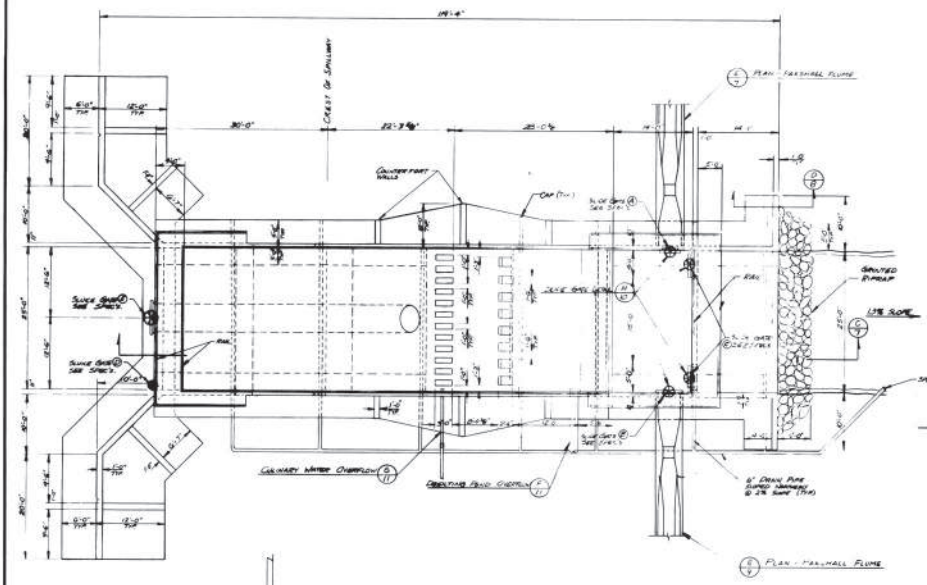
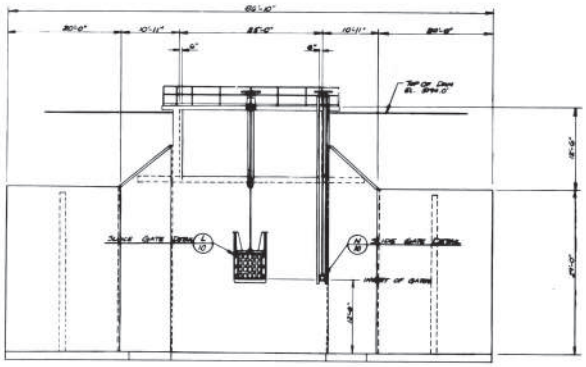
DRAFT



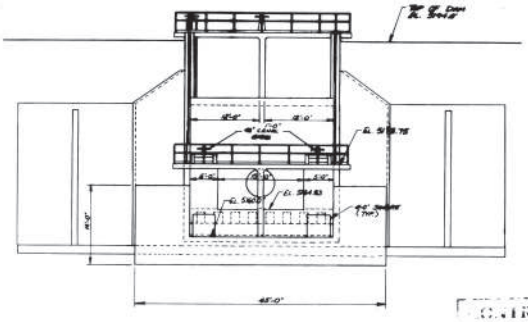
PLAN - SPILLWAY
1/8" = 1'-0"

NOTE: PLACE CONTRACTION CHAMFERS WHERE SHOWN ON EXPOSED SURFACE OF WALLS. OMIT CHAMFERS TO MATCH JOINTS IN FLOOR. PLACE CONTRACTION CHAMFERS ON FRONT WINGWALLS AND FACE WALL @ 18' O.C. MIN.



UPSTREAM ELEVATION
1/8" = 1'-0"

NOTE: ALL PILES TO BE BELATED FROM STRUCTURE



DOWNSTREAM ELEVATION
1/8" = 1'-0"

CONTRACT FINISHED DRAWING

REVISIONS		
NO.	DATE	BY
1	11-15-88	CJC
2		
3		
4		

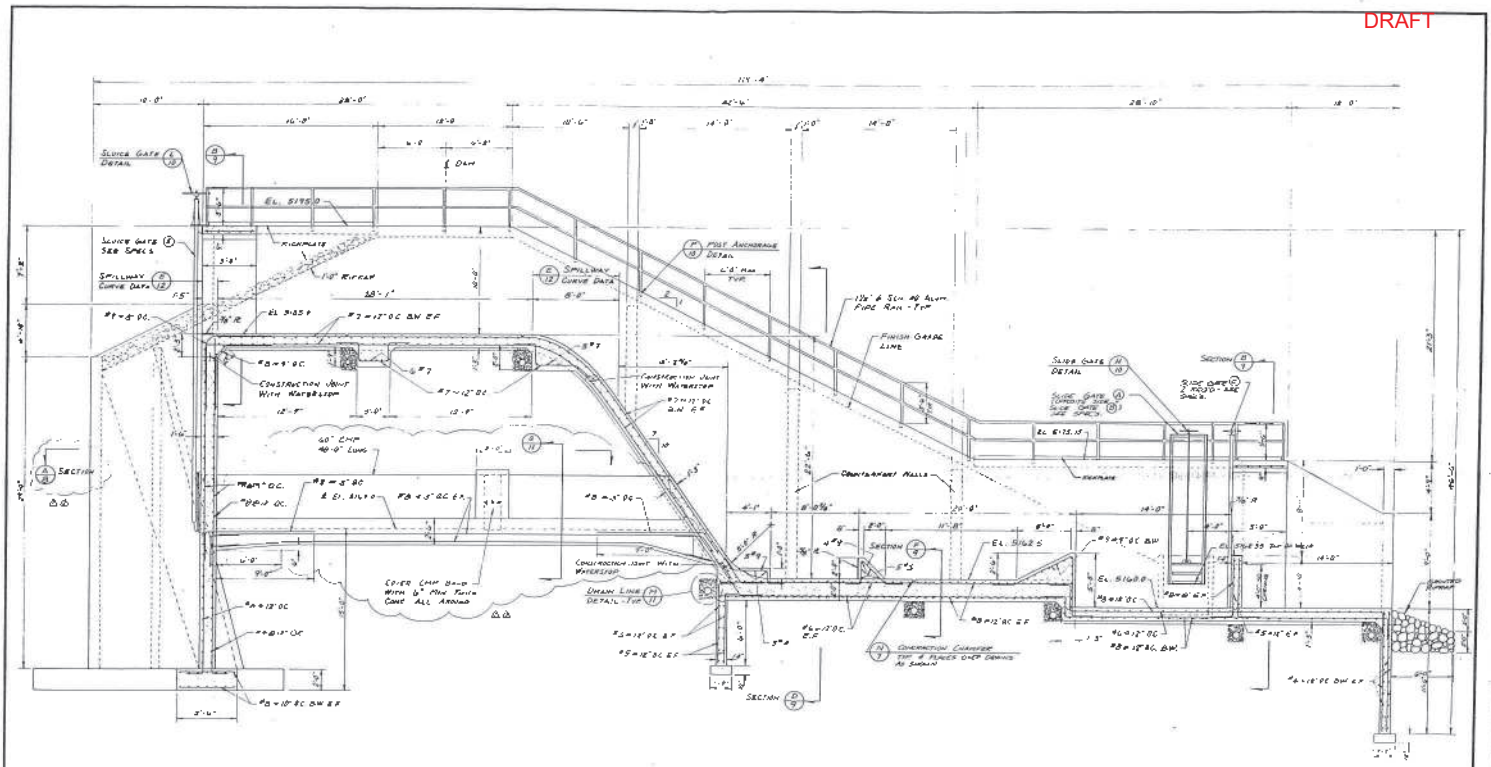
SUNRISE ENGINEERING, INC.
CONSULTING ENGINEERS & LAND SURVEYORS
Fillmore, Utah

SUNRISE ENGINEERING INC.

TOWN OF KANOSH CORN CREEK DAM PROJECT
SPILLWAY PLAN & ELEVATIONS SEP 5 1990

DESIGNED	DRAWN	CHECKED
K K	A C R	C M T
APPROVED	DATE	
		5-20-88
SCALE	SHEET NO.	
1/8"=1'-0"	6 OF 13	

DRAFT



NOTE:
ALL FILLETS TO BE CHAMFERED PER STRUCTURE

SLUICE AND SLIDE GATE SCHEDULE

Mark	Total	Type	Opening Size W&H	Gate Type	Frame Height or Seal Type	Top of Seating Level	Operating Head	Load Model Hydro	Load Model Waterstop
A	1	Fab. Slide	36x30	Flat Back	Lug	20	9	19-00	6-20 PT
B	1	Fab. Slide	60x48	Flat Back	249	19	9	15-00	6-20 PT
C	2	Fab. Slide	48x48	Flat Back w/ Flush Bottom	248	10	28	20-08	6-20 PT
D	1	Light Slide	32 8	Flat Back	247	20	49.5	26-13	6-20 PT
L	1	Hot Slide	60 8	Flat Back	—	20	19.5	30-10	30-30

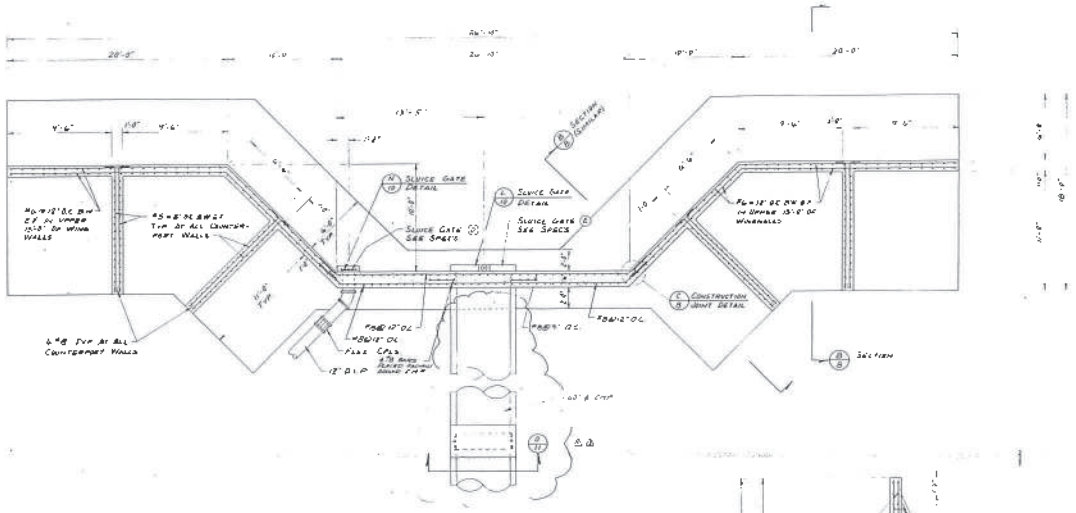
REVISIONS		
NO.	DATE	BY
1	5-16-88	CJC
2	11-15-88	CJC
3		
4		
5		

SUNRISE ENGINEERING, INC.
CONSULTING ENGINEERS & LAND SURVEYORS
FISHWATER, WISC

TOWN OF KANOSH CORN CREEK DAM PROJECT
SPILLWAY SECTION

DESIGNED	DRAWN	CHECKED
KK	ACR	CC
APPROVED	DATE	
	4-20-88	
SCALE	SHEET NO.	
1/4"=1'-0"	7 OF 13	

DRAFT



NOTE
ALL PILES TO BE SPLICED FROM STRUCTURE

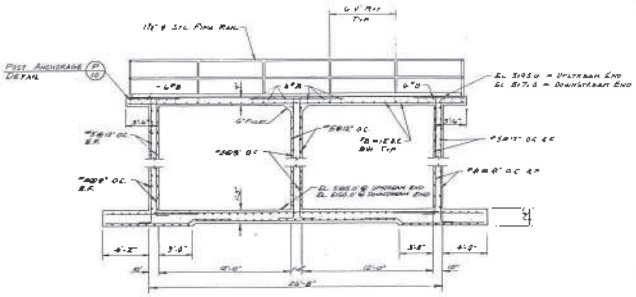
REVISIONS		
NO.	DATE	BY
A	9-16-03	CJC
B	11-13-03	CJC

SUNRISE ENGINEERING, INC.
CONSULTING ENGINEERS & LAND SURVEYORS
FITCHBURG, WISC.

TOWN OF KANOSH CORN CREEK DAM PROJECT
SPILLWAY SECTIONS & DETAILS

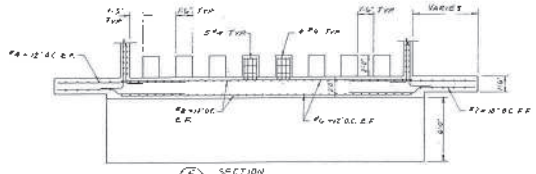
DESIGNED	CHECKED	DRAWN
W.K.	JCP	CE
APPROVED		DATE 8-20-03
SCALE AS NOTED		SHEET NO. 8 OF 13

DRAFT

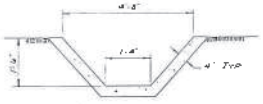


NOTE: Wall Reinforcement is Typical For All Walls Under 12'-0" High

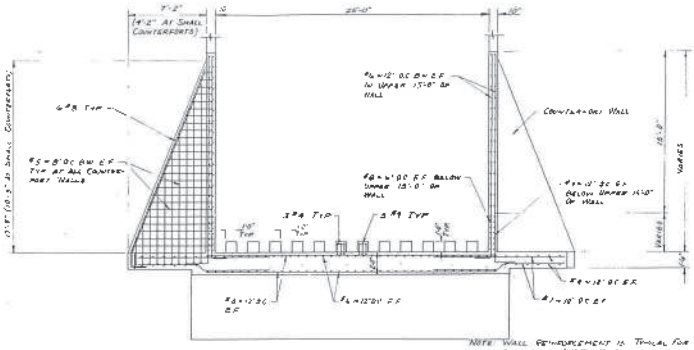
B/7 SECTION
1/4" = 1'-0"



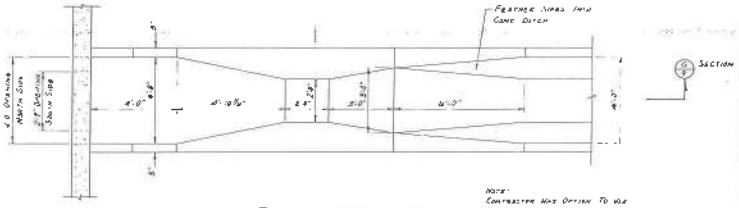
K/7 SECTION
1/4" = 1'-0"



H/13 SECTION - CONC. DITCH

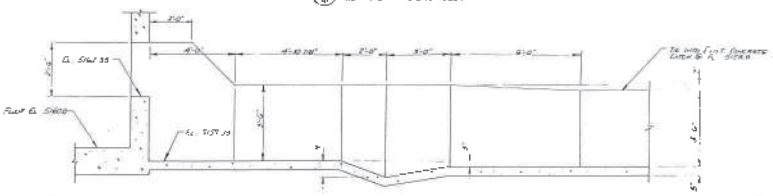


D/7 SECTION
1/4" = 1'-0"



E/6 PLAN - FRESHWATER FLUME
1/2" = 1'-0" Taken From Prod.

Note: Contractor Has Option To Use Precast Flume



G/9 SECTION
1/2" = 1'-0"

REVISIONS		
NO.	DATE	BY
1		
2		
3		
4		

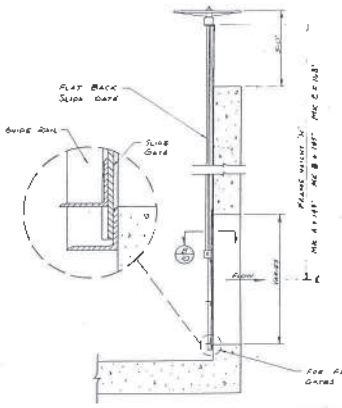
SUNRISE ENGINEERING, INC.
CONSULTING ENGINEERS & LAND SURVEYORS
Fillmore, Utah

SUNRISE ENGINEERING INC.

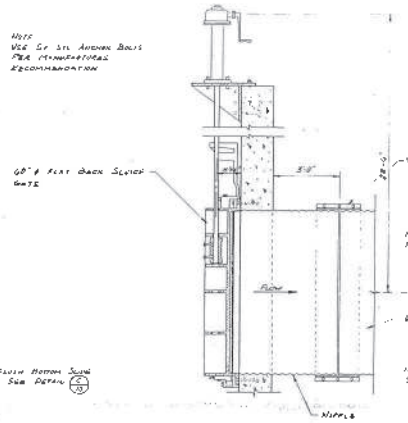
TOWN OF KANOSH CORN CREEK DAM PROJECT
SPILLWAY SECTIONS & DETAILS

DESIGNED	CHECKED	DRAWN
A.F.	ACR	CMF
SCALE	DATE	
AS NOTED	4-20-83	
SHEET NO.	9 OF 13	

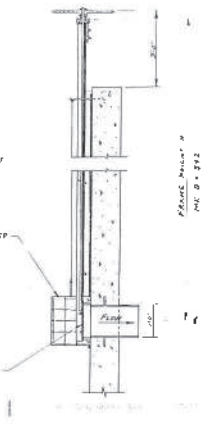
DRAFT



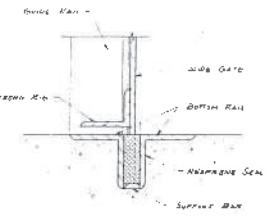
H/6 SLICE GATE DETAIL
3/4" = 1'-0"



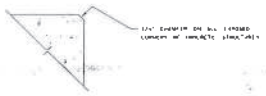
L/6 SLUICE GATE DETAIL
3/4" = 1'-0"



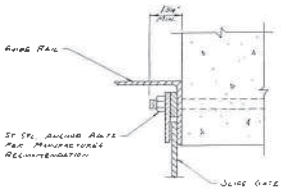
N/6 SLIDE GATE DETAIL
3/4" = 1'-0"



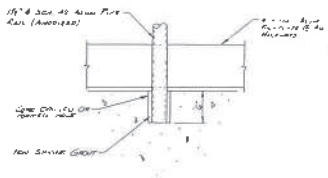
C/10 FLUSH BOTTOM DETAIL



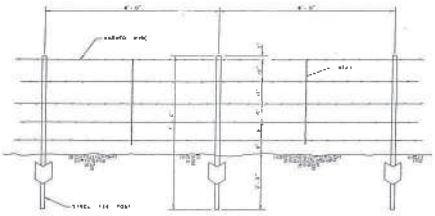
G/10 CHAMFER DETAIL
TYPICAL ALL EXPOSED CORNERS



B/10 SECTION
NO SCALE



P/9 POST ANCHORAGE DETAIL
3" = 1'-0"



M/8 STOCK FENCE DETAIL

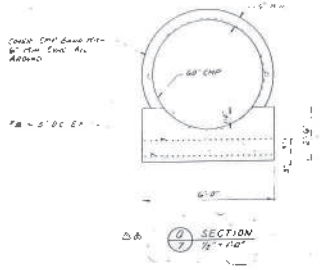
REVISIONS		
NO	DATE	BY
1		
2		
3		
4		

SUNRISE ENGINEERING, INC.
CONSULTING ENGINEERS & LAND SURVEYORS
FILLMORE, UTAH

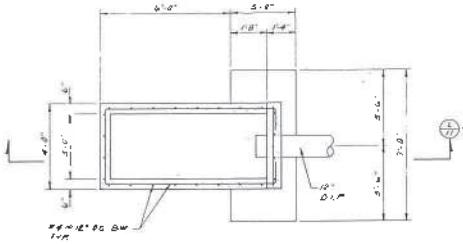
TOWN OF KANOSH CORN CREEK DAM PROJECT
MISCELLANEOUS DETAILS

DESIGNED	DRAWN	CHECKED
K.W.	A.C.H.	
APPROVED	DATE	
	8-20-85	
SCALE	SHEET NO.	
AS NOTED	10 OF 13	

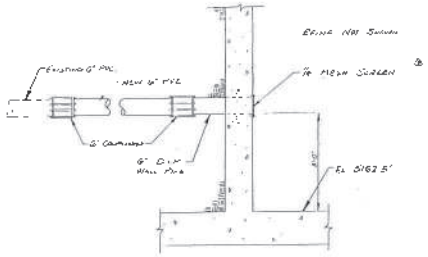
DRAFT



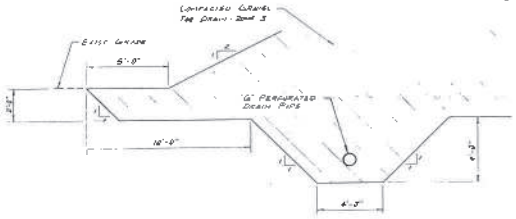
D/8 SECTION
1/2" = 1'-0"



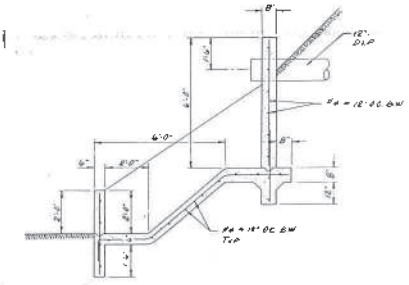
K/3 PLAN - INLET STRUCTURE
1/2" = 1'-0"



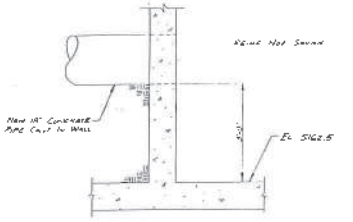
G/4 CULINARY WATER OVERFLOW
3/4" = 1'-0"



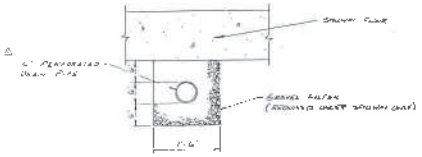
J/5 TOE DRAIN DETAIL
1/2" = 1'-0"



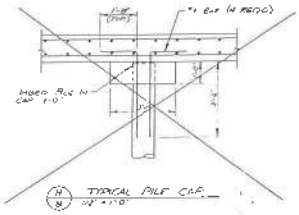
L/11 SECTION
1/2" = 1'-0"



F/4 UNSILTING POND OVERFLOW
3/4" = 1'-0"



M/7 DRAIN LINE DETAIL
1" = 1'-0"



N/N TYPICAL PILE CAP
1/2" = 1'-0"

DELETE

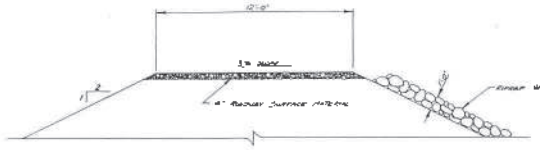
REVISIONS		
NO.	DATE	BY
3	7-14-88	CJC
2	10-18-88	CJC
1	2-22-88	CJC

SUNRISE ENGINEERING, INC.
CONSULTING ENGINEERS & LAND SURVEYORS
Fillmore, Utah

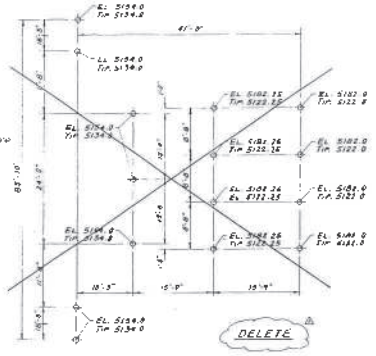
TOWN OF KANOSH CORN CREEK DAM PROJECT
MISCELLANEOUS DETAILS

DESIGNED K.H.	DRAWN A.C.P.	CHECKED C.C.
APPROVED	DATE 8-20-93	
SCALE AS NOTED	SHEET NO. 11 OF 13	

DRAFT

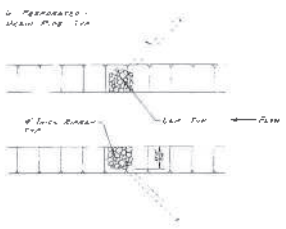


(L/5) TYPICAL TOP OF DAM DETAIL
NTS" = 1'-0"

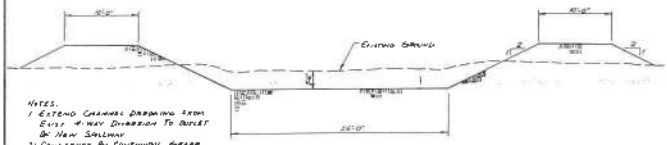


DELETE

(K/6) PILE LOCATION DIAGRAM
NTS SCALE

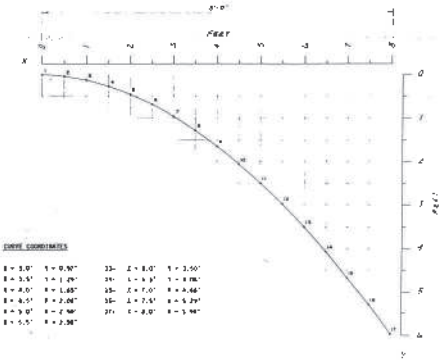


(A/12) DRAIN DETAIL
NTS SCALE



NOTES.
1. EXTEND CHANNEL DREDGING FROM EXIST. 4 WAY DIVERSION TO OUTLET OF NEW SPILLWAY
2. CONSTRUCT AS CONTINUOUS GRADE
3. FEATHER NEW BANKS FROM CHANNEL DREDGING TO EXIST. GROUND IN ATTRACTIVE FASHION

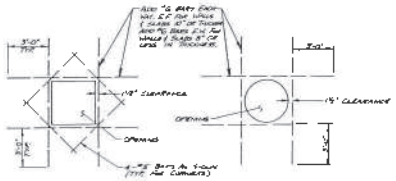
(F/5) TYPICAL CHANNEL SECTION
NTS SCALE



CURVE COORDINATES

1-	X = 0.8'	Y = 0.00'	7-	X = 3.0'	Y = 0.90'	33-	X = 8.0'	Y = 3.50'
2-	X = 0.5'	Y = 0.06'	8-	X = 3.5'	Y = 1.29'	34-	X = 6.3'	Y = 8.18'
3-	X = 1.8'	Y = 0.13'	9-	X = 4.0'	Y = 1.65'	35-	X = 7.0'	X = 4.46'
4-	X = 1.5'	Y = 0.27'	10-	X = 4.5'	Y = 2.06'	36-	X = 7.6'	X = 5.29'
5-	X = 2.9'	Y = 0.46'	11-	X = 5.0'	X = 2.50'	37-	X = 8.0'	X = 5.98'
6-	X = 2.5'	Y = 0.69'	12-	X = 5.5'	X = 2.98'			

(E/7) SPILLWAY CURVE DATA
1" = 1'-0"



NOTE:
ADDITIONAL REINFORCING REQUIRED WHEN OPENING DIMENSIONS IS LARGER THAN 2'-0" OR LARGER THAN THICKNESS OF WALL DIRECTION.
PLACE ADDITIONAL LONGITUDINAL & TRANSVERSE REINFORCING IN SAME PLANES AS PRIMARY REINFORCING WHERE POSSIBLE. USE STAGGERED POINT WHERE THE STRUCTURE DOES NOT PERMIT FULL LENGTH OF BARS.

(B/12) ADDITIONAL REINFORCING AT ALL OPENINGS IN CONCRETE

REVISIONS		
NO.	DATE	BY
1	11-15-05	C.J.C.
2		
3		
4		

SUNRISE ENGINEERING, INC.
CONSULTING ENGINEERS & LAND SURVEYORS
FILLMORE, UTAH

SUNRISE ENGINEERING INC.

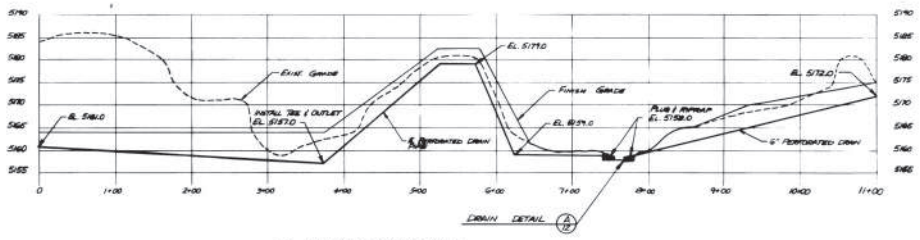
No. 5433 BLAKE D. ROBINSON

TOWN OF KANOSH CORN CREEK DAM PROJECT

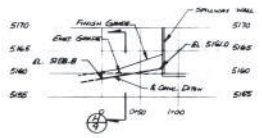
MISCELLANEOUS DETAILS

DESIGNED	DRAWN	CHECKED
R.R.	B.C.R.	C.C.
APPROVED		DATE 8-20-05
SCALE AS NOTED		SHEET NO. 15 OF 43

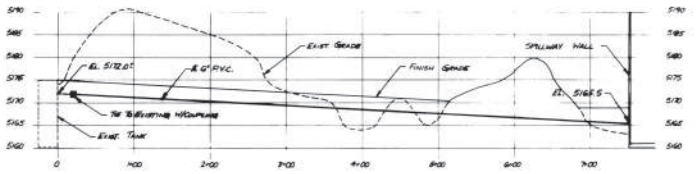
DRAFT



6" PERFORATED TOE DRAIN

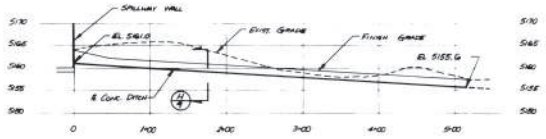


NORTH CONCRETE DITCH

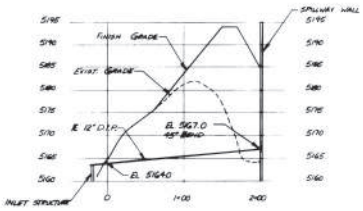


NOTE: REPLACE ONLY WHERE DISTURBED BY DAM CONSTRUCTION ACTIVITIES AS DIRECTED BY THE ENGINEER.

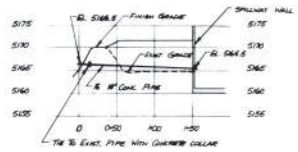
6" PVC CULINARY OVERFLOW



SOUTH CONCRETE DITCH



12" D.I.P. IRRIGATION POND INLET



18" C.P. IRRIGATION SETTLING POND OVERFLOW

REVISIONS		
NO.	DATE	BY
1		
2		
3		
4		
5		

SUNRISE ENGINEERING, INC.
CONSULTING ENGINEERS & LAND SURVEYORS
Fillmore, Utah

SUNRISE ENGINEERING INC.

No. 5454
REDEN C. ROBINSON

TOWN OF KANOSH CORN CREEK DAM PROJECT
PROFILES

DESIGNED	CHECKED	DRAWN
K K	A C R	C M T
APPROVED		DATE
		8-20-85
SCALE		SHEET NO.
AS NOTED		13 OF 13

DRAFT

GARY R. HERBERT
Governor
SPENCER J. COX
Lieutenant Governor

State of Utah
DEPARTMENT OF NATURAL RESOURCES
BRIAN C. STEED
Executive Director
Division of Water Rights
TERESA WILHELMSEN
State Engineer/Division Director

March 27, 2020

Emily Fife
State Conservationist
Natural Resources Conservation Service
Wallace F. Bennett Federal Building
125 South State Street Room 4010
Salt Lake City, UT 84138-1100

Re: Corn Creek Debris Basin / UT00322

Congress has provided $150 million in funding to the NRCS through the PL83-566 Watershed Protection and Flood Prevention Program (Watershed Act). It is our understanding that Millard County and Corn Creek Irrigation Company are requesting Federal assistance under the provisions of this act in order to remediate the existing debris basin and provide increased flood control protection to the town of Kanosh and agricultural lands.

The debris basin is on Utah Dam Safety's list of dams that needs rehabilitation. Utah Dam Safety is concerned about significant seepage through the dam foundation when the reservoir fills during high water events. Project remediation is needed to provide defensive design measures that control seepage and protects from internal erosion of the foundation and embankment. Utah Dam Safety supports this application to remediate the debris basin and bring the dam into compliance with current Dam Safety Standards, while providing increased flood control protections to Kanosh and the surrounding area.

Thank you for the time taken to consider this project for funding. Please feel free to contact me at 801-538-7376 or davemarble@utah.gov concerning additional information or questions you may have regarding Utah Dam Safety's support of this request.

Sincerely,

David K. Marble, P.E.
Assistant Utah State Engineer / Dam Safety

DKM/tg

pc: Bronson Smart - NRCS, bronson.smart@ut.usda.gov
Norm Evenstad - NRCS, norm.evenstad@ut.usda.gov
Lance Smith - NRCS, lance.smith@ut.usda.gov

Attachments: Water-Related Resource Concerns

- Wetland Riparian Inventory Memo – Cirrus Ecological Solutions
- Addendum to Wetland Riparian Inventory Memo – Cirrus Ecological Solutions
- Wetland Survey Areas Spreadsheet/Acreages – Corn Creek
- StreamStats Report for Corn Creek – U.S. Geological Survey
- Groundwater Resources of Pavant Valley, Utah (Reference Report) – U.S. Geological Survey

Cirrus Ecological Solutions, LC
965 South 100 West, Suite 200
Logan, UT 84321(435) 787-1490
Fax (435) 787-1495

MEMO

DATE: January 20, 2023

TO: Layne Jensen, Franson Civil Engineers

CC: Patricia Ayaa, Martilyn Neilsen

FROM: John Stewart, Botanist and Wetland Scientist

RE: Wetland Riparian Inventory

An inventory of channels, ditches, and other areas that collect water in the Corn Creek work areas was conducted on July 16 through 19, 2022. The project area is approximately 612 acres. The objective was to document the nature of these systems. In particular, areas that were mapped in the National Wetland Inventory (NWI) were investigated (NWI 2022). Inventory points along ditches, channels, and other areas within the work area corridors were given a unique identifier and documented via photographs and a brief description. Information on hydrology was based on field observations. Representative photographs were taken at the inventory points and are included in the data table (Cirrus 2023). A sample of those photographs are shown in Appendix A. The locations of the inventory points are shown in Figures 1 through 3 (Appendix B). A formal delineation of jurisdictional wetlands was not completed, meaning that sample points to characterize the wetland soils, hydrology, and vegetation to the level of detail required by the Army Corps of Engineers for a jurisdictional wetland delineation was not completed. The data collected during this inventory is documented in the refenced spreadsheet data table (Cirrus 2023).

Corn Creek enters the work area from the southeast as a small stream with a functioning riparian/wetland corridor (see Photos 1 through 3). At inventory point 70, the stream channel had been altered (Photo 4). At inventory point 3, the stream is entirely diverted into the Kanosh irrigation system at a flood control structure above the town of Kanosh (see Photo 5). A series of ditches and channels exist through the work area to move the water to points of use (see Photos 6 through 12). Some ditches are cement lined, while others are unlined (Cirrus 2023). There are sections of ditch that support riparian development to varying degrees (see Photos 13 through 20). Species in the areas with riparian development include coyote willow, narrowleaf cottonwood, box elder, and elm. The extent of development of such riparian/wetland areas varies as a function of ditch condition and frequency and duration of water. Sections of ditch with riparian vegetation are less common than dry-ditch segments that lack development of riparian vegetation.

Inventory points (sample points) were placed on the ditches based on access and attempting to be representative of the ditch system. Some ditches may have multiple observation points to better characterize the variability observed in the field.

Table 1 identifies the mapped soils in the work area and whether the soil is listed on the National Hydric Soils List. None of the soils were included on the list of hydric soils.

Table 1. Soil occurring in the work area polygons.		
MUSYS ID	**Soil Name**	**On Hydric Soil List***
3	Ashdown loam, 0 to 2 percent slopes	No
4	Ashdown loam, 2 to 5 percent slopes	No
7	Bandag loam, 0 to 2 percent slopes	No
8	Bandag loam, 2 to 5 percent slopes	No
22	Borvant-Pavant complex, 2 to 15 percent slopes	No
23	Boxelder silt loam, 0 to 2 percent slopes.	No
25	Calita-Erda complex, 0 to 2 percent slopes	No
27	Cessna loam, 0 to 5 percent slopes	No
31	Collard gravelly loam, 2 to 5 percent slopes	No
35	Current Spring-Maple Hollow complex, 15 to 30 percent slopes	No
37	Donnardo very stony loam, 2 to 15 percent slopes	No
38	Donnardo-Borvant-Collard complex, 2 to 5 percent slopes.	No
42	Escalante sandy loam, 0 to 2 percent slopes	No
43	Escalante sandy loam, 2 to 5 percent slopes	No
57	Hiko Peak fine sandy loam, 2 to 8 percent slopes	No
63	Hiko Peak-Heist complex, 0 to 2 percent slopes	No
102	Preston fine sand, 2 to 30 percent slopes	No
*https://www.nrcs.usda.gov/publications/query-by-state.html		

Figures 4 through 14 (Appendix B) show the NWI classifications in the work areas. Figure 4 shows a map index for the 9 maps that follow showing detailed views of the work areas, the sample points, and the NWI classifications in the work areas. Three NWI classes occur in the work areas: R4SBC (Riverine, Intermittent, Streambed, Seasonally Flooded), R4SBCx (Riverine, Intermittent, Streambed, Seasonally Flooded, excavated), and R5UBH (Riverine, Unknown Perennial, Unconsolidated Bottom, Permanently Flooded). In most cases, the NWI classified features are narrow, linear channel features that appear as thin lines on the maps. The NWI mapping was completed at small scale and the mapped features may not register well with the feature being represented on the ground. NWI classified areas outside of the work areas are shown as "other NWI" on the detail maps. The sample points symbology on the detail maps is coded to reflect the NWI classification of the feature where the sample point is located, and whether the field data confirms the NWI classification. Many sample points were located in work areas that were not classified in the NWI mapping as an aquatic resource even though similar irrigation ditch features were present and classified in other instances.

References

Cirrus (Cirrus Ecological Solutions, LC). 2023. Corn Creek IC Watershed Plan - Field Survey Riparian/Wetland Inventory (July 16 through 19, 2022), dated January 20. Excel spreadsheet. Cirrus Ecological Solutions, LC, Logan, Utah.

NRCS. 2022. Custom Soil Resource Report for Beaver-Cove Fort Area, Utah; Fishlake National Forest, Utah - Tushar-Pavant Division - Parts of Sevier, Millard, Beaver, Piute, Iron and Garfield Counties; and Millard County, Utah - Eastern Part. Web Soil Suvey, accessed January 29, 2023.

NWI (U.S. Fish and Wildlife Service National Wetland Inventory). 2022. National Wetlands Inventory Surface Waters and Wetland. https://fwsprimary.wim.usgs.gov/wetlands/apps/wetlands-mapper/. Last accessed September 29, 2022.

APPENDIX A.

PHOTOGRAPHS OF SELECTED INVENTORY POINTS



Photo 1. Sample Point 1 – natural riparian vegetation above diversion.



Photo 2. Sample Point 71 – natural riparian vegetation above diversion.



Photo 3. Sample Point 70 – looking upstream showing riparian vegetation.



Photo 4. Sample Point 70 – looking downstream showing altered riparian vegetation.



Photo 5. Sample Point 3 – channelized stream with riparian vegetation just above the Corn Creek diversion structure.



Photo 6. Sample Point 7 – lined ditch showing no riparian vegetation.



Photo 7. Sample Point 23 – lined ditch showing no riparian vegetation.



Photo 8. Sample Point 35 – unlined ditch showing no riparian vegetation.



Photo 9. Sample Point 60 – unlined ditch showing no riparian vegetation.



Photo 10. Sample Point 61 – unlined ditch showing upland grass and weeds with no riparian.



Photo 11. Sample Point 64 – unlined ditch showing no riparian.



Photo 12. Sample Point 66 – lined ditch showing no riparian.



Photo 13. Sample Point 8 – lined irrigation ditch on left showing no riparian, unlined ditch on right shows riparian.



Photo 14. Sample Point 13 – irrigation ditch showing riparian.



Photo 15. Sample Point 24 – irrigation ditch with reaches of riparian vegetation.



Photo 16. Sample Point 25 – irrigation ditch with reaches of riparian vegetation.



Photo 17. Sample Point 38 – irrigation ditch with riparian.



Photo 18. Sample Point 53 – lined irrigation ditch with riparian.



Photo 19. Sample Point 55 – irrigation ditch showing riparian.



Photo 20. Sample Point 56 – irrigation pond with associated aquatic vegetation.

APPENDIX B.

FIGURES

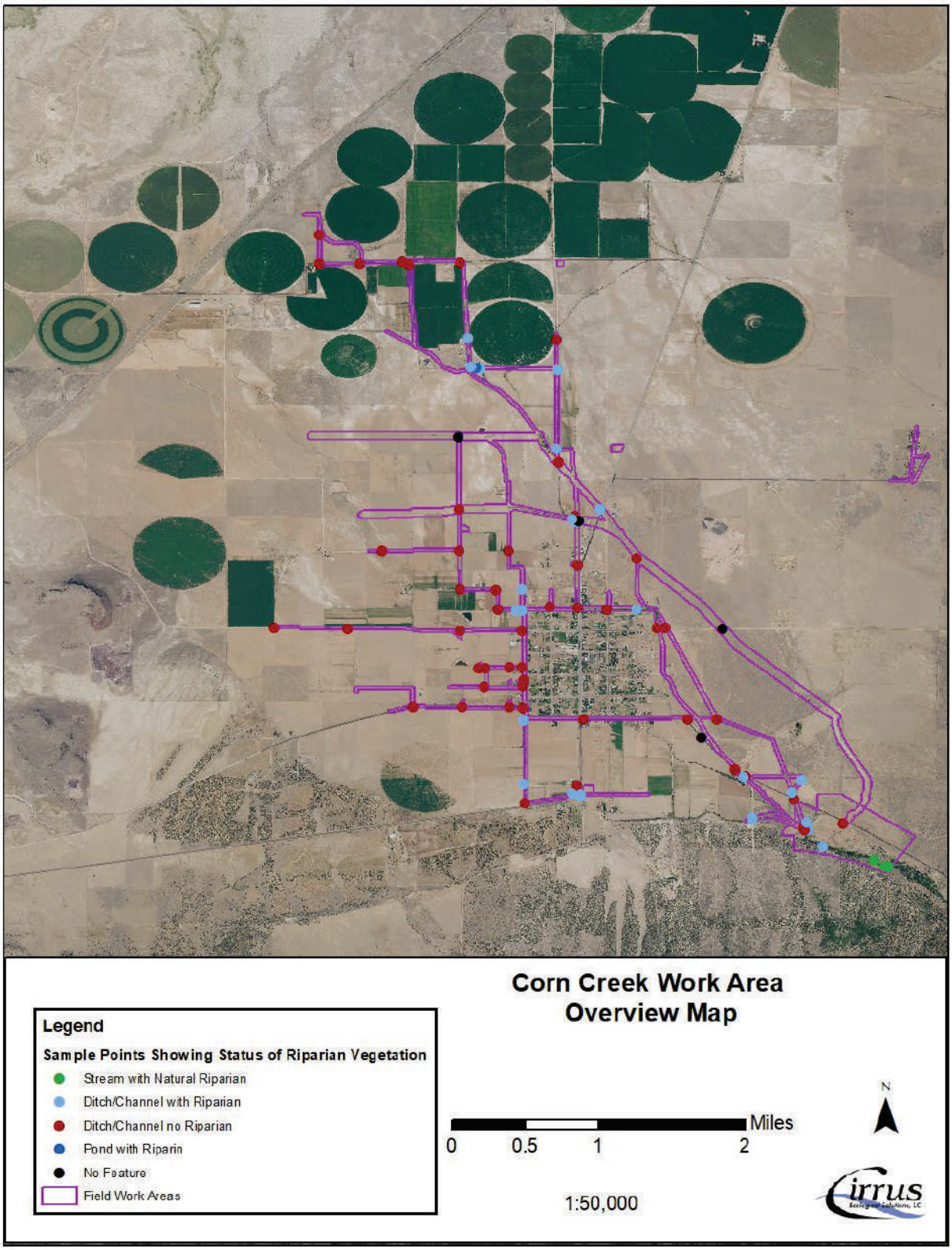


Figure 1. Overview map.

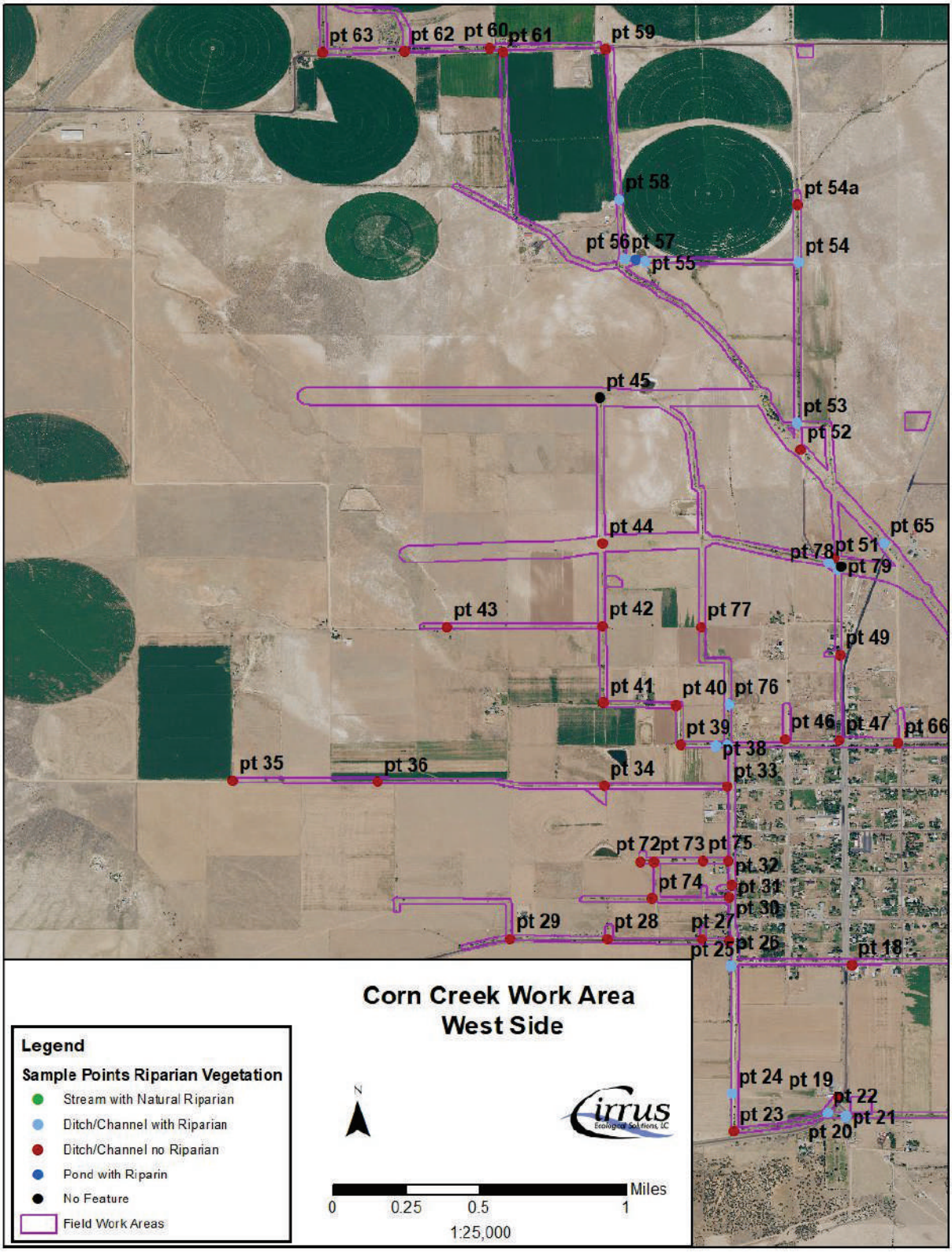


Figure 2. Close-up of west side of the project area.

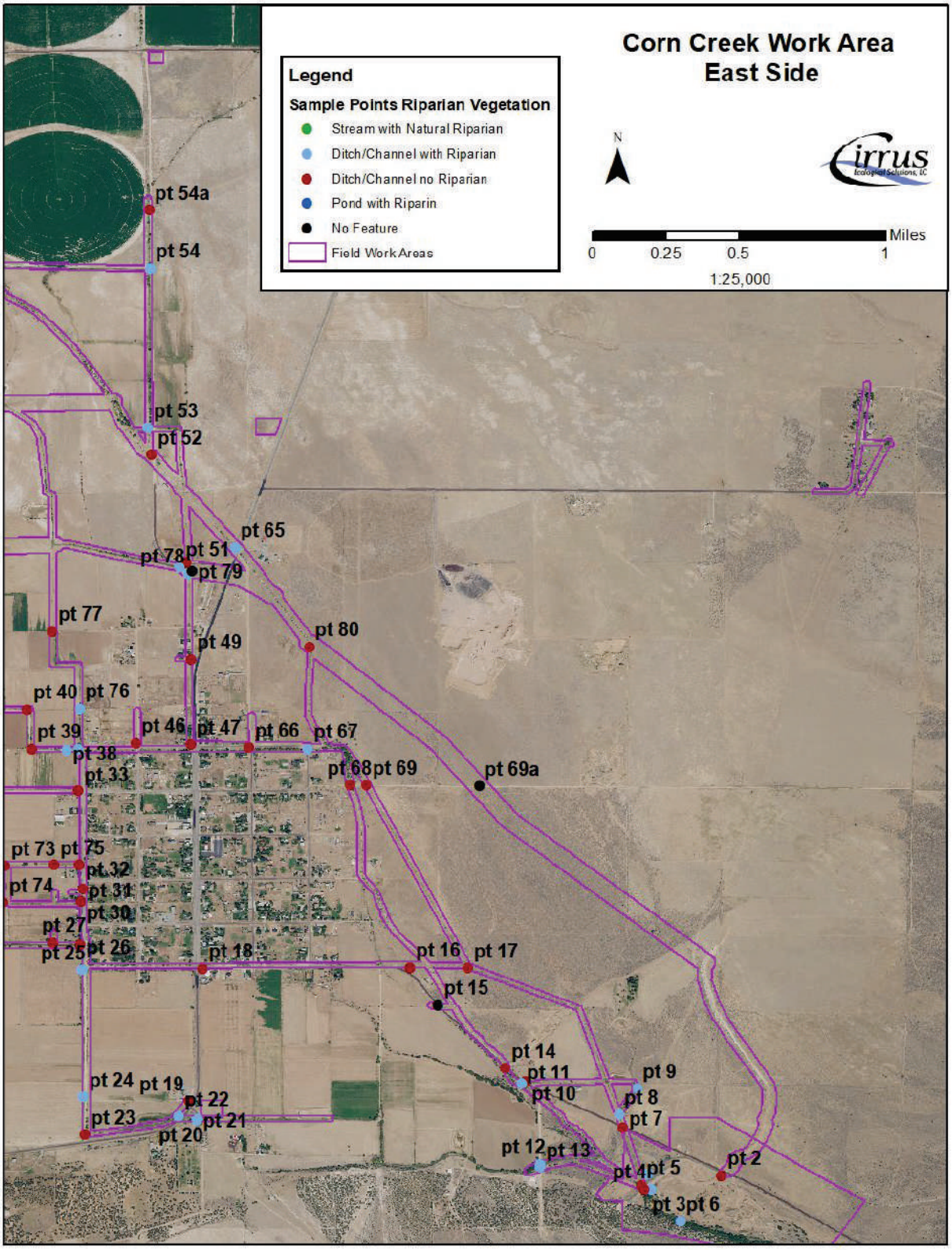


Figure 3. Close-up of east side of the project area.

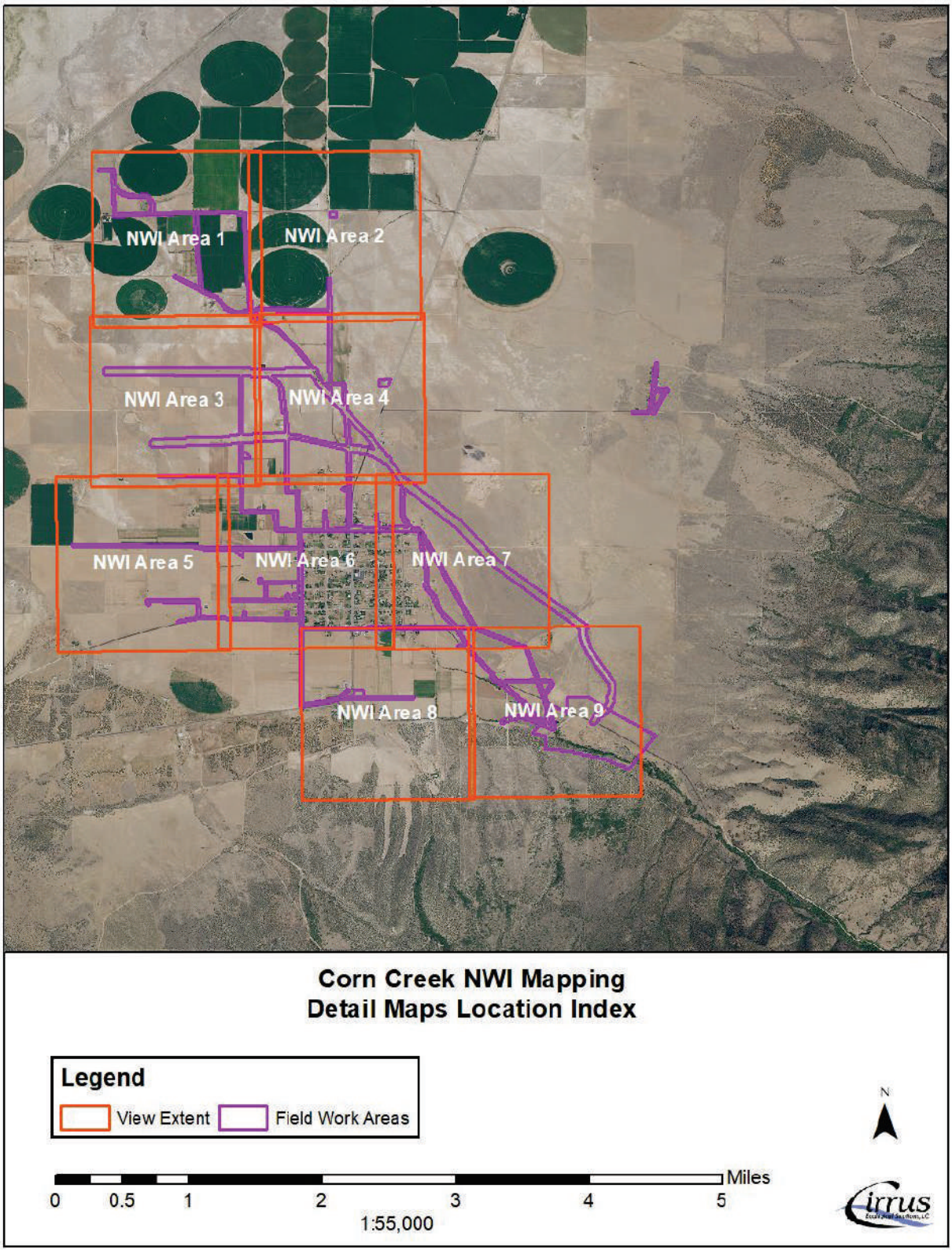


Figure 4. Corn Creek detail map location index for figures 5 through 13.

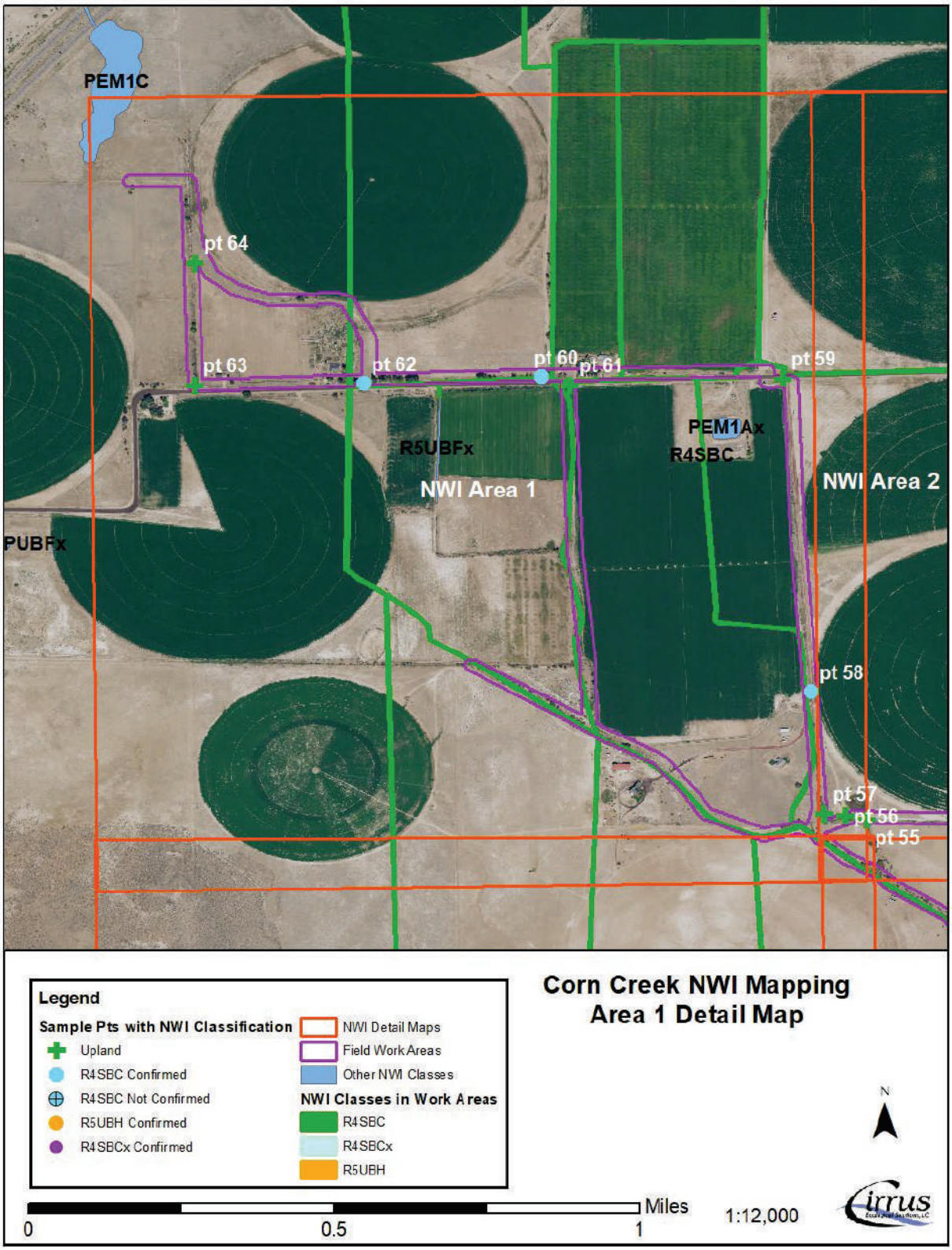


Figure 5. Corn Creek NWI mapping area 1 detail map.

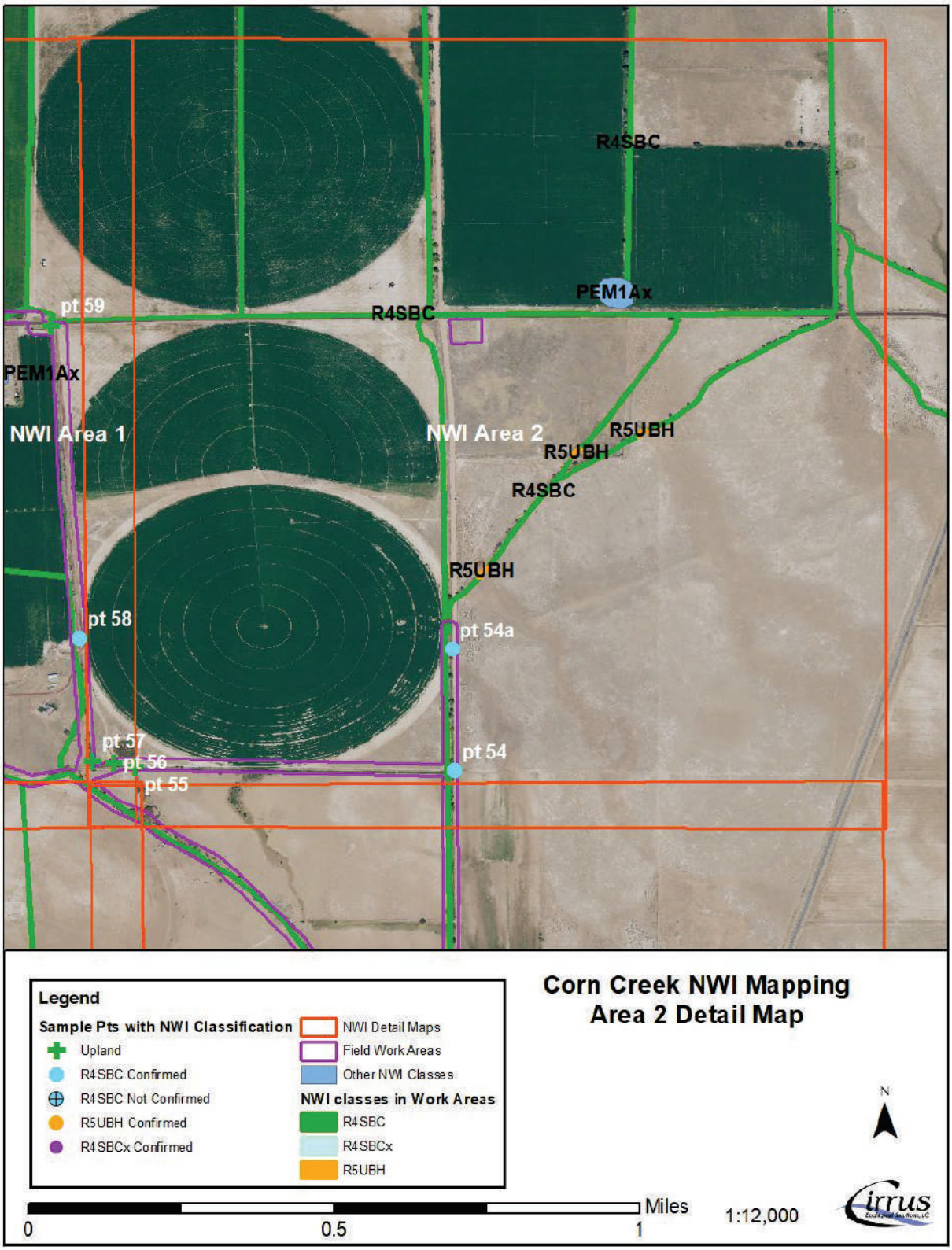


Figure 6. Corn Creek NWI mapping area 2 detail map.

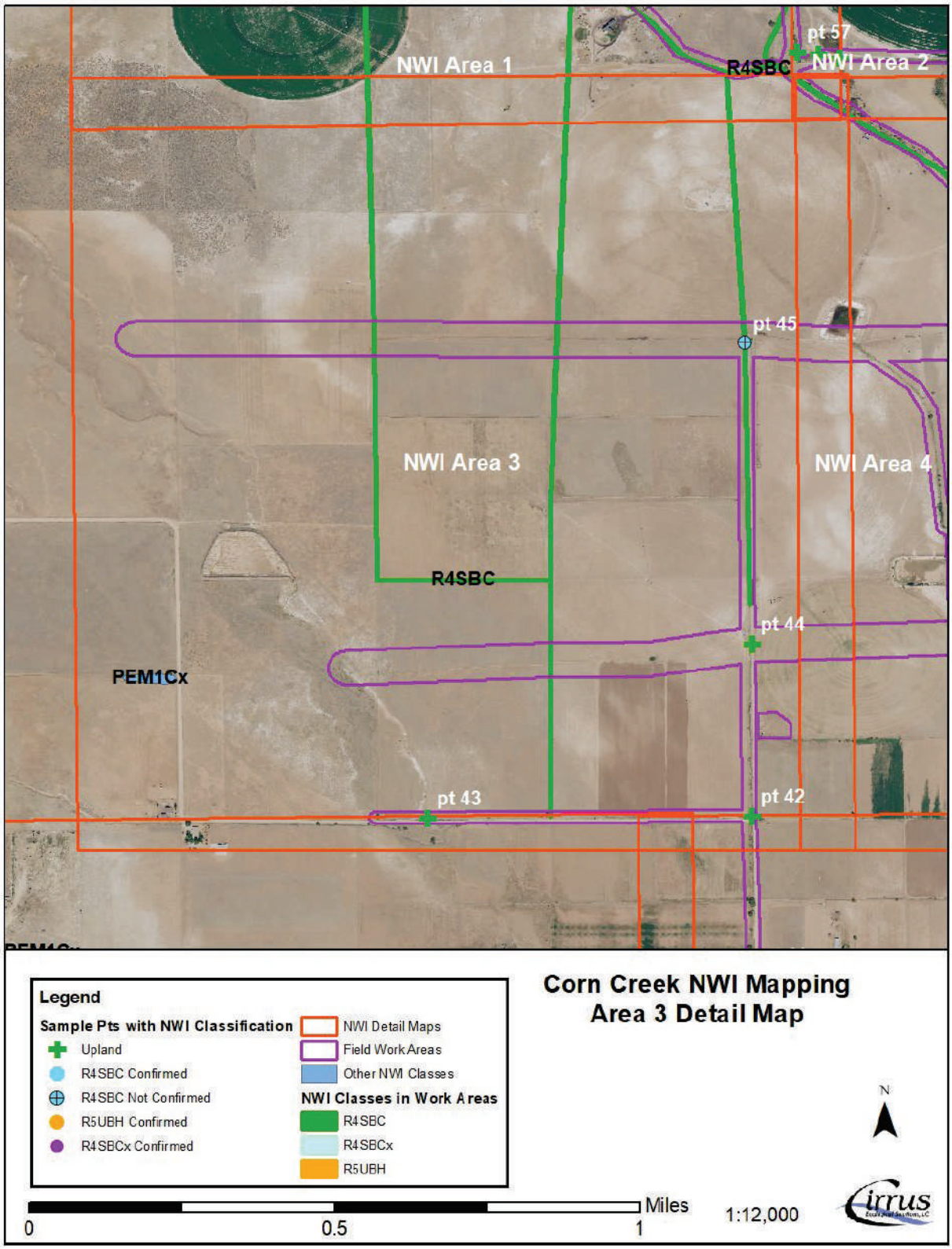


Figure 7. Corn Creek NWI mapping area 3 detail map.

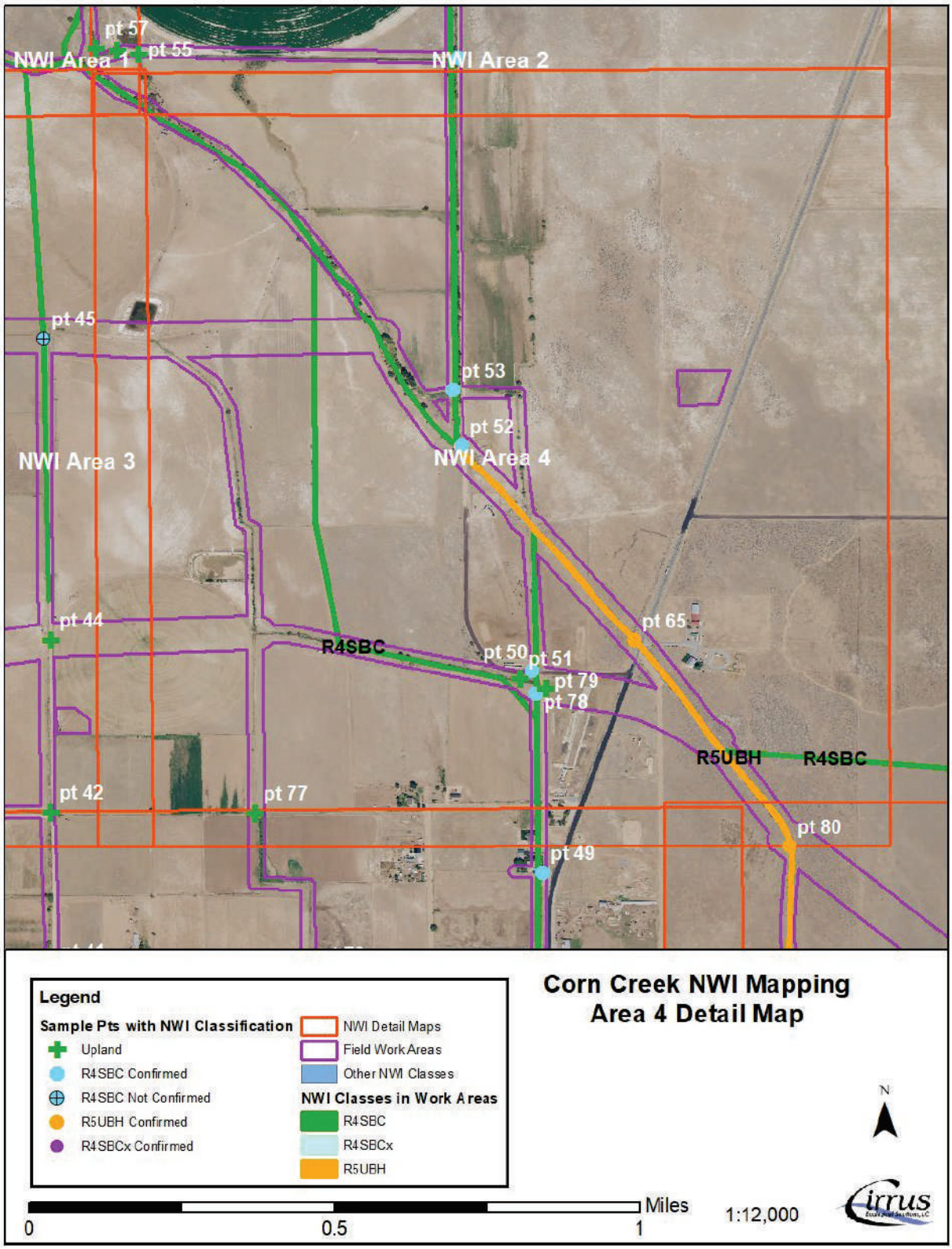


Figure 8. Corn Creek NWI mapping area 4 detail map.

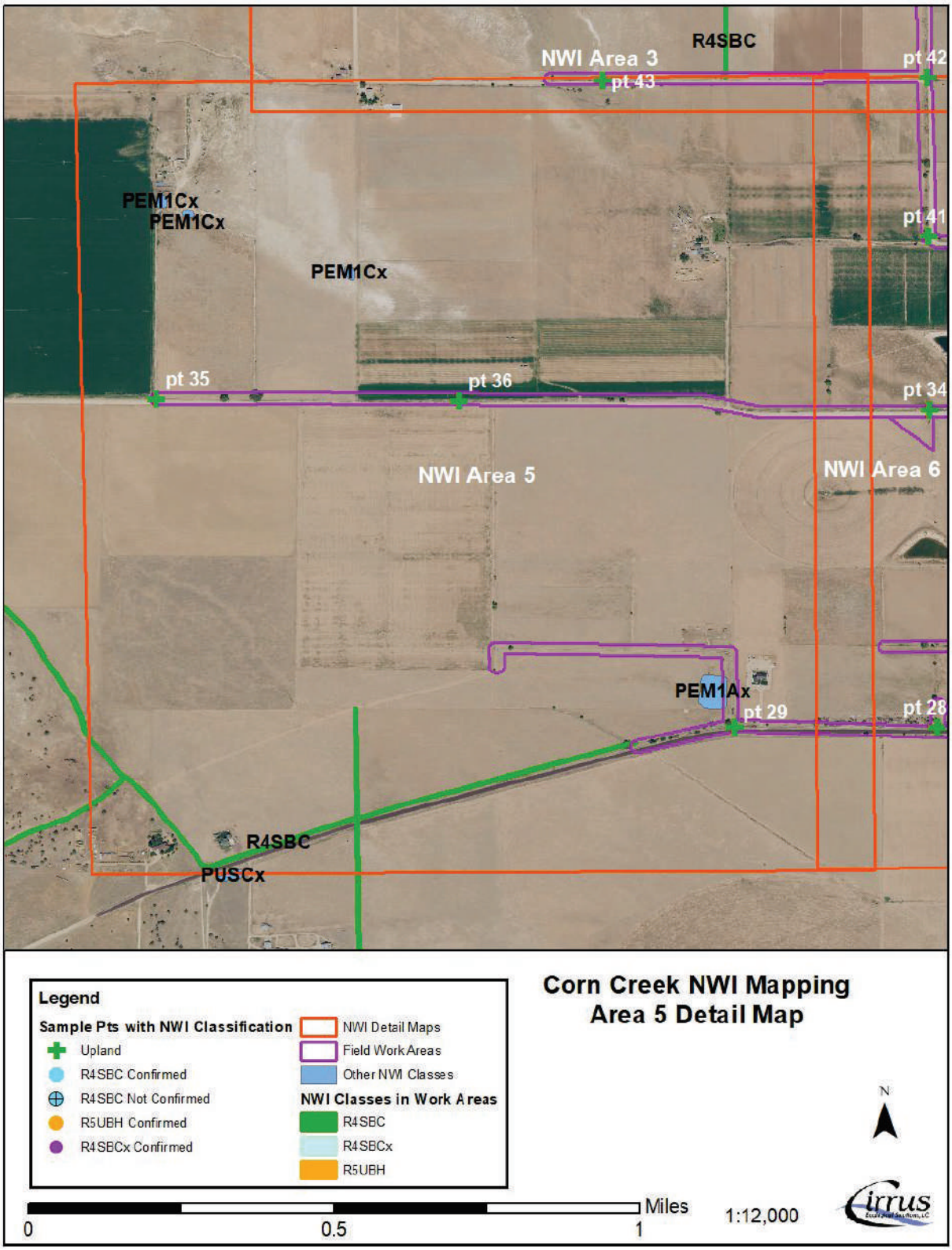


Figure 9. Corn Creek NWI mapping area 5 detail map.

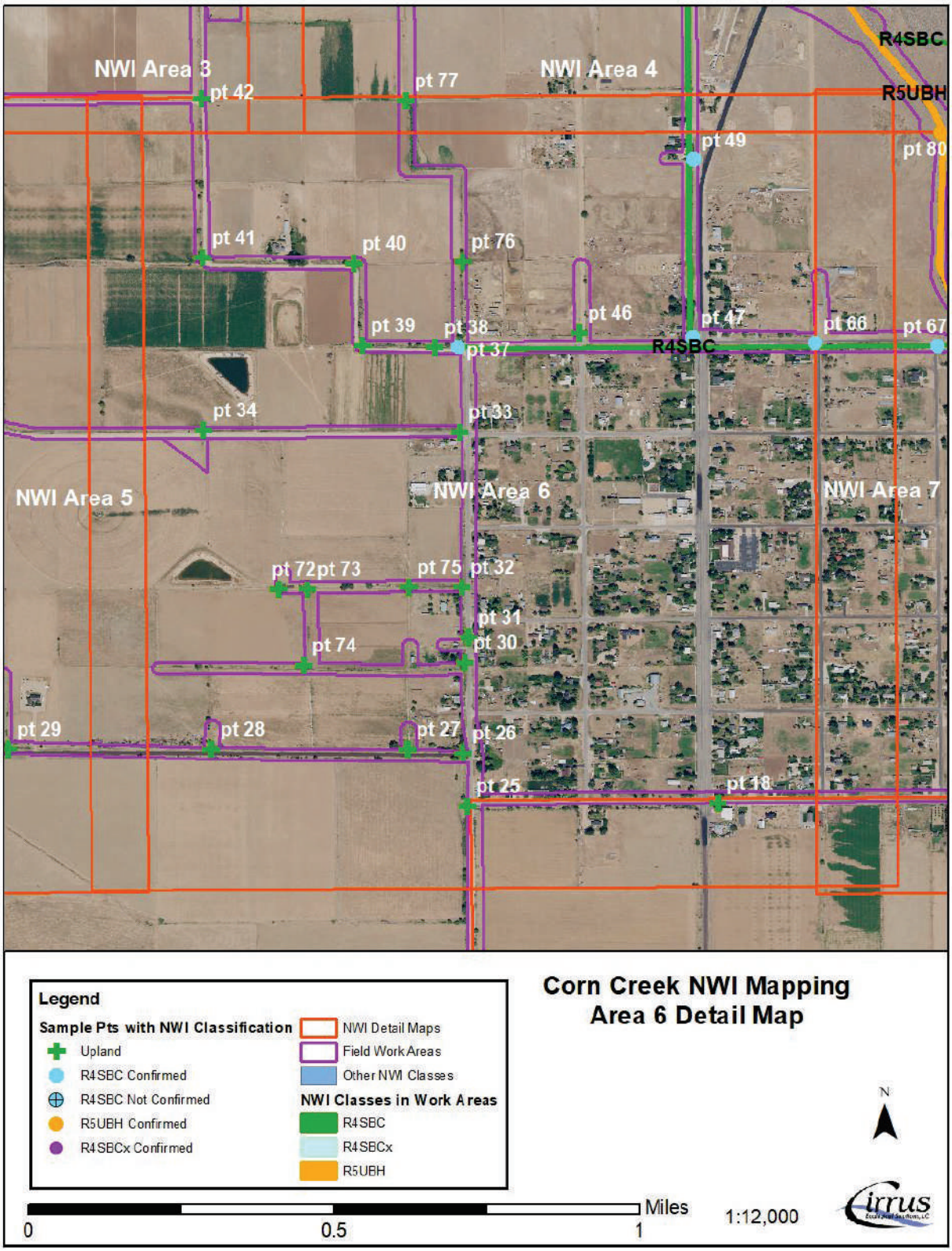


Figure 10. Corn Creek NWI mapping area 6 detail map.

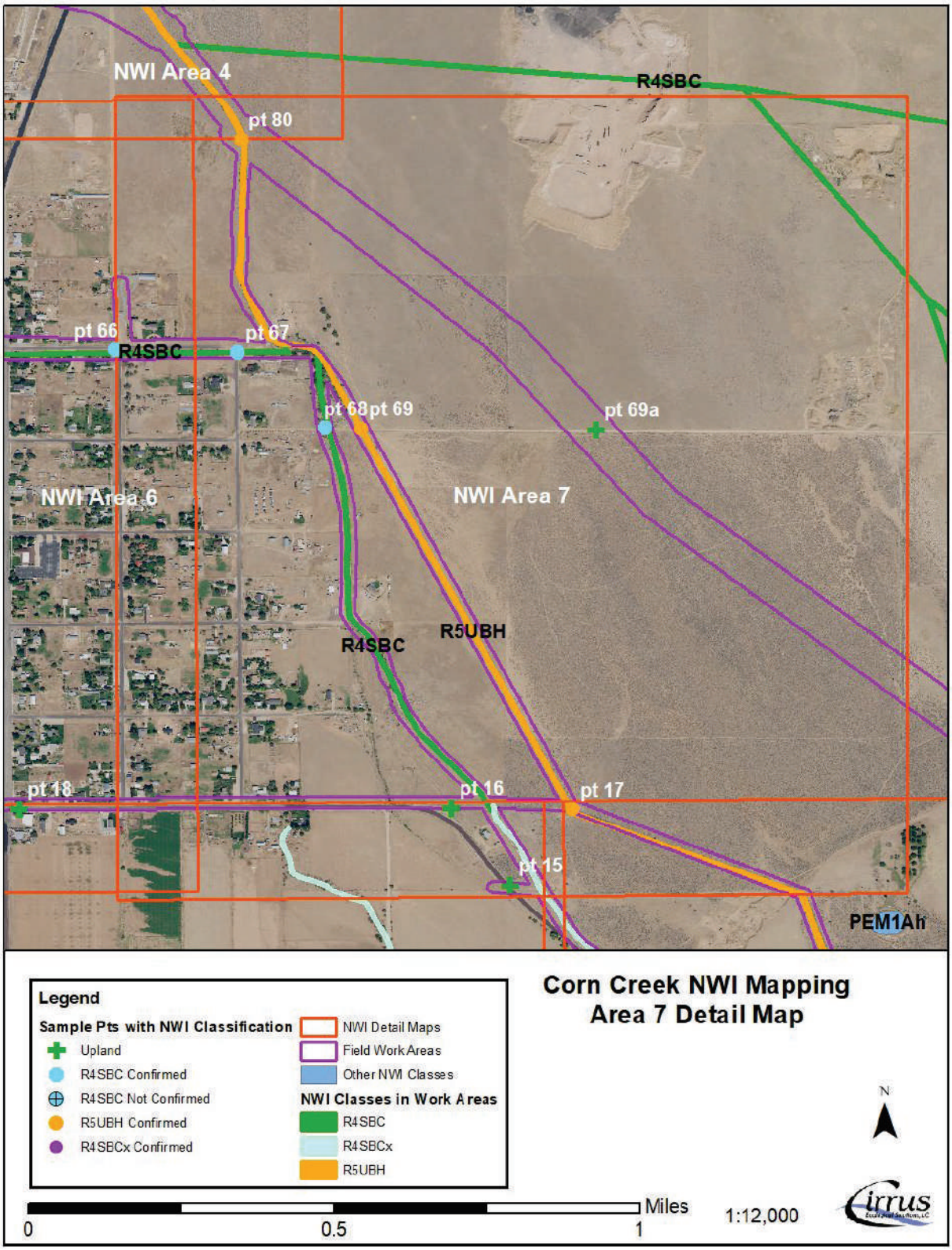


Figure 11. Corn Creek NWI mapping area 7 detail map.

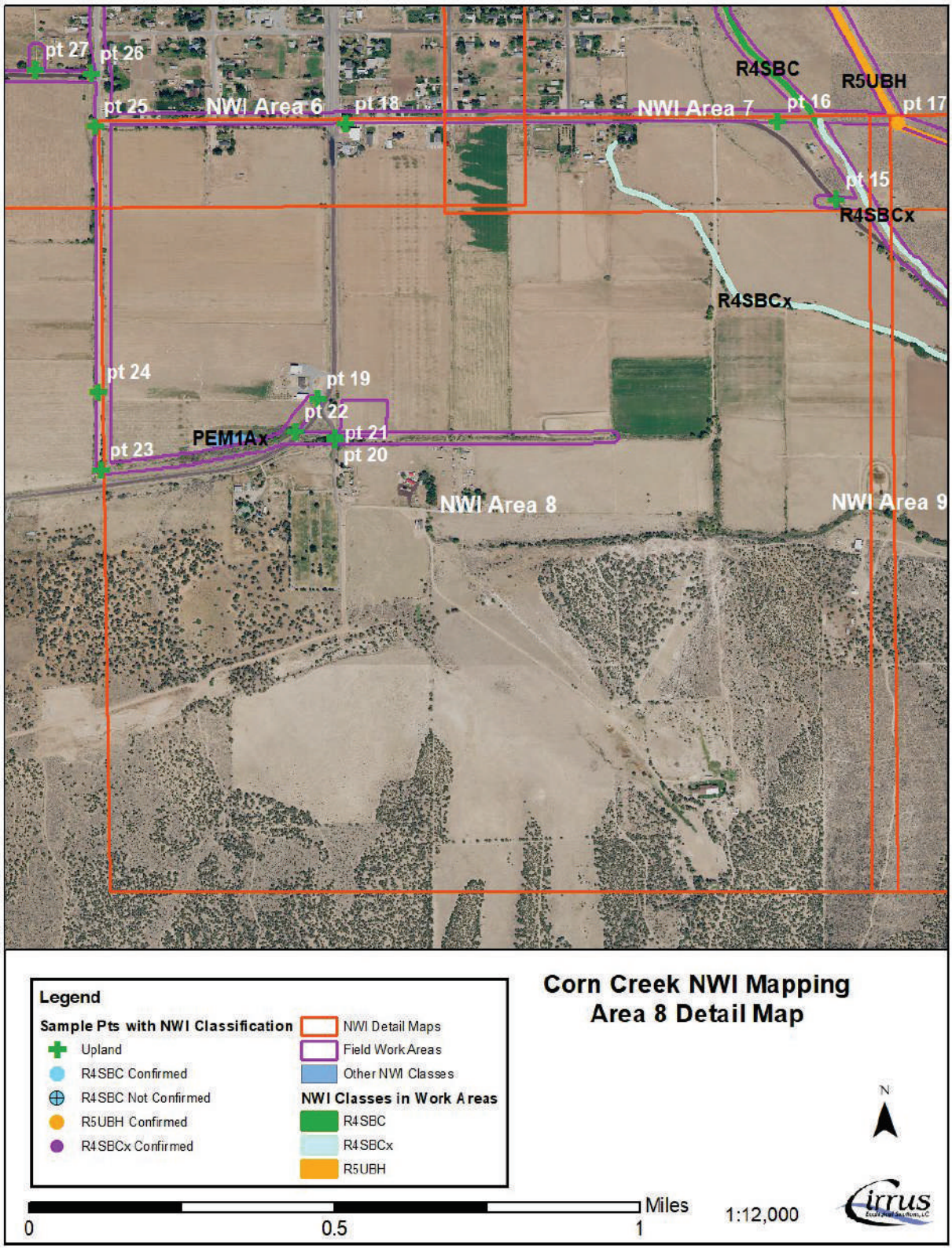


Figure 12. Corn Creek NWI mapping area 8 detail map.

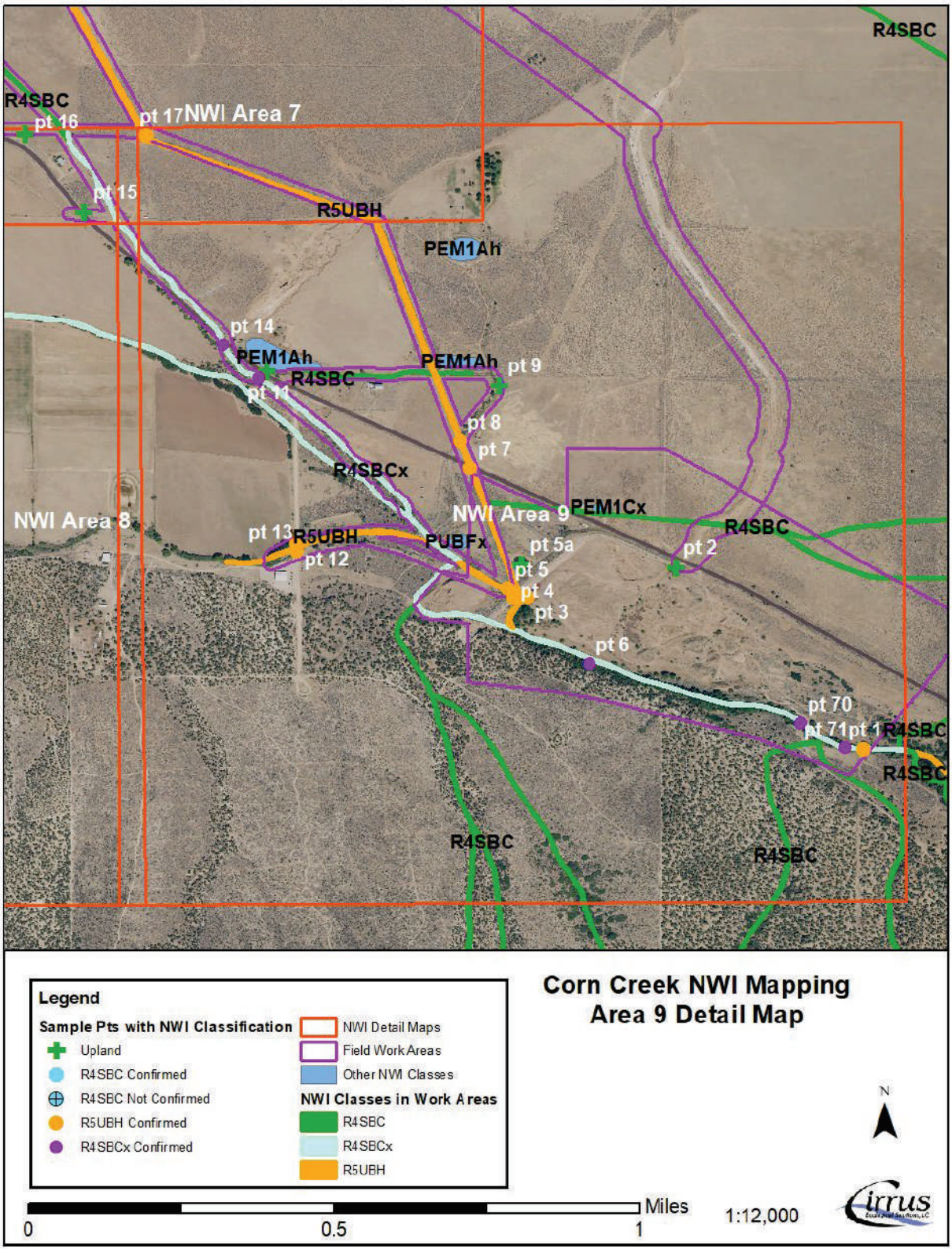


Figure 13. Corn Creek NWI mapping area 9 detail map.

Addendum: "Memo: Wetland Riparian Inventory" for the Corn Creek Watershed Plan-EA, dated January 20, 2023

John Stewart, Botanist and Wetland Scientist, Cirrus Ecological Solutions, LC

November 1, 2024

Purpose of the Addendum and Background

This document is an addendum to the memorandum "Wetland Riparian Inventory" dated January 20, 2023, prepared by Cirrus Ecological Solutions as part of their responsibility to conduct a wetland reconnaissance survey for the study area within the Corn Creek Watershed as part of the planning-level investigation for the Corn Creek Watershed Plan-Environmental Assessment (Plan-EA). This addendum was prepared following comments on the Preliminary Draft Plan-EA from the National Water Management Center (NWMC) in Little Rock, Arkansas which requested additional planning-level detail and clarification on the original memo.

The recommendation received from NWMC related to the wetlands inventory stated the following:

"Recommend reviewing NECH 610.22, 610.102, 610.36, and 610.116 and incorporating relevant and adequate details in the Affected Environment, Environmental Consequences, Coordination/Consultation, Permitting, and Mitigation portions of the Plan-EA. Actual WOTUS delineations should be conducted to provide relevant details, such as their extent and functional quality. Note that NWI data are suitable for very early pre-planning desktop review but are not suitable for NEPA and CWA analysis".

The comment itself can be broken down into the following components:

- Updating sections of the Plan-EA to reflect the guidance from the National Environmental Compliance Handbook (NECH) sections referenced.
- Completion of formal Wetland/Waters of the United States (WOTUS) delineations to provide additional details such as wetland extents (acreages) and functional quality (low, medium, or high). This would also include information on whether the identified sites are jurisdictional per U.S. Army Corps of Engineers (USACE) standards.
- National Wetlands Inventory (NWI) data alone are not suitable for National Environmental Policy Act (NEPA) and Clean Water Act Section 404 (CWA) compliance and should be supported by field survey data.

Coordination Meeting

On October 24, 2024, a coordination meeting was held over Microsoft Teams between representatives from NRCS-Utah (the lead agency for the project), Franson Civil Engineers (the AE firm preparing the Plan-EA), and Cirrus Ecological Solutions (Franson's sub-consultant responsible for the original Wetland memo and field work) to review the comment and to outline a path forward to fully address the NWMC comment in the Corn Creek Plan-EA and its supporting appendices.

By the end of the meeting, all parties were in agreement with the plan outlined below to address the comment:

1. Prepare an addendum to the original Wetlands Inventory Memo, the result of which is this document. The addendum should include all supplementary information to the original memo needed to respond to the NWMC comment.

2. Disagreement with the need for a formal wetland delineation following 1987 USACE standards during the watershed planning phase as there is no mention of this requirement in NRCS program manuals or handbooks.
3. Commitment to a formal USACE wetlands/WOTUS determination during the design/permitting phase of the project.
4. Identify what sites listed in the original field survey could be classified as wetlands and/or WOTUS and whether the sites could be considered jurisdictional under CWA.
5. An estimate of acreage of potential wetlands in the survey area, which would be included in the Affected Environment portion of the EA document.
6. A determination of acreage of indirect effects of the Preferred Alternative on any wetlands, which would be included in the Environmental Consequences portion of the document.
7. Add a reference to planned future CWA Section 404 permitting and USACE consultation requirements to the Preferred Alternative and Consultation, Coordination, and Public Participation chapters of the Plan-EA.
8. Clarification in the Plan-EA that the NWI was supported by field surveys conducted by Cirrus Ecological Solutions in 2022.

Need for a Formal USACE Wetland Delineation

NRCS-Utah has determined that, during the watershed planning phase of the Corn Creek Plan-EA project, a formal aquatic resources delineation following the 1987 USACE manuals and standards was not necessary. A wetlands reconnaissance inventory was required and has been completed at a level of detail commensurate with NRCS requirements for the planning/Plan-EA phase. The NWPM and the NWPH do not require any formal USACE delineation as a part of the planning process.

Commitment to CWA Section 404 Permitting During Design Phase

It is expected that CWA Section 404 permitting, including a formal delineation of wetlands and/or WOTUS, would be conducted during the design/permitting phase. This process would include consultation with the USACE and the necessary field surveys to complete the delineation.

Status of Wetlands and Likelihood of being Jurisdictional

Based on the field survey conducted in the study area shown in Figure 1 of Appendix B to the original memo, the following conclusion has been made by Cirrus Ecological Solutions regarding the nature of potential fringe aquatic sites within the study area along ditches and channels:

- **Sites which support riparian vegetation along man-made ditches and channels would most likely not be considered jurisdictional wetlands/WOTUS** because they (A) are excluded under Section 404 of the CWA under the exemptions of "ditches" and "artificially irrigated areas". Additionally, these ditches do not have a nexus to a navigable waterway as defined by the U.S. Supreme Court in *Sackett v. EPA.* However, it should be noted that, although the soils in these fringe riparian zones are not classified as hydric by the NRCS WebSoil Survey, they could be classified as hydric by definition. Man-made ditches and channels in the study area would not be WOTUS even though some support hydrophytic vegetation communities.
- **Sites which support riparian vegetation along the natural channel of Corn Creek (upstream of the Dam) would likely be classified as wetlands** and have been treated as such in the Plan-EA, because they (A) exhibit riparian vegetation, (B) have *naturally* occurring hydrology, and (C) are likely underlain by hydric soils. However, these sites would likely not be considered WOTUS as the creek ultimately dissipates into the surrounding watershed and does not have a significant

nexus with a navigable waterway as defined by the U.S. Supreme Court in *Sackett v. EPA.* The findings of this addendum are that sites exhibiting natural hydrology and riparian vegetation along the natural channel of Corn Creek are considered wetlands by definition but would not be considered WOTUS.

- **No sites within the study area are likely to be considered jurisdictional under Section 404 of the CWA** based on the following information:
    - Most of the sites in the study area are man-made ditches/irrigated areas which would likely be exempted under the Clean Water Act considering the recent *Sackett v. EPA* ruling of last year which codified the following applicable exemptions from WOTUS status/404 permitting:
        - Ditches (including roadside ditches), excavated wholly in and draining only dry land, and that do not carry a relatively permanent flow of water.
        - Artificially Irrigated Areas, that would revert to dry land if the irrigation ceased.
    - Additionally, in the *Sackett v. EPA* ruling the term "navigable waterway" was redefined and the "significant nexus" clause reinterpreted. "The term "navigable" refers to waters that are "navigable in fact", meaning that "they are used, or are susceptible of being used, in their ordinary condition, as highways for commerce, over which trade and travel are or may be conducted in the customary modes of trade and travel on water" (*Sackett v. EPA*, 2023).
    - The "Relative Permanence" test is also not applicable to the potential sites in the study area because, even though Corn Creek is a "relatively permanent, standing, or continuously flowing water" it is not "connected to "waters" (i.e., navigable waterways).
    - The areas along the natural channel of Corn Creek upstream of the Dam where water flows are relatively permanent would likely be classified as wetlands based on the three wetland parameters being present but would likely not be designated as jurisdictional WOTUS because Corn Creek itself is not a navigable waterway and does not discharge into a navigable waterway.

Acreage of Fringe Riparian Areas and Fringe Wetlands in the Study Area

Based on the findings above, the acreages for the fringe riparian/wetland in the study area were determined to be present (Table 1).

A Note on the National Wetlands Inventory (NWI)

To clarify, the original memorandum did utilize the preliminary data obtained from the NWI to get an idea of the type of riparian areas and/or wetlands that may be present in the Study Area but did not utilize the NWI alone to analyze the aquatic resources of the area. The NWI data was supplemented by a field survey conducted in July of 2022 and documented in the original memorandum. Potential special aquatic sites in the study area were considered in detail and at the site-specific level.

Conclusion

The information presented in this addendum provide the level of detail necessary to (1) address the comment received by NWMC on the Corn Creek Plan-EA, (2) update the information in the Plan-EA relating to wetlands, (3) assess the effects of alternative plans against CWA and NRCS wetland requirements, and (4) to conduct CWA Section 404 permitting during the design phase of the project.

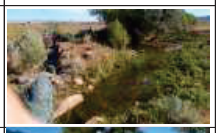
Maps, tabular data, and site photos are included as appendices to the original memorandum located in Appendix E to the Plan-EA.

Table 1. Summary of Approximate Acreage of Areas Supporting Hydrophytic Vegetation in the Study Area and Expected Effects.

Site ID (from Wetland Riparian Field Survey Inventory)	Site Type	Approximate Acres of Area Supporting Hydrophytic Vegetation	Possible Wetlands?[1]	WOTUS?[2]	Maximum Wetland Acreage Impacted by Implementation
1	Corn Creek Riparian	0.28 Acres	Yes	No	0.03 Acres
3	Corn Creek Riparian	0.01 Acres	Yes	No	0.01 Acres
5a	Pond	0.02 Acres	Yes	No	0.02 Acres
8	Riparian Vegetation along Irrigation Ditch	0.05 Acres	Yes	No	0.01 Acres
9	Riparian Vegetation along Irrigation Ditch	0.25 Acres	Yes	No	0.00 Acres
12	Riparian Vegetation along Irrigation Ditch	0.07 Acres	No	No	NA
13	Riparian Vegetation along Irrigation Ditch	0.02 Acres	No	No	NA
20	Riparian Vegetation along Irrigation Ditch	0.09 Acres	No	No	NA
21	Riparian Vegetation along Irrigation Ditch	0.07 Acres	No	No	NA
22	Riparian Vegetation along Irrigation Ditch	0.60 Acres	Yes	No	0.60 Acres
24	Riparian Vegetation along Irrigation Ditch	0.17 Acres	No	No	NA
25	Riparian Vegetation along Irrigation Ditch	0.21 Acres	Yes	No	0.21 Acres
38	Riparian Vegetation along Irrigation Ditch	0.15 Acres	Yes	No	0.15 Acres
53	Riparian Vegetation along Irrigation Ditch	0.83 Acres	Yes	No	0.83 Acres
54	Riparian Vegetation along Irrigation Ditch	0.59 Acres	Yes	No	0.59 Acres
55	Riparian Vegetation along Irrigation Ditch	0.32 Acres	Yes	No	0.32 Acres
56	Irrigation Pond	0.50 Acres	Yes	No	0.00 Acres
57	Riparian Vegetation along Irrigation Ditch	0.32 Acres	Yes	No	0.32 Acres
67	Riparian Vegetation along Irrigation Ditch	0.11 Acres	Yes	No	0.11 Acres
	TOTAL	**4.64 Acres**	**N/A**	**N/A**	**3.20 Acres**

[1]Would the site meets the criteria to be a possible wetland, i.e., hydrophytic vegetation, hydric soils, and wetland hydrology?
[2]Would the site meets the criteria to be possibly considered a jurisdictional Waters of the U.S.?

Corn Creek IC Watershed Plan - Wetland Riparian Field Survey Inventory (July 16 through 19, 2022), dated January 20, 2023															
Site Id	Latitude/ Longitude	Description	Feature Type	NWI Classification	NWI Classification Confirmed	Channel Width (feet)	Riparian Width, including channel (feet)	Width	Length	Acres	Primary Wetland Riparian Vegetation	Photographs			
1	38.782990 91 N - 112.40723 524 W	Perennial stream flowing in natural channel. Narrow wetland fringe flanked by wider riparian.	Stream and riparian wetland.	RSUBH	Yes	8	30	22	550	0.28	Coyote willow, narrow-leaf cottonwood, Russian olive, and willow tree.				
2	38.784688 79 N - 112.41173 865 W	Berm/swale to intercept flood water and move to creek/edge of detention basin.	Flood channel.	Not classified.	N/A	15	N/A	0	0	0.00	Scattered willow and tamarisk.				
3	38.782990 91 N - 112.40723 524 W	Corn Creek channel at flood gates- a ditch with a very narrow riparian fringe.	Channelized stream.	RSUBH	Yes	8	10	2	165	0.01	Deep-rooted trees and willows.				
4	38.783906 8 N - 112.41551 558 W	Corn Creek is diverted into irrigation ditches.	Channelized stream.	RSUBH	Yes	8	N/A	0	0	0.00	None.				
5	38.784098 02 W - 112.41564 665 N	Steam flow enters either cement-lined ditch or pipe.	Irrigation ditch no riparian.	RSUBH	Yes	5	N/A	0	0	0.00	None.				
5a	38.784436 68 N - 112.41537 530 W	Water storage reservoir for irrigation system	Irrigation pond with riparian.	Not classified.	N/A	N/A	2 ft wide noncontinous fringe around pond	2	403	0.02	Non-continous willow and cottonwood around reservoir margin.				

6	38.782326 97 N - 112.41370 050 W	Channelized Corn Creek above irrigation diversion struction.	Channelized stream.	R4SBCx	Yes	6 (steep-sided unlined ditch)	None	0	0	0.00	Woody riparian vegetation has been mechanically removed from the sides of the channel.				
7	38.786955 28 N - 112.41652 645 W	Cement lined irrigation ditch with pipe discharge.	Irrigation ditch no riparian.	R5UBH	Yes	5	None	0	0	0.00	None.				
8	38.787597 68 N - 112.41677 259 W	Cement lined irrigation ditch crosses earthern ditch.	Irrigation ditch no riparian on left. Irrigation ditch with riparian on right.	R5UBH	Yes	3 (cement ditches) 6 (unlined ditch)	9 (along unlined ditch)	3	775	0.05	No riparian along cement ditch; willows along unlined ditch.				
9	38.788887 80 N - 112.41584 703 W	Shallow wide swale. Unmaintaine d.	Irrigation ditch with riparian.	Not classified.	N/A	10	12	12	890	0.25	Riparian vegetation includes widely-spaced cottonwoods and willows growing in and along the ditch.				
10	38.789244 67 N - 112.42134 678 W	Unlined channel. Headgate below road crossing.	Irrigation ditch no riparian.	Not classified.	N/A	8	0	0	0	0.00	N/A				
11	38.789115 4 N - 112.42154 724 W	Unlined channel. Headgate below road crossing.	Irrigation ditch no riparian.	R4SBCx	Yes	5	0	0	0	0.00	Scattered willow and tamarisk.				
12	38.785147 63 N - 112.42065 397 W	Unlined channel. Headgate below road crossing.	Irrigation ditch with riparian.	R5UBH	Yes	5	15	10	320	0.07	Willows along ditch upstream of road crossing, elm tress below.				
13	38.784990 24 N - 112.42064 518 W	Head of cement ditch, receives water from pipe.	Irrigation ditch with riparian.	R5UBH	Yes	6	10	4	200	0.02	Willows.				

14	38.78991852 N - 112.42225978 W	Unlined channel, no riparian but there are scattered elm and willows.	Irrigation ditch no riparian	R4SBCx	Yes	5	0	0	0	0.00	Scattered elm and willow growing along channel.				
15	38.79300594 N - 112.42568927 W	Work area spoil, no ditch or channel present.	Field.	Not classified.	N/A	N/A	N/A	0	0	0.00	None.				
16	38.79300594 W - 112.42568927 N	Cement lined ditch.	Irrigation ditch no riparian.	Not classified.	N/A	3	None.	0	0	0.00	None.				
17	38.79484323 N - 112.42420190 W	Cement lined ditches and headgate.	Irrigation ditch, no riparian.	R5UBH	Yes	3	None.	0	0	0.00	None.				
18	38.79481642 N - 112.43730693 W	Cement lined ditch.	Irrigation ditch, no riparian.	Not classified.	N/A	15	None.	0	0	0.00	None.				
19	38.78827342 N - 112.43798707 W	Pipe discharge into unlined ditch.	Irrigation ditch, no riparian.	Not classified.	N/A	3	None.	0	0	0.00	None.				
20	38.78732389 N - 112.43756788 W	Earthen flood channel, has a narrow fringe of willows along ditch.	Irrigation ditch, with riparian.	Not classified.	N/A	4	6	2	2000	0.09	Willows along ditch.				

21	38.787323 89 N - 112.43756 788 W	Irrigation piped to 200 feet above road, then water empties into cement ditch then goes under the road, then empties into ditch on west side of road.	Irrigation ditch, with riparian.	Not classified.	N/A	8	18	10	300	0.07	Willow fringe on east side of road, elm riparian on west side of road.			
22	38.787500 43 N - 112.43850 91 6 W	Open irrigation ditch, 3 way headgate below road, big willow basin west of road.	Irrigation ditch, with riparian.	Not classified.	N/A	4	24	20	700	0.60	Willows.			
23	38.786590 57 N - 112.44312 634 W	Unlined ditch east of road with willows. Cement lined ditch. West of road cement lined ditch but not well maintained; rowes patches along ditch.	Irrigation ditch, no riparian.	Not classified.	N/A	4	None.	0	0	0.00	Cement ditch going north-south has rowes, ditch going east-west has scattered clumps of willows. Not consistent enough to be considered a riparian.			
24	38.788451 47 N - 112.44319 023 W	Pipe discharges water into cement ditch.	Irrigation ditch with riparian.	Not classified.	N/A	5	10	5	1450	0.17	Rowes and willows occur in patches as a riparian fringe along the ditch below the pipe discharge point.			
25	38.794740 6 N - 112.44325 932 W	Section of unlined ditch.	Irrigation ditch with riparian.	Not classified.	N/A	5	20	15	610	0.21	Cattails and willows.			
25a	38.794717 47 N - 112.44183 887 W	Open ditch, likely flood control, discharges into irrigation ditch on west side of 200 West Street.	Irrigation ditch, no riparian.	Not classified.	N/A	8	None.	0	0	0.00	None.			
26	38.795996 37 N - 112.44335 976 W	Cement-lined ditch	Irrigation ditch, no riparian.	Not classified.	N/A	4	N/A	0	0	0.00	N/A			
27	38.796101 29 N - 112.44466 299 W	Lined cement ditch, headgate for ditch spur to the north.	Irrigation ditch, no riparian.	Not classified.	N/A	5	N/A	0	0	0.00	N/A			

28	38.796095 13 N , 112.44932 170 W	Lined cement ditch, headgate far ditch to the north.	Irrigation ditch, no riparian.	Not classified.	N/A	5	N/A	0	0	0.00	N/A				
29	38.796091 98 N , 112.45412 889 W	Lined cement ditch, curves to the north, no ditch to the west.	Irrigation ditch, no riparian.	Not classified.	N/A	4	N/A	0	0	0.00	N/A				
30	38.798016 75 N , 112.44339 6 W	Unlined ditch to the west from headgate in cement ditch along road.	Irrigation ditch, no riparian.	Not classified.	N/A	4	N/A	0	0	0.00	N/A				
30a	38.798142 05 N , 112.44332 487 W	Unlined ditch to the west from headgate in cement ditch along.	Irrigation ditch, no riparian.	Not classified.	N/A	3	N/A	0	0	0.00	N/A				
31	38.798731 46 N , 112.44321 921 W	Work area spur, no ditch or channel present.	Field.	Not classified.	N/A	0	N/A	0	0	0.00	N/A				
32	38.799937 68 N , 112.44339 855 W	Spur to the west to pond, water enters pipe.	Irrigation ditch, no riparian.	Not classified.	N/A	Water is piped.	N/A	0	0	0.00	N/A				
33	38.803603 97 N , 112.44344 259 W	Headgate and start of cement ditch to west. North-south goes into a 6" pipe.	Irrigation ditch, no riparian.	Not classified.	N/A	3	N/A	0	0	0.00	N/A				
34	38.803647 85 N , 112.44950 258 W	Cement ditch, no riparian.	Irrigation ditch, no riparian.	Not classified.	N/A	3	N/A	0	0	0.00	No riparian along cement ditch, weedy.				

35	38.80383588 N - 112.46064917 W	Borrow pit unlined swale.	Irrigation ditch, no riparian.	Not classified.	N/A	3	N/A	0	0	0.00	N/A				
36	38.80383588 N - 112.46064917 W	End of cement lined ditch, continues as an unlined ditch/swale.	Irrigation ditch, no riparian.	Not classified.	N/A	3	N/A	0	0	0.00	N/A				
37	38.80563889 N - 112.44344977 W	Ditch from east enters 3 headgates, 1 to the north and 2 to the west.	Irrigation ditch with riparian.	R4SBC	Yes	3	10 to 15	9.50	650	Acreage tallied under #38.	Ditches to the west includes willow riparian border, ditch to the north includes scattered box elder and willow clumps.	 Ditch from east.	 Headgate to ditch system to the north.	 Ditch system to the west.	
38	38.80561067 N - 112.44402009 W	Two unlined ditches, low and high.	Irrigation ditch, with riparian.	Not classified.	N/A	5	10	10	650	0.15	High ditch has a willow fringe, lower ditch has limited willows and patches of horsetail.				
39	38.80566705 N - 112.44574633 W	Unlined ditch.	Irrigation ditch, no riparian.	Not classified.	N/A	6	0	0	0	0.00	Limited willow and box elders along ditch.				
40	38.80760811 N - 112.44594395 W	Unlined ditch.	Irrigation ditch, no riparian.	Not classified.	N/A	3	0	0	0	0.00	N/A				
41	38.80773729 N - 112.44952599 W	Earthen ditch.	Irrigation ditch, no riparian.	Not classified.	N/A	3	0	0	0	0.00	N/A				
42	38.81150718 N - 112.44955883 W	Road-side ditch.	Irrigation ditch, no riparian.	Not classified.	N/A	5	0	0	0	0.00	N/A				

43	38.811453 07 N - 112.45725 998 W	End of unlined ditch.	Irrigation ditch, no riparian.	Not classified.	N/A	2	0	0	0	0.00	N/A				
44	38.815592 16 N - 112.44956 106 W	Work area, not ditch or channel present.	Field.	Not classified.	N/A	N/A	N/A	0	0	0.00	N/A				
45	38.822933 84 N - 112.44963 822 W	Work area, no ditch or channel present.	Field.	R4SBC	No	N/A	N/A	0	0	0.00	N/A				
46	38.805953 72 N - 112.44060 485 W	Cement ditch running east - west, unlined ditch to the north.	Irrigation ditch, no riparian.	NOT CLASSIFIED	N/A	4	0	0	0	0.00	N/A				
47	38.805876 59 N - 112.43789 365 W	Lined cement ditch.	Irrigation ditch, no riparian.	R4SBC	Yes	3	0	0	0	0.00	N/A				
48	Number not used														
49	38.810087 34 N - 112.43788 635 W	Cement ditch running north - south, no ditch in spur to the west in work area.	Irrigation ditch, no riparian.	R4SBC	Yes	4	0	0	0	0.00	Scattered willow clumps along ditch.				
50	38.814853 09 N - 112.43802 976 W	Cement ditch.	Irrigation ditch, no riparian.	R4SBC	Yes	3	0	0	0	0.00	Scattered clumps of willows along ditch.				
51	38.814663 61 N - 112.43843 696 W	Unlined channel.	Irrigation ditch, no riparian.	Not classified.	N/A	5	10	5	0	0.00	Scattered elm, cottonwood, willows present along the ditch.				

52	38.820215 54 N - 112.43980 103 W	Flood channel crosses road in 2 3-ft culverts. There is a small roadside ditch that goes to the north on the west side of the road.	Irrigation ditch, no riparian.	R4SBC	Yes	10	0	0	0	0.00	Scattered elm and cottonwood, not continous enough to be considered a riparian.	 Flood channel.	 Roadside ditch.		
53	38.821541 64 N - 112.44000 275 W	Cement ditch comes from the east to end at ditch. Cement ditch 3 ft wide to the north with a willow-box elder riparian. Unlined ditch to the west 5 ft wide.	Irrigation ditch with riparian.	R4SBC	Yes	Unlined ditch 5; cement ditch 3	10 to 30	10	3600	0.83	Riparian fringe of willow, elm, Russian olive, and locust along ditch/road.	 Cement ditch to the north.	 Swale to the west.	 Cement ditch from the east.	
54	38.829422 08 N - 112.43989 483 W	Cement ditch with riparian to north, headgate diverts water to west in unlined ditch/wide, shallow swale full of Rumex.	Irrigation ditch with riparian.	R4SBC	Yes	Unlined ditch 10; cement ditch 3	10 to 30	13.5	1900	0.59	Rumex in swale to west, willows and elm.	 Head on ditch from north.	 Headgate on ditch to west.	 Ditch to west supports Rumex.	 Unlined ditch to north.
54a	38.832293 95 N - 112.43994 334 W	End of project work area; ditch is no longer present; no riparian.	Field.	R4SBC	No	N/A	N/A	0	0	0.00	N/A				
55	38.829482 27 N - 112.44745 618 W	Earthen ditch with willows.	Irrigation ditch with riparain.	Not classified.	N/A	6	20	14	1000	0.32	Willows.				
56	38.829604 95 N - 112.44797 053 W	Irrigation pond and overflow from pond. Pond is shallow and supports Rumex around the pond and in the pond. Overflow supports willows.	Irrigation pond with riparian.	Not classified.	N/A	N/A	10	-	-	0.50	Willows and Rumex.	 Irrigation Pond.	 Overflow from irrigation pond.		
57	38.829649 27 N - 112.44847 882 W	Ditch from the north, supports willows. Willows drop out to the north (see site 58).	Irrigation ditch with riparain.	Not classified.	N/A	6	20	14	1000	0.32	Willows.				

58	38.832556 35 N - 112.44877 864 W	Scattered willows.	Irrigation ditch with riparain	R4SBC	Yes	3	N/A	0	0	0.00	Scatter willows.				
59	38.839938 24 N - 112.44943 955 W	Unlined ditch, weedy, no riparian.	Irrigation ditch, no riparain.	Not classified.	N/A	3	N/A	0	0	0.00	None.				
60	38.840023 91 N - 112.45516 130 W	Irrigation ditch, essentially abonadoned	Irrigation ditch, no riparain.	R4SBC	Yes	3	N/A	0	0	0.00	Locust trees.				
61	38.839801 15 N - 112.45450 101 W	Unlined ditch full of upland grass and weeds.	Irrigation ditch, no riparian.	Not classified.	N/A	3	N/A	0	0	0.00	None.				
62	38.839884 45 N - 112.45937 352 W	Dry roadside ditch, row of elm, Russian olive, and cottonwood, possible remnant of pervious era when ditch saw higher use.	Irrigation ditch, no riparain.	R4SBC	Yes	2	N/A	0	0	0.00	None.				
63	38.839821 98 N - 112.46338 173 W	Irrigation ditch, essentially abandoned; scattered elm trees.	Irrigation ditch, no riparain.	Not classified.	N/A	2	N/A	0	0	0.00	None				
64	38.839821 98 N - 112.46338 173 W	North end of ditch system remanent, just a swale. No riparian.	Irrigation ditch, no riparain.	Not classified.	n/a	3	N/A	0	0	0.00	N/A				
65	38.815603 51 N - 112.43571 108 W	Storm channel, widely scattered willows and box elder.	Flood channel.	RSUBH	Yes	10	N/A	0	0	0.00	Willow and box elder.				

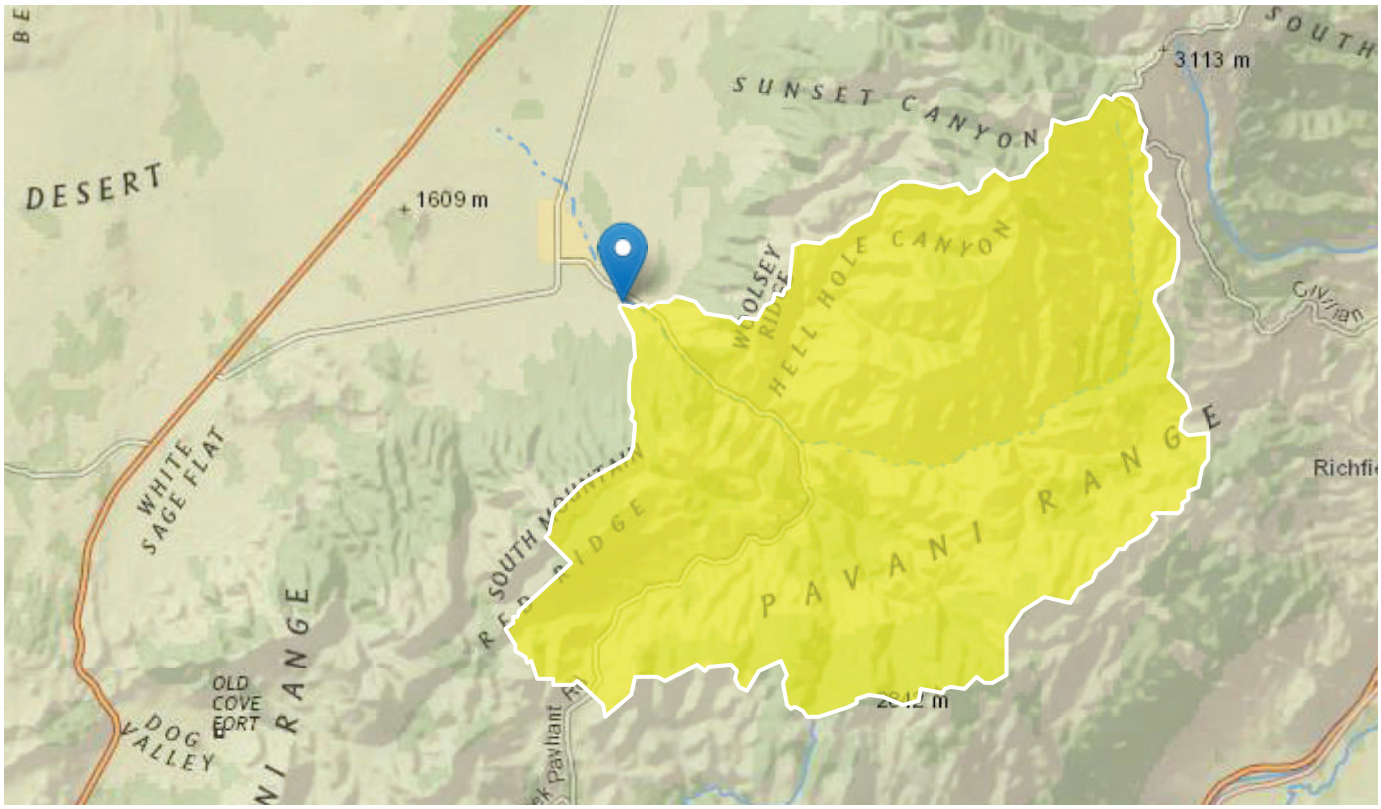
66	38.805680 77 N - 112.43498 281 W	Cement east-west, unlined ditch crosses road to the north, no riparian.	Irrigation ditch, no riparain.	R4SBC	Yes	3	N/A	0	0	0.00	None.				
67	38.805671 99 N - 112.43211 565 W	Lined cement ditch, willow riparian.	Irrigation ditch with riparain.	R4SBC	Yes	5	10	5	950	0.11	Willows.				
68	38.803892 26 N - 112.43004 818 W	Storm channel, 30 ft berm to berm.	Flood channel.	R4SBC	Yes	10 ft channel.	N/A	0	0	0.00	Scattered elm, not a riparian.				
69	38.803871 26 N - 112.42919 830 W	Line cement ditch. No riparian.	Irrigation ditch, no riparain.	R5UBH	Yes	3	N/A	0	0	0.00	None.				
69a	38.803826 28 N - 112.42565 461 W	Work area corridor, no ditch or channel.	Field.	Not classified.	N/A	N/A	N/A	0	0	0.00	None.				
70	38.780916 24 N - 112.40872 646 W	Start of Corn Creek riparian removal. Upstream natural channel, downstream channelized and riparian removed.	Stream with riparain.	R4SBCx	Yes	10	30	20	0	Acreage tallied under #1	Willow, cottonwood, mint.	 Natural channel riparian.	 Channelized, riparian removed.		
71	38.780323 58 N - 112.40763 396 W	Natural channel and riparian.	Stream, with riparian.	R4SBCx	Yes	10	30	20	-	Acreage tallied under #1	Willow, cottonwood, mint.				
72	38.799895 49 N - 112.44774 311 W	End of work area corridor, no channel feature.	Field.	Not classified.	N/A	N/A	N/A	0	0	0.00	None.				

73	38.799878 12 N - 112.44704 310 W	Fencelline, no ditch or channel.	Field.	Not classified.	N/A	N/A	N/A	0	0	0.00	None.				
74	38.798075 91 N - 112.44714 465 W	Dry unlined ditch, with plum trees.	Irrigation ditch, no riparian.	Not classified.	N/A	4	N/A	0	0	0.00	None.				
75	38.799959 18 N - 112.44469 017 W	Unlined ditch turns to the north.	Irrigation ditch, no riparain	Not classified.	N/A	5	N/A	0	0	0.00	None.				
76	38.807659 93 N - 112.44336 985 W	Cement lined ditch, occasional box elder or elm, scattered willows.	Irrigation ditch, no riparain.	Not classified.	N/A	3	N/A	0	0	0.00	Scattered box elder, elm, and willow.				
77	38.811470 57 N - 112.44470 689 W	Cement lined ditch, scattered willows.	Irrigation ditch, no riparian.	Not classified.	N/A	3	N/A	0	0	0.00	N/A				
78	38.814305 28 N - 112.43800 188 W	Cement lined ditch with water. There are willows growing along top of ditch, but it is dry along the ditch and not a riparian.	Irrigation ditch, no riparian.	R45BC	Yes	3	N/A	0	0	0.00	N/A				
79	38.814469 79 N - 112.43783 296 W	Work area corridor, no ditch or channel.	Field.	Not classified.	N/A	N/A	N/A	0	0	0.00	N/A				

80	38.810711 74 N 112.43202 135 W	Coin Creek at interception of work area corridor. Excavated storm channel with berms and scattered elm.	Flood channel.	RSUBH	Yes	II	N/A	0	0	0.00	N/A				
										4.64					

StreamStats Report

Region ID: UT
Workspace ID: UT20210729211430609000
Clicked Point (Latitude, Longitude): 38.78370, -112.41548
Time: 2021-07-29 15:14:46 -0600



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	88.8	square miles
LU92HRBN	Percent Natural Herbaceous Upland from NLCD1992	7.59	percent
BSLDEM10M	Mean basin slope computed from 10 m DEM	34	percent
PRECIP	Mean Annual Precipitation	20.6	inches
ELEV	Mean Basin Elevation	7460	feet
FOREST	Percentage of area covered by forest	74.2	percent

Parameter Code	Parameter Description	Value	Unit
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	0.21	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.032	percent
SLOP30_10M	Percent area with slopes greater than 30 percent from 10-meter NED	55.4	percent

Peak-Flow Statistics Parameters [100.0 Percent (88.8 square miles) Region 5]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	88.8	square miles	0.91	629
LU92HRBN	Percent Nat Herb Upland from NLCD1992	7.59	percent	2.14	15.6

Peak-Flow Statistics Flow Report [100.0 Percent (88.8 square miles) Region 5]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp	Equiv. Yrs.
50-percent AEP flood	209	ft^3/s	99	99	1.1
20-percent AEP flood	385	ft^3/s	60	60	3.3
10-percent AEP flood	511	ft^3/s	50	50	6.1
4-percent AEP flood	686	ft^3/s	49	49	8.9
2-percent AEP flood	867	ft^3/s	53	53	9.4
1-percent AEP flood	998	ft^3/s	61	61	8.8
0.5-percent AEP flood	1180	ft^3/s	71	71	8
0.2-percent AEP flood	1460	ft^3/s	86	86	7

Peak-Flow Statistics Citations

Kenney, T.A., Wilkowske, C.D., and Wright, S.J.,2007, Methods for Estimating Magnitude and Frequency of Peak Flows for Natural Streams in Utah: U.S. Geological Survey Scientific Investigations Report 2007-5158, 28 p. (http://pubs.usgs.gov/sir/2007/5158/)

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Application Version: 4.6.1
StreamStats Services Version: 1.2.22
NSS Services Version: 2.1.2

Ground-Water Resources of Pavant Valley, Utah

By R. W. MOWER

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1794

Prepared in cooperation with the Utah State Engineer



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Thomas B. Nolan, *Director*

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GROUND-WATER RESOURCES OF PAVANT VALLEY, UTAH

By R. W. Mower

ABSTRACT

Pavant Valley, in eastern Millard County in west-central Utah, is in the Great Basin section of the Basin and Range province. The area of investigation is 34 miles long from north to south and 9 miles wide from east to west and comprises about 300 square miles. Agriculture, tourist trade, and mining are the principal industries. The population of the valley is about 3,500, of which about half live in Fillmore, the county seat of Millard County.

The climate is semiarid and temperatures are moderate. Average normal annual precipitation in the lowlands is estimated to range from 10 to 14 inches. Precipitation is heaviest during the late winter and spring, January through May. The average monthly temperature at Fillmore ranges from 29°F in January to 76°F in July; the average annual temperature is 52°F.

Because of the aridity, most crops cannot be grown successfully without irrigation. Irrigation requirements were satisfied for about 60 years after the valley was settled by diverting streams tributary to the valley. Artesian water was discovered near Flowell in 1915. By 1920 flowing artesion wells supplied about 10 percent of the irrigation water used in the valley, not including water from the Central Utah Canal. The Central Utah Canal was constructed in 1916 to convey water to the Pavant Valley from the Sevier River. Especially since 1916, the quantity of surface water available each year for irrigation has changed with the vagaries of nature. The total percentage of irrigation water contributed by ground water, on the other hand, gradually increased to about 15 percent in 1945 and then increased rapidly to 45 percent in 1960; it will probably stabilize at about 50 percent.

Sand and gravel deposits of Recent and Pleistocene age are the principal aquifers in Pavant Valley. These deposits are coarser, more extensive, and more permeable near the mountains and become progressively finer and less permeable westward away from the mountains. As ground water moves westward from the recharge areas near the mountains, it becomes confined beneath clay beds; thus artesian conditions prevail in the lower parts of the valley. Although as many as 12 saturated beds of sand and gravel are penetrated in drilling wells to depths of 800 feet, they constitute, generally, one aquifer. The beds of coarser material are interconnected laterally, and the confining beds between them are not perfect aquicludes but merely impede the vertical movement of water. Artesian pressure increases with depth; thus, there is a continual upward flow of water from the lowest to the highest aquifer, and water not withdrawn through wells is discharged at the land surface or into basalt flows along the western edge of the valley.

Most recharge to the sand and gravel aquifers enters the ground on the alluvial fans as percolation from streams, irrigation ditches, and irrigated fields. Some

recharge results from underflow from the canyons and the face of the mountains and also from precipitation on the alluvial fans. Leakage from the Central Utah Canal is a major source of recharge to alluvial aquifers in the northern half of the valley.

The Pavant Flow in the western part of the valley and the basalt underlying the area west of the Black Rock Volcano in the southern part are both major unconfined basalt aquifers. The Pavant Flow is recharged by upward leakage of water from the underlying artesian aquifer, by percolation of irrigation water, by water moving laterally in shallow sand and gravel deposits, and by precipitation on outcrops along the western side of the valley. The basalt underlying the area west of the Black Rock Volcano is recharged by precipitation in the mountains, leakage from the artesian aquifer, and percolation of irrigation water. The basalt aquifers are relatively thin, averaging 30–60 feet in thickness where they supply water to irrigation wells.

The valley is divided into six districts based on geologic and hydrologic differences in the ground-water reservoir; these districts are designated from north to south: McCornick, Greenwood, Pavant, Flowell, Meadow, and Kanosh. Irrigation wells have been drilled in all these districts, but the Greenwood district shows the most promise for further ground-water development. During 1960 about 61,400 acre-feet of ground water was pumped for irrigation in Pavant Valley and about 5,900 acre-feet flowed from artesian wells. Total ground-water withdrawal, in acre-feet, through wells by district during 1960 was: McCornick, 7,100; Greenwood, 5,600; Pavant, 1,000; Flowell, 31,400; Meadow, 10,300; and Kanosh, 11,900.

The specific capacity of irrigation wells in the sand and gravel aquifers ranges from 6 to 100 gpm (gallons per minute) per foot of drawdown and averages 34 gpm per foot of drawdown. The wide range in specific capacity is due, in part, to the differences in the characteristics of the aquifers and, in part, to the differences in the construction and development of the wells. Specific capacities are smallest in the Pavant district, averaging about 10 gpm per foot of drawdown, and largest, commonly 80–100 gpm per foot of drawdown, in the vicinity of Hatton in the Meadow district.

The specific capacity of irrigation wells in the basalt aquifers ranges from 90 to 2,900 gpm per foot of drawdown and averages 850. The wide range is due almost entirely to differences in the characteristics of aquifers and only in small part to construction and development of wells.

The sand and gravel aquifers of the valley fill of Pavant Valley are moderately permeable and transmit water readily to wells. Pumping tests indicate that the coefficients of transmissibility range from 15,000 to 300,000 gpd per ft (gallons per day per foot) in unconsolidated aquifers, and from 180,000 to 22,500,000 gpd per ft in the basalt aquifers. The coefficient of storage ranges from 1.6×10^{-3} to 2.5×10^{-4} in the confined sand and gravel aquifers, from 0.10 to 0.25 in the unconfined sand and gravel aquifers, and about 0.06 in the basalt aquifer.

The total amount of ground water discharged in Pavant Valley during 1959 was about 98,000 acre-feet—60,000 acre-feet by wells, about 24,000 acre-feet by evapotranspiration, and 14,000 acre-feet by underflow from the valley. Discharge exceeded recharge by about 30,000 acre-feet of water, which was taken from storage. Total storage in the ground-water reservoir in 1960 was about 11,000,000 acre-feet, of which probably less than 1,000,000 acre-feet is recoverable. Most of the water not recoverable is held in fine-grained material and in areas where the aquifers are so thin that they will not yield sufficient water for irrigation.

Dissolved chemical constituents in the water in the sand and gravel aquifers increase with increasing distance from the mountains. Determined dissolved solids range from 284 ppm (parts per million) to 4,290 ppm. Water in the basalt contains more dissolved solids than water in the sand and gravel; it ranges from a low of 571 ppm in the Pavant Flow to 4,490 ppm in the basalt underlying the area west of the Black Rock Volcano.

Water from wells nearest the recharge areas is classified as low sodium hazard–medium salinity hazard. Most of the irrigation water, except in the Kanosh district, however, is classified as low sodium hazard–high salinity hazard. Water in the Kanosh district ranges from medium sodium hazard–very high salinity hazard to very high sodium hazard–very high salinity hazard. Because most of the soils in the Kanosh district are well drained and some soils contain appreciable quantities of calcium-bearing minerals, it is possible to use the water of poor quality. Boron content in water from wells ranges from none detectable to 2.5 ppm, which is about optimum for irrigation water for most crops normally grown in Pavant Valley.

The consumptive waste of ground water by plants of low economic value is not a serious problem now but could rapidly become serious. Indigenous phreatophytes occupy 35,000 acres of bottom lands in Pavant Valley. Most of them have low to moderate value for livestock grazing. Saltcedar, however, is encroaching on native pastures. The Central Utah Canal has been the means of spreading the growth of most of the saltcedar; but some of the shrubs have been imported and used as ornamental shrubbery, and some seed apparently have been spread by wind. The growth is sparse except for reaches along the Central Utah Canal, where there are a few narrow dense thickets. Enough saltcedar now grows in the valley so that under optimum weather and moisture conditions most of the noncultivated bottom land area could become infested within a few years.

INTRODUCTION

PURPOSE AND SCOPE

The ground-water resources of Pavant Valley were investigated to estimate the yield of the ground-water reservoir, to delineate parts of the valley where additional ground water can be developed for irrigation and parts where no further ground water should be developed, to estimate the recharge to the ground-water reservoir, and to determine the relation of the mineralized water west of Kanosh to recharge and to pumpage.

Ground water continues to increase in importance in the economy of Pavant Valley. At first, settlers in the valley used water from streams and springs in the valley for domestic and stock supplies and for irrigation of nearby lands; through the passage of time, however, ever-increasing quantities of ground water have been withdrawn to supply the water needs of the valley. The first wells in the valley were constructed in the late 1800's to obtain domestic and stock water in areas where water supplies from springs and streams were unavailable or were inadequate. It was not until the first flowing artesian wells in Pavant Valley were drilled in the vicinity of Flowell in 1915 that

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water from wells was used for irrigation. By 1920 about 75 flowing wells had been drilled, principally to supplement the irrigation water from several small intermittent, unreliable streams that enter the valley along its north and east sides. Some of the wells, however, were drilled to obtain irrigation water for land that had never been irrigated. Wells have been drilled at some place in the valley nearly every year since 1915.

The quantity of water withdrawn from the ground-water reservoir increased through the years in direct response to the number of wells in use. The increased ground-water withdrawal caused a general decline in artesian pressures and water levels and caused the natural discharge to diminish. Many springs, therefore, ceased to flow, marsh areas became dry, and many wells that were near the perimeter of the original area of artesian flow ceased to flow. Water levels in some wells have declined more than 50 feet since flowing wells were first drilled; however, in areas of little ground-water development, water levels have remained nearly stationary or have risen slightly.

Some wells drilled in the western part of the valley, from near Flowell southward, have tapped water too saline for irrigation, and the salinity of much of the other ground water used for irrigation in this general area approaches the maximum tolerated by the crops usually grown in Pavant Valley. The quality of the ground water in this part of the valley is deteriorating with time, apparently in response to declining water levels.

For an orderly development and use of the ground water, basic hydrologic information is needed by local and State officials who administer water rights, by Federal agencies who are concerned with land and water use, and by water users. Because ground water is a resource owned by the State and hence is public property, the amount of ground water used for irrigation in Pavant Valley is of concern to the general public. Such information assists the State Engineer in administering the State's ground-water laws and assists in adjudicating rights to the use of ground water. Federal agencies striving to conserve land and water and to administrate farm loans and Federal land on which homestead and desert-entry applications have been or may be filed need to know the perennial ground-water supply and whether the quality of the ground water will deteriorate as more is used.

LOCATION AND EXTENT OF THE AREA

Pavant Valley is in eastern Millard County, which is in west-central Utah (fig. 1). The principal area studied is about 34 miles long, from near McCornick on the north to near Kanosh on the south, and is about 9 miles wide, from the foot of the Canyon Mountains and the Pavant

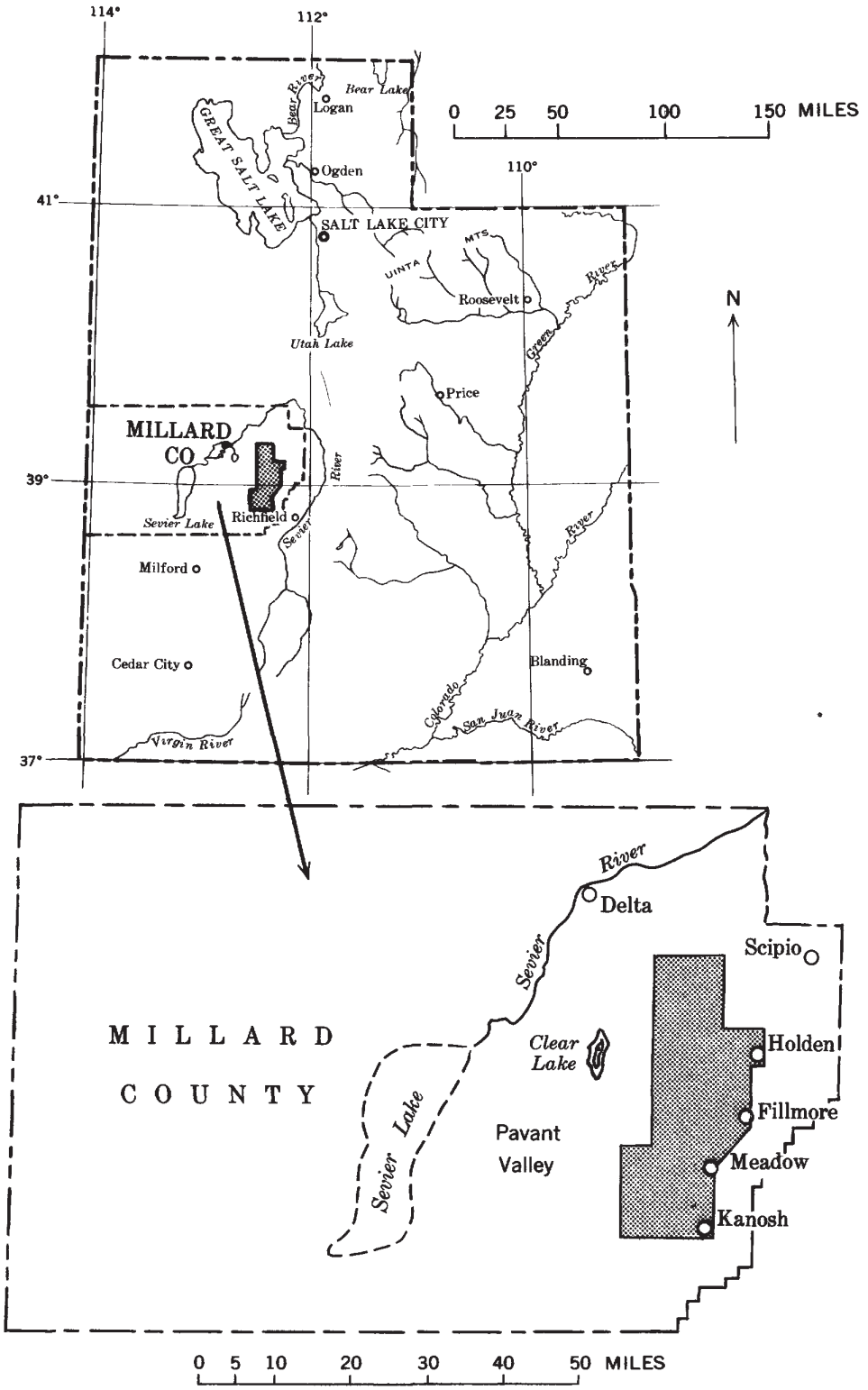


FIGURE 1.—Area (shaded) described in this report.

Range on the north and east to the exposed basalt on the west; the area includes 300 square miles. The generally north-south trending Pavant Range along the east side of the valley veers westward near Kanosh in the southern part of the valley; thus, it forms the south and the east boundaries of the valley. The south end of the Canyon Mountains forms the northeast boundary. The west boundary is marked by extinct volcanoes and basalt flows that rise 100–800 feet above the valley plain and extend northward to about the latitude of the south end of the Canyon Mountains. There is no prominent topographic relief to mark the northwest end of the valley, between the Canyon Mountains and the basalt flows, and the valley merges into the Sevier Desert plain, which covers a large part of west-central Utah. Because the northwest boundary is indistinct, it has been established, arbitrarily, at lat. 39°15′ N. for purposes of this report.

PREVIOUS INVESTIGATIONS

Several ground-water investigations resulting in reports have been made in Pavant Valley, and observations have been made of various phases of the ground-water regimen since 1908. During the summers of 1908 and 1909, Meinzer (1911) included the Pavant Valley in a reconnaissance of the ground-water resources in Juab, Millard, and Iron Counties. The artesian water in the valley had not been discovered at that time. Several test wells had been drilled with the objective of locating artesian water; but all had failed, and the report stated that the prospect for obtaining copious supplies of artesian water of good quality at any place in the valley was unfavorable. The general conclusion was that the prospect for pumping domestic and stock water supplies and, locally, small irrigation supplies was favorable. In 1915, however, several flowing wells were drilled in the Flowell area.

Livingston and Maxey (1944) made a study of leakage from artesian wells in the Flowell area in the spring of 1943. The report showed that in the Flowell area during 1943 about 1,000 acre-feet of water flowed through leaky artesian wells from the strata tapped into strata having a low head. The largest waste, however, was found to be through uncontrolled flow at the land surface. Of the 15,000 acre-feet that flowed from wells, 3,000 acre-feet was wasted.

The first comprehensive ground-water study of the Pavant Valley was made in 1942–45 by Dennis, Maxey, and Thomas (1946); however, the principal part of the valley investigated was the Flowell-Hatton area. They determined that the total discharge from this part of the ground-water reservoir was more than 40,000 acre-feet annually, of which less than half was discharged from wells and only about a

third was put to beneficial use. The other discharge was by evapotranspiration in the bottom lands where saturated sediments were at or near the land surface.

Water levels and artesian pressures in selected wells have been measured by the U.S. Geological Survey every year since 1935. Many of the measurements were reported in the annual series of water-supply papers for the years 1935–55. Chemical-quality data have been gathered intermittently since 1943. Chemical-quality data for ground water and surface water in Utah, including that of the Pavant Valley, were compiled by Connor, Mitchell, and others (1958) in a report that included all analyses made by public agencies through September 1955.

The first comprehensive geologic study of the general area of interest to the present study was the work done by Gilbert (1891), in which he described Lake Bonneville and the associated geology. Later, Maxey (1946) discussed in considerable detail the geology of the western slopes of the Pavant Range between Pioneer Creek and Corn Creek and the southern part of Pavant Valley. The geology of the Pavant Valley was discussed further by Dennis, Maxey, and Thomas (1946), who emphasized the relation of the geology to the occurrence of ground water. The geology of the Canyon Mountains was discussed by Christiansen (1951). Little, if any, geologic investigation has been made of that part of the present project area below the southern and western foothills of the Canyon Mountains and of the northern part of the Pavant Range; but, in general, the discussion of the Pavant Valley by Dennis, Maxey, and Thomas can be extrapolated into this area.

ACKNOWLEDGMENTS

The writer wishes to express his appreciation to all who aided in this study. The residents of the area supplied useful information and granted permission for the measurement and testing of their wells. Well drillers and pump companies supplied logs and information relating to the drilling and testing of wells. W. D. Criddle, Utah State Engineer, and F. T. Mayo and D. G. Stewart, engineers in the State Engineer's office, gave helpful assistance and suggestions and permitted access to files containing well data. Officers of the local electric power companies made available records of power consumption for irrigation wells. Local officials of the Soil Conservation Service, particularly Dale Webber, provided useful information concerning snowfall in the Pavant Range and water-conservation programs in the Pavant Valley.

METHODS AND PROCEDURES

Available hydrologic and related basic data for Pavant Valley were located, compiled, and evaluated before fieldwork was begun. The location of wells and of other features to be visited were plotted on a map.

Selected basic ground-water data including records of wells, well logs, water-level measurements, and chemical-quality-of-water analyses were compiled in a separate report (Mower, 1963) upon completion of the fieldwork to make this information available at an early date.

During February and March 1960, 530 wells were visited. The locations of selected wells in the valley are shown on plate 1. Water levels and artesian pressures in wells were measured where possible. The flow of wells were measured or estimated, and the type and condition of the control over the discharge was noted. Every flowing well known to the author in Pavant Valley was visited, and the rate of flow was measured or estimated from two to six times during 1960. The artesian pressure also was measured where feasible. The rates of flow and the artesian pressures of each well were compared to hydrographs of nearby observation wells to determine the average rate of flow from the wells during 1960.

Surveyed well locations were used where such information was available; however, most wells were located by automobile odometer and are accurate to within one-eighth of a mile. Aerial photographs were used for some locations in remote areas not accessible by automobiles.

Water-level measurements were made from a permanent measuring point near the top of each well. The altitudes of the measuring points for about half the wells had been determined previously; the altitudes of the measuring points for the other wells were estimated by aneroid barometer. Several field tests indicate that the error of the altitude measured with the barometer was generally less than 2 feet. However, errors approached 5 feet where the distance between bench mark and well was several miles, and where the change in altitude exceeded about 50 feet.

Water levels were measured by the wetted-tape method, using a steel tape graduated to hundredths of a foot; these measurements are accurate to 0.1 foot. Shut-in pressures in flowing wells, where the static water levels were more than 6 feet above the land surface, were measured with a mercury manometer; these measurements are accurate to within 0.2 foot. Where the static water level was above the top of the well and less than 6 feet above the land surface, a one-fourth-inch clear-plastic hose was connected tightly to the well,

and the free end was raised until the flow of water ceased. The distance between the water level in the hose and the measuring point was measured with a steel tape; these measurements are accurate to 0.1 foot. A standard time of 10 minutes was allowed to elapse between the time that the well was shut in and the time that the pressure was observed. Recording gages were maintained on five wells, water levels were measured periodically several times a year in 11 wells, and water levels were measured in about 400 wells during February and March 1960 and in about 200 wells during August and September 1960.

Drillers' logs of 280 wells were obtained from well owners, well drillers, and the Office of the State Engineer, and 69 of these logs were reported by Mower (1963).

Irrigated acreage was obtained from landowners, the Office of the State Engineer, the Soil Conservation Service, and by planimetering aerial photographs after field checking the outline of the cultivated areas shown by the photographs.

The yields of 108 of the 110 pumped irrigation wells in use during 1960 were measured one to five times each during the 1960 irrigation season. The yields of the other two wells were estimated. When conditions allowed, yields of pumped wells and large-capacity flowing wells were measured both with Cox flowmeter and the Hoff current meter; other yields were measured with weirs, Parshall flumes, and by the coordinate or projection method (sometimes called the "California method"). Errors in measurement probably were generally less than 5 percent; however, measurements made by using the coordinate method may have been in error by as much as 15 percent. The yields of small flowing wells were measured by observing the time required to fill a container of known volume.

The rate of electricity consumption and the pumping levels were measured at the time that the yield was measured; these data were used to compute pumpage during 1960 for wells equipped with electric motors. The accuracy of the pumpage calculations is limited by the accuracy of the discharge measurement. These calculations are estimated to have a maximum error of 5 percent. For wells equipped with diesel and butane engines, it was necessary to observe the length of time that the engine was operated during the irrigation season to compute pumpage. As about half the engines were equipped with hour meters, the total time of operation could be read directly. For engines not so equipped, irrigators supplied estimates of operating time or amounts pumped during 1960. For engines equipped with hour meters registering the length of operating time, the accuracy is estimated to be within 5 percent; however, even for the few engines not equipped with hour meters, the accuracy is within 10 percent.

Pumping tests made at three sites during the present study and at three other sites earlier were used to determine the hydraulic properties of the aquifer. The specific capacity of a well was computed by dividing the yield (gallons per minute) by the drawdown (feet) and obtaining the yield in gallons per minute per foot of drawdown. Specific capacity is useful in comparing the efficiency of wells, and it was used to determine an approximate coefficient of transmissibility—one of the major hydraulic properties of aquifers.

WELL-NUMBERING SYSTEM

The system of numbering wells in Utah is based on the cadastral land-survey system of the Federal Government. The well number, in addition to designating the well, locates its position to the nearest 10-acre tract in the land net. By the land-survey system the State is divided in four quadrants by the Salt Lake base and meridian, and these quadrants are designated by capital letters, thus: A, northeast quadrant; B, northwest quadrant; C, southwest quadrant; and D, southeast quadrant. Numbers designating the township and range follow the quadrant letter, and all three are enclosed in parentheses. The number after the parentheses designates the section, and the lowercase letters give the location of the well within the section. The first letter indicates the quarter section, which is generally a tract of 160 acres, the second letter indicates the 40-acre tract, and the third letter indicates the 10-acre tract. Numbers following the letters indicate the serial number of the wells within the 10-acre tract. Thus, well (C–22–6)3add–2, in Millard County, is in the SE¼SE¼NE¼ sec. 3, T. 22 S., R. 6 W., and is the second well constructed or visited in that tract. The following diagram (fig. 2) shows the method of numbering wells.

GEOGRAPHY

PHYSIOGRAPHY

Pavant Valley is in the Great Basin section of the Basin and Range province (Fenneman, 1931), and it forms the extreme southeast arm of the Sevier Desert. A low ridge formed of extinct volcanoes and basalt flows (pl. 2), which rise 100–800 feet above the valley plain, separates the Pavant Valley from the main part of the Sevier Desert to the west.

The rugged Pavant Range forms the east and south boundaries of the valley. It trends generally north-south, except near Kanosh where it veers sharply westward. The highest point on the range is about 10,300 feet above sea level and about 5,600 feet above the valley plain at Flowell.

The north end of the Pavant Range is separated from the Canyon Mountains by a low pass (Scipio Pass). The south end of the Canyon Mountains forms the northeast boundary of Pavant Valley. The Canyon Mountains trend north-south and are offset about 6 miles to the west of an extension of the axis of the Pavant Range. The maximum altitude of the Canyon Mountains is 9,240 feet and about 4,600 feet above the lowest part of the north end of Pavant Valley.

Beaches, bars, and spits of ancient Lake Bonneville are common in Pavant Valley. The Bonneville shoreline is particularly well defined and marks the highest altitude, about 5,130 feet, reached by Lake Bonneville. The Provo shoreline (an intermediate stage at which

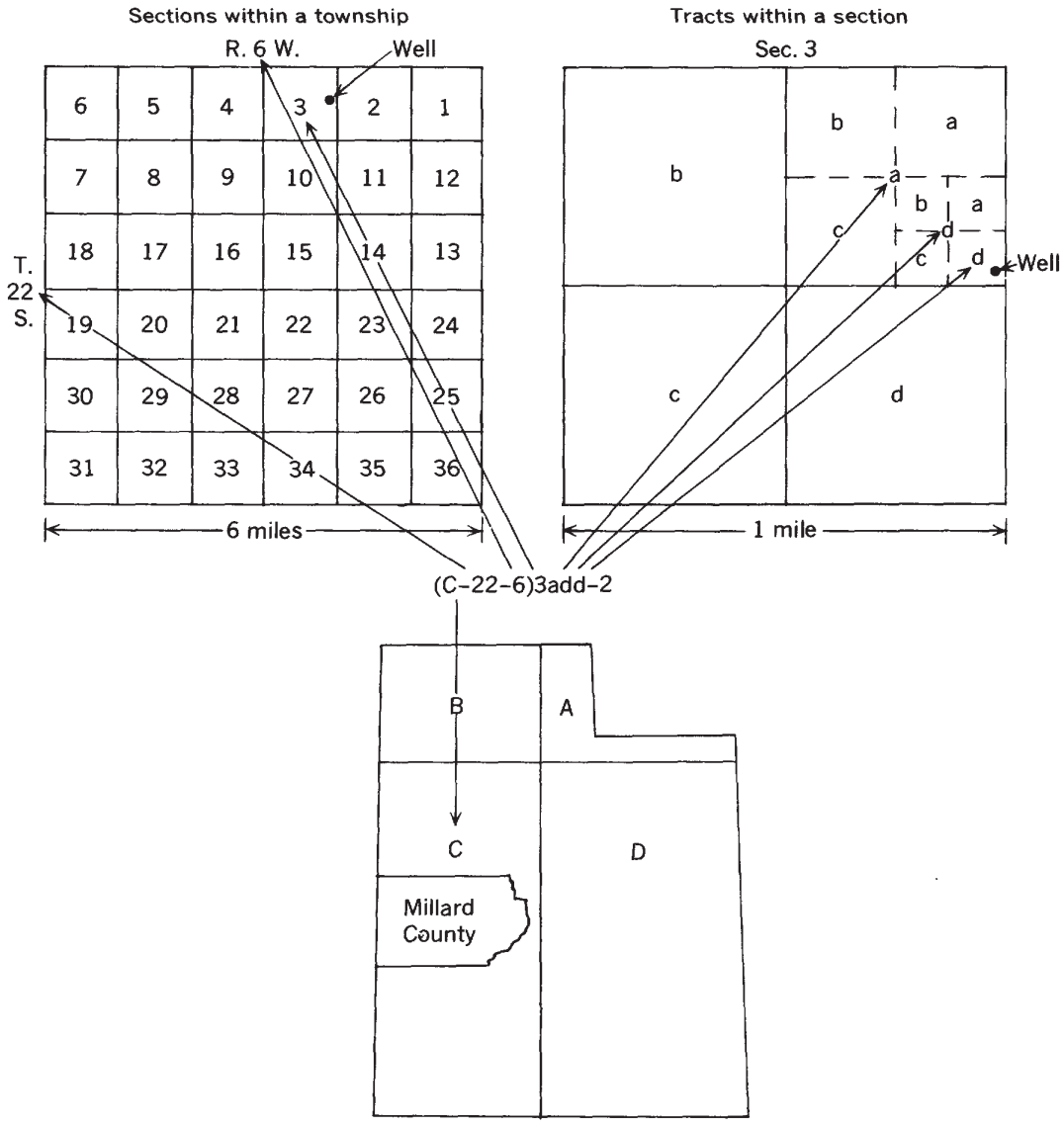


FIGURE 2.—Well-numbering system.

Lake Bonneville apparently stayed for a period of time), at an altitude of about 4,830 feet, is not as well defined as the Bonneville. Several other shorelines, both above and below the Provo shoreline, are visible on the slopes of Cedar Mountain, Bald Mountain, and West Mountain, which are low hills that project above the valley plain north and northwest of Fillmore.

Sand dunes cover a large area in the western part of the north half of Pavant Valley. Their surface is undulating, and the highest dunes rise as much as 40 feet above the interdune areas. Large rapidly moving sand dunes are encroaching on highways that cross the dune areas.

DRAINAGE

Tributary drainage to Pavant Valley includes about 500 square miles, of which about 400 square miles are in the Pavant Range and about 100 square miles are in the Canyon Mountains. Chalk and Corn Creeks supply most of the surface water used for irrigation entering the valley from the Pavant Range; other lesser streams are, from north to south: Wild Goose Creek, Maple Hollow, and Pioneer, Pine, Meadow, Walker, and Cottonwood Creeks (pl. 1). Whiskey and Eightmile Creeks are the only streams diverted for irrigation in the Pavant Valley that enter the valley from the Canyon Mountains. Nearly all the flow of these two streams is snowmelt in early spring; occasionally prolonged rainstorms during the summer result in flow.

The south half of Pavant Valley is a basin that was closed by basalt flows—which formed a low, broad dam across the middle of the valley and created a small sink area northwest of Flowell in what had been the main drainageway of the valley. All surplus water south of Chalk Creek and some water from Chalk Creek drains into The Sink, where it infiltrates into the basalt or evaporates.

In the north half of Pavant Valley, before the Central Utah Canal was constructed in 1916, surplus flood water, including some water from Chalk Creek, had drained into a broad, shallow depression, Mud Lake, north of Pavant Butte. Since 1916 the canal has intercepted the flood water, and most of it has been used for irrigation. The water exceeding the irrigation requirements is discharged into The Sink. Occasionally, more water runs off from the uplands than the canal can carry. Overflow from the canal inundates several thousand acres of low-lying lands in the northern part of the valley; however, eventually part of it reaches Mud Lake.

The high permeability of the sand dunes in the northwest part of Pavant Valley permits infiltration of almost all the precipitation on them and thereby prevents much surface runoff; consequently, no

integrated surface-drainage pattern has formed in the dune area. The shallow channel that meandered through the dune area before the surface water was diverted for irrigation has been nearly obliterated by the sand dunes. Only short remnants of the channel remain.

A gypsite playa west of Meadow and Hatton covers about 15 square miles. The playa is a collection basin for some surface drainage from the low basalt ridge to the west; the Pavant Range, where it forms the southeast boundary of the valley; and Devil's Ridge to the south. It also collects some shallow ground water that discharges in and along the east side of the playa. Other water is derived from upward leakage of artesian water and from local precipitation.

CLIMATE

PRECIPITATION

The climate of Pavant Valley ranges from semiarid on the valley plain to subhumid on the high mountains. The average total annual precipitation is estimated to range from 10 to 14 inches in the lowlands and from 14 to 35 inches on the upland slopes. Winters normally are moderate and wet. The average monthly precipitation at Fillmore is twice as much during the late winter and spring as it is during the summer. The annual precipitation varies widely from year to year and from the valley to the mountains. The average annual precipitation at Fillmore was 14.26 inches during the 69 years of record (1892–1960 inclusive), and it has ranged from 6.72 inches in 1934 to 21.28 inches in 1906. During the decade 1951–60, the average annual precipitation was 13.60 inches, 0.66 inches below the average for the period of record and 1.61 inches below the average for the previous decade, 1941–50, when it was 15.21 inches.

Snow-gaging stations are maintained in the Pavant Range near the head of Pine Creek, which is east of Meadow, and in Bear Canyon near the head of Chalk Creek, which is east of Fillmore. Precipitation as snow and estimated rainfall at the Pine Creek station during the period of record averaged 34 inches, while that at Bear Canyon averaged only 21 inches (table 1). The two records, however, are not comparable because the record for Pine Creek spans 31 years, whereas that for Bear Canyon spans 7 years. The two periods were not equivalent in precipitation. Precipitation at Bear Canyon, if represented by a longer period (31 years), would probably average about 26 inches.

The present period (1948–60) of deficient precipitation in the valley is one of three major droughts in Pavant Valley during the time that precipitation records have been kept at Fillmore. The curve in figure 3, which shows the cumulative departure from average precipitation 1892–1960, denotes periods of greater than average precipitation by

TABLE 1.—*Precipitation, as inches of water, in the Pavant Range east of Fillmore*

[From Soil Conserv. Service]

Year	Snow course						
	Pine Creek-Chalk Creek (Alt 8,500 ft)		Pine Creek (Alt 8,700 ft)			Bear Canyon (Alt 7,200 ft)	
	April 1 snowpack measurement	Total annual precipitation (computed)	April 1 snowpack measurement	Total annual precipitation observed	Total annual precipitation (computed)	April 1 snowpack measurement	Total annual precipitation (computed)
1930	11.1	32.7					
1931	10.8	17.6					
1932	14.8	25.8					
1933	14.3	34.0					
1934	7.2	10.1					
1935	10.9	21.8					
1936	10.7	30.6					
1937	16.2	25.6					
1938	15.7	30.5					
1939	11.0	24.0					
1940	15.3	23.2					
1941	11.2	27.0					
1942	13.1	23.8					
1943	8.5	18.3					
1944	15.2	27.6					
1945	15.8	37.5					
1946	7.0	19.8					
1947	10.9	31.1					
1948	17.2	25.9					
1949		20.9	16.4	29.4	29.4		
1950	9.2	15.6	11.3	19.2	19.2		
1951	3.6	25.7	6.2		14.9		
1952	21.4	31.5	28.4		41.9		
1953	14.3	25.9	16.2		29.3		
1954	12.5	22.3	12.9		23.0	9.1	16.3
1955	16.3	27.6	19.1		32.4	11.4	19.3
1956	Discontinued		12.3		20.2	5.4	8.9
1957			16.4	46.0	41.7	8.4	21.4
1958			19.7	30.9	25.6	12.4	16.1
1959			10.4	25.5	17.5	7.8	13.1
1960			16.1	38.8	26.7	12.1	20.1
Average	12.6	25.3	15.5	35.3	26.8	9.5	16.5
Adjusted average		32			34		21

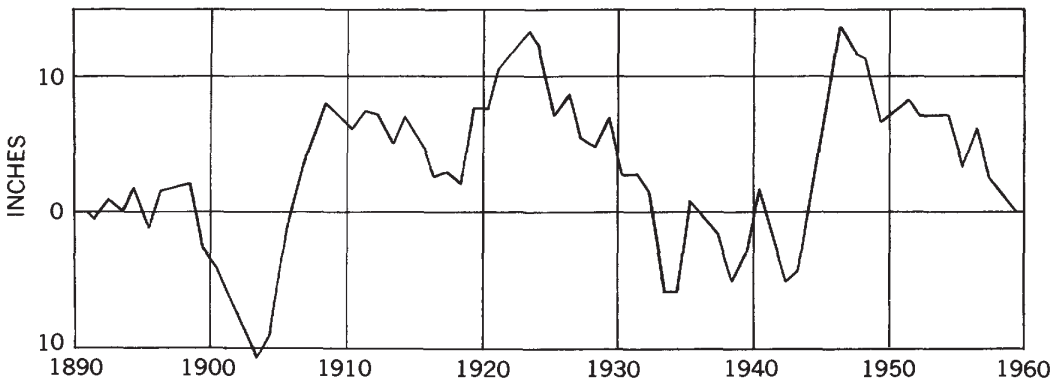


FIGURE 3.—Cumulative departure from average precipitation at Fillmore, 1892–1960. (Data from U.S. Weather Bur.)

an upward trend and periods of less than average precipitation by a downward trend. Thus, it can be seen by the general downward trend in the curve since 1948 that Pavant Valley is experiencing a pronounced drought.

The average annual precipitation figures used in this report are those computed for the entire period of record, except as indicated otherwise.

Climatological data were generally taken from official monthly and annual publications of the U.S. Weather Bureau; however, some precipitation data for stations in the Pavant Range were obtained from the Soil Conservation Service.

TEMPERATURE AND EVAPORATION

Temperatures in Pavant Valley are moderate, seldom falling below 0°F or exceeding 100°F. The mean monthly temperature at Fillmore ranges from 29°F in January to 76°F in July. The mean-annual temperature, also at Fillmore, is 52°F and the average frost-free period is about 155 days. The average date for the last killing frost in spring is May 8; that date for the first killing frost is October 10.

Evaporation from a U.S. Weather Bureau class A land pan at Milford, about 30 miles south-southwest of Pavant Valley, averaged about 82 inches from April through October of each year during 1953–60. Some evaporation occurs during November through March; so, the annual total is probably at least 85 inches. Evaporation from open-water surfaces is less than that from land pans. Estimated adjustment factors of 0.70 for ponded water and 0.75 for open streams are applied to evaporation rates at Milford to obtain the amount of evaporation in Pavant Valley.

VEGETATION

Native grasses and sagebrush grow throughout the noncultivated lowlands and contiguous foothills in Pavant Valley. There are a few small meadows supporting principally sedges and saltgrass in the bottom lands. However, greasewood, saltgrass, and rabbitbrush are the most abundant plants in the noncultivated bottom lands, where the water table is at or near the land surface. Saltcedar has recently entered the valley, and it is becoming a problem along some canals and in small irrigation reservoirs. It is also beginning to spread into the lowland pastures (1962).

In the undulating lowland part of the north half of the valley, the more stable sand dunes are covered with sagebrush and greasewood above an elevation of 5–10 feet above their bases. The lower 5–10 feet

of the dunes are covered with greasewood, saltcedar, and sparse growths of phreatophytic grasses. The interdune areas contain dense growths of phreatophytic grasses.

Willow and wild rose grow thickly along stream channels and canal banks, especially on the alluvial fans, if their growth is not controlled artificially. Scrub oak, juniper, and large shrubs are abundant on upland slopes. Dense stands of pine, fir, and aspen grow at high altitudes.

POPULATION, AGRICULTURE, AND INDUSTRY

The population of Pavant Valley in 1960 was about 3,500. Fillmore, the largest town, having half the population of the valley, is the county seat of Millard County. The economy is dependent upon agriculture, either directly or indirectly. During recent years, however, the tourist trade and the mining of volcanic cinders near Flowell have become important to the economy.

Irrigation farming, dryfarming, and stock raising are of about equal importance in the agricultural economy; however, the importance of dryfarming and stock raising depends largely on the success of irrigation farming. Cattle and sheep are grazed on mountain rangelands in the summer and desert rangelands on the valley plain all year. Winter wheat is the only dryland crop grown in the valley, and the areas where it can be grown successfully are small. Alfalfa, small grain, sugar beets, and potatoes are the principal irrigated crops. Some pasturelands are also irrigated, but usually they are in areas where irrigation water is relatively inexpensive and the land is of such poor quality that more remunerative cultivated crops cannot be grown successfully. Native meadow pastures in the bottom lands provide year-round forage for several thousand head of cattle, horses, and sheep.

An irrigated farm in Pavant Valley generally consists of 80–120 acres of cultivated land and some pasture. Farming is diversified, although the trend on many farms is toward one or two principal crops. In addition to the cultivated crops, most farmers maintain a small herd of beef or dairy cattle, or both. Most farmers reside in one of the four incorporated towns in the valley, where they maintain flocks of laying hens, a few pigs, vegetable gardens, and small orchards.

WATER USE

Nearly all the surface water in the valley is diverted for irrigation; little is used for other purposes. The towns of Fillmore, Holden, Meadow, and Kanosh tap springs in nearby canyons for municipal

water supplies. Fillmore, in addition, has two wells from which it obtains supplemental water. Stock and domestic water is obtained almost exclusively from wells, but during the winter streamflows are diverted for stock watering on farms near the mouths of the canyons.

Ground water is vital to the economy of eastern Millard County. Since 1915 some irrigation supplies have been obtained from the ground-water reservoir. Ground water provided about 10 percent of the total irrigation supply in Pavant Valley in 1920, about 15 percent in 1945, and about 45 percent in 1960. The use of ground water for irrigation will probably continue to increase for some time because not all irrigation wells for which permits have been granted have been completed, nor have all lands for which wells have been completed been brought into production. There may be a small reduction in the amount of irrigated land as a result of a pending water-rights adjudication, and as a result, at the completion of the adjudication, total annual ground-water withdrawal may decline. It is estimated that during future years of deficient precipitation as much as 60 percent of the irrigation water will be ground water; however, during years of normal to abnormally high precipitation, only about 30 percent of the total irrigation supply will be ground water.

Water in the valley is principally used for irrigation. In 1960 about 35.300 acres of land was irrigated, of which 13,400 acres was irrigated exclusively with surface water, 10,500 acres was irrigated with both surface and ground water, and 11,400 acres was irrigated exclusively with ground water (table 2). The ground-water districts given in table 2 are described on page 31.

Water is imported from the Sevier River for irrigation of land in the north half of Pavant Valley. The Central Utah Canal was constructed in 1916 for the purpose of diverting water to the valley. This canal heads on the Sevier River near the north end of the Canyon Mountains about 40 miles north of Fillmore.

TABLE 2.—*Irrigated lands, in acres, in Pavant Valley, 1960*

Ground-water district	Surface water	Ground water	Surface and ground water	Total irrigated lands in district
McCornick	50	1,750	400	2,200
Greenwood	1,700	850	850	3,400
Pavant	2,900	900	0	3,800
Flowell	4,200	3,950	3,950	12,100
Meadow	4,550	400	5,300	10,250
Kanosh	0	3,550	0	3,550
Total in valley	13,400	11,400	10,500	35,300

GENERAL GEOLOGY

The direct and indirect influences of geologic factors on all phases of the hydrologic cycle are apparent throughout Pavant Valley. The landforms affect the amount and pattern of precipitation and runoff. The geologic materials and landforms control infiltration of precipitation and ground-water recharge. Subsurface geologic features control the occurrence and movement of ground water throughout the valley.

Only the geologic features that are most closely related to surface drainage and to ground-water conditions are outlined in this report. The geology has been described in greater detail by previous investigators, whose writings were freely drawn upon to compile the summary given herein. The reader may consult the references cited in the section titled "Previous investigations" if a more detailed geologic discussion is desired.

SUMMARY OF GEOLOGIC HISTORY

Rocks dating from Precambrian time crop out in the Canyon Mountains, and rocks dating from Cambrian time crop out in the Pavant Range. Rocks of some time intervals are not present because no sediments were deposited during some periods of emergence and because some rocks have been removed by erosion.

The following discussion of the rocks in the Canyon Mountains is based on work done by Christiansen (1951). The Precambrian rocks consist of limestone in the lower part of the section and interbedded quartzite, shale, and conglomerate in the upper part; these rocks have an aggregate thickness of 7,955 feet. The basal beds are in thrust contact with younger rocks, indicating horizontal movement. The Cambrian rocks overlying the Precambrian rocks consist of 1,500 feet of coarse conglomerate and quartzite, 975 feet of limestone and shale, and 4,750 feet of limestone and dolomite—the upper part of which may be of Ordovician age. The next rocks are of Cretaceous age. They consist of coarse conglomerate in the lower part, which lies unconformably on the Cambrian rocks, and a thick sequence of sandstone, shale, and limestone. The Cretaceous rocks have a total thickness of 12,500 feet. A formation which totals 3,500 feet in thickness and consists of interbedded sandy limestone, calcareous sandstone, siltstone, and conglomerate lies unconformably on the Cretaceous rocks and is probably of Cretaceous age in the lower part and of Tertiary age in the upper part. Lying unconformably upon this formation is a bed of conglomerate which ranges in thickness from 0 to 1,800 feet and is of Tertiary age. Unconsolidated deposits of gravel, sand, and silt of Quaternary age, ranging from 0 to 1,000 feet in thickness, lie

unconformably upon the conglomerate. Besides the major periods of orogeny suggested by the unconformities, there have been several other disturbances of lesser significance.

For practicable purposes, the foregoing discussion of rocks in the Canyon Mountains also applies to rocks in the Pavant Range; however, no Precambrian rocks are exposed in the Pavant Range. The kinds of rocks and their age groups are about the same, but the thicknesses of the formations may be slightly different.

The Sevier River(?) Formation of late Pliocene or early Pleistocene age is the oldest known rock unit of the valley fill. It is a fanglomerate composed of poorly sorted pebbles, cobbles, and boulders. Its aggregate thickness probably exceeds 800 feet. Most of the coarse material is angular and is derived from all older formations in the mountains.

Lake beds of Quaternary age predating Lake Bonneville overlie the Sevier River(?) Formation. They consist of 0 to nearly 800 feet of gravel, sand, silt, and clay. Basalt flows from two extinct volcanoes underlie some of these lake deposits to depths approaching 100 feet. The Black Rock Volcano is about 2 miles west of Kanosh in the south end of the valley. Most of the basalt is buried, and data are insufficient to map the extent of the flow; however, the flow extends at least 4 miles westward from the vent. The Pavant Flow (probably late Pliocene or early Pleistocene) is contemporaneous or slightly younger than the flow from Black Rock Volcano. It was extruded from Pavant Butte near the northwest corner of Pavant Valley, and it flowed mostly northward and southward. The Pavant Flow extends the full length of the valley and is 5 miles wide in some places.

The youngest sedimentary deposits in the valley were laid down by Lake Bonneville, an extinct lake that covered most of northwestern Utah, parts of northern Nevada, and southern Idaho during Pleistocene time. The deposits consist mostly of clay and sand and probably do not exceed 20 feet in thickness.

The alluvial fans were being deposited synchronously with the lake beds. As a result, coarse sediments in the lake deposits are generally contiguous with coarse fan deposits, and fine sediments in the lake deposits are contiguous with fine fan deposits.

Two small basalt flows along the west-central part of the valley are about the same age as the Lake Bonneville Group or younger. Deposits of clay and silt in the basalt vesicles below a line of equal altitude around the edge of Tabernacle Flow (late Pleistocene) indicates that it was extruded during the Provo time. The Ice Springs Craters Flow (Recent) occurred subsequent to the disappearance of Lake Bonneville from Pavant Valley.

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GEOLOGIC FORMATIONS AND THEIR WATER-BEARING PROPERTIES

In the mountains, some of the consolidated rocks are fractured in the upper few feet of their exposed surfaces, and they supply water to springs; most of them, however, are relatively impermeable and do not contain significant quantities of water. In general, little ground water moves from the mountains to the valley in the consolidated rocks. A small quantity of water moves to the valley in the upper few feet of the consolidated rocks through cracks, joints, and bedding planes, but the quantity probably does not exceed the base flow of the mountain streams. Most of the water in the consolidated formations emerges in the canyons at springs which maintain the base flow of several small creeks. Debris on the face of and at the foot of the mountains, especially the alluvial fans, affords the principal access conduits for recharge to aquifers in the valley.

The Sevier River(?) Formation is a generally impermeable commonly cemented fanglomerate composed of sediments ranging from boulders to clay. It forms the floor of the ground-water reservoir in Pavant Valley as well as the east and northeast walls. The surface of the Sevier River(?) Formation was eroded prior to the deposition of the lacustrine deposits, and the surface is very irregular. The formation forms the cores of several hills in the central part of the valley; Bald Mountain, Cedar Mountain, and West Mountain are the three most prominent. Buried hills of the Sevier River(?) Formation apparently exist also and, locally, may control the occurrence and movement of ground water. Locally the formation furnishes small quantities of water to wells. Material at these locations has probably been reworked, becoming less firmly cemented and having coarser and more uniform texture than the parent material.

The surface of the Sevier River(?) Formation is very irregular, and it is generally at shallower depths near the mountains than it is in the middle of the valley. The shallow depth of the Sevier River(?) Formation near the mountains is the principal reason that few successful irrigation wells have been completed along the east side of the valley. The few successful wells near the mountains are probably completed in re-entrants of valley fill, where ancient streams eroded channels in the Sevier River(?) Formation.

The lacustrine beds of gravel and sand constitute the artesian aquifers, which are the major sources of ground water in Pavant Valley. The aquifers are thicker, more extensive, and more permeable near the base of the mountains than they are away from the mountains (pl. 3). Artesian pressure occurs a short distance west of the mountains, where the aquifers become interbedded with lacustrine clay beds

which confine the water. The several clay beds separate the valley fill into several interconnected aquifers that extend westward in finger-like projections. The well logs used to make the profiles on plate 3 are shown graphically in relation to sea-level datum, and the distances between the well logs are proportional to the distances between wells. The wells represented by the logs on profile *A–A′* are approximately on a north-south line through the most heavily developed parts of Pavant Valley. Profile *B–B′* is a west-east section through the Greenwood district, and profile *C–C′* is a west-east section through the Flowell district.

Close correlation of the individual strata shown in the logs of the several wells is questionable in alluvial sediments such as those in Pavant Valley, where deposition has been irregular and lenticular. Each well log in these profiles, however, shows zones in which coarse sediments predominate. These zones are thickest near the mountains and thinnest farther away. Coarse deposits lie at or near the land surface near the mountains, especially near the apex of the alluvial fans; at short distances away from the mountains however, the upper several feet of surface material is fine sand, silt, and clay.

The Pavant Flow is evident in the sections of the western two wells in profile *C–C′*. The other two profiles miss the flow by short distances; in fact, the basalt flow extends only one-fourth mile east of the line between wells (C–21–5) 5abd–1 and (C–21–5) 20 cca–2 in profile *A–A′*. The basalt is not shown on this profile because wells penetrating it were not selected for the profile.

Drillers' logs are available for 280 wells in Pavant Valley. Most of the well logs and construction data concerning wells have been obtained from notices of claims to underground waters and from well-drillers' reports filed with the Utah State Engineer. In these reports, well owners and drillers are required to give specific details about the history of the well and the well construction, including a log of the material drilled through, according to provisions of the State underground water law of March 1935. The information given on the claims for wells drilled before 1935 is probably not as accurate or complete as that for wells drilled since 1935 because the early data were mostly from memories of well owners, tenants, neighbors, and drillers.

Drillers generally distinguish the dominant material in logs such as gravel, sand, silt, and clay but do not report the degree of mixing. In outcrops, the unconsolidated sediments are seen to be poorly sorted, and they may be presumed to be equally poorly sorted at depths penetrated by wells. Thus, the terms used to describe the texture of the material penetrated are the driller's opinion. Examination of various drillers' logs of wells even within a radius of a very few feet, show

TABLE 3.—*Log of West Holden Irrigation Co. well (C–19–4)31dbb–1*

[Drilled in May 1960 by S. S. Stephenson. Pumped irrigation well near the center of the Greenwood district]

Well log described in report of well driller			Well log described by R. D. Feltis, U.S. Geol. Survey, from well samples		
	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Topsoil	5	5	No sample	5	5
Hardpan	3	8	Gravel, fine to medium, and sand (70 percent); tan silt containing very fine basalt sand (30 percent).	10	15
Gravel, cobbles, and boulders.	7	15	Silt (50 percent) and clay (30 percent), reddish-tan; sand and gravel (20 percent).	15	30
Clay, silt, and sand	15	30	Silt (70 percent), tan, and sand (30 percent).	5	35
			Clay, tan; contains fine to coarse gravel.	5	40
Clay and gravel	15	45	Silt (80 percent); gravel, fine to medium, and sand (20 percent; tan.	10	50
Gravel, water-bearing	5	50			
			Clay (90 percent) and silt (10 percent), tan; contains a few gravel particles.	15	65
Clay and silt	15	65	Silt, tan; contains some gravel	5	70
			Silt (60 percent), tan, and sand (40 percent.).	5	75
			Clay (70 percent) and silt (30 percent), tan; contains a few gravel particles.	5	80
Clay, silt, and sand; water-bearing.	13	78			
			Clay (50 percent) and silt (50 percent), tan; contains fine to medium gravel.	5	85
Gravel, water-bearing	7	85	Clay (50 percent) and silt (50 percent), tan.	5	90
			Sand, fine to coarse, angular to rounded quartz, and fine gravel (90 percent); tan silt (10 percent).	5	95
			do	5	100
			Silt (70 percent), tan; sand and fine to medium gravel (30 percent).	15	115
			Silt (40 percent) and clay (40 percent), tan; sand containing fine gravel (20 percent).	5	120
			Silt (50 percent) and clay (50 percent), tan.	10	130
			Silt (40 percent) and clay (40 percent). tan; sand (20 percent).	5	135
			Silt (50 percent) and clay (20 percent), tan; sand and gravel (30 percent).	10	145
			Silt (50 percent), tan, and sand (50 percent).	5	150
Clay, silt, and layers of small gravel.	72	157			
Gravel, water-bearing	5	162	Sand, fine to coarse, and fine to medium gravel (80 percent); tan silt (20 percent).	15	165
			Sand and fine gravel (40 percent), silt (40 percent), and tan clay (20 percent).	5	170
Clay and sand lenses	10	172	Gravel, fine to coarse, and sand (90 percent); tan silt (10 percent).	10	180
Gravel, cemented very hard.	11	183	Sand and gravel (60 percent) and silt (40 percent).	10	190
			Silt, tan, and fine to coarse gravel (80 percent); sand (20 percent).	15	205
Clay and gravel lenses	40	223	Silt (50 percent) and clay (50 percent), tan; probably contains sparse thin layers of sand and gravel.	35	240
			Silt, tan	5	245
			Silt (70 percent), tan; fine sand (30 percent).	20	265
			Silt (50 percent) and clay (20 percent), tan; fine sand (30 percent).	10	275
			Silt (70 percent), tan; and sand (30 percent).	5	280
			Silt (70 percent) and tan clay (30 percent).	10	290
			Silt (70 percent), tan, and fine sand (30 percent).	5	295

TABLE 3.—*Log of West Holden Irrigation Co. well (C–19–4)31dbb–1*—Continued

Well log described in report of well driller			Well log described by R. D. Feltis, U.S. Geol. Survey, from well samples		
	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)
Clay, gravel, and hardpan	76	299	Silt (50 percent) and clay (20 percent), tan; fine sand (30 percent).	5	300
Sand and mudstone	6	305			
Clay, sand, and conglomerate.	23	328			
Gravel, water-bearing	3	331	Silt (70 percent), tan; fine to coarse sand (30 percent); contains thin layers of fine to medium gravel in the intervals 300–310, 330–335, and 340–360 ft.	60	360
Clay, sand, and gravel	9	340			
Conglomerate	8	348			
Clay and sand	14	362			
			Silt (50 percent), tan; sand and fine to medium gravel (50 percent).	5	365
Conglomerate and cemented gravel.	12	374	Gravel (70 percent), fine to medium, and sand (30 percent).	5	370
Clay	5	379	Silt (50 percent), tan; and coarse sand (50 percent).	5	375
Conglomerate and cemented gravel.	7	386	Silt (70 percent), tan; and sand (30 percent).	5	380
Clay	5	391	Silt (50 percent), tan, and coarse sand (50 percent).	15	395
Gravel, water-bearing	2	393	Silt (60 percent), tan; sand and fine to medium gravel, (40 percent).	5	400
Clay	5	398	Gravel (40 percent), fine to medium; sand (30 percent); tan silt (30 percent).	5	405
Hardpan	14	412			
Clay	2	414			
Gravel	2	416			
			Sand (60 percent), fine to coarse, and tan silt (40 percent).	15	420
			Silt (60 percent), tan, and fine sand (40 percent).	10	430
Clay and gravel lenses	22	438	Sand (60 percent), fine to coarse, and tan silt (40 percent); contains thin layers of fine to medium gravel in the intervals 435–445 and 495–500 ft.	70	500
Clay, cemented gravel lenses, and hardpan.	85	523	No sample	23	523

that a material described as clay by one driller may be described as silt or even sand by another. Two interpretations of the material penetrated in drilling irrigation well (C–19–4)31dbb–1—about in the center of the Greenwood district—are shown in table 3. The log of this well is also shown graphically in profile *A–A′* on plate 3. The poor sorting and heterogeneous nature of the material in the valley is evident in the logs and in the columnar sections.

All the basalt in Pavant Valley has approximately the same water-bearing properties. Although the basalt is highly vesicular, an unfractured unit is practically impermeable. The basalt is strongly jointed and creviced, however, and open joints and other fractures, brecciated layers, and blocky structure impart relatively high formational permeability to the basalt. Hence, it is copiously water bearing at many places; and wells completed in the basalt commonly yield large quantities of water.

WATER RESOURCES

The water supply in Pavant Valley is derived partly from precipitation and partly from water from the Central Utah Canal. The amount of the precipitated water that can be used depends on its disposition and distribution. Much of the upland precipitation is snow, some of which disappears by sublimation. Some melt water and rainwater evaporates, some restores soil moisture, some runs off the mountain slopes at the surface; any that is left over becomes ground water which migrates toward the valley bottom by underflow.

Native vegetation consumes a large part of the soil moisture. Most surface water that is discharged by the upland streams during the growing season is diverted for irrigation, and much of the diverted water is consumed by crops. An undetermined, but large part, of the intermittent runoff from upland slopes enters the soil and replenishes soil moisture and ground water. All water that is not consumed in the uplands reaches Pavant Valley by surface runoff and underflow, except possibly a small amount of underflow from the uplands in the Corn Creek drainage. Water in the valley lowland is depleted by native and cultivated vegetation, and the unconsumed residual water moves as underflow westward from Pavant Valley to the Sevier Desert.

VOLUME OF PRECIPITATION

Average annual precipitation on Pavant Valley and the contiguous uplands is estimated to be 730,000 acre-feet (table 4). About 180,000 acre-feet is concentrated on the valley plain (that part of the valley at an altitude below 4,800 feet); about 170,000 acre-feet, on the area between 4,800 and 6,000 feet; and about 380,000 acre-feet, on the uplands above 6,000 feet. The volume of precipitation, computed by the steps outlined below, is probably in the right order of magnitude.

The available precipitation data were plotted against station altitudes, and the trend of the relation between precipitation and altitude was defined. The contours on a topographic map having a scale of 1:250,000 were used as isohyetal lines. The area between each pair of isohyets (1,000-foot contour line) in each drainage was measured with a planimeter, and the volume of precipitation was computed from the average in that area (table 4).

In this report the period of annual precipitation on the uplands above 6,000 feet is from November of the preceding year through October of the given year. This period of time was selected because the snowpack measurement taken on April 1 is actually a measurement of all the snowfall from November to March minus snowmelt, sublimation, and evaporation. The amount of snowmelt, sublimation, and evaporation to April 1 is probably small compared with total

TABLE 4.—*Average annual precipitation by drainage basin and ground-water district in Pavant Valley and contiguous uplands, Utah*

	Average annual precipitation (acre-feet)		
	Between 4,800 and 6,000 ft	Above 6,000 ft	Total
Drainage basin			
Whiskey Creek	14,300	11,200	25,500
Eightmile Creek	13,800	18,600	32,400
Scipio Pass	25,200	17,200	42,400
Wild Goose Canyon	6,700	14,200	20,900
Wide Canyon	6,000	17,300	23,300
Maple Hollow	8,200	11,600	19,800
Pioneer Creek	14,200	22,200	36,400
Between Pioneer and Chalk Creeks	14,800	7,900	22,700
Chalk Creek	4,100	78,700	82,800
Between Pine, Meadow, and Walker Creeks	5,000	4,200	9,200
Pine Creek	700	7,400	8,100
Meadow Creek	800	19,500	0,300
Walker Creek	1,200	5,800	27,000
Sunset Canyon	5,700	11,600	17,300
Cottonwood Creek	3,000	5,100	8,100
Below Corn Creek	11,600	5,200	16,800
Corn Creek	1,600	100,000	101,600
West of Corn Creek	33,000	21,800	54,800
Total (rounded)	170,000	380,000	550,000
Ground-water districts (below 4,800 ft)			
McCornick			20,000
Greenwood			44,000
Pavant			14,000
Flowell			45,000
Meadow			31,000
Kanosh			26,000
Total:			
In ground-water districts			180,000
In valley and contiguous uplands			730,000

snowfall; however, it may be appreciable for years of mild winters or early springs. Measured precipitation for 4 years at the Pine Creek snow course indicate that about 20 percent of the precipitation during the period November to March becomes snowmelt or is lost by sublimation or evaporation. Thus the correction factor of +20 percent was used to adjust average annual precipitation in the mountains in computations used in this report to compensate for these factors.

SURFACE WATER

The total surface-water inflow to Pavant Valley through natural channels—none of which leaves the valley as surface flow except during years of abnormal weather—is estimated at 104,000 acre-feet per year; an additional 17,700 acre-feet a year is brought into the valley from the Sevier River by the Central Utah Canal. The principal sources of the water in natural channels are Chalk Creek and Corn Creek, which contribute about 25,000 and 12,000 acre-feet per year, respectively. Pine and Meadow Creeks contribute about 2,000 and 5,000 acre-feet per year, respectively. All the other 14 streams are intermittent or have small discharge; however, they contribute an

aggregate of about 59,000 acre-feet of surface water per year to Pavant Valley.

The volume of inflow of the aforementioned streams was estimated using streamflow measurements made since 1938 by the Geological Survey and the Office of the State Engineer. Chalk Creek was measured 21 times during 1938–43, and it has been measured continuously since 1944, when a recording gage was installed. Pine, Meadow, and Corn Creeks have been measured 9–44 times each at irregular intervals since 1938. Streamflow measurements of the other streams are unreliable or lacking.

To estimate the volume of inflow to Pavant Valley from the streams for which there are no streamflow records, certain physical, climatologic, and hydrologic data and characteristics of the individual drainage basins were compared to corresponding characteristics of the Chalk Creek, Pine Creek, Meadow Creek, and Corn Creek drainage basins and converted to a dimensionless number, described herein as runoff efficiency. Runoff efficiency is the yield of a drainage basin per unit area divided by the yield of the Chalk Creek drainage basin per unit area with equal precipitation in each of the drainage basins. In estimating runoff efficiency, the type and relative density of vegetal cover in each of the drainage basins was compared to that in the Chalk Creek drainage basin by field reconnaissance and from inspection of aerial photographs. The relative porosity and gradient of the surface materials and the geologic formations were taken from geologic reports, from topographic maps, and by cursory examination; these were then compared to the same factors in the Chalk Creek drainage basin. Runoff efficiency was estimated from these data.

CHALK CREEK

Chalk Creek supplies more water, has a greater yield per acre of watershed, and has a more sustained flow than any other stream entering Pavant Valley. The average annual measured inflow from Chalk Creek during 1944–59 was 25,100 acre-feet, more than twice the inflow of the next largest stream (table 5). Annual inflow has ranged from 8,100 acre-feet in 1959 to 45,100 acre-feet in 1952. During the period 1944–59, its 36,000 acres of watershed yielded about 700 acre-feet per 1,000 acres from about 2,300 acre-feet of precipitation per 1,000 acres. The minimum recorded average daily flow was 4.4 cfs (cubic feet per second), and the minimum recorded average monthly flow was 6.6 cfs.

A recording gage has been maintained on Chalk Creek about 1 mile east of Fillmore since March 1944. The altitude of the gage is 5,180 feet. It is below all major tributaries, but there is one small irrigation diversion above the gage.

TABLE 5.—*Some physical characteristics of and computed inflow from watersheds tributary to Pavant Valley, Utah*

Watershed	Average altitude (feet)	Size of area (acres)	Runoff efficiency (in relation to Chalk Creek) (percent)	Precipitation on watershed (percent of total)	Surface-water inflow		Computed average annual surface-water inflow 1944–59 (acre-feet)
					Percent of Chalk Creek	Acre-feet per 1,000 acres	
Whiskey Creek	6,060	17,200	60	3	19	280	4,800
Eightmile Creek	6,290	20,800	60	5	23	280	5,800
Scipio Pass	5,940	29,400	25	5	12	100	3,000
Wild Goose Creek	6,620	12,200	70	4	25	520	6,300
Wide Canyon	6,870	12,900	85	5	24	470	6,000
Maple Hollow	6,470	11,900	85	3	20	420	5,000
Pioneer Creek	6,720	20,500	90	6	40	490	10,000
Between Pioneer and Chalk Creeks	5,950	15,700	60	2	16	250	4,000
Chalk Creek	7,980	36,000	100	21	100	700	25,100
Between Pine, Meadow, and Walker Creeks	5,980	6,500	60	1	7	280	1,800
Pine Creek	7,650	3,800	83	2	8	530	2,000
Meadow Creek	8,130	8,700	93	5	23	670	5,800
Walker Creek	7,030	3,700	75	2	6	410	1,500
Sunset Creek	6,740	9,800	70	3	15	390	3,800
Cottonwood Creek	6,590	4,700	65	1	6	320	1,500
Below Corn Creek	5,820	12,200	35	1	7	150	1,800
Corn Creek	7,590	50,000	34	26	47	240	11,800
West of Corn Creek	5,950	38,000	25	6	16	100	4,000
Total		314,000					104,000

PINE CREEK

The average annual inflow to Pavant Valley from Pine Creek during 1944–59 was estimated to be 2,000 acre-feet. It ranged from 3,600 acre-feet in 1952 to 700 acre-feet in 1959. During this period, the contributing drainage area yielded about 530 acre-feet of surface water per 1,000 acres from 1,900 acre-feet of precipitation per 1,000 acres. The inflow of Pine Creek was estimated by comparing nine measurements of its flow to measurements of Chalk Creek made the same day or within 1 day when there were no effects from local recent precipitation. The comparison shows that inflow to Pavant Valley from Pine Creek is equivalent to about 8 percent of the total average annual inflow of Chalk Creek. The runoff efficiency of the Pine Creek drainage basin is calculated to be 83 percent of the runoff of the Chalk Creek drainage basin. This calculation means that a storm yielding 100 acre-feet of surface water per unit area in the Chalk Creek drainage basin would have yielded 83 acre-feet of surface water per unit area in the Pine Creek drainage basin.

MEADOW CREEK

The average annual inflow to Pavant Valley from Meadow Creek during 1944–59 was estimated to be 5,800 acre-feet, and it ranged from 2,000 acre-feet in 1959 to 10,400 acre-feet in 1952. During this period the contributing area yielded about 670 acre-feet per 1,000 acres from

about 2,200 acre-feet of precipitation per 1,000 acres. The total annual flow of Meadow Creek was estimated by comparing 38 discharge measurements made in it on comparable dates when the flow of Chalk Creek was measured. The average annual flow of Meadow Creek is 23 percent of the flow of Chalk Creek, and its runoff efficiency is 93 percent.

CORN CREEK

The average annual inflow to Pavant Valley from Corn Creek during 1944–59 was estimated to be 12,000 acre-feet, and it ranged from 21,000 acre-feet in 1952 to 4,100 acre-feet in 1959. During this period, the contributing drainage area of 50,000 acres yielded about 240 acre-feet of surface water per 1,000 acres from 2,000 acre-feet of precipitation per 1,000 acres. The total annual flow of Corn Creek was estimated by comparing 44 discharge measurements made in it on comparable dates when the flow of Chalk Creek was measured. The runoff efficiency of the Corn Creek drainage basin is only 34 percent of that of the Chalk Creek basin, and the average annual inflow to Pavant Valley is 47 percent of the inflow of Chalk Creek, although the Corn Creek basin is 14,000 acres larger than the Chalk Creek basin.

The small runoff efficiency in the Corn Creek basin, compared with that in the Chalk Creek basin, is the result of more gentle slopes, more permeable surface materials, and denser vegetation, which all cause a greater percentage of the precipitation in the Corn Creek basin to be evaporated and transpired. Also, in the Corn Creek basin there is greater opportunity for ground water to flow out of the basin than in the Chalk Creek basin because of the dip of the geologic formations in the eastern and southern parts of Corn Creek basin.

OTHER STREAMS

The total average annual volume of inflow from all the other streams contributing water to Pavant Valley was calculated to be 59,000 acre-feet, or 57 percent of the total natural inflow to the valley during 1944–59. During this period, inflow from these streams ranged from 190,000 acre-feet in 1952 to 36,000 acre-feet in 1959. The contributing drainage areas of individual streams yielded from about 100 acre-feet per 1,000 acres in Scipio Pass and the mountains west of Corn Creek to about 520 acre-feet per 1,000 acres in the Wild Goose Creek basin (table 5). The inflow from these streams was calculated as explained in a preceding section. Nearly all of these streams have small perennial flows in their upper reaches, but most of the inflow is snowmelt during the early spring freshet and runoff from summer thundershowers.

CENTRAL UTAH CANAL

The average annual diversion from the Sevier River by the Central Utah Canal for use in Pavant Valley during 1934–60 was 17,700 acre-feet. Diversions ranged from 3,730 acre-feet in 1935 to 39,700 acre-feet in 1946 (table 6). Since 1955, annual diversions for Pavant Valley averaged 10,900 acre-feet, or only 62 percent of the average during 1934–60—and only 6,360 acre-feet were diverted during 1960.

TABLE 6.—*Summary of computed diversions, in acre-feet, from the Sevier River by the Central Utah Canal for use in Pavant Valley, Utah, 1934–60*

Year	Number of days that water was in canal	Ground-water district				Total [1]
		McCornick	Greenwood	Pavant	Flowell	
1934	35	1,770	580	2,520	660	5,530
1935	27	1,190	390	1,700	450	3,730
1936	59	2,030	670	2,890	750	6,340
1937	45	2,910	960	4,150	1,080	9,100
1938	79	4,000	1,320	5,690	1,480	12,490
1939	80	4,660	1,540	6,650	1,730	14,580
1940	69	3,640	1,200	5,180	1,340	11,360
1941	80	4,130	1,360	5,880	1,530	12,900
1942	150	12,000	3,960	17,120	4,440	37,520
1943	116	6,260	2,070	8,920	2,320	19,570
1944	133	7,240	2,390	10,310	2,680	22,620
1945	103	6,060	2,000	8,640	2,250	18,950
1946	201	12,700	4,200	18,100	4,700	39,700
1947	88	6,780	2,240	9,660	2,510	21,190
1948	131	11,640	3,850	16,600	4,310	36,400
1949	138	9,820	3,240	14,000	3,630	30,690
1950	115	7,340	2,420	10,450	2,720	22,930
1951	89	5,930	1,960	8,460	2,190	18,540
1952	157	6,270	2,070	8,930	2,320	19,590
1953	152	9,110	3,020	12,980	3,370	28,480
1954	119	6,380	2,110	9,100	2,360	19,950
1955	90	5,280	1,750	7,530	1,960	16,520
1956	58	3,120	1,030	4,450	1,150	9,750
1957	51	1,670	550	2,390	620	5,230
1958	69	5,320	1,760	7,580	1,970	16,630
1959	54	3,580	1,180	5,100	1,320	11,180
1960	43	2,040	670	2,900	750	6,360
Average annual	94	5,660	1,870	8,070	2,100	17,700

[1] Diversions taken from Sevier River Water Commissioner's annual reports. Totals are 60 percent of diversions shown in Commissioner's reports.

Annual diversions are regulated by court decree (Cox, 1936), which stipulates the quantity of water that may be diverted, and are based upon the volume of runoff in the Sevier River basin above Sevier Bridge Reservoir, about 30 miles north-northeast of Fillmore. Diversions are about 5 percent of the flow of the river when storage in the Sevier Bridge Reservoir is less than 104,000 acre-feet, but they are 57 percent of the flow when storage in the reservoir is greater than 104,000 acre-feet; thus there is a wide range in the annual diversions.

It was necessary to compute the average annual diversions listed in table 6 because flow in the canal is measured only near the diversion on the Sevier River, and water is withdrawn from the canal for irrigation of lands north of Pavant Valley. Of the 6,456 water-right shares of

the Central Utah Water Co., 2,065 are in McCornick district, 682 are in Greenwood district, 2,944 are in Pavant district, and 765 are in Flowell district (Earl Greathouse, Secretary, Central Utah Water Co., written commun., April 14, 1961); 40 percent of the rights are north of Pavant Valley and 60 percent are in Pavant Valley. It was assumed that the deliveries from the canal would be at the ratio of these percentages. The ratio of deliveries may not have been exactly 60:40 because of trading, renting, and transferring of water from one area to another. (For example, in 1960, 56.9 percent of the water delivered by the canal was used in Pavant Valley, and 43.1 percent was used north of Pavant Valley.) The ratio 60:40 is used in this report because more accurate data are not available for earlier years, and this ratio is within the accuracy of other assumptions and the water measurements.

No data are available for the quantity of water delivered in each of the four districts in Pavant Valley using water from the canal; therefore, the canal water was apportioned to each of the districts at the ratio of the water-right shares owned in each of the districts. The computed amount of water delivered in each district since 1934 is listed in table 6.

Generally, several diversions of short duration are made at intermittent intervals during the irrigation season. The longest diversion is during the early part of the irrigation season, April to June; diversions of shorter duration are made at other times later in the year. Usually, the average rate of diversion is about 90 cfs for use in Pavant Valley, although the average annual rate of diversion has been as low as 60 cfs and as high as 120 cfs. The volume of water diverted each year is governed more by the length of time that water is being diverted than by the rate of diversion. During 1934–60, water was in the canal an average of 94 days a year, but it ranged from 27 days in 1935 to 201 days in 1946. Water was in the canal an average of 61 days per year during 1955–60 and only 43 days in 1960.

GROUND WATER

In Pavant Valley, ground water is chiefly derived from the infiltration of precipitation and water used for irrigation. Some of the ground water eventually is discharged by wells or by evaporation; the residual moves westward out of the valley.

Generally, porous rocks below the water table are saturated. In the more permeable rocks, such as the beds of sand and gravel in the lake deposits, individual pore spaces are interconnected and are large enough that water moves freely through them under the force of gravity; however, in the less permeable rocks, such as the beds of clay and

silt in the lake deposits and the poorly cemented mixture of clay, sand, gravel, and boulders of the Sevier River(?) Formation, the pores are so small that water moves through them slowly. In some areas, however, the Sevier River(?) Formation has probably been reworked, and the resulting deposits of coarse materials transmit some water. The basalt vesicles are not all interconnected, but in some areas the basalt has been fractured to such an extent that it freely transmits large quantities of water.

Ground-water discharge exceeded recharge by about 30,000 acre-feet during 1959, and the excess about equals the diminution in ground-water storage (table 7). Withdrawals through wells was about 6,000 acre-feet less than total recharge, and the total natural discharge was about 37,000 acre-feet.

TABLE 7.—*Ground-water budget (estimated), in acre-feet, in Pavant Valley, 1959*

[The discrepancy of 1,000 acre-feet in the budget is due to errors in estimating some of the factors used in the computations]

Ground-water district	Recharge [1]	Discharge				Change in storage (decrease)
		Evapotranspiration [2]	Underflow (from valley)	Wells	Total	
McCornick	7,100	0	3,500	6,600	10,100	4,000
Greenwood	17,300	11,000	3,500	4,100	18,600	500
Pavant	1,300	500	1,500	1,100	3,100	500
Flowell	20,000	4,000	5,000	26,300	35,300	10,000
Meadow	14,000	8,000	500	10,100	18,600	10,000
Kanosh	6,000	0	0	11,400	11,400	5,000
Total (rounded)	66,000	23,000	14,000	60,000	97,000	30,000

[1] Includes that part of the ground water discharged from wells which is not consumed.
[2] Evapotranspiration by native vegetation on nonirrigated lands.

DELINEATION OF GROUND-WATER DISTRICTS

The valley was divided into six ground-water districts, designated from north to south: McCornick, Greenwood, Pavant, Flowell, Meadow, and Kanosh (pl. 4). The dividing lines between districts were established, generally, at places where geologic conditions formed hydrologic boundaries. The principal purpose of the division into districts was to delineate areas having like characteristics and common sources of recharge and areas of discharge. This delineation will assist in administering an orderly ground-water development. The ground water in the valley belongs to one hydrologic system, although in some respects ground-water conditions in one district are quite different from ground-water conditions in the other districts. There may be ground-water movement between districts, and ground-water development in a given district may cause effects in adjacent districts; nevertheless, each district may be considered as an entity for most purposes.

OCCURRENCE

All water beneath the land surface is designated by the term "subsurface water" (Meinzer, 1923, p. 17–32). Ground water is that part of the subsurface water that is in the zone of saturation.

The upper surface of the zone of saturation is known as the water table, and it is approximated by the water level in water-table wells, except where the upper surface lies in material of low permeability. In material of low permeability, water will rise above the water table by capillary action. Artesian water is confined by material of lower permeability than the materials of the aquifer, and it has sufficient hydraulic pressure to rise above the bottom of the confining bed. The piezometric surface as used herein is an imaginary surface that coincides with the static water level in wells tapping an artesian aquifer. Water will flow from wells where the piezometric surface is above the land surface. Although both water-table and artesian conditions exist in Pavant Valley, no attempt is made to differentiate water on this basis, except for unconfined water in the basalt aquifer near Flowell, where the water table is generally continuous with the piezometric surface. The most readily accessible ground water of good quality occurs chiefly in unconsolidated permeable alluvium between Hatton and McCornick on the valley plain and in basalt west of Kanosh and west of Flowell. In these areas the water-bearing materials are thicker, more permeable, or nearer the land surface than they are in other parts of the valley.

Beneath the floor of Pavant Valley, ground water occurs in lake beds and in alluvial-fan deposits of gravel, sand, and silt. Interbedded lenses and tongues of clay and silt confine ground water in the lowest parts of the valley. The water-bearing materials become finer grained west of the mountains, and the deposits of clay and silt become thicker as the sand and gravel become thinner. The sand and gravel thin to the extent that the permeability is so reduced at about the latitude of the west edge of the valley that, in effect, a ground-water dam is formed, which confines the water in the permeable beds within the valley. Most of the beds of water-bearing materials are connected, and leakage from one to another is great enough that, for most purposes, they may be considered to be one aquifer within each of the six ground-water districts, although single permeable beds of gravel and sand may extend several miles in any given area.

Contiguous with the uppermost saturated bed of gravel and sand in the western part of the Flowell district is a bed of basalt that contains much unconfined ground water. The basalt underlying the area west of the Black Rock Volcano in the Kanosh district contains most of the ground water in that district. Shallow beds of sand and, lo-

cally, fine gravel underlie most of the area below an altitude of 4,800 feet; together with the basalt they compose the shallow unconfined aquifer.

Beneath the lake beds and the alluvial-fan deposits, the heterogeneous and fine-grained deposits of the Sevier River(?) Formation form the bottom of the ground-water reservoir, although, locally the formation may yield small quantities of water to wells.

ABILITY OF AQUIFERS TO YIELD WATER

The quantity of water than an aquifer will yield to a well and the ability of the aquifer to transmit water depend on the physical and hydraulic properties of the materials that constitute the aquifer. Knowledge of these properties enables prediction of the hydraulic behavior of the aquifer under a given set of conditions. The terms used to denote the principal hydraulic properties are expressed mathematically as the coefficients of permeability, transmissibility, and storage and as the specific yield. Detailed geologic descriptions of materials discovered in drilling are useful in determining the hydraulic properties and thickness of aquifers, but more accurate quantitative estimates require more comprehensive laboratory or field tests.

The coefficient of permeability used in this report is the field coefficient of permeability (P_f) and is defined as the rate of flow of water, in gallons per day, through a cross-sectional area of 1 square foot of an aquifer under a hydraulic gradient of 100 percent at the prevailing water temperature. The coefficient of transmissibility (T) is the ability of the aquifer to transmit water under a given gradient. The coefficient of transmissibility may be expressed as the number of gallons of water transmitted per day, at the prevailing temperature, through a section of the aquifer 1 mile wide under a unit hydraulic gradient of 1 foot per mile. It is the average field coefficient of permeability multiplied by the thickness of the aquifer, in feet.

The amount of water releaased from or taken into storage in a saturated material depends upon the coefficient of storage of that material. The coefficient of storage of an aquifer is the volume of water yielded or taken into storage per unit surface area of the aquifer per unit change in component of head normal to that surface. For artesian conditions, the coefficient of storage represents compaction of the aquifer skeleton and expansion of the water itself as the head declines; thus, it is small, generally, being in the range of 10^{-3} to 10^{-4}. The coefficient of storage under water-table conditions is much larger, generally being in the range of 0.01 to 0.3. Under water-table conditions, it includes the water that drains by gravity out of the material as the water table declines and the small quantity released by compaction

of the aquifer and expansion of the water. The quantity of water that drains by gravity is called the specific yield, which is defined as the ratio of the volume of water that a saturated material will yield by gravity to the volume of the aquifer dewatered. The specific yield is generally several thousands of times larger than the small quantity released by compaction of the aquifer and expansion of the water; thus, for practical purposes, the specific yield can be considered equal to the coefficient of storage.

Not all the water in the interstices of an aquifer is drained by gravity; some is retained by capillary action. The ratio of the retained capillary water to the specific yield is related to the size and sorting of the aquifer materials. In general, the finer and the better sorted the material particles are, the smaller is the ratio of specific yield to the water held by capillary action. For example, a saturated clay contains more than 50 percent water by volume, but the amount of water that it will release by gravity is generally less than 0.1 percent. At the other extreme, a well-sorted gravel contains water equal to 25–35 percent of its volume; commonly the specific yield of such a gravel will be 20–30 percent, depending on the sorting and arrangement of the grains.

The coefficient of transmissibility for nonartesian aquifers can be expected to decrease as the water level declines. This relation is especially noticeable in thin aquifers, such as the basalt aquifer in the vicinity of Flowell, for, by definition, the coefficient of transmissibility is the field permeability multiplied by the saturated thickness of the aquifer.

INTERFERENCE BETWEEN WELLS

The cones of depression around wells may overlap sufficiently (interfere) in areas where wells are closely spaced to cause a substantial increase of the pumping head. The amount of initerference depends upon the distance between wells, the rate and duration of pumping, and the hydrologic properties of the aquifer.

Under water-table conditions, as soon as a pump begins discharging water from a well, the water table in the vicinity of the well is lowered and a hyrdaulic gradient toward the well is established. The water table assumes a form comparable to that of an inverted cone, the apex of the cone being at the well. At first, most of the water pumped from the well is obtained by dewatering the saturated materials surrounding the well; but, as pumping continues, the material near the well is gradually dewatered, and water is transmitted to the well from an ever-increasing distance. Thus, the cone of depression continues to expand, and the water level declines gradually. The formation and shape of the cone may be altered if it reaches areas where the aquifer is being recharged or discharged.

Water continues to percolate toward a pumped well for a time after pumping is stopped, because the hydraulic gradient is in that direction. Water gradually fills the well and the material that was dewatered by pumping; as the material is refilled, the hydraulic gradient decreases, and the recovery of the water level in the well becomes progressively slower. Eventually the water table tends to assume its original form, although, in the absence of recharge, it may remain lower than before water was withdrawn.

In artesian aquifers, the cone of depression travels many times as fast as it does in water-table aquifers, because the artesian coefficient of storage is generally less than a hundredth as large as the water-table coefficient. Mutual interference between wells, therefore, occurs sooner and is more extensive under artesian conditions than it is under water-table conditions.

PUMPING TESTS TO DETERMINE AQUIFER CONSTANTS

Five pumping tests, each involving a pumped well and nearby observation wells, were made to determine the coefficients of transmissibility and storage of the aquifers in the alluvium; one test was made to determine those of the basalt aquifer. In addition, the coefficient of transmissibility was determined by five tests where only the rate of recovery of the pumped well was observed. The Theis nonequilibrium method (Theis, 1935, p. 519–524) of analyzing pumping-test data was used to determine the coefficients. In addition to those determined from pumping and recovery tests, coefficients of transmissibility were determined by using specific capacity data from 47 wells. The results are shown in table 8.

During each of the six pumping tests, an irrigation well was pumped at a constant rate for ½–3 days, and periodic measurements were made of the drawdown in as many as nine observation wells at distances ranging from 50 to 3,000 feet in different directions from the pumped well. Because of the relatively small size of the area of each test and because of considerable differences in composition and thickness of the aquifer in short distances, the coefficients of storage and of transmissibility listed in table 8 are approximate for the aquifer tested. Although useful as guides to esimate the effects of pumping, they should not be applied to large areas.

The coefficients of transmissibility of the alluvial aquifers tested ranged from 15,000 to 300,000 gpd per ft (gallons per day per foot). This range is from low to about average for aquifers consisting of sand and gravel. The lowest values were in those artesian aquifers which were thin and where the material was fine or poorly sorted. The one pumping test made in the basalt aquifer yielded a coefficient of transmissibility of 22,500,000 gpd per ft. This coefficient is ex-

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TABLE 8.—*Discharge, specific capacity, and coefficient of transmissibility of pumped irrigation wells in Pavant Valley, Utah, 1960*

[E, signifies the measurement is estimated or some doubt exists as to the accuracy]

Well	Water right No.	Date of measurement	Aquifer material	Rate of discharge (gpm)	Volume pumped, 1960 (acre-feet)	Pumping lift (feet)	Specific capacity (gpm per foot of drawdown)	Approximate coefficient of transmissibility (gpd per ft)
McCornick ground-water district								
(C-18-5)27bab-1	A-22024	4-18-60	Alluvium	1,240	930	155	14 E	30,000
27cba-1	A-23141	4-19-60	do	1,170	775			
27dba-1	A-22437	4- 5-60	do	1,450	1,070	120 E	35 E	60,000
34adb-1	A-22178	4-19-60	do	570	400 E			
34baa-1	A-21744	4- 5-60	do	1,730	1,030	97	31	50,000
34bba-1	A-21476	4- 5-60	do	1,320	1,040	103	23	40,000
34bca-1	A-21612	4- 5-60	do	975	565			
(C-19-5)3aaa-1	A-28301	4-19-60	do	2,160	1,320	113	35	60,000
Total pumped in district (rounded)					7,100			
Greenwood ground-water district								
(C-19-4)30dab-1	A-21772	4- 6-60	Alluvium	1,440	1,425	94	32	50,000
31dbb-1	A-31647	7-14-60	do	2,410	655	126	27	60,000
(C-19-5)36baa-1	A-21452, A-22238	4-19-60	do	1,200	480 E	88	16 E	35,000
(C-20-4)5cbd-1	A-28398	5-10-60	do	2,060	1,400 E	100	38	60,000
(C-20-5)11baa-1	A-3527, A-21628	8-30-60	do	860	400 E			
Total pumped in district (rounded)					4,400			
Pavant ground-water district								
(C-20-5)24bac-2	A-21937	7- 7-60	Alluvium	540	145	96 E	10 E	15,000
26add-1	A-21928	5-10-60	do	500	220			
26ddd-1	A-21915	5-10-60	do	640	375	140 E	10 E	15,000
Total pumped in district (rounded)					700			
Flowell ground-water district								
(C-21-5)5abd-1	A-31117	7-12-60	Alluvium	900 E	20 E	120 E	10 E	15,000
6cac-1	A-28069	6-28-60	Basalt	3,370	1,500			
(C-21-5)7cdd-2 [1]	A-24648	7-20-60	do	790	40	57	2,900 E	22,500,000
7cdd-3	a-3221	4- 7-60	do	3,380	1,440	49	2,900	22,500,000
7ddc-3	A-24509	4- 7-60	do	2,050	725	56	1,075	10,000,000
8bdc-2	A-22038	4-20-60	Alluvium	1,630	945			
8cdd-2	"R"A-21865	4-20-60	do	730	300	132	11	15,000
8dbb-2	A-21884	4- 6-60	do	1,900	585	105	30 E	50,000
16bcc-2	C-15150	4-20-60	do	375	150			
17add-3	"R"C-8775	5-13-60	do	1,950	835			
17bdd-3 [2]	"R"C-4716	5- 2-60	do	960	655			105,000
17cab-1	C-2663	5- 2-60	do	375	90			
17cdd-2	"R"C-1376	4-20-60	do	730	425			
17dad-1	C-3332	6-28-60	do	350	155	47	15 E	25,000
17ddd-1	C-4616	8- 5-60	do	150	185			
18aba-1	A-27255	7-20-60	Basalt	2,920	1,200 E	68	635	5,000,000
18ada-2	A-24715	4- 7-60	Basalt and alluvium.	1,210	545	67	140	220,000
18dda-1	C-4714	6-28-60	Alluvium	420	270			
19add-1	"R"C-13525	5- 2-60	do	1,040	765			

See footnotes at end of table.

TABLE 8.—*Discharge, specific capacity, and coefficient of transmissibility of pumped irrigation wells in Pavant Valley, Utah, 1960*—Continued

Well	Water right No.	Date of measurement	Aquifer material	Rate of discharge (gpm)	Volume pumped, 1960 (acre-feet)	Pumping lift (feet)	Specific capacity (gpm per foot of drawdown)	Approximate coefficient of transmissibility (gpd per ft)
Flowell ground-water district—Continued								
(C-21-5)19ccd-3	A-29943	4-20-60	Basalt	1,220	475			
20aad-2 [3]	"R"C-149	5- 2-60	Alluvium	2,480	1,190	37	80 E	155,000
20aba-1	C-2219	9- 3-60	do	240	190			
20bab-2	"R"C-6333	5- 2-60	do	730	570			
20bdd-2	"R"C-6622	5- 2-60	do	960	540			
20cca-2 [4]	"R"C-1377	4-20-60	do	600	360			142,000
20dad-1	C-6992	5-13-60	do	275	205			
20dda-1 [5]	C-3808	5- 2-60	do	440	440			300,000
21cba-3	"R"C-7685	5-24-60	do	3,040	1,100 E			
28aaa-1	A-29390	5-24-60	do	2,080	1,040	80 E	25 E	60,000
29aaa-3	"R"C-6223	5- 3-60	do	1,820	1,350			
29bdd-2	"R"2670	7-13-60	do	1,780	385			
29cdd-2	"R"C-3334	4- 1-60	do	2,090	1,195			152,000
29cdd-3	A-29946	5-31-60	do	980	275	81	13	30,000
30dad-2	a-3868	7- 7-60	do	1,700	480			
30dbc-2	A-18002	5-24-60	do	300	245	58	6 E	15,000
31cdd-2	"R"C-6236	8- 5-60	do	1,150	395			
32bba-1 [6]	"R"C-2959	5- 2-60	do	1,160	460	29	38 E	150,000
33bcc-3	a-3756	5- 3-60	do	1,950	845	66	30 E	80,000
33ccd-1	"R" C-6335 A-25916	5- 3-60	do	1,910	500 E	56 E	48 E	170,000
33dcc-2	"R" C-71	5- 3-60	do	1,880	250 E	52	80 E	220,000
(C-21-6)1dcb-1	A-26601	4- 6-60	Basalt	3,420	1,425	55	1,760	20,000,000
(C-22-5)2ada-1	A-22141	5-12-60	Alluvium	1,170	300 E			
4bbd-1	A-25647	7-13-60	do	1,810	590	68	50 E	170,000
4cdb-1	A-22355	5-24-60	do	850	260	53	35 E	130,000
4dca-1	A-15376	5- 3-60	do	1,310	750	68	40 E	170,000
9bba-1	A-26974	5- 3-60	do	2,040	625	84	32 E	120,000
(C-22-6)3add-2	A-21831	6-14-60	Basalt and alluvium.	690	390	115		
Total pumped in district (rounded).					27,700			
Meadow ground-water district								
(C-22-5)8cdd-1	C-10473	6-11-60	Alluvium	320	275			
9cad-2	A-21941	4- 8-60	do	1,590	575	104	20	60,000
17abd-1	C-2220 C-13520	6-11-60	do	290	90			
17bdd-2	C-3295 C-8202	7- 8-60	do	430	115			
17cda-1	C-15317 C-15866	1960	do	400 E	170 E			
17dad-1	a-3585	1960	do	1,800	40 E			
17dbd-2	"R"C-12170 A-29114	5- 3-60	do	1,450	200 E			
20aad-1	C-11970	1960	do	400 E	95 E			
20aba-1	C-12113	5- 3-60	do	550	280			
20bdd-1	C-13531	6-11-60	do	130	50			
20dbc-1	C-6332	8- 5-60	do	420	50			
21acd-2	"R"A-21718	5- 3-60	do	650	310	99	14	30,000
21dda-1	A-21758	5- 3-60	do	620	245			
22dac-1	A-31096	7-13-60	do	400	255	165 E	10 E	25,000
28aad-1	A-22766	7-13-60	do	640	110	93	15 E	30,000
29cdd-1	A-13159	5-24-60	do	610	210	75	11 E	25,000
32cdd-1	A-27254	5-24-60	do	2,220	750 E			
32dbd-1	A-12492	1960	do	900 E	180 E		15 E	30,000
32dbd-2	A-22210	1960	do	2,000 E	400 E			
33abc-1	A-18018	4-22-60	do	1,180 E	450			
33ccd-1	A-21746	5-12-60	do	1,890	760	82		
33cdd-2	"R"A-13367	5-12-60	do	1,630	200 E	109	50 E	170,000

See footnotes at end of table.

TABLE 8.—*Discharge, specific capacity, and coefficient of transmissibility of pumped irrigation wells in Pavant Valley, Utah, 1960*—Continued

Well	Water right No.	Date of measurement	Aquifer material	Rate of discharge (gpm)	Volume pumped, 1960 (acre-feet)	Pumping lift (feet)	Specific capacity (gpm per foot of drawdown)	Approximate coefficient of transmissibility (gpd per ft)
Meadow ground-water district—Continued								
(C-23-5)5acd-1	A-30068	5-12-60	Alluvium	2,840	1,190	110	80	220,000
5adc-1	A-21483	7-13-60	do	900	30 E			
5cba-1	A-23484	5-12-60	do	1,820	620	84	100 E	150,000
6daa-1	C-8201	5-12-60	do	640	285			
6dcd-1	A-23646	5-12-60	do	1,620	810	98	90 E	140,000
7aaa-1	A-22898	5-12-60	do	1,680	855	104	80	120,000
Total pumped in district (rounded)					9,600			
Kanosh ground-water district								
(C-22-6)20bbb-1	A-29593	1960	Basalt		70 E			
32ccc-1	A-26617	5-12-60	do	2,330	800	46 E	500 E	2,000,000
32dcc-1	"R" A-22151	5-12-60	do	2,620	670			
(C-23-6)5cbc-1	A-24533	5-17-60	do	1,770	150 E	48	160 E	230,000
8abd-1	A-24463	5-24-60	do	2,600	425 E			
9bca-1	A-28699	5- 9-60	do	3,450	1,260	63	125 E	180,000
9ccd-1	A-14592	5- 9-60	do	1,810	810	48	180	250,000
10ccc-1	A-19930	5- 9-60	do	2,550	745	50	700 E	6,000,000
15baa 1	a-3444	4-22-60	do	2,570	535			
15bdd-2	"R" A-20809	7-13-60	do	3,120	1,600	65 E	400 E	800,000
16bad-1	A-18458	5- 9-60	do	2,350	1,070	53	300 E	500,000
16cad-1	"R" A-22139	5- 9-60	do	1,140	260	62	90 E	180,000
17cdc-1	A-24871	5-12-60	Alluvium	1,660	750 E	125 E	25 E	70,000
20caa-1	A-19929	5-12-60	do	1,500 E	900 E	97	50 E	80,000
21add-1	a-3716#1	5- 9-60	do	1,060	620	138	30	80,000
21bdd-1	a-3716#2	5- 9-60	do	1,550	780 E			
28bbb-1	A-21511	1960	do	900	420 E			
Total pumped in district (rounded)					11,900			

[1] Approximate coefficient of storage, 6.0×10^{-2}.
[2] Approximate coefficient of storage, 4.6×10^{-4}.
[3] Approximate coefficient of storage, 2.8×10^{-3}.
[4] Coefficient of storage, 1.6×10^{-3}.
[5] Coefficient of storage, 9.5×10^{-4}.
[6] Coefficient of storage, 2.5×10^{-4}.

tremely high, even higher than the famed Snake River Group in Idaho, which, as reported by Crosthwaite and Scott (1956, p. 14), has a maximum coefficient of transmissibility of several million gallons per day per foot. The basalt in the area of the test in the Pavant Valley is highly fractured. Although the vesicles have remained open, probably little water moves through them; most of it moves through the fractures.

The observed coefficient of storage of the artesian alluvial aquifers range from 1.6×10^{-3} to 2.5×10^{-4}, the usual range for aquifers consisting of sand and gravel. The coefficient of storage was 0.06 for the one test made in the basalt aquifer. This coefficient indicates that water

in the basalt is unconfined and that the water-bearing openings are sparse although large; thus the basalt has a low average porosity. Well logs suggest that the coefficient of storage of the water-table aquifers in the alluvium ranges from 0.1 to 0.25, which is about normal for water-table conditions elsewhere in similar sediments.

SPECIFIC CAPACITY OF WELLS

The highest specific capacities in Pavant Valley are in irrigation wells tapping the basalt. Data for 13 of these wells indicate that the specific capacities range from 90 to 2,900 gpm (gallons per minute) per foot of drawdown and average 900 gpm per foot of drawdown (table 8), and data for 41 irrigation wells tapping the alluvium give specific capacities that range from 6 to 100 gpm per foot of drawdown and average 34 gpm per foot of drawdown. The specific capacity of one well that tapped both the basalt and alluvium is 140 gpm per foot of drawdown. The specific capacity of a well, as used in this report, is the quantity of water yielded by the well, in gallons per minute per foot of drawdown after pumping for 24 hours. Under artesian conditions this relation is approximately constant for any drawdown where the pumping level is above the bottom of the confining bed. For water-table conditions, the specific capacity is approximately constant only when the drawdown is a small fraction of the saturated thickness; when the drawdown exceeds a small fractiion of the saturated thickness, the specific capacity decreases in direct response to the drawdown.

The specific capacity of a well and the coefficient of transmissibility of the aquifer are related. The specific capacity also depends upon the construction and development of wells, which include the following factors: The depth of penetration of the well into the aquifer; the diameter of the well; the type, size, and amount of perforations in the casing; and the type and amount of development that the well has had. Notwithstanding these factors, specific capacity is useful in estimating the coefficient of transmissibility; and a comparison of specific capacities is useful in estimating the relative efficiency of wells.

Effects of nearby pumping wells and the water-level trend cause erroneous specific capacities unless corrections are applied. Declining water levels and effects from nearby pumping wells cause the apparent specific capacity to be smaller than the true value, and rising water levels cause the apparent specific capacity to be larger.

Nearly all the irrigation wells in Pavant Valley that were constructed with the intent of equipping them with pumps are 12 inches or larger in diameter, and they were constructed and developed with reasonable care; therefore, the apparent specific capacities can be used in computing approximate transmissibility. The values of the coeffi-

cients of transmissibility computed by use of specific capacity, however, seemed to be too low. The values of the coefficients of transmissibility in table 8 that were computed from specific capacity were increased after comparing them with more accurate coefficients obtained from pumping tests.

Differences in specific capacity of wells in different parts of the valley generally indicate differences in permeability of the aquifer materials. The basalt is many times more permeable than the alluvium, and this relation is reflected in the very high specific capacity of some wells in the basalt as compared to that of wells in the alluvium. Usually, the smaller specific capacities of wells in the basalt are in areas where the basalt is thin and where alluvium has partly filled the voids in the basalt, decreasing the permeability. Wells in the basalt that have a very large specific capacity undoubtedly intersect cracks or crevices that extend many feet into the aquifer. These cracks, in effect, act as large conduits which convey water readily to the well from relatively long distances.

Commonly, wells tapping the upper parts of the alluvial fans have a specific capacity ranging from 50 to 100 gpm per foot of drawdown, the specific capacity of wells tapping the lower parts of the fans range from 25 to 50 gpm per foot of drawdown, and the specific capacities of wells on the valley floor and in the Pavant district range from 6 to 25 gpm per foot of drawdown. Well logs show that the aquifer materials grade from well-sorted coarse gravel in the upper parts of the fans through fine gravel and coarse sand in the lower parts of the fans to principally fine to coarse lacustrine sand on the valley floor. This gradation accounts for the decreasing specific capacity westward away from the mountains.

SHAPE AND SLOPE OF THE WATER TABLE AND PIEZOMETRIC SURFACE

The water table and the piezometric surface are not level or uniform, but are warped, sloping surfaces. Irregularities in the amount and direction of slope are caused by unequal additions or withdrawals of water and by differences in thickness or permeability of the aquifer. Water moves in the general direction of the slope of the water table. The rate of movement, assuming a uniform cross section, is proportional to the slope (hydraulic gradient) and to the permeability of the water-bearing material. The configuration of the water table and of the piezometric surface is shown on a map by contour lines along which all points have the same altitude. The direction of ground-water movement is at right angles to the contour lines. The ground-water contour map (pl. 4) is based on water-level measurements made during the late winter of 1960. The general direction of movement of the

ground water in Pavant Valley is shown by the use of arrows on plate 2.

As the slope of the water table depends on the permeability and thickness of the water-bearing materials and on the amount of water being transmitted, the slope is considerably different in different parts of the valley and in the various formations. Although the unconsolidated material of the valley fill near the mountains along the east side of the valley is much more permeable than the material in the bottom of the valley, the water table is steeper near the mountains because the saturated material is much thinner, except possibly in the alluvial fans of the two principal streams. The ground-water mounds in the alluvial fans of Chalk Creek and Corn Creek (pl. 4) indicate areas of appreciable recharge. The average slope of the water table in these fans is 70 and 40 feet per mile, respectively. Through the center of the valley, where permeability is relatively high, the slope is more gentle; but along the west side, where permeability is low, the slope steepens. The large relatively flat area on the piezometic surface in the Flowell district is in an area of large withdrawal and is the result of the piezometric surface not fully recovering its original position after cessation of pumping. The broad, gently sloping water table in the Kanosh district is in an area where the aquifer is highly permeable basalt.

At no place in Pavant Valley are permeable beds in the Sevier River(?) Formation extensive enough to contain large quantities of water. Although the material in the hills northwest of Fillmore is Sevier River(?) Formation, the hills are "islands" in more permeable lake deposits; therefore, ground water in the lake beds flows around them rather than through them, and they have little effect on the configuration of the water table.

WATER-LEVEL FLUCTUATIONS

The ground-water surface is not stationary but fluctuates as water is added to or withdrawn from the ground-water reservoir. The stage of the water table is a measure of the quantity of ground water in storage in the ground-water reservoir, and it can be likened to the water level in a surface reservoir. Thus, water-level fluctuations in wells indicate changes in storage resulting from recharge to or discharge from a ground-water reservoir during a specified period. They do not, however, reflect small fluctuations caused by barometric changes, passing vehicles, earthquakes, and moon, earth, and ocean tides. The major water-level fluctuations in aquifers in Pavant Valley are attributed to discharge from wells, evapotranspiration, and recharge of the ground-water reservoir by infiltration of water from stream channels, irrigation ditches, irrigated fields, and precipitation. Water levels in artesian wells also fluctuate in response to barometric changes, earth-

quakes, moving vehicles, and earth and moon tides; but these do not affect the amount of water in storage; and the magnitude and (or) the period of fluctuation is small.

Fluctuations of the water level or pressure in a well may be represented graphically. The term "hydrograph" is used to designate the resulting graph. A hydrograph shows the composite effect of all forces acting on the ground-water reservoir. By the proper selection of observation wells and periods of observation, hydrographs may show one predominant force causing water-level fluctuations. Detailed data are obtained from recording gages, of which five were maintained in Pavant Valley. Less detailed water-level data were obtained from about 200 wells.

Four distinct cyclic fluctuation periods of ground-water levels in the Pavant Valley are related to recharge or withdrawals of water from the ground-water reservoir. The shortest period is the daily cycle, and the longest period is of several years duration; in between are weekly and seasonal cycles. The daily cycle is particularly noticeable in artesian wells and results from more water being withdrawn in the day than in the night. The daily cyclic amplitude has been noted to exceed 5 feet in observation well (C–21–5)21aba–1, in which water levels show effects of pumping in wells nearly three-quarters of a mile away. Most of the irrigation wells are pumped 24 hours a day; but some, principally wells equipped with engines, are pumped only 10–15 hours a day. The daily cyclic fluctuations of water levels in wells in the artesian aquifers are mainly the result of the pumping of artesian wells equipped with engines.

Closely akin to the daily cyclic fluctuations is the weekly cycle. During the irrigation season, water levels decline, in general, from Monday through Saturday (in addition to the daily fluctuations), but from Saturday evening until Monday morning water levels rise in response to the cessation of pumping. The hydrograph for well (C–21–5)21aba–1 in figure 4 shows that water levels rise several feet every seventh day, on Sundays.

The seasonal cycle coincides with the irrigation season. Water levels begin to decline about April 1—the beginning of the irrigation season—and continue to decline until about July 1. During July and August, the water levels remain about the same. During September they rise slowly; then, more rapidly in early October. And then the rate of rise diminishes, as the piezometric head in the aquifer tends to assume a plane surface (fig. 4). The demand for irrigation water generally begins to diminish by the first part of July, when crops begin to mature, and it continues to diminish until about October 1, the end of the irrigation season. The average water level in well (C–21–5)21aba–1 remained at about 55 feet below the land surface

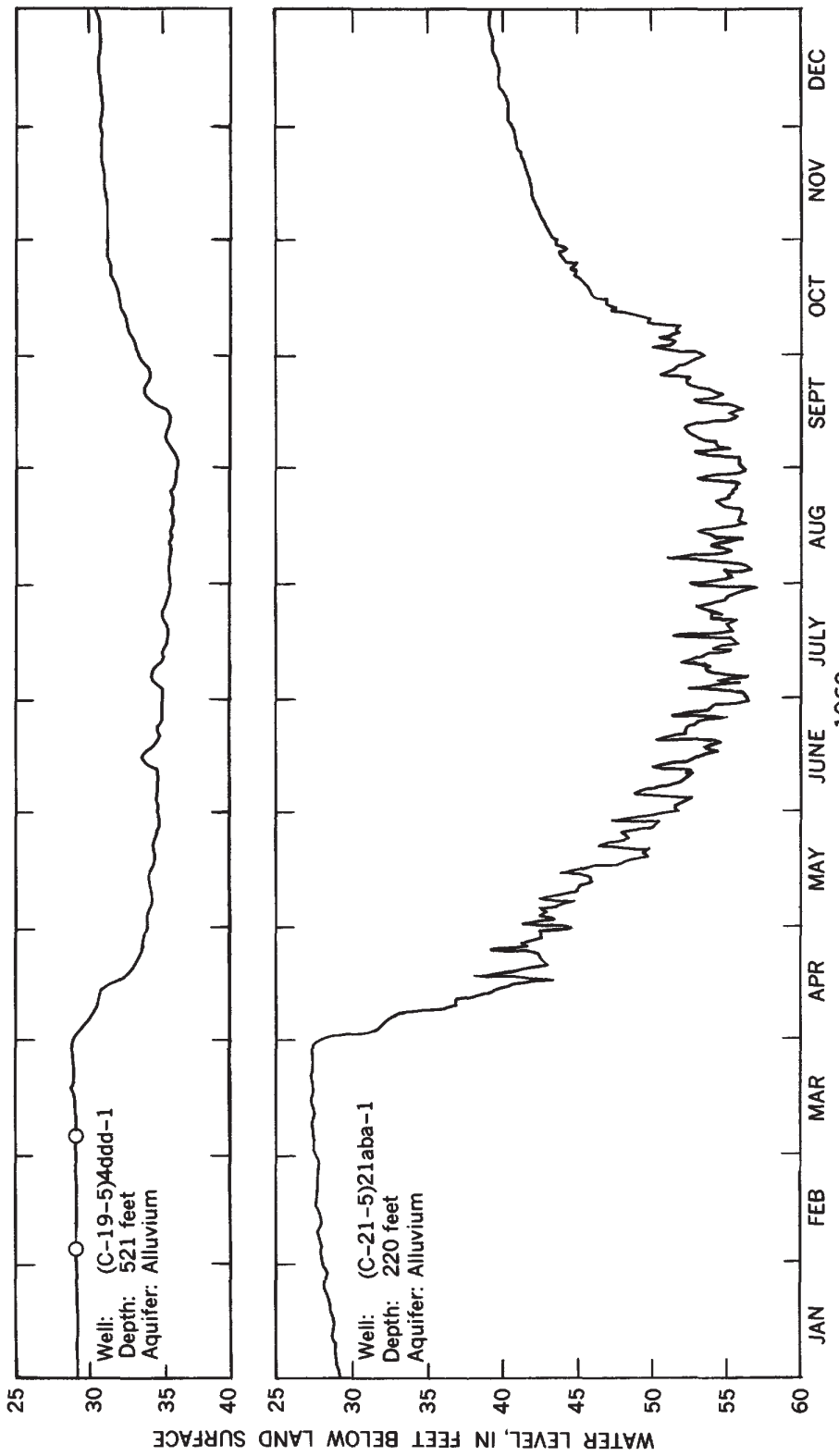


FIGURE 4.—Hydrographs of two observation wells near heavily pumped areas in Pavant Valley, 1960.

during July and August in 1960, during which time water moving into the pumped area equaled total discharge. Water levels began to rise soon after September 1—an indication that the quantity of ground water moving into the pumped area was exceeding withdrawal—and they continued to rise until the beginning of the following irrigation season. From March to September 1960, water levels declined an average of 7 feet in all of Pavant Valley and an average of 16 feet in the pumped areas.

A decline in water level in Pavant Valley during the 1960 irrigation season is shown on plate 5 by the differences in water levels, as measured in 160 wells in March and September. The largest declines are in the areas of greatest withdrawal, and, in general, the amount of decline indicates the magnitude of withdrawal. Observed seasonal declines ranged from 0 along the extreme west side of the Greenwood district to more than 60 feet near the center of the Flowell district. During the 1959 irrigation season, water levels declined an average of 2 feet throughout the valley and nearly 4 feet in the pumped area; the largest declines from March 1959 to March 1960 were in the centers of greatest pumpage (pl. 6).

Most of the annual decline is due to discharge of ground water rather than to decrease in recharge. The fact that the centers of greatest declines coincide with the centers of greatest withdrawal and that the relation between amounts of decline and withdrawal is definite confirm that this is true. Declines were relatively small in the principal recharge areas near the mountains along the east side of the valley. Plate 5 shows the same general pattern of water-level declines as plate 6, thus corroborating the theory that most of the declines are due to pumping. There were at least small declines throughout the valley, however, even where there was no withdrawal; this indicates that recharge in the valley was probably below normal. Thus, part of the water-level decline during 1959 can be attributed to below-normal recharge.

The long-term cyclic ground-water fluctuations coincide with long-term cyclic precipitation fluctuations. Usually water levels rise during periods of greater than normal precipitation and decline during periods of less than normal precipitation. Hydrographs of 11 selected observation wells are shown on plate 7; at least one observation well is in each ground-water district and in each principal aquifer in Pavant Valley. The hydrographs show that water levels in observation wells decline during periods of below-normal precipitation and rise during periods of above-normal precipitation. (Compare the hydrograph for well (C–21–5)21aba–1 on plate 7 with the curve showing cumulative departure from average precipitation 1892–1960 in figure 3.)

The average water-level decline was 8 feet beneath the entire valley

and 16 feet beneath the pumped area during the 10-year period 1950–60 (pl. 8). These 10 years include the period during which most of the pumped irrigation wells were put in operation. It can be seen that the centers of water-level declines are also the centers of greatest withdrawal and that the largest declines are in the Flowell district, which, since 1915 when the first irrigation wells were drilled, has been the center of greatest withdrawal. Declines in the intervening areas indicate that recharge since 1950 has been below normal, but the amount of decline that can be attributed to below-normal recharge is less than 5 feet in most of the area. The decline due to below-normal recharge in the area from Fillmore northwestward for about 6 miles is an exception. Here the declines have been much greater than 5 feet, even though withdrawal has been small.

In March 1960 the area of artesian flow included more than 90 square miles (pl. 9). In this area, water in the artesian aquifer had sufficient head to flow from wells at the surface. The head was reduced during the 1960 irrigation season, and so the area of artesian flow decreased by 13 square miles. The largest part of the area in which wells ceased flowing was in the Flowell district. If the 1960 rates of pumping and recharge are maintained, wells will cease flowing in all but the very lowest areas along the west side of the valley by 1965.

RECHARGE

During 1959, recharge to the Pavant Valley from all sources was estimated to be 66,000 acre-feet. The source of most of the recharge in Pavant Valley is direct penetration of precipitation, some of which percolates downward to the ground-water reservoir; infiltration from streams; and unconsumed irrigation water. The estimated recharge from each source in each of the ground-water districts is given in table 9. The methods and data used to compute recharge are discussed in the following subsections.

TABLE 9.—*Recharge (estimated), in acre-feet, from various sources in each ground-water district in Pavant Valley during 1959*

Ground-water district	Infiltration of precipitation	Seepage from streams	Deep percolation of irrigation water		Underflow from other districts (not additional recharge to the valley)	Total recharge in district
			Surface water	Ground water		
McCornick	1,500	1,000	3,300	1,300	0	7,100
Greenwood	2,000	6,000	8,500	800	500	17,800
Pavant	100	0	1,000	200	2,500	3,800
Flowell	1,000	5,000	8,500	5,500	7,500	27,500
Meadow	1,500	5,000	5,500	2,000	0	14,000
Kanosh	2,000	1,500	0	2,500	500	6,500
Total in valley (rounded)	8,000	18,000	27,000	12,000	----------	65,000

INFILTRATION OF PRECIPITATION

Seepage from precipitation is one of the principal sources of recharge in the nonirrigated sections of the valley. Precipitation may reach the ground-water reservoir after satisfying the soil-moisture deficiency in the root zone. The proportion of available water that becomes recharge is controlled largely by the physical character and moisture content of the soil and the amount and intensity of precipitation. Most of the recharge from summer storms is from runoff that collects in ephemeral streams and flows onto alluvial fans, for the thundershowers and most intense storms are usually of such short duration that the soil in other places is left dry below a depth of a few inches.

The several small retarding dams built across gullies and ravines on the alluvial fans intercept runoff from summer thundershowers and snowmelt and facilitate recharge to the ground-water reservoir. Winter storms usually result in the accumulation of snow several inches deep over the valley. When the snow melts, the ground-water reservoir may be recharged over much of the upland part of the valley between altitudes of 4,800 and 6,000 feet—by deep percolation. The average annual precipitation in this part of the valley is about 14 inches, of which 5 percent may percolate to the ground-water reservoir. On this basis, the direct infiltration of precipitation on the principal intake area during years of average recharge is about 8,000 acre-feet.

SEEPAGE FROM STREAMS

About 18,000 acre-feet of recharge per year is derived from streams in Pavant Valley. Chalk and Corn Creeks contribute most of this recharge, but all streams contribute some. Streams, after entering Pavant Valley, are above the water table and commonly lose water rapidly; they are called influent streams. Undoubtedly part of this loss is due to evapotranspiration, but most of it is due to seepage into the permeable materials underlying streambeds where they cross alluvial fans. Ordinarily the base flow of the smaller streams disappears within a mile or two of the mountains. Seepage is also appreciable in the narrow belt of alluvium that forms the floor of the canyons above the canyon mouths, and this seepage enters the valley as underflow beneath the stream channels and recharges the ground-water reservoir.

Much of the mountainous area surrounding Pavant Valley is drained by three perennial streams and by many small canyons and draws in which there may be small perennial streams or streamflow only for a few days or weeks each year. Except for runoff in the larger canyons, whose generally dependable flows during the spring freshet are diverted for irrigation, the runoff ordinarily infiltrates into the ground soon

after it enters the valley and makes a major contribution to the ground-water reservoir. In the smaller canyons, probably the greater part of the water moves as underflow through the alluvium and upper few feet of the bedrock of the canyon until it enters the ground-water reservoir in the valley. Many streams flow only in direct response to precipitation, but, because of the permeable material in the streambeds, they absorb water readily and contribute much recharge to the ground-water reservoir.

Seepage is greatest where streams flow over the upper part of the alluvial fans, ordinarily where sediments are coarsest and most permeable. Residents who have dug disposal holes near the channel of Chalk Creek in Fillmore report that water levels coincide with altitude of the streambed during late spring and early summer but that the water levels in disposal holes are much lower than the streambed at slighty greater distances from the stream. They also report that no water is observed near the stream channel during late summer and fall unless the stream had been unusually high for several days. Rises of water levels in wells tapping the Chalk Creek alluvial fan were correlated with the high spring runoff in Chalk Creek, when seepage is probably greatest, and they seem to support the conclusion that recharge to the ground-water reservoir is appreciable during high runoff. Seepage from other streams in Pavant Valley is probably comparable to that of Chalk Creek.

Sources of recharge by seepage to the ground-water reservoir in Pavant Valley are as numerous as the canyons and streams themselves. The relative importance of these sources is clearly indicated on the ground-water contour map (pl. 4). Ground water moves approximately in the direction of the slope of the water table, and the rate varies with the steepness of the water table, other factors remaining equal. The water table near Chalk and Corn Creeks slopes steeply away from them. This indicates that the streams are important sources of recharge. It was not possible to accurately determine the shape of the water table near the mountains because of the lack of water-level data in the vicinity of the alluvial fans; however, other sources of seepage recharge of lesser importance indicated on plate 4 are Wild Goose Creek, Maple Hollow, Pioneer Creek near Holden, and Meadow Creek near Meadow.

The contours on plate 4 indicate that the movement of water throughout the reservoir is evidently outward from the mountains but that water entering the valley from the ephemeral streams and from the face of the mountains is probably a small quantity compared with that from the two major perennial streams. However, although recharge other than that from the major streams is small compared

with that from the major streams, it is a significant part of the total recharge to the valley.

Man has altered the natural recharge pattern by diverting, for irrigation, water that under natural conditions would have recharged the basalt ground-water reservoir along the western part of the valley. Much of the surface water from Chalk Creek southward formerly flowed to The Sink, where appreciable quantities percolated into the underlying permeable basalt.

DEEP PERCOLATION OF IRRIGATION WATER

Total recharge from deep percolation of irrigation water was estimated to be about 39,000 acre-feet in 1959—27,000 acre-feet from unconsumed surface water and 12,000 acre-feet from unconsumed ground water (table 9). Recharge from irrigation, in this report, is regarded as the aggregate of seepage from reservoirs, ditches, and irrigated fields. When irrigation water is applied in sufficient quantities so that some infiltrates below the root zone, the excess may continue downward to the ground-water reservoir. The term "deep percolation," as used herein, refers to water that infiltrates below the root zone. Recharge derived from deep-percolation losses of irrigation water may be from water diverted from streams or pumped from wells.

Streams that have a flow sufficient for irrigation are generally diverted near the apex of the alluvial fans into ditches constructed with a gradient less than that of the natural stream channel; the diversion works are built so that the flow in the ditches is nearly constant, regardless of great variations in flow of the stream. The beds of the ditches, therefore, become more impermeable by deposition of silt and clay than the streambeds; thus, loss by seepage from the ditches is less than that from a stream of comparable size. Some of the silt and clay is removed during the annual ditch cleaning, however; so, the ditch never becomes completely impermeable. Several miles of concrete ditches have been built to convey water across some of the more permeable parts of the alluvial fans, and nearly all seepage losses have been eliminated in those reaches.

Most of the irrigated lands supplied by streams are distributed rather widely over the alluvial fans, and some lands require unduly long and sometimes wasteful ditches to convey water to them. For example, some land is irrigated on the Chalk Creek fan near the head of the fan east of Fillmore, but some water is diverted as much as 6 miles from the mouth of the canyon to the Pavant district and more than 6 miles to fields south of Flowell (pl. 10). A stream of water estimated at 75 gpm in the ditch supplying the area south of Flowell was observed to disappear into the ground in a distance of about 1

mile during a cool spring day when evaporation was small. The observed stream covered only about half of the ditch bed at the head of the reach, and it diminished in width downstream; thus, seepage from that reach of the ditch may exceed 200 gpm. Seepage losses from other reaches of this ditch and from other ditches are probably comparable.

Most of the recharge derived from deep percolation of irrigation water on the alluvial fans is from the irrigated fields. The surface material is commonly thin and relatively permeable on the alluvial fans, and it overlies coarse, very permeable material. Surface material of this type is very susceptible to large seepage losses. Available data indicate that recharge derived from deep-percolation losses constitutes about one-fourth of the water used above the altitude of 4,800 feet. Most of the seepage losses above this altitude percolate to the artesian aquifer.

The irrigated lands below an altitude of 4,800 feet lie above the artesian aquifers, but are separated from them by confining beds of clay and silt. Deep-percolation losses of irrigation water diverted from streams and pumped from wells below this altitude percolate to relatively shallow unconfined alluvial deposits, from which some of the water migrates into contiguous basalt flows. The deep-percolation losses of water applied to the land from ditches and reservoirs below an altitude of 4,800 feet is estimated to be one-fifth of the water diverted from streams or pumped from wells. The deep-percolation losses represent only part of the water not consumed by the crops. Some additional water is evaporated from reservoirs, ditches, and the soil surface in the fields; some is consumed by ditch- and reservoir-bank vegetation; some migrates laterally at shallow depths to adjacent noncultivated lands and is consumed by native vegetation, especially where the soil is underlain by shallow beds of clay; and some flows on the surface off the lower ends of irrigated fields onto noncultivated lands, where much of it is consumed by native vegetation. Other factors of lesser importance also take their toll; thus, only a part of the water not consumed by the irrigated crops ever reaches the water table.

In the computation of irrigation efficiencies for the Pavant Valley, one should consider not only deep percolation but also all the other losses previously discussed. Mr. L. S. Willardson (oral commun., April 2, 1963) found that during 1959–62 irrigation efficiencies ranged from 50 to 60 percent for about 100 farms in the vicinity of Milford. During 1960 the amount of water pumped per acre in Pavant Valley was about 15 percent less on six farms containing 2,150 acres than the amount pumped in the area studied by Willardson. This difference is

an indication that irrigation practices may be more efficient in Pavant Valley than in the vicinity of Milford. It is beyond the scope of this report, however, to determine irrigation efficiencies for Pavant Valley.

Conveyance losses of seepage, evaporation, and transpiration by canal-bank vegetation from the Central Utah Canal have not been measured directly; however, they are large. Estimates indicate that losses probably range from less than 40 percent of the total diversion during years of large diversions to more than 70 percent during years of small diversions. For purposes of the present study, losses are assumed arbitrarily, and probably conservatively, to be as follows: About 40 percent when diversions exceed 25,000 acre-feet; 50 percent when diversions range from 15,000 to 25,000 acre-feet; and 60 percent when diversions are less than 15,000 acre-feet, except for 1960, when measured losses were about 70 percent. Mr. T. C. Callister, president of the Central Utah Water Co., reported (oral commun., April 26, 1961) that 1,820 acre-feet of water was delivered to Pavant Valley by the canal during 1960, but 6,120 acre-feet was diverted into the canal at the intake for delivery to Pavant Valley.

About 97 percent of the water lost from the Central Utah Canal is seepage into the bottom and banks of the canal. Although the surface materials consist chiefly of sand, the canal is unlined; however, for part of its length, the bottom of the canal is in clay or marl. Some of the seepage is eventually lost by evapotranspiration soon after the cessation of diversion to the canal, but these losses are probably small compared with the total. Most of the seepage losses eventually percolate to underlying aquifers; thus, locally, the canal plays a major role in the ground-water regimen. About 60 percent (table 10) of the seepage losses occurs upstream from McCornick; thus, the seepage losses do not recharge aquifers in Pavant Valley. Only the losses from McCornick southward need be considered with regard to recharge in Pavant Valley. The average annual seepage losses during 1934–60 are given in table 10.

TABLE 10.—*Some dimensions of the Central Utah Canal and percentage of water loss in selected reaches, 1934–60*

	Average width (feet)	Length (miles)	Loss (percent of total loss)	Average annual loss (acre-feet)
Above McCornick	22	23	60.7	5,100
McCornick	20	5	12.0	1,000
Greenwood	18	7	15.1	1,300
Pavant	13	4	6.2	500
Flowell	10	5	6.0	500

North of Flowell, the Central Utah Canal intercepts all surface water that flows that far out into the valley. Most of the water is diverted for irrigation, or it seeps from the canal. The excess canal water is discharged from the lower end of the canal to flow into The Sink.

QUANTITY OF WATER IN STORAGE

Virtually all the ground water in Pavant Valley is in the unconsolidated lake beds and alluvial-fan deposits and in the basalt in the western and southern parts of the valley. Much of the water (possibly as much as 90 percent) is unrecoverable because the fine-grained materials, especially clay and silt, will not readily release the water to wells. Most of the recoverable ground water is in the sand and gravel deposits and the basalt.

The approximate quantity of ground water in storage was determined by multiplying the volume of saturated material by average coefficients of storage of 0.25 for the alluvium, 0.12 for the combined alluvium and basalt aquifer in the Kanosh district, and 0.06 for the basalt in the Flowell district; all coefficients were determined on the basis of pumping tests. The extent of these deposits and their saturated thicknesses were determined by interpretation of 280 well logs. The extent and average thickness of saturated material in each of the six ground-water districts are given in table 11. The volume of ground water in storage in March 1960 computed from these figures is about 11,000,000 acre-feet. The volume of ground water in storage (estimated) in each of the ground-water districts is given in table 11.

TABLE 11.—*Volume of saturated material and quantity of ground water estimated to be in storage in Pavant Valley, Utah, March 1960*

Ground-water district	Coefficient of storage	Average saturated thickness (feet)	Extent of district (acres)	Volume of saturated material (acre-feet)	Quantity of ground water in storage (acre-feet)	Quantity removed from ground-water storage during 1959 (acre-feet)	Predicted decrease in ground-water storage resulting from a decline in water level of 50 feet below the March 1960 level (acre-feet)
McCornick	0.25	275	17,500	4,800,000	1,200,000	4,000	70,000
Greenwood	.25	300	31,000	9,300,000	2,300,000	500	60,000
Pavant	.25	200	9,500	1,900,000	480,000	500	20,000
Flowell:							
Alluvium	.25	500	34,500	17,200,000	4,300,000	9,500	50,000
Basalt	.06	50	6,500	320,000	20,000	500	20,000
Meadow	.25	350	24,500	8,600,000	2,200,000	10,000	50,000
Kanosh	.12	300	14,000	4,200,000	500,000	5,000	80,000
Total for valley			137,500	46,320,000	11,000,000	30,000	350,000

The predicted decrease in ground-water storage resulting from a decline in water levels of 50 feet below the March 1960 levels is given in the last column of table 11. The predicted decreases, except for the Flowell (basalt) district, are not derived directly from the data in columns 2–4, because if water levels were to decline 50 feet the water would still be under artesian conditions throughout much of the valley. Values for the artesian coefficient of storage in the Pavant Valley range from 10^{-3} to 10^{-4}; therefore, a decline in artesian head of 50 feet would result in very small changes in storage. Nearly all the water obtained from storage would come from the relatively narrow zone of unconfined water in the eastern part of the valley. The coefficient of storage in the zone of unconfined water is approximately the same as that given in column 2 of table 11. The values given in the last column of table 11, therefore, represent principally the change in storage in the relatively narrow zone of unconfined water.

Probably less than 1 million acre-feet of the water in storage is recoverable by present-day means and methods of extracting water. Most of the water not recoverable is held in fine sand, silt, and clay or in aquifers which are so thin that they will not yield sufficient water for irrigation. The economics of seeking and pumping water would preclude pumping water below some undetermined depth for crops normally grown in Pavant Valley.

DISCHARGE

Ground water is discharged from the valley by evapotranspiration, by underflow, and from wells. The rate at which it is discharged depends on many factors, such as the depth to the water table, the nature of the vegetal cover, and the season of the year. More ground water is discharged from some parts of the valley than from others. Large quantities of water are withdrawn by plants from the zone of saturation where the water table is at or close to the land surface. Only small quantities, if any, are withdrawn by plants where the water table is more than 25 feet below the land surface, but in such areas the vegetation indirectly affects ground-water recharge and discharge by consuming water before it can become ground-water recharge. In a natural regimen the average annual discharge during a long period of years equals the average annual recharge. Ground-water discharge through wells increases recharge or reduces the natural discharge by a like amount. In addition to recharge or a reduction of natural discharge, it may also be partly or wholly derived from storage.

During 1959 the total ground-water discharge in the Pavant Valley was estimated to be 98,000 acre-feet (table 12). The underflow moving

between districts does not affect ground-water discharge from the valley, but the amount is given in table 12 to show the relation of ground water in adjacent districts.

TABLE 12.—*Discharge (estimated), in acre-feet, in each ground-water district in Pavant Valley during 1959*

Ground-water district	Evapotranspiration [1]	Withdrawn from wells	Underflow		Removed from storage	Total discharge in district
			From valley	To other districts		
McCornick	0	6,600	3,500	500	4,000	10,600
Greenwood	11,000	4,100	3,500	500	500	19,100
Pavant	500	1,100	1,500	500	500	3,600
Flowell	4,000	26,300	5,000	2,000	10,000	37,300
Meadow	8,000	10,100	500	7,500	10,000	26,100
Kanosh	0	11,400	0	0	5,000	11,400
Total ground-water discharge in valley (rounded)	24,000	60,000	14,000	----------	30,000	98,000

[1] Evapotranspiration by native vegetation on nonirrigated lands.

EVAPOTRANSPIRATION

Water evaporates from open-water surfaces and from the soil. Plant roots get water from the soil, from the capillary fringe above the water table, and directly from the zone of saturation. Plants store some water, but they discharge most of it to the atmosphere by transpiration. The depths from which plants lift water differs greatly with different types of plants and with different soils and soil conditions. Transpiration usually cannot be measured separately from evaporation; so, the two processes are referred to by the collective term "evapotranspiration."

In Pavant Valley, evapotranspiration is especially rapid in the bottom lands, where the water table is at or near the land surface and where native and cultivated water-loving vegetation abounds. No data on the rate at which ground water is evaporated and transpired in Pavant Valley were obtained during this investigation. In Malad Valley, Idaho, about 250 miles north of Pavant Valley, in which the climate, soil conditions, and types of plants are comparable to those of Pavant Valley, evapotranspiration from the zone of saturation in areas where the depth to the water table was shallow was estimated by Mower and Nace (1957) to be as much as 4 feet a year, the average for grasslands being about 1½ feet a year.

Where the water table is close enough to the land surface to cause discharge of ground water by evaporation, a residue of water-soluble minerals is left at the land surface. The depth from which water may be brought to the land surface by capillarity depends upon the texture of the material above the water table—the finer grained the material, is the greater the capillary rise. Probably little water is brought to

the land surface where the depth to the water table exceeds 10 feet. The amount of water evaporated directly from the soil surface depends upon the depth to the water table, the type of soil, and the extent and type of vegetal cover. Through passage of time, salts gradually accumulate at the land surface, and the vegetal cover becomes restricted to the more salt-tolerant varieties.

The water table beneath 35,000 acres of the valley lies sufficiently close to the land surface that evapotranspiration is operative (pl. 9). If one assumes that an average of 4 inches of water is transpired and evaporated each year from the shallow-water zone of saturation in the Meadow district where the valley is mostly devoid of vegetation, and that an average of 12 inches a year is transpired and evaporated from the zone of saturation in other parts of the valley, the annual evapotranspiration by native vegetation on nonirrigated lands from the ground-water reservoir is about 24,000 acre-feet (table 12).

SUBSURFACE OUTFLOW

About 14,000 acre-feet of ground water moves westward yearly to other parts of the Sevier Desert from Pavant Valley. The amount of annual subsurface outflow is diminishing because withdrawal of water through wells lowers the ground-water levels in the valley, thus reducing the hydraulic gradient of the outflow. The quantity of water moving through an aquifer varies with the cross-sectional area of the aquifer and the hydraulic gradient, if one assumes no change in transmissibility. The transmissibility of aquifers was estimated on the basis of pumping tests, the cross-sectional areas were determined from well logs, and the hydraulic gradient was taken from a map of the configuration of the water table and piezometric surface. The average value for each of these factors used in estimating the subsurface outflow from the valley is given in table 13.

TABLE 13.—*Subsurface outflow and controlling factors in Pavant Valley, 1959 (estimated)*

	Width of aquifer section (miles)	Average hydraulic gradient along western edge of valley during 1959 (feet per mile)	Estimated average coefficient of transmissibility (gpd per ft)	Estimated outflow during 1959 (acre-feet)
McCornick	5	19	35,000	3,500
Greenwood	7	22	20,000	3,500
Pavant	3	15	30,000	1,500
Flowell:				
Alluvium	7	9	30,000	2,000
Basalt	3	0.2	5,000,000	3,000
Meadow	5	3	30,000	500
Kanosh	7	0	500,000	0
Total subsurface outflow from valley				14,000

WELLS

About 57,500 acre-feet of water was withdrawn through wells for irrigation; 2,000 acre-feet, for domestic and stock uses; and 75 acre-feet, for municipal uses during 1959. About 48,000 acre-feet of the water withdrawn through wells was consumed, and the remainder returned to the ground-water reservoir. Before 1950, most of the discharge from wells was from flowing wells but by 1959 flowing wells contributed only about 10 percent of the total discharge from wells. Total annual ground-water withdrawal (estimated) increased from 17,700 acre-feet in 1946 to a maximum of 67,300 acre-feet in 1960 (table 14), and the number of pumped irrigation wells increased from 3 to 110 during the same period of time. Figure 5 shows that as the number of pumped irrigation wells, and consequently pumpage, increased, the quantity of discharge from flowing wells decreased.

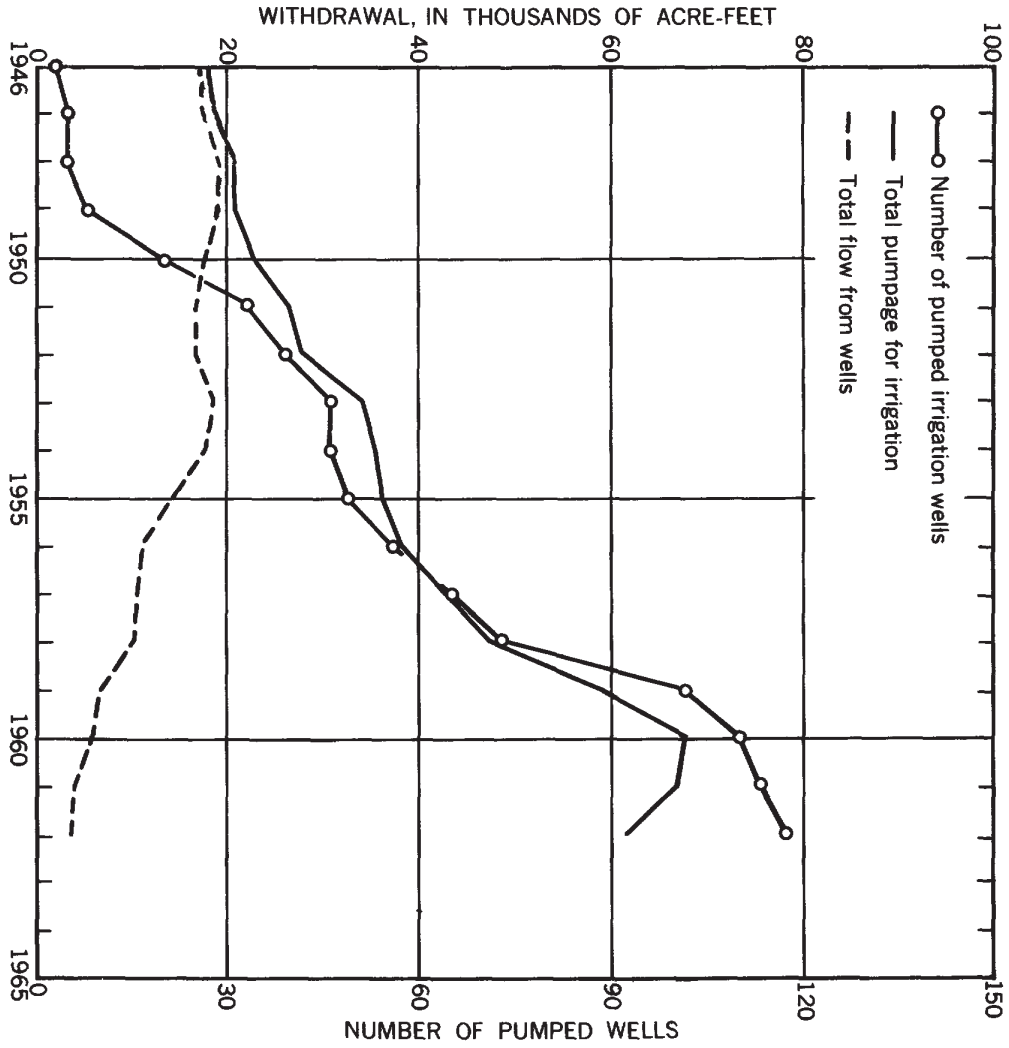


FIGURE 5.—Relation of number of pumped irrigation wells and total pumpage to total discharge from flowing wells in Pavant Valley, 1946–62.

TABLE 14.—*Discharge from wells (estimated), in acre-feet,*

Year	McCornick			Greenwood			Pavant		
	Flowed	Pumped	Total	Flowed	Pumped	Total	Flowed	Pumped	Total
1946	0	0	0	1,000	0	1,000	300	0	300
1947	0	0	0	1,000	0	1,000	300	0	300
1948	0	0	0	1,000	0	1,000	300	0	300
1949	0	0	0	1,100	0	1,100	300	0	300
1950	0	800	800	1,200	500	1,700	300	100	400
1951	0	3,100	3,100	1,200	800	2,000	300	400	700
1952	0	4,200	4,200	1,300	1,000	2,300	400	600	1,000
1953	0	3,600	3,600	1,300	1,100	2,400	400	700	1,100
1954	0	4,500	4,500	1,300	1,200	2,500	400	700	1,100
1955	0	4,600	4,600	1,300	1,300	2,600	400	700	1,100
1956	0	4,800	4,800	1,300	1,400	2,700	300	700	1,000
1957	0	4,900	4,900	1,300	2,200	3,500	300	700	1,000
1958	0	4,600	4,600	1,200	2,500	3,700	300	700	1,000
1959	0	6,600	6,600	1,200	2,900	4,100	300	800	1,100
1960	0	7,100	7,100	1,200	4,400	5,600	300	700	1,000
1961	0	7,500	7,500	900	5,500	6,400	200	800	1,000
1962	0	6,600	6,600	700	5,900	6,600	100	1,200	1,300

Flowing wells.—Flowing wells were first constructed in the valley in 1915, and they provided the only ground water used for irrigation for the next 20 years and most of the ground water used for irrigation during the following 15 years. At first most of the water was used to supplement surface water, but it was the only source of irrigation water on a few small farms. In time, additional wells were drilled to obtain supplemental irrigation water, especially during drought, when flowing wells may have provided half the irrigation water used on the valley plain.

The largest quantity of ground-water discharge from flowing wells for any year was estimated to be 19,400 acre-feet in both 1948 and 1949. Since that time, discharge from flowing wells has generally diminished, partly as a result of drought and partly as a result of lower artesian pressures caused by pumping. Before 1959 most of the water from flowing wells was used for irrigation, and use for stock and domestic supplies was incidental; however, since 1959 most of the water from flowing wells has been used for stock and domestic supplies, and any irrigation use has been incidental.

A summation of withdrawal from the Pavant Valley ground-water reservoir by district during the period 1946–62, inclusive, is given in table 14. The increase in the discharge from flowing wells in the Greenwood district from 1946 to 1952 was caused by an increase in the number of irrigation and stock wells. Because few new wells were drilled in that district during 1952–57, annual discharge remained at about 1,300 acre-feet. Since 1957, annual discharge has been slightly less, only about 1,200 acre-feet a year during 1958–60.

In the Pavant district available hydrologic data suggest that the greatest annual discharge from flowing wells was in 1953 and that total

by ground-water district, Pavant Valley, Utah, 1946–62

Flowell			Meadow			Kanosh			Total in Pavant Valley	Number of pumped irrigation wells	Total number of wells in valley
Flowed	Pumped	Total	Flowed	Pumped	Total	Flowed	Pumped	Total			
14,000	0	14,000	2,000	200	2,200	0	200	200	17,700	3	343
14,000	0	14,000	2,100	500	2,600	0	500	500	18,400	5	349
16,000	0	16,000	2,100	600	2,700	0	600	600	20,600	5	351
15,000	100	15,100	2,200	1,100	3,300	0	1,000	1,000	20,800	8	367
14,000	700	14,700	2,100	1,700	3,800	0	1,300	1,300	22,700	20	400
13,000	1,400	14,400	2,000	3,300	5,300	0	800	800	26,300	33	413
13,000	1,400	14,400	1,900	2,000	3,900	0	1,600	1,600	27,400	39	424
15,000	2,800	17,800	2,000	4,600	6,600	0	2,300	2,300	33,800	46	445
14,000	3,400	17,400	1,800	5,200	7,000	0	2,900	2,900	35,400	45	451
11,000	5,700	16,700	1,700	5,400	7,100	0	3,900	3,900	36,000	49	466
8,000	9,100	17,100	1,400	5,600	7,000	0	5,400	5,400	38,000	56	485
7,000	10,200	17,200	1,600	6,000	7,600	0	8,300	8,300	42,500	65	498
7,000	13,400	20,400	1,500	5,900	7,400	0	9,900	9,900	47,000	73	507
3,800	22,500	26,300	1,000	9,100	10,100	0	11,400	11,400	59,600	101	522
3,700	27,700	31,400	700	9,600	10,300	0	11,900	11,900	67,300	110	532
3,000	27,000	30,000	400	11,000	11,400	0	10,000	10,000	66,300	113	535
2,500	24,500	27,000	300	8,000	8,300	0	12,000	12,000	61,800	117	540

discharge has diminished annually since 1953 because artesian pressures declined as a result of the current drought.

In the Meadow and Flowell districts, from 1946 through 1953 and 1954, respectively, the total annual discharge from flowing wells remained nearly constant and during these periods the annual variations of discharge were probably related to changes in recharge. Beginning in 1954 and 1955, respectively, and continuing through 1960, however, the total annual discharge from flowing wells diminished rapidly, as a result of reduced artesian pressure caused by pumping other irrigation wells. In fact, the effects of pumping were so great during 1959 and 1960 that most of the discharge from flowing wells occurred during the nonirrigation season. Effects of pumping are discussed further in a subsequent section.

Some water discharged from flowing wells during the winter is used for stock watering and some for irrigation, but much seems to be wasted. At least 3,500 acre-feet, and perhaps as much as 5,000 acre-feet of the 6,000 acre-feet of water discharged by uncontrolled or poorly controlled flowing wells is estimated to have been wasted during the winter of 1959–60. Thus, more than 50 percent of the 1959–60 winter discharge from flowing wells was probably wasted; this is equivalent to 5 percent of all ground water withdrawn from wells during 1960 (table 15).

To determine the amount of water discharged from each of the flowing wells during 1960, the rate of flow per foot of head was determined in at least one nearby representative observation well. The 1960 data were extrapolated to each of the years 1946–59 by using the water levels in the same observation wells to obtain the average rate of flow

TABLE 15.—*Discharge (estimated), in acre-feet, from flowing wells in Pavant Valley during the winter of 1959–60*

Ground-water district	Beneficial use	Nonbeneficial use	Total
McCornick	0	0	0
Greenwood	650	500	1,150
Pavant	80	180	260
Flowell	1,800	2,000	3,800
Meadow	180	700	880
Kanosh	0	0	0
Totals (rounded)	2,500	3,500	6,000

for each year. From this extrapolation, it was possible to compute the annual discharge from each of the flowing wells. Except for computations involving a few wells for which additional information was available, it was necessary to make the following assumptions: (1) The same methods of capping the wells that were observed to be in use during the winter 1959–60 were employed during each of the years 1946–59, (2) the rate of leakage through faulty or partly open valves and around defective caps varied only in direct response to change in artesian pressure, (3) the wells for which specific information was not available were opened April 1 and closed September 30 each year, and (4) wells uncapped during 1959–60 were assumed to have been uncapped since 1946. Although these assumptions may result in erroneous discharge for some wells, they are applicable to the valley as a whole. The annual discharge of flowing wells in the valley computed by this method compares favorably with the discharges estimated by Dennis, Maxey, and Thomas (1946, p. 75). They did not include the discharge from flowing wells in the Greenwood district and that from a part of the wells in the Pavant district, but this discharge would have been a small part of the total in the valley.

Pumped irrigation wells.—Most of the ground-water discharged in Pavant Valley is pumped from wells. About 61,400 acre-feet of water was pumped from 110 wells in 1960 (table 14). The first well pumped for irrigation in Pavant Valley was drilled by the Drought Relief Administration in 1934 in the village of Hatton. The number of pumped irrigation wells increased slowly until 1950, when 20 wells were pumped. The availability of electricity for irrigation pumps in the McCornick district in 1952 and in other districts in 1958 was a big factor in the increased number of pumped irrigation wells. There were 117 pumped wells in 1962, and the number will probably range between 125 and 135 in succeeding years.

Table 8 includes the discharge, in gallons per minute, and the volume of water pumped during 1960, in acre-feet, for each pumped irrigation well in use in Pavant Valley. The discharge of wells ranged from

130 to 3,450 gpm, and the volume of water pumped ranged from 20 to 1,600 acre-feet. The smallest discharge and volumes of water pumped were from the older small-diameter artesian wells. The largest discharge and volumes of water pumped were from wells finished in the basalt aquifer.

Pumping for irrigation in the McCornick district started in 1950, when 800 acre-feet of water was pumped; by 1961 pumpage had increased to 7,500 acre-feet, although it declined slightly in 1962. Pumping for irrigation also started in the Greenwood district in 1950, when 500 acre-feet was pumped, and it reached 5,900 acre-feet in 1962. The Pavant district has the least ground-water withdrawal of the six districts. The first pumping was in 1950, when 100 acre-feet was pumped; in 1962 pumpage was only 1,200 acre-feet. Flowing wells had been used in the Flowell district for many years when the first pump was used in 1949. Pumpage in the Flowell district increased from 100 acre-feet in 1949 to 27,700 acre-feet in 1960, but it declined in 1961 and 1962 (table 14). In the Meadow district, there were two pumped wells in 1946 that pumped about 200 acre-feet of water; by 1961, pumpage had increased to 11,000 acre-feet, although it declined slightly in 1962. The first irrigation well in the Kanosh district pumped 200 acre-feet in 1946; by 1962, 12,000 acre-feet was pumped from 16 wells.

Although it is more expensive to pump water from artesian aquifers than to obtain water by natural flow, the savings in time and efficiency that can accrue from having a greater supply of water available when needed may more than offset the cost of water obtained solely from flowing wells. Nearly all the pumped irrigation wells discharge at a rate several times that of a flowing well, making it possible to irrigate a farm in a much shorter time than was possible with flowing wells and with a smaller percentage of evaporation and seepage losses from reservoirs and ditches. Larger irrigation streams enable more even distribution of water over the fields and thus help to prevent excessive percolation losses at the head of the field and insufficient irrigation at the bottom and to increase crop yield. Also, crops having a higher market value can be grown as a result of the more dependable water supply available by pumping. All these factors increase the farmer's incentive to improve his distribution systems and irrigation practices.

CHEMICAL QUALITY OF WATER

Problems of the quality of ground water are closely related to those of quantity. An insufficient supply or the overdevelopment of ground water in an area is sometimes associated with undesirable chemical characteristics of the water, such as excessive amounts of total dis-

solved solids or of a single element such as sodium. These problems may be related to the geology and hydrology or to the reuse of irrigation, municipal, and industrial water, whereby the quality of water deteriorates owing to concentration of minerals by evapotranspiration, by re-solution from the soil, or by addition of contaminates. Ultimately, reuse of irrigation water may adversely affect the user of downgradient water, as this concentrated irrigation water mixes with ground water of better quality downgradient.

The chemical quality of ground water in Pavant Valley was studied to determine its general usability and the possibility of future changes in quality. Also, knowledge of the chemical characteristics of irrigation water can be helpful in determining irrigation practices.

Most of the chemical analyses were made of water samples collected in 1943–44 and in 1956–60. Samples of ground water were collected from representative wells in the alluvium and the basalt. Selected chemical analyses of water samples from 41 wells are listed in table 16, and chemical analyses of all water samples from wells in Pavant Valley analyzed by the Geological Survey through 1962 were compiled by Mower (1963). Water samples are collected once or twice a year from several selected wells to monitor changes in quality. A total of 196 water samples from 127 wells were analyzed during 1943–62. The chemical characteristics of ground water from 10 wells is shown in figure 6.

The discussion of water quality in this report pertains only to the chemical quality of the water and does not relate to the sanitary quality of the individual supplies, except that a high nitrate content may be an indication of pollution.

PRINCIPAL CHEMICAL CHARACTERISTICS AFFECTING WATER USED FOR IRRIGATION

All natural waters contain chemical substances in solution. Water dissolves some of the rocks and soils through which it passes. The amount and character of the mineral matter taken into solution depend chiefly on the chemical and physical composition of the rocks through which the water passes, the length of time the water is in contact with the soil or rocks, and other factors such as temperature and pressure. Ground water, in general, is usually more mineralized than direct surface runoff because it remains in contact with the soil and rocks for a longer time. The concentration and character of the minerals in solution—particularly the total amount of dissolved solids, the amount of boron, and the percentage of sodium relative to other cations—determine the quality of the water for irrigation.

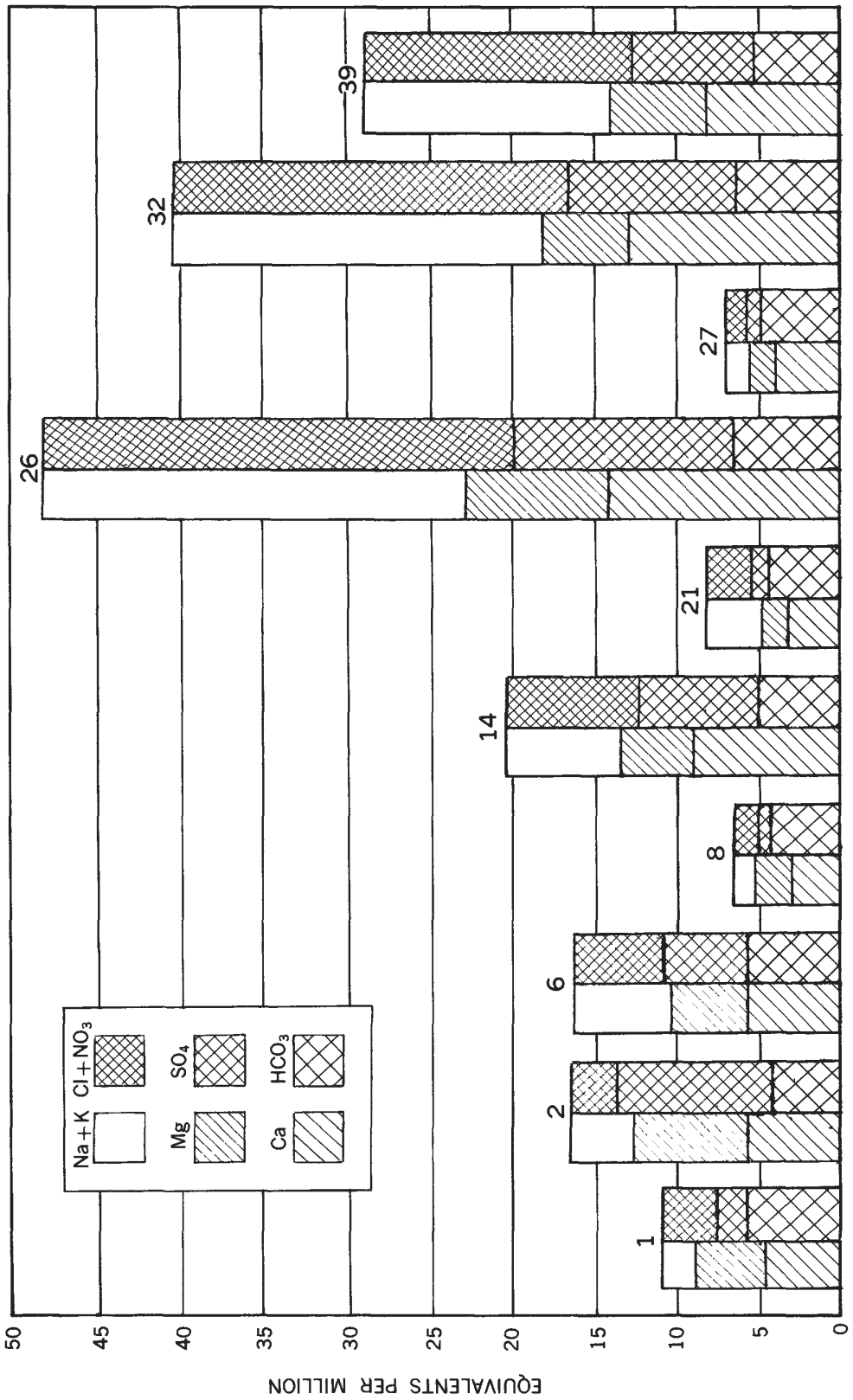


FIGURE 6.—Chemical character of representative ground waters in Pavant Valley. Numbers refer to analyses in table 16.

TABLE 16.—*Chemical analyses of water from 41 selected wells in Pavant Valley, Utah*

[Character of water-bearing material: B, basalt; G, gravel; K, conglomerate; S, sand]

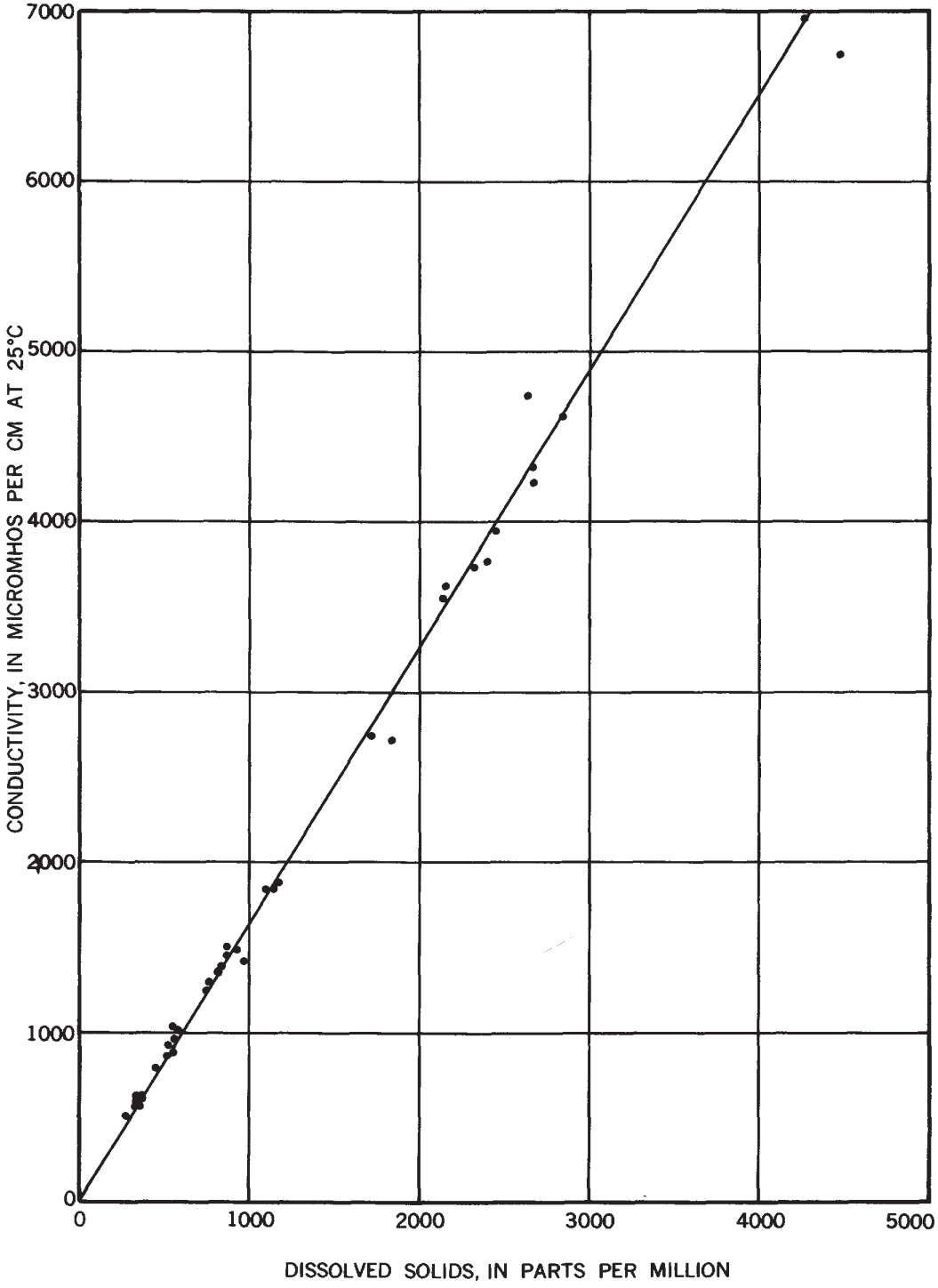
Analysis	Well	Owner	Date of collection	Depth of well (ft)	Character of water-bearing material	Temperature (°F)	Parts per million											Percent sodium	Sodium-adsorption-ratio (SAR)	Specific conductance (micromhos per cm at 25° C)	pH
							Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$				
1	(C–18–5)34baa–1	L. C. Callister	5–23–60	667	S, G	62	25	92	51	48	348	80	120	6.6	594	438	153	19	1.0	1,010	7.6
2	(C–20–5)22bcc–1	J. C. Rowley	do	400	do	63	26	111	84	91	251	450	102	1.7	989	622	416	24	1.6	1,410	7.7
3	(C–21–4)7bbc–1	A. W. Brunson	11–17–44	73	do			84	33	4.4	397	13	10	2.0	342	345	20	3	.1	628	
4	(C–21–5)6cac–1	A. R. Swallow	5– 7–57	90	B	55	30	151	54	78	309	150	238	31	884	600	347	22	1.4	1,500	
5	6dba–1	Jarold Robison	10–23–57	400	S, G		18	48	23	21	233	24	32	2.9	284	217	26	18	.6	506	7.3
6	7cdd–3	Christensen Brothers	5–24–60			54	28	111	56	136	344	238	186	16	940	510	228	37	2.6	1,490	7.7
7	7ddc–3	A. P. Robison	8–26–58		do	54	21	92	32	68	352	89	81	15	571	360	71	29	1.5	967	7.6
8	8bdc–2	Swallow and Robison	5–31–60	96		63	21	61	26	30	256	39	48	4.8	356	257	47	20	.8	602	7.7
9	8cdd–1	F. W. Johnson	8–26–58	407	S, G, B	63	20	70	26	26	264	38	53	7.7	371	280	64	17	.7	629	7.8
10	18aba–1	Robison and Brinkerhoff	do	246	G, B	56	20	70	26	26	264	38	53	7.7	371	280	64	17	.7	629	7.8
			do	150	B	55	22	114	44	96	348	186	131	13	777	464	179	31	2.0	1,250	7.6
11	18ada–2	F. G. Johnson	6–24–58	135	B, G, S	55	24	76	40	63	332	132	51	13	562	356	84	28	1.4	890	7.6
12	20dad–1	J. D. Ivie	10–11–57	293	S, G	57	17	67	24	17	319	2.0	18	18	320	267	5	12	.4	575	7.1
13	28aaa–1	Charles Owen	8–28–58	510	G, K	59	15	71	25	16	318	16	17	16	332	280	19	11	.4	578	7.2
14	29bdd–2	Lawrance Rasmussen	do	632	G, S	65	16	177	53	162	302	348	282	6.2	1,190	660	412	35	2.7	1,890	7.4
15	30dbc–3	Christensen Brothers	5–27–60	787	S, G		16	141	67	164	229	344	311	1.0	1,160	628	440	36	2.8	1,860	7.6
16	31cdd–2	J. N. Rogers	3–24–59	800	G, K	66	15	79	23	75	305	80	85	3.1	510	292	42	36	1.9	873	7.5
17	33ccd–1	L. V. Barnes	5– 8–57	250	G, S	58	13	96	23	76	242	64	165	5.8	562	336	138	33	1.8	1,030	7.8
18	(C–21–6)1ddb–1	Clyde Larsen	6–23–58	105	B	55	30	130	55	83	325	151	210	16	835	552	286	25	1.5	1,390	7.4
19	(C–22–5)4bbd–1	Olaf George	8–28–58	250	G	59	13	128	27	126	262	188	208	4.0	823	432	217	39	2.6	1,360	7.2
20	9cad–2	W. A. Paxton	10– 2–58	527	S, G	69	15	263	73	261	311	652	415	5.1	1,840	955	700	37	3.7	2,720	7.2
21	17bdd–1	William Blake	5–24–60	375	do	58	20	64	20	78	266	48	97	4.5	462	240	22	41	2.2	803	7.8
22	21acd–2	Mrs. L. Stott and others	8–27–58	340	G	57	13	85	21	84	312	52	116	8.4	532	298	42	38	2.1	936	7.5
23	33abc–1	Grant Beckstrand	do	250	S, G	55	14	75	11	34	199	34	72	7.7	346	232	69	24	1.0	595	7.7
24	(C–22–6)3add–2	Edwards and Harding	7–10–57	339	B		48	114	41	134	276	148	258	2.3	881	454	228	39	2.7	1,460	7.3
25	32ccc–1	A. L. Kimball	10– 8–58	115	do	58	37	281	126	478	344	538	1,000	9.0	2,640	1,220	938	46	6.0	4,760	7.3

26	32dcc-1	W. B. Bushnell	do	115	do	60	38	281	105	589	398	630	1,010	6.3	2,860	1,130	804	53	7.6	4,620	7.2
27	(C-23-5)5adc-1	F. T. Paxton	8-27-58	180	G	55	19	78	19	32	293	40	40	7.8	380	274	34	20	.9	635	7.6
28	(C-23-6)8abd-1	B. P. and M. Watts	5-24-60	200	B	58	47	317	88	516	352	517	1,020	7.8	2,690	1,150	861	49	6.6	4,230	7.4
29	9bca-1	Keith Pace	8-27-58	170	do	62	54	405	114	1,050	486	924	1,700	5.4	4,490	1,480	1,080	61	12	6,750	6.9
30	9ccd-1	do	5- 8-57	136	B, G	60	40	257	62	434	372	406	785	6.7	2,170	896	591	51	6.3	3,620	7.8
31	10ccc-1	C. A. Kimball	6- 5-58	96	B	60	38	265	69	523	379	495	885	10	2,470	945	634	55	7.4	3,940	7.3
32	15bbd-2	G. D. Staples, and others	5-17-60	141	do	59	40	257	63	514	380	495	840	7.7	2,400	900	588	55	7.4	3,780	7.3
33	16bad-1	Keith Pace	do	130	do	58	45	313	92	515	366	541	1,000	7.6	2,690	1,160	860	49	6.6	4,310	7.2
34	16cda-1	Alvin Englestead	5-10-58	205	do	58	40	253	71	474	370	466	820	8.9	2,310	920	617	53	6.8	3,740	7.4
35	17cdc-1	LaVal Bradshaw	6- 4-58	440	G, S	61	37	146	74	525	287	314	880	11	2,130	670	435	63	8.8	3,560	7.5
36	20caa-1	N. L. Nielson	10- 8-58	307	S, G	57	33	88	69	200	239	234	352	4.8	1,100	505	309	46	3.9	1,860	7.7
37	20cbb-1	do	8-27-58	430	do	61	37	257	136	1,140	362	533	2,000	7.8	4,290	1,200	903	67	14	6,970	7.2
38	21add-1	Victor McCanon	5-10-58	445	B	57	31	55	36	74	221	108	104	11	528	288	107	36	1.9	880	7.8
39	21bdd-1	Ronald Bradshaw	5-24-60	415	B, G	56	44	162	71	343	322	353	570	9.3	1,710	696	432	52	5.7	2,750	7.6
40	21cdd-1	D. H. Moore	5-13-58	630			22	26	17	138	218	101	104	10	525	137	0	69	5.1	876	7.4
41	28bbb-1	J. C. Moore	5-10-58	194	G, S		31	57	44	147	198	166	210	13	765	322	160	50	3.6	1,300	8.0

[1] Contains 0.47 ppm boron (B).

SPECIFIC CONDUCTANCE

Specific conductance is useful in the evaluation of irrigation water because it is an index of the concentration of dissolved solids or the salinity of the water. The higher the concentration of dissolved solids, the greater conductivity of the water. In Pavant Valley, the average ratio of specific conductance to dissolved solids is 0.61 (fig. 7).



GURE 7.—Relation of specific conductance to dissolved solids of ground water in Pavant Valley.

Specific conductance is used as a general index of suitability in some systems of classifying irrigation water. Also, water having high specific conductance speeds the corrosion of metals in which it is in contact, including well casings, pumps, and pipelines. The specific conductance of water from 122 wells in Pavant Valley has been measured, and the values are plotted in figure 2; the results from 41 wells are plotted in figure 18.

Saline soils tend to be flocculated if the sodium hazard (see the following subsection, "Sodium hazard") of irrigation water is low; as a result, the soils are friable and granular and consequently permeable. Water of high salinity can be used with varying degrees of success in Pavant Valley, depending on the soil drainage.

SODIUM HAZARD

In Pavant Valley the suitability of water for irrigation is largely determined by the amount of dissolved sodium in proportion to the amount of dissolved calcium and magnesium. A high proportion of sodium in irrigation water tends to break down the friable, granular nature of soil and thus causes the soil to become impermeable. In contrast, water containing high proportions of dissolved calcium and magnesium to dissolved sodium maintains good tilth and texture in soil.

The sodium hazard of irrigation water is generally reported as percent sodium. The classification of irrigation water according to percent sodium is not wholly satisfactory because it does not directly measure the potential for ion-exchange adsorption of sodium by the soil. The sodium-adsorption-ratio (SAR) has been used more during recent years to evaluate waters for irrigation use than the percent sodium because it is more nearly a direct measure of that potential.

Classifying water according to the amount of harm that its sodium content will do to soil is not simple because the suitability of water for irrigation is influenced by soil drainage, water management, and application of soil amendments. Also, gypsum and calcium in the soil tend to counteract the effects of sodium. The Department of Agriculture method of classifying waters for irrigation is used in this report (fig. 8). The method relates the specific conductance of water to the sodium or alkali hazard and thereby determines the suitability of water for irrigation.

In general, the poorest quality ground water in the valley is the shallow ground water in the western and southern parts of the valley. Ground water in these areas has traveled farthest from the recharge areas and may be return flow from previous irrigation. The result of both factors is that the sodium hazard is increased.

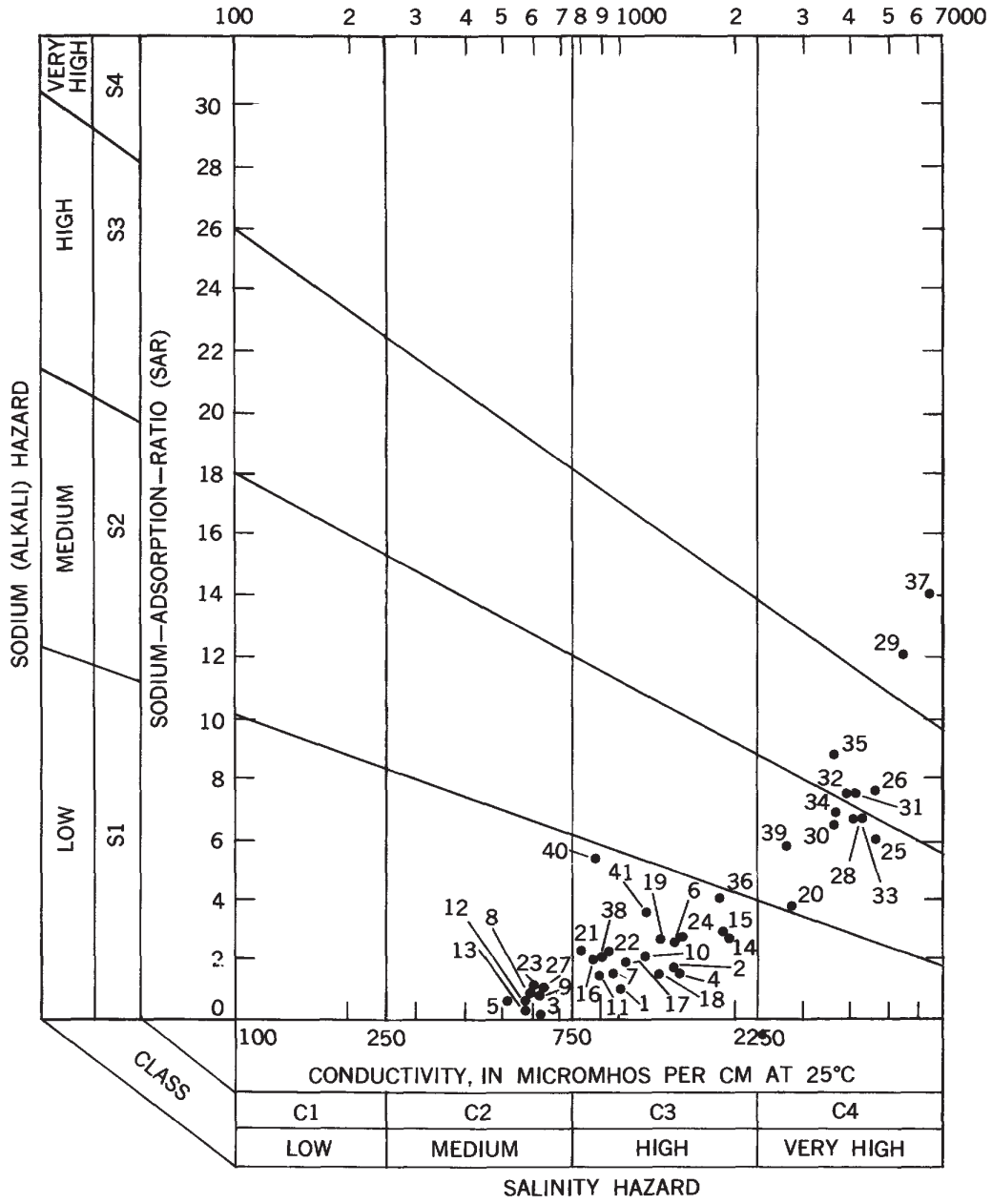


FIGURE 8.—Interpreting the analysis of irrigation water in Pavant Valley (method of U.S. Salinity Lab. Staff, 1954). Numbers refer to analyses in table 16.

BORON

Boron is essential to plant growth, but it is extremely toxic at concentrations slightly above optimum. The concentration of boron in some irrigation waters in Pavant Valley approaches the maximum tolerable for the least sensitive plants. According to the U.S. Salinity Laboratory Staff (1954), the permissible limits of boron ranges from 0.33 to 1.25 ppm (parts per million) for sensitive crops and from 1.00 to 3.75 ppm for tolerant crops. In Pavant Valley the concentration

of boron in ground water ranges from 0.1 to 2.5 ppm. Additional comments on boron are made in the following subsections, where the chemical quality of ground water in the various ground-water districts is discussed.

CLASSIFICATION OF WATER FOR IRRIGATION

The classification of irrigation water in Pavant Valley ranges from excellent to undesirable. The SAR and the specific conductance of water from 122 wells are shown on plate 1, and SAR was plotted against specific conductance on a diagram (fig. 8) to classify the water with respect to sodium and salinity hazard. Figure 8 shows that the salinity hazard of ground water used for irrigation in Pavant Valley ranges from medium to very high, but the sodium hazard ranges from low to medium for most of the water.

The U.S. Salinity Laboratory Staff (1954, p. 79–81) defines the different classes of saline and alkaline waters as follows:

Low-salinity water (C1) can be used for irrigation with most crops on most soils with little likelihood that soil salinity will develop. Some leaching is required, but this occurs under normal irrigation practices except in soils of extremely low permeability.

Medium-salinity water (C2) can be used if a moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without special practices for salinity control.

High-salinity water (C3) cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.

Very high salinity water (C4) is not suitable for irrigation under ordinary conditions, but may be used occasionally under very special circumstances. The soils must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching, and very salt-tolerant crops should be selected.

Low-sodium water (S1) can be used for irrigation on almost all soils with little danger of the development of harmful levels of exchangeable sodium. However, sodium-sensitive crops such as stone-fruit trees and avocados may accumulate injurious concentrations of sodium.

Medium-sodium water (S2) will present an appreciable sodium hazard in fine-textured soils having high cation-exchange-capacity, especially under low-leaching conditions, unless gypsum is present in the soil. This water may be used on coarse-textured or organic soils with good permeability.

High-sodium water (S3) may produce harmful levels of exchangeable sodium in most soils and will require special soil management—good drainage, high leaching, and organic matter additions. Gypsiferous soils may not develop harmful levels of exchangeable sodium from such waters. Chemical amendments may be required for replacement of exchangeable sodium, except that amendments may not be feasible with waters of very high salinity.

Very high sodium water (S4) is generally unsatisfactory for irrigation purposes except at low and perhaps medium salinity, where the solution of calcium from the soil or use of gypsum or other amendments may make the use of these waters feasible.

The chemical quality of water as it pertains to use for irrigation in each of the six ground-water districts is discussed in detail in the following subsections.

McCORNICK GROUND-WATER DISTRICT

Dissolved solids are low in the one analysis of ground water available for the McCornick district (table 16, anal. 1), but as shown in figure 8 this water has a high-salinity hazard and a low-sodium hazard. Use of this water provides little, if any, danger of the accumulation of harmful amounts of sodium; however, the salinity level is such that the water should be used on well-drained soils and for plants having good salt tolerance. The soil in the district has high quality and good drainage and therefore is suitable for irrigation by water of chemical quality similar to that indicated by the analysis in analysis 1 of table 16, providing that reasonably good irrigation practices are followed.

The amount of boron in ground water in the McCornick district was not determined, but the concentration of boron does probably not exceed 1 ppm, which is a safe concentration for crops normally grown in the district.

GREENWOOD GROUND-WATER DISTRICT

Water was analyzed from one well in the Greenwood district. The quality of water and the soil conditions in the eastern part (east of the railroad) of the Greenwood district, however, are about the same as they are in the McCornick district. The quality of the water and the soil conditions in the western part of the Greenwood district are probably about the same as they are in the western part of the Pavant district. Thus, quality problems should not arise in the irrigated parts of the Greenwood district, providing reasonably good irrigation practices are followed.

PAVANT GROUND-WATER DISTRICT

The chemical quality of ground water in the Pavant district is represented by analysis 2 in table 16, and water moving into the southeast corner of the district is represented by analysis 3. Analyses of water from nine other wells in the Pavant district are available but are not included in table 16; however, they are evaluated in the following discussion.

Water within the district has a high-salinity hazard and a low-sodium hazard according to the classification in figure 8. This water can probably be used safely on lands east of the paved county highway running north-south through the middle of the district. Special precautions and expert management of the water may be required in

irrigating lands with ground water west of this highway because of the apparent high-sodium and high-salinity content of the soils and the relatively poor local drainage.

Water moving into the southeast corner of the district has a medium-salinity hazard and a low-sodium hazard; this fact indicates that the quality of the water deteriorates from east to west.

Most of the ground water used for irrigation is used in the eastern part of the district; thus, there should be few, if any, quality problems if reasonably good irrigation practices are followed.

The amount of boron in two samples was 0.2 and 0.4 ppm, a concentration that is probably below the maximum that can be tolerated by the most sensitive plants.

FLOWELL GROUND-WATER DISTRICT

The quality of water in the Flowell district is represented by analyses 4–19 and by analysis 24, all in table 16. Water in this district has a low-sodium hazard and a medium- to high-salinity hazard. The water of poorest quality is in the southwestern part of the district. The water-level contours on plate 4 show that the poor-quality water in the southwestern part of the district originates in the Meadow district, where the water apparently flows through rock material for longer periods of time than the other water and thus has more opportunity to dissolve minerals.

Some of the ground water of poorest quality in the Flowell district is in the basalt aquifer. Much of this water is derived from upward leakage from underlying artesian aquifers and from deep-percolation losses of irrigation water withdrawn from the underlying artesian aquifers. The water in the basalt, therefore, has more opportunity to become charged with dissolved solids than does water in the artesian aquifers. For example, water from an artesian well, (C–21–5)6dba–1, has less than one-third as many dissolved solids as water from a nearby well in the basalt, (C–21–5)6cac–1.

The southwestern quarter of the Flowell district is the only area where the quality of ground water need be of much concern. Soils in the southwestern part of the district have a relatively high concentration of sodium chloride and alkali, and drainage characteristics are poor. The present (1962) quality of the soil in other parts of the district can be maintained and possibly improved through proper irrigation practices and by the application of soil amendments. Enough water must be applied during each irrigation, however, to leach some of the detrimental elements in the soil and excessive dissolved constituents in some of the ground water.

The quality of ground water in the southwestern part of the district is not likely to improve with use. In fact, it may deteriorate because pumping during the irrigation season causes the direction of flow of the ground water to the west to be reversed and thus the more highly mineralized water along the west side of the district flows into the pumped area.

The concentration of boron in the Flowell district ranges from 0.2 to 2.5 ppm. The highest concentration, which is in the southwestern part, would be toxic to the most sensitive plants but is probably not toxic to the crops commonly grown in Pavant Valley.

The relatively high concentrations of nitrate in the ground water pumped from the basalt aquifer indicates contamination from decaying organic materials or deep-percolation losses of irrigation water from fields fertilized with nitrogen fertilizer. Water from wells in the shallow lacustrine deposits also has high nitrate content. The nitrate content of these waters is 2–10 times the concentration of the deeper artesian water. The nitrate is not harmful in irrigation water and may even be beneficial.

MEADOW GROUND-WATER DISTRICT

Five water analyses in table 16 (anals. 20–23, 27) are representative of ground water in the Meadow district. Except for one sample (anal. 20), which has a medium-sodium hazard and a very high salinity hazard, water in this district has a low-sodium hazard and a medium- to high-salinity hazard. A large part of the ground water used for irrigation in the district is supplemental to surface water; thus, surface water of better quality flushes out some of the undesirable elements deposited by the ground water. In most areas in this district, ground water can probably be used safely in this manner without any danger of the soil becoming too highly mineralized for irrigation. In the western part of the district, where drainage is poor, the saline water and soil and, locally, the sodium hazard cause small crop yields.

Analyses of boron were made of ground water from two wells in the northwestern part of the district. They contained 0.2 and 0.4 ppm boron, which is below the toxic limits for even the most sensitive plants. Ground water west of the sampled wells may contain higher concentrations of boron, but these concentrations are still probably less than the toxic limits for most crops.

KANOSH GROUND-WATER DISTRICT

Only the Kanosh district has serious quality-of-water problems. Analyses 25, 26, and 28–41 in table 16 are representative of ground water in the district. The dissolved-solids content of ground water in

the district is several times that in the other districts, and the bicarbonate content is of the same order of magnitude. Nearly all the water has a very high salinity hazard and a medium- to high-sodium hazard. Samples represented by analyses 29 and 37 in table 16, however, have a very high salinity hazard and a very high sodium hazard. Water from wells nearest the principal recharge area, represented by analyses 36, 38, 40, and 41 in figure 7 and in table 16, are of slightly better quality than other ground water in the district.

The concentration of boron in water from one well (anal. 31, table 16) was 1.5 ppm. This concentration is less than the toxic limit of most semitolerant and tolerant plants and there is probably no place in the district where the concentration of boron exceeds the toxic limits for plants normally grown in Pavant Valley.

Fortunately, most of the soil in the district has good texture and is well drained, otherwise it would not be possible to use the available ground water for irrigation. Some of the soils contain appreciable quantities of gypsum, which helps to alleviate the sodium hazard.

Chemical data indicate that ground water in the district is from three sources; from Devil's Ridge, from near Kanosh around or through Black Rock Volcano, and from the mountains across the south end of the valley. Plate 2 shows the general sources or paths of the ground water. The water mixes as it moves through the district, and by the time that the water reaches the northwestern part of the district it has been thoroughly mixed.

Water moving westward from Devil's Ridge is of a different chemical character than that moving westward from Black Rock Volcano; this water is, in turn, chemically different from the water moving north and northwestward from the mountains across the south end of the district. The waters mix as they move downgradient, and additional minerals are taken into solution as the water moves through the district. Also, return flow of irrigation water percolates to the aquifer and carries with it higher concentration of dissolved solids than the original water had contained. The final result is that the ground water near the northwestern part of the district is chemically different from the parent waters. It is not possible to determine the relative quantities of water from each of the sources because of the additional minerals taken into solution as the water flows through the district.

The chemical quality of the ground water is deteriorating with time because of deep percolation by excess irrigation water and encroachment of more highly mineralized water from the west. The irrigation water that percolates to the water table is more highly mineralized than the applied water because it contains much of the mineral matter left behind by water that evaporates from the soil or is transpired by the plants.

As previously stated, ground water becomes more highly mineralized with time as it moves through rock material; thus, water that had flowed through a certain well in the past is more highly mineralized than the water presently at the well. One reason that the ground water in the district becomes more highly mineralized with time is that water flowing beyond the pumped area reverses direction of flow during the irrigation season and returns to the pumped area. Thus the rate of deterioration of the quality of ground water in the Kanosh district will increase as water levels decline.

TEMPERATURE

The temperature of water from 178 wells in Pavant Valley ranged from 52° to 85° F. The temperature of the shallowest water is about the same as the mean annual air temperature of 52° F. Ground-water temperature increases an average of 1°F for each 80 feet of depth in the sediments in the valley. The temperature also increases westward from the mountains toward areas of recent volcanic activity. Near the mountains along the east side of the valley, the temperature of the ground water ranges from 52° to 57° F; along the west side of the valley, the temperature ranges from about 60° to 85° F, except that the temperature of water from wells in the basalt aquifer ranges from 54° to 57° F. A temperature of 143° F was measured for springs along Devil's Ridge west of Hatton, but the rate of flow is only 1 or 2 gpm. Wells in Pavant Valley have not been known to tap water warmer than 85° F.

The temperature of ground water, in general, increases 1°–3° F through the irrigation season. This temperature rise is caused principally by excess irrigation water that has been warmed at the land surface and has returned to the aquifer and by upward migration of warmer water from lower depths.

PHREATOPHYTES

The infestation of the bottom lands by phreatophytes of little or no economic value, principally saltcedar, is one of the greatest threats to agriculture in Pavant Valley. These plants use water that could be used more beneficially by plants of greater economic value, and generally their demand for water equals and commonly exceeds that of crops. Most of the indigenous phreatophytes in the valley have a low to fair economic value as forage, but saltcedar has no value.

Phreatophytes habitually send their roots down to the water table or to the capillary fringe above it; thus, they grow in areas of shallow ground water, along stream channels, canal banks, flood plains, and reservoirs. Indigenous phreatophytes grow on about 35,000 acres

in Pavant Valley, and they range from sparse growths of greasewood and pickleweed to dense growths of meadow grasses. The locations and extent of the phreatophyte areas are shown on plate 9, but no attempt was made to determine or show density of growth.

Sedges, wirerush, and saltgrass are the most desirable indigenous phreatophytes in Pavant Valley, and they compose nearly all the native bottom-land pastures. The most common undesirable indigenous phreatophytes in the bottom lands are greasewood, rabbitbrush, and pickleweed. Cottonwood, willow, wild rose, and rabbitbrush are the predominant indigenous phreatophytes along ditch banks and creek channels above the bottom lands. Alfalfa is an imported phreatophyte, and it is one of the major crops grown in the valley.

Saltcedar, or tamarisk, as it is sometimes called, presents a real threat to the economy of Pavant Valley because of its voracious use of water and, under favorable conditions, its ability to rapidly infest wet areas and areas of shallow ground water. It has been in the valley only a few years, and at present (1962) there are a relatively few saltcedar plants growing throughout the valley. The greatest concentration is along the banks of the Central Utah Canal, but there are scattered plants in the meadow pastures, along ditch banks and laterals leading from wells and streams and along the shores of overnight-storage reservoirs. Most of the saltcedars have grown from seed, probably carried into Pavant Valley by the Central Utah Canal; some seeds may have been windborne, and some plants have been imported for ornamental shrubbery. The fact that saltcedar plants have established themselves in all parts of the bottom lands, although very sparsely, is a serious threat to the entire bottom lands and to the stream channels tributary to the valley.

SUMMARY

Although water levels in the Flowell and Meadow districts are declining at an apparently alarming rate, a serious depletion problem will probably not arise if the 1962 rate of pumpage is continued because the quantity of natural discharge is still large. As water levels decline, an increasing quantity of natural discharge will be intercepted by wells, thus the total ground-water discharge will be reduced. This condition will, in turn, cause a dimunition in the rate of water-level decline. Eventually, total ground-water discharge will equal recharge if withdrawal by wells does not exceed recharge; at this time average annual water levels will again be in equilibrium.

The Greenwood ground-water district is the only district in which more ground-water development is possible. The wells should have optimum spacing to minimize mutual interference and to intercept the maximum practical quantity of natural discharge, which would entail

drilling several wells in the northern and western parts of the district. Further development of ground water equaling or exceeding total natural discharge from the district will cause the small flowing irrigation and stock wells in the western part of the district to cease flowing and will eventually intercept ground water now being discharged by evapotranspiration.

The Kanosh district is the only place where a quality-of-water problem is serious. The gradual increase in concentration of chemical constitutents in the ground water will continue as long as pumpage exceeds recharge. Salt concentration in the soil from the use of ground water will also continue to increase.

The concentration of boron is below the toxic limit for tolerant plants in all well waters for which boron was determined. It seems reasonable to assume that the toxic limit of boron is not exceeded in any of the ground waters now being used, and probably the toxic limit of boron is not exceeded in any of the ground water in Pavant Valley.

Consumptive waste of ground water by useless vegetation is not serious, but the spread of saltcedar into native meadow pastures with an attending increase in consumptive waste of ground water is very threatening. The saltcedar plants now present in the valley should be eradicated completely, at once, while the cost is relatively small and before they form dense thickets which make them nearly impossible to eradicate.

Ground water is being wasted from flowing wells each winter. Of the 6,000 acre-feet of water that flowed from wells during the winter 1959–60, more than 50 percent, and possibly as much as 80 percent, was wasted. Most of the waste could be eliminated by installation of better control devices. This would help alleviate the general decline of water levels in the valley.

There is no or little rejected recharge in Pavant Valley; thus, the amount of recharge cannot be increased by lowering water levels. However, some of the water that has flowed beyond the pumped areas will return and in effect act as additional recharge when water levels in the pumped areas decline sufficiently to reverse the hydraulic gradient in the natural discharge areas.

Ground-water withdrawal by wells in Pavant Valley increased from 23,000 acre-feet in 1950 to 67,000 acre-feet in 1960, and the number of pumped irrigation wells increased from 20 to 110 in the same length of time. Artesian pressures declined from about 5 feet in areas of small withdrawal to more than 35 feet in the Flowell district during the period 1950–60. Withdrawal in 1960 was only slightly less than the average annual recharge of 70,000 acre-feet. Natural discharge was about 45,000 acre-feet; thus, more than 40,000 acre-feet of ground water was taken from storage.

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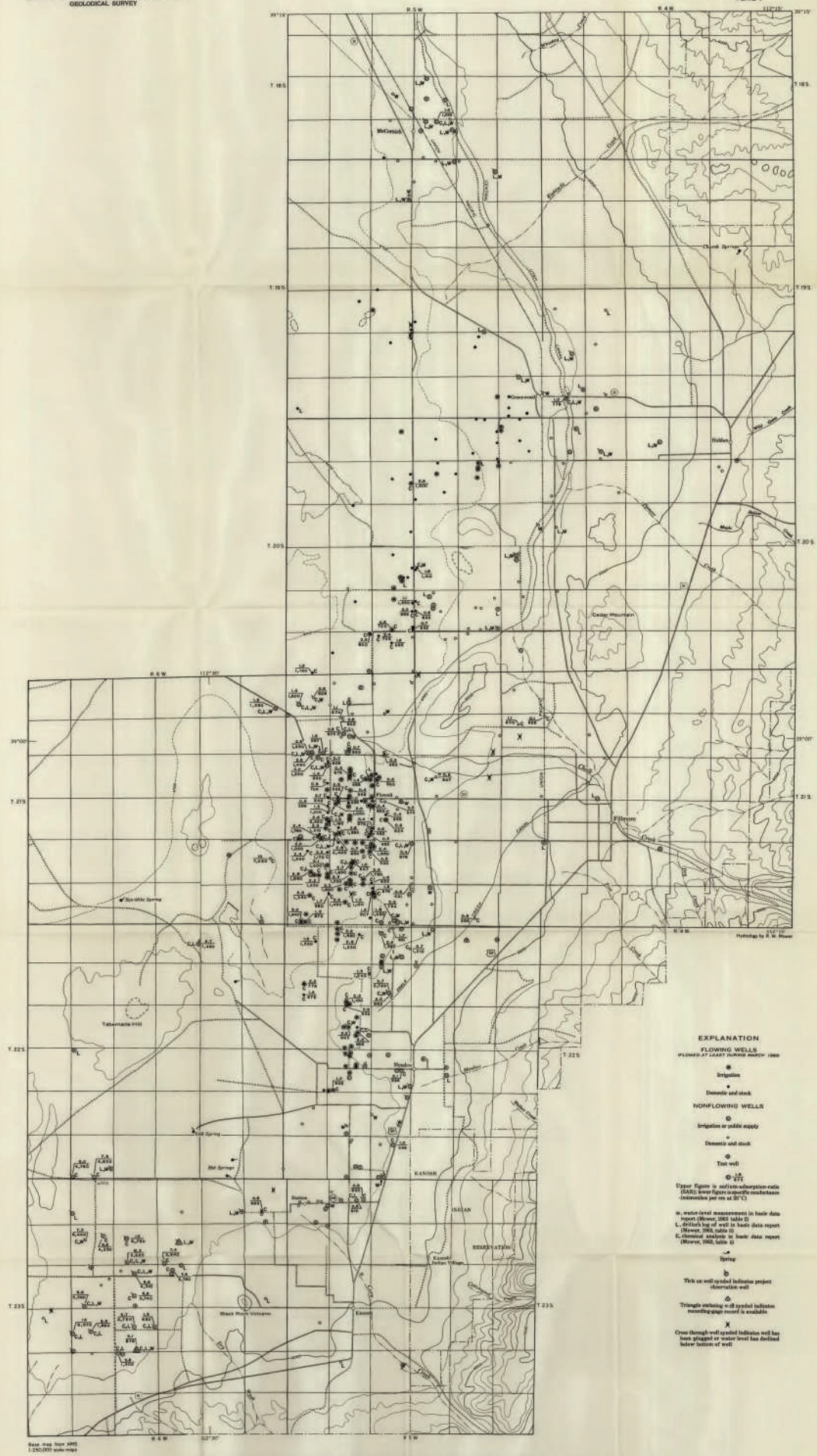
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UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER-SUPPLY PAPER 1794
PLATE I



EXPLANATION

FLOWING WELLS
FLOWED AT LEAST DURING MARCH 1960

- Irrigation
- Domestic and stock

NONFLOWING WELLS

- Irrigation or public supply
- Domestic and stock
- Test well

Upper figure is sodium-adsorption-ratio (SAR); lower figure is specific conductance (micromhos per cm at 25°C)

w, water-level measurement in basic data report (Mower, 1963, table 2)
L, driller's log of well in basic data report (Mower, 1963, table 3)
C, chemical analysis in basic data report (Mower, 1963, table 1)

- Spring

Tick on well symbol indicates project observation well

Triangle enclosing well symbol indicates recording-gage record is available

Cross through well symbol indicates well has been plugged or water level has declined below bottom of well

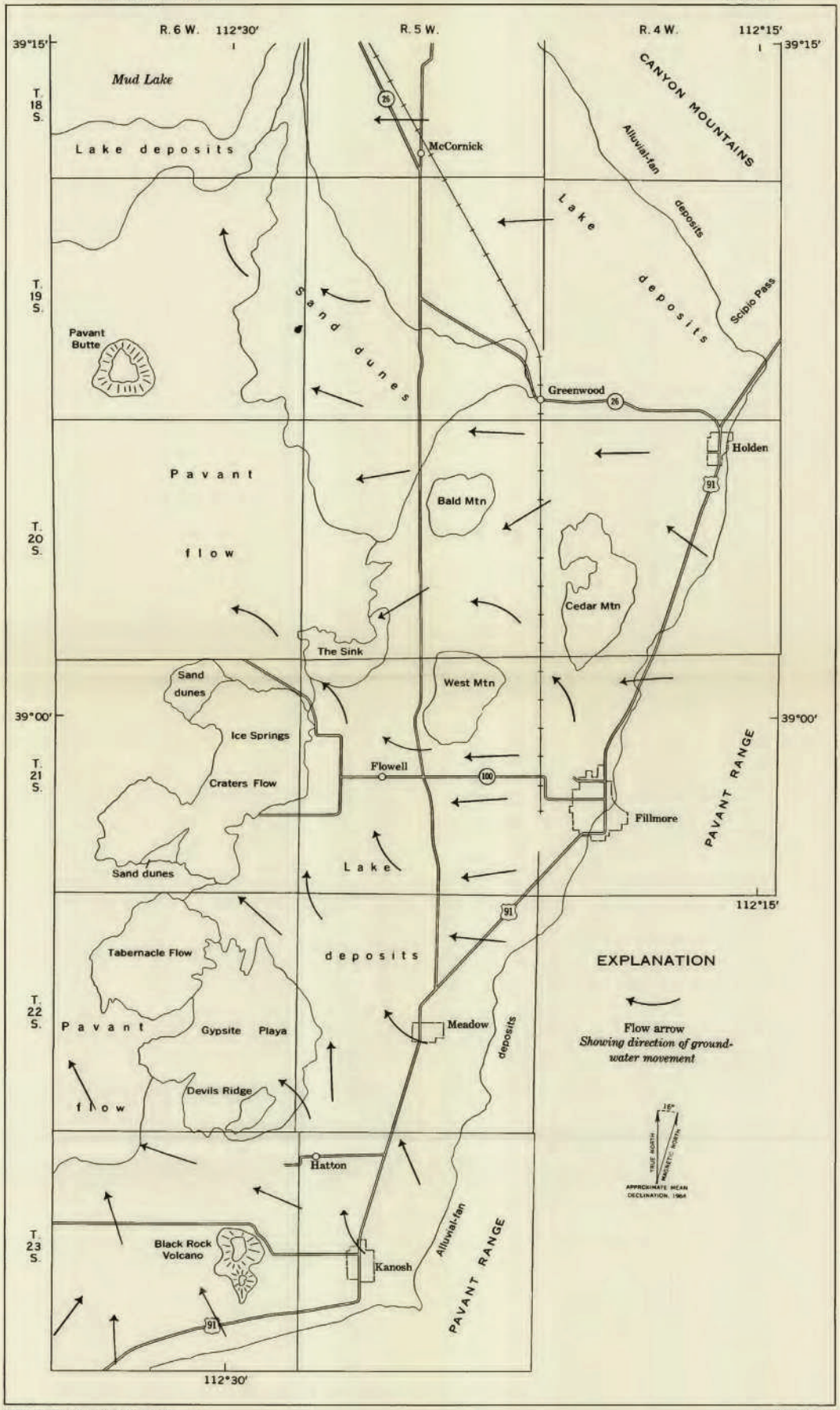
MAP OF PAVANT VALLEY, UTAH, SHOWING LOCATION OF SELECTED WELLS AND HYDROGEOCHEMICAL DATA

SCALE 1:62,500

1 0 1 2 3 4 5 MILES

1 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
Datum is mean sea level



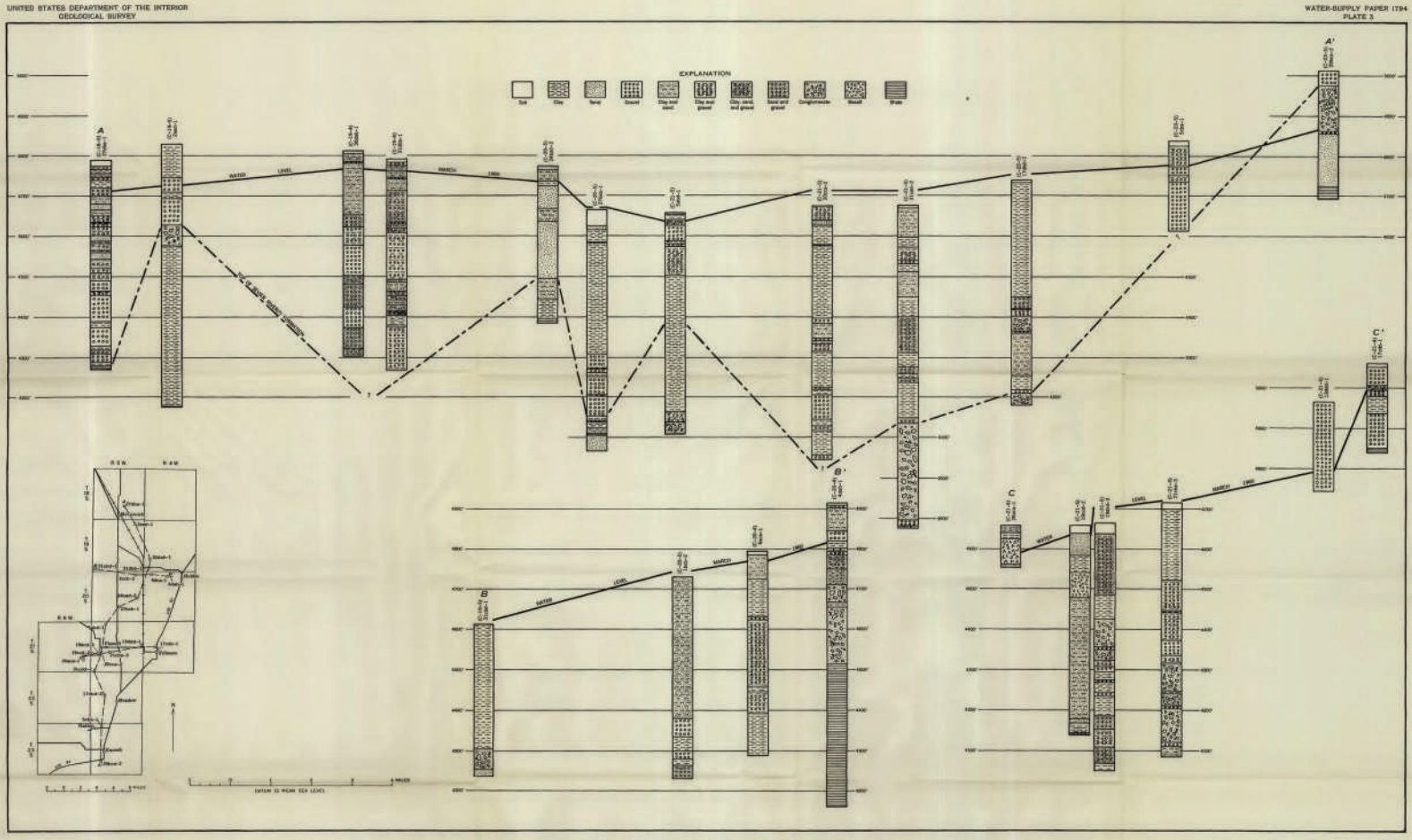
Base adapted from Millard County General Highway Map

By R. W. Mower

GENERALIZED GEOLOGIC MAP OF PAVANT VALLEY, UTAH

1 0 1 2 3 4 5 MILES

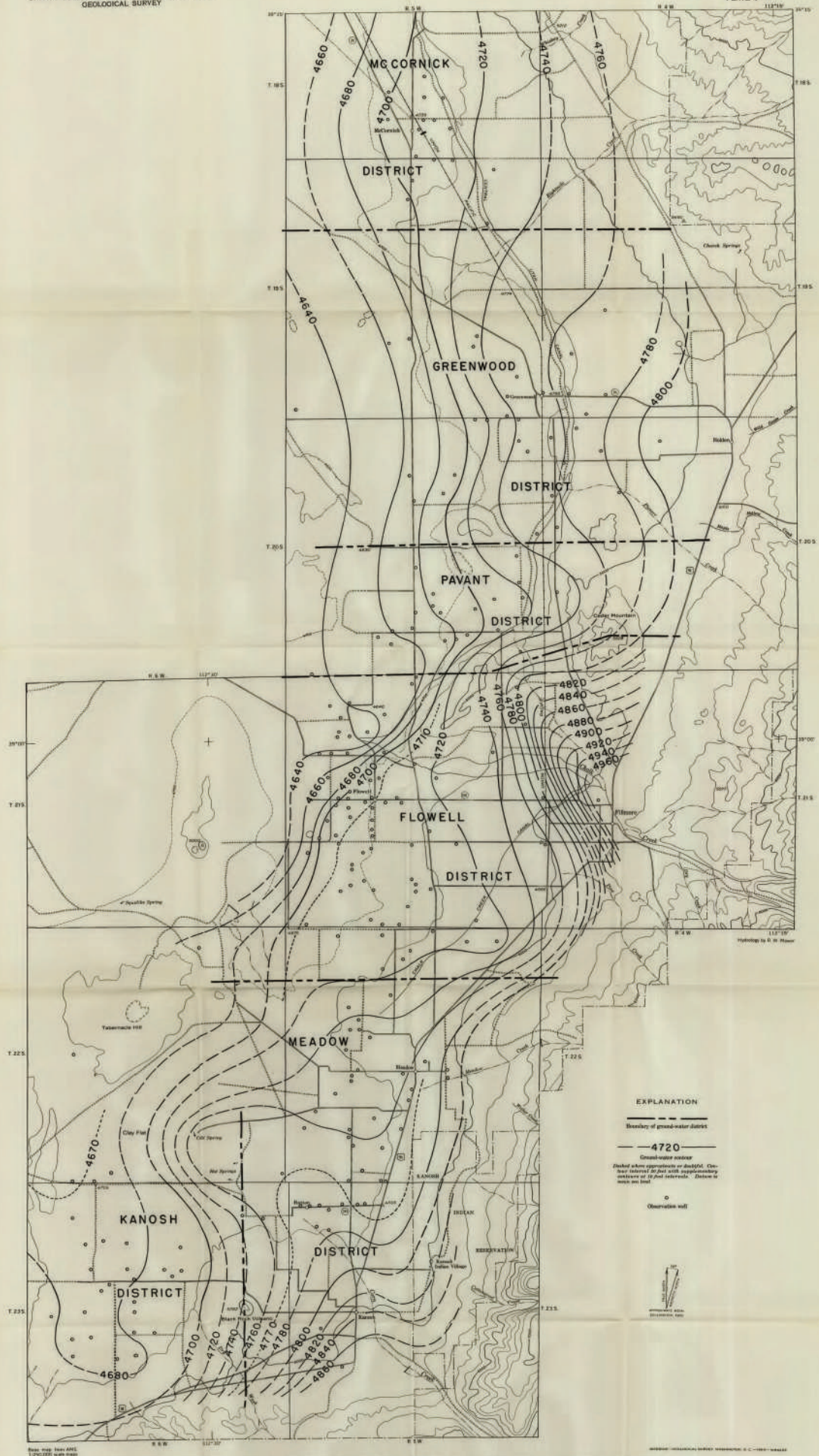
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STRIP LOGS FROM DRILLERS' LOGS OF WELLS IN PAVANT VALLEY, UTAH

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

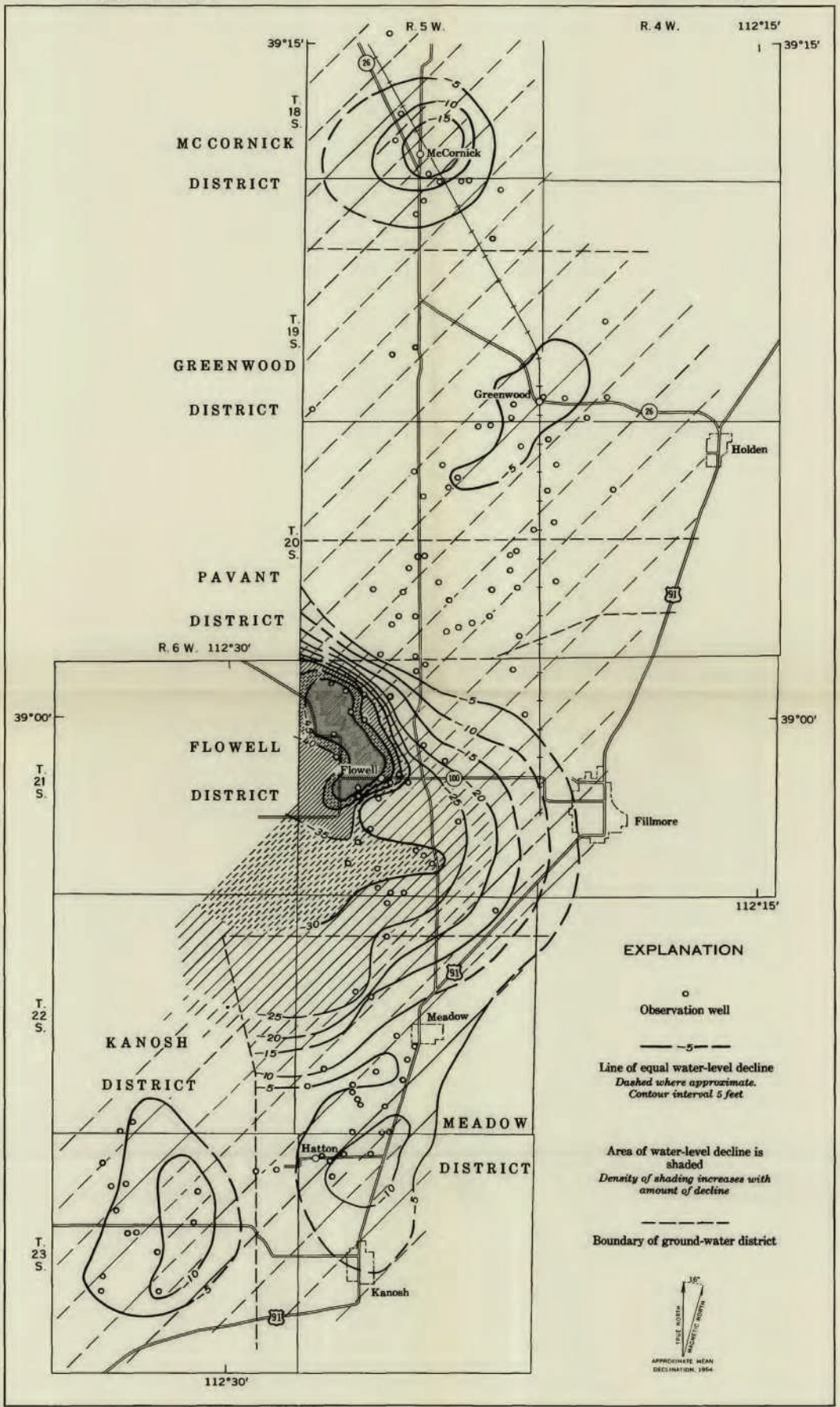
WATER-SUPPLY PAPER 1794
PLATE 4



MAP OF PAVANT VALLEY, UTAH, SHOWING GROUND-WATER CONTOURS, MARCH 1960

SCALE 1:62,500

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
DATUM IS MEAN SEA LEVEL



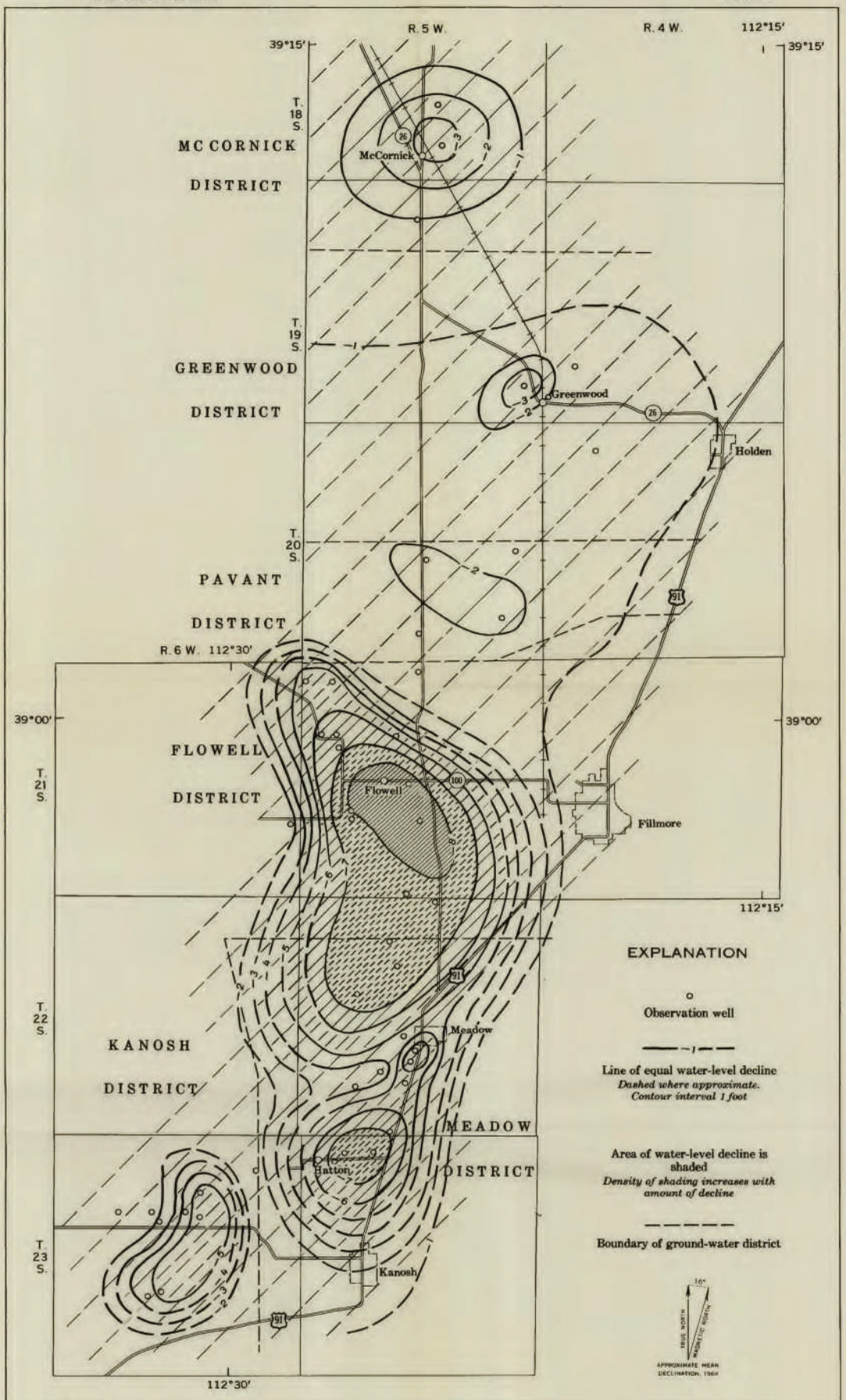
Base adapted from Millard County General Highway Map

Hydrology by R. W. Mower

MAP SHOWING DECLINE OF GROUND-WATER LEVEL FROM MARCH TO SEPTEMBER 1960 IN PAVANT VALLEY, UTAH

1 0 1 2 3 4 5 MILES

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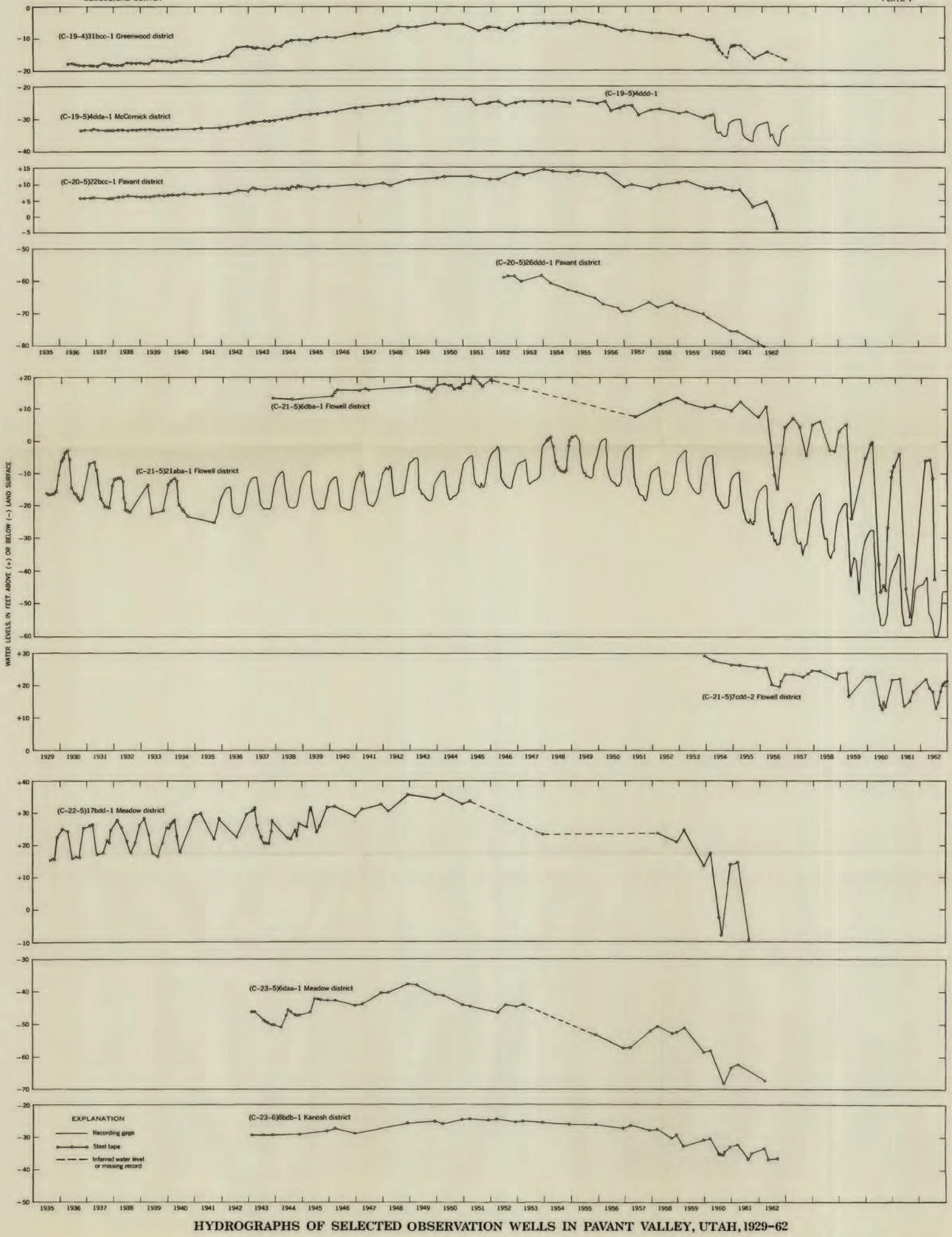
Base adapted from Millard County General Highway Map

Hydrology by R. W. Mower

MAP SHOWING DECLINE OF GROUND-WATER LEVEL FROM MARCH 1959 TO MARCH 1960 IN PAVANT VALLEY, UTAH

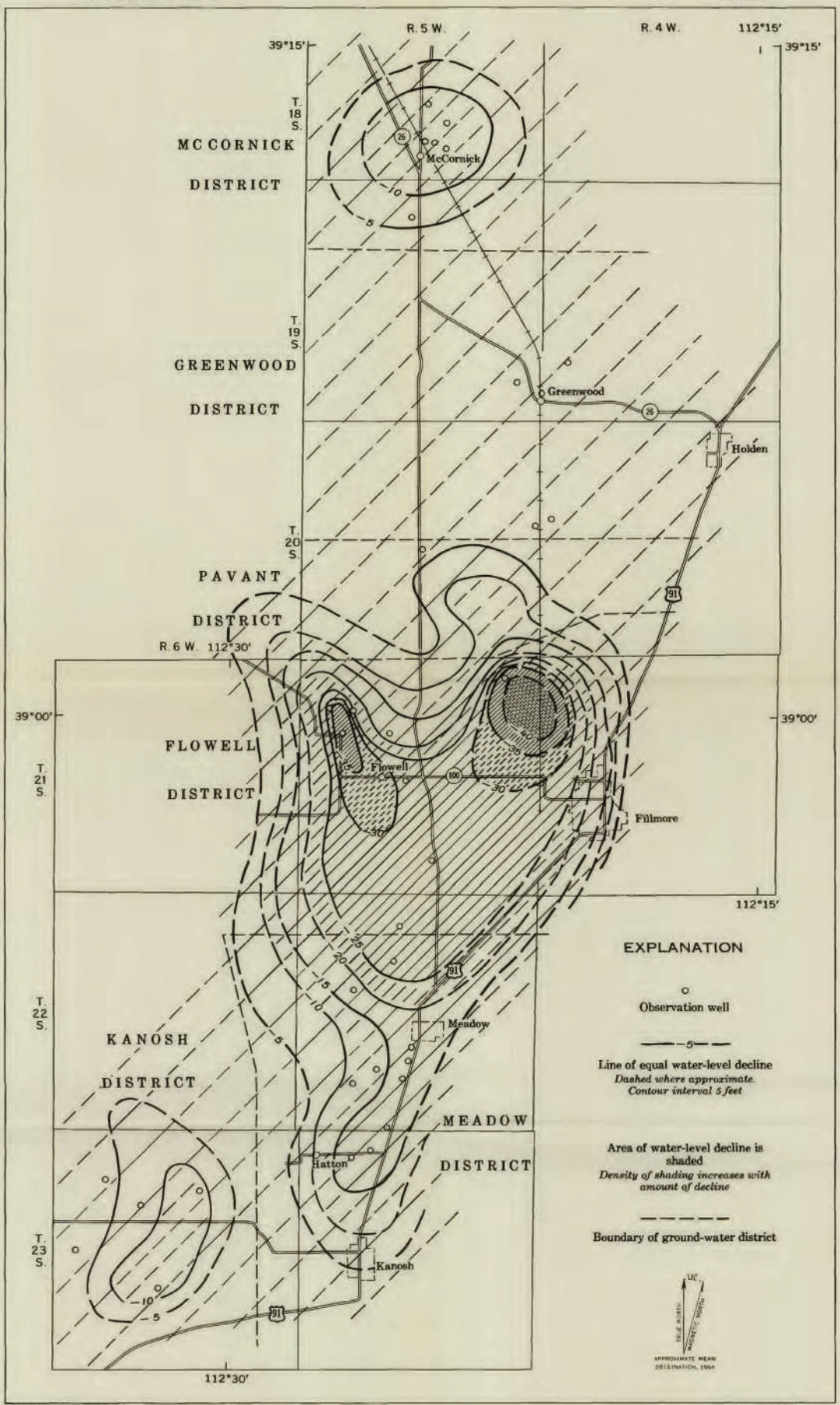
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HYDROGRAPHS OF SELECTED OBSERVATION WELLS IN PAVANT VALLEY, UTAH, 1929–62

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Base adapted from Millard County General Highway Map

Hydrology by R. W. Mower

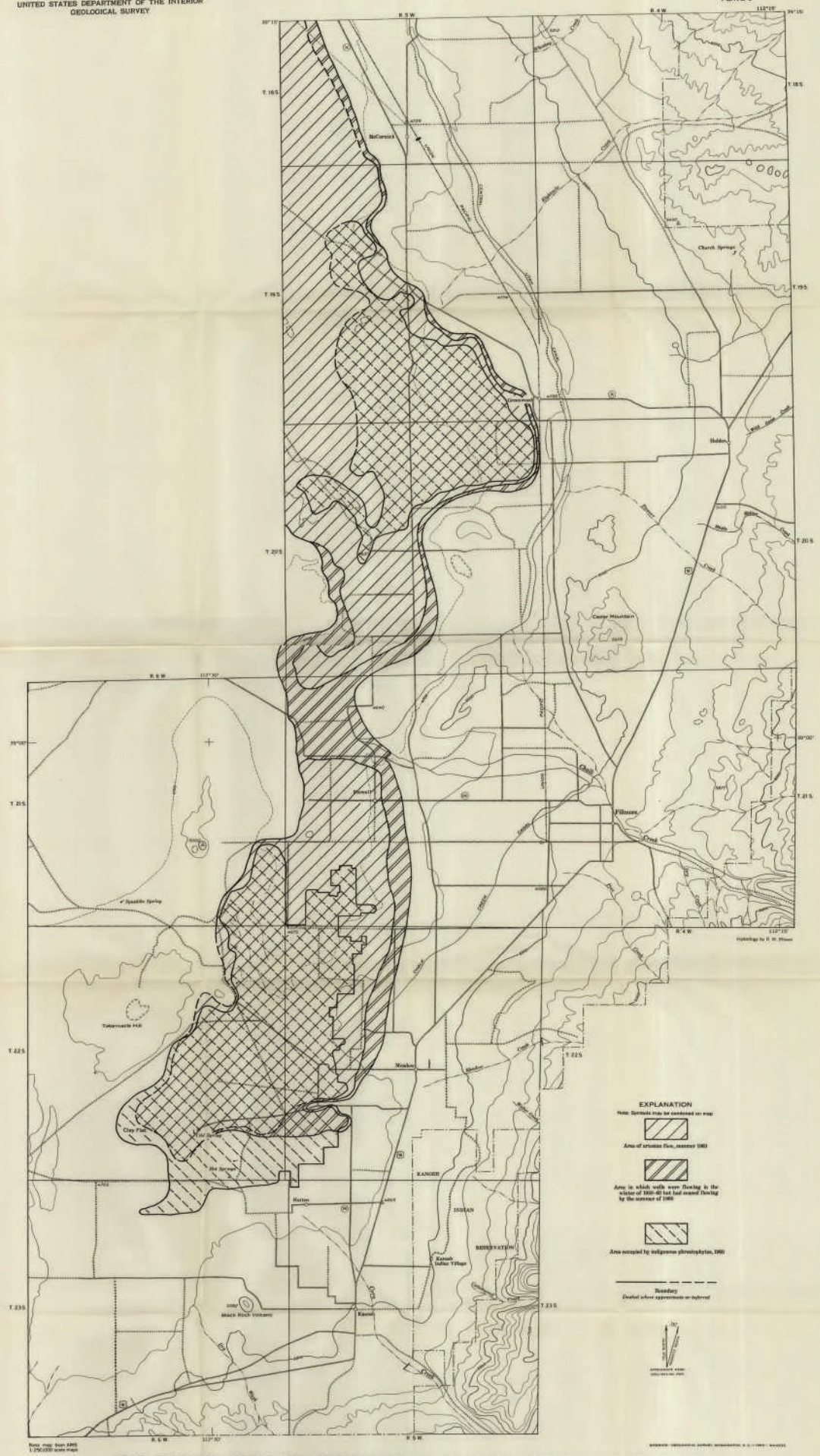
MAP SHOWING DECLINE OF GROUND-WATER LEVEL FROM MARCH 1950 TO MARCH 1960 IN PAVANT VALLEY, UTAH

1 0 1 2 3 4 5 MILES

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UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER-SUPPLY PAPER 1794
PLATE 9



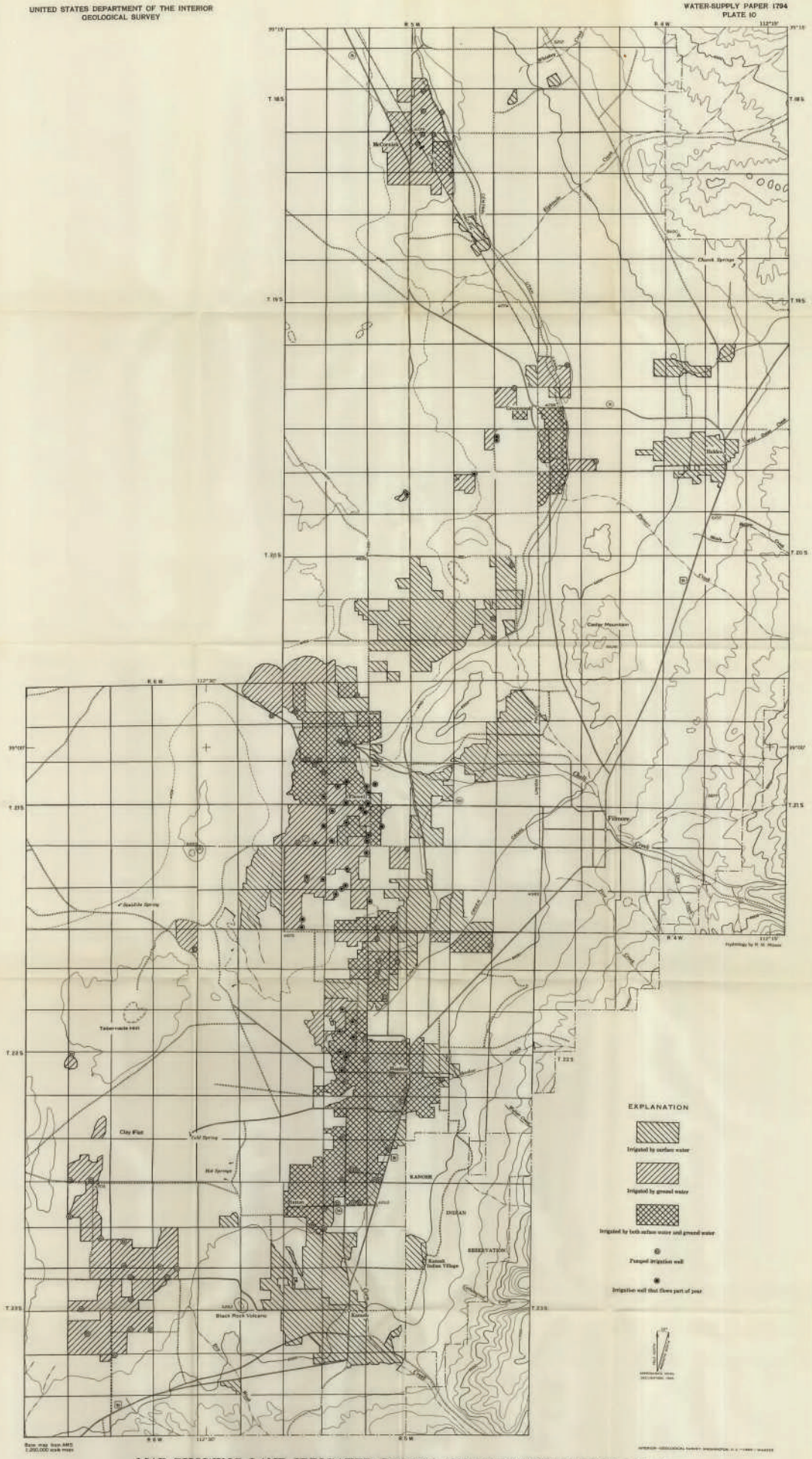
MAP SHOWING AREAS OF ARTESIAN FLOW AND PHREATOPHYTE OCCUPATION DURING 1960 IN PAVANT VALLEY, UTAH

SCALE 1:62 500

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
DATUM IS MEAN SEA LEVEL

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER-SUPPLY PAPER 1794
PLATE 10



MAP SHOWING LAND IRRIGATED DURING 1960 IN PAVANT VALLEY, UTAH

SCALE 1:62'500

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
DATUM IS MEAN SEA LEVEL

Attachments: Air-Related Resource Concerns

- 2020 Annual Air Quality Report – Utah Department of Air Quality (UDAQ, 2021)

Utah Division of Air Quality
2020 Annual Report



UTAH DEPARTMENT *of*
ENVIRONMENTAL QUALITY

AIR
QUALITY

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Acronyms

AO	Approval Order
AHERA	Asbestos Hazard Emergency Response Act
ATLAS	Air Toxics, Lead-Based Paint, and Asbestos Section
AMS	Air Monitoring Section
BACT	Best Available Control Technology
CAA	Clean Air Act
CFR	Code of Federal Regulations
CO	Carbon Monoxide
DAQ	Division of Air Quality
DEQ	Department of Environmental Quality
EPA	Environmental Protection Agency
EVSE	Electric Vehicle Supply Equipment
HAPs	Hazardous Air Pollutants
MACT	Maximum Available Control Technology
$\mu g/m^3$	Micrograms Per Cubic Meter
Micron	One Millionth of a Meter
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NOI	Notice of Intent
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NSPS	New Source Performance Standard
NSR	New Source Review
O_3	Ozone
PB	Lead
PM	Particulate Matter
PM_{10}	Particulate Matter Smaller Than 10 Microns in Diameter
$PM_{2.5}$	Particulate Matter Smaller Than 2.5 Microns in Diameter
PPB	Parts Per Billion
PPM	Parts Per Million
SBEAP	Small Business Environmental Assistance Program
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SO_x	Sulfur Oxides
TSCA	Toxic Substances Control Act
TSP	Total Suspended Particles
UAC	Utah Administrative Code
VOCs	Volatile Organic Compounds

NOTE

THIS REPORT IS INTENDED TO PROVIDE AN OVERVIEW OF UTAH'S AIR QUALITY PROGRAM. THIS REPORT IS PUBLISHED BEFORE END-OF-YEAR DATA CAN BE CERTIFIED AND MAY BE SUBJECT TO CHANGE.

Introduction

The mission of the Utah Division of Air Quality (DAQ) is to safeguard Utah's air through balanced regulation. The purpose of DAQ is to achieve and maintain levels of air quality which will protect human health and safety, and to the greatest degree practicable, prevent injury to plant and animal life and property, foster the comfort and convenience of the people, promote the economic and social development of this state, and facilitate the enjoyment of the natural attractions of this state. It is the responsibility of the DAQ to ensure that the air in Utah meets health and visibility standards established under the federal Clean Air Act (CAA). To fulfill this responsibility, the DAQ is required by the federal government to ensure compliance with the U.S. Environmental Protection Agency's (EPA) National Ambient Air Quality Standards (NAAQS) statewide and visibility standards at national parks. The DAQ enacts rules pertaining to air quality standards, develops plans to meet the federal standards when necessary, administers emissions reductions incentive programs, issues preconstruction and operating permits to stationary sources, and ensures compliance with state and federal air quality rules.

The DAQ allocates a large portion of its resources to implementing the CAA. The Utah Air Conservation Act (Utah Code §19-2) delegates rulemaking power to the Utah Air Quality Board (Board) to promulgate rules pertaining to air quality issues. DAQ staff supports the Board in its policy-making role. The Board is made up of nine members representing local government, environmental groups, the public, industry, and the Executive Director of the Department of Environmental Quality. The Board members have diverse interests, are knowledgeable in air pollution matters, and are appointed by the Governor with consent of the Senate. The Director of the DAQ is the Board's Executive Secretary.

The Utah air quality rules define the Utah air quality program. Implementation of the rules requires the DAQ's interaction with industry, other government agencies, and the public. The state air quality program is responsible for the implementation of the federal standards under the CAA, as well as state rules for pollution sources not regulated by the CAA.

2020 Synopsis

The DAQ accomplished much in 2020 towards fulfilling our mission to safeguard and improve Utah's air. With an increasing population, industrial base, and more stringent federal air quality standards, it has been a challenge to meet air quality objectives; however, 2020 proved to be a year in which we made great strides to ensure cleaner air in the years to come.

The following is a brief list of notable air quality achievements from 2020:

Particulate Matter

- In January 2020, Governor Herbert submitted long-term Maintenance Plans to EPA that demonstrate how the three $PM_{2.5}$ nonattainment areas will maintain compliance with the 2006 24-hr $PM_{2.5}$ standard through the year 2035. EPA reviewed the plans and proposed redesignation of the Salt Lake and Provo areas to attainment. More information on this accomplishment can be found on page 39 of this report.

- EPA redesignated all three of Utah's PM_{10} nonattainment areas to attainment status for the federal 24-hour PM_{10} standard. The areas are now in the first of two 10-year maintenance periods. More information on this accomplishment can be found on page 38 of this report.

Ozone

- In 2018, three areas in Utah were designated nonattainment for the more stringent 2015 ozone standard. The three areas are currently classified as marginal status. Baseline inventories were submitted to EPA in 2020 and EPA is currently reviewing them for approval. The ambient monitoring data shows that the Southern Wasatch Front has attained the standard. The Northern Wasatch Front and the Uinta Basin will not be able to attain the standard by the statutory attainment date and will be reclassified to moderate. DAQ has begun work in anticipation of the CAA requirements associated with reclassification to moderate, which include a State Implementation Plan (SIP) for each area.

- Meeting the SIP requirements will require a significant amount of work for DAQ, including all new photochemical modeling for the Uinta Basin and the Wasatch Front. Section 179b of the CAA gives states the opportunity to demonstrate that international emissions are causing the violations of the standard. In response to a request from the Utah Petroleum Association, DAQ has spent a significant amount of time in 2020 on a 179b demonstration that would prevent the Northern Wasatch Front from being reclassified to moderate. The preliminary data shows that the Wasatch Front is not, in fact, significantly impacted by international emissions on high ozone summer days. If the final data analysis confirms the preliminary conclusion, then DAQ plans to focus 2021 efforts on producing a scientifically-sound model to support the CAA-required SIP demonstration, as opposed to spending more time on the discretionary 179b demonstration.

- DAQ scientists partnered with EPA to apply recent scientific findings about air emissions in the Uinta Basin to the Uinta Basin Emissions Inventory. This technical analysis is described in two white papers authored by UDAQ and EPA. This information will be used to update emission inventories in order to improve photochemical modeling for ozone regulatory purposes. More information on this accomplishment can be found at the links below:
  - Uinta Basin VOC Composition Study Impacts on the 2017 Oil and Gas Emissions Inventory

- Produced Water Disposal Facility Emission Factors & their Impact on the 2017 Oil and Gas Emissions Inventory

Regional Haze

- In November 2020, EPA finalized approval of Utah's Regional Haze SIP for the first planning period. The second planning period SIP amendment is due July 2021. More information on this accomplishment and topic can be found on page 43 of this report.

Air Quality Research Projects

- FY2021 funding included ongoing legislative funding of $500,000 for DAQ to select air quality research projects through a competitive process. This annual research funding helps DAQ improve its knowledge of the unique atmospheric and chemical conditions that contribute to air pollution in Utah. Information regarding the projects funded for FY21 can be found on Page 34 of this report.

Compliance

- DAQ inspectors conducted over 1,200 compliance inspections throughout the State. This includes full compliance evaluations at all 76 major sources and 556 minor sources. Additionally, there were 338 stack test/CEM (continuous emissions monitors) audits and reviews, 508 asbestos/lead-based paint phone calls, and 260 miscellaneous inspections (surveillance, compliance, partial inspections). The DAQ collected $201,051 in penalties in 2020.
- DAQ now employs two full time compliance inspectors stationed in the Uinta Basin as a concerted effort to focus on rural Utah.
- More information on Compliance can be found on Page 56 of this report.

Permitting

- DAQ issued 97 permits during the 2020 Fiscal Year, with an average of 158 days to issue the permit from the submission of an application, down from 220 days in Fiscal Year 2019.
- There are currently 77 Title V sources in Utah.
- More information on Permitting can be found on Page 60 of this report.

Air Quality Standards

The CAA requires the EPA to set NAAQS for pollutants considered harmful to public health and the environment. The CAA establishes two types of air quality standards: primary and secondary. Primary standards are set to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards are set to protect public welfare, including protection from decreased visibility and damage to animals, crops, vegetation, and buildings.

Standards are composed of a numerical value and a form (see Table 2). The form may be a statistical value, such as the 98th percentile calculation or a rolling average over a designated period of time that is then compared against the numerical value.

The EPA has established health-based NAAQS for six pollutants known as criteria pollutants. The six criteria pollutants are carbon monoxide, nitrogen dioxide, ozone, particulate matter, sulfur dioxide, and lead. Each of these pollutants is addressed in greater detail later in this chapter. Table 1 provides a brief description of each criteria pollutant and Table 2 provides a brief description of each criteria pollutant's primary and secondary standard. The EPA establishes the primary health standards after considering both the concentration level and the duration of exposure that can cause adverse health effects. Pollutant concentrations that exceed the NAAQS are considered unhealthy for some portion of the population. At concentrations between 1.0 and 1.5 times the standard, while the general public is not expected to be adversely affected by the pollutant, the most sensitive portion of the population may be. However, at levels above 1.5 times the standard, even healthy people may see adverse effects.

The DAQ monitors each of these criteria pollutants, as well as meteorological conditions and several non-criteria pollutants for special studies at various monitoring sites throughout the state.

Table 1. EPA Designated Criteria Pollutants

Name	Sources	Health Effects	Welfare Effects
Carbon Monoxide (CO), a clear, colorless, odorless gas.	Burning of gasoline, wood, natural gas, coal, oil, etc.	Reduces the ability of blood to transport oxygen to body cells and tissues. May be particularly hazardous to people who have heart or circulatory (blood vessel) problems and people who have damaged lungs or breathing passages.	
Nitrogen Dioxide (NO_2) (one component of NO_x) smog-forming chemical.	Burning of gasoline, natural gas, coal, oil, and other fuels; Cars are also an important source of NO2	Can cause lung damage, illnesses of breathing passages and lungs (respiratory system).	Ingredient of acid rain (acidaerosols) which can damage trees, lakes, flora and fauna. Acid aerosols can also reduce visibility.
Ozone (O_3) (ground-level ozone is the principal component of smog)	Chemical reaction of pollutants; Volatile Organic Compounds (VOCs) and NO_x	Can cause breathing problems, reduced lung function, asthma, irritated eyes, stuffy nose, and reduced resistance to colds and other infections. It may also speed up aging of lung tissue.	Can damage plans and trees; smog can cause reduced visibility.
Particulate Matter (PM_{10}, $PM_{2.5}$) dust, smoke, soot.	Burning of gasoline, natural gas, coal, oil, and other fuels; industrial plans; agriculture (plowing or burning fields); unpaved roads, mining, construction activities. Particles are also formed from the reaction of VOCs, NO_x, SO_x, and other pollutants in the air.	Can cause nose and throat irritation, lung damage, bronchitis, and early death.	Main source of haze that reduces visibility.
Sulfur Dioxide (SO_2)	Burning of coal and oil (including diesel and gasoline); industrial processes.	Can cause breathing problems and may cause permanent damage to lungs.	Ingredient of acid rain (acidaerosols) which can damage trees, lakes, flora and fauna. Acid aerosols can also reduce visibility.
Lead (Pb)	Paint (houses, cars), smelters (metal refineries); manufacture of lead storage batteries; note: burning leaded gasoline was the primary source of lead pollution in the U.S. until the federal government mandated unleaded gasoline.	Damages the nervous systems, including the brain, and causes digestive system damage. Children are at special risk. Some lead-containing chemicals cause cancer in animals.	Can harm wildlife.

Table 2. Ambient Air Quality Standards for Criteria Air Pollutants

Pollutant	Averaging Time	Primary / Secondary	Standard	Form
Ozone (O_3)	8 Hour	Primary and Secondary	0.070 ppm	Annual Fourth-highest daily maximum 8-hr concentration, averaged over three years
Respirable Particulate Matter (PM_{10})	24 Hour	Primary and Secondary	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over three years
Fine Particulate Matter ($PM_{2.5}$)	24 Hour	Primary and Secondary	35 $\mu g/m^3$	98th percentile, averaged over three years
	Annual	Primary	12 $\mu g/m^3$	Annual mean, averaged over three years
		Secondary	15 $\mu g/m^3$	Annual mean, averaged over three years
Carbon Monoxide (CO)	1 Hour	Primary	35 ppm	Not to be exceeded more than once per year
	8 Hour	Primary	9 ppm	Not to be exceeded more than once per year
Nitrogen Dioxide (NO_2)	1 Hour	Primary and Secondary	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over three years
	Annual	Primary and Secondary	53 ppm	Annual mean
Sulfur Dioxide (SO_2)	1 Hour	Primary	75 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over three years
	3 Hour	Secondary	0.5 ppm	Not to be exceeded more than once per year
Lead (Pb)	Rolling 3 month average	Primary and Secondary	0.15 $\mu g/m^3$	Not to be exceeded

Ambient Air Quality in Utah

Utah's Air Monitoring Network

The Air Monitoring Section (AMS) operates a network of monitoring stations throughout Utah. The monitors are situated to measure air quality in both neighborhoods and industrial areas. Table 3 shows the monitoring station locations and monitored constituents for stations operated in 2020.

Table 3. Utah Monitoring Network Stations

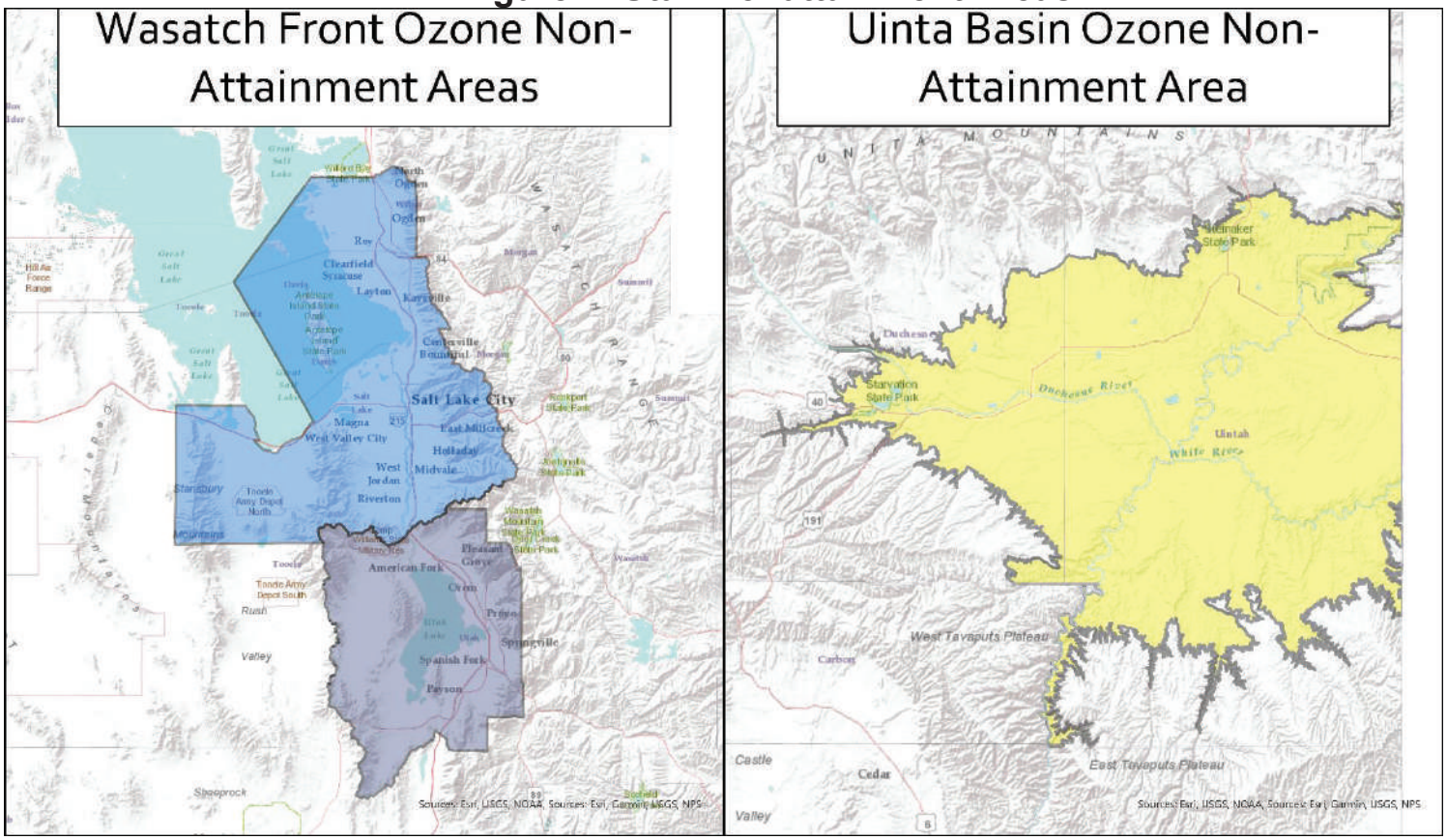
Station	City	Address	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Met.
Air Monitoring Center	SLC	240 N. 1950 W.	X	X	X	X	X	X	
Antelope Island	None	North end of island							X
Bountiful	Bountiful	200 W. 1380 N.		X	X		X		X
Copperview	Midvale	8449 S. Monroe St.	X	X	X		X	X	X
Enoch	Enoch	3840 N. 325 E. Minersville Hwy.		X	X		X		X
Erda	Tooele	2163 West Erda Way		X	X		X		X
Escalante	Escalante	755 West Main			X				
Harrisville	Harrisville	425 W. 2250 N.	X	X	X		X		X
Hawthorne	SLC	1675 S. 600 E.	X	X	X	X	X	X	X
Herriman	Riverton	14058 Mirabella Dr.		X	X	X	X		X
Hurricane	Hurricane	150 N. 870 W.		X	X		X		X
Lindon	Lindon	30 N. Main St.	X	X	X	X	X		X
Magna	Magna	9228 W. 2700 S.		X	X	X	X	X	X
Near Road	Murray	4951 S. Galleria Dr.	X	X	X		X		X
Price #2	Price	351 S. Weasel Run Rd.		X	X				X
Prison	SLC	On Prison Site	X	X	X		X		X
Roosevelt	Roosevelt	290 S. 1000 W.		X	X		X		X
Rose Park	SLC	1354 W. Goodwin Ave.	X	X	X		X	X	X
Saltair	None	6640 W. 1680 N.					X		X
Smithfield	Smithfield	675 W. 220 N.		X	X	X	X		X
Spanish Fork	Spanish Fork	312 W. 2050 N.			X		X		X
Vernal	Vernal	628 N. 1700 W.		X	X		X		X

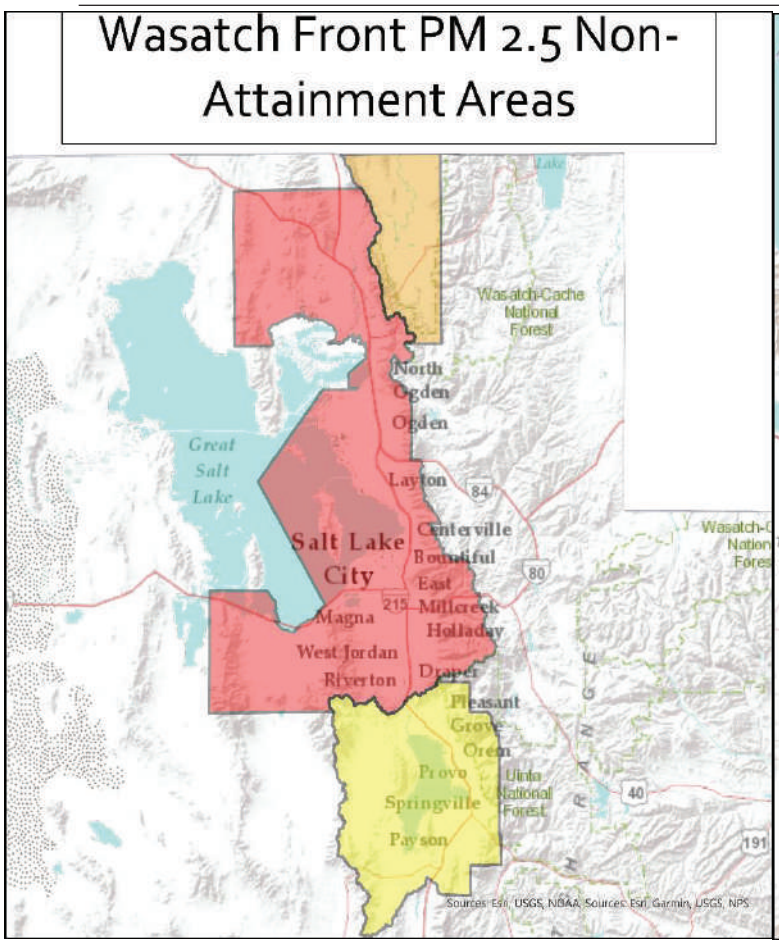
NAAQS Nonattainment & Maintenance Areas

The CAA has three different designations for areas based on whether or not they meet the NAAQS for each pollutant. Areas in compliance with the NAAQS are designated as attainment areas. Areas where there is no monitoring data showing that they are or are not in compliance with the NAAQS are designated as unclassifiable areas. Areas that are not in compliance with the NAAQS are designated as nonattainment areas. A maintenance area is an attainment area that was once designated as nonattainment for one of the NAAQS, and has since demonstrated to the EPA that it has and will continue to attain that standard for a period of a minimum of 10 years.

Most of the State of Utah has been designated as either Attainment or Unclassifiable for all of the NAAQS. Figure 1 contains maps of the current nonattainment areas within the state by pollutant, and Figure 2 shows the maintenance areas in Utah.

Figure 1. Utah Nonattainment Areas




Wasatch Front PM 2.5 Non-Attainment Areas
Great Salt Lake
Wasatch-Cache National Forest
North Ogden
Ogden
Layton
Salt Lake City
Centerville
Bountiful
East Millcreek
Holladay
Magna
West Jordan
Riverton
Draper
Pleasant Grove
Orem
Provo
Springville
Payson
Uinta National Forest
Sources: Esri, USGS, NOAA, Sources: Esri, Garmin, USGS, NPS

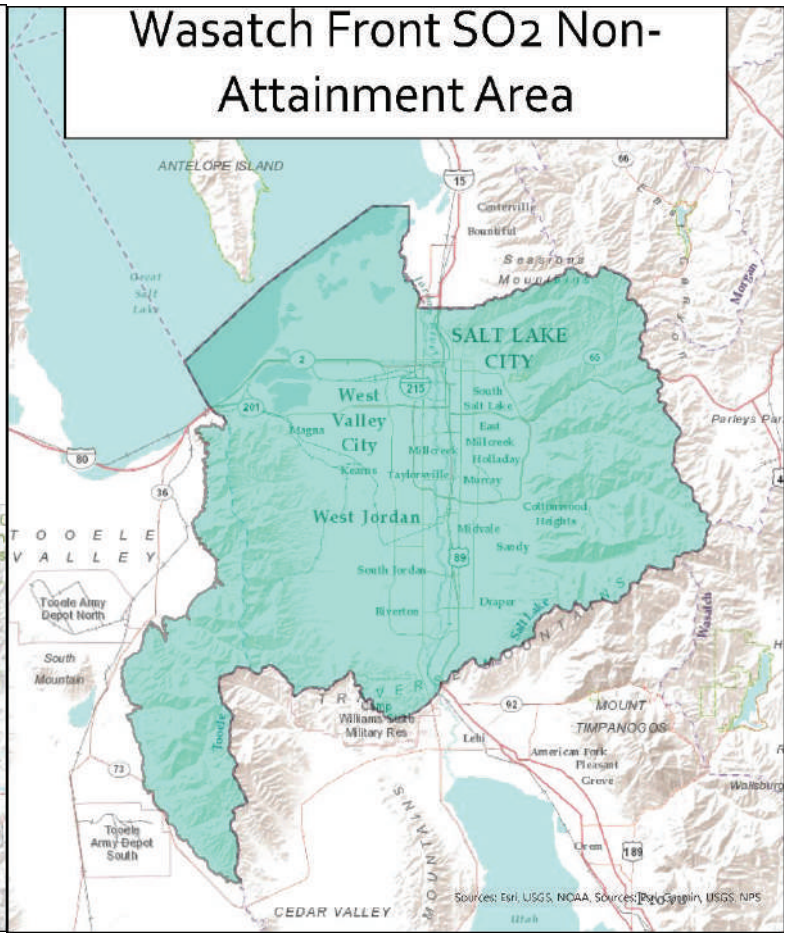
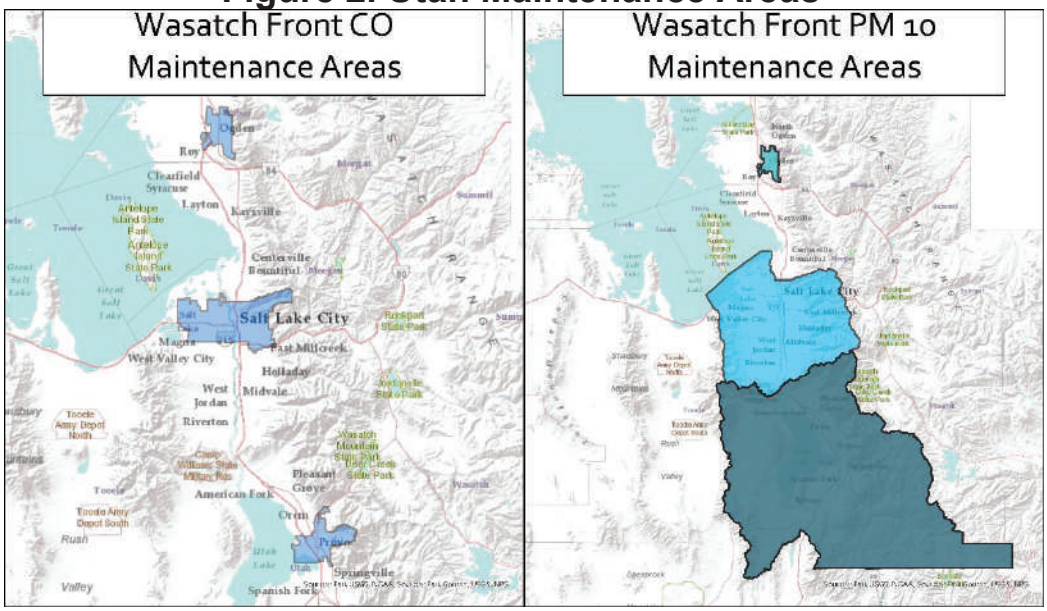

Wasatch Front SO2 Non-Attainment Area
ANTELOPE ISLAND
Great Salt Lake
Centerville
Bountiful
Wasatch Mountains
SALT LAKE CITY
West Valley City
Magna
Millcreek
Holladay
Murray
Taylorsville
Kearns
West Jordan
Cottonwood Heights
Midvale
Sandy
South Jordan
Riverton
Draper
TOOELE VALLEY
Tooele Army Depot North
South Mountain
Oquirrh Mountains
Camp Williams South Military Res
Lehi
MOUNT TIMPANOGOS
American Fork
Pleasant Grove
Orem
Tooele Army Depot South
CEDAR VALLEY
Sources: Esri, USGS, NOAA, Sources: Esri, Garmin, USGS, NPS

Figure 2. Utah Maintenance Areas





Criteria Air Pollutants

Carbon Monoxide (CO)

Carbon monoxide is a colorless and odorless gas formed by the incomplete combustion of carbon-based fuel. Carbon monoxide is primarily produced from on-road motor vehicles. Other significant sources of carbon monoxide emissions are wood burning stoves and fireplaces. The remaining emissions come from industrial facilities, construction equipment, miscellaneous mobile sources and other types of space heating.

Because motor vehicle emissions are the major source of carbon monoxide, the highest concentrations occur during morning and evening rush hours near high-traffic areas. The worst problems occur when there are large numbers of slow-moving vehicles in large parking lots, busy intersections, and traffic jams. Historically, as exhibited in the CAA, it was the EPA's presumption that all elevated carbon monoxide levels were the result of mobile source emissions, and a state had to go through a rigorous demonstration to prove otherwise. In Utah, areas of elevated carbon monoxide concentrations were always found near roadways. Carbon monoxide problems are greater in winter due to several factors: cold weather makes motor vehicles run less efficiently, wood burning, and other space heating take place, and temperature inversions trap carbon monoxide near the ground.

Standards

The EPA has developed two national standards for carbon monoxide. They are 35 ppm of CO averaged over a one-hour period, and 9 ppm of CO averaged over an eight-hour period. A violation of the NAAQS occurs with the second exceedance of either standard at a single location in a calendar year. Once a location is in violation, it is designated as a "nonattainment area."

Utah Monitoring Data

Three cities in Utah (Salt Lake City, Ogden, and Provo) were at one time designated as nonattainment areas for carbon monoxide. Due primarily to improvements in motor vehicle technology, Utah has complied with the carbon monoxide standards since 1994 (see Figure 3 and Figure 4). Salt Lake City, Ogden, and Provo were successfully re-designated to attainment status in 1999, 2001, and 2006, respectively.

Figure 3. Carbon Monoxide Second Highest 1-HourConcentration

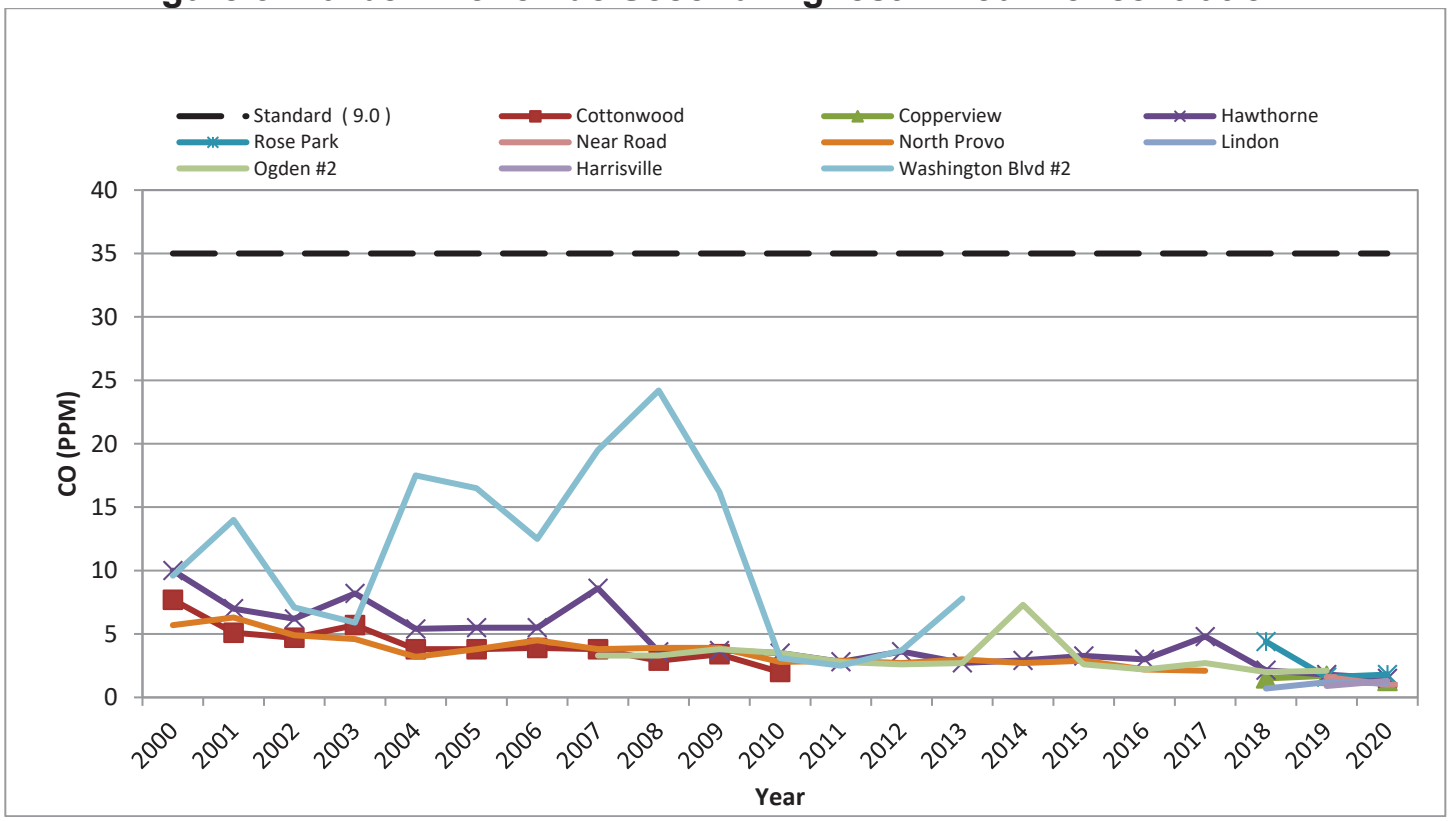
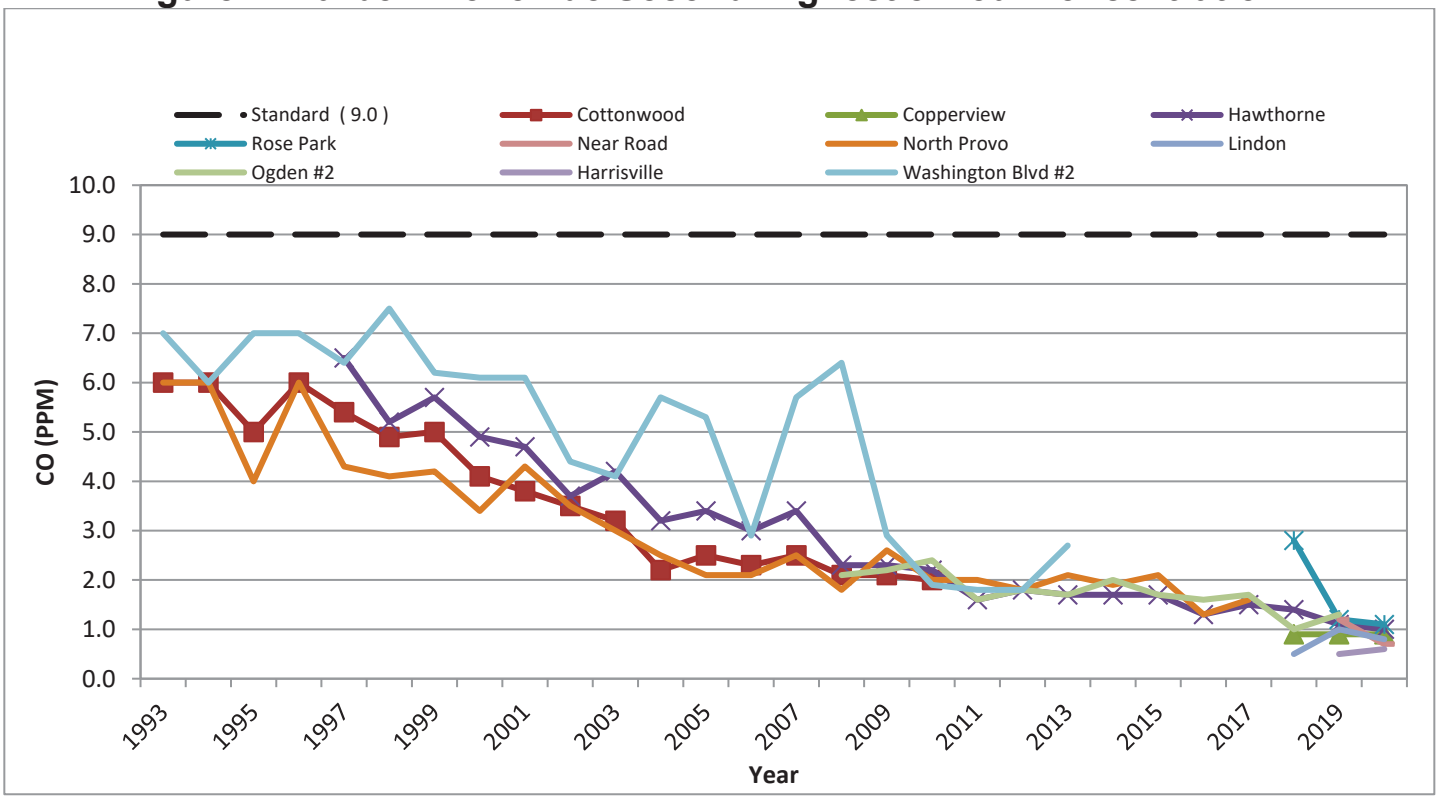


Figure 4. Carbon Monoxide Second Highest 8-HourConcentration



Nitrogen Dioxide (NO_2)

During high temperature combustion, nitrogen in the air reacts with oxygen to produce various oxides of nitrogen, or NO_x, a reddish-brown gas. One of the oxides of nitrogen, NO_2, is a criteria pollutant.

Oxides of nitrogen react with other air contaminants to form other criteria pollutants. In the summer along the Wasatch Front, and in the winter in the Uinta Basin, photochemical reactions between NO_2 and volatile organic compounds (VOCs) lead to the formation of ground-level ozone. In the winter, NO_2 reacts with ammonia to form fine particulate matter ($PM_{2.5}$). Both of these seasonal scenarios can result in increased pollution. Utah continues to struggle with both the ozone and particulate matter standards; and because of this, the DAQ is mindful of the trend in NO_2 concentrations illustrated in Figure 5.

Standards

The EPA has established two national standards for NO_2 – an hourly standard and an annual standard. The hourly standard is set at 100 ppb measured as the three-year average of the 98th percentile of the annual distribution of daily maximum one-hour average concentrations.

The annual NO_2 standard of 0.053 ppm is expressed as an annual arithmetic mean (average) as seen on Figure 6. The DAQ monitors the concentrations of NO_2 at various locations throughout the state.

Utah Monitoring Data

As shown in Figures 5 and 6, Utah has never exceeded these standards.

Figure 5. Three-Year Average Nitrogen Dioxide Hourly Averages

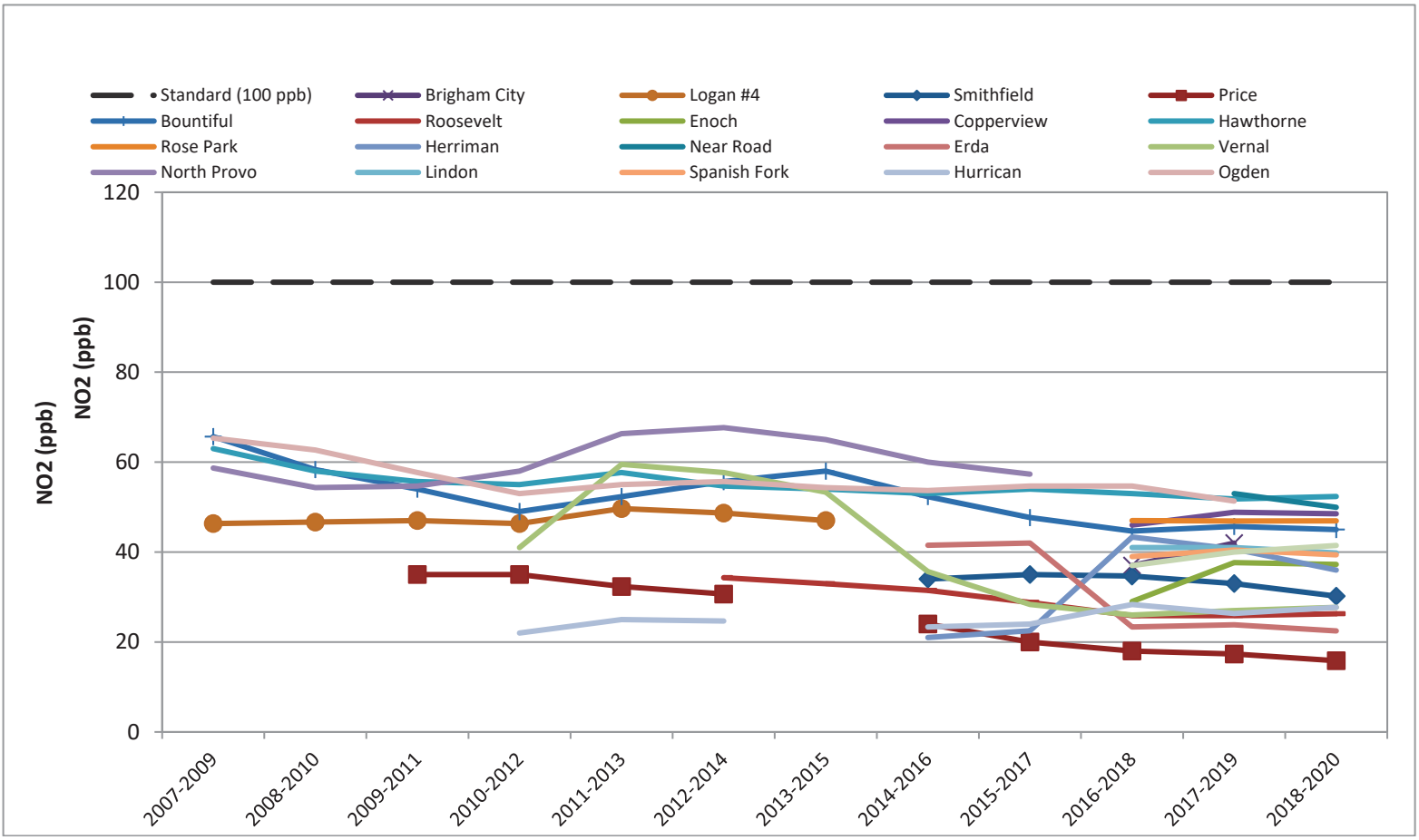
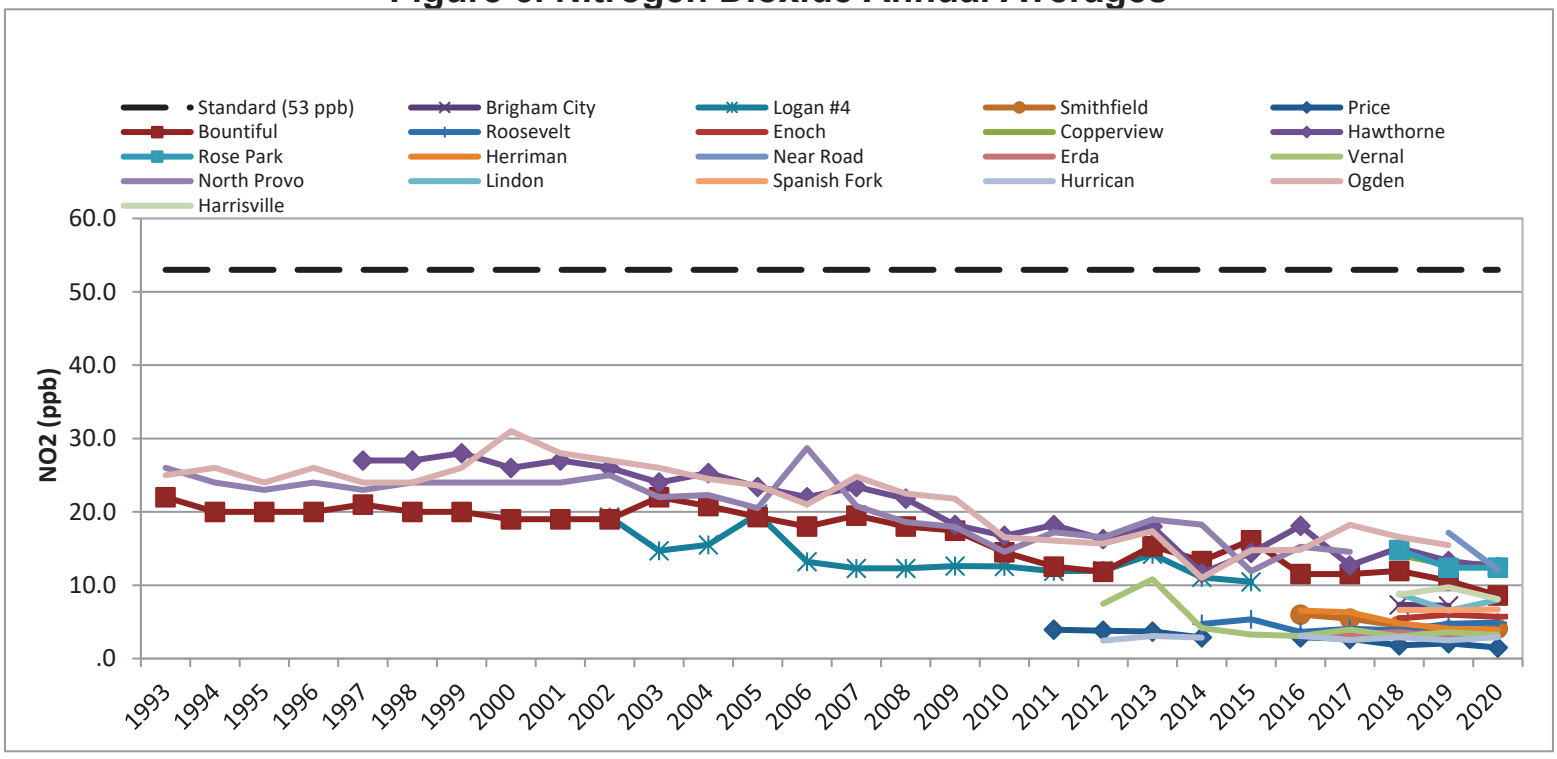


Figure 6. Nitrogen Dioxide Annual Averages



Ozone (O_3)

Ozone is a clear, colorless gas composed of molecules of three oxygen atoms. Ground-level ozone that is regulated by EPA should not be confused with the stratospheric ozone layer located approximately 15 miles above the earth's surface that shields the earth from cancer-causing ultraviolet radiation. Ground level ozone is formed by a complex chemical reaction involving VOCs and oxides of nitrogen (NO_x) in the presence of sunlight.



Some major sources for both VOCs and NO_x are vehicle engine exhaust, emissions from industrial facilities, gasoline vapors, chemical solvent use, oil and gas production, and biogenic emissions from natural sources, such as vegetative growth.

Ozone production is a year-round phenomenon, and the highest ozone levels generally occur during the summer when strong sunlight, high temperatures, and stagnant meteorological conditions combine to drive the chemical reactions and trap the air within a region for several days. However, in the past decade, it was found that under very unique circumstances, high ozone levels can occur during the wintertime. In the Uinta Basin of Utah, wintertime ozone is associated with temperature inversions, snow cover, significant VOC and NOx emissions associated with oil/gas production, and solar radiation (sunlight). Research is on-going to better understand the chemical processes that lead to wintertime ozone production. The maximum daily 8-hour monitor values for the Ouray monitor in the Uinta Basin and the Hawthorne monitor on the Wasatch Front illustrate the timing of high values in each area. Figure 10 shows that higher values in the Basin are typically seen in the winter months, whereas higher values on the Wasatch Front are typically observed in the summer.

Ozone Standards

In October of 2015, the EPA strengthened the ozone NAAQS from 75 ppb to 70 ppb, based on a three-year average of the annual 4th highest daily eight-hour average concentration. The standard was reviewed again in 2020 and the EPA chose to retain the standard at 70 ppb.

Utah Monitoring Data

Figures 7-9 show the annual 4th highest eight-hour ozone concentrations for monitors on the Wasatch Front, in the Uinta Basin, and other monitors located throughout the state. Figure 11 shows how each area compares to the NAAQS with the three-year average of the 4th highest eight-hour ozone concentration. The heavy black dashed lines indicate the previous standard of 75 ppb. The heavy red dashed line indicates the current 70 ppb standard. Ozone monitors operated by the DAQ along the Wasatch Front show exceedances of the current standard in Weber, Davis, and Salt Lake counties. There were also exceedances in Uinta County and Duchesne County during the winter. In 2016, the Governor recommended that portions of the Wasatch Front and Uinta Basin be designated nonattainment, and that the rest of the State be designated attainment/unclassifiable. In August 2018, the EPA designated portions of the Wasatch Front and Uinta Basin nonattainment for ozone. Based on monitoring data from 2018, 2019, and preliminary data from 2020, Utah County is currently attaining the ozone standard.

Figure 7. Ozone 4th Highest 8-Hour Concentration

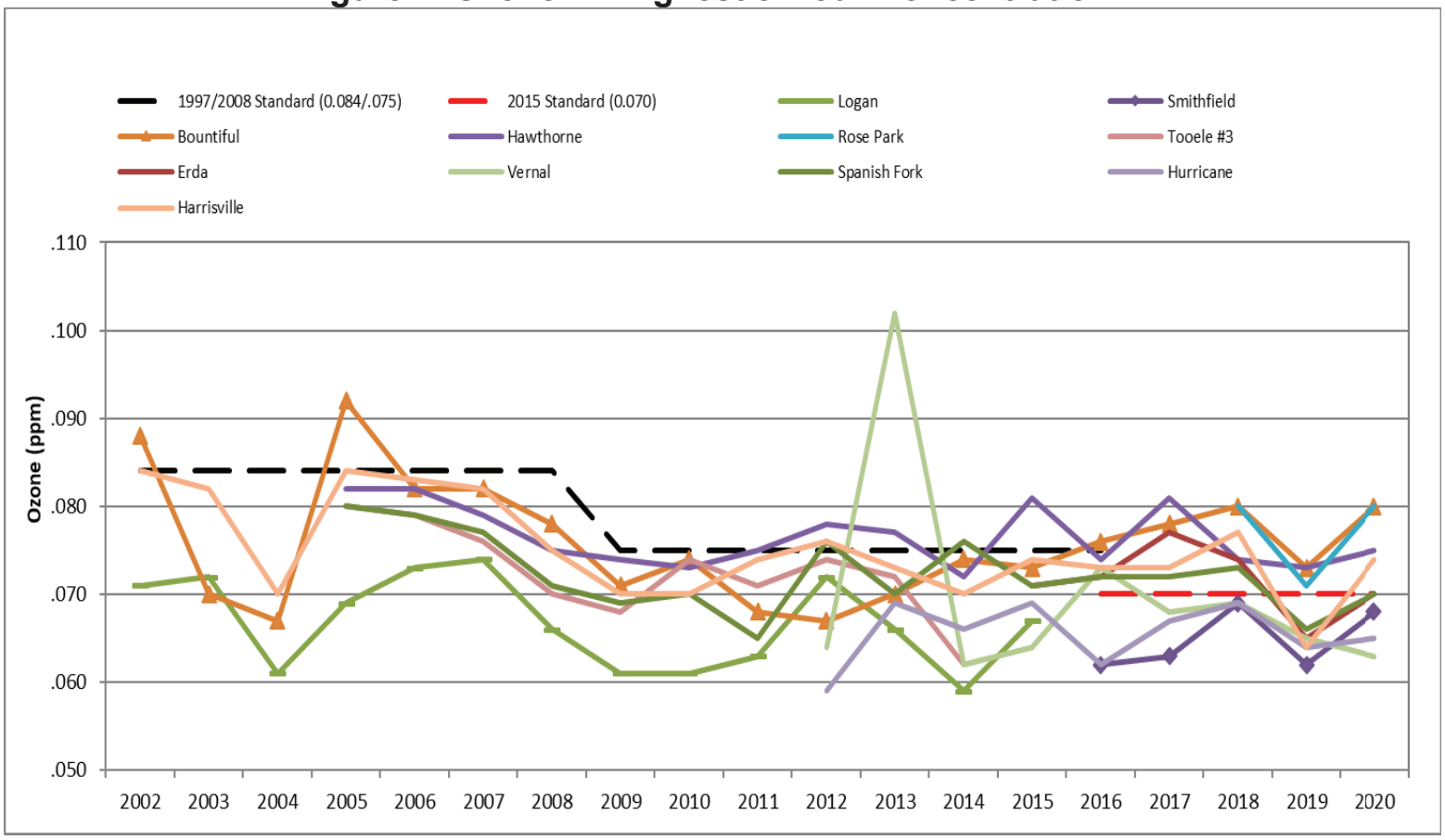


Figure 8. Ozone 4th Highest 8-Hour Concentration in Uinta Basin

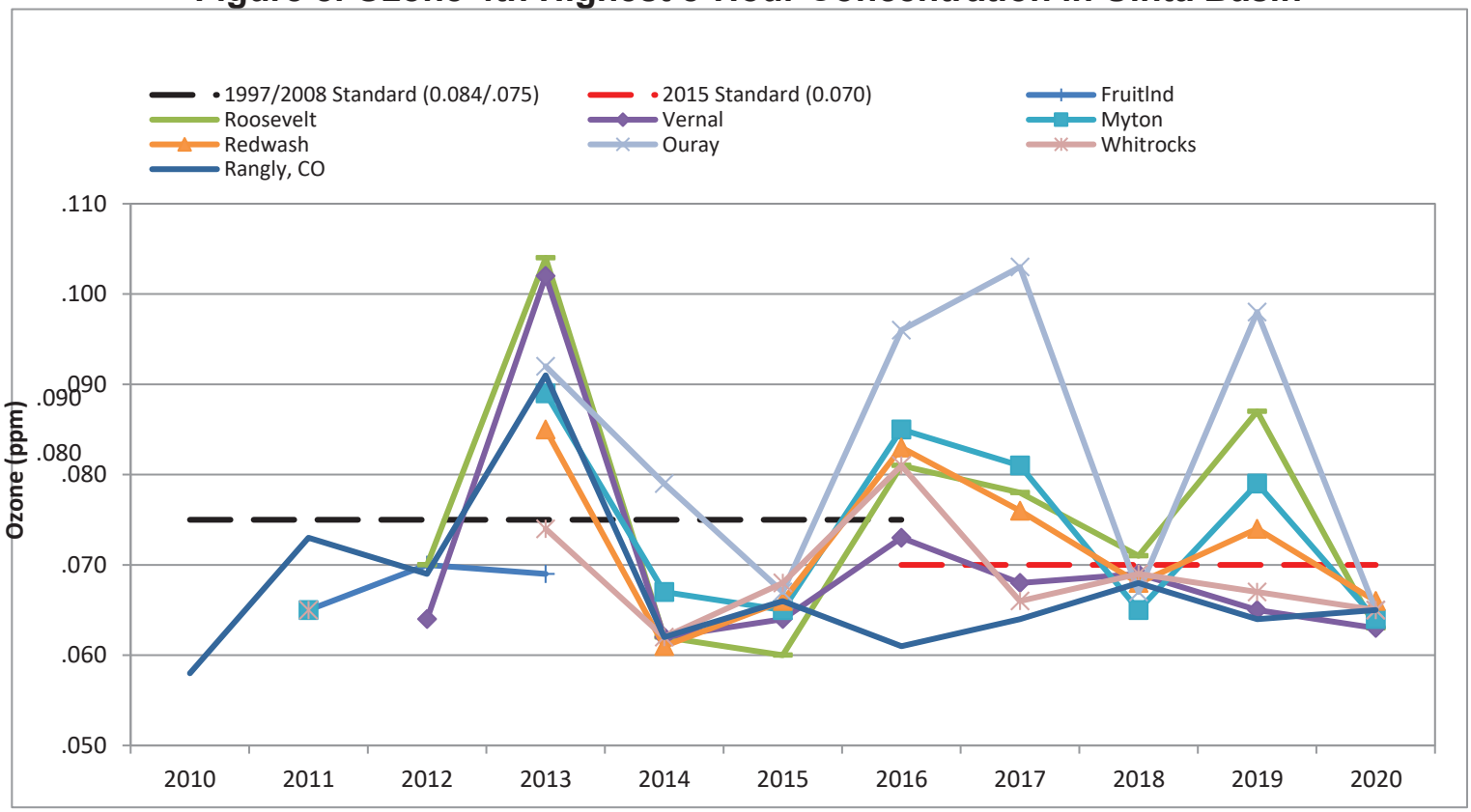


Figure 9. Ozone 4th Highest 8-Hour Concentration in Wasatch Front

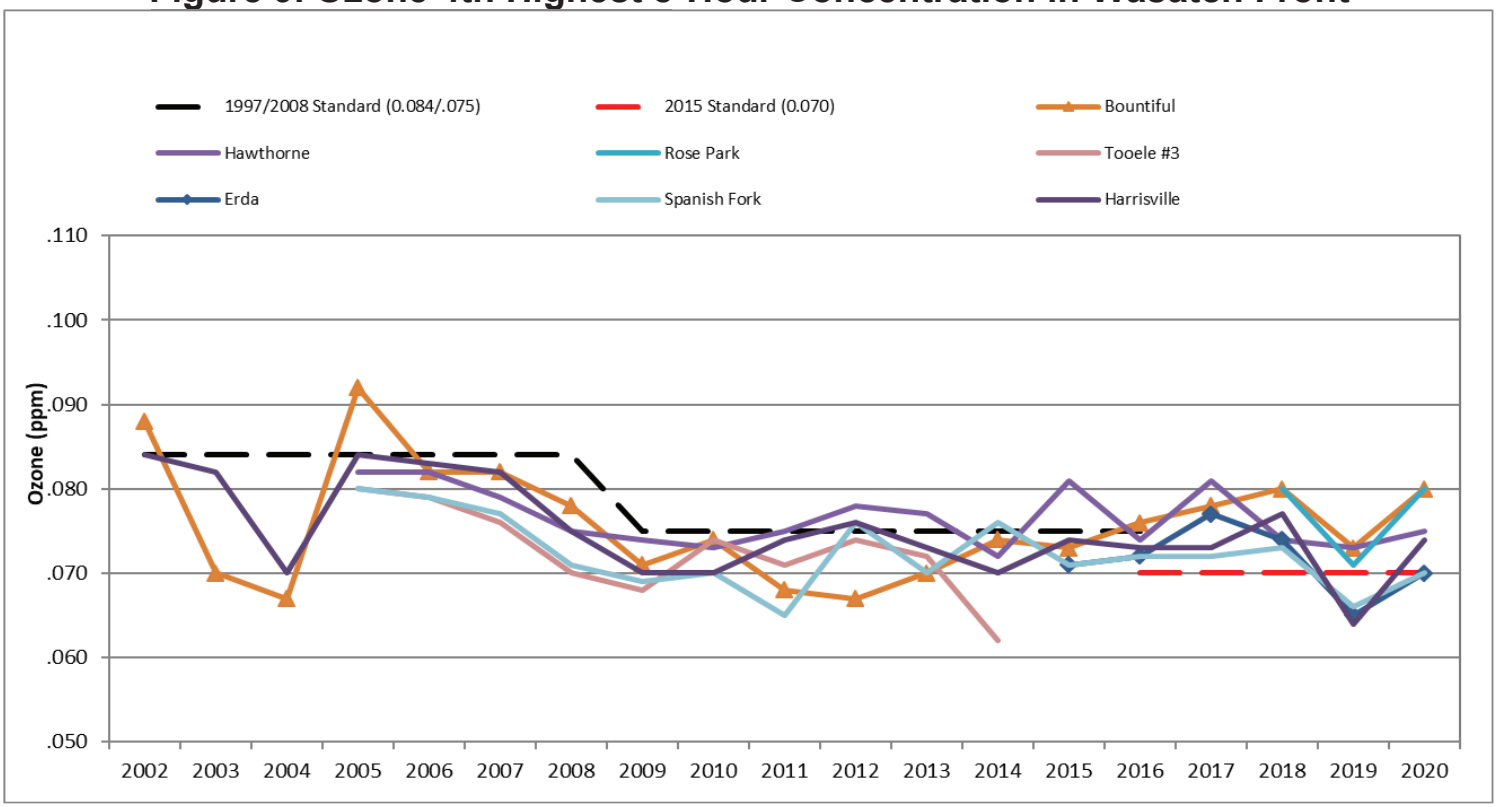


Figure 10. Daily Maximum 8-Hour Ozone Average

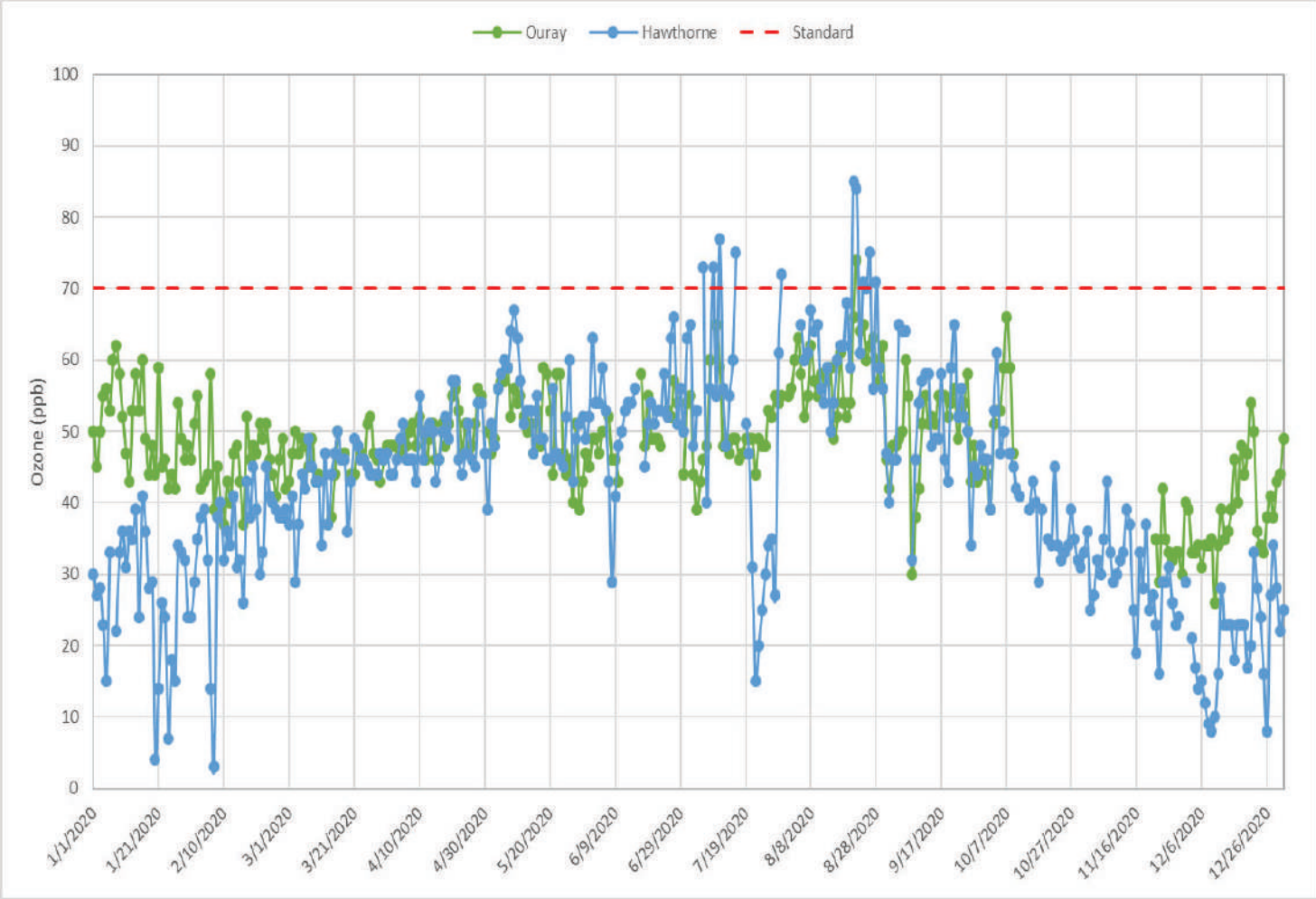
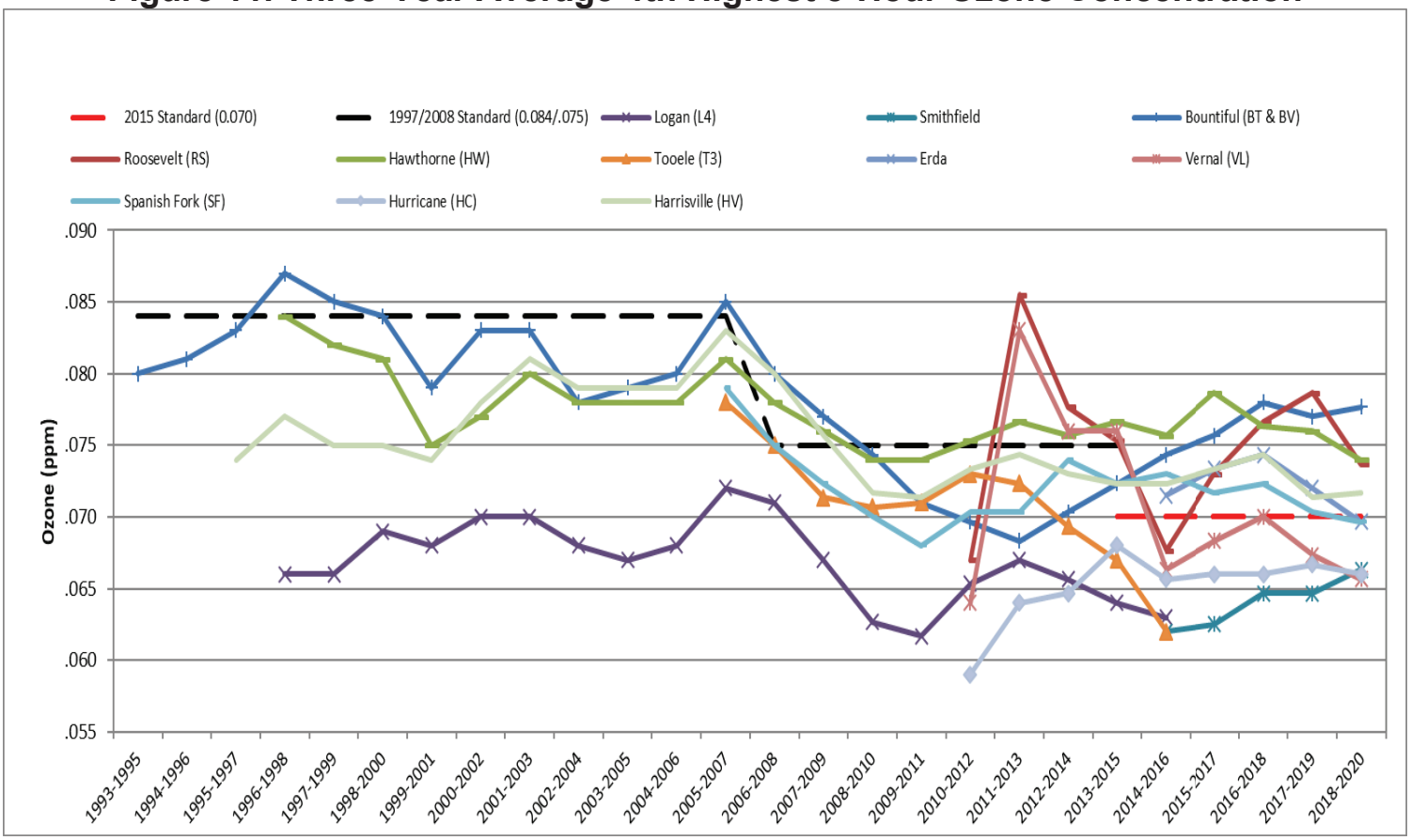


Figure 11. Three-Year Average 4th Highest 8-Hour Ozone Concentration



Particulate Matter (PM)

Regulated particulate matter is a complex mixture of extremely tiny particles of solid or semi-solid material suspended in the atmosphere and is divided into two categories: PM_{10} and $PM_{2.5}$.

PM_{10} is a particulate less than ten micrometers in diameter, which is about one-seventh the width of a strand of human hair. $PM_{2.5}$, or fine particulate, is a subset of PM_{10} that measures 2.5 microns in diameter or less. The coarse fraction of PM_{10}, which is larger than 2.5 microns, is typically made up of "fugitive dust" (sand and dirt blown by winds from roadways, fields, mining, and construction sites) and contains large amounts of silicate (sand-like) material. Primary $PM_{2.5}$ is directly emitted into the atmosphere from combustion sources such as fly ash from power plants, black carbon from cars and trucks, and soot from fireplaces and woodstoves. These particles are so small that they can become imbedded in human lung tissue, exacerbating respiratory diseases and cardiovascular problems. Other negative effects are reduced visibility and accelerated deterioration of buildings.

The majority of Utah's $PM_{2.5}$ is called secondary aerosol, meaning that it is not emitted directly as a particle, but is produced when gasses such as sulfur dioxide (SO_2), NO_x, and VOCs react with other gasses in the atmosphere, such as ammonia, to become tiny particles. Wintertime temperature inversions not only provide ideal conditions for the creation of secondary aerosols, they also act to trap air in valleys long enough for concentrations of $PM_{2.5}$ to build up to levels that can be unhealthy. The smallest of particles that make up $PM_{2.5}$ are major contributors to visibility impairment in both urban and rural areas. Along the Wasatch Front, the effects can be seen as the thick, brownish haze that lingers in our northern valleys, particularly in the winter. The DAQ currently operates PM_{10} and $PM_{2.5}$ monitors throughout the state to assess the ambient air quality with respect to the standards for both PM_{10} and $PM_{2.5}$.

Standards – PM_{10}

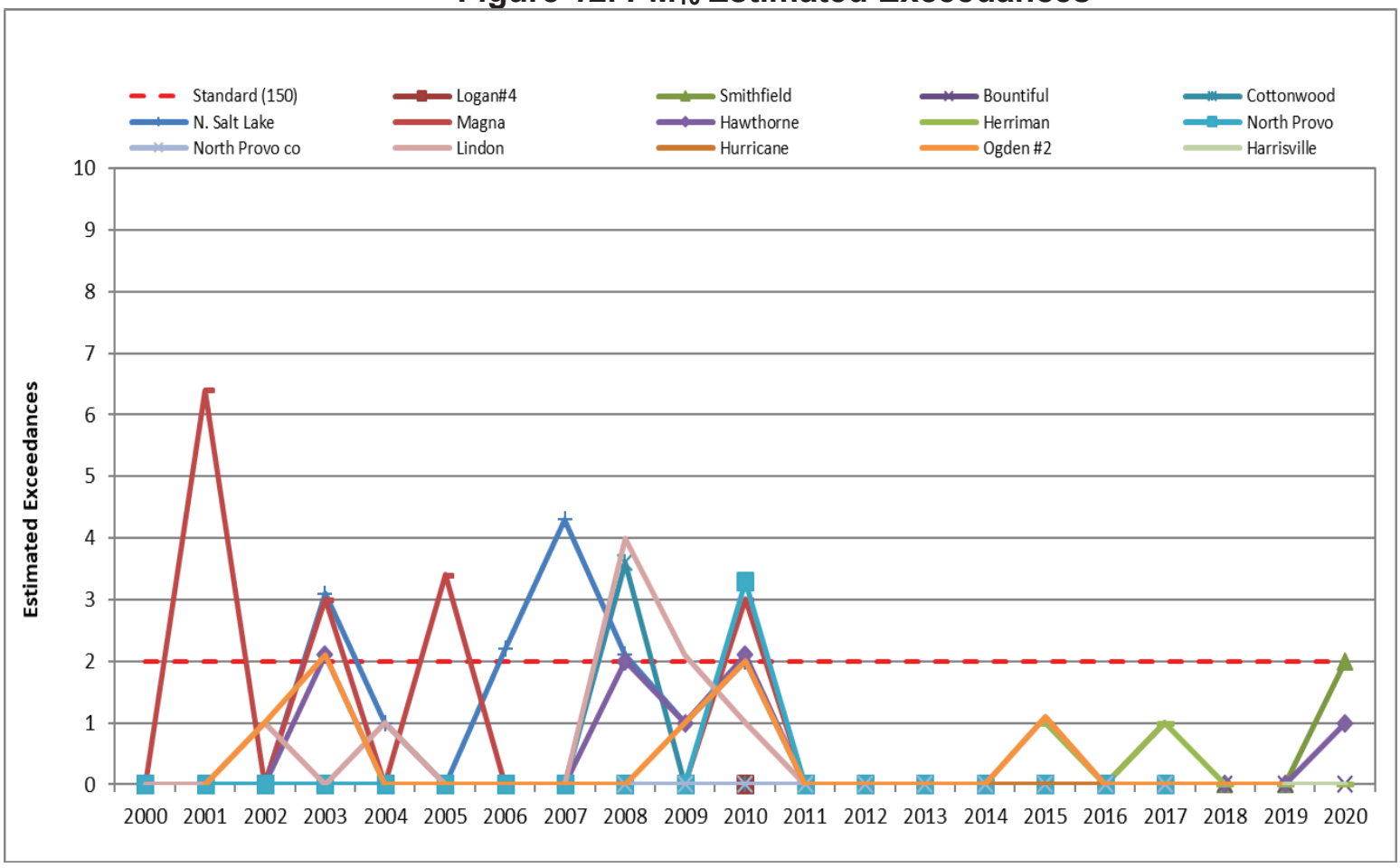
The EPA established the 24-hour air quality standard for PM_{10} in July 1987 as 150 $\mu g/m^3$. The standard is met when the probability of exceeding the standard is no greater than once per year for a three-year averaging period. In other words, four estimated exceedances within a three-year period would constitute a violation. Salt Lake County and Utah County had been designated nonattainment for PM_{10} shortly after the standard was promulgated. Ogden City was also designated as a nonattainment area due to one year of high concentrations (1992), but was determined to be attaining the standard in January 2013.

Utah Monitoring Data

State Implementation Plans (SIP) were written and promulgated in 1991, and included control strategies that were responsible for the marked decrease in PM_{10} concentrations observed in the early 1990s. Ogden City, and Salt Lake and Utah Counties were officially designated as attainment for PM_{10} effective March 27th, 2020. These three former nonattainment areas are now subject to the maintenance plans that were approved by EPA and the areas must continue to attain the standard for the first maintenance period of ten years.

High values of monitored PM_{10} sometimes result from exceptional events, such as dust storms and wildfires. This was the case in 2010, when Utah experienced an exceptional dust storm on March 30th, resulting in very high PM_{10} values across the State's air monitoring network. The DAQ has flagged data collected during exceptional events incurred from 2008 through 2011 and in 2015. Those events are currently under review for exclusion per the EPA Exceptional Event Rule. There were no exceptional events for high-wind in 2016 through 2020. Figure 12 shows the PM_{10} estimated exceedances at monitored sites in Utah since 2000.

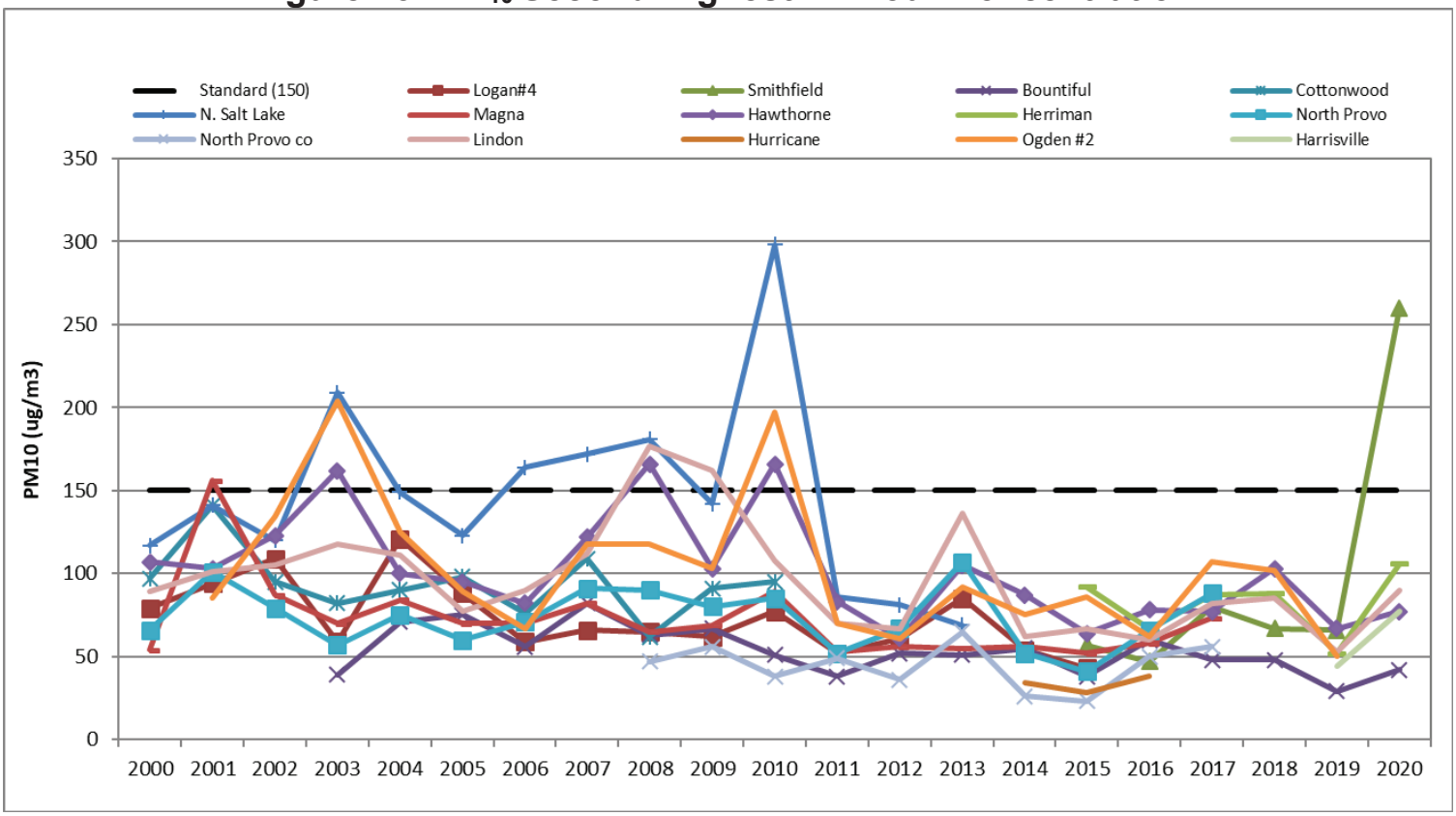
Figure 12. PM_{10} Estimated Exceedances



The statistical form of the standard essentially allows for one exceedance per year, regardless of how high the value may be. For this reason, it is often useful to look at the second highest value collected at a particular location.

Figure 13 shows the second highest 24-hour PM_{10} concentrations recorded at each station since 2000. The heavy dashed line indicates the NAAQS.

Figure 13. PM_{10} Second Highest 24-Hour Concentration



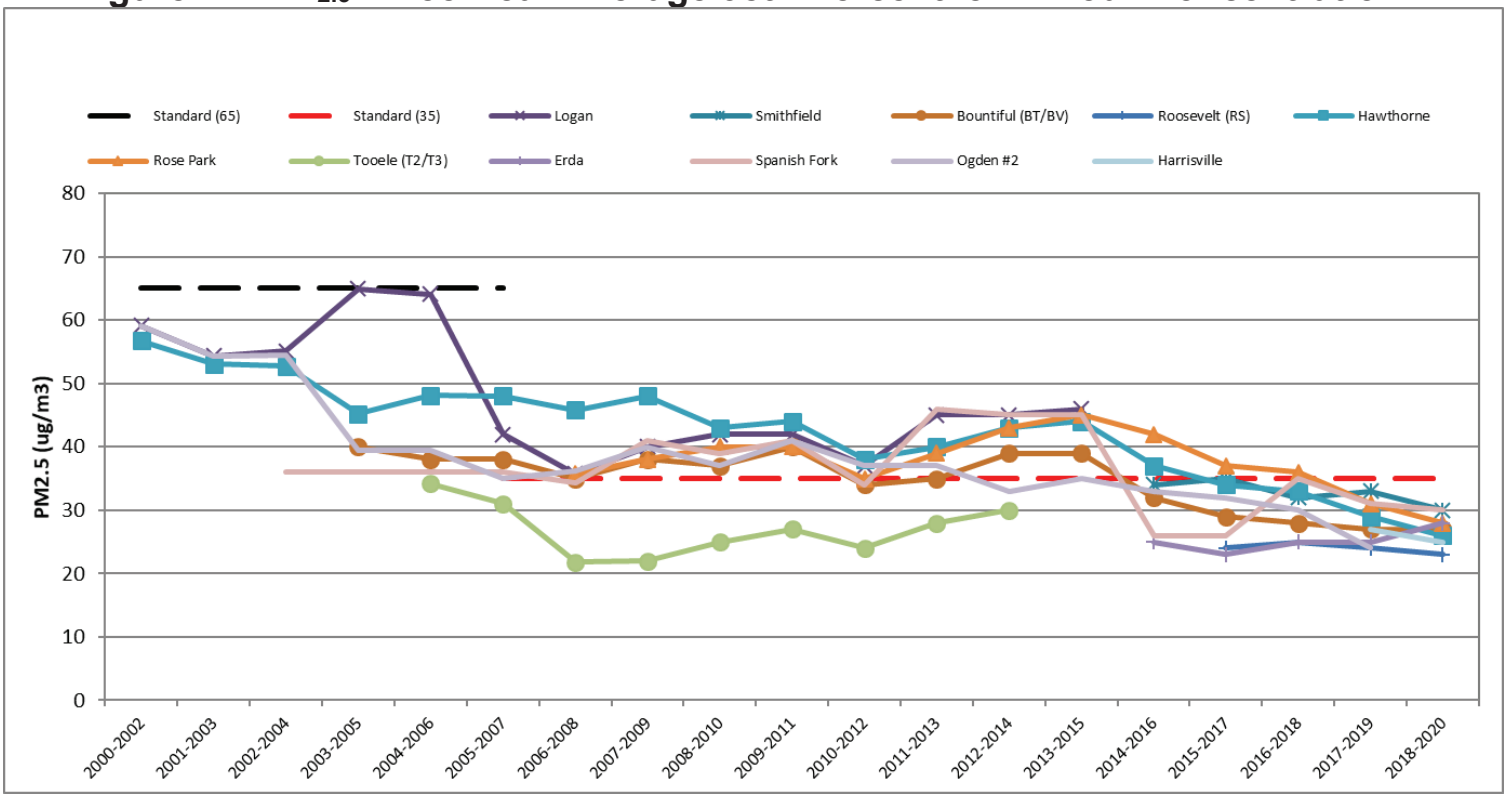
Standards – $PM_{2.5}$

The EPA first established standards for $PM_{2.5}$ in 1997. In 2006, the EPA lowered the 24-hour $PM_{2.5}$ standard from 65µg/m^3 to 35 µg/m^3. In 2012, the EPA lowered the annual standard from 15µg/m^3 to 12µg/m^3. The $PM_{2.5}$ NAAQS underwent a review in 2020 and the standards were retained. Both standards are evaluated by considering monitored data collected during a three-year period. This minimizes the effects of year-to-year meteorological variability. The 24-hour standard is met when the average of 98th percentile values collected for each of the three years is less than or equal to 35 µg/m^3. The 98th percentile concentration for each year is selected from all of the data recorded at a given monitor, such that the values of at least 98 percent of all that data are of a lower concentration.

Utah Monitoring Data

Figure 14 shows that all monitors in Utah are in compliance with the 1997 standard. The three- year averages from 2018-2020 show that all monitors are in compliance with the 2006 standard.

Figure 14. $PM_{2.5}$ Three-Year Average 98th Percentile 24-Hour Concentration



The annual standard is met when the three-year average of annual mean concentrations is no greater than 12µg/m^3.

Figures 15 and 16 show that all locations meet the annual standard.

Figure 15. $PM_{2.5}$ Annual Mean Concentration

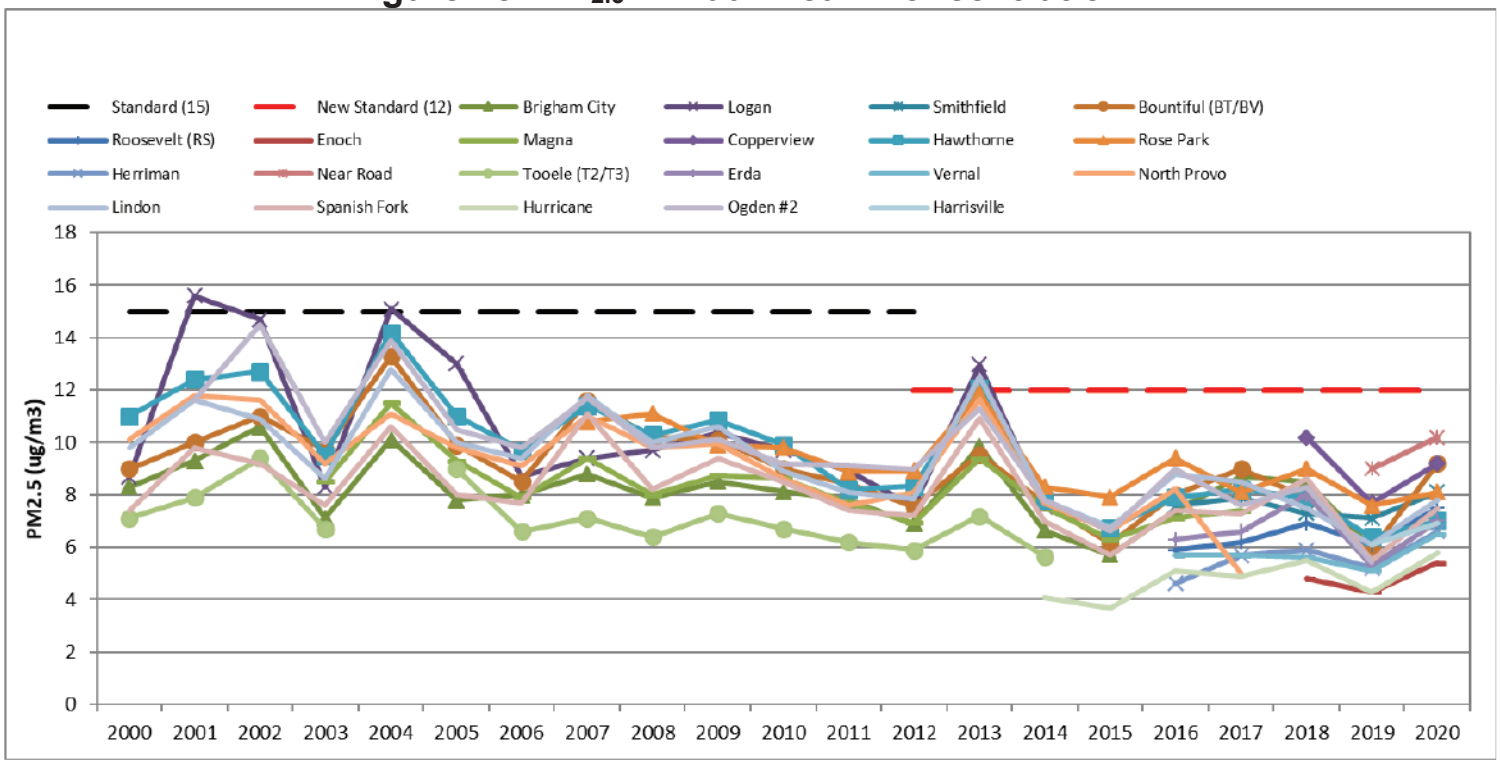
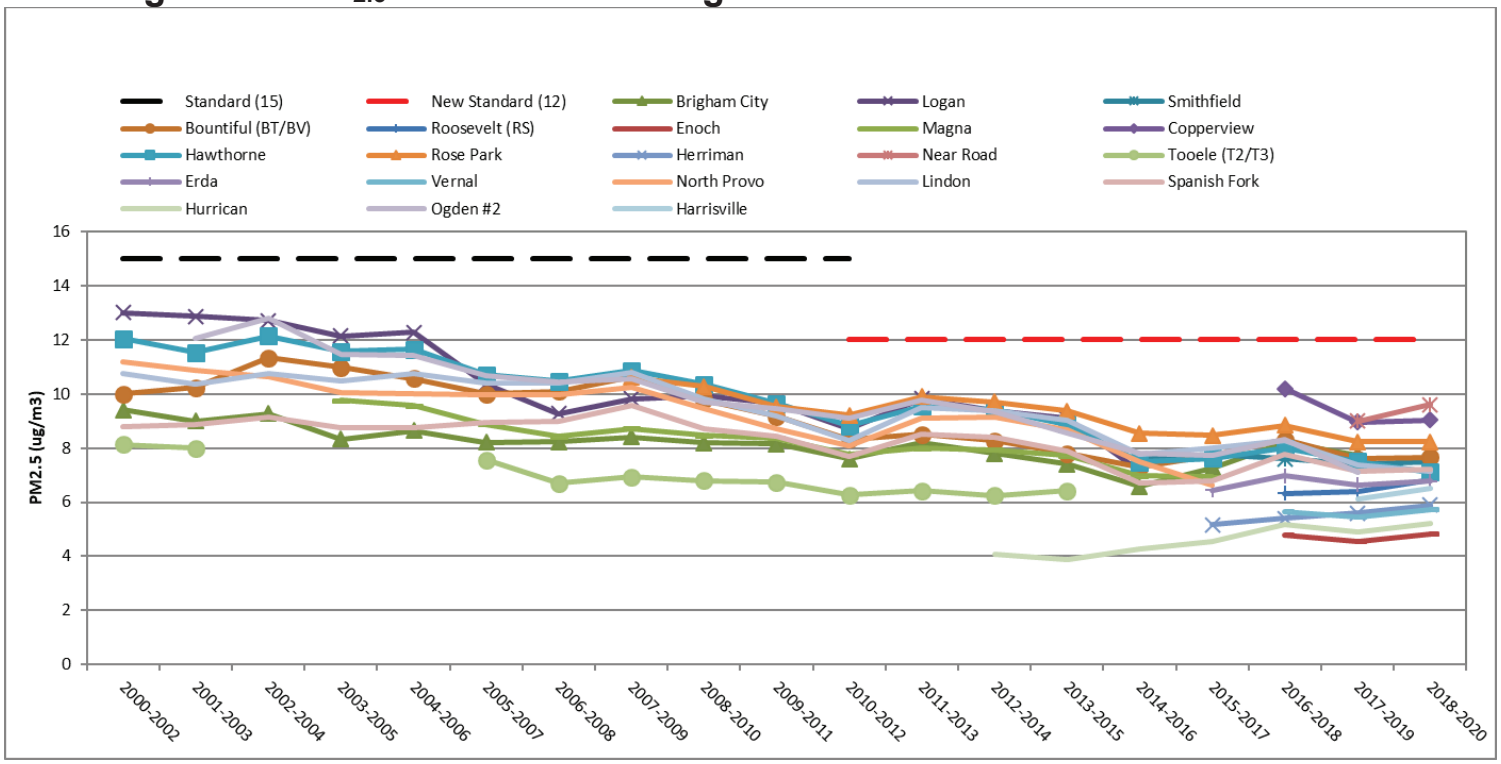


Figure 16. $PM_{2.5}$ Three-Year Average of the Annual Mean Concentration



Also illustrated in Figures 15 and 16 is a downward trend in the annual mean concentrations. This is interesting to note because trends in the annual averages are not as easily obscured by short term meteorology as are trends in the 24-hour values. This downward trend is likely also indicative of trends in 24-hour concentrations, absent the influence of year-to-year variability in the severity of wintertime cold pool (inversion) conditions.

EPA has proposed that the Salt Lake and Provo nonattainment areas be redesignated to attainment status. The final rule is expected to be published in the Federal Register in early 2021. The Logan nonattainment areas will likely be proposed for redesignation to attainment in early 2021 as well.

Sulfur Dioxide (SO_2)

Sulfur dioxide is a colorless gas with a pungent odor. In the atmosphere, sulfur dioxide is easily converted into sulfates, which are detected as particulates. It is also converted into sulfuric acid, the major acidic component of acid rain. It is emitted primarily from stationary sources that burn fossil fuels such as power plants and refineries. SO_2 is also a byproduct of copper smelting. Diesel fuel and, to a lesser extent, gasoline contain sulfur and are considered contributors to sulfur dioxide in the atmosphere.

Standards

In 1971, EPA established a 24-hour average SO_2 standard of 0.14 ppm, and an annual arithmetic average standard of 0.030 ppm. In 2010, EPA revised the primary standard for SO_2, setting it at 75 ppb for a three-year average of the 99th percentile of the annual distribution of daily maximum one-hour average concentrations for SO_2. The secondary standard is a three-hour standard of 0.5 ppm and is not to be exceeded more than once per year.

Utah Monitoring Data

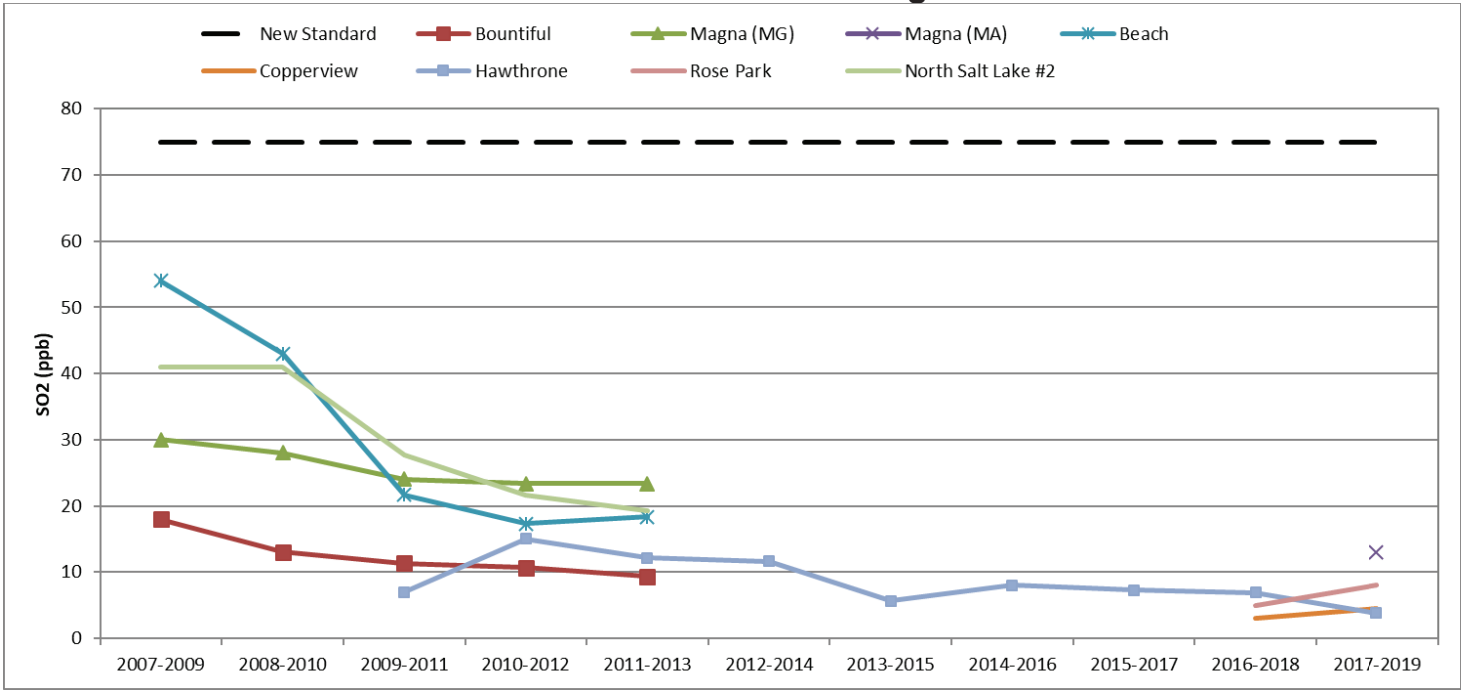
Throughout the 1970s, the Magna monitor routinely measured violations of the 1971 24-hour standard. Consequently, all of Salt Lake County and parts of eastern Tooele County above 5,600 feet were designated as nonattainment for that standard. Two significant technological upgrades at the Kennecott smelter costing the company nearly one billion dollars resulted in continued compliance with the SO_2 standard since 1981. In the mid-1990s, Kennecott, Geneva Steel, the five refineries in Salt Lake City, and several other large sources of SO_2 made dramatic reductions in emissions as part of an effort to curb concentrations of secondary particulates (sulfates) that were contributing to PM_{10} violations. More recently, Kennecott closed Units 1, 2, and 3 of its coal-fired power plant in 2016, and it closed Unit 4 in 2019, resulting in further SO_2 emissions reductions.

Utah submitted an SO_2 Maintenance Plan and re-designation request for Salt Lake and Tooele Counties to the EPA in April of 2005, but EPA never took formal action on the request. Because of changes in the emissions in subsequent years, and changes in the modeling used to demonstrate attainment of the standard, in November, 2019, the State of Utah withdrew the 2005 Maintenance Plan and re-designation request. DAQ is currently working very closely with EPA to develop a new maintenance plan and redesignation request to address the 1971 standard. DAQ will conduct modeling and other analyses in 2021 with the goal of submitting an approvable maintenance plan and redesignation request to EPA by the end of that year.

On November 1, 2016, Governor Herbert submitted a recommendation to EPA that all areas of the state be designated as attainment for the 2010 SO_2 NAAQS based on monitoring and air quality modeling data. On January 9, 2018, EPA formally concurred with this recommendation and designated all areas of the state attainment/unclassifiable.

Figure 17 shows the most current measurements to compare against the primary SO2, NAAQS of 75 ppb.

Figure 17. Sulfur Dioxide Three-Year Average of 99th Percentile of Daily Maximum One-Hour Averages



Lead (Pb)

Lead in the ambient air exists primarily as particulate matter in the respirable size range. Historically, the major source of lead emissions came from the burning of leaded gasoline. However, because leaded gasoline for automobiles was completely phased out in the U.S. by the end of 1995, lead from gasoline is no longer a significant problem. Currently, the primary source of lead emissions in Utah is the extraction and processing of metallic ores. Exhaust from small aircraft is another source of lead emissions in the state. Utah has not exceeded the health standard for lead since the late 1970s, and the EPA authorized the discontinuation of lead monitoring in Utah in 2005; however, in both 2008 and 2010, the EPA set new monitoring requirements for lead, and the DAQ resumed monitoring in 2010.

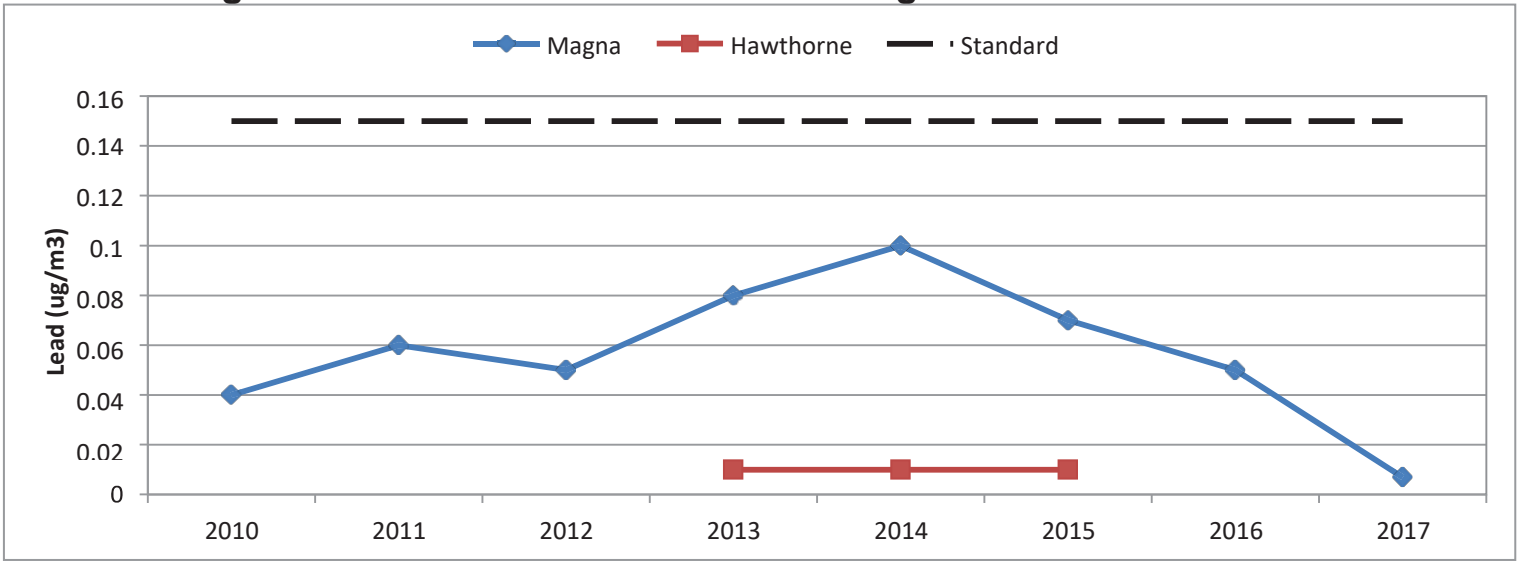
Standards

On November 12, 2008, the EPA strengthened the NAAQS for lead. The previous standard was a calendar quarter (three-month) average concentration not to exceed 1.5 $\mu g/m^3$. The new standard is 0.15 $\mu g/m^3$ as total suspended particles (TSP), measured as a three-month rolling average.

Utah Monitoring Data

The new standard included a new monitoring requirement, so the DAQ began lead monitoring again at the Magna station near the Kennecott copper smelter (See Figure 18). Data was collected from January 2010 through June 2017, at which time DAQ was able to demonstrate the likelihood of violating the standard was so remote, it would no longer be necessary to run the monitor. With EPA's concurrence, the Magna lead monitor was shut down in June 2017. UDAQ and EPA continue to monitor requirements, such as source emission thresholds, population, and NAAQS revisions that may trigger the necessity to resume monitoring lead in Utah.

Figure 18. Lead Max Three-Month Average 24-Hour Concentration



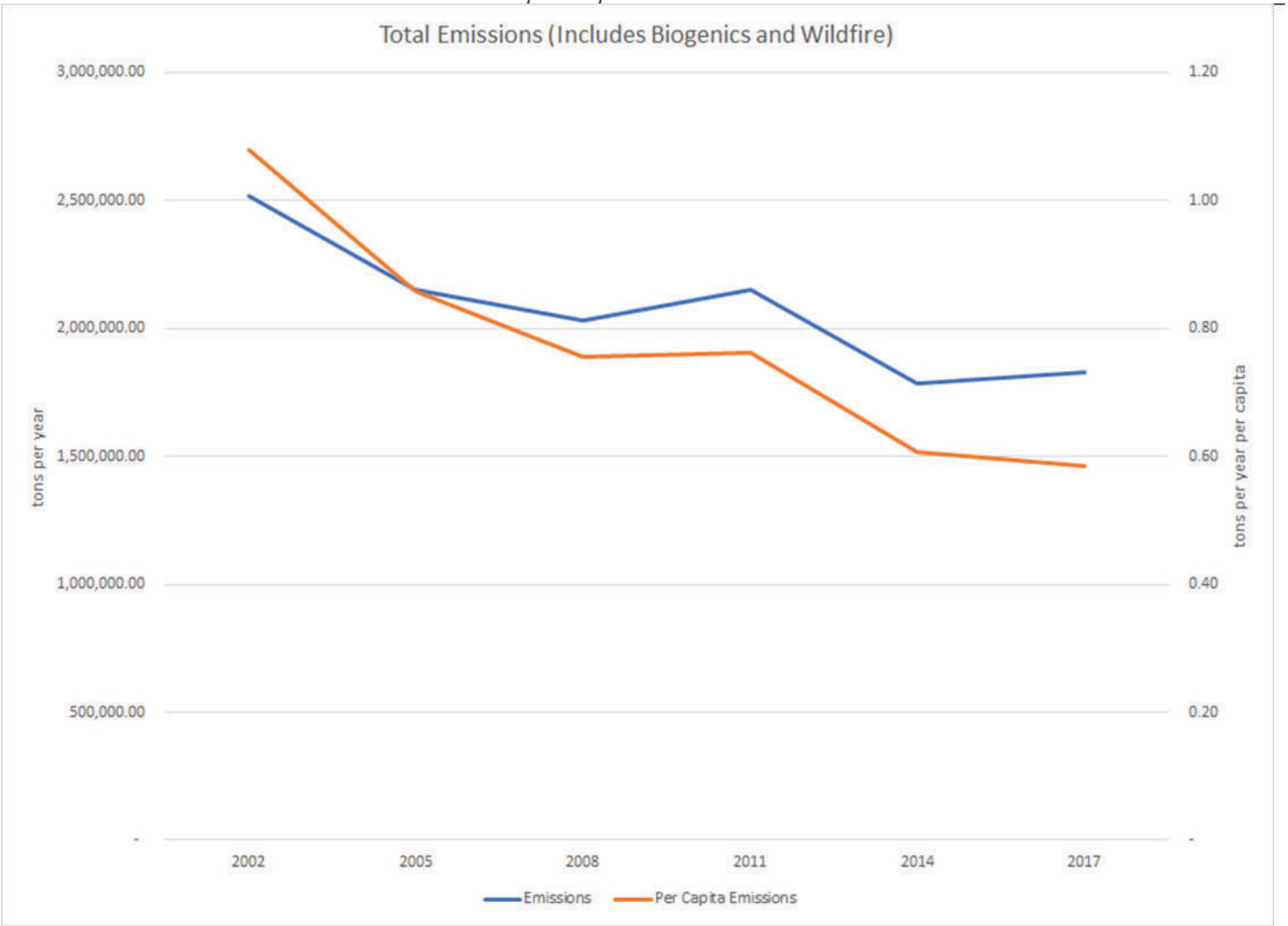
Emissions Inventories

Every three years, EPA develops the National Emissions Inventory (NEI), and requires each state to submit its inventory data into the NEI directly. To do so, the DAQ collects information about the quantity and characteristics of the various air pollutants released by all emission sources in the state. In addition to these triennial inventories, emissions information is also collected annually from the largest industrial sources to meet the fee requirements of Title V, Operating Permits, of the CAA, or requirements in various sections of the SIP. Finally, additional detailed inventories are prepared, as needed, for special projects such as SIP development, to quantify emissions during specific seasonal air pollution episodes. Much of this data is uploaded into the NEI annually, as available.

Once collected, the inventory information is reviewed, quality assured, analyzed, stored in the DAQ data system and the NEI, if required, and made available to the public. The DAQ uses this emissions information to review trends over time, as input data for air quality modeling analysis and as an indicator of the effectiveness of existing and projected control strategies.

Figure 19: Total Emissions

Figure 19 shows total statewide emissions (including all anthropogenic sources, biogenics, and wildfires) and per capita emissions from the same sources from 2002 through 2017. Despite a 34% increase in population over this period, total statewide emissions declined by 27.3%, resulting in a 45.7% reduction in per capita emissions.



Sources of Air Contaminants

Emission inventories are typically organized into three types of sources: Point, Area, and Mobile.

Point sources are stationary industrial or commercial sites, such as power plants, refineries, and manufacturing facilities. They emit more than 100 tons per year of a regulated pollutant, or are otherwise federally required to submit an inventory. Air pollutants released from these sources are reported directly to DAQ staff through the State and Local Emissions Inventory System (SLEIS). The mobile sector consists of emissions from non-stationary sources such as cars, trains, and aircraft. Mobile emissions are further broken down into on-road, non-road, and VOC refueling categories. On-road mobile sources primarily consist of personal and commercial cars and trucks, and contribute the largest part of the mobile source emissions. Non-road mobile sources consist of a diverse group of heavy construction equipment, small engines (lawnmowers and snow blowers), trains, and aircraft. VOC refueling emissions are vapors

released from gasoline tanks of mostly older vehicles without on-board refueling vapor recovery technology.

Estimating emissions from mobile sources requires understanding vehicle emission characteristics and knowing their model years. It is also necessary to know how they are driven, where they are driven, and the distances they are driven. On-road mobile sources produce about 39% of the annual man-made pollution (NOx, $PM_{2.5}$ exhaust, and VOC) along the Wasatch Front. Although heavy-duty diesel vehicles account for only 7.5% of the vehicle miles travelled, they produce over 30% of the pollution. Mobile sources have historically been the largest source of emissions in areas not meeting the NAAQS, but with the implementation of federal emissions standards and the introduction of Tier 3 fuel in Utah, this will change over the next few years.

Area sources are generally much smaller stationary sources, and due to their greater number, are generally accounted for in a group. However, as the NAAQS become more restrictive, it is necessary to start tracking emissions more closely from smaller industrial sources. Additionally, as mobile source emissions drop, area sources are quickly becoming the largest source of emissions. Home heating, agricultural burning and harvesting, construction, residential and commercial energy generation, wildfires, and biogenics (emissions from vegetation) are examples of area source categories. The upstream oil and gas inventory is unique in the area source inventory because rather than using surrogate activity data and generic emission factors, oil and gas companies submit an inventory for their facilities.

Triennial Emissions Inventory

Under current federal law, Utah is required to collect a statewide emission inventory every three years.

The 2017 triennial inventory is the most recent statewide inventory available. The 2017 triennial inventory covers 486 individual point sources, 128 area categories, 65 oil and gas categories, 32 on-road categories, and 215 non-road categories. Table 4 shows total emissions, by county, of the criteria pollutants, CO, NO_x, PM_{10}, $PM_{2.5}$, SO_2, and VOCs. Figure 16 shows the 2017 triennial emissions inventory in six pie charts, displaying the relative proportion of emissions generated within source categories.

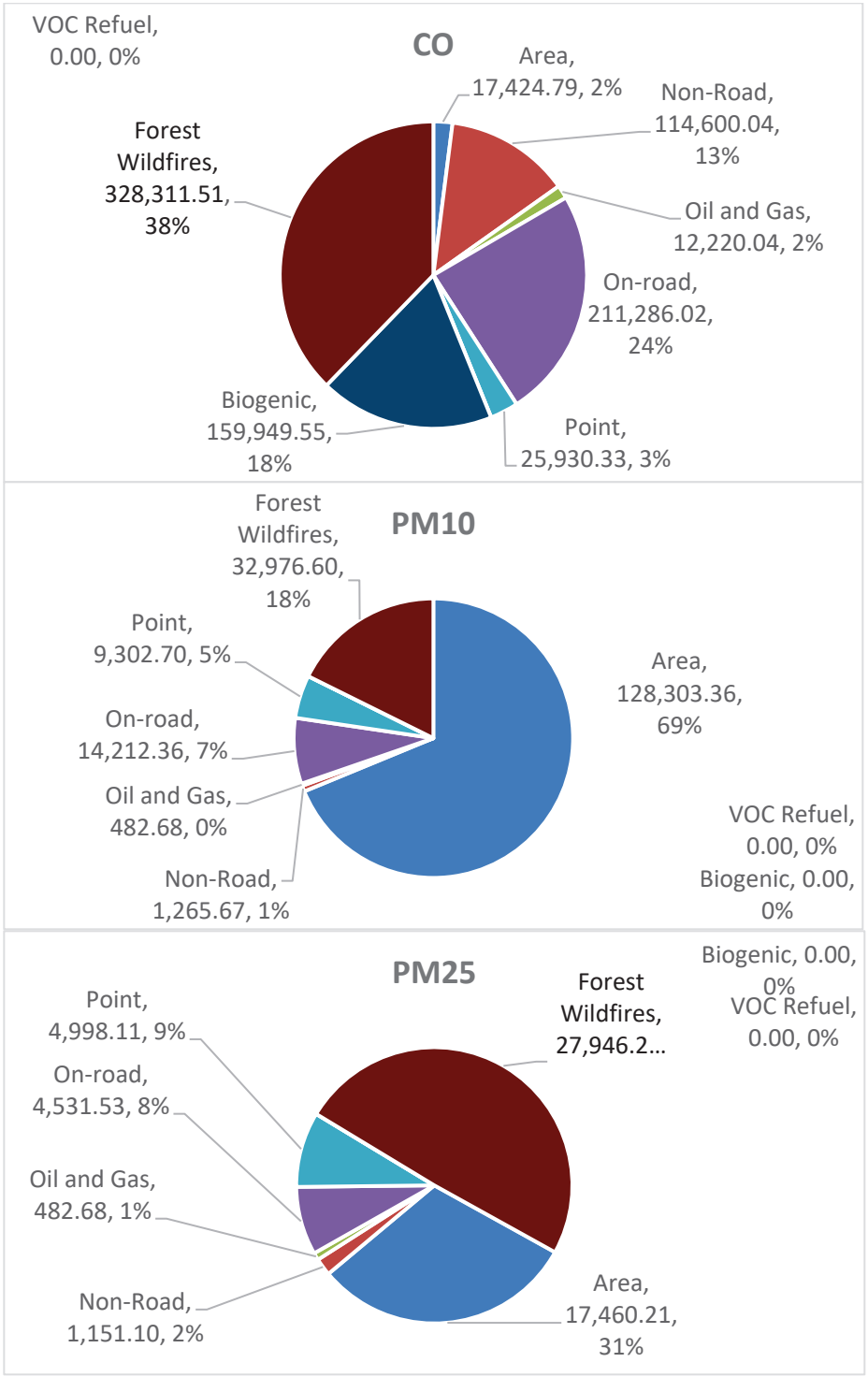
The figures in the charts represent statewide annual emissions and should not be compared to the inventories used in the $PM_{2.5}$ or other SIPs, which are seasonal and area specific. Biogenic and wildfire emissions produced from non-anthropogenic (non-human) natural activity are usually estimated as segments within the area source category, but have been listed separately due to their unique nature and impact.

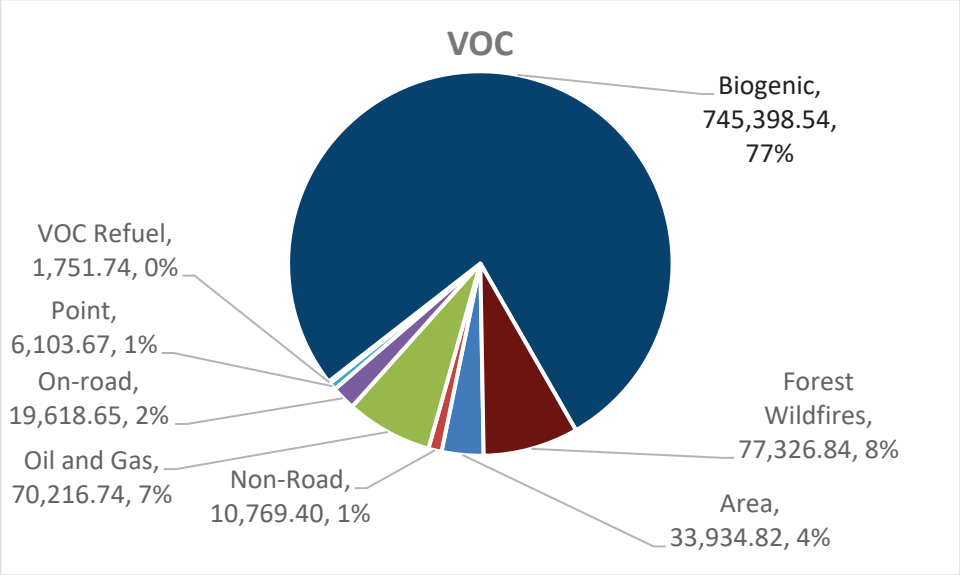
Table 4. 2017 Triennial Inventory (tons/year)

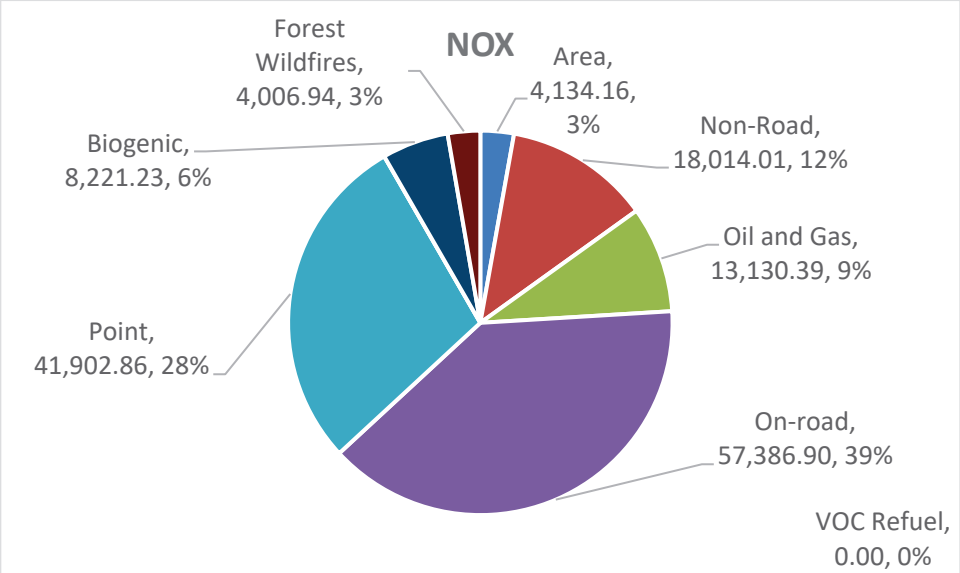
County Name	CO	NOx	PM_{10}	$PM_{2.5}$	SO2	VOC
Beaver	9,360.74	2,009.93	3,211.75	553.44	9.49	27,597.62
Box Elder	29,756.51	4,893.39	9,151.64	2,202.54	181.12	40,317.99
Cache	14,704.70	2,188.78	8,843.71	1,337.11	41.86	11,782.56
Carbon	7,606.01	2,620.92	4,464.61	645.22	488.50	17,147.58
Daggett	2,441.85	820.89	545.94	88.77	2.79	9,520.50
Davis	29,981.77	6,564.15	3,399.96	927.99	165.36	11,780.94
Duchesne	13,842.39	7,936.32	6,944.39	1,139.99	39.43	37,532.62
Emery	20,083.59	17,983.29	7,244.46	1,447.11	5,802.28	36,752.05
Garfield	53,913.49	1,289.40	6,983.94	4,006.81	321.32	55,625.73
Grand	13,709.56	2,736.21	3,801.89	518.30	7.59	40,977.97
Iron	252,692.12	6,362.13	27,887.93	20,471.68	1,560.09	90,072.73
Juab	12,444.25	2,495.00	2,531.27	472.68	18.52	33,614.21
Kane	11,520.10	884.30	3,695.19	452.89	8.09	42,417.16
Millard	28,407.38	15,312.98	6,705.59	2,018.81	2,536.65	64,439.92
Morgan	3,970.71	2,223.11	1,117.82	173.63	199.60	7,326.22
Piute	3,930.51	194.87	1,072.74	288.47	14.66	8,719.54
Rich	3,125.76	251.00	1,746.98	291.66	0.80	7,646.69
Salt Lake	109,695.71	24,583.24	17,073.58	4,358.27	2,486.93	29,580.19
San Juan	21,136.43	1,945.59	7,122.89	936.52	19.40	77,783.03
Sanpete	7,000.29	1,017.08	4,913.45	660.74	15.72	17,057.26
Sevier	10,203.59	1,805.23	5,185.07	926.44	41.59	18,504.12
Summit	13,290.35	3,708.91	3,714.32	814.08	168.80	17,241.56
Tooele	33,952.33	5,774.69	7,645.79	2,681.10	202.63	48,353.36
Uinta	19,666.77	7,907.88	6,882.60	1,243.95	39.48	93,036.36
Utah	76,172.07	11,694.28	17,367.10	4,895.68	312.07	36,544.60
Wasatch	7,122.20	1,090.87	4,029.14	571.15	11.94	13,626.37
Washington	28,966.24	4,944.07	7,440.27	1,201.15	36.47	39,292.90
Wayne	5,507.90	492.76	1,265.28	184.96	2.98	20,018.24
Weber	25,369.66	4,627.14	4,399.39	996.83	34.91	10,779.62
Total	**869,574.96**	**146,358.40**	**186,388.71**	**56,507.96**	**14,771.06**	**965,089.67**
Multiple (portable facilities)	147.32	438.10	154.66	61.89	76.53	30.72
Grand Total	**869,722.29**	**146,796.50**	**186,543.37**	**56,569.85**	**14,847.58**	**965,120.39**

The triennial inventory for 2017 changed this year because of updated EPA calculations for wildfires, locomotives, and airport equipment. Point sources were also subtracted from Area source data.

Figure 20. 2017 Triennial Emissions Inventory by Source Category – Statewide, Annual (tons/year)




VOC
Biogenic, 745,398.54, 77%
VOC Refuel, 1,751.74, 0%
Point, 6,103.67, 1%
On-road, 19,618.65, 2%
Oil and Gas, 70,216.74, 7%
Non-Road, 10,769.40, 1%
Area, 33,934.82, 4%
Forest Wildfires, 77,326.84, 8%


NOX
Forest Wildfires, 4,006.94, 3%
Area, 4,134.16, 3%
Non-Road, 18,014.01, 12%
Biogenic, 8,221.23, 6%
Oil and Gas, 13,130.39, 9%
Point, 41,902.86, 28%
On-road, 57,386.90, 39%
VOC Refuel, 0.00, 0%

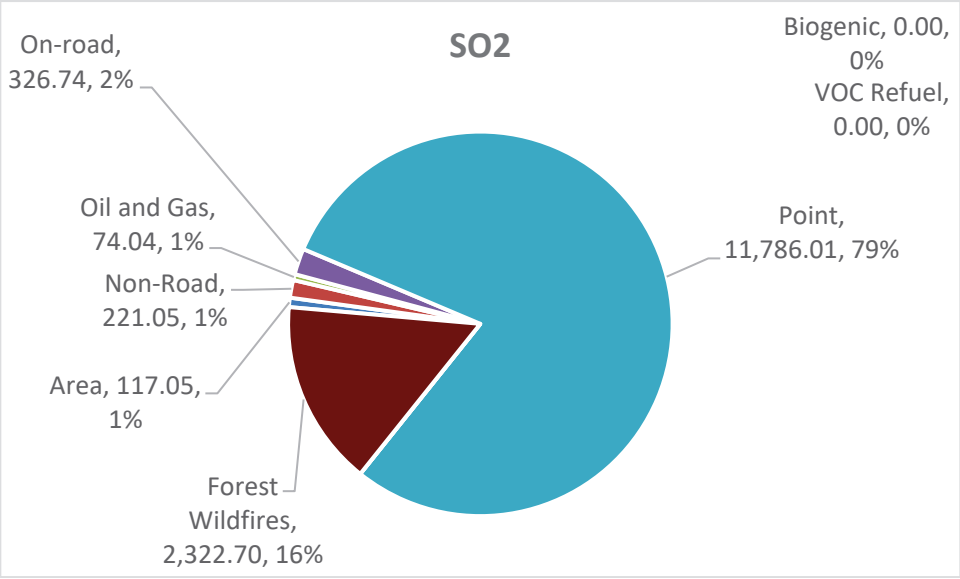
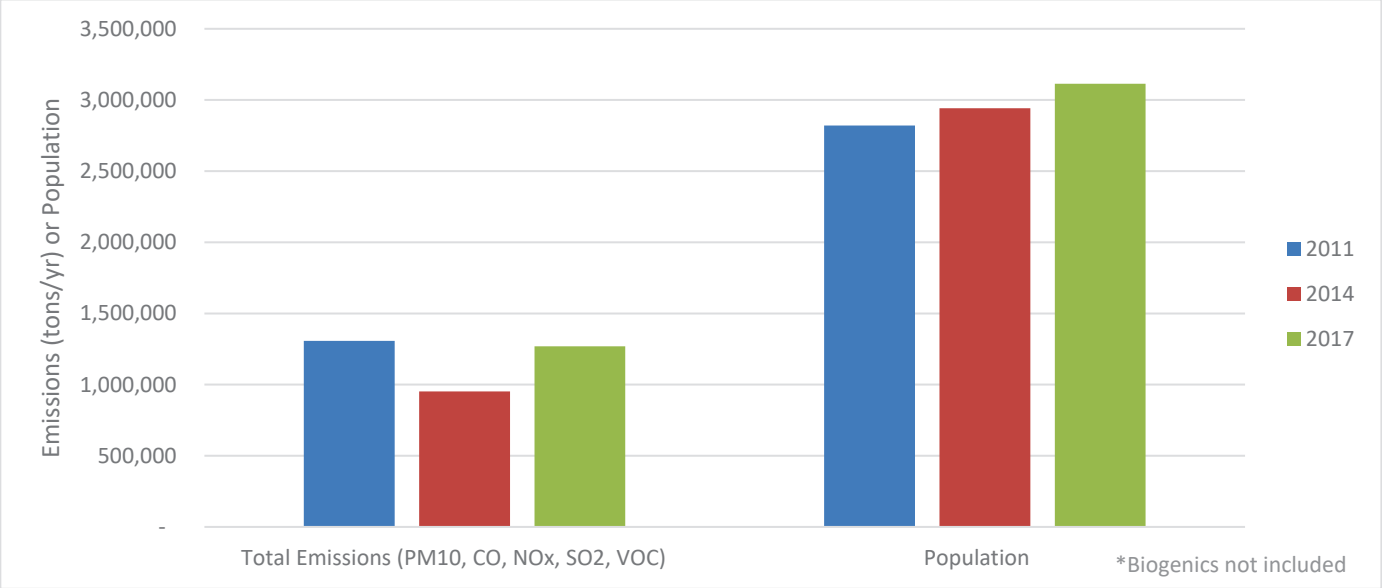

SO2
On-road, 326.74, 2%
Biogenic, 0.00, 0%
VOC Refuel, 0.00, 0%
Oil and Gas, 74.04, 1%
Point, 11,786.01, 79%
Non-Road, 221.05, 1%
Area, 117.05, 1%
Forest Wildfires, 2,322.70, 16%

Figure 21: Statewide Population Growth vs. Emissions Reductions



Division Organization

The DAQ is divided into three branches: Planning, Compliance, and Permitting.

The *Planning Branch* is responsible for developing and coordinating the implementation of comprehensive plans to reduce air pollution and collecting and analyzing the data necessary to show the effectiveness of those plans. The Planning Branch is organized into three sections. The *Air Monitoring Section* is responsible for establishing and operating the monitoring network to gather and analyze data used to determine ambient concentrations of air pollutants, as well as meteorological conditions when those pollution concentrations occurred. The *Inventory Section* has the primary responsibility to collect and collate emissions inventories in order to understand the origins of the various contaminants detected in the air. This includes both historic inventories and projection inventories, reflecting current and proposed control strategies. The *Technical Analysis Section* refines and analyzes available emissions inventories and monitoring data, using computer models to evaluate the impacts of new and existing sources of air pollution and to understand the relationship between the emissions, meteorology, and pollutant concentrations measured in the air for past, current and future pollution episodes. The Planning Branch is also involved in identifying the air quality impacts of transportation issues, which include vehicle inspection and maintenance, clean fuels, and highway construction. The *Air Quality Policy Section* uses this information to develop SIPs in order to ensure that Utah's ambient air comes into and remains in compliance with the federal health standards. Additionally, the Air Quality Policy section coordinates all of the rule-making activities of the Division, in addition to applying for and administering all grant and incentive programs to reduce pollution.

The *Compliance Branch* is responsible for ensuring that industries and residents comply with Utah's air quality rules and is comprised of three sections: *Major Source Compliance Section*, *Minor Source Compliance Section*, and *Air Toxics, Lead-Based Paint, and Asbestos Section (ATLAS)*. The Major and Minor Source Compliance sections are responsible for ensuring that all Utah air quality regulatory requirements are met. This is done through inspections and enforcement actions. ATLAS is responsible for the enforcement of federal and state regulations for preconstruction asbestos removal and a number of outreach and enforcement programs designed to reduce exposure to lead-based paint. Through the *Small*

Business Environmental Assistance Program (SBEAP), the Compliance Branch also assists small businesses in complying with state and federal regulations, including New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), New Source Review (NSR), and Utah's air quality rules. The SBEAP can advise small businesses on permitting requirements, emission calculations, technical issues, and pollution prevention techniques.

The *Permitting Branch* is responsible for issuing construction and operating permits to stationary sources that emit air pollutants, and is comprised of three sections: *Minor Source NSR*, *Major Source NSR*, and *Operating Permits*. Construction permits are issued to new or modified stationary sources of air pollution through the NSR program. Operating permits are issued on an ongoing basis through Title V of the CAA to "major" stationary sources.

Planning Branch

The *Planning Branch* is principally responsible for developing SIPs and administrative rules in order to ensure that Utah's ambient air meets the federal health standards, even as our population and our economy continue to grow. These plans address a variety of air quality issues, but most often focus on areas of the state where the monitoring identifies air quality that is unhealthy for one or more of the criteria pollutants. In addition to developing plans and rules, the Planning Branch is actively engaged in acquiring the funding for and administering and managing many projects and initiatives that are aimed at improving air quality throughout the State.



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Status of Projects and Initiatives

Air Quality Research Projects

Legislative funding for air quality research has provided DAQ with the resources to investigate the complex conditions that lead to high pollution levels during winter inversions and summer ozone episodes. Better understanding of the unique conditions that lead to poor air quality helps DAQ craft effective regulations, target emission sources, and apply appropriate emission-control technologies. In addition, this state funding is critically important for leveraging federal, state, private-sector sponsorships, and in-kind support for research initiatives.

In 2018, the Utah Legislature approved $500,000 in ongoing funding for air-quality research through the Science for Solutions Research Grant. This annual research funding will help DAQ improve its knowledge of the unique atmospheric and chemical conditions that contribute to air pollution in Utah.

For detailed information about DAQ's applied air quality research projects, please visit our website at: aqresearch.utah.gov

Current Research Projects (FY 2021)

Five air-quality research projects were funded for fiscal year (FY) 2021 by the state legislature through the Science for Solutions Research Grant:

Emissions of Reactive Organics from Natural Gas-Fueled Engines

Utah State University scientists will improve estimates of the magnitude and composition of emissions from natural gas-fueled artificial lift engines used for oil extraction in the Uinta Basin. Recent ambient air measurements have implicated natural gas-fueled engines as a large source of reactive organics, including formaldehyde, ethylene, propylene, and other compounds. The results from this project will allow DAQ to better understand and model this source of ozone-forming pollution in the Uinta Basin and develop science-based, effective emissions reduction strategies for wintertime ozone.

Vertical Ozone Profiles in the Uinta Basin and Validating Drones as an Air Measurement Platform

The University of Utah will conduct vertical ozone profile measurements from ground level to the mid-stratosphere to develop a better understanding of ozone layers and evolution over Utah. Data collected by drones and balloons will provide information on the vertical distribution of ozone and nitrous dioxide (NO_2) among other gases. This data will be used by DAQ to inform policy and decision makers.

Quantitative Attribution of Wildfires on Summertime Ozone Concentrations along the Wasatch Front

Wildfires can significantly enhance summertime ozone and aerosol concentrations, which can degrade air quality and have adverse effects on human health. While air quality has improved across much of the U.S., the Western U.S. has seen a recent increase in wildfire activity. This project will assess the contribution of regional fires and long-range smoke transport to poor air quality in the Salt Lake Valley. This study will also improve our understanding of how wildfires interact with urban plumes, improve air quality modeling capabilities, and guide the implementation of effective regulatory policies.

Halogen Sources and their Influence on Winter Air Pollution in the Great Salt Lake Basin

The Great Salt Lake Basin is meteorologically and chemically distinct from other regions in the U.S. It is subject to both persistent cold air pools in complex terrain that lead to winter air pollution and potentially large inputs of natural and anthropogenic sources of halogen species. This project will investigate the role of these halogen sources in regulating the severity of winter fine particulate matter ($PM_{2.5}$). Results from this study will improve estimates of halogen emissions and enhance Utah DAQ's understanding of winter $PM_{2.5}$ chemistry.

Winter Measurements of Heavy-duty Vehicles to Characterize the Cold Temperature Effectiveness of Selective Catalytic Reductions Catalyst in Controlling Oxide of Nitrogen Emissions

The Salt Lake City region in Utah experiences periods of high particulate levels in the winter months due to the combination of its topography, winter atmospheric inversions and local emissions. Secondary nitrate particles comprise the dominant fraction of the particles in these episodes and are the result of the reaction of oxides of nitrogen (NO_X) with ammonia. A significant fraction of NO_X emissions in the Salt Lake City area are produced by heavy-duty vehicles operating in or traveling through the area on the interstate highway system. This study will measure wintertime NOx emissions from local heavy-duty vehicle activity in order to improve Utah DAQ emissions inventory estimates and better inform policy.

Goals and Priorities (FY 2022)

DAQ has recently sent out a Request for Proposals (RFP) for soliciting new applied air quality research projects. In order to meet Utah's upcoming regulatory challenges, DAQ will look to fund air quality research projects that prioritize one or more of the following seven goals:

Source Contributions to Summer-Time Ozone

The Wasatch Front often experiences exceedances of the national ambient air quality standard for ozone during the summer. Regulating locally-formed ozone to reach attainment is complicated by the fact that ozone has a mix of different sources. These include stratospheric transport, wildfires, biogenic emissions as well as international and US anthropogenic sources. To help establish control regulations, more measurements are needed to determine the contributions from these sources to high summer-time surface ozone.

$PM_{2.5}$ Formation and Precursor Gases

To better inform air pollution control strategies in northern Utah, it is necessary to understand the complex chemical processes that contribute to secondary $PM_{2.5}$ formation. Secondary $PM_{2.5}$ accounts for over 70% of total $PM_{2.5}$ during wintertime air pollution episodes. It is produced from complex atmospheric chemistry that involves several different gaseous compounds. UDAQ would like to better understand and quantify the sources of compounds contributing to wintertime air pollution along the Wasatch Front and Cache Valley. Information on their spatial, temporal and vertical distribution as well as photolysis rates is also needed.

Physico-Chemical PM Composition

Supermicron particles, such as dust and chloride salts, can serve as area sources of halogens and condensational sinks for gas-phase nitric acid (HNO_3) thereby controlling the formation of secondary $PM_{2.5}$ when present in sufficient mass loading. To better understand the role that these fine and coarse-mode aerosols play in wintertime $PM_{2.5}$ atmospheric chemistry, more information is needed on size-resolved PM chemical composition, mass loading, and gas-particle partitioning.

Emissions Inventory Improvements

Recent studies along the Wasatch Front and Uinta Basin highlighted discrepancies between inventory estimates and measurements of several key precursors to the formation of ozone and $PM_{2.5}$. These include carbonyls, hydrocarbons, alcohols, halogens and ammonia, among others. Reconciling differences between inventory estimates and observations is needed for improved modeling of ozone and $PM_{2.5}$. Improved representation of emission sources and their estimated activity, spatio-temporal distribution and chemical speciation is particularly needed.

Air Exchange Processes and Pollutants Mass Transport

Air mass exchanges are important meteorological processes affecting the transport of air pollutants. Air exchanges across the Great Salt Lake, different Utah valleys, and canyons as well as between the polluted boundary layer and free troposphere affect the transport and mixing of key precursors to $PM_{2.5}$ and ozone. Regional meteorological processes also lead to long-range transport of ozone and its precursors. A more detailed characterization of these processes and their impact on air pollutants chemistry is needed. Better estimates of the mass transport of air pollutants, such as halogens and ammonia, are also needed.

Air Quality and Meteorological Model Improvements

Air quality models remain important tools for guiding policy makers in preparing State Implementation Plans to demonstrate compliance with federal air quality standards. Modeling enables UDAQ to demonstrate and quantify the effectiveness of future emissions control strategies. Better representation of the complex meteorological features, chemical mechanisms and physical processes associated with wintertime and summertime air pollution episodes is needed.

Toxic Urban Air Pollutants

Davis County has a large industrial complex with multiple oil refineries, chemical facilities and manufacturing industries. Given their close proximity to these sources, communities in this area are at high risk of exposure to air toxics. Identifying sources of these toxic pollutants is essential to reduce their emissions and associated risks. Compounds of particular interest include dichloromethane and formaldehyde. While previous source apportionment studies provided insight on emission sources of these air toxics in the Bountiful area, near-source monitoring is needed for better source identification.

General Updates

PM_{10} Redesignation

In 1987, the EPA defined a size "indicator" of the suspended particles that were of concern to public health. These were "fine" particles with an aerodynamic diameter of ten microns or less, and this regulated subset of total suspended particles was called PM_{10}. Both Salt Lake and Utah Counties were out of compliance with the EPA's new 24-hour health standard for PM_{10}. In 1991, the Board developed a SIP for each area. Both SIPs were successful, and by 1996 both areas were found to be attaining the standard. Ogden City was designated as moderate nonattainment in 1995; however, a clean data determination was approved and SIP elements were suspended.

In 1997, the EPA replaced PM_{10} as the indicator of fine particulate matter with a sub-set of particles having an aerodynamic diameter of only 2.5 microns or less. This would be known as $PM_{2.5}$. Both PM_{10} and $PM_{2.5}$ include a complex mixture of extremely small particles and liquid droplets. These particles can be emitted directly, as in smoke from a fire. Such particles are referred to as "primary" particulate. The particles can also form in the atmosphere when "precursor" gases such as SO_2, NO_x, VOCs, and ammonia undergo complex chemical reactions. The particles that form during these chemical reactions are referred to as secondary particulate. Secondary particulate is prominent during Utah's winter inversions.

The PM_{10} standard for controlling fine particulate is less restrictive than the $PM_{2.5}$ standard in Utah. However, the DAQ spent considerable effort developing what are called Maintenance Plans for Utah's three PM_{10} nonattainment areas. These areas include the Salt Lake County, Utah County, and Ogden City nonattainment areas (see Figure 2). The plans use air modeling to demonstrate at least ten years of continued compliance with the PM_{10} health standard.

No additional emission controls were needed to demonstrate the ten years of compliance. Certainly though, the emission controls recently adopted by the Board to address $PM_{2.5}$ will have a positive effect on PM_{10} levels. The maintenance plans were submitted to EPA in 2016 and on March 27, 2020, the EPA redesignated the three former nonattainment areas to attainment status. The areas are now in the first of two 10-year maintenance periods.

Reclassification of Utah's $PM_{2.5}$ Nonattainment Areas

With the $PM_{2.5}$ NAAQS lowered in 2006, Salt Lake City, Provo, and Logan areas were classified as moderate nonattainment. Moderate SIPs were submitted to EPA; however, Salt Lake City and Provo failed to attain the 24-hour standard (35 $\mu g/m^3$) as of the statutory attainment date of December 31, 2015. As a result, EPA reclassified these areas from moderate nonattainment areas to aerious nonattainment areas. Action to reclassify these areas was not unexpected. In fact, the moderate area SIPs for the Salt Lake City and Provo nonattainment areas demonstrated that it would be impracticable to attain by the statutory attainment date. The plan for the Logan nonattainment area did predict attainment by 2015. The EPA granted two one-year extensions to the moderate area attainment date for the Logan nonattainment area, extending the attainment date to December 31, 2017. The Logan nonattainment area did attain the standard by December 31, 2017. EPA proposal for redesignation of the Logan nonattainment areas is expected in early 2021.

Reclassification to serious nonattainment required Utah to revise its implementation plans. The serious area SIP amendments reach beyond the level of emission controls determined to be "reasonably available" which were included in Utah's moderate area SIPs, and achieve a level defined as the "best available." The additional controls implemented through the serious SIP, coupled with favorable meteorology brought the areas into attainment of the standard by the attainment date of December 31, 2019.

Attainment of the standard does not mean the area is reclassified to attainment status. The EPA must act to redesignate an area from nonattainment to attainment status. The CAA outlines five requirements that a nonattainment area must satisfy for redesignation to occur.

1. Attainment of the Standard
2. Fully Approved Attainment SIP
3. Improvement in Air Quality is due to Permanent and Enforceable Emissions Reductions
4. The State has met requirements applicable to the area under CAA Section 110 and part D
5. Fully Approved Maintenance Plan

All regulatory requirements for redesignation have been met for all three areas, with the maintenance plan being the core requirement for redesignating areas to attainment. The plans demonstrate continued attainment of the standard through 2035 with an intermediate year check in 2026. Eight years after redesignation, UDAQ is required to submit a maintenance plan revision demonstrating attainment for the second 10-year maintenance period.

EPA has proposed that the Salt Lake and Provo nonattainment areas be redesignated to attainment status. The final rule is expected to be published in the Federal Register in early 2021. The Logan nonattainment areas will likely be proposed for redesignation to attainment in early 2021 as well.

Wasatch Front Ozone

When EPA developed the first NAAQS for ozone in 1979, Salt Lake and Davis counties designated as nonattainment areas for that 1-hour standard. Following that first designation, both Salt Lake and Davis counties met the standard and were redesignated to attainment. Since 1979, the EPA changed the ozone NAAQS in 1997, 2008, and 2015. All areas of Utah met the 1997 and 2008 standards.

With a change in the ozone NAAQS in 2015, the EPA designated three nonattainment areas in Utah. Two of the nonattainment areas are on the Wasatch Front: one in Utah County and another that includes Salt

Lake, Davis, and parts of Weber and Tooele counties. The official nonattainment designations occurred in 2018.

In partnership with local universities and the EPA, several local studies have helped staff better understand ozone formation and transport along the Wasatch Front. Some of the studies' conclusions are:

- Ozone formation is associated with clear, sunny summer days with little wind.
- On a seasonal basis, the Wasatch Front experiences some transport of ozone and its precursors from upwind states and international sources, although the impact of that transport during high ozone periods is still being analyzed.
- The Great Salt Lake and diurnal wind patterns contribute to ozone formation.
- Vehicles are the largest source of NO_x.
- A large portion of VOCs come from biogenics (natural sources such as plants).
- Elevated ozone coincided with elevated levels of VOCs and NO_x, which are the primary chemical precursors of ozone formation.

Based on monitoring data from 2018, 2019, and preliminary data from 2020, Utah County is currently attaining the standard. Ozone monitors along the Wasatch Front continue to show exceedances of the current ozone NAAQS in Weber, Davis, Tooele, and Salt Lake counties. These counties are likely to be reclassified from marginal to moderate nonattainment status after August 2021. DAQ has already begun planning efforts for the required moderate area SIP, including creating a detailed inventory of emissions from the nonattainment area. DAQ is looking into the feasibility of an international transport demonstration as a means to account for the impact of international emissions on Utah's ability to attain the ozone standard on the Wasatch Front. It is unclear whether the Wasatch Front is unduly impacted by international emissions on days that the state exceeds the standard. Regardless of the impact, DAQ is committed to doing what it can to attain the ozone standard.

Uinta Basin Ozone

The EPA and DAQ have been monitoring ozone levels in the Uinta Basin (Basin) since about 2009 and have been working towards greater understanding of the wintertime ozone phenomenon since first observing the elevated levels. Several years of study have established the following thoughts on ozone formation in the Basin:

- Ozone formation is associated with stable meteorological conditions, snow cover, and sunshine.
- NO_x comes from hot combustion sources, and the highest levels are in the oil production areas and population centers.
- VOC comes from oil and gas production with the highest levels in the gas production areas.
- There is high year-to-year variation in ozone levels due to variation in meteorological conditions, principally snow cover.
- Elevated ozone coincided with elevated levels of VOCs and NO_x, which are the primary chemical precursors of ozone formation.
- Complex patterns of light winds within the Basin appear to produce an east-west "sloshing" of air that contributes to intra-basin mixing of ozone and ozone precursors.
- Chemical reactions during these winter episodes differ greatly from summer ozone formation in urban areas.
- Aromatic VOCs such as toluene and xylene contribute in secondary formation of wintertime ozone pollution in the Basin; therefore, VOC control measures focused on these types of VOCs will be particularly effective.
- Formaldehyde (HCHO) and other aldehydes are the dominant radical sources needed for ozone formation and are important chemical species to control.

Research funding was used for an aerial helicopter study of oil and gas sources on both Indian and state lands combined with ground observations in the winter/spring of 2018. This was a cooperative study between the Ute Tribe, BLM, UDAQ, and EPA and provided further understanding of where potential emissions from oil and gas production equipment can originate. Unfortunately, the cold winter and snow resulted in less than optimal results. A study into the composition of VOC emissions from oil and gas wells in the Basin began in the fall of 2018 and sampling went into 2019. A thorough evaluation of the results of this study by a technical team of EPA and UDAQ staff, with coordination with the Ute Tribe, led to revised emissions factors for oil and gas sources and an update to the 2017 Uinta Basin Oil and Gas Emission Inventory (UBOGEI). This provides a more accurate data set for use in upcoming photochemical modeling and development of control strategies to help bring the Basin into attainment with the 2015 ozone standard. Additionally, through permitting requirements and sampling requests by EPA, a large number of samples from produced water disposal ponds have been collected and provided a larger, technically valid data set to also update the value estimated in the 2017 UBOGEI. This update added a significant increase in total annual VOC's for the Basin.

An EPA sponsored targeted airshed grant was awarded to DAQ in 2019 that would help fund the replacement of older natural gas engines that support oil and gas operations in the Basin with newer, cleaner natural gas engines. There are large amounts of older engines in the Basin which, even though they are smaller in horsepower (25 to 100 HP), emit significant emissions of VOCs in the airshed. This replacement program was funded at 5 million dollars. Unfortunately, no one has applied for this grant in 2020 potentially due to the decrease in production and economic impact of the COVID-19 pandemic. However, the feedback from operators also indicated that to replace these engines with newer, larger engines is not practical as the power needed is so small that those engines would be too much for the facility. DAQ is working with EPA and operators on other options that would work within the requirements of the grant.

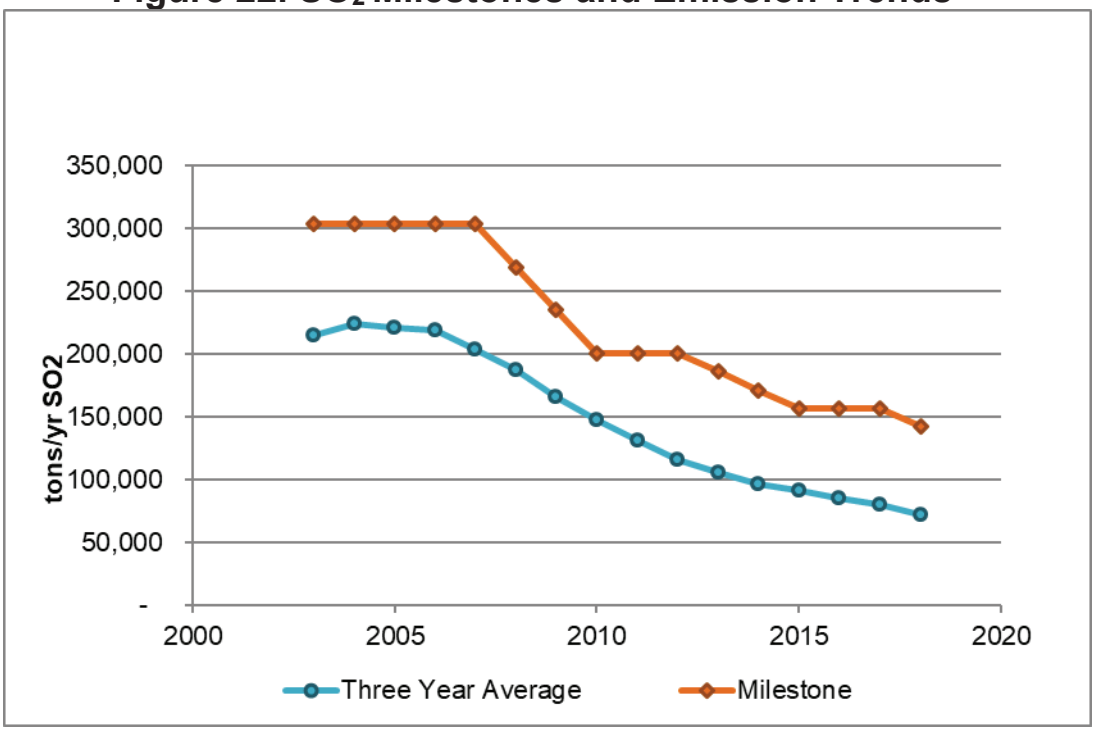
On August 3, 2018, the EPA designated the Uinta Basin as an ozone nonattainment area with a marginal classification. This will require attainment of the 2015 ozone standard by August 3, 2021. Unfortunately, several monitors in the Basin measured high levels of ozone during a strong inversion in February 2019. These monitored levels indicate that it will almost be impossible for the Basin to attain the ozone standard by 2021. Therefore, the DAQ, EPA, and Ute Tribe are beginning to plan for the likely bump up in nonattainment classification from marginal to moderate. This bump up would most likely occur around February of 2022 with a moderate SIP due in February of 2023. The moderate SIP will require additional controls and a modeled attainment demonstration of the standard by August of 2024. The understanding of the emissions and sources of the ozone precursors VOCs and NOx will be the stepping stones to control strategies and future regulations included in the SIP. Information gathered from the 2017 oil and gas emission inventory will be vital to understanding emissions that contribute to ozone formation in the Basin.

There were no ozone exceedances monitored in the Basin in 2020 and as such the Basin will be eligible for requesting a one-year extension on the current attainment date of August 3, 2021. However, the data still indicates that the Basin will not attain by August 3, 2022. If there are no exceedances in 2021, there would be the option of a second-year extension and the possibility of attainment by August 3, 2023. In the meantime, UDAQ continues to plan for the potential bump up to a moderate classification and the need for a SIP. Planning includes contacting sources that will need to implement Reasonably Available Control Technology (RACT) requirements, and preparing projected and episodic inventories to support the development of a working photochemical model for the Basin.

Regional Haze SIP

Utah's Regional Haze Plan includes regional targets for SO_2 emissions, with a backstop-trading program to ensure that the emission reduction goals are achieved. Each year, the states participating in the program compile an inventory of SO_2 emissions and then compare the emissions to the milestones established in the plan. The regional emissions for 2018 were 71,994 tons, 51% below the milestone. The emissions are far below the milestone due to the early installation of emission controls at power plants and other emission sources. The region has been well below the milestone every year of the Regional Haze program as shown below. Though 2018 was the final milestone for this program, it is still a requirement in the SIP. Therefore, Utah and the other participating states will continue to submit an annual SO_2 report.

Figure 22. SO_2 Milestones and Emission Trends



The Regional Haze Plan also includes a section addressing long-term strategies for reducing haze-causing emissions from stationary sources. In 2015, the Board approved an updated version of the stationary sources section called Alternative to BART (Best Available Retrofit Technology) that had been developed in close cooperation with staff and management from EPA Region 8. After a long review period, the EPA headquarters decided to disapprove portions of the plan and issue a Federal Implementation Plan (FIP) in its place. The Utah Attorney General's Office, PacifiCorp, and other entities challenged the disapproval in court. EPA recently reconsidered the decision. EPA approved the final portion of Utah's Regional Haze SIP for the first planning period on November 27, 2020. With the approval, EPA also found "that Utah's SIP fully satisfies the requirements of section 309 of the Regional Haze Rule and therefore the State has fully complied with the requirements for reasonable progress, including BART, for the first implementation period.

The SIP for the second Regional Haze Planning Period (2021-2028) is due July 2021. The DAQ is working with western states through the Western Regional Air Partnership to complete the technical work required for this SIP. The DAQ is working with various sources to determine what emission controls may be necessary to achieve reasonable progress during this second planning period.

Air Quality Incentive Programs

The DAQ administers several incentive programs created to encourage individuals and businesses to voluntarily reduce emissions. Funding for these programs comes from various sources, including settlement agreements, legislative appropriations, and federal grant programs. The following sections provide a summary of each program. More information on these programs is available online at airincentives.utah.gov.

Targeted Air Shed Grants

Through congressional appropriations, EPA provides funding opportunities to the top five most polluted nonattainment areas for ozone, annual $PM_{2.5}$, or 24-hour $PM_{2.5}$ standards through competitive grants, also known as Targeted Air Shed grants. Successful recipients use the funding to reduce air pollution in their nonattainment areas. UDEQ was a recipient of these funds in 2016, 2017, and 2018 for targeting emissions in the state's three nonattainment areas for the 24-hour $PM_{2.5}$ standards: Logan, Salt Lake, and Provo and the Uinta Basin nonattainment area for wintertime ozone.

School Bus Replacements

School buses were part of the focus in 2016 for the Logan and Provo nonattainment areas. UDEQ received $2,477,250 for 35 diesel school bus replacements in the Cache County/Logan City School District and 10 diesel school bus replacements in the Provo School District. In 2017, $3,184,875 was awarded to UDEQ for heavy-duty diesel truck replacements in the Logan, UT, nonattainment area. Cache County and Hyrum, Logan, Nibley, and North Logan cities will replace 16 heavy-duty diesel trucks with this funding, with over $1,090,000 still available for new projects.

The school bus replacement projects are estimated to reduce emissions by nearly 70 tons per year and over 1,942 over the lifetime of the projects. The heavy-duty diesel truck replacement projects are estimated to reduce emissions over 94 tons per year and over 1,790 tons over the lifetime of the projects.

Vehicle Repair and Replacement Assistance Program

In March of 2017, EPA awarded $2,477,250 to DEQ for the Logan, Utah-Idaho Nonattainment Area and in September of 2019, EPA awarded $4,698,489 to DEQ for the Salt Lake City, Utah Nonattainment Area. Money from these grants fund a vehicle repair and replacement assistance program (VRRAP). An individual whose vehicle does not pass an emissions test may receive financial assistance from the VRAAP to replace the failed vehicle with a newer, cleaner one or to repair it so that it passes a subsequent emissions test. The amount of financial assistance depends on household income, household size, and whether the applicant chooses to replace or repair the failed vehicle. Financial assistance can be as high as $5,000 for a vehicle replacement or $1,000 for a repair. The program is administered by the Bear River Health Department in the Logan, UT-ID Nonattainment Area, with the Davis, Salt Lake, and Weber-Morgan Health Departments administering the program in the Salt Lake City, UT Nonattainment Area.

The Salt Lake City VRRAP had planned to start Spring/Summer 2020; however, COVID has delayed program implementation until 2021. The Logan VRRAP officially opened for the public on April 20, 2017. As of September 30, 2020, the VRRAP has repaired 824 and replaced 189 vehicles. These activities are anticipated to reduce emissions annually by 8.12 tons of NMOG, NO_x, and PM and reduce lifetime emissions of NMOG, NO_x, and PM by 59.40 tons.

Uinta Basin Non-Road Engine Replacement Assistance Program

In October 2019, EPA awarded DEQ a Targeted Air Shed Grant of $5 million to administer an incentive program called the Uinta Basin Non-road Engine Replacement Assistance Program. The Program aimed to provide financial assistance of up to 40% of the cost to replace pre-2008, non-road, natural gas engines supporting oil and gas production with newer, cleaner engines. DEQ intended to work and partner with the Ute Tribe and oil and gas producers to reach out to all potential applicants and eligible energy production equipment. However, the future of the $5 million Uinta Basin TAG is uncertain. Unfortunately, DEQ has not been able to garner interest in oil and gas producers investing in natural gas engine upgrades. We believe this is mainly because many producers would have to purchase larger-powered engines in order to comply with our current rules. Doing so would significantly over-power their sites which is understandably unappealing to them. An amendment to this grant is likely. Alternative projects are being explored and their viability evaluated. DEQ remains in communication with EPA to discuss the amendment process and project suitability.

Wood Stove Conversion Program

The DAQ's wood stove and fireplace conversion program helps residents, particularly low-income households, reduce their emissions from burning wood by providing financial assistance to convert their wood burning devices to cleaner-burning devices. Residents in Utah's $PM_{2.5}$ nonattainment areas are eligible to participate. The conversion program plays an important role in reducing emissions as one wood stove is shown to emit as much as 100% more than its gas-powered counterpart. Although monitoring data shows that all three nonattainment areas have attained the 24-hour $PM_{2.5}$ NAAQS, wood-burning remains a major contributor to particulate pollution. Woodstove conversions will help ensure the areas continue to attain the standard in the future.

The wood stove and fireplace conversion program started in December 2017 after the EPA awarded Utah just over $9.5 million through a competitive Targeted Airshed Grant. Originally scheduled as a five-year program, demand has outpaced funding, and the grant funds will be spent well before the five-year mark. The Salt Lake City, Provo, and Logan nonattainment areas all received approximately $3.2 million for conversions. Approximately 900 conversions have been completed in the Salt Lake area, and the Provo and Logan area projects will be completed in early 2021, with similar numbers. The emission reduction estimates will be calculated upon grant completion.

During the 2019 legislative session, the State Legislature identified the continued replacement of wood burning devices with cleaner-burning devices as a key strategy to continued improvement in air quality throughout the State. As a result, they allocated an additional $9 million to augment the wood stove and fireplace conversion program.

The program has gained overwhelming popularity with the public and participation response to the programs have exceeded all expectations. As of the end of December 2020, DAQ has completed over 3,039 projects with the combined funding. More information on the program, including eligibility requirements and registration dates, is available at stoves.utah.gov.

Electric Vehicle Supply Equipment (EVSE) Projects

Workplace Electric Vehicle Charging Funding Assistance Program

During the 2019 General Legislative Session, the State Legislature appropriated $4.9 million to incentivize the installation of electric vehicle supply equipment (EVSE) throughout the State. The EVSE incentive program allows businesses, non-profit organizations, and other governmental entities (excluding State Executive Branch agencies) to apply for a grant for reimbursement of up to 50% of the purchase and installation costs for a pre-approved EVSE project. Funds can be used for the purchase and installation of both Level 2 or DC fast charging EVSE.

The program began to accept applications on September 16, 2019. As of December 9, 2020, 12 projects totaling just over $350,000 have been completed, with 75 Level 2 and nine DC fast EVSE installed throughout the State. DAQ has pre-approved an additional 29 projects encumbering approximately $775,000 of the available funds.

Volkswagen (VW) EVSE

As a result of the VW settlement described in the section below, the DAQ has awarded over $3.8 million to 18 government entities to install 96 level 2 and 26 DC fast chargers throughout Utah. As of December 14, 2020, 46 Level 2 and 11 DC fast chargers have been installed. More details on the VW Settlement and the VW EVSE program are provided in the section below.

Volkswagen (VW) Settlement

In 2015, the United States (U.S.) Environmental Protection Agency (EPA) issued two notices of violation of the CAA to Volkswagen Group[3] (Volkswagen or VW), the German automotive manufacturer. The EPA asserted that VW installed software that activated emissions controls only while undergoing emissions testing, but rendered certain emissions controls inoperative during normal driving conditions. Consequently, approximately 500,000 2.0-liter diesel vehicles (models 2009 to 2015) and 90,000 3.0-liter diesel vehicles (models 2009-2016) sold across the U.S. emitted between 9 and 40 times the nitrogen oxides (NO_x) emissions allowed by federal law[4].

Utah received approximately $35 million from a nationwide settlement with VW for violations of the CAA. Utah's portion will help offset excess nitrogen oxides (NO_x) emissions from the approximately 7,000 VW, Audi, and Porsche vehicles in the state affected by the automaker's violations.

The DAQ estimates that these excess NO_x emissions contributed between 351 to 1,556 tons of NO_x over the span of time they were operating in Utah. Approximately 70 percent of the affected vehicles were registered in the seven counties designated as nonattainment for particulate matter ($PM_{2.5}$) under the National Ambient Air Quality Standards.

Governor Herbert designated the DEQ as the lead agency to administer these monies. DEQ's responsibilities as lead agency include the development of an Environmental Mitigation Plan (EMP). On behalf of the DEQ, the DAQ oversaw this process and invited the public to provide input on the EMP and worked with an advisory committee on recommendations.

The VW settlement included a prescribed list of categories for NO_x mitigation projects. DAQ crafted an EMP using these guidelines, input from the public, and recommendations from an advisory committee. Final selection of Eligible Mitigation Action (EMA) categories was based on the advisory committee's recommendations, public input, and DAQ goals:

- To achieve significant NO_x reductions that work toward fully mitigating the excess lifetime NO_x emissions from the non-compliant VW vehicles and contribute to the State's ongoing goal of reaching attainment of the NAAQS.
- To maximize the amount of emissions reductions for each dollar spent.
- To benefit areas in Utah that bear a disproportionate amount of the air pollution burden.
- To stimulate emerging vehicle technologies that result in long-term emissions benefits.
- To provide economic and health benefits to the citizens of Utah.

The plan focuses the $35 million settlement funds on upgrades to government-owned diesel truck and bus fleets as well as the expansion of electric-vehicle (EV) charging equipment. Funding allocations are as follows:

- Class 4-8 Local Freight Trucks and School Bus, Shuttle Bus, and Transit Bus: 73.5%
- Light-Duty, Zero Emissions Vehicle Supply Equipment: 11%
- Administrative Costs: 8.5%
- Diesel Emission Reduction Act (DERA) options: 7%

Applications for funding were available from October 1, 2018, to November 30, 2018. Government entities as defined in Utah Code § 63G-7-102(4) and federal government agencies were eligible to apply.

DAQ received 50 applications for the Class 4-8 Local Freight Trucks, School Bus, Shuttle Bus, and Transit Bus categories and 25 applications for the Light-Duty, Zero Emissions Vehicle Supply Equipment category with combined projects totaling over $71 million. Projects were prioritized and selected based on their reduction of nitrogen oxides (NO_x), cost-per-ton of NO_x reduced, value to the nonattainment areas and community benefits. Successful projects are shown in the subsequent tables. Awardees have three years to complete their projects. More information on the VW Settlement is available at vw.utah.gov.

[3] The Volkswagen Group collectively includes Volkswagen AG, Audi AG, Volkswagen Group of America, Inc., Porsche AG, and Porsche Cars North America, Inc. Notice of Violation from Phillip A. Brooks, EPA Air Enforcement Division to David Geanacopoulos and Stuart Johnson, Volkswagen Group of America, Inc. (September 18, 2015); Notice of Violation from Susan Shinkman, EPA Office of Civil Enforcement to David Geanacopoulos and Stuart Johnson, Volkswagen Group of America, Inc. and Joseph Folz and Walter J. Lewis, Porsche Cars North America, Inc. (November 2, 2015).

State of Utah VW Settlement Awards Class 4-8 Local Freight Truck, School Bus, Shuttle Bus and Transit Bus Categories			
Awardee	**Project Type**	**Award Amount**	**# of Vehicles Awarded**
Bountiful City	Diesel sanitation trucks replaced with new diesel trucks	$145,000	2
Canyons School District	Diesel school bus replacements to diesel	$826,000	14
Davis School District	Diesel school bus replacements to diesel	$136,260	2
Jordan School District	Diesel school bus replacements to diesel	$138,992	2
North Salt Lake City	Diesel freight truck replaced with new diesel trucks	$108,741	1
Orem City	Diesel dump trucks and fire trucks replaced with new diesel trucks and Diesel shuttle bus replacement to diesel	$1,070,000	5
Park City Municipal Corp	Diesel transit bus replacements to electric	$3,693,941	6
Pleasant Grove City	Diesel dump trucks replaced with new diesel	$410,112	5
Salt Lake City Corporation	Diesel maintenance trucks, utility trucks, and fire trucks replaced with new diesel trucks	$1,773,853	14
Salt Lake City School District	Diesel school bus replacements to electric	$699,660	4
Salt Lake Urban Search & Rescue	Diesel freight trucks replaced with new diesel trucks	$86,740	1
Tooele County School District	Diesel school bus replacements to diesel	$132,000	2
UDOT	Diesel snow plows replaced with new diesel snow plows	$2,604,948	22
Utah Transit Authority	Diesel transit bus replacements to electric	$13,079,240	20
	Totals	**$24,905,487**	**100**

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State of Utah VW Settlement Awards Light-Duty Zero Emission Vehicle Supply Equipment Category (EVSE)						
Awardees	**Award Amount (based on vendor bids at time of application submittal - November, 2018)**	**EVSE Type Included in Project Proposal**	**Number of EVSEs Proposed in Project Proposal**	**Number of Actual EVSEs Installed by Project Completion**	**Reimbursement Amount for Completed Projects**	**Location of Project**
Clinton City	$60,129.00	Level 2	3	3	$46,808.38	**Location 1-** Civic Center Park **Location 2**- Center Park **Location 3 -**Powerline Park
Davis Technical College	$49,000.00	Level 2	4	4	$46,037.00	Davis Applied Technical College Campus
Utah Division of Facilities and Construction Management (DFCM)	$49,401.00	Level 2	11	12	$49,401.00	**Location 1-** Multi State Agency Office Building **Location 2-** Regional Building 2
Kamas City	$41,227.00	Level 2	1	Still in Process	Still in Process	City Office
Kaysville City	$69,988.00	Level 2	9	9	$69,572.00	**Location 1-** City Hall **Location 2**- 100 E. 200 N. Kaysville, UT **Location 3-** 300 North Flint St., Kaysville, UT **Location 4-** Kaysville Operations Center
Lehi City	$16,755.00	Level 2	1	1	$16,755.00	City Hall
Murray City Power	$157,608.00	Level 2	2	Still in Process	Still in Process	Murray Park Recreation Center
		DC Fast Chargers	1	Still in Process		
Orem City	$308,269.00	DC Fast Chargers	4	4	$270,675.00	City Hall
Provo City	$752,500.00	Level 2	20	Still in Process	Still in Process	**Location 1.** Provo City Center **Location 2**. Recreation Center (Parks & Rec) **Location 3**. Academy Library **Location 4**. Public Works Complex **Location 5**. Provo Power Complex **Location 6**. Rock Canyon Park **Location 7**. North Park **Location 8**. Spring Creek Park **Location 9**. Pioneer Park
Salt Lake County Health Department	$603,095.00	Level 2	8	Still in Process	Still in Process	The Salt Lake County Environmental Health Department
		DC Fast Chargers	2	Still in Process		
Sandy City	$118,982.00	DC Fast Chargers	3	3	$118,982.00	City Hall
Saratoga Springs	$26,788.00	Level 2	3	3	$26,788.00	Municipal Campus
South Salt Lake City	$136,517.00	Level 2	4	Still in Process	Still in Process	City Hall
Timpanogos Cave National Monument	$10,966.00	Level 2	1	Still in Process	Still in Process	Timpanogos Cave National Monument Visitor Center
Utah Department of Transportation (UDOT)	$1,047,623.00	Level 2	11	10 (Still in Process)	$204,401 (Still in Process)	**Location 1-**Calvin Rampton **Location 2**- Garden City **Location 3** Castle Dale City/Museum **Location 4-** Monticello Visitor Center **Location 5**- Bluff Maintenance Station **Location 6** Richfield Administrative Office **Location 7**- Kanab **Location 8**- The Fork Rest Area
		DC Fast Chargers	16	4 (Still in Process)		**Location 9**- Grassy Mountain Rest Area West and East Bound **Location 10**- UDOT Price District Office
Utah Valley University	$99,000.00	Level 2	6	4 (Still in Process)	$72,790 (Still in Process)	**Location 1**- Orem Main Campus **Location 2**- Business Resource Building **Location 3**- Auxiliary Service Building
Weber State University	$143,694.00	Level 2	8	Still in Process	Still in Process	**Location 1**- Campus Services Building **Location 2**- Hurst Center **Location 3**- Reed K. Swenson Building **Location 4** Dee Event Center
West Valley City	$140,564.00	Level 2	4	Still in Process	Still in Process	**Location 1**- City Hall **Location 2**- West Valley City Fitness Center
Total	**$3,832,106**	Level 2	96	46	**$645,018**	
		DC Fast Chargers	26	11		

Utah Clean Diesel Program



The Utah Clean Diesel Program aims to cut emissions from heavy- duty diesel vehicles and equipment that operate in the State's nonattainment areas. In 2020, the EPA awarded the Utah Clean Diesel Program $2.64 million to replace diesel refuse haulers, short-haul delivery trucks, and school buses with newer, cleaner versions. Fleet owners receive a 25 percent incentive toward the purchase of new vehicles and equipment that meet the cleanest emissions standards.

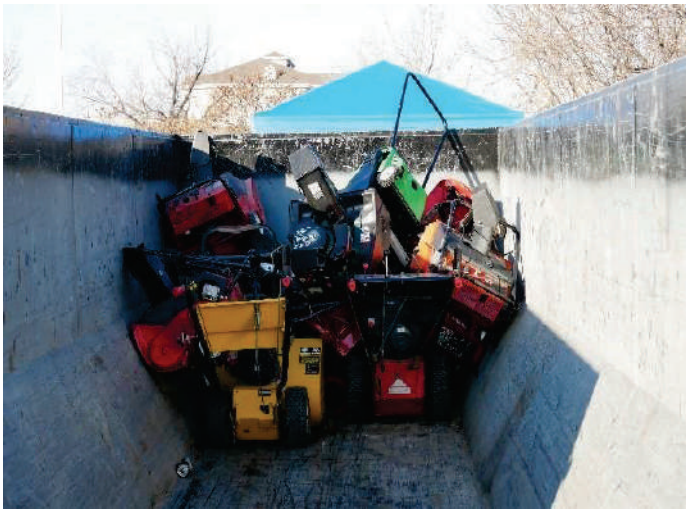
Retiring engine model years 2006 and older diesel trucks that are currently operational and have a minimum of three years remaining in their useful life and replacing them with current model years can achieve approximately 71 to 90 percent reductions in NO_x, 97 to 98 percent reductions in $PM_{2.5}$, and 89 to 91 percent reductions in VOCs, according to the EPA Emissions Standards for Heavy-Duty Highway Engines and Vehicles.

EPA provides a separate allocation of clean diesel funding for participating states, known as the State Clean Diesel Grant program, that UDEQ will use to offer $760,967 for the replacement of diesel school buses to all-electric school buses and another $979,814 for the replacement of diesel non-road vehicles, refuse trucks, Class 8 trucks, and school buses. VW Settlement funding of $1,217,300 will provide added funds for this project for a total of $2,958,081. DAQ is currently partnering with Salt Lake City School district who will be awarded $875,00 to replace four diesel school buses with electric school buses through this program.

Nearly $24 million in federal grants have been awarded through the Utah Clean Diesel Program since 2008, resulting in thousands of tons reduced from diesel emissions.

2020 Division of Air Quality Electric Snow Blower Exchange

The 2020 Snow Blower Exchange was cancelled due to COVID-19 concerns. DAQ plans to bring the program back in Fall 2021.

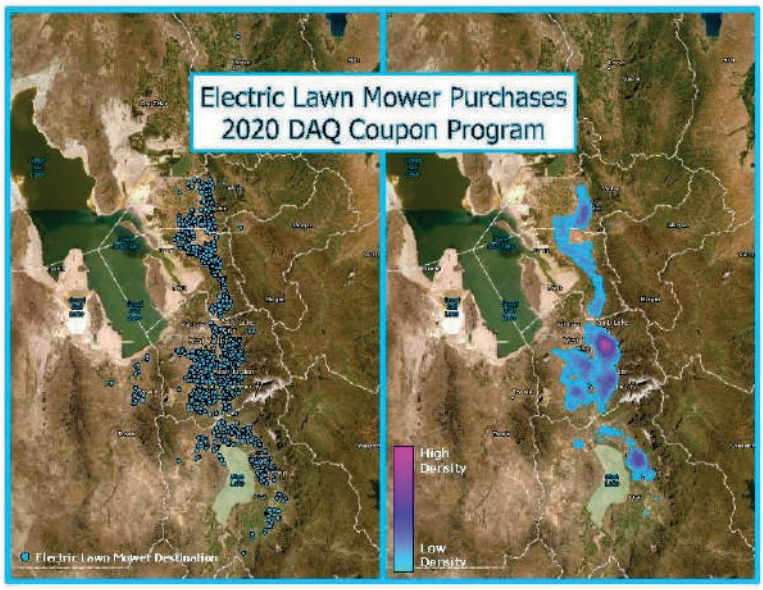


2020 State of Utah Yard Equipment Exchange

The 2020 Yard Equipment Exchange was cancelled due to COVID-19 concerns. DAQ plans to bring the program back in Spring 2021.

2020 State of Utah Online Electric Lawn Mower Discount Program

DAQ partnered with Home Depot to offer 1,200 participants $150 coupons toward the purchase of an electric lawn mower of their choice, retailing at $299 or more. Coupons were valid exclusively at homedepot.com and not valid in-store. Residents of the $PM_{2.5}$ nonattainment area (Davis, Salt Lake, Weber, Tooele, and Utah Counties) were eligible to receive this coupon. Online registration opened Monday, April 6, 2020 on a first-come, first-served basis. 1,200 initial registrations were filled and a coupon code was emailed to each eligible participant. Only one coupon per household was allowed. Recycling a gas-powered lawn mower was not required as eligibility for this program. 636 coupons were used before they expired on June 15, 2020. A second registration period opened July 1, 2020, and offered an additional 600 $150 online coupons. 314 more coupons were claimed before they expired on July 6, 2020. A total of 950 electric lawn mowers were purchased across the Wasatch Front between the two rounds of the program. The map below shows all locations where the electric mowers will be used.



Free-Fare Day Pilot Project

During the 2019 Legislative Session, the Legislature appropriated $500,000 to the DAQ to administer a Trip Reduction Program. A primary component of the Trip Reduction Program is a Free-Fare Day Pilot Project. The DAQ has worked closely with the Utah Transit Authority (UTA) to provide free fares during inversion periods when pollution concentrations are increasing and projected to reach levels that are harmful to human health. The DAQ originally anticipated the provision of seven free fare days over the life of the program. However, due to ridership changes associated with the COVID-19 pandemic, the total number of free fare days will be determined based upon estimated foregone fare revenues and remaining available funding. As a result of favorable air quality conditions, no free fare days were implemented in 2020. At the end of the project, the DAQ will provide a report to the Legislature that analyzes the air quality benefits of the program. The UTA will provide much of the data necessary for the report, including ridership data and results from surveys administered on Free-Fare days.

Ancillary Programs

Transportation Conformity

Several Metropolitan Planning Organizations (MPOs) are responsible for developing, producing, and adopting Metropolitan (or Regional) Transportation Plans (MTP or RTP) and Transportation Improvement Programs (TIP) within the state. The MPOs include Cache MPO (CMPO), Dixie MPO, Mountainland Association of Governments (MAG), and the Wasatch Front Regional Council (WFRC). MPOs located in nonattainment and/or maintenance areas have the responsibility to ensure that the current MTP and TIP conform to the Utah SIP through a process known as transportation conformity. The Federal Highway Administration and Federal Transit Administration review the conformity determinations along with the MTP and TIP in consultation with the EPA to ensure that the relevant planning and air quality regulations have been adequately addressed. The Utah Department of Transportation (UDOT) is responsible for transportation conformity within isolated rural nonattainment areas when a non-exempt FHWA/FTA project(s) needs funding or approval.

CMPO, MAG, and WFRC demonstrated conformity to the SIP for the Plans and TIPs for their respective areas' established conformity for the 2050 RTP in June of 2019 and the 2019-2024 TIP in August 2018: Cache County, Utah portion of the $PM_{2.5}$ moderate nonattainment. MAG established conformity for the 2050 RTP in June 2019 and the 2021-2025 TIP in August 2020: Provo\Orem City CO maintenance area; Utah County PM_{10} and $PM_{2.5}$ moderate nonattainment area; Southern Wasatch Front, UT Ozone marginal nonattainment area (portion of Utah County).

WFRC established conformity for the 2021-2026 TIP in August 2019 and the 2050 RTP in May of 2019: Salt Lake City and Ogden City CO maintenance areas; Salt Lake County and Ogden City PM_{10} nonattainment areas; Salt Lake $PM_{2.5}$ moderate non-attainment area (Davis, Salt Lake, and Weber Counties and portions of Box Elder and Tooele Counties); Northern Wasatch Front, UT Ozone marginal nonattainment area (Davis, Salt Lake, and Weber Counties and portions of Box Elder and Tooele Counties);

UDOT was not required to establish conformity for the Uinta Basin, UT Ozone marginal nonattainment area (portions of Duchesne and Uinta Counties).

Utah Air Quality Public Notifications

The DAQ provides air quality forecasting on its webpage for the current and next two days. The Air Monitoring Section (AMS) provides air pollution information based on the daily air quality status. The AMS data is used to determine the relationship of existing pollutant concentrations to the NAAQS. There is a three-tiered air quality alert system: unrestricted, voluntary action and mandatory action. This system is used to implement winter and summer controls on the use of solid fuel burning devices, fire places, and motor vehicles, and to advise the public and industrial sources to act to reduce their pollution footprint during these events. The forecast call determines which restrictions are in place for a given county. In addition, the webpage advises the public as to current air quality conditions using the standard Air Quality Index (AQI) categories: good, moderate, unhealthy for sensitive groups, unhealthy and very unhealthy. Each advisory category listed on the webpage is accompanied by a health protection message that recommends actions affected groups can take to mitigate the effects of pollution on them and links to the AQI web site for further information. The AMS advisory is calculated for five major pollutants: ground-level ozone, particulate pollution (particulate matter), carbon monoxide, sulfur dioxide, and nitrogen

dioxide. The outreach program information consolidated in the three-day forecast includes the Summer and Winter Control Programs and Choose Clean Air information.

The DEQ is also sponsoring an electronic mail server (Listserv). Subscribers are automatically notified by e-mail when unhealthy air pollution levels are forecast throughout Utah and when action alerts are issued.

The National Center for Automotive Sciences and Technology at Weber State University developed a mobile app called Utah Air for the DAQ. It provides similar information directly on smart phones and other mobile devices. The application is free and can be downloaded from both the Android and Apple app stores. As of December 2020, the application has been downloaded onto over 100,000 mobile devices.

Choose Clean Air
DEQ continues to emphasize the Choose Clean Air program and has developed an interactive website containing information about ways individuals can help improve air quality by making smart choices in their personal lives. The website can be found at http://www.cleanair.utah.gov/.

Winter Control Program (unrestricted, voluntary action, mandatory action)
This program originated with the PM_{10} SIP, but was significantly strengthened in December 2012 to be much more proactive and less reactive. Now, instead of waiting until an area is exceeding a standard, action alerts are called when the DAQ meteorologists see that we are in the early building stages of an inversion that will likely lead to pollution concentrations at or above the trigger level of 25µg/m^3. The program runs annually from November through early March. In addition to the burning restrictions, residents are encouraged to drive less and are directed to information on other ways they can reduce pollution.

Summer Control Program (unrestricted, voluntary action, mandatory action)
Action days are announced whenever the probability of exceeding the ozone standard is forecasted to be high. High temperature and stagnant air masses contribute to this probability. Residents are encouraged to minimize driving whenever the ozone or PM standards are approached.

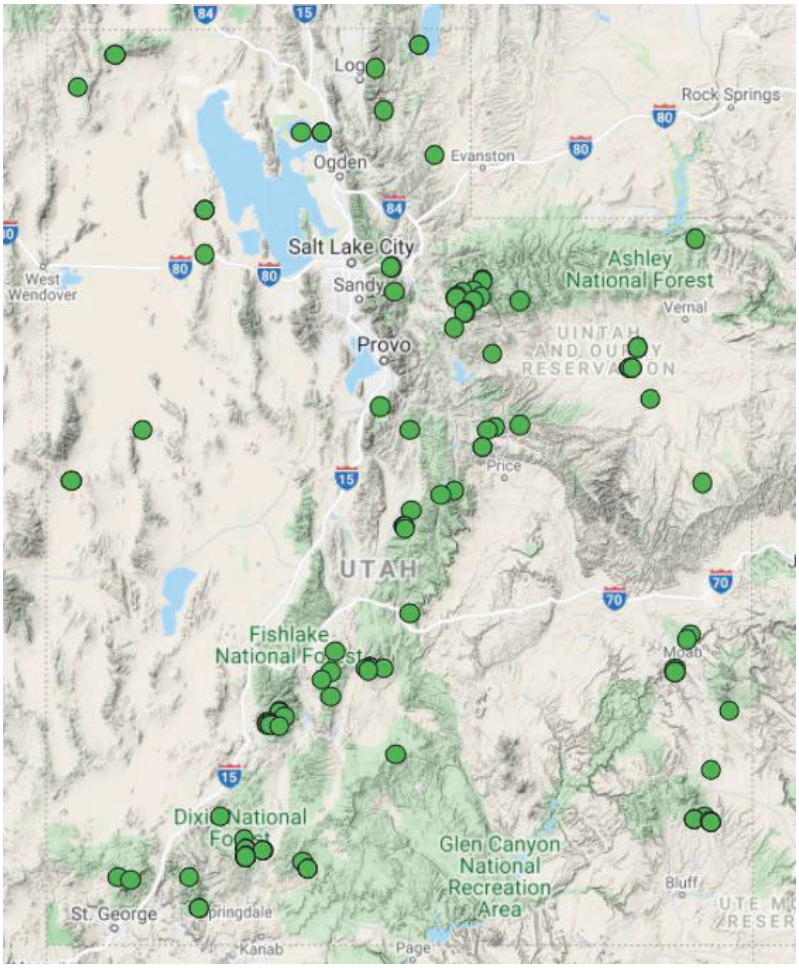
Smoke Management in Utah
Utah's first Smoke Management Plan (SMP) was written in 1999. The plan is designed to meet the requirements of Title R307, state administrative rule for air quality; Regional Haze Rule, 40 CFR 51.309(d)(6); and the policies of the EPA Interim Air Quality Policy on Wildland and Prescribed Fires. The signatories to the SMP are: US Forest Service, Bureau of Land Management, National Park Service, US Fish and Wildlife Service, Bureau of Indian Affairs, and the Utah Division of Forestry, Fire, and State Lands.



The SMP serves as an operational plan for the state administrative rule, R307-204 Emission Standards: Smoke Management, by providing direction and operating procedures for all organizations involved in the management of prescribed fire. R307-204 establishes by rule the procedures and the permitting process that land managers are required to follow to mitigate the impact of smoke on air quality and visibility in the State.

The following table provide a 5-year view of the numbers of permitted prescribed burns and acres burned across Utah.

Year	Acres Burned	Number of Prescribed Burn Projects
2016	16,757	225
2017	13,019	171
2018	12,802	188
2019	18,171	164
2020	5,636	120



Each green dot pictured in the figure above represents a prescribed fire in Utah in 2020.

Vehicle Inspection/Maintenance Programs

Inspection/Maintenance (I/M) programs were adopted in the early 1980s as a required strategy to attain the ozone and carbon monoxide NAAQS. These programs were very effective in improving air quality. They have played an important role in reducing emissions that contribute to ozone and carbon monoxide. Their continued operation is necessary for the Wasatch Front to remain in attainment of these standards. The county health departments administer these programs.

The most recent I/M program to be implemented in Utah is in Cache County. The program was fully implemented on January 1, 2014, and is running smoothly. In 2017, Weber County implemented a revised I/M program that includes diesel vehicles. For diesels less than 14,000 lbs. GVW manufactured between 1998 and 2006, they perform a visual inspection to verify the vehicle's emission controls have not been tampered with. For 2007 and newer vehicles, they perform a full On-Board Diagnostics test. Weber County Health Department has found that about 20% of the tested vehicles are failing. During the 2018 General Legislative Session HB 101 passed which created a pilot program requiring Utah County to require a diesel emissions inspection program. This program started on January 1, 2019 and continues until 2021.[1]

Smoking Vehicles

Vehicles emitting excessive smoke contribute to poor air quality. To promote clean air, several local health departments operate smoking vehicle education and notification programs. There were two bills passed during the 2015 General Legislative Session that helped enhance the smoking vehicle programs in the state:

- HB17 clarified that visible emissions from gas or certain diesel-powered vehicles are not allowed on Utah roads.
- HB110 gave the Utah Division of Motor Vehicles the authority to suspend a vehicle's registration if the vehicle does not meet air emissions standards.

The DAQ worked with the local health departments, Utah Division of Motor Vehicles, and Utah Highway Patrol to develop a method of enforcing these laws. People who spot a vehicle producing excessive smoke can report it through a statewide smoking vehicle hotline at 385- GOTSMOG(468-7664) or through their respective county health departments:

Cache County 435-792-6611
Davis County 801-546-8860
Salt Lake County 385-468-SMOG(7664)
Utah County 801-851-SMOG(7664)
Weber County 801-399-7140

Salt Lake County Health Department applied for and was awarded a grant to create a statewide smoking vehicle hotline. This program created a single number (385- GOTSMOG(468-7664)) to report vehicles that have visible emissions. They also created a webpage, utahsmokingvehicles.org, which includes the information needed to report a smoking vehicle as well as direct links to each respective county health department's smoking vehicle reporting webpage. Salt Lake County worked with the other local health departments to create and implement the program during 2018.

[1] See Utah Code Section 41-6a-1642 (6) and (7)

Compliance Branch

The Compliance Branch is comprised of three sections: Major Source Compliance, Minor Source Compliance, and the ATLAS. These sections are responsible for ensuring compliance with all air pollution orders, permits, rules, and standards. This is accomplished through inspections, audits of stack tests and continuous emission monitoring systems (CEMS), plan and report reviews, accreditation and certification programs, compliance assistance/outreach activities, and, when necessary, enforcement actions.



Major and Minor Source Compliance

The Major and Minor Source Compliance sections are responsible for ensuring compliance at more than 4,500 facilities within the state. The Major Source Compliance Section is responsible for inspections and report/plan reviews for the large facilities, audits of stack tests and continuous emission monitoring systems, and any associated enforcement. The Minor Source Compliance Section is responsible for inspections and report/plan reviews at small to medium-sized facilities, audits, stack tests, fugitive dust control, abrasive blasting, residential solid fuel burning, gasoline transport/filling station vapor recovery, open burning, and any associated enforcement.



Table 5 below summarizes the compliance activities of these two sections for 2020

Table 5. Major and Minor Source Compliance Summary

TASK	2020
Source Inspections	517
On-site Stack Test/CEM Audits	26
Stack Test/CEM Reviews	392
Emission Reports Reviewed	132
Temporary Relocations Accepted	63
Fugitive Dust Control Plans Accepted	1143
Soil Remediation Report Reviews	51
Open Burn Permit Application Completed Online	220
Miscellaneous Inspections	194
Complaints Received	171
Wood Burning Complaints	0
Breakdown Reports Received	12
Compliance Actions Resulting from a Breakdown	0
VOC Inspections	0
SCAN Warning Letters	17
Notices of Violation	3
Compliance Advisories	60
Settlements	32
Total Inspections	737
Penalties Assessed	**$201,051.60**

Air Toxics, Lead-Based Paint, and Asbestos Section (ATLAS)

ATLAS determines compliance with multiple regulations involving asbestos and lead-based paint (LBP). ATLAS is responsible for the following programs:

Lead-Based Paint

Toxic Substances Control Act (TSCA) Title IV, 40 CFR Part 745 and, Utah Administrative Code (UAC) R307-840, 841, and 842. Under this program, ATLAS performs regulatory oversite of training providers, regulated projects subject to the LBP Activities Rule and the LBP Renovation, Repair, and Painting Rule, certification of individuals and firms, and lead-based paint outreach activities.

Asbestos in Schools

TSCA Title II Asbestos Hazard Emergency Response Act (AHERA), 40 CFR Part 763 and, UAC R307-801-4. Under this program, ATLAS deals with the review and approval of AHERA

Management Plans, performs inspections of buildings subject to AHERA, and inspections and asbestos abatement for structures subject to AHERA.

Asbestos NESHAP and State Asbestos Work Practices

40 CFR Part 61, Subpart M, UAC R307-214-1 and UAC R307-801. Under this program, ATLAS deals with the certification of individuals and companies, review of asbestos project notification forms, review of demolition notification forms, review of alternative work practice requests, inspection of asbestos abatement projects, demolition of structures, and asbestos outreach activities. ATLAS performed 472 total inspections.

Table 6. ATLAS Activity Summary

TASK	2020
Asbestos NESHAP Inspections	196
Asbestos AHERA (School) Inspections	215
Asbestos State Rules (Only) Inspections	32
Asbestos Notifications Accepted	1906
Asbestos Telephone Calls	4275
Asbestos Individuals Certifications	828
Asbestos Company Certifications	87
Asbestos Alternate Work Practices	51
Lead-Based Paint Inspections	29
Lead-Based Paint Abatement Notifications	10
Lead-Based Paint Telephone Calls	810
Lead-Based Paint Letters Prepared & Mailed	74
Lead-Based Paint Course Audit	3
Lead-Based Paint Individual Certifications	214
Lead-Based Paint Firm Certifications	107
Notices of Violations	1
Compliance Advisories	71
Warning Letters	40
Settlement Agreements	12
Penalties Collected	$41,901.90

Utah Asthma Task Force

The Utah Asthma Task Force is a multi-agency task force to address the problem of asthma in Utah. The task force meets quarterly and has a number of projects currently underway in addition to the programs initiated under the State Asthma Plan. The Division toxicologist, a member of the ATLAS team, is a founding member of the Task Force. The Division supports the Task Force in the preparation of public announcements and media communication relating to the risks of asthma symptoms associated with air pollution.

The goal of the DAQ for 2020 is to work with the Asthma Task Force to update the Utah Asthma Program web page http://health.utah.gov/asthma/ and clarify the two causal connections between adverse asthma effects and air pollution. Namely, the neuromuscular reflex that causes constriction of bronchi and upper respiratory airways characteristic of acute asthma attacks, and secondly, the exacerbation of chronic airway inflammation that makes asthma patients more susceptible to the full range of adverse health effects associated with exposure to air pollution.

Small Business Environmental Assistance 507 Program (SBEAP)

The CAA 507 Programs consist of three parts: A Small Business Ombudsman (SBO) to act as an advocate for small business, a Small Business Environmental Assistance Program (SBEAP) to provide technical support, and a Small Business Compliance Advisory Panel (CAP) to provide feedback and help identify small business issues. The SBEAP helps small businesses understand and comply with state environmental regulations including air quality rules. The SBEAP continues to assist small businesses by providing web resources, responses to email and telephone inquiries and assistance with permitting through a pre-design program. The Small Business CAP remains active with meetings scheduled quarterly.

Enforcement Actions

The following enforcement actions may be taken depending on the magnitude of the alleged violation(s), prior compliance history, and degree of cooperation of an alleged violator:

- Warning Letter—a notification sent to violators to resolve minor, and/or first-time violations.
- Early Settlement Agreement – a less formal administrative resolution of an alleged violation(s) in which the DAQ and the recipient agree in writing to specific actions taken to correct the alleged violation(s). Any stipulated penalties are discounted by 20% to encourage quick resolution. Supplemental Environmental Projects may be used to offset a portion of any cash payments for stipulated penalties. All collected penalties become part of the State General Fund.
- Notice of Violation and Order for Compliance – a formal, traditional declaration of a violation(s) which involves the Attorney General's Office. The cited violation(s) become final after 30-days, unless formal appeal procedures are followed.
- Settlement Agreement – a resolution of a Notice of Violation and Order for Compliance. The DAQ and the recipient agree to specific actions taken to correct the potential violation(s). No discounts of stipulated penalties are offered. The DAQ legal costs may also be collected. Supplemental Environmental Projects may be agreed to, to offset a portion of any cash payments for stipulated penalties. All collected penalties become part of the State General Fund.

Most enforcement actions are resolved through Warning Letters or Early Settlement Agreements. In rare instances, Notices of Violations and Orders for Compliance are used. In the extremely rare instance where the aforementioned enforcement actions fail to resolve a compliance issue, procedures are in place for Board hearings/administrative law judge review or formal judicial action. Environmental criminal cases are referred to the appropriate law enforcement agency.

Permitting Branch

The DAQ Permitting Branch is responsible for implementing state and federal air permitting programs that are intended to control air emissions from new and modified stationary sources that emit air pollutants. Permits are legally enforceable documents that specify the size and number of allowable emission units, operational limits of permitted emission units and emission limits for each permitted source. Permitted emission limits can be emission limitations (mass or concentration) or surrogate limits such as production rates, hours of operation, fuel consumption, or a combination thereof. Opacity, the measure of opaqueness or transparency of emission plumes, is also a common metric used to both limit and measure source emissions. Permits include testing and monitoring requirements. The results of the tests and the monitoring data are used to determine if a source of air pollution is operating in compliance with the permit and the rules.



The branch issues two types of permits. New Source Review (NSR) permits, also known as Approval Orders (AOs), are pre- construction-type permits for new and modified sources of air emissions. These are issued by the New Source Review Sections and have been required in Utah since 1969. An Operating Permits Section issues the Title V Operating Permits to the "major" stationary sources in the state, as required in Title V of the federal CAA. There are currently 77 of these sources. Operating permits consolidate all air quality related requirements from numerous state and federal air quality programs into a single regulatory document. The purpose of an operating permit is to clarify for the permit holder, as well as DAQ compliance inspectors, the wide range of requirements applicable to any regulated source by placing those requirements into one consolidated document.

In addition, the branch processes a number of smaller actions such as de minimus determinations for NSR, name changes, tax exemption certificates for pollution control equipment purchases, and soil aeration approvals.

New Source Review

Any new or modified source of air pollution in Utah is required to obtain an AO before it is allowed to begin construction. For areas that are not in compliance with the NAAQS, an NSR permit assures that air quality is not further degraded from the existing levels by new emission sources. In areas that are in compliance with the NAAQS, an NSR permit assures that new emissions do not significantly worsen air quality. These processes are outlined in both state and federal rules.

The application for an AO, called a notice of intent (NOI), is reviewed to make sure that the source installs appropriate state-of-the-art emission controls. For major sources in nonattainment areas, state-of-the-art technology is known as lowest achievable emissions rate (LAER). For areas in attainment of the NAAQS and for minor sources in nonattainment areas, state-of-the-art controls are known as the best available control technology (BACT). Both LAER and BACT are case-by-case determinations of control technology for a specific source. BACT considers the technical feasibility of implementing the control, the cost and the environmental benefits of the control equipment, while LAER technology considers only technological feasibility and environmental benefits.

The general public and the EPA are given an opportunity to review the proposed AO before it is issued. The Utah Air Quality Rules specify the criteria indicating which sources must obtain an AO. The New Source Review permitting program issued 97 permits during 2019. It took an average of 158 days to issue the permit from the submission of an application. Potential applicants are encouraged to contact the DAQ prior to submitting the necessary paperwork.

Operating Permits

Congress created Title V of the CAA in 1990. This Title requires states to issue an operating permit to the larger or "major" sources of air pollution within the state. Utah developed and submitted a program in 1994 and received approval from the EPA in 1995. Operating permits are legally enforceable documents issued to air pollution sources after the source has begun to operate. A primary purpose of the permit is to consolidate the applicable requirements from the many and varied air quality programs such as NSR permits, SIPs, federal New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP), and Maximum Available Control Technology (MACT). Like the AOs, the general public is given an opportunity to review the draft operating permits before they are issued. In addition, the EPA has up to 45 days to review the proposed operating permit. The criteria indicating which sources must obtain an operating permit are specified in R307-415 of the Utah Administrative Code (UAC). As with the NSR permit or AOs, potential applicants are encouraged to contact the DAQ prior to submitting the necessary paperwork.

Another significant objective of the Title V program is to shift the compliance liability from the regulating agency to the permitted source. Each year, the source must certify that it is in compliance with all permit terms and conditions, or indicate non-compliance issues. False reports have criminal implications beyond the civil liabilities of other violations. In addition, sources must report the results of monitoring at least every six months. Permit provisions for monitoring, record keeping, and reporting are added or enhanced to assure compliance with the permit conditions and limits.

An operating permit has a life of only five years (as opposed to the AO that does not expire. These permits, both initially and upon renewal, are complex and care must be taken to ensure that federal requirements for the Compliance Assurance Monitoring Rule (CAM) and any other new requirements (such as new MACT Standards) are included.



AIR QUALITY

Attachments: Plant & Animal Related Resource Concerns

- Utah Natural Heritage Online Species Search Report Memo – Cirrus Ecological Solutions
- USFWS IPaC Species List/Report: Corn Creek – Utah Ecological Services Field Office
- Threatened, Endangered, Proposed, Candidate Species Review – Cirrus Ecological Solutions
- Botanical Report – Western-Enviro Resources
- Biological Assessment "Elementary/Short-Form" -- Franson Civil Engineers

Cirrus Ecological Solutions, LC
965 South 100 West, Suite 200
Logan, UT 84321(435) 787-1490
Fax (435) 787-1495

MEMO

DATE: January 20, 2023

TO: Layne Jensen, Franson Civil Engineers

CC: Patricia Ayaa, Martilyn Neilsen

FROM: Stephanie Trapp, Wildlife Biologist; John Stewart, Terrestrial Ecologist

RE: Corn Creek – Utah Natural Heritage Species Review

The project area consists of a series of channels, ditches, and other areas that collect water in the Corn Creek work area above and within the vicinity of Kanosh, Utah. The project area is approximately 612 acres (Figure 1).

Utah Natural Heritage Species

The bald eagle (*Haliaeetus leucocephalus*), burrowing owl (*Athene cunicularia*), Sonoran Mountain kingsnake (L*ampropeltis pyromelana*), and Bonneville cutthroat trout (*Oncorhynchus clarkii utah*) were identified by the Utah Natural Heritage Program as potentially present within 2-miles of the project area. This memo report addresses the potential presence of these species in the project area.

Bald Eagles

Bald eagles are capable of foraging over great distances in search of carrion but are typically found near large rivers and bodies of water where they hunt for fish. Nests are generally located in large trees within 1.5 kilometers of water.

No large bodies of water or nesting habitat are located within the project area that would provide suitable foraging or nesting habitat for bald eagles. No bald eagles were identified during habitat surveys. Therefore, no impacts are expected for this species (NatureServe 2022a).

Burrowing Owls

Burrowing owls are generally found in flat grassland areas with open habitat and suitable soils for subterranean burrows. They generally forage on large insects and small rodents, but will occasionally consume amphibians, reptiles, and small birds. Burrowing owls are generally found in colonies, with multiple burrows and multiple burrowing owls found close together in suitable habitat. Burrowing owl colonies have been noted in vacant lots and disturbed areas near development (NatureServe 2022b).

The large, disturbed area in the southeast of the project area boundary may provide suitable burrowing owl habitat. However, no burrowing owls or burrows large enough to support this species were identified during

habitat surveys, suggesting that this species is not currently present. Therefore, no impacts are expected for burrowing owls.

Sonoran Mountain Kingsnake

Sonoran mountain kingsnakes are generally found in rocky terrain near water as well as low-elevation mesic canyons. Preferred vegetation types include pinyon-juniper and oak-juniper woodlands as well as pine-fir woodlands and chaparral. They are often found on or under large rocks, logs, or other cover objects. This kingsnake forages for lizards, small mammals, and other small snakes (NatureServe 2022c).

This cryptic species can be difficult to detect. No direct surveys were completed to try to find individuals were observed during site visit. Instead, given the habitat suitability within and near the project area, it is assumed that this species could be present. However, given the limited habitat disturbance compared to habitat availability, the project may affect, but is not likely to adversely affect this species.

Bonneville Cutthroat Trout

Bonneville cutthroat trout are found in smaller headwaters, ranging from high elevation streams with riparian tree cover to lower-elevation areas surrounded by sage-steppe grasslands. They prefer slow, deeper waters with bank stability and cover. Spawning occurs in sand and gravel substrate in flowing water (NatureServe 2022d).

Corn creek may provide suitable habitat in areas that have not been disturbed or diverted into ditches for agricultural use. Within the project area, Corn Creek has been diverted for irrigation, and therefore does not provide suitable habitat for this species. Therefore, no impacts are expected for Bonneville cutthroat trout.

References

NatureServe. 2022a. Bald Eagles. Nature Serve Explorer. Available at: https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.104470/Haliaeetus_leucocephalus

NatureServe. 2022b. Burrowing Owls. Nature Serve Explorer. Available at: https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.106553/Athene_cunicularia

NatureServe. 2022c. Sonoran Mountain Kingsnake (Arizona Mountain Kingsnake). Available at: https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.104417/Lampropeltis_pyromelana

NatureServe. 2022d. Bonneville Cutthroat Trout. Available at: https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.103129/Oncorhynchus_clarkii_utah

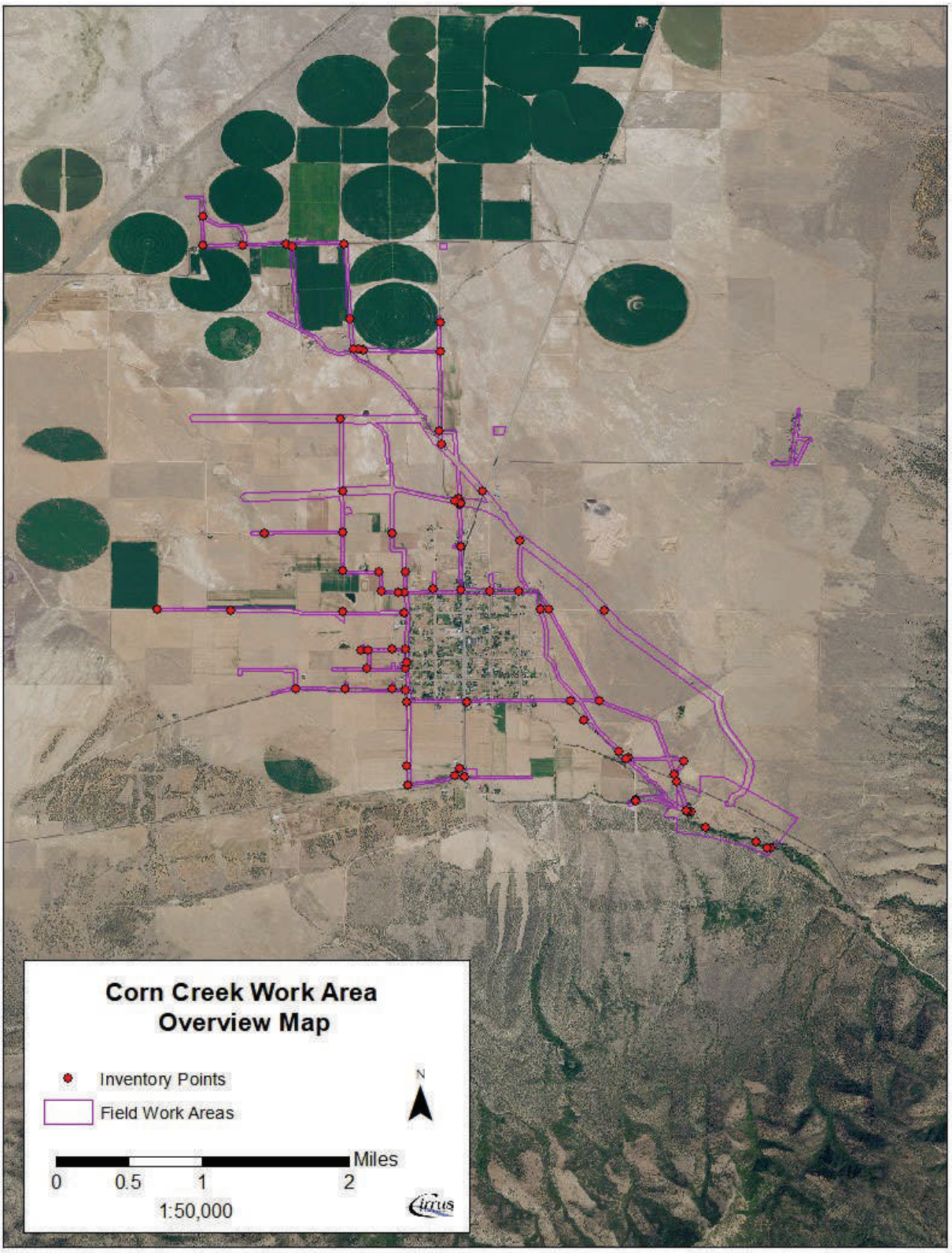


Figure 1. Overview map.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Utah Ecological Services Field Office
2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603
Phone: (801) 975-3330 Fax: (801) 975-3331

In Reply Refer To: 10/15/2024 13:43:51 UTC
Project Code: 2025-0005625
Project Name: Corn Creek Watershed Plan-Environmental Assessment

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed, and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological

evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

https://www.fws.gov/sites/default/files/documents/endangered-species-consultation-handbook.pdf

Migratory Birds: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts, see https://www.fws.gov/program/migratory-bird-permit/what-we-do.

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures, see https://www.fws.gov/library/collections/threats-birds.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/partner/council-conservation-migratory-birds.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

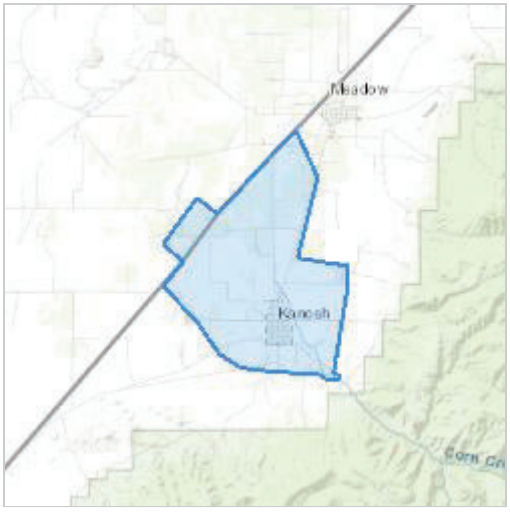
Utah Ecological Services Field Office
2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603
(801) 975-3330

PROJECT SUMMARY

Project Code: 2025-0005625
Project Name: Corn Creek Watershed Plan-Environmental Assessment
Project Type: Flooding
Project Description: PL-566 authorized Watershed Plan-EA project for the Corn Creek Watershed in Millard County, Utah

Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@38.82965025,-112.45860801201786,14z



Counties: Millard County, Utah

ENDANGERED SPECIES ACT SPECIES

There is a total of 2 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

---

1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

INSECTS

NAME	STATUS
Monarch Butterfly *Danaus plexippus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9743	Candidate

FLOWERING PLANTS

NAME	STATUS
Ute Ladies'-tresses *Spiranthes diluvialis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/2159	Threatened

CRITICAL HABITATS

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

YOU ARE STILL REQUIRED TO DETERMINE IF YOUR PROJECT(S) MAY HAVE EFFECTS ON ALL ABOVE LISTED SPECIES.

IPAC USER CONTACT INFORMATION

Agency: Franson Civil Engineers
Name: Landon Richins
Address: 1276 South 820 East, Suite 100
City: American Fork
State: UT
Zip: 84003
Email lrichins@fransoncivil.com
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Cirrus Ecological Solutions, LC
965 South 100 West, Suite 200
Logan, UT 84321(435) 787-1490
Fax (435) 787-1495

MEMO

DATE: January 20, 2023

TO: Layne Jensen, Franson Civil Engineers

CC: Patricia Ayaa, Martilyn Neilsen

FROM: Stephanie Trapp, Wildlife Biologist; John Stewart, Terrestrial Ecologist

RE: Corn Creek – Threatened, Endangered, Proposed, Candidate Species Review

The project area consists of a series of channels, ditches, and other areas that collect water in the Corn Creek work area above and within the vicinity of Kanosh, Utah. The project area is approximately 612 acres (Figure 1).

Federally Protected Species

The U. S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) database identified monarch butterflies (*Danaus plexippus plexippus*) and Ute Ladies'-tresses (*Spiranthes diluvialis*) as the only threatened, endangered, proposed, or candidate species potentially found within the project area (USFWS 2022). It also identified one migratory bird species, long-eared owl (*Asio otus*). This memo report addresses the potential presence of monarch butterflies and long-eared owl in the project area. Ute Ladies'-tresses was addressed under a separate contract and is therefore, not addressed in this report.

Monarch Butterfly

The monarch butterfly is currently listed as a candidate species under the Endangered Species Act (ESA) of 1973. In 2020, the USFWS reviewed the monarch butterfly for listing as a threatened or endangered species under the ESA. The review determined that monarch butterflies warrant listing as threatened or endangered but have been precluded from listing at this point by higher priority actions (USFWS 2020).

Monarch butterflies are found throughout the eastern and western United States and Canada during the summer and migrate to coastal California and northern Mexico for winter. While in the intermountain west, monarch butterflies rely on a range of nectar-producing flowers for foraging, but generally only use milkweed (*Asclepias spp.*) for egg laying. This makes milkweed a limiting factor for monarch butterflies on their summer range. Threats to the monarch butterfly includes loss of habitat from development or conversion to agriculture, pesticide use, logging operations at wintering sites in Mexico, and drought (USFWS 2020).

Habitat surveys were completed throughout the project area to determine if any milkweed was present as potential foraging and egg laying habitat for monarch butterflies. No milkweed was observed during the surveys and no monarch butterfly individuals were observed during the habitat survey. Given the wide-ranging foraging capabilities of monarch butterflies, it is possible monarch butterflies occasionally forage on other non-milkweed species in the project area. However, the lack of milkweed suggests that the project area does not provide high-quality breeding habitat for monarch butterflies. Therefore, no effect is expected for monarch butterflies.

Long-eared Owl

The USFWS IPaC list also identified one migratory bird that could be present within the project area. Long-eared owls are present in Utah year-round, typically nesting between March and May each year. Nests are often located in dense woodland areas and can be taken from other species that create large stick nests, such as magpies *(Pica hudsonia*), great blue herons (*Ardea herodias*), and crows (*Corvus brachyrhynchos*). They forage on small rodents in open habitat, often perching on the edge of forest openings searching for prey (NatureServe 2022).

Habitat surveys were completed to identify any potential long-eared owl nesting habitat within the project area. The riparian woodland corridor located at the upper end (southeast) of the project area along Corn Creek above the irrigation diversion may provide some low-quality potential habitat for long-eared owls should they be present in the area (see Photos 1 through 3). The trees in this area may not provide the density required for nesting, but the open fields could provide suitable foraging habitat. No nests or long-eared owls were identified during the habitat survey. Due to the lateness of the field survey, no calling surveys were completed. Given the small area of potential habitat disturbance, the project may affect, but is not likely to adversely affect long-eared owls.

References

NatureServe. 2022. Long-eared Owl. NatureServe Explorer. Available at: https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.101120/Asio_otus

USFWS (United States Fish and Wildlife Service). 2020. Endangered and Threatened Wildlife and Plants; 12-Month Finding for the Monarch Butterfly. Federal Register. Vol. 85, No. 243. December 17, 2020.

USFWS (United States Fish and Wildlife Service). 2022. Information for Planning and Consultation. Corn Creek Environmental Assessment. Project Code: 2022-00220011.

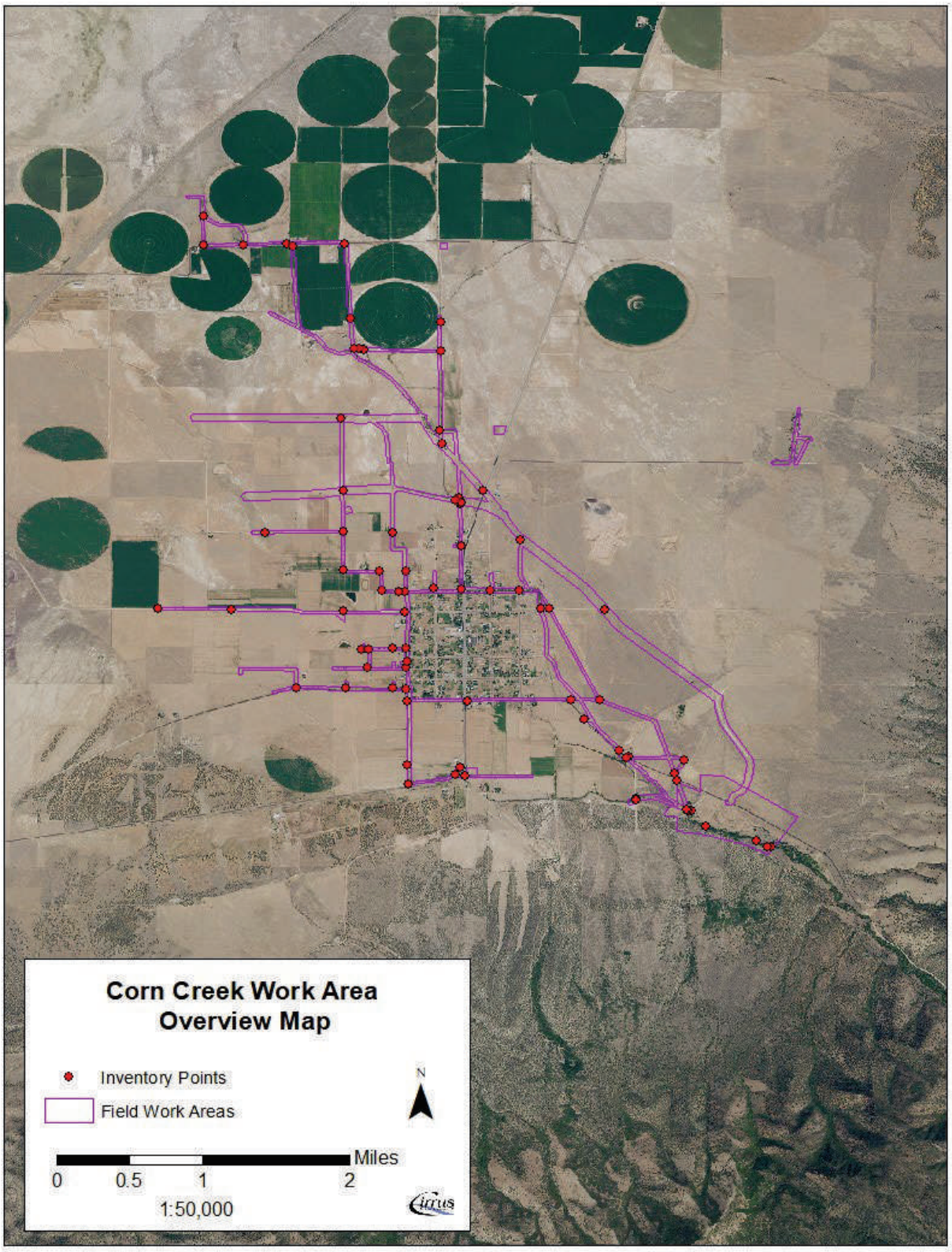


Figure 1. Overview map.



Photo 1. Sample Point 1 – natural riparian area above the diversion showing woody vegetation.



Photo 2. Sample Point 71 – natural riparian vegetation above diversion.



Photo 3. Sample Point 70 – looking upstream showing riparian vegetation.

BOTANICAL REPORT

FOR THE PROPOSED:

CORN CREEK WATERSHED PLAN & ENVIRONMENTAL ASSESSMENT

MILLARD COUNTY, UTAH

PREPARED FOR:

FRANSON CIVIL ENGINEERS

PREPARED BY:
WESTERN-ENVIRO RESOURCES
PO BOX 294
SPRINGVILLE, UTAH

AUGUST 2022

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1.0 EXECUTIVE SUMMARY

Proposed Project:	**Corn Creek Watershed Plan & Environmental Assessment**	
Client:	*Kanosh Town* 55 North Main Street, Kanosh, Utah 84637	
Consultant/Contractor:	***Franson Civil Engineers*** 1276 South 820 East, American Fork, UT 84003	***WESTERN-ENVIRO Resources, Inc.*** PO Box 294 Springville, UT 84663
Land Status/ Managing Agencies:	Private Property and Paiute Indian Tribe of Utah (Tribe) Lands	
Date(s) of Surveys:	August 20-23, 2021	
Description of Project Location:	Sections 5, 6, 7, 8, 10, 15, 16, 17, 18, 19, 20, 21, 22, 27, 28 & 29 in Township 23 South, Range 5 West, Salt Lake Base and Meridian (S.L.B.&M.), Millard County, Utah.	
Project Manager:	Layne Jensen, PE	
Survey Crew Lead:	Bridget Atkin, MS, MLA, Plant Ecologist	

SUMMARY OF SURVEY RESULTS:

Project Area:	598.94 acres
Acreage Surveyed for Plant Resources:	4,344.83 acres
Target Plant Species:	Plant species listed by the U.S. Fish and Wildlife Service (USFWS) as Threatened, Endangered, Proposed, and Candidate (TEPC); specifically, *Spiranthes diluvialis*
Number of Target Plant Species Observed:	None (0)
Target Plant Species Habitat Documented:	Approximately 0.053 acres of suitable *S. diluvialis* habitat documented within the Assessment Area; no proposed disturbance would impact any suitable habitat.

2.0 INTRODUCTION AND BACKGROUND

WESTERN-ENVIRO, Inc. (WESTERN-ENVIO) in coordination with Franson Civil Engineering, conducted field surveys and prepared a Botanical Report (BR) related to the proposed Corn Creek Watershed Plan – Environmental Assessment. The proposed project is a joint project sponsored by the U.S. Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), Kanosh Town, and Corn Creek Irrigation Company. Surveys focused on characterizing and mapping habitats respective to Federally listed plant species and identifying the presence of listed target species within corresponding habitats, if applicable. Work specifically involved the following tasks:

- Identifying potential habitats for Federally listed TEPC plant species, as per the USFWS requirements (USFWS 2022a).
- Determining if TEPC plant species have previously been identified within the project area and its immediate surroundings. This task was accomplished by referencing the Utah Natural Heritage Program (UNHP) (UNHP 2022).
- Conducting field assessments for TEPC species, specifically *S. diluvialis*, within the proposed impact area and in respective species survey buffer.

This report documents findings related to TEPC plant species within the Assessment Area, as identified in 2021, and the proposed project area, which was refined during planning in 2022 (Map 2, Appendix A). In addition, field assessments and reporting pertain to an associated 300-foot survey buffer (project area) (Map 2, Appendix A). This report is intended to provide guidance during planning, permitting, and agency consultation for the proposed project.

2.1 PROJECT LOCATION AND DESCRIPTION

The project area is in Kanosh, Utah, extending from Interstate-15 (I-15) roughly south-southeast to the mouth of Kanosh Canyon (Map 1, Appendix A) in Sections 5, 6, 7, 8, 10, 15, 16, 17, 18, 19, 20, 21, 22, 27, 28 & 29 in Township 23 South, Range 5 West, S.L.B.&M., Millard County, Utah. The project follows Corn Creek (a natural drainage) and a series of narrow irrigation canals.

The proposed project would implement watershed protection measures with the primary objectives of flood prevention and agricultural water management. Water shortages each irrigation season have increased demand on groundwater resources, limited crop production and cropping options, and impacted economic development in Kanosh.

3.0 RESOURCE SURVEY METHODOLOGY

3.1 BOTANICAL SURVEY

The project area was evaluated for habitats suitable to TEPC plant species, specifically targeting *S. diluvialis*. If habitat appropriate to any of the listed TEPC plant species was not present, the area was classified as negative. If an area contained habitat that could potentially support any of the listed species, it was surveyed using methodology that would provide 100-percent coverage for detecting corresponding species within suitable habitat (USFWS 2011). Table 3.1 details survey methodology.

Table 3-1. Botanical resource survey methodology for target species.

SPECIES	DATE OF SURVEY	PLANT SURVEY BUFFER	LEVEL OF SURVEY	TRANSECT WIDTH
S. diluvialis	August 20, 2021	300 Feet	100 percent coverage within suitable habitat	Variable depending on habitat; up to 6 feet

*Source USFWS 2011

A habitat suitability rating (e.g., suitable, or not suitable) for respective Millard County-listed TEPC plant species (i.e., target plant species) was assigned. Vegetation associations, geology, hydrology, and substrate qualities were considered indicators of habitat suitability, in accordance with documented and personal knowledge of known habitat parameters specific to target plant species.

Data recorded during 2021 botanical survey were collected using hand-held Trimble®GPS (Global Positioning System) units running Terasync® data recording software. In addition, field notes and photos were taken of the project area to record general site characteristics. Botanical surveys and reporting were completed by Bridget Atkin; vita found in Appendix B.

4.0 EXISTING CONDITIONS

4.1 GENERAL DESCRIPTION OF PROJECT AREA

The project is situated in the central Utah between the I-15 corridor to the west and the Pahvant Mountains to the east. The project area is characterized by agricultural land, rural residential development within the town of Kanosh and the Kanosh Indian Reservation, and open rangelands. The portion of the project area which intercepts rural development includes residential homes, small farms, commercial buildings, utility, and road infrastructure. Terrain is mostly flat with the elevation gradually rising towards the Pahvant Mountains to the east, including the portion of the project that covers the mouth of Kanosh Canyon.

The dominant vegetation communities within the project area are characterized in the valley bottom by both active and fallow agricultural fields (Figures 4-1 and 4-2), transitioning to mixed desert shrublands along the base of the Pahvant Mountains (Figure 4-3), and a riparian woodland in the eastern-most portion of the project that closely aligns with Corn Creek which drains Kanosh Canyon (Figure 4-4).

Agricultural lands occupy the central and northern portions of the project area surrounding the town of Kanosh. Because agricultural development and grazing are a common land use practices within this region, the overall composition of native vegetation cover is respectively degraded. Where land isn't being actively

irrigated and under cultivation, fallow fields have transitioned to dry rangelands dominated by non-native herbaceous species, including *Sisymbrium altissimum, Bromus tectorum*, *Bromus inermis,* and *Thinopyrum intermedium*.

Some areas, supporting mixed desert shrubland appear to have experienced relatively heavy grazing pressures from livestock; vegetation community compositions qualify as generally low in respect to species diversity with sparse shrub cover, minimal native forb, or native bunchgrass cover (Figure 4-5).

The riparian corridor associated with Corn Creek is narrow and characterized by a mature and varied woody canopy, including *Populus angustifolia*, *Salix exigua*, *Acer negundo*, and *Elaeagnus angustifolia* within the higher reach and *Salix fragilis* and *Rhus trilobata* within the lower reach of the drainage (Figures 4-6 and 4-7).

4.2 GEOLOGY

Most of the project area is in Late Holocene Alluvium with Fine-grained Lacustrine and Alluvial Deposits in the eastern portion of the project area, and Middle and Early Holocene Alluvium associated with Kanosh Canyon and the surrounded area (USDA NRCS 2022).

Figure 4-1. The western portion of the project follows irrigation ditches which intercept fields which were not actively being irrigated during the 2021 season. These areas were characterized by dry canals surrounded by ruderal grass and forb species.



Figure 4-2. Western portions of the project follow irrigation ditches which intercept actively cultivated and irrigated fields. Canals within this area are densely vegetated by ruderal herbaceous plant species.



Figure 4-3. The project area and surrounding region are characterized by widely spaced mixed desert shrubland along the eastern extent of the project area.



Figure 4-4. Riparian corridor aligning with Corn Creek, which drains Kanosh Canyon.



Figure 4-5. The project area and surrounding region are characterized by mixed desert shrubland along the eastern extent of the project area.



Figure 4-6. Riparian corridor aligning with Corn Creek, within the eastern-most extent of the project area.



Figure 4-7. The riparian corridor associated with the lower reach of Corn Creek is characterized by introduced woody species, including Salix fragilis and Elaeagnus angustifolia.



Table 4-1. Plant species documented within the project area.

BOTANICAL NAME	COMMON NAME	BOTANICAL NAME	COMMON NAME
Grass and grass-like species:			
Agropyrom cristarum	Crested wheatgrass	*Elymus repens*	Quackgrass
Aristida purpurea	Purple three awn	*Juncus arcticus*	Arctic rush
Bromus inermis	Smooth brome	*Juncus ensifolius*	Swordleaf rush
Bromus tectorum	Cheatgrass	*Panicum capillare*	Witchgrass
Carex nebrascensis	Nebraska sedge	*Poa pratensis*	Kentucky bluegrass
Distichlis spicata	Saltgrass	*Polypogon monspeliensis*	Annual rabbitsfoot grass
Echinochloa crus-galli	Barnyardgrass	*Schedonorus pratensis*	Meadow fescue
Eleocharis palustris	Commoon spikerush	*Sporobolus airoidies*	Alkali sacaton
Equisetum arvense	Field horsetail	*Thinopyrum intermedium*	Intermediate wheatgrass
Forbs*:*			
Acroptilon repens	Russian knapweed	*Iva annua*	Marsh elder
Alyssum desertorum	Desert madwort	*Iva axillaris*	Povertyweed
Amaranthus retroflexus	Redroot amaranth	*Lactuca serriola*	Prickly lettuce
Apocynum cannabinum	Indianhemp	*Lepidium latifolium*	Broadleaved pepperweed
Arctium minus	Lesser burdock	*Lycopus asper*	Rough bugleweed
Artemisia ludoviciana	White sagebrush	*Malcolmia africana*	African mustard
Asclepias labriformis	Utah milkweed	*Malva neglecta*	Common mallow
Asclepias speciosa	Showy milkweed	*Medicago sativa*	Alfalfa
Astragalus utahensis	Utah milkvetch	*Melilotus officinalis*	Sweetclover
Bassia hyssopifolia	Five-horn smotherweed	*Mentha arvensis*	Wild mint
Bassia prostrata	Forage kochia	*Mirabilis linearis*	Narrowleaf four o'clock
Bassia scoparia	Burningbush	*Onopordum acanthium*	Scotch thistle
Cardaria draba	Whitetop	*Polygonum aviculare*	Prostrate knotweed
Chenopodium album	Lambsquarters	*Ranunculus cymbalaria*	Alkali buttercup
Cirsium arvense	Canada thistle	*Rumex crispus*	Curly dock
Cirsium vulgare	Bull thistle	*Salsoa tragus*	Prickly Russian thistle
Cleome serrulate	Rocky mountain beeplant	*Sisymbrium altissimum*	Tall tumblemustard
Conium maculatum	Poison hemlock	*Solidago canadensis*	Canada goldenrod
Convolvulus arvensis	Field bindweed	*Sphaeralcea parvifolia*	Small-leaf globemallow
Conyza canadensis	Horseweed	*Taraxacum officinale*	Common dandelion

BOTANICAL NAME	COMMON NAME	BOTANICAL NAME	COMMON NAME
Cynoglossum officinale	Houndstongue	*Tragopogon dubius*	Yellow salsify
Descurainia pinnata	Western tansymustard	*Urtica dioica*	Stinging nettle
Dipsacus fullonum	Fuller's teasel	*Verbascum thapsus*	Common mullein
Epilobium ciliatum	Fringed willowherb	*Verbena hastata*	Swamp verbena
Erodium cicutarium	Redstem stork's bill	*Xanthium strumarium*	Rough cocklbur
Grindelia squarosa	Curlycup gumweed		
Helianthus annuus	Common sunflower		
Trees, Shrubs, and sub shrubs:			
Acer negundo	Boxelder	*Quercus gambelii*	Gambel oak
Artemisia nova	Black sagebrush	*Rhus trilobata*	Skunkbush sumac
Artemisia tridentata	Big sagebrush	*Rosa woodsii*	Wood's rose
Atriplex canescens	Fourwing saltbush	*Salix amygdaloides*	Peach leaf willow
Elaeagnus angustifolia	Russian olive	*Salix boothii*	Booth's willow
Ephedra viridis	Mormon tea	*Salix exigua*	Coyote willow
Ericameria nauseosa	Rubber rabbitbrush	*Sambucus nigra*	Black elderberry
Gutierrezia sarothrae	Broom snakeweed	*Shepherdia argentea*	Silver buffaloberry
Juniperus osteosperma	Utah juniper	*Tamarix chinensis*	Five-stamen tamarisk
Lonicera involucrata	Twinberry honeysuckle	*Ulmus pumila*	Siberian elm
Populus angustifolia	Narrowleaf cottonwood		

5.0 EVALUATED SPECIES INFORMATION

WESTERN-ENVIRO conducted an online search of the USFWS Information, Planning, and Conservation System (IPaC) database to determine plant species which have been reported in Millard County (USFW 2022b). Based on the results of the database search *S. diluvialis* was identified as having potential to occur within the project area.

6.0 SURVEY RESULTS

Spiranthes diluvialis **(Ute ladies'-tresses)** is listed as a Threatened species. This species grows in wet meadows and on the banks of perennial streams and rivers. The project area was evaluated in accordance with known *Spiranthes diluvialis* habitat parameters outlined in "Ute ladies'-tresses Field Survey Guidelines, U.S. Fish and Wildlife Service" (USFWS 2007), Range-wide Status Review of *Spiranthes diluvialis* (Fertig et al. 2005), and personal knowledge of the area and species requirements.

The botanical survey was conducted August 20 through 23, 2021, during the survey period appropriate for *S. diluvialis* within this region (USFWS 2011). Within the Assessment Area, which is outside of the currently proposed project disturbance extent (i.e., impact area), 0.053 acre of habitat suitable to this species was documented within Corn Creek riparian corridor (Maps 2 and 3, Appendix A). The documented suitable habitat was closely aligned with the hydrology of Corn Creek, at the mouth of Kanosh Canyon in the southeasternmost portion of the project area. The habitat was dominated by *Agrostis stolonifera, Agrostis gigantea, Juncus arcticus* sub. *litoralis* and Eleocharis palustris. Habitat encountered was classified as moderately suitable (Figures 6-1 and 6-2). *S. diluvialis* surveys were conducted within the identified suitable habitat; no *S. diluvialis* individuals were located.

Figure 6-1. Moderately suitable *S. diluvialis* habitat identified along Corn Creek.



Figure 6-2. Moderately suitable *S. diluvialis* habitat identified along Corn Creek.



7.0 REFERENCES

Fertig, Walter, Rick Black, and Paige Wolken. 2005. Rangewide Status Review of Ute lady's tresses (*Spiranthes diluvialis*). US Fish and Wildlife Service and Central Utah Water Conservancy District. Salt Lake City, UT. 101 pp.

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U.S. Fish and Wildlife Service [USFWS]. 2011. Utah Field Office Guidelines for Conducting and Reporting Botanical Inventories and Monitoring of Federally Listed, Proposed and Candidate Plants. USFWS Utah Field Office. Salt Lake City, Utah.

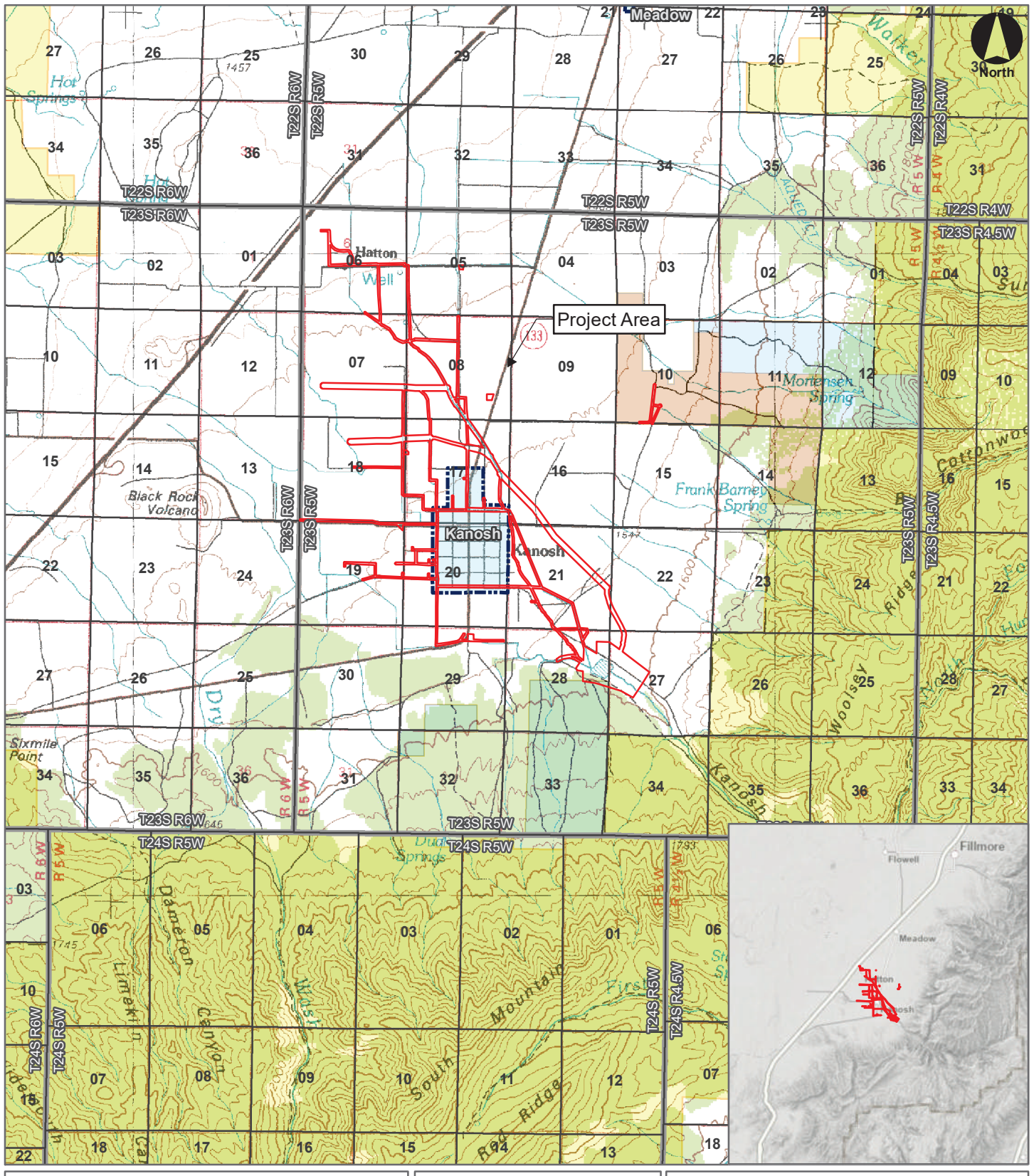
U.S. Fish and Wildlife Service [USFWS]. 2022a. United States Fish and Wildlife Service. Environmental Conservation Online System. Accessed online: https://ecos.fws.gov/ecp/report/species-listings-by-state?stateAbbrev=UT&stateName=Utah&statusCategory=Listed

U.S. Fish and Wildlife Service [USFWS]. 2022b. United States Fish and Wildlife Service – Information, Planning, and Conservation System.

Utah Natural Heritage Program [UNHP]. 2022. Utah Natural Heritage Program, Utah Division of Wildlife Resources, Utah Department of Natural Resources, Letter describing the search for TESPC, and species of concern located within one-half mile of the Project area.

8.0 APPENDICES

APPENDIX A
MAPS



WESTERN-ENVIRO RESOURCES

Project Location

0 1,400 2,800 4,200 5,600 7,000 Feet

VERSION:	NA
SURVEYED:	NA

LEGEND

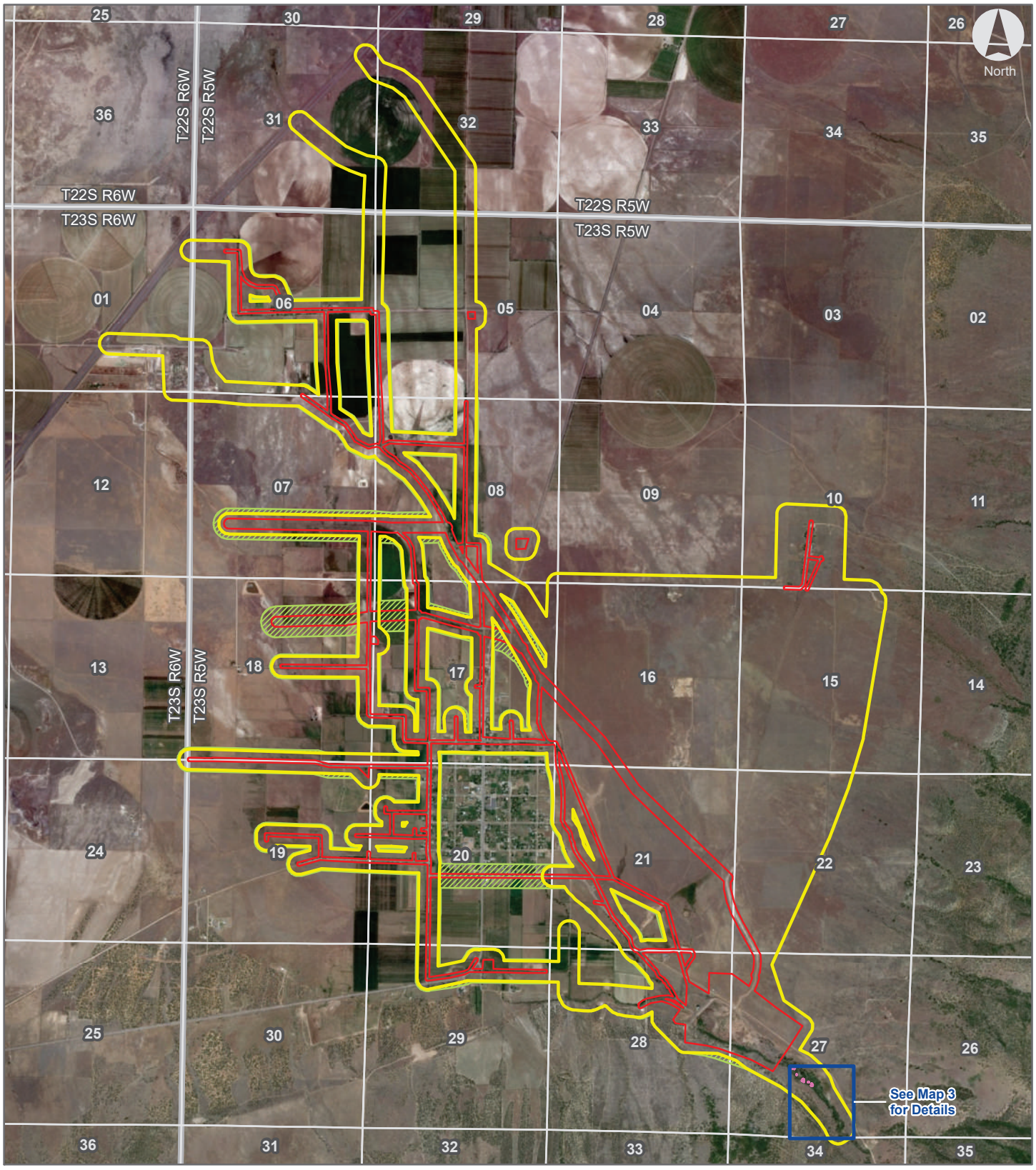
- Project Area
- Municipality

Federal | Private | State | Tribal

Corn Creek Watershed Plan - EA

LOCATION: SECTIONS 5, 6, 7, 8, 10, 15, 16, 17, 18, 19, 20, 21, 22, 27, 28 & 29 in T.23S, R.5W., S.L.B.M.
MILLARD COUNTY, UTAH

USGS 100K Topo	JUL 21, 2022 SCALE: 1" = 7,000' AUTHOR: JH	MAP 1



WESTERN-ENVIRO RESOURCES

Botanical Resources - Overview

0 800 1,600 2,400 3,200 4,000 Feet

VERSION:	NA
SURVEYED:	NA

LEGEND

- Project Area (598.94 Ac)
- 2021 Assessment Area (4,344.83 Ac)
- 2022 Additonal Assessment Area (355.47 Ac)
- *Spiranthes diluvialis* Habitat (0.053 Ac)

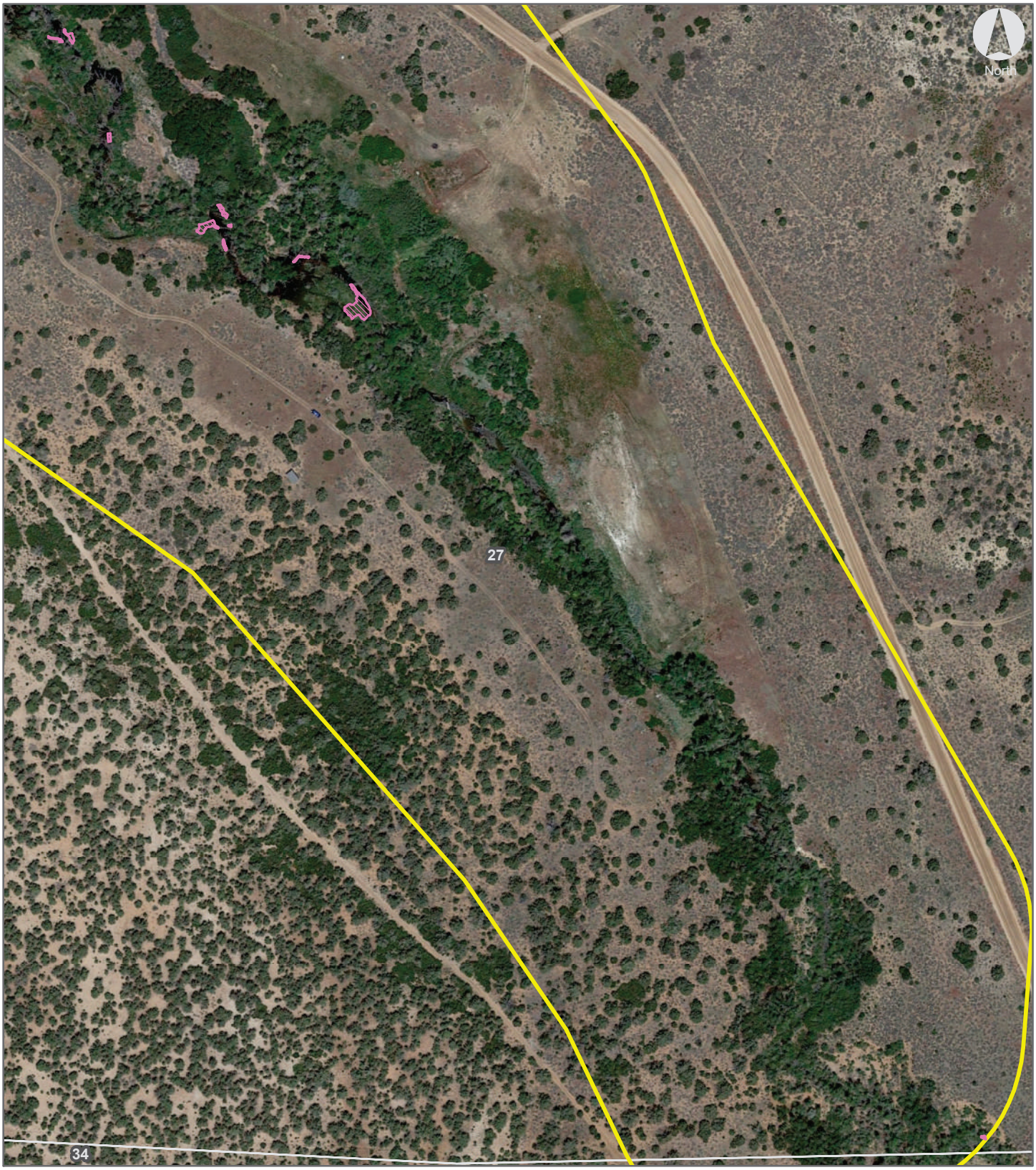
Corn Creek Watershed Plan - EA

LOCATION: SECTIONS 5, 6, 7, 8, 10, 15, 16, 17, 18, 19, 20, 21, 22, 27, 28 & 29 in T.23S, R.5W., S.L.B.M.
MILLARD COUNTY, UTAH

2018 Google Imagery

AUG 11, 2022
SCALE: 1" = 4,000'
AUTHOR: JH

MAP 2



WESTERN-ENVIRO
RESOURCES

Botanical Resources - Detail

0 50 100 150 200 250 Feet

VERSION:	NA
SURVEYED:	NA

LEGEND

- 2021 Assessment Area (4,344.83 Ac)
- *Spiranthes diluvialis* Habitat (0.053 Ac)

Corn Creek Watershed Plan - EA

LOCATION: SECTIONS 5, 6, 7, 8, 10, 15, 16, 17, 18, 19, 20, 21, 22, 27, 28 & 29 in T.23S, R.5W., S.L.B.M.
MILLARD COUNTY, UTAH

2018 Google Imagery

AUG 11, 2022
SCALE: 1" = 250'
AUTHOR: JH

MAP 3

APPENDIX B
QUALIFICATIONS

BRIDGET ATKIN – PLANT ECOLOGIST and ENVIRONMENTAL PLANNER – Ms. Atkin has 17 years of plant and environmental planning experience in the Intermountain West. She is experienced in the preparation and application of NEPA documents from scoping to project construction and compliance. She has managed projects involving the Clean Water Act, Section 404 Wetlands and was primary coordinator with Federal and State agencies. She is experienced with surveying and monitoring TEPC species, water-related planning, and permitting processes. She has managed hundreds of projects focusing on monitoring and mapping flora resources throughout the Intermountain West and has conducted natural resource surveys, inventories, and plant identification. Ms. Atkin holds a B.S. degree in horticulture, a M.S. degree in Plant Science, and has an M.L.A. from the Landscape Architecture and Environmental Planning department, all from Utah State University (USU).

Biological Assessment

Corn Creek Watershed Plan-EA

Prepared By:

FRANSON CIVIL ENGINEERS

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American Fork, Utah 84003
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Prepared For:

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service
Utah State Office
125 South State Street, Room 4010
Salt Lake City, Utah 84138
(801) 524-4550

November 2024

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1 Introduction

This Biological Assessment (BA) has been prepared to document the potential effects of the Corn Creek Watershed Plan-EA Project on Federally listed species afforded protection under Section 7 of the Endangered Species Act (ESA). The Natural Resources Conservation Service (NRCS) is the lead Federal agency for the project. It is providing technical and financial assistance to the sponsor, Kanosh Town, through the Watershed Flood Prevention & Operations (WFPO) Program (Public Law 83-566).

Kanosh Town, the Sponsoring Local Organization (SLO) for the project, in coordination with Corn Creek Irrigation Company (CCIC) and the Kanosh Band of Paiute Indians (Kanosh Band), is developing a Plan-EA that seeks to identify a viable alternative solution to address current flood prevention and agricultural water management problems in the Town of Kanosh, Utah and for the Kanosh Band of Paiute Indians located in Millard County, Utah.

2 Project Description

2.1 Project Area

The project is being planned for the Corn Creek Watershed, located in Millard County.

2.2 Action Area

The Action Area includes the area of disturbance associated with project measures, including the associated species buffers (0.5 mile for birds and 300 feet for plants). The Action Area is shown in Figure 1.

The Action Area is located within the North American Deserts ecoregion. The ecoregion is defined by low growing grasses and shrubs and other vegetation consistent with a sagebrush steppe environment. Land uses in the Action Area are primarily residential (urban) and agricultural.

2.3 Project Details

The Proposed Action consists of the following measures (Figures showing project measures are included at the end of this section):

2.3.1 Reconstruct the Corn Creek Dam and Debris Basin

The current Corn Creek Dam and Debris Basin would be reconstructed to bring it into compliance with NRCS and Utah State Dam Safety criteria. The new debris basin would have an updated alignment farther downstream and a taller embankment. The proposed embankment crest elevation is designed to be 5,208.75 feet and the height of the embankment measured from the lowest downstream toe elevation is approximately 50 feet.

2.3.2 Replace the Spillways of Corn Creek Dam

The Primary, Secondary, Emergency, and Auxiliary Spillways of the Dam would be replaced as well. The proposed primary spillway/low level outlet is a 42-inch conduit with a crest elevation of 5,177 feet. This conduit would discharge into a box that would dissipate energy, split water

between two pipelines, and measure flow. This outlet pipe would have a trash rack and be controlled with a guard gate at the inlet of the pipe.

The proposed secondary spillway is a morning glory and standpipe type design with a crest elevation of 5,199 feet and effective weir length of 22 feet. The 84-inch standpipe would have a 100-inch trash ring that would keep floating debris from blocking the flow of water into the spillway and blocking downstream culverts. The 84-inch standpipe would transition to a 60-inch conduit that would discharge into the energy dissipation box. During periods of high or flood flow, the box would discharge water to the existing channel downstream of the embankment.

The proposed emergency spillway is a side channel spillway design with a crest elevation of 5,203.8 feet and width of 200 feet. A concrete weir wall would discharge into a concrete side channel that would route the water to the existing emergency channel. The existing emergency spillway culverts that convey water across Kanosh Canyon Road do not have the capacity needed and have a high potential to be plugged in by debris. The road would be regraded to remove the culverts and create a broad swale that would convey floodwater to the existing flood channel. The elimination of culverts would greatly reduce the potential for debris to prevent floodwater from flowing into the existing flood channel.

The proposed auxiliary spillway would be constructed as an armored spillway over the dam with a crest elevation of 5,205.4 feet and width of 200 feet. The proposed armoring is a fabric-formed concrete mattress. The water would be routed into the existing channel downstream of the embankment.

2.3.3 Secondary Regulating Pond Relocation/Kanosh Band Secondary System

The reconstruction of the debris basin would involve moving the dam downstream and increasing the height of the dam to create additional flood detention storage in the debris basin. This would eliminate the existing Kanosh Town secondary pond. The pond would be relocated approximately a half mile upstream of the current pond location. The new pond would supply both the Kanosh

Town and the Kanosh Band of Paiutes (the Tribe) secondary systems from a higher elevation. This would provide additional pressure in the two secondary systems.
The proposed scope would include the following elements:

1. A diversion structure to divert a percentage of the Corn Creek flow for the Tribe and Town's secondary water systems, as well as divert water to the naturally clay-lined bypass channel along the debris basin that minimizes seepage losses for CCIC.
2. A splitting structure to split the diverted water between the Tribe and the Town.
3. A regulating pond at a suitable elevation to temporarily hold water and provide enough pressure for the Tribe's secondary water system, as well as the Town's secondary water system.
4. Pipelines to convey this water to the two existing secondary water system pipelines below the debris basin, a short pipeline to convey water from the diversion structure to the bypass channel on the southwest side of the debris basin that would minimize seepage losses, and an overflow pipe to convey excess water from the secondary pond to the bypass line for use by CCIC.
5. A secondary water pipe network for the Tribe connecting to their existing 12-inch PVC pipeline at their existing pond to convey water directly to the residential homes for outdoor water use.

2.3.4 Berm and Channel Modification

Downstream of the Debris Basin, all water in Corn Creek is conveyed by the CCIC ditch system. The flood modeling did not assume there was any warning of flooding or changes made to the terrain like sandbagging or modifications to the ditches. The modeling showed that Kanosh begins flooding during the 2-year storm event because the East Field Single Ditch takes more water from the splitting structure than it has capacity to safely convey. The splitting structure is based on shares, not on channel capacities. Installing bypasses near the existing splitting structure to prevent the Hatton and East/Middle Ditches from breaching is one of the proposed actions. The first bypass would route water that exceeds the capacity of the East/Middle Ditch to the Hatton Ditch. The second bypass would route water that exceeds the capacity of the Hatton Ditch to the West Ditch. Minimal modifications to the last two blocks of the West Ditch allowed the upstream capacity of the West Ditch to be fully utilized.

Another measure is to enlarge the West Ditch downstream of the Main Street culvert. The improvements include enlarging the existing channel, extending the channel, lining the ditch with concrete, and replacing the two 65 cfs capacity culverts with bridges over the concrete channel. This would allow the floodwater to be contained within the ditch until it can be safely discharged beyond the homes and structures in Kanosh.

To prevent the floodwater from overtopping I-15, it was important to route the water through multiple culverts and a large capacity I-15 culvert. As the floodwater spread out, it was important that it didn't travel north of this culvert. Shortening the existing emergency channel releases the floodwater farther south and allows more water to reach the larger culvert. Constructing a berm north of the culvert to prevent the floodwater from flowing north routes more water through the large culvert. Finally, raising 800 feet of an existing dirt road to prevent the water from flowing north was also one of

the actions that would utilize the large capacity I-15 culvert enough to prevent the overtopping of I-15. Some other measures were much smaller berms that direct the floodwater into the Hatton Ditch and away from structures and minor grading to direct floodwater into the West Ditch

2.3.5 Pipe Network

The current CCIC open ditches lose approximately 44% of the water conveyed. A gravity pipe system is proposed to greatly reduce seepage and evaporation losses and increase irrigation water deliveries to the farmers in the area. Diversion boxes would be installed at current irrigation turnouts.

The proposed pipe system would replace the equivalent of approximately 4.9 miles of open ditches. Up to approximately 14.1 miles of ditches would have pipe installed adjacent to the ditch because the ditch would be needed to convey floodwater. The ends of laterals that are used infrequently or serve a single shareholder may not be piped if funding becomes short.

There are multiple splitting/measurement structures proposed for the piped system. A main splitting/measurement structure is proposed where the 60-inch debris basin outlet would discharge. This main splitting box would dissipate energy and distribute the water into two pipelines. The pipelines would have a combined capacity of about 40 cfs. Other splitting/measurement structures would also divide water downstream where previous ditches have been combined to reduce the amount of pipe needed.

A sharp crested weir would be used in the splitting structures. This would ensure uniform controlled flow into each of the pipe sections. The sharp crested weir would also be used to measure flow; therefore, there would not be a need for separate measurement structures. There would be a staff gauge in the splitting structure and possibly a water level measurement device that could be transmitted to a SCADA system.

2.3.6 Kanosh Band Secondary Water System

The Corn Creek Watershed Project aims to improve irrigation systems for the Kanosh Band of Paiute Indian Tribe by adding a secondary system to the existing pipeline between the debris basin and the community.

The new regulating pond would be at a higher elevation that would allow it to service both the Town and Kanosh Band. The secondary system for the Kanosh Band would reduce the demand for existing culinary water systems. Water would be diverted from Corn Creek before it reaches the debris basin, stored in a new regulating pond with a partition to separate the Tribe's water from the Town's water. The Tribe's current pipeline, installed in 2005, has not been effectively used, leading to flooding and underutilization of water shares. The new system would allow better management of Tribal water rights, providing up to 400 gpm to supply 17 developed lots, though actual flow in Corn Creek would determine the amount of water available. The Town of Kanosh, with rights to 10% of CCIC’s water, would also benefit from the new system, which includes relocating their pond to a higher elevation to increase adequate pressure.

The management measures seek to optimize water distribution and minimize seepage, thereby supporting both the Tribe's and the Town's irrigation needs.

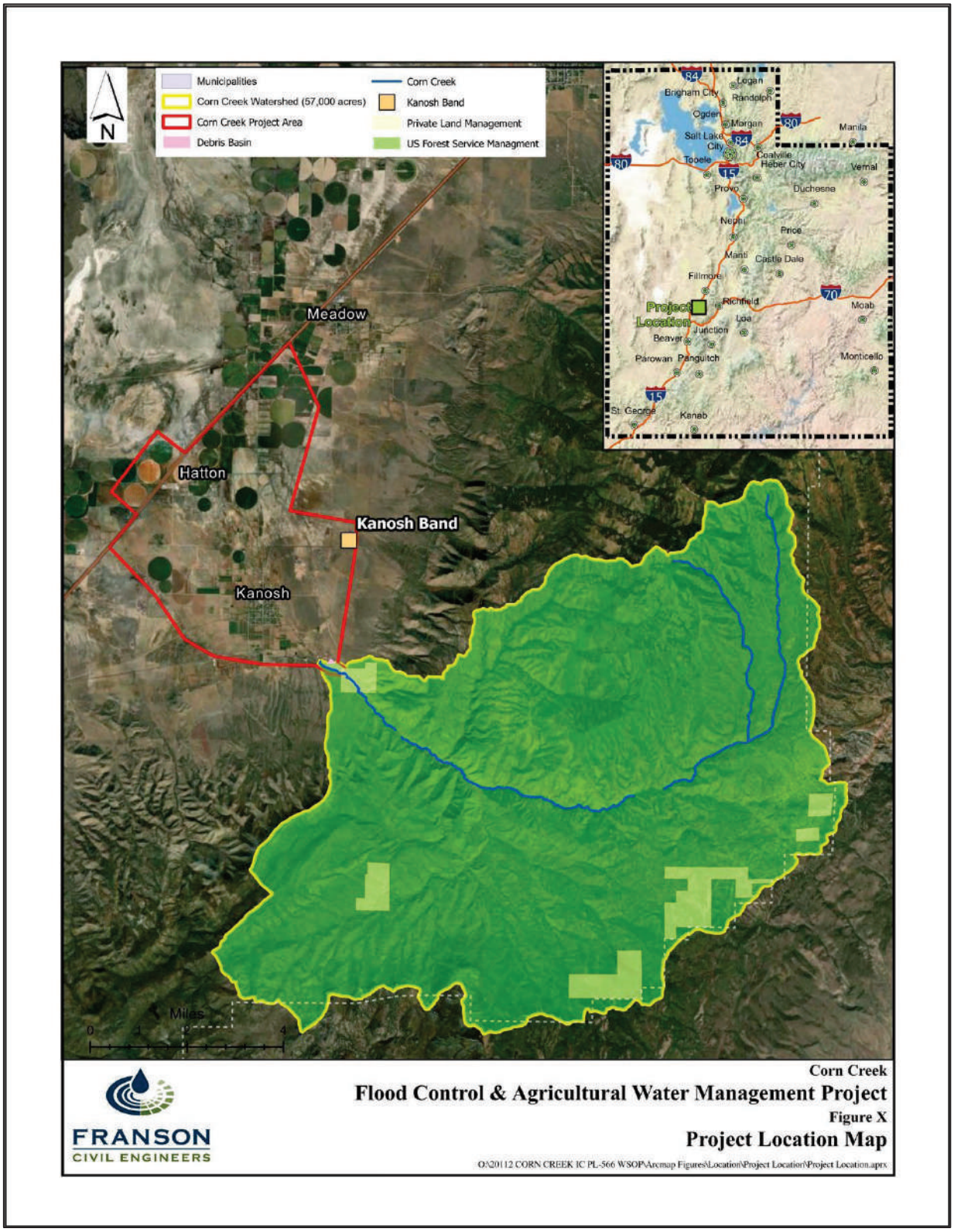


Figure 1 Project Action Area and Corn Creek Watershed

2.3.7 Timing of Construction

Construction would begin in Fall 2026 and would utilize typical construction machinery and equipment. It is estimated that construction will be completed in late 2027.

2.4 Conservation Measures

The following conservation measures are proposed for the species considered in this BA:

1. Limiting ground disturbance to only areas necessary to safely implement the Preferred Alternative.
2. Restricting construction activities to avoid sensitive breeding or nesting seasons if potential habitat for the Monarch butterfly and other special status animal species potentially present in the project area is identified during screening prior to construction.
3. Using existing roadways and maintenance routes where available to reduce disruption of habitat.
4. Restoring disturbed vegetation within the animal habitat as close as possible to pre-existing conditions on completion of the project.
5. Ensuring that contractors and project managers can recognize the special status animal species identified in this Biological Assessment as potentially present in the project area.
6. Prioritizing the protection of special status animal species if identified in pre-construction surveys in or adjacent to the construction corridor.
7. Placing appropriate buffers on nests if construction activities should occur in the late spring/early summer or any time active breeding, nesting, or pre-fledging behavioral activities occur. This would be done in accordance with the USFWS Utah Raptor Guidelines until fledging activities conclude.
8. Reinstating disturbed areas as close as practicable to pre-existing conditions at the end of the project to restore affected bird habitat.
9.

3 Species Considered

3.1 Species that May Be Present

An official species list was obtained for the Action Area from the Information for Planning and Consultation (IPaC) system on March 21, 2022, and last updated on October 15, 2024 (see Attachment A). The species listed as threatened or endangered that “may be present in the area of the proposed action” are listed in Table 1. There is no designated critical habitat for any of the species within or adjacent to the Action Area.

Table 1 Listed Species that May Occur in the Study Area & Rationale for Further Consideration in this Biological Assessment

Species	Status	Species Consideration in this BA and Likely Occurrence
Monarch Butterfly (*Danaus plexippus*)	Candidate	**Considered.** Monarch butterflies require milkweed (*Asclepias spp.*), nectar sources, overwintering habitat, and migration habitat (USFWS, 2020). There is potential for suitable habitat for the Monarch butterfly in the Action Area.
Ute Ladies'-Tresses (ULT) (*Spiranthes diluvialis*)	Threatened	**Considered.** Potentially Suitable habitat for the ULT was identified in the Action Area during the IPaC analysis..

3.2 Species Carried Forward

Monarch Butterfly and ULT were both identified as potentially occurring in the vicinity of proposed project activities; therefore, these species are being carried forward in this BA for further analysis.

3.3 Species Descriptions and Effect Analyses

3.3.1 Monarch Butterfly

The Monarch butterfly is an insect species, that was listed as a candidate species by the USFWS in 2020 (USFWS, 2020). Although findings of the USFWS review determined the Monarch butterfly to be eligible for listing as a threatened or endangered ESA species, higher priority actions have precluded formal listing. However, as NRCS is the lead agency for the project and NRCS policy requires consultation on candidate species in addition to listed species, the species has been considered in this BA.

The monarch butterfly is a migratory insect that spends its winters in coastal California and northern Mexico. The species requires Milkweed (*Asclepias sp.)* for egg laying. Monarch butterfly summer habitat is limited by the presence or absence of Milkweed for both food and reproduction, in areas where it is not present, Monarch butterflies will typically not be found. In Utah, it is possible that Monarch butterflies would forage on other non-milkweed species given their wide-ranging foraging capabilities if Milkweed is present somewhere else nearby (Cirrus, 2022 and USFWS, 2024).

The Monarch butterfly is distinguished by its relatively large wingspan for a butterfly of 3 to 4 inches that has an orange-black coloration, the black border is accompanied by a double row of white spots (USFWS, 2024). The Monarch butterfly has two sets of wings, each spanning approximately the same length. Monarch butterfly caterpillars, or larvae, have black, yellow and white stripes and reach lengths of two inches before metamorphosis.

Current threats to the Monarch butterfly include loss of habitat from development or conversion to agriculture, pesticide use, logging operations at wintering sites in Mexico, and drought

(Cirrus, 2022). The IPaC report for the Action Area did not identify any proposed or designated final critical habitat for the WYBC in the Action Area.

3.3.2 Survey Conditions & Findings – Monarch Butterfly

A habitat suitability assessment for the Monarch Butterfly occurred from July 16 through 19, 2022 and was conducted by Cirrus Ecological Solutions (Attachment B) to determine if any suitable habitat exists within the Action Area. No Monarch Butterfly individuals or Milkweed were identified during the survey. The survey concluded that no habitat for the Monarch exists in the Action Area.

3.3.3 Direct and Indirect Effects – Monarch Butterfly

The Monarch butterfly is not typically found in areas lacking the presence of Milkweed either within or near the evaluated site, such as the Action Area. Because of this, no suitable habitat for the Monarch butterfly was identified in the Action Area (Cirrus, 2022). As there is no suitable habitat in the Action Area, the Proposed Action would have no direct or indirect effects on the Monarch Butterfly.

3.3.4 Ute Ladies'-Tresses

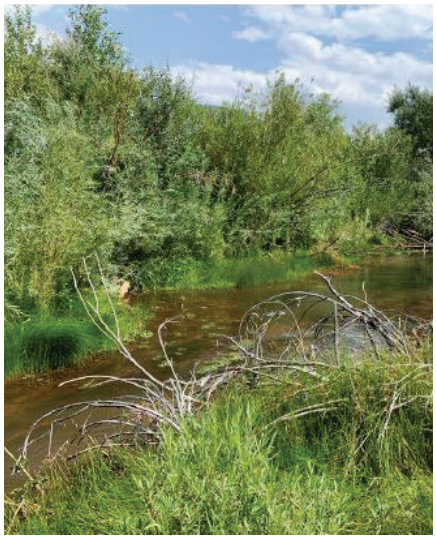


Figure 2 Moderately Suitable Habitat from Field Survey

The ULT is a white-flowered, perennial, terrestrial herb that is a member of the family *Orchidaceae* (orchids) that occurs in low to mid-elevation wetlands and riparian zones in the central Rocky Mountains and typically grows to be between 8 and 20 inches tall (USFWS, 2021a). The species was listed as threatened by the USFWS on January 17, 1992, because of its rarity, small population sizes, and threats of loss or modification to riparian habitats (USFWS, 1992).

Suitable ULT habitat is generally characterized by old stream channels, alluvial terraces, sub-irrigated meadows, and other wetland habitats. ULTs have also been documented within irrigated pastures, riparian shrublands, and deciduous forests below 7,000 feet in elevation. The species blooms from late July through August (USFWS 2021).

Current threats to the ULT include loss of riparian and wetland habitat as a result of urbanization, flooding, and dewatering of habitat from dam control and stream channel re-routing for agricultural development (USFWS 2021a).Survey Conditions & Findings – Ute Ladies'-Tresses

A habitat suitability assessment for the ULT was conducted from August 20 to August 23, 2021, by Western-Enviro Resources, based in Springville, Utah (Attachment C) to determine if any suitable habitat exists in the Action Area and to identify if any ULT individuals existed in the project area. The survey was conducted during the ULT blooming window and surveyed ~4,345 acres, which included the standard 300-foot plant survey buffer and using transect widths of up to 6-feet. A moderately suitable habitat for the ULT was found closely aligned with the hydrology of Corn creek, but no ULT individuals were located (Western-Enviro Resources, 2021). The suitable habitat is located southeast of the Action Area and outside of all extents of the Proposed Action. A copy of the botanical report is included as Attachment C.

3.3.5 Direct and Indirect Effects – ULT

No suitable ULT habitat or ULT individuals were found in the Action Area, although some moderately suitable habitat was found along the Corn Creek channel southeast of the Action Area. The minimum buffer between the Proposed Action and ULT habitat is 300 feet, thus there would be no direct or indirect effects on the ULT as a result of the Proposed Action.

4 Conclusion and Determination of Effects

4.1 Determination of Effects – No Effect

Considering all the information presented in the preceding sections of this BA, it can be reasonably concluded that the magnitude of impacts on the ULT and Monarch Butterfly resulting from the Proposed Action is expected to have no impact on either species (i.e., **no effect**).

The Monarch Butterfly and ULT were not identified as being present in the Action Area during field surveys. Additionally, there would be no overlap between the Proposed Action and any suitable habitat in the Action Area. Additionally, the Proposed Action would not occur within 300-feet of any suitable habitat for ULTs, maintaining the minimum work buffer for plants specified by the USFWS.

The table below summarizes and presents the determinations of effects for all of the ESA species considered in this BA. No actions related to the Proposed Action would have any effect on designated critical habitat for any species.

Table 2 Determination of Effects

Species	Status	Determination of Effects
Monarch Butterfly (*Danaus plexippus*)	Candidate	**No Effect.** No suitable habitat or individuals identified in the Action Area.
Ute Ladies'-Tresses (*Spiranthes diluvialis*)	Threatened	**No Effect.** No suitable habitat or individuals identified in the Action Area.

5 Literature Cited

Cirrus Ecological Solutions. 2023. *Memo: Corn Creek – Threatened, Endangered, Proposed, Candidate Species Review*.

EPA. 2021. Ecoregion Level III * IV by State. Utah. https://gaftp.epa.gov/EPADataCommons/ORD/Ecoregions/ut/ut_front.pdf

USFWS. 2021a. Environmental Conservation Online System (ECOS). Accessed August 26, 2024. Species Profile: Ute ladies'-tresses (*Spiranthes diluvialis*). https://ecos.fws.gov./ecp0/profile/speciesProfile?sld=2159.

USFWS. 1992. Interim Survey Requirements for Ute Ladies'-tresses Orchid (*Spiranthes diluvialis*). Available at https://www.fws.gov/sites/default/files/documents/SPDI_interimSurveyRequirements_1992_revised%202017.pdf.

USFWS. 2024. Corn Creek Watershed Plan-Environmental Assessment ECOS IPaC Report (2025-0005625).

USFWS. 2020. Monarch Butterfly (*Danaus plexippus*) Species Status Assessment Report. V2.1 96 pp + appendices.

Western-Enviro Resources. August 2022. Botanical Report for the Proposed: Corn Creek Watershed Plan & Environmental Assessment, Millard County, Utah.

Ute Ladies'-Tresses, USFWS. Hotze, Public Domain, https://www.fws.gov/banner/ute-ladies-tresses.

6 Attachments

Attachment A. USFWS IPaC Species Report, most recent version (October 15, 2024)
Attachment B. Corn Creek Species Review Memo (Monarch) – Cirrus Ecological Solutions
Attachment C. Botanical Report (ULT) – Western-Enviro Resources & Proposed Action Maps

Attachments: Human-Related Resource Concerns

- Redacted Copy of Cultural Resource Report – Certus Environmental Solutions, LLC
- Executive Orders 12898 and 14096 for Environmental Justice Criteria
- 1996 Corn Creek Dam Inspection Letter – Utah Division of Water Rights
- June 2010 Corn Creek Dam Safety Letter – Utah Division of Water Rights
- May 2011 Corn Creek Dam Inspection Report -- Utah Division of Water Rights
- April 2023 Corn Creek Dam Inspection Report – Utah Division of Water Rights
- Millard County Progress, May 11, 1984
- Kanosh Band of Paiute Indians Comprehensive Economic Development Strategy (Reference)

COVER PAGE

Must Accompany All Project Reports Submitted to the Utah SHPO

Report Title: *A Cultural Resource Assessment for the Corn Creek Watershed Plan-EA, Kanosh, Millard County, Utah*

UDSH Project Number: U23HY0520
Report Date: March 26, 2024
Report Author(s): Sheri Murray Ellis
Record Search Date(s): August 10, 2023
Intensive Acres Surveyed (<15m intervals): 375.4 acres
USGS 7.5' Series Map Reference(s): Kanosh, UT

Org. Project Number: FRA05
County(ies): Millard
Principal Investigator: Sheri Murray Ellis
Field Supervisor(s): Sheri Murray Ellis
Recon Acres Surveyed (<15m intervals): 24.6 ac.

Sites Reported	Count	Smithsonian Trinomials
Revisits (no updated site forms)	0	
Updates (updated site forms attached)	2	42MD2016, 42MD2017
New recordings (site forms attached)	14	42MD4696 – 42MD4708, 42MD4713
Total Count of Archaeological Sites in APE	16	42MD2016, 42MD2017, 42MD4696 – 42MD4708, 42MD4713
Historic Structures (structures forms Attached)	0	
Total National Register Eligible Sites	7	42MD2017, 42MD4703–42MD4708

*Please list all site numbers per category. Number strings are acceptable (e.g. "42TO1-13; 42TO15"). Cells should expand to accommodate extensive lists.

Checklist of Required Items for Submittal to SHPO

☒ "Born Digital" Report in a PDF/A format
- ☒ SHPO Cover Sheet
- ☒ File Name is the UDSH Project Number with no hyphens or landowner suffixes

☒ "Born Digital" Site forms in PDF/A format
- ☒ UASF with embedded maps and photos
- ☒ File name is Smithsonian Trinomial without leading zeros (e.g. 42TO13 not 42TO00013)
- ☒ Photo requirements (including size and quality)

☒ Archaeological Site Tabular Data
- ☒ Single spreadsheet for each project
- ☒ Follows UTSHPO template (info here: https://goo.gl/7SLMqj)

☒ GIS data
- ☒ Zipped polygon shapefile or geodatabase of survey (if different from APE) or other activity area with required field names and variable intensity denoted
- ☒ Zipped polygon shapefile or geodatabase of site boundaries with a the required field name

An Archaeological Resource Assessment for the Corn Creek Watershed Plan-EA, Kanosh, Millard County, Utah

REDACTED

Prepared for

Franson Civil Engineers
and
Natural Resources Conservation Service, State Office

Prepared by

Sheri Murray Ellis, MS, RPA
Owner/Consultant



Certus Environmental Solutions, LLC
Salt Lake City, Utah
801.230.7260

PLPCO Permit No. 176
Utah Antiquities Report No. U23HY0520

Certus Project Number FRA05

March 26, 2024

PROJECT SUMMARY SHEET

Report Title: *An Archaeological Resource Assessment for the Corn Creek Watershed Plan-EA, Kanosh, Millard County, Utah*

State Report No.: U23HY0520

Project Description: The Town of Kanosh, in conjunction with the Corn Creek Irrigation Company (the CCIC) and the Kanosh Band of Paiute Indians (Kanosh Band), proposes to address flooding and improve agricultural water management within the Corn Creek Watershed of south-central Utah. The Preferred Alternative proposes installing new flood control features, improving existing flood control systems, replacing inadequate and failing water conveyance pipes, and piping open canal systems to reduce water loss from seepage and evaporation, among other things. Part of the funding for the projects would come from the Natural Resources Conservation Service (NRCS) under the Watershed Protection and Flood Prevention Act of 1954 (P.L. 83-566). Issuance of such federal funding by the NRCS invokes the National Historic Preservation Act and its implementing regulations at 36 CFR §800 for the consideration of historic properties in project planning and execution. Franson Civil Engineers, under contract to the project sponsors, is assisting in the design and National Environmental Policy Act (NEPA) evaluation for the project. Franson subcontracted to Certus Environmental Solutions (Certus) to assist in conducting a cultural resource assessment for the projects to be used by the NRCS in compliance with 36 CFR §800. The results of the assessment by Certus are presented herein.

Survey Area and Area of Potential Effects: The NRCS, as the lead agency for the purpose of 36 CFR §800, has defined the area of potential effects (APE) for the flood protection and water projects as that area encompassing all locations of anticipated ground disturbance for the Preferred Alternative as well as all lands that could be affected by flood waters under the No Action alternative and via a breach of the dam under the Preferred Alternative. The cultural resource survey area—i.e., the area subjected to field inspection—consists of a series of linear corridors and polygons within which watershed improvement projects and construction staging would occur under the Preferred Alternative. The linear corridors range from 15 to 30 meters (50 to 100 feet) wide depending on the nature of the proposed improvements. In total, the survey area encompassed approximately 400 acres. The remainder of the APE outside of these areas were not subject to field inspections but were reviewed through archival research.

Agencies: Natural Resources Conservation Service; Town of Kanosh; Corn Creek Irrigation Company; Kanosh Band of Paiute Indians

Location: Kanosh, Millard County, Utah

- T. 22S, R. 5W, Sec.31 & 32;
- T. 23S, R. 5W, Sec. 4–8, 10, 15–22, and 27–29

Land Ownership: Private, Municipal, Tribal, State (Division of Wildlife Resources)

Date(s) of Fieldwork: August 16-19, 2023; September 19, 2023

Methods: Intensive-level and reconnaissance-level archaeological survey; no buildings will be impacted, even if in the survey area

Acres Surveyed: 400 acres (375.4 intensive & 24.6 reconnaissance)

Cultural Resource Sites in Survey Area: 16 (42MD2016, 42MD2017, 42MD4696 – 42MD4708, 42MD4713)

Resources Recommended Eligible for the NRHP: 7 (42MD2017, 42MD4703–42MD4708)

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PROJECT DESCRIPTION

The Town of Kanosh, in conjunction with the Corn Creek Irrigation Company (the CCIC) and the Kanosh Band of Paiute Indians (Kanosh Band), proposes to address flooding and improve agricultural water management within the Corn Creek Watershed of south-central Utah (see **Figure 1** for general location). The project may entail installing new flood control features, improving existing flood control systems, replacing inadequate and failing water conveyance pipes, and piping open canal systems to reduce water loss from seepage and evaporation, among other things. The Preferred Alternative from studies conducted for the project would include the following:

- **Reconstruction of the Corn Creek Dam and Debris Basin**: extension of the dam's length and height; addition of a second spillway and auxiliary spillway;

- **Flood Routing and Channel Improvements**: existing CCIC ditch system maintained to serve in flood control with modifications to route water away from the Kanosh townsite and into lands to the north and northeast; some existing ditch segments would be piped; modifying water control structures on existing ditches; construction of a new concrete ditch segment between Main Street and 200 West; replacing select existing culverts; and other minor modifications to some existing ditch channels;

- **Installation of Berms**: construct a 2,200-foot long earthen berm around the project area for flood control on I-15; construct a series of smaller earthen berms to divert water around private property and into the Hatton Ditch;

- **Road Improvements**: raise approximately 800 feet of an existing dirt road to prevent overtopping during flood events;

- **Gravity Flow Irrigation Pipeline and Related Infrastructure**: construct a gravity flow pipe irrigation system to convey most of the available irrigation water—mostly adjacent to existing ditches, which would, as noted above, be retained to help carry and direct flood waters.

- **Secondary Water System Regulating Pond and Related Infrastructure**: construct a new regulating pond upstream from the reconstructed Corn Creek Dam and east of the existing debris basin; install new pipe downstream of the debris basin to connect the new pond to the existing Kanosh secondary water system; construct a new splitting structure to split water between the Kanosh townsite and the Kanosh Band; and install a new pipeline system with connections to each home on the Kanosh Band Reservation.

Part of the funding for the projects would come from the Natural Resources Conservation Service (NRCS) under the Watershed Protection and Flood Prevention Act. Issuance of such federal funding by the NRCS invokes the National Historic Preservation Act and its implementing regulations at 36 CFR §800 for the consideration of historic properties in project planning and execution.

Franson Civil Engineers, under contract to the project sponsors, is assisting in the design and National Environmental Policy Act (NEPA) evaluation for the projects. Franson subcontracted to Certus Environmental Solutions (Certus) to assist in conducting a cultural resource assessment for the projects to be used by the NRCS in compliance with 36 CFR §800. The results of the assessment by Certus are presented herein.

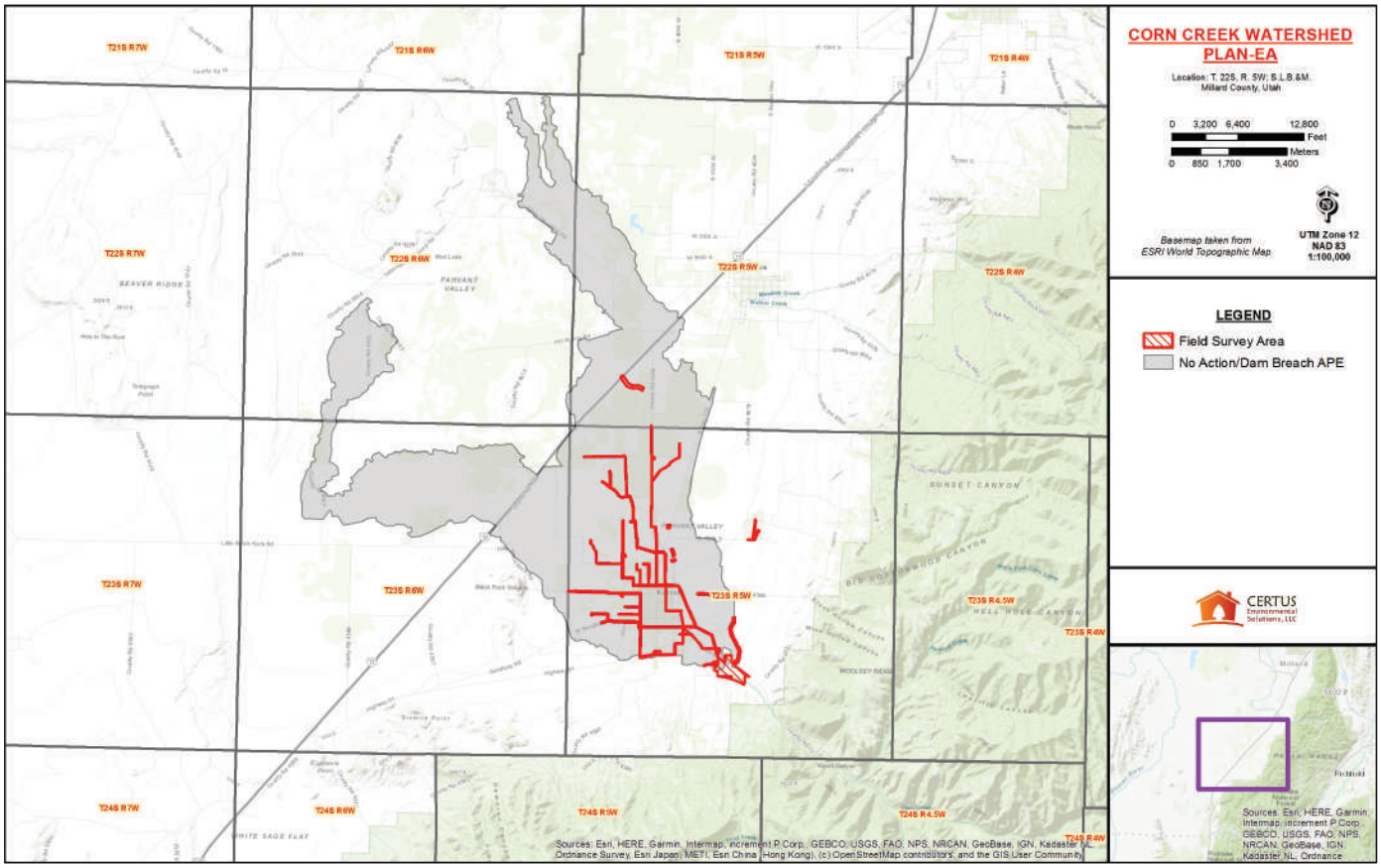


Figure 1. General location of the Corn Creek Watershed Plan-EA Project Area

Fieldwork, which was carried out by the author August 16–19 and September 19, 2023, consisted of a combination intensive-level and reconnaissance-level survey for archaeological resources. Reconnaissance-level methods were employed only in two areas of the project where access or other field conditions posed safety hazards. Because no buildings or structures, beyond those directly associated with the canals or culverts that are the subject of the undertaking, would be altered, demolished, moved, or otherwise directly impacted by the project, such resources were not inventoried, even if they were located inside the survey area boundary. Cultural resource survey work was carried out under Utah State Antiquities Project No. U23HY0520 and Utah Public Lands Policy Coordination Office (PLPCO) Principal Investigator Permit No. 176.

Personnel Qualifications

Sheri Murray Ellis, Principal Investigator for Certus under State of Utah PLPCO Permit No. 176, conducted fieldwork for the project. Ms. Ellis meets all standards for professional qualifications for both archaeology and architectural history and for both prehistoric and historic period resources. Ms. Ellis holds an M.S. in American Studies (a multi-disciplinary degree that includes archaeology and history). Ms. Ellis has more than 32 years of professional experience in cultural resource assessments in Utah and the western United States.

Cultural Resources Survey Area and Area of Potential Effects

The cultural resource survey area and as determined by the NRCS consists of a series of linear corridors and polygons within which the project components described above for the Preferred Alternative and construction staging would occur (see **Figures 2 & 3**). Since the majority of the improvements would be located at-grade or below-grade and would not introduce new visual intrusions, the indirect effects from the undertaking are expected to be confined to the survey area as defined here. Additionally, the survey area around the Corn Creek Dam includes a buffer of at least 30 meters (100 feet) depending on final design to account for the increased visual nature of the dam from its additional height and length.

The linear corridors of the survey area range from 15 to 30 meters (50 to 100 feet) wide depending on the nature of the proposed improvements. Where existing ditches would be altered or where no ditches are currently located, the corridor width is generally limited to 15 meters wide. Where new pipelines would be installed adjacent to existing ditches, the corridor width was as much as 30 meters wide. In total, the survey area encompassed approximately 400 acres.

The area of potential effects (APE) as defined by the NRCS under 36 CFR §800.4 also includes the areas that could be potentially flooded and damaged if no action is taken (i.e., the No Action alternative) as well as the area that could be flooded if the dam improvements under the Preferred Alternative breaches (see **Figure 1).** Collectively, this APE contains 17,864 acres. This APE was not included in the survey area for the undertaking but was reviewed through archival research.

Lands within the survey area are mostly owned by private parties and the local municipal government, but lands owned by the Utah Division of Wildlife Resources (3.4 acres) and the Kanosh Band (8.4 acres) also were present in the survey area.

The survey area is located in Township 22 South, Range 5 West, Sections 31 and 32 and Township 23 South, Range 5 West, Sections 4–8, 10, 15–22, and 27–29 of the Salt Lake Base and Meridian. This area can be found on USGS 7.5 minute topographic quadrangle Kanosh, Utah (see **Figures 2 & 3**).

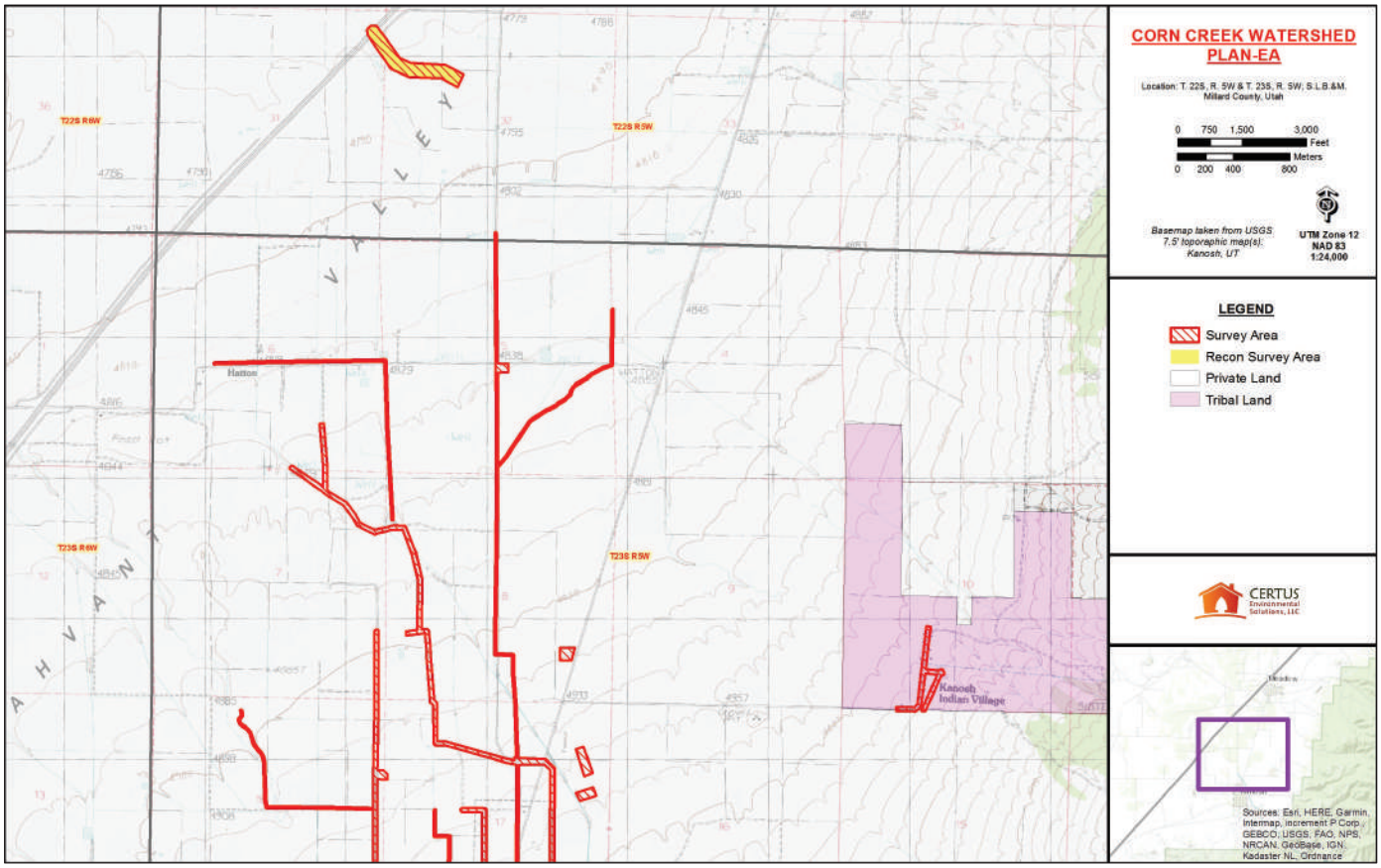


Figure 2. Location of survey area; Map 1 of 2

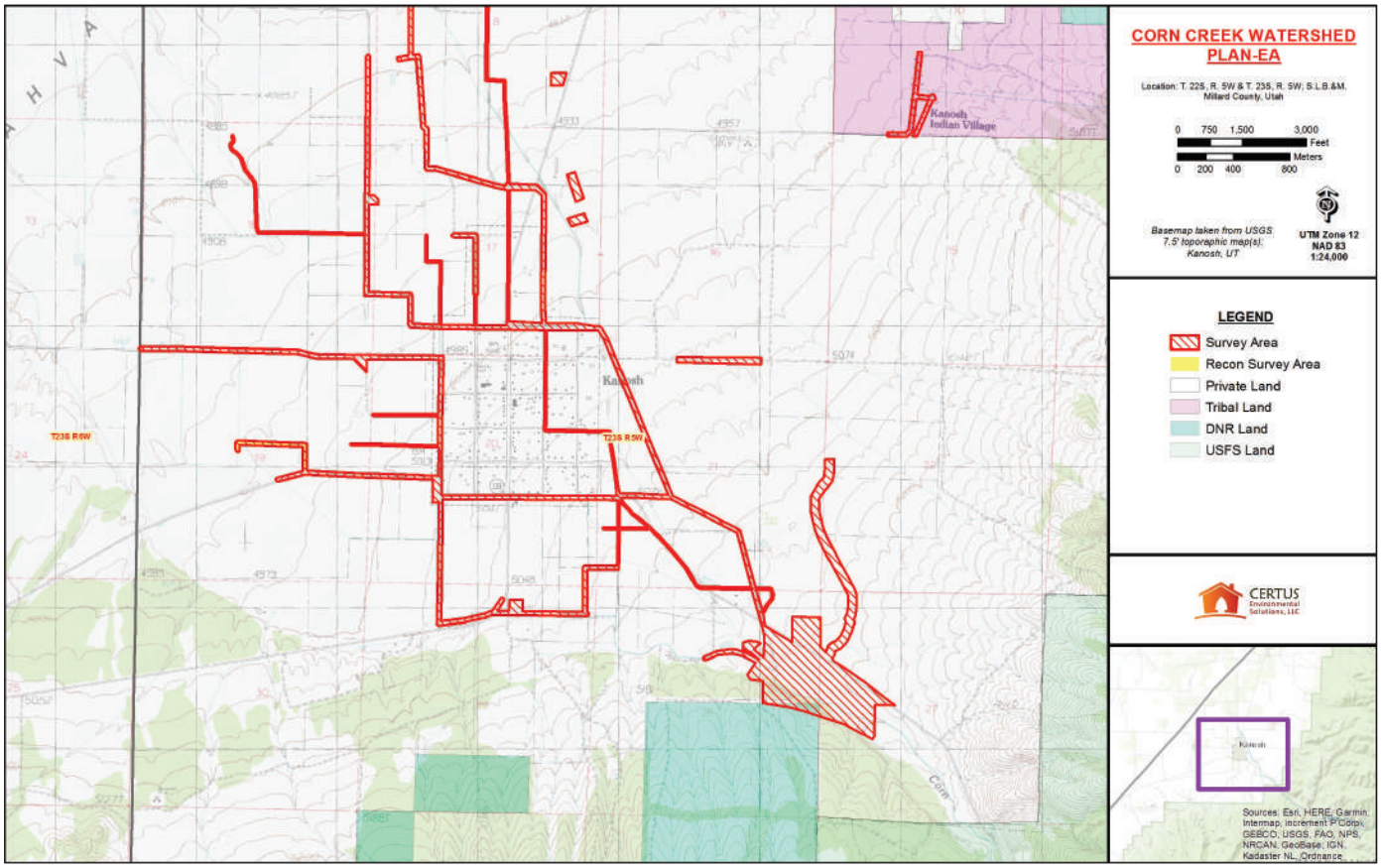


Figure 3. Location of survey area; Map 2 of 2

PROJECT SETTING

The project area is located in south-central Utah in an area known as the Pahvant Valley. More specifically, it is situated in and around the small, rural community of Kanosh and on the adjacent Paiute Indian Tribe of Utah Kanosh Reservation (Kanosh Indian Village). Portions of the project area encompass Corn Creek—both the natural and channelized sections of the creek—while most others are centered on a series of open irrigation ditches or follow subsurface waterlines. It also encompasses the existing Corn Creek dam and debris basin. Elevation of the survey area ranges from roughly 4775 to 5300 feet above sea level.

Vegetation in the survey area varies by location. Riparian plants are found along the Corn Creek channel and several of the open ditch/canal channels while native sagebrush community species are found away from these waterways and outside of the developed community. Within Kanosh proper, vegetation large comprises introduced agricultural cultigens, ornamental landscaping (e.g., introduced lawns, trees, and shurbs), and invasive weeds deriving from past ground disturbance. A small area of juniper is present in the extreme southeast portion of the survey area, on a ridge south of Corn Creek.

Lands outside the core area of Kanosh are lightly developed and primary used for agricultural purposes—growing corn, alfalfa, and other crops and grazing livestock. In town, lands are developed with typical suburban lots with single-family dwellings and introduced landscaping. Soils across the area are light to medium brown silty loam with a moderate content of alkalai. They appear highly erodible.

FILE SEARCH

Certus conducted a search of the online site and project files of the Utah State Historic Preservation Office (SHPO) on August 10, 2023. The file search encompassed an area extending 1/4 mile in all directions from the edge of each survey area. The file search was conducted to:

a) identify any areas of the survey area that may not require additional field inventory;

b) identify any previously documented sites in the survey area that should be considered relative to potential project impacts; and

c) assess the potential for encountering cultural resources during the field survey for the project and obtain information about the types of cultural resources likely to be present.

Field Survey Area

SHPO records indicate that 18 prior cultural resource surveys have been undertaken in the vicinity of the current survey area. These inventories occurred between 1991 and 2022 with most occurring after 2003. Thirteen of the previous surveys intersect the current survey area but did not encompass it in a meaningful way. As such, Certus reinventoried all previously surveyed portions of the current survey area.

Nine archaeological sites have been previously documented in the file search area according to Sego map records. One of the sites (a historical Forest Service campground) appears to be misplotted and is not actually located in the file search area. The remaining eight sites include two historic period resources—a concrete pipeline (42MD2016) and an irrigation ditch (42MD2017)—that are partially located in the current survey area. See the **Findings** section of this report for more information about these sites. The other six sites include four historical artifact scatters/trash dumps, one historical road, and one

prehistoric temporary camp/lithic scatter. All of these sites are located outside the current survey area, though one of the historical artifact scatters (42MD2018) is located just barely outside such that any expansion of the survey area boundary in that area would extend into the site.

In addition to the records of the SHPO, Certus reviewed historical General Land Office (GLO) maps for the current survey area. Historical GLO maps are available online for the various townships and range. Only the map dating to 1879 provides any detailed illustration of lands located within the current survey area. This map depicts a ditch, referred to as the Indian Ditch, which may correspond with previously reported site 42MD2017. Several drainage channels or ditches (they are unlabeled) also are depicted on the map within the plat of Kanosh, as are several roads, buildings, and a telegraph line. No evidence of the telegraph line was observed during fieldwork, and most of the roads shown in the GLO map have been replaced by modern versions thereof.

No Action/Dam Breach Area of Potential Effects

In addition to reviewing project, site, and structures files for the field survey area, Certus reviewed site and structures records held by the Utah SHPO for the broader APE. County Recorder records were also reviewed to identify all primary buildings in the APE that date to the historic period (i.e., created during or before 1974). These properties could be affected by flooding under the No Action alternative. This search indicates that 12 archaeological sites are known to be present in the APE, excluding those newly located in the survey area and reported in the **Findings** section of this report. The 13 previously reported sites are as follows (see also **Figure 4 in Appendix A** for locations):

- 42MD461: Prehistoric Rock Art (Undetermined)
- 42MD996: Multi-component (Eligible)
- 42MD997: Prehistoric Camp (Eligible)
- 42MD1548: Lithic Scatter (Ineligible)
- 42MD1601: Lithic Scatter (Ineligible)
- 42MD2016: Historic Pipeline (Ineligible)
- 42MD2019: Lithic Scatter (Ineligible)
- 42MD3624: Historic Artifact Scatter (Ineligible)
- 42MD3625: Historic Artifact Scatter (Ineligible)
- 42MD3629: Historic Artifact Scatter (Ineligible)
- 42MD3630: Historic Artifact Scatter (Ineligible)
- 42MD3631: Historic Artifact Scatter (Ineligible)

Beyond the 12 previously reported archaeological sites, 162 primary buildings dating to the historic period were identified in the APE through both Utah SHPO and County Recorder records. See **Appendix A** for a list of these properties and figures (**Figures 4 & 5**) showing their locations). Additional historical outbuildings are likely present in the area but are not enumerated here due to lack of information about their specific ages. Of the162 known historical buildings, only 7 have evaluated previously for their National Register eligibility. These properties are as follows:

- ~4675 W Hatton Ln (Eligible)
- ~4750 W Hatton Ln (Eligible)
- 4909 W Hatton Ln (Eligible)
- 10 N Main St (Listed on NRHP)
- 60 N Main St (Eligible)
- 35 W Center St (Eligible)
- 60/70 W Center St (Eligible)

FIELD METHODS

Certus applied a combination of intensive-level and reconnaissance-level archaeological survey methods accepted by the Utah State Historic Preservation Office (SHPO) and other agencies in Utah to identify cultural resources that could be affected by the undertaking. Intensive-level methods were employed across the vast majority of the study and consisted of Sheri Murray Ellis of Certus inventorying the area

by walking multiple transects spaced no more than 15 meters (50 feet) apart. Where reconnaissance-level methods were applied (see **Figures 2 and 3** for location), survey transects were more widely spaced and more irregular. These reconnaissance methods were only employed it two areas of the survey corridor where field safety hazards exceeded acceptable thresholds to continue regular intensive-level methods.

Navigation within the survey areas was accomplished using a handheld GPS unit capable of sub-meter accuracy, air photos, and physical landmarks. A cutoff age of 50 years using 2023 as the base year (i.e., created during or before 1973) was used to identify resources requiring documentation and evaluation under 36 CFR §800.

Because no buildings or structures unrelated to the canals that are one of the subjects of the project will be physical altered, moved, demolished, or otherwise directly impacted by the proposed undertaking, historical resources of this type were not documented as part of the survey reported herein.

Resource Evaluation Methods

Certus employed regulatory standard methods for evaluating the historical significance of cultural resources encountered during the field inventory. To that end, Certus evaluated all identified cultural resources for their eligibility for listing on the National Register of Historic Places (the National Register). The evaluation considered the four criteria of the National Register as listed in 36 CFR §60.4 and followed the guidelines issued by the National Park Service (NPS) in Bulletin 15, *How to Apply the National Register Criteria for Evaluation* (NPS). The National Register criteria state that a resource may be considered eligible for listing on the Register if it:

Criterion A – is associated with events that have made a significant contribution to the broad patterns of our history; OR

Criterion B – is associated with the lives of persons significant in our past; OR

Criterion C – embodies the distinctive characteristics of a type, period, or method of construction, or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components may lack individual distinction; OR

Criterion D – has yielded, or may be likely to yield, information important in prehistory or history.

Resources considered potentially eligible for the National Register pursuant to one of the above criteria are also to be assessed for integrity of location, design, setting, materials, workmanship, feeling, and association. To be eligible for listing on the National Register, the resource must possess integrity of those elements directly related to the criterion or criteria under which it would be determined eligible.

Findings for the Survey Area

Certus identified two isolated occurrences and 16 archaeological sites in the survey area for the Corn Creek Watershed Plan-EA (see **Table 1**). The isolate's and sites include both prehistoric and historic period resources. Historic period sites are the most numerous and are mostly represented by canals and other historical water control features. Descriptions of the isolates and sites are provided below along with discussions of their eligibility for the National Register. Their locations are shown in **Figures 6 & 7.**

REDACTED ACCORDING TO FEDERAL LAW

Figure 6. Survey results; Map 1 of 2

REDACTED ACCORDING TO FEDERAL LAW

Figure 7. Survey results; Map 2 of 2

Resources Noted but Not Documented

In conducting the cultural resource survey for this undertaking, Certus observed two types of resource conditions that were not formally documented as sites or isolated occurrences. Specifically, two sections of the survey area displayed what can best be described as lithic landscape conditions wherein lithic debitage, absent any tools or features, were broadly and very diffusely scattered across the landscape. These areas occurred on the ridge south of Corn Creek and along the Corn Creek Flood Channel (see **Figure 5**). Where artifacts were sufficiently interpretable as a site, Certus documented them as such. Where the debitage, which was non-diagnostic, lacked such interpretability and a boundary could not realistically be drawn around the artifacts to define a specific use area, Certus did not report the materials.

The second resource type not documented as part of the fieldwork were buildings and structures not related to the water management and distribution features such as canals, the debris basin, etc. but located within the survey area. No such buildings or structures are identified for demolition or alteration as part of the current undertaking, and piping small ditches adjacent to them does not have the potential to adversely affect them.

Isolated Occurrences

Two isolated occurrences were observed in the APE during fieldwork. These include four pieces of white chert debitage (IO-01) located north of the Corn Creek Dam and a piece of apparently abandoned historical farm equipment (IO-02) located in a fallow field east of Kanosh. The white chert debitage dates to the general prehistoric period and is temporally non-diagnostic. The farm equipment appears to be the remains of a tractor-drawn disc harrow likely dating to the 1930s or 1940s.

Certus recommends both of the isolated occurrences ineligible for the National Register under all criteria. They do not appear to be associated with any specific prehistoric or historic period events of importance or with any identifiable persons of prehistoric or historic significance. They also do not represent a type, style, manner of construction, work of a master, or resource of high artistic value and do not appear to be associated with established cultural resource districts or landscapes to which they may contribute. Lastly, they have not yielded information important to improving our understanding of the past and do not appear to have the potential to do so with additional on-site investigation.

Archaeological Sites

Certus identified 16 archaeological sites in the survey area for the Corn Creek Watershed Plan-EA (see **Table 1**). The sites include both prehistoric and historic period resources, though historic period sites are the most numerous and are mostly represented by canals and other historical water control features. Descriptions of the sites are provided below along with discussions of their eligibility for the National Register. Their locations are shown in **Figures 6 & 7.**

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Table 1. Sites documented in the survey area

Site Number	Description
42MD2016	Historical concrete water pipeline
42MD2017	Historical ditch (the Indian Ditch)
42MD4696	Corn Creek Dam & Debris Basin
42MD4697	Prehistoric temporary camp
42MD4698	Prehistoric temporary camp
42MD4699	Prehistoric temporary camp
42MD4700	Prehistoric temporary camp
42MD4701	Historical structure/pump house
42MD4702	Prehistoric rock art on a relocated boulder
42MD4703	South & West Field Ditches system
42MD4704	Middle Ditch system
42MD4705	East Field Ditch system
42MD4706	Hatton Ditch system
42MD4707	East Middle Hatton Ditch system
42MD4708	West Ditch system
42MD4713	Kanosh City Ditch

Site 42MD2016—Concrete Water Pipeline

Site 42MD2016 is a historical concrete water pipeline located east of Kanosh and between Corn Creek and the Paiute Indian Village. The site was first documented in 2005 by the NRCS and does not appear to have had an update to its site record since. The NRCS described the site as follows:

> The site consists of a buried concrete pipe running from an earthen dam/flood structure on the south to a rock lined ditch on the north. This concrete [pipe] links to the rock lined ditch and are clearly associated. The orientation of the site is followed by linking a series of upright concrete cylinders/pipes. These cylinders range from 4 to ten feet high. There are a total of five of these structures more or less equally spaced (approximately 400 meters apart) along the site's length. The upright concrete cylinders are likely vents or some type of outtake structure. Of the two cylinders that were able to be viewed inside, one was partially full of rocks. These cylinders were approximately 12 inches in diameter. The actual pipeline is completely buried for most of its length and measures approximately 12 inches in diameter. One section appears breached by flooding. Other sections, near the middle of the site, are exposed and partially breached, also due to flooding, but are still intact. The pipeline runs north for half its length, then after approximately one mile it turns slightly to 15 degrees east. The concrete transitional structure between this site and site 42MD2017 [(the rock lined ditch)] bears the imprint 1943 and was likely the year of construction. (Leeflang 2005a)

Certus revisited the portion of this site in and near the current project area to the extent that private property access had been granted. The site appeared to be in the same condition as it was described in 2005 by the NRCS. As a matter of interpretation, the "cylinders" referred to in the 2005 site form may well be standpipes used to increase pressure along the pipeline and ensure consistent water flow along the length of it.

Very little information could be located about this pipeline. It does appear likely that the line was constructed in 1943. It appears to have replaced an open ditch that connected to the rock lined ditch (42MD2017) noted in the 2005 site description. That ditch may be the one depicted on an 1879 GLO map, which shows a ditch labeled "Indian Ditch" extending from Corn Creek to the Paiute Indian Village. Given the erodible nature of soils in the area of said ditch's alignment, sediment deposition would have been a challenge in keeping the open ditch flowing. The pipeline would have reliably carried the water to the open ditch segment still left in the village and allowed for irrigation in that area.

National Register Eligibility Review for Site 42MD2016

Site 42MD2016 was ***determined ineligible*** as a result of its documentation and evaluation in 2005 (Leeflang 2005a). The basis of this determination was a lack of association with any notable historical events or persons, a lack of engineering and construction merit with accompanying decreases in integrity do to erosion/breaching, and a lack of potential to yield information important to improving our understanding of the past. Certus agrees with this existing determination and adds that while the pipeline appears to have been associated with irrigation or other non-culinary water distribution to the Paiute Indian Village and was part of a larger irrigation water project that started at least as early as the 1870s for Tribal land, the pipeline was both a much later addition/change to that system and appears to have been relatively short-lived due to damage from erosion.

Site 42MD2017—Indian Ditch

Site 42MD2017 is a historical irrigation ditch located on and south of the Paiute Indian Village (reservation) east of Kanosh in the Pahvant Valley. The site was first documented by the NRCS in 2005, and its record does not appear to have been updated since. In 2005, the NRCS described the site as follows:

> The site is a historic rock lined ditch that once provided water to the residents of the Kanosh Indian Reservation. The ditch runs generally south from the reservation townsite, for approximately 1.2 miles. On the south end of the site the ditch meets site 42MD2016, a buried concrete pipe, and ends (sic). These two sites are clearly associated and joined by a cement transitional structure. 42MD2016 fed this site with water. 42MD2017 likely originally continued south prior to the construction of 42MD2016 but there is no evidence and it was possibly destroyed by the construction of 42MD2016. Both sites are now inactive and 42MD2017 is largely in-filled with sediment. This ditch is rock lined for much of its length and is visible and easily followed for most of its length. Near its northern end, sections of the ditch become less visible. The rock lining of the ditch is visible as two rock alignments for much of its length. Some areas show only a shallow linear depression and the absence of rock lining. Most of the rock lining appears to be mortared together. The ditch was likely lined with mortar for its entire length originally. The ditch ranges from 20 centimeters to 100 centimeters wide but is generally 40 centimeters wide. It is approximately 30 centimeters deep based on the overall ditch shape. (Leeflang 2005b)

Certus revisited the portion of this site in and near the current project area to the extent that private property access had been granted. The site appeared to be in the same condition as it was described in 2005 by the NRCS, at least for the northern section on Tribal land. The ditch segment observed by Certus was almost entirely buried and exhibited no evidence of rock lining. Rather, it appeared as a shallow concrete-lined channel averaging 1 meter wide and less than 50 centimeters deep. The channel

had a widely flared cross-section with a narrow floor. As part of updating the site record to current standards, Certus also documented a pond or impoundment basin located at the north end of the ditch. This impoundment appears to have been by the ditch and allowed for the storage of a small amount of water for reservation uses. The impoundment is roughly oval in shape and measures approximately 90 meters long by 25 meters wide by 2 meters deep. A tall screw-lift turnout is located on the west side of the pond to allow water to flow out of the impoundment and into the occupied townsite. It is unclear when this pond/impoundment was constructed. It does not appear on the 1879 GLO map of the area but is visible in aerial imagery dating to the 1950s.

The specific date of construction for the ditch remains somewhat unclear. The 1879 GLO map for the area depicts a ditch labeled as the "Indian Ditch" extending from Corn Creek to the Tribal lands and entering said lands in the approximate location of the ditch reported here. It is unlikely the concrete lining observed by Certus on the northern part of the ditch dates to this period and was likely a later addition to the ditch to help reduce water loss from seepage. The ditch was replaced by a bypass pipeline designed in 2004.

National Register Eligibility Review for Site 42MD2017

Site 42MD2017 was ***determined eligible*** for the National Register under Criterion A as a result of its documentation and evaluation in 2005 (Leeflang 2005b). The basis of this determination was the apparent association of the ditch with the development of irrigation practices on the Paiute Indian Tribe of Utah's Kanosh reservation. Certus agrees with this determination and finds that the ditch segment discussed here, despite being largely buried, retains sufficient integrity of location, materials, workmanship, design, setting, feeling, and association to reflect its association with historical irrigation on the reservation lands.

Site 42MD4696—Corn Creek Dam & Debris Basin

Site 42MD4696 is the Corn Creek Dam & Debris Basin located on Corn Creek south of Kanosh in the Pahvant Valley. The site encompasses a large area of approximately 50,621 square meters and includes the main dam/berm and spillway as well as a series of berms northwest of the dam. The site is located along Corn Creek at the base of a ridge. The main earthen berm (i.e., the dam) stands approximately 45 feet tall and is approximately 1900 feet long. This berm is up to 115 feet wide at the base (toe-to-toe) and approximately 15 feet wide at the top. It has an L-shaped footprint. The spillway is located near the southwest end of the dam. It is constructed of cast-in-place concrete. This spillway structure was either built in 1985 or substantially rebuilt in 1985 due to damage from an extreme flood event. The reconstructed dam appears to follow the same footprint as the original historical structure.

The dam creates a large impoundment behind it that serves as a debris basin to prevent flooding in the nearby community. It does not appear that much in the way of dredging was conducted to create a specific basin. Rather, the natural terrain served as the basin. That said, it appears that in relatively recent years, the basin area has been used as a dumping ground for debris and that rocks and gravels have been mined and sorted in the area as large piles of sorted material are present throughout the basin area. A small raised pond area is located on the northwest side of and abutting the dam. This pond appears to have been constructed during or after the repair/reconstruction efforts in 1985 as it is not visible in earlier aerial images.

The earthen berms northwest of the dam create a roughly U-shaped impoundment between the dam and the berms. Thee berms stand roughly 15 feet tall and measure as much as 40 feet wide across their bases.

There are three segments to the berms, which are separated from each other by two small gaps—one to allow for the passage of the East Middle Hatton Ditch and one of indeterminate purpose.

The original date of construction of the dam and basin could not be determined from archival records. Such records available online only list the 1985 reconstruction date for the spillway. The features are not present on the 1879 GLO map of the area, but they are clearly visible in a 1958 aerial image and appear to have been there for some period of time—there is no evidence of recent ground disturbance in the images, and vegetation appears to have regrown in the previously disturbed areas. These aerial images also show that the Corn Creek channel shifted its location in response to the presence of the structures and placement of piles of rock and soil in the basin area. It is possible that the original dam/berm here was constructed during the 1920s amidst a statewide effort to address flooding. Specifically, in 1922 the U.S. Bureau of Agricultural Engineering teamed up with the Utah Experiment Station, the Utah Extension Service, and local irrigation companies to build flood control berms and basins at several locations in Utah. These locations included Salt Creek near Nephi, Chalk Creek near Fillmore, Shoal Creek near Enterprise, and Corn Creek near Kanosh (Honker 1999: 35). While it remains unclear if the dam and basin discussed here represent the same feature constructed during the 1920s, it is likely the current facilities at least built upon the earlier earthworks and flood control efforts.

National Register Eligibility Review for Site 4MD4696

Certus recommends site 42MD4696 ***ineligible*** for the National Register under all criteria for the reasons outlined below. The site appears to retain integrity of location, materials, and association but generally lacks integrity of design, workmanship, setting, and feeling due to the changes made it 1985. At present, the site appears as a modern flood management feature.

This site is associated with flood prevention for the community of Kanosh. This topic is a significant one in the general area due to the long history of damaging floods that challenged original settlement and expansion of the community. The dam and debris basin would have been the most substantial large-scale effort at flood control in the area and would have been a significant feature of those efforts; however, the reconstruction in 1985 substantially altered the feeling of the site and added additional features not previously present. Given these conditions, Certus recommends that the site lacks sufficient integrity to convey its historic period association and would be ineligible for the National Register under Criterion A.

Although no specific information about the parties associated with the site was found, the construction was likely carried out with government involvement simply due to the magnitude of the effort. That is, it is not associated with any specific individuals who are important in history but associated with a larger communal body or government agency. As such, the site would be ineligible for the National Register under Criterion B.

This site, while a notable engineering feature, lacks integrity of historical design and workmanship due to the reconstruction in 1985. Therefore, it is recommended ineligible for the National Register under Criterion C.

This site type is not conducive to possessing cultural deposits or other characteristics not visible on the ground surface, and the site has not yet yielded information important to improving our understanding of the past. As such, Certus recommends this site ineligible for the National Register under Criterion D.

Site 42MD4697—Prehistoric Temporary Camp

Site 42MD4697 is a prehistoric camp represented by a small, diffuse scatter of lithic debitage. The site is located on the north-facing gentle slope of a ridge above Corn Creek. The landscape is characterized by a sparse juniper woodland and light to medium brown silty loam with a mat of subangular surface gravels. The site measures approximately 130 meters long by 25 meters wide and encompasses an area of 2,270 square meters. No features were observed.

The artifact assemblage is estimated to include between 50 and 75 artifacts, the majority of which are obsidian secondary and tertiary flakes. A few flakes of grey chert, one grey quartzite core, and one biface fragment also were observed. Neither the core nor the biface fragment is temporally diagnostic. The site location may be the result of stormwater washing artifacts down slope from higher up on the ridge. The ridge top appears as a lithic landscape with a broad and sparse scatter of mostly obsidian debitage that lacks sufficient clustering and organization to be defined as a true site. Soils on-site are moderately erodible, but there was no specific evidence of sediment accumulation on the site itself.

National Register Eligibility Review for Site 4MD4697

Certus recommends site 42MD4697 ***ineligible*** for the National Register under all criteria for the reasons outlined below. The site appears to retain integrity of location, materials, setting, feeling, and association. Design and workmanship do not apply to this site.

This site is associated with the prehistoric occupation of the Pahvant Valley area. Due to a lack of temporally diagnostic artifacts or features, the site cannot yet be attributed to any specific period in prehistory. The site lacks internal organization and may be the result of artifact accumulation due to stormwater runoff. As such, it is not interpretable in association with any specific prehistoric events. Given this, Certus recommends the site ineligible for the National Register under Criterion A.

No specific information about the parties associated with the site was found in either archival sources or at the site itself. As such, the site would be ineligible for the National Register under Criterion B.

This site lacks any engineered or constructed features and is not representative of a type, style, or manner of construction. It also is not the work of a master, does not possess high artistic value, and cannot be tied to an existing larger cultural entity, such as a district or landscape. Therefore, it is recommended ineligible for the National Register under Criterion C.

This site has not yet yielded information important to improving our understanding of the past and does not appear to have the potential to yield such information with additional investigation. The limited nature of the occupation period coupled with the depositional environment that appears to be such that no accumulation of cultural deposits is likely. Obsidian sourcing is possible given the presence of obsidian artifacts, but this, too, would be of limited utility given the small and homogenous nature of the artifact assemblage. As such, Certus recommends this site ineligible for the National Register under Criterion D.

Site 42MD4698—Prehistoric Temporary Camp

Site 42MD4698 is a prehistoric camp represented by a small, diffuse scatter of lithic debitage. The site is located on the northeast-facing slope of a ridge above Corn Creek. The landscape is characterized by a sparse juniper woodland and light to medium brown silty loam with a mat of subangular surface gravels.

The site measures approximately 38 meters long by 24 meters wide and encompasses an area of 773 square meters. No features were observed.

Certus counted 56 artifacts at the site. The majority of them were obsidian secondary and tertiary flakes. A few flakes of chert and one large grey quartzite primary flake also were observed as was a possible mottled grey and white chert uniface. The uniface is not temporally diagnostic. The site location may be the result of stormwater washing artifacts down slope from higher up on the ridge. There is no particular evidence of sediment accumulation at the site itself.

National Register Eligibility Review for Site 4MD4698

Certus recommends site 42MD4698 ***ineligible*** for the National Register under all criteria for the reasons outlined below. The site appears to retain integrity of location, materials, setting, feeling, and association. Design and workmanship do not apply to this site.

This site is associated with the prehistoric occupation of the Pahvant Valley area. Due to a lack of temporally diagnostic artifacts or features, the site cannot yet be attributed to any specific period in prehistory. The site lacks internal organization and may be the result of artifact accumulation due to stormwater runoff. As such, it is not interpretable in association with any specific prehistoric events. Given this, Certus recommends the site ineligible for the National Register under Criterion A.

No specific information about the parties associated with the site was found in either archival sources or at the site itself. As such, the site would be ineligible for the National Register under Criterion B.

This site lacks any engineered or constructed features and is not representative of a type, style, or manner of construction. It also is not the work of a master, does not possess high artistic value, and cannot be tied to an existing larger cultural entity, such as a district or landscape. Therefore, it is recommended ineligible for the National Register under Criterion C.

This site has not yet yielded information important to improving our understanding of the past and does not appear to have the potential to yield such information with additional investigation. The limited nature of the occupation period suggests cultural deposits are unlikely. Obsidian sourcing is possible given the presence of obsidian artifacts, but this, too, would be of limited utility given the small and homogenous nature of the artifact assemblage. As such, Certus recommends this site ineligible for the National Register under Criterion D.

Site 42MD4699—Prehistoric Temporary Camp

Site 42MD4699 is a prehistoric camp represented by a diffuse scatter of lithic debitage. The site is located on the toeslopes of a ridge above Corn Creek. The landscape is characterized by a sparse juniper woodland and light to medium brown silty loam with a mat of subangular surface gravels. The site measures approximately 108 meters long by 30 meters wide and encompasses an area of 2,840 square meters. The site area has been impacted recently by heavy (tracked) equipment travel and ground surface disturbance associated with apparent debris-clearing efforts along the adjacent Corn Creek channel. This disturbance is generally limited to the north half of the site and extended several inches below modern ground surface.

Certus estimates between 75 and 100 artifacts were present at the site. The majority of them were obsidian secondary and tertiary flakes. A few flakes of white chert, grey chert, and red quartzite also were

observed. No tools, features, or artifact concentrations were observed. The site location may be the result of stormwater washing artifacts down slope from higher up on the ridge. There is some evidence of sediment accumulation at the site, and the artifacts largely appear to have "settled" at the base of the adjacent slope.

National Register Eligibility Review for Site 4MD4699

Certus recommends site 42MD4699 ***ineligible*** for the National Register under all criteria for the reasons outlined below. The site appears to retain integrity of location, materials, setting, feeling, and association. Design and workmanship do not apply to this site.

This site is associated with the prehistoric occupation of the Pahvant Valley area. Due to a lack of temporally diagnostic artifacts or features, the site cannot yet be attributed to any specific period in prehistory. The site lacks internal organization and may be the result of artifact accumulation due to stormwater runoff. As such, it is not interpretable in association with any specific prehistoric events. Given this, Certus recommends the site ineligible for the National Register under Criterion A.

No specific information about the parties associated with the site was found in either archival sources or at the site itself. As such, the site would be ineligible for the National Register under Criterion B.

This site lacks any engineered or constructed features and is not representative of a type, style, or manner of construction. It also is not the work of a master, does not possess high artistic value, and cannot be tied to an existing larger cultural entity, such as a district or landscape. Therefore, it is recommended ineligible for the National Register under Criterion C.

This site has not yet yielded information important to improving our understanding of the past and does not appear to have the potential to yield such information with additional investigation. The limited nature of the occupation period suggests cultural deposits are unlikely, and any buried artifacts were likely washed into the site from the adjacent ridge or pushed into a subsurface context by the heavy equipment travelling over the site. Obsidian sourcing is possible given the presence of obsidian artifacts, but this, too, would be of limited utility given the small and homogenous nature of the artifact assemblage. As such, Certus recommends this site ineligible for the National Register under Criterion D.

Site 42MD4700—Prehistoric Temporary Camp

Site 42MD4700 is a large prehistoric camp represented by a diffuse scatter of lithic debitage. The site is located on a gentle west-facing slope in the eastern part of the Pahvant Valley. More specifically, it is mostly located west of the Corn Creek flood control channel, which was constructed around 1985. The landscape is characterized as a sagebrush plain with light to medium brown silty loam having a sparse mat of subangular surface gravels. The site measures approximately 632 meters long by 180 meters wide and encompasses an area of 55,186 square meters. It exists in an area best described as a lithic landscape. In this area, random pieces of obsidian debitage can be found all over with essentially no concentration of artifacts that would indicate a specific occupation area or use area. Certus defined the site boundary as the area within which the greatest concentration of artifacts was located. The site was impacted by the construction of the flood control channel, though the vast majority of artifacts are located east of the channel; only a handful of artifacts were found west of the channel.

Certus estimates between 100 and 200 artifacts were present at the site. The overwhelming majority (estimated at 95% or more) of them were obsidian secondary and tertiary flakes. A few flakes of white chert and light tan/white quartzite also were noted. No tools, features, or artifact concentrations that could indicate activity loci were observed. The site location may be the result of stormwater washing artifacts down slope from higher up on the ridge. There is no evidence of notable sediment accumulation at the site, though a few artifacts were partially buried due to the erodible nature of the soils and stormwater ponding causing minor soil upheaval.

National Register Eligibility Review for Site 4MD4700

Certus recommends site 42MD4700 ***ineligible*** for the National Register under all criteria for the reasons outlined below. The site appears to retain integrity of location, materials, setting, feeling, and association. Design and workmanship do not apply to this site.

This site is associated with the prehistoric occupation of the Pahvant Valley area. Due to a lack of temporally diagnostic artifacts or features, the site cannot yet be attributed to any specific period in prehistory. The site lacks internal organization and exhibits no definable activity loci. Rather, it appears as a slightly greater artifact concentration against a broad lithic debitage landscape. It is not interpretable in association with any specific prehistoric events. Given this, Certus recommends the site ineligible for the National Register under Criterion A.

No specific information about the parties associated with the site was found in either archival sources or at the site itself. As such, the site would be ineligible for the National Register under Criterion B.

This site lacks any engineered or constructed features and is not representative of a type, style, or manner of construction. It also is not the work of a master, does not possess high artistic value, and cannot be tied to an existing larger cultural entity, such as a district or landscape. Therefore, it is recommended ineligible for the National Register under Criterion C.

This site has not yet yielded information important to improving our understanding of the past and does not appear to have the potential to yield such information with additional investigation. The undefined nature of the occupation period and lack of evidence of sediment accumulation suggests cultural deposits are unlikely. Obsidian sourcing is possible given the presence of obsidian artifacts, but this, too, would be of limited utility given the small and homogenous nature of the artifact assemblage. As such, Certus recommends this site ineligible for the National Register under Criterion D.

Site 42MD4701—Historical Structure

Site 42MD4701 is a small, semi-subterranean structure located on the northwest edge of the Corn Creek Dam and immediately south of SR-106 near Kanosh. The structure is constructed of cast-in-place concrete and has a thick concrete roof with a slight arch to it. An access door is located in the west elevation and is flanked by two tapering mortared stone and concrete walls. A manhole-type opening is located in the top of the structure, near its east edge and implies the structure is used for water storage, pumping, or similar functions. All elevations of the structure are buried save for the exposed access opening in the west elevation.

Certus was unable to locate any archival information about this structure. Given its apparent function, it was likely built either by the Corn Creek Irrigation Company as part of its vast network of irrigation

ditches and water distribution facilities or by the municipality as part of its water system. The structure is visible in a 1958 aerial image of the area—the earliest available image of reasonable scale.

National Register Eligibility Review for Site 4MD4701

Certus recommends site 42MD4701 ***ineligible*** for the National Register under all criteria for the reasons outlined below. The site appears to retain integrity of location, materials, design, workmanship, setting, and feeling. It generally lacks association as it is unclear from simply viewing the resource what its function is.

This site appears to be associated with water management for the community of Kanosh, but its specific role within that system is unclear. Regardless, the structure is very minor, and the lack of discussion in archival sources suggests it did not play an important role in the overall water system of the area during the historic period. Thus, Certus recommends this site ineligible for the National Register under Criterion A.

Although no specific information about the parties associated with the site was found, the construction was likely carried out with government or other agency/quasi-agency involvement given its apparent association with the Kanosh community's water system. That is, it is not associated with any specific individuals who are important in history but associated with a larger communal body or government agency. As such, the site would be ineligible for the National Register under Criterion B.

This site, while an engineering/architectural feature, is not a notable representative of a type, style, or manner of construction, is not the work of a master, and does not possess high artistic value. There also is no established larger cultural entity, such as a district or landscape, to which it could contribute. Therefore, it is recommended ineligible for the National Register under Criterion C.

This site type is not conducive to possessing cultural deposits or other characteristics not visible on the ground surface, and the site has not yet yielded information important to improving our understanding of the past. As such, Certus recommends this site ineligible for the National Register under Criterion D.

Site 42MD4702—Prehistoric Rock Art

Site 42MD4702 is a boulder containing prehistoric petroglyphs that is located west of the Corn Creek Dam & Debris Basin (site 42MD4696). The boulder is situated in a debris pile of materials removed from an unknown location and placed at the present site. It is unclear if the boulder came from the immediate area or from some other off-site location. Based on the orientation of the petroglyphs, it appears the boulder is lying on its side compared to how it was oriented when *in situ*.

Ten separate images are visible on one side and on the top of the boulder, though not all of the images are clear enough to be decipherable. All are pecked lightly into the boulder, which does not exhibit any clear patination. The images include three apparent pronghorn, one Kokopelli-like anthropomorph, and a series of geometric designs, wavy lines, and circles. The images appear most consistent with the Fremont culture group, which is known to have occupied the Pahvant Valley.

National Register Eligibility Review for Site 4MD4702

Certus recommends site 42MD4702 ***ineligible*** for the National Register under all criteria due primarily to a lack of integrity of location. While the boulder on which the petroglyphs are located likely came from the Kanosh area, the fact that it has been moved from its original location disassociates the "site" from the landscape in which it was originally located and, therefore, alters the potential interpretation of its meaning in prehistory.

Site 42MD4703—South & West Field Ditches System

Site 42MD4703 is a historical irrigation ditch system—the South & West Field Ditches system—carrying water from the main weir on Corn Creek through the southern and southwestern parts of the community of Kanosh. The system is owned and operated by the Corn Creek Irrigation Company, which was established in 1877. Certus documented approximately 1,553 linear meters of ditches associated with this canal system. The vast majority of these ditches were concrete-lined, though a few unlined ditches, mostly laterals and sublaterals, were observed. The concrete-lined sections are generally associated with the "low flow" system, which is used when water levels in the source creek are low. Numerous historical water control features, including diversions and turnouts were documented along the various ditches. In most cases, the turnouts comprise screw-lift gates set in cast-in-place concrete frames. The concrete ditch segments are uniform in size and shape. They are relatively shallow being up to 50 centimeters deep and up to 1 meter wide. They have a flared cross-section with a narrow flat bottom. The unlined ditches vary more widely in size but are generally similar or smaller in overall dimensions.

Certus was unable to locate any archival information specifically noting the construction date of this system. It likely was not built prior to the formation of the Corn Creek Irrigation Company, and it does not appear on the 1879 GLO map of the area. The main ditches associated with this system (i.e, excluding sublaterals) are visible in a 1958 aerial image of the area. A newspaper article from 1899 indicates that the irrigation company had 3,000 acres of land under irrigation at that time, which suggests most of the canal systems associated with this company were constructed prior to 1900. The Utah Division of Water Rights indicates a priority water right date of 1880 for the diversion serving this system.

National Register Eligibility Review for Site 4MD4703

Certus recommends site 42MD4703 ***eligible*** for the National Register under Criterion A for the reasons outlined below. The site appears to retain integrity of location, materials, design, workmanship, setting, feeling, and association.

This site is associated with irrigation agriculture in the Kanosh area. Agriculture formed the basis of the community's economy during the historic period and allowed for both the original settlement in 1867 and for the continued existence and expansion of the community in the decades that followed. As such, irrigation agriculture played a very important role in local history, and the South & West Field Ditches system was a notable part of that system that opened lands southwest and west of town for agricultural development. Therefore, Certus recommends this site eligible for the National Register under Criterion A.

The primary canals associated with this site were constructed under the auspices of the Corn Creek Irrigation Company, which does not qualify as a historically important person or persons

for the purpose of the National Register. As such, Certus recommends the site ineligible under Criterion B.

This site, while an engineering/architectural feature, is not a notable representative of a type, style, or manner of construction, is not the work of a master, and does not possess high artistic value. There also is no established larger cultural entity, such as a district or landscape, to which it could contribute. Therefore, it is recommended ineligible for the National Register under Criterion C.

This site type is not conducive to possessing cultural deposits or other characteristics not visible on the ground surface, and the site has not yet yielded information important to improving our understanding of the past. As such, Certus recommends this site ineligible for the National Register under Criterion D.

Site 42MD4704—Middle Ditch System

Site 42MD4704 is the historical Middle Ditch irrigation ditch system that carries water from Corn Creek through the north and northwestern parts of the rural community of Kanosh. The system is owned and operated by the Corn Creek Irrigation Company, which was established in 1877. Certus documented approximately 9,658 linear meters of ditches associated with this canal system, including the Crooked Lane Lateral and several sublaterals. The main east-west portion of the named canal, which extends along the south side of 200 North in Kanosh, is concrete lined. The concrete was likely installed during the 1970s according to the irrigation company. The concrete-lined sections are generally associated with the "low flow" system, which is used when water levels in the source creek are low.

This ditch appears to be fed from a diversion on the Hatton Ditch (site 42MD4706), which is, in turn, fed by the main weir on Corn Creek. Nearly all of the remaining ditches documented in association with this site were unlined. The concrete ditch segments are uniform in size and shape. They are relatively shallow being up to 50 centimeters deep and up to 1 meter wide. They have a flared cross-section with a narrow flat bottom. The unlined ditches vary more widely in size but are generally similar or smaller in overall dimensions. Numerous historical water control features, including diversions and turnouts were documented along the various ditches. In most cases, the turnouts comprise screw-lift gates set in cast-in-place concrete frames.

Certus was unable to locate any archival information specifically noting the construction date of this system. It likely was not built prior to the formation of the Corn Creek Irrigation Company in 1877. Several ditches in the apparent location of some of the ditch segments associated with this site appear to be depicted on the 1879 GLO map of the area, but these ditches are not labeled as such on the map. The main ditches associated with this system (i.e, excluding sublaterals) are visible in a 1958 aerial image of the area. A newspaper article from 1899 indicates that the irrigation company had 3,000 acres of land under irrigation at that time, which suggests most of the canal systems associated with this company were constructed prior to 1900. The Utah Division of Water Rights indicates a priority water right date of 1880 for the diversion serving this system.

National Register Eligibility Review for Site 4MD4704

Certus recommends site 42MD4704 ***eligible*** for the National Register under Criterion A for the reasons outlined below. The site appears to retain integrity of location, materials, design, workmanship, setting, feeling, and association.

This site is associated with irrigation agriculture in the Kanosh area. Agriculture formed the basis of the community's economy during the historic period and allowed for both the original settlement in 1867 and for the continued existence and expansion of the community in the decades that followed. As such, irrigation agriculture played a very important role in local history, and the Middle Ditch system was a notable part of that system that opened lands southwest and west of town for agricultural development. Therefore, Certus recommends this site eligible for the National Register under Criterion A.

The primary canal associated with this site was constructed under the auspices of the Corn Creek Irrigation Company, which does not qualify as a historically important person or persons for the purpose of the National Register. As such, Certus recommends the site ineligible under Criterion B.

This site, while an engineering/architectural feature, is not a notable representative of a type, style, or manner of construction, is not the work of a master, and does not possess high artistic value. There also is no established larger cultural entity, such as a district or landscape, to which it could contribute. Therefore, it is recommended ineligible for the National Register under Criterion C.

This site type is not conducive to possessing cultural deposits or other characteristics not visible on the ground surface, and the site has not yet yielded information important to improving our understanding of the past. As such, Certus recommends this site ineligible for the National Register under Criterion D.

Site 42MD4705—East Field Ditch System

Site 42MD4705 is the historical East Field Ditch irrigation ditch system that carries water from the main weir on Corn Creek through the eastern part of the rural community of Kanosh and on to the north to lands in and around the small burg of Hatton. The system is owned and operated by the Corn Creek Irrigation Company, which was established in 1877. Certus documented approximately 21,198 linear meters of ditches associated with this canal system, including laterals and sublaterals. The main ditch and several of the laterals are lined with concrete, which was likely installed during the 1970s according to the irrigation company. The concrete-lined sections are generally associated with the "low flow" system, which is used when water levels in the source creek are low. Some of the laterals and most of the sublaterals are unlined. The concrete ditch segments are uniform in size and shape. They are relatively shallow being up to 50 centimeters deep and up to 1 meter wide. They have a flared cross-section with a narrow flat bottom. The unlined ditches vary more widely in size but are generally similar or smaller in overall dimensions. Numerous historical water control features, including diversions and turnouts were documented along the various ditches. In most cases, the turnouts comprise screw-lift gates set in cast-in-place concrete frames.

Certus was unable to locate any archival information specifically noting the construction date of this system. It likely was not built prior to the formation of the Corn Creek Irrigation Company, and it does not appear on the 1879 GLO map of the area. The main ditches associated with this system (i.e, excluding sublaterals) are visible in a 1958 aerial image of the area. A newspaper article from 1899 indicates that the irrigation company had 3,000 acres of land under irrigation at that time, which suggests most of the canal systems associated with this company were constructed prior to 1900. The Utah Division of Water Rights indicates a priority water right date of 1880 for the diversion serving this system.

National Register Eligibility Review for Site 4MD4705

Certus recommends site 42MD4705 ***eligible*** for the National Register under Criterion A for the reasons outlined below. The site appears to retain integrity of location, materials, design, workmanship, setting, feeling, and association.

This site is associated with irrigation agriculture in the Kanosh area. Agriculture formed the basis of the community's economy during the historic period and allowed for both the original settlement in 1867 and for the continued existence and expansion of the community in the decades that followed. As such, irrigation agriculture played a very important role in local history, and the East Field Ditch system was a notable part of that system that opened lands east and north of town for agricultural development. Therefore, Certus recommends this site eligible for the National Register under Criterion A.

The primary canal associated with this site was constructed under the auspices of the Corn Creek Irrigation Company, which does not qualify as a historically important person or persons for the purpose of the National Register. As such, Certus recommends the site ineligible under Criterion B.

This site, while an engineering/architectural feature, is not a notable representative of a type, style, or manner of construction, is not the work of a master, and does not possess high artistic value. There also is no established larger cultural entity, such as a district or landscape, to which it could contribute. Therefore, it is recommended ineligible for the National Register under Criterion C.

This site type is not conducive to possessing cultural deposits or other characteristics not visible on the ground surface, and the site has not yet yielded information important to improving our understanding of the past. As such, Certus recommends this site ineligible for the National Register under Criterion D.

Site 42MD4706—Hatton Ditch System

Site 42MD4706 is the historical Hatton Ditch irrigation ditch system that carries water from the main weir on Corn Creek through the eastern part of the rural community of Kanosh and on to the north to the community of Hatton. The system is owned and operated by the Corn Creek Irrigation Company, which was established in 1877. Certus documented approximately 8,422 linear meters of ditches associated with this canal system, including laterals and sublaterals. The site was documented in three sections where it intersects the current project area.

The main ditch and laterals were unlined. Most of the unlined ditches operated by the irrigation company are part of the "high flow" irrigation system, which is used when water levels in the source creek are high. The main ditch had a flat-bottomed cross-section with flared sides flanked by berms created from the material dredged from the channel. The channel itself measured between 2 and 3 meters wide and up to 1.5 meters deep, though the typical flow channel is much smaller than that. Very few water control features were observed along the documented portions of the ditch system. This is due to the fact that the majority of the site in the current survey area is part of the ditch that merely carries the water through Kanosh and to Hatton where it is then diverted into field ditches for the purpose of irrigation; no water shares in the ditch are likely held by parties between the weir and the community of Hatton.

Certus was unable to locate any archival information specifically noting the construction date of this system. It likely was not built prior to the formation of the Corn Creek Irrigation Company in 1877; however, a ditch approximately a combined alignment between this ditch and the East Middle Hatton Ditch (site 42MD4707) is illustrated on the 1879 GLO map of the area and is labeled as the Peterburg Ditch. The main ditches associated with this system (i.e, excluding sublaterals) are visible in a 1958 aerial image of the area. A newspaper article from 1899 indicates that the irrigation company had 3,000 acres of land under irrigation at that time, which suggests most of the canal systems associated with this company were constructed prior to 1900. The Utah Division of Water Rights indicates a priority water right date of 1880 for the diversion serving this system.

National Register Eligibility Review for Site 4MD4706

Certus recommends site 42MD4706 ***eligible*** for the National Register under Criterion A for the reasons outlined below. The site appears to retain integrity of location, materials, design, workmanship, setting, feeling, and association.

This site is associated with irrigation agriculture in the Hatton area. Agriculture formed the basis of the community's economy during the historic period and allowed for both the original settlement in 1859 and for the continued existence and expansion of the community in the decades that followed. As such, irrigation agriculture played a very important role in local history, and the Hatton Ditch system was a notable part of that system. In fact, it appears the Hatton Ditch is one of the primary suppliers of irrigation water to the community. Therefore, Certus recommends this site eligible for the National Register under Criterion A.

The primary canal associated with this site was constructed under the auspices of the Corn Creek Irrigation Company, which does not qualify as a historically important person or persons for the purpose of the National Register. As such, Certus recommends the site ineligible under Criterion B.

This site, while an engineering/architectural feature, is not a notable representative of a type, style, or manner of construction, is not the work of a master, and does not possess high artistic value. There also is no established larger cultural entity, such as a district or landscape, to which it could contribute. Therefore, it is recommended ineligible for the National Register under Criterion C.

This site type is not conducive to possessing cultural deposits or other characteristics not visible on the ground surface, and the site has not yet yielded information important to improving our understanding of the past. As such, Certus recommends this site ineligible for the National Register under Criterion D.

Site 42MD4707—East Middle Hatton Ditch System

Site 42MD4707 is the historical East Middle Hatton Ditch irrigation ditch system that carries water from the main weir on Corn Creek through the rural community of Kanosh and on to the north to the community of Hatton. The system is owned and operated by the Corn Creek Irrigation Company, which was established in 1877. Certus documented approximately 2,796 linear meters of ditches associated with this canal system. The site was documented in three sections where it intersects the current project area.

The main ditch and lateral documented here are lined with concrete and are relatively shallow being up to 50 centimeters deep and up to 1 meter wide. The concrete was likely installed during the 1970s

according to the irrigation company. The concrete-lined ditches in the area are generally associated with the "low flow" system, which is used when water levels in the source creek are low. They have a flared cross-section with a narrow flat bottom. Nearly the entire lateral, which extends along the north side of 300 South in Kanosh has been filled in and is buried in the "park strip" between the road and adjacent developed parcels. The top of a few short sections of this ditch are visible, but the exposed sections are short and not continuous. It is unclear if a pipe has been installed in this lateral ditch and buried or if the ditch was simply abandoned in place and backfilled. No water control features were observed along the documented portions of the ditch system. This is due to the fact that the majority of the site in the current survey area is part of the ditch that merely carries the water through Kanosh and to Hatton where it is then diverted into field ditches for the purpose of irrigation; no water shares in the ditch are likely held by parties between the weir and the community of Hatton.

Certus was unable to locate any archival information specifically noting the construction date of this system. It likely was not built prior to the formation of the Corn Creek Irrigation Company in 1877; however, a ditch approximately a combined alignment between this ditch and the Hatton Ditch (site 42MD4706) is illustrated on the 1879 GLO map of the area and is labeled as the Petersburg Ditch. "Petersburg" was the original name of Hatton. The main ditches associated with this system (i.e, excluding sublaterals) are visible in a 1958 aerial image of the area. A newspaper article from 1899 indicates that the irrigation company had 3,000 acres of land under irrigation at that time, which suggests most of the canal systems associated with this company were constructed prior to 1900.

National Register Eligibility Review for Site 4MD4707

Certus recommends site 42MD4707 ***eligible*** for the National Register under Criterion A for the reasons outlined below. The buried lateral ditch is recommended non-contributing as it is no longer fully visible on the ground surface. The overall site appears to retain integrity of location, materials, design, workmanship, setting, feeling, and association.

This site is associated with irrigation agriculture in the Hatton community. Agriculture formed the basis of the community's economy during the historic period and allowed for both the original settlement in 1859 and for the continued existence and expansion of the community in the decades that followed. As such, irrigation agriculture played a very important role in local history, and the East Middle Hatton Ditch system was a notable part of that system. In fact, it appears the East Middle Hatton Ditch is one of the primary suppliers of irrigation water to the community. Therefore, Certus recommends this site eligible for the National Register under Criterion A.

The primary canal associated with this site was constructed under the auspices of the Corn Creek Irrigation Company, which does not qualify as a historically important person or persons for the purpose of the National Register. As such, Certus recommends the site ineligible under Criterion B.

This site, while an engineering/architectural feature, is not a notable representative of a type, style, or manner of construction, is not the work of a master, and does not possess high artistic value. There also is no established larger cultural entity, such as a district or landscape, to which it could contribute. Therefore, it is recommended ineligible for the National Register under Criterion C.

This site type is not conducive to possessing cultural deposits or other characteristics not visible on the ground surface, and the site has not yet yielded information important to improving our

understanding of the past. As such, Certus recommends this site ineligible for the National Register under Criterion D.

Site 42MD4708—West Field Ditch System

Site 42MD4708 is the historical West Field Ditch irrigation ditch system that carries water from the main weir on Corn Creek into the south part of the rural community of Kanosh. The system is owned and operated by the Corn Creek Irrigation Company, which was established in 1877. Certus documented approximately 14,539 linear meters of ditches associated with this canal system, all of which appear to represent the main ditch rather than any laterals or sublaterals.

The main ditch exhibits both lined (with concrete) and unlined segments. From the weir to a point just south of 300 South in Kanosh, the channel is unlined. The concrete-lined sections are generally associated with the "low flow" system, which is used when water levels in the source creek are low while the unlined ditches are part of the "high flow" irrigation system. The segment paralleling the south side of 300 South to the east of Main Street is lined with concrete, and the segment between Main Street and 200 West is unlined. Though the three sections vary somewhat in their shape due to their different lining conditions, they average between 5 and 6 meters wide across the top by up to 1.5 meters deep. The concrete-lined section is larger than the unlined sections and was enlarged to accommodate flood water in addition to irrigation water. No historical water control features were observed along the canal.

Certus was unable to locate any archival information specifically noting the construction date of this system. It likely was not built prior to the formation of the Corn Creek Irrigation Company, and it does not appear on the 1879 GLO map of the area. The main ditches associated with this system (i.e, excluding sublaterals) are visible in a 1958 aerial image of the area. A newspaper article from 1899 indicates that the irrigation company had 3,000 acres of land under irrigation at that time, which suggests most of the canal systems associated with this company were constructed prior to 1900.

National Register Eligibility Review for Site 4MD4708

Certus recommends site 42MD4708 ***eligible*** for the National Register under Criterion A for the reasons outlined below. The site appears to retain integrity of location, materials, design, workmanship, setting, feeling, and association.

This site is associated with irrigation agriculture in the Kanosh area. Agriculture formed the basis of the community's economy during the historic period and allowed for both the original settlement in 1867 and for the continued existence and expansion of the community in the decades that followed. As such, irrigation agriculture played a very important role in local history, and the West Field Ditch system was a notable part of that system that helped opened lands west of town for agricultural development. The sheer size of the canal channel compared to other named canals in the area suggests it was intended to carry a substantial amount of irrigation water. Therefore, Certus recommends this site eligible for the National Register under Criterion A.

The primary canal associated with this site was constructed under the auspices of the Corn Creek Irrigation Company, which does not qualify as a historically important person or persons for the purpose of the National Register. As such, Certus recommends the site ineligible under Criterion B.

This site, while an engineering/architectural feature, is not a notable representative of a type, style, or manner of construction, is not the work of a master, and does not possess high artistic value. There also is no established larger cultural entity, such as a district or landscape, to which it could contribute. Therefore, it is recommended ineligible for the National Register under Criterion C.

This site type is not conducive to possessing cultural deposits or other characteristics not visible on the ground surface, and the site has not yet yielded information important to improving our understanding of the past. As such, Certus recommends this site ineligible for the National Register under Criterion D.

Site 42MD4713—Kanosh City Ditch

Site 42MD4713 is a historical irrigation ditch referred to locally only as the "City Ditch" or "Kanosh City Ditch." Historically, the City Ditch appears to have drawn water from the East Middle Hatton Ditch and carried it west along the north side of 300 South in Kansoh. It is unclear if the main ditch fed smaller ditches throughout the town or simply extended along 300 South. At present, this ditch is abandoned, and segments of the original ditch have either been piped or filled in to match the surrounding grade. The segment of the ditch east of roughly 250 East 300 South remains open and comprises a concrete-lined ditch measuring roughly 50 centimeters deep and up to 1 to 1.25 meter wide. This ditch segment has a flared cross-section with a narrow flat bottom. To the west of there, and west to Main Street, the top of a few short sections of this concrete-lined ditch are visible in the park strip/shoulder of 300 South. These segments are short and not continuous. In total, Certus documented 1,626 meters of the main ditch for the present undertaking.

Certus was unable to locate any archival information specifically noting the construction date of this system. It likely was not built prior to the formation of the Corn Creek Irrigation Company in 1877 as it appears to pull water from one of the irrigation company's ditches, and it is not depicted on the 1879 GLO map of the community. It appears the city-sponsored irrigation system was abandoned when the Corn Creek Irrigation Company system was constructed throughout the community.

National Register Eligibility Review for Site 4MD4713

Certus recommends site 42MD4713 ***ineligible*** for the National Register under all criteria for the reasons outlined below. The overall site appears to retain integrity of location and generally of association, but it lacks integrity of materials, design, workmanship, setting, and feeling due to the abandonment and either removal or backfilling of the majority of this ditch.

This site is associated with irrigation agriculture in the Kanosh community and appears to date to relatively early in the town's establishment. Agriculture formed the basis of the community's economy during the historic period and allowed for both the original settlement in 1859 and for the continued existence and expansion of the community in the decades that followed. As such, irrigation agriculture played a very important role in local history; however, the City Ditch lacks sufficient integrity to convey its association with that history. Therefore, Certus recommends this site ineligible for the National Register under Criterion A.

The primary canal associated with this site was constructed under the auspices of the town's governmental body, which does not qualify as a historically important person or persons for the purpose of the National Register. As such, Certus recommends the site ineligible under Criterion B.

This site, while an engineering/architectural feature, is not a notable representative of a type, style, or manner of construction, is not the work of a master, and does not possess high artistic value. There also is no established larger cultural entity, such as a district or landscape, to which it could contribute. Overall, the site lacks the structural integrity needed to qualify for the National Register. Therefore, it is recommended ineligible under Criterion C.

This site type is not conducive to possessing cultural deposits or other characteristics not visible on the ground surface, and the site has not yet yielded information important to improving our understanding of the past. As such, Certus recommends this site ineligible for the National Register under Criterion D.

FINDINGS FOR THE NO ACTION/DAM BREACH APE

As noted, the APE for the No Action alternative and Preferred Alternative Dam Breach scenario includes those lands that could be inundated or otherwise experience flood impacts if no action is taken to address current flooding conditions or if the renovated dam breaches. Also as previously noted, Certus did not conduct a field survey of those portions of the APE outside the specific survey area for the Preferred Alternative and that cultural resources in that broader APE area were identified through archival research. As such, the resources discussed herein as being present in those portions of the APE outside the survey area should be considered an estimate of the total sum of resources present therein; that is, additional resources not mentioned in archival sources may be present in the area.

The archival review of the broader APE, as discussed in the **File Search** section of this report, identified 12 archaeological sites and 162 primary historical buildings. See that section of the report for more information about these resources.

SUMMARY AND RECOMMENDATIONS

Certus conducted an archaeological resources inventory for the Corn Creek Watershed Plan-EA Preferred Alternative under the jurisdiction of the NRCS. A file search for known cultural resources in the APE for the No Action alternative also was conducted.

Sixteen archaeological sites were documented in the survey area (see **Table 2**). Nine of the sites are historical irrigation canal systems and other water management/conveyance features. One additional site is a historical flood control site, and another is an apparent pump house or water storage feature. The remaining five sites represent prehistoric period land uses.

Certus has recommended seven of the 16 sites as eligible for the National Register. These sites are all historical canal/ditch systems.

Table 2. Documented sites in the survey area and National Register eligibility recommendations

Site Number	Description	National Register Recommendation
42MD2016	Historical concrete water pipeline	Not Eligible
42MD2017	**Historical ditch (the Indian Ditch)**	**Eligible**
42MD4696	Corn Creek Dam & Debris Basin	Not Eligible
42MD4697	Prehistoric temporary camp	Not Eligible
42MD4698	Prehistoric temporary camp	Not Eligible

Table 2. Documented sites in the survey area and National Register eligibility recommendations

Site Number	Description	National Register Recommendation
42MD4699	Prehistoric temporary camp	Not Eligible
42MD4700	Prehistoric temporary camp	Not Eligible
42MD4701	Historical structure/pump house	Not Eligible
42MD4702	Prehistoric rock art on a relocated boulder	Not Eligible
42MD4703	**South & West Field Ditches system**	**Eligible**
42MD4704	**Middle Ditch system**	**Eligible**
42MD4705	**East Field Ditch system**	**Eligible**
42MD4706	**Hatton Ditch system**	**Eligible**
42MD4707	**East Middle Hatton Ditch system**	**Eligible**
42MD4708	**West Ditch system**	**Eligible**
42MD4713	City Ditch	Not Eligible

A total of 175 cultural resources, including archaeological sites and historical buildings were identified in the No Action alternative APE. **Table 3**, below, summarizes those sites and buildings that have been determined eligible for the National Register and would, therefore, need to be considered relative to potential adverse effects from the undertaking or, more specifically, the lack of action to address current flood conditions:

Table 3. Known National Register-eligible sites & buildings in the No Action/Dam Breach APE

Site Number or Address	Description	National Register Determination
42MD996	Multi-component site	Eligible
42MD997	Prehistoric camp	Eligible
~4675 W Hatton Ln	Single-family dwelling	Eligible
~4750 W Hatton Ln	Single-family dwelling	Eligible
4909 W Hatton Ln	Single-family dwelling	Eligible
10 N Main St	Single-family dwelling	Eligible/Listed on NRHP
60 N Main St	Single-family dwelling	Eligible
35 W Center St	Single-family dwelling	Eligible
60/70 W Center St	Single-family dwelling	Eligible

The proposed watershed improvement projects would involve piping of extensive portions of some of the historical irrigation site networks documented in the survey area and the placement of buried pipes adjacent to others. Where the ditches are piped, historical water control features would be removed or buried. More specific information about the anticipated impacts to the eligible sites listed in **Table 2** and recommended findings of effect under 36 CFR §800 are provided in **Table 4**. As can be seen from this table, Certus is recommending a finding of **adverse effect** for three of the eligible irrigation system sites due to the extent the systems would be altered through replacement with underground pipelines.

Table 4. Anticipated impacts and recommended findings of effect for eligible sites under the Preferred Alternative

Site Number	Description of Impact	Recommended Finding of Effect
42MD2017	New pipeline buried adjacent to ditch with minor changes to the pond/impoundment to connect the new pipe to the water system in the Kanosh Indian Village	No Adverse Effect
42MD4703	Approximately half of the concrete-lined ditch would be piped and half would have a pipe buried adjacent to it. The earthen ditches associated with the system would remain unaltered.	**Adverse Effect**
42MD4704	A buried pipeline system would be placed adjacent to the existing ditches, which would remain unaltered.	No Adverse Effect
42MD4705	A buried pipeline system would be placed adjacent to the existing ditches, which would remain unaltered.	No Adverse Effect
42MD4706	A buried pipeline system would be placed adjacent to the existing ditches, which would remain unaltered.	No Adverse Effect
42MD4707	The concrete-lined ditch would be piped underground, and the ditch would effectively be destroyed.	**Adverse Effect**
42MD4708	A 1-block long segment of the main ditch along 300 South west of Main Street, which is currently unlined, would be enlarged and lined with concrete to match the segment of the ditch east of Main Street. Much of the rest of the system would be replaced with buried pipelines.	**Adverse Effect**

Regarding the archaeological sites and historical buildings located in the APE for the No Action/Dam Breach scenario, flooding would impact these resources with the same frequency, severity, and effect as is currently experienced. Generally speaking, the eligible historical buildings are all located sufficiently far from the Corn Creek water source that they are extremely unlikely to suffer adverse effects from flooding. The effects of flooding on the known National Register-eligible archaeological sites in the No Action alternative APE are less predictable, as it depends on the depth and flow rate of water across the sites and whether both are sufficiently high as to move artifacts, scour away sediments at the site and cause "deflation," or otherwise alter artifact provenience or feature integrity. That said, any effects experienced by these sites under the No Action alternative would represent no change from current conditions.

The information presented herein reflects the opinions and recommendations of the author. The NRCS will issue all final determinations of eligibility for all documented sites and a finding of effect relative to those sites. These determinations will be issued under separate cover.

REFERENCES CITED

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National Park Service (NPS). 2002. *How to Apply the National Register Criteria for Evaluation.* National Register Bulletin 15. Utah Centennial County History Series. Accessed online on January 9, 2014 at: http://www.nps.gov/history/nr/publications/bulletins/nrb15/

An Archaeological Resource Assessment for the
Corn Creek Watershed Plan-EA,
Kanosh, Millard County, Utah

APPENDIX A:

HISTORICAL BUILDINGS LOCATED IN THE NO ACTION ALTERNATIVE APE

Historical Buildings (Built 1974 or earlier) in No Action/Dam Breach APE

Address	Eligibility	Address	Eligibility
~260 N 100 E	Unevaluated	90 W 100 S	Unevaluated
257 N 100 E	Unevaluated	95 W 100 S	Unevaluated
190 N 100 E	Unevaluated	150 W 100 S	Unevaluated
~130 N 100 E	Unevaluated	160 W 100 S	Unevaluated
45 S 100 E	Unevaluated	335 N 100 W	Unevaluated
65 S 100 E	Unevaluated	195 N 100 W	Unevaluated
95 S 100 E	Unevaluated	180 N 100 W	Unevaluated
115 S 100 E	Unevaluated	~145 N 100 W	Unevaluated
145 S 100 E	Unevaluated	95 N 100 W	Unevaluated
150 S 100 E	Unevaluated	15 N 100 W	Unevaluated
175 S 100 E	Unevaluated	65 S 100 W	Unevaluated
210 S 100 E	Unevaluated	110 S 100 W	Unevaluated
215 S 100 E	Unevaluated	165 S 100 W	Unevaluated
255 S 100 E	Unevaluated	180 S 100 W	Unevaluated
285 S 100 E	Unevaluated	235 S 100 W	Unevaluated
290 S 100 E	Unevaluated	265 S 100 W	Unevaluated
35 E 100 N	Unevaluated	180 N 200 E	Unevaluated
45 E 100 N	Unevaluated	90 N 200 E	Unevaluated
65 E 100 N	Unevaluated	60 S 200 E	Unevaluated
85 E 100 N	Unevaluated	210 S 200 E	Unevaluated
90 E 100 N	Unevaluated	240 S 200 E	Unevaluated
110 E 100 N	Unevaluated	270 S 200 E	Unevaluated
140 E 100 N	Unevaluated	40 E 200 N	Unevaluated
160 E 100 N	Unevaluated	90 E 200 N	Unevaluated
165 E 100 N	Unevaluated	~180 W 200 N	Unevaluated
190 E 100 N	Unevaluated	~210 W 200 N	Unevaluated
45 W 100 N	Unevaluated	85 E 200 S	Unevaluated
90 W 100 N	Unevaluated	115 E 200 S	Unevaluated
110 W 100 N	Unevaluated	135 E 200 S	Unevaluated
145 W 100 N	Unevaluated	165 E 200 S	Unevaluated
30 E 100 S	Unevaluated	170 E 200 S	Unevaluated
55 E 100 S	Unevaluated	195 E 200 S	Unevaluated
89 E 100 S	Unevaluated	215 E 200 S	Unevaluated
90 E 100 S	Unevaluated	15 W 200 S	Unevaluated
140 E 100 S	Unevaluated	25 W 200 S	Unevaluated
170 E 100 S	Unevaluated	~28 W 200 S	Unevaluated
190 E 100 S	Unevaluated	30 W 200 S	Unevaluated
195 E 100 S	Unevaluated	65 W 200 S	Unevaluated
210 E 100 S	Unevaluated	~83 W 200 S	Unevaluated
215 E 100 S	Unevaluated	90 W 200 S	Unevaluated
30 W 100 S	Unevaluated	115 W 200 S	Unevaluated
60 W 100 S	Unevaluated	145 W 200 S	Unevaluated

Address	Eligibility	Address	Eligibility
160 W 200 S	Unevaluated	310 N Main St	Unevaluated
180 W 200 S	Unevaluated	260 N Main St	Unevaluated
95 N 200 W	Unevaluated	215 N Main St	Unevaluated
90 N 200 W	Unevaluated	190 N Main St	Unevaluated
15 S 200 W	Unevaluated	165 N Main St	Unevaluated
25 S 200 W	Unevaluated	135 N Main St	Unevaluated
45 S 200 W	Unevaluated	110 N Main St	Unevaluated
~110 S 200 W	Unevaluated	95 N Main St	Unevaluated
115 S 200 W	Unevaluated	94 N Main St	Unevaluated
160 S 200 W	Unevaluated	~89 N Main St	Unevaluated
180 S 200 W	Unevaluated	60 N Main St	Eligible/Contributing
240 S 200 W	Unevaluated	55 N Main St	Unevaluated
55 E 300 S	Unevaluated	45 N Main St	Unevaluated
~160 E 300 S	Unevaluated	25 N Main St	Unevaluated
215 E 300 S	Unevaluated	15 N Main St	Unevaluated
245 E 300 S	Unevaluated	10 N Main St	**Listed**
35 E Center St	Unevaluated	10 S Main St	Unevaluated
50 E Center St	Unevaluated	20 S Main St	Unevaluated
70 E Center St	Unevaluated	25 S Main St	Unevaluated
80 E Center St	Unevaluated	30 S Main St	Unevaluated
85 E Center St	Unevaluated	50 S Main St	Unevaluated
113 E Center St	Unevaluated	60 S Main St	Unevaluated
115 E Center St	Unevaluated	65 S Main St	Unevaluated
120 E Center St	Unevaluated	80 S Main St	Unevaluated
160 E Center St	Unevaluated	95 S Main St	Unevaluated
175 E Center St	Unevaluated	110 S Main St	Unevaluated
~185 E Center St	Unevaluated	115 S Main St	Unevaluated
190 E Center St	Unevaluated	125-135 S Main St	Unevaluated
~240 E Center St	Unevaluated	140 S Main St	Unevaluated
250 E Center St	Unevaluated	145 S Main St	Unevaluated
35 W Center St	Eligible/Contributing	155 S Main St	Unevaluated
70/80 W Center St	Eligible/Contributing	165 S Main St	Unevaluated
115 W Center St	Unevaluated	185 S Main St	Unevaluated
~4675 W Hatton Ln	Eligible/Contributing	190 S Main St	Unevaluated
~4750 W Hatton Ln	Eligible/Contributing	215 S Main St	Unevaluated
4909 W Hatton Ln	Eligible/Contributing	255 S Main St	Unevaluated
5159 W Hatton Ln	Unevaluated	270 S Main St	Unevaluated
365 N Main St	Unevaluated	285 S Main St	Unevaluated
~320 N Main St	Unevaluated	325 S Main St	Unevaluated

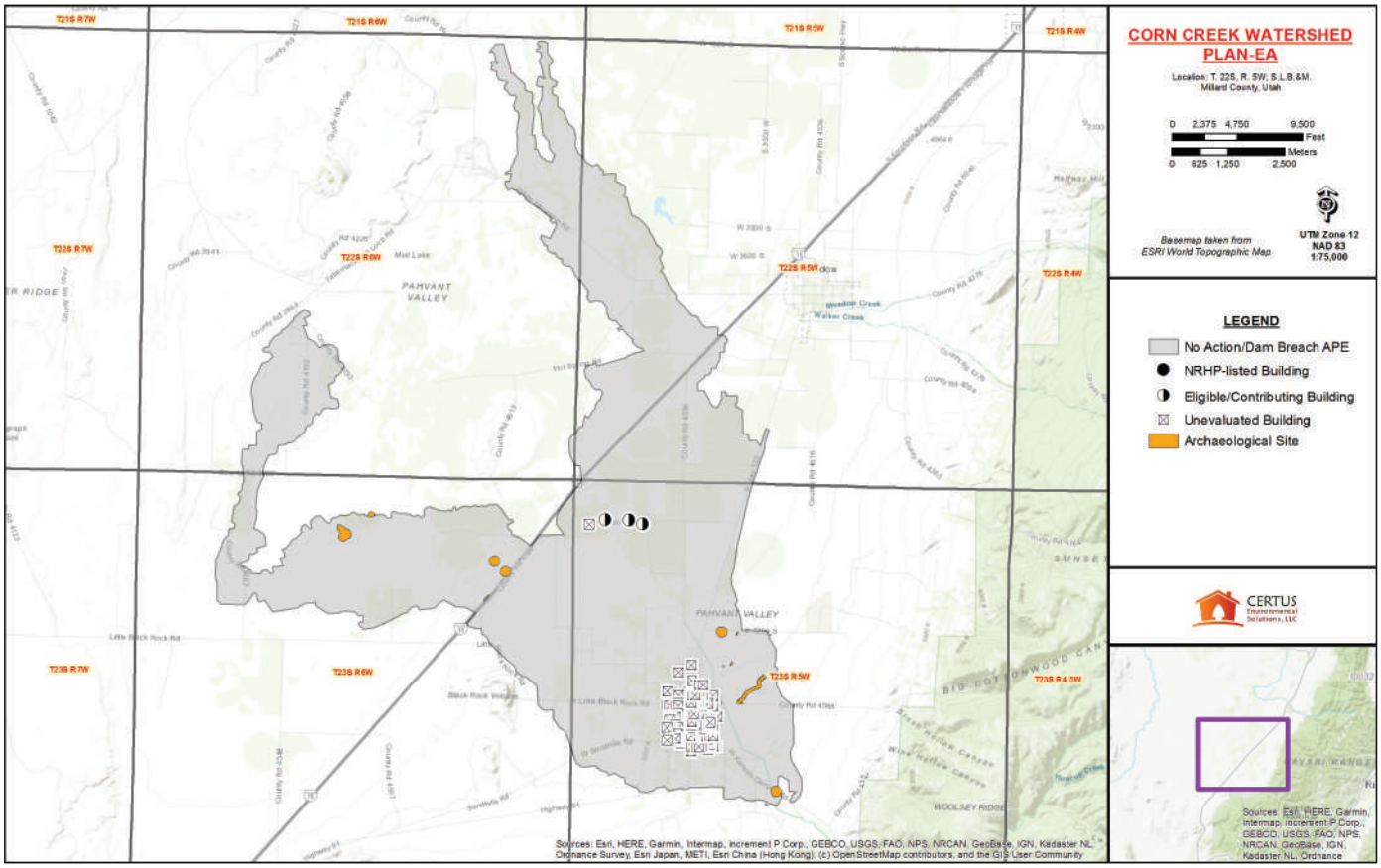


Figure 4. Overview of No Action/Dam Breach APE and known cultural resources

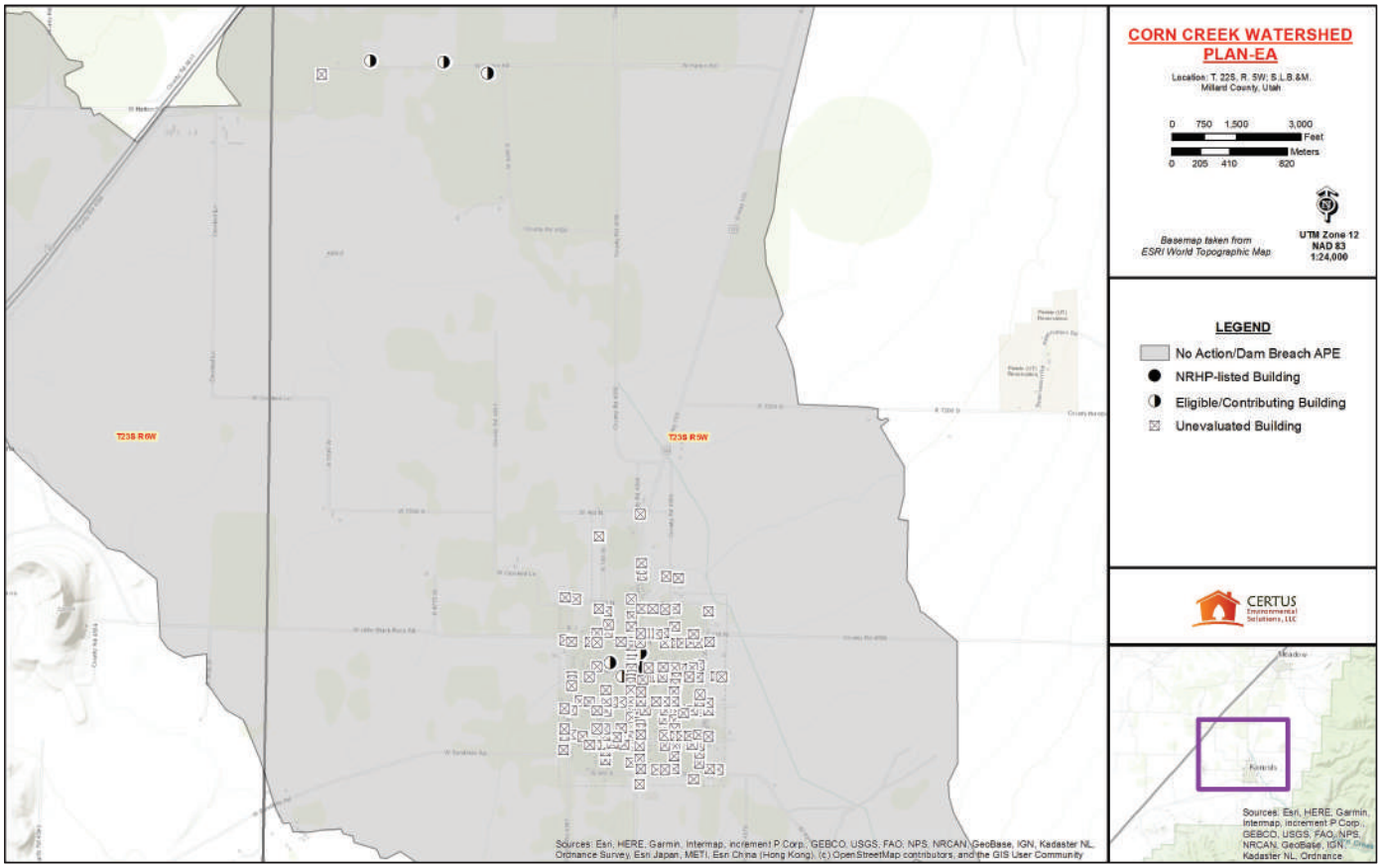


Figure 5. Detail of No Action/Dam Breach APE and locations of known historical buildings

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Presidential Documents

Title 3—

The President

Executive Order 12898 of February 11, 1994

Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:

Section 1–1.*Implementation.*

1–101. *Agency Responsibilities.* To the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands.

1–102. *Creation of an Interagency Working Group on Environmental Justice.* (a) Within 3 months of the date of this order, the Administrator of the Environmental Protection Agency (''Administrator'') or the Administrator's designee shall convene an interagency Federal Working Group on Environmental Justice (''Working Group''). The Working Group shall comprise the heads of the following executive agencies and offices, or their designees: (a) Department of Defense; (b) Department of Health and Human Services; (c) Department of Housing and Urban Development; (d) Department of Labor; (e) Department of Agriculture; (f) Department of Transportation; (g) Department of Justice; (h) Department of the Interior; (i) Department of Commerce; (j) Department of Energy; (k) Environmental Protection Agency; (l) Office of Management and Budget; (m) Office of Science and Technology Policy; (n) Office of the Deputy Assistant to the President for Environmental Policy; (o) Office of the Assistant to the President for Domestic Policy; (p) National Economic Council; (q) Council of Economic Advisers; and (r) such other Government officials as the President may designate. The Working Group shall report to the President through the Deputy Assistant to the President for Environmental Policy and the Assistant to the President for Domestic Policy.

(b) The Working Group shall: (1) provide guidance to Federal agencies on criteria for identifying disproportionately high and adverse human health or environmental effects on minority populations and low-income populations;

(2) coordinate with, provide guidance to, and serve as a clearinghouse for, each Federal agency as it develops an environmental justice strategy as required by section 1–103 of this order, in order to ensure that the administration, interpretation and enforcement of programs, activities and policies are undertaken in a consistent manner;

(3) assist in coordinating research by, and stimulating cooperation among, the Environmental Protection Agency, the Department of Health and Human Services, the Department of Housing and Urban Development, and other agencies conducting research or other activities in accordance with section 3–3 of this order;

(4) assist in coordinating data collection, required by this order;

(5) examine existing data and studies on environmental justice;

(6) hold public meetings as required in section 5–502(d) of this order; and

(7) develop interagency model projects on environmental justice that evidence cooperation among Federal agencies.

1–103. *Development of Agency Strategies.* (a) Except as provided in section 6–605 of this order, each Federal agency shall develop an agency-wide environmental justice strategy, as set forth in subsections (b)–(e) of this section that identifies and addresses disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. The environmental justice strategy shall list programs, policies, planning and public participation processes, enforcement, and/or rulemakings related to human health or the environment that should be revised to, at a minimum: (1) promote enforcement of all health and environmental statutes in areas with minority populations and low-income populations; (2) ensure greater public participation; (3) improve research and data collection relating to the health of and environment of minority populations and low-income populations; and (4) identify differential patterns of consumption of natural resources among minority populations and low-income populations. In addition, the environmental justice strategy shall include, where appropriate, a timetable for undertaking identified revisions and consideration of economic and social implications of the revisions.

(b) Within 4 months of the date of this order, each Federal agency shall identify an internal administrative process for developing its environmental justice strategy, and shall inform the Working Group of the process.

(c) Within 6 months of the date of this order, each Federal agency shall provide the Working Group with an outline of its proposed environmental justice strategy.

(d) Within 10 months of the date of this order, each Federal agency shall provide the Working Group with its proposed environmental justice strategy.

(e) Within 12 months of the date of this order, each Federal agency shall finalize its environmental justice strategy and provide a copy and written description of its strategy to the Working Group. During the 12 month period from the date of this order, each Federal agency, as part of its environmental justice strategy, shall identify several specific projects that can be promptly undertaken to address particular concerns identified during the development of the proposed environmental justice strategy, and a schedule for implementing those projects.

(f) Within 24 months of the date of this order, each Federal agency shall report to the Working Group on its progress in implementing its agency-wide environmental justice strategy.

(g) Federal agencies shall provide additional periodic reports to the Working Group as requested by the Working Group.

1–104. *Reports to the President.* Within 14 months of the date of this order, the Working Group shall submit to the President, through the Office of the Deputy Assistant to the President for Environmental Policy and the Office of the Assistant to the President for Domestic Policy, a report that describes the implementation of this order, and includes the final environmental justice strategies described in section 1–103(e) of this order.

Sec. 2–2. *Federal Agency Responsibilities for Federal Programs.* Each Federal agency shall conduct its programs, policies, and activities that substantially affect human health or the environment, in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under, such programs, policies, and activities, because of their race, color, or national origin.

Sec. 3–3.*Research, Data Collection, and Analysis.*

3–301. *Human Health and Environmental Research and Analysis.* (a) Environmental human health research, whenever practicable and appropriate, shall include diverse segments of the population in epidemiological and clinical studies, including segments at high risk from environmental hazards, such as minority populations, low-income populations and workers who may be exposed to substantial environmental hazards.

(b) Environmental human health analyses, whenever practicable and appropriate, shall identify multiple and cumulative exposures.

(c) Federal agencies shall provide minority populations and low-income populations the opportunity to comment on the development and design of research strategies undertaken pursuant to this order.

3–302. *Human Health and Environmental Data Collection and Analysis.* To the extent permitted by existing law, including the Privacy Act, as amended (5 U.S.C. section 552a): (a) each Federal agency, whenever practicable and appropriate, shall collect, maintain, and analyze information assessing and comparing environmental and human health risks borne by populations identified by race, national origin, or income. To the extent practical and appropriate, Federal agencies shall use this information to determine whether their programs, policies, and activities have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations;

(b) In connection with the development and implementation of agency strategies in section 1–103 of this order, each Federal agency, whenever practicable and appropriate, shall collect, maintain and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding facilities or sites expected to have a substantial environmental, human health, or economic effect on the surrounding populations, when such facilities or sites become the subject of a substantial Federal environmental administrative or judicial action. Such information shall be made available to the public, unless prohibited by law; and

(c) Each Federal agency, whenever practicable and appropriate, shall collect, maintain, and analyze information on the race, national origin, income level, and other readily accessible and appropriate information for areas surrounding Federal facilities that are: (1) subject to the reporting requirements under the Emergency Planning and Community Right-to-Know Act, 42 U.S.C. section 11001–11050 as mandated in Executive Order No. 12856; and (2) expected to have a substantial environmental, human health, or economic effect on surrounding populations. Such information shall be made available to the public, unless prohibited by law.

(d) In carrying out the responsibilities in this section, each Federal agency, whenever practicable and appropriate, shall share information and eliminate unnecessary duplication of efforts through the use of existing data systems and cooperative agreements among Federal agencies and with State, local, and tribal governments.

Sec. 4–4. *Subsistence Consumption of Fish and Wildlife.*

4–401. *Consumption Patterns.* In order to assist in identifying the need for ensuring protection of populations with differential patterns of subsistence consumption of fish and wildlife, Federal agencies, whenever practicable and appropriate, shall collect, maintain, and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence. Federal agencies shall communicate to the public the risks of those consumption patterns.

4–402. *Guidance.* Federal agencies, whenever practicable and appropriate, shall work in a coordinated manner to publish guidance reflecting the latest scientific information available concerning methods for evaluating the human health risks associated with the consumption of pollutant-bearing fish or

wildlife. Agencies shall consider such guidance in developing their policies and rules.

Sec. 5–5. *Public Participation and Access to Information.* (a) The public may submit recommendations to Federal agencies relating to the incorporation of environmental justice principles into Federal agency programs or policies. Each Federal agency shall convey such recommendations to the Working Group.

(b) Each Federal agency may, whenever practicable and appropriate, translate crucial public documents, notices, and hearings relating to human health or the environment for limited English speaking populations.

(c) Each Federal agency shall work to ensure that public documents, notices, and hearings relating to human health or the environment are concise, understandable, and readily accessible to the public.

(d) The Working Group shall hold public meetings, as appropriate, for the purpose of fact-finding, receiving public comments, and conducting inquiries concerning environmental justice. The Working Group shall prepare for public review a summary of the comments and recommendations discussed at the public meetings.

Sec. 6–6. *General Provisions.*

6–601. *Responsibility for Agency Implementation.* The head of each Federal agency shall be responsible for ensuring compliance with this order. Each Federal agency shall conduct internal reviews and take such other steps as may be necessary to monitor compliance with this order.

6–602. *Executive Order No. 12250.* This Executive order is intended to supplement but not supersede Executive Order No. 12250, which requires consistent and effective implementation of various laws prohibiting discriminatory practices in programs receiving Federal financial assistance. Nothing herein shall limit the effect or mandate of Executive Order No. 12250.

6–603. *Executive Order No. 12875.* This Executive order is not intended to limit the effect or mandate of Executive Order No. 12875.

6–604. *Scope.* For purposes of this order, Federal agency means any agency on the Working Group, and such other agencies as may be designated by the President, that conducts any Federal program or activity that substantially affects human health or the environment. Independent agencies are requested to comply with the provisions of this order.

6–605. *Petitions for Exemptions.* The head of a Federal agency may petition the President for an exemption from the requirements of this order on the grounds that all or some of the petitioning agency's programs or activities should not be subject to the requirements of this order.

6–606. *Native American Programs.* Each Federal agency responsibility set forth under this order shall apply equally to Native American programs. In addition, the Department of the Interior, in coordination with the Working Group, and, after consultation with tribal leaders, shall coordinate steps to be taken pursuant to this order that address Federally-recognized Indian Tribes.

6–607. *Costs.* Unless otherwise provided by law, Federal agencies shall assume the financial costs of complying with this order.

6–608. *General.* Federal agencies shall implement this order consistent with, and to the extent permitted by, existing law.

6–609. *Judicial Review.* This order is intended only to improve the internal management of the executive branch and is not intended to, nor does it create any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity by a party against the United States, its agencies, its officers, or any person. This order shall not be construed to create any right to judicial review involving the compliance or noncompliance

of the United States, its agencies, its officers, or any other person with this order.



THE WHITE HOUSE,
February 11, 1994.

[FR Citation 59 FR 7629]

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Title 3—

The President

Executive Order 14096 of April 21, 2023

Revitalizing Our Nation's Commitment to Environmental Justice for All

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in order to advance environmental justice, it is hereby ordered as follows:

Section 1. *Policy*. To fulfill our Nation's promises of justice, liberty, and equality, every person must have clean air to breathe; clean water to drink; safe and healthy foods to eat; and an environment that is healthy, sustainable, climate-resilient, and free from harmful pollution and chemical exposure. Restoring and protecting a healthy environment—wherever people live, play, work, learn, grow, and worship—is a matter of justice and a fundamental duty that the Federal Government must uphold on behalf of all people.

We must advance environmental justice for all by implementing and enforcing the Nation's environmental and civil rights laws, preventing pollution, addressing climate change and its effects, and working to clean up legacy pollution that is harming human health and the environment. Advancing environmental justice will require investing in and supporting culturally vibrant, sustainable, and resilient communities in which every person has safe, clean, and affordable options for housing, energy, and transportation. It is also necessary to prioritize building an equitable, inclusive, and sustainable economy that offers economic opportunities, workforce training, and high-quality and well-paying jobs, including union jobs, and facilitating an equitable transition of the workforce as part of a clean energy future. Achieving this vision will also require improving equitable access to parks, tree cover, playgrounds, sports fields, rivers, ponds, beaches, lakes, and all of the benefits provided by nature, including America's public lands and waters. Pursuing these and other objectives integral to advancing environmental justice can successfully occur only through meaningful engagement and collaboration with underserved and overburdened communities to address the adverse conditions they experience and ensure they do not face additional disproportionate burdens or underinvestment.

We have more work to do to make environmental justice a reality for our Nation, both for today and for the generations that will follow us. Even as many communities in the United States have prospered and thrived in recent decades, many other communities have been left behind. Communities with environmental justice concerns face entrenched disparities that are often the legacy of racial discrimination and segregation, redlining, exclusionary zoning, and other discriminatory land use decisions or patterns. These decisions and patterns may include the placement of polluting industries, hazardous waste sites, and landfills in locations that cause cumulative impacts to the public health of communities and the routing of highways and other transportation corridors in ways that divide neighborhoods. These remnants of discrimination persist today.Communities with environmental justice concerns exist in all areas of the country, including urban and rural areas and areas within the boundaries of Tribal Nations and United States Territories. Such communities are found in geographic locations that have a significant proportion of people who have low incomes or are otherwise adversely affected by persistent poverty or inequality. Such communities are also found in places with a significant proportion of people of color,

including individuals who are Black, Latino, Indigenous and Native American, Asian American, Native Hawaiian, and Pacific Islander. Communities with environmental justice concerns also include geographically dispersed and mobile populations, such as migrant farmworkers.

Communities with environmental justice concerns experience disproportionate and adverse human health or environmental burdens. These burdens arise from a number of causes, including inequitable access to clean water, clean air, natural places, and resources for other basic human health and environmental needs; the concentration of pollution, hazardous waste, and toxic exposures; and underinvestment in affordable housing that is safe and healthy and in basic infrastructure and services to support such housing, including safe drinking water and effective sewage management. The cumulative impacts of exposure to those types of burdens and other stressors, including those related to climate change and the environment, further disadvantage communities with environmental justice concerns. People in these communities suffer from poorer health outcomes and have lower life expectancies than those in other communities in our Nation. Moreover, gaps in environmental and human health data can conceal these harms from public view, and, in doing so, are themselves a persistent and pernicious driver of environmental injustice.

Nearly three decades after the issuance of Executive Order 12898 of February 11, 1994 (Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations), the Federal Government must build upon and strengthen its commitment to deliver environmental justice to all communities across America. Our Nation needs an ambitious approach to environmental justice that is informed by scientific research, high-quality data, and meaningful Federal engagement with communities with environmental justice concerns and that uses the tools available to the Federal Government, including enforcement of civil rights and environmental laws. Our Nation must also take further steps to dismantle racial discrimination and institutional bias that disproportionately affect the health, environment, safety, and resiliency of communities with environmental justice concerns.

To ensure that the Nation's policies and investments respond to the needs of every community, all people should be afforded the opportunity to meaningfully participate in agency decision-making processes that may affect the health of their community or environment. The Federal Government must continue to remove barriers to the meaningful involvement of the public in such decision-making, particularly those barriers that affect members of communities with environmental justice concerns, including those related to disability, language access, and lack of resources. The Federal Government must also continue to respect Tribal sovereignty and support self-governance by ensuring that Tribal Nations are consulted on Federal policies that have Tribal implications. In doing so, we must recognize, honor, and respect the different cultural practices—including subsistence practices, ways of living, Indigenous Knowledge, and traditions—in communities across America. As our Nation reaffirms our commitment to environmental justice, the Federal Government must continue to be transparent about, and accountable for, its actions.

It is the policy of my Administration to pursue a whole-of-government approach to environmental justice. This order builds upon my Administration's ongoing efforts to advance environmental justice and equity consistent with Executive Order 13985 of January 20, 2021 (Advancing Racial Equity and Support for Underserved Communities Through the Federal Government), Executive Order 13990 of January 20, 2021 (Protecting Public Health and the Environment and Restoring Science To Tackle the Climate Crisis), Executive Order 14008 of January 27, 2021 (Tackling the Climate Crisis at Home and Abroad), Executive Order 14052 of November 15, 2021 (Implementation of the Infrastructure Investment and Jobs Act), Executive Order 14057 of December 8, 2021 (Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability), Executive Order 14082 of September 12,

2022 (Implementation of the Energy and Infrastructure Provisions of the Inflation Reduction Act of 2022), and Executive Order 14091 of February 16, 2023 (Further Advancing Racial Equity and Support for Underserved Communities Through the Federal Government). This order also supplements the foundational efforts of Executive Order 12898 to address environmental justice. In partnership with State, Tribal, territorial, and local governments, as well as community organizations, businesses, and members of the public, the Federal Government will advance environmental justice and help create a more just and sustainable future for all.

Sec. 2. *Definitions*. As used in this order:

(a) ''Agency'' means an executive agency as defined by 5 U.S.C. 105, excluding the Government Accountability Office and independent regulatory agencies, as defined in 44 U.S.C. 3502(5).

(b) ''Environmental justice'' means the just treatment and meaningful involvement of all people, regardless of income, race, color, national origin, Tribal affiliation, or disability, in agency decision-making and other Federal activities that affect human health and the environment so that people:

(i) are fully protected from disproportionate and adverse human health and environmental effects (including risks) and hazards, including those related to climate change, the cumulative impacts of environmental and other burdens, and the legacy of racism or other structural or systemic barriers; and

(ii) have equitable access to a healthy, sustainable, and resilient environment in which to live, play, work, learn, grow, worship, and engage in cultural and subsistence practices.

(c) ''Federal activity'' means any agency rulemaking, guidance, policy, program, practice, or action that affects or has the potential to affect human health and the environment, including an agency action related to climate change. Federal activities may include agency actions related to: assuring compliance with applicable laws; licensing, permitting, and the reissuance of licenses and permits; awarding, conditioning, or oversight of Federal funds; and managing Federal resources and facilities. This may also include such activities in the District of Columbia and the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, American Samoa, Guam, the U.S. Virgin Islands, and other Territories and possessions of the United States.

(d) ''Tribal Nation'' means an American Indian or Alaska Native tribe, band, nation, pueblo, village, or community that the Secretary of the Interior acknowledges as a federally recognized Tribe pursuant to the Federally Recognized Indian Tribe List Act of 1994, 25 U.S.C. 5130, 5131.

Sec. 3. *Government-Wide Approach to Environmental Justice*. (a) Consistent with section 1–101 of Executive Order 12898 and each agency's statutory authority, each agency should make achieving environmental justice part of its mission. Each agency shall, as appropriate and consistent with applicable law:

(i) identify, analyze, and address disproportionate and adverse human health and environmental effects (including risks) and hazards of Federal activities, including those related to climate change and cumulative impacts of environmental and other burdens on communities with environmental justice concerns;

(ii) evaluate relevant legal authorities and, as available and appropriate, take steps to address disproportionate and adverse human health and environmental effects (including risks) and hazards unrelated to Federal activities, including those related to climate change and cumulative impacts of environmental and other burdens on communities with environmental justice concerns;

(iii) identify, analyze, and address historical inequities, systemic barriers, or actions related to any Federal regulation, policy, or practice that impair

the ability of communities with environmental justice concerns to achieve or maintain a healthy and sustainable environment;

(iv) identify, analyze, and address barriers related to Federal activities that impair the ability of communities with environmental justice concerns to receive equitable access to human health or environmental benefits, including benefits related to natural disaster recovery and climate mitigation, adaptation, and resilience;

(v) evaluate relevant legal authorities and, as available and appropriate, take steps to provide, in consultation with unions and employers, opportunities for workforce training and to support the creation of high-quality and well-paying jobs, including union jobs, for people who are part of communities with environmental justice concerns;

(vi) evaluate relevant legal authorities and, where available and appropriate, consider adopting or requiring measures to avoid, minimize, or mitigate disproportionate and adverse human health and environmental effects (including risks) and hazards of Federal activities on communities with environmental justice concerns, to the maximum extent practicable, and to address any contribution of such Federal activities to adverse effects—including cumulative impacts of environmental and other burdens—already experienced by such communities;

(vii) provide opportunities for the meaningful engagement of persons and communities with environmental justice concerns who are potentially affected by Federal activities, including by:

(A) providing timely opportunities for members of the public to share information or concerns and participate in decision-making processes;

(B) fully considering public input provided as part of decision-making processes;

(C) seeking out and encouraging the involvement of persons and communities potentially affected by Federal activities by:

(1) ensuring that agencies offer or provide information on a Federal activity in a manner that provides meaningful access to individuals with limited English proficiency and is accessible to individuals with disabilities;

(2) providing notice of and engaging in outreach to communities or groups of people who are potentially affected and who are not regular participants in Federal decision-making; and

(3) addressing, to the extent practicable and appropriate, other barriers to participation that individuals may face; and

(D) providing technical assistance, tools, and resources to assist in facilitating meaningful and informed public participation, whenever practicable and appropriate;

(viii) continue to engage in consultation on Federal activities that have Tribal implications and potentially affect human health or the environment, pursuant to Executive Order 13175 of November 6, 2000 (Consultation and Coordination With Indian Tribal Governments), the Presidential Memorandum of January 26, 2021 (Tribal Consultation and Strengthening Nation-to-Nation Relationships), and the Presidential Memorandum of November 30, 2022 (Uniform Standards for Tribal Consultation), and fulfill obligations established pursuant to Executive Order 13007 of May 24, 1996 (Indian Sacred Sites);

(ix) carry out environmental reviews under the National Environmental Policy Act (NEPA), 42 U.S.C. 4321 *et seq.*, consistent with the statute and its implementing regulations and through the exercise of the agency's expertise and technical judgment, in a manner that:

(A) analyzes direct, indirect, and cumulative effects of Federal actions on communities with environmental justice concerns;

(B) considers best available science and information on any disparate health effects (including risks) arising from exposure to pollution and

other environmental hazards, such as information related to the race, national origin, socioeconomic status, age, disability, and sex of the individuals exposed; and

(C) provides opportunities for early and meaningful involvement in the environmental review process by communities with environmental justice concerns potentially affected by a proposed action, including when establishing or revising agency procedures under NEPA;

(x) in accordance with Title VI of the Civil Rights Act of 1964, 42 U.S.C. 2000d, and agency regulations, ensure that all programs or activities receiving Federal financial assistance that potentially affect human health or the environment do not directly, or through contractual or other arrangements, use criteria, policies, practices, or methods of administration that discriminate on the basis of race, color, or national origin;

(xi) ensure that the public, including members of communities with environmental justice concerns, has adequate access to information on Federal activities, including planning, regulatory actions, implementation, permitting, compliance, and enforcement related to human health or the environment, when required under the Freedom of Information Act, 5 U.S.C. 552; the Government in the Sunshine Act, 5 U.S.C. 552b; the Clean Air Act, 42 U.S.C. 7401 *et seq.*; the Clean Water Act, 33 U.S.C. 1251 *et seq.*; the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), 42 U.S.C. 11001 *et seq.*; or other environmental statutes with public information provisions;

(xii) improve collaboration and communication with State, Tribal, territorial, and local governments on programs and activities to advance environmental justice;

(xiii) encourage and, to the extent permitted by law, ensure that Government-owned, contractor-operated facilities take appropriate steps to implement the directives of this order;

(xiv) consider ways to encourage and, as appropriate, ensure that recipients of Federal funds—including recipients of block grant funding—and entities subject to contractual, licensing, or other arrangements with Federal agencies advance environmental justice;

(xv) develop internal mechanisms to achieve the goals of this order, including by:

(A) creating performance metrics and other means of accountability;

(B) identifying and dedicating staff, funding, and other resources; and

(C) providing appropriate professional development and training of agency staff; and

(xvi) consistent with section 2–2 of Executive Order 12898, ensure that Federal activities do not have the effect of:

(A) excluding persons, including populations, from participation in Federal activities on the basis of their race, color, or national origin;

(B) denying persons, including populations, the benefits of Federal activities on the basis of their race, color, or national origin; or

(C) subjecting persons, including populations, to discrimination on the basis of their race, color, or national origin.

(b) The Administrator of the Environmental Protection Agency (EPA) shall:

(i) in carrying out responsibilities under section 309 of the Clean Air Act, 42 U.S.C. 7609, assess whether each agency analyzes and avoids or mitigates disproportionate human health and environmental effects on communities with environmental justice concerns; and

(ii) report annually to the Chair of the Council on Environmental Quality (CEQ) and the White House Environmental Justice Interagency Council (Interagency Council) described in section 7 of this order on EPA's Clean

Air Act section 309 reviews regarding communities with environmental justice concerns and provide recommendations on legislative, regulatory, or policy options to advance environmental justice in Federal decision-making.

(c) In carrying out assigned responsibilities under Executive Order 12250 of November 2, 1980 (Leadership and Coordination of Nondiscrimination Laws), the Attorney General shall assess agency efforts to ensure compliance with civil rights laws in programs and activities receiving Federal financial assistance that potentially affect human health or the environment and shall report annually based on publicly available information to the Chair of CEQ regarding any relevant pending or closed litigation.

Sec. 4. *Environmental Justice Strategic Plans*. (a) No later than 18 months after the date of this order and every 4 years thereafter, each agency shall submit to the Chair of CEQ and make available to the public online an Environmental Justice Strategic Plan.

(b) Each Environmental Justice Strategic Plan shall, based on guidance provided by the Chair of CEQ under section 9 of this order, set forth the agency's vision, goals, priority actions, and metrics to address and advance environmental justice and to fulfill the directives of this order, including through the identification of new staffing, policies, regulations, or guidance documents.

(c) Each Environmental Justice Strategic Plan shall also identify and address opportunities through regulations, policies, permits, or other means to improve accountability and compliance with any statute the agency administers that affects the health and environment of communities with environmental justice concerns. Such measures may include:

(i) increasing public reporting by regulated entities;

(ii) expanding use of pollution measurement and other environmental impact or compliance assessment tools such as fenceline monitoring;

(iii) improving the effectiveness of remedies to provide relief to individuals and communities with environmental justice concerns, such as remedies that penalize and deter violations and promote future compliance, including harm mitigation and corrective action; and

(iv) considering whether to remove exemptions or waivers that may undermine the achievement of human health or environmental standards.

(d) No later than 2 years after the submission of an Environmental Justice Strategic Plan, each agency shall submit to the Chair of CEQ, and make available to the public, an Environmental Justice Assessment that evaluates, based on guidance provided by the Chair of CEQ under section 9 of this order, the effectiveness of the agency's Environmental Justice Strategic Plan. The Environmental Justice Assessment shall include an evaluation of:

(i) the agency's progress in implementing its Environmental Justice Strategic Plan;

(ii) any barriers to implementing the agency's Environmental Justice Strategic Plan; and

(iii) steps taken to address any barriers identified.

(e) An agency's completion of an Environmental Justice Strategic Plan and Environmental Justice Assessment shall satisfy the requirements of section 1–103 of Executive Order 12898.

(f) The Environmental Justice Scorecard established under section 223(d) of Executive Order 14008 shall address agency progress toward achieving the goals outlined in this order and shall include, among other items, a section on agencies' Environmental Justice Strategic Plans and Environmental Justice Assessments.

(g) The Chair of CEQ may request additional periodic reports, information, or evaluations on environmental justice issues from agencies.

(h) Independent regulatory agencies are strongly encouraged to comply with the provisions of this order and to provide a notice to the Chair

of CEQ of their intention to do so. The Chair of CEQ shall make such notices publicly available and maintain a list online of such agencies.

Sec. 5. *Research, Data Collection, and Analysis to Advance Environmental Justice*. (a) To address the need for a coordinated Federal strategy to identify and address gaps in science, data, and research related to environmental justice, the Director of the Office of Science and Technology Policy (OSTP) shall establish an Environmental Justice Subcommittee of the National Science and Technology Council (Environmental Justice Subcommittee).

(i) The Director of OSTP, in consultation with the Chair of CEQ, shall designate at least two co-chairs of the Environmental Justice Subcommittee and may designate additional co-chairs as appropriate. The membership of the Subcommittee shall consist of representatives of agencies invited by the Director, in consultation with the Chair of CEQ.

(ii) The Environmental Justice Subcommittee and the Interagency Council described in section 7 of this order shall hold an annual summit on the connection of science, data, and research with policy and action on environmental justice.

(iii) The Environmental Justice Subcommittee shall prepare, and update biennially, an Environmental Justice Science, Data, and Research Plan (Research Plan) to:

(A) analyze any gaps and inadequacies in data collection and scientific research related to environmental justice, with a focus on gaps and inadequacies that may affect agencies' ability to advance environmental justice, including through the Environmental Justice Strategic Plans required under section 4 of this order;

(B) identify opportunities for agencies to coordinate with the research efforts of State, Tribal, territorial, and local governments; academic institutions; communities; the private sector; the non-profit sector; and other relevant actors to accelerate the development of data, research, and techniques—including consideration of Indigenous Knowledge—to address gaps and inadequacies in data collection and scientific research that may affect agencies' ability to advance environmental justice;

(C) provide recommendations to agencies on the development and use of science, data, and research to support environmental justice policy and the agency responsibilities outlined in section 3 of this order;

(D) provide recommendations to the Chair of CEQ on data sources to include in the Climate and Economic Justice Screening Tool established pursuant to section 222(a) of Executive Order 14008;

(E) provide recommendations to agencies on ethical standards, privacy protections, and other requirements for the development and use of science, data, and research addressed in the Research Plan, including recommendations with respect to engaging in consultation with and obtaining consent of Tribal Nations; and

(F) provide recommendations to agencies on:

(1) encouraging participatory science, such as research or data collection undertaken by communities or the public, and, as appropriate, integrating such science into agency decision-making processes;

(2) taking steps to ensure or encourage, as appropriate, that collections of data related to environmental justice include data from the Territories and possessions of the United States;

(3) improving the public accessibility of research and information produced or distributed by the Federal Government, including through the use of machine-readable formats, where appropriate;

(4) disaggregating environmental risk, exposure, and health data by race, national origin, income, socioeconomic status, age, sex, disability, and other readily accessible and appropriate categories;

(5) identifying and addressing data collection challenges related to patterns of historical or ongoing racial discrimination and bias;

(6) analyzing cumulative impacts (including risks) from multiple sources, pollutants or chemicals, and exposure pathways, and accounting for non-chemical stressors and current and anticipated climate change;

(7) in collaboration with Tribal Nations, as appropriate, collecting, maintaining, and analyzing information on consumption patterns of fish, wildlife, and plants related to subsistence and cultural practices of Tribal and Indigenous populations;

(8) providing opportunities for meaningful engagement for communities with environmental justice concerns on the development and design of data collection and research strategies relevant to those communities; and

(9) implementing sections 3–3 and 4–4 of Executive Order 12898 in an efficient and effective manner.

(b) Consistent with sections 3–3 and 4–4 of Executive Order 12898, each agency shall take appropriate steps, considering the recommendations of the Environmental Justice Subcommittee, to promote the development of research and data related to environmental justice, including enhancing the collection of data, supporting the creation of tools to improve the consideration of environmental justice in decision-making, providing analyses of cumulative impacts and risks, and promoting science needed to inform decisions that advance environmental justice.

(c) When conducting research and data collection in furtherance of the directives in this order and Executive Order 12898, agencies shall comply with applicable regulations and directives, including those related to standards of ethics for the protection of human subjects, such as those set forth in Executive Order 12975 of October 3, 1995 (Protection of Human Research Subjects and Creation of National Bioethics Advisory Commission), and the Presidential Memorandum of January 27, 2021 (Restoring Trust in Government Through Scientific Integrity and Evidence-Based Policymaking).

Sec. 6. *Community Notification on Toxic Chemical Releases*. To ensure that the public, including members of communities with environmental justice concerns, receives timely information about releases of toxic chemicals that may affect them and health and safety measures available to address such releases:

(a) Each agency shall report in accordance with sections 301 through 313 of EPCRA after considering applicable EPA guidance and without regard to the Standard Industrial Classification or North American Industry Classification System delineations.

(b) No later than 6 weeks following a release requiring notification by an agency under section 304(a) of EPCRA, the notifying agency shall hold a public meeting providing the information required under section 304(b)(2) of EPCRA, including information on the nature of the release, known or anticipated health risks, and the proper precautions to take as a result. The agency shall provide notice of a public meeting no later than 72 hours after a release.

(c) The Administrator of EPA shall evaluate available legal authorities and consider any additional steps it may require or encourage non-Federal facilities that report releases under EPCRA to undertake in connection with the report.

(d) The Administrator of EPA shall provide the Environmental Justice Subcommittee established by section 5 of this order with an annual report on trends in data in the Toxic Release Inventory established by section 313 of EPCRA to inform the development of the Research Plan required under section 5(a)(iii) of this order.

Sec. 7. *White House Environmental Justice Interagency Council*. (a) Section 1–102(b) of Executive Order 12898, as amended by section 220(a) of Executive Order 14008, and further amended by section 4(b) of Executive Order 14082, creating the White House Environmental Justice Interagency Council, is amended to read as follows:

''(b) Membership. The Interagency Council shall consist of the following additional members:

(i) the Secretary of State;

(ii) the Secretary of Defense;

(iii) the Attorney General;

(iv) the Secretary of the Interior;

(v) the Secretary of Agriculture;

(vi) the Secretary of Commerce;

(vii) the Secretary of Labor;

(viii) the Secretary of Health and Human Services;

(ix) the Secretary of Housing and Urban Development;

(x) the Secretary of Transportation;

(xi) the Secretary of Energy;

(xii) the Secretary of Veterans Affairs;

(xiii) the Secretary of Homeland Security;

(xiv) the Administrator of the Environmental Protection Agency;

(xv) the Director of the Office of Management and Budget;

(xvi) the Chair of the Council of Economic Advisers;

(xvii) the Administrator of General Services;

(xviii) the Executive Director of the Federal Permitting Improvement Steering Council;

(xix) the Director of the Office of Science and Technology Policy;

(xx) the Assistant to the President and National Climate Advisor;

(xxi) the Assistant to the President for Domestic Policy;

(xxii) the Assistant to the President for Economic Policy;

(xxiii) the Executive Director of the White House Gender Policy Council;

(xxiv) the Senior Advisor to the President for Clean Energy Innovation and Implementation; and

(xxv) other relevant agency heads as determined by the Chair of CEQ.''

(b) Section 1–102(d) of Executive Order 12898, as amended by section 220(a) of Executive Order 14008, is further amended by adding the following sentence at the end: ''The Interagency Council shall support and facilitate interagency collaboration on programs and activities related to environmental justice, including the development of materials for environmental justice training to build the capacity of Federal employees to advance environmental justice and to increase the meaningful participation of individuals from communities with environmental justice concerns in Federal activities.''

(c) Section 1–102(g) of Executive Order 12898, as amended by section 220(a) of Executive Order 14008, is amended to read as follows: ''Officers. The head of each agency on the Interagency Council shall designate an Environmental Justice Officer within the agency with the authority to represent the agency on the Interagency Council and with the responsibility for leading agency planning and implementation of the agency's Environmental Justice Strategic Plan, coordinating with CEQ and other agencies, and performing such other duties related to advancing environmental justice as the head of the agency deems appropriate.''

(d) Section 1–102 of Executive Order 12898, as amended by section 220(a) of Executive Order 14008, is further amended by adding the following at the end:

''(h) Memorandum of Understanding. The Interagency Council shall adopt a Memorandum of Understanding among its members that sets forth the objectives, structure, and planned operations of the Interagency Council.

(i) Public meetings. In coordination with the White House Environmental Justice Advisory Council, the Interagency Council shall hold at least one public meeting per year. The Interagency Council shall prepare, for public review, a summary of the comments and recommendations discussed at public meetings of the Interagency Council.

(j) Clearinghouse. The Administrator of EPA, in coordination with the Interagency Council, shall, no later than March 31, 2024, establish a public, internet-based, whole-of-government clearinghouse composed of culturally and linguistically appropriate and accessible materials related to environmental justice, including:

(i) information describing the activities of the members of the Interagency Council to address issues relating to environmental justice;

(ii) information on technical assistance, tools, and resources to assist communities with environmental justice concerns in building capacity for public participation;

(iii) copies of training materials developed by the Interagency Council or its members to help individuals and employees understand and carry out environmental justice activities; and

(iv) any other information deemed appropriate by the Administrator, in coordination with the Interagency Council.''

(e) Section 5–5(a) of Executive Order 12898 is amended to read as follows: ''The public may submit recommendations to Federal agencies relating to the incorporation of environmental justice principles into Federal agency programs or policies. Each Federal agency shall convey such recommendations to the Interagency Council.''

Sec. 8. *White House Office of Environmental Justice*. (a) The White House Office of Environmental Justice is hereby established within CEQ.

(b) The Office shall be headed by a Federal Chief Environmental Justice Officer, who shall be appointed by the President. The Federal Chief Environmental Justice Officer shall advance environmental justice initiatives, including by coordinating the development of policies, programs, and partnerships to achieve the policies set forth in this order; identifying opportunities for collaboration and coordination with State, Tribal, territorial, and local governments; supporting the Interagency Council; and advising the Chair of CEQ and the Interagency Council on environmental justice matters.

(c) The heads of all agencies shall cooperate with the Federal Chief Environmental Justice Officer and provide such information, support, and assistance as the Federal Chief Environmental Justice Officer may request, as appropriate.

Sec. 9. *Guidance*. Within 6 months of the date of this order, the Chair of CEQ shall issue interim guidance, in consultation with the Interagency Council, to inform agency implementation of this order, and shall request recommendations on the guidance from the White House Environmental Justice Advisory Council established by Executive Order 14008 (Advisory Council). To reduce redundancy and streamline reporting obligations, the interim guidance shall identify ways for agencies to align other related efforts, such as obligations that agencies may have under Executive Order 13985 and Executive Order 14008. Within 18 months of the date of this order, the Chair of CEQ shall issue final guidance after considering any recommendations of the Advisory Council. The Chair of CEQ may revise any guidance, or issue additional guidance under this order, as appropriate, and shall consider any additional recommendations made by the Advisory Council in issuing or revising guidance under this section.

Sec. 10. *Reports to the President*. Within 1 year of the date for the submission of agency Environmental Justice Strategic Plans to the Chair of CEQ under

section 4(a) of this order, the Chair shall, after consultation with the Interagency Council and after considering recommendations from the Advisory Council, submit to the President a report that describes the implementation of this order, includes each agency's Environmental Justice Strategic Plan, provides recommendations for additional steps to advance environmental justice, and, beginning with the second report, also provides any insights gathered from each agency's Environmental Justice Assessment required under section 4(d) of this order.

Sec. 11. *General Provisions*. (a) Nothing in this order shall be construed to impair or otherwise affect:

(i) the authority granted by law to an executive department or agency, or the head thereof; or

(ii) the functions of the Director of the Office of Management and Budget relating to budgetary, administrative, or legislative proposals.

(b) This order shall be implemented consistent with applicable law and subject to the availability of appropriations.

(c) This order is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.



THE WHITE HOUSE,
April 21, 2023.

[FR Doc. 2023–08955
Filed 4–25–23; 8:45 am]
Billing code 3395–F3–P

State of Utah
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER RIGHTS

Michael O. Leavitt
Governor
Ted Stewart
Executive Director
Robert L. Morgan
State Engineer

1636 West North Temple, Suite 220
Salt Lake City, UT 84116-3156
801-538-7240
801-538-7467 (Fax)

May 22, 1996

Melvin Whittaker
Corn Creek Irrigation Company
Kanosh, UT 84637

Re: Corn Creek/UT00322

A field inspection of the above-referenced dam was completed on May 16, 1996, with the following in attendance:

NAME	REPRESENTING
Terry Monroe	Division of Water Rights
Melvin Whittaker	Owner Representative
Charlie Hatton	Owner Representative

Based on our visual observation of the dam and appurtenant facilities, we have observed some items which need attention to ensure the satisfactory long-term operation of the facilities:

1. The large trees and vegetation in the southeast corner of the basin that could clog the outlet or spillway should be removed.

2. The embankment drains should be kept clear for unobstructed flow and should be equipped with rodent screens.

3. Continue to control all woody vegetation growing on the embankment.

Your cooperation is appreciated. If you have any questions, please feel free to contact Kirk Forbush at 1-801-896-4429.

Sincerely,

Robert L. Morgan

Robert L. Morgan, P.E.
State Engineer

RLM/tlm

pc: Kirk Forbush - Regional Engineer
Director - Millard County Emergency Services

GARY R. HERBERT
Governor
GREG BELL
Lieutenant Governor

State of Utah
DEPARTMENT OF NATURAL RESOURCES
MICHAEL R. STYLER
Executive Director
Division of Water Rights
KENT L. JONES
State Engineer/Division Director

June 9, 2010

Dean Perkins
Corn Creek Irrigation Company
Kanosh, UT 84637

Re: Corn Creek / UT00322

As you are aware, during high spring runoff a few weeks ago, several safety related concerns arose with Corn Creek Dam, as follows:

1. Stop logs were placed into the entrance of the spillway.
2. Reservoir water discharged from an unknown pipe at the downstream toe of the embankment where the dam alignment bends from a north-south direction to an east-west direction and is immediately adjacent to the canyon road.
3. Reservoir water was "bubbling up" across the canyon road to the north.
4. Apparent seepage from the reservoir was observed below the downstream toe of the dam in the maximum section.

Your efforts and cooperation with the Dam Safety Office to monitor and address these concerns are appreciated. We understand that flooding of Kanosh residents may occur if discharges from the dam are too high. In cooperation with this office, you opened the outlet to the maximum extent you could without causing downstream flooding. This additional discharge allowed the reservoir to be lowered. As the reservoir was drawn down the stop logs were removed from the spillway and the other observed safety concerns were significantly reduced and eventually eliminated.

We wish to remind you that the spillway was not designed to accommodate stop logs and these logs should not be placed in the structure. Excess reservoir storage results in greater downstream risk to the population in the event of a failure. We support providing better downstream protection by increasing discharge capacity in a way that will not result in flooding. Discussions have included increasing downstream canal capacity or directing flow through an additional channel to the north across the canyon road.

In accordance with Section 73-5a-503 of the Utah Code, the State Engineer directs the Corn Creek Irrigation Company, as the owner of the dam, to have engineering studies conducted that evaluate the safety concerns observed at the dam and outlined above. Recommendations must be provided to make repairs and/or modifications that will prevent these problems in the future. The outlet gate must be fully opened until these issues are resolved. All repairs and/or modifications must be coordinated with Dam Safety and approved by this office in advance of implementation.

1594 West North Temple, Suite 220, PO Box 146300, Salt Lake City, UT 84114-6300
telephone (801) 538-7240 • facsimile (801) 538-7467 • TTY (801) 538-7458 • *www.waterrights.utah.gov*

UTAH DNR WATER RIGHTS

Your efforts to address these safety related concerns at Corn Creek Dam are appreciated. If you have any questions or need further clarification, please contact me at 801-538-7376.

Sincerely,

David K. Marble, P.E.
Assistant State Engineer

DKM/jm

cc: Kirk Forbush – Regional Engineer
Mayor of Kanosh

GARY R. HERBERT
Governor
GREG BELL
Lieutenant Governor

State of Utah
DEPARTMENT OF NATURAL RESOURCES
Division of Water Rights

MICHAEL R. STYLER
Executive Director
KENT L. JONES
State Engineer/Division Director

May 23, 2011

DEAN PERKINS
CORN CREEK IRRIGATION COMPANY
KANOSH, UT 84637

DIVISION OF WATER RIGHTS - DAM SAFETY SECTION
DAM INSPECTION REPORT – 2011

Dam Name/Number:	Corn Creek/UT00322		
Date:	May 19, 2011	Hazard:	High
Storage Level:	2" below spillway	Dam Type:	Earthen
Spillway Flow:	0	Purpose of Inspection:	Annual
Outlet Flow:	70 cfs estimated	Weather:	Cool/rain

Representatives at the Inspection:

Name	*Representing*
Terry Monroe	Division of Water Rights
Dean Perkins	Corn Creek Irrigation Co.
Doug Perkins	Corn Creek Irrigation Co.
Richard Penny	Corn Creek Irrigation Co.

Item		Comments:
		We understand that flooding of Kanosh residents may occur if discharges from the dam are too high. However, in light of the seepage concerns with this dam, every effort should be made to maximize the discharge from the dam in order to lower the reservior level.

Item		Necessary Maintenance and Repair:
1	c	Repair the small scarp/landslide located north of the spillway and above the regulating pond by excavating the toe and recompacting to its original profile.
1	c	Continue efforts to control woody vegetation on the embankment.
5	d	All outlet controls should be lubricated and exercised on a regular basis.

Item		Immediate Action Required:
2	d	Apparent seepage from the reservior was observed below the downstream toe of the dam in the maximum section. A concentrated flow of approximately 2-3 gpm was observed and the water appeared cloudy with sediment. The flow was sufficent to show evident discoloring of the water that has ponded below the toe. The source of the water is not clearly evident, but this situation is extremely serious and merits your full attention. In discusions on the dam site, Richard Penny stated that the dam is being observed every two hours. This should continue until the reservior has been vacated. Dave Marble requested that a daily report be phoned into him to keep Dam Safety apprised of what is occurring.

EAP Review (High and Moderate Hazard only):	Yes	No
1. Call list is up to date. (Names, phone numbers, etc)	☐	☐
2. Copies of the EAP are distributed to the appropriate agencies/people	☐	☐
3. Inundation map is included and legible	☐	☐
4. Other comments: Not reviewed.		

1. Embankment	N/A	Not Inspected	Inundated	Good	Monitor	Maintenance	Critical
a. Crest	---	---	☐	☒	☐	☐	☐
b. U/S Slope	---	---	☒	☐	☐	☐	☐
c. D/S Slope	---	---	☐	☐	☐	☒	☐
d. Groins	---	---	☐	☒	☐	☐	☐

2. Abutment/ Foundation	N/A	Not Inspected	Inundated	Good	Monitor	Maintenance	Critical
a. Left Abutment	---	---	☐	☒	☐	☐	☐
b. Right Abutment	---	---	☐	☒	☐	☐	☐
c. U/S Toe	---	---	☒	☐	☐	☐	☐
d. D/S Toe	---	---	☐	☐	☐	☐	☒

3. Reservoir Basin	N/A	Not Inspected	Inundated	Good	Monitor	Maintenance	Critical
a. Shore Stability	---	☐	☐	☒	☐	☐	☐
b. Reservoir Bottom	---	☐	☒	☐	☐	☐	☐

4. Spillway	N/A	Not Inspected	Inundated	Good	Monitor	Maintenance	Critical
a. Freeboard	☐	---	☐	☒	☐	☐	☐
b. Intake	☐	---	☐	☒	☐	☐	☐
c. Concrete Structures	☐	---	☐	☒	☐	☐	☐
d. Stilling Basin	☐	---	☐	☒	☐	☐	☐
e. Outfall Channel	☐	---	☐	☒	☐	☐	☐

5. Outlet	N/A	Not Inspected	Inundated	Good	Monitor	Maintenance	Critical
a. Conduit	☐	☒	☐	☐	☐	☐	☐
b. Intake	☐	---	☒	☐	☐	☐	☐
c. Stilling Basin	☐	---	☐	☒	☐	☐	☐
d. Discharge Channel	☐	---	☐	☒	☐	☐	☐
e. Controls	☐	---	☐	☐	☐	☒	☐
f. Venting	☒	---	☐	☐	☐	☐	☐

6. Instrumentation	N/A	Not Inspected	Inundated	Good	Monitor	Maintenance	Critical
a. Monuments	☒	---	☐	☐	☐	☐	☐
b. Staff Gage	☒	---	☐	☐	☐	☐	☐
c. Piezometers	☒	---	☐	☐	☐	☐	☐
d. Drains	☐	---	☐	☒	☐	☐	☐
e. Other	☒	---	☐	☐	☐	☐	☐

Your cooperation is appreciated. If you have any questions, please feel free to contact Kirk Forbush at (435) 896-4429.

Sincerely,

David K. Marble, P.E.
Assistant State Engineer

DKM/jm

pc: Kirk Forbush - Water Rights Regional Engineer
Director Millard County Emergency Services

SPENCER J. COX
Governor
DEIDRE M. HENDERSON
Lieutenant Governor

State of Utah

DEPARTMENT OF NATURAL RESOURCES
Division of Water Rights

JOEL FERRY
Executive Director

TERESA WILHELMSEN
State Engineer/Division Director

April 28, 2023

BRANDON GEORGE, PRESIDENT
CORN CREEK IRRIGATION COMPANY
P.O. BOX 51
KANOSH, UT 84637

UT DIVISION OF WATER RIGHTS – DAM SAFETY SECTION

DAM INSPECTION REPORT – 2023

Dam Name / Number	**Corn Creek / UT00322**		
Inspection Date	April 27, 2023	**Hazard rating**	High
Weather	Sunny, 69°	**Rating is appropriate?**	Yes
Reservoir Level, ft	At outlet elevation	**SOP is current?***	No
Date of last outlet insp.	Unknown	**EAP is current?***	No
Spillway Flow, cfs	0	**EAP is distributed?***	No

*Based on conversation with the Owner's representative.

Representatives at the Inspection:

Name	Representing
Stan Koyle, Loren Schumway, Hayden George	Corn Creek Irrigation Company
Shane Brunson	Millard County Sherriff's Office
Collin Pace	Division of Water Rights Regional Office
Chuck Williamson	Division of Water Rights, Dam Safety

Checklist Item	Necessary Action, Maintenance and/or Repair:
1 - 6, 8	Remove all sagebrush and other woody vegetation from the dam embankment. Monitor the dam for rodent activity. When encountered exterminate and completely backfill burrows.
7	Remove willow from the upstream toe of the dam.
10	Remove woody vegetation from the reservoir basin. Fill the abandoned culinary line that connects the reservoir basin to the downstream toe near the north corner with grout.
12	Remove willow from the spillway intake.
15	Remove woody vegetation and obstructions from the spillway channel.
16	Exercise outlet controls at least annually.

18	Monitor the outlet intake for woody debris accumulation and remove as necessary.
20, 21	Remove willow from the discharge channel and outlet stilling basin.
25	Install rodent screens on all toe drains.

Checklist Item	Comments:
EAP/SOP	Please review your Emergency Action Plan (EAP)/Standard Operating Plan (SOP) and update as necessary. Copies of the EAP and SOP should be distributed to this office and appropriate agencies.
	We understand that Brandon George is the new president of the irrigation company. Dam Safety records have been updated to reflect this change.

Embankment	N/A	Not Inspected	Inundated	Good	Monitor	Maintenance	Critical
1. Crest	---	☐	☐	☐	☐	☒	☐
2. Upstream Slope	---	☐	☐	☐	☐	☒	☐
3. Downstream Slope	---	☐	☐	☐	☐	☒	☐
4. Groins	---	☐	☐	☐	☐	☒	☐

Abutment/Foundation	N/A	Not Inspected	Inundated	Good	Monitor	Maintenance	Critical
5. Left Abutment	---	☐	☐	☐	☐	☒	☐
6. Right Abutment	---	☐	☐	☐	☐	☒	☐
7. Upstream Toe	---	☐	☐	☐	☐	☒	☐
8. Downstream Toe	---	☐	☐	☐	☐	☒	☐

Reservoir Basin	N/A	Not Inspected	Inundated	Good	Monitor	Maintenance	Critical
9. Shore Stability	---	☐	☐	☒	☐	☐	☐
10. Reservoir Basin	---	☐	☐	☐	☐	☒	☐

Spillway	N/A	Not Inspected	Inundated	Good	Monitor	Maintenance	Critical
11. Freeboard	☐	☐	☐	☒	☐	☐	☐
12. Intake	☐	☐	☐	☐	☐	☒	☐
13. Concrete Structures	☐	☐	☐	☒	☐	☐	☐
14. Stilling Basin	☒	☐	☐	☐	☐	☐	☐
15. Discharge Channel	☐	☐	☐	☐	☐	☒	☐

Outlet	N/A	Not Inspected	Inundated	Good	Monitor	Maintenance	Critical
16. Controls	☐	☐	☐	☐	☒	☐	☐
17. Venting	☒	☐	☐	☐	☐	☐	☐
18. Intake	☐	☐	☐	☐	☒	☐	☐
19. Conduit	☐	☒	☐	☐	☐	☐	☐
20. Stilling Basin	☐	☐	☐	☐	☐	☒	☐
21. Discharge Channel	☐	☐	☐	☐	☐	☒	☐

Instrumentation	N/A	Not Inspected	Inundated	Good	Monitor	Maintenance	Critical
22. Monuments	☒	☐	☐	☐	☐	☐	☐
23. Staff Gage	☒	☐	☐	☐	☐	☐	☐
24. Piezometers	☒	☐	☐	☐	☐	☐	☐
25. Drains	☐	☐	☐	☐	☐	☒	☐
26. Other	☒	☐	☐	☐	☐	☐	☐
27. Readings	☒	Received	Yes ☐	No ☐	Reviewed	Yes ☐	No ☐

Photo #1



Caption: Rodent burrows near dam crest.

Photo #2



Caption: Willow growth in spillway intake.

Photo #3



Caption: Trees growing in reservoir basin.

Photo #4



Caption: Willow growth in outlet discharge channel.

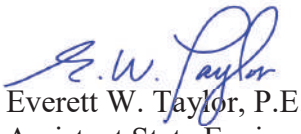
This report presents the results of an engineering evaluation of the dam and appurtenant structures based on visual observations and discussions with the Owner's representative at the time of the inspection. The status and performance of the dam may vary with time and changing conditions.

This inspection does not relieve the Owner/Operator of the legal duties, obligations, or liabilities incident to ownership and operation of the dam and reservoir.

This inspection does not include an assessment of site safety related to facility personnel and public access.

Your cooperation is appreciated. If you have any questions, please feel free to contact Chuck Williamson at (801) 538-7404.

Sincerely,



Everett W. Taylor, P.E.
Assistant State Engineer

EWT/tg

pc: Terry Monroe - Water Rights Regional Engineer, terrymonroe@utah.gov
Shane Brunson Emergency Manager Millard County Sheriff`s Office, SBrunson@co.millard.ut.us
brandongeorge@ipsc.com

The Millard County Progress

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USPS 4467-4000 Fillmore, Utah 84631 Volume 90, Number 19 — Friday, May 11, 1984

Kanosh Dam Breaks



A large gap in the Kanosh Dam was left after reservoir water undermining it had been seeping through the spillway wing wall for a couple of weeks and finally collapsed this portion of the dam.



Water rushes through break in Kanosh Dam as it head toward town.



Concrete spillway with walkway at the top is still intact, but washed away and cocked at an angle and is now useless. Break in dam is the vacant area just to the right of the spillway.



Street at the south end of town was breached and canal widened to keep water from flowing north down Main Street.



Water washes across road leading to the dam inundating these corrals and threatening to wash out the road.



Floodwaters swirl around this house located on the road leading to the broken dam.

Kanosh residents were keeping a wary eye on runoff-swollen Corn Creek Saturday, after fighting throughout the night Friday to protect their town from flood waters released when an earthen dam broke at 7 p.m.

The sheriff's department, Sheriff's Posse, state and county road crews, the Utah Highway Patrol, Forest Service and Bureau of Land Management crews, along with Kanosh citizens and volunteers from nearby towns, turned out in force to fight the oncoming flood waters.

Their efforts paid off, and the town escaped with only some flooding of yards and streets and water in the basements of about half a dozen homes.

But one of the two roads leading to and from the small town of 450 people was breached to divert the main force of the water to keep it from running down Main Street.

Workers toiled through the night to keep the road at the north end of town open after the raging creek undermined one lane. It is now the town's only link to the outside.

Officials were worried Saturday about more of the earthen dam giving way, and also about the rising waters of Corn Creek, fed by increasing snowmelt in Saturday's warm weather.

The stream now flows through the middle of the earthen dam where 50 to 75 feet of dirt was washed away from around the spillway in the center.

The concrete spillway itself was loosened and knocked out of line, and while it was not broken, it is useless.

Sheriff Ed Phillips said there was no wall of water as the earthen dam collapsed, but more a gradual buildup of water until about three feet of water was spreading over the adjacent area.

"It looked as if it were happening in slow motion" he said. A rough estimate of damage to farm fields, irrigation systems and homes is several hundred thousand dollars, but much more work is needed before an accurate assessment can be made.

The dam was built to catch debris, and the water behind it spread out probably a half mile wide. When the dam broke, the water sent tons of mud and debris down a half-mile-wide swath toward town.

One resident who saw the three-foot-high wall of water rolling down the street described it as looking in the dark like a huge brown animal coming down the road.

Fillmore contractor DeLyle Carling and soil conservationist Cloyd Day were at the dam site to check on its stability Friday when the dam gave way. They called in the alarm.

The sheriff, who was recently appointed director of Millard County civil defense, said much property damage had been averted by efforts that have been continuing since a leak was discovered on April 16. The county sent several pieces of heavy equipment to the area at that time, and operators have been working to clean out the silt and debris building up behind the dam, and to deepen channels diverting the runoff water from town.

"The citizens of Kanosh are to be commended," Phillips said. "As soon as the dam broke, people swung into action. Dozens of pieces of their own equipment were put into use digging. With a little bit of luck and hard work, they averted a lot of damage." Wherever anything was endangered, people dug ditches to divert the water.

Sandbags had been filled and stockpiled in anticipation of the dam's collapse, but many volunteers turned out Friday evening to fill more sandbags and worked late into the night. Four or five inches of water ran through Kanosh streets before the roadway at the south end of town could be breached.

Channels directing the creek water around each end of town kept the community from getting the brunt of the flood, but considerable road damage resulted all over.

When the raging creek undermined one lane of the two-lane road at the north end of town, a backhoe operator worked feverishly to dig a diversion to rechannel part of the water to the road's borrow pit.

Local farmers brought in truckloads of straw to help deter the water from running across the road, while road crews dumped dirt and rocks to build up a wall between the creek and the road.

After the main force of the water had passed Kanosh, it headed toward the two farming communities of Hatton, west of Kanosh and then on toward I-15. The Highway Patrol stationed personnel at points on I-15 where the water was expected to hit, but it had lost much of its impact by the time it had reached that far and caused no damage to the highway. But a patrolman monitored I-15 throughout the night. Hatton received about 15 inches of water in places, but no damage was reported.

Continued to Page 2

Weather Report

By Jay T. Rogers

APRIL	HIGH	LOW	PRECIP	SNOW
27	44	24	10	3"
28	52	24		
29	58	28		
30	62	35		

We had 4.03 precip. for April, average is 1.89.

MAY				
1	59	40	16	
2	61	43	37	
3	68	39		

American Legion Meeting

Thurs., June 7, 1984 at 8 p.m.

Hartman pleads guilty

Kyle Dallas Hartman, 34, of Deseret, who was arrested for the Feb. 3, 1984 rape and assault of a Delta woman, pleaded "guilty and mental illness" to a charge of aggravated sexual assault in Judge David Sam's Fourth District Court in Fillmore on Monday. Hartman's guilty plea was the result of plea bargaining in which three other counts against him were dropped. He had also been charged with rape, kidnapping, and forcible sodomy in addition to the aggravated sexual assault charge to which he admitted his guilt.

Prosecuting Attorney Dexter Anderson explained to Judge Sam that since all the charge stemmed from a single incident, he agreed to dropping the other charges in return for the guilty plea. He assured the judge that the victim and the Sheriff's Department -- in particular Sheriff Ed Phillips and Detective Robert Dekker, the investigating officer in the case -- agreed with the plea bargain.

Judge Sam questioned Mr. Hartman about whether his Defense Attorney, Eldon Eliason of Delta, had appraised him of the full implication of a guilty plea to that charge. The judge also made sure that Mr. Hartman understood that, even though he claimed mental illness and even if examining psychiatrists agreed with his claim, he could still be sentenced to prison for a term from five years to life. The judge then accepted Mr. Hartman's guilty plea.

Hartman was remanded to the sheriff's custody to be transported to the Utah State Hospital in Provo for an evaluation to determine his sanity. Judge Sam set Hartman's evaluation hearing at 9:30 a.m. on May 31, 1984 in his courtroom in Provo.

Holden man arrested on sex charge

Collie P. Robison, Jr., 28, of Holden was arrested Sunday, May 6, 1984, and charged with the aggravated rape, kidnapping, and sodomy of a 14 year old girl. Sheriff's Detective Robert Dekker said the incident was reported to police at 6:45 a.m. Sunday morning and occurred sometime between 2 a.m. and the time it was reported.

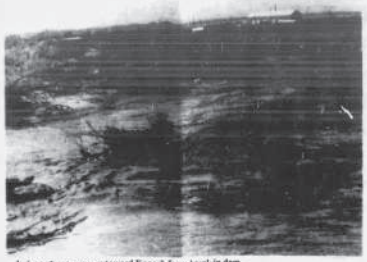
Dekker said the suspect reportedly took the girl from the Fillmore area to a point west of Flowell where the claimed assault was alleged to have taken place. Robison was arrested later that day in Orem.

Bail was set at $150,000 by Judge Ronald Hare in J.P. Court on the day of Robison's arrest. Arraignment was held at 2 p.m. Monday in J.P. Court where Judge Hare released the suspect on his own recognizance after assurance from his mother that he would appear in court.

At the arraignment Milo Harmon of Nephi, who is on contract with Millard County as public defender, was appointed as Mr. Robison's attorney. A Preliminary Hearing date will be set on Thursday Judge Hare said.



Area in front of broken dam (center of photo) was inundated.



A river of water surges toward Kanosh from break in dam.



Only one lane of traffic is left on which to enter or leave town. The floodwaters ate away half the road north of Kanosh Friday night before workmen could divert some of the water to the road's ditch.



Culvert on road at south end of town could not carry all the water and was removed so channel could be widened to prevent flooding of Kanosh streets and homes.



Three metal and one concrete culverts under road north of town are full even though some of the water was diverted to the roadway's ditch on the other side.



Workmen survey area of dam still endangered. Earth from the dam was breaking off into the raging creek below as it pounded at the dam at a point where it makes a curve before heading for the opening it tore in the dam on Friday.

Kanosh Dam Breaks

Continued from Front Page

Kanosh was without telephone service for about two hours Friday night as two or three telephone poles were washed out during the height of the flood.

The town's culinary water was not affected.

"About a half dozen basements in Kanosh were flooded with water, varying from a few inches to three feet," the sheriff said.

Sheriff's dispatcher Jody Mitchell said water pouring through the dam continued to overwhelm Corn Creek channel and irrigation ditches. She said crews were working to contain the water by stacking sandbags along stream banks.

She said the shallow flow of water continued onto farm fields and into residential areas but was doing little more damage.

The runoff, however, was pushing toward I-15 several miles away, where it was at the level of the roadbed Saturday afternoon, said Highway Patrol Dispatcher Ruth Mitchell.

"If the water keeps rising, we will have a problem," she said.

Runoff already forced the Department of Transportation to close an interchange at Kanosh, she said. Crews were hauling in sandbags, rocks and fill in anticipation of water seeping over the interstate late Saturday, Ms. Mitchell said.

Sheriff's Posse members were on duty at road checkpoints from the time the dam broke until Sunday, allowing only townspeople and officials into the area. Sightseers were turned away.

A portion of the dam, about 100 feet from the break, was in danger of giving way on Saturday. The creek is pounding at that area, where the creek makes a turn, and several tons of earth had fallen into the creek as it ate away at the wall of the dam. Workmen hauled in truckloads of dirt and rock fill and dumped it where the dam had been eaten away to replace it as soon as it crumbled in from of them. They kept ahead of the creek, but feared it could go out at any time.

"If this section here give way," Melvin Whitaker said on Saturday, "we won't have control of the water going down through town. If we can keep the water going through the division (break in the dam), then we can keep the water in the channels, but if it goes through here (the endangered part of the dam) there's no place for it to go but right directly into town." Orval Kimball agreed. He said, "We cannot dam that stream of water off. It'll shoot right over everything, right through town." And Corn Creek is growing each day as the snow melts to feed its rushing waters.

By Monday, workmen had everything pretty well under control. The area of the dam that was causing concern on Saturday has been shored up and appears stable at the present time. They are still deepening, widening, and clearing debris from channels and repairing diversion points that were washed away in the flood. Truckloads of dirt are being hauled further up the canyon to protect the town's culinary water supply which is being threatened by the swollen creek.

Engineers say the dam cannot be repaired and will have to be replaced. The cost to replace the dam has been estimated at half a million dollars.

Mayor Frank Harding and the Kanosh Town Council asked on Monday that the area be declared a disaster in order to open the way for requesting federal funds to aid in the needed repair work. The County Commission, at their meeting on Tuesday, went a step further and declared that the entire county was in a "disaster emergency situation." They said since each town in the county is in a potential flood situation that the declaration should be made now. Volunteers have been filling sandbags this past week in Fillmore and currently Highway I-15 is being threatened at a point between Meadow and Kanosh. The Shingle Mill water shed at the present time contains 1,028 percent of normal moisture and Pine Creek is at 300 percent of last year.

The escaping water from the Kanosh Dam is now creating a lake near the cinder beds between Kanosh and Flowell.



Corn Creek behind the dam (right side of photo) makes a curve at this point. Area of dam on the far right side of photo was caving off into the creek threatening that portion of the dam. Break in dam can be discerned at top right of photo.



Workmen rush to dump dirt and rock into area of dam that was breaking off. Water at the center-right of photo is coming from break in dam.

Fillmore City Council minutes

The following are the minutes of the Fillmore City Council meeting held Tuesday, April 10, 1984, in the Fillmore City Building at 7:30 p.m.

Those present: Doris Rasmussen, Mayor; Dallin S. Nielsen, Terry O. Scottorn, Jer'E Brinkerhoff, Dr. Brent D. Jackson, Freeman Rowley, Council; Carol C. Wise, Recorder; and Dwight F. Day, Administrator.

The purpose of the meeting was to develop a 1984-85 budget. Expenditures in the general fund were discussed in detail. Department budgets were tentatively set. Utility budgets were discussed briefly.

The procedure used in handling delinquent utility accounts was reviewed. There was no indication that the Council wished to change the procedures.

Meeting adjourned at 11:30 p.m.

The following are the minutes of the regular meeting held Tuesday, April 17, 1984, at 7:30 p.m. in the Fillmore City Building.

Those present for the meeting were: Doris Rasmussen, Mayor; Dallin S. Nielsen, Terry O. Scottorn, Jer'E Brinkerhoff, Dr. Brent D. Jackson, Freeman Rowley, Council; Carol C. Wise, Recorder; Dwight F. Day, Administrator.

A public hearing for taking comments concerning the proposed picnic shelter to be constructed at North Park with a Community Development Block grant had been advertised. No one was present for the purpose of commenting on the project.

Mrs. Carolyn McNeil, General Manger of I.C.P.A. and UAMPS presented a video taped progress report on construction at the IPP Plant. She then presented a check from UAMPS for $45,875.00 which represents savings in power costs over the past quarter. Mrs. McNeil requested that the City designate a representative to serve on a political action committee and proposed that the City pass a resolution endorsing the formation of the Utah Public PowerPac and encourage city officials and administrative and executive employees to support the Pac.

Councilman Scottorn suggested that a news article be prepared informing the public of the UAMPS refund checks and administrator Day's contribution to the management of UAMPS as member of the executive board.

Councilman Scottorn also requested that a memo be sent to all City employees warning them against the use of City equipment for private use.

The Council agreed that Councilman Scottorn should meet with Millard County and work out an agreement for County help with road work this summer. It was also agreed that two persons be hired right away to work on streets.

Mr. Alden Robinson from Sunrise Engineering made a presentation on the proposed hydro-power plant which would handle five to 10 percent of the City's power needs. He recommended that the City proceed with the application for license.

The following members of the library board were present: Messrs. Nord Brockbank and Roy Olpin, Mrs. Gwen Hunter, Mrs. Tafta Watson and Mrs. Sharon Olpin. Mrs. Tafta Watson, President of the Library Board and Mrs. Olpin reviewed floor plans for the new library pointing out functional areas included in the new facility. After considerable discussion concerning the best way to proceed with the project, motion by Councilman Brinkerhoff that the City authorize the Library Board to recommend an architect and have prepared a contract for services to bring the project to bidding stage, the contract to be presented to the Council for approval. Motion was seconded by Councilman Nielsen. Carried unanimously.

The Council agreed to begin selection of Cable TV companies who may be interested in a franchise in the City.

Councilman Scottorn reported that the Planning Commission has approved the annexation of eight acres for the LDS church on 500 South and about 300 East. Motion by Councilman Scottorn that public hearing on this annexation be set for June 5. Motion was seconded by Councilman Jackson. Carried unanimously.

The traffic control on the corner of 200 North and 200 West was discussed. Crosswalks and two stop signs will be installed as soon as possible.

Council approved the purchase of a used trailer for transporting lawn mowers for $400.00. Motion by Councilman Nielsen and seconded by Councilman Scottorn. Carried unanimously (Councilman Jackson was excused for balance of meeting).

It was agreed to set a date for filling sandbags for Monday, April 23. The bags will be stockpiled for the expected spring run-off.

Bills numbered 3562 through 3590 and 3338 through 3351 which total $24,561.56 with the exception of check no. 3581 to Sunrise Engineering. Motion by Councilman Rowley and seconded by Councilman Brinkerhoff. Carried unanimously.

Motion by Councilman Scottorn and seconded by Councilman Nielsen approved the minutes of the previous regular meeting. Carried unanimously.

Meeting adjourned at 12:10 a.m.

Fillmore City Planning Commission minutes

The following are the minutes of the Fillmore City Planning Commission meeting held Wednesday, April 11, 1984, at the Fillmore City Building.

Those present were: Jerry Warner, Chairman; Harold Anderson; Dorothy Beckham; Robert Hare; Robert Frampton; Barbara Reese; Terry Scottorn; Nord Brockbank; Carolyn Rowley, Secretary; Pat Iverson - excused; Val Kofoed and Laurie Kofoed, visitors.

The meeting was called to order at 7:56 p.m. and Jerry Warner-Chairman conducted the meeting. Approval of March 14, 1984 minutes were read and motioned to be approved by Terry Scottorn, seconded by Robert Hare. Vote unanimous. Minutes of October 26, 1983 were read and approved; motion to be approved by Robert Hare, seconded by Harold Anderson, Vote unanimous.

First order of business is for a request for possible placement of City Streets by Val Kofoed. He is considering to purchase the S.W. corner of Swallow's ground at the east end of 1st North street to build a home on, and in doing so would block the extension of 1st North on the current block system. Val wanted to know how the Planning Commission felt about putting a jog in the city roads. He brought a plat map to show the council where he is talking about. It was suggested he not the problems he may run into and take the recommendation the the city council. Also suggested he check with the county recorder to find out if the Swallows own the ground the street would be built on. There are now seen objections. City will want to see a drawn out plat map of the proposal.

Next item of business is for the Annexation for the 1st-4th ward chapel. The map shown was designated Plat "J." Need to find out the status of the street and to review clarifications of North boundary. Terry Scottorn moved to approve the annexation, seconded by Harold Anderson. Vote unanimous. Motion carried.

Also discussed was the Annexation proposal of Ron Branson's denial due to the Moratorium on Fillmore's water.

Meeting adjourned at 8:46 p.m.

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The Progress



KANOSH BAND

Comprehensive Economic Development Strategy

Kanosh Band of Paiute Indians

The Kanosh Band controls and operates their businesses and economic development ventures, including the control and administration of this CEDS. The PITU is available to support the Band as requested.

Prepared August 2022 for:

Kanosh Band of Paiute Indians
P.O. Box 116
Kanosh, Utah 84637

Kanosh Band of Paiute Indians

Prepared by:

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ACKNOWLEDGEMENTS
KANOSH BAND

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Cameron Echo Hawk, Economic Development Representative

Paiute Indian Tribe of Utah:
Corrina Bow, Tribal Chairwoman
Shane Parashonts, Tribal Administrator
Tyler Prisbrey, Chief Financial Officer
Rebecca Hill, Executive Assistant
Megan Johnson, IT Multimedia and Communications Specialist

Cedar Band:
Delice Tom, Band Chairwoman
Paul Terry, Economic Development Representative

Indian Peaks Band:
Tamra Borchardt-Slayton, Band Chairwoman

Koosharem Band:
Toni Kanosh, Band Chairwoman

Shivwits Band:
Hope Silvas, Band Chairwoman
Cameron Echo Hawk, Economic Development Representative
Tina Gonzalez, Economic Development Representative

Technical support:
Amy Wilson, SEE Renewal, LLC

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INTRODUCTION
KANOSH BAND

Purpose of the CEDS

The primary purpose of this Comprehensive Economic Development Strategy (CEDS) is to update the 2000 CEDS for the Kanosh Band of Paiutes.

Scope of the CEDS

The Kanosh Band CEDS encompasses Band lands and considers all human activity within the Band's service area that generates income for the Band including labor, capital, and enterprises. The CEDS evaluates current economic conditions and reflects on the past by considering progress made towards the goals in the 2000 CEDS. The CEDS creates a cohesive framework for decision-making and will contribute to long-term community, land, and energy planning.

Determination of Need

The Band desires to utilize technical assistance, and other resources available to the Band to assist in planning for, initiating, and deploying a broad range of economic planning and implementation projects in the years to come. To that end, we agree that partnership planning opportunities made available to tribes under the U.S. Economic Development Administration (EDA) and through this CEDS document will serve as a valuable tool in addressing the unique needs of the Kanosh Band.

Term

Pursuant to 13 C.F.R. § 303.6(b)(3)(ii), the EDA is requesting this CEDS to be updated or revised by 09/30/2025 to uniformly match other regional plan renewal dates.

Authority

The CEDS is a Band policy document based on the Band's vision for the economy and corresponding resources in the years to come. The CEDS is designed to set the framework for short-term economic management actions by providing a clear direction to Band leaders and staff. The methodology used for the development of this plan is consistent with 13 C.F.R. § 303.7, and the Public Works and Economic Development Act of 1965, as amended (42 U.S.C. § 3121 et seq.).

Benefits of the CEDS

Aside from meeting certain eligibility requirements for funding under the EDA, the CEDS lays the groundwork for continuing economic development planning processes aimed at growing existing relationships important to the Band's economy. The CEDS also serves as the primary mechanism for seeking out and creating new Band, regional, and private economic and community partnerships for mutual benefit.

Other benefits of the CEDS include:

- ⇒ Helps to build on the strengths of the region, as well as to identify gaps in resources or expertise that need to be addressed.
- ⇒ Facilitates regional collaboration needed to expand supply chains and grow and support new industry clusters.
- ⇒ Helps to attract federal funds and technical assistance by demonstrating resources are used efficiently and effectively.
- ⇒ Will make the Band and surrounding region more resilient and better positioned to plan for, respond to, and recover from natural disasters and economic shocks.
- ⇒ Serves as a call to action for economic development.

CEDS Strategy Committee

The PITU Strategy Committee supported the development, implementation, and revision or replacement of the CEDS for the Kanosh Band.

Paiute Indian Tribe of Utah:
Name: Shane Parashonts
Email: sparashonts@pitu.gov

Cedar Band:
Name: Paul Terry, Economic Development Representative
Email: pterry@cedarbandcorp.com

INTRODUCTION
KANOSH BAND

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Name: Tamra Borchardt-Slayton, Band Chairwoman
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Kanosh Band:
Name: Darlene Arrum, Band Chairwoman
Email: kanosh@utahpaiutes.org

Cameron Echo Hawk, Economic Development Representative

Koosharem Band:
Name: Toni Kanosh, Band Chairwoman
Email: koosharem@utahpaiutes.org

Shivwits Band:
Name: Hope Silvas, Band Chairwoman

Name: Cameron Echo Hawk, Economic Development Representative
Email: cechohawk@shivwitsbc.com

Name: Tina Gonzales, Economic Development Representative
Email: tm12gonzales@gmail.com

The above committee members represent the main economic interests of the Tribe and have the capacity to undertake and implement an effective planning process. Prior to submitting this document to the EDA, the PITU provided the public, appropriate governments, and pertinent interest groups in the region with adequate notice of and opportunity to comment on the CEDS for a period of thirty (30) days.

INTRODUCTION
KANOSH BAND

Organization

In accordance C.F.R. § 303.7(b), the CEDS includes the following components:

- ⇒ Summary of current social and economic conditions in the planning area.
- ⇒ In-depth analysis of economic and community development strengths, weaknesses, opportunities, and threats (commonly known as a "SWOT" analysis).
- ⇒ Economic development strategy that looks toward a more resilient future and is consistent with applicable local and state strategies.
- ⇒ Performance measures used to evaluate the Band's development and implementation of the CEDS.

CEDS Implementation and Review

The CEDS Strategy Committee is responsible for meeting the report and update provisions under 13 C.F.R. § 303.6(b)(3) and for implementing and reviewing the CEDS in accordance with the performance measures outlined in this CEDS.

BAND LANDS
KANOSH BAND

Kanosh Band; (kawnaw'os, willow jug)

The Kanos Band members are descendants of Paiute people who traditionally lived in Central and Southwest Utah, Northern Nevada, Southwestern California, and Northern Arizona. These ancestral lands were home to thousands of Paiute people. Like other tribes, the Paiutes were subject to ungratified treaties, forceful removal and consolidation, unfilled promises, and mistreatment.

The Kanosh Band was first recognized by the U.S. Federal Government in 1929. In 1954, the United States Congress, without the agreement or authority of the Shivwits Band, passed the Termination Act thereby discontinuing federal recognition and services to the Band. The Kanosh Band's federal recognition was later restored by Congress in 1980 by the Paiute Restoration Act, Public Law 96-277. "The Federal trust relationship is…restored or confirmed as to the Kanosh Band of Paiute Indian of Utah." 94 Stat. 317, Section 3(a).

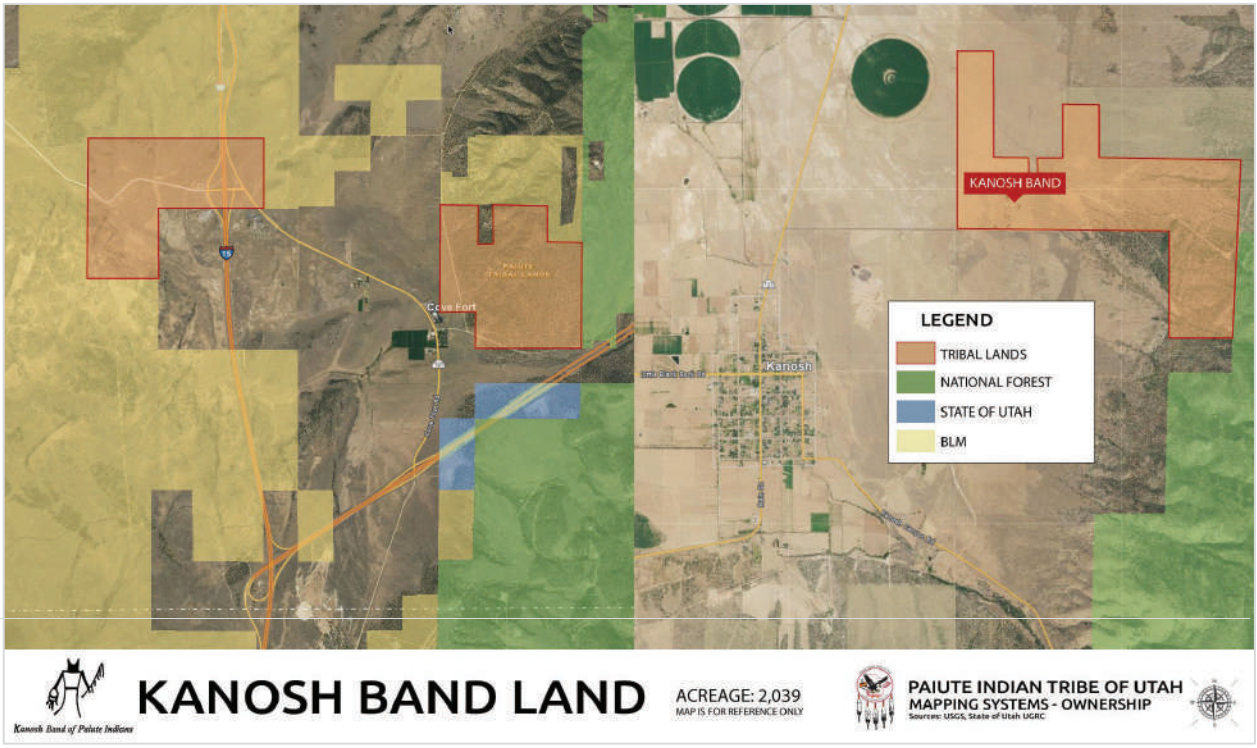


Kanosh Band of Paiute Indians

"Kanosh Logo meaning; a medicine man that sings songs to make it rain. This drawing was possibly made by Earl Pikyavit." https://pitu.gov/bands/.

The Kanosh Band Reservation encompass a total of 2,039 acres and consists of Kanosh Village, Cove Fort West, and Cove Fort East. It is located in the west-central portion of Utah, in Southeastern Millard County approximately 153 miles south of Salt Lake City on Interstate Highway 15. Band headquarters are located on approximately 632 acres of developed land one (1) mile east of the town of Kanosh. Band members residing on the Reservation live at this location. An additional 563 acres is approximately twenty-four (24) miles south on Interstate Highway 15. This parcel is undeveloped but has good development potential. Travel distance from the Kanosh Band to the PITU's Tribal headquarters in Cedar City is 210 miles roundtrip. The Band has a completed land use plan accessible at the Band headquarters (refer to Kanosh Band Reservation Land Use Plan 1999).

BAND LANDS
KANOSH BAND



CURRENT SOCIAL AND ECONOMIC CONDITIONS OF THE KANOSH BAND

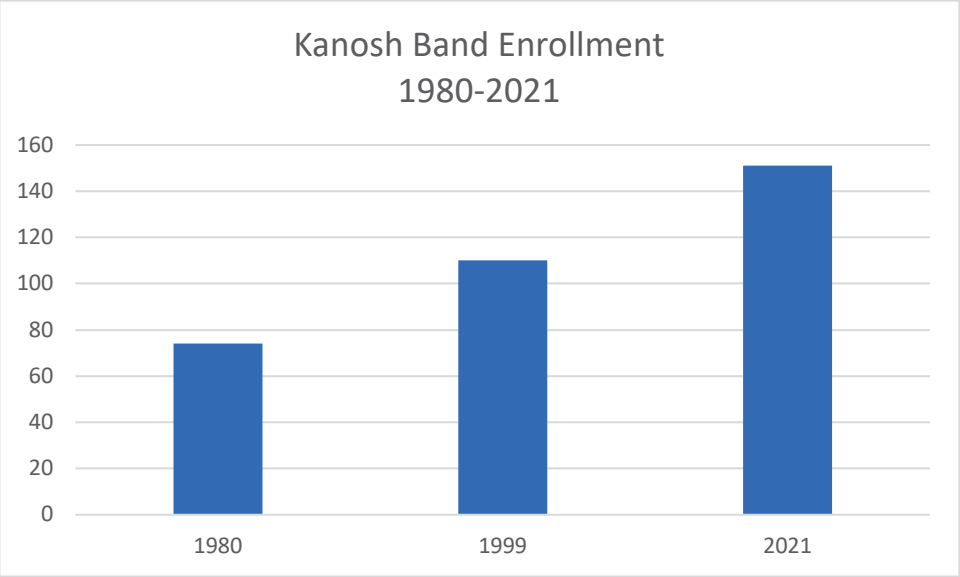
Summary Background

Population Characteristics

Band Enrollment

Kanosh enrolled population has expanded in recent years.

KANOSH BAND ENROLLMENT			
Band	**1980**	**1999**	**2021**
Kanosh	74	110	151

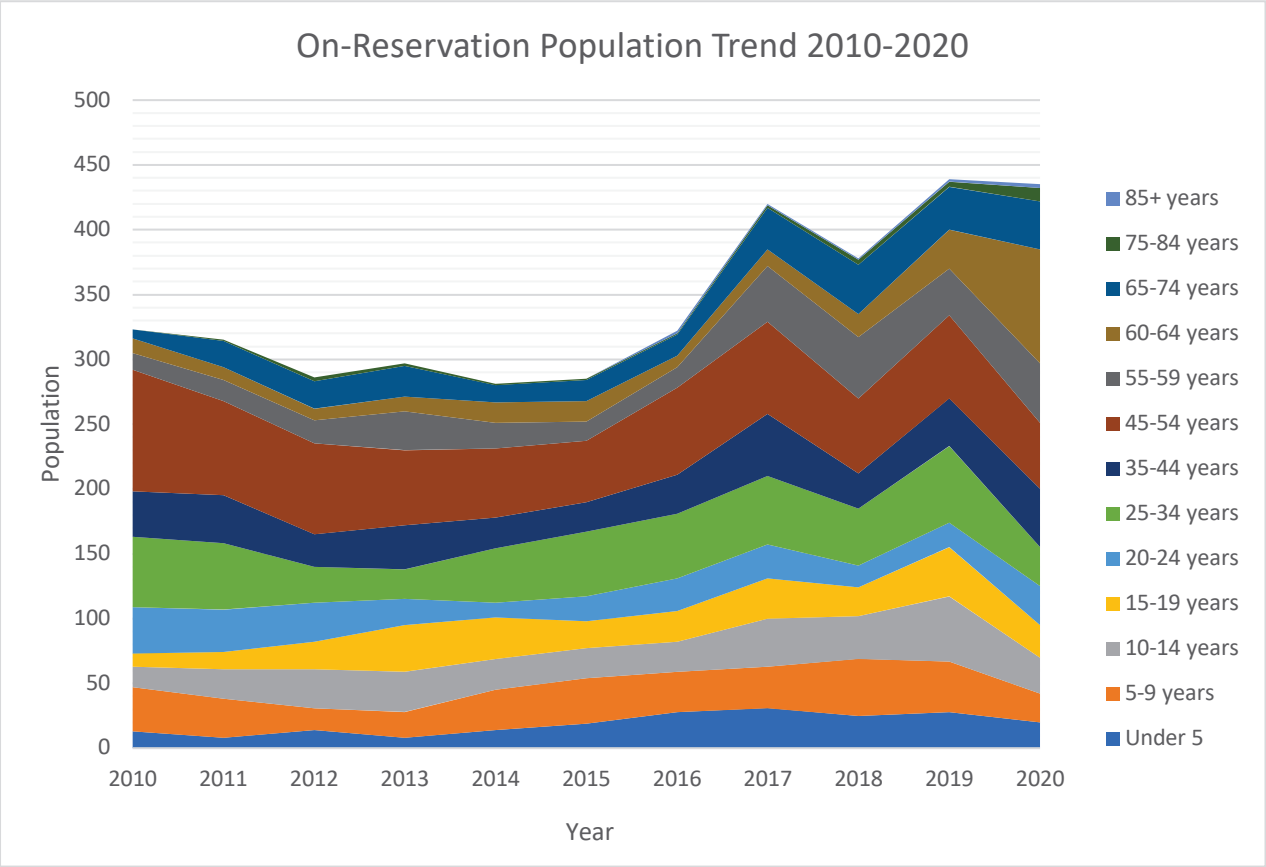


CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU

Summary Background

Population Trend

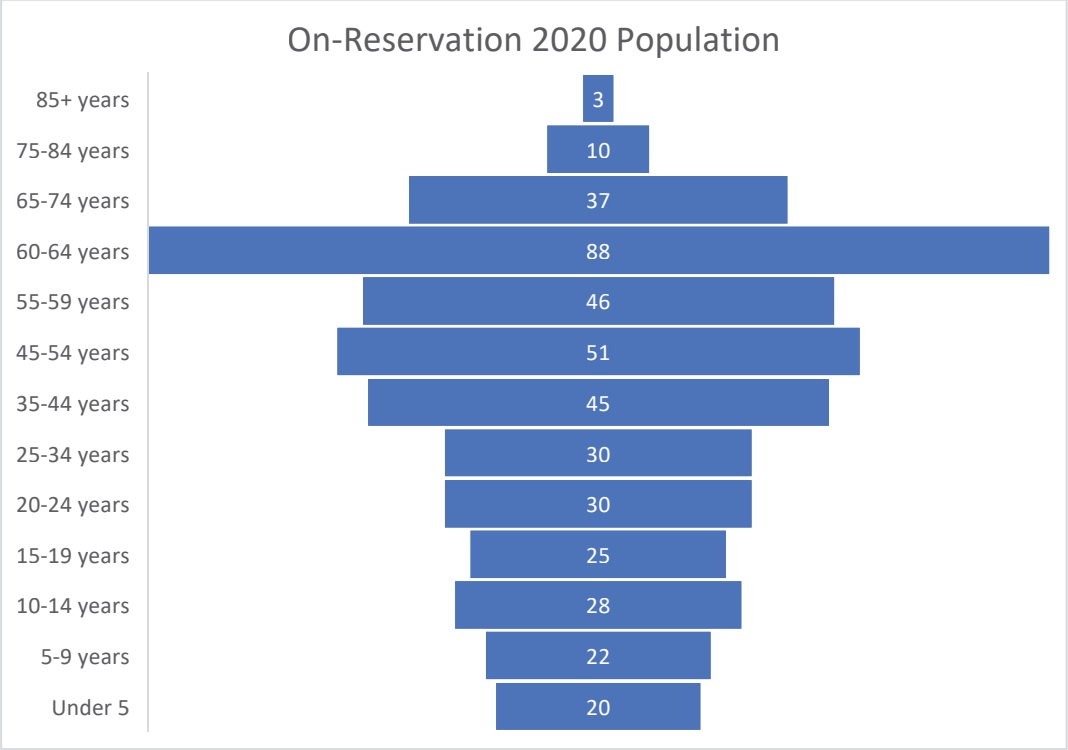
According to 2020 American Community Survey 5-Year Estimates for the Tribe's Reservation, the on-Reservation population is 435. Except for 2012 through 2015, the on-Reservation population has increased since 2010. The population increase is consistent with the Tribe's membership enrollment.



CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU

Summary Background

With a median age of fifty (50), nearly forty-three (43%) percent of the Tribe's population is between the ages of forty-five (45) and sixty-four (64). (See Table S0101 American Community Survey, 2020). This creates a noticeable population bulge in the 60-64 cohort. The population graphic takes on an upside-down pyramid shape because of the Tribe's aging population.



SERVICE AREA POPULATION TREND

The most recent decennial census data shows the median age of individuals living on-Reservation is significantly higher than those living in the off-Reservation service area. The total population in Millard County is 12,963 and the median age is thirty-five (35). (See Table P1 Decennial Census Survey, Millard County and Table S01010 American Community Survey 5-Year Estimate, 2020, respectively).

CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU

Summary Background

Households

In 2020, there were 143 households located on the Reservation. Married-couple families made up twenty-nine (29%) percent of the households on the Reservation, while cohabitating couple households made up nearly four (4%) percent of households. Female householders with no spouse or partner occupied forty-one (41%) percent of all households, while almost twenty-seven (27%) percent of households were male householders with no spouse or partner present. Fourteen (14%) percent of the people living alone were male, and nearly twelve (12%) percent were female. (See Table S1101 American Community Survey, 2020).

SERVICE AREA HOUSEHOLDS

Census data shows Millard County has 5,103 housing units. (See 2016-2020 American Community Survey 5-Year Estimates for Millard County). Compared to the other counties in the Tribe's service area, Millard County has the fewest number of housing units. (See Table H1 2020 Decennial Census for Millard County).

Grandparents

Fifty-seven (57) grandparents living on the Tribe's Reservation reported living with their grandchildren under eighteen (18) years old in 2020. Of those grandparents, nearly sixty-seven (67%) percent were responsible for the basic needs of their grandchildren. (See Table S1002 American Community Survey, 2020).

School Enrollment

Fifty-seven (57) grandparents living on the Tribe's Reservation reported living with their grandchildren under eighteen (18) years old in 2020. Of those grandparents, nearly sixty-seven (67%) percent were responsible for the basic needs of their grandchildren. (See Table S1002 American Community Survey, 2020).

CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU

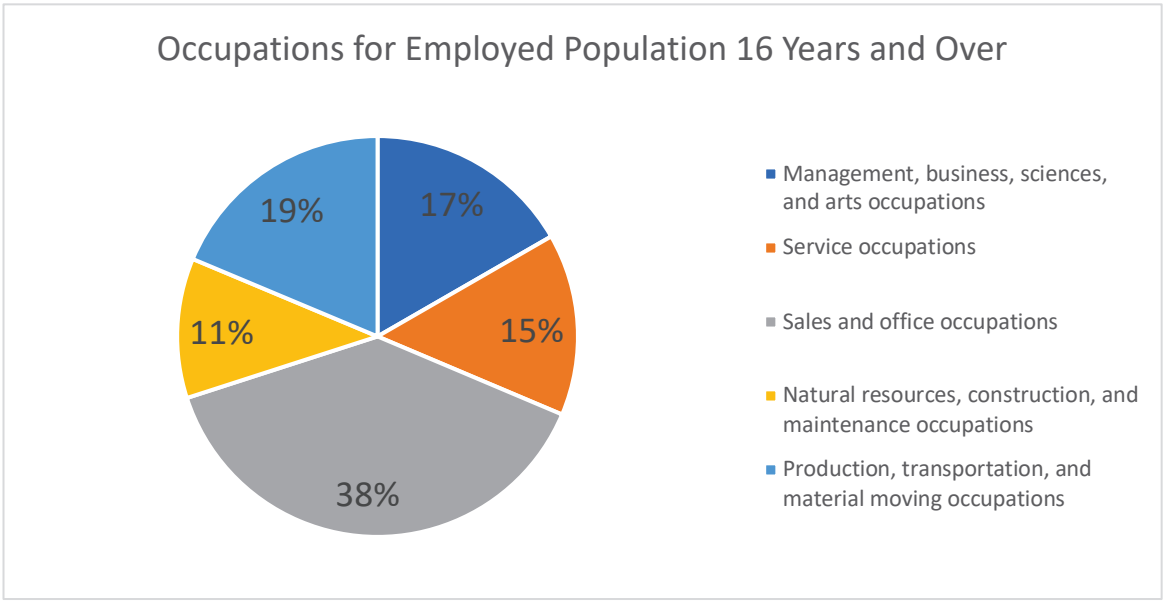
Summary Background

Employment Status & Occupation

Of the individuals sixteen (16) and over living on the Reservation, forty-four (44%) percent were employed in 2020. Consequently, the 2020 unemployment rate for the Tribe's Reservation was 6.6%. At thirty-five (35%) percent, the fifty-five (55) to fifty-nine (59) year-old cohort has the most considerable unemployment rate among those aged sixteen (16) years and older on the Reservation. (See Table S2301 American Community Survey, 2020).

An estimated eighty-seven (87%) percent of the employed population living on the Reservervation were private wage and salary workers; nearly thirteen (13%) percent identified as federal, state, or local government workers. Zero (0%) percent of individuals living on the Reservation were self-employed workers in their own not incorporated businesses (See Table S2408 American Community Survey, 2020).

According to 2020 survey data, seventeen (17%) percent of those living on the Tribe's Reservation worked in management, business, sciences, and arts. Almost fifteen (15%) percent worked in service occupations, and nearly thirty-nine (39%) percent worked in sales and office occupations. Eleven (11%) percent of workers worked in natural resources, construction, and maintenance occupations. And nearly nineteen (19%) percent worked in production, transportation, and material moving fields. (See Table S1401 American Community Survey, 2020).



CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU

Summary Background

Concerning married-couple households on the Reservation who participate in the labor force, 2020 census data shows both the husband and wife working in nearly twenty-nine (29%) percent of married-couple households and the husband alone working in two (2%) percent of married-couple households. The wife alone participated in the labor force in nearly twelve (12%) percent of married couple households on the Reservation. Neither the husband nor the wife were in the labor force in fifty-seven (57%) percent of married-couple households. (See Table S2302 American Community Survey, 2020).

CEDS SURVEY

With respect to employment opportunities on the Reservation, CEDS survey respondents showed overwhelming support when asked to consider whether the Tribe should initiate activities needed to diversify employment opportunities on the Reservation. For instance, ninety-three (93%) percent of 2022 CEDS Community Survey respondents "agreed" or "strongly agreed" the Tribe should support environmental and natural resource-related occupations. Likewise, eighty (80%) percent of survey respondents are in favor of supporting manufacturing occupations; eighty-seven (87%) percent support trade, transportation, energy distribution, and communication facility-related occupations; and eighty-six (86%) percent of respondents feel the Tribe should support knowledge-based professions. When asked whether the Tribe should support service-related fields, such as those in customer service, restaurants, and hospitality industries, eighty-three (83%) percent of respondents strongly agreed, and six (6%) percent strongly disagreed.

SERVICE AREA EMPLOYMENT STATUS & OCCUPATION

The Band is unique from the county in its service area in that the leading occupations on the Reservation are sales and service occupations. The American Community Survey shows management, business, sciences, and arts occupations employ the highest percentage of workers in Millard County. Whereas nineteen (19%) percent of workers sixteen (16) and older in Millard County are employed in sales and office occupations. (See 2016-2020 American Community Survey).

CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU

Summary Background

OFF-RESERVATION SERVICE AREA OCCUPATIONS FOR THE CIVILIAN EMPLOYED POPULATION 16 YEARS AND OVER 2016-2020 American Community Survey 5-Year Estimates		
OCCUPATION	**MILLARD COUNTY**	**PITU RESERVATION**
Management, business, sciences, and arts occupations	29.50%	17%
Service occupations	16.20%	15%
Sales and office occupations	18.50%	38%
Natural resources, construction, and maintenance occupations	18%	11%
Production, transportation, and material moving occupations	17.90%	19%

Housing Characteristics

According to the 2020 Census dataset, there are 163 housing units on the Reservation. Of those units, 143 were identified as occupied. Sixty-nine (69%) percent of the residential structures are single-family structures. Twenty (20%) percent are classified as mobile homes, and nine (9%) percent are classified as multi-family units. The median value of owner-occupied residential units on the Reservation is $88,300. In addition, the median monthly rent for a residential unit within this area is $406. (See Table DP04 American Community Survey, 2020).

CEDS SURVEY

During stakeholder meetings held with the Tribe, participants expressed concerns about the lack of affordable and quality housing options on and around the Reservation. The lack of housing impacts the Tribe's ability to accommodate its housing needs. Likewise, the 2022 CEDS Community Survey shows that ninety-three (93%) percent of respondents either “strongly agree” or “agree” the Tribe should initiate, promote, and support activities needed to improve access to quality and affordable housing. Stakeholders expressed a broad range of factors contributing to the lack of housing stock, including limited land base, compromised soil quality, and financing opportunities.

CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU

Summary Background

The Utah Paiute Tribal Housing Authority provides qualified families of the PITU, and other eligible Native American Families in the service area, with opportunities to obtain safe, acceptable, and affordable housing through the Native American Housing and Self-Determination Act (NAHASDA) and other programs. A Board of Commissioners and the Housing Authority Director oversee the Utah Paiute Tribal Housing Authority.

The Board consists of representatives from each Paiute Band in the Housing Authority's service area. Please see the Utah Paiute Tribal Housing Authority's website for more information.

SERVICE AREA POPULATION HOUSING CHARACTERISTICS

According to American Community Survey 5-year estimates (2016-2020) census data, eighty-eight (88%) percent of housing units in Millard County are classified as single-family, while only seventy (70%) percent of houses on the Reservation are single-family houses.

OFF-RESERVATION SERVICE AREA HOUSING INVENTORY CHARACTERISTICS 2016-2020 American Community Survey 5-Year Estimates		
HOUSING TYPE	**MILLARD COUNTY**	**PITU RESERVATION**
Single-family houses	88.30%	69.90%
Apartments	8.10%	9.20%
Mobile homes	3.50%	20.20%
Other	0%	0.60%

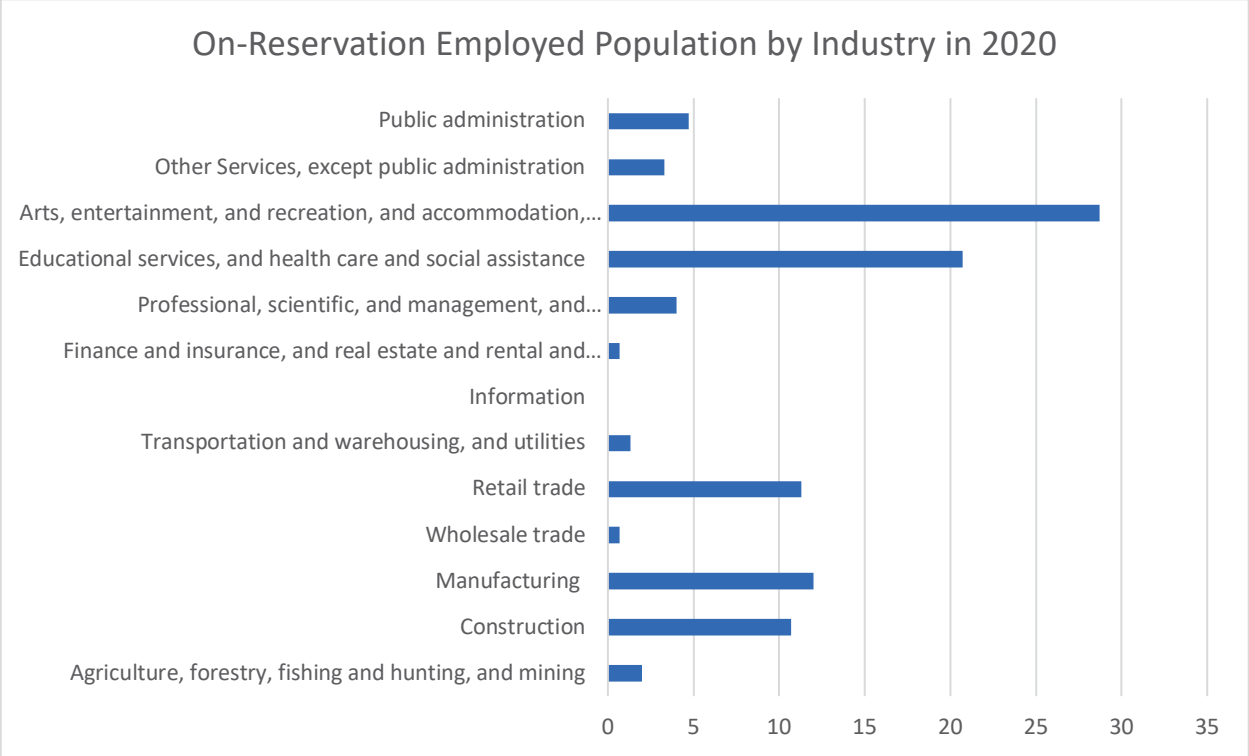
The median home value in Millard County is $166,900 and the median monthly rent for this area is $754.

OFF-RESERVATION SERVICE AREA HOUSING FINANCIAL CHARACTERISTICS 2016-2020 American Community Survey 5-Year Estimates		
	MILLARD COUNTY	**PITU RESERVATION**
Median home value	$166,900	$88,300
Median monthly rent	$754	$406

CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU
Summary Background

Industry

In 2020, the civilian employed population sixteen (16) years and older living on the Reservation worked in the following industries:



The arts, entertainment, recreation, and accommodation industry and educational services, healthcare, and social assistance industry support the majority of jobs held by individuals living on the Reservation.

ON-RESERVATION EMPLOYED POPULATION BY INDUSTRY 2016-2020 American Community Survey 5 -Year Estimates	
INDUSTRY	**PERCENT**
Educational services, and health care and social assistance	20.7
Arts, entertainment, recreation, accommodation, and food services	28.7

CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU

Summary Background

CEDS SURVEY

Comments collected during takeholder meetings show a strong desire to grow the economy by supporting a diverse range of industries. Similarly, the 2022 CEDS Community Survey shows that respondents favor supporting economic development in the coming years. For instance, when asked how important it is for the Tribe to support economic development activities over the next five (5) years, sixty (60%) percent "strongly agreed."

SERVICE AREA INDUSTRY

The education, healthcare, and social assistance industry employs twenty (20%) percent of off-Reservation workers living in Millard County. Likewise, twenty-one (21%) percent of workers living on the Reservation work in the education, healthcare, and social assistance industry. The retail industry also employs a consistent percentage of on Reservation and off-reservation workers. For example, the 2016-2020 American Community Survey results show twelve (12%) percent of workers living in Millard County and twelve (12%) percent of employed on-Reservation individuals work in the retail industry.

OFF-RESERVATION SERVICE AREA
PERCENT BY INDUSTRY
2016-2020 American Community Survey 5-Year Estimates

INDUSTRY	MILLARD COUNTY	PITU RESERVATION
Agriculture, forestry, fishing, hunting, and mining	12%	2%
Construction	6.40%	10.70%
Manufacturing	8.70%	12%
Wholesale trade	0.70%	0.70%
Retail trade	11.40%	11.30%
Transportation, warehousing, and utilities	13.30%	1.30%
Information	0.60%	0%
Finance, insurance, real estate, and rental and leasing	1%	0.70%
Professional, scientific, management, administrative, and waste management services	5.50%	4%
Educational services, health care, and social assistance	20.60%	20.70%
Arts, entertainment, recreation, accommodation, and food services	9.90%	28.70%
Other services, except public administration	4.50%	3.30%
Public administration	5.30%	4.70%

CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU

Summary Background

Income

The median income of households on the Reservation was $39,297 in 2020. Eighteen (18%) percent of households had income below $10,000 a year, and two (2%) percent had income over $200,000 yearly. Median earnings for full-time, year-round workers were $35,000 a year. (See Table S1901 American Community Survey, 2020).

ON-RESERVATION HOUSEHOLD INCOME 2016-2020 American Community Survey 5- Year Estimates	
EARNINGS	**PERCENT**
Less than $10,000	18.2
$10,000 to $14,999	4.9
$15,000 to $24,999	7.0
$25,000 to $34,999	9.1
$35,000 to $49,000	19.6
$50,000 to $74,999	23.8
$75,000 to $99,000	9.1
$100,000 to $149,000	6.3
$150,000 to $199,000	0.0
$200,000 or more	2.1

According to the 2016-2020 Census information, nearly seventy-five (75%) percent of the Tribe's on-Reservation households received earnings between 2016 and 2020. About forty-three (43%) percent of households received Social Security, and thirteen (13%) percent of households received retirement income other than Social Security. The average income for Social Security was $ 8,349 a year.

THE PROPORTION OF HOUSEHOLDS ON THE RESERVATION WITH VARIOUS INCOME SOURCES 2016-2020 American Community Survey 5-Year Estimates	
EARNINGS DISTRIBUTION	**PERCENT**
Wage and salary earnings	74.8
Social Security	42.7
Retirement income	13.3
Supplemental Security Income (SSI)	24.5
Cash public assistance income	2.8

CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU

Summary Background

CEDS SURVEY

When asked to consider existing economic, social, and environmental factors that *hinder* economic development on the Tribe's Reservation, such as competitive pay, fifty-three (53%) percent of the 2022 CEDS Community Survey respondents "strongly agreed" such factors impact the Tribe's economy. Similarly, eighty-seven (87%) percent of survey respondents "strongly agreed" or "agreed" that the Tribe should initiate, promote, and support activities needed to improve access to competitive pay for workers living on the Reservation.

Poverty

Concerning families and individuals living in poverty on the Reservation, census data shows that twenty-seven (27%) percent of people living on the Tribe's Reservation were in poverty between 2016 and 2020. During that same period, twenty-five (25%) percent of all families with related children of the householder under eighteen (18) years old were in poverty. Meaning, of the twenty-seven (27%) percent of people living in poverty on the Reservation, twenty-five (25%) percent were living in households where the head of the household was responsible for one (1) or more children under the age of eighteen (18) living in the home. Unfortunately, a little more than forty-nine (49%) percent of children under eighteen (18) living on the Reservation were below the poverty level. (See Table S1702 American Community Survey, 2020).

ON- RESERVATION POVERTY RATES
2016-2020 American Community Survey 5-Year Estimates

COHORT	PERCENT
People in poverty	27.0
Children under 18 years below poverty	49.4
People 65 years old and over below poverty	8.0
People 18 to 64 years below poverty	24.3

Nearly five (5%) percent of married-couple family households on the Reservation lived below the poverty line in 2020, compared to a little more than thirty-eight (38%) percent of female householders with no spouse present. Moreover, of the family households in poverty, ninety (90%) percent with related children of the householder under five (5) and between five (5) years and seventeen (17) years old were below the poverty level. (See Table S1702 American Community Survey, 2020).

CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU

Summary Background

According to the 2016-2020, nearly twenty-nine (29%) percent of households received assistance through the Supplemental Nutrition Assistance Program (SNAP). Sixty-one (61%) percent of the families that received SNAP had children under eighteen (18) years old, and fifty-six (56%) percent had one (1) or more people sixty (60) years and older. (See Table S2201 American Community Survey, 2020).

Education

With respect to the educational attainment of people on the Reservation, eighty-four (84%) percent of people twenty-five (25) years and over had a high school diploma or General Education Development (GED) diploma in 2020. Of those with a high school diploma or GED, almost twenty (20%) percent of the population had some college, eight (8%) percent had an Associate's degree, seven (7%) percent had a Bachelor's degree, and a little over one (1%) percent had a graduate or professional degree. Conversely, a little over sixteen (16%) percent of people twenty-five (25) years and older on the Reservation do not have a high school diploma or GED. (See Table S1502 American Community Survey, 2020).

EDUCATIONAL ATTAINMENT OF PEOPLE 25 YEARS AND OVER LIVING ON-RESERVATION
2016-2020 American Community Survey 5-Year Estimates

EDUCATIONAL ATTAINMENT	PERCENT
Less than a high school diploma	16.5
High school diploma or equivalency	47.7
Some college, no degree	19.7
Associate degree	8.4
Bachelor's degree	6.5
Graduate or professional degree	1.3

Concerning the educational attainment of people eighteen (18) to twenty-four (24) years living on the Reservation in 2020, a little more than sixty-four (64%) percent of people eighteen (18) to twenty-four (24) years had a high school diploma or GED. Of those individuals, a little more than thirteen (13%) percent had some college or an Associate's degree. Conversely, nearly thirty-six (36%) percent had less than a high school diploma or GED.

CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU

Summary Background

EDUCATIONAL ATTAINMENT OF PEOPLE 18-24 YEARS LIVING ON-RESERVATION 2016-2020 American Community Survey 5-Year Estimates	
EDUCATIONAL ATTAINMENT	**PERCENT**
Less than high school diploma	35.6
High school diploma or equivalency	51.1
Some college or Associate's degree	13.1

The PITU Education Department plays a crucial role in supporting Paiute membership in attaining higher levels of education. In addition to managing the PITU Higher Education Scholarship Fund, the Education Department is the first stop for individuals interested in seeking information about vocational training, green energy internships, college and university admissions, and financial aid.

AREA ACADEMIC & VOCATIONAL INSTITUTIONS		
IN-STATE UNIVERSITY	**IN-STATE COLLEGE & TECHNOLOGY**	**OUT-OF-STATE UNIVERSITY**
Southern Utah University	Salt Lake Community College	University of Nevada
Utah State University	Snow College	Northern Arizona University
University of Utah	College of Eastern Utah	Haskell Indian Nations University
Utah Valley University	Utah College of Applied Technologies	Fort Lewis College
Brigham Young University	Southwest Technical College	Southwestern Indian Polytechnic Institute
Weber State University	Utah Technical College	San Juan College

CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU
Summary Background

CEDS SURVEY

When asked to consider existing economic, social, and environmental factors that *hinder* economic development on the Reservation, such as access to education, fifty-three (53%) percent of the 2022 CEDS Community Survey respondents “strongly agreed” such factors impact the Tribe’s economy. Similarly, ninety-seven (97%) percent of survey respondents “strongly agreed” or “agreed” that the Tribe should initiate, promote, and support activities needed to improve access to education on the Reservation and for off-Reservation members.[1]

Survey results also show the overwhelming majority of respondents favor supporting a broad range of workforce development initiatives, programs, and activities to promote economic development. For instance, sixty-seven (67%) percent of survey respondents expressed that it is "extremely important" for the Tribe to support workforce development programs and the types of educational and training activities needed to employ more Tribal members in all industries, and twenty-three (23%) percent feel it is "important."

Concerning workforce development opportunities in energy-related industries, sixty-seven (67%) percent of respondents expressed that it is "extremely important" for the Tribe to support workforce development programs and the types of educational and training activities needed to employ more Tribal Members in energy-related inudstires, and twenty-three (23%) percent feel it is "important."

SERVICE AREA EDUCATIONAL ATTAINMENT

Census data shows clear disparities in educational attainment for individuals living on the Reservation compared to those living within the Tribe’s service area. For instance, nearly seventeen (17%) percent of those twenty-five (25) years an older living on the Reservation had less than a high school education. However, ten (10%) of adults twenty-five (25) years and older living in Millard County had less than a high school diploma. Seven (7%) percent of individuals twenty-five (25) years and older living on the Reservation in 2016-2020 had at least a bachelor’s degree, whereas seventeen (17%) percent of individuals living in Millard County had a bachelor’s degree or higher.

[1] PITU Tribal members residing in PITU’s service area are eligible for Tribal education programs and services administered through the PITU Education Department.

CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU

Summary Background

OFF-RESERVATION SERVICE AREA EDUCATIONAL ATTAINMENT OF PEOPLE 25 YEARS AND OVER 2016-2020 American Community Survey 5-Year Estimates		
EDUCATIONAL ATTAINMENT	**MILLARD COUNTY**	**PITU RESERVATION**
Less than a high school diploma	10.40%	16.50%
High School diploma or equivalency	32.40%	47.70%
Some college, no degree	23.40%	19.70%
Associate's degree	11.50%	8.40%
Bachelor's degree	17.30%	6.50%
Graduate or professional degree	5%	1.30%

With respect to the State of Utah, in 2016-2020, ninety-three (93%) percent of people twenty-five (25) years and over had at least graduated from high school and thirty-five (35%) percent had a bachelor's degree or higher. An estimated seven (7%) percent did not complete high school.

STATE OF UTAH EDUCATIONAL ATTAINMENT OF PEOPLE 25 YEARS AND OVER 2016-2020 American Community Survey 5-Year Estimates	
EDUCATIONAL ATTAINMENT	**PERCENT**
Less than a high school diploma	7.0
High school diploma or equivalency	22.8
Some college, no degree	25.5
Associate's degree	10.0
Bachelor's degree	23.0
Graduate or professional degree	11.7

CURRENT SOCIAL AND ECONOMIC CONDITIONS OF PITU
Summary Background

Home Internet & Computers

According to 2020 Census data, sixty-five (65%) percent of households on the Reservation had a broadband internet subscription in 2020. Sixty-one (61%) percent of households had a desktop or laptop computer, and forty-eight (48%) percent had a tablet or other portable wireless computer. (See Table S2801 American Community Survey, 2020).

In 2021, PITU provided iPads to all Tribal members eighteen (18) years and older, Chromebooks to member households with K12 students, and MacBook Air laptops to all college students. The PITU recognized the importance of providing households and students with the necessary equipment and devices to stay connected to the Tribe, to access virtual meetings, receive digital correspondence, receive health updates, access telehealth, access tribal programs, support distance learning and support and encourage continued social distancing efforts.

PITU is also strategically working to provide in ground fiber access to band areas to add accessibility to even faster and more stable broadband services. It is estimated that eighty (80%) percent to ninety (90%) percent of PITU households have at least one (1) connected device, access to at least two (2) broadband services, and the ability to apply for discounts.

Current options for broadband access on tribal lands last review in 2021 for Kanosh include Centracom Fiber, and Frontier Fiber.

CEDS SURVEY

When surveyed for the 2022 CEDS, ninety (90%) percent of respondents expressed that the Tribe should initiate, promote, and support the activities needed to improve broadband communications on the Reservation.

GEOLOGY, CLIMATE, AND INFRASTRUCTURE
Summary Background

Geology

The geology in southwestern Utah is the meeting of the Mojave Desert, Great Basin, and Colorado Plateau. The topography is marked by high peaks, cliff sides, and canyons. The geology and topography of Band lands is susceptible to flooding, wildfire, earthquakes, and landslides. Additionally, due to geographic positioning and shifts in weather patterns, the Reservation suffers from sustained drought conditions.[2]

Climate

Southwestern Utah's climate is classified as arid. This area experiences extremes in both temperature and precipitation. Weather data shows these extremes have increased in the last ten (10) years. It is likely that a deeper examination of weather data would show even greater variables in what were "typically" wet or dry periods. Extreme heat is damaging to soil conditions, water supplies, and to the health and wellness of the human population. While extremes in precipitation can be equally damaging, it brings additional risk elements such as landslides, damage to infrastructure, including roadways, and water and wastewater systems.

WEATHER DATA FOR KANOSH WEATHER STATION, UTAH[2] 2000-2022	
Mean minimum temperature	40.8
Mean maximum temperature	67.0
Mean temperature	53.9

Infrastructure

The Kanosh Band lands supports range of infrastructure assets necessary for the economy, public health, and safety. The Band does not have formally adopted building codes. The Band does, however, utilize construction best practices to construct community facilities. Where applicable, the Band closely adheres to building standards required by funding sources.

[2] Additional information on the drought conditions in the American Southwest may be accessed at https://www.drought.gov/news/new-noaa-report-exceptional-southwest-drought-exacerbated-human-caused-warming.

GEOLOGY, CLIMATE, AND INFRASTRUCTURE

Summary Background

Band infrastructure includes the following facilities:

1. Kanosh Band Community Building
2. Band managed water system on reservation
3. Provides water to residential homes, the community building, and the Kanosh Community Health Center located on the reservation
4. K-Rez C-Store
5. K-Rez C-Store Well & Well House
6. Old Red Building in Kanosh (vacant)
7. Kanosh Play Park

SWOT
Economic Strategy

The SWOT analysis is an evaluation of the Band's strengths, weaknesses, opportunities, and threats. The intent of identifying the strengths and weaknesses is to reflect on the current economic condition of the Band. The purpose of naming strengths and opportunities is to better understand strengths and capacities and to begin to identify areas of competitive advantage.

Strengths

- Family
- Education
- Housing
- Unity

Weaknesses

- Communication
- Education
- Housing

Opportunities

- Education
- Business Development

Threats

- Lack of financial resources
- Attitude toward education
- Alcohol and drug abuse

STRATEGIC ACTION PLAN
Economic Strategy

Kanosh Band Mission

"We the Kanosh Band are pushing for perpetual agricultural, individual and community prosperity. Through the enhancement of cultural and traditional values, improved communications, enhanced education among members, and economic development, the Kanosh Band will prosper and be successful in the next centuries to come."

Goal 1. Maintain and improve family unity, tradition, and values.

Objective 1. Promote more involvement in Band gatherings.

Milestone 1: May – Family picnics; hand games (cards & songs).

Milestone 2: June – Pow-wow.

Milestone 3: July – Youth Pow-wow

Objective 2. Revitalize the Youth Pow-wow.

Milestone 1: Get all the Band Members involved.

Milestone 2: Have the youth motivate the elders about the Pow-wow.

Milestone 3: Promote the Pow-wow by personally inviting K-12 students

Responsible Party: Band members with communities.

STRATEGIC ACTION PLAN

Economic Strategy

Goal 2. Improve communication among Band, Tribe and others.

Objective 1. Involve all Band members to be willing and open to planning discussions.

Milestone 1: Coordinate with local, regional, and Tribal economic development.

Milestone 2: Kanosh Paiute language program.

Responsible Party: Band Council with elders.

Goal 3. Enhance education among Band members.

Objective 1. Take advantage of and use current education opportunities.

Milestone 1: Activate all resources-school busses, education system.

Milestone 2: Utilize Tribal education programs to a greater extent.

Responsible Party: Parents.

Goal 4. Encourage Band members to obtain the necessary knowledge and skills to operate and manage a business.

Objective 1. Use current vocational school programs-encourage business programs to be available to entrepreneurial band members.

Milestone 1: Utilize Tribal educational directors to help set up programs.

Milestone 2: In-house businesses courses.

Milestone 3: Utilize available resources from BIA, Tribe, Band, government, etc. to provide scholarships for Band members.

Responsible Party: Education Representative, Band Chairperson, and Economic Development Representative.

COMMUNITY ECONOMIC RESILIENCY

Economic Strategy

Community resiliency refers to the sustained ability of a community to use available resources, including energy, technology, communication, transportation, and food, to respond to, withstand, and recover from adverse situations. Resiliency allows for improved adaptation and growth before, during and after natural, human, and technological disasters. Economic resiliency is similar to community resiliency in that it describes the ability to prevent, withstand and quickly recover from major disruptions to the economic base. Disruptions include economic downturns or other significant events which impact demand for local goods and consumer spending.

It is paramount that the PITU and the Kanosh Band acquire the resources needed to catalyze Tribal and non-Tribal investments and position themselves more competitively across all economic sectors to protect the Tribe's economy against climate change, natural disasters, and economic downturn. The Tribe is determined to succeed. The Tribe has faced numerous obstacles and setbacks but is resolute to strengthen its sovereignty, its ability to self-govern and strengthen its capacity to perpetuate its culture, traditions, and values for the generations to come. The Tribe is not content to merely survive, it is our goal to thrive, and control the Tribe's future and destiny.

The PITU has taken the following measures to strengthen Tribal resiliency:

INCREASED EFFICIENCY OF TRIBAL OPERATIONS.

- ⇒ Emphasis on efficiency and effective utilization of funds, consolidation of operations, increased financial management, business minded led strategies, investment in internal infrastructure, streamlining processes, increasing accountability and expectations.
- ⇒ Improvements in information technology (website, communication, social media, cloud-based systems, servers, security, back-ups, etc.).

INCREASED FACILITY IMPROVEMENTS AND UTILIZATION.

- ⇒ Road, water system, and water utilization improvements and improvements made through renovated facilities.
- ⇒ Increased infrastructure improvement (roads, communication, etc.).

COMMUNITY ECONOMIC RESILIENCY

Economic Strategy

INCREASED UTILIZATION AND PROTECTION OF TRIBAL WATER RIGHTS.

⇒ Increasing use of water, purchasing new water rights, and safeguarding water throughout all Tribal lands.

INCREASED ACCESS TO MEDICAL CARE

⇒ The Tribe employs professional medical staff trained in general and family medicine. Although medical staff is not equipped to provide emergency services, they support tribal members following a disaster. These employees also distribute life-saving medicines and administer immunizations.

INCREASED EMERGENCY OPERATIONS

⇒ The Emergency Manager is responsible for identifying and addressing current emergency gaps, developing and/or improving the Tribe's Emergency Operations Plan (EOP), Hazard Mitigation Plan, and collaborating closely with Federal, State, and local emergency management to provide for the safety and protection of the people and property during disaster or emergency situations. The Emergency Manager coordinates and collaborates response efforts with the Paiute Tribe Emergency Response Team (TERT) and with community, state, and federal partners.

INCREASED EMERGENCY OPERATIONS CONTINUED

⇒ TERT plans, prepares, and coordinates the response to emergencies affecting Tribal lands. TERT work group consists of Emergency Managers from each constituent Band. Band Emergency Managers (EM) are elected by each Band every four years and are key components of the Tribe's emergency preparedness framework. Band EMs are charged with cultivating positive relationships with response partners, particularly city and county offices that support the Tribe with life-saving services such as police, fire, ambulance, and emergency medical care. They are also encouraged to participate in emergency management training and exercises, promote preparedness in their communities, support band members during disaster, and keep tribal leaders informed.

Attachments: Planning Process & Alt. Documentation

- PR&G Alternative Formulation & Screening Matrix Report
- Ecosystem Services Framework Worksheet Documentation
- Cumulative Effects Analysis Documentation
- Economic Investigations & Analysis Report
- Economic Analysis Spreadsheet (excel)

PR&G ALTERNATIVE FORMULATION AND SCREENING PROCESS FOR THE CORN CREEK WATERSHED PLAN-ENVIRONMENTAL ASSESSMENT LOCATED IN MILLARD COUNTY, UTAH

LEAD AGENCY: USDA NATURAL RESOURCES CONSERVATION SERVICE (NRCS)

SPONSORING LOCAL ORGANIZATION: TOWN OF KANOSH, UTAH

CO-SPONSORING LOCAL ORGANIZATIONS: CORN CREEK IRRIGATION COMPANY (CCIC) AND THE KANOSH BAND OF PAIUTE INDIANS

CONSULTANT: FRANSON CIVIL ENGINEERS (FCE)



PHASE I: PROBLEMS & OPPORTUNITIES, DEFICIENCIES, OBJECTIVES, & PLANNING CONSTRAINTS

TABLE 1: PROBLEMS AND OPPORTUNITIES

Problem Statement(s): **Flood Prevention** **Agricultural Water Management**	The Corn Creek Watershed, located in Millard Couty, Utah, currently experiences problems related to Flood Prevention and Agricultural Water Management. The Town of Kanosh is at risk of significant flooding due to the noncompliance of Corn Creek Dam and Debris Basin with State and NRCS standards and is at risk of imminent failure due to foundation issues. Additionally, the CCIC system experiences significant seepage and evaporation losses. The Kanosh Band of Paiute Indians (Kanosh Band) does not have access to secondary water and currently relies on their culinary system to meet high outdoor demands, preventing their current system from reliably meeting indoor needs.
Opportunity 1 - Improve Public Safety	Improve the Safety of the residents of Kanosh Town through the implementation of project measures.
Opportunity 2 - Resilience to Flooding	Enhance community resilience to flood risks through the implementation of project measures.
Opportunity 3 - Flood Risk Awareness	Increase the level of breach and flood risk awareness in the community.
Opportunity 4 - Water Conservation	Conserve water resources and optimize agricultural water delivery systems in the watershed.
Opportunity 5 - Tribal Culinary System	Improve resilience of the culinary system for the Kanosh Band through project measures.
Opportunity 6 - Reduce Pumping Demands	Reduce community reliance on groundwater for late season irrigation and reduce pumping demands.

IDENTIFIED DEFICIENCIES
Deficiency 1. Corn Creek Dam and Debris Basin
Deficiency 2. Seepage & Evaporation Losses in CCIC System
Deficiency 3. Kanosh Band Secondary Water Access
Deficiency 4. Flooding Issues in Kanosh Town

Federal Objective (Required by PR&G)

The Federal Objective specifies that Federal water resource investments shall reflect national priorities, encourage economic development, and protect the environment by:
1. Seeking to maximize sustainable economic development;
2. Seeking to avoid the unwise use of floodplains and flood-prone areas and minimize adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area may be used; and
3. Protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems.

TABLE 2: PROJECT OBJECTIVES

Objective 1 - Dam Safety Compliance	Address dam safety complaince problems with Corn Creek Dam and Debris Basin through the year 2080.
Objective 2 - Breach Hazards	Address recognized breach and flood hazards for infrastructure downstream of Corn Creek Dam through the year 2080.
Objective 3 - Access to Secondary Water	Develop and implement a solution to providee a secondary water source to the Kanosh Band to rimprove the resilience of their culinary system through the year 2080.
Objective 4 - Drought Resilience	Develop and implement a solution that will allow the residents of the watershed to be more resilient to drought conditions, which are forecasted to increase in frequency as a result of long-term climate change.

TABLE 3: CONSTRAINTS AND CONSIDERATIONS

Constraint 1 - Disruptions to Property	Avoid disruptions to existing residential and commercial properties during the implementation of the project in Kanosh Town and on Tribal land.
Constraint 2 - Cultural/Historic Impacts	Avoid adverse impacts to cultural and historic resources in the watershed to the maximum extent possible during project implementation.
Constraint 3 - Transportation Impacts	Avoid impacts to existing transportation infrastructure to ensure continued access for emergency services and residents during implementation.
Constraint 4 - Irrigation Water Access	Avoid disruptions to the ability of farmers to access their water supply during the irrigation season.
Constraint 5 - Environmental Justice	Avoid adverse impacts to the socioeconomic conditions of the Kanosh Band of Paiutes, which constitute an environmental justice population.

PHASE II: FORMULATION OF POTENTIALLY SUITABLE MANAGEMENT MEASURES TO ADDRESS EACH IDENTIFIED DEFICIENCY

DEFICIENCY #1: CORN CREEK DAM AND DEBRIS BASIN

TABLE 4: INITIAL APPROACHES AND MANAGEMENT MEASURES

7 carried forward
11 considered

Initial Approaches & Management Measures	Initial Qualitative Evaluation	Carried Forward?
RECONSTRUCT THE CURRENT DEBRIS BASIN		
Update the Debris Basin to have an updated alignment and a taller embankment.	The current debris basin would be reconstructed. The new debris basin would have an updated alignment farther downstream and a taller embankment. The proposed embankment crest elevation is designed to be 5,208.75 feet and the height of the embankment measured from the lowest downstream toe elevation is approximately 50 feet. Carried Forward.	Y
REPAIRING AND UPGRADING THE EXISTING DAM AND DEBRIS BASIN		
remove much of current dam, add filter and drain system, add material to downstream slope for stability, and install deep seepage cutoff wall.	To bring the existing dam into compliance with current standards, a majority of the dam would need to be removed, a filter and drain system installed to collect high seepage through the current core, and additional material placed on the downstream slope to improve stability. This is in addition to the need to install a deep seepage cutoff wall from the crest and replacement of the spillway and low-level outlet. These factors combine to make rehabilitation and raising of the current dam infeasible when compared to the cost to remove and replace the existing dam. Not Carried Forward.	N
USE THE AG. WATER MANAGEMENT SYSTEM FOR FLOOD CONTROL		
Use the ag. Water management system to convey the floodwater.	During initial scoping it was hoped that the agricultural water management system would be able to convey a significant portion of the floodwater. However, the hydrological study performed found that the100-year design flood event has a peak flow of 1,945 cfs which is far greater than the needs of the agricultural water system of 40 cfs. It is impractical and not cost effective to construct a pipe system that could take even ten percent of the design flood. Utilizing the existing ditch system to convey high water and a portion of the floodwater is a far more cost-effective solution. Not Carried Forward.	N
REMOVAL OF DEBRIS BASIN W/CONNECTION TO EXISTING CHANNELS		
Remove the debris basin divert floodwaters to the flood channel by installing a large diversion.	The removal of the debris basin eliminates the potential flooding from a failed dam, but it increases flooding potential in all cases other than the worst-case condition where the debris basin dam fails. The removal of the debris basin does not meet the purpose and need to protect Kanosh from flooding. Any diversion structures and flood channels constructed to protect Kanosh would be subject to debris blockages and sediment accumulation without a debris basin to remove the debris and sediment. Regardless of what measures are taken downstream, debris and sediment in floodwater will increase the potential for flooding and damage. Removing the debris basin is not a feasible option whether downstream improvements are made or not due to the threat posed by the debris and sediment. Not Carried Forward.	N
DIVERT ALL EXCESS FLOOD WATER TO THE EMERGENCY CHANNEL		
	One of the actions considered routed the 100-year flood out the existing emergency channel utilizing a debris basin or direct diversion by a diversion structure and extension of the flood channel to move the floodwater to the flood channel. During the initial evaluations, it became evident that overtopping I-15, which is considered critical infrastructure, occurs when a peak flow of more than 1,000 cfs is routed through the emergency channel without any other improvements. The largest flood event that could be routed through the emergency channel without any other improvements, that did not overtop I-15, was the 25-year flood event. The flood channel is a critical piece in the effort to provide flood protection but, due to concerns with overtopping I-15, it can only be a part of the solution. Not Carried Forward.	N
RECONSRUCT THE PRIMARY &SECONDARY SPILLWAY		
	The proposed primary spillway/low level outlet is a 42-inch conduit with a crest elevation of 5,177 feet. This conduit would discharge into a box that would dissipate energy, split water between two pipelines, and measure flow. This outlet pipe would have a trash rack and be controlled with a guard gate at the inlet of the pipe. The proposed secondary spillway is a morning glory and	

Reconstruct the primary spillway to be compliant with standards	standpipe type design with a crest elevation of 5,199 feet and effective weir length of 22 feet. The 84-inch standpipe would have a 100-inch trash ring that would keep floating debris from blocking the flow of water into the spillway and blocking downstream culverts. The 84-inch standpipe would transition to a 60-inch conduit that would discharge into the energy dissipation box. Carried Forward.	Y
RECONSTRUCT THE EMERGENCY & AUXILIARY SPILLWAY		
Reconstruct the auxiliary spillway to be compliant with standards	The proposed emergency spillway is a side channel spillway design with a crest elevation of 5,203.8 feet and width of 200 feet. A concrete weir wall would discharge into a concrete side channel that would route the water to the existing emergency channel. The road would be regraded to remove the culverts and create a broad swale that would convey floodwater to the existing flood channel. The proposed auxiliary spillway would be constructed as an armored spillway over the dam with a crest elevation of 5,205.4 feet and width of 200 feet. The proposed armoring is a fabric-formed concrete mattress. . Carried Forward.	Y
FLOODPROOFING OF STRUCTURES (NONSTRUCTURAL)		
Utilized various floodproofing techniques to address problems related to flooding in the watershed.	Various options including demolition, dry floodproofing, wet floodproofing, floodwalls, raising of the structure, and construction of a berm alonf the south and east of Kanosh were considered as nonstructural measures to address the flood prevention option. Carried Forward.	Y
RELOCATION OF STRUCTURES/BUYOUTS (NONSTRUCTURAL)		
Conduct property buyouts as a nonstructural measure to address flood prevention problems in the watershed.	The values for the flooded properties with structures, according to Millard County records, is $89,757,800. Actual relocation and buyouts would also include the cost of moving, demolition of existing buildings, and more. This measure would constitute a nonstructural solution to the flood prevention problem required by the PR&G. Carried Forward.	Y
REMOVE THE DAM EMBANKMENT		
Remove the dam embankment.	This measure would remove the dam embankment and use the emergency channel to route water that exceeded the capacity of the current ditch system. The best way to route water without an embankment is to divert it upstream. This measure would install a diversion structuree to pass the first 575 cfs toward the current ditch system and the next 1,000 cfs toward the emergency channel. The rest of the water would be routed toward the existing channel to prevent damage to I-15, which is critical infrastructure. Without a way to remove debris, the culverts necessary to route the floodwaters would be blocked. The diversion structure would be difficult or impossible to design so that it could handle debris and still function. Carried Forward.	Y
REMOVE THE DEBRIS BASIN		
Remove the Debris Basin of the dam	The removal of the debris basin eliminates the potential flooding from a failed dam, but it increases flooding potential in all cases other than the worst-case scenario where the debris basin dam fails. The removal of the debris basin does not meet the purpose and need to protect Kanosh from flooding. Any diversion structures and flood channels constructed to protect Kanosh would be subject to debris blockages and sediment accumulation without a debris basin to remove the debris and sediment. Regardless of what measures are taken downstream, debris and sediment in floodwater will increase the potential for flooding and damage. Carried Forward.	Y

DEFICIENCY #2: SEEPAGE AND EVAPORATION LOSSES IN THE CCIC SYSTEM

TABLE 4: INITIAL APPROACHES AND MANAGEMENT MEASURES

Initial Approaches & Management Measures	Initial Qualitative Evaluation	Carried Forward?
GRAVITY PIPE NETWORK		
Install gravity pipe network to reduce seepage/evaporation losses in the system.	A gravity pipe system is proposed to greatly reduce seepage and evaporation losses and increase irrigation water deliveries to the farmers in the area. Diversion boxes would be installed at current irrigation turnouts. The proposed pipe system would replace the equivalent of approximately 4.9 miles of open ditches. Up to approximately 14.1 miles of ditches would have pipe installed adjacent to the ditch because the ditch would be needed to convey floodwater. The ends of laterals that are used infrequently or serve a single shareholder may not be piped if funding becomes short. Carried Forward.	Y
SPLITTING STRUCTURES FOR PIPE NETWORK		
Install splitting structures for the proposed pipe network	There are multiple splitting/measurement structures proposed for the piped system. A main splitting/measurement structure is proposed where the 60-inch debris basin outlet would discharge. This main splitting box would dissipate energy and distribute the water into two pipelines. The pipelines would have a combined capacity of about 40 cfs. Other splitting/measurement structures would also divide water downstream where previous ditches have been combined to reduce the amount of pipe needed. A sharp crested weir would be used in the structures to ensure uniform controlled flow and to provide measurement data. Carried Forward.	Y
CANAL LINING WITH A MEMBRANE		
Line canal to reduce seepage losses.	On an average year, it is estimated that 3,148 acre-feet of the total 7,164 acre-feet inflow (44%) in the CCIC system is lost due to seepage. To save the water lost due to seepage, canal lining and piping actions were considered. Canal lining with membrane liners was considered as a method to reduce canal seepage; however, this action has a shorter life and lacked local support. Not Carried Forward.	N
CONCRETE LINED CANALS		
Line canals with concrete to reduce seepage losses.	The potential implementation of concrete lined canals was initially considered to mitigate seepage within the CCIC canal system. Presently, the existing double ditches (low water ditches) are already lined with concrete. CCIC's experience has been unsatisfactory with the lined ditches. To meet current demands, a newly installed concrete-lined canal system would exceed the size of the current concrete-lined ditches. Concrete-lined canals present open water channels and have raised concerns due to risks to public safety and lacking the flexibility of allowing crossings at any point along the alignment. Landowners, in turn, express a preference for buried pipe systems on their property rather than open canals. This choice has both political and safety considerations. Furthermore, the proposed canal lining action falls short in terms of cost-effectiveness and durability when compared to piped systems. Not Carried Forward.	N
PRESSURIZED PIPE NETWORK		
Pipe canal to reduce seepage losses.	To save the water loss due to seepage and to allow better water management, piping alternatives were evaluated. Both gravity flow and pressurized systems were evaluated. For the pressurized systems, the delivering capacities evaluated were 10 cfs, 5 cfs, and a true pressurized irrigation (PI) system. A true PI system delivers the total flow evenly across all acres served. The true PI system would allow shareholders to take water at almost any time, but the flow would be less than the 5 or 10 cfs delivery capacities that assume a form of a turn system. Laterals in a true PI system could be smaller due to the lower flow. In the pressurized actions, both pressure reducing valves (PRVs) and higher pressure rated pipe were modeled to handle the high pressures at the end of the system. Not Carried Forward.	N

2 carried forward
5 considered

DEFICIENCY #3: KANOSH BAND SECONDARY WATER ACCESS

TABLE 4: INITIAL APPROACHES AND MANAGEMENT MEASURES

2 carried forward
3 considered

Initial Approaches & Management Measures	Initial Qualitative Evaluation	Carried Forward?
CONSTRUCT SECONDARY WATER SYSTEM FOR KANOSH BAND		
Install secondary system for Tribe by adding to the existing pipeline.	The Corn Creek Watershed Project aims to improve irrigation systems for the Kanosh Band of Paiute Indian Tribe by adding a secondary system to the existing pipeline between the debris basin and the community. The new regulating pond would be at a higher elevation that would allow it to service both the Town and Kanosh Band. The secondary system for the Kanosh Band would reduce the demand for existing culinary water systems. Water would be diverted from Corn Creek before it reaches the debris basin, stored in a new regulating pond with a partition to separate the Tribe's water from the Town's water. Carried Forward.	Y
RELOCATE THE SECONDARY REGULATING POND TO HIGHER ELEVATION		
Relocate the regulating pond to a higher elevation to provide more pressure.	The pond would be relocated approximately a half mile upstream of the current pond location. The new pond would supply both the Kanosh Town and the Kanosh Band of Paiutes (the Tribe) secondary systems from a higher elevation. This would provide additional pressure for the Kanosh system and adequate pressure in the Tribal system. Carried Forward.	Y
RECREATION MANAGEMENT MEASURES		
Potential measures to increase recreational opportunities in the watershed.	Recreation actions in the project area included creating trails, public lookouts and water access at the debris basin, and better access to Corn Creek for recreation. However, these recreation actions were ruled out because there was a lack of local interest and support. Sponsors felt that they lacked the resources available to fund and maintain a recreation action. Additionally, the project does not have an authorized purpose of Public Recreation. Not Carried Forward.	N

DEFICIENCY #4: FLOODING ISSUES IN KANOSH TOWN

TABLE 4: INITIAL APPROACHES AND MANAGEMENT MEASURES

2 carried forward
4 considered

Initial Approaches & Management Measures	Initial Qualitative Evaluation	Carried Forward?
FLOOD CHANNELS		
conduct various channel improvements to route floodwater to different areas using flood channels	Channel 1 would utilize the existing emergency spillway channel and expand it to the northwest to connect with the Hatton Ditch to the north of Kanosh. Channel 1 was assumed to have a bottom width of 30 feet with side slopes of 1:1. To meet NRCS standards to prevent erosion, the channel would have to be lined. Another related action that was considered was extending Channel 1 to send a portion of the floodwater back to the west. Channel 2 and Channel 3 are alignments that route the water to the west once the flood was downstream of Kanosh. Various factors make this measure infeasible including flood easements and costs. Not Carried Forward.	N
ENLARGING EXISTING CHANNELS TO CONVEY FLOODWATER DOWNSTREAM OF KANOSH		
Obtain easements and enlarge existing channels to convey floodwater downstream of the town.	Although only existing channels would be enlarged, the recorded and prescriptive easements would not be sufficient when enlarging and increasing the capacity of the channels. Additional easements would need to be obtained for nearly all enlarged channels. The existing channels are in more developed areas and, as a result, the needed easements would be more difficult and costly for the sponsors to obtain. There is also the potential for the needed space not being available due to adjacent development. Structures may need to be purchased. By comparison, the financial implications of this measure is too great compared to other measures. Not Carried Forward.	N
BERM FLOOD PREVENTION		
Construct a berm to address flooding in ditches in Kanosh Town	This measure would construct a berm north of a large culvert to prevent the floodwater from flowing north. Shortening the existing emergency channel releases the floodwater farther south and allows more water to reach the larger culvert. This plan routes more water through the large culvert. This plan would also raise 800 feet of an existing dirt road to prevent the water from flowing north as one of the actions that would utilize the large capacity I-15 culvert enough to prevent the overtopping of I-15. Carried Forward.	Y
CHANNEL IMPROVEMENTS		
Implement channel modifications to address flooding in ditches in Kanosh Town	Minimal modifications to the last two blocks of the West Ditch allowed the upstream capacity of the West Ditch to be fully utilized. Another proposed action is to enlarge the West Ditch downstream of the Main Street culvert. The improvements include enlarging the existing channel, extending the channel, lining the ditch with concrete, and replacing the two 65 cfs capacity culverts with bridges over the concrete channel. This would allow the floodwater to be contained within the ditch until it can be safely discharged beyond the homes and structures in Kanosh. Carried Forward.	Y

TABLE 5: MEASURES CONSIDERED AND SELECTED FOR INCORPORATION INTO ALTERNATIVES

C = Compatible/Combinable, M = Mutually Exclusive or Unecessarily Redundant

PHASE III & IV: PAIRWISE COMPATIBILITY FOR EACH MANAGEMENT MEASURE AND COMBINATION INTO ALTERNATIVE P

M = Mutually Exclusive or Incompatible

C = Compatible in an alternative

	Pairwise Compatibility	DEFICIENCY #1: CORN CREEK DAM & DEBRIS BASIN							DEF. #2: SEEPAGE LOSSES CCIC		DEF. #3: KANOSH BAND SECONDARY		DEF. #4: FLOODING IN KANOSH TOWN		Preliminary Evaluation of Combinations	Carried Forward?
		Reconstruct the Current Debris Basin	Reconstruct the Primary & Secondary Spillway	Reconstruct the Emergency & Auxiliary Spillway	Floodproofing of Structures	Relocations of Structures/Buyouts	Remove the Debris Basin	Remove the Dam Embankment	Gravity Pipe Network	Splitting Structures for Pipe Network	Construct Secondary Water System for Kanosh Band	Relocate Secondary Regulating Pond to Higher Elevation	Berm Flood Prevention	Channel Improvements		
DEFICIENCY #1: CORN CREEK DAM AND DEBRIS BASIN	Reconstruct the Current Debris Basin	NA	C	C	M	M	M	M	C	C	C	C	C	C	Reconstructing the current debris basin is compatible for combination into an alternative plan with all other considered measures except for the nonstructural options of either floodproofing structures or conducting property buyouts and the option to remove the dam and debris basin.	Y
	Reconstruct the Primary & Secondary Spillway	C	NA	C	M	M	M	M	C	C	C	C	C	C	Reconstructing the primary & secondary spillways is compatible for combination into an alternative plan with all other considered measures except for the nonstructural options of either floodproofing structures or conducting property buyouts and the option to remove the dam and debris basin.	Y
	Reconstruct the Emergency & Auxiliary Spillway	C	C	NA	M	M	M	M	C	C	C	C	C	C	Reconstructing the emergency and auxiliary spillway is compatible for combination into an alternative plan with all other considered measures except for the nonstructural options of either floodproofing structures or conducting property buyouts and the option to remove the dam and debris basin.	Y
	Floodproofing of Structures	M	M	M	NA	M	M	M	C	C	C	C	M	M	Floodproofing of structures is not compatible with any structural flood prevention measures. It is also incompatible with the nonstructural measure to conduct property buyouts. However, it can be combined with structural ag. Water management measures to be formed into an alternative plan.	Y
	Relocation of Structures/Buyouts	M	M	M	M	NA	M	M	C	C	C	C	M	M	Property buyouts/relocations is not compatible with any structural flood prevention measures or the nonstructural measures to floodproof downstream structures. However, it can be combined with structural ag. Water management measures to be formed into an alternative plan.	Y
	Remove the Debris Basin	M	M	M	M	M	NA	C	C	C	C	C	M	M	Removal of the Debris Basin is compatible only with the removal of the embankment and the agricultural water management measures. Cannot be combined with any other flood prevention measures.	Y
	Remove the Dam Embankment	M	M	M	M	M	C	NA	C	C	C	C	M	M	Removal of the Dam Embankment is compatible only with the removal of the debris basin and the agricultural water management measures. Cannot be combined with any other flood prevention measures.	Y
DEFICIENCY #2: SEEPAGE & EVAPORATION LOSSES IN CCIC SYSTEM	Gravity Pipe Network	C	C	C	C	C	C	C	NA	C	C	C	C	C	The gravity pipe network measure is compatible with all considered structural and nonstructural management measures.	Y
	Splitting Structures for Pipe Network	C	C	C	C	C	C	C	C	NA	C	C	C	C	The splitting structures for pipe network measure is compatible with all considered structural and nonstructural management measures.	Y
DEFICIENCY #3: KANOSH BAND SECONDARY WATER ACCESS	Construct Secondary Water System for Kanosh Band	C	C	C	C	C	C	C	C	C	NA	C	C	C	The secondary water system for the Kanosh Band is compatible with all considered structural and nonstructural management measures.	Y
	Relocate Secondary Regulating Pond to Higher Elevation	C	C	C	C	C	C	C	C	C	C	NA	C	C	Relocating the secondary pond to a higher elevation for pressure and to supply the Kanosh Band secondary system is compatible with all considered structural and nonstructural management measures.	Y
DEFICIENCY #4: FLOODING ISSUES IN KANOSH TOWN	Berm Flood Prevention	C	C	C	M	M	M	M	C	C	C	C	NA	C	A berm is compatible for combination into an alternatve plan with all other considered measures except for the nonstructural options of either floodproofing structures or condutcting property buyouts and the option to remove the dam and debris basin.	Y
	Channel Improvements	C	C	C	M	M	M	M	C	C	C	C	C	NA	The Channel Modifications are compatible for combination into an alternative plan with all other considered measures except for the nonstructural options of either floodproofing structures or condutcting property buyouts and the option to remove the dam and debris basin.	Y

PHASE V: FIRST SCREENING OF THE INITIAL ARRAY AGAINST THE FEDERAL/PROJECT OBJECTIVES & PLANNING CONSTRAINTS

TABLE 6: SUMMARY OF INITIAL ALTERNATIVES AND 1ST SCREENING BASED ON OBJECTIVES AND CONSTRAINTS

N = not met, Y = met, NA = not applicable

ID	ALTERNATIVE DESCRIPTION	Federal Objective	Dam Safety Objective	Breach Hazards Objective	Access to Secondary Water Objective	Drought Resilience Objective	Property Disruptions Constraint	Cultural/Historic Impacts Constraint	Transportation Impacts Constraint	Irrigation Water Access Constraint	Environmental Justice Constraint	CARRIED FORWARD Y/N?
Alternative 1 -- No Action -- FWOFI Alternative	No Action Alternative (FWOFI) Alternative Existing conditions would continue, the problems and opportunities would not be met and conditions would generally worsen. However, required to be carried forward as an analytic baseline in NEPA analysis.	N	N	N	N	N	Y	N	Y	Y	N	Y
Alternative 2 -- Proposed Action -- Dam Replacement Alternative	Dam Replacement Alternative • Reconstruct the Current Debris Basin • Reconstruct the Primary & Secondary Spillways • Reconstruct the Emergency & Auxiliary Spillways • Berm and Channel Modifications • Gravity Pipe Network in Kanosh • Splitting Structures for Pipe Network • Construct Secondary Water System for Kanosh Band • Relocate Secondary Regulating Pond to Higher Elevation	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Alternative 3 -- Proposed Action -- Buyouts Alternative (Nonstructural)	Buyouts Alternative (Nonstructural) • Conduct Relocations/Buyouts of Properties in the Floodplain • Gravity Pipe Network in Kanosh • Splitting Structures for Pipe Network • Construct Secondary Water System for Kanosh Band • Relocate Secondary Regulating Pond to Higher Elevation	N	N	Y	Y	Y	N	N	Y	Y	Y	Y
Alternative 4 -- Proposed Action -- Floodproofing Alternative (Nonstructural)	Floodproofing Alternative (Nonstructural) • Floodproofing of Structures in the Floodplain • Gravity Pipe Network in Kanosh • Splitting Structures for Pipe Network • Construct Secondary Water System for Kanosh Band • Relocate Secondary Regulating Pond to Higher Elevation	N	N	Y	Y	Y	N	N	N	Y	Y	N
Alternative 5 -- Proposed Action -- Dam Removal Alternative	Dam Removal Alternative • Remove the Dam Embankment • Remove the Debris Basin • Gravity Pipe Network in Kanosh • Splitting Structures for Pipe Network • Construct Secondary Water System for Kanosh Band • Relocate Secondary Regulating Pond to Higher Elevation	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y

PHASE VI: SECOND SCREENING OF THE INITIAL ARRAY AGAINST THE ECOYSTEM SERVICES AND ECONOMIC BENEFITS/B/C RATIO

TABLE 7: SUMMARY OF 2ND SCREENING OF INITIAL ARRAY OF ALTERNATIVES BY ECOSYSTEM SERVICES AND ECONOMICS

N = not met/Decreased or Did Not Increase Service Provision, Y = met/Increased Service Provision, NA = not applicable

ID	ALTERNATIVE NAME	PROVISIONING	REGULATING	CULTURAL	SUPPORTING	BCR	ANNUAL NET BENEFITS	CARRIED FORWARD?
Alternative 1: No Action (FWOFI)	**Alternative 1 -- No Action -- FWOFI Alternative.** Although this alternative does not improve the provision of any ecosystem service categories or meet the minimum BCR, it is carried forward into the final array because it is required under NEPA and the PR&G.	N	N	N	NA	0	$0	Y
Alternative 2: Dam Replacement Alternative	**Alternative 2 -- Proposed Action -- Dam Replacement Alternative.** The Dam Replacement Alternative would improve the provision of provisioning, regulating, and cultural ecosystem services in the watershed and would meet the BCR requirement, with a BCR of 3.53 and net benefits of $3,112,796. This plan provides significantly greater economic and ecosystem service benefits than any other plan considered. Additionally, this plan is also the more cost-effective solution of the considered plans that meet the purpose and need.	Y	Y	Y	NA	3.53	$3,112,796	Y
Alternative 3: Buyouts Alternative (Nonstructural)	**Alternative 3 -- Proposed Action -- Buyouts Alternative (Nonstructural)** The Buyouts Alternative would improve the provision of provisioning, regulating, and cultural ecosystem services in the watershed, it would meet the BCR requirement, with a BCR of 1.06 and net benefits of $2,520,432. The costs of this alternative, however, are exorbitant, with annual costs of $3,794,486. However, because this alternative is a nonstructural-structural combination alternative, which is required to be carried forward for flood prevention projects, it was carried forward to the final array despite its high costs and significantly lower benefits compared to the Dam Replacement plan.	Y	Y	Y	NA	1.06	$215,995	Y
Alternative 4: Dam Removal Alternative	**Alternative 4 -- Proposed Action -- Dam Removal Alternative** The Dam Removal Alternative was eliminated because it did not benefit all ecosystem service categories. In those service categories where the service would be improved, it would be improved to a significantly lower margin than the other alternatives in the initial array. For this reason, the Plan was not analyzed quantitatively under the economic screening. Becuase it does not fully support the ecosystem framework of the PR&G, the Dam Removal Alternative was not carried forward into the final array of alternatives.	Y	Y	N	NA	NA	NA	N

PHASE VII: IDENTIFICATION OF THE FINAL ARRAY OF ALTERNATIVES (TO BE SCREENED USING C,E,E,& A)

TABLE 8: FINAL ARRAY OF ALTERNATIVES

Alternative 1 -- No Action -- FWOFI Alternative	Taking no action would consist of activities carried out if no federal funding were provided. The debris basin's high hazard dam would continue to pose a high risk of failure during a large flood, due to the seepage problem occurring in the dam's foundation. This could result in devastating flood damage to the Town of Kanosh. Flood flows would pass through the historic channels with the flooding events continuing. Irrigation flows would continue to be lost through seepage and evaporation from the earthen canals. The Town's secondary water system would keep receiving insufficient pressures for irrigation and would continue increasing the demand on their culinary water systems. The Tribe would continue to have culinary water shortages due to outdoor water use and no effective way to utilize their CCIC shares and water from Corn Creek. Existing conditions and trends would continue. The No-Action Alternative would not meet the purpose and need for the project. However, the No-Action Alternative is carried forward as the basis of comparison for impact analysis.
Alternative 2 -- Proposed Action -- Dam Replacement Alternative	The current debris basin would be reconstructed. The new debris basin would have an updated alignment farther downstream and a taller embankment. The proposed embankment crest elevation is designed to be 5,208.75 feet and the height of the embankment measured from the lowest downstream toe elevation is approximately 50 feet. The proposed primary spillway/low level outlet is a 42-inch conduit with a crest elevation of 5,177 feet. This conduit would discharge into a box that would dissipate energy, split water between two pipelines, and measure flow. This outlet pipe would have a trash rack and be controlled with a guard gate at the inlet of the pipe.The proposed secondary spillway is a morning glory and standpipe type design with a crest elevation of 5,199 feet and effective weir length of 22 feet. The 84-inch standpipe would have a 100-inch trash ring that would keep floating debris from blocking the flow of water into the spillway and blocking downstream culverts. The proposed emergency spillway is a side channel spillway design with a crest elevation of 5,203.8 feet and width of 200 feet. A concrete weir wall would discharge into a concrete side channel that would route the water to the existing emergency channel. The road would be regraded to remove the culverts and create a broad swale that would convey floodwater to the existing flood channel. The proposed auxiliary spillway would be constructed as an armored spillway over the dam with a crest elevation of 5,205.4 feet and width of 200 feet. The proposed armoring is a fabric-formed concrete mattress. The Plan would install bypasses near the existing splitting structure to prevent the Hatton and East/Middle Ditches from breaching. The first bypass would route water that exceeds the capacity of the East/Middle Ditch to the Hatton Ditch. The second bypass would route water that exceeds the capacity of the Hatton Ditch to the West Ditch. Additionally this plan would install a large capacity culvert to prevent the water fromovertopping I-15, which is critical infrastructure. The plan would enlarge the West Ditch downstream of the Main Street culvert and Construct a berm north of the culvert to prevent the floodwater from flowing north routes more water through the large culvert. Finally, 800 feet of an eixsting dirt road would be raised to prevent the water from flowing north. For agricultural water management, a gravity pipe system would be installed to greatly reduce seepage and evaporation losses and increase irrigation water deliveries to the farmers in the area. Diversion boxes would be installed at current irrigation

	turnouts. The proposed pipe system would replace approximately 4.9 miles of open ditches. Up to approximately 14.1 miles of ditches would have pipe installed adjacent to the ditch because the ditch would be needed to convey floodwater. Multiple splitting/measurement structures would be installed for the for the piped system and a sharp crested weir would be used in the splitting structures to ensure uniform controlled flow. The regulating pond would be relocated approximately a half mile upstream of the current pond location. The new pond would supply both the Kanosh Town and the Kanosh Band of Paiutes secondary systems from a higher elevation. This would provide additional pressure in the two secondary systems. Lastly, the plan would add a secondary system to the existing pipeline between the debris basin and the Kanosh Band Tribal community.
Alternative 3 -- Proposed Action -- Buyouts Alternative (Nonstructural)	This Alternative Plan would address flood prevention problems in the watershed through nonstructural measures, which is a requirement for projects having that authorized purpose under PL 83-566. The nonstructural measures for flood control have been combined with "fewer or smaller" structural agricultural water management measures for this alternative, as described in the NWPM and DM 9500-013 in order to meet both purposes of the project. The nonstructural flood prevention measures would consist of conducting property buyouts of all homes in the breach zone of Corn Creek Dam and Debris Basin, effectively removing the risk to life and property for the homes downstream of the Dam and eliminating the flood prevention hazards in this area. The dam would remain at high hazard level and could be expected to breach eventually, causing environmental problems downstream. However, the nonstructural approach would provide a nonstructural solution to the problem, which is required to be fully analyzed as part of the final array of Alternative Plans under the PR&G. The structural agricultural water management measures would include a gravity pipe secondary system to greatly reduce seepage and evaporation losses and increase irrigation water deliveries to the farmers in the area. Diversion boxes would be installed at current irrigation turnouts. The proposed pipe system would replace approximately 4.9 miles of open ditches. Up to approximately 14.1 miles of ditches would have pipe installed adjacent to the ditch. Multiple splitting/measurement structures would be installed for the for the piped system and a sharp crested weir would be used in the splitting structures to ensure uniform controlled flow. The regulating pond would be relocated approximately a half mile upstream of the current pond location. The new pond would supply both the Kanosh Town and the Kanosh Band of Paiutes secondary systems from a higher elevation. This would provide additional pressure in the two secondary systems. Lastly, the plan

	would add a secondary system to the existing pipeline between the debris basin and the Kanosh Band Tribal community.
Environmentally Preferred Alternative (from NEPA)	The NEPA process mandates that an environmentally preferred alternative be identified as a part of the planning process. Additionally, if a CWA Section 404 permit (any potential impacts to WOTUS) is required, the principles of the U.S. Army Corps of Engineers (USACE) Least Environmentally Damaging Practicable Alternative (LEDPA) should be followed and complied with during the development of alternative plans. LEDPA principles are best adhered to using the framework of first, avoidance, then, minimization, then, and only then, mitigation. Action Alternative 1 – Dam Replacement Alternative is the environmentally preferable/LEDPA alternative for this Plan-EA.
Locally Preferred Alternative	Under the PR&G, it is required to identify an alternative plan that is locally preferred. This alternative was developed with sponsors and local interests that have oversight or implementation authorities and responsibilities. In the case of this project, the locally preferred alternatives in Action Alternative 1 – Dam Replacement Alternative.

TABLE 9: SUMMARY AND COMPARISON OF ALTERNATIVES -- PLANNING PROCESS

Green = Met, Red = Not Met

ITEM OR CONCERN	ALTERNATIVE 1 - NO ACTION/FWOFI	ALTERNATIVE 2 - DAM REPLACEMENT	ALTERNATIVE 3 - BUYOUTS
NEPA PURPOSE AND NEED			
PURPOSE & NEED	This alternative would not meet the purpose and need. Flood control, ag. Water management and problems would persist.	Flood Prevention and Ag. Water Mgmt. purposes would be met. Needs would be addressed. Is the environmentally preferred (LEDPA) and locally preferred alternative.	Flood Prevention and Ag. Water Mgmt. purposes would be met using nonstructural measures for flood control. However, would relocate many residents and be very costly.
PROJECT OBJECTIVES			
FEDERAL OBJECTIVE	The FWOFI Alternative would not meet the Federal Objective as it would not meet the Guiding Principles of the PR&G, promote sustainable economic development, protect the environment, or protect the floodplain. Federal Objective not met.	Alternative 2 would meet the Federal Objective by meeting all the Guiding Principles of the PR&G, promoting sustainable economic development, being the LEDPA Plan, and protecting the floodplain downstream of the Dam. Federal Objective met.	Alternative 3 would not meet the Federal Objective, although it would meet parts of it such as some of the Guiding Principles of the PR&G. However, the Plan would not promote sustainable economic development, protect the environment, or protect the downstream floodplain. Federal Objective not met.
OBJECTIVE #1. Dam Safety Compliance	The FWOFI Alternative would not address dam safety compliance problems with Corn Creek Dam and Debris Basin as no funding would be provided to address the issue. Objective would not be met.	The Dam Replacement Alternative would replace Corn Creek Dam and Debris Basin and bring it into compliance with State and NRCS safety standards, meeting this project objective.	The Buyouts Alternative would not bring Corn Creek Dam and Debris Basin into compliance with State and NRCS dam safety standards as the nonstructural measures would remove properties rather than repairing the deficiencies at the dam itself. Objective not met.
OBJECTIVE #2. Breach Hazards	This Plan would not increase awareness of breach/flood hazards in the watershed as no funding would be provided. Objective would not be met.	The replacement of the Dam would be visible to all residents of the watershed and public notices issued, increasing awareness of the problem(s) posed by the current dam and the risks of a breahc. Objective met.	The Plan would certainly increase awareness of breach hazards as many properties and their owners would be relocated and bought out, which would inherently inform them of the rationale supporting that decision. Objective met.
OBJECTIVE #3. Secondary Water Access	Secondary water in the CCIC system would not be conserved and the Kanosh Band would continue to rely on their culinary supply for secondary uses. Objective would not be met.	This Plan would install a gravity pipe secondary system in the CCIC service area to reduce losses and conserve water and install a secondary system for the Kanosh Band to reduce their reliance on culinary water for outdoor use. Objective met.	This Plan would install a gravity pipe secondary system in the CCIC service area to reduce losses and conserve water and install a secondary system for the Kanosh Band to reduce their reliance on culinary water for outdoor use. Objective met.
OBJECTIVE #4. Drought Resilience	Residents of the watershed would not be more drought resilient as a result of this plan because not measures would be implemented to conserve water supply. Objective not met.	The Agricultural Water Management measures of this plan would conserve water and increase water use efficiency, making the communities of Kanosh and the Kanosh Band more resilient to drought conditions. Objective met.	The Agricultural Water Management measures of this plan would conserve water and increase water use efficiency, making the communities of Kanosh and the Kanosh Band more resilient to drought conditions. Objective met.
CONSTRAINTS			
CONSTRAINT #1. Disruptions to Property	No construction would occur under this alternative, and so, no disruptions to property would occur. This alternative meets this constraint.	Implementation of the Plan would avoid direct disruptions to residential and commercial properties and would meet this planning constraint.	Implementation of this Plan would not meet this planning constraint as various residential and commercial properties would be disrupted in order to conduct the nonstructual flood prevention measure of property buyouts/relocations.
CONSTRAINT #2. Cultural Site Impacts	This alternative does not meet this planning constraint. By not installing any flood control infrastructure, all historic/cultural sites in the indirect/No Action APE would be damaged in this scenario.	Although this Plan would have adverse impacts to some historic sites, the constraint specifies avoidance to the extent practicable. The historic sites in the Indirect APE would be protected by this Plan. This planning constraint is met by this Plan.	This Plan would not provide flood prevention protection to historic properties in the indirect APE which would eventually experience significant damage, or even destruction, when the dam eventually breached. Does not meet this constraint.
CONSTRAINT #3. Transportation Impacts	No construction would occur under this alternative, and so, no existing transportation infrastructure would be impacted. This alternative meets this constraint.	This Plan would meet this constraint because, although traffic delays may occur during construction, the roads would still be available for use by emergency services during the implementation period.	This plan would meet this planning constraint as property buyouts and relocations would not affect transportation routes or access for emergency services.
CONSTRAINT #4. Irrigation Water Access	No construction would occur under this alternative, and so, no changes would be made to the ability of farmers to access their irrigation water during the irrigation season.	Agricultural Water Management measures would be implemented outside of the typical irrigation season so that access to irrigation water for farmers would not be impeded.	Agricultural Water Management measures would be implemented outside of the typical irrigation season so that access to irrigation water for farmers would not be impeded.
CONSTRAINT #5. Environmental Justice	Problems related to secondary water access for the Kanosh Band of Paiutes would continue, impeding their ability to fully utilize their unique cultural role in the community and allowing adverse conditions for an EJ population to continue.	This Plan would provide significant direct benefits to an EJ population (the Kanosh Band) by installing a secondary system for them and relocating the Kanosh Town regulating pond, allowing the Band to better prioritize their unique cultural role in the area.	This Plan would provide significant direct benefits to an EJ population (the Kanosh Band) by installing a secondary system for them and relocating the Kanosh Town regulating pond, allowing the Band to better prioritize their unique cultural role in the area.
PR&G EVALUATION CRITERIA			

COMPLETENESS	This alternative would not constitute a complete alternative as no Problems or Opportunities would be addressed.	This alternative would account for all necessary investments to achieve the planned effects and is a complete solution that fully addresses the Problems and Opportunities.	This alternative would account for all necessary investments to achieve the planned effects and is a complete solution that fully addresses the Problems and Opportunities.
EFFECTIVENESS	This alternative would not constitute an effective solution as no problems would not be solved and no project objectives met, including the Federal Objective.	This alternative would address all the identified problems and meet all of the project objectives to constitute an effective solution.	This alternative would constitute only a partially effective solution as the Federal Objective and one of the project objectives would not be met by the plan.
EFFICIENCY	This alternative would not cost anything to implement and so would constitute a cost effective alternative that would be an efficient solution.	This alternative is the NEE alternative and has net positive economic benefits and a BCR of 4.07. This alternative constitutes a cost efficient solution.	This alternative has net positive economic benefits but has a BCR of 1.06 which is significantly lower than the other action plan even though it does meet the minimum value of 1.0, due to the exorbitant cost to conduct property buyouts. Because this plan would require a much higher financial investment to achieve less benefits than a cheaper plan, it is not a cost efficient solution.
ACCEPTABILITY	This alternative would not be acceptable or consistent with existing Federal laws as it would not protect the environment and would not address any of the problems in the watershed.	This alternative would comply with all Federal and State regulatory frameworks and is the environmentally preferred alternative from NEPA and the locally preferred alternative. The problems in the watershed would be addressed. This alternative constitutes an acceptable solution.	This alternative would not be acceptable as it is highly unlikely that property buyouts could be conducted on an entirely voluntary basis, requiring the use of eminent domain to accomplish it. This alternative does not constitute an acceptable solution.

PR&G Ecosystem Services Scoping and Evaluation Worksheet

Franson Civil Engineers

PROJECT NAME	Corn Creek Watershed Plan-EA
PROJECT NUMBER	20112
PROJECT MANAGER	Layne Jensen

Overview of Framework

The PR&G Ecosystem Services Framework is an analysis approach that traces the pathways of natural ecosystem processes to the benefits which they grant to society in monetary and non-monetary terms. NRCS requires that an ecosystem services framework be worked within throughout the preliminary investigation and planning process. Ecosystem services are broken into four service categories which include:

(1) Provisioning Services: tangible goods for human use such as food, clean air, fresh water, energy, fuel, forage, fiber, and minerals.
(2) Regulating Services: maintain natural processes which provide buffers against environmental catastrophe such as long-term storage of carbon; climate regulation; water filtration, purification, and storage; soil stabilization; flood prevention/control; and disease regulation.
(3) Supporting Services: underlying processes maintaining conditions for life such as pollination, seed dispersal, soil formation, and nutrient cycling.
(4) Cultural Services: services related to the cultural or spiritual needs of people such as educational, aesthetic, spiritual and cultural heritage values, recreational experiences, and tourism opportunities.

Evaluation Approach

Ecosystem services are first evaluated from a qualitative perspective during scoping to identify the types of services present in the watershed, and then specifically to identify those that could interact with (impact or be impacted by) the authorized project purpose(s)/problems.

Regulatory Requirement (Level II PR&G Analysis)

The National Watershed Program Manual (NWPM) requires a level II PR&G analysis for any WSOP or REHAB program that will have a Federal construction cost-share of more than $10 million. This level of PR&G analysis requires the robust development of an ecosystem service framework and resulting ecosystem services flows.

Use of this Worksheet

This worksheet was created as a way to document our incorporation and use of the ecosystem services framework and to provide written evidence of the evaluation approach described above. Fill in all the applicable fields on this worksheet for the project you are working on. If it is not a text form or dropdown list, it should not be changed. Depending on the project, not every form or field will be applicable.

AFFECTED ENVIRONMENT: IDENTIFICATION/SCOPING FOR ECOSYSTEM SERVICES

In the tables below, identify ecosystem services that currently exist in the project area and place them under the appropriate service categories as described in the "Overview of Framework" section of this worksheet. Remember, the initial evaluation of ecosystem services should be conducted from a qualitative perspective. The services identified should be directly related to the PL-566 authorized purpose(s)/Problem(s) for the project. Incidental service benefits will be identified in a later section.

Table 1 Scoped Provisioning Services in the Project Area

PROVISIONING SERVICES
Water Savings/Seepage Control
Food Production/Agriculture
Drinking Water Supply
NA

Provisioning Services: tangible goods for human use such as food, clean air, fresh water, energy, fuel, forage, fiber, and minerals.

Table 2 Scoped Regulating Services in the Project Area

REGULATING SERVICES
Flood Prevention/Public Safety Generated by Dam and Debris Basin
Secondary Water Quality
Drought/Climate Change Resiliency
NA

Regulating Services: maintain natural processes which provide buffers against environmental catastrophe such as long-term storage of carbon; climate regulation; water filtration, purification, and storage; soil stabilization; flood prevention/control; and disease regulation.

Table 3 Scoped Supporting Services in the Project Area

SUPPORTING SERVICES
Evaluated as an intermediate ecosystem service, therefore it is not carried forward in this ecosystem services analysis.
NA
NA
NA

Supporting Services: underlying processes maintaining conditions for life such as pollination, seed dispersal, soil formation, and nutrient cycling.

Table 4 Scoped Cultural Services in the Project Area

CULTURAL SERVICES
Agricultural Development of Watershed
Support of Tribal Community
Aesthetic/Scenic Value of the Watershed
Existence Value of Cultural/Historic Sites

Cultural Services: services related to the cultural or spiritual needs of people such as educational, aesthetic, spiritual and cultural heritage values, recreational experiences, and tourism opportunities.

FORECASTED FUTURE CONDITIONS (NO ACTION/FWOFI/ANALYTIC BASELINE)

In the section below, evaluate the reasonably projected changes in the ecosystem service benefits you identified in the previous section. The main focus of this projections should be on how the change in the provision of the service will alter the benefits they provide to society/human welfare. Again, this section should be qualitative and does not necessarily need to provide any specific quantities of services. This write-up (or some slight variation of it) will be included in the Plan-EA/EIS.

The projected changes in the provision of ecosystem services in the project area if no Federal Investment were made would result in overall reductions in the ecosystem service benefits that the natural systems in the project area provide to society. The following changes in ecosystem service benefits would be expected if existing conditions are to continue:

1. Water Savings/Seepage Control Provisioning Service:
- Unreliable irrigation water deliveries to Kanosh farmers would continue.

2. Food Production/Agriculture Provisioning Service:
- Crop yields in the watershed would remain in their current conditions until a Dam breach
- Once the dam breaches, agricultural land would be largely damaged, reducing crop yields.

3. Drinking Water Supply Provisioning Service:
- Kanosh Town's secondary system would function, but with low pressure in high elevation areas.
- The Kanosh Band's culinary system would continue to be strained due to outdoor demands.

4. Flood Prevention/Public Safety Regulating Service:
- The Corn Creek Dam and Debris Basin would remain at high risk of failure.
-The Dam can be reasonably expected to fail if existing conditions continue.
- The Kanosh Community would be at high risk of flooding and damages when the dam breaches.

5. Secondary Water Quality Regulating Service:
- Water quality delivered to farmers would not change, which is currently subject to pollution/contamination

6. Drought/Climate Change Resiliency Regulating Service:
- Continued groundwater withdrawals to supplement irrigation water deliveries to the existing CCIC system.
- Continued seepage/evaporation losses from the open irrigation ditch system, providing inadequate supply.
- As long-term climate trends develop, Kanosh and the surrounding community will become less resilient to environmental catastrophe than they currently are.

7. Agricultural Development Cultural Service:
- Agriculture as an economic sector would remain in its current condition until the dam breached.
- A dam breach would significantly impact the agricultural viability of the area, potentially destroying some cropland.

8. Tribal Community Cultural Service:
- The Kanosh Band would continue to have inadequate water supply and would not become more resilient to long-term climate impacts.

9. Aesthetic/Scenic Value Cultural Service:
- The scenic value of the watershed would not change if existing conditions were allowed to continue until a dam breach.
- When the dam breaches, the damages and removal of the dam itself would negatively impact the aesthetic value.

10. Cultural/Historic Site Existence Value Cultural Service:
- Cultural and historic sites would remain in their current condition prior to a dam breach.
- When the dam breaches, the sites within the Indirect APE would be adversely impacted.

MONETIZING, QUANTIFYING, AND QUALIFYING ECOSYSTEM SERVICES

The decision tree below was provided by the National Watershed Management Center (NWMC) and should be a helpful reference in completing this section of the worksheet.

NWMC Decision Tree for Ecosystem Services

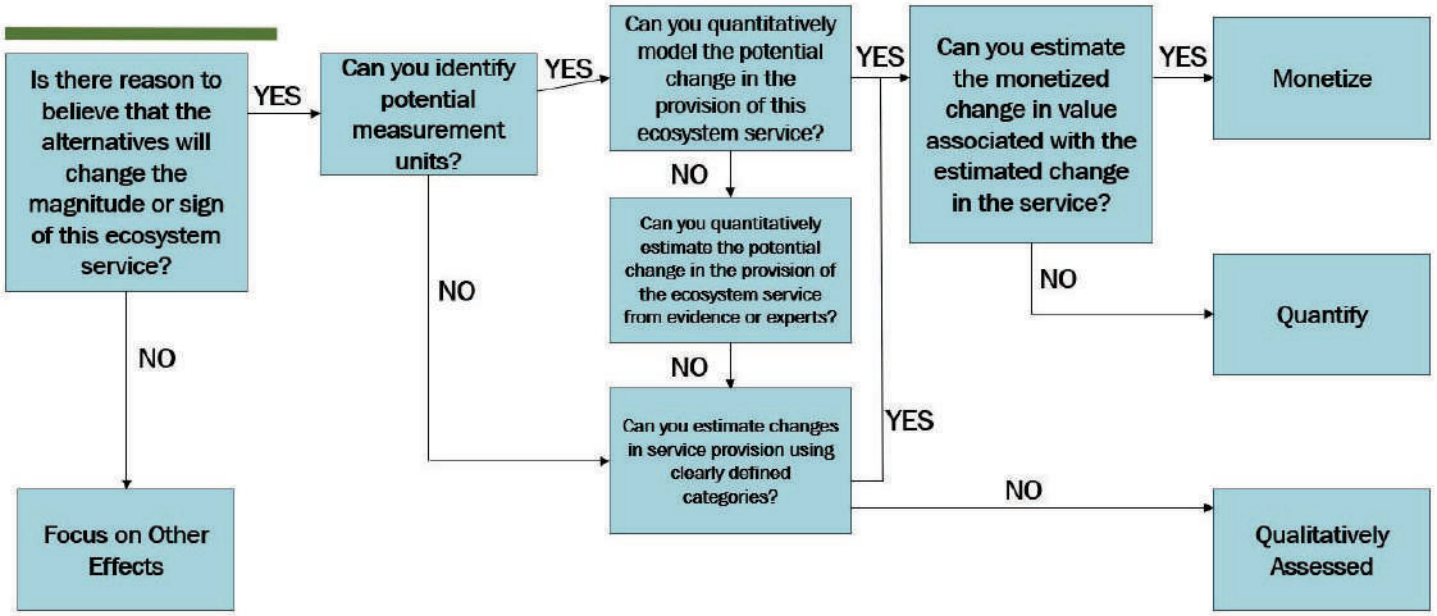


Table 5 Summary of Ecosystem Services & Their Representative Metrics

PROVISIONING SERVICES		
SERVICE	**MONETIZED/QUANTIFIED/QUALIFIED?**	**REPRESENTATIVE METRIC**
Water Savings/Seepage	Quantified	Average Annual Water Savings (AF)
Food Production/Agriculture	Quantified	Annual Change in Crop Yields (tons/yr)
Drinking Water Supply	Monetized	Cost/Benefits of Ag. Water Measures
NA	Not Applicable	NA
REGULATING SERVICES		
SERVICE	**MONETIZED/QUANTIFIED/QUALIFIED?**	**REPRESENTATIVE METRIC**
Flood Prevention/Public Safety	Monetized	Cost/Benefits of Flood Damages/Breach
Secondary Water Quality	Qualified/Non-Monetized	Observed Parameter Improvements
Drought/Climate Resiliency	Quantified	Average Annual Water Savings (AF)
NA	Not Applicable	NA
SUPPORTING SERVICES		
SERVICE	**MONETIZED/QUANTIFIED/QUALIFIED?**	**REPRESENTATIVE METRIC**
NA	Not Applicable	NA
NA	Not Applicable	NA
NA	Not Applicable	NA
NA	Not Applicable	NA
CULTURAL SERVICES		
SERVICE	**MONETIZED/QUANTIFIED/QUALIFIED?**	**REPRESENTATIVE METRIC**
Agricultural Development	Quantified	Average Annual Water Savings (AF)
Tribal Community	Monetized	Cost/Benefits of Ag. Water Measures
Aesthetic/Scenic Value	Qualified/Non-Monetized	Subjective Changes in Viewshed
Cultural/Historic Site Value	Quantified	No./Sites at Risk of Damage in Breach

Examples of Monetized Representative Metrics: flood damage benefits (dollars), expected tourism (dollars)

Examples of Quantified Representative Metrics: protected/restored acres of farmland, crop yields, acre-feet of saved water, WQ Index, habitat units, wildlife/fish/plant species population changes

Examples of Qualified Representative Metrics: aesthetic improvements, vegetation restoration, new recreational opportunities, improved access to the outdoors

MONETIZED ECOSYSTEM SERVICES BENEFITS SUMMARY FOR ALTERNATIVES

Fill in the table below to summarize the estimated monetized benefits of the ecosystem services you identified (if applicable). This table should be provided to the project economist to be included in the economic analysis. It should also be noted that, if necessary, the non-monetized ecosystem service benefits should be provided to the economist to serve as a tradeoff if the B/C ratio does not meet at least 1. These benefits may be used to raise the B/C ratio given subjective values.

Also note, if there were no monetized benefits identified or if any of the ecosystem service categories were eliminated during scoping, note that in the table by including a line that says, "not monetized for this plan".

Table 6 Monetized Benefits Summary for Ecosystem Services

	No Action	Action Alternative 1	Action Alternative 2
PROVISIONING SERVICES			
Water Savings/Seepage	Not Monetized for this Plan	Not Monetized for this Plan	Not Monetized for this Plan
Food Production/Agriculture	Not Monetized for this Plan	Not Monetized for this Plan	Not Monetized for this Plan
Drinking Water Supply	$0 Ag. Water Benefit	$1,490,049 Ag. Water Benefit	$1,490,049 Ag. Water Benefit
NA	NA	NA	NA
REGULATING SERVICES			
Flood Prevention/Public Safety	$0 Reduction Benefit	$2,855,348 Reduction Benefit	$2,520,432 Reduction Benefit
Secondary Water Quality	Not Monetized for this Plan	Not Monetized for this Plan	Not Monetized for this Plan
Drought/Climate Change Resiliency	Not Monetized for this Plan	Not Monetized for this Plan	Not Monetized for this Plan
NA	NA	NA	NA
SUPPORTING SERVICES			
Intermediate Service, Not Analyzed	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA
CULTURAL SERVICES			
Agricultural Development	Not Monetized for this Plan	Not Monetized for this Plan	Not Monetized for this Plan
Benefits to Tribal Community	$0 Ag. Water Benefit	$1,490,049 Ag. Water Benefit	$1,490,049 Ag. Water Benefit
Aesthetic/Scenic Value of Watershed	Not Monetized for this Plan	Not Monetized for this Plan	Not Monetized for this Plan
Existence Value of Cultural/Historic Sites	Not Monetized for this Plan	Not Monetized for this Plan	Not Monetized for this Plan
Total Annual Monetized Benefits	$0	$4,345,396	$4,010,481
Total Annual Monetized Costs	$0	$1,232,600	$3,794,486
Benefit-Cost Ratio	0.0	3.53	1.06
Annual Monetized Net Benefit	$0	$3,112,796	$215,995

IDENTIFICATION OF INCIDENTAL ECOSYSTEM SERVICES

If necessary (usually meaning the B/C ratio for alternative(s) are not reaching 1 with the benefits of problem/authorized purpose related ecosystem benefits), incidental ecosystem services may be used to help raise the B/C ratio to 1 subjectively. The identification of incidental ecosystem services can also help support the environmental/NEPA analysis in the Plan-EA/EIS document.

If desired, fill in the tables below for incidental ecosystem services in the project area.

Table 7 Incidental Provisioning Services in the Project Area

PROVISIONING SERVICES
Soil Characteristics/Underlying Geology
Fish and Wildlife Habitat/Migratory Birds
NA
NA

Provisioning Services: tangible goods for human use such as food, clean air, fresh water, energy, fuel, forage, fiber, and minerals.

Table 8 Incidental Regulating Services in the Project Area

REGULATING SERVICES
Debris Basin Protection of Irrigation Ditches/Channels
Air Quality/GHG Emissions
Riparian Areas
NA

Regulating Services: maintain natural processes which provide buffers against environmental catastrophe such as long-term storage of carbon; climate regulation; water filtration, purification, and storage; soil stabilization; flood prevention/control; and disease regulation.

Table 9 Incidental Supporting Services in the Project Area

SUPPORTING SERVICES
NA
NA
NA
NA

Supporting Services: underlying processes maintaining conditions for life such as pollination, seed dispersal, soil formation, and nutrient cycling.

Table 10 Incidental Cultural Services in the Project Area

CULTURAL SERVICES
NA
NA
NA
NA

Cultural Services: services related to the cultural or spiritual needs of people such as educational, aesthetic, spiritual and cultural heritage values, recreational experiences, and tourism opportunities.

ENVIRONMENTAL CONSEQUENCES: IMPACTS OF ALTERNATIVES ON ECOSYSTEM SERVICES

In the environmental consequences chapter of the Plan-EA/EIS, the impacts of each alternative in the final array on ecosystem services must be evaluated. If the service is monetized or quantified, the dollars or values associated with that service under each alternative should be listed in the descriptions. In the sections below, generate write-ups for the Plan-EA/EIS that evaluate the environmental consequences/impacts to the ecosystem services in the project area.

Ecosystem Services Impact Write-Ups:

No Action/FWOFI: Provisioning Services would not be improved but would diminish over time under this Alternative Plan. See the "Forecasted Future Conditions" section of this worksheet/documentation.

Action Alternative 1: Provisioning Services would be improved under this alternative. Average water conservation of ~3,148 AF would result in an expected crop yield increase of ~64% for Alfalfa and ~73% for grass hay over ~3,000 acres of land. This equates to an average annual crop yield increase of ~7,400 tons of Alfalfa and ~983 tons of Grass Hay. The installation of the proposed agricultural water management measures would provide an average annual monetary benefit of $1,490,049 to the area, demonstrating benefits to the provisioning service of drinking water supply.

Action Alternative 2: Provisioning Services would be improved under this alternative. Average water conservation of ~3,148 AF would result in an expected crop yield increase of ~64% for Alfalfa and ~73% for grass hay over ~3,000 acres of land. This equates to an average annual crop yield increase of ~7,400 tons of Alfalfa and ~983 tons of Grass Hay. The installation of the proposed agricultural water management measures would provide an average annual monetary benefit of $1,490,049 to the area, demonstrating benefits to the provisioning service of drinking water supply.

No Action/FWOFI: Regulating Services would not be improved but would diminish over time under this Alternative Plan. See the "Forecasted Future Conditions" section of this worksheet/documentation.

Action Alternative 1: This alternative would protect the Town of Kanosh against the 100-year storm event/the Dam Breach and would provide annual monetary flood damage reduction benefits of $2,921,303. The quality of secondary water would be improved as the water would be piped and would not be subject to contamination via pollutants, this will created an observed decrease in turbidity. The watershed would become more resilient to drought/climate change under this Plan as significant water savings would occur (~3,148 AF), decreasing reliance on the groundwater system for late season irrigation needs.

Action Alternative 2: This alternative would relocate the structures within the breach zone of Corn Creek Dam by conducting property buyouts, which is a very costly option. However, the avoided annual damage reduction benefit of doing this would be $3,600,905. The quality of secondary water would be improved as the water would be piped and would not be subject to contamination via pollutants, this will create an observed decrease in turbidity. The watershed would experience ~3,148 AF of water savings, but would lose the storage of Corn Creek Dam when it eventually breached, leaving the community in a worse position to combat drought/climate change impacts than if the dam were rehabilitated. Although the damage reduction benefit is higher under this Plan than Action Plan 1, it comes with significantly higher costs, bringing the B/C ratio of this Plan down substantially lower than Action Plan 1.

SUPPORTING SERVICES EVALUATED AS INTERMEDIATE SERVICE IN THIS PLAN, NO ADDITIONAL INFORMATION NECESSARY.

No Action/FWOFI: Cultural Services would not be improved but would be diminished over time under this Alternative Plan. See the "Forecasted Future Conditions" section of this worksheet/documentation.

Action Alternative 1: Agricultural development and viability would be supported/improved by this plan as it would protect the open space viewshed and encourage the perpetuation of the agricultural sector. Additionally, there would be benefits to the Kanosh Band Tribal community as a result of the agricultural water management measures which would provide an average annual monetary benefit of $1,490,049. Although this Plan would include some adverse impacts to cultural/historic properties, it would ultimately protect the historic properties that would otherwise be damaged during a dam breach within the indirect APE.

Action Alternative 2: Agricultural development and viability would be supported/improved by this plan as it would protect the open space viewshed and encourage the perpetuation of the agricultural sector. However, there would be significant damages to agricultural land when the dam breach eventually occurs. There would also be benefits to the Kanosh Band Tribal community as a result of the agricultural water management measures, resulting in an average annual monetary benefit of $1,490,049. This plan would not protect historic properties within the indirect APE, which would ultimately be damaged by the eventual dam breach.

CORN CREEK CUMULATIVE EFFECTS ANALYSIS

STEP 1: IDENTIFY THE SIGNIFICANT CUMULATIVE EFFECTS ISSUES ASSOCIATED WITH THE PROPOSED ACTION(S) AND DEFINE THE ASSESSMENT GOALS

Resource Concern	Alternative	Effect Type & Duration	Significant?
Prime/Unique Farmland	Dam Replacement	Direct Permanent Benefits	**Yes**
Prime/Unique Farmland	Buyouts Alternative	Direct Permanent Benefits	**Yes**
Prime/Unique Farmland	Buyouts Alternative	Direct Permanent Impact	**Yes**
Erosion/Sedimentation	Dam Replacement	Direct Temporary Impact	No
Erosion/Sedimentation	Dam Replacement	Direct Permanent Benefits	No
Erosion/Sedimentation	Buyouts Alternative	Direct Temporary Impact	No
Erosion/Sedimentation	Buyouts Alternative	Direct Permanent Benefit	No
Surface Water Quantity	Dam Replacement	Direct Permanent Benefit	No
Surface Water Quantity	Buyouts Alternative	Direct Permanent Benefit	No
Beneficial Use Impairment	Dam Replacement	Direct Permanent Benefit	No
Beneficial Use Impairment	Buyouts Alternative	Direct Permanent Benefit	No
Sediment Management (WQ)	Dam Replacement	Direct Temporary Impact	No
Sediment Management (WQ)	Dam Replacement	Direct Permanent Benefit	No
Sediment Management (WQ)	Buyouts Alternative	Direct Temporary Impact	No
Sediment Management (WQ)	Buyouts Alternative	Direct Permanent Impact	No
Surface Water Quality	Dam Replacement	Direct Temporary Impacts	No
Surface Water Quality	Dam Replacement	Direct Permanent Benefit	No
Surface Water Quality	Buyouts Alternative	Direct Temporary Impacts	No
Surface Water Quality	Buyouts Alternative	Direct Permanent Benefit	No
Groundwater Quantity	Dam Replacement	Direct Permanent Benefits	**Yes**

Resource Concern	Alternative	Effect Type & Duration	Significant?
Groundwater Quantity	Dam Replacement	Indirect Permanent Impacts	No
Groundwater Quantity	Buyouts Alternative	Direct Permanent Benefits	**Yes**
Groundwater Quantity	Buyouts Alternative	Indirect Permanent Impacts	No
Groundwater Quality	Dam Replacement	Indirect Permanent Impact	No
Groundwater Quality	Dam Replacement	Direct Permanent Benefit	No
Groundwater Quality	Buyouts Alternative	Indirect Permanent Impact	No
Groundwater Quality	Buyouts Alternative	Direct Permanent Benefit	No
Floodplain Management	Dam Replacement	Direct Permanent Benefit	**Yes**
Floodplain Management	Buyouts Alternative	Direct Permanent Benefit	**Yes**
Wetlands/Aquatic Sites	Dam Replacement	Direct Permanent Impact	No
Wetlands/Aquatic Sites	Buyouts Alternative	Direct Permanent Impact	No
Air Quality	Dam Replacement	Direct Temporary Impact	No
Air Quality	Buyouts Alternative	Direct Temporary Impact	No
Climate Change/GHG	Dam Replacement	Direct Temporary Impact	No
Climate Change/GHG	Buyouts Alternative	Direct Temporary Impact	No
Invasive Species/Weeds	Dam Replacement	Indirect Permanent Impact	**Yes**
Invasive Species/Weeds	Buyouts Alternative	Indirect Permanent Impact	**Yes**
Migratory Birds	Dam Replacement	Indirect Temporary Impact	No
Migratory Birds	Buyouts Alternative	Indirect Temporary Impact	No
Wildlife Habitat/Species	Dam Replacement	Indirect Temporary Impact	No
Wildlife Habitat/Species	Buyouts Alternative	Indirect Temporary Impact	No
Riparian Vegetation	Dam Replacement	Direct Permanent Impact	No

Resource Concern	Alternative	Effect Type & Duration	Significant?
Riparian Vegetation	Buyouts Alternative	Direct Permanent Impact	No
Cultural/Historic Sites	Dam Replacement	Direct Permanent Impacts	**Yes**
Cultural/Historic Sites	Buyouts Alternative	Direct Permanent Impacts	**Yes**
Environmental Justice	Dam Replacement	Direct Permanent Benefits	**Yes**
Environmental Justice	Buyouts Alternative	Direct Permanent Benefits	**Yes**
Population/Socioeconomics	Buyouts Alternative	Direct Permanent Impacts	**Yes**
Employment/Socioeconomics	Dam Replacement	Direct Temporary Benefit	No
Employment/Socioeconomics	Buyouts Alternative	Direct Permanent Impact	**Yes**
Income/Socioeconomics	Dam Replacement	Direct Permanent Benefits	**Yes**
Income/Socioeconomics	Buyouts Alternative	Indirect Permanent Impact	No
Income/Socioeconomics	Buyouts Alternative	Direct Permanent Benefit	**Yes**
Occupation/Socioeconomics	Dam Replacement	Direct Permanent Benefit	**Yes**
Occupation/Socioeconomics	Buyouts Alternative	Direct Permanent Benefit	**Yes**
Risk of Dam Failure	Dam Replacement	Direct Permanent Benefits	No
Risk of Dam Failure	Buyouts Alternative	Indirect Permanent Impacts	No
Public Safety/Drowning Risk	Dam Replacement	Direct Permanent Benefit	No
Public Safety Drowning Risk	Buyouts Alternative	Direct Permanent Benefit	No
Transportation Infrastructure	Dam Replacement	Direct Temporary Impact	No
Transportation Infrastructure	Dam Replacement	Direct Permanent Benefit	No
Transportation Infrastructure	Buyouts Alternative	Direct Temporary Impact	No
Scenic Beauty/Visual	Dam Replacement	Direct Temporary Impacts	No

Resource Concern	Alternative	Effect Type & Duration	Significant?
Scenic Beauty/Visual	Dam Replacement	Indirect Temporary Impacts	No
Scenic Beauty/Visual	Buyouts Alternative	Direct Temporary Impacts	No
Scenic Beauty/Visual	Buyouts Alternative	Indirect Temporary Impacts	No
Land Use Designations	Dam Replacement	Direct Permanent Impact	No
Land Use Designations	Buyouts Alternative	Direct Permanent Impact	No
Agricultural Land Use	Dam Replacement	Direct Permanent Benefit	No
Agricultural Land Use	Buyouts Alternative	Direct Permanent Benefit	No
Residential Land Use	Dam Replacement	Direct Permanent Benefit	No
Residential Land Use	Buyouts Alternative	Direct Permanent Benefit	No
Residential Land Use	Buyouts Alternative	Direct Permanent Impacts	No
Provisioning Ecos. Services	Dam Replacement	Direct Permanent Benefits	No
Provisioning Ecos. Services	Buyouts Alternative	Direct Permanent Benefits	No
Regulating Ecos. Services	Dam Replacement	Direct Permanent Benefits	No
Regulating Ecos. Services	Buyouts Alternative	Direct Permanent Impacts	No
Cultural Ecos. Services	Dam Replacement	Direct Permanent Benefits	No
Cultural Ecos. Services	Buyouts Alternative	Direct Permanent Benefits	No

STEP 2: ESTABLISH THE GEOGRAPHIC SCOPE FOR THE ANALYSIS

Resource Concern Category in Plan-EA	Geographic Area for CE Analysis
Prime and Unique Farmland	Corn Creek Watershed, Utah
Surface Water Quantity	Corn Creek Watershed, Utah
Groundwater Quantity	Groundwater Basin
Floodplain Management	Corn Creek Watershed, Utah
Invasive Species/Noxious Weeds	Millard County, Utah
Cultural and Historic Resources	Corn Creek Watershed, Utah
Environmental Justice and Civil Rights	Millard County, Utah
Socioeconomics (Local, Regional, and National Economy)	Millard County, Utah

- The largest geographic area identified for the significant CE issues is **Millard County,** which will be used as the Geographic Scope for the entire CE Analysis.

STEP 3: ESTABLISH A TIME FRAME FOR THE ANALYSIS

TOTAL PROJECT PERIOD OF ANALYSIS IS 52 YEARS

Significant CE Issue	Expected Duration of Effects	Time Frame for CE Analysis
Farmland/Benefits/Alt. 2	50-Years	5-Years
Farmland/Benefits/Alt. 3	50-Years	5-Years
Farmland/Impacts/Alt. 3	50-Years	5-Years
Water Quantity/Benefits/Alt. 2	50-Years	5-Years
Water Quantity/Benefits/Alt. 3	50-Years	5-Years
GW Quantity/Benefits/Alt. 2	50-Years	5-Years
GW Quantity/Benefits/Alt. 3	50-Years	5-Years
Floodplains/Benefits/Alt. 2	50-Years	5-Years
Floodplains/Benefits/Alt. 3	50-Years	5-Years
Invasive Sp./Impacts/Alt. 2	5-Years	1-Year
Invasive Sp./Impacts/Alt. 3	5-Years	1-Year
Cultural/Impacts/Alt. 2	50-Years	1-Year
Cultural/Impacts/Alt. 3	50-Years	1-Year
Env. Justice/Benefits/Alt. 2	50-Years	5-Years
Env. Justice/Benefits/Alt. 3	50-Years	5-Years
Population/Impacts/Alt. 3	50-Years	5-Years

Significant CE Issue	Expected Duration of Effects	Time Frame for CE Analysis
Employment/Impacts/Alt. 3	2-Years	2-Years
Occupation/Benefits/Alt. 2	50-Years	5-Years
Occupation/Benefits/Alt. 3	50-Years	5-Years

- The longest time frame identified for the significant CE issues **is 5 years**, which will be used as the time frame for the entire CE Analysis. This will include a review of recently completed projects (in the past 1 year) and a forecast of projects expected to either (A) be constructed, or (B) begin construction in the next 5 years.

STEP 4: IDENTIFY OTHER ACTIONS AFFECTING THE RESOURCES, ECOSYSTEMS, AND HUMAN COMMUNITIES OF CONCERN.

- *FEDERAL PROJECTS* (Corn Creek Watershed – 5-Year Forecast)
  - Natural Resources Conservation Service
    - Millard County EWP 2023-Spring Site & Water Crossing
      - *This Emergency Watershed Protection (EWP) project includes the installation of riprap, concrete wall replacement, grading, earthen dike building, and a concrete low-water crossing. Bids for construction were opened in May 2024.*
    - Lower Sevier Watershed Plan-EA
      - *This project is being funded by NRCS through the PL 83-566 program, like this one, for the Lower Sevier River Watershed near Delta in Millard County. The project seeks to make improvements to the "C" Canal Water Efficiency Project to reduce water loss from leakage and evapotranspiration and to improve public safety along the canal. The scoping phase was completed in 2022. The Plan-EA is currently still in development. If approved, the project would likely begin construction sometime in the next 5-years.*
  - U.S. Forest Service
    - Desert Experimental Range in Pine Valley
      - *The USFS established the Desert Experimental Range in Pine Valley, Millard County in 1933 as a center for cold desert rangeland research. It encompasses 87 square miles and is designated as a biosphere reserve. Recent projects in this experimental range include Utah State University's Quantitative Soil Survey and Interpretation project, funded by the USDA REEIS program and supported by the U.S. Geological Survey as well. The study focused on soil erosion, vegetation dynamics, and climate change impacts using portable wind tunnels. The project studies took place in 2023.*
    - White Sage Flat Habitat Restoration Project Phase 2
      - *The USFWS conducts pinyon-juniper woodland management to restore ecosystems, reduce wildfire risks, and improve wildlife habitats. This project consists of the reduction of pinyon-juniper fuel*

loading southeast of Kanosh, Utah. This project will consist of different methods to reduce fuel loading such as anchor chaining, reseeding, bull hog mastication of smaller trees with skid steers and hand removal. Expected to be completed in 2025.

- Intermountain Power Agency (IPA)
  - Intermountain Power Project (IPP)
    - *The Intermountain Power Project (IPP) began construction in October 2022 and is anticipated to be completed in 2025. The project is transitioning the existing coal-fired power plant near Delta, Utah, in Millard County, to a combined-cycle natural gas facility capable of utilizing Hydrogen.*
- Federal Energy Regulatory Commission
  - Kern River Delta Lateral Project
    - *A Record of Decision (ROD) was approved in January 2023 for the Kern River Delta Lateral Project which would install a 24-inch diameter high pressure natural gas pipeline and ancillary facilities on 6.9 miles of BLM managed public land in Millard County. The BLM will issue a 30-year right-of-way grant and a temporary use permit to construct and operate the pipeline. This project connects the project to the Intermountain Power Project (IPP) north of Delta. Construction began in 2023 and was completed in Spring 2024.*
- Bureau of Land Management
  - Renewable Energy Development in Millard County
    - *The BLM purchased two parcels, covering ~3,045 acres in Millard County, within the Fishlake National Forest to put toward geothermal energy development in January 2023. Leases for the project were announced in March 2023.*
  - Three Knolls Project Phase II
    - *This project will expand and improve ~1,035 acres of sagebrush habitat at the south end of the Valley Mountains by removing existing juniper via mastication and seeding techniques. The project is located ~12 miles southeast of Scipio in the foothills of the Valley Mountains in Millard County, Utah. The project is expected to be implemented in 2025.*

- *STATE PROJECTS* (Corn Creek Watershed – 5-Year Forecast)
  - Utah Division of Wildlife Resources (DWR)
    - Pahvant Wildlife Management Area (WMA) Habitat Improvement
      - *The DWR has been implementing habitat improvement projects on the Pahvant WMA in Millard County to improve habitat conditions for vegetation management and infrastructure improvements. These improvements occur annually and are ongoing.*
    - Fillmore WMA Habitat and Private Land Habitat Improvement Project
      - *Phase II of this project will improve wildlife habitat in WMA in Millard County. Also, co-sponsored by the USFWS through their Partners Program to improve winter habitat for deer, elk, and wild turkeys through improvements like pinyon-juniper removal and fencing.*

Located in the Fillmore and Holden areas of Millard County. Expected to be implemented in 2025.

- Utah Department of Transportation
  - US-6 Delta to Juab County Line & SR-174
    - *This project seeks to make various road improvements to US-6 between Delta and the Juab County Line/SR-174. Work began on this project in May 2024, and it is 86% complete at the time of writing this Plan-EA.*
  - I-70/I-15 Interchange Bridge Maintenance
    - *This project consisted of routine maintenance to the I-70/I-15 Interchange Bridge in Millard County. The project began work in April 2022 and was completed in September 2024.*

- *LOCAL PROJECTS* (Corn Creek Watershed – 5-Year Forecast)
  - Kanosh Band of Paiute Indians
    - Geothermal Energy Development
      - *The Kanosh Band was awarded a grant from the Department of the Interior's Energy and Mineral Development Program in September 2024 to support geophysical studies to evaluate the feasibility of geothermal energy development on Tribal lands.*
    - RV Park Enhancement
      - *The Kanosh Band was awarded a Department of Agriculture grant through the Rural Business Development Grant Program (RBDG) to provide technical assistance, training, and a computerized financial system for an RV park on their land.*
    - Park and Playground Upgrades
      - *The Kanosh Band is collaborating with the Native American Initiative (NAI) program to upgrade an existing park and playground on Tribal land. The NAI also recently helped install new streetlights for the community.*

STEP 5: PERFORM CUMULATIVE EFFECTS ANALYSIS FOR THE PROJECT

Action Alternative 2 – Proposed Action – Dam Replacement Alternative

- Prime and Unique Farmland Benefits – Cumulative Effects
  - Improved farmland productivity/crop yield
    - *No interactive or additive adverse or beneficial effects from any of the projects.*
  - agricultural viability
    - *Additive Benefit to Lower Sevier Watershed Plan-EA. Adds to benefits to ag. Water management in the county.*
  - crop damage from flooding reduced
    - *Interactive Benefit to Kanosh Band Geothermal Energy Development. Less risk of damage to lands due to flooding.*
  - reduce the risk of economic loss for farmers.
    - *No interactive or additive adverse or beneficial effects from any of the projects.*
- Surface Water Quantity Benefits – Cumulative Effects

    - Seepage/Evaporation reduction/Water Savings
        - *Additive Benefit to Lower Sevier Watershed Plan-EA. Adds to the benefits of water conservation and ag. Water management in Millard County.*
- Groundwater Quantity Benefits – Cumulative Effects
    - Reduced demand on groundwater
        - *No interactive or additive adverse or beneficial effects from any of the projects.*
    - Increased system sustainability for Kanosh Band
        - *No interactive or additive adverse or beneficial effects from any of the projects.*
- Floodplain Management Benefits – Cumulative Effects
    - Reduce flooding and flood damages to the community
        - *Interactive Benefit to all three Kanosh Band projects as damages from flooding would be less likely to occur, promoting geothermal development and protecting the RV park and playground.*
    - Protection of the floodplain from damages
        - *Interactive Benefit to the White Sage Flat Habitat Restoration project. Protection of floodplain functionality promotes natural ecosystem function, a goal of the project which takes place in the upper Corn Creek Watershed.*
- Invasive Species/Noxious Weeds Adverse Impacts – Cumulative Effects
    - Potential introduction of additional or more invasive species/noxious weeds
        - *Interactive Adverse Effect to the White Sage Flat Habitat Restoration project. By potentially bringing more/additional invasive plants into the watershed during construction, the goal to restore vegetative conditions in the watershed of this project could be diminished somewhat. Although there is not a guarantee that invasive species would be introduced and BMPs will be used, there is always potential during construction.*
- Cultural & Historic Resources Adverse Impacts – Cumulative Effects
    - Irreversible adverse effects to NRHP site(s)
        - *No interactive or additive adverse or beneficial effects from any of the projects.*
- Environmental Justice & Civil Rights Benefits – Cumulative Effects
    - Support of the Kanosh Band (EJ Pop.) through implementation
        - *Interactive Benefit to all projects from the Kanosh Band, as damages from flooding would be less likely to occur, promoting geothermal development and protecting the RV park and playground. Improves conditions for an EJ population in Millard County.*
- Socioeconomics (Occupation) Benefits – Cumulative Effects
    - Saved water/Extended growing season/Long-term agricultural development
        - *Additive Benefit to Lower Sevier Watershed Plan-EA. Adds to benefits to ag. Water management in the county.*
    - Tribal Land agricultural expansion
        - *Additive Benefit to Lower Sevier Watershed Plan-EA. Adds to benefits to ag. Water management in the county.*

Action Alternative 3 – Nonstructural-Structural Combination – Buyouts Alternative

- Prime and Unique Farmland Benefits – Cumulative Effects
  - Improved farmland productivity/crop yield
    - *No interactive or additive adverse or beneficial effects from any of the projects.*
  - agricultural viability
    - *Additive Benefit to Lower Sevier Watershed Plan-EA. Adds to benefits to ag. Water management in the county.*
  - crop damage from flooding reduced
    - *Interactive Benefit to Kanosh Band Geothermal Energy Development. Less risk of damage to lands due to flooding.*
  - reduced the risk of economic loss for farmers.
    - *No interactive or additive adverse or beneficial effects from any of the projects.*
- Prime and Unique Farmland Adverse Impacts – Cumulative Effects
  - Imminent flood damage from breach to agricultural fields
    - *No interactive or additive adverse or beneficial effects from any of the projects.*
- Surface Water Quantity Benefits – Cumulative Effects
  - Seepage/Evaporation reduction/Water Savings
    - *Additive Benefit to Lower Sevier Watershed Plan-EA. Adds to the benefits of water conservation and ag. Water management in Millard County.*
- Groundwater Quantity Benefits – Cumulative Effects
  - Reduced demand on groundwater
    - *No interactive or additive adverse or beneficial effects from any of the projects.*
  - Increased system sustainability for Kanosh Band
    - *No interactive or additive adverse or beneficial effects from any of the projects.*
- Floodplain Management Benefits – Cumulative Effects
  - Reduce flooding and flood damages to the community
    - *No interactive or additive adverse or beneficial effects from any of the projects.*
- Invasive Species/Noxious Weeds Adverse Impacts – Cumulative Effects
  - Potential introduction of additional or more invasive species/noxious weeds
    - *Interactive Adverse Effect to the White Sage Flat Habitat Restoration project. By potentially bringing more/additional invasive plants into the watershed during construction, the goal to restore vegetative conditions in the watershed of this project could be diminished somewhat. Although there is not a guarantee that invasive species would be introduced and BMPs will be used, there is always potential during construction.*

- Cultural & Historic Resources Adverse Impacts – Cumulative Effects
  - Irreversible adverse effects to NRHP site(s)
    - *No interactive or additive adverse or beneficial effects from any of the projects.*

- Environmental Justice & Civil Rights Benefits – Cumulative Effects
  - Support of the Kanosh Band (EJ Pop.) through implementation
    - *Interactive Benefit to all projects from the Kanosh Band, as damages from flooding would be less likely to occur, promoting geothermal development and protecting the RV park and playground. Improves conditions for an EJ population in Millard County.*
- Socioeconomics (Population) Adverse Impacts – Cumulative Effects
  - Relocations reduce county population
    - *No interactive or additive adverse or beneficial effects from any of the projects.*
- Socioeconomics (Employment) Adverse Impacts – Cumulative Effects
  - Relocations driving out business owners
    - *No interactive or additive adverse or beneficial effects from any of the projects.*
- Socioeconomics (Occupation) Benefits – Cumulative Effects
  - Saved water/Extended growing season/Long-term agricultural development
    - *Additive Benefit to Lower Sevier Watershed Plan-EA. Adds to benefits to ag. Water management in the county.*
  - Tribal Land agricultural expansion
    - *Additive Benefit to Lower Sevier Watershed Plan-EA. Adds to benefits to ag. Water management in the county.*

CONCLUSION

NRCS reviewed the potential for there to be additive or interactive effects from the two Action Alternatives in combination with projects that have occurred or will occur in the next 5-years in Millard County, Utah. Effects on various resources are anticipated as a result of the implementation of either Alternative Plan, but only the resource concerns identified above were deemed to have impacts significant enough to potentially be cumulative. Several effects would have interactive or additive cumulative benefits to other projects in the area. The only adverse cumulative effect that could occur under either Alternative, is the potential to introduce invasive/noxious botanical species into the watershed during construction. However, BMPs will be implemented in either case to avoid or minimize the extent of these effects.

Notably, the Proposed Actions would result in permanent beneficial cumulative effects to environmental justice communities within Millard County by providing benefits to the Kanosh Band of Paiutes.

Economic Investigation and Analysis Report

Corn Creek Watershed Plan

Proposed Floodwater Retarding Structures

Millard County, Utah

Prepared for:



November 2024

Prepared by:

Hal Gordon, Economist

1.0 SUMMARY OF REQUIREMENTS AND GUIDELINES

The NRCS National Watershed Program Manual (NWPM) was used as a reference for the economic analysis along with three other documents: the National Resource Economics Handbook, Part 611 Water Resources Handbook for Economics, USDA/Natural Resources Conservation Service, July 1998; Principles and Guidelines for Water and Land Related Resources Implementation Studies (P&G), December 1983; and Guidance for Conducting Analyses Under the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies and Federal Water Resource Investments (PR&G), DM 9500-013. The latter includes requirements set forth in the Council on Environmental Quality (CEQ) Principles and Requirements for Federal Investments in Water Resources (P&R) and Interagency Guidelines (IAG). DM 9500-013 provides guidance on completing a PR&G analysis, including steps in the planning and evaluation process, differences between project- and programmatic-level evaluations, direction on incorporating an ecosystem services framework, and techniques for economic analysis.

According to the PR&G, the alternative that maximizes net economic benefits is referred to as the National Efficiency Evaluation (NEE) alternative and will be the preferred alternative. PR&G requires that public benefits (monetary and non-monetary) be maximized relative to cost. Furthermore, there is not a hierarchal relationship among the economic, social, or environmental goals regardless of whether they can be monetized. Agency policy allows for the use of social effect goals to make the case for flood control activities, even if the associated benefit-cost (B/C) ratio is less than 1:1. This is due to the difficulty in monetizing the value of life and quality of life, which is laden with subjective value judgments. Threat to human life and quality factors can therefore be used to outweigh purely economic considerations when appropriate. PR&G allows a wide range of alternatives to illustrate the range of potential tradeoffs among environmental, economic, and social goals.

The Federal Objective, as set forth in the Water Resources Development Act of 2007, specifies that Federal water resources investments shall reflect national priorities, encourage economic development, and protect the environment by: (1) seeking to maximize sustainable economic development; (2) seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and (3) protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems.

The guiding principles in P&G and PR&G constitute the concepts that should consider when analyzing Federal investments in water resources and the P&G and PR&G General Requirements are topics that

agencies must consider when analyzing Federal investments in water resources. The following Principles constitute the overarching concepts the Federal government seeks to promote through Federal investments in water resources now and into the foreseeable future.

A. Healthy and Resilient Ecosystems. Federal investments in water resources should protect and restore the functions of ecosystems and mitigate any unavoidable damage to these natural systems.

B. Sustainable Economic Development. Federal investments in water resources should encourage sustainable economic development.

C. Floodplains. Federal investments in water resources should avoid the unwise use of floodplains and flood-prone areas and minimize adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used.

D. Public Safety. Threats to people, including both loss of life and injury from natural events, should be assessed in the determination of existing and future conditions and, ultimately, in the decision-making process.

E. Environmental Justice. Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Agencies should ensure that Federal actions identify any disproportionately high and adverse public safety, human health, or environmental burdens of projects on minority, Tribal, and low-income populations.

F. Watershed Approach. A watershed approach to analysis and decision-making facilitates evaluation of a more complete range of potential solutions and is more likely to identify the best means to achieve multiple goals over the entire watershed.

2.0 ALTERNATIVES EVALUATED

According to the PR&G and the NWPM, “Flood Prevention” was the purpose analyzed for the Corn Creek Watershed Plan-EA. Table 6, Comparison of NEE Benefits and Costs, contains a summary of the average annual project costs and benefits. The Excel Workbook “CornCreekFloodDamagesBenefits.xml”, with associated sheets within the workbook, provide the detail for the complete economic analysis. The

project area contains one sub-basin surrounding the town of Kanosh, Utah. Incremental analysis was conducted considering two improvements: Dam/Channel Work and Gravity Pipeline. The individual dam and channel improvements work in conjunction with each other and the omission of any item within the increment would render the remaining options ineffective. The gravity pipeline was analyzed as a separate increment.

Once flood waters pass Interstate Highway-15, waterways dissipate into farm and desert grazing land, there are no additional flood damages. Incremental analysis was conducted considering two flood control measures.

As described in the General Plan EA, the main purpose of the watershed plan is to reduce the average annual flood damages and improve irrigation water management. While only flood-damage and irrigation water management related benefits were quantified, other types of benefits serving the project purposes were still considered qualitatively when evaluating the costs and benefits of project alternatives.

According to PR&G, after preliminary consideration, agencies may remove from detailed study those alternatives that do not achieve the Federal Objective and Guiding Principles. In addition, alternatives that may at first appear reasonable but clearly become unreasonable because of cost, logistics, existing technology, social, or environmental reasons may also be eliminated from further analysis. These alternatives were briefly discussed to indicate that they were considered, and the analysis documented the reason(s) why they were eliminated (e.g., they do not achieve the Federal Objective and Guiding Principles).

In general, the NEE alternative was developed in accordance with PR&G by evaluating economic, social, and environmental impacts from flood damage reduction in the rural community. Given the emphasis placed on the construction of flood control structures by the local steering committee to provide flood mitigation, the geographic extents of evaluated alternatives are limited to the area in which one or more of the proposed structural alternatives would have an estimated impact to the 500-year flood depth. The project life was 50-years, the flood protection design was for 100-year flood event and the average annual flood benefits were based on 2-year through the 500-year flood event (because any of the flood events could occur during the 50-year project life). The annual benefits of the project alternatives are based on the estimated reduction in average annual floodwater damages with proposed flood control measures in place compared to future conditions without mitigative action (No Action Alternative). Two

categories: 1) Flood Control and 2) Agricultural Water Management were identified in the development of action alternatives.

Alternatives considered included the No Action Alternative, nonstructural alternatives, the locally preferred alternative, and the NEE Alternative. Alternatives were compared against the No Action Alternative which involved projecting existing resources and conditions into the future to establish a benchmark against which alternatives were evaluated. Tradeoffs between alternatives with respect to environmental, economic, and social goals were identified.

The project area, including the city of Kanosh, has the possibly of flooding over 234 structures (valued at over $27 million) in the 500-year floodplain.

Both structural and nonstructural alternatives were evaluated for this planning study. However, nonstructural alternatives were eliminated from detailed study by the planning team due to exorbitant cost compared to the potential benefits. Following are summaries of eliminated alternatives, which propose to mitigate damages from the 100-year flood.

Flood Control Alternatives Evaluated but Eliminated

Floodproofing Alternative

Flood proofing of structures for both homes and businesses include several possible options, of which the following have been considered:

Dry floodproofing (sealing a structure to prevent floodwaters from entering the structure), wet floodproofing (allowing water to enter and exit the structure), floodwalls built around structures and raising structures.

Floodproofing does not manage the overall flood concerns. The construction and easement costs are extreme compared to the benefits and are not supported locally compared to other alternative options. Politically, this option would be unpopular because it would make access to a property difficult and would be visually unappealing.

Another flood proofing scenario considered was to construct a berm along the south and east of Kanosh. This would provide flood proofing for Kanosh with a bigger berm instead of the individual structures. This scenario was rejected because constructing berms on this alignment would complicate the routing

of irrigation water and traffic, be politically and locally unpopular, have high easement costs, restrict land use by property owners and would not protect farm land from damage by sediment and debris.

Relocations and Buyouts and Irrigation Pipeline Alternative

A non-structural alternative would be to leave the dam in place, relocate structures out of the floodway and implement the pipeline improvement (Alternative 1B - Agricultural Water Management). With no change to the existing dam, the existing structures in the floodway would be removed and no longer incur damages. The roads, crossings and cropland would continue to have flood damages. This Alternative would meet the project purpose of reducing flood damages to structures in town and improve irrigation water management but would not reduce flood damages to cropland and roads. The Relocation and Irrigation Pipeline annual costs would be about $3.8 million and the annual benefits of reduced flooding to Relocated Structures and the Irrigation Pipeline would be about $4.0 million – with a benefit cost ratio of about 1.06. This Alternative would be unacceptable to the sponsors and residences because of its high cost, disruption to the local community, it does not address all the flood concerns, the dam may not meet current dam safety standards and there is a high possibility of dam failure in the near future.

Remove Dam and Channel Improvements Alternative

Remove the debris basin dam and divert the water upstream to an emergency channel. This action was rejected because the results would be similar to the No-Action alternative. The diversion structure would have difficulty handling debris and still function. The removal of the debris basin eliminates the potential flooding from a failed dam but it increases flooding potential in all cases other than the worst-case scenario where the debris basin dam fails. The removal of the debris basin does not meet the purpose and need to protect Kanosh from flooding and was eliminated from further study.

Other Flood Actions Evaluated but Eliminated

The existing debris basin and system of ditches currently being used to provide flood control for the town of Kanosh and surrounding area has been determined to be insufficient to provide the necessary protection. Several additional flood control actions were considered but eliminated:

- Repairing and upgrading the existing dam and debris basin
- Using the agricultural water management system for flood control
- Removal of Debris Basin with Direct Connection to Existing Channels and/or Flood Channels

- Routing all excess flood water though the emergency channel
- Flood channels to route the floodwater downstream of Kanosh
- Enlarging existing channels to convey floodwater downstream of Kanosh

Agricultural Water Management Actions Evaluated but Eliminated

On an average year, it is estimated that 44% of the irrigation water in the Corn Creek Irrigation Company system is lost due to seepage. To save the water lost due to seepage, canal lining and piping actions were considered.

Canal Lining

Canal lining with membrane liners was considered as a method to reduce canal seepage, however, this action has a shorter life and lacked local support.

Concrete lined canals were initially considered to mitigate seepage within the CCIC canal system. Presently, the existing double ditches (low water ditches) are already lined with concrete. CCIC's experience has been unsatisfactory with the lined ditches. This unfavorable experience mainly stems from the accelerated deterioration caused by delivering stock water during the winter months, leading to upheaval during freeze/thaw cycles. Consequently, CCIC's preferred approach involves replacing deteriorating concrete-lined ditches with pipes rather than reinstalling concrete linings.

Landowners expressed a preference for buried pipe systems rather than open canals. This choice has both political and safety considerations. Furthermore, the proposed canal lining action falls short in terms of cost-effectiveness and durability when compared to piped systems. As a result, these cumulative factors contributed to the elimination of concrete lined canals as a viable option for the project.

Pressurized Irrigation Pipeline

The pressurized irrigation (PI) system delivers the total flow evenly across all acres served. The true PI system would allow shareholders to take water at almost any time, but the flow would be less than the 5 or 10 cfs delivery capacities that assume a form of a turn system. Laterals in a true PI system could be smaller due to the lower flow. In the pressurized actions, both pressure reducing valves (PRVs) and higher pressure rated pipe were modeled to handle the high pressures at the end of the system.

Pressurized pipe that carried the full water right were expensive but did not have sufficient capacity to provide significant relief for the flooding conditions. Additionally, a flow of 85 cfs in Corn Creek when crops could benefit from that flow is very rare. The extra cost of a larger capacity system that could usually only be utilized for a few weeks when crop water demand is low could not be justified. Since the proposed alternative for flood control included the maintenance and continued use of the existing ditches to convey flood water, it was felt that these ditches could also convey high water during years when high water is available. With the pipe system delivering the actual crop demand the seepage losses in the unlined ditches is acceptable to CCIC shareholders.

In addition to pressurized irrigation systems being more expensive than a gravity flow system, CCIC shareholders felt that a pressurized system could not be operated equitably without the expense of a full-time water master to monitor water use. Additionally, laterals on the gravity flow system could be more easily reduced in length or eliminated to provide flexibility if cost reduction became necessary.

Recreation Action Evaluated but Eliminated

Recreation actions in the project area included creating trails, public lookouts and water access at the debris basin, and better access to Corn Creek for recreation. However, these recreation actions were ruled out because there was a lack of local interest and support. Sponsors felt that they lacked the resources available to fund and maintain a recreation action.

Alternatives Considered for Detailed Study

The following sections describes the alternatives carried forward for a detailed resource impact analysis. These included a No Action and a Proposed Action Alternative 1. The No Action Alternative represents a baseline condition, while the Proposed Action Alternative 1 was developed to meet project needs in the most effective way possible. Along with the No Action Alternative, Alternative 1 contains two measures proposing construction of flood control structures and irrigation water management were identified and evaluated in detail. These are further described below.

<u>No Action Alternative</u>

Under the No Action Alternative, there would be no federal technical and/or financial assistance through the Watershed Protection and Flood Prevention Program for implementation on any part in the project area. The debris basin's high hazard dam would continue to pose a high risk of failure during a large flood, due to the seepage problem occurring in the dam's foundation. This could result in devastating

flood damage to the Town of Kanosh. Flood flows would pass through the same historic channels and waterways with the severity of the flooding events continuing, dependent upon the nature, timing, and severity of the event. Irrigation flows would continue to be lost through seepage and evaporation from the earthen canals. The Town secondary water systems would keep receiving insufficient pressures for sprinkler irrigation and would continue encroaching on and increasing the demand on their culinary water systems. The Tribe would continue to have culinary water shortages due to outdoor water use and no effective way to utilize their CCIC shares and water from Corn Creek. No federally funded project measures would be implemented. Existing conditions and trends would continue. The No Action Alternative would not meet the purpose and need for the project. However, the No Action Alternative is carried forward as the basis of comparison for impact analysis.

Two scenarios of the existing conditions were considered. One where the debris basin embankment breached (Catastrophic) and one where the debris basin embankment functioned as designed. The Catastrophic or breached model was ultimately used to represent the No Action Alternative because of the current foundation seepage will eventually cause failure of the dam.

Proposed Action Alternative 1

Alternative 1 contains two measures: A) Construction of flood control structures and B) Agricultural water management. The Proposed Action meets the purpose and need of the project.

Alternative 1A - Flood Control

- Reconstruct the debris basin and dam embankment to eliminate the existing seepage problem that has structurally compromised the dam and to construct the structure to comply with all Utah Dam Safety and NRCS standards.
- Relocate the existing town secondary pond that is downstream of the debris basin since the proposed dam alignment crosses the current pond location. This will also increase pressures in the Town's secondary water system. The new pond will also have the elevation necessary to provide the Tribe's secondary system sufficient pressure. Both secondary systems will reduce the demand on their culinary water systems.
- Construct the Main Spillway or low-level outlet.
- Construct the Secondary Spillway using a standpipe design that would allow flood waters to pass without the need of human adjustments while capturing floating debris and a large portion of the sediment in the debris basin.

- Construct an Emergency Spillway and use the existing Emergency Channel to convey flood water away from Kanosh
- Construct an Auxiliary Spillway that will create the spillway capacity necessary to pass the PMF without overtopping the debris basin embankment.
- Create bypass channels that prevent flow in ditches from exceeding their capacity and route flows above the existing ditches capacity to the West ditch /natural channel where other improvements will be made to increase capacity.
- Improve the West Ditch/natural channel to prevent flooding in Kanosh. The natural channel ends when it reaches town and transitions to the West Ditch.
- Construct berms and raise a road in the project area to better utilize existing culverts under I-15 to prevent overtopping I-15 and protect structures in the project area

Alternative 1B - Agricultural Water Management

- Construct a gravity pipe system to greatly reduce seepage and evaporation losses. This will also reduce a public safety hazard of having open ditches in town with the potential for children and animals to fall into the ditches.
- Construct Structures for flow measurement and better water management.

3.0 THE PREFERED ALTERNATIVE

The National Efficiency Evaluation (NEE) alternative and the Federally Recommended alternative is Alternative 1. The NEE alternative is defined as the federally assisted alternative with the greatest public benefits, with appropriate consideration of costs. Public benefits (i.e., positive ecosystem services) encompass environmental, economic, and social goals; include monetary and non-monetary effects; and allow for the consideration of both quantified and unquantified measures.

Alternative 1 is the preferred alternative. Alternative 1 was selected by the sponsor based on the beneficial outcomes and proposed costs. Each sub-measures in Alternative 1 had benefit cost ratios that were greater than 1.00 as shown in Table 2.

Table 2. Comparison of Benefits and Costs [1/]

	Average Annual Costs [3/]	Average Annual Benefits [2/]	Benefit Cost Ratio	Net Benefits
Alternative 1A - Dam/Channel	$602,800	$2,855,348	4.74	$2,252,548
Alternative 1B - Pipeline	$629,800	$1,490,049	2.37	$860,249
Grand Total	$1,232,600	$4,345,396	3.53	$3,112,796

[1/] Discount rate 2.5% with a 52-year period of analysis. Price base 2023

Agency policy allows for the use of the other social effects to justify a proposed action, even if the associated B/C ratio were less than 1:1. This is due to a priority placed on protecting lives. Also, trying to monetize the value of life, or in the case of flood control structures, avoidance of loss of life, is laden with subjective value judgments. Threat to human life can therefore be used to supersede purely economic considerations when deemed appropriate.

The preferred alternative will allow the sponsors to protect existing property and infrastructure downstream of the flood control structures. Average annual monetary benefits are estimated to be $4,345,396. Average annual cost is estimated at $1,232,600 resulting in net benefits of $3,112,796. Socially, the threat to human life will be minimized. Environmentally, adverse impacts will be minimized during construction. Long-term there would be adverse, although negligible, impacts.

Benefit to Cost Ratio: 3.53 to 1.0

Net beneficial Effects: $3,112,796

Funding Schedule: The most likely scenario is for the project to be implemented over two years including the design and construction.

Funding Schedule*				
Fiscal Year		PL-83-566	Other Funds	Total
2025	Alternative 1A - Dam/Channel	$1,367,000	$0	$1,367,000
2026	Alternative 1A - Dam/Channel	$14,579,000	$185,000	$14,764,000
2025	Alternative 1B - Pipeline	$1,300,500	$0	$1,300,500
2026	Alternative 1B - Pipeline	$12,151,500	$3,664,000	$15,815,500

Period of Analysis: 52 years (including 2 years for design and construction)

Project Life: 50 years

4.0 PERIOD OF ANALYSIS

The Period of Analysis used was 52-years (including 2 years for design and construction). Floods from the 2, 5, 10, 25, 50, 100, 200 and 500-year storm events were analyzed to estimate average annual flood-related damages.

A net present value analysis was conducted to compare the costs of project alternatives. Average annual values were also estimated. All costs of installation, operation and maintenance were based on 2023 prices. The costs associated with designing and implementing all structural measures were assumed to be implemented over a two-year period immediately preceding operation. The NEE alternative with a 52-year period of analysis yielded the highest net benefits using the mandated 2.5% discount rate for all federal water resource projects for FY23 to discount and amortize the anticipated streams of costs and benefits.

5.0 ECONOMIC ANALYSIS AND DOCUMENTATION

A customized Excel worksheet, including Federal Emergency Management Agency (FEMA) depth-damage curves and locally-obtained data, was used to evaluate benefits and costs of alternatives. Each project alternative, storm event and flood damage category were included in the worksheet to estimate average annual damages. Alternative cost estimates provided by the project engineers were also included in the worksheet. Economic data and results were linked in the worksheet to create the required PR&G tables for the final project report.

6.0 ENVIRONMENTAL AND SOCIAL BENEFITS

Environmental and social benefits were not monetized but are further explained for each alternative studied in detail in the Environmental Consequences Section of the Plan EA.

Environmentally adverse impacts will be minimized during construction. Long-term, there would only be negligible adverse impacts anticipated from any of the evaluated alternatives. The region is arid with sparse trees along the banks of intermittently dry streams.

Socially, the threat of loss of life or property will be minimized with reduced flood depths at buildings and roads. The annual average daily traffic (five-year average) near Kanosh is variable as displayed in the table below:

Location Description	5-Year Avg
Interstate-15 Kanosh	14,600
SR 133 Meadow	21,800
200 N via Main St - I 15 Meadow	1,356
I 15 Kanosh via Six Mile Rd - SR 133 (Approx 350 S) Kanosh	184

Interstate 15 on the western edge of the watershed is a major route from Salt Lake City to Arizona and southern California. There are about 25 miles of county major collector and rural roads near the project area (Utah Department of Transportation, 2020).

Incidental recreation after construction will continue and may possibly benefit from the structural alternatives through enhancement of wildlife and scenic improvement. Waterbodies developed from the impoundments would likely attract wildlife for short periods of time, but not significantly increase hunting, fishing, and general outdoor activity in the vicinity of the dams. The flood control structures were not designed to hold water for a significant amount of time and were not designed for recreational purposes.

7.0 RURAL COMMUNITY AND AGRICULTURAL DAMAGES

The stream of monetary benefits was described in average annual equivalent terms. The average annual expected benefits were the difference between the No Action Alternative and each project Alternative. The expected average annual damages for each alternative, storm event (8-events), and damage category below were estimated with the following equation:

$$\sum_{I=1}^{8} (\underline{PFED_{i-1} + FED_i})/2 * (PPFE_{i-1} - PFE_i)$$

$PFED_{i-1}$ – Previous Flood Event Damages
FED_i – Flood Event Damages
$PPFE_{i-1}$ – Probability of Previous Flood Event
PFE_i – Probability of Flood Event

7.1 STRUCTURE, CONTENT & VEHICLE DAMAGES

Structure, building contents and vehicle damages for each storm event and project alternative were estimated based on structures identified from aerial imagery, property data provided by the Millard

County, Utah tax assessor, and water depths obtained from hydraulic simulation of the evaluated storm events. The structure damages were estimated using methodology described in the Structural Damages Calculations Template (Tim Goody, NWMC). The value of the structures was estimated by subtracting the depreciated replacement value from the County Tax Accessor's structure value. The structures in the project area that are affected by flooding are located in a small rural town. Most if not all the structures are 40-60 years old, most typical about 45-years old. Based on the Life Cycle Chart (Swiftestimator.com, building cost reports online 2/2007) the Depreciated Multiplier ranges from 17% to 36% (20-30 years effective age). A Depreciated Multiplier of .20 was selected because most homes and businesses are well kept and necessary repairs and maintenance have been made. The structure value used in the flood damage analysis was estimated as: The County Tax Accessed Value * (1- Depreciated Replacement Value Factor) (see: CornCreekFloodDamagesBenefitsData.xls for calculations). For vehicles, local project managers estimated the typical vehicle replacement dollar value.

This estimated Depreciated Replacement Values is also consistent with the USACE National Structure Inventory documentation: "Structure Valuation - These replacement values for structures are then depreciated in order to obtain depreciated replacement value; each structure is depreciated by 1% per year for the first 20 years, after which it is assumed that routine maintenance would keep structure values at 80% of their replacement values".

(https://www.hec.usace.army.mil/confluence/nsi/technicalreferences/latest/technical-documentation).

Areas flooded and flood depths where damage occurs with and without project were estimated by Franson Civil Engineers, Logan, Utah. Building types, contents, and the typical number of vehicles and vehicle values associated with impacted buildings were estimated using interpolation of flood depth-damage curves developed by FEMA. The percent damage factor was multiplied by each building structure and vehicle dollar value to estimate flood damages. Total value of structures on impacted properties is shown below. This value does not include land values, only structure values. There were 234 structures valued at over $27 million in the 500-year floodplain.

Table 3. Watershed Project Number and Value of Structures Summary

Kanosh, Utah	Total Structures	Residences & Apartments	Commercial Properties	Public Properties	Ag Buildings
Number	234	224	8	1	1

Value	$27,662,036	$26,374,163	$1,057,526	$222,658	$7,689

The number of structures that could be flooded and their total structural value are displayed below. Also displayed are the present value and average annual damages to the structures, contents and associated vehicles for each flood event, for each of the two sub-basins:

	Home			Commercial			Public			Shed			Present Value	Annual
Event	< 1 ft	1 to 3 ft	> 3 ft	< 1 ft	1 to 3 ft	> 3 ft	< 1 ft	1 to 3 ft	> 3 ft	< 1 ft	1 to 3 ft	> 3 ft	Damage	Damage
2-yr	11	0	0	0	0	0	1	0	0	0	0	0	$650,274	-
5-yr	70	0	0	0	0	0	0	0	0	2	0	0	$4,287,510	$740,668
10-yr	163	6	0	2	0	0	0	0	0	3	0	0	$9,730,572	$700,904
25-yr	177	12	0	5	0	0	0	0	0	3	1	0	$11,042,911	$623,204
50-yr	189	14	0	5	0	0	0	0	0	3	1	0	$11,914,129	$229,570
100-yr	193	19	0	5	0	0	0	0	0	3	1	0	$12,491,685	$122,029
200-yr	196	24	0	5	0	0	0	0	0	3	1	0	$13,052,940	$63,862
500-yr	193	33	0	4	1	0	0	0	0	3	1	0	$13,743,392	$40,194
													Total:	$2,520,432

Maximum structure and content damage values were estimated as a percentage (about 75% structure and 60% content damages at 10-feet flood depth in a 1-story, no basement home) of assessed property values. Estimated floodwater depths (where damage occurs) for various storms (including the 500-year storm) for each structure were based on the results of the hydrology and hydraulics (H&H) simulation modeling. Floodwater data was then used with water depth to damage functions to estimate structural and content damages based on the ground elevation of each structure where damages occur. A similar analysis was conducted for vehicles located at the property within the floodplain area. Damages to vehicles was estimated to begin at 0.5 foot of flood depth. Each affected property was estimated to have a minimum of two vehicles. The vehicle value was estimated to be $13,000/vehicle.

7.2 ROAD DAMAGES

Road damages for each storm event and project alternative were estimated. Road location, flood depth and road surface area impacted by floodwater were identified. Areas flooded, flood depths and monetary damages with and without project were estimated by Franson Civil Engineers, Logan, Utah. The cost of road repair or replacement was estimated. The roads evaluated were assumed stay open during the flooding since they are the routes in and out of Kanosh. Roads can be damaged to the point of needing full replacement when there is traffic during flooding. To be conservative, damages were assumed to be less than full replacement value at various depths. There were no road damages estimated if the flood depth was less than 0.1 foot. If flood depth was between 0.1- and 0.5-foot, flood damages were estimated to be half the road repair or replacement cost. If flood depth was greater than .5-foot, flood damages were estimated to be 75% of the total road repair replacement cost.

7.3 CROP DAMAGES

Crop flood damages from each storm event and project alternative were estimated. About 3,400 acres of cropland is flooded over one-foot flood depth during the 500-year storm event. Many crops are grown in the project area; however, three crops make up 94-percent of total cropland and are: Alfalfa, Grass (mixed) Hay and Grass Pasture. Only Alfalfa and Grass (Mixed) Hay were evaluated. It was assumed that no damages occurred to Grass Pasture. Areas flooded and flood depths with and without project were estimated by the project GIS specialist with Franson Civil Engineers, Logan, Utah. Crop yield data from a review of the USDA Web Soil Survey and estimated using a five-year average crop yields and prices from Utah Agricultural Statistics and Annual Summary Report - 2021 (Utah Department of Agriculture and Food). Flood depths were estimated to be 1 foot or less, 1 to 3 feet and over 3 feet.

Over the evaluated flood area, the topography does not lead to inundation for more than 48 hours so crop respiration damage was minimal. However, it was assumed that scour damage would occur in the flooded areas. Crop damage from scour was assumed to occur at 2 feet per second velocities or higher. This is the NRCS maximum velocity when designing a vegetated flood channel. Franson Civil Engineers correlated the amount of flooded area with the areas that had velocities that were greater than 2 feet per second. This resulted in an Inundation damage factor about forty-percent crop loss for all flood depths. The "Seasonal Damage Factor" represents the probability that the flood event occurs during the crop growing/harvest season, and then is multiplied by the crop damage factor. The Seasonal (crop) Damage Factor was estimated as: [0.5 times (Harvest Starts minus Plant Starts), plus 0.5 times (Harvest Ends minus Harvesting Starts)], divided by 365 Days.

The Average Crop Value per acre was estimated as: The Average Unit Price times Average Yield. The dollar crop damages per flood event were estimated by the sum of the Seasonal Damage Factor, the Inundation Factor, and the Average Crop Value per Acre. The flood event losses were estimated as the sum of Damage Value per Acre times Acres Flooded, for each flood event.

7.4 IMPROVED WATER MANAGEMENT

An irrigation water pipeline was evaluated to improve irrigation water delivery. The pipeline will be installed adjacent to the existing ditches, and the ditches will be left in place to allow the routing of floodwater off-site reducing flood damages.

Only improved crop yield was included as a monetary benefit. Many crops are grown in the project area; however, three crops make up 94-percent of total cropland and are: Alfalfa, Grass (mixed) Hay and Grass Pasture. The project crop acres were estimated by multiplying the total crop area by the weighted percentage of the three largest crop acres, to account for all the acreage without having to separate the analysis into all the different crops. The table below shows the top 3 irrigated crops, number of acres, and increase in yield with project. Crop yield data from a review of the USDA Web Soil Survey and estimated using a five-year average crop yields and prices from Utah Agricultural Statistics and Annual Summary Report - 2021 (Utah Department of Agriculture and Food).

Crop	Irrigated Acres (both with and without project)	Assumed 5-Yr Average Yield Increase with Project (ton/acre)
Alfalfa	2,486	3.01
Other Hay	387	2.54
Pasture	125	0.00

The Pipeline increment was evaluated for the entire project area. Thirteen areawide pipeline scenarios were evaluated to determine the preferred pipeline design. Both pressurized and non-pressure systems were considered. Criteria considered included: Flow Capacity, Delivery Capacity, Pressurized/Gravity Flow and Pressure Reducing Valves. The pipeline design that provided the capacity to meet irrigators crop demand and the irrigation company's desired operation method (and was the most cost effective), was the gravity flow system with a capacity of 40 cfs. The system also allows the accurate measurement of water, allowing irrigators to better manage their water use and maximize crop production. The greatest benefit of this alternative will be increasing the water supply by at least 44% from 4,016 acre-feet to 7,164 acre-feet of available irrigation water. These water savings are available to 2,998 irrigation acres in the service area or 12.6 inches per acre annually. The pipeline will not require a separate stockwater pipeline and will have the capability to deliver stockwater during the non-irrigation season.

7.5 OTHER AGRICULTURAL DAMAGES

There are several ranches in the project area. Based on modeling, no significant flood damage or disruptions to livestock operations or rangeland is expected. Flood waters are shallow and livestock move

to higher ground. There were no other livestock operation damages identified within the project area affected by storms up to and including the 500-year event.

Over the evaluated flood area, the topography does not generate significant ponding. Ponding across all the flood models did not occur for more than 48 hours so damage from saturated soil was not evaluated. Pasture accounts for less than 4% of land, so pasture erosion and sedimentation were not calculated.

7.6 SCOUR & SEDIMENT DAMAGES

Flood erosion scour and sediment deposition damages from each storm event and project alternative were estimated. Areas and quantity of scour and sediment with and without projects were estimated by Franson Civil Engineers, Logan, Utah. Scour was assumed to occur at 2 feet per second velocities or higher. This is the NRCS maximum velocity when designing a vegetated flood channel. Franson Civil Engineers correlated the amount of flooded area with the areas that had velocities that were greater than 2 feet per second. The cost per acre to clean-up or regrade soil on eroded areas was then estimated.

Sediment deposition damages was defined as a percentage of the annual sediment deposited in the sedimentation basin above town, and was estimated to be up to about 2,625 Cubic Yards in the flooded area without improvements. Damages were estimated as the cost to remove sediment from deposition areas.

7.7 RECREATION

Based on evidence found at the site and information from local residences, the dam site and upstream and downstream waterways are used by some people for recreational purposes. Incidental recreational activities such as fishing, hunting, and hiking/walking are expected to be minimal. Since there is no official or unofficial count of usage, estimated annual visitor-days is not available. Therefore, incidental recreation impacts were not evaluated.

7.8 OTHER DAMAGES

No additional damages affected by storms up to and including the 500-year were identified. Urban damages (emergency aid, clean-up, sewer, debris removal, etc.) were not identified or estimated by local county officials. Beyond Interstate-15, there were no additional structures, culverts, bridges or stream crossings damaged.

7.9 PROJECT BENEFITS SUMMARY

The planning policy used for this plan/environmental document (PR&G) state that Federal investments in water resources as a whole should strive to maximize public benefits, with appropriate consideration of costs. Public benefits (i.e., positive ecosystem services) encompass environmental, economic, and social goals; include monetary and non-monetary effects; and allow for the consideration of both quantified and unquantified measures. The preferred alternative will allow the Sponsors to reduce flood damages and reduce the potential for loss of life. The preferred alternative maximizes public benefits.

As reflected in the table below, current average annual floodwater damages without project (present condition) are $2,936,192. Floodwater damages with project (NEE Alternative 1) flood control structures were estimated to be $80,845.

Table 4. Summary of Annual Expected Damages

	No Action	Alt 1A
Structure, Contents & Vehicles	$2,520,432	$57,403
Roads/Crossings	$397,331	$17,408
Crop - Flood	$5,200	$3,458
Crop - Non-Pressurized Pipeline	-	$0
Erosion	$8,151	$2,577
Sediment	$5,079	$0
Total:	$2,936,192	$80,845

As reflected in the Table below, the benefits to downstream properties were estimated as the difference between with and without project damages reflect the average annual benefits. Alternative 1 would provide to downstream properties about $4,345,397 average annual benefits.

Table 5. Summary of Floodwater Reduction Benefits

Plan Annual Expected Benefits		
Category	Alt 1A	Alt 1B
Structure, Contents & Vehicles	$2,463,029	
Roads/Crossings	$379,923	

Crop - Flood	$1,742	
Crop - Non-Pressurized Pipeline	$0	$1,490,049
Erosion	$5,574	
Sediment	$5,079	
Total:	$2,855,348	$1,490,049

Other Alternative 1 Beneficial Effects

- Reduces the threat to loss of life to over 690 people who live and/or work in the inundation zone (assuming 3 people/residence, 2 people/commercial and public property).
- Provide flood protection to 224 residences and apartments, 8 commercial structures, 1 public property and roadways within the inundation zone.
- Provides protection for dozens of vehicles and their occupants who utilize the five major roads in the inundation area.
- Reduces the threat of loss of access and loss of emergency services for downstream properties and property owners.
- Provides downstream flood protection for the residents in the area, as well as those working, recreating, or traversing within the downstream floodplains, for 50 years.

7.10 WATERSHED PROJECT COSTS

Project costs for flood control and channel work were estimated by Franson Civil Engineers, Logan, Utah in September, 2023. Installation and operation & maintenance costs for each activity are described in detail in the cost tabs in the project engineer's Excel worksheet.

All costs were allocated to the flood prevention purpose according to the procedure in the National Resource Economics Handbook, Part 611 Water Resources Handbook for Economics, Chapter 6 Costs and Cost Allocation (NRCS 2014b). Work Plan-EA tables were constructed based on the calculated cost allocated to flood prevention. Within this purpose the costs were shared between NRCS and the local and state entities as specified in the NWPM, in this case cost share for flood prevention is 100 percent federal and 0 percent local. Within these guidelines, engineering is 100 percent federal; and operation, maintenance, and replacement is 100 percent local. See Work Plan in the Plan-EA for the results of the cost allocation/cost sharing process.

All costs were amortized at the Fiscal Year 2023 Federal Water Resource Discount of 2.50 percent for 52 years. Average Annual Costs are computed as the sum of the amortized construction cost and the annual operation and maintenance cost. Engineers estimate that each of the structures would last 50 years, the life of the project.

All project implementation costs were estimated by the project engineers, including installation and annual operation and maintenance. All costs were converted to Present Values by discounting each cost to the beginning of the period of analysis using the applicable project discount rate. Installation expenditures before the project is installed were brought forward to the end of the period of installation by charging compound interest at the project discount rate from the date the costs are incurred. Finally, the project discount rate was used to convert the present values to average annual equivalent terms.

Replacement costs are necessary if the installed structure's life is less that the project life. Average Annual Replacement Costs are calculated by amortizing the Present Value of the worn-out structure's construction cost, with the current FY discount rate over the project structure's life. If the physical life of the alternative is the same as the project, replacement costs are not included and we assume the Replacement Costs are the same as the Average Annual Costs. In this project the structure's life was equal to the project life and replacement costs were not necessary and not calculated. All estimated values and damages were assessed within a customized Excel template.

Table 6. Watershed Project Annual Cost Summary

Evaluation Unit	Project Outlays		Total
	Amortization of Installation Cost[1/]	Operation, Maintenance & Replacement	
Alternative 1A - Dam/Channel	$584,300	$18,500	$602,800
Alternative 1B - Pipeline	$619,800	$10,000	$629,800
Total Project	$1,204,100	$28,500	$1,232,600

[1/] Discount rate 2.5% with a 52-year period of analysis. Price base 2023

7.11 WATERSHED PROJECT BENEFITS AND COSTS

For the preferred Alternative 1, the average annual monetary benefits are estimated to be $4,345,396. Average annual cost is estimated at $1,232,600 resulting in net benefits of $3,112,796. Alternative 1, produces a B/C ratio of 3.53 to 1.00. Incidental recreation after construction will continue.

Environmentally adverse impacts will be minimized during construction. Long-term there would be adverse, although negligible, environmental impacts.

Table 7. Watershed Project Benefit-Cost Summary[1/]

	Average Annual Costs [3/]	Average Annual Benefits [2/]	Benefit Cost Ratio	Net Benefits
Alternative 1A - Dam/Channel	$602,800	$2,855,348	4.74	$2,252,548
Alternative 1B - Pipeline	$629,800	$1,490,049	2.37	$860,249
Grand Total	$1,232,600	$4,345,396	3.53	$3,112,796

[1/] Discount rate 2.5% with a 54-year period of analysis. Price base 2023

Final Economic Tables

All economic tables for Alternative 1 are displayed below. The economic table names are defined in Title 390 – National Watershed Program Manual, Subpart B – Economic and Structural Tables. The following table shows cost-share percentages and amounts for watershed project plan implementation for each of the sub-basins.

Table X-X: Alternative 1 Cost-Share Summary

Alternative 1

Works of Improvement	%[3]	NRCS	%[3]	Sponsors	Total
Cost-Sharable Items					
Construction Costs	100%	$24,063,000	0%	$0	$24,063,000
Engineering Technical Assistance Costs[4]	100%	$5,054,000	0%	$0	$5,054,000
Project Admin. Costs [1]	100%	$281,000	0%	$0	$281,000
Subtotal: Cost-Share Costs		$29,398,000		$0	$29,398,000
Non Cost-Sharable Items [2]					
Construction Costs	0%	$0	100%	$3,589,000	$3,589,000
Engineering Costs	0%	$0	100%	$0	$0
Real Property Landrights[5]	0%	$0	100%	$150,000	$150,000
Mitigation	0%	$0	100%	$0	
Permits	0%	$0	100%	$110,000	$110,000
Project Admin. Costs [1]	0%	$0	100%	$0	$0
Subtotal: Non Cost-Share Costs		$0		$3,849,000	$3,849,000
TOTAL:	88%	$29,398,000	12%	$3,849,000	$33,247,000

[1/] The sponsors and NRCS will each bear the costs of project administration that each incurs.

[2/] If actual non-cost-sharable item expenditures vary from these figures, the responsible party will bear the change.

[3/] As per NWPM Section 500.42 and Figure 500-E2. PL-566 cost share rates depend on the authorized purposes of the particular watershed plan. For flood prevention measures, PL-566 pays 100% of construction and engineering. Installation of compensatory mitigation is considered part of the construction of the flood control measure (per text between Figures 500-E1 and 500-E2). Real property rights acquisition is 100% sponsor cost for most PL-566 activities. However, acquisition of property rights for mitigation and recreation may be cost-shared (see referenced sections).

[4/] Cost-sharable at 100% NRCS if Sponsor hires engineering for structure design. Not cost-shareable if sponsor's engineering is for elements required for real property rights (road improvements, power line modification, livestock water supply line, etc.).

[5/] Construction elements required to satisfy real property rights are also 100% Sponsor cost.

Watershed Works of Improvement	NRCS Cost	%	Sponsors Cost	%	Total Cost
Cost-Sharable Items					
Flood Control [1/]	$15,946,000	100%	$0	0%	$15,946,000
Agricultural Water Management	$13,326,000	75%	$3,575,000	25%	$16,901,000
Tribe	$126,000	90%	$14,000	10%	$140,000
Recreation	$0	50%	$0	50%	$0
Subtotal: Cost-Sharable Costs	$29,398,000		$3,589,000		$32,987,000
Non-Cost-Sharable Items [3/]					
NRCS Technical Assistance/Engineering	$0	0%	$185,000	100%	$185,000
Project - Construction Administration	$0	0%	$75,000	100%	$75,000
Permits			$0	100%	$0
Land Acquisition			$0	100%	$0
Subtotal: Non-Cost-Sharable Costs	$0	0%	$260,000	0%	$260,000
Grand Total:	$29,398,000		$3,849,000		$33,247,000

Economic Table 1: Estimated Installation Cost for Alternative 1 [1/]

Installation Cost Items	Estimated Costs		
	PL-83-566 Funds	Other Funds	Total
Alternative 1A - Dam/Channel	$15,946,000	$185,000	$16,131,000
Alternative 1B - Pipeline	$13,452,000	$3,664,000	$17,116,000
Total Project	$29,398,000	$3,849,000	$33,247,000

[1/] Price base 2023

Economic Table 2: Estimated Cost Distribution for Alternative 1 [1/]

Installation Cost Items	Installation Costs: PL-83-566 Funds				Installation Costs: Other Funds							
	Construction Costs	Engineering Technical Assistance Costs	Project Admin. Costs	**Total PL-83-566 Costs**	Construction Costs	Engineering Costs	Real Property Landrights	Mitigation	Permits	Project Admin. Costs	**Total Other Funds**	Total Project Cost
Alternative 1A - Dam/Channel	$13,212,000	$2,598,000	$136,000	$15,946,000	$0	$0	$75,000	$0	$110,000	$0	$185,000	$16,131,000
Alternative 1B - Pipeline	$10,851,000	$2,456,000	$145,000	$13,452,000	$3,589,000	$0	$75,000	$0	$0	$0	$3,664,000	$17,116,000
Total Project	$24,063,000	$5,054,000	$281,000	$29,398,000	$3,589,000	$0	$150,000	$0	$110,000	$0	$3,849,000	$33,247,000

Installation Cost Items	Amortized Costs, FY2022 Rate	Annual OM&R	Total Annual Costs
Alternative 1A - Dam/ Channel	$584,300	$18,500	$602,800
Alternative 1B - Pipeline	$619,800	$10,000	$629,800
Total Project	$1,204,100	$28,500	$1,232,600

[1/] Discount rate 2.5% with a 52 year period of analysis. Price base 2023

Economic Table 4: Estimated Average Annual Costs for Alternatives 1 [1/]

Evaluation Unit	Project Outlays		Total
	Amortization of Installation Cost	Operation, Maintenance & Replacement	
Alternative 1A - Dam/Channel	$584,300	$18,500	$602,800
Alternative 1B - Pipeline	$619,800	$10,000	$629,800
Total Project	$1,204,100	$28,500	$1,232,600

[1/] Discount rate 2.5% with a 52 year period of analysis. Price base 2023

[2/] From Table 2

Economic Table 5: Estimated Average Annual Flood Damage Reduction Benefits
Alternative 1

Item	Average Annual Damages Without Project		Average Annual Damages With Project		Average Annual Benefits	
	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related	Ag Related	Non-Ag Related
Floodwater Damage						
Structures, Contents, Vehicles		$2,520,432		$57,403		$2,463,029
Roads/Crossings		$397,331		$17,408		$379,923
Crop	$5,200		$3,458		$1,742	
Subtotal	$5,200	$2,917,762	$3,458	$74,810	$1,742	$2,842,952
Sediment/Erosion Damage	$13,230		$2,577		$10,653	
Subtotal	$13,230		$2,577		$10,653	
Indirect Damage[2]						
Non-Pressurized Pipeline					$1,490,049	
Subtotal					$1,490,049	
Grand Total	$18,430	$2,917,762	$6,035	$74,810	$1,502,444	$2,842,952

[1/] Discount rate 2.5% with a 52 year period of analysis. Price base 2023

[2/] Irrigation Pipe is additional benefits and does not eliminate existing damages

Economic Table 6: Comparison of Benefits and Costs [1/]
Alternative 1

	Average Annual Costs [3/]	Average Annual Benefits [2/]	Benefit Cost Ratio	Net Benefits
Alternative 1A - Dam/Channel	$602,800	$2,855,348	4.74	$2,252,548
Alternative 1B - Pipeline	$629,800	$1,490,049	2.37	$860,249
Grand Total	$1,232,600	$4,345,396	3.53	$3,112,796

[1/] Discount rate 2.5% with a 54 year period of analysis. Price base 2023
[2/] From Table 5.
[3/] From Table 4.