and Henderson and were supplied by the LVVWD.
Water Supply The project is served by the Las Vegas Valley Water District's 3205 and 3090 Pressure Zones. The 3090 Pressure Zone is serving all of Phase I and 32 units in Phase 2. The 3205 Pressure Zone is serving 129 units in Phase 2. The hydraulic grades for the 3205 Pressure Zone are taken from the intersection of the 24" lines in Lindon Lane and Chavez Road and were provided by the LVVWD. The hydraulic grade lines for the 3090 Pressure Zone are taken from the 30" lines in Sorrano Road at Showers Drive in the northeast corner of the project site.
Commentary: Water Supply
Key items to note: 1. Pressure zone elevations – this information makes checking the static head criteria easier. 2. The location where the existing system will be tapped (if not analyzing from the storage tank or pump to the proposed project site)

3. Analysis Data

Agency guidelines include the analysis scenarios to be considered, the hydraulic performance criteria, and the unit demands for each land use. The agency bases their selection of which scenarios to consider upon their interpretation of the state code. The published guidelines can vary from state to state and between agencies in the same state. As a consequence, this section of the report must clearly state the guidelines specified by the agency that you, the engineer, are certifying.

Scenario refers to the different water demands experienced by a water system throughout a given year or when suppressing a fire. This video provides more detailed information about demand scenarios. There are four scenarios commonly defined:

- Average Day (AD)
- Maximum Day (MD)
- Peak (maximum) Hour (PH)
- Maximum Day Plus Fire Flow (MD+FF).

The average day demand scenario is not used as an analysis scenario but is the basis for computing the other scenarios.

Criteria refer to the three system performance points:

- minimum residual pressure at each system junction
- maximum velocity in each pipe
- maximum unit headloss in each pipe

The specific values for each criterion vary depending upon the scenario analyzed. The minimal residual pressure at each junction provides an overview of the system performance as a whole, while the maximum velocity and maximum unit headloss criteria help assess the performance of each component (pipeline) in the system. Maximum velocity and unit headloss criteria can both be used directly for sizing individual pipelines within the system.

Unit demand is the estimate of water demand (flow) needed per "unit" (flow per housing unit, flow per area unit, or flow per capita). Unit demands vary by agency and are a result of the agency's analysis of historical water usage within their system.

For the report, the scenario, criteria and unit demands are described together in a single section, often with the heading "criteria." Each criterion can be stated in paragraph form or in a list.

Example criteria statements

Criteria

The City of Henderson Water District state the demands for this project as 1.18 gpm/unit for the maximum day demand and 1.81 gpm/unit for the peak hour demand. The static head criteria are set at a 50 psi minimum and 100 psi maximum. The minimum residual pressures for the maximum day, peak hour, and maximum day demand plus fire flow are 40 psi, 30 psi, and 20 psi respectively. All pipeline shall not exceed 7.5 ft/s, and the maximum unit headloss shall be 5.0 ft/1000 ft for the maximum day plus the fire flow scenario and 3.5 ft/1,000 ft for the peak hour scenario. The minimum fire flow required is 1,500 gpm.

Criteria – City of Henderson

A.	Water Demands	
	Maximum Day Demand	1.18 gpm/unit
	Peak Hour Demand	1.81 gpm/unit
B.	Fireflow Requirements	1,500 gpm
C.	Minimum Required Residual Pressures	
	Maximum Day Demand	40 psi
	Peak Hour Demand	30 psi
	Maximum Day Demand Plus Fireflow	20 psi
D.	Maximum Velocity	8 ft/s
E.	Maximum Unit Headloss	10 ft/1,000 ft
F.	Hydraulic Grades:	
	Maximum Day Demand	2964 feet
	Peak Hour Demand	2936 feet
	Maximum Day Demand Plus Fireflow	2964 feet

Water Demands. Using the unit demands and the proposed development land use plan, the engineer computes the system water demand and distributes the demand to nodes within the system. The writing in this section refers the reader to the table of water demands – briefly describing the columns, rows, and the units in the table. The columns are usually the junction ID (the node), number of (dwelling) units, and water demand for each scenario analyzed (e.g., MD or PH). The junction numbers listed in the water demand table must be the same as those on the maps showing the water distribution system.

Example water demand statements

Water Demands

Water demands are projected for maximum day and peak hour demand conditions. The projections, shown in Table 1, are distributed to nodes shown in Figures 2 and 3.

Table 1. Water Demand Projections - 2975 Pressure Zone

		Demands (gpm)	
Node	**Units**	**Max. Day**	**Peak Hr.**
1	5	5.90	9.05
2	5	5.90	9.05
3	5	5.90	9.05
4	6	7.08	10.86
…	…	…	…
19	6	7.08	10.86
23	1	1.18	1.81
TOTAL	**92**	**108.6**	**166.5**

NOTE: This example is a residential neighborhood, so the term "units" refers to the number of single family dwelling units serviced at that junction.

Water Demands

Water demands are projected for maximum day and peak hour demand conditions. Offsite demands for Pod 301 are accounted for in the model at J-32 and shown in Table 2. The projections in Table 2 are distributed to nodes shown in Figures 2 and 3.

[Table 2 immediately follows this paragraph; Figures 2 and 3 follow on subsequent pages.]

5. Analysis Results

This section tells the software name and version used for the analysis and states the results of the analysis. (Since the methods for analysis are set by the agency, a detailed description of the methods is usually not required.) The analysis involves selecting some initial pipeline diameters, materials and operation controls, and then computing the result in the hydraulic model. If initial results do not meet the required criteria, the engineer makes adjustments until all criteria are met before writing the results.

Even if the model meets the criteria on the first try, the engineer must make adjustments to ensure that no part of the system is overdesigned.

The analysis produces two output tables per scenario. One table will provide all of the residual pressures at each junction, and the other table reports the maximum velocity and unit headloss in each pipeline. The analysis output produces more tables if the project is built in phases or across more than one pressure zone. The engineer includes all tables in an appendix to the report.

When writing about the results, it is necessary to mention only the junction with the lowest residual pressure and the pipeline(s) with the highest velocity and unit headloss. The engineer can write this information in paragraph or list form. For more complicated projects, where the project is developed in phases or is served by two or more pressure zones, it is simpler to report the results in lists.

Example analysis results statement

Water Distribution Analysis

WaterCAD, a computer program for water distribution analysis, provides results included in the Appendix. The minimum residual pressures are 65.15 psi for the MD scenario at J-12, 52.88 for the PH scenario at J-12, and 36.85 psi for the MD+FF scenario at J-16. The maximum velocity is 5.9 ft/s in P-10. The maximum unit headloss is 4.75 ft/1000 ft and 3.22 ft/1000 ft in P-10 for both the PH and MD+FF scenarios.

Water Distribution Analysis

WCAD, a computer program for water distribution analysis, provides results included in the Appendix. The minimum residual pressures are as follows:

Build-out

3090 Pressure Zone	
Maximum Day Demand	44.62 psi
Peak Hour Demand	43.96 psi
Maximum Day Demand Plus Fireflow	41.16 psi
3205 Pressure Zone	
Maximum Day Demand	60.14 psi
Peak Hour Demand	51.05 psi
Maximum Day Demand Plus Fireflow	49.31 psi

Phase 1

Maximum Day Demand	45.45 psi
Peak Hour Demand	44.79 psi
Maximum Day Demand Plus Fireflow	39.27 psi

Note: This example comes from a report where the residual pressure was the only criterion the agency required to be analyzed.

6. Conclusion & Recommendations

Because the results section showed that the proposed water system meets the criteria, the conclusion of the report is typically just one sentence stating that the modeled system satisfies the required criteria.

The recommendations for a system state if there are any special conditions to be considered when operating the system. If the engineer modified the hydraulic model to comply with the agency criteria, those modification must be listed in this section as part of the recommendations. Examples include:

- The system is experiencing high pressures in certain areas. The engineer recommends which system connections require Pressure Reducing Valves (PRVs) based upon their elevation.
- A new commercial site requires a backflow prevention valve. The engineer recommends specific backflow prevention solutions to reduce the amount of pressure loss through the valve.
- The storage tank is sized to handle an ultimate condition but is too large for the interim condition to cycle the water every 72 hours. The engineer recommends the maximum water level in the tank during the interim condition to ensure the water cycles through the system properly.
- Pump maintenance schedules may require the pumps to shut off during certain parts of the day. The engineer recommends the optimum operating time for the pumps.

Example conclusions and recommendations sections
Conclusion Minimum residual pressures indicated by the model satisfy the required residual pressure criteria. Based on static pressure, any finished floor elevation below 3020.44 feet (80 psi) in the 3205 Pressure Zone and below 2905.44 (80 psi) in the 3090 Pressure Zone will require an individual PRV.
Conclusion Minimum residual pressures indicated by the model satisfy the required residual pressure criteria for maximum day and peak hour before the meter. For the fireflow condition, minimum residual pressures indicated by the model satisfy the required residual pressure criteria.
Conclusion Minimum residual pressures indicated by the model satisfy the required residual pressure criteria. The projects will have static pressures ranging from 70.17 psi to 74.64 psi in Unit 3 and 74.04 psi to 84.09 psi in Unit 2. Based on static pressure, any finished floor elevation below 2790.44 feet (80 psi) in the 2975 Pressure Zone will require a PRV.

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