TETRA TECH

PREDICTIONS OF THE EFFECTS OF GROUNDWATER PUMPING IN THE COLORADO REGIONAL GROUNDWATER FLOW SYSTEM SOUTHEASTERN NEVADA

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ATTACHMENT

Attachment 1 Production Wells

1.0 INTRODUCTION

With the projected population growth in southeastern Nevada and the increase in industrial activities and generation of electricity, there is an increasing demand for water. During the recent several decades, the Office of the Nevada State Engineer has received many applications for water-rights permits for groundwater production within the Colorado River Groundwater Flow System in southeastern Nevada.

This report provides the results of modeling simulations of the groundwater system in selected basins of the Colorado River Groundwater Flow System in southeastern Nevada and in parts of Utah and Arizona. The simulations were performed using a recently updated groundwater flow model of the area (Tetra Tech, 2012).

Seven different scenarios were evaluated. The first two were developed within the framework of existing permits. The first scenario evaluates the effects of existing pumping, assuming that the average of the reported pumping during the years 2009, 2010, and 2011 would continue at that rate in the future. The exception to this statement is that the rate for pumping of carbonate-rock aquifer wells in Coyote Spring Valley and the Muddy River Springs Area in 2011 would continue in the future. The second scenario simulates pumping the full amount of all existing groundwater rights, continued into the future.

Scenarios 3 through 7 simulate pumping the full amount of all existing groundwater rights, plus pending groundwater applications before the Nevada State Engineer's Office through 2009, in five different steps. Scenario 3 simulates all existing groundwater rights plus all large (>1,000 af/yr) pending applications with filing dates up to and through 1989. Scenario 4 simulates all existing groundwater rights plus all large pending applications with filing dates up to and through 1994. Scenarios 5 through 7 continue similar cumulative simulations by including all large pending applications through 1999, 2004, and 2009, respectively.

Predictions are provided for a period of 1,000 years, beginning in 2011. Because of the large increases in projected pumping, the simulated drawdown reached the boundaries of the model. The model was constructed without head-dependent boundary conditions at the edges of the model domain, with the exception of the boundary with Lake Mead. Thus, as originally constructed, drawdown at the edge of the model would not cause capture of water from basins outside the model domain. The model was modified to include General-Head Boundary (GHB) conditions for those external model cells where known flux boundary conditions (implemented using the Well Package) are specified in the model. These additional boundary conditions allow water to enter the model from neighboring basins in response to drawdown at these cells.

Results are presented at simulated pumping times of 10, 50, 100, 500, and 1000 years. The predicted drawdowns are presented in a series of maps for the uppermost model layer, which

represents the water table. Temporal plots present the changes in simulated discharge at selected springs in the Muddy River Springs Area, at Rogers and Blue Point Springs (combined), and at selected locations along the Muddy River and the Virgin River.

2.0 APPROACH

This section describes the approach used to incorporate the rates and locations of pumping into the simulations, and the possible effects that boundary conditions will have on the predictions.

2.1 FUTURE PUMPING

Seven different pumping scenarios were simulated, each with increasing rates of pumping from the model area. Pumping in surrounding areas (outside the model area) is not considered. Information on the locations and rates of existing groundwater rights and pending groundwater-rights applications was provided to Tetra Tech by the National Park Service (William Van Liew, written communication, 2012), based on a review and compilation of records of the Nevada State Engineer's Office by National Park Service personnel.

The seven different scenarios are based on existing groundwater rights and pending applications:

1. Current locations and rates of pumping
2. All existing groundwater rights, both currently pumped and unpumped
3. All existing groundwater rights, plus all large pending applications filed through 1989.
4. All existing groundwater rights, plus all large pending applications filed through 1994.
5. All existing groundwater rights, plus all large pending applications filed through 1999.
6. All existing groundwater rights, plus all large pending applications filed through 2004.
7. All existing groundwater rights, plus all large pending applications filed through 2009.

Pending applications were compiled into groups, depending on the application date. For example, Group 1 is composed of the applications submitted through 1989, Group 2 are those applications submitted in 1990 through 1994, and so forth. Table 2.1-1 provides the total pumping per Hydrographic Area (HA) for each grouping, and the total pumping for each scenario. For the pending applications, only applications for 1,000 af/yr or greater were included. This table provides a snapshot of the increase in pumping as a function of pending application filing date, and the total projected pumping by HA of all existing groundwater rights plus large pending applications. The most pumping would occur in the Virgin River Valley (251,192 af/yr), followed by Coyote Spring Valley (210,892 af/yr) and Tule Desert (44,092 af/yr). The simulated pumping rate increases from 21,016 af/yr (Scenario 1, current pumping

rates) to 656,901 af/yr (Scenario 7, all existing groundwater rights plus all large pending applications through 2009). This is more than a thirty-fold increase.

Table 2.1-1 Rates and Locations of Groundwater Pumping for Predictive Scenarios 1 through 7.

Group	1	2	3	4	5	6	7	
	Current Pumping[1]	Total, existing rights	thru 1989	1990-1994	1995-1999	2000-2004	2005-2009	Total
Hydrographic Area (HA)								
Clover Valley (HA 204)	-	-	-	-	-	14,480	-	14,480
Lower Meadow Valley Wash (HA 205)	-	-	-	-	-	-	-	-
Kane Springs Valley (HA 206)	-	1,000	-	-	-	-	17,376	18,376
Coyote Spring Valley (HA 210)	5,727	16,100	27,512	-	163,280	4,000	-	210,892
Black Mountains (HA 215)	1,510	1,665	-	1,665	4,000	4,000	-	11,330
Garnet Valley (HA 216)	1,249	3,328	1,665	-	5,614	4,000	-	14,607
Hidden Valley (North) (HA 217)	-	-	-	-	24,164	4,000	-	28,164
California Wash (HA 218)	20	2,862	7,240	2,534	4,000	11,724	-	28,360
Muddy River Springs Area (HA 219)	5,964	13,688	-	7,240	-	-	-	20,928
Lower Moapa Valley (HA 220)	-	-	-	14,480	-	-	-	14,480
Tule Desert (HA 221)	-	9,340	-	-	13,032	-	21,720	44,092
Virgin River Valley (HA 222)	6,546	12,272	65,884	119,460	53,576	-	-	251,192
TOTALS	21,016	60,255	102,301	145,379	267,666	42,204	39,096	656,901
Scenario Totals								
Scenario #1[2]	21,016							
Scenario #2[3]		60,255						
Scenario #3[4]			162,556					
Scenario #4[5]				307,935				
Scenario #5[6]					575,601			
Scenario #6[7]						617,805		
Scenario #7[8]							656,901	

[1] "Current pumping" is the average of pumping for three years (2009 through 2011), with the exception of carbonate-rock aquifer wells MX-5 and CSI-1 thru 4 in Coyote Spring Valley; and MX-6, Arrow Canyon Well, and Arrow Canyon Well #2 in Muddy River Springs Area, for which it is the annual pumping for one year: 2011.

[2] Scenario #1 is all current pumping.

[3] Scenario #2 is all existing groundwater rights.

[4] Scenario #3 is all existing groundwater rights plus all large (over 1,000 af/yr) pending applications through 1989.

[5] Scenario #4 is all existing groundwater rights plus all large (over 1,000 af/yr) pending applications through 1994.

[6] Scenario #5 is all existing groundwater rights plus all large (over 1,000 af/yr) pending applications through 1999.

[7] Scenario #6 is all existing groundwater rights plus all large (over 1,000 af/yr) pending applications through 2004.

[8] Scenario #7 is all existing groundwater rights plus all large (over 1,000 af/yr) pending applications through 2009.

While the existing groundwater rights and pending applications greater than 1,000 af/yr total 656,901 af/yr, the sum of all pending applications and existing permits has been estimated to exceed one million af/yr. Thus, the simulations likely only evaluate about 65% of the total pumping if all existing rights and pending applications were granted.

The wells simulated in Scenario 1 are those listed in Group 1, and the projected rates of pumping are, for wells not involved in the Order 1169 pumping, the averages of the reported rates of pumping in 2009, 2010, and 2011. For the wells involved in Order 1169 pumping, the projected rates are the reported rates in 2011.

For Scenarios 2 through 7, the projected rates are the cumulative rates. For Scenario 2, the projected rates are those given for Group 2 wells. For Scenario 3, the projected rates are for Group 2 and Group 3 wells combined. The addition of a new group continues for each successive scenario. For Scenario 7, the projected rates are the cumulative rates for Groups 2 through 7.

Attachment I provides the names of wells (existing and proposed) and the rates of pumping from each well for the different temporal groupings. The assigned names of pumping locations ("wells") for pending applications were developed from information on the geographic area, the applicant, and the temporal grouping. In addition, a sequence number is added at the end of the "well" name so that each well has a unique name. For example, the name "CSV_CSI_5_3" indicates a projected well in Coyote Spring Valley by the applicant Coyote Springs Investment. This groundwater-right application was submitted during the period 1994 through 1999 (Group 5). The sequence number "3" was arbitrarily assigned to distinguish it from other future "wells" by the same applicant in the same geographic area during the same time frame.

The pending water-rights applications provide the locations of wells using the cadastral (township and range) system, rather than locations based on latitude and longitude, or other coordinate system. The cadastral descriptions were used to estimate locations using the Bureau of Land Management's Geocommunicator system (www.geocommunicator.gov). This system provides coordinates for the center of the quarter-quarter section. The locations of the wells, as provided by the coordinates, were checked by plotting using the ArcGIS datasets that were used for development of the model. In instances where there was an existing well at the location specified in a pending water-right application, the pumping was allocated to the existing well, and the depths of the screened interval were used to determine the model layers to be pumped.

For those locations that did not have nearby existing wells, model layers were assigned by first evaluating the depths of HGUs in the model cell in which the new diversion would occur, using HUFPrint (Banta and Provost 2008). In most instances, there was a clear choice of the HGU to simulate pumping at a location. Unless a carbonate HGU was present within the upper 3,000 to 4,000 feet (approximately), simulated pumping was assumed to be from the upper 6 to 8

model layers, or 1,060 to 1,860 feet below the top of model layer 1. The top of this layer is at the approximate elevation of the water table, so that these wells could be 2,000 to 3,000 feet deep, depending on location. If a Paleozoic carbonate HGU was present in the model cell at a reasonable depth, the top of the screened interval in the well was assumed to be in the uppermost layer where the carbonate HGU was present, and the bottom was assumed to be approximately 1,000 feet deeper. These values were used as guidelines, with the intent being to have the simulated well pumping from several model layers to avoid excessive close-in drawdown, while still be at reasonable depths.

2.2 MODEL SETUP

For the predictions of the effects of pumping, some of the datasets for the model described in Tetra Tech (2012) were modified for the longer simulations. Others were unchanged.

Initial Conditions – The hydraulic heads calculated by the model for the end of the long-term run (representing December 31, 2011) were used as the initial hydraulic heads for the predictive simulations.

Time discretization – During the model calibration, monthly and yearly stress periods were used allowing seasonal effects and longer term changes in pumping rates to be evaluated. The model predictions cover 1,000 years with constant pumping over this period. Therefore, a single-stress period of 1,000 years was used, with time steps every 10 years. Constant time steps were used to allow storage of heads and drawdowns at convenient times.

Material Properties – No material properties were changed.

Boundary Conditions – Most boundary-condition datasets were not changed. These include recharge, stream-flow routing, and external boundary fluxes (implemented with the Well Package). Because seasonal ET was not being evaluated, the ET rate was changed from monthly to annual totals. ET was simulated using the Well Package during calibration and for the predictive simulations. The Well Package was used during calibration so that the seasonal changes could be used to drive changes in the flow system. For the predictions, changing to the ET Package was considered, but was not implemented because of concerns about model stability that use of a head-dependent flux boundary condition might cause. The primary cause of convergence issues in the calibration models was the result of use of the Stream-Routing Package. Adding a second head-dependent boundary condition near the streams was considered as likely to cause additional convergence problems, and was not attempted for these predictions.

During model calibration, the stage in Lake Mead was adjusted monthly. However, for the predictions, the stage was set to an elevation of approximately 1,133 ft, the lake stage at the end of the long-term simulation (representing the end of 2011). This stage is lower than was

present during much of the long-term simulation, and water levels were declining near the lake at the end of that simulation. Because of these transient changes that were occurring near the end of the long-term simulation, the predictive models indicate some small drawdowns occurring near the lake. These are the result of the changed lake stage, not local pumping.

Preliminary simulations of the predictive runs indicated that substantial drawdown was simulated at some of the external boundaries of the model, indicating that water would be captured from neighboring basins outside the domain of the model, if the intervening rocks were not impermeable. Certainly, if drawdown occurred along boundaries where a prescribed flux into or out of the model was applied, the flux should change as the result of the drawdown. Therefore, for the predictive runs, general-head boundaries (GHB) were applied to those external model cells where non-zero prescribed flux boundaries were used in the model. A GHB dataset was developed, in which the boundary head for each GHB cell was set to the initial head used for the predictive runs, and the GHB conductance was calculated from the hydraulic conductivity calculated for the cell by HUFPrint (Banta and Provost 2008), the thickness of the cell, the length of the cell measured perpendicular to the dominant compass direction (north-south or east-west) of the flow into or out of the model, and an arbitrarily selected distance from the cell center. For these predictive runs, this distance was set to 15,000 feet. Increasing this distance would decrease the GHB conductance and cause the model to simulate less capture from neighboring basins and greater drawdown, whereas decreasing the distance would cause the GHB to act more like a constant-head boundary and produce more capture and less drawdown. As there is no information with which to estimate this parameter through model calibration, this parameter will remain a source of uncertainty in the predictions which could be evaluated through sensitivity analysis and/or by expansion of the model to include the neighboring basins.

Preliminary runs indicated that wells that were placed in lower permeability materials, such as the Muddy Creek (CAU) or volcanic rocks might not be able to sustain the prescribed pumping rate. The model, through the MNW package, calculates the drawdown in the well caused by entrance losses and uses this to calculate water levels in the well. If the water level decreases to below the bottom of the well, the production rate is decreased. It was assumed that the management action to this well response would be to drill additional wells near the location of the original point of diversion. In the model, this meant the definition of additional wells in the model cell, with the rate of simulated pumping from each well equal to the simulated production rate at that location divided by the number of wells at that location. The wells where this modification was necessary were determined by running Scenario 7 for 20 or 30 years and noting those where the well drawdown was too great. In most areas, only one well was needed. However, some areas required up to 8 wells. With continued pumping, even production from the group of wells might be reduced, and declines in the simulated pumping rates indicate that this happened in the simulations.

2.3 FEATURES OF THE MODEL THAT MAY AFFECT THE PREDICTIONS

There are several features of the model that should be considered when considering the model's predictions:

1. Because the model is an approximation of the groundwater system, the model predictions can be used to estimate the timing and relative magnitudes of effects of pumping, but consideration of the uncertainty inherent in the model predictions should be a factor in permitting and management decisions. As reliable data are collected on the response of the groundwater system to pumping and models are improved, the uncertainty in modeling predictions will decrease.
2. The model was developed using the simplification that the transmissivities of model layers would not change as water levels change. As drawdown occurs at the water table, the uppermost sediments and/or rock becomes desaturated and are unable to transmit water to wells. The resulting decrease in the aquifer transmissivity is not simulated in this model. This simplification will cause the model to calculate less drawdown (because of the constant transmissivity) than it would if the changes in thickness were simulated. In the simulations where drawdowns of hundreds of feet are calculated, the effects of this simplification may become significant, and the drawdown would be underestimated.
3. Most of the Las Vegas Valley Shear zone is treated as a no-flow boundary in the model, because the current-day movement of water is considered to be minor. Because this boundary segment was simulated as no-flow, GHB boundary conditions were not developed along this segment. However, with changes in pumping within the model domain and in Las Vegas Valley, the flow across the shear zone may change. These changes are not considered in the model. Future pumping in the model domain may impact water levels and groundwater flow in Las Vegas Valley, and vice versa.
4. As discussed in Section 2.2, the model does not consider changes in ET rate as drawdown is simulated beneath ET areas. The highest ET rates occur along streams or in groundwater discharge areas where there is a supply of water to support the plants. If pumping were to cause the water supply to dry up, the ET rate would decrease because the plant community would have to change to one that did not consume as much water. However, in the model, the ET rate is not changed. As a result, the model will tend to overpredict the amount of drawdown where ET is occurring after the spring or stream dries up, and thus tend to overpredict the drawdown near those areas later in the simulation. The effect only becomes apparent after the stream or spring dries up. The only places where this effect was observed were in a small area along Meadow Valley Wash where the simulated streamflow was small and the stream was dried up by pumping in other areas, and an area in the lower part of the Virgin River, where large amounts of pumping upstream caused the

river to dry up. In both instances, the drawdown caused by pumping became larger than the drawdown caused by the excess ET. The effect was not detected near the Muddy River Springs.

3.0 PREDICTION RESULTS

The results of the model predictions are presented through a series of maps of the model area showing the simulated drawdown at selected times, and graphs of the simulated spring discharge or streamflow vs. time at selected locations. The scales for figures at a location or locations are the same for all scenarios to allow the reader to more easily compare the differences in the simulation results.

Information is provided on both drawdown and discharge because of the relation between the two. For example, when drawdown occurs beneath a stream that is well-connected with the groundwater system, the drawdown will cause either a decrease in the groundwater discharge into a gaining stream, or an increase in the loss from a losing stream. The pumping causing the drawdown is "capturing" water from the stream. A second effect is a decrease in the drawdown beneath the stream. The change in water level is "buffered" or reduced by the change in the flux into or from the stream. Similar effects occur with springs that are fed by the groundwater system. If the stream or spring is dry, however, drawdown cannot change the flux and the drawdown is not buffered. Thus, drawdown maps can provide information on whether a stream or spring is flowing and able to buffer the drawdown. In the drawdown maps presented below, streams or spring which appear to affect the drawdown patterns are likely to be flowing. If the pattern of drawdown is not affected by the stream or spring, the stream or spring is likely to be dry, or to be poorly connected to the groundwater system.

These simulations predict changes from the conditions described by the long-term model, which simulated the groundwater system through 2011. In areas where pumping has already caused drawdown or changes in flow, the predicted changes are in addition to the changes that have already occurred.

3.1 SCENARIO 1

Scenario 1 is based on the current pumping within the project area. There likely is some pumping from wells in Lower Meadow Valley Wash; however, no information on pumping there was found in available reports or in the on-line database available on the Nevada State Engineer's website. The total pumping in this scenario was intended to be 21,106 acre feet per year (af/yr); however, the model would not allow pumping of well MVWD30 at the specified rate, and the simulated pumping was 20,916 af/yr. This rate remained essentially constant during the 1,000-year simulation, but did vary slightly during the simulation.

Drawdown Maps

Simulated drawdown in layer 1 of the model is shown on Figures 3.1-1a through 3.1-1e, for simulated times of 10, 50, 100, 500, and 1,000 years. Layer 1 represents the water table, and drawdown in deeper layers will differ from that simulated for layer 1, depending on the depth of

pumping and the geology. In addition, the streams are in layer 1, and their effect on the drawdown is greater in layer 1 than in deeper layers. Where the model simulates the streams as flowing, they reduce the drawdown beneath and adjacent to them because they effectively add recharge to the model through the capture of streamflow. The simulated water table may change little near flowing streams, but drawdown can be transmitted beneath the streams in deeper sediments or rocks.

The model-predicted drawdown is calculated based on the simulated water levels at the end of the long-term run (December 2011), which includes pumping at these wells at similar rates. Thus, Scenario 1 is an estimate of the future changes in the groundwater system assuming that pumping continues at the same locations and at similar rates as it has been occurring within the period 2009 through 2011. Groundwater pumping has been occurring in four primary areas: the Muddy River Springs area, Garnet Valley, Coyote Spring Valley, and the Virgin Valley.

The simulated drawdown at the water table after 10 years of additional pumping is slightly less than 1 foot in the vicinity of the Muddy River Springs. In the carbonate aquifer beneath Coyote Spring Valley, Hidden Valley (North), Garnet Valley, California Wash, and the rest of the Muddy River Springs Area HA, drawdown is widespread and in the range of 1 to 2 feet. The combination of high transmissivity and low storativity results in widespread but small declines in water levels. On the western side of the model, drawdown greater than 1 foot does not extend west of the Gass Peak Thrust. In the Virgin Valley, the predicted drawdown is much more limited in extent, but is in the range of 5 to 10 feet in places. There is a well (VVWD30) located in the southern part of the valley near the Nevada-Arizona boundary which has little drawdown. The hydraulic conductivity in the model at this location is too low to sustain the pumping, and the MNW turned off the pumping from this well. As a result, this well is effectively removed from the predictive simulations.

The effect of the flow in the Virgin River on the simulated drawdown in layer 1 is apparent in the pattern of drawdown near the river. The drawdown is causing capture of water from the river, either by decreasing the discharge of groundwater into the river, or by increasing the loss of water from the river. The capture of this water buffers, or decreases the drawdown beneath and adjacent to the river, and the indicated drawdown is less than in areas more distant from the river. Drawdown near the river is less than 1 foot although there is pumping occurring both north and south of the river. In comparison, the model simulates drawdown between 2 and 5 feet in the area between the northernmost area of pumping in the Virgin Valley and the area immediately north of the river.

The model is simulating small amounts of water-level change occurring near Lake Mead, although there is no pumping being simulated in this area. Part of these changes in water levels is caused by changes in lake stage that were simulated in the long-term run. The lake stage used in the predictive scenarios is lower than the lake stage during much of the long-term calibration

simulation which was used to develop the initial-head dataset for the predictive simulations, and water levels close to the lake decrease as a result of the decrease in lake stage. At later times, the effects of pumping begin to dominate. The net change in flux to the lake is an increase in the discharge to the lake of 174 af/yr.

At 50 years (Figure 3.1-1b), the drawdown in the carbonate aquifer in the western part of the model has increased to the range of 2 to 5 feet with two small areas of drawdown greater than 5 feet. These occur where no pumping is being simulated. The cause of these small areas has not been investigated, but it is likely that the drawdown is being propagated upwards from a deeper zone of greater drawdown. The eastern extent of drawdown has moved eastward beyond the area of the Muddy River Springs, and the simulated drawdown near the springs is in the range of 2 to 5 feet. The drawdown has also extended to the western boundary of the model and southward to essentially all of the Las Vegas Shear Zone (LVVSZ), which was treated as a no-flow boundary in the model. GHB cells are present along the western edge of the model to simulate movement of water from the basins to the west. At 50 years, the model simulates a small increase of inflow (about 2 af/yr) around the entire model boundary. The great majority of this increase is across the western boundary. There is uncertainty in the predicted magnitude of the increase in GHB flux because of the absence of any information related to changes in flows across the model boundary. The values provided here should be evaluated in comparisons between different predictive scenarios, but not to estimate impacts on neighboring basins.

Drawdown in parts of the Virgin Valley has increased into the range of 20 to 50 feet, and has spread to the east. The buffering effect of the Virgin River on drawdown is more apparent in the 50-year simulation results than at 10 years. Within Arizona, the effect of the river on drawdown does not extend past where the river valley is aligned approximately east-west. The buffering effect is greatly diminished upstream of where the river valley alignment changes generally to the northeast near Littlefield Springs. Closer investigation of the geologic model indicates that the hydrogeologic unit QCD is absent through this more upstream reach of the river in the model. The QCD unit has a higher hydraulic conductivity than does the CAU hydrogeologic unit, and thus cells containing the QCD unit are more highly connected to the river than where it is absent, and therefore the buffering effect is greater.

Simulation results for 100 years are similar to those at 50 years, but with increased drawdown. Where the carbonate aquifer in the western part of the model is being pumped, drawdown has increased to the range of 5 to 10 feet. In the vicinity of the Muddy River Springs, the drawdown in approximately 5 feet, and the pattern of the drawdown shows the buffering effect of the springs. Thus, decreases in the discharge rates from the springs would be expected; these are discussed below. Drawdown in the Virgin Valley has increased to greater than 20 feet, and has begun to spread to the west as well as to the east. Between the areas of drawdown in the carbonate-rock aquifer in the western part of the model and the Virgin Valley, two small areas of drawdown have developed. One area runs along the east side of the Lower Meadow Valley

Wash topographic basin. The other area where greater than 1 foot of drawdown is simulated is along the east side of the Mormon Mountains. These appear to examples of the transmission of drawdown upward from deeper layers.

The primary changes at 500 and 1,000 years are the continued growth of the area where drawdown is occurring and the deepening of the drawdown in the interior of these areas. Simulated pumping in the Virgin Valley near Mesquite has impacted water levels to the south of the Virgin River, and to the east of Beaver Dam Wash; the drawdown is transmitted from layers below the water table (deeper than the buffering effects of the rivers). Drawdown in the Muddy River Springs area at 1,000 years is approximately 10 feet, and the pattern of drawdown still shows the buffering effects of capture of the discharge. The drawdown at Rogers and Blue Point Springs is predicted to be less than 1 foot, although the edge of the 1-2 foot region is only a few miles away. The model simulates a decrease in the combined discharge from the springs (discussed below), indicating that the model does simulate drawdown at these springs in Scenario 1. Along the LVVSZ south of Apex, there is an area where the drawdown at the water table is approximately 20 to 23 feet, a few feet more than in surrounding areas. The higher values of drawdown along the LVVSZ were also present in a simulation in which the pumping in a group of nearby wells (in the Black Mountains HA) was set to zero. This area of higher simulated drawdown coincides with an area where the CAU is present at the water table (in layer 1). The carbonate aquifer (PC4) is present to the north of this area of higher drawdown, and has a hydraulic conductivity three to four orders of magnitude greater than the CAU. The large contrast in hydraulic conductivity appears to have caused minor numerical problems along this boundary between the two HGUs. Cells where these problems appear to originate are visible in Figure 3.1-1b and 3.1-1c two to three miles north of the LVVSZ.

Graphs of Discharge vs. Time

Changes in spring discharge and stream flow are shown in Figures 3.1-2a through 3.1-2d. The simulated discharges from springs in the Muddy River Springs area are shown in Figure 3.1-2a. Percentage decreases in spring discharge range from 22% at Baldwin and Muddy Springs up to 99% at Pederson. The simulation predicts that Pederson would dry up in slightly less than 500 years.

The decrease in spring discharge causes declines in the simulated flow in the Muddy River (Fig 3.1-2b). The location called “Muddy River, upper” is in the Muddy River a short distance below where the discharge from Baldwin Spring enters the river. This location was identified as stream location 09415880 in the synoptic stream gaging report for the Muddy River (Beck and Wilson, 2006). The flow at this location is predicted to decrease approximately 38% during the 1,000 year simulation. Note that the simulated flow at the gage near Moapa at the beginning of the predictive simulation (approximately 25 cfs) is approximately two-thirds of the observed flow (37 cfs in early 2010), as discussed in the model documentation report (Tetra

Tech, 2012). The average flow measured near Glendale in 2011 was also approximately 37 cfs, but the model simulates additional groundwater and surface water discharge (from Meadow Valley Wash) into the Muddy River upstream of the Glendale gage, producing a simulated flow of approximately 63 cfs at the gage. Flow at the gage near Moapa is predicted to decrease approximately 29%, and near Glendale and near the Bowman Reservoir diversion by about 21%. Approximately two-thirds of the decrease in flow that was simulated at the Glendale gage occurs upstream of the Moapa gage, and one-third occurs along the Muddy River downstream of the Moapa gage and in Meadow Valley Wash.

The simulated combined discharge from Rogers and Blue Point Springs is shown on Figure 3.1-2c. There is a simulated 12% decrease in the discharge in 1,000 years. This discharge point is simulated through use of Drain boundary conditions in layers 1 through 18, based on a conceptual model that the Rogers Spring Fault provides a permeable pathway throughout the geologic section, and that the rocks, rather than the permeability of the fault, limit the movement of water to the surface. In the model, the flow is derived primarily from layers 1 through 10, and a small amount comes from layers 16 through 18. The highest head is in layer 9 (1595.19), which 1.19 feet higher than the elevation of the drain (1594 ft) used to represent the springs. Thus, a small amount of drawdown will cause the simulated discharge to decrease, and only 1.2 feet of drawdown will cause the flow to stop. As a result, the drawdown map is too coarse of a tool to evaluate the impacts of pumping on the combined discharge at Rogers and Blue Point Springs, and the calculated spring discharge (which was used to develop Figure 3.1-2c) should be used instead.

The simulated flow in the Virgin River and Beaver Dam Wash are shown in Figure 3.1-2d. For Scenario 1, the streamflow in Beaver Dam Wash is essentially un-affected by the pumping. However, streamflow in the Virgin River is affected by a few percent. The streamflow near Overton is impacted more than that at Littlefield.

Pumping also caused increases of flow into the model domain through the GHBs. The changes in GHB flow were 2 af/yr (50 years), 5.8 af/yr (100 years), 14 af/yr (200 years), 31 af/yr (500 yrs), and 41 af/yr (1,000 years). As noted previously, these estimates should be used primarily to compare the results from different scenarios. However, these values are small compared to the simulated pumping (approximately 21,000 af/yr), indicating that with the current pumping, impacts on surrounding basins will probably be minor.

During the 1,000 year simulation, there was a net increase in the simulated discharge of 174 af/yr to Lake Mead (from 3571 af/yr to 3745 af/yr), largely in response to the lower lake stage used in the predictive simulation. The discharge into Lake Mead increased from 3,571 af/yr to more than 3,900 af/yr 20 years after the start of the simulation. It then decreased to 3,745 af/yr after 1,000 years, for a net decrease of 174 af/yr. Most of this change is the result of changing lake stage in the long-term simulation (1949-2011) that was used to generate the

starting-head dataset used for the predictive simulations. A simulation was made with no pumping, and the groundwater flow in and out of the lake was similar to that simulated in Scenario 1. With no pumping for 1,000 years, the net flow into the lake was 3,763 af/yr, compared with 3,745 af/yr with the present-day pumping. Thus the effect of the Scenario 1 pumping on flow into the lake was a reduction of approximately 18 af/yr.

Because of the variability in flow into the lake caused by the changing lake stage during the long-term run, the results for Scenarios 2 through 7 will be compared with the 18 af/yr decrease in discharge to the lake predicted to occur by the present-day pumping (Scenario 1).

3.2 SCENARIO 2

Scenario 2 evaluates the effects of pumping at rates equal to the total of all existing groundwater rights, both those currently pumped and unpumped. In addition to wells simulated in Scenario 1, there are 13 new simulated locations of pumping included. Three are in Coyote Spring Valley, two in Kane Springs Valley, two within the Moapa Indian Reservation in California Wash, three near Apex in Garnet Valley, and two in the Tule Desert. In Coyote Spring Valley, the simulated pumping increases from 5,727 af/yr to 16,100 af/yr. The total simulated pumping increases from 21,106 af/yr (Scenario 1) to 60,254 af/yr in Scenario 2, an approximate three-fold increase. Because of limitations on the productivity of wells imposed by the MNW package, the simulated pumping decreased from 60,064 af/yr in year 10 down to 60,063 af/yr in year 1,000, a minor change from the intended amount.

Drawdown Maps

Simulated drawdown is shown on Figures 3.2-1a through 3.2-1e. In the vicinity of the Muddy River Springs, the simulated drawdown after 10 years is approximately 5 feet, compared with less than 1 foot simulated for Scenario 1 pumping. The drawdown pattern shows the effects of capture of water from the Muddy River Springs. Throughout much of the carbonate aquifer in the western part of the model, drawdown after 10 years of simulated pumping is greater than 2 feet. In the Tule Desert, drawdown is greater than 20 feet near the two pumping wells, and is simulated as being approximately 100 feet near PW-1, the eastern of the two wells. [In the simulations, it was necessary to distribute the pumping from PW-2 using four wells located at the same cell to avoid having the MNW package reduce the rate of pumping from PW-2 significantly.] As would be expected, the drawdown in the Virgin River Valley near Mesquite has also increased from the 10-year Scenario 1 prediction.

At 50 years (Figure 3.2-1b), drawdown near the Muddy River Springs has increased to more than 10 feet. The area affected by drawdown greater than 2 feet has expanded to most of the western and southwestern boundaries of the model and much of this area experiences greater than 10 feet of drawdown. Drawdown in the Tule Desert has increased to greater than 50 feet

near the two wells, and the drawdown cones caused by pumping in the Tule Desert and Kane Springs Valley have begun to coalesce.

Continued pumping causes greater and wider drawdown (Figures 3.2-1c through 3.2-1e). Near the Muddy River Springs, the drawdown at 100 years is approximately 20 feet, at 500 years it is approximately 25 to 35 feet, and at 1000 years, the simulated drawdown is approximately 50 feet. The patterns of drawdown still show the effects of buffering caused by capture of the spring discharge and stream flow after 1,000 years of pumping. Drawdown in the Tule Desert has increased to greater than 100 feet near the two pumping wells at 100 years, more than 200 feet at 500 years, and greater than 500 feet near PW-1 at 1,000 years.

Along stretches of the Muddy River, Meadow Valley Wash, the Virgin River, and Beaver Dam Wash, drawdown is less than on either side of these stretches, because of the buffering effect of capture of the surface flow. Drawdown is transmitted below the streams and rivers in deeper layers. For example, there is drawdown on the east side of Beaver Dam Wash at 100 years and later, although there is no pumping being simulated in this area.

In the 500 and 1,000 year simulations, there is an approximately east-west zone of low drawdown that is located approximately seven miles south of Mesquite. Evaluation of the details in the geologic model indicated that there is part of the carbonate aquifer (PC1 thrust sheet) present in this zone along the southeastern side of the structural basin that is connected with the carbonate aquifer present at much greater depth beneath the basin. As a result, this shallow occurrence of the carbonate aquifer can transmit water upward, and limit the drawdown where it is present at shallow depth.

In Figure 3.2-1e, there is a small area along Meadow Valley Wash where the simulated drawdown is in the 100 to 200-foot range. This is likely caused by the continued simulation of ET in this area after the stream has dried up and can no longer serve as a source of water to the model. In nature, the plant community would change to one that could survive using less water. However, in the model, the ET rate is not changed, and the model calculates more drawdown than would occur along this short stretch of the stream.

Graphs of Discharge vs. Time

Simulated discharges from the springs in the Muddy River Springs area are shown in Figure 3.2-2a. In contrast with the results from Scenario 1, where only the discharge from Pederson Spring is predict to cease, the pumping in Scenario 2 is predicted to cause all of the springs but Muddy Spring to effectively stop flowing by the end of the simulation. Pedersen Spring and Plummer are predicted to go completely dry quickly, in approximately 30 and 60 years, respectively. Pipeline-Jones Springs would go completely dry in approximately 325 years. Flow at Baldwin Spring would stop in approximately 525 years. Cardy-Lamb Spring is predicted to become dry in approximately 1,000 years. The rate of decline at Muddy Spring is

high enough that it would likely cease flowing by 1,100 years; however, it would lose half its flow in approximately 200 years. The differences in the lengths of time that the springs continue to flow is caused by their different elevations. The higher springs (such as Pederson and Plummer) are more sensitive to drawdown, and stop flowing earlier. Muddy Spring is located close to the Muddy River, and continues to flow longer.

The simulated impact on the flow in the Muddy River is shown in Figure 3.2-2b. The model predicts that the flow near Moapa will cease in approximately 1,000 years. The streamflow in the river at Glendale and above the diversion near Bowman Reservoir is predicted to decrease by about 50% in 200 years. These two locations receive discharge from Meadow Valley Wash, which continues to be fed by groundwater discharge occurring in the lower part of Meadow Valley Wash.

The pumping simulated in Scenario 2 is predicted to cause the combined discharge from Rogers and Blue Point springs to decrease from 2.25 cfs to approximately 1.3 cfs in 1,000 years (Figure 3.2-2c), or about 40%. The drawdown maps show drawdown in layer 1, and indicate that there will be less than 1 foot of drawdown at 500 years at the water table. However, Figure 3.2-2c indicates that there likely will be noticeable reductions in discharge at 100 or 200 years. The greatest change in discharge occurs in layers 9 and 10. However, the simulated drawdown is only a few tenths of a foot. In these layers, drawdown of about 1.2 feet would cease the discharge from these layers. Thus the simulated discharge is sensitive to small amounts of head change. There is a large degree of uncertainty related to the magnitude of the effect of drawdown on the discharge rate, but it is likely that the impact of drawdown on the discharge from Rogers and Blue Point Springs would be less than simulated by the model. Vegetated areas that appear to be fed by groundwater are located along the Rogers Springs fault, and have higher elevations than Rogers Spring. This suggests that the excess head in the groundwater system is greater than the 1.2 feet that the model simulates.

In the Virgin River Valley (Figure 3.2-2d), the simulated discharges in Beaver Dam Wash do not change substantially, and there are small changes in the simulated flows in the Virgin River. The Virgin River near Overton shows the greatest decline, about 10% in 300 years and 15% over the 1,000-year period.

Over the 1,000 year simulation, the model simulates a net decrease in groundwater discharge to Lake Mead of 26 af/yr more than Scenario 1. There is also more water that enters the model through the GHB cells around the margin of the model. At 1,000 years, the GHB cells provide 98 af/yr, compared with 41 af/yr for Scenario 1.

3.3 SCENARIO 3

Scenario 3 evaluates the effects of the pumping included in Scenario 2 (all existing groundwater rights, currently pumped and unpumped, 60,254 af/yr) plus simulated pumping at

rates equal to all pending applications filed through 1989. The total simulated pumping would increase to 162,555 af/yr. The simulated pumping was approximately 162,366 af/yr after 10 years, and decreased a small amount to 161,680 af/yr after 1,000 years. Additional withdrawals were simulated in Coyote Spring Valley, California Wash, Garnet Valley, and along the Virgin River approximately 12 to 18 miles downstream of Mesquite. The predicted drawdown is presented in Figure 3.3-1a through 3.3-1e. The simulated pumping locations from Scenario 2 are shown on these drawdown maps as white circles; new simulated pumping locations that were added in Scenario 3 are shown as blue circles.

Drawdown Maps

After 10 years of pumping (Figure 3.3-1a), the predicted drawdown in the Muddy River Springs area is approximately 10 feet, approximately twice that for Scenario 2. The drawdown pattern shows the buffering effect caused by capture of the discharge from the springs. The extent of the drawdown in the carbonate aquifer is predicted to be slightly greater than in Scenario 2 at this time; however the magnitude of the drawdown within this area is substantially greater than in Scenario 2, reaching 10-20 feet over an area of the Muddy River Springs Area and central Coyote Spring Valley. The Tule Desert drawdown is the same after 10 years in Scenario 2 and 3. The new simulated pumping along the Virgin River shows predicted drawdown greater than 100 feet.

After 50 years of pumping, the drawdown in the Muddy River Springs area has increased to more than 20 feet. The area with greater than 20 feet of drawdown also extends over most of the distribution of the PC4 thrust sheet, which will be referred to as the western carbonate aquifer (only in the context of this model) in this report. The new area of simulated pumping along the Virgin River shows predicted drawdown between 200 and 500 feet, and greater than 500 feet in the pumping center.

Scenario 3 pumping for 100 years shows predicted drawdown of approximately 50 feet at the Muddy River Springs area (Figure 3.3-1c). Drawdown along the western model boundary (between Coyote Spring Valley and Tikapoo Valley) is predicted to be approximately 20 feet. At the water table, the predicted drawdown at Rogers and Blue Point Springs is less than 1 foot. Widespread drawdown greater than 200 feet is predicted along the Virgin River, with more than 500 feet of drawdown locally.

The drawdown near the Muddy River Springs (and throughout much of the western model area) after 500 years (Figure 3.3-1d) is predicted to be greater than 100 feet. The drawdown along the Virgin River is greater than 500 feet near the pumping center of the new wells after 500 years. After 1,000 years, the predicted drawdown has increased further, and drawdown greater than 100 feet is shown in approximately 40% of the model domain. After 500 years, the line representing 1 foot of drawdown at the water table is approximately 3 miles away from Rogers and Blue Point Springs. After 1,000 years, the line is only about 1 mile away.

Graphs of Discharge vs. Time

The impacts on the Muddy River Springs (Figure 3.3-2a) occur much faster in Scenario 3 than in Scenario 2. All of the springs are predicted to dry up within about 175 years, including the Muddy Spring. The streamflow in the Muddy River also declines much more and faster than in Scenario 2. At the locations near the Bowman Reservoir diversion and at Glendale, the streamflow is predicted to decrease by approximately two-thirds within 175 years, and to be zero cfs near Moapa. These rapid declines in streamflow at Glendale will cause significant impacts to downstream water users.

Figure 3.3-2c shows the predicted impacts to the combined discharge from Rogers and Blue Point Springs. By 200 years, the discharge rate is predicted to decline by approximately 25%. The discharge is predicted to have ceased before 1,000 years, probably around 800 years. [The point at 1,000 years indicates that the discharge is zero at 1,000 years, but the spring discharge may have stopped prior to that time. The projection of the trend based on the points at 100, 200 and 500 years indicates that the spring would dry up after approximately 800 years of pumping.]

The net flux of water at Lake Mead has changed from discharge from the groundwater system into the lake at approximately 3,571 af/yr to a flow from the lake into the groundwater system at about 897 af/yr at 1,000 years. This is a net change of approximately 4,642 af/yr greater than occurred in Scenario 1, or about 2.9% of the total pumping. The inflow into the model from areas outside the model was 392 af/yr.

The flow in the Virgin River near Overton is predicted to decrease 50% in about 30 years, and to cease at about 170 years (Fig. 3.3-2d). Streamflows at the other locations are relatively un-impacted because they are upstream of the large number of wells introduced in Scenario 3.

In summary, while the impacts of simulated pumping of all existing groundwater rights (Scenario 2) are predicted to cause substantial, but relatively slow, impacts on the groundwater and surface water in the Muddy River Springs area and Muddy River, the simulation of pumping at rates equal to all existing groundwater rights plus all pending applications through 1989 (as evaluated in Scenario 3) is predicted to greatly accelerate the impacts in the Muddy River Springs and Muddy River, as well as to substantially deplete surface flows in the Virgin River below the locus of the proposed new pumping wells along the Virgin River.

3.4 SCENARIO 4

Scenario 4 (all existing rights plus all pending applications filed through 1994) involves an increase in the simulated pumping up to 307,934 af/yr, an increase of approximately 140,000 af/yr over Scenario 3. The additional simulated pumping would occur primarily in the Beaver

Dam Wash drainage basin within Nevada. There would also be additional pumping near Apex; in the Lower Moapa Valley (two locations a few miles south of the Muddy River, and a third a few miles south of the Mormon Mountains); and in the Muddy River Springs Area HA at the southern end of the Meadow Valley Mountains north of the Muddy River. The model-simulated pumping rate was 305,635 af/yr after 10 years, and decreased substantially to 233,364 af/yr after 1,000 years. More than a third of this decline occurred in the first 100 years, indicating that pumping at these rates cannot be maintained in some areas (those with high simulated drawdown discussed below).

Drawdown Maps

The drawdown at 10 years differs from the Scenario 3 drawdown primarily where new wells are simulated along the eastern Nevada boundary, and in Lower Moapa Valley (Figure 3.4-1a). In the northernmost pumping center in Beaver Dam Wash, the simulated drawdown exceeds 1,700 feet, indicating that this production will not be sustainable. The drawdown in the western carbonate aquifer is very similar to that in Scenario 3. However, drawdown from the southern pumping center in Lower Moapa Valley has already coalesced with the drawdown caused by pumping further west.

By 50 years, the simulated drawdown in the northernmost pumping center along Beaver Dam Wash has exceeded 3,400 feet, and exceeds 200 feet in other centers (Figure 3.4-1b). After 100 years, the maximum drawdown exceeds 3,700 feet, and the drawdown reaches the eastern model boundary along most of its length (Figure 3.4-1c). In the Lower Moapa Valley, the drawdown in the northern center exceeds 500 feet near the well, and exceeds 100 feet in the southern center. Drawdown near the Muddy River Springs is approximately 50 feet.

After 500 years, the drawdown along the eastern Nevada border near Beaver Dam Wash exceeds 500 feet over large areas (Figure 3.4-1d). Maximum drawdown has increased to over 3,900 feet. The drawdown in the Muddy River Springs area is greater than 100 feet. After 1,000 years, the simulated drawdown exceeds 200 feet over approximately 2/3 of the model area (Figure 3.4-1e). The greatest drawdown is nearly 4,000 feet.

Graphs of Discharge vs. Time

The effect of the pumping on spring discharge and streamflow is shown in Figures 3.4-2a through 3.4-2d. In the Muddy River Springs area, all springs are predicted to be dry by approximately 100 years, and some much sooner (Figure 3.4-2a). The Muddy River near Moapa is predicted to be totally dry in about 100 years; the Muddy River near the Bowman Reservoir diversion is predicted to be dry in less than 500 years, and the river at Glendale is predicted to be dry by about 630 years (Figure 3.4-2b).

The combined discharge at Rogers and Blue Point Springs is predicted to decrease by 10% in 100 years, and by more than 30% in 200 years (Figure 3.4-2c). Springflow is predicted to cease in less than 600 years.

In the Virgin River Valley, Beaver Dam Wash at the gage near Enterprise (which is located in Utah about one-half mile downstream of where Beaver Dam Wash flows from Nevada into Utah) is predicted to become dry by 10 years. Further downstream near Littlefield, it becomes dry after 100 years (Figure 3.4-2d). The Virgin River near Overton is predicted to be dry by 30 years of pumping. Upstream, near Littlefield, the flow in the Virgin River is predicted to decrease by approximately 20% within 60 years, but to nearly stabilize after that. The quantity of water in the Virgin River introduced into the model at the Virgin River Gorge is sufficient to prevent the river at Littlefield from drying up with this amount of pumping.

The flow into the lake reverses approximately 400 years after pumping starts, and the lake becomes a net source of water to the groundwater system. The net change in flux represents a capture of 7,028 af/yr more than the capture in Scenario 1. The neighboring basins are estimated to provide approximately 517 af/yr.

3.5 SCENARIO 5

The pumping in Scenario 5 (based on all existing rights plus all pending applications filed through 1999) has increased to 575,600 af/yr, with several new wells simulating a very large increase (163,280 af/yr) in pumping rate in Coyote Spring Valley. There are several new wells in other locations in the southern part of the western carbonate aquifer, in the Tule Desert, in the Tule Springs Hills area in the Virgin River Valley HA just east of the Tule Desert, and along the Virgin River near and west of Mesquite. The pumping in the model was about 570,419 af/yr after 10 years, and decreased to 464,462 af/yr after 1,000 years for a decline of 105,957 af/yr. Approximately 72,300 af/yr of this decreased productivity resulted from production that was simulated in Scenario 4. The simulated drawdown is shown in Figures 3.5-1a through 3.5-1e.

Drawdown Maps

After 10 years, the additional simulated pumping has created an area of drawdown exceeding 50 feet in the central part of Coyote Spring Valley, and drawdown exceeding 20 feet in most of the western carbonate aquifer. The drawdown in the vicinity of the Muddy River Springs exceeds 20 feet. In the Tule Desert, the simulated drawdown is more than 100 feet near some of the wells. Drawdown in other areas is similar to that simulated in Scenario 4.

Simulated drawdown after 50 years exceeds 100 feet in most of the western carbonate aquifer, including the area near the Muddy River Springs. In the Tule Desert and vicinity, the drawdown exceeds 200 feet near all the new simulated pumping wells. The simulated drawdown cones of all pumping centers in the western carbonate aquifer have coalesced, and the simulated

drawdown cones in the Virgin Valley and Tule Desert have begun to coalesce, meaning that the drawdown simulated near one pumping center is increased by pumping in nearby pumping centers.

After 100 years (Figure 3.5-1c), the drawdown in most of the western carbonate aquifer is greater than 200 feet, including the Muddy River Springs area. Drawdown in the Tule Desert and vicinity exceeds 200 feet. In addition, the increase in pumping along the Virgin River near Mesquite has increased the drawdown simulated in the pumping center approximately 15 miles downstream from Mesquite. This impact is caused by drying up the Virgin River further upstream than was simulated in Scenario 4. At this time, the simulated drawdown from most pumping centers has coalesced throughout the model area.

After 500 years of pumping, the simulated drawdown throughout the western carbonate aquifer exceeds 500 feet, as does the drawdown along more than 1/3 of the Virgin River and approximately 2/3 of the well fields along the eastern Nevada boundary and in the Tule Desert and vicinity. After 1,000 years, drawdown exceeds 500 feet over more than 2/3 of the model domain.

Graphs of Discharge vs. Time

The discharge from all the springs in the Muddy River Springs area is predicted to cease within 20 years (Figure 3.5-2a). Streamflow in the Muddy River (Figure 3.5-2b) above the Bowman Reservoir diversion is predicted to cease within 110 years, and at Glendale about 20 years later. Discharge from Rogers and Blue Point Springs is predicted to cease within 200 years (Figure 3.5-2c). The Virgin River is predicted to stop flowing within 20 years near Overton, while the simulated decrease in flow near Littlefield is similar to that simulated in Scenario 4. Streamflow in Beaver Dam Wash at Enterprise is predicted to cease within 10 years, and within 100 years near Littlefield.

The direction of net flow at Lake Mead changes from groundwater discharge to recharge at about 210 years. The net change in flux is approximately 9,446 af/yr greater than in Scenario 1 after 1,000 years of pumping. The net change in the flux from neighboring basins at 1,000 years is approximately 2,584 af/yr.

3.6 SCENARIO 6

Scenario 6 (based on all existing rights plus all pending applications filed through 2004 increases the total simulated pumping to 617,805 af/yr. Simulated pumping added in Scenario 6 occurs in the southern half of the western carbonate aquifer, and in the Clover Mountains. The simulated pumping rate was 612,623 af/yr after 10 years, and declined to 505,931 af/yr after 1,000 years, a decline of 106,691 af/yr. This is only slightly greater than in Scenario 5, and

indicates that the wells that will not be able to sustain the initial productivity were added in Scenarios 4 and 5.

Drawdown Maps

The predicted drawdown is presented in Figures 3.6-1a through 3.6-1e. After 10 years of pumping, the drawdown in the southern half of the western carbonate aquifer has increased a relatively small amount. The pumping in the Clover Mountains has caused coalesced drawdown cones to develop around each of the four additional wells. Continuing pumping causes the drawdown to increase in the areas where these new wells are simulated, but drawdown is similar to calculated in Scenario 5 in other areas. After 100 years, drawdown exceeds 500 feet around each of the new simulated pumping wells in the Clover Mountains.

Graphs of Discharge vs. Time

The figures for the discharge from springs in the Muddy River Springs area for Scenarios 5 (Figure 3.5-2a) and 6 (Figure 3.6-2a) are nearly identical. Both predict flow from the springs will cease within 20 years, but discharge rates for Scenario 6 are less at 10 years than those for Scenario 5. The simulated streamflows in the Muddy River are also very similar, with both scenarios predicting similar declines in flow rates, and similar dates for the flow to cease totally.

The combined discharge from Rogers and Blue Point Springs decreases more rapidly in Scenario 6 (Figure 3.6-2c) than in Scenario 5. Scenario 6 indicates that discharge will cease within 150 to 200 years.

The simulated streamflows in the Virgin River basin are essentially identical in Scenarios 5 and 6 (Figure 3.6-2d). The additional pumping in the Clover Mountains is too distant to noticeably affect flow rates in the Virgin River within 1,000 years, and the Scenario-6 simulated pumping dried up the flows in Beaver Dam Wash quickly.

Lake Mead recharge to the model at 1,000 years increases from 5,701 af/yr in Scenario 5 to 5,989 af/yr in Scenario 6. The net change in lake flux is a reduction of approximately 9,734 af/yr greater than Scenario 1. Surrounding basins provide an additional 2,858 af/yr in year 1,000 in response to the pumping.

3.7 SCENARIO 7

The final scenario evaluates pumping from all existing rights plus all pending applications filed through 2009. The total simulated pumping for Scenario 7 was set to 656,901 af/yr. New wells are simulated in Kane Springs Valley, in the northern Tule Desert, and in the Clover Mountains. The simulated pumping was 651,468 af/yr after 10 years, and decreased to 537,860 af/yr in year 1,000, a reduction of 113,608 af/yr.

Drawdown Maps

The simulated drawdowns are shown on Figures 3.7-1a through 3.7-1e. The most apparent changes in the drawdown at 10 years are in the northern part of the Tule Desert, around the new simulated pumping wells there. There is also more simulated drawdown in the northern part of Kane Springs Valley. After 50 years of pumping, the drawdown cone from the new wells in northern Tule Desert is beginning to coalesce with the drawdown from the wells along the Nevada-Utah border. Continued pumping results in expansion of the areas affected by the pumping. By 500 years, the effects of continuing baseflow in the streams are present only in upper Meadow Valley Wash, stretches of Clover Creek (a tributary of Meadow Valley Wash east of Caliente), stretches of Beaver Dam Wash in its northern third of its length, and two sections of the Virgin River (upstream of Littlefield Springs and a few miles on either side of the Nevada-Arizona border). These stretches continue to show the effects of buffered drawdown due to capture, but the effects are absent in other areas where they were previously present. After 1,000 years, these perennial stretches are slightly smaller. More than 500 feet of drawdown is predicted to have occurred over approximately 70% of the model domain.

Graphs of Discharge vs. Time

The simulated spring discharges and streamflows are presented in Figures 3.7-2a through 3.7-2e. These figures are very similar to those of Scenarios 5 and 6. Except for the streamflow in the Virgin River at Littlefield, all surface flow rates are quickly diminished. Rogers and Blue Point Springs flows decline more slowly than flows closer to the areas of significant production. Nonetheless, the simulations predict that the flow at Rogers and Blue Point Springs will cease between 150 and 200 years after the start of Scenario 7 simulated pumping (Figure 3.7-2c).

After 1,000 years, simulated water movement from Lake Mead into the groundwater system is at a rate of 5,980 af/yr, slightly less than in Scenario 6. The cause of the small decrease, with the increased pumping, is unknown but may be associated with changes in the other boundary fluxes. This represents capture of 9,725 af/yr more than in Scenario 1. The net flow from neighboring basins increased from 2,858 af/yr (Scenario 6) to 3,028 af/yr (Scenario 7).

4.0 SUMMARY AND CONCLUSIONS

Seven different predictive scenarios were evaluated, ranging from a continuation into the future of current pumping rates only, through pumping from all existing rights plus all pending applications filed through 2009. These simulations indicate:

1. The impacts of pumping on spring discharge and stream flow will increase as time passes, and as the rates of pumping increase.
2. With a continuation of current rates of pumping (Scenario 1), the model predicts that a new equilibrium may be established after more than 1,000 years, and the impacts on most springs will be less than a 35% reduction in discharge. Pederson Spring, however, is predicted to dry up in approximately 500 years, and the discharge from Cardy-Lamb Spring is predicted to decrease by 74% in 1,000 years.
3. If pumping were to increase to a rate equal to the total of all existing groundwater rights (Scenario 2), the Muddy River Springs will completely dry up in approximately 1,100 years. The higher elevation springs will dry up sooner. Pedersen Spring and Plummer Spring are predicted to go completely dry in approximately 30 and 60 years, respectively. Pipeline-Jones Springs would go completely dry in approximately 325 years. Flow at Baldwin Spring would stop in approximately 525 years. The rate of decline at Muddy Spring is high enough that it would likely cease flowing by 1,100 years; however, it would lose half its flow in approximately 200 years. After 50 years, the flow in the Muddy River at Glendale is predicted to decline by 16%, and is predicted to decrease to less than 40% of the existing flow within about 500 years. The model further predicts that the discharge from Rogers and Blue Point Springs will decline approximately 40% in 1,000 years. Flows in the Virgin River basin near Overton will be reduced by approximately 13% over this period. Thus, the model is predicting that the groundwater system will not be able to supply the existing groundwater rights without impacting surface-rights holders. There will also be impacts at areas where there are sensitive habitats.
4. With the addition of simulated pumping of all pending applications through 1989, as represented by Scenario 3, impacts become greater and occur more quickly. Pedersen Spring is predicted to go completely dry in **less than 20 years**. All discharge from the Muddy River Springs ceases within approximately 150 years, and the flow in the Muddy River at Moapa ceases in about 160 years. The modeling predicts that the streamflow does not stabilize at a new equilibrium, but continues to decline past the end of the 1,000-year simulation. Pumping near the Virgin River will totally deplete the baseflow in the lower reaches. The combined discharge from Rogers and Blue Point Springs is predicted to decrease by 65% in 500 years.
5. The pumping simulated in Scenarios 4 through 7 is predicted to cause greater and faster impacts to the groundwater and surface-water resources.

6. The effects of drawdown will cause impacts outside the modeled area, and capture flow from adjoining basins, including those in Utah and Arizona. The magnitude of this impact is not known, but could be estimated by linking this model with models of other areas.
7. In some areas, the aquifers may not be able to sustain the projected pumping, regardless of effects elsewhere. In Scenarios 4 through 7, the maximum predicted drawdown exceeded 3,000 feet. The model also lowered the rate of production as water levels were lowered to below the assigned screen intervals of the wells.
8. There is uncertainty in these projections that needs to be evaluated further. A detailed uncertainty analysis is recommended. However, it is unlikely that the general conclusions will be altered substantially, but changes in new equilibrium discharge rates (for lower pumping rates) or rates of depletion would be expected to become better defined through the uncertainty analysis.

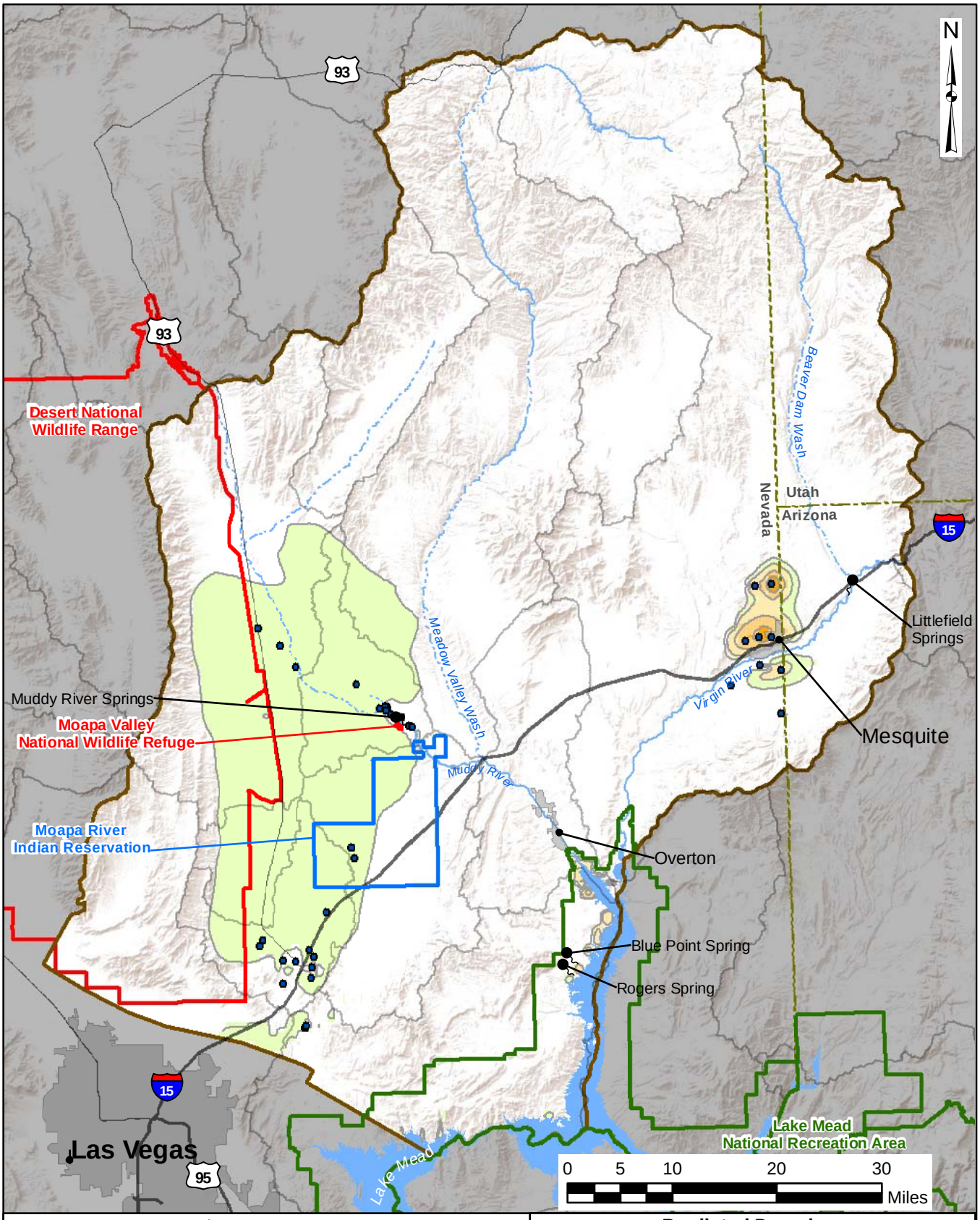
5.0 REFERENCES

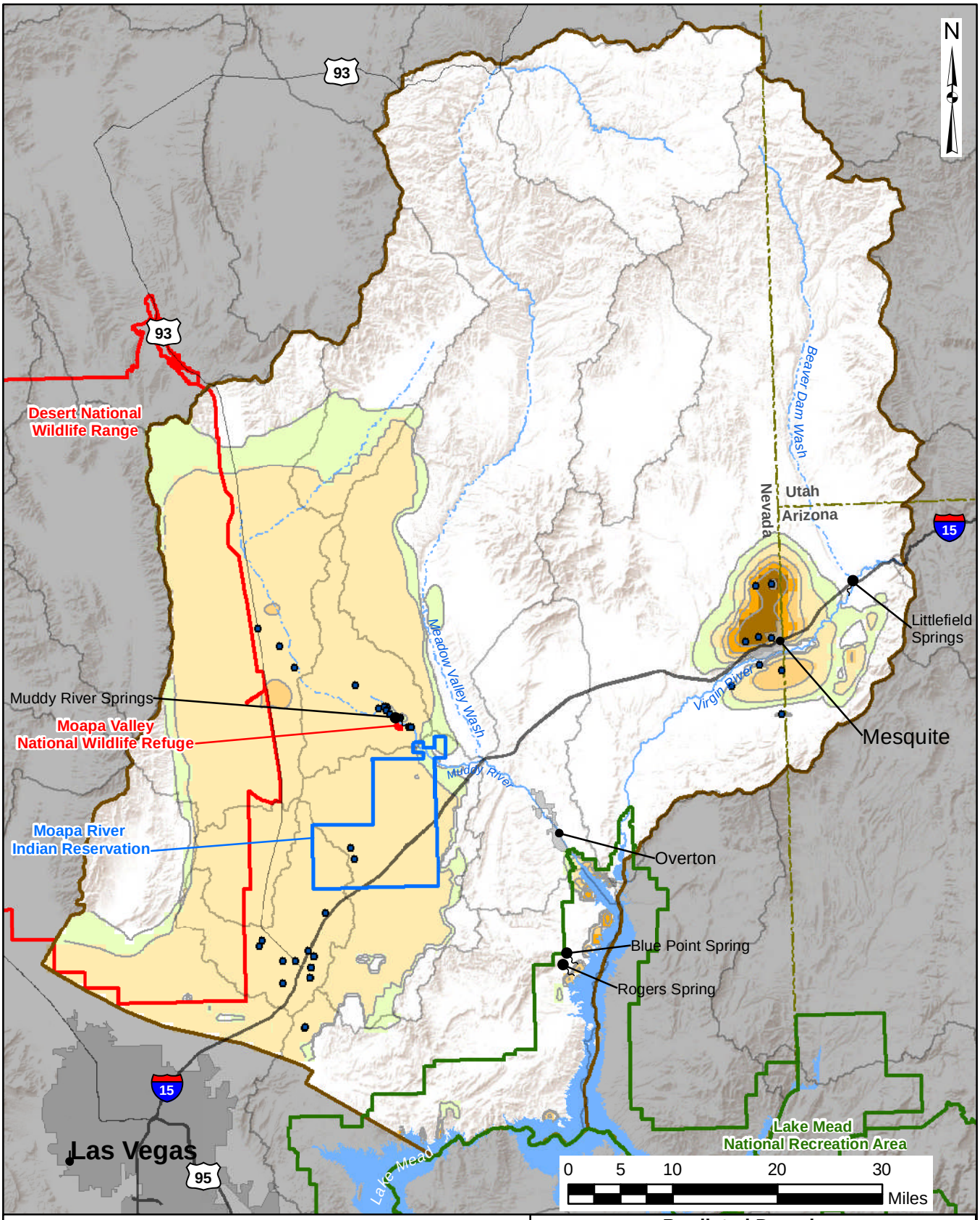
Banta, E.R., Provost, A.M., 2008, User guide for HUFPrint, a tabulation and visualization utility for the Hydrogeologic-Unit Flow (HUF) Package of MODFLOW: U.S. Geological Survey Techniques and Methods 6-A27, 13p.

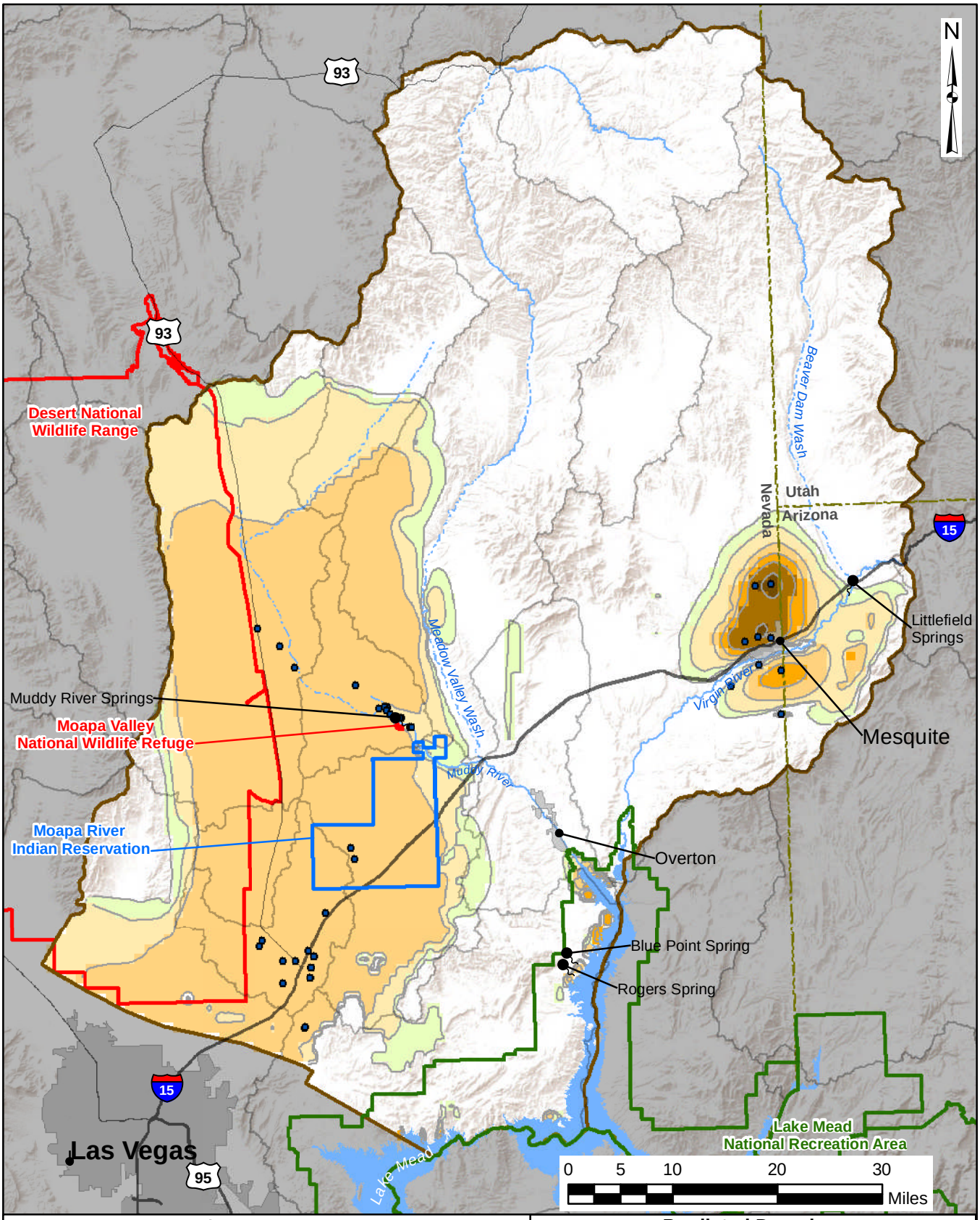
Beck, D.A. and Wilson, J.W., 2006, Synoptic discharge, water-property, and pH measurements for Muddy River Springs Area and Muddy River, Nevada, February 7, 2001: U.S. Geological Survey Scientific Investigations Report 2006-5237, 12 p.

Tetra Tech GEO, 2012, Development of a Numerical Groundwater Flow Model of Selected Basins within the Colorado Regional Groundwater Flow System, Southeastern Nevada (Version 1.0), 70 p., plus figures and 2 appendices.

FIGURES


N
93
93
Desert National
Wildlife Range
Beaver Dam Wash
Nevada
Utah
Arizona
15
Littlefield
Springs
Meadow Valley Wash
Virgin River
Mesquite
Muddy River Springs
Moapa Valley
National Wildlife Refuge
Muddy River
Moapa River
Indian Reservation
Overton
Blue Point Spring
Rogers Spring
15
Las Vegas
95
Lake Mead
Lake Mead
National Recreation Area
0 5 10 20 30
Miles
Legend
< 1
1 - 2
2 - 5
5 - 10
10 - 20
20 - 50
50 - 100
100 - 200
200 - 500
> 500
Pumping Wells
Active Model Domain
State Boundary
Drawdown is in feet.
TITLE:
Predicted Drawdown
Scenario 1
10 years
LOCATION:
Colorado Regional Groundwater Flow System
Southeastern Nevada
TETRA TECH
FIGURE
3.1-1a


N
93
93
Desert National
Wildlife Range
Beaver Dam Wash
Utah
Arizona
Nevada
15
Littlefield
Springs
Meadow Valley Wash
Virgin River
Mesquite
Muddy River Springs
Moapa Valley
National Wildlife Refuge
Muddy River
Moapa River
Indian Reservation
Overton
Blue Point Spring
Rogers Spring
15
Las Vegas
95
Lake Mead
Lake Mead
National Recreation Area
0 5 10 20 30
Miles
Legend
< 1
1 - 2
2 - 5
5 - 10
10 - 20
20 - 50
50 - 100
100 - 200
200 - 500
> 500
Pumping Well Location
Active Model Domain
State Boundary
Drawdown is in feet.
TITLE:
Predicted Drawdown
Scenario 1
50 years
LOCATION:
Colorado Regional Groundwater Flow System
Southeastern Nevada
TETRA TECH
FIGURE
3.1-1b

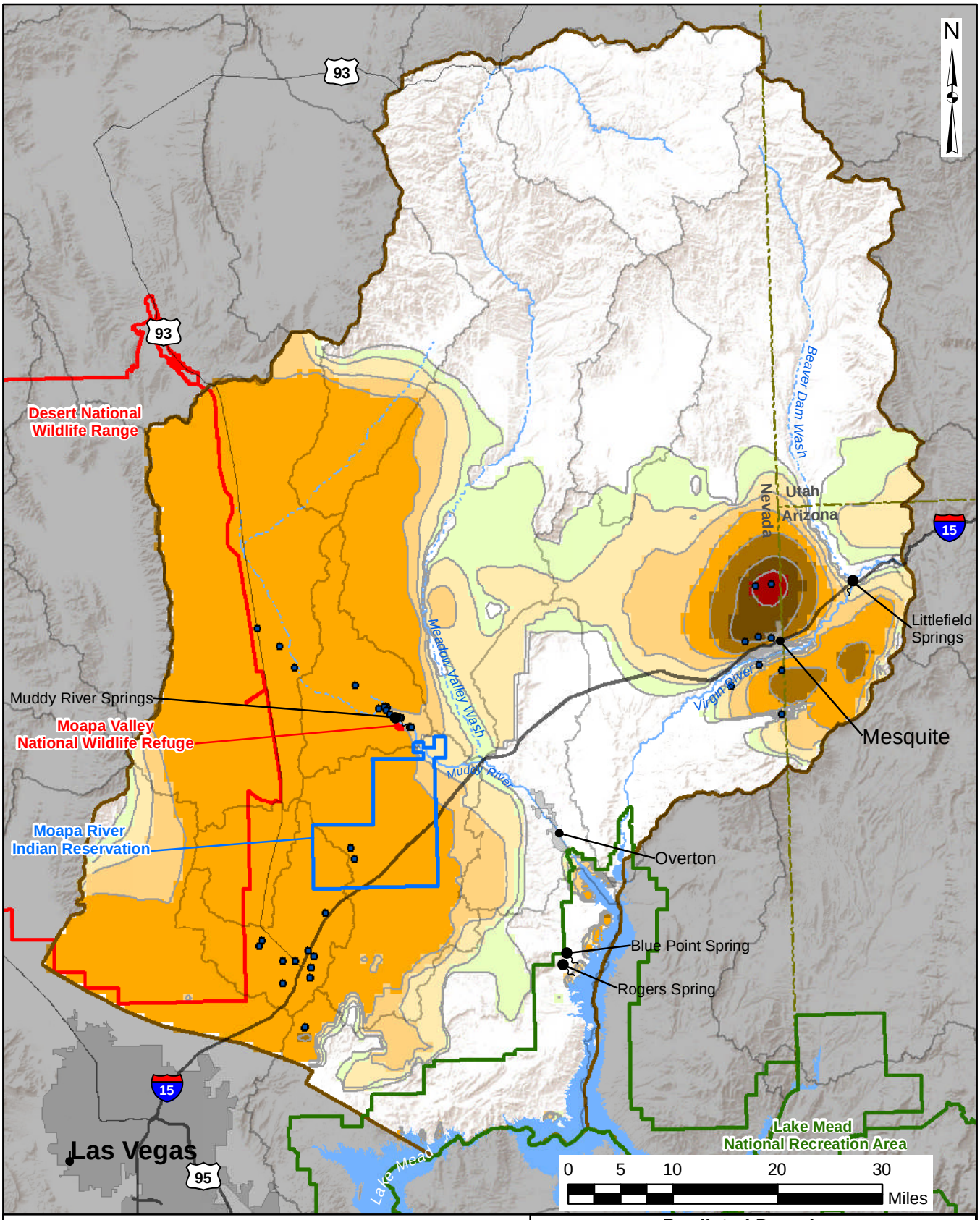


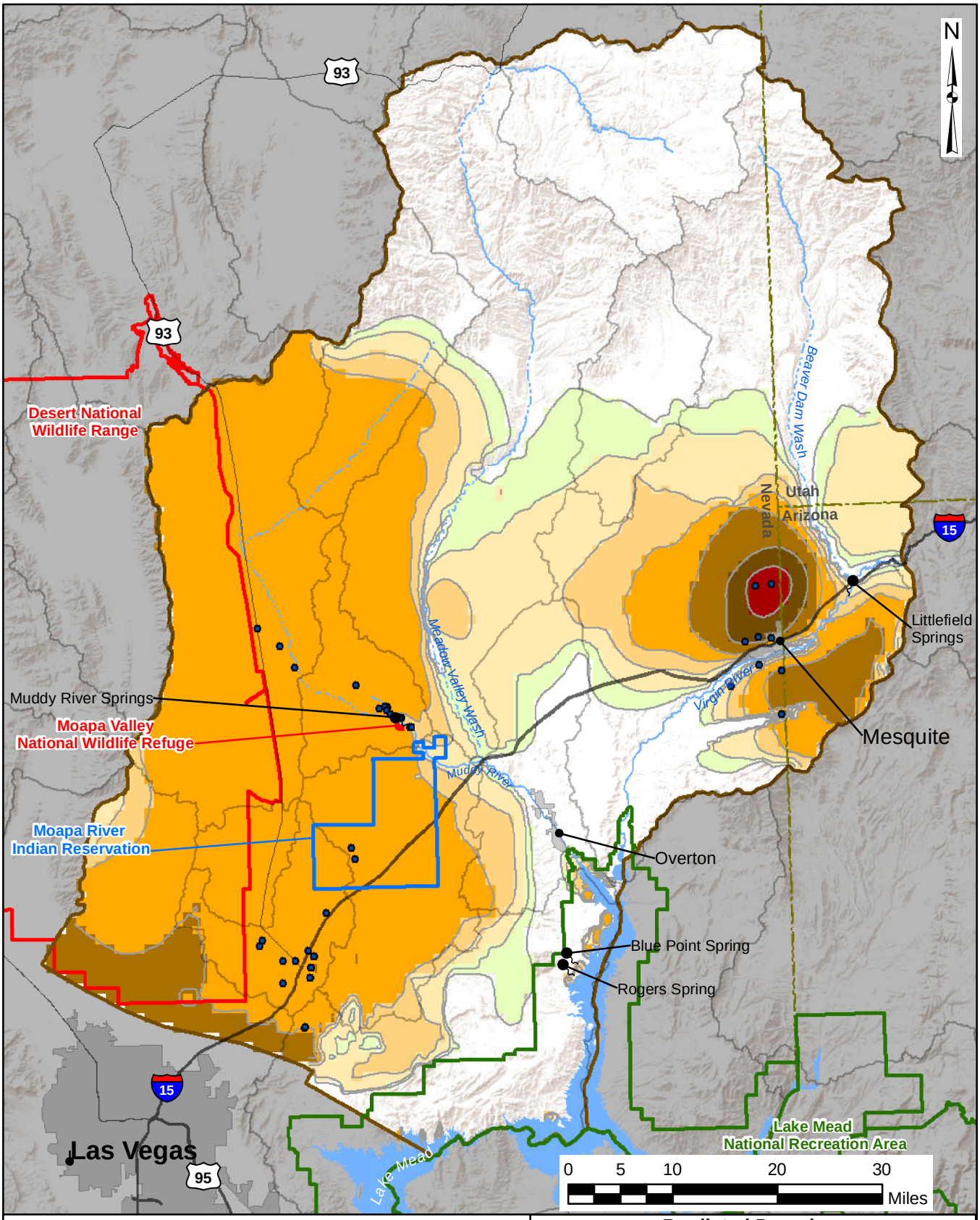
TITLE: **Predicted Drawdown**
Scenario 1
100 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.1-1c


N
93
93
Desert National
Wildlife Range
Utah
Nevada
Arizona
15
Littlefield
Springs
Beaver Dam Wash
Meadow Valley Wash
Virgin River
Muddy River Springs
Moapa Valley
National Wildlife Refuge
Muddy River
Mesquite
Moapa River
Indian Reservation
Overton
Blue Point Spring
Rogers Spring
15
Las Vegas
95
Lake Mead
Lake Mead
National Recreation Area
0 5 10 20 30
Miles
Legend
< 1
1 - 2
2 - 5
5 - 10
10 - 20
20 - 50
50 - 100
100 - 200
200 - 500
> 500
Pumping Well Location
Active Model Domain
State Boundary
Drawdown is in feet.
TITLE:
Predicted Drawdown
Scenario 1
500 years
LOCATION:
Colorado Regional Groundwater Flow System
Southeastern Nevada
TETRA TECH
FIGURE
3.1-1d

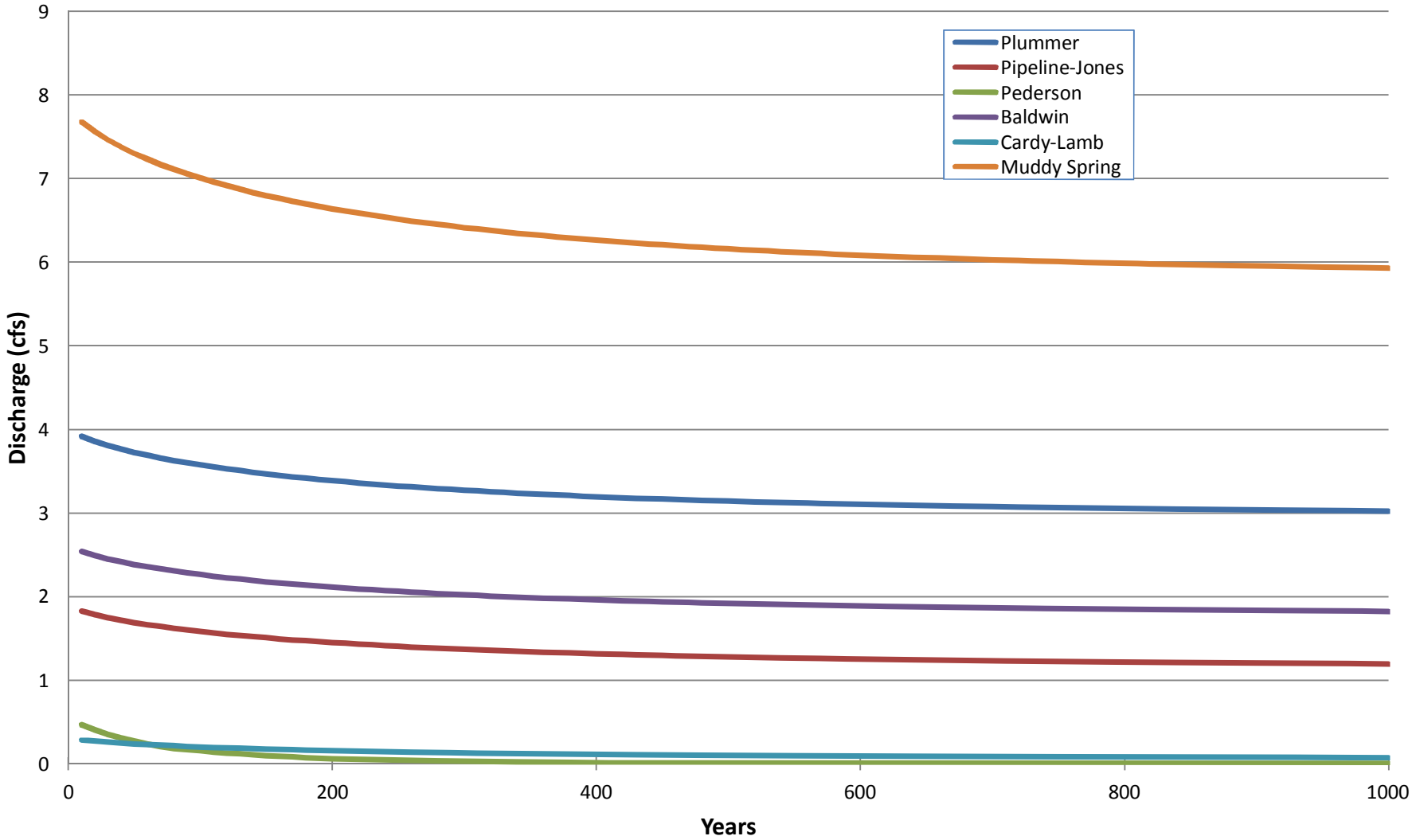


TITLE: **Predicted Drawdown**
Scenario 1
1000 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.1-1e

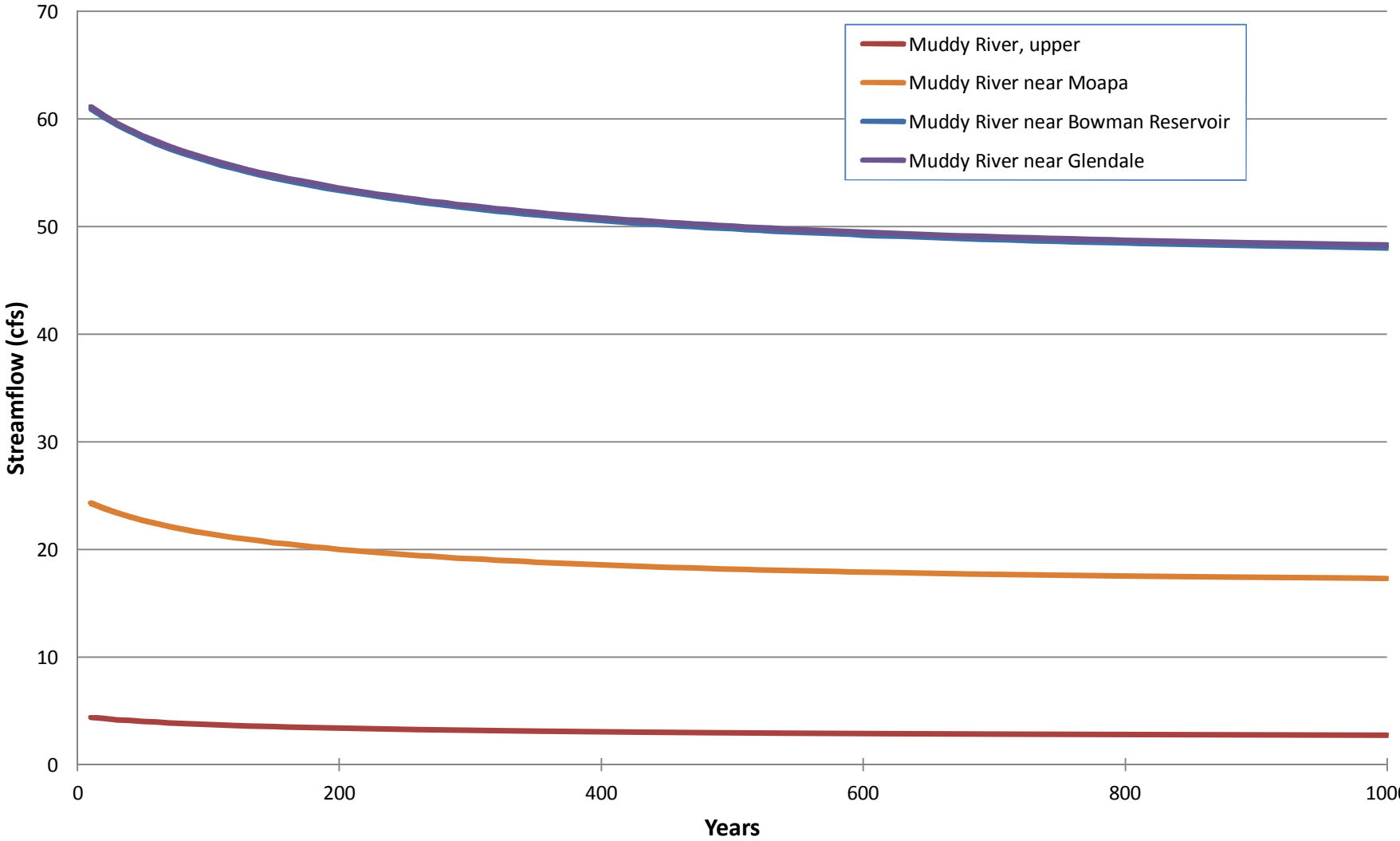


Simulated spring discharges in the Muddy River Springs area, Scenario 1

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.1-2a

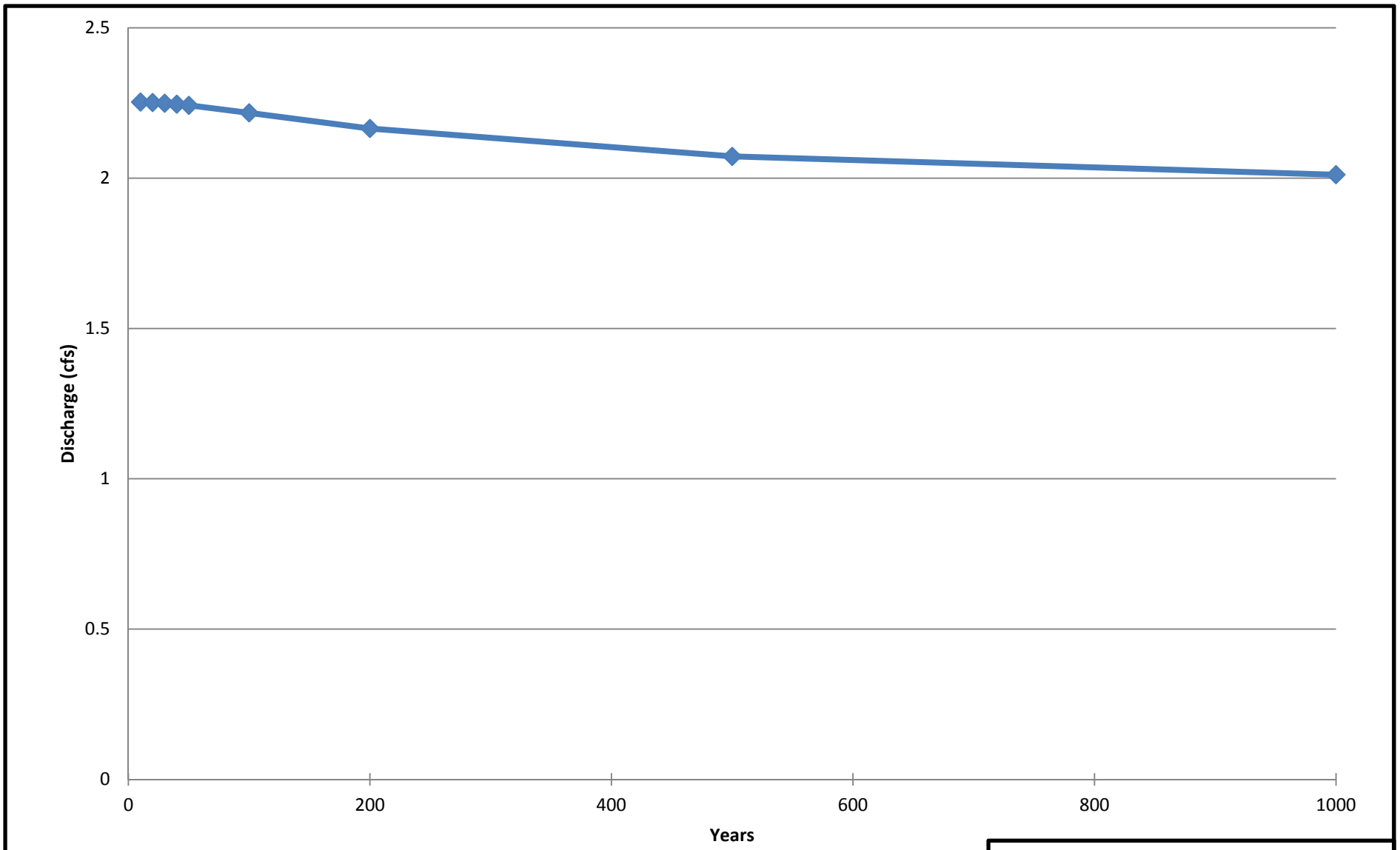


Simulated streamflow in the Muddy River, Scenario 1

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.1-2b

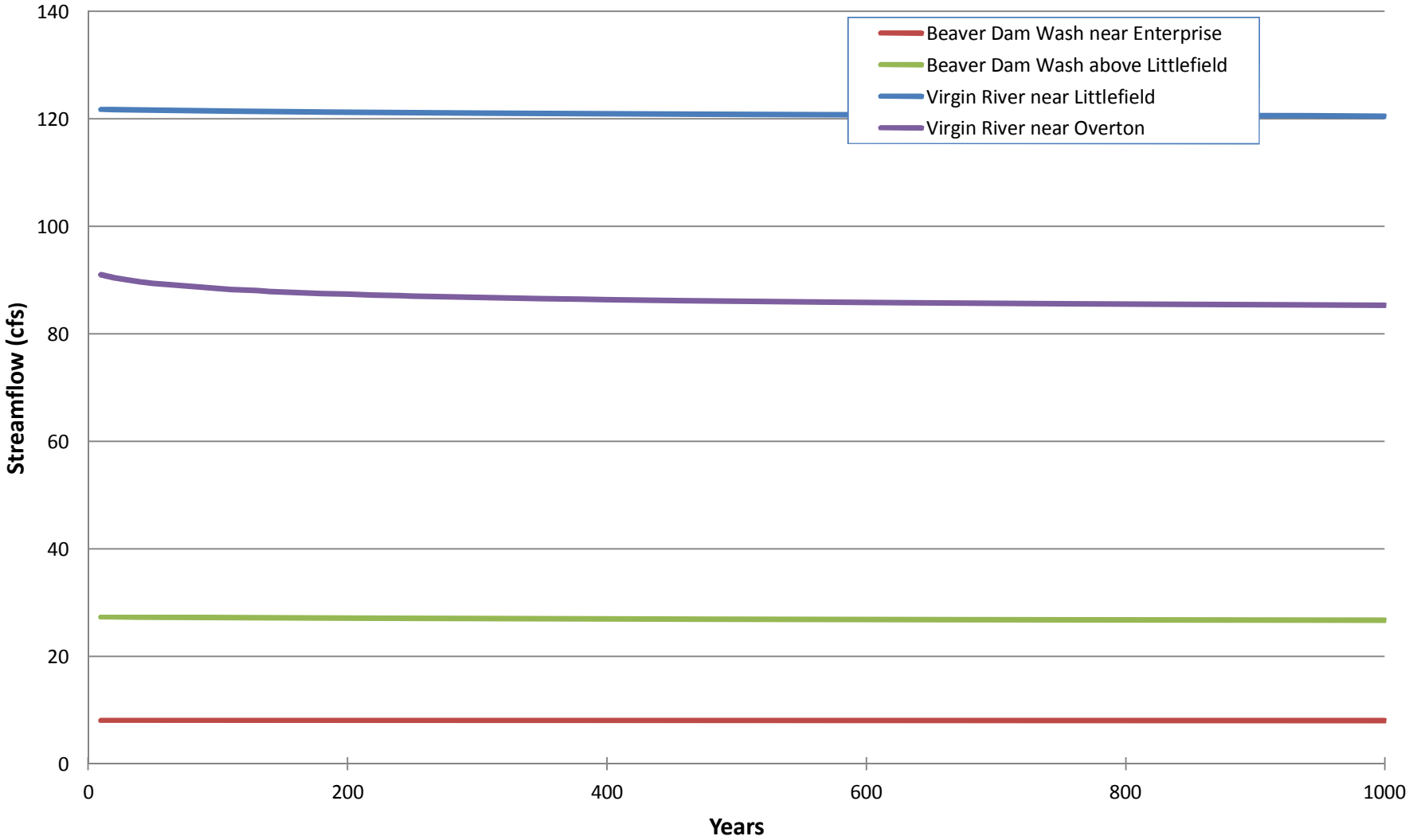


Simulated combined discharge from Rogers and Blue Point Springs, Scenario 1

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.1-2c

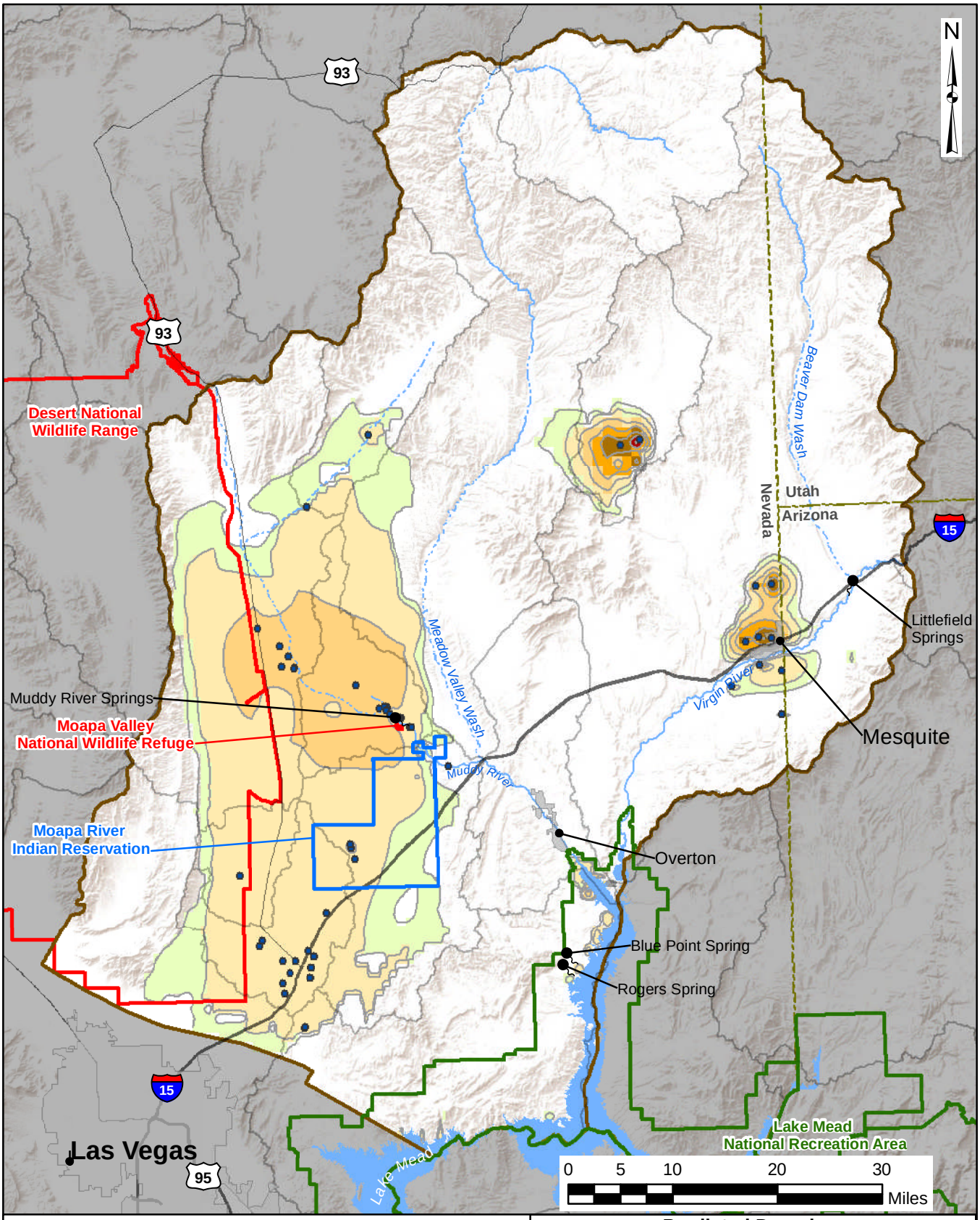


Simulated streamflow in Beaver Dam Wash and the Virgin River, Scenario 1

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.1-2d

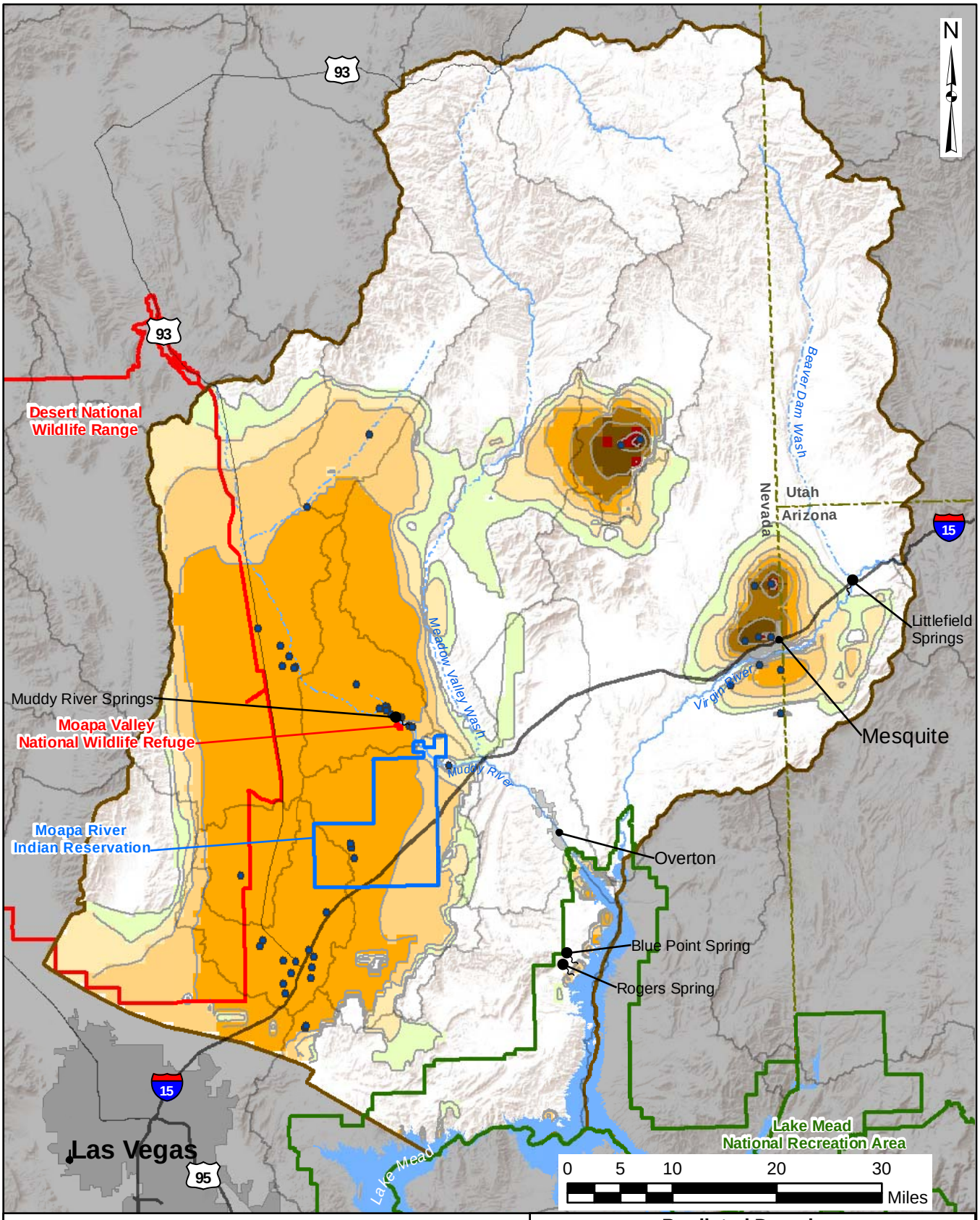


TITLE: **Predicted Drawdown**
Scenario 2
10 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.2-1a



Legend

< 1	20 - 50	Pumping Well Location
1 - 2	50 - 100	Active Model Domain
2 - 5	100 - 200	
5 - 10	200 - 500	
10 - 20	> 500	State Boundary

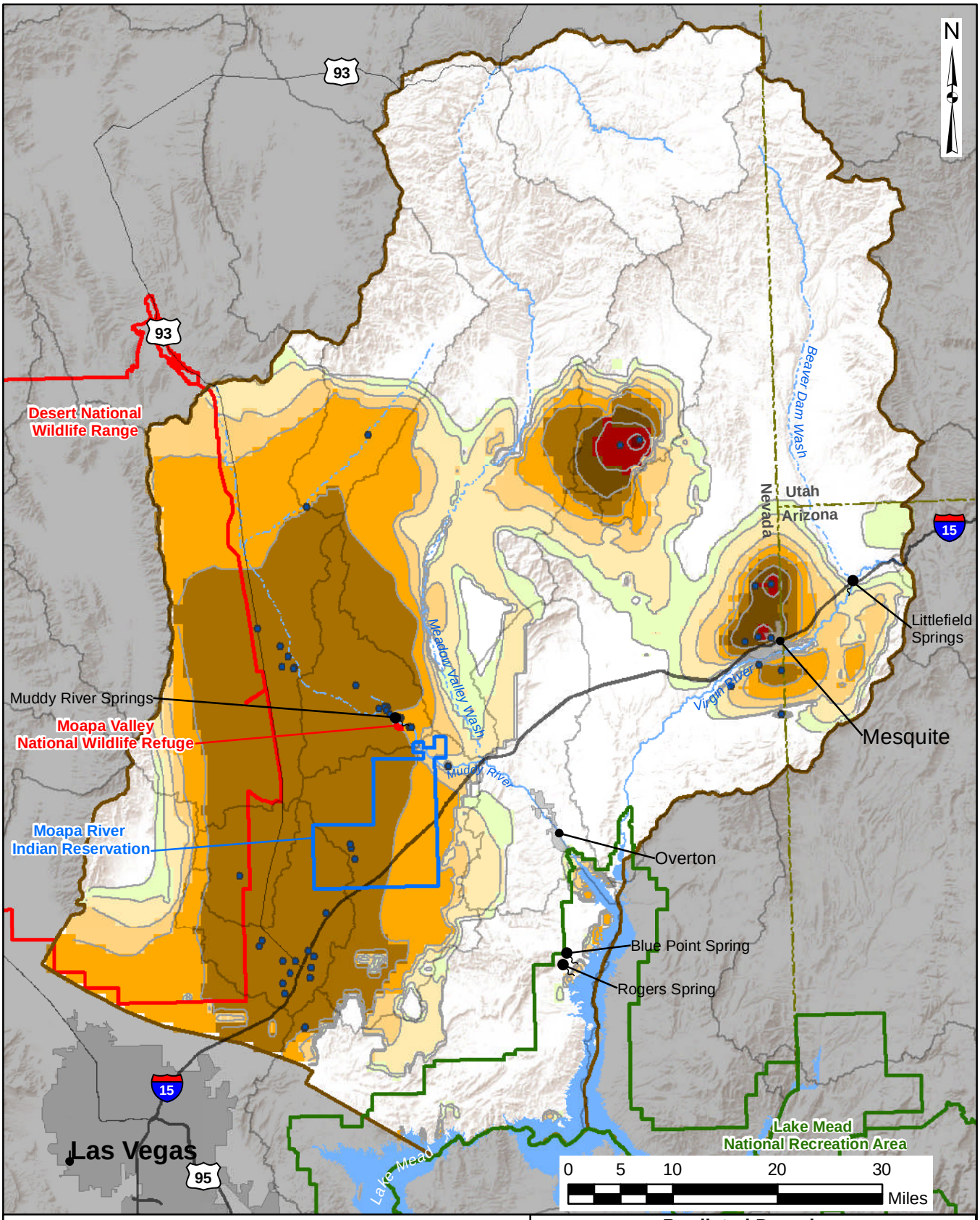
Drawdown is in feet.

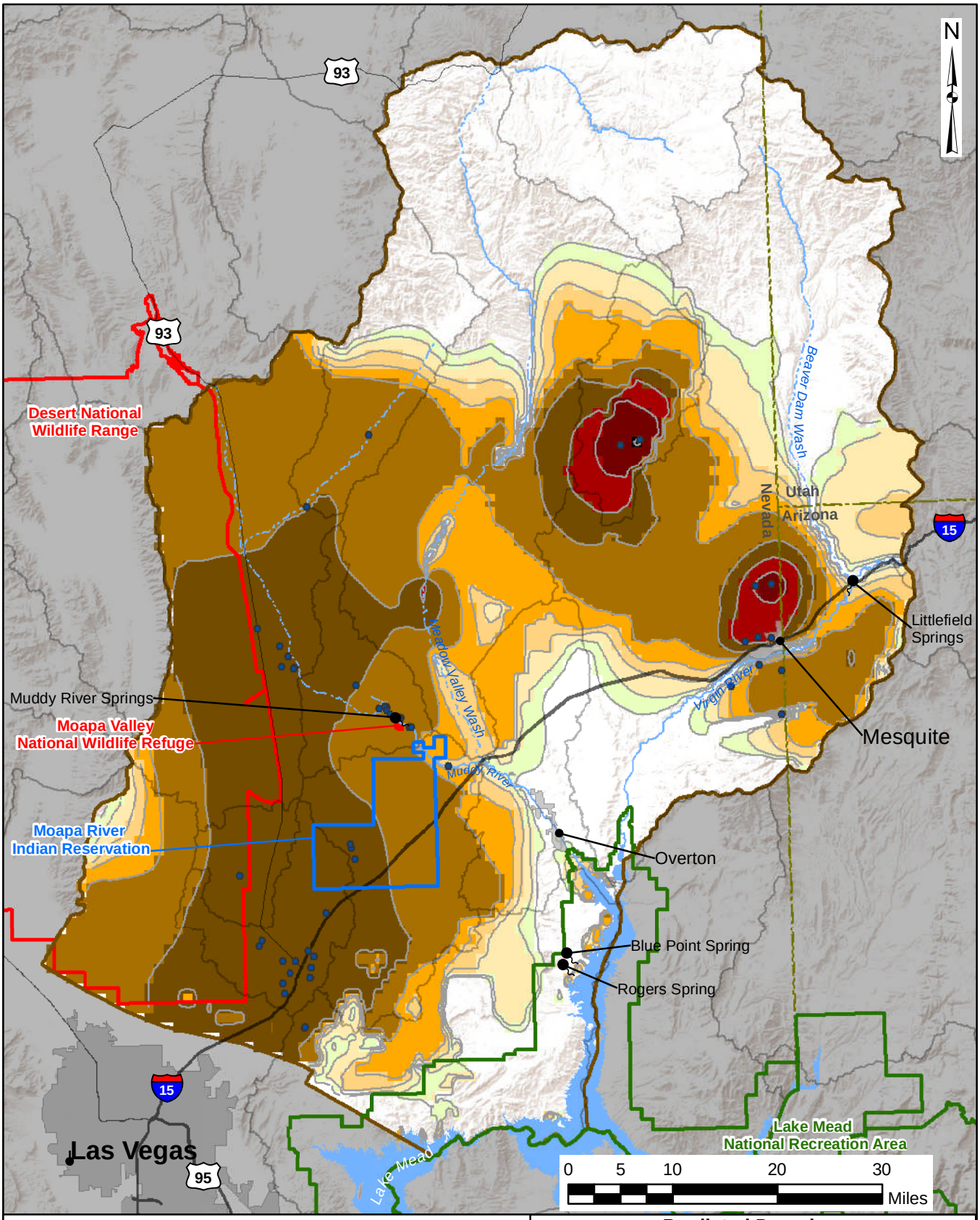
TITLE: **Predicted Drawdown**
Scenario 2
50 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.2-1b


N
93
93
Desert National
Wildlife Range
Utah
Arizona
Nevada
15
Beaver Dam Wash
Littlefield
Springs
Meadow Valley Wash
Virgin River
Mesquite
Muddy River Springs
Moapa Valley
National Wildlife Refuge
Muddy River
Moapa River
Indian Reservation
Overton
Blue Point Spring
Rogers Spring
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Las Vegas
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Lake Mead
Lake Mead
National Recreation Area
0 5 10 20 30
Miles
Legend
< 1
1 - 2
2 - 5
5 - 10
10 - 20
20 - 50
50 - 100
100 - 200
200 - 500
> 500
Pumping Well Location
Active Model Domain
State Boundary
Drawdown is in feet.
TITLE:
Predicted Drawdown
Scenario 2
100 years
LOCATION:
Colorado Regional Groundwater Flow System
Southeastern Nevada
TETRA TECH
FIGURE
3.2-1c



Legend

< 1	20 - 50	Pumping Well Location
1 - 2	50 - 100	Active Model Domain
2 - 5	100 - 200	
5 - 10	200 - 500	State Boundary
10 - 20	> 500	

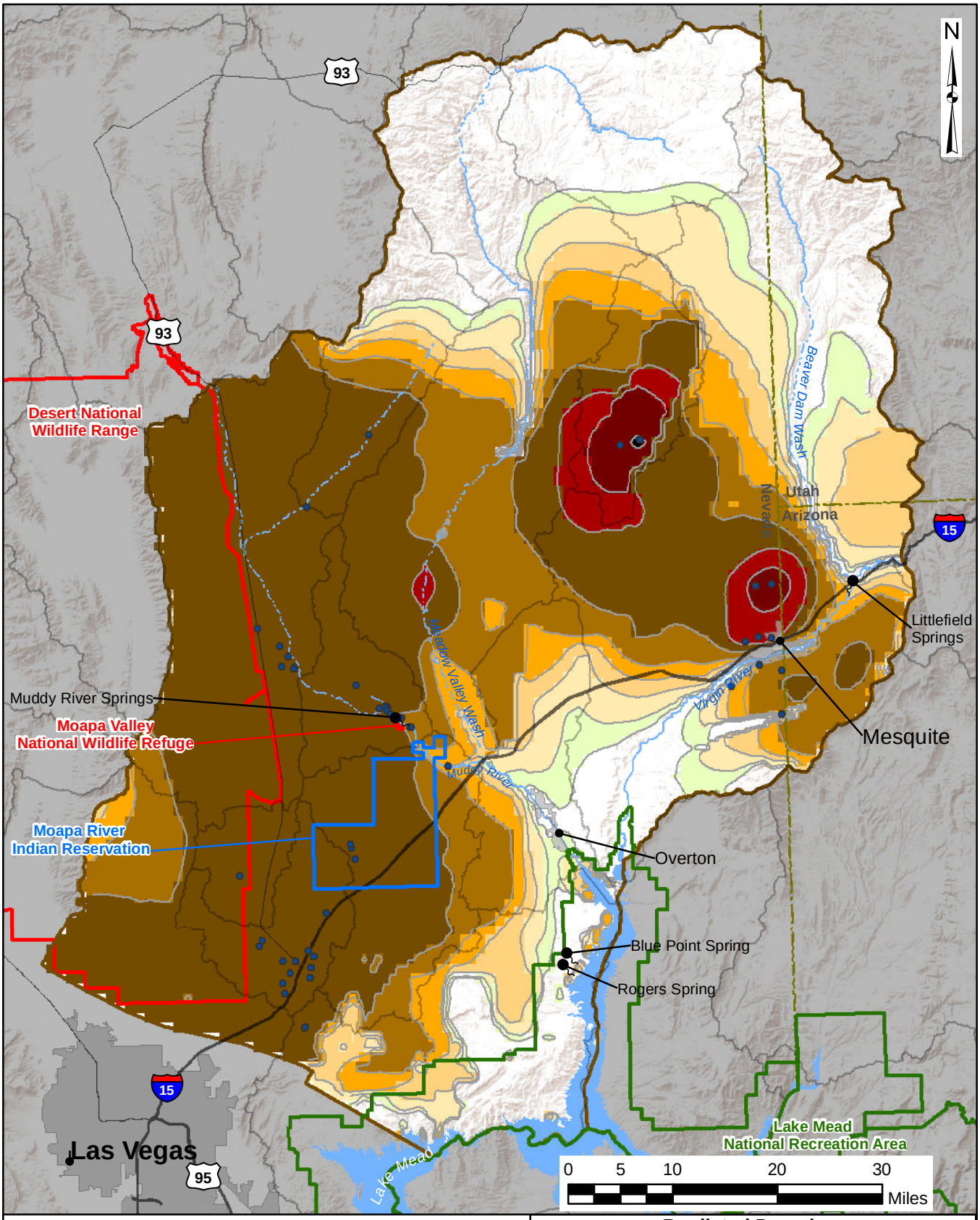
Drawdown is in feet.

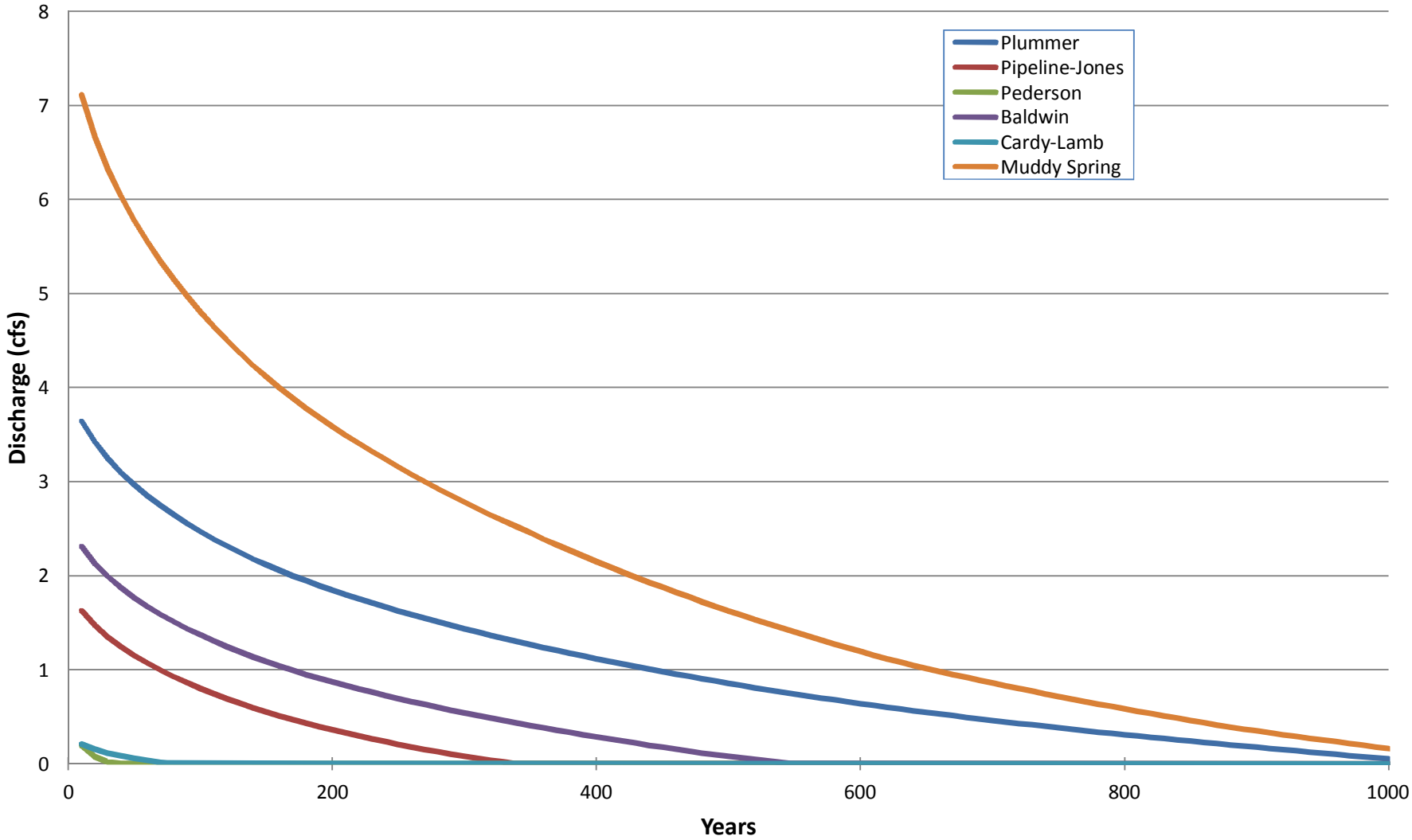
TITLE: **Predicted Drawdown**
Scenario 2
500 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.2-1d


N
93
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Desert National
Wildlife Range
Utah
Arizona
Nevada
Beaver Dam Wash
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Littlefield
Springs
Meadow Valley Wash
Virgin River
Mesquite
Muddy River Springs
Moapa Valley
National Wildlife Refuge
Muddy River
Moapa River
Indian Reservation
Overton
Blue Point Spring
Rogers Spring
15
Las Vegas
95
Lake Mead
Lake Mead
National Recreation Area
0 5 10 20 30
Miles
Legend
< 1
1 - 2
2 - 5
5 - 10
10 - 20
20 - 50
50 - 100
100 - 200
200 - 500
> 500
Pumping Well Location
Active Model Domain
State Boundary
Drawdown is in feet.
TITLE:
Predicted Drawdown
Scenario 2
1000 years
LOCATION:
Colorado Regional Groundwater Flow System
Southeastern Nevada
TETRA TECH
FIGURE
3.2-1e

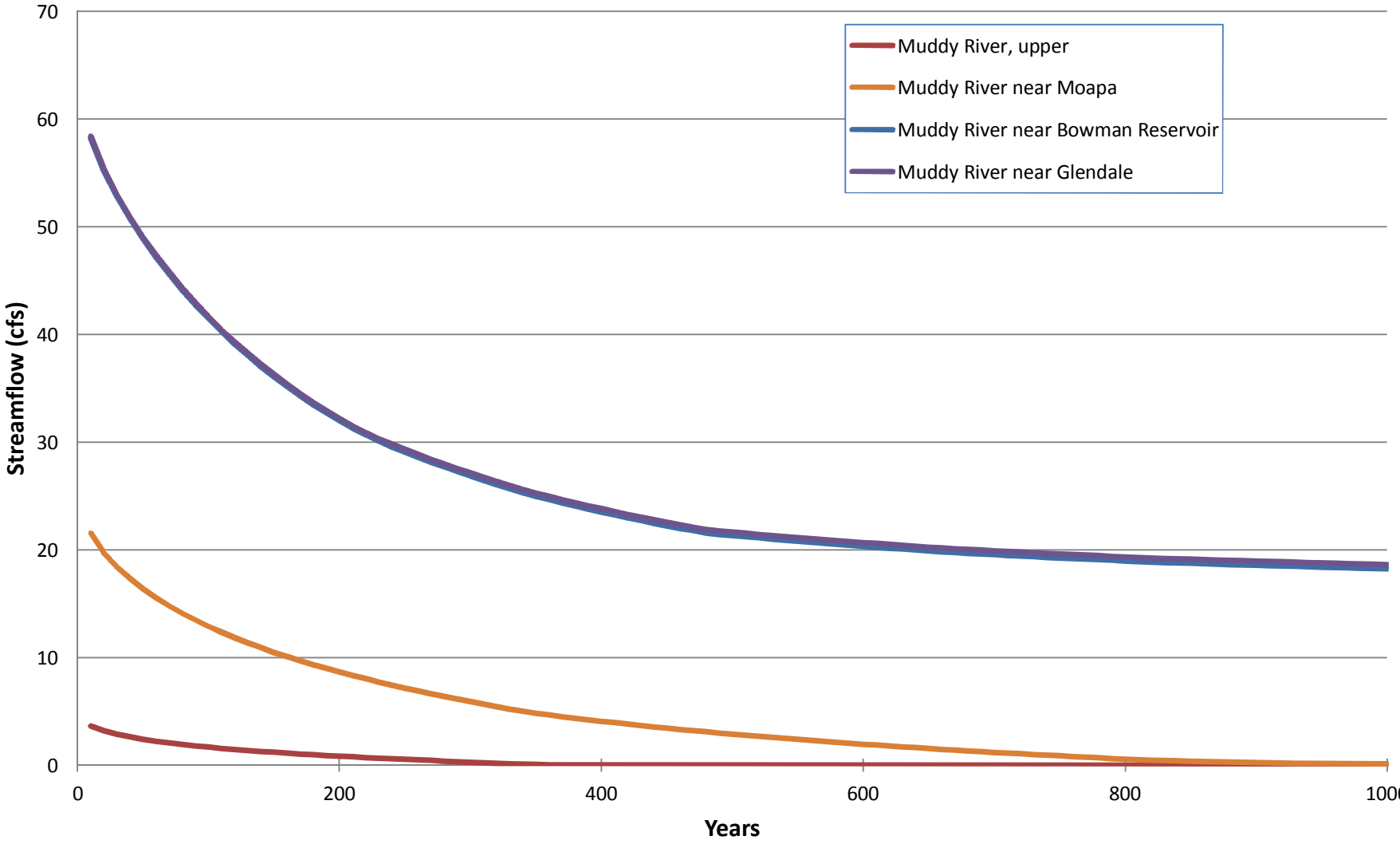


Simulated spring discharges in the Muddy River Springs area, Scenario 2

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.2-2a

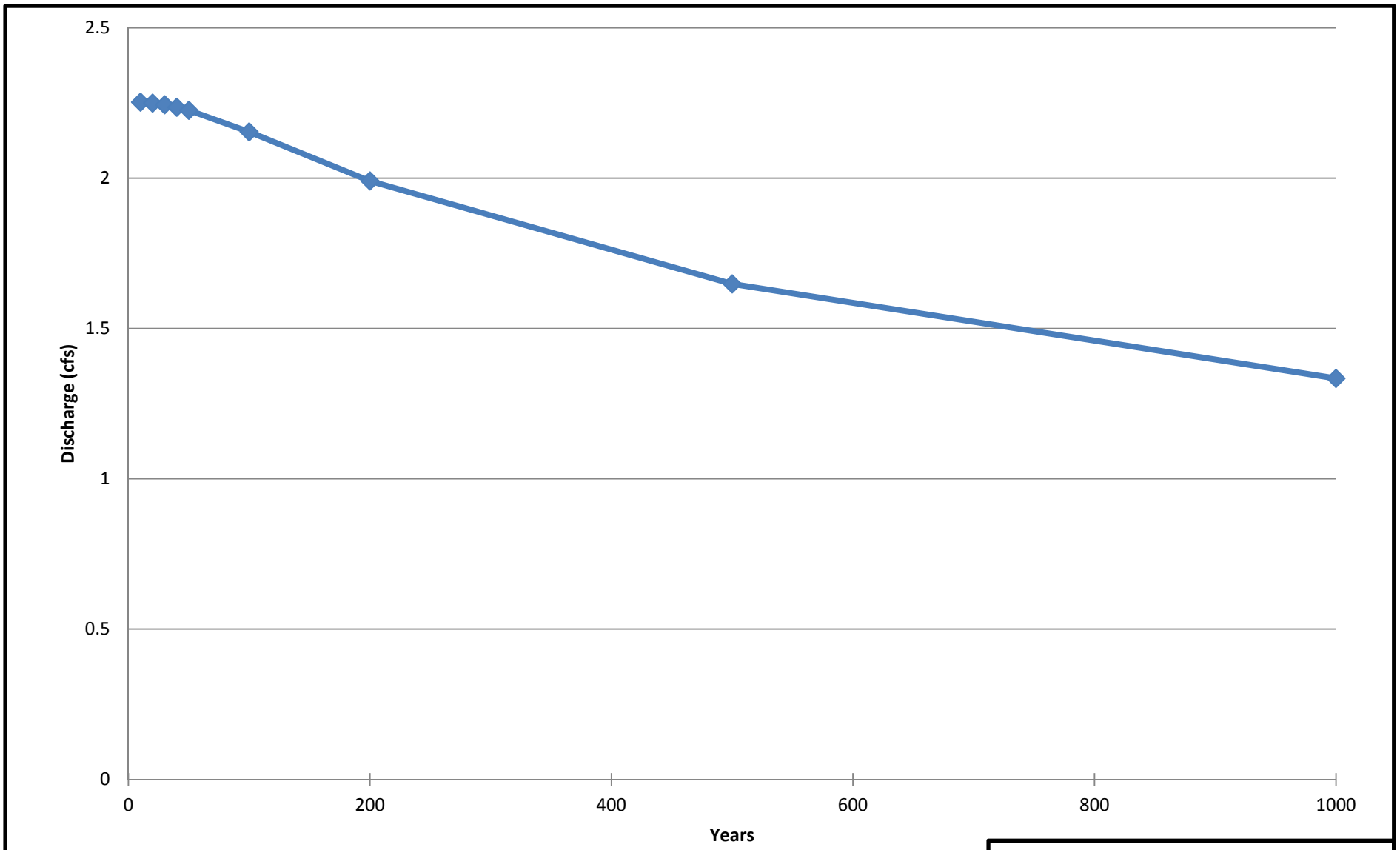


Simulated streamflow in the Muddy River, Scenario 2

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.2-2b

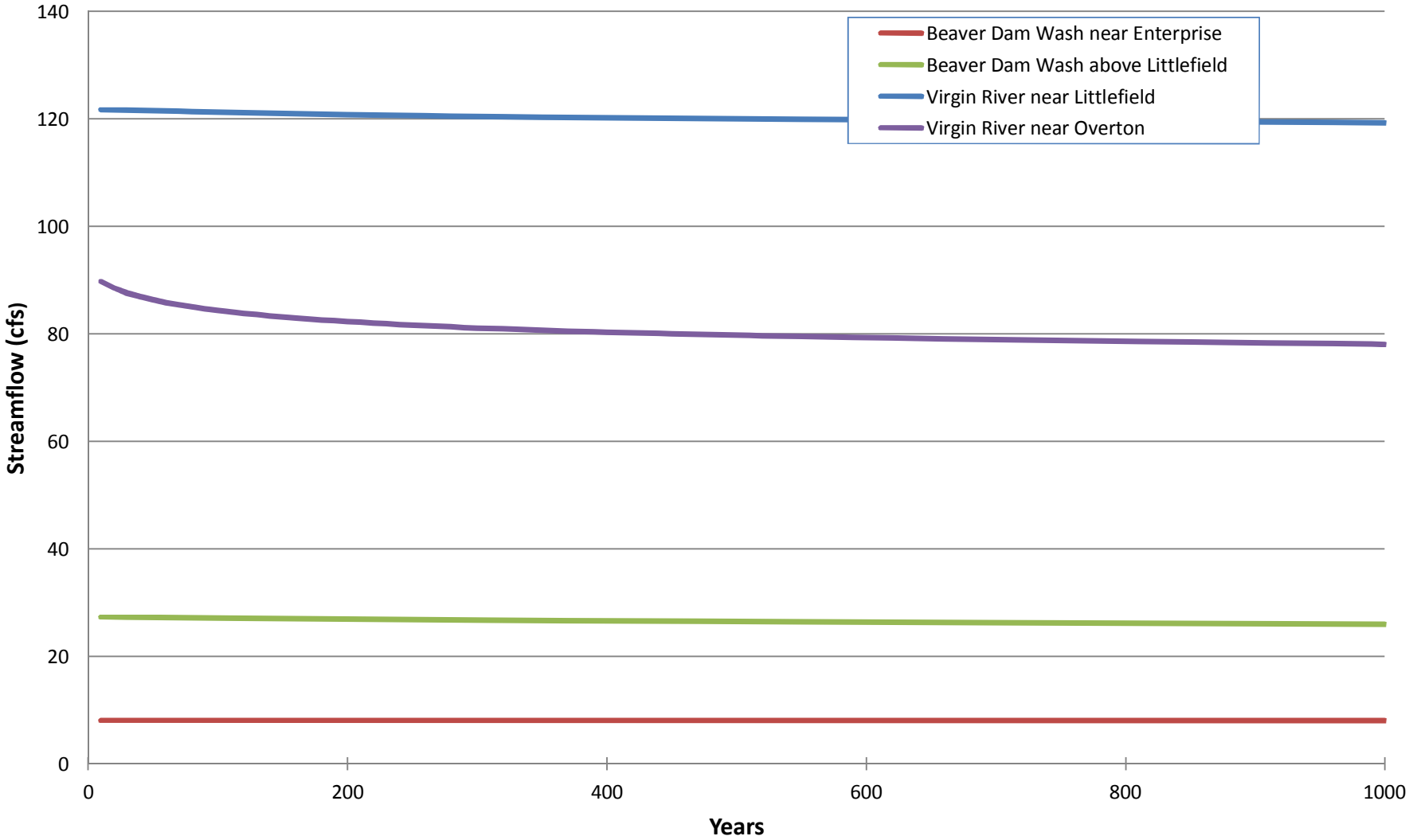


Simulated combined discharge from Rogers and Blue Point Springs, Scenario 2

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.2-2c

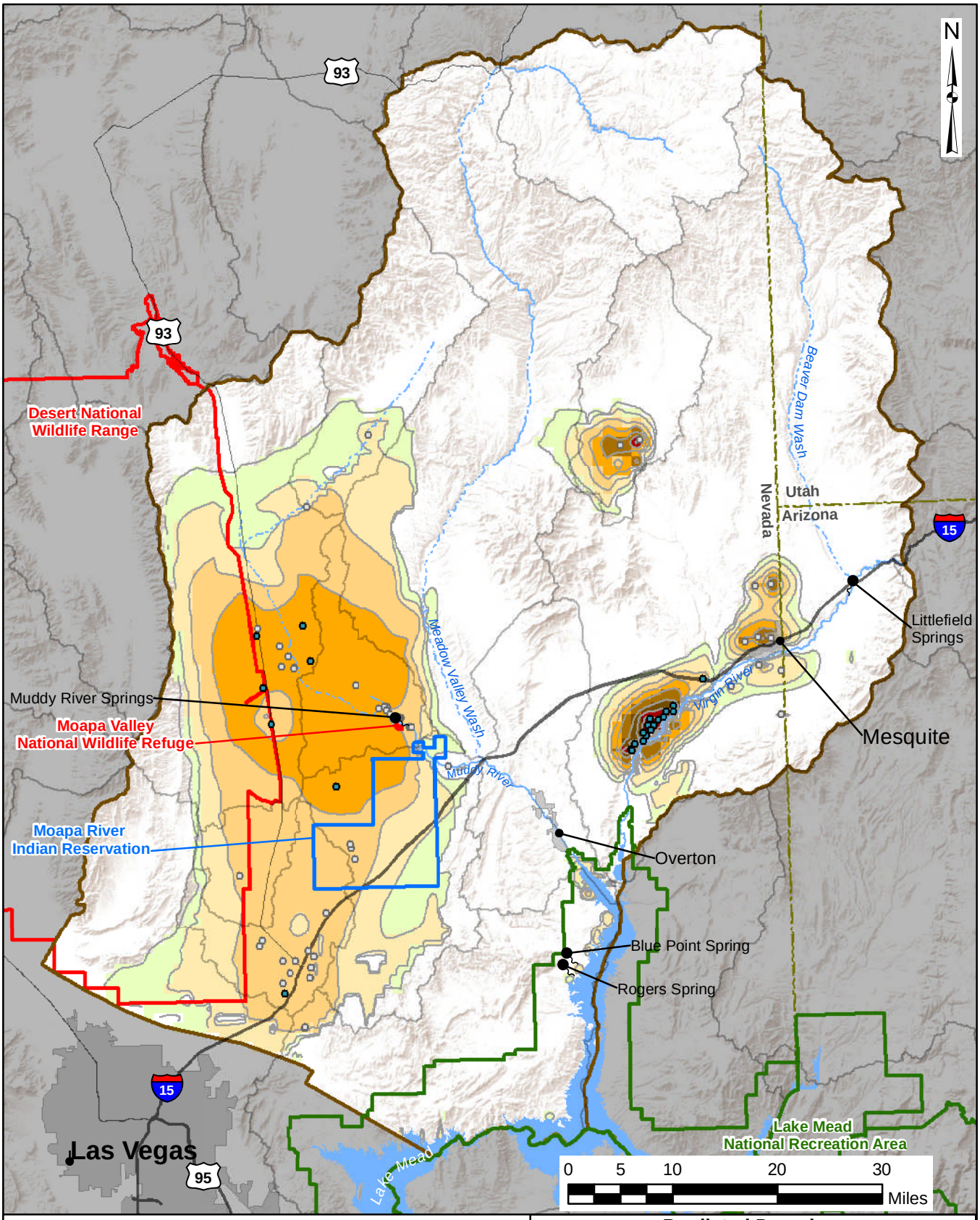


Simulated streamflow in Beaver Dam Wash and the Virgin River, Scenario 2

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.2-2d

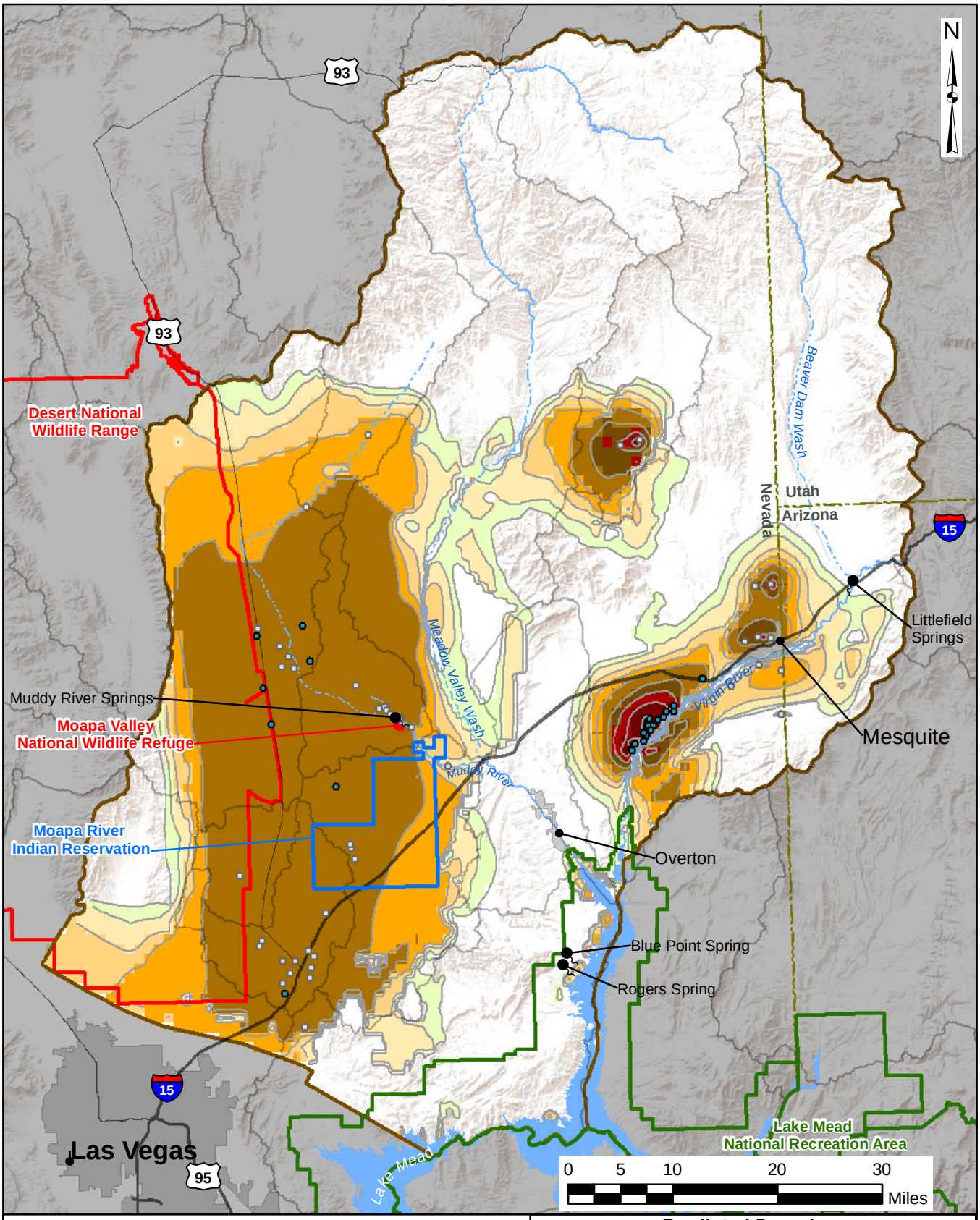


TITLE: **Predicted Drawdown**
Scenario 3
10 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.3-1a

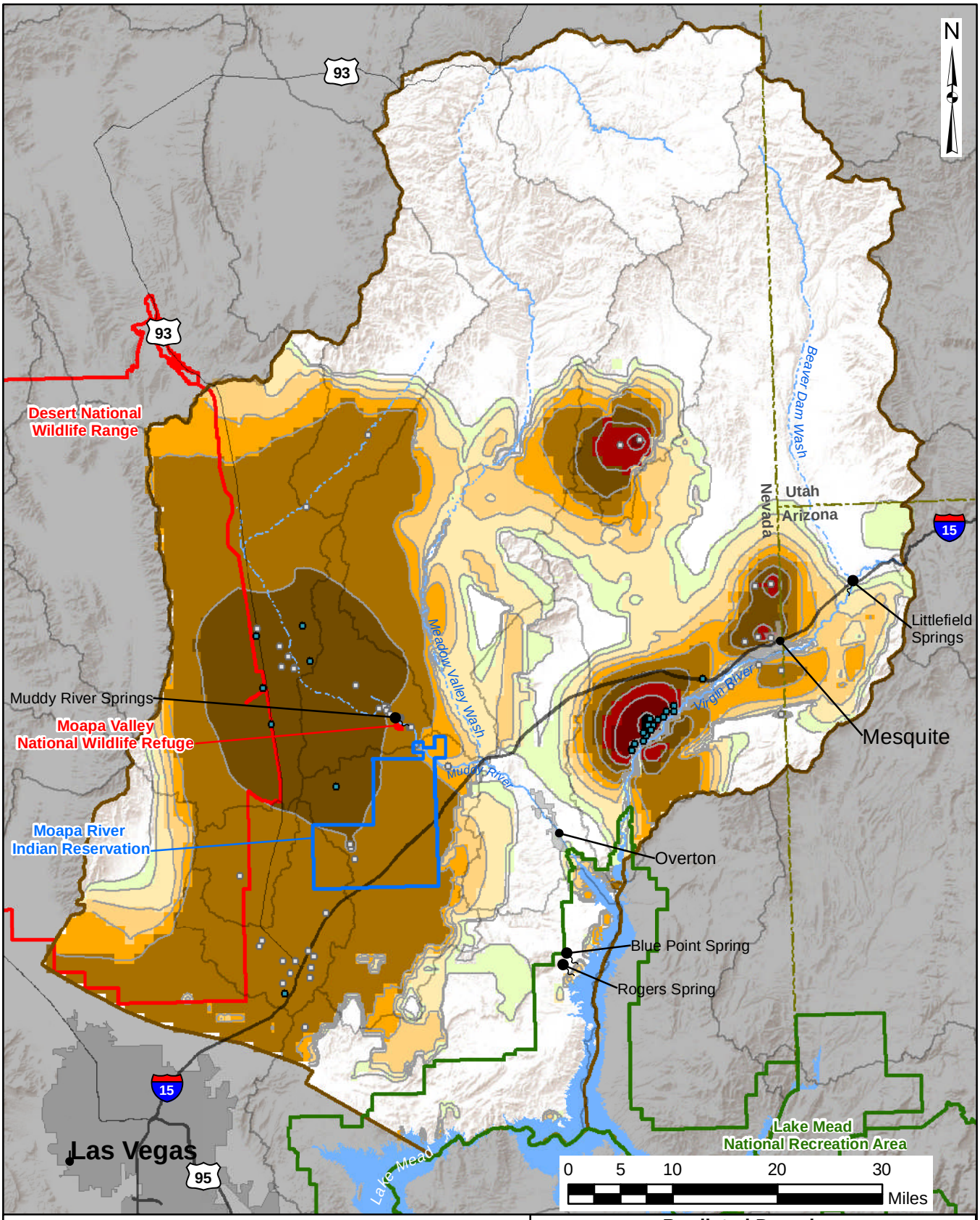


TITLE: **Predicted Drawdown**
Scenario 3
50 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.3-1b



Legend

< 1	20 - 50	Pumping Wells; existent	
1 - 2	50 - 100	Pumping Introduced in Scenario	
2 - 5	100 - 200		
5 - 10	200 - 500	Active Model Domain	
10 - 20	> 500	State Boundary	

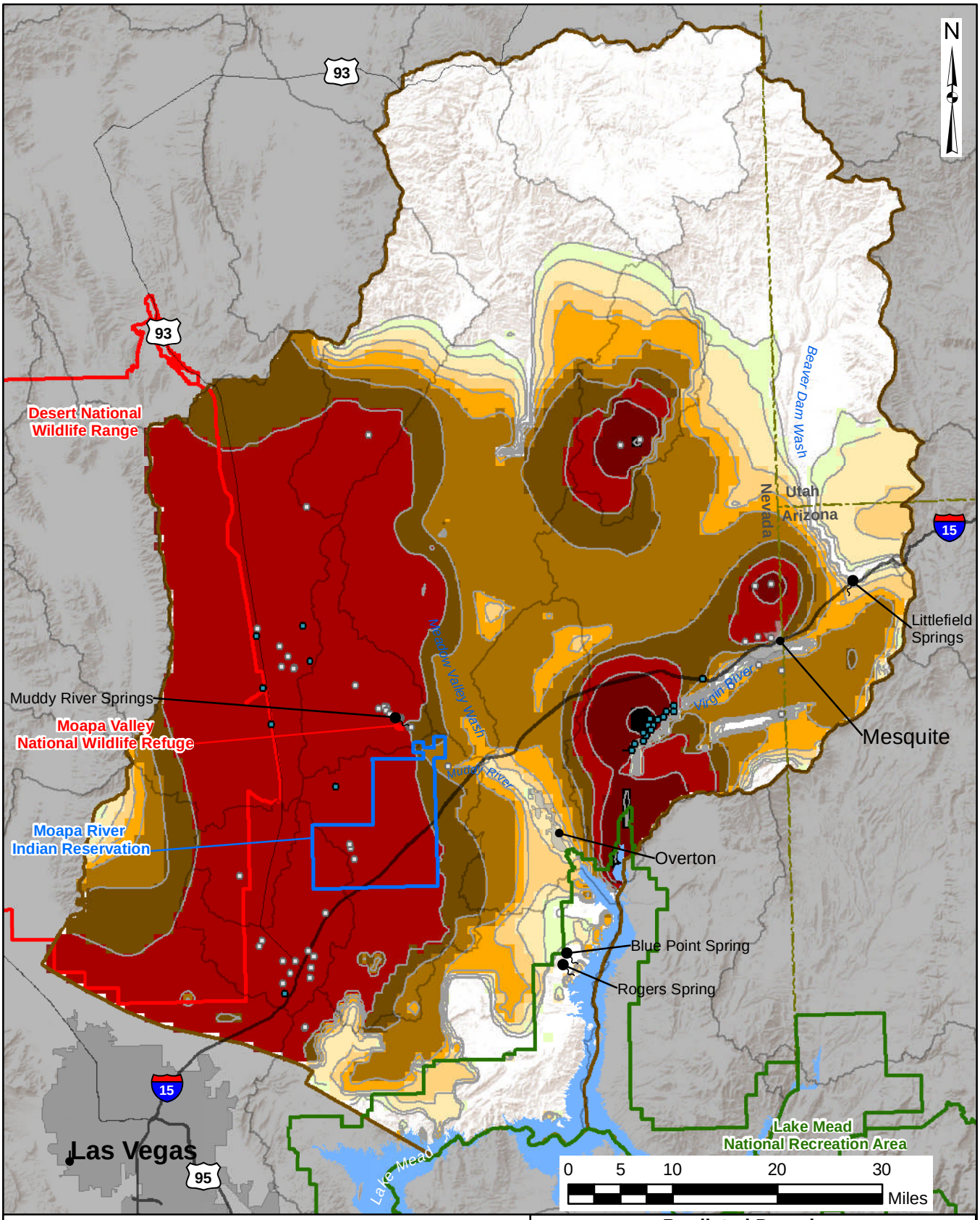
Drawdown is in feet.

TITLE: **Predicted Drawdown**
Scenario 3
100 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.3-1c



Legend

< 1	20 - 50	Pumping Wells; existent	
1 - 2	50 - 100	Pumping Introduced in Scenario	
2 - 5	100 - 200		
5 - 10	200 - 500	Active Model Domain	
10 - 20	> 500	State Boundary	

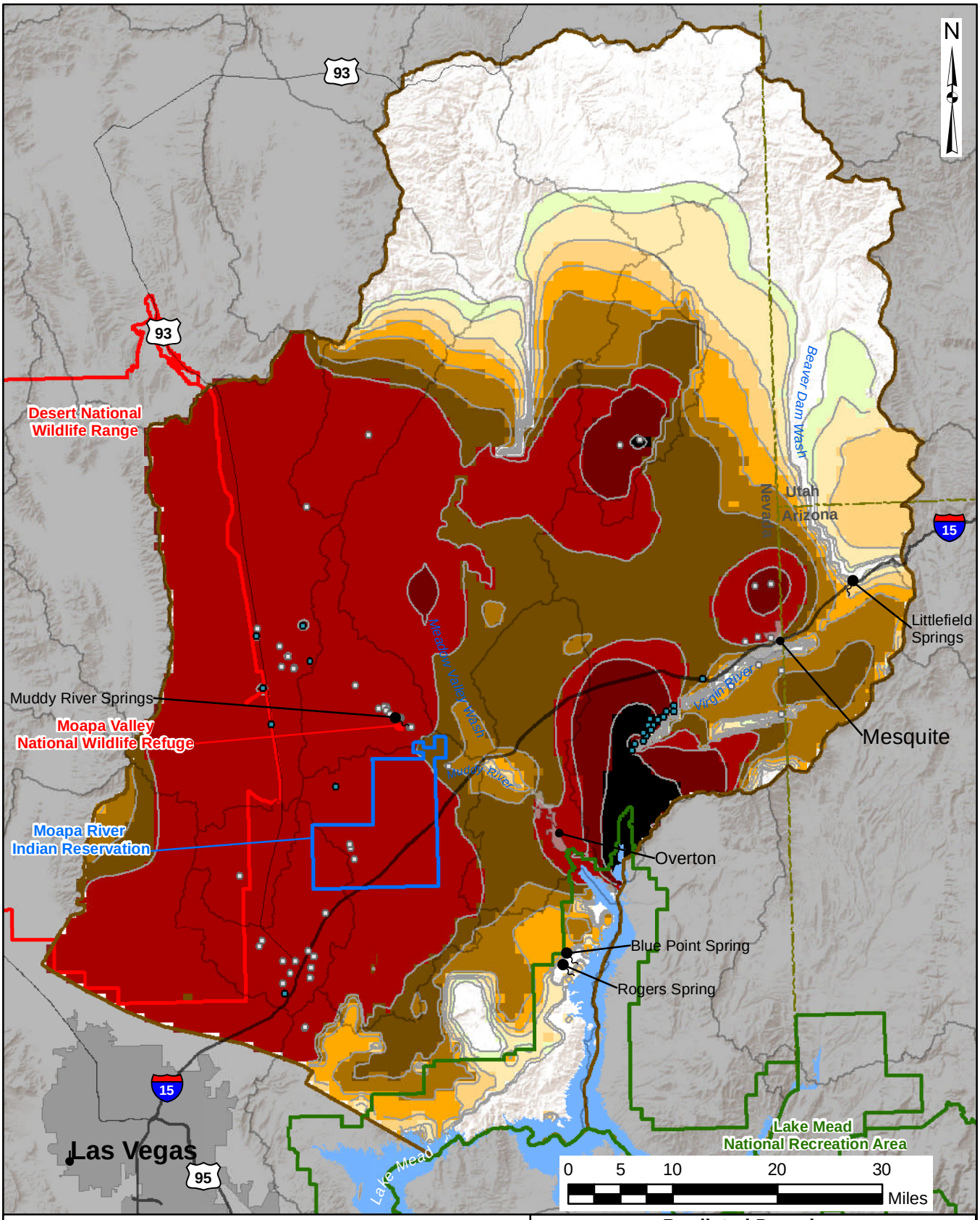
Drawdown is in feet.

TITLE: **Predicted Drawdown**
Scenario 3
500 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.3-1d

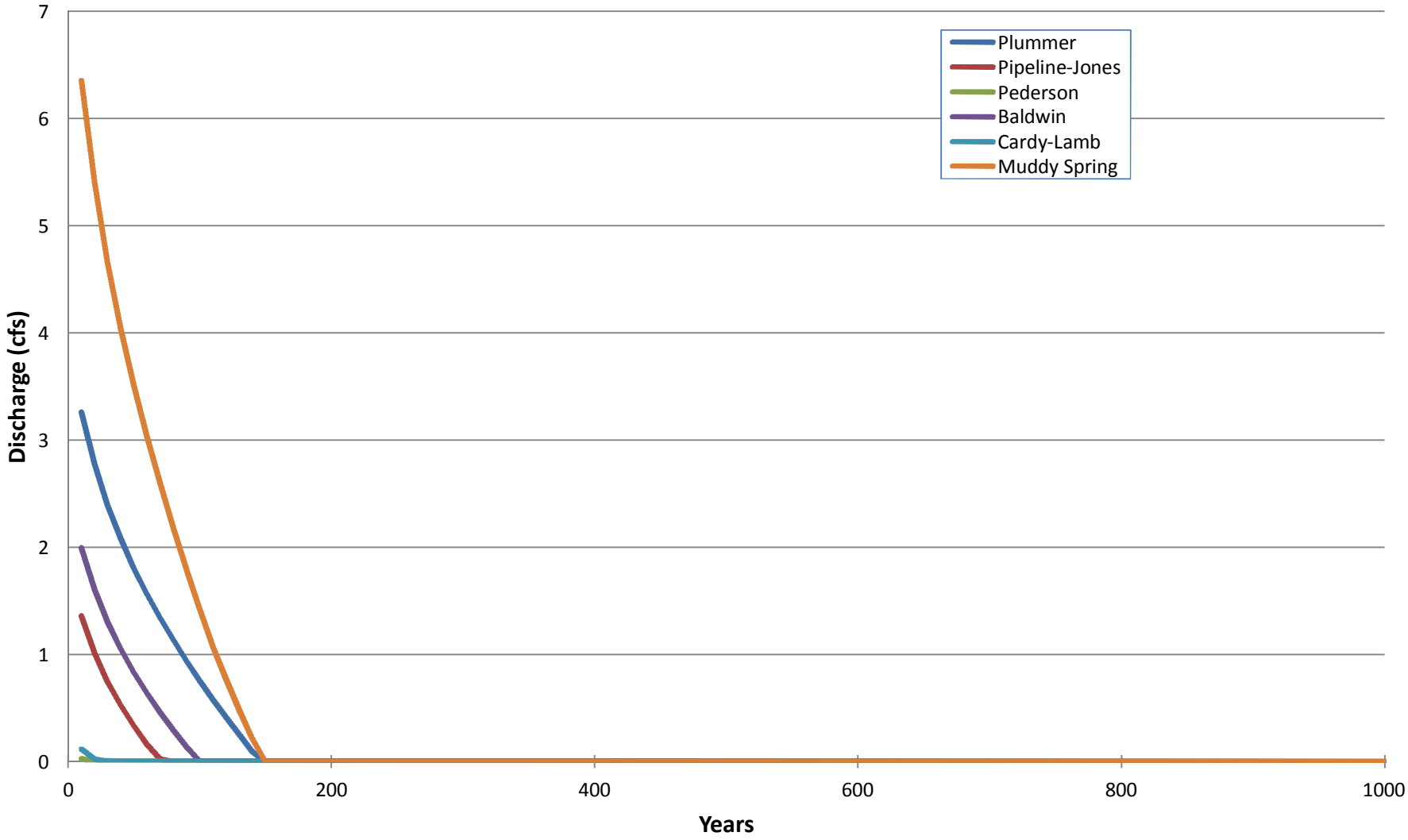


TITLE: **Predicted Drawdown**
Scenario 3
1000 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.3-1e

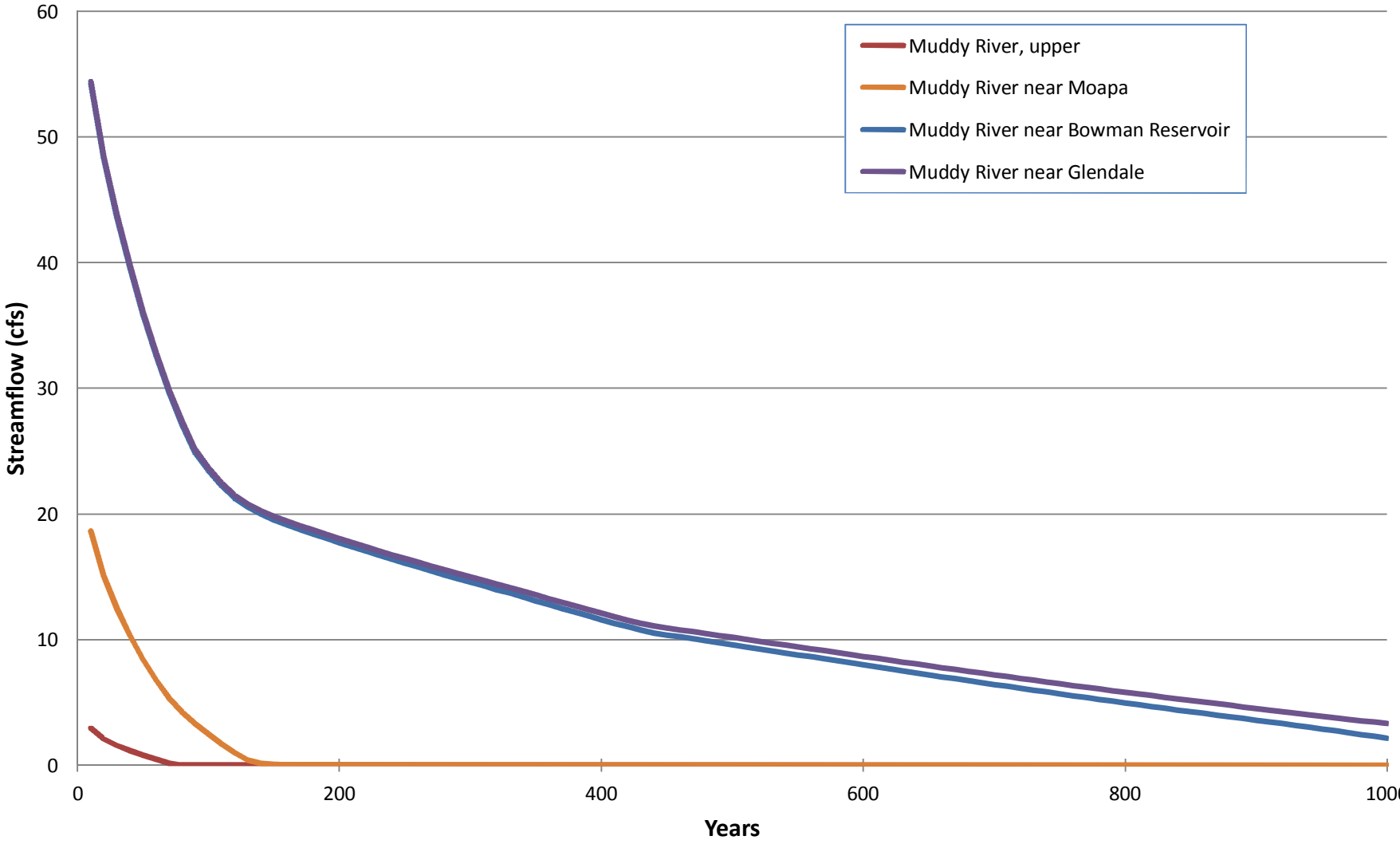


Simulated spring discharges in the Muddy River Springs area, Scenario 3

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.3-2a

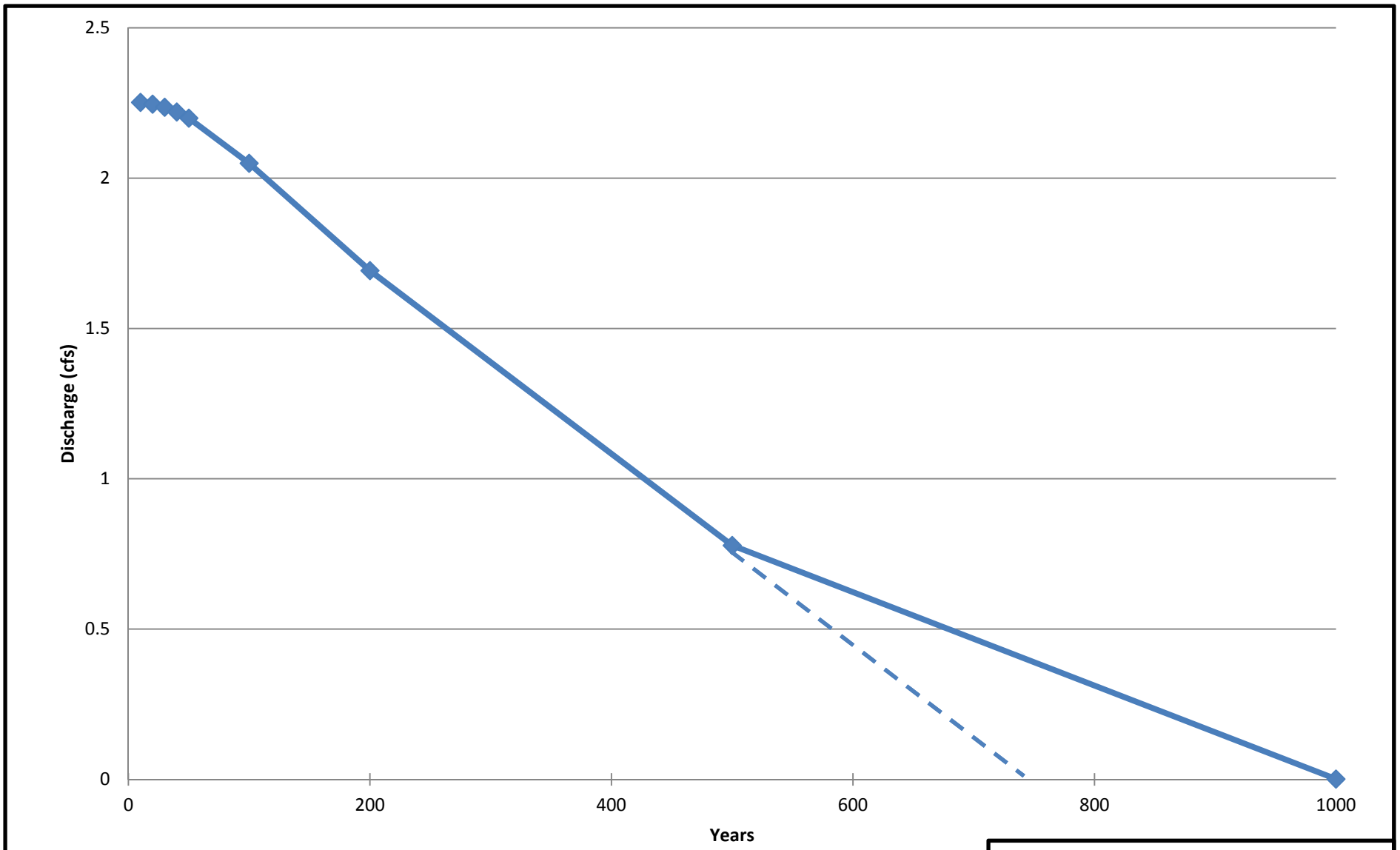


Simulated streamflow in the Muddy River, Scenario 3

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.3-2b

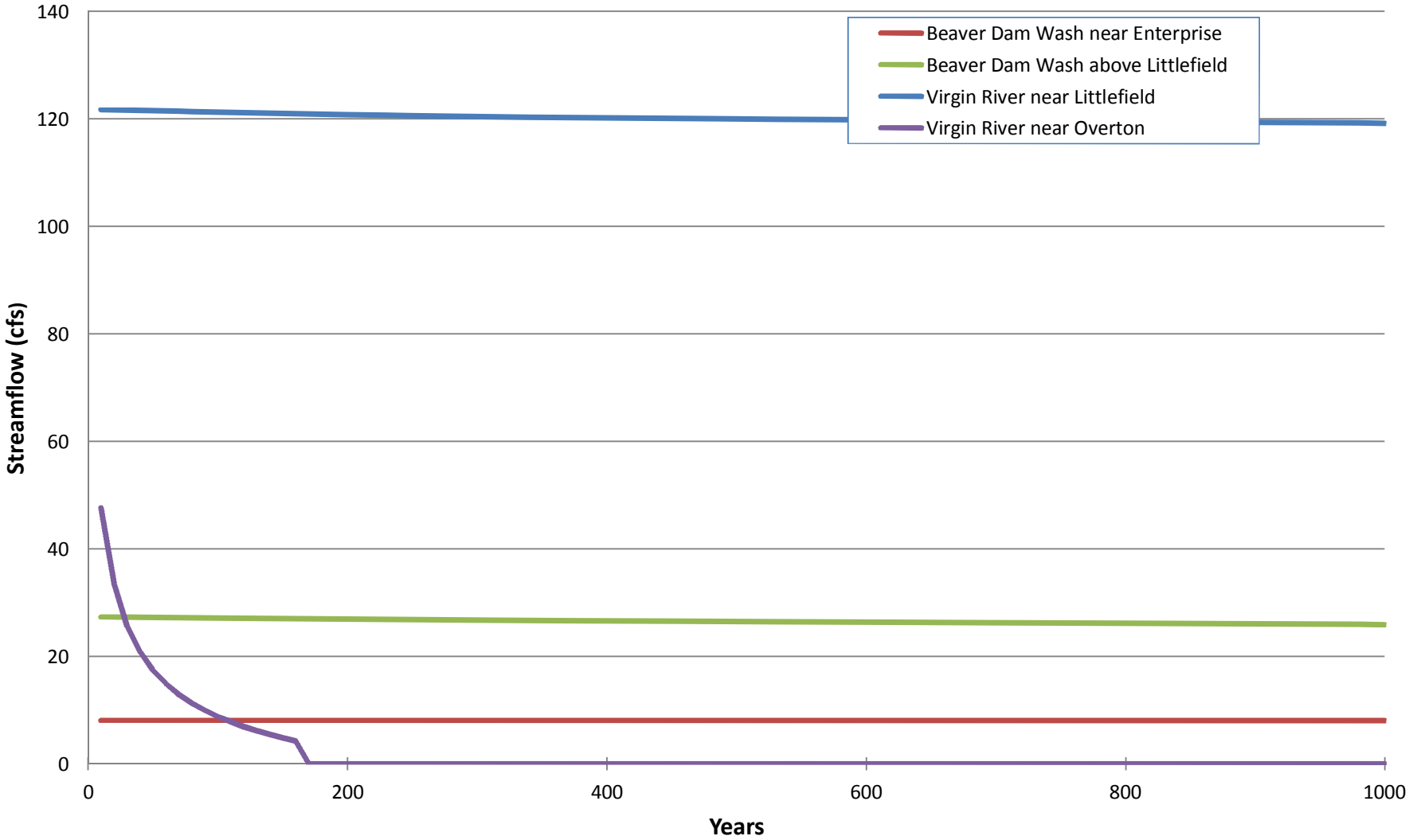


Simulated combined discharge from Rogers and Blue Point Springs, Scenario 3

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.3-2c

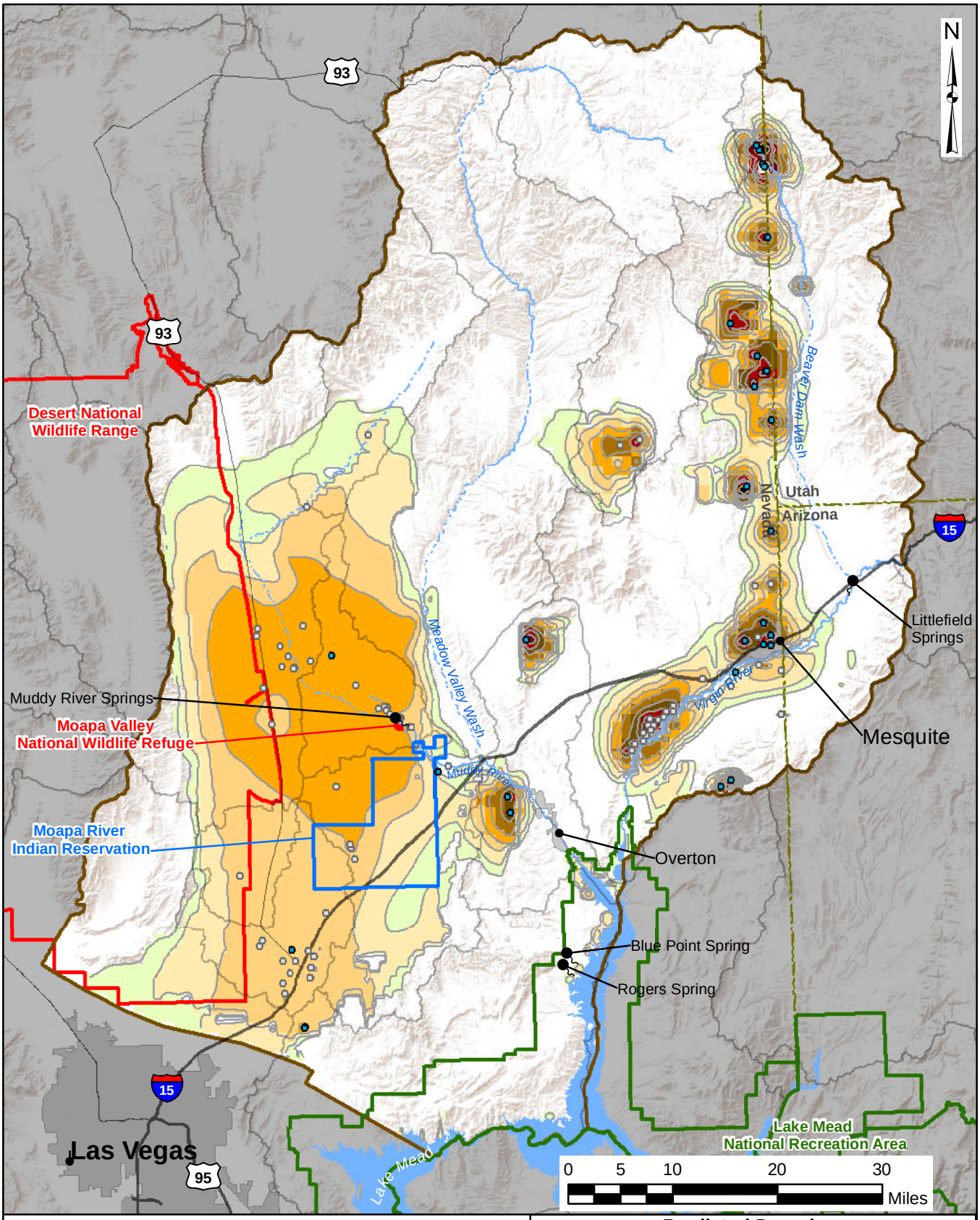


Simulated streamflow in Beaver Dam Wash and the Virgin River, Scenario 3

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.3-2d



Legend

< 1	20 - 50	Pumping Wells; existent
1 - 2	50 - 100	Pumping Introduced in Scenario
2 - 5	100 - 200	
5 - 10	200 - 500	Active Model Domain
10 - 20	> 500	State Boundary

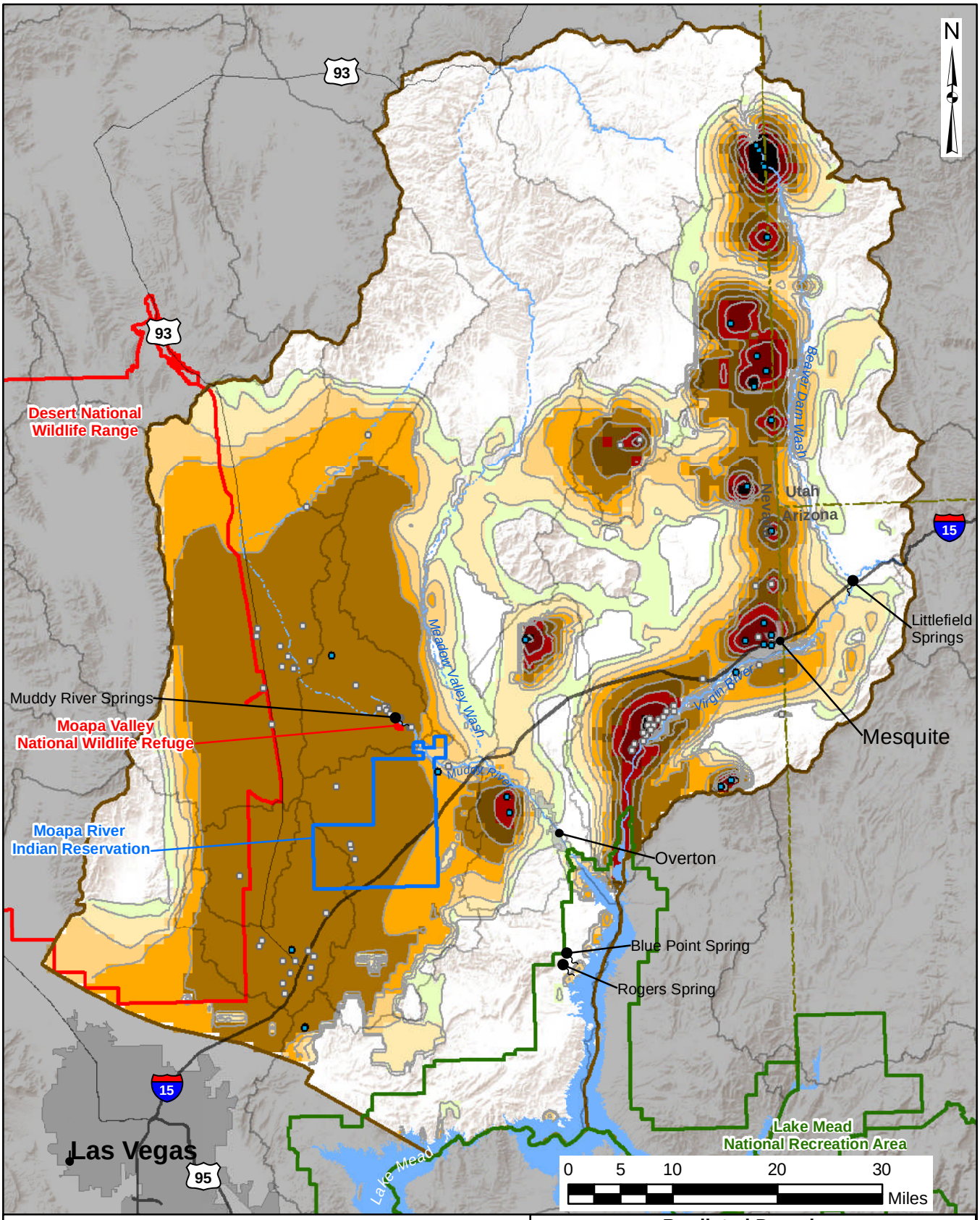
Drawdown is in feet.

TITLE: **Predicted Drawdown**
Scenario 4
10 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.4-1a

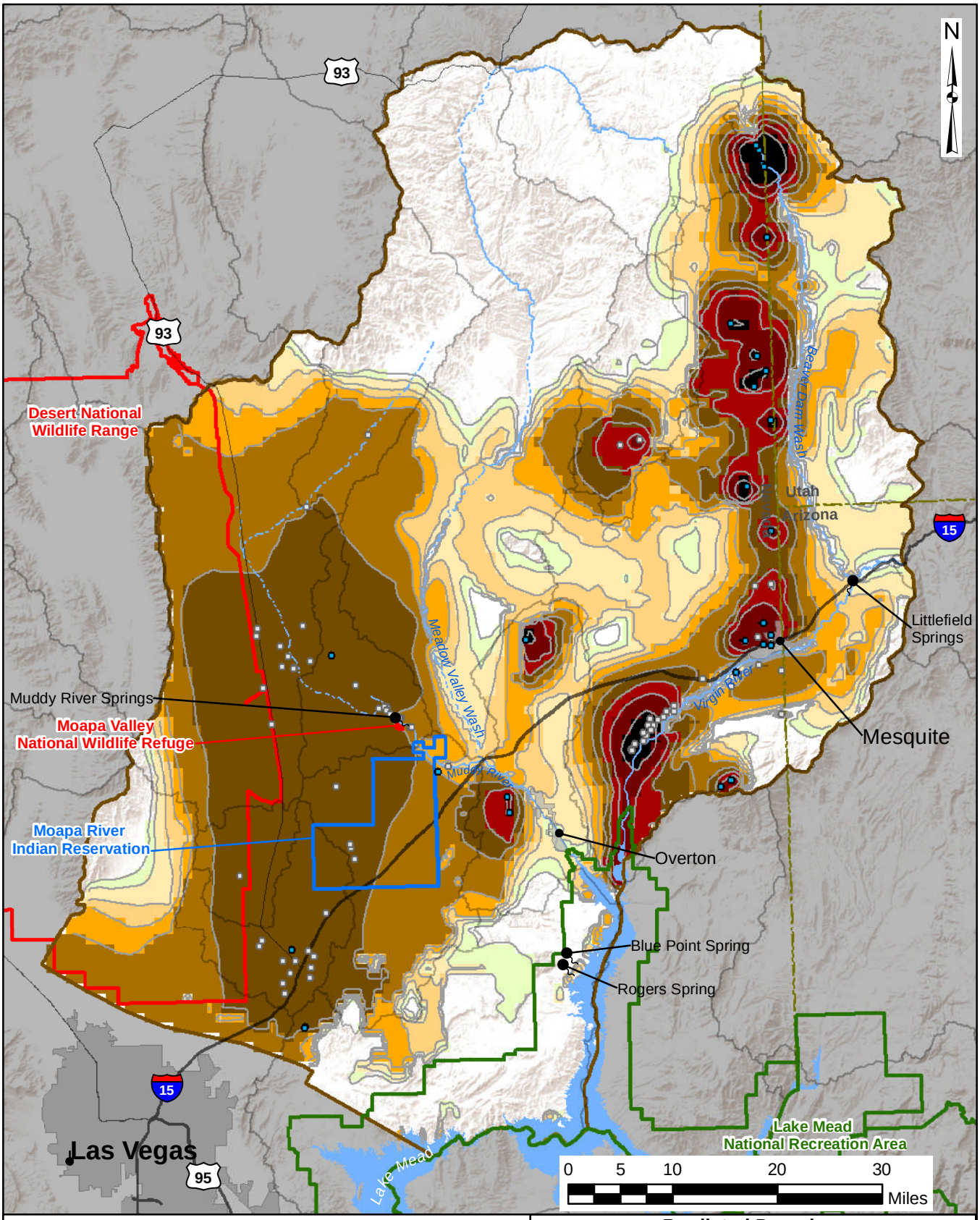


TITLE: **Predicted Drawdown**
Scenario 4
50 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.4-1b



Legend

< 1	20 - 50	Pumping Wells; existent
1 - 2	50 - 100	Pumping Introduced in Scenario
2 - 5	100 - 200	
5 - 10	200 - 500	Active Model Domain
10 - 20	> 500	State Boundary

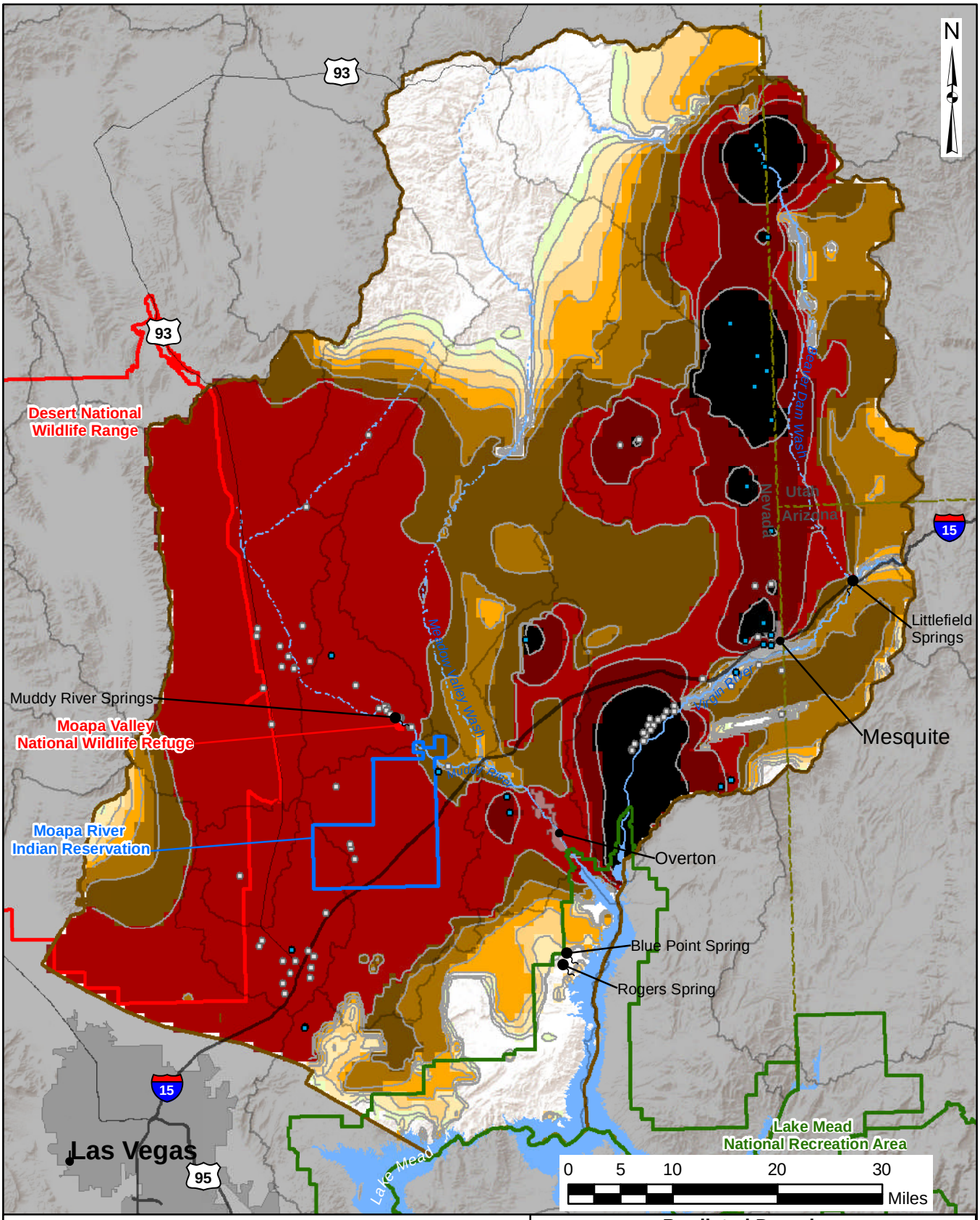
Drawdown is in feet.

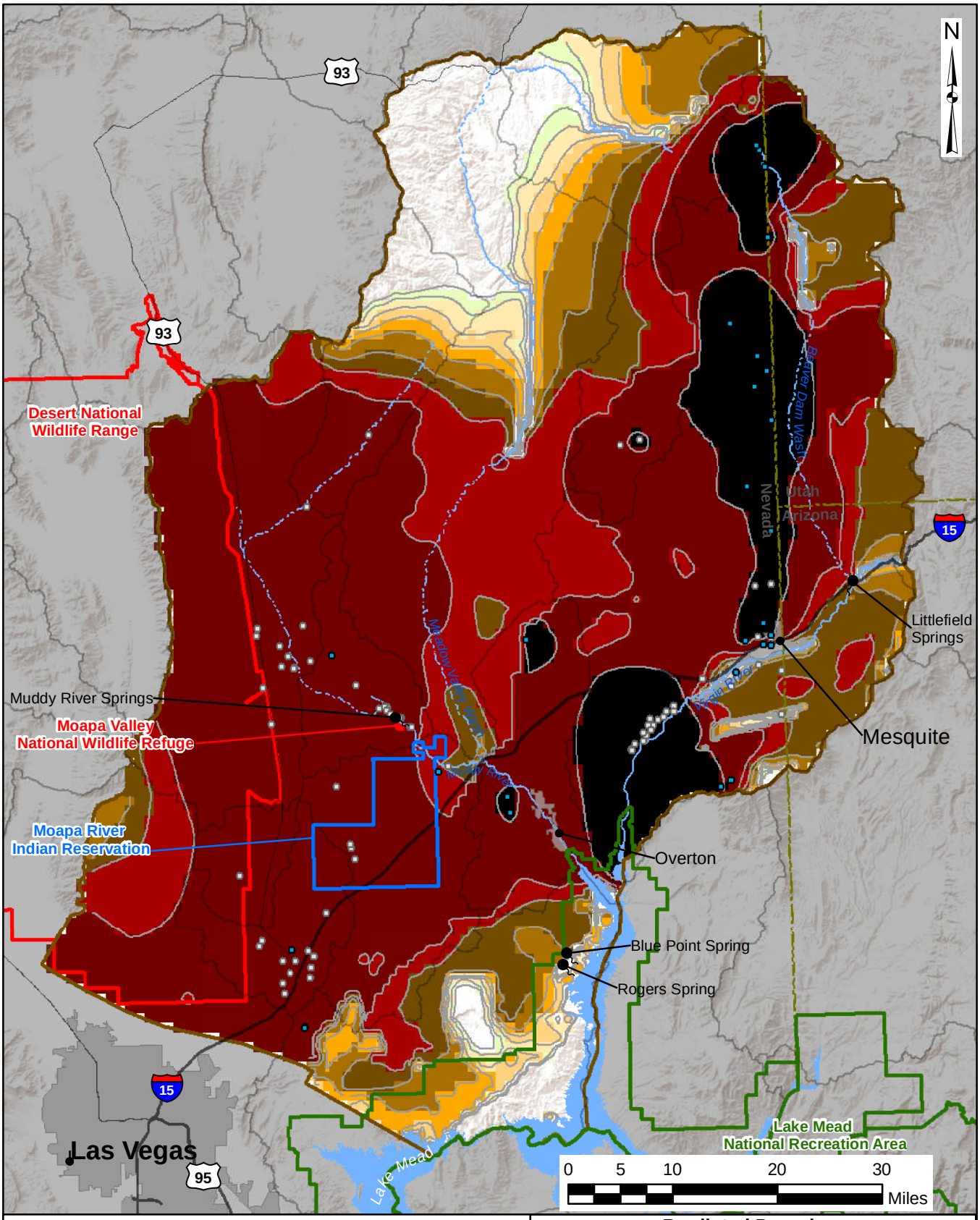
TITLE: **Predicted Drawdown**
Scenario 4
100 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.4-1c


N
93
93
Desert National
Wildlife Range
Beaver Dam Wash
Nevada
Utah
Arizona
15
Littlefield
Springs
Muddy River Springs
Moapa Valley
National Wildlife Refuge
Meadow Valley Wash
Virgin River
Mesquite
Moapa River
Indian Reservation
Overton
Blue Point Spring
Rogers Spring
15
Las Vegas
95
Lake Mead
Lake Mead
National Recreation Area
0 5 10 20 30
Miles
Legend
< 1
1 - 2
2 - 5
5 - 10
10 - 20
20 - 50
50 - 100
100 - 200
200 - 500
> 500
Pumping Wells; existent
Pumping Introduced in Scenario
Active Model Domain
State Boundary
Drawdown is in feet.
TITLE:
Predicted Drawdown
Scenario 4
500 years
LOCATION:
Colorado Regional Groundwater Flow System
Southeastern Nevada
TETRA TECH
FIGURE
3.4-1d



Legend

< 1	20 - 50	Pumping Wells; existent
1 - 2	50 - 100	Pumping Introduced in Scenario
2 - 5	100 - 200	
5 - 10	200 - 500	Active Model Domain
10 - 20	> 500	

State Boundary

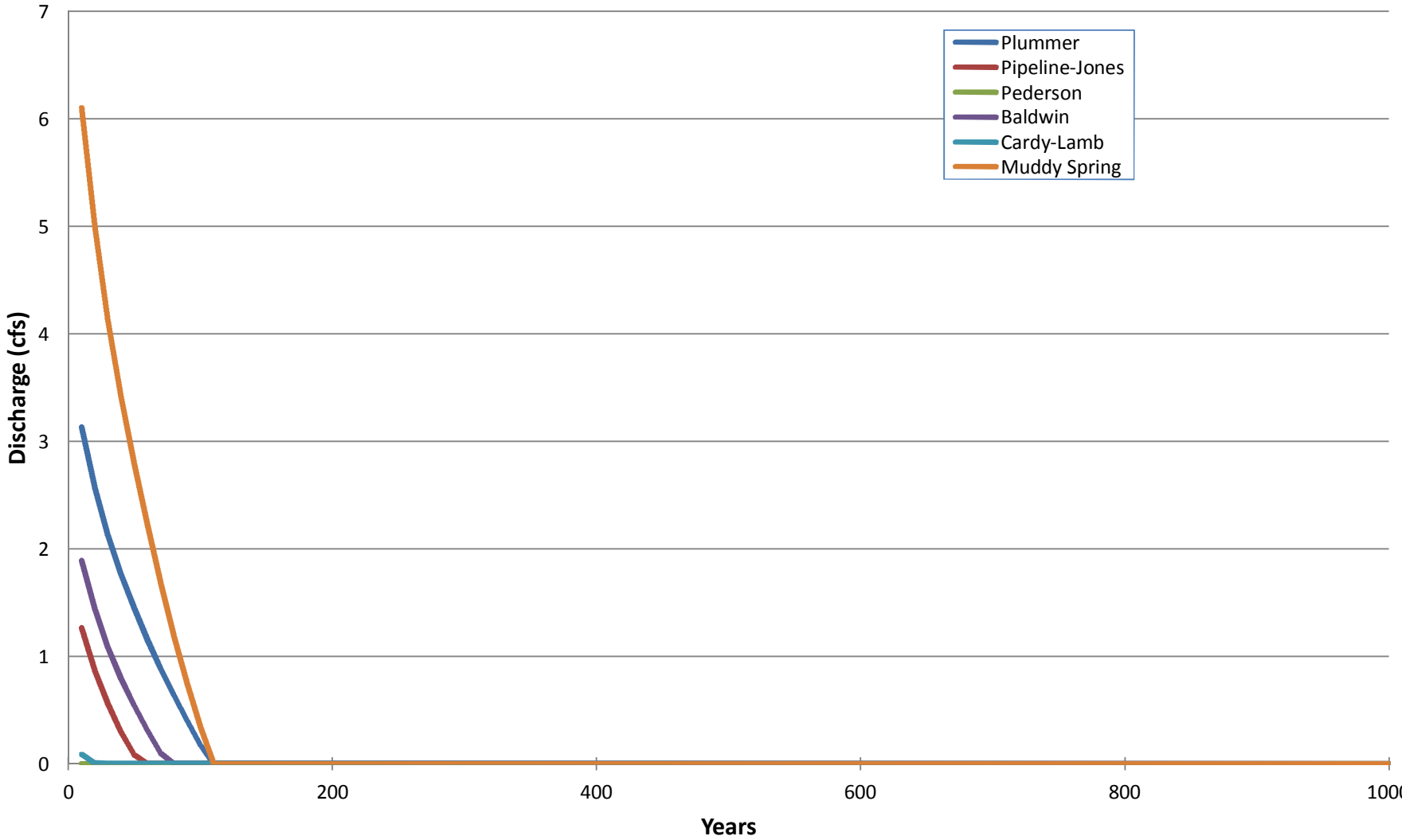
Drawdown is in feet.

TITLE: **Predicted Drawdown**
Scenario 4
1000 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.4-1e

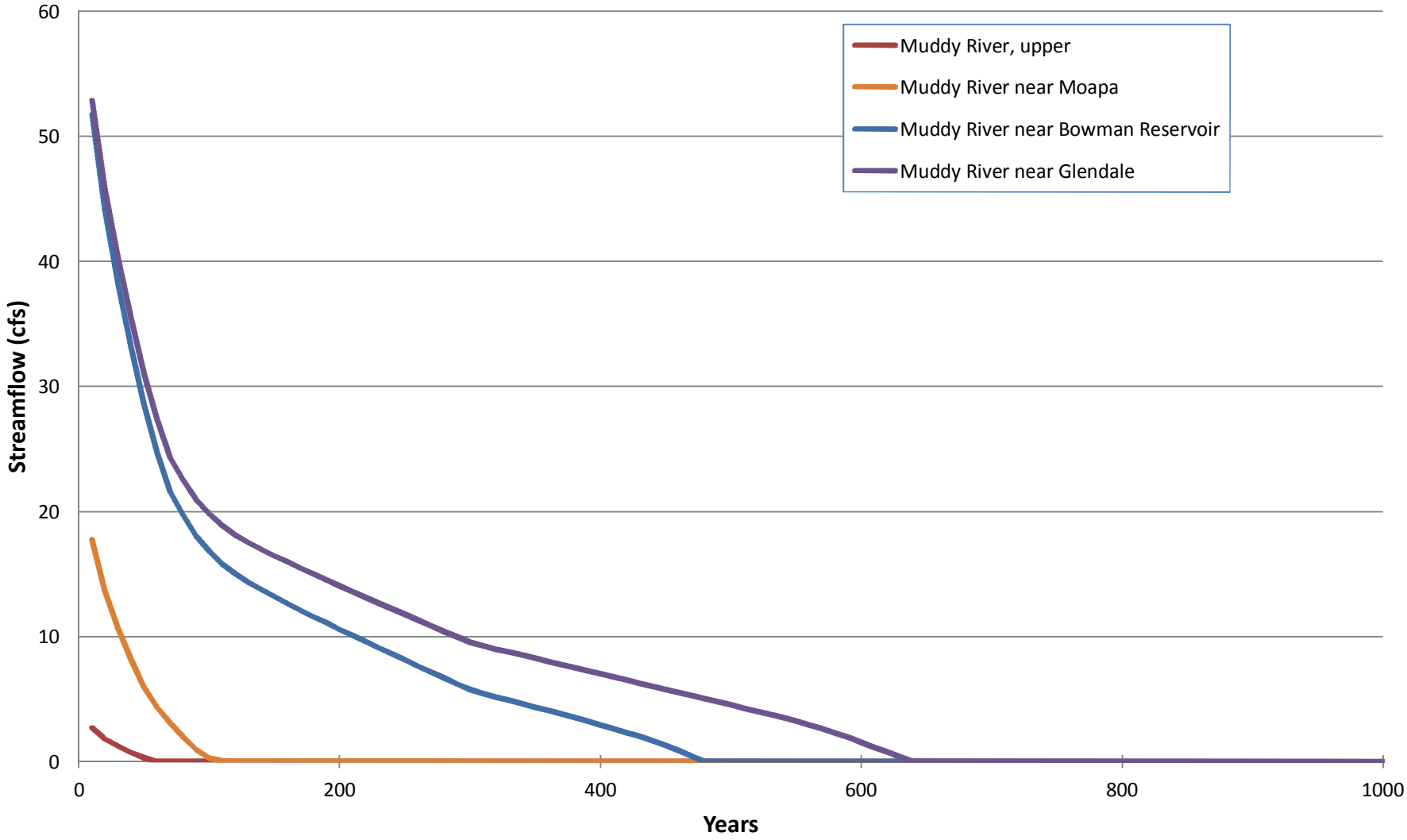


Simulated spring discharges in the Muddy River Springs area, Scenario 4

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.4-2a

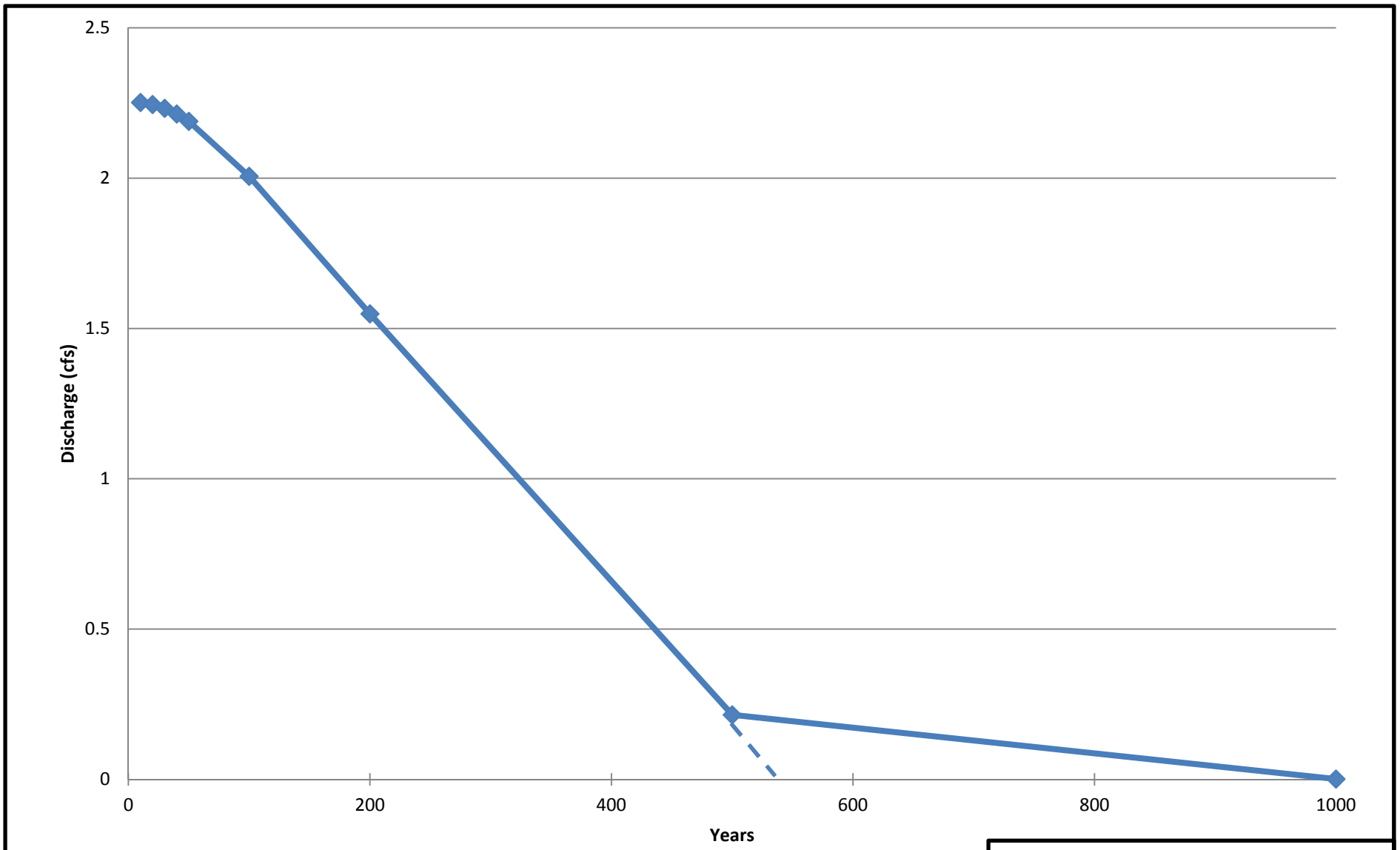


Simulated streamflow in the Muddy River, Scenario 4

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.4-2b

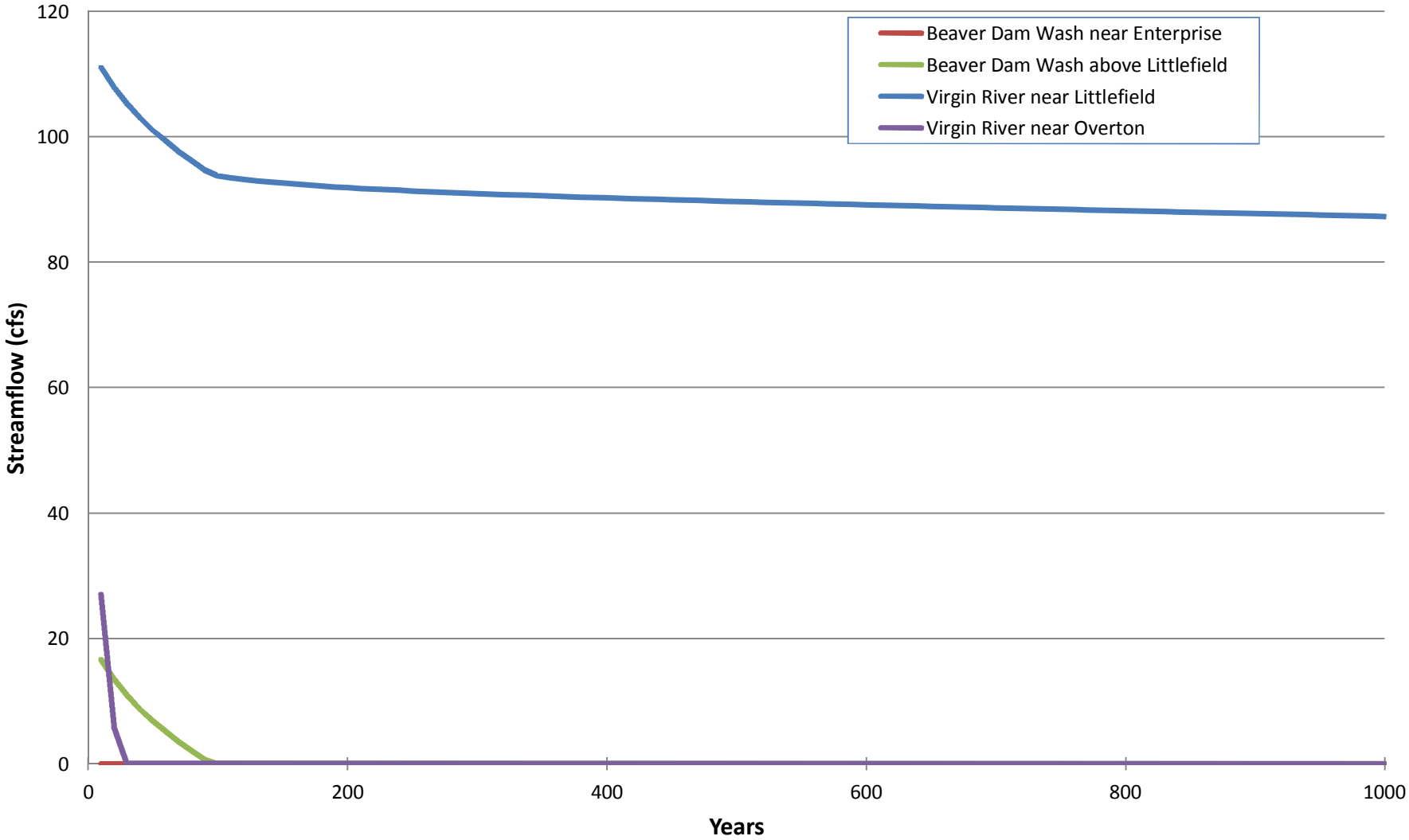


Simulated combined discharge from Rogers and Blue Point Springs, Scenario 4

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.4-2c

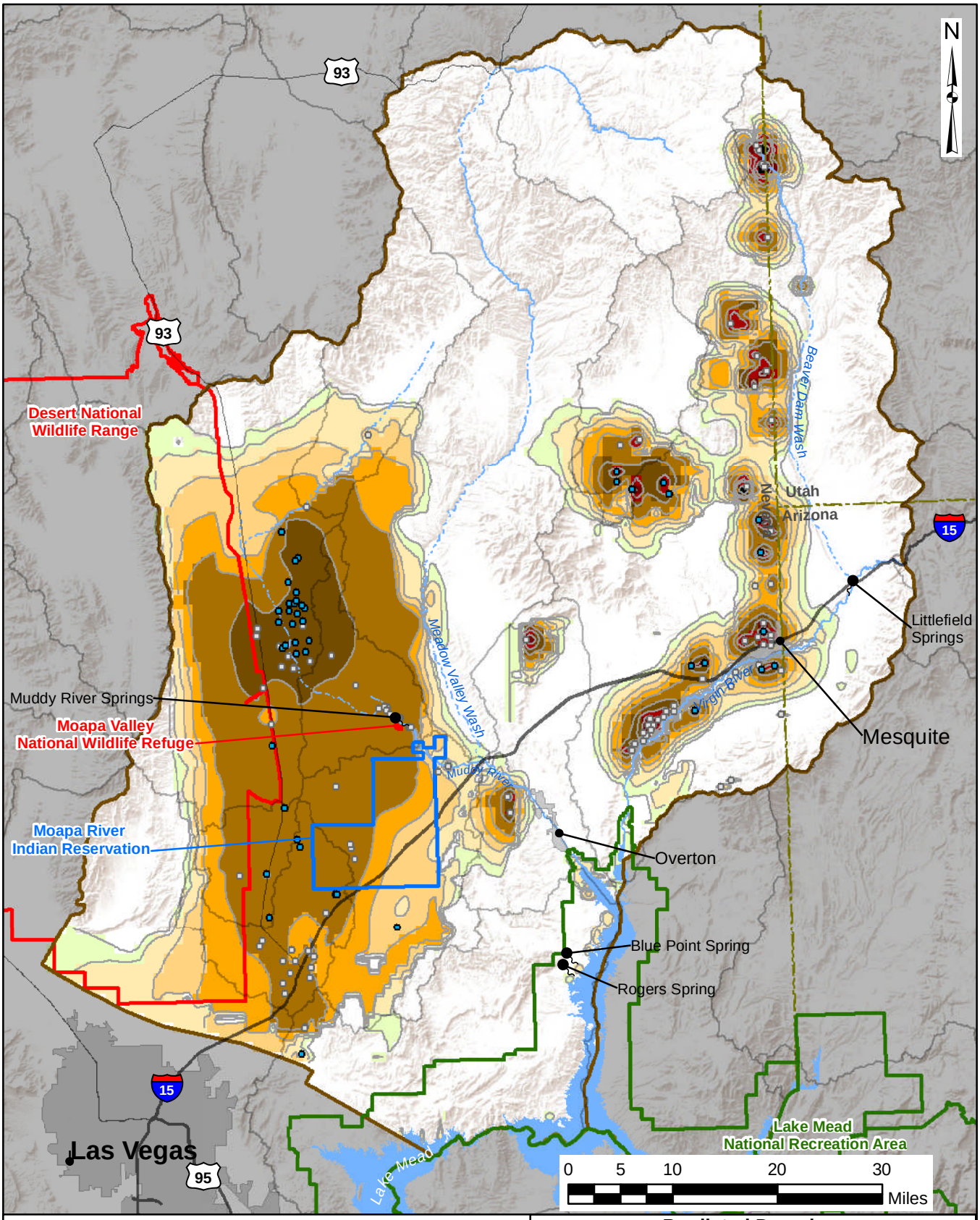


Simulated streamflow in Beaver Dam Wash and the Virgin River, Scenario 4

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.4-2d

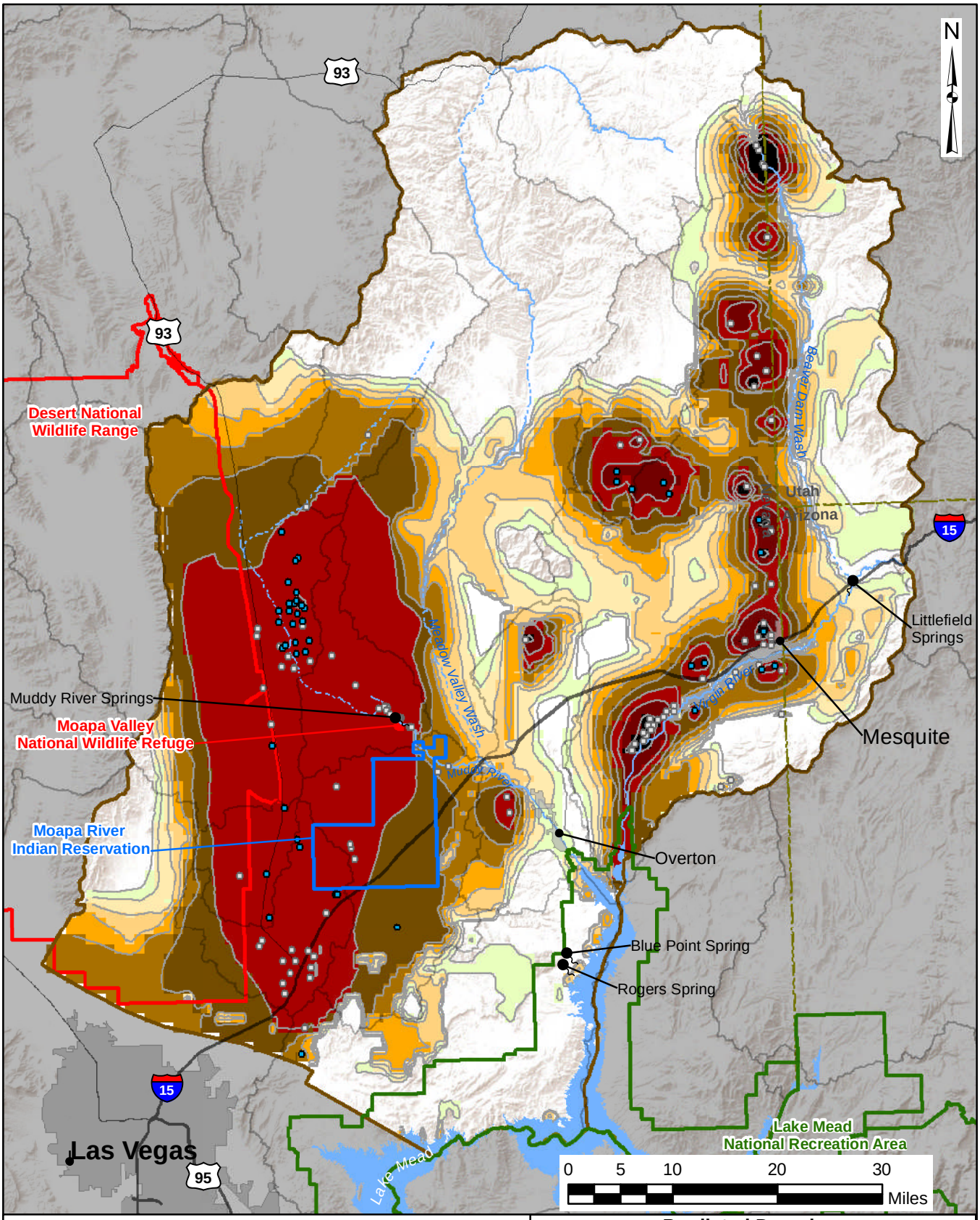


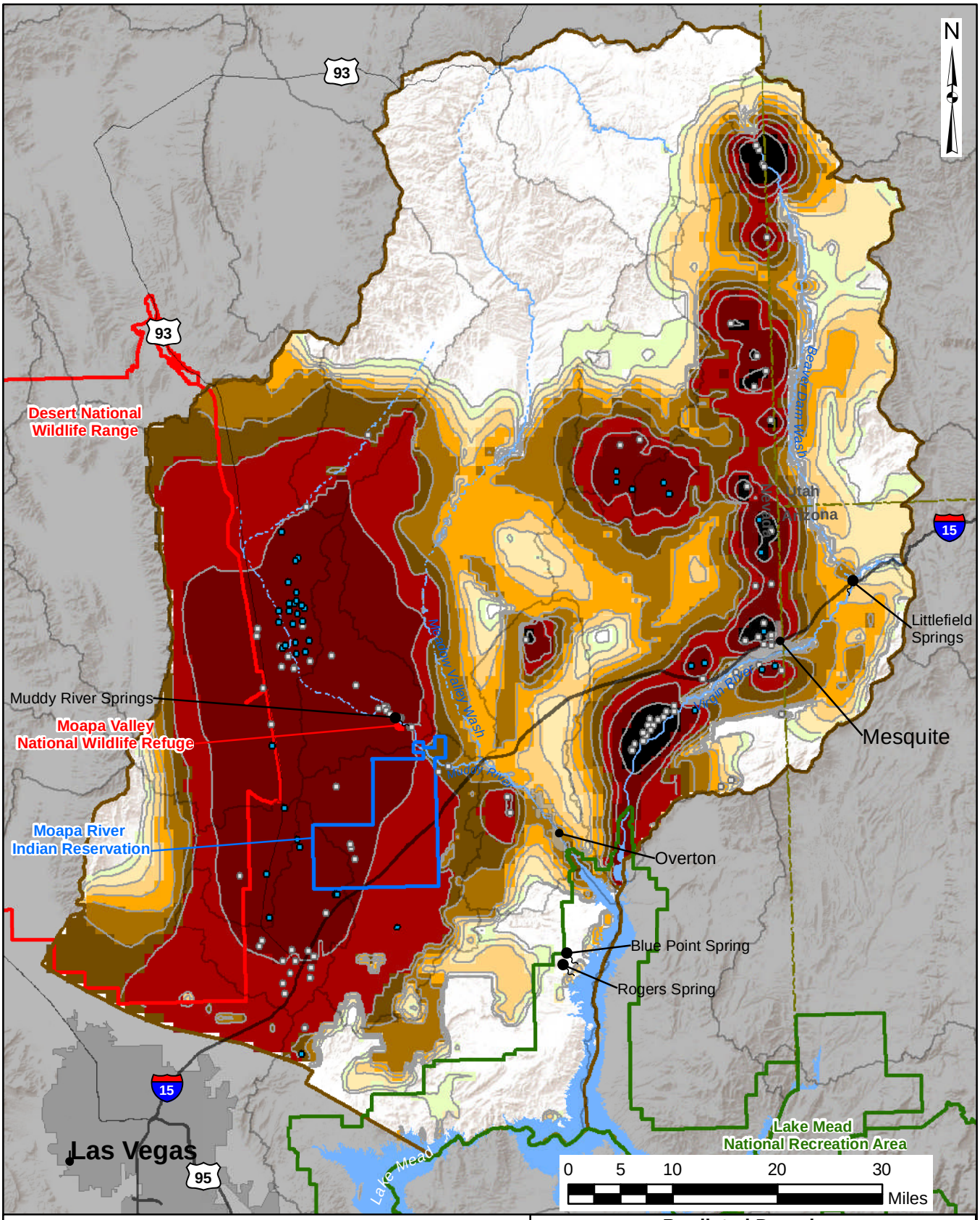
TITLE: **Predicted Drawdown**
Scenario 5
10 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.5-1a


N
93
93
Desert National
Wildlife Range
Utah
Arizona
15
Littlefield
Springs
Beaver Dam Wash
Muddy River Springs
Moapa Valley
National Wildlife Refuge
Meadow Valley Wash
Virgin River
Mesquite
Muddy River
Moapa River
Indian Reservation
Overton
Blue Point Spring
Rogers Spring
15
Las Vegas
95
Lake Mead
Lake Mead
National Recreation Area
0 5 10 20 30
Miles
Legend
< 1
1 - 2
2 - 5
5 - 10
10 - 20
20 - 50
50 - 100
100 - 200
200 - 500
> 500
Pumping Wells; existent;
Pumping Introduced in Scenario
Active Model Domain
State Boundary
Drawdown is in feet.
TITLE:
Predicted Drawdown
Scenario 5
50 years
LOCATION:
Colorado Regional Groundwater Flow System
Southeastern Nevada
TETRA TECH
FIGURE
3.5-1b

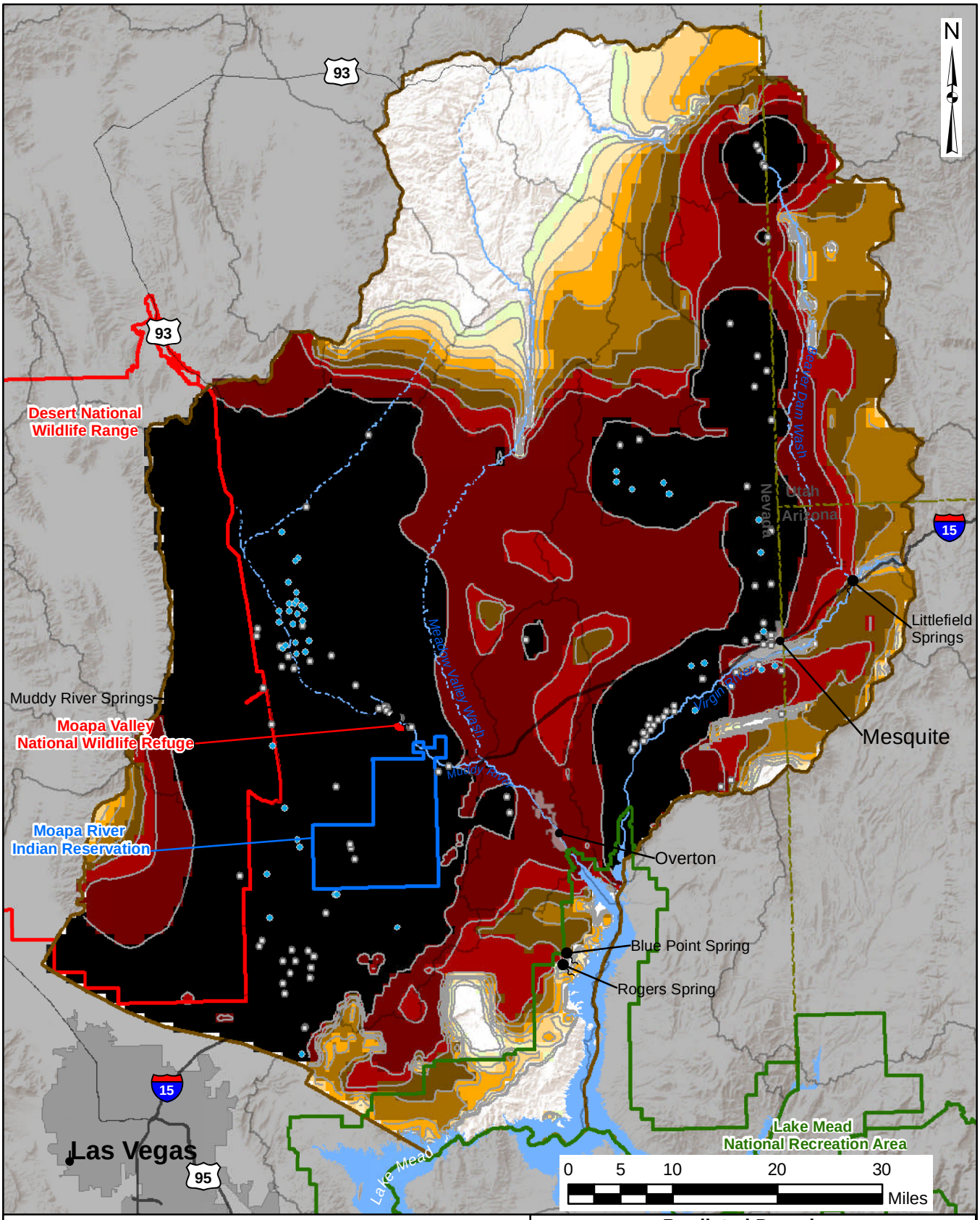


TITLE: **Predicted Drawdown Scenario 5 100 years**

LOCATION: **Colorado Regional Groundwater Flow System Southeastern Nevada**

TETRA TECH

FIGURE **3.5-1c**



Legend

< 1	20 - 50	Pumping Wells; existent;
1 - 2	50 - 100	Pumping Introduced in Scenario
2 - 5	100 - 200	
5 - 10	200 - 500	Active Model Domain
10 - 20	> 500	

State Boundary

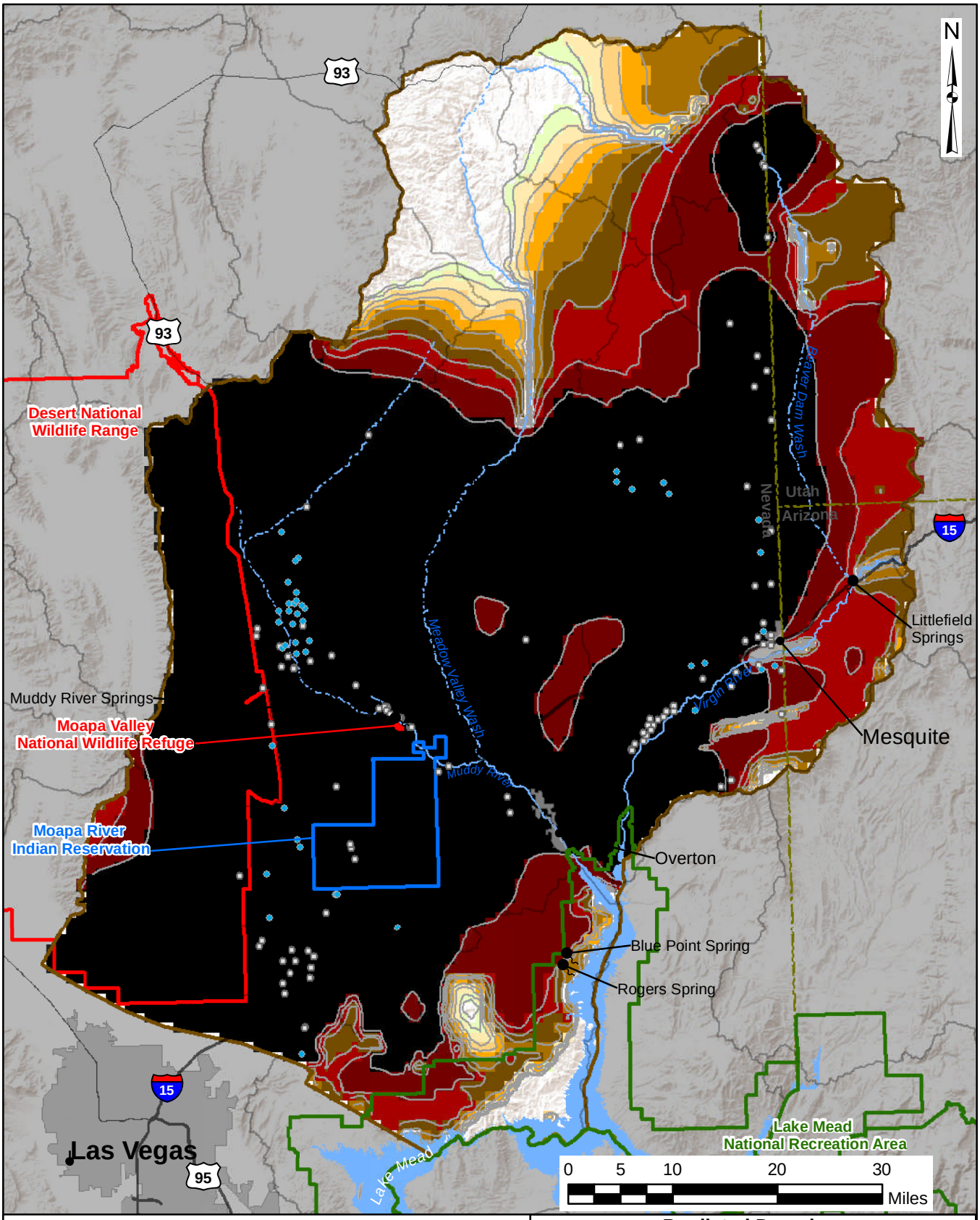
Drawdown is in feet.

TITLE: **Predicted Drawdown**
Scenario 5
500 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.5-1d



Legend

< 1	20 - 50	Pumping Wells; existent;
1 - 2	50 - 100	Pumping Introduced in Scenario
2 - 5	100 - 200	
5 - 10	200 - 500	Active Model Domain
10 - 20	> 500	State Boundary

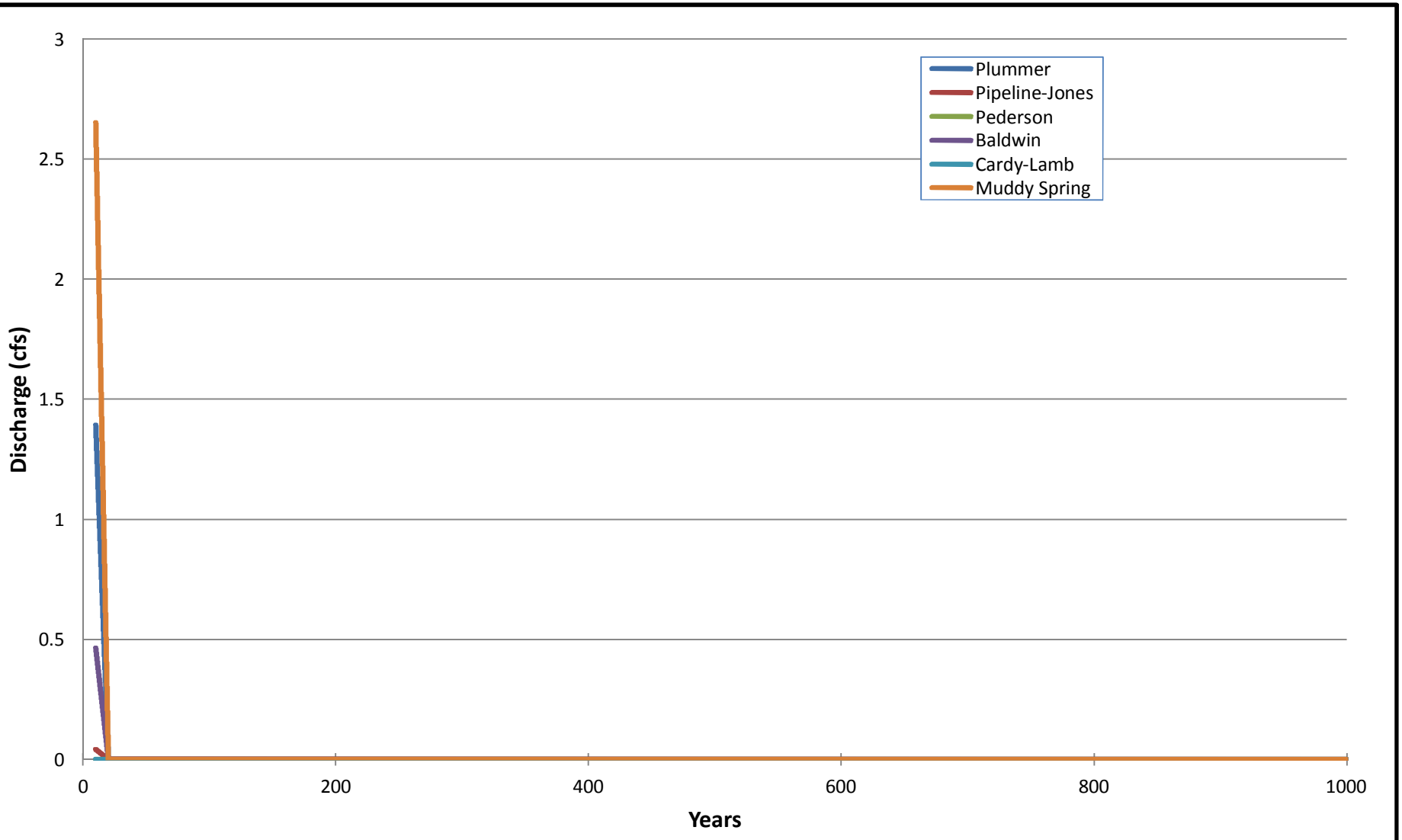
Drawdown is in feet.

TITLE: **Predicted Drawdown**
Scenario 5
1000 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.5-1e

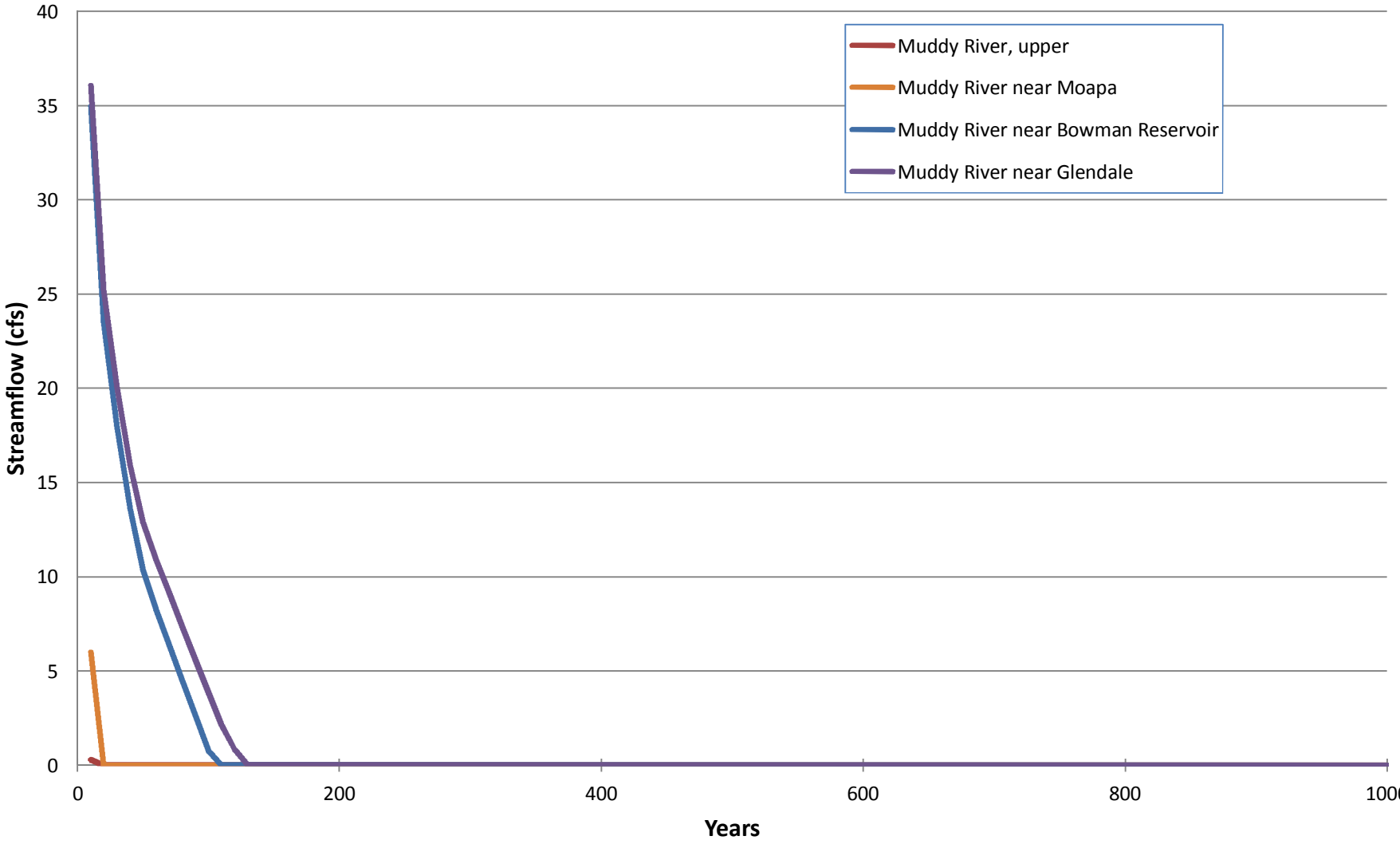


Simulated spring discharges in the Muddy River Springs area, Scenario 5

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.5-2a

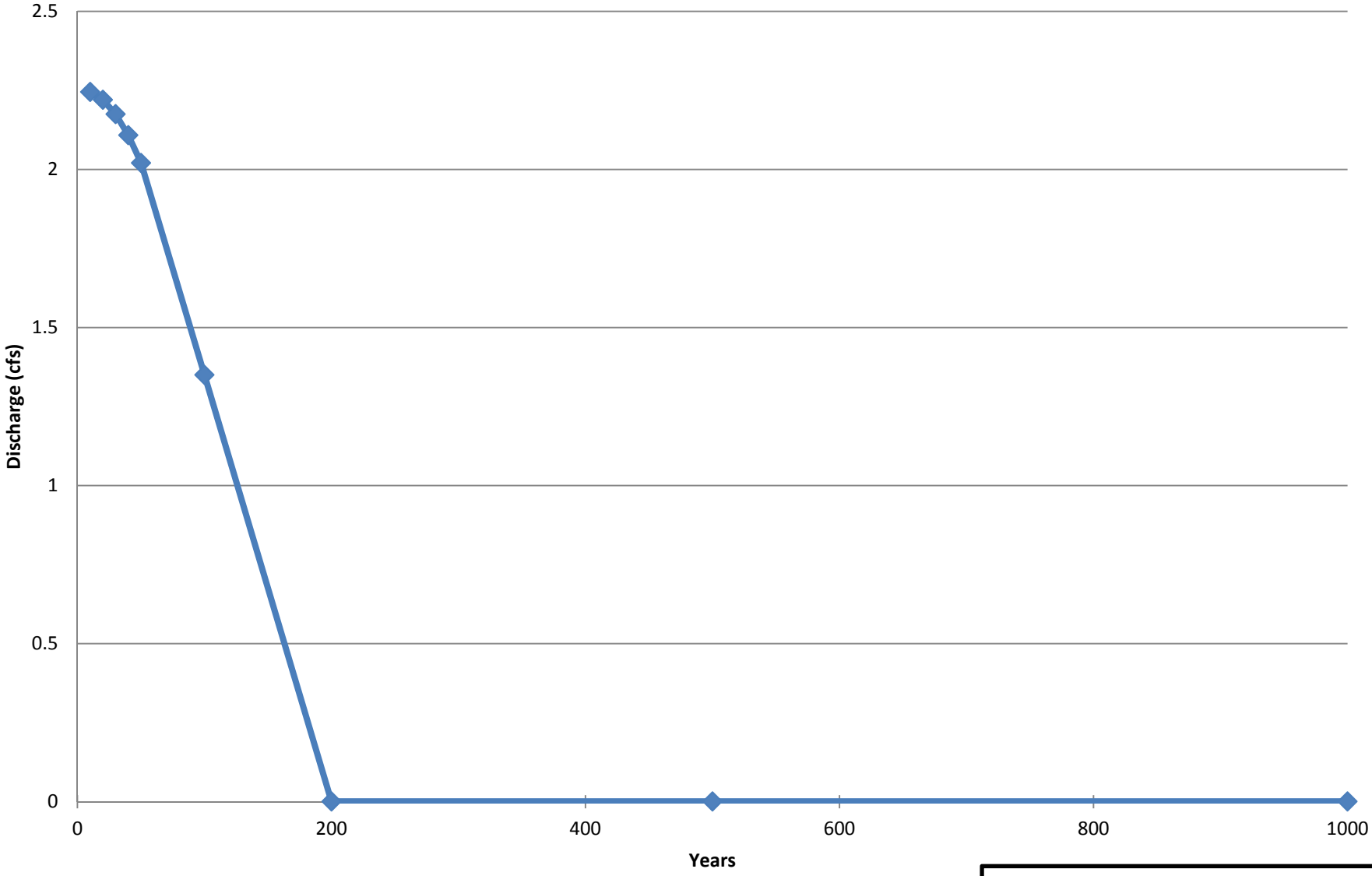


Simulated streamflow in the Muddy River, Scenario 5

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.5-2b

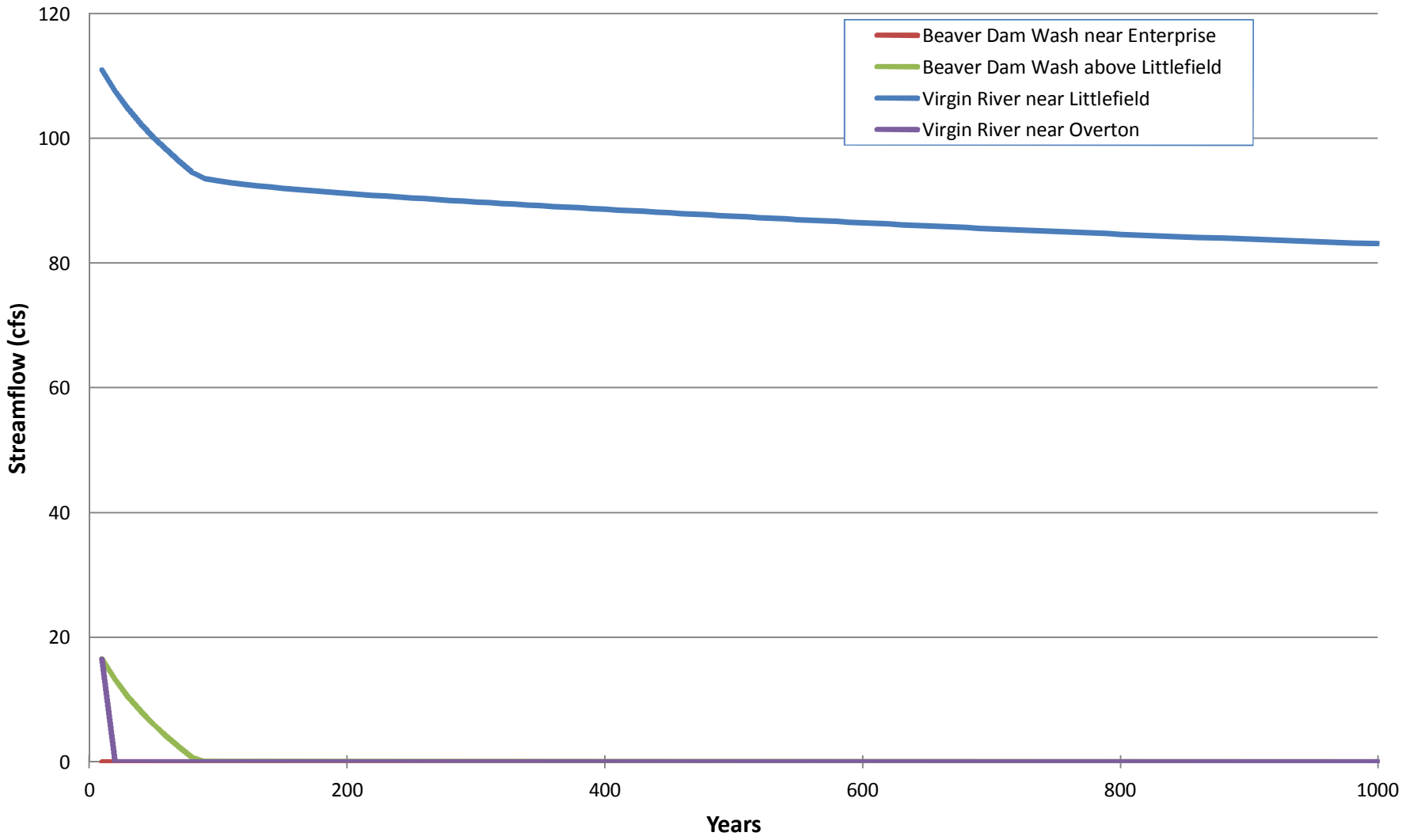


Simulated combined discharge from Rogers and Blue Point Springs, Scenario 5

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.5-2c

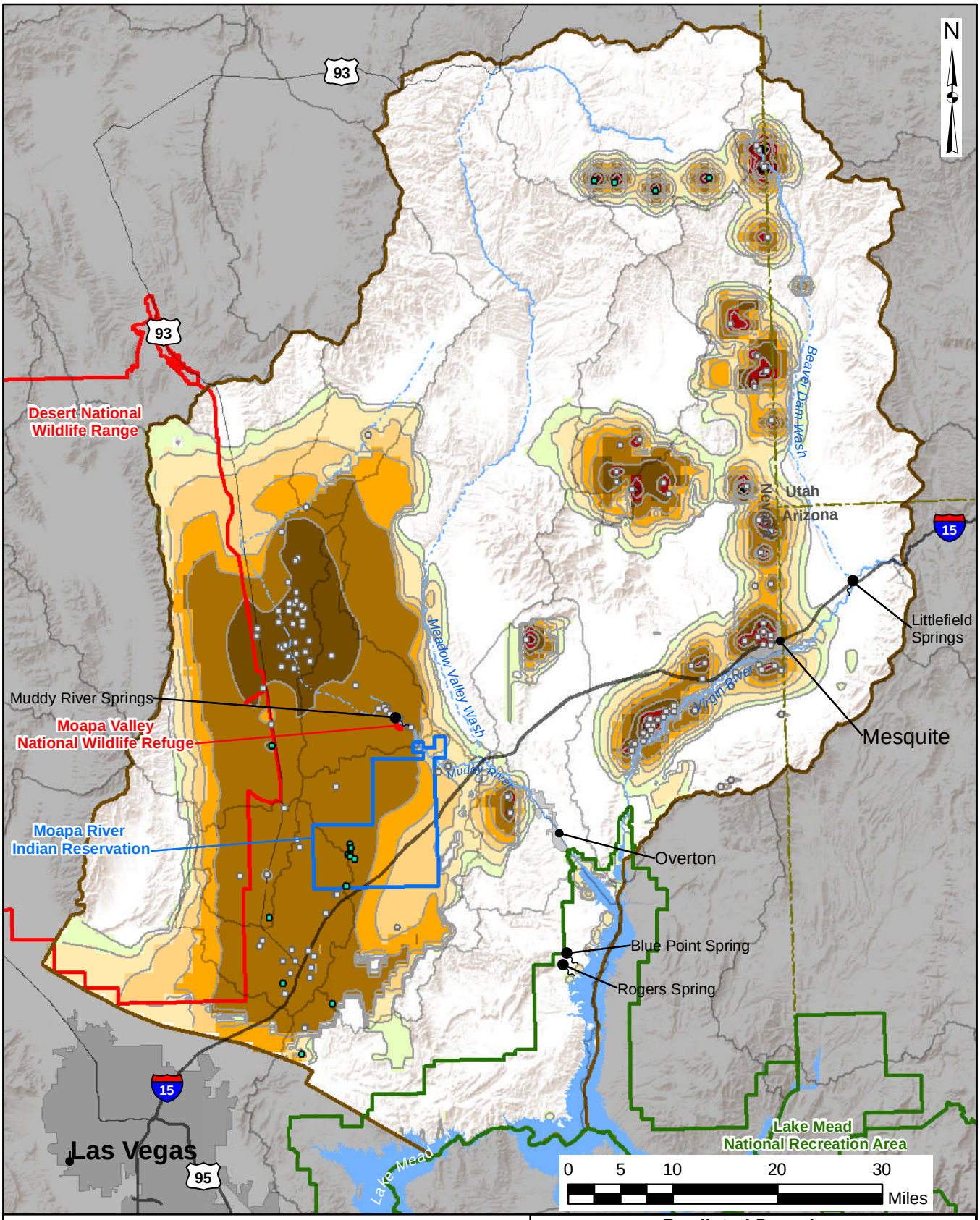


Simulated streamflow in Beaver Dam Wash and the Virgin River, Scenario 5

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.5-2d

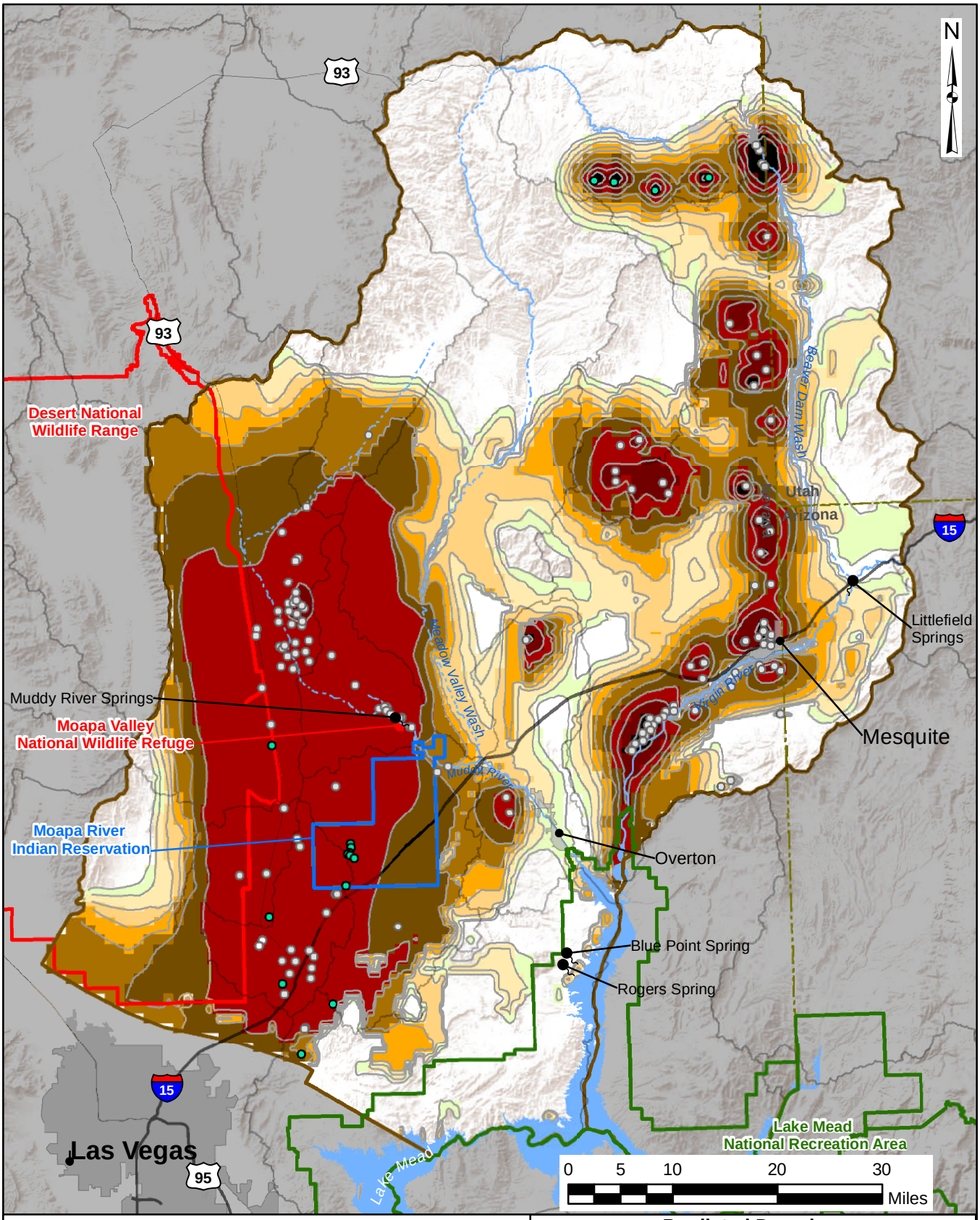


TITLE: **Predicted Drawdown**
Scenario 6
10 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.6-1a



Legend

< 1	20 - 50	Pumping Wells; existent
1 - 2	50 - 100	Pumping Introduced in Scenario
2 - 5	100 - 200	
5 - 10	200 - 500	Active Model Domain
10 - 20	> 500	

State Boundary

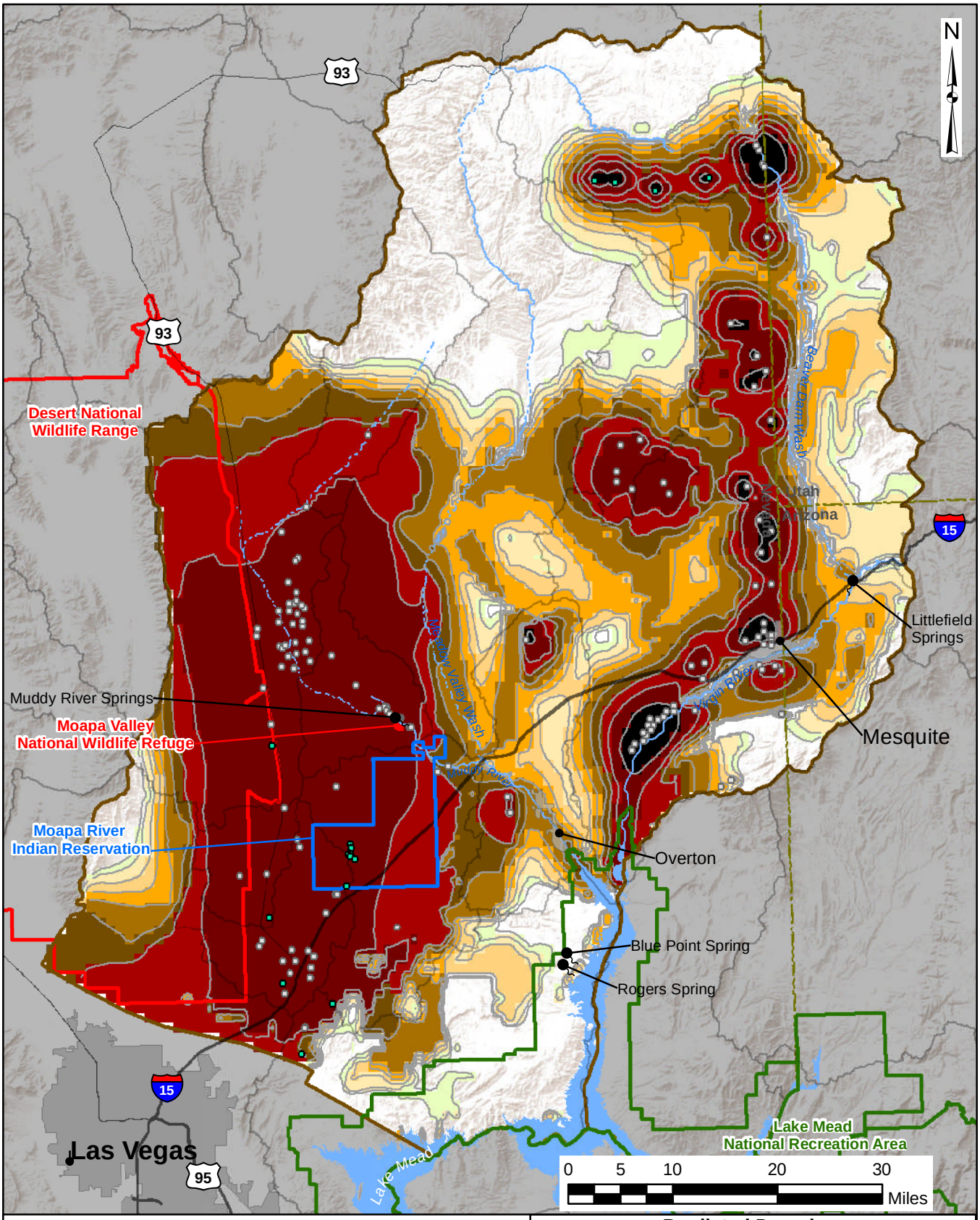
Drawdown is in feet.

TITLE: **Predicted Drawdown Scenario 6 50 years**

LOCATION: **Colorado Regional Groundwater Flow System Southeastern Nevada**

TETRA TECH

FIGURE **3.6-1b**

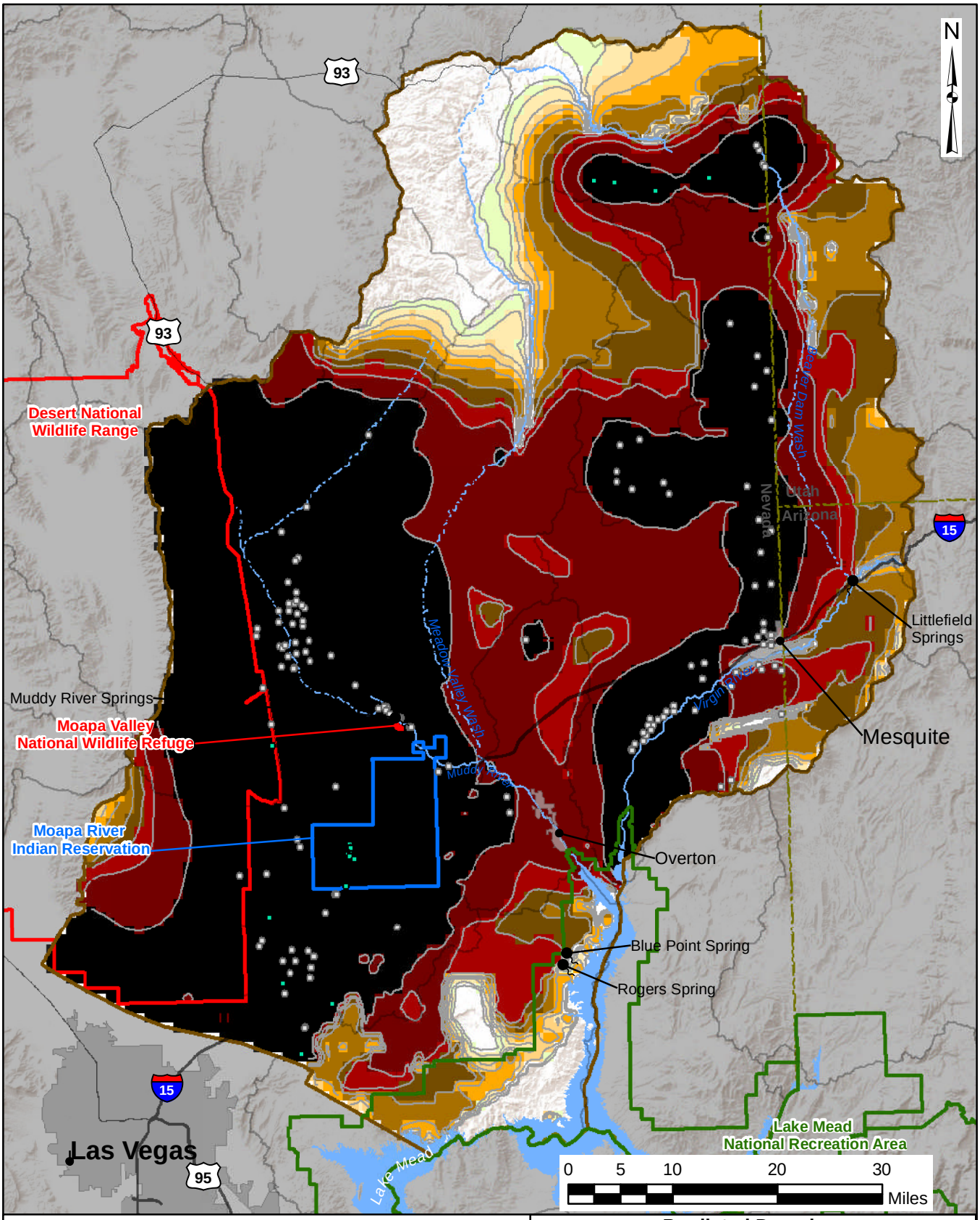


TITLE: **Predicted Drawdown**
Scenario 6
100 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.6-1c



Legend

< 1	20 - 50	Pumping Wells; existent	
1 - 2	50 - 100	Pumping Introduced in Scenario	
2 - 5	100 - 200		
5 - 10	200 - 500	Active Model Domain	
10 - 20	> 500	State Boundary	

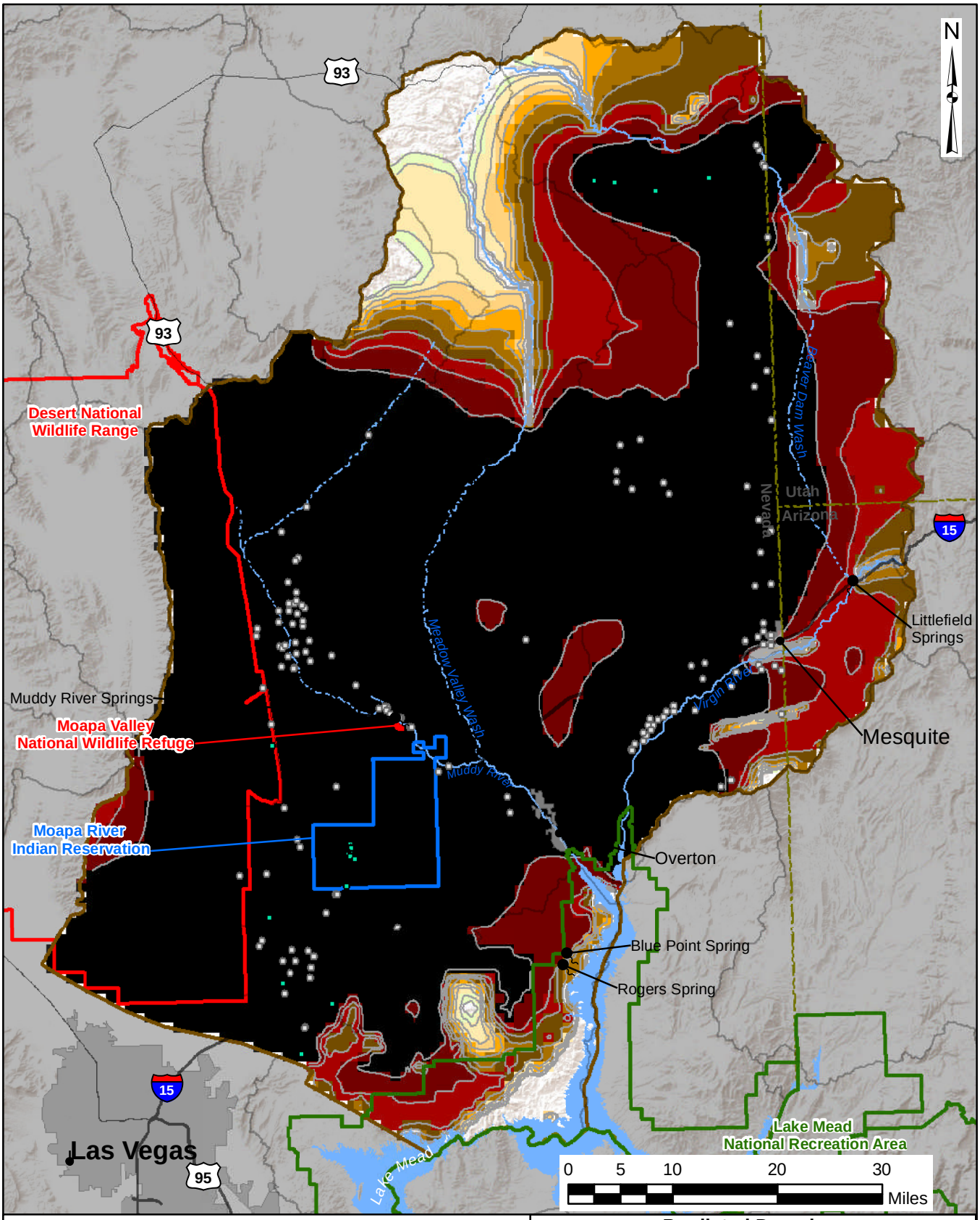
Drawdown is in feet.

TITLE: **Predicted Drawdown**
Scenario 6
500 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.6-1d



Legend

< 1	20 - 50	Pumping Wells; existent	
1 - 2	50 - 100	Pumping Introduced in Scenario	
2 - 5	100 - 200		
5 - 10	200 - 500	Active Model Domain	
10 - 20	> 500	State Boundary	

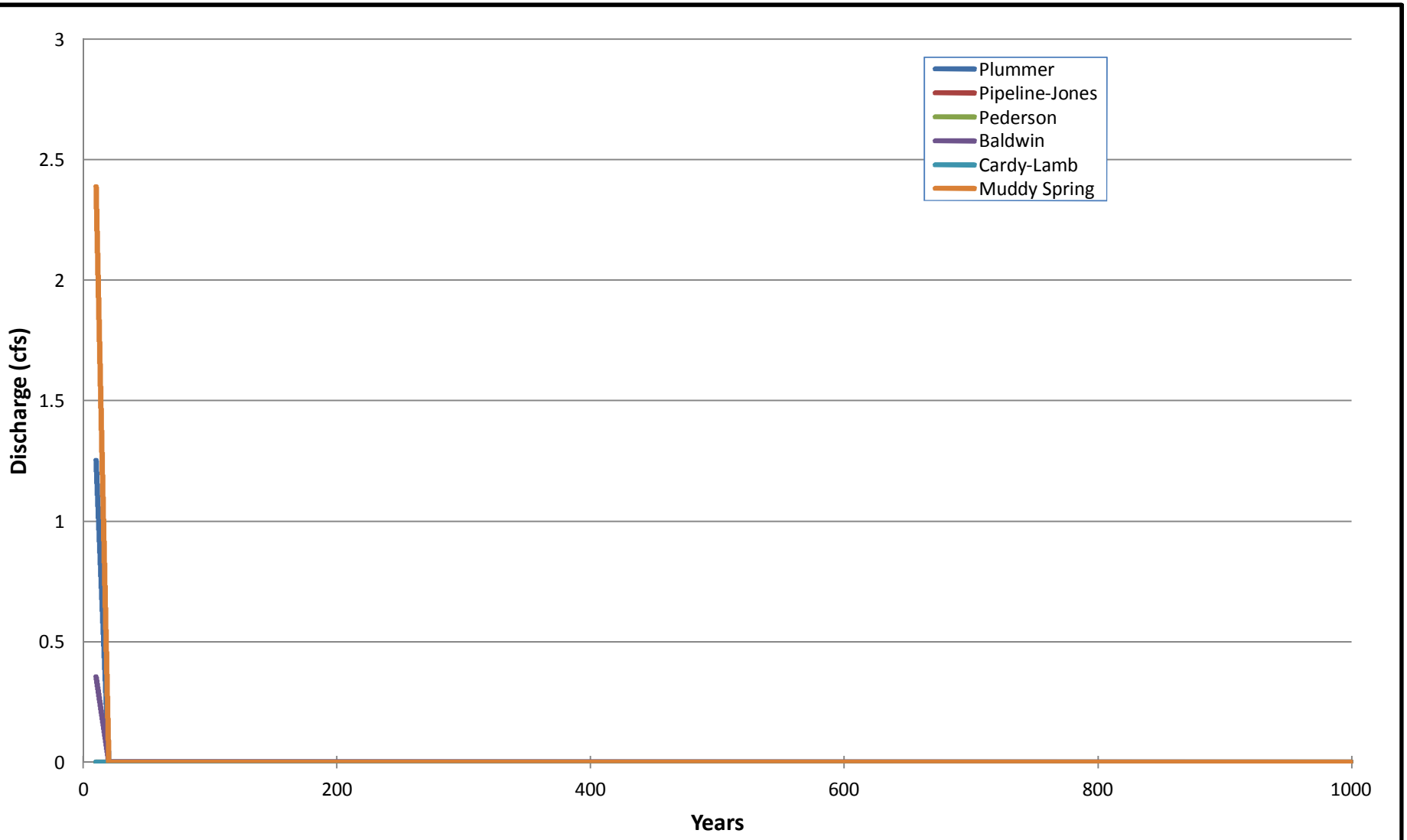
Drawdown is in feet.

TITLE: **Predicted Drawdown**
Scenario 6
1000 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.6-1e

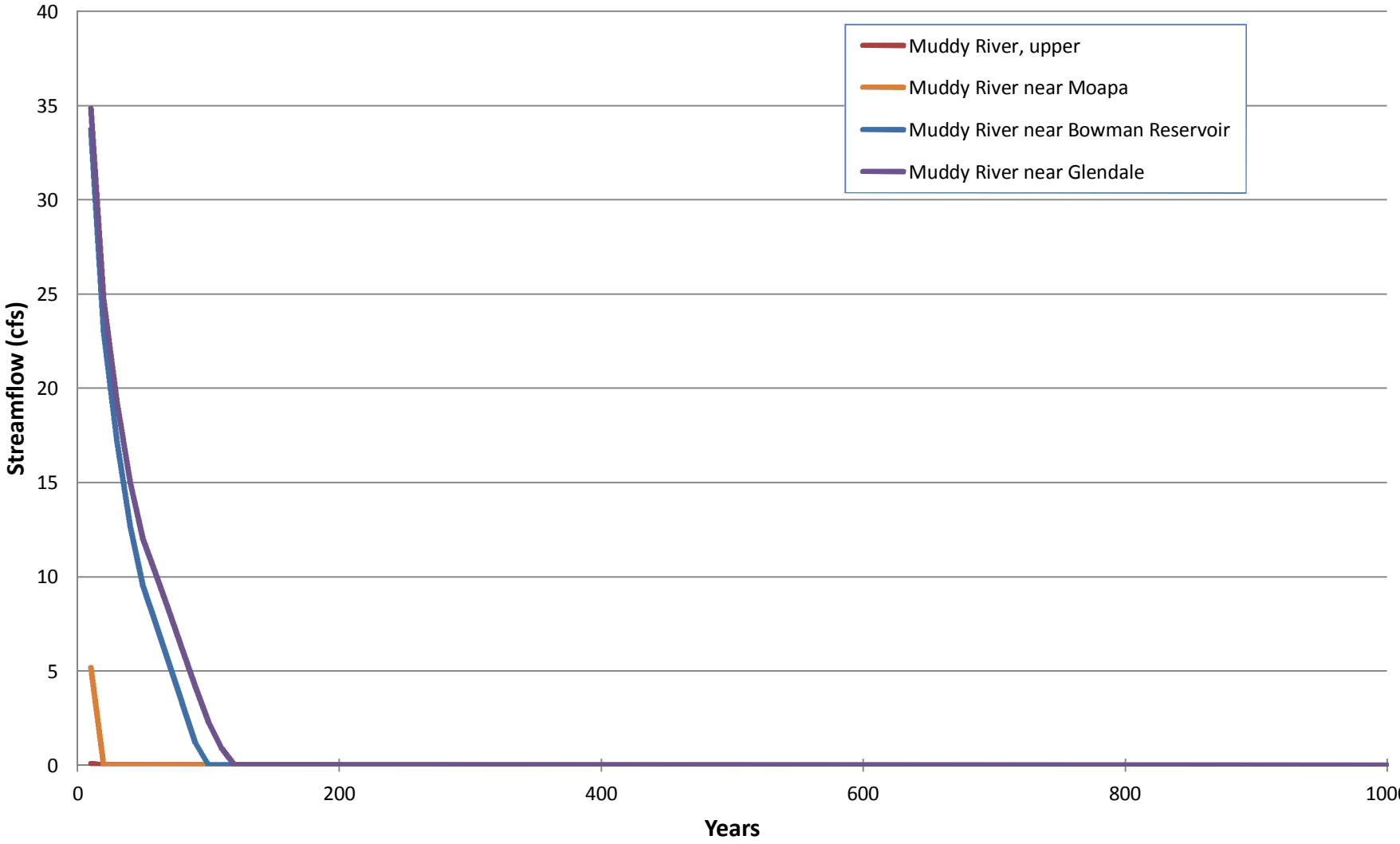


Simulated spring discharges in the Muddy River Springs area, Scenario 6

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.6-2a

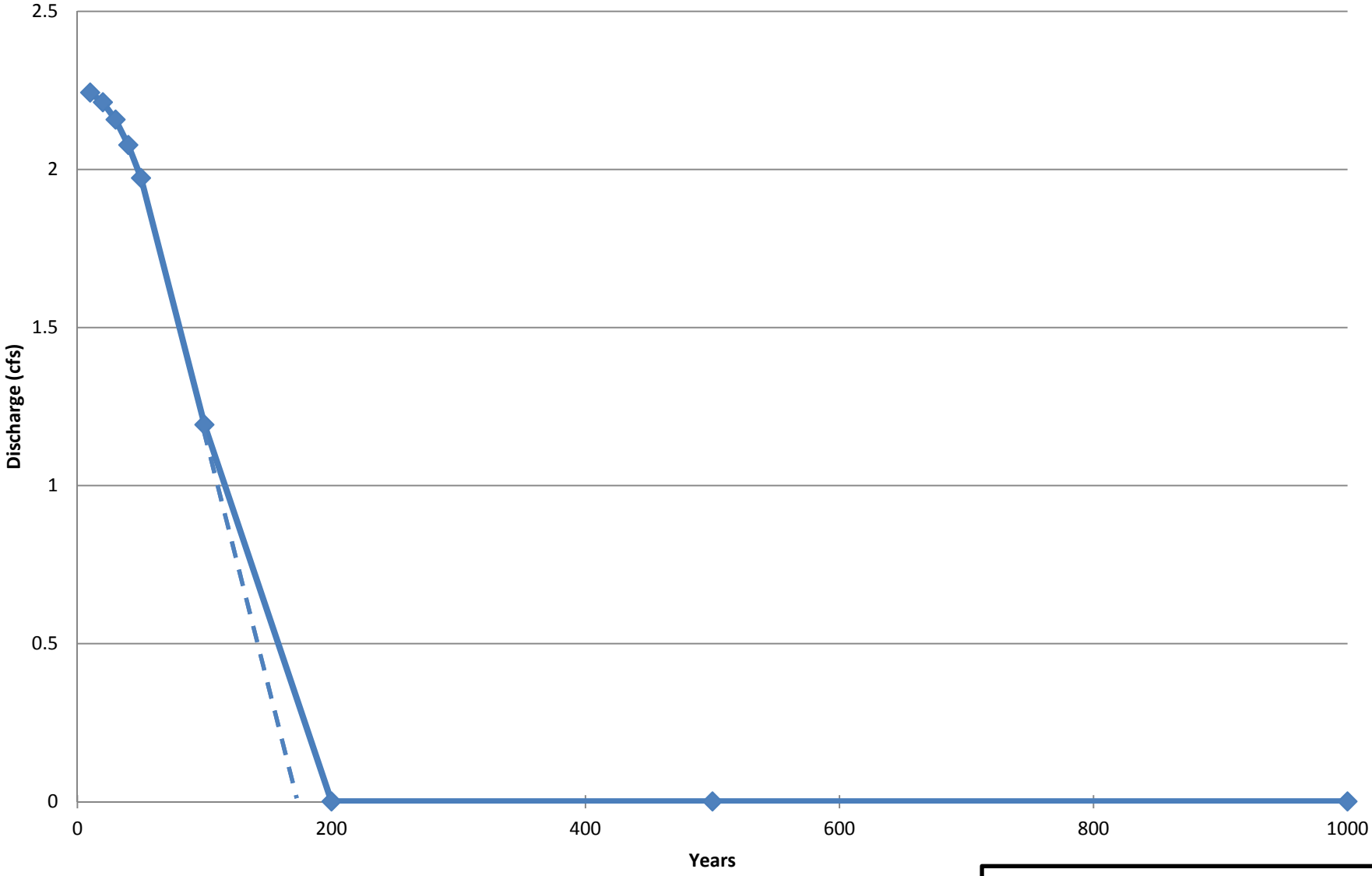


Simulated streamflow in the Muddy River, Scenario 6

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.6-2b

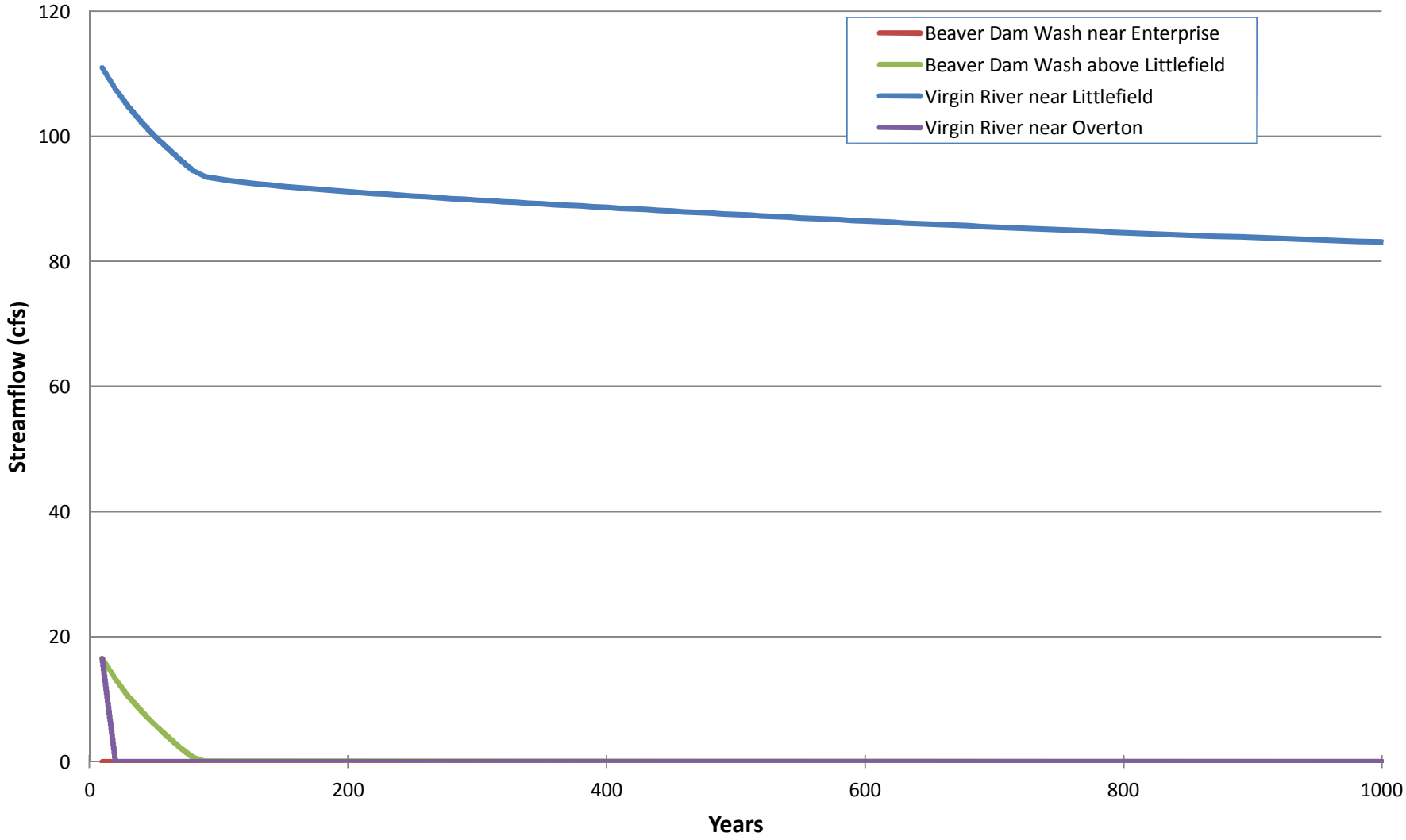


Simulated combined discharge from Rogers and Blue Point Springs, Scenario 6

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.6-2c

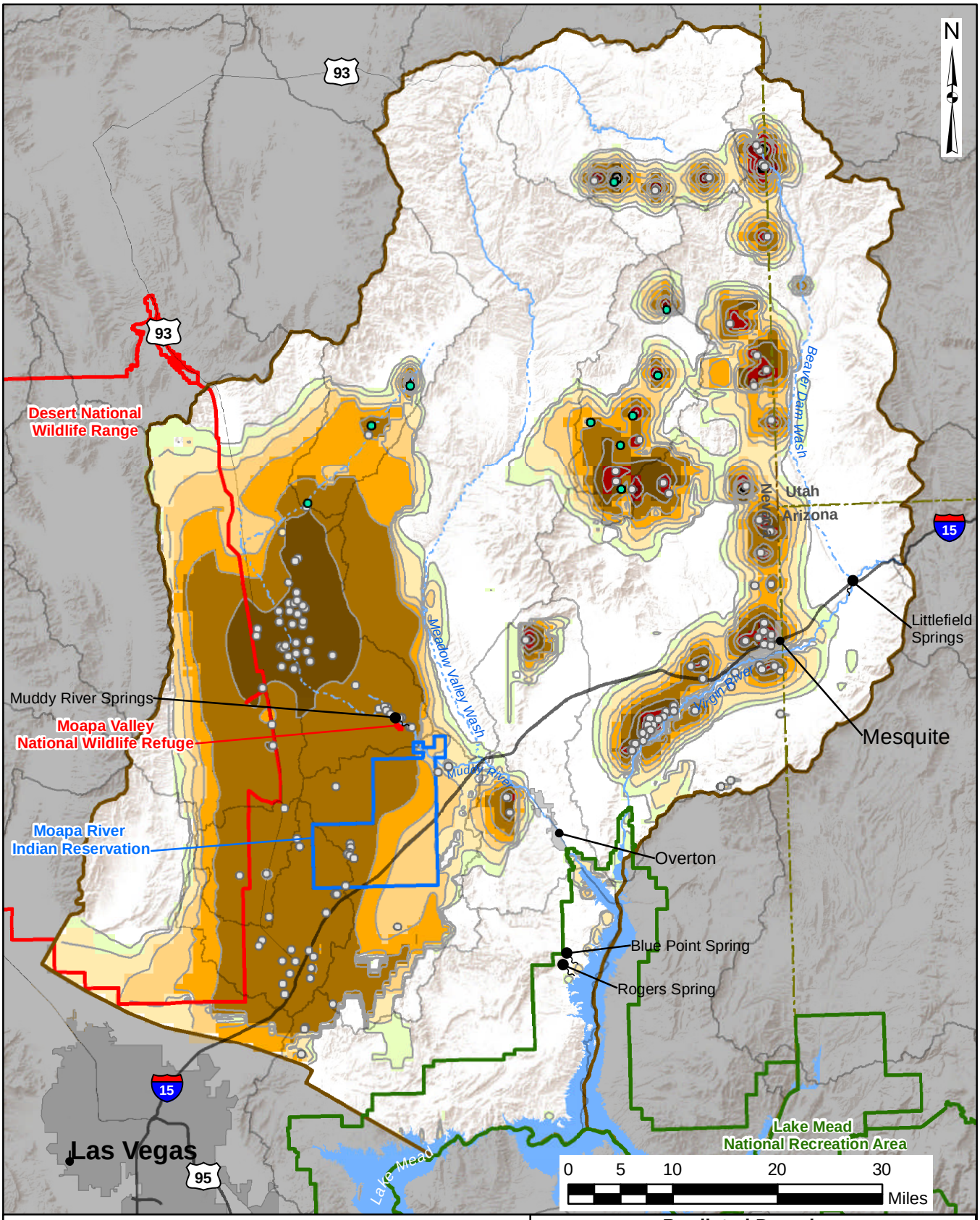


Simulated streamflow in Beaver Dam Wash and the Virgin River, Scenario 6

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.6-2d

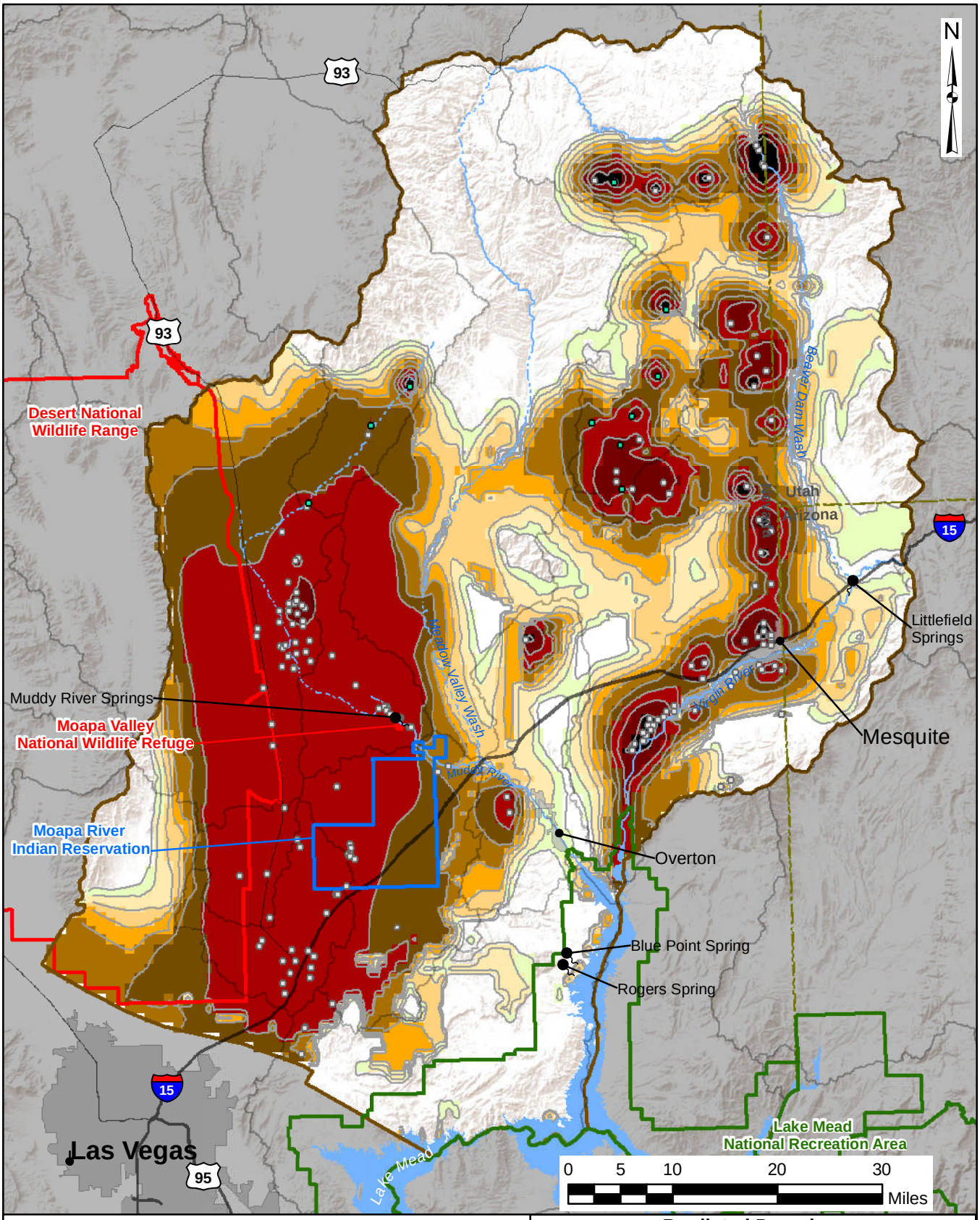


TITLE: **Predicted Drawdown**
Scenario 7
10 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.7-1a

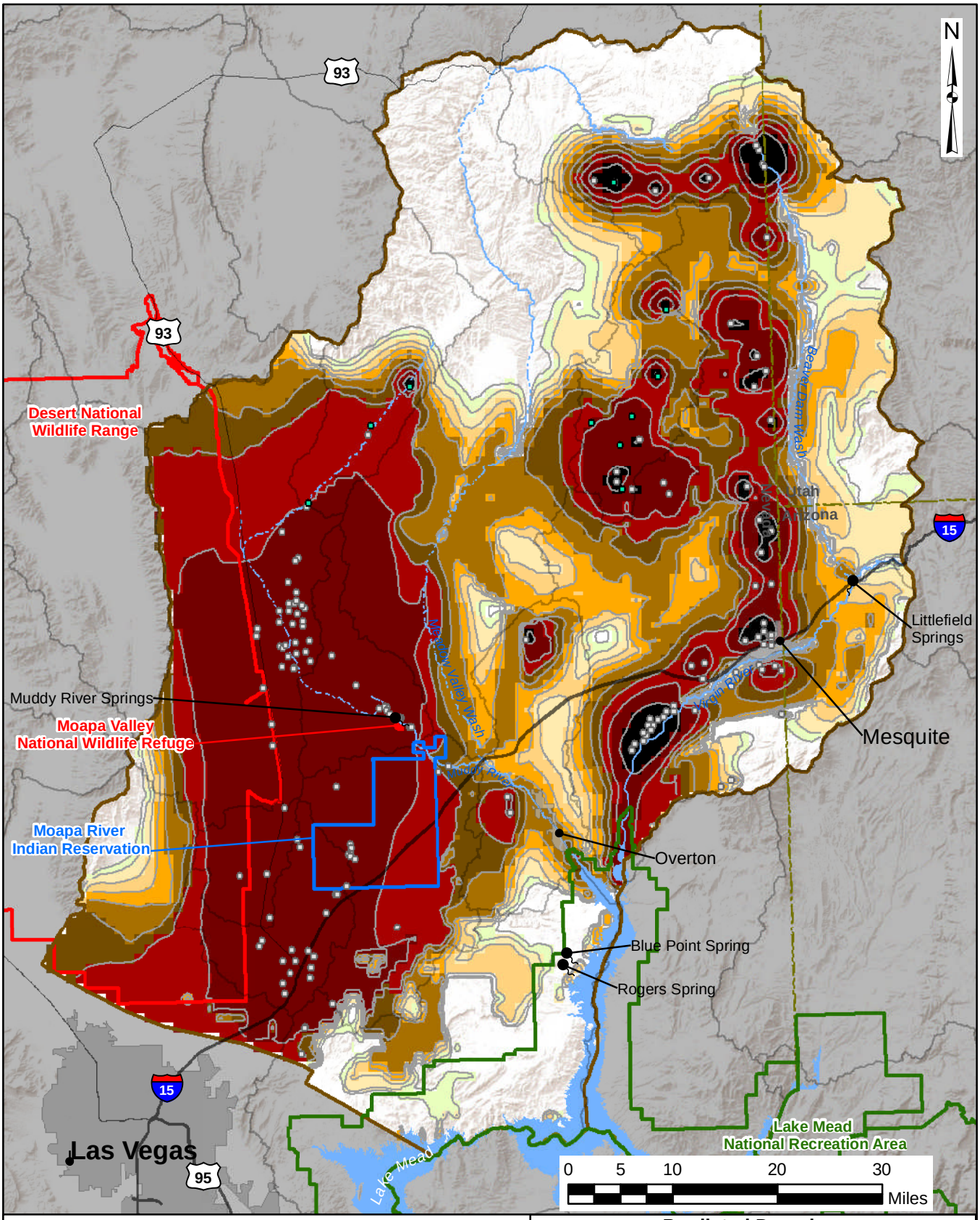


TITLE: **Predicted Drawdown Scenario 7 50 years**

LOCATION: **Colorado Regional Groundwater Flow System Southeastern Nevada**

TETRA TECH

FIGURE **3.7-1b**

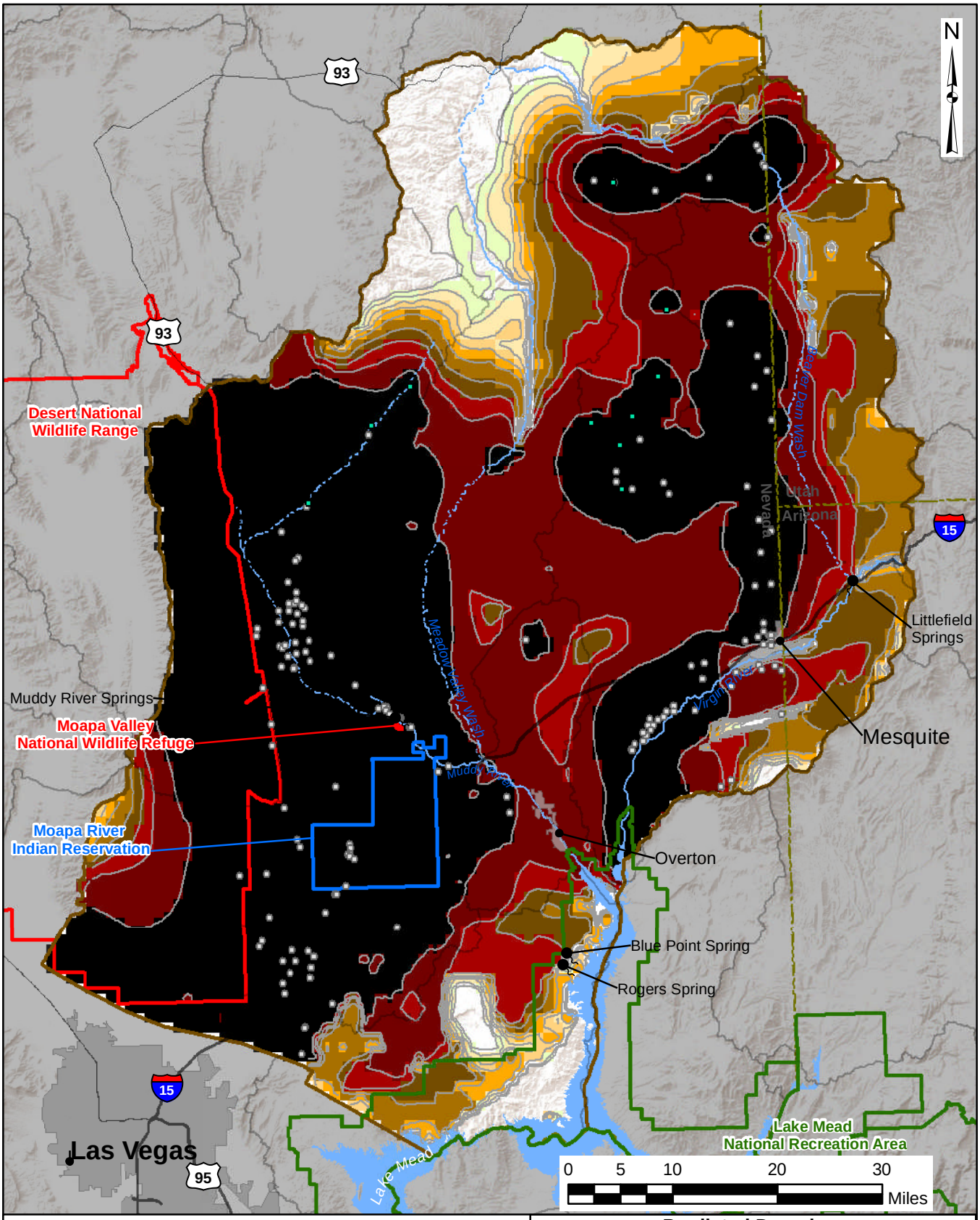


TITLE: **Predicted Drawdown**
Scenario 7
100 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.7-1c



Legend

< 1	20 - 50	Pumping Wells; existent	
1 - 2	50 - 100	Pumping Introduced in Scenario	
2 - 5	100 - 200		
5 - 10	200 - 500	Active Model Domain	
10 - 20	> 500		

State Boundary

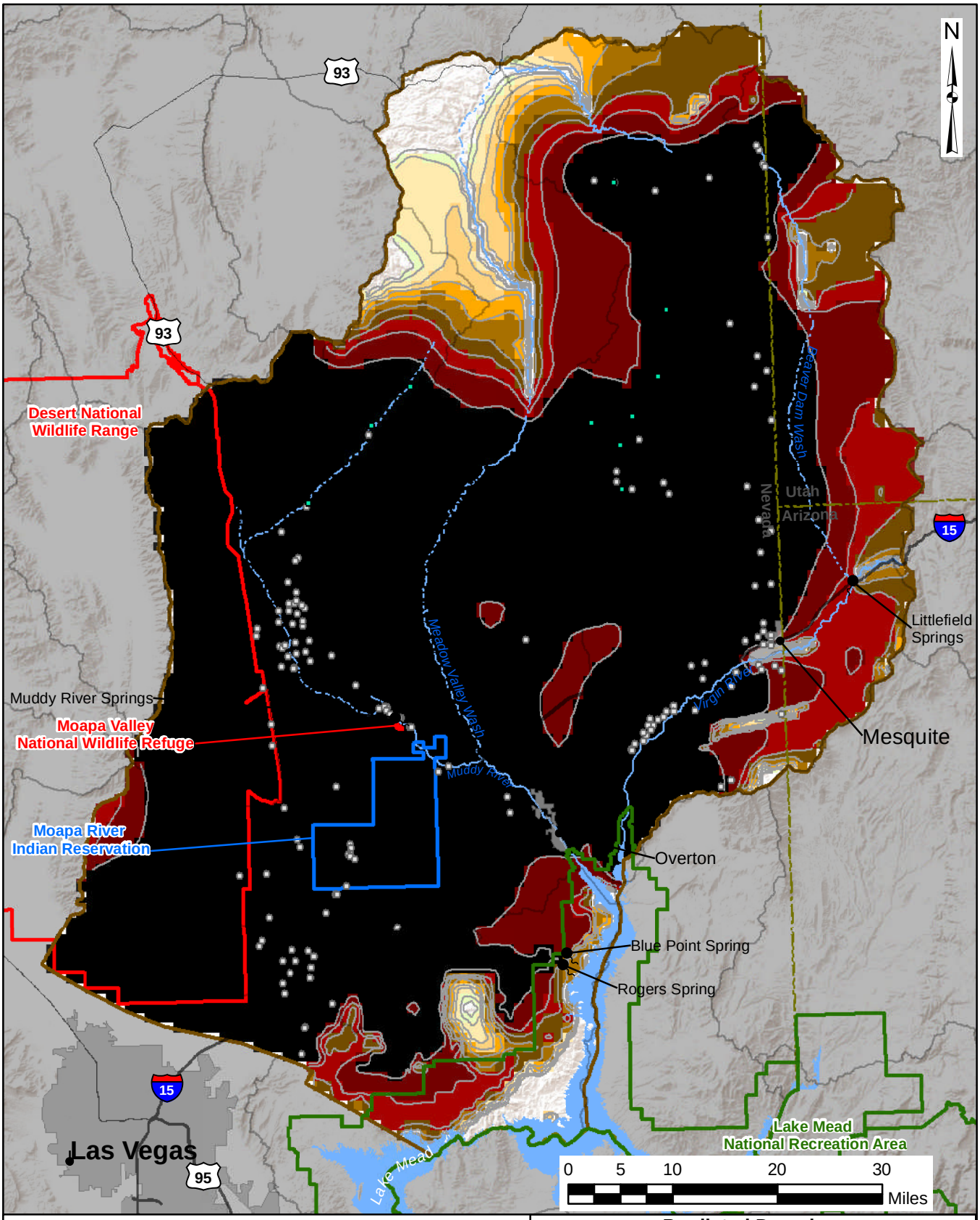
Drawdown is in feet.

TITLE: **Predicted Drawdown**
Scenario 7
500 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.7-1d

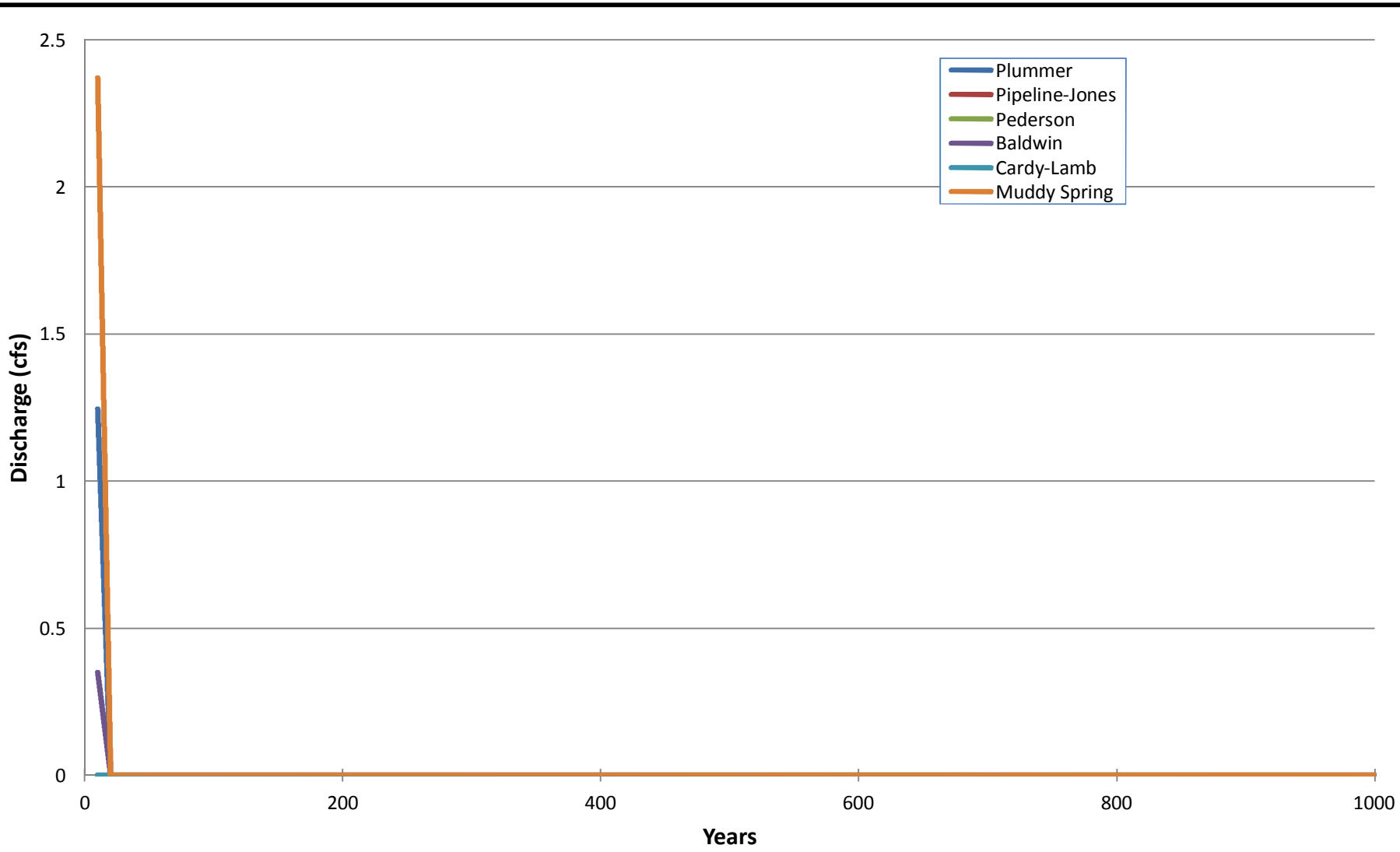


TITLE: **Predicted Drawdown**
Scenario 7
1000 years

LOCATION: **Colorado Regional Groundwater Flow System**
Southeastern Nevada

TETRA TECH

FIGURE
3.7-1e

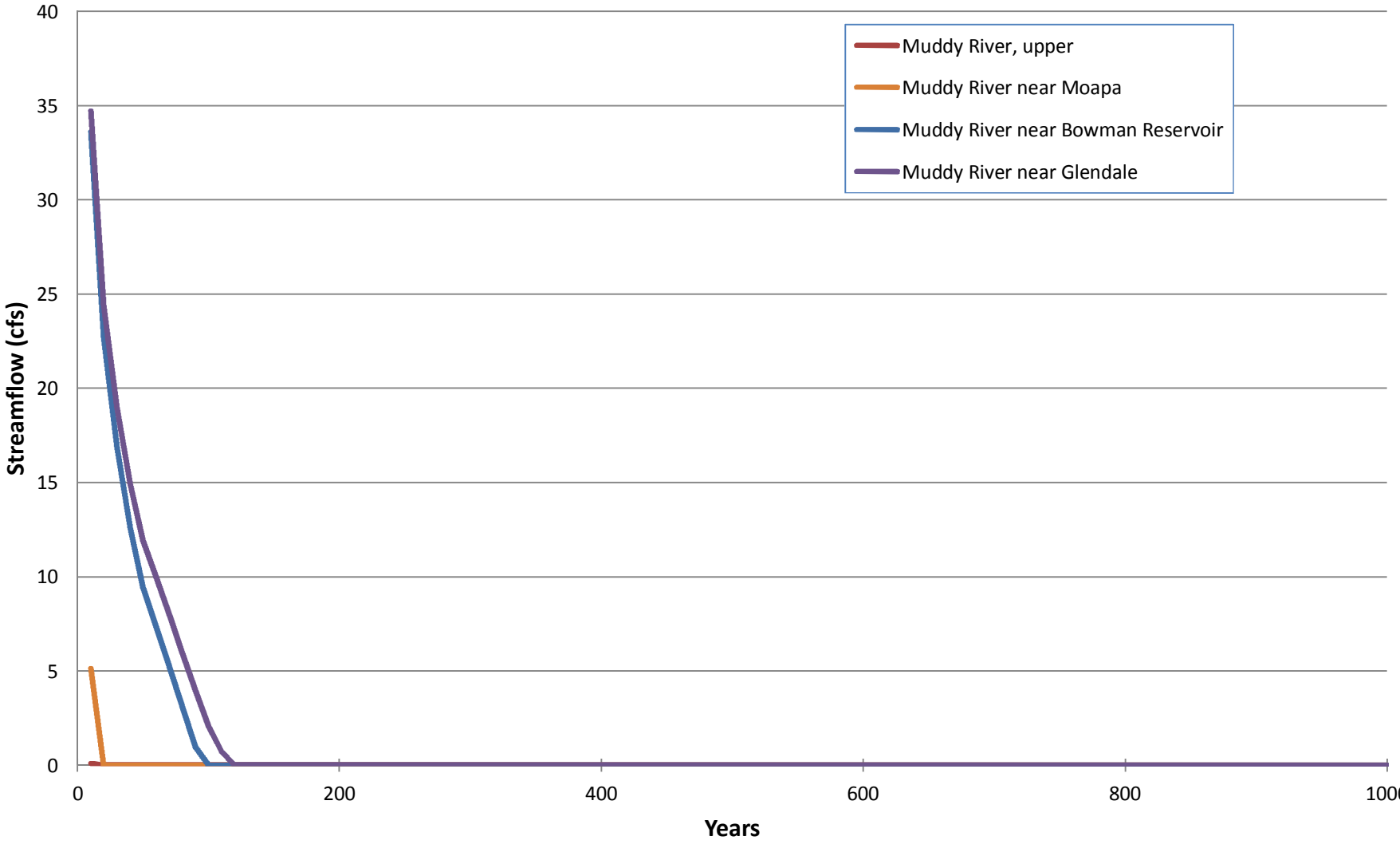


Simulated spring discharges in the Muddy River Springs area, Scenario 7

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.7-2a

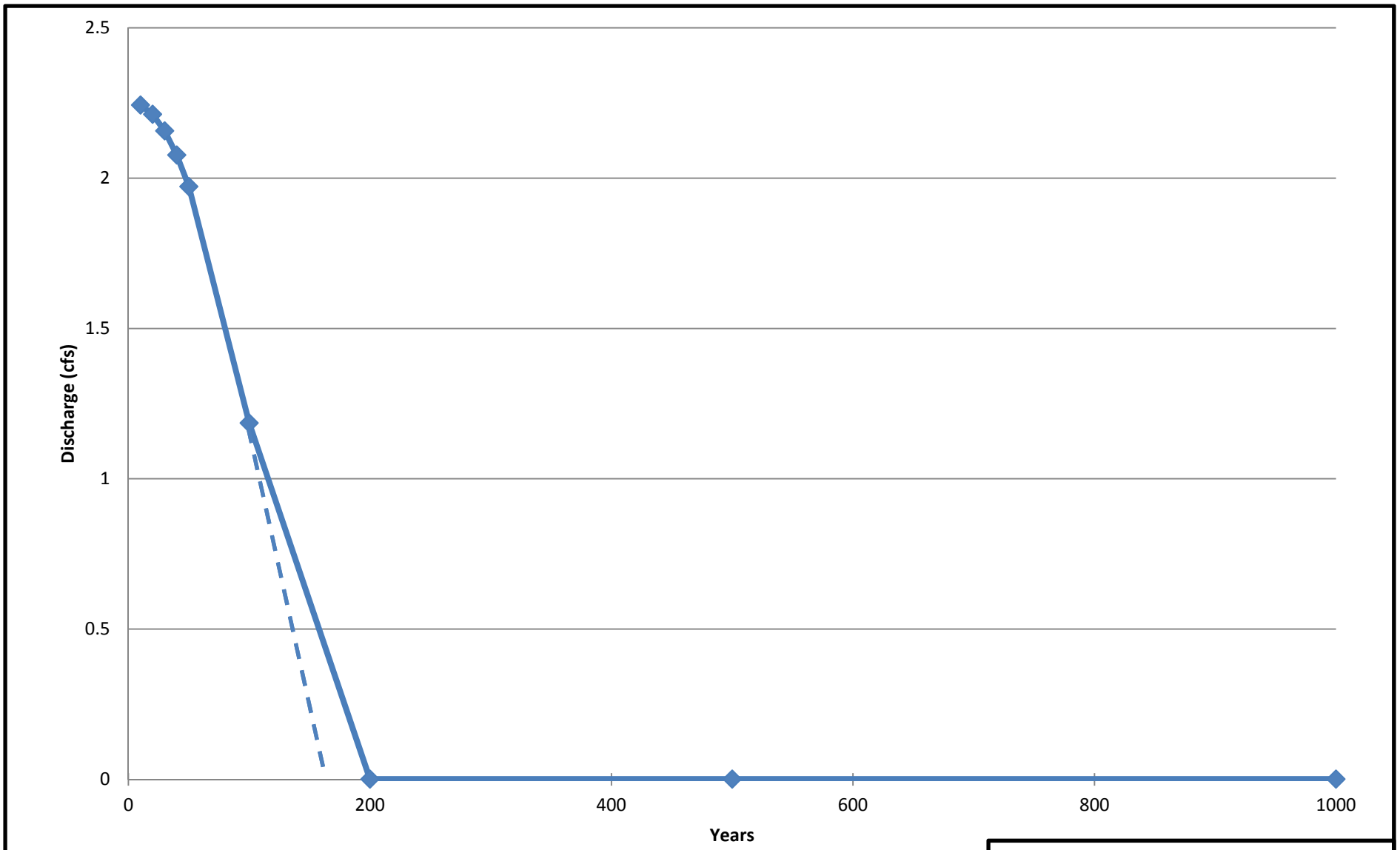


Simulated streamflow in the Muddy River, Scenario 7

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.7-2b

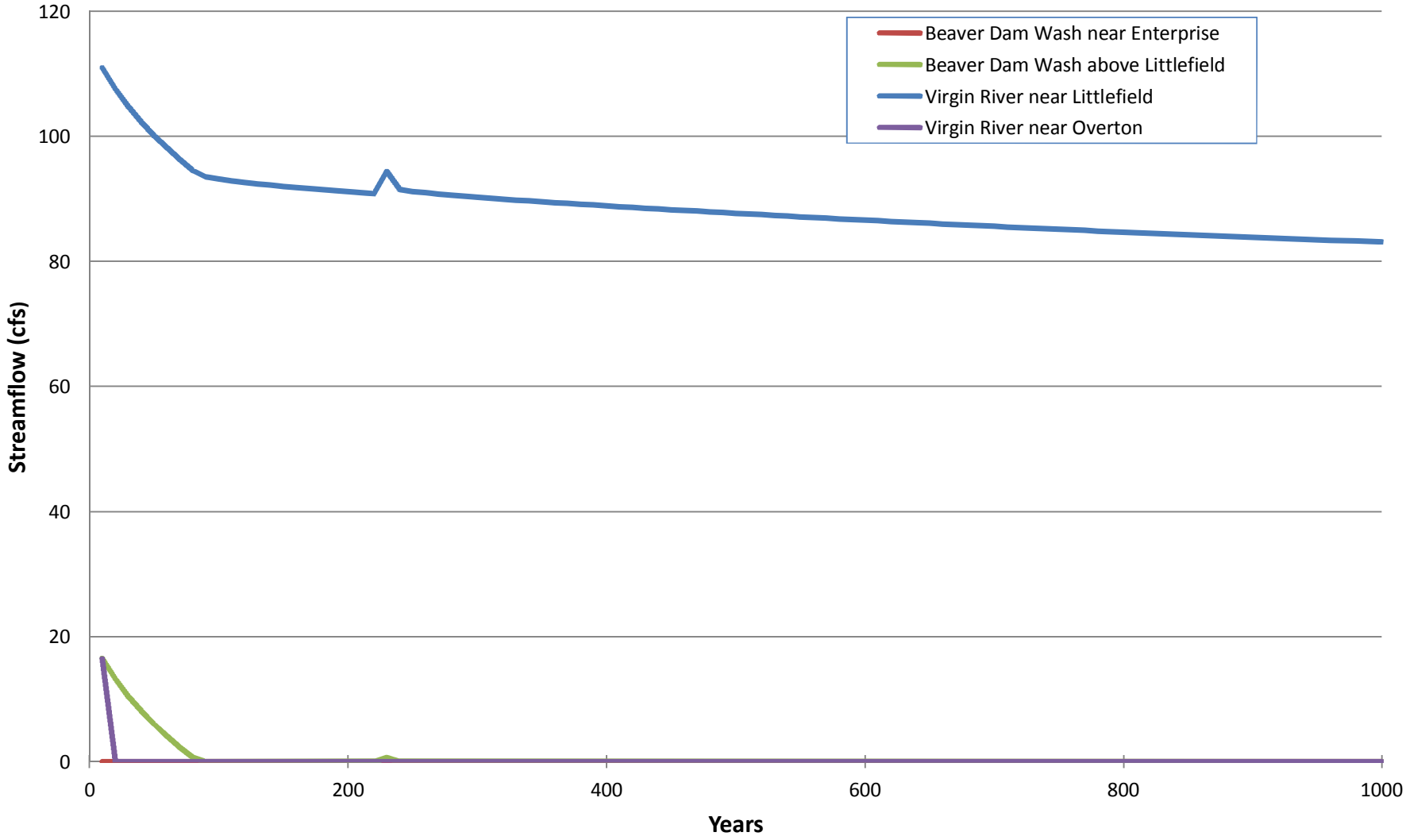


Simulated combined discharge from Rogers and Blue Point Springs, Scenario 7

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.7-2c



Simulated streamflow in Beaver Dam Wash and the Virgin River, Scenario 7

Lower Colorado River Flow System

TETRA TECH GEO

Figure 3.7-2d

ATTACHMENT I

Production Wells

PERMITS APPLICATION

TETRA TECH

GROUP NO	HYDROGRAPHIC AREA	GROUNDWATER DEVELOPER	Pumping Rate (af/yr))	PUMPING WELL(S)	QQ	QTR	SEC	TWN	RNG	Top Screen Elev (ft)	Bottom Screen Elev	PERMIT/APPLICATION NOS	PRIORITY/FILING DATE
1	Coyote Spring Valley (HA 210)	SNWA	4131	MX-5	SE	SE	23	13S	63E	2050.1	1548.1	77291-77306	
1	Coyote Spring Valley (HA 210)	CSI	1114	CSI-3	SW	SE	10	13S	63E	2282.4	1200.4	74094	
1	Coyote Spring Valley (HA 210)	CSI	482	CSI-4	NW	NE	5	13S	63E	2467.2	1144.2	74095	
1	Black Mountains (HA 215)	Nevada Cogeneration Associates	85	EPB-2	SE	SE	13	19S	63E	1684.7	1225.7	55269	1990
1	Black Mountains (HA 215)	Nevada Cogeneration Associates	632	EGV-3	NE	SE	13	19S	63E	1733.5	1480.5	58032	1990
1	Black Mountains (HA 215)	Nevada Cogeneration Associates	793	EBM-4	NE	SE	13	19S	63E	1825.9	1304.9	58031	1992
1	Garnet Valley (HA 216)	Las Vegas Valley Water District	89	Duke WS-1	NE	NE	15	18S	63E	1711.5	1563.5	54073, 79001-79010	1989
1	Garnet Valley (HA 216)	Las Vegas Valley Water District	307	Duke WS-2	NE	NE	15	18S	63E	1455.9	304.9	54073, 79001-79010	1989
1	Garnet Valley (HA 216)	Las Vegas Valley Water District	45	Mirant 1	NE	NE	5	18S	63E	2266.0	587.0	54073, 79001-79010	1989
1	Garnet Valley (HA 216)	Las Vegas Valley Water District	149	PW-WS1	NE	SE	5	18S	63E	2478.3	548.3	54073, 79001-79010	1989
1	Garnet Valley (HA 216)	Chemical Lime Company of AZ	78	US LIME-1						1532.2	1232.2		1997
1	Garnet Valley (HA 216)	Chemical Lime Company of AZ	62	US LIME-2	NE	NE	14	18S	63E	1814.9	1664.9	63261	1997
1	Garnet Valley (HA 216)	Dry Lake Water LLC	6	DRY LAKE GV-2	NE	NE	27	18S	63E	1573.0	1193.0	66784	2000
1	Garnet Valley (HA 216)	Republic Environmental Technologies		#1									
1	Garnet Valley (HA 216)	Republic Environmental Technologies	169	#2	NW	NE	19	18S	64E	1483.2	1403.2	67711-67720	2001
1	Garnet Valley (HA 216)	Republic Environmental Technologies	112	#5	SE	SE	7	18S	64E	1691.9	1451.9	67711-67720	2001
1	Garnet Valley (HA 216)	Republic Environmental Technologies	112	#6	SE	SW	19	18S	64E	2439.5	1349.5	67711-67720	2001
1	Garnet Valley (HA 216)	Nevada Power Company	120	RW-1	NW	SW	21	17S	64E	1572.3	1239.3	74399	2006
1	California Wash (HA 218)	Moapa Band of Paiutes	2	ECP-1	SE	NE	15	16S	64E	2171.8	1108.8	70257	1989
1	California Wash (HA 218)	Moapa Band of Paiutes	18	TH-1	SW	NW	23	16S	64E	1968.5	1106.0	76643	1989
1	Muddy River Springs Area (HA 219)	Moapa Valley WD	1681	Arrow Canyon Well	SE	NE	7	14S	65E	1748.3	1303.3	52520, 55450, 58269	1988
1	Muddy River Springs Area (HA 219)	Moapa Valley WD	155	Arrow Canyon Well #2	SE	NE	7	14S	65E	1399.5	1127.5	66043	2000
1	Muddy River Springs Area (HA 219)	Moapa Valley WD	1	MX-6	NE	NE	35	13S	64E	1831.0	1351.0	46932	1983
1	Muddy River Springs Area (HA 219)	Nevada Power Company	199	Lewis #1	NW	NE	8	14S	65E	1840.8	1740.8	24185-24186	1967
1	Muddy River Springs Area (HA 219)	Nevada Power Company	346	Lewis #2	SE	NE	8	14S	65E	1806.1	1760.1	22635	1965
1	Muddy River Springs Area (HA 219)	Nevada Power Company	233	Lewis #3	SW	NE	8	14S	65E	1867.9	1767.9	22633	1965
1	Muddy River Springs Area (HA 219)	Nevada Power Company	250	Lewis #4	NW	SE	8	14S	65E	1837.2	1737.2	22632	1965
1	Muddy River Springs Area (HA 219)	Nevada Power Company	353	Lewis #5	NW	SE	8	14S	65E	1831.0	1731.0	22636	1965
1	Muddy River Springs Area (HA 219)	Nevada Power Company	621	Perkins	NE	NE	22	14S	65E	1718.6	1618.6	50272	1986
1	Muddy River Springs Area (HA 219)	Nevada Power Company	653	Behmer	NW	NW	23	14S	65E	1678.5	1613.5	29296 & 29298	1975
1	Muddy River Springs Area (HA 219)	LDS	320	LDS East	NW	NW	15	14S	65E	1757.2	1680.2	50723-50733	1987
1	Muddy River Springs Area (HA 219)	LDS	476	LDS West	SW	SW	9	14S	65E	1803.6	1733.6	50723-50733	1987
1	Muddy River Springs Area (HA 219)	LDS	676	LDS Central	NE	NE	16	14S	65E	1763.2	1713.2	50723-50733	1987
1	Virgin River Valley (HA 222)	Virgin Valley WD	197	VVWD2						1608.7	1470.7		
1	Virgin River Valley (HA 222)	Virgin Valley WD	735	VVWD26						1347.3	847.3		
1	Virgin River Valley (HA 222)	Virgin Valley WD	1430	VVWD27						1472.3	232.3		
1	Virgin River Valley (HA 222)	Virgin Valley WD	567	VVWD28						1151.1	651.1		
1	Virgin River Valley (HA 222)	Virgin Valley WD	73	VVWD29						1478.2	458.2		
1	Virgin River Valley (HA 222)	Virgin Valley WD	111	VVWD30						520.7	-479.4		
1	Virgin River Valley (HA 222)	Virgin Valley WD	2089	VVWD31						278.2	-721.8		
1	Virgin River Valley (HA 222)	Virgin Valley WD	50	VVWD32						1737.5	877.5		
1	Virgin River Valley (HA 222)	Virgin Valley WD	1294	VVWD33						1355.3	15.3		
2	Kane Springs Valley (HA 206)	CSI	500	KPW-1	NE	SW	6	11S	64E			72220	
2	Kane Springs Valley (HA 206)	CSI	500	(none)	SE	SW	31	9S	65E			72219	
2	Coyote Spring Valley (HA 210)	SNWA	9000	MX-5	SE	SW	14	13S	63E	2050.1	1548.1	77291-77306	
2	Coyote Spring Valley (HA 210)	CSI	1500	CSI-2	SE	SW	14	13S	63E	1930.0	1204.0	70429	
2	Coyote Spring Valley (HA 210)	CSI	1600	CSI-1	SW	SE	22	13S	63E	2226.6	1396.6	70430	
2	Coyote Spring Valley (HA 210)	CSI	1000	CSI-3	SW	SE	10	13S	63E	2282.4	1200.4	74094	
2	Coyote Spring Valley (HA 210)	CSI	500	CSI-4	NW	NE	5	13S	63E	2467.2	1144.2	74095	
2	Coyote Spring Valley (HA 210)	Nevada Power Company	2500	RW-2	NE	NE	26	13S	63E	2150.1	1500.1	77164	
2	Black Mountains (HA 215)	Nevada Cogeneration Associates	95	EPB-2	SE	SE	13	19S	63E	1684.7	1225.7	55269	1990
2	Black Mountains (HA 215)	Nevada Cogeneration Associates	695	EGV-3	NE	SE	13	19S	63E	1733.5	1480.5	58032	1990
2	Black Mountains (HA 215)	Nevada Cogeneration Associates	875	EBM-4	NE	SE	13	19S	63E	1825.9	1304.9	58031	1992

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2	Garnet Valley (HA 216)	SNWA	325	Duke WS-1	NE	NE	15	18S	63E	1711.5	1563.5	54073, 79001-79010	1989
2	Garnet Valley (HA 216)	SNWA	1120	Duke WS-2	NE	NE	15	18S	63E	1455.9	304.9	54073, 79001-79010	1989
2	Garnet Valley (HA 216)	SNWA	165	Mirant 1	NE	NE	5	18S	63E	2266.0	587.0	54073, 79001-79010	1989
2	Garnet Valley (HA 216)	SNWA	545	PW-WS1	NE	SE	5	18S	63E	2478.3	548.3	54073, 79001-79010	1989
2	Garnet Valley (HA 216)	SNWA	45	RW-1	NW	SW	21	17S	64E	1572.3	1239.3	54073, 79001-79010	1989
2	Garnet Valley (HA 216)	Georgia Pacific Corp	144	EBA-1	SE	NE	34	18S	63E	2418.0	833.2	1991	56855
2	Garnet Valley (HA 216)	Chemical Lime Company of AZ	0	US LIME-1						1532.2	1232.2		
2	Garnet Valley (HA 216)	Chemical Lime Company of AZ	158	4(none)	SW	SE	23	18S	63E			64880	1997
2	Garnet Valley (HA 216)	Chemical Lime Company of AZ	126	US LIME-2	NE	NE	14	18S	63E	1814.9	1664.9	63261	1997
2	Garnet Valley (HA 216)	Dry Lake Water LLC	157	DRY LAKE GV-2	NE	NE	27	18S	63E	1573.0	1193.0	66784	2000
2	Garnet Valley (HA 216)	Republic Environmental Technologies	0	#1									
2	Garnet Valley (HA 216)	Republic Environmental Technologies	202	#2	NW	NE	19	18S	64E	1483.2	1403.2	67711-67720	2001
2	Garnet Valley (HA 216)	Republic Environmental Technologies	133	#5	SE	SE	7	18S	64E	1691.9	1451.9	67711-67720	2001
2	Garnet Valley (HA 216)	Republic Environmental Technologies	133	#6	SE	SW	19	18S	64E	2439.5	1349.5	67711-67720	2001
2	Garnet Valley (HA 216)	Nevada Power Company	75	RW-1	NW	SW	21	17S	64E	1572.3	1239.3	74399	2006
2	Hidden Valley (North) (HA 217)	Nevada Power Company	0	(none)	SW	SW	25	16S	62E			54074	1989
2	California Wash (HA 218)	Nevada Power Company	362	(none)	SE	SW	5	15S	66E			50559	1987
2	California Wash (HA 218)	Moapa Band of Paiutes	1000	ECP-1	SE	NE	15	16S	64E	2171.8	1108.8	70257	1989
2	California Wash (HA 218)	Moapa Band of Paiutes	500	ECP-2	NE	NE	15	16S	64E	2094.7	1005.7	70258	1989
2	California Wash (HA 218)	Moapa Band of Paiutes	500	ECP-3	NE	NE	15	16S	64E	2202.4	776.4	70259	1989
2	California Wash (HA 218)	Moapa Band of Paiutes	500	TH-1	SW	NW	23	16S	64E	1968.5	1106.0	76643	1989
2	Muddy River Springs Area (HA 219)	Moapa Valley WD	6215	Arrow Canyon Well	SE	NE	7	14S	65E	1748.3	1303.3	52520, 55450, 58269	1988
2	Muddy River Springs Area (HA 219)	Moapa Valley WD	573	Arrow Canyon Well #2	SE	NE	7	14S	65E	1399.5	1127.5	66043	2000
2	Muddy River Springs Area (HA 219)	Moapa Valley WD	4	MX-6	NE	NE	35	13S	64E	1831.0	1351.0	46932	1983
2	Muddy River Springs Area (HA 219)	Nevada Power Company	680	Lewis #1	NW	NE	8	14S	65E	1840.8	1740.8	24185-24186	1967
2	Muddy River Springs Area (HA 219)	Nevada Power Company	616	Lewis #2	SE	NE	8	14S	65E	1806.1	1760.1	22635	1965
2	Muddy River Springs Area (HA 219)	Nevada Power Company	680	Lewis #3	SW	NE	8	14S	65E	1867.9	1767.9	22633	1965
2	Muddy River Springs Area (HA 219)	Nevada Power Company	680	Lewis #4	NW	SE	8	14S	65E	1837.2	1737.2	22632	1965
2	Muddy River Springs Area (HA 219)	Nevada Power Company	680	Lewis #5	NW	SE	8	14S	65E	1831.0	1731.0	22636	1965
2	Muddy River Springs Area (HA 219)	Nevada Power Company	905	Perkins	NE	NE	22	14S	65E	1718.6	1618.6	50272	1986
2	Muddy River Springs Area (HA 219)	Nevada Power Company	325	Behmer	NW	NW	23	14S	65E	1678.5	1613.5	29296 & 29298	1975
2	Muddy River Springs Area (HA 219)	LDS	675	LDS East	NW	NW	15	14S	65E	1757.2	1680.2	50723-50733	1987
2	Muddy River Springs Area (HA 219)	LDS	655	LDS West	SW	SW	9	14S	65E	1803.6	1733.6	50723-50733	1987
2	Muddy River Springs Area (HA 219)	LDS	1000	LDS Central	NE	NE	16	14S	65E	1763.2	1713.2	50723-50733	1987
2	Tule Desert (HA 221)	Lincoln County/Vidler	2100	PW-1	SW	NW	4	10S	69E			66932	
2	Tule Desert (HA 221)	Lincoln County/Vidler	7240	PW-2	SE	SW	6	10S	69E			81619	
2	Virgin River Valley (HA 222)	Virgin Valley WD	369	VVWD2						1608.7	1470.7		
2	Virgin River Valley (HA 222)	Virgin Valley WD	1378	VVWD26						1347.3	847.3		
2	Virgin River Valley (HA 222)	Virgin Valley WD	2681	VVWD27						1472.3	232.3		
2	Virgin River Valley (HA 222)	Virgin Valley WD	1062	VVWD28						1151.1	651.1		
2	Virgin River Valley (HA 222)	Virgin Valley WD	137	VVWD29						1478.2	458.2		
2	Virgin River Valley (HA 222)	Virgin Valley WD	208	VVWD30						520.7	-479.4		
2	Virgin River Valley (HA 222)	Virgin Valley WD	3917	VVWD31						278.2	-721.8		
2	Virgin River Valley (HA 222)	Virgin Valley WD	93	VVWD32						1737.5	877.5		
2	Virgin River Valley (HA 222)	Virgin Valley WD	2426	VVWD33						1355.3	15.3		
3	Coyote Spring Valley	SNWA	4344	CSV_S_3_1	SE	SW	5	13S	63E			54055	1989
3	Coyote Spring Valley	SNWA	4344	CSV_S_3_2	SE	SE	32	13S	63E			54056	1989
3	Coyote Spring Valley	SNWA	4344	CSV_S_3_3	SE	NW	16	14S	63E			54057	1989
3	Coyote Spring Valley	SNWA	7240	CSV_S_3_4	NE	NE	1	13S	63E			54058	1989
3	Coyote Spring Valley	SNWA	7240	CSV_S_3_5	NW	NW	19	13S	64E			54059	1989
3	California Wash	Moapa Band of Paiutes	7240	CW_MBP_3_1	NW	NW	16	15S	64E			54076	1989
3	Garnet Valley	Bonneville Nevada Corp.	1665	GV_BNC_3_1	SE	NE	34	18S	63E			54130	1989
3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_1	NE	SE	11	14S	69E			54078	1989

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3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_2	NE	NE	14	14S	69E			54079	1989
3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_3	NW	NW	14	14S	69E			54080	1989
3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_4	NE	SE	15	14S	69E			54081	1989
3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_5	SE	SW	15	14S	69E			54082	1989
3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_6	SW	SE	16	14S	69E			54083	1989
3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_7	SE	NE	21	14S	69E			54084	1989
3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_8	SE	NW	21	14S	69E			54085	1989
3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_9	SW	SE	21	14S	69E			54086	1989
3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_10	SW	NW	28	14S	69E			54087	1989
3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_11	NE	NE	29	14S	69E			54088	1989
3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_12	SE	SE	29	14S	69E			54089	1989
3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_13	NW	NW	32	14S	69E			54090	1989
3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_14	NW	SW	31	14S	69E			54091	1989
3	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_3_15	SE	SE	31	14S	69E			54092	1989
3	Virgin River Valley	Virgin Valley WD	724	VR_VVWD_3_16	SE	NE	32	13S	70E			54175	1989
4	Virgin River Valley	Virgin Valley WD	724	VR_VVWD_4_1	NE	SE	26	13S	70E			54681	1990
4	Virgin River Valley	Virgin Valley WD	14480	VR_VVWD_4_2	SE	SW	21	05S	71E			54682	1990
4	Virgin River Valley	Virgin Valley WD	7240	VR_VVWD_4_3	NW	NE	33	05S	71E			54683	1990
4	Virgin River Valley	Virgin Valley WD	14480	VR_VVWD_4_4	SE	NE	33	05S	71E			54684	1990
4	Virgin River Valley	Virgin Valley WD	3620	VR_VVWD_4_5	NE	NE	4	07S	71E			54689	1990
4	Virgin River Valley	Virgin Valley WD	7240	VR_VVWD_4_6	SW	NW	13	08S	70E			54690	1990
4	Virgin River Valley	Virgin Valley WD	7240	VR_VVWD_4_7	SE	SW	32	08S	71E			54691	1990
4	Virgin River Valley	Virgin Valley WD	7240	VR_VVWD_4_8	NW	NE	4	09S	71E			54692	1990
4	Virgin River Valley	Virgin Valley WD	7240	VR_VVWD_4_9	NE	SW	8	09S	71E			54693	1990
4	Virgin River Valley	Virgin Valley WD	7240	VR_VVWD_4_10	SE	SE	28	09S	71E			54694	1990
4	Virgin River Valley	Virgin Valley WD	7240	VR_VVWD_4_11	SW	SW	31	10S	71E			54695	1990
4	Virgin River Valley	Virgin Valley WD	7240	VR_VVWD_4_12	SW	NW	21	05S	71E			54696	1990
4	Virgin River Valley	Virgin Valley WD	3620	VR_VVWD_4_13	SE	SW	21	11S	71E			54697	1990
4	Virgin River Valley	Virgin Valley WD	3620	VR_VVWD_4_14	NW	NW	34	11S	71E			54698	1990
4	California Wash	Nevada Power Company	2534	CW_NPC_4_1	SE	NW	7	15S	66E			54634	1990
4	Garnet Valley	James Adams	0	GV_JA_4_1	NW	NE	11	18S	63E			57011	1991
4	Virgin River Valley	Virgin Valley WD	1448	VR_VVWD_4_15	SW	NW	22	15S	70E			55943	1991
4	Virgin River Valley	Virgin Valley WD	1448	VR_VVWD_4_16	SW	SW	14	15S	70E			55944	1991
4	Virgin River Valley	Virgin Valley WD	3620	VR_VVWD_4_17	SE	SW	8	13S	71E			56793	1991
4	Virgin River Valley	Virgin Valley WD	3620	VR_VVWD_4_18	NW	NW	16	13S	71E			56828	1991
4	Virgin River Valley	Virgin Valley WD	3620	VR_VVWD_4_19	NE	NW	9	13S	71E			56829	1991
4	Virgin River Valley	Virgin Valley WD	7240	VR_VVWD_4_20	NE	SE	12	13S	70E			56959	1991
4	Black Mountains	Nevada Cogeneration Co	555	BM_NCG_4_1	NE	SE	13	19S	63E			58592	1993
4	Black Mountains	Nevada Cogeneration Co	555	BM_NCG_4_2	NE	SE	13	19S	63E			58593	1993
4	Black Mountains	Nevada Cogeneration Co	555	BM_NCG_4_3	SE	SE	13	19S	63E			58594	1993
4	Muddy River Springs Area	Moapa Valley WD	7240	MRS_MVWD_4_1	NE	NE	33	13S	64E			59369	1993
4	Lower Moapa Valley	Moapa Valley WD	7240	LMV_MVWD_4_1	NW	NW	10	13S	67E			59368	1993
4	Lower Moapa Valley	Moapa Valley WD	3620	LMV_MVWD_4_2	SW	NW	32	15S	67E			59370	1993
4	Lower Moapa Valley	Moapa Valley WD	3620	LMV_MVWD_4_3	SE	SE	19	15S	67E			59371	1993
5	Hidden Valley (North)	Nevada Power Company	4033	HV_NPC_5_1	NW	SE	27	15S	63E			62997	1997
5	Hidden Valley (North)	Nevada Power Company	16131	HV_NPC_5_2	NW	SE	29	16S	63E			62999	1997
5	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_5_1	NE	SE	20	13S	70E			63292	1997
5	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_5_2	SW	SE	19	13S	70E			63293	1997
5	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_5_3	NE	NE	5	13S	71E			63294	1997
5	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_5_4	NE	NE	18	14S	70E			63295	1997
5	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_5_5	NW	NE	28	13S	71E			63296	1997
5	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_5_6	SE	NW	29	13S	71E			63297	1997
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_1	SE	SW	23	12S	63E			63272	1997

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5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_2	SE	NE	25	12S	63E			63273	1997
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_3	NE	NE	15	13S	63E			63274	1997
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_4	SE	SE	23	12S	63E			63275	1997
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_5	NE	SW	36	11S	63E			63276	1997
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_6	NW	SW	12	13S	63E			63867	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_7	NW	SW	13	13S	63E			63868	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_8	SW	SW	11	13S	63E			63869	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_9	NE	SW	7	13S	64E			63870	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_10	NW	SW	18	13S	64E			63871	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_11	SE	SW	11	12S	63E			63872	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_12	SW	SW	25	12S	63E			63873	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_13	SW	SW	13	12S	63E			63874	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_14	SW	SW	36	11S	63E			63875	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_15	NE	NE	22	11S	63E			63876	1998
5	5Coyote Spring Valley	5Dry Lake Water	4000	CSV_DLW_5_1	NE	SE	28	14S	63E			64039	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_16	NW	SE	36	12S	63E			64186	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_17	SW	SE	35	12S	63E			64187	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_18	NE	SW	34	12S	63E			64188	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_19	NE	SW	27	12S	63E			64189	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_20	NW	NE	25	12S	63E			64190	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_21	NW	SW	24	12S	63E			64191	1998
5	Coyote Spring Valley	CSI	7240	CSV_CSI_5_22	NE	SW	26	12S	63E			64192	1998
5	5Hidden Valley (North)	5Dry Lake Water	4000	HV_DLW_5_1	SW	SE	21	17S	63E			66162	1998
5	5Black Mountains	5Dry Lake Water	4000	BM_DLW_5_1	NE	NW	36	19S	63E			64041	1998
5	5Garnet Valley	5Dry Lake Water	2000	GV_DLW_5_1	NE	NE	14	16S	63E			62996	1998
5	5Garnet Valley	5Dry Lake Water	2000	GV_DLW_5_2	SW	NE	11	16S	63E			62998	1998
5	5California Wash	5Dry Lake Water	4000	CW_DLW_5_1	NE	NE	33	17S	65E			64037	1998
5	Garnet Valley	Nevada Power Company	807	GV_NPC_5_1	SE	SE	9	17S	64E			64222	1998
5	Garnet Valley	Nevada Power Company	807	GV_NPC_5_2	SW	SW	10	17S	64E			64223	1998
5	Virgin River Valley	Lincoln County WD	7240	VR_LCWD_5_1	SE	NE	17	11S	69E			64694	1998
5	Virgin River Valley	Lincoln County WD	7240	VR_LCWD_5_2	NE	SE	32	12S	71E			64695	1998
5	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_5_1	NE	NE	5	13S	71E			64793	1999
5	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_5_2	NE	SE	35	10S	69E			64974	1999
5	Virgin River Valley	Virgin Valley WD	4344	VR_VVWD_5_3	NE	SW	26	10S	69E			64795	1999
5	Tule Desert	Virgin Valley WD	4344	TD_VVWD_5_1	NE	NW	32	10S	69E			64796	1999
5	Tule Desert	Virgin Valley WD	4344	TD_VVWD_5_2	SE	NE	25	10S	68E			64797	1999
5	Tule Desert	Virgin Valley WD	4344	TD_VVWD_5_3	SE	NE	24	10S	68E			64798	1999
6	California Wash	Moapa Paiutes	1300	ECP-2	NE	NE	15	16S	64E	2094.7	1005.7	65948, 66473	2000
6	California Wash	Moapa Paiutes	2600	ECP-1	SE	NE	15	16S	64E	2171.8	1108.8	65946, 65947, 65949, 66475	2000
6	California Wash	Moapa Paiutes	600	CW_MBP_6_1	SE	SE	15	16S	64E			65944	2000
6	California Wash	Moapa Paiutes	600	CW_MBP_6_2	SW	SE	15	16S	64E			66474	2000
6	California Wash	Moapa Paiutes	600	CW_MBP_6_3	NE	NE	22	16S	64E			65945	2000
6	California Wash	Moapa Paiutes	1300	CW_MBP_6_4	SE	SW	34	16S	64E			65954, 65955	2000
6	California Wash	Moapa Paiutes	724	TH-1	SW	NW	23	16S	64E	1968.5	1106.0	66476	2000
6	Clover Valley	Lincoln County/Vidler	3620	CV_LCV_6_1	SW	SE	2	06S	68E			67964	2001
6	Clover Valley	Lincoln County/Vidler	3620	CV_LCV_6_2	NE	SW	6	06S	69E			67965	2001
6	Clover Valley	Lincoln County/Vidler	3620	CV_LCV_6_3	NE	SW	11	06S	69E			67966	2001
6	Clover Valley	Lincoln County/Vidler	3620	CV_LCV_6_4	NE	NE	3	06S	70E			67967	2001
6	5Coyote Spring Valley	5Dry Lake Water	4000	CSV_DLW_6_1	NE	SE	28	14S	63E			67892	2001
6	5Black Mountains	5Dry Lake Water	4000	BM_DLW_6_1	NE	NW	36	19S	63E			67893	2001
6	5Garnet Valley	5Dry Lake Water	4000	GV_DLW_6_1	NE	NE	27	18S	63E			67894	2001
6	5Hidden Valley (North)	5Dry Lake Water	4000	HV_DLW_6_1	SW	SE	21	17S	63E			67895	2001
6	5California Wash	5Dry Lake Water	4000	CW_DLW_6_1	NE	NW	4	19S	64E			67896	2001

GROUP NO	HYDROGRAPHIC AREA	GROUNDWATER DEVELOPER	Pumping Rate (af/yr))	PUMPING WELL(S)	QQ	QTR	SEC	TWN	RNG	Top Screen Elev (ft)	Bottom Screen Elev	PERMIT/APPLICATION NOS	PRIORITY/FILING DATE
7	Kane Springs Valley	Lincoln County WD	4344	KSV_LCWD_7_1	SW	SE	25	08S	65E			74147	2006
7	Kane Springs Valley	Lincoln County WD	4344	KSV_LCWD_7_2	SE	SW	31	09S	65E			74148	2006
7	Kane Springs Valley	Lincoln County WD	4344	KSV_LCWD_7_3	SE	SW	6	11S	64E			74149	2006
7	Kane Springs Valley	Lincoln County WD	4344	KSV_LCWD_7_4	SE	SW	11	09S	65E			74150	2006
7	Tule Desert	Lincoln County/Vidler	3620	TD_LCV_7_1	SE	SW	6	10S	69E			76285	2007
7	Tule Desert	Lincoln County/Vidler	3620	TD_LCV_7_2	SW	NW	2	09S	69E			76286	2007
7	Tule Desert	Lincoln County/Vidler	3620	TD_LCV_7_3	NW	SE	27	09S	68E			76287	2007
7	Tule Desert	Lincoln County/Vidler	3620	TD_LCV_7_4	SW	SW	1	08S	69E			76288	2007
7	Tule Desert	Lincoln County/Vidler	3620	TD_LCV_7_5	NE	NW	31	10S	69E			76289	2007
7	Tule Desert	Lincoln County/Vidler	3620	TD_LCV_7_6	NW	NE	29	09S	69E			76290	2007

MODEL COORDINATES

Group	Well	Pumping Rate (af/yr)	UTM East (m)	UTM North (m)	LSE (ft)	Top Screen Elev (ft)	Bottom Screen Elev. (ft)	Row	Col	Top Layer	Bottom Layer	HGU
1	MX-5	4131	688163	4074022	2176	2050	1548	144	67			
1	CSI-3	1114	685892	4077334	2332	2282	1200	131	58			
1	CSI-4	482	682445	4079988	2517	2467	1144	121	44			
1	EPB-2	85	689628	4018599	2440	1685	1226	301	73			
1	EGV-3	632	689784	4018826	2436	1734	1481	301	74			
1	EBM-4	793	689784	4018826	2434	1826	1305	301	74			
1	Duke WS-1	89	686264	4028981	2249	1712	1564	294	60			
1	Duke WS-2	307	686264	4028981	2249	1456	305	294	60			
1	Mirant 1	45	683194	4032122	2566	2266	587	292	47			
1	PW-WS1	149	682733	4031264	2528	2478	548	293	45			
1	US LIME-1	78	690310	4030549	2072	1532	1232	293	76			
1	US LIME-2	62	688253	4028887	2165	1815	1665	294	68			
1	DRY LAKE GV-2	6	686306	4025493	2425	1573	1193	297	60			
1	#2	169	690674	4027890	2366	1483	1403	295	77			
1	#5	112	691053	4029626	2152	1692	1452	294	79			
1	#6	112	690552	4026318	2499	2439	1349	296	77			
1	RW-1	120	693007	4036449	2072	1572	1239	289	87			
1	ECP-1	2	696808	4046393	2234	2172	1109	255	102			
1	TH-1	18	697313	4044763	2206	1969	1106	261	104			
1	Arrow Canyon Well	1681	701103	4067768	1868	1748	1303	169	119			
1	Arrow Canyon Well #2	155	701103	4067768	1870	1400	1128	169	119			
1	MX-6	1	697482	4071381	2288	1831	1351	155	104			
1	Lewis #1	199	702182	4068043	1841	1841	1741	168	123			
1	Lewis #2	346	702339	4067921	1826	1806	1760	169	124			
1	Lewis #3	233	701956	4068021	1868	1868	1768	168	122			
1	Lewis #4	250	702196	4067485	1837	1837	1737	171	123			
1	Lewis #5	353	702196	4067485	1831	1831	1731	171	123			
1	Perkins	621	705772	4065009	1744	1719	1619	180	138			
1	Behmer	653	706110	4064883	1729	1679	1614	181	139			
1	LDS East	320	704558	4066397	1757	1757	1680	175	133			
1	LDS West	476	702825	4066886	1814	1804	1734	173	126			
1	LDS Central	676	704193	4066346	1763	1763	1713	175	131			
1	VVWD2	197	759660	4074456	1676	1609	1471	143	192			
1	VVWD26	735	761450	4078650	1647	1347	847	126	193			
1	VVWD27	1430	759511	4078740	1642	1472	232	126	192			
1	VVWD28	567	757413	4078028	1651	1151	651	128	190			
1	VVWD29	73	755318	4071219	1678	1478	458	156	189			
1	VVWD30	111	762985	4066979	2821	521	-479	173	194			
1	VVWD31	2089	762985	4073582	1878	278	-722	146	194			
1	VVWD32	50	758997	4086619	2136	1738	878	94	191			
1	VVWD33	1294	761445	4086857	2055	1355	15	93	193			
2	KPW-1	500	689961	4098665	-1	-1	-1	52	74	1	6	PC4
2	KSV_CSI_2_1	500	699543	4109817	-1	-1	-1	205	158	1	6	CAU,QCD
2	MX-5	9000	687083	4075781	2176	2050	1548	137	63			
2	CSI-2	1500	687083	4075781	2210	1930	1204	137	63			
2	CSI-1	1600	686122	4074262	2277	2227	1397	143	59			
2	CSI-3	1000	685892	4077334	2332	2282	1200	131	58			
2	CSI-4	500	682445	4079988	2517	2467	1144	121	44			
2	RW-2	2500	687941	4073885	2200	2150	1500	145	66			

Group	Well	Pumping Rate (af/yr)	UTM East (m)	UTM North (m)	LSE (ft)	Top Screen Elev (ft)	Bottom Screen Elev. (ft)	Row	Col	Top Layer	Bottom Layer	HGU
2	EPB-2	95	689628	4018599	2440	1685	1226	301	73			
2	EGV-3	695	689784	4018826	2436	1734	1481	301	74			
2	EBM-4	875	689784	4018826	2434	1826	1305	301	74			
2	Duke WS-1	325	686264	4028981	2249	1712	1564	294	60			
2	Duke WS-2	1120	686264	4028981	2249	1456	305	294	60			
2	Mirant 1	165	683194	4032122	2566	2266	587	292	47			
2	PW-WS1	545	682733	4031264	2528	2478	548	293	45			
2	RW-1	45	693007	4036449	2072	1572	1239	289	87			
2	EBA-1	144	686592	4023911	2431	2418	833	298	61			
2	US LIME-1	0	690310	4030549	2072	1532	1232	293	76			
2	GV_CLC_2_1	158	687405	4027035	-1	-1	-1	295	64	2	6	PC4
2	US LIME-2	126	688253	4028887	2165	1815	1665	294	68			
2	DRY LAKE GV-2	157	686306	4025493	2425	1573	1193	297	60			
2	#2	202	690674	4027890	2366	1483	1403	295	77			
2	#5	133	691053	4029626	2152	1692	1452	294	79			
2	#6	133	690552	4026318	2499	2439	1349	296	77			
2	RW-1	75	693007	4036449	2072	1572	1239	289	87			
2	HV_NPC_2_1	0	679721	4042115	-1	-1	-1	272	33	1	6	PC4
2	CW_NPC_2_1	362	711724	4058934	-1	-1	-1	205	158	1	8	CAU,QCD
2	ECP-1	1000	696808	4046393	2234	2172	1109	255	102			
2	ECP-2	500	696714	4046984	2234	2095	1006	253	101			
2	ECP-3	500	696714	4046984	2276	2202	776	253	101			
2	TH-1	500	697313	4044763	2206	1969	1106	261	104			
2	Arrow Canyon Well	6215	701103	4067768	1868	1748	1303	169	119			
2	Arrow Canyon Well #2	573	701103	4067768	1870	1400	1128	169	119			
2	MX-6	4	697482	4071381	2288	1831	1351	155	104			
2	Lewis #1	680	702182	4068043	1841	1841	1741	168	123			
2	Lewis #2	616	702339	4067921	1826	1806	1760	169	124			
2	Lewis #3	680	701956	4068021	1868	1868	1768	168	122			
2	Lewis #4	680	702196	4067485	1837	1837	1737	171	123			
2	Lewis #5	680	702196	4067485	1831	1831	1731	171	123			
2	Perkins	905	705772	4065009	1744	1719	1619	180	138			
2	Behmer	325	706110	4064883	1729	1679	1614	181	139			
2	LDS East	675	704558	4066397	1757	1757	1680	175	133			
2	LDS West	655	702825	4066886	1814	1804	1734	173	126			
2	LDS Central	1000	704193	4066346	1763	1763	1713	175	131			
2	PW-1	2100	741241	4109052	-1	-1	-1	44	179	1	6	MU1
2	PW-2	7240	738290	4108210	-1	-1	-1	44	177	6	8	PC1
2	VVWD2	369	759660	4074456	1676	1609	1471	143	192			
2	VVWD26	1378	761450	4078650	1647	1347	847	126	193			
2	VVWD27	2681	759511	4078740	1642	1472	232	126	192			
2	VVWD28	1062	757413	4078028	1651	1151	651	128	190			
2	VVWD29	137	755318	4071219	1678	1478	458	156	189			
2	VVWD30	208	762985	4066979	2821	521	-479	173	194			
2	VVWD31	3917	762985	4073582	1878	278	-722	146	194			
2	VVWD32	93	758997	4086619	2136	1738	878	94	191			
2	VVWD33	2426	761445	4086857	2055	1355	15	93	193			
3	CSV_S_3_1	4344	682238	4078963	-1	-1	-1	125	43	1	6	PC4
3	CSV_S_3_2	4344	683231	4070947	-1	-1	-1	157	47	2	6	PC4

Group	Well	Pumping Rate (af/yr)	UTM East (m)	UTM North (m)	LSE (ft)	Top Screen Elev (ft)	Bottom Screen Elev. (ft)	Row	Col	Top Layer	Bottom Layer	HGU
3	CSV_S_3_3	4344	684552	4065360	-1	-1	-1	179	53	6	8	PC4
3	CSV_S_3_4	7240	689342	4080522	-1	-1	-1	118	72	1	6	PC4
3	CSV_S_3_5	7240	690473	4075060	-1	-1	-1	140	76	1	6	PC4
3	CW_MBP_3_1	7240	694468	4055878	-1	-1	-1	217	92	1	6	PC4
3	GV_BNC_3_1	1665	686592	4023911	-1	-1	-1	298	61	1	6	PC4
3	VR_VVWD_3_1	4344	746521	4068213	-1	-1	-1	168	183	1	8	CAU
3	VR_VVWD_3_2	4344	746537	4067408	-1	-1	-1	171	183	1	8	CAU
3	VR_VVWD_3_3	4344	745326	4067373	-1	-1	-1	171	182	1	8	CAU
3	VR_VVWD_3_4	4344	744937	4066557	-1	-1	-1	174	182	1	8	CAU
3	VR_VVWD_3_5	4344	744137	4066132	-1	-1	-1	176	181	1	8	CAU
3	VR_VVWD_3_6	4344	742855	4066265	-1	-1	-1	175	180	1	8	CAU
3	VR_VVWD_3_7	4344	743346	4065303	-1	-1	-1	179	181	1	8	CAU
3	VR_VVWD_3_8	4344	742540	4065279	-1	-1	-1	179	180	1	8	CAU
3	VR_VVWD_3_9	4344	742960	4064486	-1	-1	-1	183	180	1	8	CAU
3	VR_VVWD_3_10	4344	742171	4063655	-1	-1	-1	186	180	1	8	CAU
3	VR_VVWD_3_11	4344	741760	4064048	-1	-1	-1	184	180	1	8	CAU
3	VR_VVWD_3_12	4344	741782	4062837	-1	-1	-1	189	180	2	8	CAU
3	VR_VVWD_3_13	4344	740574	4062416	-1	-1	-1	191	179	1	8	CAU
3	VR_VVWD_3_14	4344	739968	4061477	-1	-1	-1	195	178	1	8	CAU
3	VR_VVWD_3_15	4344	740090	4061372	-1	-1	-1	195	179	1	8	CAU
3	VR_VVWD_3_16	724	750976	4072362	-1	-1	-1	151	186	1	8	CAU
4	VR_VVWD_4_1	724	756012	4073315	-1	-1	-1	147	189	2	8	CAU
4	VR_VVWD_4_2	14480	759648	4153473	-1	-1	-1	14	192	1	6	TVC
4	VR_VVWD_4_3	7240	760121	4151477	-1	-1	-1	16	192	1	6	TVC
4	VR_VVWD_4_4	14480	760458	4151042	-1	-1	-1	16	192	1	6	TVC
4	VR_VVWD_4_5	3620	760867	4140223	-1	-1	-1	23	192	1	8	TVC, MU1
4	VR_VVWD_4_6	7240	755159	4126886	-1	-1	-1	32	189	1	8	KT1, PR1
4	VR_VVWD_4_7	7240	759307	4121920	-1	-1	-1	35	191	1	8	PR1, PC1
4	VR_VVWD_4_8	7240	760751	4119677	-1	-1	-1	37	192	1	6	PCI
4	VR_VVWD_4_9	7240	758898	4117242	-1	-1	-1	38	191	1	8	MUI
4	VR_VVWD_4_10	7240	761474	4112088	-1	-1	-1	42	193	1	8	CAU
4	VR_VVWD_4_11	7240	757706	4101892	-1	-1	-1	49	190	1	8	MUI
4	VR_VVWD_4_12	7240	759219	4154265	-1	-1	-1	14	191	1	8	TVC
4	VR_VVWD_4_13	3620	761400	4094972	-1	-1	-1	61	193	1	8	CAU
4	VR_VVWD_4_14	3620	760370	4080952	-1	-1	-1	117	192	1	8	CAU
4	CW_NPC_4_1	2534	710125	4058049	-1	-1	-1	208	155	9	10	PC4
4	GV_JA_4_1	0	687632	4030678	-1	-1	-1	293	65	3	8	PC4
4	VR_VVWD_4_15	1448	753786	4055843	-1	-1	-1	217	188	1	1	XLB
4	VR_VVWD_4_16	1448	755314	4056800	-1	-1	-1	213	189	1	1	XLB
4	VR_VVWD_4_17	3620	760384	4077693	-1	-1	-1	130	192	1	8	CAU
4	VR_VVWD_4_18	3620	761458	4077424	-1	-1	-1	131	193	2	8	CAU
4	VR_VVWD_4_19	3620	761509	4079118	-1	-1	-1	124	193	1	8	CAU
4	VR_VVWD_4_20	7240	757515	4078196	-1	-1	-1	128	190	1	8	CAU
4	BM_NCG_4_1	555	689784	4018826	-1	-1	-1	301	74	5	8	PC4
4	BM_NCG_4_2	555	689784	4018826	-1	-1	-1	301	74	5	8	PC4
4	BM_NCG_4_3	555	689628	4018599	-1	-1	-1	301	73	1	6	PC4
4	MRS_MVWD_4_1	7240	693846	4075953	-1	-1	-1	137	90	1	6	PC4
4	LMV_MVWD_4_1	7240	723780	4078324	-1	-1	-1	127	168	1	4	PC1
4	LMV_MVWD_4_2	3620	721322	4051839	-1	-1	-1	233	166	1	8	MU2

Group	Well	Pumping Rate (af/yr)	UTM East (m)	UTM North (m)	LSE (ft)	Top Screen Elev (ft)	Bottom Screen Elev. (ft)	Row	Col	Top Layer	Bottom Layer	HGU
4	LMV_MVWD_4_3	3620	720810	4054265	-1	-1	-1	223	166	1	8	MU2, MU1
5	HV_NPC_5_1	4033	686550	4052558	-1	-1	-1	230	61	1	6	PC4
5	HV_NPC_5_2	16131	683834	4042430	-1	-1	-1	271	50	1	6	PC4
5	VR_VVWD_5_1	4344	751181	4074788	-1	-1	-1	141	186	1	8	CAU
5	VR_VVWD_5_2	4344	749179	4074325	-1	-1	-1	143	185	1	8	CAU
5	VR_VVWD_5_3	4344	760294	4079624	-1	-1	-1	122	192	1	8	CAU
5	VR_VVWD_5_4	4344	749762	4067503	-1	-1	-1	170	185	1	6	CAU
5	VR_VVWD_5_5	4344	762057	4074303	-1	-1	-1	143	193	1	8	CAU
5	VR_VVWD_5_6	4344	760059	4073841	-1	-1	-1	145	192	1	8	CAU
5	CSV_CSI_5_1	7240	687269	4083930	-1	-1	-1	105	64	3	8	PC4
5	CSV_CSI_5_2	7240	689711	4083150	-1	-1	-1	108	73	1	8	PC4
5	CSV_CSI_5_3	7240	686320	4077026	-1	-1	-1	132	60	1	8	PC4
5	CSV_CSI_5_4	7240	688078	4083931	-1	-1	-1	105	67	2	8	PC4
5	CSV_CSI_5_5	7240	688662	4090807	-1	-1	-1	77	69	1	6	PC4
5	CSV_CSI_5_6	7240	688299	4077869	-1	-1	-1	129	68	1	6	PC4
5	CSV_CSI_5_7	7240	688339	4076254	-1	-1	-1	135	68	1	6	PC4
5	CSV_CSI_5_8	7240	686712	4077439	-1	-1	-1	131	61	1	6	PC4
5	CSV_CSI_5_9	7240	690381	4078235	-1	-1	-1	128	76	1	6	PC4
5	CSV_CSI_5_10	7240	689877	4076495	-1	-1	-1	134	74	1	6	PC4
5	CSV_CSI_5_11	7240	687179	4087152	-1	-1	-1	92	63	1	8	CAU, PC4
5	CSV_CSI_5_12	7240	688517	4082322	-1	-1	-1	111	69	1	8	PC4
5	CSV_CSI_5_13	7240	688420	4085545	-1	-1	-1	98	68	3	8	PC4
5	CSV_CSI_5_14	7240	688278	4090398	-1	-1	-1	79	68	1	6	PC4
5	CSV_CSI_5_15	7240	686170	4094804	-1	-1	-1	61	59	5	8	PC4
5	CSV_DLW_5_1	4000	684692	4062157	-1	-1	-1	192	53	1	6	PC4
5	CSV_CSI_5_16	7240	689362	4081128	-1	-1	-1	116	72	1	6	PC4
5	CSV_CSI_5_17	7240	687766	4080704	-1	-1	-1	118	66	1	6	PC4
5	CSV_CSI_5_18	7240	685738	4081074	-1	-1	-1	116	57	3	8	PC4
5	CSV_CSI_5_19	7240	685692	4082687	-1	-1	-1	110	57	4	8	PC4
5	CSV_CSI_5_20	7240	689300	4083546	-1	-1	-1	106	72	1	6	PC4
5	CSV_CSI_5_21	7240	688465	4084337	-1	-1	-1	103	68	2	8	PC4
5	CSV_CSI_5_22	7240	687301	4082720	-1	-1	-1	110	64	2	8	PC4
5	HV_DLW_5_1	4000	684300	4035822	-1	-1	-1	289	52	1	6	PC4
5	BM_DLW_5_1	4000	689185	4014613	-1	-1	-1	304	71	8	9	PC4
5	GV_DLW_5_1	2000	688969	4046566	-1	-1	-1	254	70	1	6	PC4
5	GV_DLW_5_2	2000	688539	4047764	-1	-1	-1	249	69	1	6	PC4
5	CW_DLW_5_1	4000	703978	4034249	-1	-1	-1	291	130	8	10	PC4
5	GV_NPC_5_1	807	694347	4039258	-1	-1	-1	283	92	1	6	PC4
5	GV_NPC_5_2	807	694649	4039265	-1	-1	-1	283	93	1	6	PC4
5	VR_LCWD_5_1	7240	759657	4096709	-1	-1	-1	55	192	1	8	CAU
5	VR_LCWD_5_2	7240	759866	4091705	-1	-1	-1	74	192	1	8	CAU
5	VR_VVWD_5_1	4344	760294	4079624	-1	-1	-1	122	192	1	8	CAU
5	VR_VVWD_5_2	4344	745752	4100765	-1	-1	-1	49	182	1	6	KTI, PRI
5	VR_VVWD_5_3	4344	744901	4102353	-1	-1	-1	48	182	1	5	KTI
5	TD_VVWD_5_1	4344	740092	4101413	-1	-1	-1	49	179	1	6	PC1
5	TD_VVWD_5_2	4344	737668	4102555	-1	-1	-1	48	177	2	6	PC1
5	TD_VVWD_5_3	4344	737625	4104165	-1	-1	-1	47	177	2	6	PC1
6	ECP-2	1300	696714	4046984	2234	2095	1006	253	101			PC4
6	ECP-1	2600	696808	4046393	2234	2172	1109	255	102			PC4

Group	Well	Pumping Rate (af/yr)	UTM East (m)	UTM North (m)	LSE (ft)	Top Screen Elev (ft)	Bottom Screen Elev. (ft)	Row	Col	Top Layer	Bottom Layer	HGU
6	CW_MBP_6_1	600	696607	4045627	-1	-1	-1	258	101	1	6	PC4
6	CW_MBP_6_2	600	696305	4045400	-1	-1	-1	259	100	1	6	PC4
6	CW_MBP_6_3	600	696644	4045194	-1	-1	-1	260	101	1	6	PC4
6	CW_MBP_6_4	1300	696020	4040580	-1	-1	-1	278	99	1	6	PC4
6	TH-1	724	697313	4044763	2206	1969	1106	261	104			
6	CV_LCV_6_1	3620	734231	4148778	-1	-1	-1	17	175	1	6	TVC
6	CV_LCV_6_2	3620	737326	4148592	-1	-1	-1	17	177	1	6	TVC
6	CV_LCV_6_3	3620	743662	4147312	-1	-1	-1	18	181	1	6	TVC
6	CV_LCV_6_4	3620	751924	4149285	-1	-1	-1	17	186	1	6	TVC
6	CSV_DLW_6_1	4000	684692	4062157	-1	-1	-1	192	53	1	6	PC4
6	BM_DLW_6_1	4000	689185	4014613	-1	-1	-1	304	71	8	9	PC4
6	GV_DLW_6_1	4000	686306	4025493	-1	-1	-1	297	60	1	6	PC4
6	HV_DLW_6_1	4000	684300	4035822	-1	-1	-1	289	52	1	6	PC4
6	CW_DLW_6_1	4000	693989	4022382	-1	-1	-1	299	90	1	6	PC4
7	KSV_LCWD_7_1	4344	737293	4148614	-1	-1	-1	17	177	1	6	TVC
7	KSV_LCWD_7_2	4344	699962	4111206	-1	-1	-1	42	114	1	6	PC4
7	KSV_LCWD_7_3	4344	690192	4099255	-1	-1	-1	51	75	1	4	PC4
7	KSV_LCWD_7_4	4344	705883	4117247	-1	-1	-1	38	138	1	6	TVC
7	TD_LCV_7_1	3620	738290	4108210	-1	-1	-1	44	177	6	8	PC1
7	TD_LCV_7_2	3620	744018	4118829	-1	-1	-1	37	181	1	6	CAU,TVC,MU1
7	TD_LCV_7_3	3620	733795	4111709	-1	-1	-1	42	174	6	8	PC1
7	TD_LCV_7_4	3620	745430	4129017	-1	-1	-1	30	182	1	6	MU1
7	TD_LCV_7_5	3620	738482	4101369	-1	-1	-1	49	177	3	6	PC1
7	TD_LCV_7_6	3620	740169	4112689	-1	-1	-1	41	179	1	6	CAU,MU1