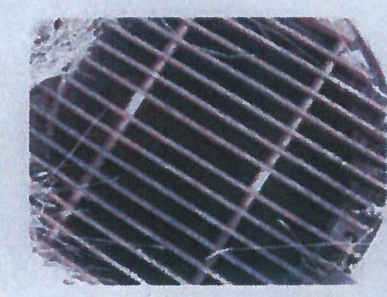

Minden-Tahoe Airport Drainage Master Plan

Final Report

Report Prepared for

DOUGLAS COUNTY

Douglas County, Nevada

Report prepared by

MEAD & HUNT

January 2011

REGISTERED PROFESSIONAL ENGINEER · STATE OF NEVADA
LEE B. MOEN
EXP. 12-31-11
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1.0 Introduction

1.1 Project

Minden-Tahoe Airport (Airport) is a 990-acre general aviation municipal airport in Douglas County in western Nevada. The Airport is owned and operated by Douglas County. The Airport is approximately three nautical miles north of the city of Minden, 32 nautical miles south of the City of Reno and 12 nautical miles east of Lake Tahoe. See Figure 1 and Figure 2 for the location and site maps.

The Airport serves a variety of general aviation aircraft types, ranging from gliders and small single and multi-engine powered aircraft to corporate jets. It is also home to the Minden Tanker Base and the Sierra Front Interagency Dispatch Center with the primary mission of acting as a base for air-tankers fighting fires in the Sierra Nevada region. Current uses include fixed-base operations, refueling services, aircraft mechanics and avionics, administrative offices, and enclosed aircraft hangars. Several businesses conduct airport-related light manufacturing operations. Other uses include some Douglas County School District bus and maintenance operations as well as office space and vehicle maintenance operations for the Douglas County Road Department.

1.2 Objective and Study Approach

Douglas County retained Mead & Hunt, Inc. (Mead & Hunt) to develop a Drainage Master Plan for the Minden-Tahoe Airport. The objective of this Drainage Master Plan is to evaluate the adequacy of the existing Airport drainage system for both the existing condition and proposed onsite development and develop conceptual measures to mitigate areas where the drainage system is inadequate.

Mead & Hunt first conducted a review of the existing drainage and land use through documents and drawings pertaining to the Airport. A preliminary reconnaissance survey was conducted to identify general drainage patterns and conduct discussions with the Airport staff. At a later stage of the study, a detailed physical survey was conducted to measure dimensions, inverts, and slopes of existing channels and pipes. The existing site conditions are described in Section 2 of this report.

Drainage standards issued by Douglas County and Federal Aviation Authority (FAA) regulations pertaining to drainage were reviewed to identify hydrologic and hydraulic criteria to be used for the study. Based on an understanding of existing land use, drainage conditions, and prevailing drainage design criteria, Mead & Hunt created a hydrologic and hydraulic model reflecting the existing conditions of the Airport drainage using XPSWMM version 2009. XPSWMM is a proprietary hydrology/hydraulics package that allows dynamic unsteady modeling of rainfall-runoff process and hydraulic routing of stormwater. The modeling parameters and assumptions are outlined in Sections 3 and 4.

The impacts of future developments on drainage were evaluated by incorporating the future land use in the model. The source for future land use was the Airport Layout Drawing (see Figure 3), developed and presented in the *Airport Master Plan, Draft Final Report* (May 2008). The results of this impact evaluation are described in Section 5.

Finally, alternative scenarios were simulated in the model with improved conveyance and storage facilities to mitigate flooding effects. Based on these findings, recommendations were made regarding drainage improvements necessary to mitigate flooding. These are described in Section 6.

1.3 Hydrology and Hydraulic Criteria

The design recommendations contained in the Drainage Master Plan have been made with the objective of meeting current hydrology and hydraulic standards issued by Douglas County and FAA. The standards that have been adopted and their respective sources are listed below:

1.3.1 Design Storm Frequency and Runoff Determination

According to Section 6.6.1 of Douglas County drainage standards (Douglas County, 2007), drainage facilities for all commercial, industrial, and residential developments (this definition includes the planned development on the airport) shall be designed to convey the peak runoff for a design storm with a 25-year return period. This criterion also applies to drainage crossings under development and local roadways.

Section 6.6.2 of the drainage standards specifies that a Soil Conservation Service Type II, 24-hour synthetic rainfall distribution shall be used for storm runoff calculations. This distribution was adopted in the XPSWMM model created for the analysis.

Combining the two guidelines described above, a 25-year 24-hour storm is used as a basis for design of conveyance facilities.

1.3.2 Peak Flow Rate Downstream of Airport

According to Section 6.1.4.1 of the drainage standards, an increase in the peak rate of flow from development shall not be allowed. Section 6.1.5 of the same document specifies that this evaluation shall be done for the 2-year 24-hour, 10-year 24-hour, 25-year 24-hour, and 100-year 24-hour storms. Accordingly, this Drainage Master Plan aims to mitigate any increase in peak flow for all of these storms through detention storage.

1.3.3 Emergency Flow Paths

According to Section 6.6.1 of the drainage standards, all developments shall provide emergency flow paths for storm events with a 100-year return period. As such, most areas of the airport will be inundated in a 100-year event as discussed in Section 2.2. Nonetheless, based on our analysis of both existing and proposed buildings, no obstructions to emergency flow paths were found.

2.0 Site Description

2.1 Topography

Ground elevations on the Airport property range from 4,692 feet to 4,730 feet (vertical datum is NGVD29). Open area grades on the Airport property range from 0.3% to 1.0%, sloping from east to west and from south to north.

2.2 Floodplain

The Airport site is within the 100-year storm floodplain to varying degrees per the most recent Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) dated January 20, 2010. The Airport property is located at the intersecting corner of four Douglas County FIRM panels: 32005C0070G, 32005C0090G, 32005C0235G, and 32005C0255G. Approximately half of the Airport property is mapped as Zone X (with 100-year flood depths of less than 1 foot). The remainder of the Airport property is classified as Zone AO with depths ranging from 1 foot to 3 feet or Zone AE with defined base flood elevations. See Figure 4 for the mapping of the flood zones on the Airport property.

2.3 Soils

The soils on the Airport property are classified almost entirely as Hydrologic Soil Group C (Gardnerville Series). Some areas on the southern and eastern portions of the Airport property are classified as Group B and Group A. Hydrologic Group C soils have a slow infiltration rate when thoroughly wet and a slow rate of water transmission. Hydrologic Group B soils have a moderate infiltration rate when thoroughly wet and have a moderate rate of water transmission. Hydrologic Group A soils have a high infiltration rate (low runoff potential) when thoroughly wet and a high rate of water transmission. See Appendix 1 for the Hydrologic Soil Group report generated using Web Soil Survey 2.0 (USDA, 2008).

2.4 Offsite Contributing Areas

The Airport has a significant offsite catchment area totaling approximately 20,427 acres draining onto the site. The eastern boundary of the Airport intercepts the majority of this offsite drainage from a watershed identified as the Airport Wash drainage basin (Offsite-1). The Airport Wash watershed area originates in the Pine Nut Mountains and has a contributing area of 16,169 acres. The eastern boundary of the Airport also intercepts offsite drainage from offsite catchments identified as Offsite-2, Offsite-3, and Offsite-4 with areas of 2,098 acres, 1,992 acres, and 168 acres respectively. These offsite contributing areas, which have been documented as part of an earlier study (R.O. Anderson, 2007), are illustrated in Figure 5 and summarized in Table 1. Please note that the delineation in Figure 5 was made visually because of the absence of original electronic files, and is approximate.

Table 1. Offsite Contributing Areas

Catchment ID	Area (acres)
Offsite – 1	16,169
Offsite – 2	2,098
Offsite – 3	1,992
Offsite – 4	168
Total	**20,427**

2.5 Onsite Subcatchments

The onsite areas were also divided into subcatchments as shown in Figure 6 and summarized in Table 2. The subcatchment delineations were made on the basis of topography and drainage network.

Table 2. Summary of Onsite Subcatchments

Catchment ID	Area (acres)	Impervious area, existing (%)	Impervious area, proposed (%)
A-1	286	10.0	48.5
A-2	70	0.0	9.6
A-3	234	8.1	52.0
A-4	69	58.6	70.5
A-5	88.32	49.7	55.0
A-6	113.48	25.8	37.9
A-7	79.21	0.0	7.0
A-8	18.26	0.0	0.0

2.6 Existing Drainage

The Airport's existing storm drainage system consists of drainage ditches and culverts to convey offsite and local drainage flows through the Airport site. In general terms, the drainage network on the Airport property can be divided into three main branches – northeast branch, west branch, and south branch (Figure 7).

The northeast branch arcs northwesterly from the eastern boundary and flows westward along Firebrand Circle before discharging into the drainage ditch along Heybourne Road. The west branch originates in the southwestern quadrant of the Airport, flows northward along the western boundary of the Airport before discharging into the same discharge point as the north branch. The south branch flows southwesterly from the eastern boundary and discharges into the Heybourne Irrigation Canal, which flows west of Heybourne Road.

The north branch conveys flows from Offsite - 2 (i.e., Offsite catchment no. 2) in additional to local drainage, while the south branch conveys flows from Offsite - 1, Offsite - 3, and Offsite - 4.

Each of the branches described above is made up of several tributaries defined by pipes and/or open channels. These reaches have been listed with their lengths, types, and dimensions in Appendix 2 and are shown in Figure 7.

2.7 Existing Land Use

The Airport is operated with one paved primary runway (Runway 16/34), oriented in a north/south direction and with a paved crosswind runway (Runway 12/30) oriented in a northwest/southeast direction (see Figure 3). There is also a dirt runway (Runway 12G/30G) oriented parallel to the crosswind runway used primarily for glider/sailplane operations located northeast of the crosswind runway. A third paved runway (Runway 03/21) and associated taxiway is currently closed. Runway 16/34 is 7,400 feet long and 100 feet wide. Runway 12/30 is 5,300 feet long and 75 feet wide. Runway 12G/30G is 2,200 feet long and 60 feet wide. A taxiway system provides access between the runways and the landside aviation facilities.

The primary landside development area at the Airport consists of two aircraft-parking apron areas located west of Runways 16/34 and 12/30 intersections. These facilities include a terminal area, aircraft parking aprons, Fixed Base Operator (FBO) facilities, general aviation aircraft storage hangars, fuel storage facilities, and access roadways.

The remainder of the Airport property consists of open, vegetated areas. Native grasses and brushes occupy much of the open areas of the Airport. Native grasses grow between runways and taxiways and in graded areas.

Approximate impervious areas including the runways, taxiways, and landside development is 161 acres while the pervious area, including all undeveloped areas, is 1,605 acres.

2.8 Proposed Land Use

The Airport Layout Drawing presented in the Airport Master Plan (Figure 3) defines the future configuration of runways and taxiways, some additional hangars, and airport buildings, but it is not a comprehensive plan for the ultimate land uses for the Airport. The Airport Master Plan does define potential development land uses for the remaining areas within the new Airport property line. Only the southeast corner of the property is reserved for open space.

Planned major improvements are as follows:

- Shift Runway 12/30 1,640 feet to the southeast.
- Shift Runway 12G/30G 900 feet to the southeast and 150 feet to the northeast and widen Runway 12G/30G to 100 feet
- Construct Runway 03/21 (1,800 feet long by 100 feet wide) at the location of the previous parallel taxiway to the closed Runway 03/21
- New and revised taxiways
- Glider turnouts and staging areas
- Aircraft parking areas and storage facilities

The additional impervious (paved) area expected as a result of the proposed developments is approximately 251acres.

3.0 Hydrologic Modeling

3.1 Software Used

The hydrologic component (RNF) of the XPSWMM software was used to determine the runoff hydrographs.

3.2 Design Storm

The Soil Conservation Service Type II, 24-hour Synthetic Rainfall Distribution was used to generate the design storm hyetographs. NOAA Atlas 14 Precipitation Frequency Estimates (NOAA, undated) were used to determine cumulative rainfall depths to convert the synthetic distribution to storms of various frequencies (see Appendix 3). Following are the cumulative rainfall depths for each period according to NOAA Atlas 14:

Table 3. Cumulative rainfall depths for Synthetic Rainfall Distribution

Storm Frequency	Cumulative rainfall depth
1 year	1.01
2-year	1.27
10-year	1.88
25-year	2.25
100-year	2.85

3.3 Infiltration

The software package used for the hydrologic modeling, XPSWMM, has an built-in equation for computing infiltration rates. Among the various methods available in the program, the Horton method was selected for this analysis. The input parameters for the Horton equation depend on the soil type. As discussed in Section 2(E) of the drainage standards, most surface soils on the Airport belong to Hydrologic Group C. Accordingly, the following infiltration parameters were used for calculating infiltration:

Table 4. Infiltration Parameters

Parameter	Value
Maximum infiltration rate (Fo)	0.06 in/hr
Minimum (Asymptotic) infiltration (Fc)	0.06 in/hr
Decay coefficient	0.001 sec^{-1}
Maximum infiltration volume	0.0 inch

XPSWMM also allows input of depression storage, which represents the loss cause by surface ponding, surface wetting, interception by vegetation, etc. Depression storage for both the impervious and pervious areas was assumed to be zero, on a conservative basis.

The value of Manning's "n" was assumed to be 0.014 for impervious areas and 0.03 for pervious areas. The program also allows input of a percentage value for "Zero Detention," which indicates the portion of the subcatchment impervious area with zero detention (immediate runoff), in order to simulate immediate runoff. The value of Zero Detention was set to 25%.

3.4 Land Use

As far as hydrology is concerned, the impact of new developments is manifested in the form of an increase in impervious areas, which causes an increase in peak runoff rate and runoff volume. The existing land use of the Airport was compared with proposed land use per the Airport Master Plan to document the future increase in impervious areas. All proposed runways, taxiways, turnouts, staging areas, parking areas, and storage facilities were scaled off existing drawings and the Airport Master Plan layout plan, and their entire footprint area of proposed developments was assumed to be impervious. The existing and proposed impervious areas for onsite contributing areas have been documented in Table 2.

3.5 Runoff from Onsite Subcatchments

As shown in Table 2, eight subcatchments have been identified on the Airport property. To obtain finer resolution inflow at various points in the drainage system, each of these catchments were further divided into smaller areas. Runoff obtained from these areas was then input to those XPSWMM nodes that will receive inflow from those areas based on topography. Appendix 4 shows associations between the XPSWMM nodes and subcatchments. The runoff from subcatchments was evaluated for both existing and developed scenarios by varying the impervious areas between the two scenarios.

3.6 Runoff from Offsite Contributing Watersheds

R. O. Anderson (Anderson, 2007) created a hydrologic model of the offsite hydrographs (see Table 1) in HEC-1, the results of which are available in their report submitted to the Airport. While electronic copies of the model were not available, we were able to accurately replicate the results of the hydrologic study using HEC-HMS. The offsite hydrographs thus derived were used as proxy for flow input at the XPSWMM nodes representing the locations where the Airport receives offsite flows. The HEC-HMS hydrographs are shown in Appendix 5. Runoff from offsite areas is not expected to change between the existing and developed scenario since no development is anticipated there.

4.0 Hydraulic Modeling

4.1 Method of Analysis

The hydraulic component (HDR) of XPSWMM software was used to route the inflow hydrographs through the airport's drainage system.

4.2 Roughness Coefficients

Roughness coefficients for the channels were based on site observations, while those for pipes were adopted from standard roughness for any particular type of pipe.

4.3 Evaluation of Drainage Adequacy

The following process was adopted to evaluate the adequacy of the existing drainage infrastructure:

4.3.1 Existing Scenario

An "existing scenario" model was created by modeling the drainage system in its present condition (i.e., existing slopes, pipe types, and dimensions) and with the existing amount of impervious areas in the subcatchments. Existing impervious areas (see Table 2) were used to reflect the present condition.

In these model results, it was observed that the overflow takes place at certain manholes because of lack of existing capacity during large storms. The overflowing volume is either locally stored or finds an alternative flow path. Thus, the existing scenario model does not provide a realistic estimate of downstream peak flow, an estimate of which is required according to County standards. Therefore, a "modified existing scenario" model was created for the sake of comparison; this model has upsized hydraulic capacities of pipes and channels to prevent overflow, but uses the existing impervious areas.

4.3.2 Proposed Scenario

A "proposed scenario" model was created by changing percentages of impervious areas to reflect proposed conditions in the "modified existing scenario" model. Pipe and channel dimensions were modified to handle the excess flow in fully developed conditions. Downstream peak flow in the proposed scenario was compared with the downstream peak flow in the modified existing scenario to determine retention requirements.

4.3.3 Model Files

A CD attached with this report contains the following model electronic model files:

a. Existing conditions showing existing impervious areas and existing conveyance capacities: MTA-EX-RNF-EX-HDR.xp

b. Modified existing model with existing impervious areas but increased conveyance capacities: MTA-EX-RNF-NEW-HDR.xp
c. Proposed project model with upgraded conveyance capacity but without detention storage: MTA-NEW-RNF-NEW-HDR.xp
d. Proposed project model with upgraded conveyance capacity and detention areas: MTA-EX-RNF-NEW-HDR-DETENTION.xp

The file nomenclature is based on 'RNF' representing the runoff hydrology (i.e., impervious areas), 'HDR' representing hydraulic conditions (i.e., conveyance capacities), and 'EX' and 'NEW' representing existing and proposed conditions respectively.

5.0 Identification of Impacts

The drainage model was executed with the proposed land use and existing drainage facilities to identify impacts. The objective of impact identification was twofold:

- Evaluate whether pipes and open channels have the capacity to convey the 25-year 24-hour storm in the scenario where the Airport is fully developed
- Compare post-development peak flow rate downstream of the Airport with the existing peak flow rate

5.1 Capacity Evaluation

The evaluation of the channel and pipe capacity was created by observing the results of the "proposed scenario" XPSWMM model runs. The indication of a particular conveyance being undersized is provided either by overtopping of bank (in case of channel) or upstream flooding (in case of pipes). To prevent the effect of backwater from affecting the observations, an iterative process was followed wherein the size of undersized pipes/culverts was increased starting from the downstream end of the system and moving downstream to upstream.

On completion of this evaluation, it was found that 28 pipe reaches, two rectangular box culverts, and four reaches of open channel require improvements to convey a 25-year 24-hour storm when the Airport is fully developed. These reaches are summarized in Appendix 6.

5.2 Comparing Downstream Peak Flow

As Table 5 shows, the 100-year peak flows downstream of the Airport in the developed scenario (without mitigation) are higher than peak flows in the existing scenario. This indicates the need for detention storage since the corresponding Douglas County drainage standards do not allow for any increase in peak flow downstream because of new development.

Table 5. Comparison of Downstream Peak Flows

At Northern Outfall Near Firebrand Circle		
	Pre-development[1] 100-year peak flows (cfs)	Post-development peak flows without mitigation (cfs)
100-year, 24-hour	616	662
25-year, 24-hour	501	576
10-year, 24-hour	452	496
2-year, 24-hour	391	407

The difference in pre- and post-development peak outflows into the Heybourne Ditch from the Southern branch of the drainage is negligible since the catchment flowing into this branch does not have significant impervious areas under planned developments. The additional flows in the future scenario can be mitigated by adding retention facilities as described in section 6.

6.0 Recommended Improvements

6.1 Conveyance Facility Improvements

Appendix 6 indicates which pipes, box culverts, or channels are undersized and require improvements to convey the 25-year 24-hour storm. These locations are highlighted in Figure 8. The recommended sizes are indicative and equivalent conveyance in any other shape may be provided. Since this is a planning-level study, the objective is only to be indicative about the nature and magnitude of the solutions.

Certain recommendations which require a substantial size increase (for example, Link L1 is recommended to be upgraded from a single 3' pipe to seven 4' pipes) are indicative of the facility being severely inadequate in existing condition. When the Airport proceeds to engineering design of these improvements, alternative solutions to provide equal conveyance may be found based on detailed site assessments of these specific facilities.

6.2 Detention Facilities

For the 100-year 24-hour storm, the outflow in post-development conditions was found to be 46 cfs higher than pre-development flows, as shown in Table 5. County standards call for a zero-increase in flow downstream in the post-development scenario.

[1] Pre-development flows from the pre-project model are not suitable for comparison as the system is currently undersized leading to overflows at a number of locations. These overflows are not captured in the model results. Therefore, a proxy pre-project model was created with original impermeable areas but upgraded conveyance capacities, which accurately reflected the cumulative flow resulting from all drainage staying in the system.

Table 6. Mitigation of Downstream Peak Flows Through Detention Storage

At Northern Outfall Near Firebrand Circle		
	Pre-development 100-year peak flows (cfs)	Post-development peak flows with detention basins (cfs)
100-year, 24-hour	616	609
25-year, 24-hour	501	501
10-year, 24-hour	452	446
2-year, 24-hour	391	388

To mitigate for the additional flows, a detention basin with 2.75 AF capacity is proposed in the northwest corner of the property (near the intersection of Heybourne Road and Firebrand Circle) and another one of 2.5 AF capacity is proposed along the eastern boundary of the Airport (in the triangular wedge formed by Taxiway C and Runway 30. Proposed locations of both basins are shown in Figure 8 and estimated reduction in peak flows are presented in Table 6.

7.0 References

Douglas County, *Design Criteria and Improvement Standards*, June 2007 and November 2007.

Minden-Tahoe Airport, *Airport Master Plan, Draft Final Report*, May 2008.

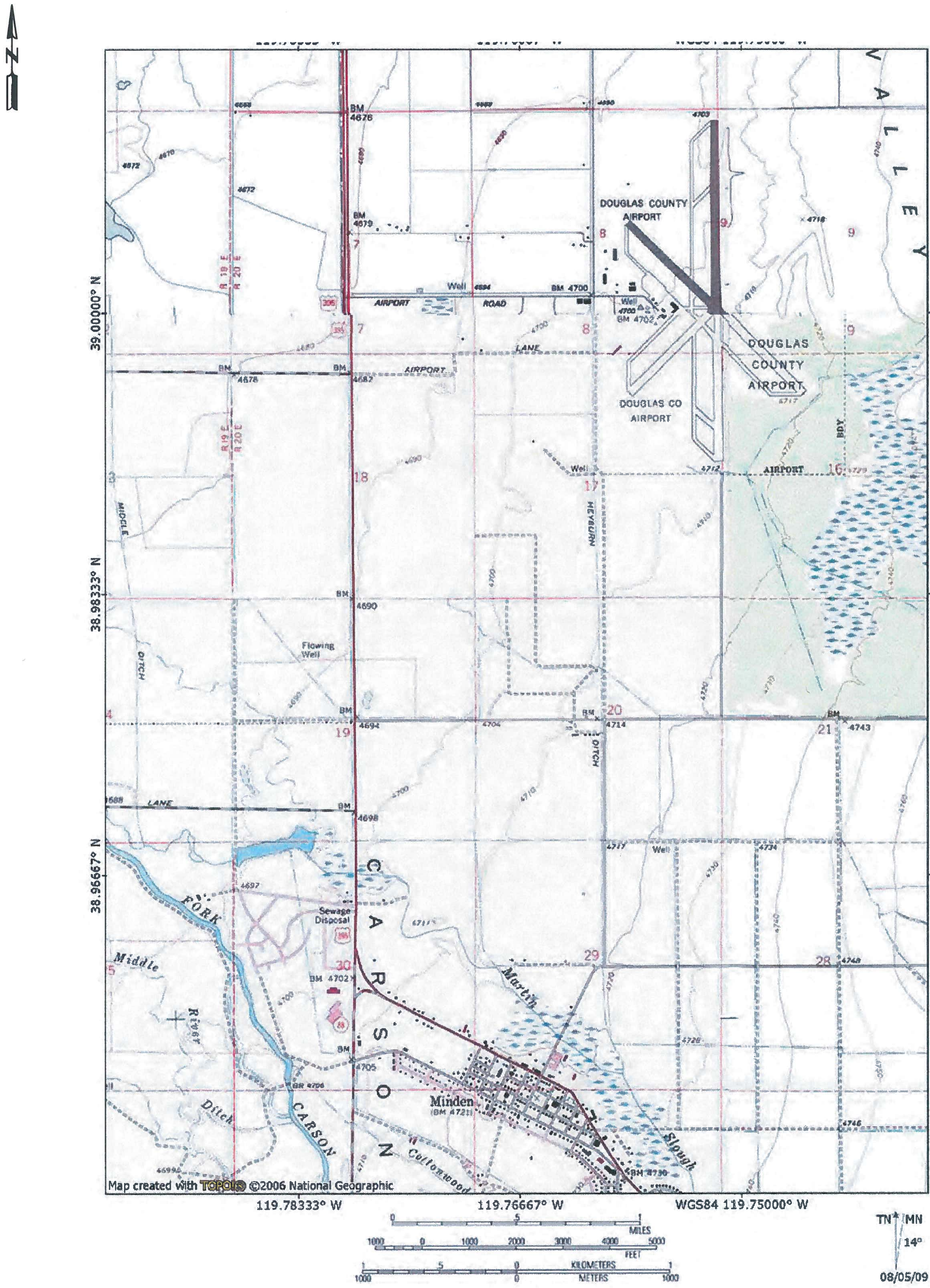
National Oceanic and Atmospheric Administration, *Point Precipitation Frequency Estimates from NOAA Atlas 14* (for Minden, NV), http://hdsc.nws.noaa.gov/hdsc/pfds/sa/nv_pfds.html, undated.

R.O. Anderson Engineering, Inc., *Sewer & Storm Drainage Master Plan*, April 2007.

United States Department of Agriculture (USDA), Web Soil Survey 2.0, www.websoilsurvey.nrcs.usda.gov, 2008.

Figures

MEAD & HUNT Inc.



Source: National Geographic TOPO! Mapping Software

MINDEN-TAHOE AIRPORT
DRAINAGE MASTER PLAN

MEAD & HUNT

FIGURE 1: LOCATION MAP

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MINDEN-TAHOE AIRPORT
DOUGLAS COUNTY NEVADA

MINDEN-TAHOE AIRPORT
DRAINAGE MASTER PLAN

MEAD & HUNT

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FIGURE 2: SITE PLAN

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RUNWAY DATA

	RUNWAY 16/34 EXISTING	RUNWAY 16/34 FUTURE	RUNWAY 12/30 EXISTING	RUNWAY 12/30 FUTURE	RUNWAY 12G/30G EXISTING	RUNWAY 12G/30G FUTURE	RUNWAY 3/21 EXISTING	RUNWAY 3/21 FUTURE
APPROACH VISIBILITY MINIMUMS	> 1-MILE	< 3/4-MILE	VISUAL	≥ 1-MILE	VISUAL	SAME	---	VISUAL
FAR PART 77 APPROACH SLOPE	34:1	50:1	20:1	34:1	20:1	SAME	---	20:1
FAR PART 77 APPROACH CATEGORY	VISUAL	PRECISION	VISUAL	NON-PRECISION	VISUAL	SAME	---	VISUAL
RUNWAY LENGTH x WIDTH	7400' x 100'	SAME	5300' x 75'	SAME	2200' x 60'	2200' x 100'	---	1800' x 100'
RUNWAY PAVEMENT TYPE	ASPHALT	SAME	ASPHALT	SAME	DIRT	AV TURF	---	AV TURF
PAVEMENT STRENGTH (IN 1000 LBS.)	30s, 50d	SAME	30s, 50d	SAME	---	---	---	---
RUNWAY LIGHTING	MIRL	SAME	NONE	SAME	NONE	SAME	---	NONE
RUNWAY MARKING	NON-PRECISION	PRECISION	VISUAL	NON-PRECISION	VISUAL	SAME	---	VISUAL
EFFECTIVE RUNWAY GRADIENT %	0.13%	SAME	0.42	0.58	.055	0.68	---	0.72
MAXIMUM RUNWAY GRADIENT %	0.001%	SAME	0.004%	0.006%	0.005%	0.007%	---	0.018%
RUNWAY LINE-OF-SIGHT	CRITERIA MET	SAME	CRITERIA MET	SAME	CRITERIA MET	SAME	---	CRITERIA MET
VISUAL APPROACH AIDS	VASI-4	PAPI	NONE	SAME	NONE	SAME	---	NONE
NAVIGATIONAL AIDS	GPS, BEACON	MALSR,BEACON,GPS	GPS	SAME	NONE	SAME	---	NONE
AIRPORT REFERENCE CODE	C-III	SAME	B-I (SMALL)	SAME	B-I (SMALL)	SAME	---	B-I (SMALL)
RUNWAY SAFETY AREA (RSA) WIDTH	500'	SAME	120'	SAME	120'	SAME	---	120'
RSA LENGTH BEYOND STOP END	1000'	SAME	240'	SAME	240'	SAME	---	240'
RUNWAY OBJECT FREE AREA (OFA) WIDTH	800'	SAME	250'	SAME	250'	SAME	---	250'
OFA LENGTH BEYOND STOP END	950'/250'	1000'/1000'	240'	SAME	240'	SAME	---	240'
OBSTACLE FREE ZONE (OFZ) WIDTH *	400'	SAME	250'	SAME	250'	SAME	---	250'
OFZ LENGTH BEYOND STOP END *	200'	SAME	200'	SAME	200'	SAME	---	200'
RUNWAY CENTERLINE TO HOLD LINE	250'	SAME	125'	SAME	125'	SAME	---	125'
TAXIWAY OBJECT FREE AREA	186'	SAME	131'	SAME	131'	SAME	---	131'
TAXIWAY SAFETY AREA	118'	SAME	79'	SAME	79'	SAME	---	79'
TAXIWAY WINGTIP CLEARANCE	34'	SAME	26'	SAME	26'	SAME	---	26'
TAXIWAY SURFACE TYPE	ASPHALT	SAME	ASPHALT	SAME	---	ASPHALT	---	ASPHALT

* No OFZ object penetrations

NON-STANDARD CONDITIONS

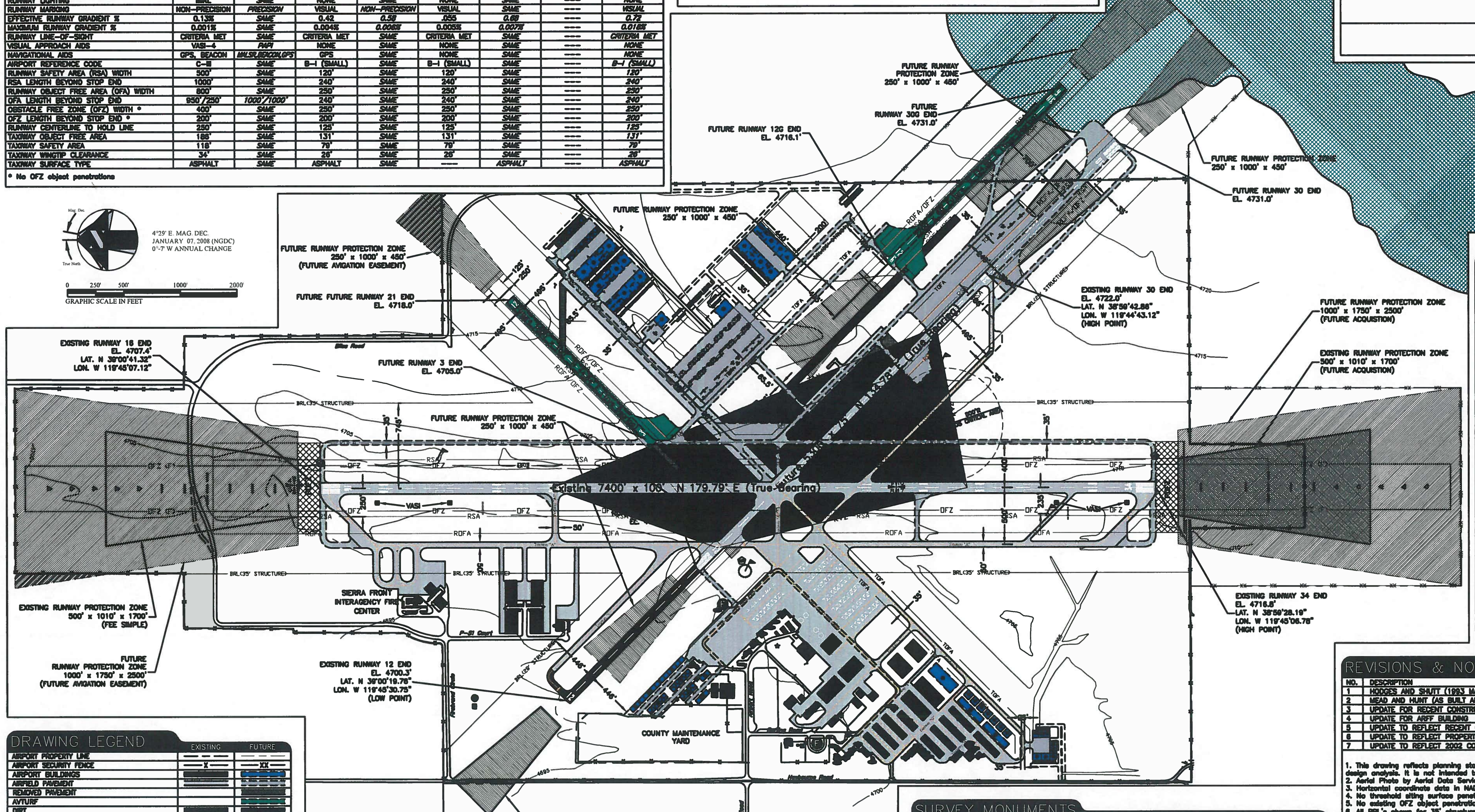
	A/C DESIGN GROUP EXISTING	A/C DESIGN GROUP FUTURE	STANDARD EXISTING	STANDARD FUTURE	NON-STANDARD EXISTING	NON-STANDARD FUTURE	REMARKS
RW 16 ROFA BEYOND RW END	C-III	SAME	1000'	SAME	950'	1000'	[illegible]
RW 34 ROFA BEYOND RW END	C-III	SAME	1000'	SAME	250'	1000'	[illegible]

SPONSOR APPROVAL

CHAIRMAN, DOUGLAS COUNTY BOARD OF COMMISSIONERS DATE

FAA APPROVAL

The contents of this plan do not necessarily reflect the official views or policy of the FAA. Acceptance of this document by the FAA does not in any way constitute a commitment on the part of the United States to participate in any development depicted herein, nor does it indicate that the proposed development is environmentally acceptable in accordance with appropriate public laws.



ALL WEATHER WINDROSE

RUNWAY	10.5-KNOT	13-KNOT	16-KNOT
RUNWAY 16/34	92.61%	95.55%	98.57%
RUNWAY 12/30	92.28%	95.54%	----
COMBINED	95.36%	97.83%	99.00%

SOURCE: WIND ROSE AND ANALYSIS TABULATION PROVIDED BY BARNARD DUNKELBERG AND CO., DATA PROVIDED BY ALL-WEATHER INC. MINDEN-TAHOE AIRPORT, AUTOMATED WEATHER OBSERVATION SYSTEM (AWOS). PERIOD OF RECORD – JANUARY 2006–JANUARY 2007. ONE MINUTE OBSERVATIONS, TOTAL OBSERVATIONS 469,414.

REVISIONS & NOTES

NO.	DESCRIPTION	DATE
1	HODGES AND SHUTT (1993 MASTER PLAN)	MAY 4, 1993
2	MEAD AND HUNT (AS BUILT ALP)	DEC 2000
3	UPDATE FOR RECENT CONSTRUCTION AND PROPERTY ACQUISITION	JUNE 2002
4	UPDATE FOR ARFF BUILDING	DEC 2002
5	UPDATE TO REFLECT RECENT CONSTRUCTION (AIP 10-11)	OCT 2003
6	UPDATE TO REFLECT PROPERTY RELEASE	JAN 2004
7	UPDATE TO REFLECT 2002 CONSTRUCTION	OCT 2005

1. This drawing reflects planning standards specific to this airport and is not a product of detailed engineering design analysis. It is not intended to be used for construction documentation or navigation.
2. Aerial Photo by Aerial Data Service, INC. October 2007.
3. Horizontal coordinate data in NAD83, vertical data is NAVD88.
4. No threshold siting surface penetrations.
5. No existing OFZ object penetrations.
6. All BRL's shown for 35' structure heights.

DRAWING LEGEND

	EXISTING	FUTURE
AIRPORT PROPERTY LINE		
AIRPORT SECURITY FENCE	—x—	—xx—
AIRPORT BUILDINGS		
AIRFIELD PAVEMENT		
REMOVED PAVEMENT		
AVTURF		
DIRT		
PAVED ROADS		
RUNWAY PROTECTION ZONE		
AVIATION EASEMENT		
POTENTIAL WETLANDS		SAME
HOLD LINES		SAME
BUILDING RESTRICTION LINE	—BRL—	—BRL—
RUNWAY SAFETY AREA	—RSA—	—RSA (F)—
RUNWAY OBJECT FREE AREA	—ROFA—	—ROFA (F)—
TAXIWAY OBJECT FREE AREA	—TOFA—	
OBJECT FREE ZONE	—OFZ—	—OFZ (F)—
FUEL STORAGE AREA		
AIRPORT BEACON		
LIGHTED WIND CONE & SEGMENTED CIRCLE		
WIND CONE		
PRECISION APPROACH PATH INDICATOR (PAPI)		
SECTION CORNER		
RUNWAY END IDENTIFIER LIGHTS (REIL)		
AIRPORT REFERENCE POINT (ARP)		
NON-DIRECTIONAL BEACON (NDB)		
GATE		

AIRPORT DATA

	EXISTING	FUTURE
AIRPORT ELEVATION (AMSL) NAVD 88	4726.0'	4731.0'
AIRPORT REFERENCE POINT (ARP) NAD 83	LAT. N 39°00'01.00" LON. W 119°45'04.30"	LAT. N 39°00'01.02" LON. W 119°44'59.95"
MEAN MAX. TEMPERATURE (HOTTEST MONTH)	90° F	SAME
AIRPORT REFERENCE CODE RW 16/34	C-III	SAME
RW 3/21	B-I (SMALL)	SAME
RW 12/30	B-I (SMALL)	SAME
RW 12G/30G	B-I (SMALL)	SAME
TAXIWAY LIGHTING	REFLECTORS	SAME

DESIGN AIRCRAFT

RUNWAY	AIRCRAFT	WINGSPAN	APPROACH SPEED	MTOW	UNDERCARRIAGE
16/34	P-3 ORION	99.7'	134 KTS	135,000 LBS	28'
12/30	BEECH BARON 58	37.8'	96 KTS	5,500 LBS	10.5'
12G/30G	PIPER PAWNEE PA-25	36.1'	69 KTS	2,900 LBS	10'
3/21	PIPER PAWNEE PA-25	36.1'	69 KTS	2,900 LBS	10'

SURVEY MONUMENTS

ITEM	CONTROL STATION IDENTIFICATION NUMBER	DESCRIPTION/PROTECTION
M1	FAA MEV A	STAINLESS STEEL ROD IN SLEEVE
M2	MEV AP STA A	CGS TOPOGRAPHIC DISK SET IN CONCRETE
M3	MEV AP STA B	CGS TOPOGRAPHIC DISK SET IN CONCRETE

RUNWAY END DATA

RUNWAY END COORDINATES (NAD83)	RUNWAY 16	RUNWAY 34	RUNWAY 3	RUNWAY 21	RUNWAY 12	RUNWAY 30	RUNWAY 12G	RUNWAY 30G
EXISTING	LAT. N 39°00'41.32" LON. W 119°45'07.12"	LAT. N 38°59'28.19" LON. W 119°45'06.78"	-	-	LAT. N 39°00'19.78" LON. W 119°45'30.75"	LAT. N 38°59'42.88" LON. W 119°44'43.12"	-	-
FUTURE	SAME	SAME	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

RUNWAY ELEVATIONS (NAVD88)	RUNWAY 16/34 EXISTING	RUNWAY 16/34 FUTURE	RUNWAY 3/21 EXISTING	RUNWAY 3/21 FUTURE	RUNWAY 12/30 EXISTING	RUNWAY 12/30 FUTURE	RUNWAY 12G/30G EXISTING	RUNWAY 12G/30G FUTURE
END	4707.4'/4716.8'	SAME	-	4705.0'/4718.0'	4700.3'/4722.0'	4700.0'/4731.0'	-	4716.1'/4731.0'
HIGH POINT	4716.8'	SAME	-	4718.0'	4722.0'	4731.0'	-	4731.0'
LOW POINT	4707.4'	SAME	-	4705.0'	4700.3'	4700.0'	-	4716.1'
TOUCHDOWN ZONE ELEVATION	4716.8'	SAME	-	4718.0'	4722.0'	4731.0'	-	4731.0'

MINDEN-TAHOE AIRPORT

Douglas County, Nevada

AIRPORT LAYOUT DRAWING

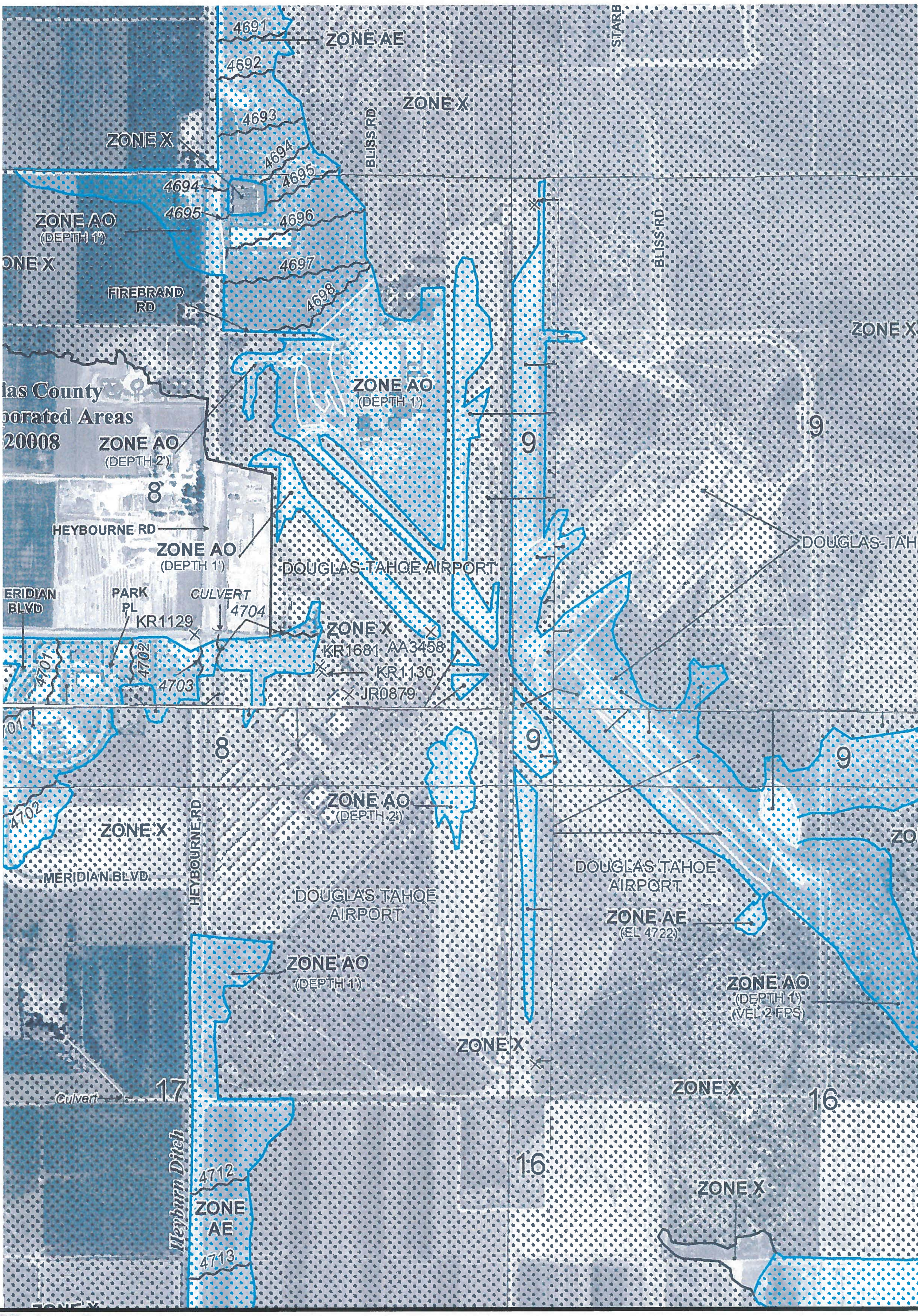
Barnard Dunkelberg & Company

TULSA
1616 East 15th Street
Tulsa, Oklahoma 74120
918.585.8844

DENVER
1743 Wazee Street, Suite 400
Denver, Colorado 80202
303.825.8844

DATE: MAY 2008
SCALE: 1" = 500'
SHEET NO. 2 OF 20

FIGURE 3

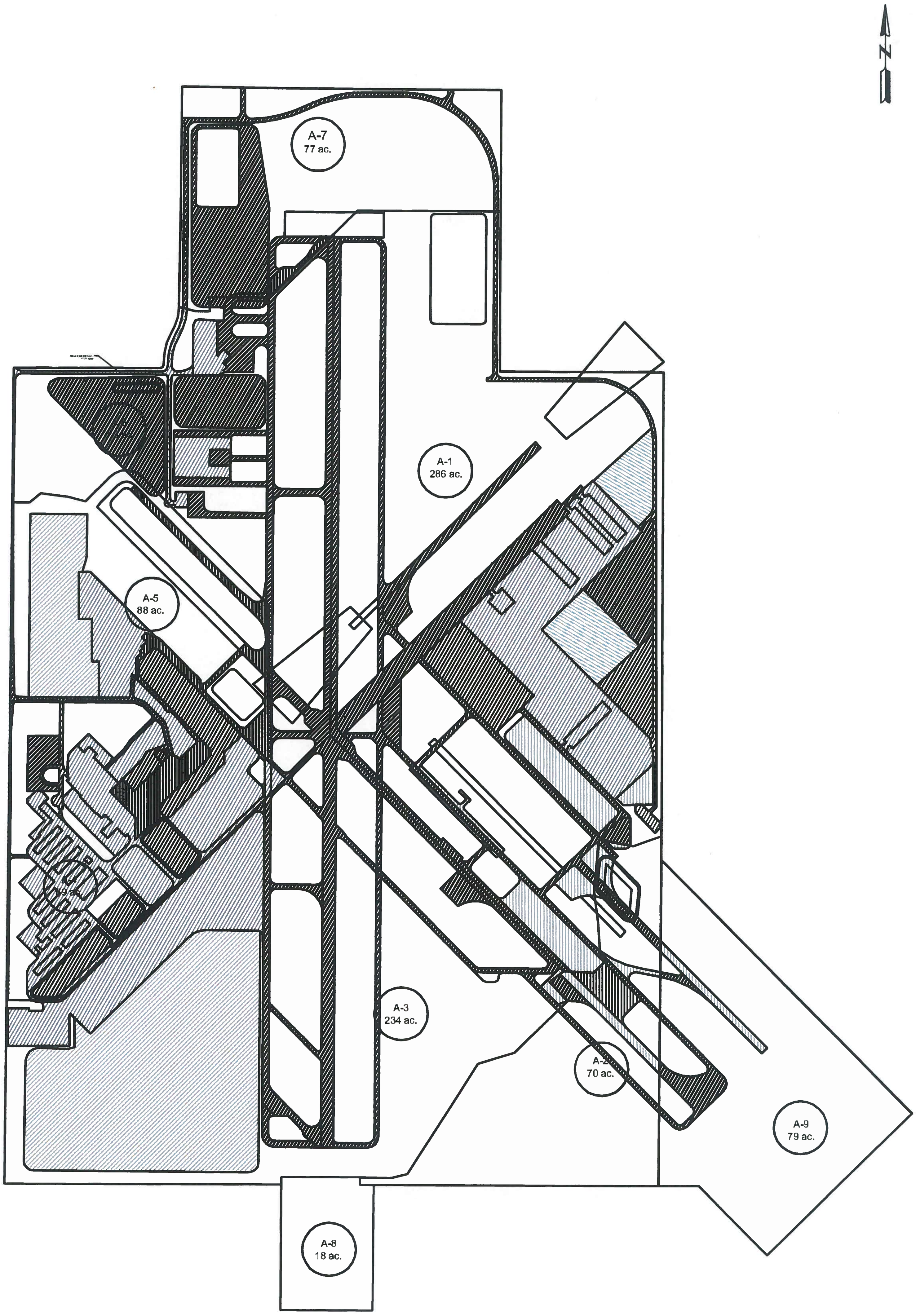


MINDEN-TAHOE AIRPORT
DRAINAGE MASTER PLAN

MEAD & HUNT

04192-8001
04192-8001
4-01-09

FIGURE 4: FLOODPLAIN MAP



12/21/2010 2:04:01 PM
X:\04192\080011\TECH\CADD\MINDEN-TAHOE DMP\DWG\EXHIBITS\EXHIBIT-6.DWG

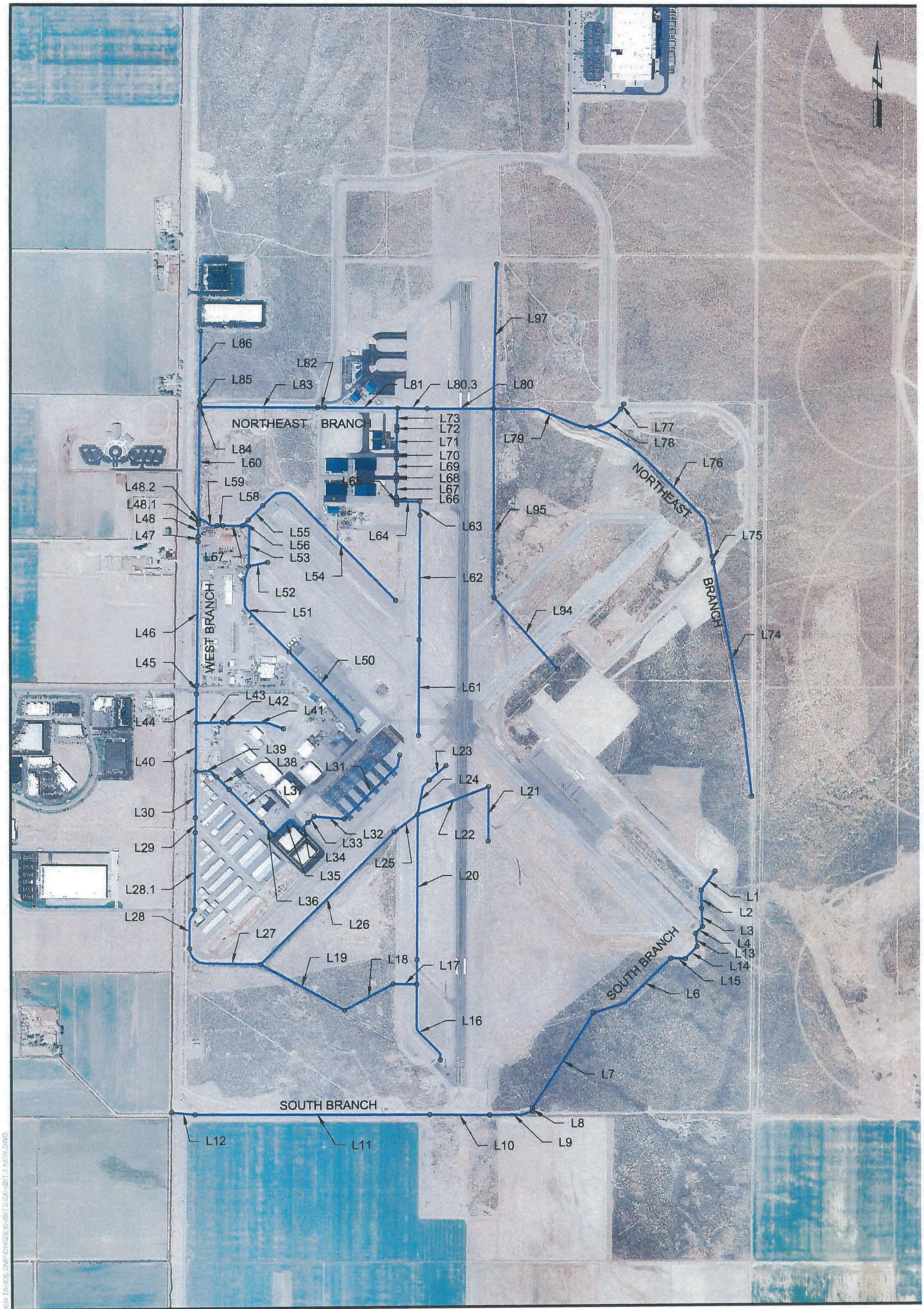
MINDEN-TAHOE AIRPORT
DOUGLAS COUNTY NEVADA

MINDEN-TAHOE AIRPORT
DRAINAGE MASTER PLAN

MEAD & HUNT

04192-8001
04192-8001
4-01-09

FIGURE 6: ONSITE SUBCATCHMENTS



MINDEN-TAHOE AIRPORT
DRAINAGE MASTER PLAN

FIGURE 7: EXISTING DRAINAGE NETWORK

04192-8001
04192-8001
4-01-09

MINDEN-TAHOE AIRPORT
DOUGLAS COUNTY NEVADA

MINDEN-TAHOE AIRPORT
DRAINAGE MASTER PLAN

EXISTING CONVEYANCE
RECOMMENDED FOR IMPROVEMENT

MEAD & HUNT

04192-8001
04192-8001
4-01-09

FIGURE 8: RECOMMENDED IMPROVEMENTS

Appendices

Appendix 1. Hydrologic Soil Group Report

Hydrologic Soil Group
(Minden-Tahoe Airport)

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Soil Ratings

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Political Features

- Cities

Water Features

- Oceans
- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:14,400 if printed on B size (11" × 17") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 11N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Douglas County Area, Nevada
Survey Area Data: Version 3, Dec 12, 2006

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Douglas County Area, Nevada				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
311	Gardnerville clay loam	C	21.5	0.8%
312	Gardnerville clay loam, drained	C	421.2	16.4%
313	Gardnerville clay loam, slightly saline-alkali	C	739.1	28.8%
314	Gardnerville clay	C	208.8	8.1%
315	Gardnerville clay, slightly saline-alkali	C	13.5	0.5%
351	Godecke fine sandy loam	C	592.2	23.1%
391	Haybourne sand, 0 to 4 percent slopes	B	13.9	0.5%
611	Nevador fine sandy loam, 0 to 2 percent slopes	B	292.1	11.4%
831	Saralegui sand, 0 to 2 percent slopes	B	42.1	1.6%
953	Toll sand, clay substratum, 0 to 2 percent slopes	A	14.1	0.5%
985	Turria clay loam, wet	C	30.9	1.2%
1051	Voltaire variant clay loam	D	177.0	6.9%
Totals for Area of Interest			**2,566.1**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: All Components

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "All Components" returns the lowest or highest attribute value among all components of the map unit, depending on the corresponding "tie-break" rule. In this case, the "tie-break" rule indicates whether the lowest or highest value among all components should be returned. For this aggregation method, percent composition ties cannot occur.

The result returned by this aggregation method represents either the minimum or maximum value of the corresponding attribute throughout the map unit. The result may well be based on a map unit component of very minor extent.

Component Percent Cutoff: *None Specified*

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Lower

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

Appendix 2. Existing Reach Properties

Appendix 2 - Existing Drainage Pipes and Open Channels

Link Name	Shape	Length (ft)	No. of barrels	Diameter/ Height (ft)	Bottom Width (ft)
L1	Circular	188	3	1.5	-
L2	Trapezoidal	170	1	4	0
L3	Circular	160	1	3	-
L4	Trapezoidal	90	1	4	0
L6	Trapezoidal	892	1	5	10
L7	Trapezoidal	1039	1	1.5	10
L8	Circular	30	1	2	-
L9	Trapezoidal	407	1	3	6
L10	Circular	550	1	3	-
L11	Trapezoidal	2355	1	3	0
L12	Circular	80	1	3	-
L13	Trapezoidal	121	1	4	12
L14	Trapezoidal	157	1	4	25
L15	Trapezoidal	133	1	4	35
L16	Trapezoidal	779	1	2	0
L17	Circular	218	1	1.5	-
L18	Trapezoidal	505	1	4.5	0
L19	Trapezoidal	879	1	5	0
L20	Trapezoidal	1342	1	3	0
L21	Circular	499	1	2.5	-
L22	Circular	697	1	2.5	-
L23	Circular	204	1	1	-
L24	Trapezoidal	339	1	1.5	0
L25	Circular	272	1	2.5	-
L26	Trapezoidal	1729	1	8	10
L27	Trapezoidal	631	1	5	10
L28	Trapezoidal	458	1	6	8
L28.1	Trapezoidal	718	1	6	8
L29	Circular	137	1	3.5	-
L30	Trapezoidal	424	1	8	8
L31	Circular	793	1	2	-
L32	Circular	277	1	2	-
L33	Trapezoidal	81	1	3	10
L34	Circular	97	1	2	-
L35	Circular	325	1	2	-
L36	Circular	155	1	2	-
L37	Trapezoidal	428	1	4	8
L38	Circular	163	1	3	-
L39	Trapezoidal	212	1	5	4
L40	Trapezoidal	449	1	8	8
L41	Trapezoidal	515	1	2	0
L42	Circular	43	1	1.5	-
L43	Trapezoidal	239	1	2	0
L44	Trapezoidal	263	1	8	8
L45	Circular	80	1	3	-
L46	Trapezoidal	1326	1	6.5	8.5

Link Name	Shape	Length (ft)	No. of barrels	Diameter/ Height (ft)	Bottom Width (ft)
L47	Circular	48	3	1.5	-
L48	Trapezoidal	109	1	5	9
L48.1	Circular	28	1	3.5	-
L48.2	Trapezoidal	26	1	6	8
L50	Circular	965	1	2.5	-
L51	Trapezoidal	960	1	4	4
L52	Circular	176	1	2	-
L53	Trapezoidal	429	1	4	4
L54	Trapezoidal	1678	1	1.5	0
L55	Circular	186	1	2	-
L56	Trapezoidal	76	1	4.5	0
L57	Trapezoidal	179	1	4	4
L58	Circular	52	1	2	-
L59	Trapezoidal	191	1	5	0
L60	Trapezoidal	1026	1	5	13
L61	Circular	876	1	1	-
L62	Trapezoidal	1149	1	1.5	0
L63	Circular	128	1	2	-
L64	Circular	213	1	2	-
L65	Circular	31	1	3	-
L66	Circular	36	1	3	-
L67	Trapezoidal	145	1	5	8
L68	Circular	59	1	3	-
L69	Trapezoidal	149	1	5	8
L70	Circular	56	1	3	-
L71	Trapezoidal	199	1	5	5
L72	Circular	44	1	3	-
L73	Trapezoidal	170	1	5	10
L74	Trapezoidal	2188	1	4	8
L75	Circular	60	2	5	-
L76	Trapezoidal	1726	1	5	4
L77	Circular	55	3	5	-
L78	Trapezoidal	341	1	4	9
L79	Trapezoidal	923	1	4	9
L80	Rectangular	608	2	3	4.8
L80.3	Rectangular	273	2	3	4.8
L81	Trapezoidal	672	1	5	10
L82	Circular	61	1	5	-
L83	Trapezoidal	1085	1	3.5	6
L84	Trapezoidal	19	1	5	13
L85	Circular	46	2	3.5	-
L86	Trapezoidal	630	1	4	6
L94	Circular	901	1	2.5	-
L95	Trapezoidal	1744	1	6	8
L97	Trapezoidal	1331	1	2	5

Appendix 3. Point Precipitation Frequency Estimates from NOAA Atlas 14

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

MINDEN, NEVADA (26-5191) 38.9547 N 119.7758 W 4747 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Sat Mar 28 2009

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.08	0.12	0.15	0.20	0.25	0.36	0.44	0.61	0.81	1.01	1.22	1.44	1.63	1.81	2.20	2.50	2.86	3.31
2	0.10	0.15	0.18	0.25	0.31	0.45	0.55	0.76	1.02	1.27	1.53	1.81	2.06	2.29	2.78	3.17	3.63	4.20
5	0.13	0.20	0.25	0.33	0.41	0.57	0.69	0.94	1.28	1.61	1.95	2.31	2.65	2.94	3.58	4.06	4.64	5.37
10	0.16	0.25	0.31	0.42	0.52	0.68	0.79	1.08	1.48	1.88	2.28	2.73	3.11	3.46	4.17	4.72	5.39	6.18
25	0.21	0.33	0.40	0.55	0.67	0.83	0.94	1.26	1.75	2.25	2.75	3.31	3.77	4.16	4.96	5.61	6.33	7.21
50	0.26	0.40	0.49	0.66	0.82	0.97	1.04	1.39	1.95	2.54	3.12	3.78	4.29	4.71	5.56	6.27	7.03	7.94
100	0.32	0.48	0.59	0.80	0.99	1.12	1.17	1.52	2.15	2.85	3.51	4.28	4.83	5.27	6.17	6.94	7.71	8.62
200	0.38	0.58	0.72	0.97	1.21	1.29	1.33	1.66	2.35	3.17	3.92	4.79	5.39	5.85	6.76	7.60	8.35	9.25
500	0.49	0.74	0.92	1.24	1.53	1.55	1.58	1.84	2.62	3.60	4.49	5.53	6.18	6.63	7.55	8.47	9.15	10.01
1000	0.58	0.88	1.09	1.47	1.82	1.84	1.86	1.98	2.82	3.94	4.93	6.11	6.79	7.24	8.14	9.12	9.71	10.51

* These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.

*** Upper bound of the 90% confidence interval**
Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.09	0.13	0.17	0.22	0.28	0.40	0.48	0.67	0.89	1.12	1.35	1.60	1.82	2.01	2.44	2.76	3.16	3.65
2	0.11	0.17	0.21	0.28	0.35	0.49	0.60	0.83	1.12	1.41	1.70	2.02	2.29	2.54	3.09	3.51	4.00	4.64
5	0.15	0.23	0.28	0.38	0.47	0.62	0.75	1.03	1.42	1.77	2.15	2.58	2.95	3.27	3.96	4.47	5.10	5.91
10	0.19	0.28	0.35	0.47	0.59	0.75	0.86	1.18	1.64	2.06	2.51	3.03	3.46	3.84	4.62	5.20	5.92	6.81
25	0.25	0.38	0.46	0.62	0.77	0.94	1.03	1.38	1.95	2.48	3.04	3.70	4.20	4.63	5.50	6.18	6.96	7.93
50	0.30	0.46	0.57	0.77	0.95	1.10	1.17	1.54	2.20	2.80	3.46	4.23	4.80	5.25	6.18	6.93	7.73	8.75
100	0.38	0.57	0.71	0.95	1.18	1.30	1.33	1.72	2.46	3.15	3.91	4.80	5.42	5.90	6.87	7.69	8.50	9.52
200	0.47	0.71	0.89	1.19	1.48	1.52	1.55	1.91	2.74	3.52	4.39	5.41	6.10	6.59	7.58	8.46	9.25	10.25
500	0.62	0.94	1.17	1.57	1.94	1.96	1.98	2.16	3.14	4.02	5.08	6.29	7.07	7.55	8.53	9.48	10.24	11.13
1000	0.76	1.16	1.43	1.93	2.39	2.41	2.44	2.46	3.45	4.43	5.64	7.01	7.83	8.29	9.26	10.30	10.94	11.76

* The **upper** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **greater** than.
** These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

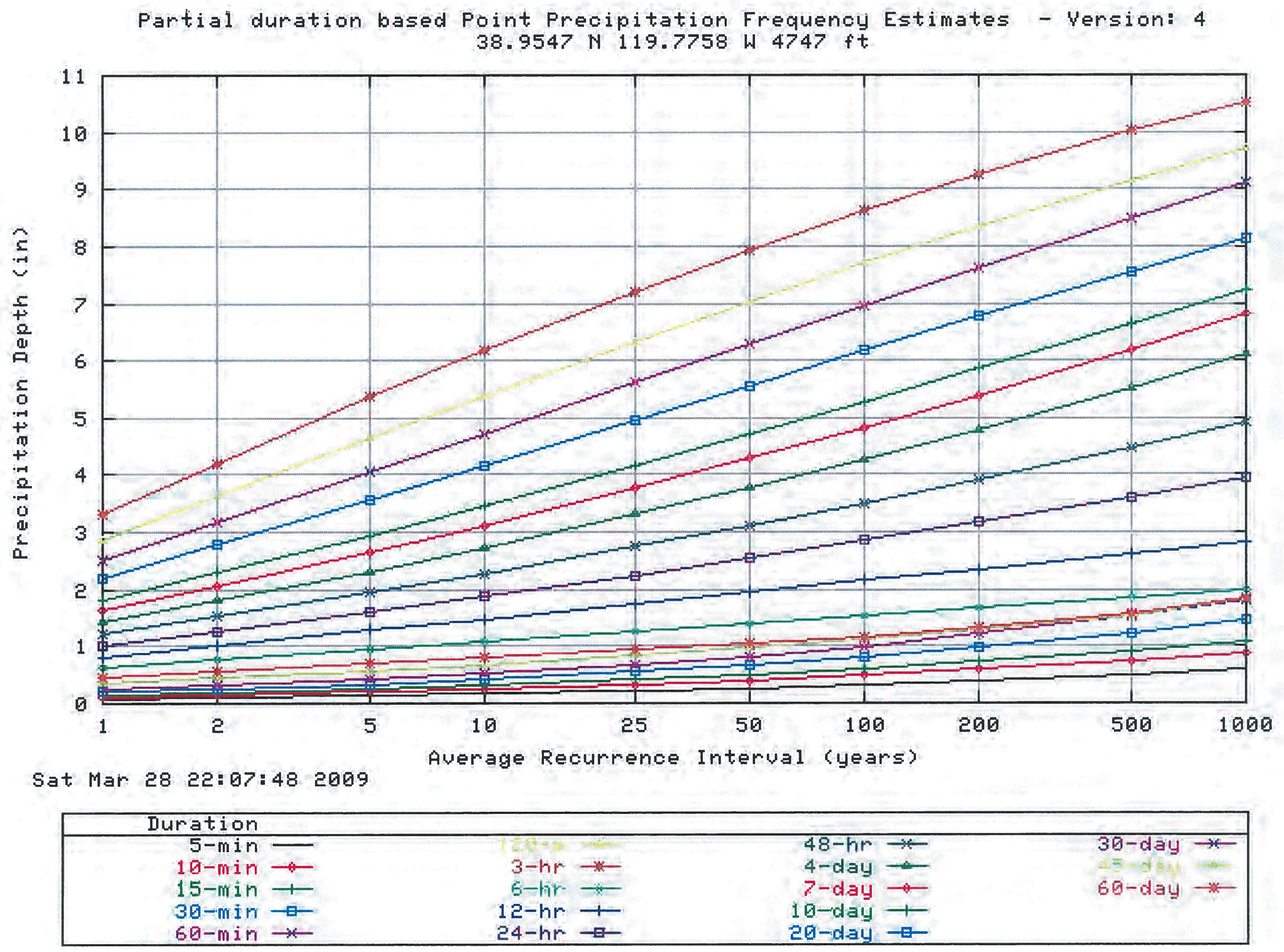
*** Lower bound of the 90% confidence interval**
Precipitation Frequency Estimates (inches)

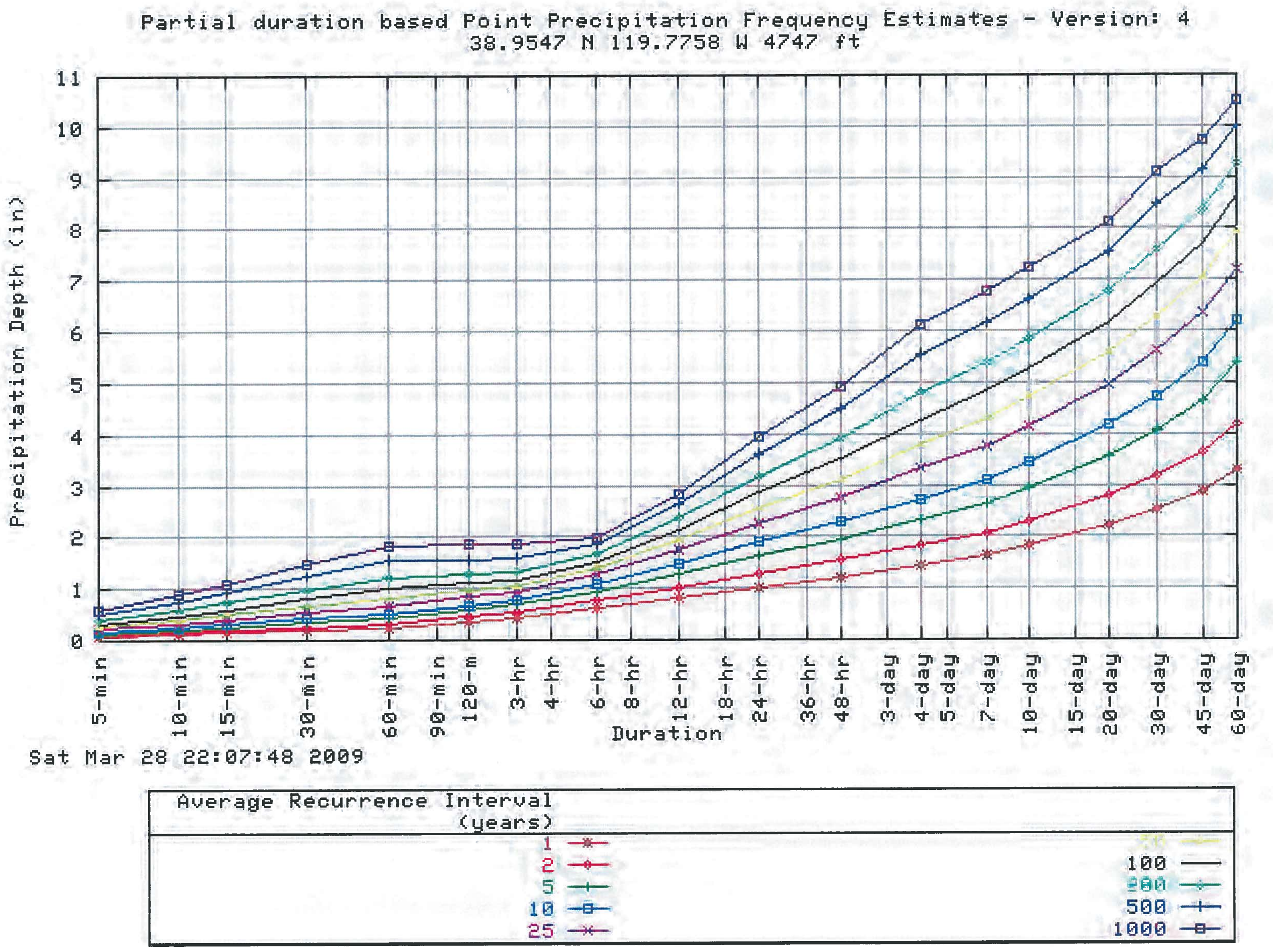
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.07	0.11	0.13	0.18	0.22	0.34	0.40	0.56	0.73	0.93	1.11	1.29	1.46	1.62	1.98	2.26	2.59	2.99

2	0.09	0.14	0.17	0.23	0.28	0.41	0.51	0.70	0.92	1.17	1.39	1.62	1.84	2.05	2.50	2.86	3.29	3.80
5	0.12	0.18	0.22	0.30	0.37	0.52	0.63	0.86	1.15	1.47	1.76	2.07	2.37	2.64	3.21	3.67	4.21	4.86
10	0.15	0.22	0.28	0.37	0.46	0.61	0.72	0.98	1.32	1.71	2.06	2.44	2.78	3.10	3.74	4.26	4.87	5.59
25	0.18	0.28	0.34	0.46	0.57	0.73	0.83	1.13	1.54	2.04	2.46	2.94	3.35	3.70	4.42	5.03	5.71	6.52
50	0.21	0.32	0.40	0.54	0.67	0.83	0.91	1.23	1.68	2.29	2.77	3.33	3.78	4.16	4.93	5.59	6.32	7.16
100	0.25	0.38	0.47	0.63	0.78	0.93	0.99	1.32	1.83	2.54	3.09	3.72	4.22	4.63	5.44	6.16	6.90	7.75
200	0.29	0.43	0.54	0.73	0.90	1.02	1.10	1.40	1.95	2.79	3.42	4.12	4.67	5.08	5.92	6.69	7.46	8.29
500	0.34	0.51	0.64	0.86	1.06	1.16	1.26	1.51	2.10	3.13	3.85	4.67	5.27	5.68	6.53	7.37	8.12	8.94
1000	0.38	0.58	0.71	0.96	1.19	1.32	1.42	1.58	2.22	3.39	4.19	5.08	5.71	6.12	6.97	7.87	8.57	9.37

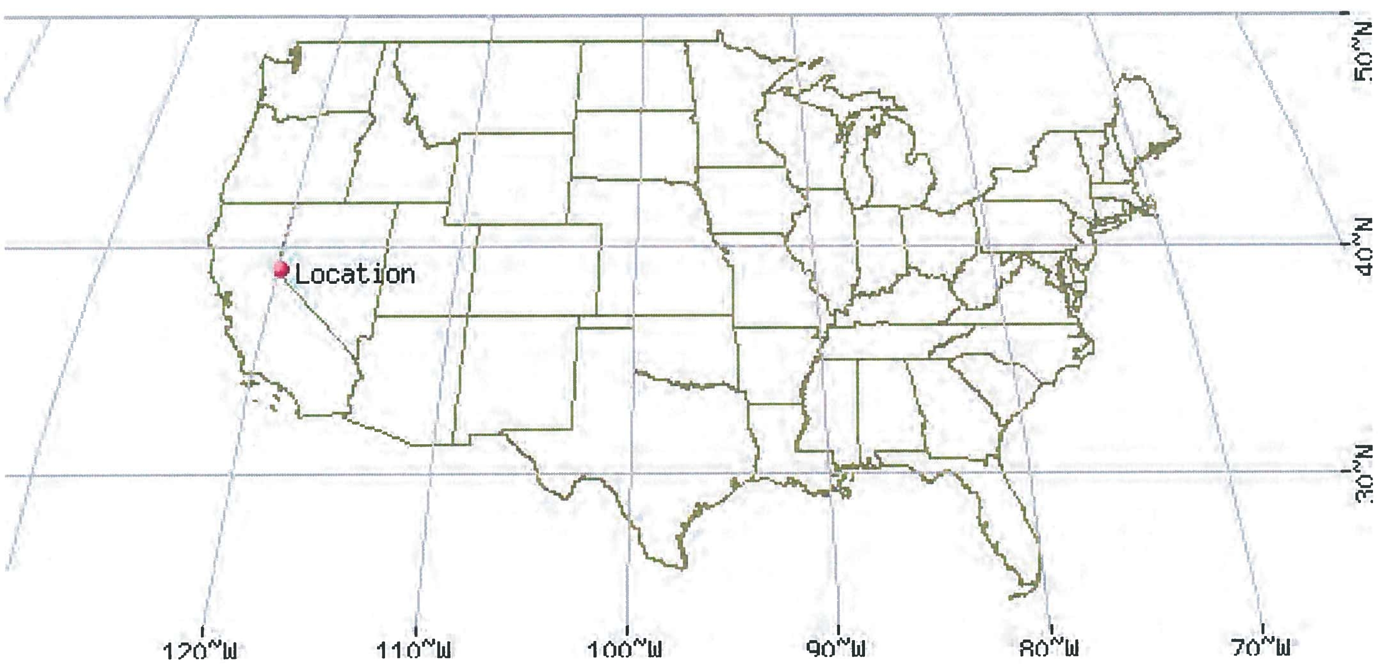
* The **lower** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **less** than.
** These precipitation frequency estimates are based on a partial duration maxima series. **ARI** is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

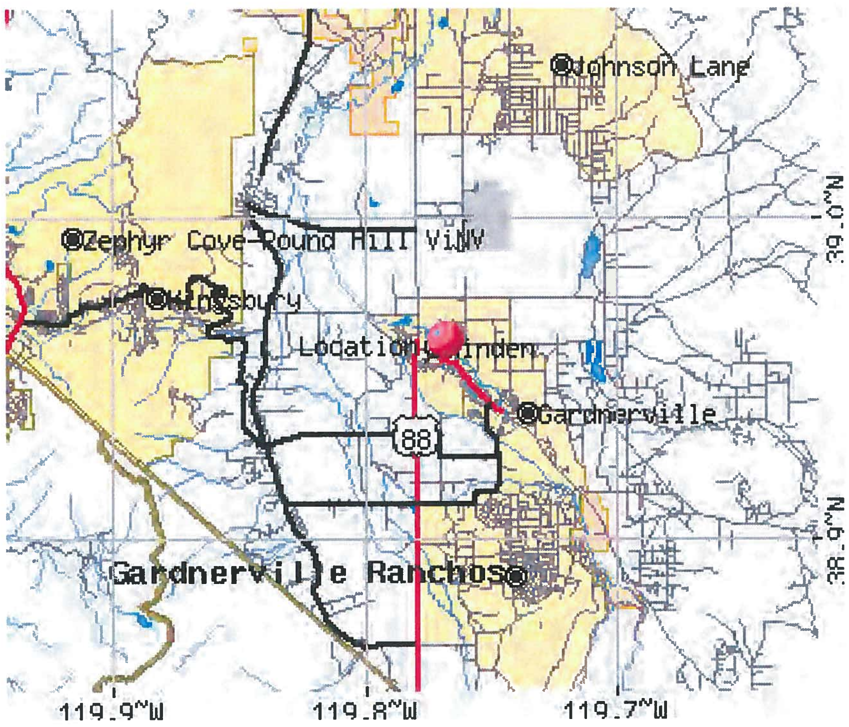
Text version of tables




Partial duration based Point Precipitation Frequency Estimates - Version: 4
38.9547 N 119.7758 W 4747 ft
Precipitation Depth (in)
0
1
2
3
4
5
6
7
8
9
10
11
5-min
10-min
15-min
30-min
60-min
90-min
120-m
3-hr
4-hr
6-hr
8-hr
12-hr
18-hr
24-hr
36-hr
48-hr
3-day
4-day
5-day
7-day
10-day
15-day
20-day
30-day
45-day
60-day
Duration
Sat Mar 28 22:07:48 2009
Average Recurrence Interval
(years)
1
2
5
10
25
100
200
500
1000

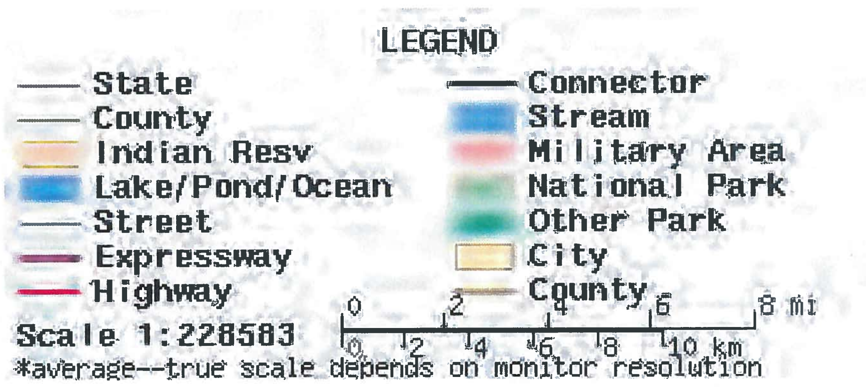
Maps -


Location
50°N
40°N
30°N
120°W
110°W
100°W
90°W
80°W
70°W



These maps were produced using a direct map request from the [U.S. Census Bureau Mapping and Cartographic Resources](#) **[Tiger Map Server](#)**.

Please read [disclaimer](#) for more information.



Other Maps/Photographs -

[View USGS digital orthophoto quadrangle (DOQ)](#) covering this location from TerraServer; **USGS Aerial Photograph** may also be available from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the [USGS](#) for more information.

Watershed/Stream Flow Information -

[Find the Watershed](#) for this location using the U.S. Environmental Protection Agency's site.

Climate Data Sources -

Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study, please refer to [NOAA Atlas 14 Document](#).

Using the **[National Climatic Data Center's (NCDC)](#)** station search engine, locate other climate stations within:
+/-30 minutes ...OR... +/-1 degree of this location (38.9547/-119.7758). Digital ASCII data can be obtained directly from [NCDC](#).

Find [Natural Resources Conservation Service (NRCS)](#) SNOTEL (SNOwpack TELemetry) stations by visiting the **[Western Regional Climate Center's state-specific SNOTEL station maps](#)**.

Hydrometeorological Design Studies Center
DOC/NOAA/National Weather Service
1325 East-West Highway
Silver Spring, MD 20910
(301) 713-1669
Questions?: HDSC.Questions@noaa.gov

[Disclaimer](#)

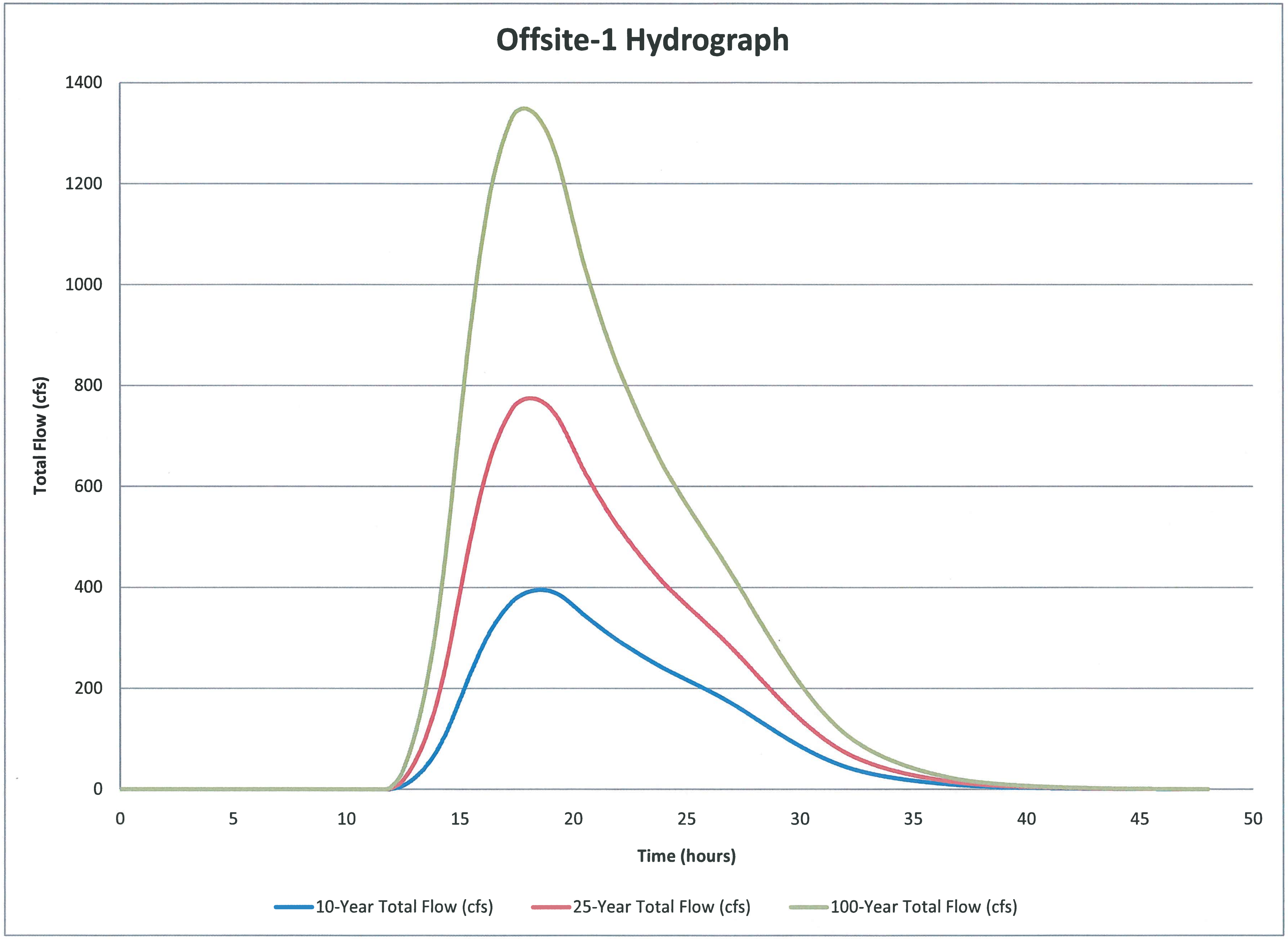
Appendix 4. Associations Between XPSWMM Nodes and Subcatchments

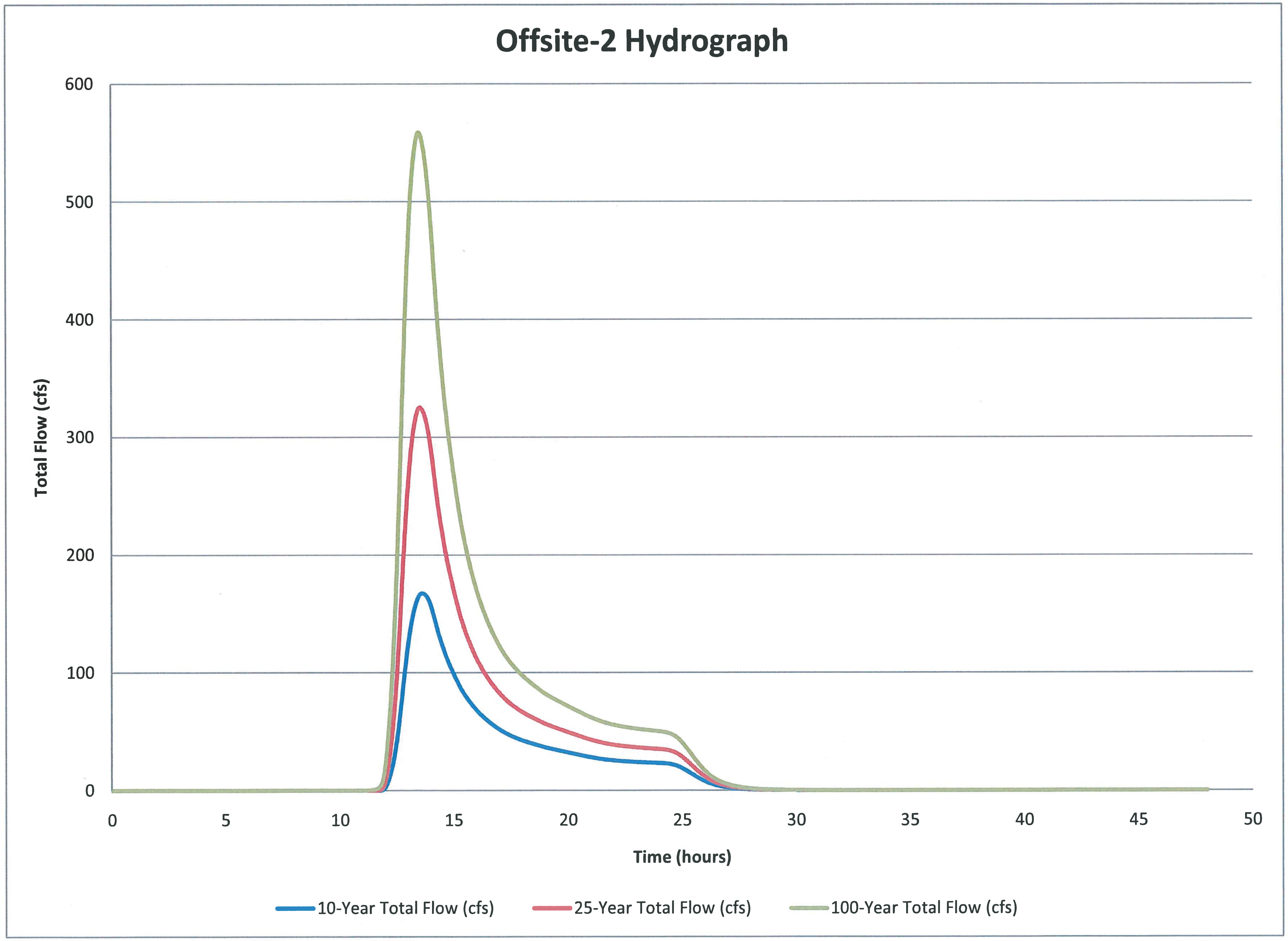
MEAD & HUNT Inc.

Appendix 4 - Associations between XPSWMM nodes and Subcatchments

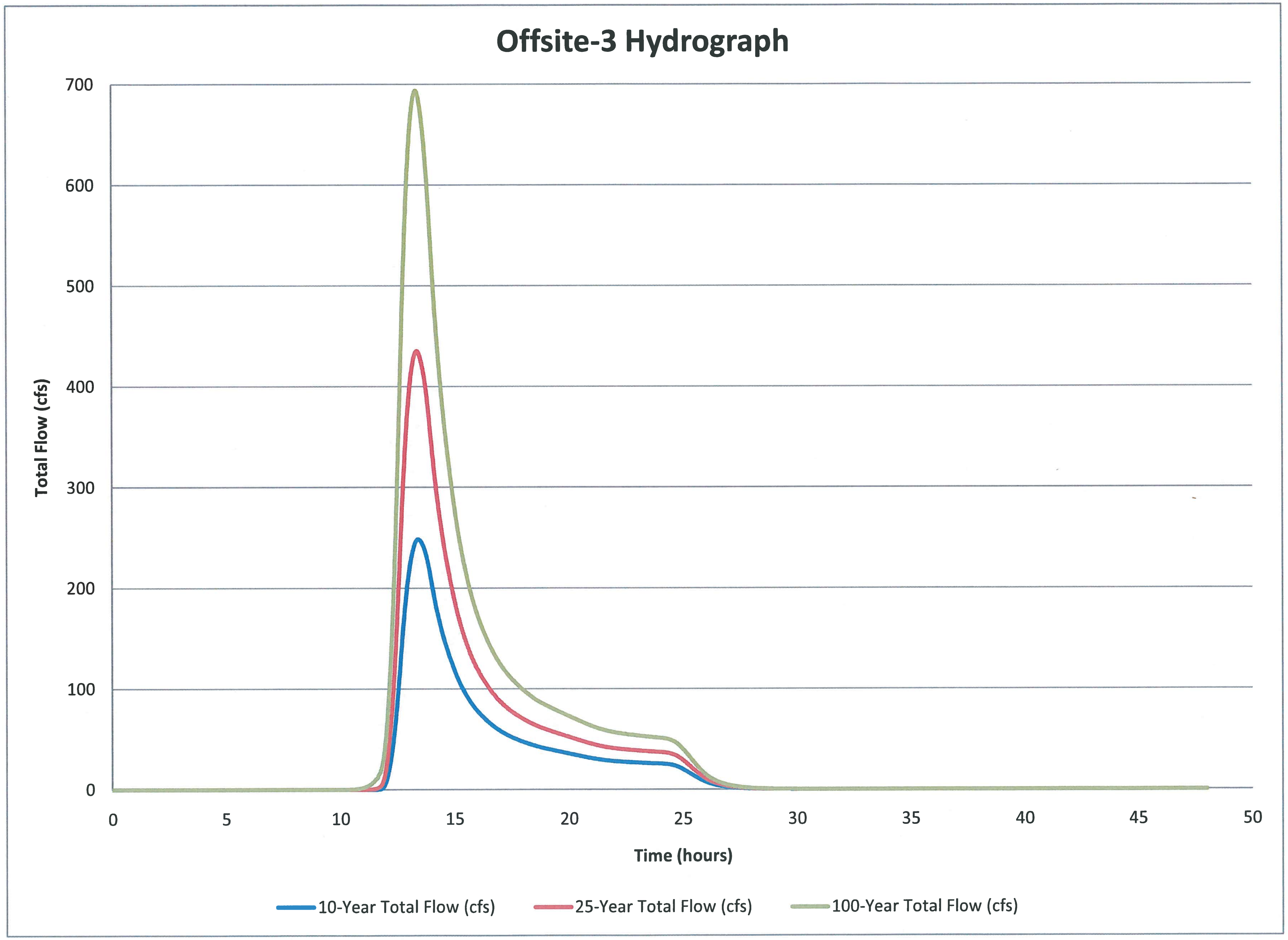
Subarea	Inflow Node	Area (ac)	Area (SF)
A-3	N28	2.91	126,753
A-2	N2	4.04	176,112
A-4	N36	4.93	214,795
A-6	N66	5.24	228,183
A-6	N69	5.49	239,062
A-4	N33.1	6.53	284,353
A-4	N38	7.90	344,280
A-3	N21	7.96	346,842
A-1	N82	8.21	357,644
A-4	N33	8.45	368,243
A-2	N1	9.63	419,366
A-1	N79	12.87	560,559
A-4	N46	14.30	623,056
A-6	N70	14.72	641,241
A-5	N51	15.50	675,120
A-6	N85.1	15.81	688,494
A-5	N59	16.34	711,770
A-3	N31	16.48	717,963
A-5	N55	17.38	756,988
A-8	N11	18.26	795,407
A-5	N56	18.62	810,872
A-6	N67	19.75	860,447
A-5	N57	20.49	892,425
A-1	N81	21.19	923,205
A-3	N25	22.14	964,479
A-3	N27	25.27	1,100,619
A-4	N42	26.99	1,175,866
A-3	N23	45.31	1,973,740
A-1	N105	46.02	2,004,456
A-3	N32	47.64	2,075,071
A-6	N86	52.48	2,285,811
A-2	N4	56.42	2,457,864
A-3	N26	66.03	2,876,243
A-1	N103	73.78	3,213,956
A-1	N102	123.48	5,378,607

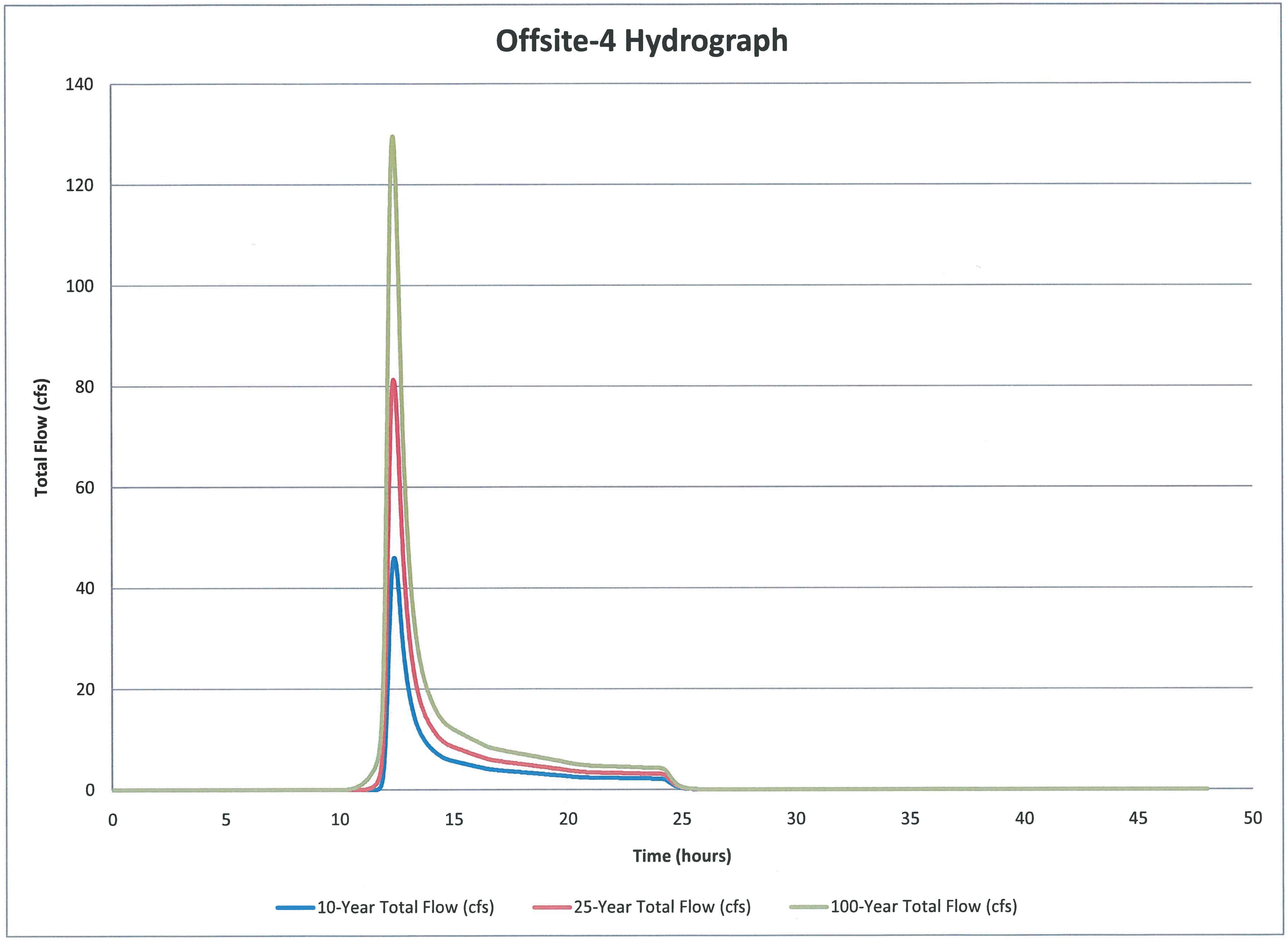
Appendix 5. HEC-HMS Hydrographs


Offsite-1 Hydrograph
Total Flow (cfs)
1400
1200
1000
800
600
400
200
0
0
5
10
15
20
25
30
35
40
45
50
Time (hours)
10-Year Total Flow (cfs)
25-Year Total Flow (cfs)
100-Year Total Flow (cfs)



Offsite-2 Hydrograph
Total Flow (cfs)
600
500
400
300
200
100
0
0
5
10
15
20
25
30
35
40
45
50
Time (hours)
10-Year Total Flow (cfs)
25-Year Total Flow (cfs)
100-Year Total Flow (cfs)


Offsite-3 Hydrograph
Total Flow (cfs)
0
100
200
300
400
500
600
700
Time (hours)
0
5
10
15
20
25
30
35
40
45
50
10-Year Total Flow (cfs)
25-Year Total Flow (cfs)
100-Year Total Flow (cfs)


Offsite-4 Hydrograph
Total Flow (cfs)
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
45
50
Time (hours)
10-Year Total Flow (cfs)
25-Year Total Flow (cfs)
100-Year Total Flow (cfs)

Appendix 6. Recommended Conveyance Improvements

MEAD & HUNT Inc.

Appendix 6 - Recommended improvements

Link name	Existing configuration				Recommended configuration			
	Shape	No. of barrels	Diameter/ Height (ft)	Bottom width (ft)	Shape	No. of barrels	Diameter/ Height (ft)	Bottom width (ft)
L1	Circular	3	1.5	-	Circular	7	4	-
L2	Trapezoidal	1	4	0	Trapezoidal	1	3	10
L3	Circular	1	3	-	Circular	7	4	-
L4	Trapezoidal	1	4	0	Trapezoidal	1	4	10
L8	Circular	1	2	-	Circular	3	5	-
L10	Circular	1	3	-	Trapezoidal	1	3.5	10
L11	Trapezoidal	1	3	0	Trapezoidal	1	3	6
L12	Circular	1	3	-	Circular	5	4.5	-
L17	Circular	1	1.5	-	Circular	1	2	-
L21	Circular	1	2.5	-	Circular	2	3.5	-
L22	Circular	1	2.5	-	Circular	2	4.5	-
L23	Circular	1	1	-	Circular	1	2	-
L25	Circular	1	2.5	-	Circular	2	4.5	-
L32	Circular	1	2	-	Circular	1	2.5	-
L34	Circular	1	2	-	Circular	1	2.5	-
L35	Circular	1	2	-	Circular	1	2.5	-
L36	Circular	1	2	-	Circular	1	2.5	-
L42	Circular	1	1.5	-	Circular	2	2	-
L47	Circular	3	1.5	-	Circular	3	2	-
L50	Circular	1	2.5	-	Circular	2	2.5	-
L52	Circular	1	2	-	Circular	1	3.5	-
L55	Circular	1	2	-	Circular	3	2	-
L58	Circular	1	2	-	Circular	1	3	-
L61	Circular	1	1	-	Circular	3	1.5	-
L63	Circular	1	2	-	Circular	3	3	-
L64	Circular	1	2	-	Circular	4	3	-
L80	Rectangular	2	2	4.8	Rectangular	3	5	6
L80.3	Rectangular	2	3	4.8	Rectangular	3	5	6
L82	Circular	1	5	-	Circular	2	5	-
L85	Circular	2	3.5	-	Circular	3	3.5	-
L94	Circular	1	2.5	-	Circular	3	4.5	-
L86	Trapezoidal	1	4	6	Trapezoidal	1	4	10

Notes:

1. Refer to Figure 8 for link locations
2. In addition to above improvements, two detention basins are proposed in the locations indicated on Figure 8