"F"

Luhdorff and Scalmanini Consulting Engineers, Review Memo

Anthem Winery P14-00320-MOD and Exception to Road and Street Standards,
Variance P14-00321-VAR and Viewshed, and
Agricultural Erosion Control Plan P14-00322-ECPA
Planning Commission Hearing Date (Wednesday, February 5, 2020)

Luhdorff & Scalmanini
Consulting Engineers

January 27, 2020
File No. 19-1-116

Mr. Donald Barrella
Napa County Department of Planning, Building & Environmental Services
Engineering and Conservation Division
1195 Third St., #210
Napa, CA 94559

SUBJECT: Water Availability Analysis Review for the Proposed Anthem Winery, Major Use Permit Modification (P14-00320)

Dear Mr. Barrella:

In response to your request, Luhdorff & Scalmanini, Consulting Engineers (LSCE) has reviewed revised documents related to the proposed Use Permit modification (P14-00320) for the Anthem Winery, which includes an increase in permitted winery production capacity, increased vineyard acreage, and marketing program expansion (Project). The Project documentation describes three sources of water that would supply new uses: groundwater from three wells (referred to as Wells 3, 6, and 8), harvested rainwater, and reclaimed winery process water. As requested by Napa County, this letter provides a summary of the Project's Water Availability Analysis (WAA) and comments on the adequacy of the WAA.

We previously provided two rounds of peer review of the Project WAA, including the WAA Memorandum by Richard C. Slade and Associates (RCS) and the accompanying Tier 1 Water Use Calculations by RSA+. The two prior rounds of peer review are documented in a memorandum dated August 10, 2017 and a letter dated January 22, 2018. This letter addresses revisions to the Project and the WAA incorporated since the October 2018 Planning Commission hearing. Those Project revisions include:

- reductions in the proposed uses of water through reductions in the number of marketing events and reductions of landscape irrigation demands,
- reductions in the projected availability of water supplies from harvested rainwater and reclaimed winery process water, consistent with published references and County guidance.

500 First Street
Woodland, CA 95776
(530) 661-0109
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This letter provides our review of the revised WAA including revised water use calculations dated January 9, 2019.[1] Because the Project has been revised since our previous review, this letter takes precedence over our prior August 2017 memorandum and January 2018 letter.

SUMMARY OF REVISED PROJECT WAA FINDINGS

Since the October 2018 Napa County Planning Commission hearing, the WAA has been revised to reflect a reduction in the proposed water use and reductions in the projected availability of water supplies from rainwater harvesting and winery process water reclamation.

As part of the Tier 1 analysis, the WAA estimates all current and future water use on the Project parcels. The WAA also identifies sources of supply that will meet the Project water demands, including through a parcel-specific analysis of groundwater recharge. The WAA evaluates groundwater recharge potential on the Project parcels and concludes that average annual recharge to groundwater is 11.02 acre-feet/year (AF/yr) and 5.49 AF/yr in during drought periods. The analysis of groundwater recharge potential is unchanged from the version presented to the Planning Commission in October 2018.

Total current and proposed uses of groundwater on the Project parcels is expected to be 4.71 AF/yr in average years and 5.40 AF/yr in dry years, proposed production of groundwater across all three Project wells is 0.92 acre-feet (AF) in average years and 1.61 AF in dry years (**Table 1**). While this suggests that the proposed use of groundwater would not exceed an amount that would result in long-term reductions of groundwater levels or depletions of groundwater storage, the WAA also demonstrates, through aquifer testing at the three Project wells, that Project groundwater use would be operationally constrained by the effective pumping capacity of the Project wells. The WAA accounts for the physical constraints on Project well capacity, in part by reducing the proposed uses of water proposing to develop new sources of supply from harvested rainwater and reclaimed winery process water.

[1] RSA+, "Tier 1 Water Use Calculations *for Anthem Winery, 3454 Redwood Rd, Napa, CA*" revised, January 9, 2019. Prepared for Julie Arbuckle.

Table 1. Applicant-Estimated Existing and Proposed Water Use by Source of Supply (Acre-Feet/Year)

	Groundwater (GW)				Reclaimed Process Wastewater	Harvested Rainwater	Total
	Non-Project		Project	Total GW			
	4	1,5,7	3,6,8				
Existing Use – Average Year (WAA)	0.15	3.64	0.60	4.39	0	0	4.39
Proposed Project – Average Year (WAA)	0.15	3.64	0.92	4.71	0.69	1.32	6.72
Proposed Project – Dry Year (WAA)	0.15	3.64	1.61	5.40	0.69	0.63	6.72

The revised WAA reflects reductions in the proposed uses of water for marketing events and visitation and new landscaping. In total, the proposed use of water by the Project has been reduced by 0.32 AF/yr. As a result, the planned water use for winery and hospitality activities is 1.6 AF/yr, reduced from 1.92 AF/yr in the version of the Project reviewed in October 2018 (**Table 2**).

Table 2: Proposed Anthem Winery – Water Uses by Type (Acre-Feet/Year)

	Residential	Vineyard	Winery/ Hospitality	Total
Existing Project				
Parcel 1 (APN: 035-460-038)	0.75	0	-	0.75
Parcel 2 (APN: 035-470-046)	0.75	2.89	0	3.64
			Total	**4.39**
Proposed Project				
Parcel 1 (APN: 035-460-038)	0.75	0.62		1.37
Parcel 2 (APN: 035-470-046)	0.75	3.00	1.60	5.35
			Total	**6.72**

Revisions to the WAA incorporated since the October 2018 Planning Commission hearing also reflect more limited projections of water availability from the proposed new sources: rainwater harvesting and winery process water reclamation. The availability from rainwater harvesting has been reduced to account for inefficiencies and losses consistent with guidance from the American Rainwater Catchment Systems Association (ARCSA).[2] Specifically, the revised WAA anticipates that the Project will be able to capture and reuse 85% of rainfall received in average years and dry years. The revised WAA also anticipates that the Project will be able to reclaim and reuse 90% of winery process water, consistent with public comments received at the October 2018 Planning Commission hearing.

The revised Tier 1 water use calculations, provided as part of the WAA, includes tables showing the monthly project water balance by source of supply and type of use.[3] These water balance summaries also show how water from each of the three sources (groundwater, harvested rainwater, and reclaimed process water) will be stored to facilitate use of water to meet demands that occur after the water is collected. The proposed water storage capacity of 480,000 gallons is sufficient to contain the projected maximum single month storage requirement of approximately 346,000 gallons in average years and 265,000 gallons in dry years (**Table 3**).

Table 3: Proposed Anthem Winery –Projected Maximum Water Storage (Gallons)

	Average Year (Gallons)	Dry Year (Gallons)
Maximum Groundwater Storage	0	39,102
Maximum Reclaimed Process Water Storage	113,387	113,387
Maximum Harvested Rainwater Storage	233,768	113,261
Maximum Single Month Total Storage, All Sources	346,022 (April)	264,895 (April)

COMMENTS RECEIVED ON THE WATER AVAILABILITY ANALYSIS

Several commenters who own, or have recently owned parcels, with water supply wells near the Project parcels have noted their experiences with dry wells, declining well yields over time, and limited well yields. Comments about the limited yield of wells on other parcels are consistent, anecdotally, with the

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[2] Boulware, E.W.B. 2009. "*Rainwater Catchment Design and Installation Standards*". American Rainwater Catchment Systems Association. August 28, 2009.

[3] RSA+, "Tier 1 Water Use Calculations *for Anthem Winery, 3454 Redwood Rd, Napa, CA*" revised, January 9, 2019. Prepared for Julie Arbuckle.

findings of the aquifer testing performed by RCS for the Anthem Winery WAA. In the case of APN 035-460-036, which adjoins the Anthem parcels, commenters described two “dry wells”. Public Well Completion Reports show that there were two dry test holes drilled in 2004 and 2009, but both test holes were abandoned at the time of drilling rather than being converted to completed wells. See Well Completion Reports E0099860 and E013575, Attachment A. This distinction is important because a dry borehole or test well that is never converted to a functional well is quite different from an operational well that ceases to function. The proposed Conditions of Approval for the Anthem Winery account for the likelihood that groundwater availability may be vary from one location to another by requiring that future sources of water (including wells not analyzed as part of the WAA) be evaluated if needed to supply the project in the future.

The Anthem Winery WAA acknowledges that well yields estimated by well drillers through short-term airlift tests lasting only a few hours typically overstate long-term well yields and do not provide useful data for evaluating aquifer parameters. These limitations are also noted in the County’s WAA Guidance Document. The Anthem Winery WAA does not rely on well yields estimated by well drillers in the determination of the available groundwater supply for the Project. Instead, the Anthem Winery WAA uses measured groundwater production data collected at the three project wells during controlled tests to support the determination of pumping capacities for each well and for the three wells in combination. That approach is consistent with the County’s WAA Guidance Document.

Actual well yields may vary with time due to various factors including changing groundwater levels in the wells, the condition of the pump installed in the well, and the condition of the well. For the Anthem Winery WAA, several sources of information were used to evaluate the availability of groundwater, these include well yields estimated from aquifer testing conducted for the WAA calculated groundwater recharge rates, and a calculated total groundwater storage volume potentially accessible by the project wells.

CONCLUSION

The extent of peer review provided for this project reflects the relatively limited water supply available for the Project. While water supply constraints are not unique to this Project, the Project has received additional scrutiny due to the relatively limited capacity of the Project wells documented by the WAA, the reliance on estimates of water use for existing uses, and the proposal to develop new sources of supply from harvested rainwater and reclaimed winery process water to meet the majority of new water demands.

The revised Project incorporates more limited projections of the availability of water from harvested rainwater and reclaimed winery process water than were initially proposed. The revised Project also incorporates reductions in the proposed uses of water through reductions in the number of marketing events and reductions of landscape irrigation demands. Information provided as part of the WAA show that projected water supplies will likely be sufficient to meet the proposed demands under average year and dry year conditions. Through the implementation of project-specific conditions of approval, the

County will be able to verify that the Project is able to realize the proposed sources of supply consistent with the WAA.

We appreciate the opportunity to provide this review. If you have any questions, or wish to discuss any of the above, we would be pleased to respond.

Sincerely,

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

Reid Bryson
Senior Hydrologist

Enclosure

CC: Vicki Kretsinger Grabert, LSCE

35-460-36

ORIGINAL
File with DWR
Page 1 of 1

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. **e0099860**

Owner's Well No. TH#1-'09
Date Work Began 10/6/2009, Ended 10/12/2009
Local Permit Agency Napa County Environmental Mgmt
Permit No. E09-00448 Permit Date 10/6/2009

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ROTARY FLUID AIR

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION Describe material, grain, size, color, etc.
0	20	BROWN CLAY
20	60	SHALE
60	75	SHALE & CLAY
75	100	SHALE
100	225	SHALE & CLAY
225	230	SHALE & SANDSTONE
230	240	SHALE
240	275	HARD SHALE
275	330	SHALE
330	360	HARD SHALE
360	385	SHALE & CLAY
385	400	HARD SHALE
400	430	SHALE & CLAY
430	560	SOFT SHALE
560	660	SHALE
660	780	SHALE & CLAY

TOTAL DEPTH OF BORING 780 (Feet)
TOTAL DEPTH OF COMPLETED WELL ______ (Feet)

WELL OWNER

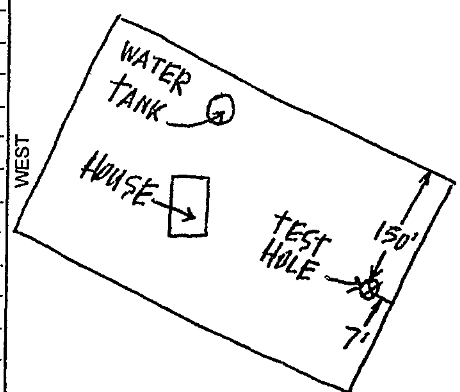
Name [redacted]
Mailing Address [redacted]
CITY STATE ZIP

WELL LOCATION

Address 3099 Dry Creek Road
City Napa CA
County Napa
APN Book 035 Page 460 Parcel 030
Township ____ Range ____ Section ____
Latitude ____ DEG. MIN. SEC. Longitude ____ DEG. MIN. SEC.

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH



Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
— Deepen
— Other (Specify)
— DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ✓
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

1

DEPTH TO FIRST WATER ____ (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL ____ (Ft.) & DATE MEASURED ____
ESTIMATED YIELD * 0 (GPM) & TEST TYPE AIR LIFT
TEST LENGTH ____ (Hrs.) TOTAL DRAWDOWN ____ (Ft.)
May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	780	9								

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	3			✓	SOIL
3	31		✓		CHIPS
31	780			✓	PEA GRAVEL

ATTACHMENTS (✓)

— Geologic Log
— Well Construction Diagram
— Geophysical Log(s)
— Soil/Water Chemical Analysis
— Other ______

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME HUCKFELDT WELL DRILLING, INC.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

2110 Penny Lane, Napa, CA 94559
ADDRESS CITY STATE ZIP

Signed [signature] WELL DRILLER/AUTHORIZED REPRESENTATIVE
10/19/09 DATE SIGNED
439-746 C-57 LICENSE NUMBER

DWR 188 REV. 11-97
IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

35-460-30

ORIGINAL
File with DWR
Page 1 of 1

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. **e013575**

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE | LONGITUDE

APN/TRS/OTHER

Owner's Well No. TW #1-'04

Date Work Began 5/17/2004, Ended 5/20/2004

Local Permit Agency Napa County Environmental Mgmt

Permit No. 96-12577 Permit Date 12/17/2003

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD ROTARY FLUID AIR

DEPTH FROM SURFACE Ft. to	Ft.	DESCRIPTION Describe material, grain, size, color, etc.
0	20	BROWN CLAY
20	199	90% SHALE/ 10% CLAY
199	205	SANDSTONE
205	400	SHALE & CLAY
400	460	CLAY
460	600	60% SHALE/ 40% CLAY
		BACKFILLED TEST WELL WITH PEA GRAVEL
		TO 35'. INSTALLED BENTONITE CHIPS
		TO 5'. CONCRETE TO 3'. NATURAL MATERIAL
		TO SURFACE.

RECEIVED
JUN - 1 2004
DEPT. OF ENVIRONMENTAL MANAGEMENT

TOTAL DEPTH OF BORING 600 (Feet)

TOTAL DEPTH OF COMPLETED WELL ___ (Feet)

WELL OWNER

Name [redacted]

Mailing Address [redacted]

[redacted]

CITY STATE ZIP

WELL LOCATION

Address 3099 Dry Creek Road

City Napa CA

County Napa

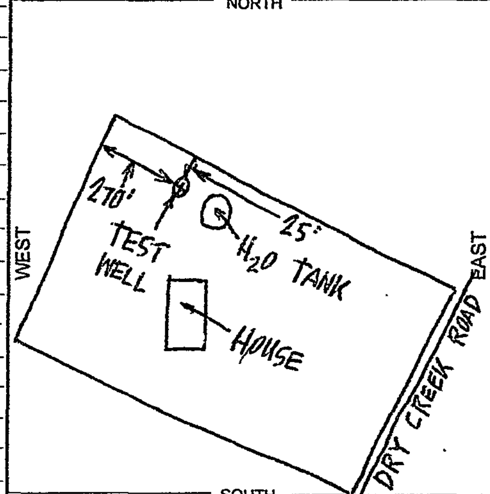
APN Book 35 Page 460 Parcel 30

Township ___ Range ___ Section ___

Latitude ___ DEG. MIN. SEC. Longitude ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH



WEST | EAST

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
— Deepen
— Other (Specify)

— DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)

WATER SUPPLY
— Domestic — Public
— Irrigation — Industrial

MONITORING —
TEST WELL ✓
CATHODIC PROTECTION —
HEAT EXCHANGE —
DIRECT PUSH —
INJECTION —
VAPOR EXTRACTION —
SPARGING —
REMEDIATION —
OTHER (SPECIFY) —

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL ___ (Ft.) & DATE MEASURED ___

ESTIMATED YIELD * ___ (GPM) & TEST TYPE ___

TEST LENGTH ___ (Hrs.) TOTAL DRAWDOWN ___ (Ft.)

May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft. to	Ft.	BORE-HOLE DIA. (Inches)	BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	600	9								

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to	Ft.	CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	3			✓	SOIL
3	5	✓			CONCRETE
5	35		✓		CHIPS
35	600			✓	GRAVEL

ATTACHMENTS (✓)

— Geologic Log
— Well Construction Diagram
— Geophysical Log(s)
— Soil/Water Chemical Analysis
— Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME HUCKFELDT WELL DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

2110 Penny Lane Napa CA 94559
ADDRESS CITY STATE ZIP

Signed [signature] 05/26/04 439-746
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

RAINWATER CATCHMENT DESIGN

AND

INSTALLATION STANDARDS

by

Chairman
E. W. Bob Boulware, P.E.

Contributors:
Timothy Pope - Dennis Lye, PhD- Billy A. Kniffen
Joseph Wheeler - William Morris - Richard Jennings
Jack Shultz, P.E.- Will Ed Winters, P.E. - Cado Daily- John Kight, P.E.

August 28, 2009

ARCSA
AMERICAN RAINWATER CATCHMENT SYSTEMS ASSOCIATION

ASPE

RAINWATER CATCHMENT DESIGN AND INSTALLATION STANDARDS

TABLE OF CONTENTS

1.0 SCOPE

1.1 General

1.1.1 Rainwater Catchment System is defined as a system that utilizes the principal of collecting and using precipitation from a rooftop or other manmade, above ground collection surface.

1.1.2 This Rainwater Catchment Design and Installation Standard, (hereinafter referred to as the *Standard*) has been developed by a joint effort of the American Rainwater Catchment Systems Association (ARCSA) and the American Society of Plumbing Engineers (ASPE). The purpose of this standard is to assist engineers, designers, plumbers, builders / developers, local government, and end users in safely implementing a rainwater catchment system. This standard is intended to apply to new rainwater catchment installations, as well as alterations, additions, maintenance and repairs to existing installations.

1.1.3 The standards mentioned herein are intended to be consistent with, and complimentary to, the requirements of the Uniform Plumbing Code, International Plumbing Code, National Institute of Health, and local Board of Health. However, installers are advised to consult with the plumbing authority regarding local conditions, requirements and restrictions.

1.2 PERFORMANCE OBJECTIVES

1.2.1 Rainwater systems are capable of producing high quality water, to levels meeting public utility standards, but only if properly maintained by the system owner or operator. The objectives of this Standard are to provide guidance in how to provide and maintain a healthy alternative to utility provided water, and to optimize rainwater utilization, while ensuring that:

A. Consumers of rainwater are safeguarded from illness as a consequence of poor design, installation, maintenance or illegal work.

B. The public is safeguarded from injury or loss of amenity due to a failure of the supply, installation, maintenance, or operation of the rainwater catchment system.

C. The Rainwater System will serve to maintain and enhance the quality of the environment while ensuring compliance with the intent of relevant regulations and government officials.

1.2.2 This Standard applies to the following applications

A. Non-Potable

B. Potable

C. Fire Protection

D. Agricultural

E. Industrial

1.3 UNITS OF MEASUREMENT

1.3.1 Values are stated in U.S. Customary Units and shall be considered as the standard.

1.4 RELATED STANDARDS

1.4.1 NSF International Protocol P151: Health Effects From Rainwater Catchment System Components.

1.4.2 NSF / ANSI 61: Drinking Water System Health Effects.

End of Section

2.0 ACCEPTABLE MATERIALS AND COMPONENTS

2.1 General

2.1.1 The following standards are referenced in this document.

2.1.2 The listing of a reference in this consensus standard shall imply the application of the latest issue, revision or affirmation, including all referenced documents listed therein.

2.2 Related Standards

2.2.1 American National Standards Institute (ANSI)

A. ANSI A21.10 — ANSI Standards for Ductile-Iron and Gray-Iron Fittings.

B. ANSI B16.22 — Wrought Copper and Copper Allow Solder Joint Pressure Fittings.

2.2.2 ASTM International (ASTM)

A. ASTM B 32 — Specifications for Solder Metal.

B. ASTM B 75 — Specifications for Seamless Copper Tub.

C. ASTM B 828 — Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings

.

D. ASTM B 638 — Test Method for Tensile Properties of Plastics.

E. ASTM B 695 — Test Method for Compressive Properties of Rigid Plastics.

F. ASTM D 1599 — Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tube and Fittings.

G. ASTM D 1600 — Terminology for Abbreviated Terms Relating to Plastics.

H. ASTM 1785 — Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedule 40, 80, and 120.

I. ASTM D 2104 — Specification for Polyethylene (PE) Plastic Pipe, Schedule 40.

J. ASTM D 2241 — Specification for Poly Vinyl Chloride (PVC) Pressure Plastic Pipe.

K. ASTM D 2282 — Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR).

L. ASTM 2466 — Standard Specification for Poly Vinyl Chloride (PVC) Plastic Fittings, schedule 40.

M. ASTM 2467 — Standard Specification for Poly Vinyl Chloride (PVC) Plastic Fittings, Schedule 80.

N.	ASTM D 2447	Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
O.	ASTM D 2468	Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40.11
P.	ASTM D 2657	Practice for Heat-Joining Polyolefin Pipe and Fittings.
Q.	ASTM D 2661	Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
R.	ASTM D 2665	Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
S.	ASTM D 2855	Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
T.	ASTM D 2949	Specification for 3.25-in. Outside Diameter Poly (Vinyl Chloride)(PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
U.	ASTM D 3261	Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
V.	ASTM D 3311	Specification for Drain, Waste, and Vent (DWV) Plastic Fittings.
W.	ASTM D 3350	Specification for Polyethylene Plastics Pipe and Fittings Materials.
X.	ASTM E 84	Test Method for Surface Burning Characteristics of Building Materials.
Y.	ASTM E 412	Terminology Relating to Plastic Piping Systems.
Z.	ASTM F 628	Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core.
Aa.	ASTM F 714	Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
Bb.	ASTM F 1866	Specification for Poly (Vinyl Chloride) (PVC) Plastic Schedule 40 Drainage and DWV Fabricated Fittings.
Cc.	ASTM F 1901	Specification for Polyethylene (PE) Pipe and Fittings for Roof Drain Systems.

2.2.3 American Water Works Association (AWWA)

A.	AWWA C110	Standard for Ductile-Iron and Gray-Iron Fittings, 3 in.- 48 in. (76 mm-1,219 mm), for Water C606 Grooved and Shouldered Joints.
B.	AWWA C.606	Grooved and Shoulder Joints.

2.2.4 Cast Iron Soil Pipe Institute (CISPI)

A. CISPI 301

B. CISPI 310 Specification for Couplings for Use In Connection With Hubless Cast Iron Soil Pipe and Fittings For Sanitary and Storm Drain Waste and Vent Piping Applications.

2.2.5 American Society of Mechanical Engineers (ASME)

A. ASME A 112.6.4 Roof, Deck and Balcony Drains.

2.2.6 Copper Development Association (CSA)

A. Copper Tube Handbook.

2.2.7 Crane Technical Paper No. 410, - Flow of Fluids Through Valves, Fittings and Pipe,@ 1988.

2.2.8 International Organization for Standardization (ISO)

A. ISO 899 Plastics- Determination of Tensile Creep Behavior.

2.2.9 National Weather Service

A. NWS HYDRO-35 Five to Sixty Minute Precipitation Frequency of the Eastern and Central United States.

B. National Climate Data Center http://www.ncdc.noaa.gov/oa/ncdc.html

2.2.10 NOAA Technical Memorandum

A. NOAA Short Duration Rainfall Frequency Relations for California.

B. NOAA Short Duration Rainfall Frequency Relations for the Western United States.

2.2.11 NSF International

A. Protocol P151: Health Effects from Rainwater Catchment System Components.

B. NSF / ANSI Standard 14: Plastic Piping System Components and Related Materials.

C. NSF / ANSI Standard 42: Drinking Water Treatment Units--Aesthetic Effects.

D. NSF / ANSI Standard 53: Drinking Water Treatment Units-- Health Effects.

E. NSF / ANSI Standard 55: Ultraviolet Microbiological Water Treatment Systems.

F. NSF / ANSI Standard 58: Reverse Osmosis Drinking Water Treatment Systems.

G. NSF / ANSI Standard 60: Drinking Water System Chemicals Health Effects.

H. NSF / ANSI Standard 61: Drinking Water System Components Health Effects

2.2.12 American Public Health Association

A. Standard Methods for the Examination of Water and Wastewater.

End of Section

3.0 DESIGN AND INSTALLATION REQUIREMENTS

3.1 Collection Parameters.

3.1.1 All piping and plumbing component materials used in the installation of a rainwater harvesting system shall be as approved for the specific use per local plumbing code, or be listed by an ANSI accredited product certification program as available.

A. Collection roofing, gutters, piping, fittings, valves, screens, down spouts, leaders, flushing devices, tanks, and liners, shall be approved for the intended use.

B. All tank interior surfaces, and equipment shall be washed clean before they are put into service.

C. For water storage volumes less than 360 gallons (1,363 liters), or intended for minor utility, irrigation and garden use, no treatment is required.

D. Water level control devices that control pumps, makeup water valves, etc, in contact with the water supply, shall be mercury free devices.

E. Overhanging vegetation and proximity to air borne pollution sources are to be avoided.

F. These standards do not apply to the collection of rainwater from vehicular parking or other similar surfaces.

3.1.2 For non-potable water applications,

A. The collection surface may be constructed of any above-ground, hard surface, impervious material.

B. Harvested rainwater must be filtered or treated to an appropriate quality suitable for intended use. No treatment is required for sub surface irrigation, agricultural, or garden use. For above surface Irrigation, the local authority having jurisdiction should be consulted regarding required water quality.

3.2 Conveyance System

3.2.1 The Roof Drainage System. Gutters and downspouts used to collect rainwater shall comply with the following:

A. All piping, plumbing components, and material used shall be manufactured of material approved for the intended application, conforming to the standards described herein in Chapter 2, and meeting the intent of applicable Building and Plumbing Codes.

B. Gutter and down spout systems leading to the cistern shall be fitted with debris excluder or equivalent device.

3.2.2 Washers and Pre-filtration. All collected rainwater, for potable water application, shall pass through a roof washer or pre-filtration system before the water enters the cistern(s). Roof washer systems shall meet the following design requirements:

A. A sufficient amount of rainwater shall be wasted, and not allowed to enter the cistern, to wash accumulated debris from collection surface. Approximate amount of rainfall to be wasted shall be adjustable as necessary to minimize cistern water contamination. (See Chapter Five, *Acceptable Piping Schematics*, for guidance in determining pre-wash water volume)

B. The inlet to the roof washer shall be provided with a debris screen that protects the roof washer from the intrusion of waste and vermin. The debris screen shall be corrosion resistant and shall have openings no larger than 0.5 inches and no smaller than 0.25 inches nominal. Pre-filters which have a self-cleaning design are not required to have the aforementioned debris screen.

Exception: This item is not required for pre-filters which provide their own method of diverting the prescribed first flush.

C. Water drained from the first-flush diverter or pre-filter will be piped away from the storage tank and terminate in a location which will not cause damage to property or cause erosion.

D. If more than one cistern is used a screen, roof washer or pre-filtration system shall be provided for each cistern.

Exception: Where cisterns are interconnected to supply water in series, a single pre filter will be permitted

E. First flush diverters and pre-filters shall be provided with an automatic means of self draining between rain events.

F. Roof washers shall be readily accessible for regular maintenance.

G. Pre-filtration screens or filters shall be maintained consistent with manufacturer's specifications.

3.3 CISTERNS / STORAGE. The following are the minimum requirements for cisterns:

3.3.1 General:

A. Cisterns may be used as storm-water collection points that help to minimize flood damage, while providing a reservoir for later use. Cisterns shall have access to allow inspection and cleaning.

3.3.2 Installation:

A. Cisterns may be installed either above or below grade

B. Tank shall comply with the Administrative Authority having jurisdiction, local building codes and ordinances, and / or as certified by a structural engineer.

C. Above grade plastic tanks shall be certified by the manufacturer for intended application.

D. Above grade cisterns shall be protected from direct sunlight and shall:

1. Be constructed using opaque, UV resistant, materials: i.e. heavily tinted plastic, lined metal, concrete, wood, or painted to prevent algae growth,

   or

2. Have specially constructed sun barriers e.g. installed in garages, crawlspaces, sheds, etc.

E. Below grade cisterns, located outside of the building, shall be provided with manhole risers a minimum of 4 inches above surrounding grade and / or installed in such a way as to prevent surface or ground water from entering through the top of any fittings.

F. Where the installation requires a foundation, the foundation shall be flat and shall be designed to support the cistern weight when the cistern is full consistent with bearing capability of adjacent soil.

G. In areas where sustained freezing temperatures occur, provisions will be made to keep cistern and the related piping from freezing.

H. All cisterns shall be installed in accordance with the manufacturer's installation instructions.

1. Underground tanks shall comply with OSHA's construction Industry Standards Part 1926 Subpart P, Fall protection rules and regulations and any local codes relating to excavation and backfill technique or safety.

2. Above grade tanks shall be installed on a sturdy and level, foundation or platform, adequately secured with adequate drainage.

I. In a situation where the soil can become saturated, an underground tanks shall be ballasted, or otherwise secured, to prevent the tank from floating out of the ground when empty. The combined weight of the tank and hold down ballast should meet or exceed the buoyancy force of the tank, calculated as follows:

Example:

1. Buoyant force of Cistern (lbs) =

Cistern Volume (cubic feet) x 62.4 (lbs / cubic foot) e.g.

For 1000 gallon tank, Buoyant force will be 1000 gallons x (1 cubic foot / 7.48 gallons) x 62.4 (lbs / cubic foot

= 8342 lbs

2. If concrete used as ballast, the volume needed will be:

Volume (cubic feet) = 8342 lbs x cubic feet / 150 lbs

= 55.6 cubic feet (2.1 cubic yards)

J. Cisterns shall be provided with a means for draining and cleaning.

K. All cistern openings shall be protected from unintentional entry by humans or vermin. Manhole covers shall be provided and shall be secured to prevent tampering.

1. Where an opening is provided that could allow the entry of personnel, the opening shall be marked,

“DANGER - CONFINED SPACE@.

3.3.3 Inlets, Outlets and Openings.

A. Cistern inlets shall be provided to permit water to enter tank with minimum turbulence.

B. The overflow outlet, or flap valve, shall be protected with a screen having openings no greater than 0.125 inches, or as otherwise appropriate, for preventing entrance of insects or vermin entering the cistern.

1. Overflow outlet shall be sized in accordance with prevailing gutter and down spout requirements.

2. Water from the cistern overflow shall be discharged in a manner consistent with local storm water runoff requirements and as approved by the local authority having jurisdiction, or may be allowed to infiltrate excess collected water into the aquifer.

3.4 PUMP.

3.4.1 Where a pump is provided in conjunction with the rainwater harvesting system, the pump shall meet the following provisions:

A. The pump and all other pump components shall be listed and approved for use with potable water systems.

B. The pump shall be capable of delivering a minimum of 15 psig residual pressure at the highest and / or most remote outlet served. Minimum pump pressure shall allow for friction and other pressure losses. Maximum pressures shall not exceed 80 psig. A pressure reducing valve shall be provided at water branch distribution piping if the pump is capable of exceeding 75 psig.

3.5 FILTRATION. Filtration shall meet the following provisions

3.5.1 Where rainwater is used for non-potable use and for non critical operations, such as irrigation, wash down, etc., a final stage filtration system is not required.

3.5.2 Where rainwater is used for non-potable use, interior to an occupied facility, for makeup for laundry, toilets, process, etc.; the water is to be filtered as a safeguard against sediment or discoloration, and for proper operation of valves or other devices.

3.6 PIPING

3.6.1 There shall be no direct connection of any rainwater harvesting pipe system and a public utility- provided domestic potable water pipe system without an approved back flow device.

3.6.2 Separation shall be maintained between potable and non potable water systems at all times. Cross connections, without proper protection in accordance with local applicable plumbing code, will not be permitted.

A. All material used as part of a rainwater harvesting system shall be as listed for the purpose intended, as designated by local applicable code.

B. Where rainwater harvesting pipe and potable water pipe are installed in the same trench, wall cavity, or other location, the potable water pipe shall be separated by a minimum distance of twelve inches (12") above the rainwater - harvesting pipe. Both pipes shall be installed below local frost depth.

3.6.3 Piping Materials.

A. Rainwater distribution water piping, fittings and other related system components shall be suitable for domestic water application as indicated in the applicable local building and / or plumbing code, or as otherwise described in Section 2.

B. Plastic piping shall be protected from UV radiation by a factory apply protective coating, or painted with a compatible latex paint. Piping and solvent cements shall be approved for the intended use.

3.6.4 Labeling. If a Rainwater Harvesting System is applied to any building, facility or residence, it shall be so indicated as follows:

A. All rainwater supplied fixtures, not specifically treated for potable water use, shall be prominently labeled

“NON-POTABLE - DO NOT DRINK@

B. Non-potable water piping shall be designated by colored bands and solid color piping as specified by the authority having jurisdiction or national code agencies, and labeled:

ANON POTABLE - RAINWATER”

C. Outlets and fixtures served with harvested rainwater shall be easily recognizable by color or a symbol for non-potable water.

3.6.5 Inspections. Rainwater harvesting systems are considered a private water system under the responsibility of the building owner / operator, and shall be minimally inspected according to the following schedule:

A. Inspection of all elements before they are covered (rough-in inspection)

B. Final inspection including testing.

C. In addition to testing required by the code for plumbing systems, the following also apply:

1. Testing and Commissioning

2. Piping. A flow test shall be preformed through the system to the point of water distribution and disposal. In addition, the water distribution system shall be tested and proved tight at the operating pressure. Where the manufacturer permits, a 50-psi hydrostatic test may substitute for the test above. All lines and components shall be watertight.

D. Other inspections as needed to assure proper system operation.

3.6.6 System Maintenance. It is the property owner's responsibility to maintain the system components according to manufactures written recommendations.

3.6.7 Rainwater harvesting systems shall be maintained in functioning order for the life of the system.

A. Filtration and Disinfection systems shall be serviced in accordance with manufactures recommendations.

B. System Abandonment. If the owner of a rainwater harvesting system elects to cease use of, or fails to properly maintain such system, they shall abandon the system. To abandon the system, the system owner shall minimally:

1. Remove or disable all system connecting piping to utility provided water system..

2. Replace the rainwater harvesting pipe system with an approved potable water supply pipe system. Where an existing potable pipe system is already in place, fixtures may be re-connected to the existing system.

3. Secure cistern from accidental access by sealing or locking tank inlets and access points, and / or filling with sand or equivalent.

3.7 POTABLE RAINWATER APPLICATIONS

3.7.1 Collection Surfaces for potable water applications shall be as noted in 3.1.1 above but shall also be made of non-toxic material.

A. Painted surfaces are only acceptable if paint has been certified to ensure the toxicity level of the paint is acceptable for drinking water contact. Lead, chromium or zinc based paints are not permitted.

B. Enameled Steel.

C. Flat Roofs: Roof products shall be certified to NSF Protocol P151.

D. Collection of water from vehicular parking surfaces is prohibited.

Not approved for potable water

E. Wood / Cedar shake roofing.

F. Copper roofing materials.

G. Lead flashing is not approved for potable water.

Not Recommended for Potable Water or to be used with caution.

H. Bitumen / Composition roofing.

I. Galvanized, zinc-coated metal.

3.7.2 Cistern Inlets:

A. Methodology of water entering cistern shall be to maintain A quiet flow A in the cistern by minimizing splashing and disturbance of sediment in bottom of cistern.

B. For potable water applications, and recommended for maintaining good water quality, the pipe entering the cistern shall terminate in a return bend elbow pointed upward at the bottom of the tank, or equivalent calming device.

3.7.3 Cistern outlets shall be provided with floating inlet to draw water from the cistern just below the water surface.

A. Alternate: Cistern outlet to be located at least 4 inches above the bottom of the cistern.

3.7.4 Cisterns shall be intended for potable water use.

A. Cisterns shall be certified for use with potable water with NSF, or recognized equivalent. Plastic tanks shall be constructed of virgin plastic and shall adhere to requirements of NSF / ANSI Standard 61.

B. Cisterns shall not be connected directly to a public or community water supply without approved back-flow protection. Make-up water to rainwater storage tanks, when provided, may be made through a reverse pressure principle back flow device or an air gap per local plumbing codes.

C. If installed below grade, cisterns shall be separated from sanitary waste piping a distance as recommended by local authority having jurisdiction, or local plumbing codes, and up gradient from septic field piping where applicable.

3.7.5 Filtration

A. Carbon filtration may be provided for reduction of taste, odor and organic chemicals.

B Filtration and Disinfection systems shall be located after water storage tank and as close to the final point of use as possible.

C. All particulate filtration shall be installed upstream of disinfection systems.

D. Filters shall be adequate size to extend service time and must be comply with NSF / ANSI Standard 53.

3.7.6 Water Disinfection

A. Chlorination: Chlorination may be used with an automated demand feed system, and if used, shall enable adequate contact time and residual according to local health authorities.

B. Ozone: Ozone may be used with an approved ozone system ensuring adequate contact time with the ozone. Provision must be made to off- gas ozone to a safe environment.

C. Ultra-violet disinfection may be used and shall be provided between final filtration (5 micron maximum) and final point of use.

3.7.7 Operation and Maintenance

A. After several cycles of rain harvesting, a initial sample of the resultant accumulated water shall be tested for compliance according to procedures listed in the latest edition of Standard Methods for the Examination of Water and Wastewater (ALPHA).

B. For a Private System, prior to placing the water system into service, water quality testing, at a minimum shall be performed for E. Coli, Total Coliform, and heterotrophic bacteria. Subsequent periodic testing to assess the ongoing integrity of ths system is recommended.

C. For a Public System (defined as a system where 25 different persons consume water from the system over a 60 day period):

1. In addition to the above tests, water shall be tested for cryptosporidium.

2 Subsequent annual tests shall be made for Total Coliform, E Coli, Heterotrophic bacteria and any chemicals of concern.

3 Records of test results shall be maintained for at least two (2) years.

End of Section

4.0 DEFINITIONS

In addition to definitions used in the Uniform and International Plumbing Codes, the following definitions apply to rainwater harvesting systems:

1. AUXILIARY SUPPLY:	Water supply that is arranged and protected from contamination that is available to provide an alternate means of filling a cistern.
2. CALMING INLET:	A device that permits water to enter a storage tank with minimal disturbance to particles that may have settled to bottom of the tank. See Quiescent Flow.
3. CISTERN :	The central storage component of the rainwater harvesting system. Protection and maintenance of the cistern is essential for the health of the system.
4. CODE:	Refers to the local written authority i.e. the Uniform Plumbing Code, International Plumbing Code, NSF International, etc.
5. COLLECTION AREA:	Area from which rainwater is collected for use in a rainwater harvesting system (e.g. roof area).
6. DEBRIS EXCLUDER:	A screen or other device installed on the gutter or down spout system to prevent the accumulation of leaves, needles, or other debris in the system.
7. DISINFECTION:	Reduction of viable micro-organisms to a level that is deemed suitable for the intended application. Typical units of measure are Colony Forming Units per deca-liter (cfu / dl).
8. DRY RUN PROTECTION:	System for protecting the water pump against running dry.
9. EVAPORATION FIELD:	Element in the ground that is filled with gravel, ballast or special non-permeable plastic elements and that stores rainwater that is fed into it on an intermediate basis before the water evaporates into the atmosphere or seeps into the surrounding soil.
10. FILTRATION:	Physical removal of liquid-borne contaminants by means of separation from the output flow. Particulate filtration removes suspended particles (measured in units of Total Suspended Solids (TSS); while other forms of filtration, such as carbon / absorption filtration, removes dissolved compounds measured in units of Total Dissolved Solids (TDS).

11. GROUND WATER: Water that saturates into the ground and no longer flows across the surface, it is considered "Groundwater"

12. FIRE SPRINKLER RESERVE: Volume of water needed for fire protection that is not available for any other use and accessible only by the fire pump

13. FLAT: Having a slope no greater than 1 in 50.

14. HARVESTED WATER: Process water system for utilizing rainwater for potable, non-potable, industrial or irrigation application.

15. LEACH FIELD, EVAPORATION / TRANSPIRATION FIELD: Element in the ground that is filled with gravel, ballast or special permeable plastic elements and that stores rainwater that is fed into it on an intermediate basis before the water seeps into the surrounding soil.

16. MINIMUM WATER VOLUME: Recoverable water volume that is constrained by the process such that neither sediment nor scum can be sucked into the deliverable water.

17. OVERFLOW LEVEL: The highest level that water from a drainage system can rise to.

18. OVERFLOW LINE: Line for leading away rainwater when the rainwater reservoir is full, e.g. into the sewage system or a seepage system

19. PIPING SYSTEM: Pipes that conveys the harvested rainwater and distributes it to various fixtures.

20. POINT OF USE: A point in a domestic water system, nearest to a water consuming plumbing fixture, where water is used.

21. PRECIPITATION: Water that has precipitated from the atmosphere (e.g. rain, snow, mist, dew)

22. PRECIPITATION CHARACTERISTICS: Characteristics of a precipitation event (e.g. intensity, duration)

23. PRIVATE WATER SYSTEM: System used by less than 25 persons over a 60 day period.

24. PROCESS WATER: Water to be used for household and commercial applications.

25. PROCESS WATER LINE: System of lines from the process water pump to the individual points at which water is drawn.

26. PROCESS WATER PUMP:	Pumps process water from the rainwater reservoir to the points at which it is drawn.
27. PROCESS WATER REQUIREMENTS:	Planning value for the process water amount that is expected to be required in a specified period of time.
28. PUBLIC WATER SYSTEM:	System that is used by 25 or more different persons over a 60 day period.
29. QUANTITY OF PRECIPITATION:	Precipitation at a certain place, expressed as the water height over a horizontal area for a span of time under consideration .
30.QUIESCENT INFLOW:	Routing of rainwater into rainwater reservoirs so that the existing sediment is not activated in the rainwater reservoir and an immediate sedimentation of solids is possible.
31. RAINWATER :	Water from natural precipitation that was not contaminated by use.
32. RAINWATER HARVESTING SYSTEM:	Water system for utilizing rainwater, consisting of a cistern(s), pipe, fittings, pumps and/or other plumbing appurtenances, required for and/or used to harvest and distribute rainwater.
33. RAINWATER LINE:	Supply, drainage, overflow and emptying lines of a rainwater harvesting system.
34. RAINWATER YIELD:	Net water volume (water inflow) ,determined over a certain period of time, available for use as process water. Typically this is approximately 80% of theoretical collectable rainwater.
35. RETURN ELBOW :	A section of pipe with a 180-degree bend.
36. ROOF DRAINAGE SYSTEM:	A system, comprised of roof drains, overflow drains, scuppers, gutters and down spouts, used to convey the rainwater from the roof surface to the roof washer and the cistern.
37. ROOF SURFACE :	The surface rainwater harvesting systems rely on for the collection of rainwater that has fallen on a building roof.
38. ROOF WASH OR ROOF WASHER:	A device or method for removal of sediment and debris from collection surface by diverting initial rainfall from entry into the cistern(s). Also called a First Flush Device
39. SCREEN:	A filtration device, constructed of corrosion resistant wire or other approved mesh, having openings in determined sizes.

40. SEDIMENTATION:	Separation of solids from the water via gravity.
41. SLOPE OR SLOPING:	Having a slope greater than 1 in 50.
42. SUB-SURFACE IRRIGATION:	Water that is applied below ground level, and is not directly exposed to the above ground surface and/or surrounding air.
43. SUCTION LINE:	Water pump inlet piping.
44. SUN BARRIERS :	A cover, or erected structure, specifically to shelter a cistern from the direct rays of the sun.
45. SUPPLEMENTAL SUPPLY:	Equipment for providing a supplemental supply of drinking water or non-drinking water into process water systems
46. SURFACE IRRIGATION:	Water that is applied above ground level and is directly exposed to the above ground surface and/or air.
47. SURFACE WATER:	Any rain water that touches the ground and flows across the surface of the ground (roadway, parking surface, gully, creeks, streams etc.) to be termed “surface water”.
48. SYSTEM CONTROL UNIT:	Control unit for the automatic operation of the rainwater harvesting system .
49. TRANSFER PUMP:	A mechanical device to transfer collected water from down spouts to remote cisterns.
50.USEFUL VOLUME:	Volume that can be completely used during operation (Typically .80 - .90 of storage volume).
51. YIELD COEFFICIENT:	Ratio of the rainwater annually flowing into the rainwater harvesting system to the total amount of rainwater in the accompanying precipitation area , allowing for leakage, splashing, evaporation, etc. (Typically .75 - .90).

End of Section

5.0 ACCEPTABLE PIPING SCHEMATICS

Figure 1: Potable and / or Non-Potable Water

Figure shows an above ground application in a non-freeze environment. In an environment where freezing is possible, tank should be moved to a heated environment or buried below the frost line, as shown in the following details.

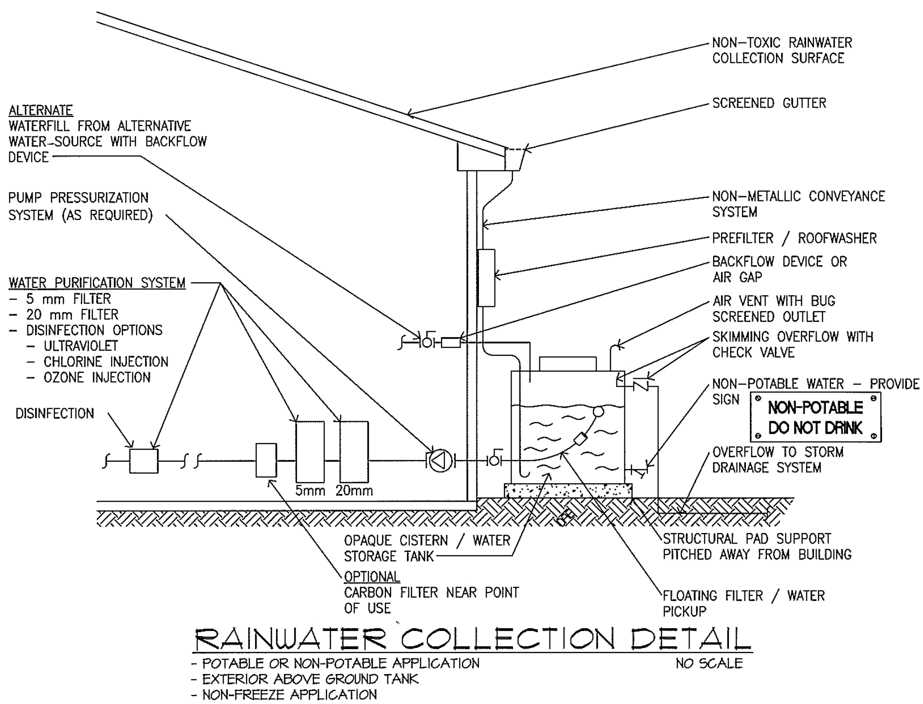


Figure 1

Figure 2: Underground Exterior Cistern for Potable Application.

Where carbon filters are used, they may be put down stream of chlorine and ozone disinfection systems, but are recommended to be upstream of Ultraviolet disinfection systems. Where soil saturation is a possibility, it is recommended that the combined weight of the tank and ballast must meet or exceed the buoyancy upward force of an empty cistern. This buoyance force (lbs.) is equal to the volume of the tank (cubic feet) x 62.4 lbs / cubic feet, or tank volume (gallons) x 8.34 lbs / gallon water

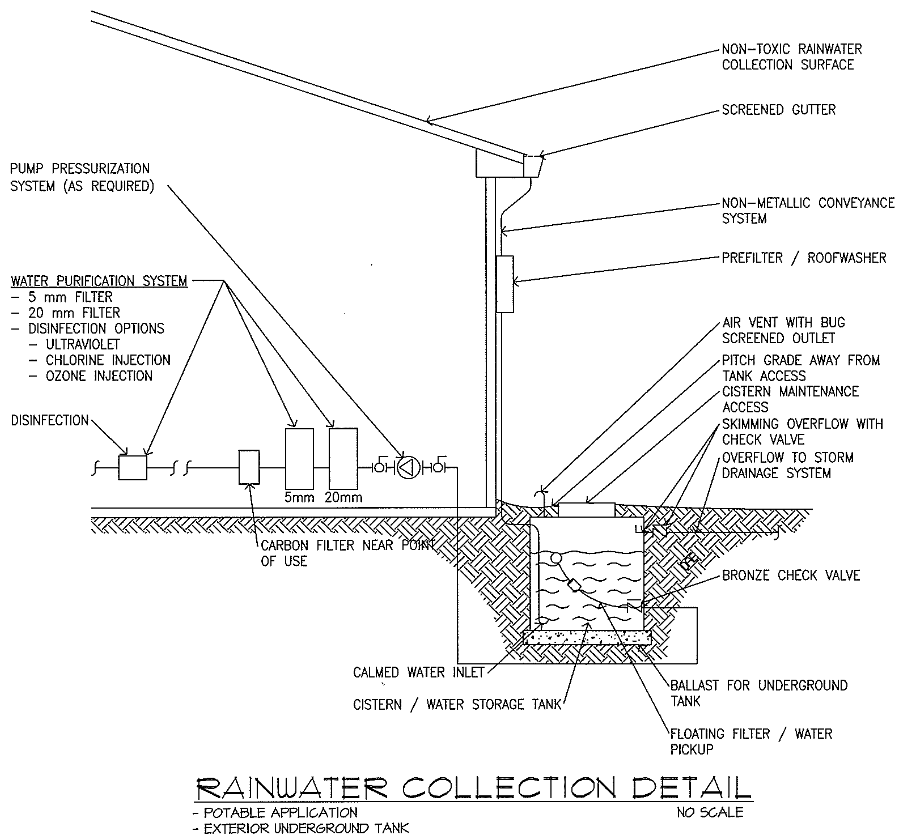


Figure 2

Figure 3: Non-Potable Water

This application is suitable for lawn and plant irrigation or process water makeup. Filters to remove particulate may be added to improve water quality in order o avoid problems with sprinkler or process devices. Signage marking water outlets as " Non-Potable, Do Not Drink " are required in a public environment and highly recommended elsewhere.

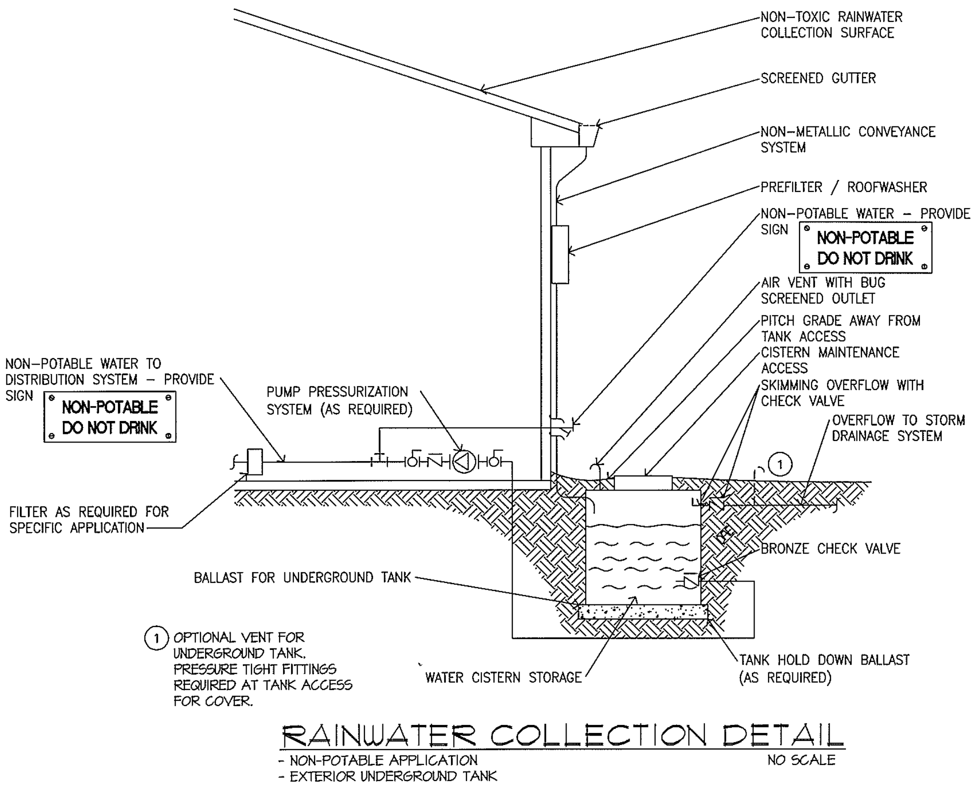


Figure 3.

Figure 4: Potable and Non-Potable Water

Installing a water storage tank in a heated environment is preferred for an installation subject to freezing. Appropriate signage is necessary to label non-potable water outlets.

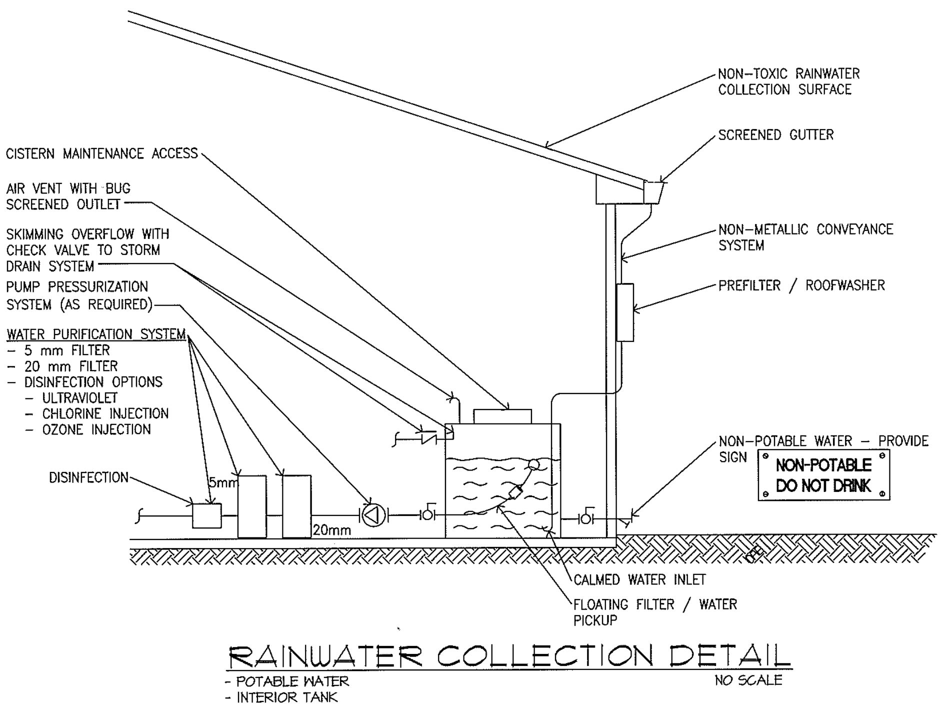


Figure 4.

5.1 ROOF WASHER

Roof Washers are commonly used to waste the initial water coming off the collection surface before being allowed to fill the cistern. Commonly used roof wash amounts are indicated below, but may be varied to reflect actual site and seasonal conditions.

Estimated Roof Contamination Potential

High Contamination [1]	Medium Contamination	Low Contamination[2]
.03" / 8mm	.01" / 2 mm	.002" / .5mm

Notes:

(1) High Contamination is considered to have high content of organic debris from animal waste, adjacent trees, and / or airborne contamination.

(2) Low Contamination is considered to either have frequent rainfall to keep collection surface clean, and / or minimal non toxic contamination.

(3) Sample Calculation: 1000 square foot collection surface, medium contamination:

Gallons = .01" rain x 1000 Square Feet x .623 gallons / square foot - inch:
= 6.23 gallons

Figure 5.

There are many different styles of roof wash devices. The simplest versions involve filling a stand pipe section of piping that contains adequate volume, that once full, then overflows into the cistern.(See Figure 6). A short coming of this concept is that it allows mixing from the contaminated pre-wash volume and the water to be saved in the cistern.

Another commercially available first flush diverter (See Figure 7.) attempts to address the mixing issue by using a stand pipe and floating ball. Once the standpipe is filled with the pre-wash water, a floating ball seals off the remaining flow preventing the pre-wash water from being mixed with the remaining flow. The remaining rainfall is then diverted to the
cistern. This device has a drain at the bottom that allows diverted water to slowly drain after each rainfall event and a clean-out plug to clean out any accumulated debris.

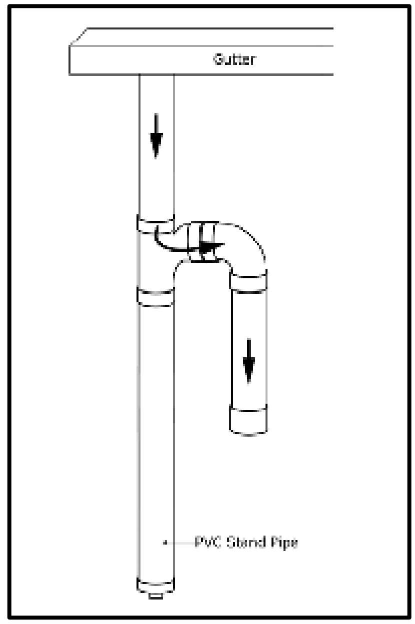


Figure 6.

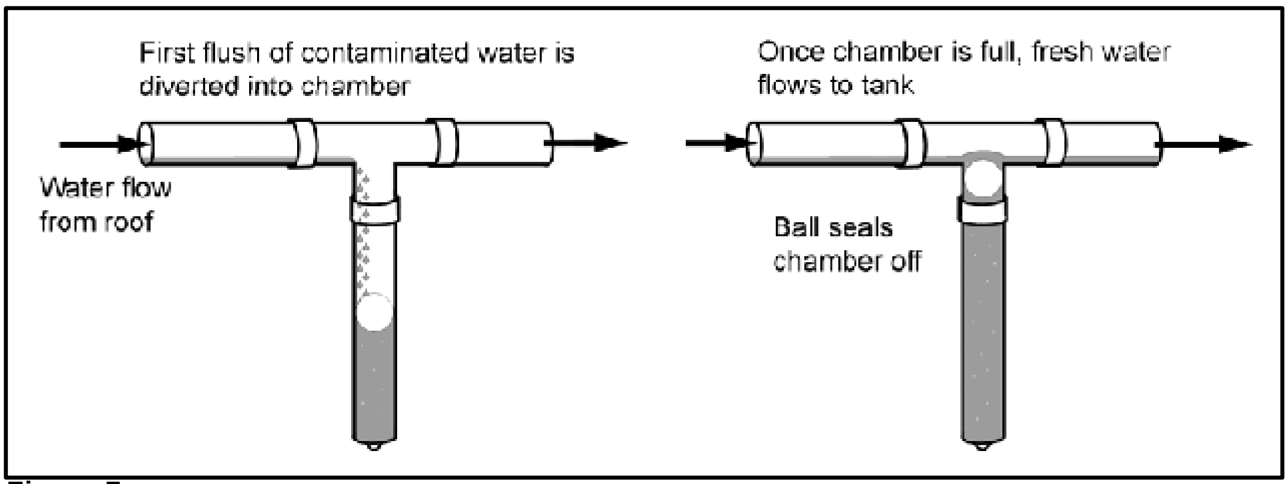


Figure 7.

Other commercially available combination pre-filter and roof wash devices are available to help maintain the water quality of the rainwater harvesting system.

The volume of pre-wash for a nominal 4" (4.046 inch actual) diameter PVC pipe can be determined as follows in Figure 8a.

4" PVC Pipe Storage Volume

Length : feet (meters)	Volume: gallons (liters)
1 (.3)	.7 (2.6)
3 (.9)	2.0 (7.6)
5 (4.6)	3.3 (12.5)
10 (3.0)	6.7 (25.4)
15 (4.6)	10.5 (38.1)

Figure 8a.

The volume of pre-wash for a nominal 6" (6.065 inch actual) diameter PVC pipe can be seen in Figure 8b.

6" PVC Pipe Storage Volume

Length : feet (meters)	Volume: gallons (liters)
1 (.3)	1.5 (5.7)
3 (.9)	4.5 (17.0)
5 (4.6)	7.5 (28.4)
10 (3.0)	15.0 (56.8)
15 (4.6)	22.5 (85.2)

Figure 8b.

Maintenance Worksheet for

____

	Change UV light	Change or Rinse Filters	Test For Bacteria	Clean First Flush	Check for leaks	Test for Giardia/Cryptos-poridium
Frequency:	Annually	Quarterly or as needed	Quarterly	Quarterly or after each rain	After Each Rain or Quarterly	initially and as required
Date Done						
Date Done						
Date Done						
Date Done						

Date	Meter Reading	Date	Meter Reading	Date	Meter reading	Date	Meter Reading	Date	Meter Reading	Date	Meter Reading

Installer: name; Phone
Test Water: _____Health Department; address/phone_______________ (retain all records)
Order UV Light From (Size):________________
Order Filters (Size and Specs)____ From____________

Calculation Procedure

Step 1: Estimate demand:

Interior Water Requirement*: On average, a conserving American household uses 45.2 gallons per person/day to operate toilets, showers, clothes washers, sinks, and other water -using fixtures and appliances. Water demand can be minimized by using water efficient water fixtures. An example of how to estimate water demand is shown as follows:

Residential Indoor Water Use

Fixture	Flow Rate (per use or min) **	Average # uses/day or min/day per person	Daily Demand / person (gal)	Number of people in household	Household Total Daily Demand/ (gal)	Household Total Monthly demand (gal)	Household Total Yearly demand (gal)
Toilets	1.6	5.1	8.16	3	24.48	742	8,935
Shower (based on 2.5 gal/min)	1.66	5.3	8.80	3	26.39	800	9,634
Faucets (based on 2.5 gal/min)	1.66	8.1	13.45	3	40.34	1,222	14,723
Dishwasher (1997- 2001) (gal/use)	4.5	0.1	0.45	3	1.35	41	493
Clothes washer (1998 - 2001) (gal/use)	27	0.37	9.99	3	29.97	908	10,939
Total Demand					**122.5**	**3,713**	**44,724**

*Source: "Handbook of Water Use and Conservation" Amy Vickers, 2001, Waterplow Press, Amherst, MA, ISBN I-931579-07-5

** Actual Flow (MFR)

Irrigation Water Requirement: Water used to irrigate landscaping often equals or exceeds interior water use. Supplemental irrigation water requirements can be greatly reduced by the use of 3 inches or more of top mulch, selecting native plants or plants that thrive in regions with similar climate, and using passive rainwater techniques. Because plant water needs vary greatly depending on soils, climate, plant size, etc. it is recommended that a calculator for your region
be referenced. For calculators, visit the ARCSA website at: www.arcsa.org.

Step 2: Sizing the Collection System

The collection surface is often dictated by architectural constraints, such as roof area, etc. The amount of surface area, based on the needed water volume, is described as follows:

Surface Area (Square Feet) = Demand (Gallons) / 0.623 x Precipitation Density (inches) x system efficiency

Note:
- 0.623 (gallons / square foot / inch) conversion factor = 7.48 (gallons / cubic foot) / 12 (inches per foot). 1 inch of water covering 1 square foot of surface area = 0.623 gallons
- Surface area is horizontal projection of roof surface and not actual surface area (measure the area the roof covers, not the actual roof).
- Precipitation Density period consistent with time period being considered (monthly, yearly, etc)
- This coefficient accounts for collection system loss from leakage, evaporation, roof composition, etc. Roof coefficients are approximately 0.80 – 0.85.

Step 3: Sizing the Storage[1]

Once the area of roof catchment has been determined and the average rainfall has been established the maximum amount of rain that can be collected can be calculated using the formula:

Run-off (Gallons) = A x ***(Rainfall - B)*** x ***Roof Area***

A is the efficiency of collection and values of 0.80-0.85 (i.e. 80-85% efficiency) have been used.

B is the loss associated with adsorption and wetting of surfaces and a value of .08 inches per month (2.0 inches per year) has been used (eg Martin, 1980).

Rainfall should be expressed in Inches and ***Roof Area*** in Square Feet

[1]Adapted from Martin, T.J. (1980). *Supply aspects of domestic rainwater tanks*. South Australian Department of Environment, Adelaide.

The maximum volumes of rainwater that can be collected from various areas of roof and at a range of average annual rainfalls are shown in Appendix III. This information should only be used as an initial guide. If the maximum volumes are less than the annual water demand then either the catchment area will need to be increased or water demand will need to be reduced.

The next step is to calculate the size of the tank. The tank needs to be large enough to ensure that:

1. The required volume of water can be collected by the tank.

2. The volume of water in the tank will be sufficient to meet demand during the drier months or through periods of low or no rainfall.

The simplest way of checking a tank size estimated to provide water throughout an average year is to use monthly rainfall data and to assume that at the start of the wetter months the tank is empty. The following formula should then be used for each month:

Vt = V t-1 + (Run-off - Demand)

Vt = theoretical volume of water remaining in the tank at the end of the month
V t-1 = volume of water left in the tank from the previous month.
Run-off should be calculated as discussed above (***A*** = 0.80, ***B*** = .08 inches).

Starting with the tank empty then ***Vt-1*** = 0. If after any month ***Vt*** exceeds the volume of the tank then water will be lost to overflow. If ***Vt*** is ever a negative figure then demand exceeds the available water. Providing the calculated annual run-off exceeds the annual water demand, ***Vt*** will only be negative if periodical overflows reduce the amount of water collected so that it is less than the demand.

Tank size is not necessarily based on collecting total roof run-off. For example, the maximum water that can be collected from a roof area of 20 square feet with a monthly rainfall of 4.0 inches, will be about 40 gallons. If the water demand is less than this, some overflow may occur while demand is still met. If water demand is to be met throughout the month, the tank should be large enough so that ***Vt*** is never negative.

Calculations should be repeated using various tank sizes until ***Vt*** is 0 at the end of every month. The greater the values of ***Vt*** over the whole year, the greater the security of meeting water demand when rainfalls are below average or when dry periods are longer than normal.

The greater the security, the higher the cost of the tank.

Step 4: System Adjustment

To optimize performance and cost, going back through the calculation modifying surface area and the cistern storage capacity is recommended.

NORMALS 1971-2000	YRS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
BIRMINGHAM AP,AL	30	5.45	4.21	6.10	4.67	4.83	3.78	5.09	3.48	4.05	3.23	4.63	4.47	53.99
HUNTSVILLE, AL	30	5.52	4.95	6.68	4.54	5.24	4.22	4.40	3.32	4.29	3.54	5.22	5.59	57.51
MOBILE, AL	30	5.75	5.10	7.20	5.06	6.10	5.01	6.54	6.20	6.01	3.25	5.41	4.66	66.29
MONTGOMERY, AL	30	5.04	5.45	6.39	4.38	4.14	4.13	5.31	3.63	4.22	2.58	4.53	4.97	54.77
ANCHORAGE, AK	30	0.68	0.74	0.65	0.52	0.70	1.06	1.70	2.93	2.87	2.09	1.09	1.05	16.08
ANNETTE, AK	30	9.67	8.05	7.96	7.37	5.73	4.72	4.26	6.12	9.49	13.86	12.21	11.39	100.83
BARROW, AK	30	0.12	0.12	0.09	0.12	0.12	0.32	0.87	1.04	0.69	0.39	0.16	0.12	4.16
BETHEL, AK	30	0.62	0.51	0.67	0.65	0.85	1.60	2.03	3.02	2.31	1.43	1.37	1.12	16.18
BETTLES,AK	30	0.84	0.61	0.55	0.38	0.85	1.43	2.10	2.54	1.82	1.08	0.90	0.87	13.97
BIG DELTA,AK	30	0.34	0.41	0.22	0.20	0.77	2.38	2.77	2.11	1.03	0.73	0.59	0.39	11.94
COLD BAY,AK	30	3.08	2.59	2.48	2.30	2.65	2.89	2.53	3.59	4.51	4.54	4.79	4.33	40.28
FAIRBANKS, AK	30	0.56	0.36	0.28	0.21	0.60	1.40	1.73	1.74	1.12	0.92	0.68	0.74	10.34
GULKANA,AK	30	0.45	0.52	0.36	0.22	0.59	1.54	1.82	1.80	1.44	1.02	0.67	0.97	11.40
HOMER, AK	30	2.61	2.04	1.82	1.21	1.07	0.96	1.45	2.28	3.37	2.77	2.87	3.00	25.45
JUNEAU, AK	30	4.81	4.02	3.51	2.96	3.48	3.36	4.14	5.37	7.54	8.30	5.43	5.41	58.33
KING SALMON, AK	30	1.03	0.72	0.79	0.94	1.35	1.70	2.15	2.89	2.81	2.10	1.54	1.39	19.41
KODIAK, AK	30	8.17	5.72	5.22	5.48	6.31	5.38	4.12	4.48	7.84	8.36	6.63	7.64	75.35
KOTZEBUE, AK	30	0.55	0.42	0.38	0.41	0.33	0.57	1.43	2.00	1.70	0.95	0.71	0.60	10.05
MCGRATH, AK	30	1.04	0.74	0.81	0.66	1.02	1.45	2.32	2.75	2.36	1.46	1.46	1.44	17.51
NOME, AK	30	0.92	0.75	0.60	0.65	0.74	1.14	2.15	3.23	2.51	1.58	1.28	1.01	16.56
ST. PAUL ISLAND, AK	30	1.74	1.25	1.12	1.12	1.21	1.41	1.91	2.96	2.79	2.70	2.87	2.13	23.21
TALKEETNA, AK	30	1.45	1.28	1.26	1.22	1.64	2.41	3.24	4.53	4.35	3.06	1.78	1.96	28.18
UNALAKLEET, AK	30	0.40	0.31	0.39	0.35	0.55	1.25	2.15	2.92	2.10	0.89	0.66	0.47	12.44
VALDEZ, AK	30	6.02	5.53	4.49	3.55	3.08	3.01	3.84	6.62	9.59	8.58	5.51	7.59	67.41
YAKUTAT, AK	30	13.18	10.99	11.41	10.80	9.78	7.17	7.88	13.27	20.88	24.00	15.17	15.85	160.38
FLAGSTAFF, AZ	30	2.18	2.56	2.62	1.29	0.80	0.43	2.40	2.89	2.12	1.93	1.86	1.83	22.91
PHOENIX, AZ	30	0.83	0.77	1.07	0.25	0.16	0.09	0.99	0.94	0.75	0.79	0.73	0.92	8.29
TUCSON, AZ	30	0.99	0.88	0.81	0.28	0.24	0.24	2.07	2.30	1.45	1.21	0.67	1.03	12.17
WINSLOW, AZ	30	0.46	0.53	0.61	0.27	0.36	0.30	1.18	1.31	1.02	0.90	0.55	0.54	8.03
YUMA, AZ	30	0.38	0.28	0.27	0.09	0.05	0.02	0.23	0.61	0.26	0.26	0.14	0.42	3.01
FORT SMITH, AR	30	2.37	2.59	3.94	3.91	5.29	4.28	3.19	2.56	3.61	3.94	4.80	3.39	43.87
LITTLE ROCK, AR	30	3.61	3.33	4.88	5.47	5.05	3.95	3.31	2.93	3.71	4.25	5.73	4.71	50.93
NORTH LITTLE ROCK, AR	30	3.37	3.27	4.88	5.03	5.40	3.51	3.15	2.97	3.53	3.81	5.74	4.53	49.19
BAKERSFIELD, CA	30	1.18	1.21	1.41	0.45	0.24	0.12	0.00	0.08	0.15	0.30	0.59	0.76	6.49
BISHOP, CA	30	0.88	0.97	0.62	0.24	0.26	0.21	0.17	0.13	0.28	0.20	0.44	0.62	5.02
EUREKA, CA.	30	5.97	5.51	5.55	2.91	1.62	0.65	0.16	0.38	0.86	2.36	5.78	6.35	38.10
FRESNO, CA	30	2.16	2.12	2.20	0.76	0.39	0.23	0.01	0.01	0.26	0.65	1.10	1.34	11.23
LONG BEACH, CA	30	2.95	3.01	2.43	0.60	0.23	0.08	0.02	0.10	0.24	0.40	1.12	1.76	12.94
LOS ANGELES AP, CA	30	2.98	3.11	2.40	0.63	0.24	0.08	0.03	0.14	0.26	0.36	1.13	1.79	13.15
LOS ANGELES C.O., CA	30	3.33	3.68	3.14	0.83	0.31	0.06	0.01	0.13	0.32	0.37	1.05	1.91	15.14
MOUNT SHASTA, CA	30	7.06	6.45	5.81	2.65	1.87	0.99	0.39	0.43	0.87	2.21	5.08	5.35	39.16
REDDING, CA	30	6.50	5.49	5.15	2.40	1.66	0.69	0.05	0.22	0.48	2.18	4.03	4.67	33.52
SACRAMENTO, CA	30	3.84	3.54	2.80	1.02	0.53	0.20	0.05	0.06	0.36	0.89	2.19	2.45	17.93
SAN DIEGO, CA	30	2.28	2.04	2.26	0.75	0.20	0.09	0.03	0.09	0.21	0.44	1.07	1.31	10.77
SAN FRANCISCO AP, CA	30	4.45	4.01	3.26	1.18	0.38	0.11	0.03	0.07	0.20	1.04	2.49	2.89	20.11

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SAN FRANCISCO C.O., CA	30	4.72	4.15	3.40	1.25	0.54	0.13	0.04	0.09	0.28	1.19	3.31	3.18	22.28
SANTA BARBARA, CA	30	3.57	4.28	3.51	0.63	0.23	0.05	0.03	0.11	0.42	0.52	1.32	2.26	16.93
SANTA MARIA, CA	30	2.64	3.23	2.94	0.91	0.32	0.05	0.03	0.05	0.31	0.45	1.24	1.84	14.01
STOCKTON, CA	30	2.71	2.46	2.28	0.96	0.50	0.09	0.05	0.05	0.33	0.82	1.77	1.82	13.84
ALAMOSA, CO	30	0.25	0.21	0.46	0.54	0.70	0.59	0.94	1.19	0.89	0.67	0.48	0.33	7.25
COLORADO SPRINGS, CO	30	0.28	0.35	1.06	1.62	2.39	2.34	2.85	3.48	1.23	0.86	0.52	0.42	17.40
DENVER, CO	30	0.51	0.49	1.28	1.93	2.32	1.56	2.16	1.82	1.14	0.99	0.98	0.63	15.81
GRAND JUNCTION, CO	30	0.60	0.50	1.00	0.86	0.98	0.41	0.66	0.84	0.91	1.00	0.71	0.52	8.99
PUEBLO, CO	30	0.33	0.26	0.97	1.25	1.49	1.33	2.04	2.27	0.84	0.64	0.58	0.39	12.39
BRIDGEPORT, CT	30	3.73	2.92	4.15	3.99	4.03	3.57	3.77	3.75	3.58	3.54	3.65	3.47	44.15
HARTFORD, CT	30	3.84	2.96	3.88	3.86	4.39	3.85	3.67	3.98	4.13	3.94	4.06	3.60	46.16
WILMINGTON, DE	30	3.43	2.81	3.97	3.39	4.15	3.59	4.28	3.51	4.01	3.08	3.19	3.40	42.81
WASHINGTON DULLES AP, D.C		3.05	2.77	3.55	3.22	4.22	4.07	3.57	3.78	3.82	3.37	3.31	3.07	41.80
WASHINGTON NAT'L AP, D.C.	30	3.21	2.63	3.60	2.77	3.82	3.13	3.66	3.44	3.79	3.22	3.03	3.05	39.35
APALACHICOLA, FL	30	4.87	3.76	4.95	3.00	2.62	4.30	7.31	7.29	7.10	4.18	3.62	3.51	56.51
DAYTONA BEACH, FL	30	3.13	2.74	3.84	2.54	3.26	5.69	5.17	6.09	6.61	4.48	3.03	2.71	49.29
FORT MYERS, FL	30	2.23	2.10	2.74	1.67	3.42	9.77	8.98	9.54	7.86	2.59	1.71	1.58	54.19
GAINESVILLE, FL	30	3.51	3.39	4.26	2.86	3.23	6.78	6.10	6.63	4.37	2.50	2.17	2.56	48.36
JACKSONVILLE, FL	30	3.69	3.15	3.93	3.14	3.48	5.37	5.97	6.87	7.90	3.86	2.34	2.64	52.34
KEY WEST, FL	30	2.22	1.51	1.86	2.06	3.48	4.57	3.27	5.40	5.45	4.34	2.64	2.14	38.94
MIAMI, FL	30	1.88	2.07	2.56	3.36	5.52	8.54	5.79	8.63	8.38	6.19	3.43	2.18	58.53
ORLANDO, FL	30	2.43	2.35	3.54	2.42	3.74	7.35	7.15	6.25	5.76	2.73	2.32	2.31	48.35
PENSACOLA, FL	30	5.34	4.68	6.40	3.89	4.40	6.39	8.02	6.85	5.75	4.13	4.46	3.97	64.28
TALLAHASSEE, FL	30	5.36	4.63	6.47	3.59	4.95	6.92	8.04	7.03	5.01	3.25	3.86	4.10	63.21
TAMPA, FL	30	2.27	2.67	2.84	1.80	2.85	5.50	6.49	7.60	6.54	2.29	1.62	2.30	44.77
VERO BEACH, FL	30	2.89	2.45	4.20	2.88	3.80	6.03	6.53	6.04	6.84	5.04	3.04	2.19	51.93
WEST PALM BEACH, FL	30	3.75	2.55	3.68	3.57	5.39	7.58	5.97	6.65	8.10	5.46	5.55	3.14	61.39
ATHENS, GA	30	4.69	4.39	4.99	3.35	3.86	3.94	4.41	3.78	3.53	3.47	3.71	3.71	47.83
ATLANTA, GA	30	5.03	4.68	5.38	3.62	3.95	3.63	5.12	3.67	4.09	3.11	4.10	3.82	50.20
AUGUSTA,GA	30	4.50	4.11	4.61	2.94	3.07	4.19	4.07	4.48	3.59	3.20	2.68	3.14	44.58
COLUMBUS, GA	30	4.78	4.48	5.75	3.84	3.62	3.51	5.04	3.78	3.07	2.33	3.97	4.40	48.57
MACON, GA	30	5.00	4.55	4.90	3.14	2.98	3.54	4.32	3.79	3.26	2.37	3.22	3.93	45.00
SAVANNAH, GA	30	3.95	2.92	3.64	3.32	3.61	5.49	6.04	7.20	5.08	3.12	2.40	2.81	49.58
HILO, HI	30	9.74	8.86	14.35	12.54	8.07	7.36	10.71	9.78	9.14	9.64	15.58	10.50	126.27
HONOLULU,HI	30	2.73	2.35	1.89	1.11	0.78	0.43	0.50	0.46	0.74	2.18	2.27	2.85	18.29
KAHULUI, HI	30	3.74	2.36	2.35	1.75	0.66	0.23	0.49	0.53	0.39	1.05	2.17	3.08	18.80
LIHUE, HI	30	4.59	3.26	3.58	3.00	2.87	1.82	2.12	1.91	2.69	4.25	4.70	4.78	39.57
BOISE, ID	30	1.39	1.14	1.41	1.27	1.27	0.74	0.39	0.30	0.76	0.76	1.38	1.38	12.19
LEWISTON, ID	30	1.14	0.95	1.12	1.31	1.56	1.16	0.72	0.75	0.81	0.96	1.21	1.05	12.74
POCATELLO, ID	30	1.14	1.01	1.38	1.18	1.51	0.91	0.70	0.66	0.89	0.97	1.13	1.10	12.58
CHICAGO,IL	30	1.75	1.63	2.65	3.68	3.38	3.63	3.51	4.62	3.27	2.71	3.01	2.43	36.27
MOLINE, IL	30	1.58	1.51	2.92	3.82	4.25	4.63	4.03	4.41	3.16	2.80	2.73	2.20	38.04
PEORIA, IL	30	1.50	1.67	2.83	3.56	4.17	3.84	4.02	3.16	3.12	2.77	2.99	2.40	36.03
ROCKFORD, IL	30	1.41	1.34	2.39	3.62	4.03	4.80	4.10	4.21	3.47	2.57	2.63	2.06	36.63
SPRINGFIELD, IL	30	1.62	1.80	3.15	3.36	4.06	3.77	3.53	3.41	2.83	2.62	2.87	2.54	35.56
EVANSVILLE, IN	30	2.91	3.10	4.29	4.48	5.01	4.10	3.75	3.14	2.99	2.78	4.18	3.54	44.27
FORT WAYNE, IN	30	2.05	1.94	2.86	3.54	3.75	4.04	3.58	3.60	2.81	2.63	2.98	2.77	36.55
INDIANAPOLIS, IN	30	2.48	2.41	3.44	3.61	4.36	4.13	4.42	3.82	2.88	2.76	3.61	3.03	40.95
SOUTH BEND, IN	30	2.27	1.98	2.89	3.62	3.50	4.19	3.73	3.98	3.79	3.27	3.39	3.09	39.70
DES MOINES, IA	30	1.03	1.19	2.21	3.58	4.25	4.57	4.18	4.51	3.15	2.62	2.10	1.33	34.72

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DUBUQUE, IA	30	1.28	1.42	2.57	3.49	4.12	4.08	3.73	4.59	3.56	2.50	2.49	1.69	35.52
SIOUX CITY, IA	30	0.59	0.62	2.00	2.75	3.75	3.61	3.30	2.90	2.42	1.99	1.40	0.66	25.99
WATERLOO, IA	30	0.84	1.05	2.13	3.23	4.15	4.82	4.20	4.08	2.95	2.49	2.10	1.11	33.15
CONCORDIA, KS	30	0.66	0.73	2.35	2.45	4.20	3.95	4.20	3.24	2.50	1.84	1.45	0.86	28.43
DODGE CITY, KS	30	0.62	0.66	1.84	2.25	3.00	3.15	3.17	2.73	1.70	1.45	1.01	0.77	22.35
GOODLAND, KS	30	0.43	0.44	1.20	1.51	3.46	3.30	3.54	2.49	1.12	1.05	0.82	0.40	19.76
TOPEKA, KS	30	0.95	1.18	2.56	3.14	4.86	4.88	3.83	3.81	3.71	2.99	2.31	1.42	35.64
WICHITA, KS	30	0.84	1.02	2.71	2.57	4.16	4.25	3.31	2.94	2.96	2.45	1.82	1.35	30.38
GREATER CINCINNATI AP	30	2.92	2.75	3.90	3.96	4.59	4.42	3.75	3.79	2.82	2.96	3.46	3.28	42.60
JACKSON, KY	30	3.56	3.68	4.38	3.79	5.16	4.67	4.59	4.13	3.77	3.18	4.20	4.27	49.38
LEXINGTON, KY	30	3.34	3.27	4.41	3.67	4.78	4.58	4.81	3.77	3.11	2.70	3.44	4.03	45.91
LOUISVILLE, KY	30	3.28	3.25	4.41	3.91	4.88	3.76	4.30	3.41	3.05	2.79	3.81	3.69	44.54
PADUCAH KY	30	3.47	3.93	4.27	4.95	4.75	4.51	4.45	2.99	3.56	3.45	4.53	4.38	49.24
BATON ROUGE, LA	30	6.19	5.10	5.07	5.56	5.34	5.33	5.96	5.86	4.84	3.81	4.76	5.26	63.08
LAKE CHARLES, LA	30	5.52	3.28	3.54	3.64	6.06	6.07	5.13	4.85	5.95	3.94	4.61	4.60	57.19
NEW ORLEANS, LA	30	5.87	5.47	5.24	5.02	4.62	6.83	6.20	6.15	5.55	3.05	5.09	5.07	64.16
SHREVEPORT, LA	30	4.60	4.21	4.18	4.42	5.25	5.05	3.99	2.71	3.21	4.45	4.68	4.55	51.30
CARIBOU, ME	30	2.97	2.06	2.57	2.64	3.28	3.31	3.89	4.15	3.27	2.99	3.12	3.19	37.44
PORTLAND, ME	30	4.09	3.14	4.14	4.26	3.82	3.28	3.32	3.05	3.37	4.40	4.72	4.24	45.83
BALTIMORE, MD	30	3.47	3.02	3.93	3.00	3.89	3.43	3.85	3.74	3.98	3.16	3.12	3.35	41.94
BLUE HILL, MA	30	4.78	4.06	4.79	4.32	3.79	3.93	3.74	4.06	4.13	4.42	4.64	4.56	51.22
BOSTON, MA	30	3.92	3.30	3.85	3.60	3.24	3.22	3.06	3.37	3.47	3.79	3.98	3.73	42.53
WORCESTER, MA	30	4.07	3.10	4.23	3.92	4.35	4.02	4.19	4.09	4.27	4.67	4.34	3.80	49.05
ALPENA, MI	30	1.76	1.35	2.13	2.31	2.61	2.53	3.17	3.50	2.80	2.33	2.08	1.83	28.40
DETROIT, MI	30	1.91	1.88	2.52	3.05	3.05	3.55	3.16	3.10	3.27	2.23	2.66	2.51	32.89
FLINT, MI	30	1.57	1.35	2.22	3.13	2.74	3.07	3.17	3.43	3.76	2.34	2.65	2.18	31.61
GRAND RAPIDS, MI	30	2.03	1.54	2.59	3.48	3.35	3.67	3.56	3.78	4.28	2.80	3.35	2.70	37.13
HOUGHTON LAKE, MI	30	1.61	1.25	2.05	2.29	2.57	2.93	2.75	3.72	3.11	2.26	2.14	1.75	28.43
LANSING, MI	30	1.61	1.45	2.33	3.09	2.71	3.60	2.68	3.46	3.48	2.29	2.66	2.17	31.53
MARQUETTE, MI	30	2.60	1.85	3.13	2.79	3.07	3.21	3.01	3.55	3.74	3.66	3.27	2.43	36.31
MUSKEGON, MI	30	2.22	1.58	2.36	2.91	2.95	2.58	2.32	3.77	3.52	2.80	3.23	2.64	32.88
SAULT STE. MARIE, MI	30	2.64	1.60	2.41	2.57	2.50	3.00	3.14	3.47	3.71	3.32	3.40	2.91	34.67
DULUTH, MN	30	1.12	0.83	1.69	2.09	2.95	4.25	4.20	4.22	4.13	2.46	2.12	0.94	31.00
INTERNATIONAL FALLS, MN	30	0.84	0.64	0.96	1.38	2.55	3.98	3.37	3.14	3.03	1.98	1.36	0.70	23.93
MINNEAPOLIS-ST.PAUL, MN	30	1.04	0.79	1.86	2.31	3.24	4.34	4.04	4.05	2.69	2.11	1.94	1.00	29.41
ROCHESTER, MN	30	0.94	0.75	1.88	3.01	3.53	4.00	4.61	4.33	3.12	2.20	2.01	1.02	31.40
SAINT CLOUD, MN	30	0.76	0.59	1.50	2.13	2.97	4.51	3.34	3.93	2.93	2.24	1.54	0.69	27.13
JACKSON, MS	30	5.67	4.50	5.74	5.98	4.86	3.82	4.69	3.66	3.23	3.42	5.04	5.34	55.95
MERIDIAN, MS	30	5.92	5.35	6.93	5.62	4.87	3.99	5.45	3.34	3.64	3.28	4.95	5.31	58.65
TUPELO, MS	30	5.14	4.68	6.30	4.94	5.80	4.82	3.65	2.67	3.35	3.38	5.01	6.12	55.86
COLUMBIA, MO	30	1.73	2.20	3.21	4.16	4.87	4.02	3.80	3.75	3.42	3.18	3.47	2.47	40.28
KANSAS CITY, MO	30	1.15	1.31	2.44	3.38	5.39	4.44	4.42	3.54	4.64	3.33	2.30	1.64	37.98
ST. LOUIS, MO	30	2.14	2.28	3.60	3.69	4.11	3.76	3.90	2.98	2.96	2.76	3.71	2.86	38.75
SPRINGFIELD, MO	30	2.11	2.28	3.82	4.31	4.57	5.02	3.56	3.37	4.83	3.47	4.46	3.17	44.97
BILLINGS, MT	30	0.81	0.58	1.12	1.74	2.48	1.89	1.28	0.85	1.34	1.26	0.75	0.67	14.77
GLASGOW, MT	30	0.35	0.26	0.47	0.75	1.72	2.20	1.78	1.25	0.98	0.71	0.39	0.37	11.23
GREAT FALLS, MT	30	0.68	0.51	1.01	1.40	2.53	2.24	1.45	1.65	1.23	0.93	0.59	0.67	14.89
HAVRE, MT	30	0.47	0.36	0.70	0.87	1.84	1.90	1.51	1.20	1.03	0.62	0.45	0.51	11.46
HELENA, MT	30	0.52	0.38	0.63	0.91	1.78	1.82	1.34	1.29	1.05	0.66	0.48	0.46	11.32
KALISPELL, MT	30	1.47	1.15	1.11	1.22	2.04	2.30	1.41	1.25	1.20	0.96	1.45	1.65	17.21

NORMALS 1971-2000	YRS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
MISSOULA, MT	30	1.06	0.77	0.96	1.09	1.95	1.73	1.09	1.15	1.08	0.83	0.96	1.15	13.82
GRAND ISLAND, NE	30	0.54	0.68	2.04	2.61	4.07	3.72	3.14	3.08	2.43	1.51	1.41	0.66	25.89
LINCOLN, NE	30	0.67	0.66	2.21	2.90	4.23	3.51	3.54	3.35	2.92	1.94	1.58	0.86	28.37
NORFOLK, NE	30	0.57	0.76	1.97	2.59	3.92	4.25	3.74	2.80	2.25	1.72	1.44	0.65	26.66
NORTH PLATTE, NE	30	0.39	0.51	1.24	1.97	3.34	3.17	3.17	2.15	1.32	1.24	0.76	0.40	19.66
OMAHA EPPLEY AP, NE	30	0.77	0.80	2.13	2.94	4.44	3.95	3.86	3.21	3.17	2.21	1.82	0.92	30.22
OMAHA (NORTH), NE	30	0.76	0.77	2.25	3.07	4.57	3.84	3.75	2.93	3.03	2.49	1.67	0.95	30.08
SCOTTSBLUFF, NE	30	0.54	0.58	1.16	1.79	2.70	2.65	2.13	1.19	1.22	1.01	0.80	0.56	16.33
VALENTINE, NE	30	0.30	0.48	1.11	1.97	3.20	3.01	3.37	2.20	1.61	1.22	0.72	0.33	19.52
ELKO, NV	30	1.14	0.88	0.98	0.81	1.08	0.67	0.30	0.36	0.68	0.71	1.05	0.93	9.59
ELY, NV	30	0.74	0.75	1.05	0.90	1.29	0.66	0.60	0.91	0.94	1.00	0.63	0.50	9.97
LAS VEGAS, NV	30	0.59	0.69	0.59	0.15	0.24	0.08	0.44	0.45	0.31	0.24	0.31	0.40	4.49
RENO, NV	30	1.06	1.06	0.86	0.35	0.62	0.47	0.24	0.27	0.45	0.42	0.80	0.88	7.48
WINNEMUCCA, NV	30	0.83	0.62	0.86	0.85	1.06	0.69	0.27	0.35	0.53	0.66	0.80	0.81	8.33
CONCORD, NH	30	2.97	2.36	3.04	3.07	3.33	3.10	3.37	3.21	3.16	3.46	3.57	2.96	37.60
MT. WASHINGTON, NH	30	8.52	7.33	9.42	8.43	8.21	8.36	8.02	8.08	8.55	7.66	10.49	8.84	101.91
ATLANTIC CITY AP, NJ	30	3.60	2.85	4.06	3.45	3.38	2.66	3.86	4.32	3.14	2.86	3.26	3.15	40.59
ATLANTIC CITY C.O.,NJ	30	3.44	2.88	3.79	3.25	3.16	2.46	3.36	4.16	3.02	2.71	2.96	3.18	38.37
NEWARK, NJ	30	3.98	2.96	4.21	3.92	4.46	3.40	4.68	4.02	4.01	3.16	3.88	3.57	46.25
ALBUQUERQUE, NM	30	0.49	0.44	0.61	0.50	0.60	0.65	1.27	1.73	1.07	1.00	0.62	0.49	9.47
CLAYTON, NM	30	0.30	0.27	0.62	0.99	2.08	2.21	2.81	2.69	1.56	0.74	0.54	0.32	15.13
ROSWELL, NM	30	0.39	0.41	0.35	0.58	1.30	1.62	1.99	2.31	1.98	1.29	0.53	0.59	13.34
ALBANY, NY	30	2.71	2.27	3.17	3.25	3.67	3.74	3.50	3.68	3.31	3.23	3.31	2.76	38.60
BINGHAMTON, NY	30	2.58	2.46	2.97	3.49	3.55	3.80	3.49	3.35	3.59	3.02	3.32	3.03	38.65
BUFFALO, NY	30	3.16	2.42	2.99	3.04	3.35	3.82	3.14	3.87	3.84	3.19	3.92	3.80	40.54
ISLIP, NY	30	4.27	3.33	4.76	4.13	3.90	3.71	2.93	4.48	3.39	3.63	3.86	4.13	46.52
NEW YORK C.PARK, NY	30	4.13	3.15	4.37	4.28	4.69	3.84	4.62	4.22	4.23	3.85	4.36	3.95	49.69
NEW YORK (JFK AP), NY	30	3.62	2.70	3.79	3.75	4.13	3.59	3.92	3.64	3.50	3.03	3.48	3.31	42.46
NEW YORK (LAGUARDIA AP), NY		3.56	2.75	3.93	3.68	4.16	3.57	4.41	4.09	3.77	3.26	3.67	3.51	44.36
ROCHESTER, NY	30	2.34	2.04	2.58	2.75	2.82	3.36	2.93	3.54	3.45	2.60	2.84	2.73	33.98
SYRACUSE, NY	30	2.60	2.12	3.02	3.39	3.39	3.71	4.02	3.56	4.15	3.20	3.77	3.12	40.05
ASHEVILLE, NC	30	4.06	3.83	4.59	3.50	4.42	4.38	3.87	4.30	3.72	3.18	3.82	3.40	47.07
CAPE HATTERAS, NC	30	5.84	3.94	4.95	3.29	3.92	3.82	4.95	6.56	5.68	5.31	4.93	4.56	57.75
CHARLOTTE, NC	30	4.00	3.55	4.39	2.95	3.66	3.42	3.79	3.72	3.83	3.66	3.36	3.18	43.51
GREENSBORO-WNSTN-SALM-NC		3.54	3.10	3.85	3.43	3.95	3.53	4.44	3.71	4.30	3.27	2.96	3.06	43.14
RALEIGH, NC	30	4.02	3.47	4.03	2.80	3.79	3.42	4.29	3.78	4.26	3.18	2.97	3.04	43.05
WILMINGTON, NC	30	4.52	3.66	4.22	2.94	4.40	5.36	7.62	7.31	6.79	3.21	3.26	3.78	57.07
BISMARCK, ND	30	0.45	0.51	0.85	1.46	2.22	2.59	2.58	2.15	1.61	1.28	0.70	0.44	16.84
FARGO, ND	30	0.76	0.59	1.17	1.37	2.61	3.51	2.88	2.52	2.18	1.97	1.06	0.57	21.19
GRAND FORKS, ND	30	0.68	0.58	0.89	1.23	2.21	3.03	3.06	2.72	1.96	1.70	0.99	0.55	19.60
WILLISTON, ND	30	0.54	0.39	0.74	1.05	1.88	2.36	2.28	1.48	1.35	0.87	0.65	0.57	14.16
AKRON, OH	30	2.49	2.28	3.15	3.39	3.96	3.55	4.02	3.65	3.43	2.53	3.04	2.98	38.47
CLEVELAND, OH	30	2.48	2.29	2.94	3.37	3.50	3.89	3.52	3.69	3.77	2.74	3.38	3.14	38.71
COLUMBUS, OH	30	2.53	2.20	2.89	3.25	3.88	4.08	4.62	3.72	2.92	2.31	3.19	2.93	38.52
DAYTON, OH	30	2.60	2.29	3.29	4.03	4.17	4.21	3.75	3.49	2.65	2.72	3.30	3.08	39.58
MANSFIELD, OH	30	2.63	2.17	3.36	4.17	4.42	4.52	4.23	4.60	3.44	2.68	3.76	3.26	43.24
TOLEDO, OH	30	1.93	1.88	2.62	3.24	3.14	3.80	2.80	3.19	2.84	2.35	2.78	2.64	33.21
YOUNGSTOWN, OH	30	2.34	2.03	3.05	3.33	3.45	3.91	4.10	3.43	3.89	2.46	3.07	2.96	38.02
OKLAHOMA CITY, OK	30	1.28	1.56	2.90	3.00	5.44	4.63	2.94	2.48	3.98	3.64	2.11	1.89	35.85
TULSA, OK	30	1.60	1.95	3.57	3.95	6.11	4.72	2.96	2.85	4.76	4.05	3.47	2.43	42.42

NORMALS 1971-2000	YRS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
ASTORIA, OR	30	9.62	7.87	7.37	4.93	3.28	2.57	1.16	1.21	2.61	5.61	10.50	10.40	67.13
BURNS,OR	30	1.18	1.11	1.24	0.85	1.05	0.66	0.40	0.45	0.50	0.72	1.11	1.30	10.57
EUGENE, OR	30	7.65	6.35	5.80	3.66	2.66	1.53	0.64	0.99	1.54	3.35	8.44	8.29	50.90
MEDFORD, OR	30	2.47	2.10	1.85	1.31	1.21	0.68	0.31	0.52	0.78	1.31	2.93	2.90	18.37
PENDLETON, OR	30	1.45	1.22	1.26	1.13	1.22	0.78	0.41	0.56	0.63	0.99	1.63	1.48	12.76
PORTLAND, OR	30	5.07	4.18	3.71	2.64	2.38	1.59	0.72	0.93	1.65	2.88	5.61	5.71	37.07
SALEM, OR	30	5.84	5.09	4.17	2.76	2.13	1.45	0.57	0.68	1.43	3.03	6.39	6.46	40.00
SEXTON SUMMIT, OR	30	4.71	4.29	3.92	2.38	1.35	0.94	0.35	0.61	1.20	2.93	5.32	5.18	33.18
ALLENTOWN, PA	30	3.50	2.75	3.56	3.49	4.47	3.99	4.27	4.35	4.37	3.33	3.70	3.39	45.17
ERIE, PA.	30	2.53	2.28	3.13	3.38	3.34	4.28	3.28	4.21	4.73	3.92	3.96	3.73	42.77
HARRISBURG, PA	30	3.18	2.88	3.58	3.31	4.60	3.99	3.21	3.24	3.65	3.06	3.53	3.22	41.45
MIDDLETOWN/HARRISBURG APT		3.18	2.88	3.58	3.31	4.60	3.99	3.21	3.24	3.65	3.06	3.53	3.22	41.45
PHILADELPHIA, PA	30	3.52	2.74	3.81	3.49	3.89	3.29	4.39	3.82	3.88	2.75	3.16	3.31	42.05
PITTSBURGH, PA	30	2.70	2.37	3.17	3.01	3.80	4.12	3.96	3.38	3.21	2.25	3.02	2.86	37.85
AVOCA, PA	30	2.46	2.08	2.69	3.28	3.69	3.97	3.74	3.10	3.86	3.02	3.12	2.55	37.56
WILLIAMSPORT, PA	30	2.85	2.61	3.21	3.49	3.79	4.45	4.08	3.38	3.98	3.19	3.62	2.94	41.59
BLOCK IS.,RI	30	3.68	3.04	3.99	3.72	3.40	2.77	2.62	3.00	3.19	3.04	3.77	3.57	39.79
PROVIDENCE, RI	30	4.37	3.45	4.43	4.16	3.66	3.38	3.17	3.90	3.70	3.69	4.40	4.14	46.45
CHARLESTON AP,SC	30	4.08	3.08	4.00	2.77	3.67	5.92	6.13	6.91	5.98	3.09	2.66	3.24	51.53
CHARLESTON C.O.,SC	30	3.62	2.62	3.83	2.44	2.77	4.96	5.50	6.54	6.13	3.02	2.18	2.78	46.39
COLUMBIA, SC	30	4.66	3.84	4.59	2.98	3.17	4.99	5.54	5.41	3.94	2.89	2.88	3.38	48.27
GREENV'L-SPARTANB'RG AP, SC		4.41	4.24	5.31	3.54	4.59	3.92	4.65	4.08	3.97	3.88	3.79	3.86	50.24
ABERDEEN, SD	30	0.48	0.48	1.34	1.83	2.69	3.49	2.92	2.42	1.81	1.63	0.75	0.38	20.22
HURON, SD	30	0.49	0.57	1.67	2.29	3.00	3.28	2.86	2.07	1.80	1.59	0.89	0.39	20.90
RAPID CITY, SD	30	0.37	0.46	1.03	1.86	2.96	2.83	2.03	1.61	1.10	1.37	0.61	0.41	16.64
SIOUX FALLS, SD	30	0.51	0.51	1.81	2.65	3.39	3.49	2.93	3.01	2.58	1.93	1.36	0.52	24.69
BRISTOL-JOHNSON CTY TN	30	3.52	3.40	3.91	3.23	4.32	3.89	4.21	3.00	3.08	2.30	3.08	3.39	41.33
CHATTANOOGA, TN	30	5.40	4.85	6.19	4.23	4.28	3.99	4.73	3.59	4.31	3.26	4.88	4.81	54.52
KNOXVILLE, TN	30	4.57	4.01	5.17	3.99	4.68	4.04	4.71	2.89	3.04	2.65	3.98	4.49	48.22
MEMPHIS, TN	30	4.24	4.31	5.58	5.79	5.15	4.30	4.22	3.00	3.31	3.31	5.76	5.68	54.65
NASHVILLE, TN	30	3.97	3.69	4.87	3.93	5.07	4.08	3.77	3.28	3.59	2.87	4.45	4.54	48.11
OAK RIDGE,TN	30	5.13	4.50	5.72	4.32	5.14	4.64	5.16	3.39	3.75	3.02	4.86	5.42	55.05
ABILENE, TX	30	0.97	1.13	1.41	1.67	2.83	3.06	1.70	2.63	2.91	2.90	1.30	1.27	23.78
AMARILLO, TX	30	0.63	0.55	1.13	1.33	2.50	3.28	2.68	2.94	1.88	1.50	0.68	0.61	19.71
AUSTIN/CITY, TX	30	1.89	1.99	2.14	2.51	5.03	3.81	1.97	2.31	2.91	3.97	2.68	2.44	33.65
AUSTIN/BERGSTROM, TX	30	2.21	2.02	2.36	2.63	5.12	3.42	2.03	2.51	2.88	3.99	3.02	2.53	34.72
BROWNSVILLE, TX	30	1.36	1.18	0.93	1.96	2.48	2.93	1.77	2.99	5.31	3.78	1.75	1.11	27.55
CORPUS CHRISTI, TX	30	1.62	1.84	1.74	2.05	3.48	3.53	2.00	3.54	5.03	3.94	1.74	1.75	32.26
DALLAS-FORT WORTH, TX 30		1.90	2.37	3.06	3.20	5.15	3.23	2.12	2.03	2.42	4.11	2.57	2.57	34.73
DALLAS-LOVE FIELD, TX	30	1.89	2.31	3.13	3.46	5.30	3.92	2.43	2.17	2.65	4.65	2.61	2.53	37.05
DEL RIO, TX	30	0.57	0.96	0.96	1.71	2.31	2.34	2.02	2.16	2.06	2.00	0.96	0.75	18.80
EL PASO, TX	30	0.45	0.39	0.26	0.23	0.38	0.87	1.49	1.75	1.61	0.81	0.42	0.77	9.43
GALVESTON, TX	30	4.08	2.61	2.76	2.56	3.70	4.04	3.45	4.22	5.76	3.49	3.64	3.53	43.84
HOUSTON, TX	30	3.68	2.98	3.36	3.60	5.15	5.35	3.18	3.83	4.33	4.50	4.19	3.69	47.84
LUBBOCK, TX	30	0.50	0.71	0.76	1.29	2.31	2.98	2.13	2.36	2.57	1.70	0.71	0.67	18.69
MIDLAND-ODESSA, TX	30	0.53	0.58	0.42	0.73	1.79	1.71	1.89	1.77	2.31	1.77	0.65	0.65	14.80
PORT ARTHUR, TX	30	5.69	3.35	3.75	3.84	5.83	6.58	5.23	4.85	6.10	4.67	4.75	5.25	59.89
SAN ANGELO, TX	30	0.82	1.18	0.99	1.60	3.09	2.52	1.10	2.05	2.95	2.57	1.10	0.94	20.91

NORMALS 1971-2000	YRS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
SAN ANTONIO, TX	30	1.66	1.75	1.89	2.60	4.72	4.30	2.03	2.57	3.00	3.86	2.58	1.96	32.92
VICTORIA, TX	30	2.44	2.04	2.25	2.97	5.12	4.96	2.90	3.05	5.00	4.26	2.64	2.47	40.10
WACO, TX	30	1.90	2.43	2.48	2.99	4.46	3.08	2.23	1.85	2.88	3.67	2.61	2.76	33.34
WICHITA FALLS, TX	30	1.12	1.58	2.27	2.62	3.92	3.69	1.58	2.39	3.19	3.11	1.68	1.68	28.83
MILFORD, UT	30	0.73	0.77	1.21	0.99	0.94	0.44	0.76	1.04	0.92	1.12	0.77	0.58	10.27
SALT LAKE CITY, UT	30	1.37	1.33	1.91	2.02	2.09	0.77	0.72	0.76	1.33	1.57	1.40	1.23	16.50
BURLINGTON, VT	30	2.22	1.67	2.32	2.88	3.32	3.43	3.97	4.01	3.83	3.12	3.06	2.22	36.05
LYNCHBURG, VA	30	3.54	3.10	3.83	3.46	4.11	3.79	4.39	3.41	3.88	3.39	3.18	3.23	43.31
NORFOLK, VA	30	3.93	3.34	4.08	3.38	3.74	3.77	5.17	4.79	4.06	3.47	2.98	3.03	45.74
RICHMOND, VA	30	3.55	2.98	4.09	3.18	3.96	3.54	4.67	4.18	3.98	3.60	3.06	3.12	43.91
ROANOKE, VA	30	3.23	3.08	3.84	3.61	4.24	3.68	4.00	3.74	3.85	3.15	3.21	2.86	42.49
OLYMPIA, WA	30	7.54	6.17	5.29	3.58	2.27	1.78	0.82	1.10	2.03	4.19	8.13	7.89	50.79
QUILLAYUTE, WA	30	13.65	12.35	10.98	7.44	5.51	3.50	2.34	2.67	4.15	9.81	14.82	14.50	101.72
SEATTLE C.O., WA	30	5.24	4.09	3.92	2.75	2.03	1.55	0.93	1.16	1.61	3.24	5.67	6.06	38.25
SEATTLE SEA-TAC AP, WA	30	5.13	4.18	3.75	2.59	1.78	1.49	0.79	1.02	1.63	3.19	5.90	5.62	37.07
SPOKANE, WA	30	1.82	1.51	1.53	1.28	1.60	1.18	0.76	0.68	0.76	1.06	2.24	2.25	16.67
WALLA WALLA WA	30	2.25	1.97	2.20	1.83	1.95	1.15	0.73	0.84	0.83	1.77	2.85	2.51	20.88
YAKIMA, WA	30	1.17	0.80	0.70	0.53	0.51	0.62	0.22	0.36	0.39	0.53	1.05	1.38	8.26
BECKLEY, WV	30	3.23	2.96	3.63	3.43	4.39	3.92	4.78	3.45	3.23	2.64	2.88	3.09	41.63
CHARLESTON, WV	30	3.25	3.19	3.90	3.25	4.30	4.09	4.86	4.11	3.45	2.67	3.66	3.32	44.05
ELKINS, WV	30	3.43	3.20	3.92	3.53	4.77	4.61	4.84	4.26	3.83	2.86	3.42	3.44	46.11
HUNTINGTON, WV	30	3.21	3.09	3.83	3.33	4.41	3.88	4.46	3.88	2.80	2.73	3.32	3.37	42.31
GREEN BAY, WI	30	1.21	1.01	2.06	2.56	2.75	3.43	3.44	3.77	3.11	2.17	2.27	1.41	29.19
LA CROSSE, WI	30	1.19	0.99	2.00	3.38	3.38	4.00	4.25	4.28	3.40	2.16	2.10	1.23	32.36
MADISON, WI	30	1.25	1.28	2.28	3.35	3.25	4.05	3.93	4.33	3.08	2.18	2.31	1.66	32.95
MILWAUKEE, WI	30	1.85	1.65	2.59	3.78	3.06	3.56	3.58	4.03	3.30	2.49	2.70	2.22	34.81
CASPER, WY	30	0.58	0.64	0.90	1.52	2.38	1.43	1.29	0.73	0.98	1.14	0.82	0.62	13.03
CHEYENNE, WY	30	0.45	0.44	1.05	1.55	2.48	2.12	2.26	1.82	1.43	0.75	0.64	0.46	15.45
LANDER, WY	30	0.52	0.54	1.24	2.07	2.38	1.15	0.84	0.57	1.14	1.37	0.99	0.61	13.42
SHERIDAN, WY	30	0.77	0.57	1.00	1.77	2.41	2.02	1.11	0.80	1.38	1.41	0.80	0.68	14.72
GUAM, PC	30	5.58	5.11	4.24	4.16	6.39	6.28	11.66	16.17	13.69	11.88	9.34	6.11	100.61
JOHNSTON ISLAND, PC	30	1.64	1.29	2.01	1.86	1.14	0.87	1.40	2.07	2.46	2.78	4.78	2.70	25.00
KOROR, PC	30	11.20	9.65	8.79	9.45	11.27	17.54	16.99	14.47	11.65	13.41	11.62	12.33	148.37
KWAJALEIN, MARSHALL IS., PC		5.12	3.73	3.82	7.63	8.62	8.86	10.24	10.42	11.82	11.46	10.74	7.94	100.40
MAJURO, MARSHALL IS, PC	30	8.09	6.86	8.43	11.30	11.53	11.09	12.41	11.95	11.96	13.73	12.81	11.50	131.66
PAGO PAGO, AMER SAMOA, PC		14.02	12.14	11.15	11.16	10.43	5.94	5.76	6.43	7.36	10.03	11.16	13.38	118.96
POHNPEI, CAROLINE IS., PC	30	12.52	9.78	13.96	16.94	19.41	17.06	16.72	16.37	14.94	16.30	14.74	15.87	184.61
CHUUK, E. CAROLINE IS., PC	30	8.58	8.77	8.15	10.94	11.29	12.82	12.45	15.09	13.12	10.69	11.09	10.98	133.97
WAKE ISLAND, PC	30	1.40	1.89	2.38	2.11	1.70	1.95	3.44	5.62	4.82	4.27	2.78	1.87	34.23
YAP, W CAROLINE IS., PC	30	7.24	5.45	6.14	5.58	8.15	13.46	13.25	14.41	13.53	12.25	8.82	9.34	117.62
SAN JUAN, PR	30	3.02	2.30	2.14	3.71	5.29	3.52	4.16	5.22	5.60	5.06	6.17	4.57	50.76