RECLAMATION
*Managing Water in the West*

FOR OFFICIAL USE ONLY

**Technical Memorandum No. 3437-NCA-FEA-2016-03**
**Technical Memo and Appendices A-D**

# Feasibility Design Steady State Hydraulics and Pump Selection

**North Central Arizona Water Supply Study, Arizona**
**Lower Colorado Region**



FOR OFFICIAL USE ONLY

## Mission Statements

The mission of the Department of the Interior is to protect and manage the Nation's natural resources and cultural heritage; provide scientific and other information about those resources; and honor its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

**BUREAU OF RECLAMATION**
**Technical Service Center, Denver, Colorado**
**Water Conveyance Group, 86-68140**

**Technical Memorandum No. 3437-NCA-FEA-2016-03**

# Feasibility Design Steady State Hydraulics and Pump Selection

## North Central Arizona Water Supply Study, Arizona Lower Colorado Region


Prepared: Michelle Norris
Civil Engineer, Water Conveyance Group 8140

Prepared: Matthew Shaw
Mechanical Engineer, Hydraulic Equipment Group 8420

Technical Review: Linda Bowles
Civil Engineer, Water Conveyance Group 8140

Technical Approval: Chou Cha, P.E.
Civil Engineer, Civil Structures Group 8150

Peer Review: Timothy P. Brown, P.E.
Civil Engineer, Civil Structures Group 8150


Date



| REVISIONS | | | | | |
|---|---|---|---|---|---|
| Date | Description | Prepared | Checked | Technical Approval | Peer Review |
| | | | | | |

# Table of Contents

Page

# 1. Report Purpose

The purpose of this Technical Memorandum is to communicate the feasibility design steady state hydraulic analysis and pump selection progress for the North Central Arizona Water Supply Feasibility Study (NCAWSFS). This report is a supplemental report addressing only the steady state hydraulics and pump selection and supports the overarching North Central Arizona Pipeline, North Central Arizona Water Supply Study Feasibility Report. The information provide in this study could be used for future transient analysis.

# 2. Project Background

## 2.1 Overall Background

The purpose of the proposed NCAWSFS is to construct a filtered bulk surface water supply pipeline to meet existing and future municipal and industrial water demands of the NCAWSFS participants. This water supply is necessary to supplement or replace poor quality water and to meet a portion of the NCAWSFS participants' projected water demands through 2050.

## 2.2 Alternative/Alignment Discussion

There are two intake options at Lake Powell and two initial pipe alignment connections. Hydraulically, the two intake options are similar, however the east intake option requires approximately 12,200 feet of additional pipe when compared to the west intake option. Downstream of the LeChee tank turnout, the alignment is identical for both alternatives.

In November, 2015, Reclamation Phoenix Area Office (PXAO) and Technical Service Center (TSC) decided to select the east intake as an alternative to evaluate the steady state hydraulics and pump selection. This decision was made as a starting point for the hydraulic analysis and did not constitute a final and preferred selection of the intake site and beginning of pipe alignment.

The project pipeline alignment includes all features to convey water to NCAWSFS participants between Lake Powell to the Town of Gray Mountain, Arizona, including spurs to Bitter Springs, Tuba City, and Keams Canyon, Arizona. The project includes the construction of a new pipeline and various appurtenant features such as reservoir-side pumping plant, booster/re-lift plants, forebay tanks, water storage tanks, air chambers, regulating tanks, forebay tanks, pressure reducing valves, valve vaults, and participant delivery vaults within a study area located in Northern Arizona.

Transmission lines are primarily along State Highway 89 between Bodaway Gap to Bitter Springs and along State Highway 160 between State Highway 89 to Tuba City.

# 3. Steady State Modeling and Pump Selection

This section presents additional detail on the design criteria for the transmission line and turnouts including pipeline hydraulics and design requirements, pipeline appurtenances, pipeline surge, pumping plants and associated facilities, and in-line storage facilities.

## 3.1 Steady State Modeling

### 3.1.1 Pipeline

A pipeline beginning at Glen Canyon Dam and Reservoir and ending at Gray Mountain including associated turnouts will serve as the primary conveyance to deliver water. The pipeline is sized to deliver year 2050 maximum day demands, with diameters as large as 40" at the intake, to 4" on low flow tank turnouts.

### 3.1.1 Pipeline Hydraulics

NCAWSFS hydraulics and pipeline sizing were based on the maximum day demands from 2050, shown in Appendix A. The hydraulic gradient profile is presented in Appendix B.

As discussed in Section 2, the pipeline intake begins downstream of Glen Canyon Dam. The ground elevation downstream of the dam at the site of the proposed reservoir side pumping plant is approximately El. 3655' and the tank elevation at the highest delivery point is approximately El. 6433'. The total rise is approximately 2778 feet. The static head experienced by the system is reduced by on-line water tanks along the alignment, and is generally not designed to exceed 230 psi in order to accommodate a variety of pipe material options in final design. Some areas along the Keams Canyon Spur required higher pressure systems – as high as 270 psi – in order to eliminate the need for pump stations or tanks on the side of steep mesas. These areas are further discussed in Section 3.2.

The hydraulic grade line along the conduit and at each participant delivery location was calculated for maximum day demand in year 2050 and in agreement with existing tank heights provided by PXAO, shown in Appendix C. If an existing tank is not present or if the full tank water surface elevation is unknown, the desired pressure by the NCAWSFS participants would need to be further clarified in the final design phase(s). The hydraulic analysis includes a hydraulic grade line profile illustrating the ground profile, and hydraulic profile. The ground profile was based on contour data from LiDAR data provided to TSC in 2012, and from the 2013 IFSAR data provided for the Tuba City/Hopi Spur.

Hydraulic analyses that predict the pipe hydraulic grade line for each reach and spur were developed using Microsoft Excel and using the Bentley WaterCAD V8i (Bentley, 2014) software program. Pipeline hydraulics for the NCAWSFS feasibility level design were developed in accordance with Reclamation's *Design Standards No. 3, Water Conveyance Systems*, Chapter 11, "General Hydraulic Considerations" (Reclamation, 1994). The Hazen-Williams method was used to calculate pipe friction losses, using a nominal value of 145 for the C coefficient. Typical bend and other minor losses were calculated using

methods described in Chapter 11 of Reclamation (1994) and were applied based on the lengths and alignments of the segment reaches. Surge pressures in the pipe were estimated by adding a 30-percent factor to the static design pressure of the pipe – a full transient analysis has yet to be completed at this stage.

## 3.2 Reach and Spur Descriptions

The easting and northing coordinates of all tanks and pump stations in Arizona State Plane Coordinates are included in the appendices. Since the completion of this model, PXAO has ground truthed the pump site locations and found that 11 of the pump stations and three of the tanks need to be relocated up or downstream slightly in order to accommodate existing utilities, steep slopes, or significant washes. TSC has not evaluated the movement of these pumping plants as part of this study.

### 3.2.1 Lake Powell to Tuba City Spur Tee

This reach consists of five pumping plants located along the reach from Lake Powell to the Tuba City spur. Each plant would include canned vertical turbine pumps and will have a forebay tank, air chamber, and electrical power substation. The plant facility would include auxiliary mechanical systems and HVAC units. There are four in-line regulating tank site locations along this reach of the pipeline, listed in Appendix D. Turnouts along this reach include Page Tank, LeChee Tank, Coppermine Tank, Bodaway Gap Tank, and the Bitter Springs Spur. The main transmission line continues southward from the end of this reach.

### 3.2.2 Bitter Springs Spur

This reach consists of one pumping plant located along the reach from Bodaway Gap to Bitter Springs. Each plant would include canned vertical turbine pumps and will have a forebay tank, air chamber, and electrical power substation. The plant facility would include auxiliary mechanical systems and HVAC units. One additional booster plant will be required at the Cedar Ridge turnout tee. There is one pressure regulating tank site location along this reach of the pipeline, outlined in Appendix D. Turnouts along this reach include Cedar Ridge Tank, and the end point at Bitter Springs Tank.

### 3.2.3 Tuba City Spur Tee to Gray Mountain

This reach consists of two pumping plants located along the reach from Tuba City Spur Tee to the southernmost delivery point of Gray Mountain. Each plant would include canned vertical turbine pumps and will have a forebay tank, air chamber, and electrical power substation. The plant facility would include auxiliary mechanical systems and HVAC units. There are eight in-line regulating tank site locations along this reach of the pipeline, listed in Appendix D. Turnouts along this reach include Cameron Tank, and the termination of the reach at Gray Mountain.

### 3.2.4 Hopi/Tuba City Spur to Keams Canyon

This reach consists of ten pumping plants located along the reach from Tuba City Spur Tee to the easternmost delivery point of Keams Canyon. Each plant would include canned vertical turbine pumps and will have a forebay tank, air chamber, and electrical power substation. The plant facility would include auxiliary mechanical systems and HVAC units. There are two in-line regulating tank site locations along this reach of the pipeline, listed in Appendix C. Turnouts along this reach include Tuba City Tank, Moenkopi Tank, Coal Mine Tank, Howell Mesa Tank, Hotevilla Tank, Oraibi Tank, Kykotsmovi Tank, Shungopavi Tank, Sipaulovi Top Tank, Mishongnovi Tank, Sipaulovi Lower Tank, Polacca West Tank, Polacca East Tank, and the termination of the reach at Keams Canyon Tank.

## 3.3 Pump Selection

Pumps were selected to meet the capacity and total head of the feasibility level steady state design. Pump curves and pump data sheet can be seen in Appendix D.

### 3.3.1 Assumptions – Pumps

Pump selection for the NCAWSFS relied on the following design assumptions. Further explanation of each assumption follows this summarized list.

- Treated, potable or not potable water with particulates and biologic material removed.
- Chlorine concentrations are less than 3 parts per million (ppm).
- Pumping plants are indoors.
- Ambient temperature in the pumping plants is less than 104 °F (40 °C).
- Each pumping plant has one installed spare pump.
- Canned vertical turbine pumps are used at all pumping plants to simplify pump selection at the feasibility stage.
- Fixed speed pumps with induction motors.
- Range of flow set by the number of identical pumps.
- Forebay tank water surface elevations will meet the pumping plant design requirements.
- Suction pressure of booster pumping plants will meet the pumping plant design requirements.

**Treated water:**
Water is treated to remove biologic material, including mussels, and particulates but may or may not be potable. Invasive mussel species pose a significant reliability issue. The NCAWSFS assumes that all water in the water supply is free of mussels. Water treatment methods and facilities are not part of this study.

**Chlorine concentrations are less than 3 ppm:**
Chlorine concentration levels impact pump impeller material selection, which in turn affects pump efficiency. To provide the most efficient pump the NCAWSFS assumes that chlorine levels are less than 3 ppm, which allows for the most options of material selection.

**Pumping plants are indoors:**
The pumps and motors are indoors protected from the weather.

**Ambient pumping plant temperature less than 104 °F (40 °C):**
Pumping plant ambient temperature will be conditioned as required to less than the pump motor's rating of 40 degrees Celsius.

**Installed spare pump:**
Reliability of municipal water supplies is a critical design consideration. To ensure that each pumping plant can operate, even with one pump removed for maintenance, the study assumes that one pump in each pumping plant is a spare pump. Spare pumps also prolong the operational lifetime of each pumping plant by cycling through each installed pump. Cycling through installed pumps means that even at peak flow, one pump sits idle.

**Canned vertical turbine pumps:**
Pump selection for the NCAWSFS focused on canned vertical turbine pumps. Canned vertical turbine pumps were chosen because this type of pump was more widely available given the pumping plant head and flow requirements of the feasibility study. The design of vertical turbine pumps can also accommodate high heads over a wide range of flows by combining multiple pump stages. The ability to pump a wide range of flows at high pressure head means that the project may be able to lift water with fewer pumping plants.

Drawbacks of pumping plants with canned vertical turbine pumps are increased maintenance and excavation costs. Compared to horizontal split case pumps, canned vertical turbine pumps require more excavation to set the can into the ground. Due to their design, vertical turbine pumps with more moving parts require more routine maintenance than a horizontal split case pumps.

**Fixed speed pumps with induction motors:**
Variable speed drives were not part of our feasibility study. If required, pumping plant flow output would be changed by turning pumps on or off.

**Range of flow set by the number of pumps:**
Minimum flow requirements were not part of the feasibility design study. The range of flow at each pumping plant would be set by the number of identical pumps per pumping plant. For example: at a pumping plant with 4 active pumps (and 1 installed spare), each pump supplies approximately 1/4 of the total pumping plant design flow. Subsequent design efforts should document the minimum flow

for each pumping plant to provide pump selections that more closely match the operation conditions. The range of flows the pumps would operate over was not analyzed and was not accounted for in the selection of the number of pumps.

**Forebay tank water surface elevations:**
Minimum forebay tank water surface elevations will allow gravity flow to pumps and provide adequate net positive suction head to exceed the minimum net positive suction head requirements of the pumps.

**Booster pumping plant suction pressure:**
Pressure on the suction side of the booster plants will be adequate to supply water to the pumps and adequate net positive suction head to exceed the minimum net positive suction head requirements of the pumps.

## 3.4 Recommended Considerations for Final Design

### 3.4.1 Steady State Hydraulics

The steady state hydraulics for this feasibility study is based on the current and most available alignment. As the design continues to be refined into feasibility and final design, it is recommended that the steady state hydraulics be updated to maintain consistency between the alignment changes and hydraulic modeling. Although the hydraulics is not significantly impacted by the location adjustments of the pumping plant as ground truthed, the steady state hydraulic model should be updated with the adjusted location of the pumping plants as well.

### 3.4.2 Pumps

Pump selection for the NCAWSFS focused on having the same style of pump at every facility in the project (canned vertical turbine type pumps) to provide a baseline comparison and simplify pump selection at the feasibility stage. Pumping plants with low flows and high heads typically require pumps with multiple stages. Pumps with more stages require additional maintenance, and five of the pumping plants for the NCAWSFS have pumps with more than 6 stages. Pumps with greater than 6 stages are not recommended due to the increased number of moving parts and associated increased maintenance. However, the pumping plants below had pumps with more than 6 stages:

| Pumping Plant Name | Number of stages | Flow* | | Rated TDH | |
|---|---|---|---|---|---|
| | | (gpm) | (cfs) | (feet) | (psi) |
| Pumping Plant 6 | 7 | 1,049.57 | 2.34 | 304 | 130 |
| Pumping Plant 7 | 22 | 31.93 | 0.07 | 384.02 | 170 |
| Bitter Springs | 14 | 457.32 | 1.02 | 584 | 250 |
| Cedar Ridge Turnout Booster | 10 | 139.05 | 0.31 | 139 | 60 |
| Hopi 10 Pumping Plant | 10 | 392.43 | 0.87 | 514 | 220 |

* Flow includes 3% wear factor

Final design efforts should consider other design alternatives such as using a different pump type, adding pumping plants and/or adjusting the pipe alignment to allow for a wider selection of pump types. Some of the feasibility pump selections, limited by the assumptions made for this feasibility study, would be unsuitable at final design. Final design efforts should compare the cost of pumps with more moving parts and specialized high pressure components such as ANSI high pressure valves against the cost of adding more pumping plants to the system with pumps that require less maintenance such as horizontal split case pumps and lower pressure AWWA valves.

# 4. References

[1] “Design Standards No. 3 Water Conveyance Systems, Chapter 11 General Hydraulic Consideration,” Bureau of Reclamation, Denver, Colorado 1994.

[2] "ANSI/HI 9.8, Rotodynamic Pumps for Pump Intake Design", Hydraulic Institute, Parsippany, New Jersey, 2012

[3] "ANSI/HI 2.3, Rotodynamic (Vertical) Pumps for Design and Application", Hydraulic Institute, Parsippany, New Jersey, 2013

[4] "NEMA MG 10, Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors", National Electric Manufactures Association, Rosslyn, Virginia, 2013.

# APPENDIX A

# Participant Water Demands

TURNOUTS, TANK COORDINATES AND DEMAND - NCAWSFS

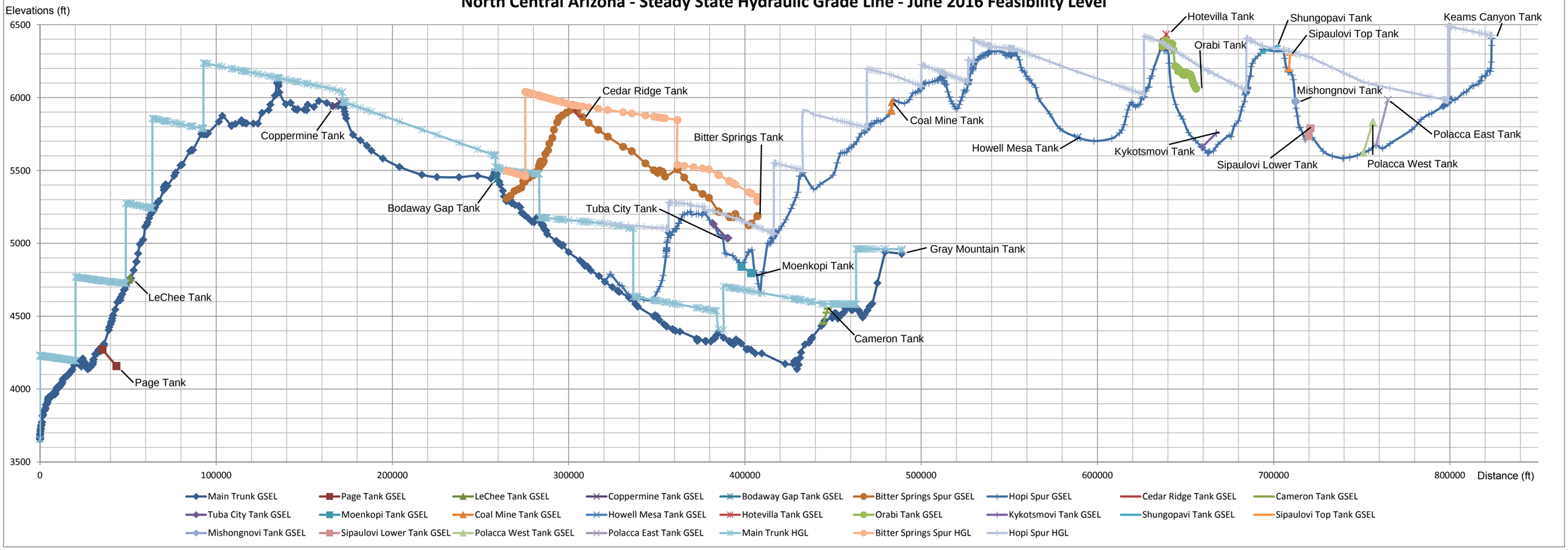
| NAME | TURNOUTS | | | | EXISTING TANKS | | | DEMAND AT TURNOUT [2] (AFY) (with Peaking Factor) | DEMAND AT TURNOUT (cfs) (with Peaking Factor) | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| | AZ STATE PLANE | | GRD ELEV | STATION[1] | AZ STATE PLANE | | GRD ELEV | | | |
| | NORTHERN | EASTERN | | | NORTHERN | EASTERN | | | | |
| **MAIN TRUNK - INTAKE TO LECHEE - EAST ALTERNATIVE** | | | | | | | | | | |
| Page (east) | 2145314 | 838930 | 4273 | 363+00 | 2150295 | 835616 | 4388 | 6,185 | 8.54 | |
| LeChee (east) | 2131271 | 838221 | 4752 | 513+50 | 2131039 | 839010 | 4810 | 5,841 | 8.07 | |
| **MAIN TRUNK - INTAKE TO LECHEE -WEST ALTERNATIVE** | | | | | | | | | | |
| Page (west) | 2150542 | 827212 | 4076 | 148+27.9650 | 2150295 | 835616 | 4388 | 6,185 | 8.54 | |
| LeChee (west) | 2131002 | 837965 | 4750 | 394+00 | 2131038 | 839010 | 4810 | 5,841 | 8.07 | |
| **MAIN TRUNK - LECHEE TO BODAWAY/GAP** | | | | | | | | | | |
| Copper Mine | 2019444 | 849944 | 5942 | 2156+00 | 2020722 | 853377 | 6130 | 551 | 0.76 | |
| Bodaway/Gap | 1929797 | 839810 | 5485 | 3076+00 | 1929184 | 840327 | 5473 | 1,003 | 1.39 | |
| **MAIN TRUNK - BODAWAY/ GAP TO GRAY MOUNTAIN** | | | | | | | | | | |
| Cameron | 1764029 | 843847 | 4447 | 4937+00 | 1765077 | 841458 | 5431 | 1,590 | 2.20 | |
| Gray Mountain | 1731249 | 833192 | 4940 | 5288+19.13 | 1735101 | 824555 | 4929 | 51 | 0.07 | This area has been proposed as a growth area. At final design, further investigate the demand. May require increasing the demand increased to 78 AFY. |
| **BITTER SPRINGS SPUR - BODAWAY/ GAP TO BITTER SPRINGS** | | | | | | | | | | |
| Cedar Ridge | 1961789 | 815677 | 5923 | 388+00 | 1963434 | 818504 | 6058 | 220 | 0.30 | |
| Bitter Springs | 2051097 | 778522 | 5134 | 1398+68.17 | 2050889 | 781992 | 5270 | 500 | 0.69 | Demand data from DOWL HKM dated 10/20/2008. |
| **TUBA CITY SEGMENT - US 89/MOENAVE TO TUBA CITY** | | | | | | | | | | |
| Tuba City | 1877078 | 902500 | 5132 | 625+07.4584 | 1875283 | 901344 | 5120 | 11,325 | 15.64 | |
| **HOPI SEGMENT - TUBA CITY TO KEAMS CANYON** | | | | | | | | | | |
| Moenkopi | 1864993 | 909810 | 4839 | 170+00 | 1862860 | 905197 | 4917 | 1,318 | 1.82 | Demand includes Moenkopi and Lower Moenkopo. |
| Coal Mine | 1818784 | 964425 | 5910 | 1019+00 | 1818232 | 964126 | 5970 | 306 | 0.42 | |
| Howell Mesa | 1812221 | 1039997 | 5727 | 2076+00 | | | 5727 | 276 | 0.38 | |
| Hotevilla | 1791192 | 1071368 | 6350 | 2558+00 | 1790145 | 1070108 | 6430 | 1,454 | 2.01 | Includes demands for Hotevilla and Bacavi. |
| Oraibi | 1791191 | 1071370 | 6350 | 2558+02 | | | 6062 | 78 | 0.11 | |
| Kykotsmovi | 1781562 | 1089529 | 5660 | 2783+00 | 1776907 | 1083646 | 5775 | 500 | 0.69 | |
| Shungopavi | 1764454 | 1111645 | 6305 | 3116+00 | 1756206 | 1110305 | 6352 | 792 | 1.09 | |
| Sipaulovi Top | 1752850 | 1121403 | 6187 | 3274+00 | 1752490 | 1121067 | 6295 | 369 | 0.51 | |
| Mishongnovi (Ned L). | 1750864 | 1121450 | 5977 | 3330+00 | 1750778 | 1121494 | 5987 | 50 | 0.07 | |
| Sipaulovi Lower | 1747097 | 1120897 | 5737 | 3387+00 | 1748043 | 1121131 | 5793 | 199 | 0.27 | |
| Polacca West | 1755784 | 1150051 | 5623 | 3699+00 | 1759883 | 1147298 | 5825 | 729 | 1.01 | |
| Polacca East | 1760478 | 1154943 | 5671 | 3770+00 | 1765786 | 1154610 | 5986 | 1,200 | 1.66 | The demand of 1,929 AFY was split between Polacca East and Polacca West turnouts. |
| Keams Canyon | 1755208 | 1211914 | 6408 | 4426+96.70 | 1755208 | 1211914 | 6408 | 615 | 0.85 | |

[1] Stationing shown is based on stationing along each segment.

[2] Demands were taken from Table 3-6 of the North Central Arizona Water Supply Feasibility Study (NCAWSFS) Design Report-Draft dated 1/15/14 unless otherwise noted.

# APPENDIX B

# North Central Arizona - Steady State Hydraulic Grade Line - June 2016 Feasibility Level



# APPENDIX C

# Tank Summary Table

| | Label | Tank Base Elevation (ft) | Maximum Tank Water Elevation (ft) | HGL at Turnout Tee (ft) | X (ft) | Y (ft) | Pumped or Gravity Fed? |
|---|---|---|---|---|---|---|---|
| End of Pipe (Delivery) Tanks | T-Existing Bitter Springs | 5,264.84 | 5,287.58 | 5,340.18 | 781,882.41 | 2,050,905.62 | Gravity |
| | T-Existing Bodaway Gap | 5,473.06 | 5,492.65 | 5,602.47 | 840,347.62 | 1,929,095.56 | Gravity |
| | T-Existing Cameron | 4,531.00 | 4,551.00 | 4,584.57 | 841,457.55 | 1,765,077.42 | Gravity |
| | T-Existing Cedar Ridge | 6,051.48 | 6,075.13 | 5,948.73 | 818,439.43 | 1,963,387.68 | Pumped |
| | T-Existing Coal Mine | 5,969.81 | 5,998.31 | 6,156.66 | 964,106.90 | 1,818,113.79 | Gravity |
| | T-Existing Copper Mine | 6,127.33 | 6,143.51 | 6,059.36 | 853,458.48 | 2,020,722.97 | Pumped |
| | T-Existing Gray Mountain | 4,929.00 | 4,949.00 | N/A end of line | 824,554.84 | 1,735,100.97 | Pumped |
| | T-Existing Hotevilla | 6,433.72 | 6,467.23 | 6,377.56 | 1,070,108.49 | 1,790,145.09 | Pumped |
| | T-Existing Keams Canyon | 6,408.00 | 6,428.00 | N/A end of line | 1,211,913.75 | 1,755,208.05 | Pumped |
| | T-Existing Kykotsmovi | 5,755.37 | 5,770.02 | 6,204.42 | 1,083,646.03 | 1,776,907.08 | Gravity |
| | T-Existing LeChee | 4,807.76 | 4,833.48 | 5,272.94 | 839,096.96 | 2,131,005.29 | Gravity |
| | T-Existing Mishongnovi | 5,978.07 | 5,985.27 | 6,304.69 | 1,121,494.05 | 1,750,778.16 | Gravity |
| | T-Existing Moenkopi | 4,917.00 | 4,937.00 | 5,156.33 | 905,196.87 | 1,862,859.68 | Gravity |
| | T-Existing Page | 4,377.57 | 4,419.86 | 4,743.07 | 835,702.10 | 2,150,281.14 | Gravity |
| | T-Existing Polacca East | 5,984.51 | 6,008.16 | 6,084.65 | 1,154,610.25 | 1,765,786.33 | Gravity |
| | T-Existing Polacca West | 5,831.59 | 5,870.25 | 6,106.00 | 1,147,298.27 | 1,759,883.16 | Gravity |
| | T-Existing Shungopavi Water Tower | 6,465.27 | 6,488.99 | 6,357.97 | 1,110,305.52 | 1,756,206.33 | Pumped |
| | T-Existing Sipaulovi Lower | 5,788.86 | 5,812.52 | 6,281.46 | 1,121,130.61 | 1,748,042.78 | Gravity |
| | T-Existing Sipaulovi Top | 6,293.25 | 6,310.81 | 6,317.36 | 1,121,066.60 | 1,752,489.50 | Gravity |
| | T-Existing Tuba City | 5,036.25 | 5,074.11 | 5,222.53 | 904,523.94 | 1,868,810.73 | Gravity |
| | T-Proposed Howell Mesa | 5,727.00 | 5,747.00 | 6,176.74 | 1,039,986.92 | 1,812,269.52 | Gravity |
| | T-Proposed Oraibi | 6,062.00 | 6,082.00 | 6,377.55 | 1,078,062.15 | 1,776,538.95 | Gravity |
| Pump Plant Forebay Tanks | T-Forebay Bitter Springs Spur PP | 5,440.45 | 5,460.00 | N/A, in line | 827,722.24 | 1,937,896.41 | Pumped |
| | T-Forebay Hopi PP1 | 5,077.00 | 5,101.00 | N/A, in line | 879,467.57 | 1,868,244.33 | Pumped |
| | T-Forebay Hopi PP2 | 5,047.35 | 5,062.00 | N/A, in line | 916,029.50 | 1,849,326.86 | Gravity |
| | T-Forebay Hopi PP3 | 5,484.02 | 5,502.00 | N/A, in line | 916,818.65 | 1,833,334.29 | Pumped |
| | T-Forebay Hopi PP4 | 5,776.80 | 5,798.00 | N/A, in line | 951,524.57 | 1,824,151.12 | Pumped |
| | T-Forebay Hopi PP5 | 6,062.68 | 6,077.00 | N/A, in line | 979,816.58 | 1,811,238.16 | Pumped |
| | T-Forebay Hopi PP6 | 6,097.38 | 6,109.00 | N/A, in line | 1,001,877.03 | 1,796,922.26 | Pumped |
| | T-Forebay Hopi PP7 | 6,229.28 | 6,244.00 | N/A, in line | 1,004,255.73 | 1,794,886.03 | Pumped |
| | T-Forebay Hopi PP8 | 6,005.00 | 6,022.00 | N/A, in line | 1,069,163.26 | 1,800,190.20 | Gravity |
| | T-Forebay Hopi PP9 | 6,032.26 | 6,049.00 | N/A, in line | 1,107,804.91 | 1,769,930.16 | Gravity |
| | T-Forebay Hopi PP10 | 5,964.07 | 5,979.07 | N/A, in line | 1,192,231.29 | 1,764,983.40 | Gravity |
| | T-Forebay PP2 | 4,180.00 | 4,195.00 | N/A, in line | 849,439.34 | 2,147,326.97 | Pumped |
| | T-Forebay PP3 | 4,710.00 | 4,725.00 | N/A, in line | 838,334.71 | 2,132,920.42 | Pumped |
| | T-Forebay PP4 | 5,222.00 | 5,241.00 | N/A, in line | 839,647.36 | 2,118,666.50 | Pumped |
| | T-Forebay PP5 | 5,769.89 | 5,788.00 | N/A, in line | 839,209.35 | 2,089,905.58 | Pumped |
| | T-Forebay PP6 | 4,392.56 | 4,412.00 | N/A, in line | 855,289.36 | 1,818,181.97 | Gravity |
| | T-Forebay PP7 | 4,564.00 | 4,582.00 | N/A, in line | 839,407.00 | 1,746,378.87 | Pumped |
| In-Line Regulating Tanks | T-Hopi Reg Tank 1 | 5,218.00 | 5,258.00 | N/A, in line | 890,705.13 | 1,873,761.41 | Pumped |
| | T-Hopi Reg Tank 2 | 5,214.86 | 5,232.00 | N/A, in line | 897,791.04 | 1,876,728.04 | Gravity |
| | T-Hopi Reg Tank 3 | 6,155.00 | 6,170.00 | N/A, in line | 990,942.41 | 1,805,671.70 | Pumped |
| | T-Hopi Reg Tank 4 | 6,320.00 | 6,350.00 | N/A, in line | 1,007,896.24 | 1,787,598.05 | Pumped |
| | T-Hopi Reg Tank 5 | 6,307.00 | 6,335.00 | N/A, in line | 1,014,720.98 | 1,798,175.90 | Gravity |
| | T-Hopi Reg Tank 6 | 6,358.00 | 6,378.00 | N/A, in line | 1,071,288.17 | 1,791,264.76 | Pumped |
| | T-Hopi Reg Tank 7 | 6,333.00 | 6,353.00 | N/A, in line | 1,112,420.12 | 1,763,757.10 | Pumped |
| | T-Hopi Reg Tank 8 | 6,317.39 | 6,329.00 | N/A, in line | 1,119,875.68 | 1,755,148.10 | Gravity |
| | T-Reg Tank 1 Bitter Springs Spur | 5,925.00 | 5,950.00 | N/A, in line | 815,714.31 | 1,961,696.16 | Pumped |
| | T-Reg Tank 2 Bitter Springs Spur | 5,508.00 | 5,538.00 | N/A, in line | 792,331.61 | 2,014,688.71 | Gravity |
| | T-Reg Tank 1 | 6,109.28 | 6,135.00 | N/A, in line | 838,684.38 | 2,048,067.00 | Pumped |
| | T-Reg Tank 2 | 5,943.00 | 5,973.00 | N/A, in line | 850,544.76 | 2,014,011.17 | Gravity |
| | T-Reg Tank 3 | 5,493.00 | 5,523.00 | N/A, in line | 839,679.33 | 1,929,675.08 | Gravity |
| | T-Reg Tank 4 | 5,153.00 | 5,178.00 | N/A, in line | 844,672.76 | 1,914,947.77 | Gravity |
| | T-Reg Tank 5 | 4,616.00 | 4,636.00 | N/A, in line | 854,620.40 | 1,864,820.15 | Gravity |

**Horizontal Datum:** Arizona State Plane, Central Zone, North American Datum of 1983 (NAD83)
**Vertical Datum:** NAVD 88

# APPENDIX D

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: PMP-2**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/21/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 224.415 | gpm | |
| Head: | 75 | ft | 37.5587 |

| **PUMP CURVE** | | Head grid line | Distance up |
|---|---|---|---|
| Flow (gpm) | Head (ft) | below curve | to curve |
| 0 | 913 | 900 | 6.3561 |
| 224.415 | 904 | 900 | 2.1381 |
| 448.83 | 894 | 825 | 34.6816 |
| 673.245 | 880 | 825 | 27.5579 |
| 897.66 | 867 | 825 | 20.8527 |
| 1122.075 | 851 | 825 | 13.0483 |
| 1346.49 | 835 | 825 | 4.8935 |
| 1570.905 | 818 | 750 | 34.1877 |
| 1795.32 | 802 | 750 | 25.7943 |
| 2019.735 | 784 | 750 | 17.049 |
| 2244.15 | 768 | 750 | 8.8014 |
| 2468.565 | 752 | 750 | 0.7653 |
| 2692.98 | 736 | 675 | 30.5126 |
| 2917.395 | 721 | 675 | 22.8304 |
| 3141.81 | 707 | 675 | 15.9972 |
| 3366.225 | 693 | 675 | 9.034 |
| 3590.64 | 682 | 675 | 3.5537 |
| 3815.055 | 669 | 600 | 34.3862 |
| 4039.47 | 656 | 600 | 28.287 |
| 4263.885 | 646 | 600 | 22.839 |
| 4488.3 | 634 | 600 | 17.0769 |
| 4712.715 | 626 | 600 | 13.0632 |
| 4937.13 | 617 | 600 | 8.2808 |
| 5161.545 | 606 | 600 | 2.9767 |
| 5385.96 | 595 | 525 | 34.8538 |
| 5610.375 | 579 | 525 | 27.2472 |
| 5834.79 | 561 | 525 | 17.9943 |
| 6059.205 | 540 | 525 | 7.3962 |
| 6283.62 | 515 | 450 | 32.7213 |
| 6508.035 | 487 | 450 | 18.6373 |
| 6732.45 | 455 | 450 | 2.2719 |
| 6956.865 | 417 | 375 | 21.0507 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: PMP-3**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/21/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 224.415 | gpm | |
| Head: | 75 | ft | 39.15 |

| **PUMP CURVE** | | Head grid line | Distance up |
|---|---|---|---|
| Flow (gpm) | Head (ft) | below curve | to curve |
| 0 | 846 | 825 | 11.0064 |
| 224.415 | 823 | 750 | 37.8633 |
| 448.83 | 802 | 750 | 27.3242 |
| 673.245 | 785 | 750 | 18.1358 |
| 897.66 | 770 | 750 | 10.3657 |
| 1122.075 | 754 | 750 | 2.3232 |
| 1346.49 | 741 | 675 | 34.4298 |
| 1570.905 | 728 | 675 | 27.8072 |
| 1795.32 | 713 | 675 | 19.9058 |
| 2019.735 | 699 | 675 | 12.3277 |
| 2244.15 | 685 | 675 | 5.0379 |
| 2468.565 | 671 | 600 | 36.8689 |
| 2692.98 | 660 | 600 | 31.5114 |
| 2917.395 | 651 | 600 | 26.4481 |
| 3141.81 | 643 | 600 | 22.6514 |
| 3366.225 | 636 | 600 | 19.0417 |
| 3590.64 | 626 | 600 | 13.662 |
| 3815.055 | 615 | 600 | 7.6227 |
| 4039.47 | 600 | 600 | 0.2534 |
| 4263.885 | 585 | 525 | 31.2956 |
| 4488.3 | 566 | 525 | 21.2231 |
| 4712.715 | 544 | 525 | 9.7974 |
| 4937.13 | 521 | 450 | 36.9914 |
| 5161.545 | 494 | 450 | 23.0146 |
| 5385.96 | 465 | 450 | 7.829 |
| 5610.375 | 434 | 375 | 30.7979 |
| 5834.79 | 400 | 375 | 12.7898 |
| 6059.205 | 366 | 300 | 34.3179 |
| 6283.62 | 329 | 300 | 14.8814 |
| 6508.035 | 293 | 225 | 35.2385 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: PMP-4**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/21/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 224.415 | gpm | |
| Head: | 75 | ft | 36.5506 |

| **PUMP CURVE** | | | |
|---|---|---|---|
| Flow (gpm) | Head (ft) | Head grid line below curve | Distance up to curve |
| 0 | 966 | 900 | 32.3216 |
| 224.415 | 937 | 900 | 18.1542 |
| 448.83 | 914 | 900 | 6.9587 |
| 673.245 | 896 | 825 | 34.4941 |
| 897.66 | 880 | 825 | 26.5706 |
| 1122.075 | 863 | 825 | 18.7416 |
| 1346.49 | 849 | 825 | 11.5991 |
| 1570.905 | 835 | 825 | 4.8542 |
| 1795.32 | 820 | 750 | 34.3428 |
| 2019.735 | 806 | 750 | 27.0507 |
| 2244.15 | 789 | 750 | 19.0198 |
| 2468.565 | 773 | 750 | 11.1932 |
| 2692.98 | 756 | 750 | 3.0281 |
| 2917.395 | 743 | 675 | 32.9664 |
| 3141.81 | 730 | 675 | 26.8906 |
| 3366.225 | 720 | 675 | 21.7156 |
| 3590.64 | 711 | 675 | 17.3398 |
| 3815.055 | 703 | 675 | 13.5635 |
| 4039.47 | 693 | 675 | 8.8679 |
| 4263.885 | 678 | 675 | 1.6516 |
| 4488.3 | 661 | 600 | 29.9627 |
| 4712.715 | 641 | 600 | 20.2094 |
| 4937.13 | 616 | 600 | 7.6193 |
| 5161.545 | 593 | 525 | 33.0997 |
| 5385.96 | 565 | 525 | 19.4364 |
| 5610.375 | 535 | 525 | 4.7962 |
| 5834.79 | 501 | 450 | 24.8274 |
| 6059.205 | 467 | 450 | 8.0695 |
| 6283.62 | 431 | 375 | 27.2833 |
| 6508.035 | 392 | 375 | 8.4457 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: PMP-5**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/21/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 250 | gpm | |
| Head: | 45 | ft | 38.5973 |

| PUMP CURVE | | Head grid line below curve | Distance up to curve |
|---|---|---|---|
| Flow (gpm) | Head (ft) | | |
| 0 | 741 | 720 | 17.836 |
| 250 | 714 | 675 | 33.159 |
| 500 | 689 | 675 | 11.8564 |
| 750 | 666 | 630 | 30.9994 |
| 1000 | 645 | 630 | 12.7122 |
| 1250 | 624 | 585 | 33.4301 |
| 1500 | 603 | 585 | 15.2464 |
| 1750 | 583 | 540 | 36.4944 |
| 2000 | 564 | 540 | 20.4308 |
| 2250 | 548 | 540 | 6.8324 |
| 2500 | 536 | 495 | 34.8752 |
| 2750 | 529 | 495 | 29.2224 |
| 3000 | 517 | 495 | 18.8339 |
| 3250 | 499 | 495 | 3.838 |
| 3500 | 476 | 450 | 22.05 |
| 3750 | 447 | 405 | 36.2445 |
| 4000 | 414 | 405 | 7.7333 |
| 4250 | 377 | 360 | 14.9094 |
| 4500 | 338 | 315 | 19.6319 |
| 4750 | 296 | 270 | 22.0381 |
| 5000 | 252 | 225 | 23.4125 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: PMP-6**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/21/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 50 | gpm | |
| Head: | 40 | ft | 35.3855 |

| **PUMP CURVE** | |
|---|---|
| Flow (gpm) | Head (ft) |
| 0 | 571 |
| 50 | 562 |
| 100 | 551 |
| 150 | 539 |
| 200 | 525 |
| 250 | 513 |
| 300 | 498 |
| 350 | 484 |
| 400 | 470 |
| 450 | 455 |
| 500 | 442 |
| 550 | 430 |
| 600 | 419 |
| 650 | 411 |
| 700 | 402 |
| 750 | 390 |
| 800 | 378 |
| 850 | 365 |
| 900 | 351 |
| 950 | 335 |
| 1000 | 320 |
| 1050 | 303 |
| 1100 | 286 |
| 1150 | 268 |
| 1200 | 248 |
| 1250 | 225 |
| 1300 | 200 |

| Head grid line below curve | Distance up to curve |
|---|---|
| 560 | 9.9791 |
| 560 | 1.3694 |
| 520 | 27.047 |
| 520 | 16.6482 |
| 520 | 4.8366 |
| 480 | 28.8497 |
| 480 | 16.1588 |
| 480 | 3.6948 |
| 440 | 26.4232 |
| 440 | 13.5642 |
| 440 | 1.8185 |
| 400 | 26.2722 |
| 400 | 17.187 |
| 400 | 9.6728 |
| 400 | 1.6672 |
| 360 | 26.9554 |
| 360 | 16.1546 |
| 360 | 4.385 |
| 320 | 27.2322 |
| 320 | 13.4926 |
| 280 | 35.0909 |
| 280 | 20.6923 |
| 280 | 5.5374 |
| 240 | 24.9076 |
| 240 | 6.7714 |
| 200 | 22.4409 |
| 160 | 35.0875 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: PMP-7**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/21/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 2.5 | gpm | |
| Head: | 30 | ft | 32.6763 |

| **PUMP CURVE** | | Head grid line | Distance up |
|---|---|---|---|
| Flow (gpm) | Head (ft) | below curve | to curve |
| 0 | 492 | 480 | 12.7552 |
| 2.5 | 485 | 480 | 5.6514 |
| 5 | 481 | 480 | 1.0609 |
| 7.5 | 478 | 450 | 30.8013 |
| 10 | 475 | 450 | 26.7362 |
| 12.5 | 470 | 450 | 22.0841 |
| 15 | 466 | 450 | 17.0978 |
| 17.5 | 459 | 450 | 9.9244 |
| 20 | 450 | 450 | 0.3591 |
| 22.5 | 440 | 420 | 21.8835 |
| 25 | 429 | 420 | 9.5608 |
| 27.5 | 415 | 390 | 27.0519 |
| 30 | 399 | 390 | 9.4628 |
| 32.5 | 380 | 360 | 21.8701 |
| 35 | 359 | 330 | 32.0586 |
| 37.5 | 337 | 330 | 8.049 |
| 40 | 314 | 300 | 15.5111 |
| 42.5 | 290 | 270 | 22.1227 |
| 45 | 265 | 240 | 27.4448 |
| 47.5 | 238 | 210 | 31.033 |
| 50 | 210 | 210 | 0.1116 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Bitter Springs Turnout Booster Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/21/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 25 | gpm | |
| Head: | 45 | ft | 31.7312 |

| **PUMP CURVE** | | | | |
|---|---|---|---|---|
| Flow (gpm) | Head (ft) | | Head grid line below curve | Distance up to curve |
| 0 | 781 | | 765 | 11.3509 |
| 25 | 773 | | 765 | 5.9137 |
| 50 | 765 | | 720 | 31.5062 |
| 75 | 756 | | 720 | 25.3206 |
| 100 | 747 | | 720 | 19.1505 |
| 125 | 738 | | 720 | 13.0185 |
| 150 | 731 | | 720 | 7.7988 |
| 175 | 723 | | 720 | 2.3221 |
| 200 | 717 | | 675 | 29.9372 |
| 225 | 710 | | 675 | 24.9834 |
| 250 | 702 | | 675 | 19.3622 |
| 275 | 695 | | 675 | 13.9974 |
| 300 | 686 | | 675 | 7.7849 |
| 325 | 675 | | 675 | 0.1143 |
| 350 | 663 | | 630 | 22.9676 |
| 375 | 647 | | 630 | 12.0925 |
| 400 | 630 | Rev -> | 585 | 31.5447 |
| 425 | 611 | | 585 | 18.0783 |
| 450 | 591 | | 585 | 4.1327 |
| 475 | 569 | | 540 | 20.4782 |
| 500 | 546 | | 540 | 4.1631 |
| 525 | 522 | | 495 | 18.8205 |
| 550 | 495 | | 495 | 0.3099 |
| 575 | 469 | | 450 | 13.0865 |
| 600 | 440 | | 405 | 24.8581 |
| 625 | 410 | | 405 | 3.8286 |
| 650 | 380 | | 360 | 14.1732 |
| 675 | 349 | | 315 | 23.887 |
| 700 | 317 | | 315 | 1.1816 |
| 725 | 284 | | 270 | 10.1577 |
| 750 | 252 | | 225 | 18.8702 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Cedar Ridge Turnout Booster Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/21/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 10 | gpm | |
| Head: | 12.5 | ft | 30.6921 |

| PUMP CURVE | | Head grid line below curve | Distance up to curve |
|---|---|---|---|
| Flow (gpm) | Head (ft) | | |
| 0 | 205 | 200 | 12.7736 |
| 10 | 203 | 200 | 8.3443 |
| 20 | 201 | 200 | 1.4385 |
| 30 | 198 | 187.5 | 25.8611 |
| 40 | 195 | 187.5 | 18.8996 |
| 50 | 192 | 187.5 | 10.7162 |
| 60 | 188 | 187.5 | 2.362 |
| 70 | 184 | 175 | 23.126 |
| 80 | 180 | 175 | 11.2858 |
| 90 | 175 | 162.5 | 29.95 |
| 100 | 169 | 162.5 | 15.3252 |
| 110 | 163 | 162.5 | 0.0684 |
| 120 | 155 | 150 | 13.0435 |
| 130 | 147 | 137.5 | 23.9472 |
| 140 | 138 | 137.5 | 2.0265 |
| 150 | 128 | 125 | 8.1062 |
| 160 | 117 | 112.5 | 11.9084 |
| 170 | 105 | 100 | 12.4151 |
| 180 | 92 | 87.5 | 9.914 |
| 190 | 77 | 75 | 4.5208 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Copermine Turnout Booster Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/21/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 25 | gpm | |
| Head: | 12.5 | ft | 30.3177 |

| **PUMP CURVE** | | | |
|---|---|---|---|
| Flow (gpm) | Head (ft) | Head grid line below curve | Distance up to curve |
| 0 | 188 | 187.5 | 0.589 |
| 25 | 184 | 175 | 21.8588 |
| 50 | 181 | 175 | 14.7956 |
| 75 | 178 | 175 | 7.3516 |
| 100 | 175 | 175 | 0.5145 |
| 125 | 172 | 162.5 | 23.8213 |
| 150 | 169 | 162.5 | 16.7313 |
| 175 | 166 | 162.5 | 8.0287 |
| 200 | 162 | 150 | 29.289 |
| 225 | 158 | 150 | 18.6338 |
| 250 | 153 | 150 | 6.8557 |
| 275 | 148 | 137.5 | 25.879 |
| 300 | 143 | 137.5 | 12.7488 |
| 325 | 136 | 125 | 27.5181 |
| 350 | 130 | 125 | 11.1423 |
| 375 | 122 | 112.5 | 22.4702 |
| 400 | 114 | 112.5 | 2.5716 |
| 425 | 104 | 100 | 10.8744 |
| 450 | 95 | 87.5 | 17.5115 |
| 475 | 85 | 75 | 23.2598 |
| 500 | 74 | 62.5 | 26.8197 |
| 525 | 62 | 50 | 28.5861 |
| 550 | 50 | 37.5 | 29.4085 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Hopi 1 Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/21/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 250 | gpm | |
| Head: | 20 | ft | 30.9196 |

| PUMP CURVE | |
|---|---|
| Flow (gpm) | Head (ft) |
| 0 | 302 |
| 250 | 292 |
| 500 | 282 |
| 750 | 272 |
| 1000 | 260 |
| 1250 | 248 |
| 1500 | 237 |
| 1750 | 226 |
| 2000 | 220 |
| 2250 | 217 |
| 2500 | 212 |
| 2750 | 203 |
| 3000 | 191 |
| 3250 | 177 |
| 3500 | 160 |
| 3750 | 143 |
| 4000 | 125 |
| 4250 | 107 |
| | |
| | |
| | |
| | |

| Head grid line below curve | Distance up to curve |
|---|---|
| 300 | 3.6528 |
| 280 | 18.5765 |
| 280 | 3.0138 |
| 260 | 17.9197 |
| 260 | 0.4181 |
| 240 | 13.119 |
| 220 | 26.0571 |
| 220 | 9.8937 |
| 200 | 30.6666 |
| 200 | 25.9206 |
| 200 | 17.9391 |
| 200 | 3.9387 |
| 180 | 16.8541 |
| 160 | 25.8432 |
| 160 | 0.6346 |
| 140 | 4.7994 |
| 120 | 8.3427 |
| 100 | 10.8734 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Hopi 2 Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/21/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 100 | gpm | |
| Head: | 45 | ft | 32.2048 |

| **PUMP CURVE** | | | |
|---|---|---|---|
| Flow (gpm) | Head (ft) | Head grid line below curve | Distance up to curve |
| 0 | 692 | 675 | 11.8406 |
| 100 | 675 | 675 | 0.1111 |
| 200 | 663 | 630 | 23.2858 |
| 300 | 652 | 630 | 15.9683 |
| 400 | 642 | 630 | 8.4693 |
| 500 | 632 | 630 | 1.4356 |
| 600 | 622 | 585 | 26.2657 |
| 700 | 611 | 585 | 18.6412 |
| 800 | 600 | 585 | 11.0688 |
| 900 | 592 | 585 | 5.3574 |
| 1000 | 584 | 540 | 31.7263 |
| 1100 | 570 | 540 | 21.3453 |
| 1200 | 550 | 540 | 7.4518 |
| 1300 | 527 | 495 | 23.1984 |
| 1400 | 501 | 495 | 4.1109 |
| 1500 | 472 | 450 | 15.7061 |
| 1600 | 441 | 405 | 25.8908 |
| 1700 | 409 | 405 | 2.7281 |
| 1800 | 375 | 360 | 10.5534 |
| 1900 | 340 | 315 | 17.9951 |
| 2000 | 304 | 270 | 24.573 |
| 2100 | 267 | 225 | 30.2063 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Hopi 3 Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/21/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 100 | gpm | |
| Head: | 40 | ft | 34.4868 |

| **PUMP CURVE** | |
|---|---|
| Flow (gpm) | Head (ft) |
| 0 | 560 |
| 100 | 548 |
| 200 | 539 |
| 300 | 530 |
| 400 | 521 |
| 500 | 513 |
| 600 | 504 |
| 700 | 495 |
| 800 | 487 |
| 900 | 480 |
| 1000 | 473 |
| 1100 | 461 |
| 1200 | 444 |
| 1300 | 425 |
| 1400 | 403 |
| 1500 | 379 |
| 1600 | 353 |
| 1700 | 326 |
| 1800 | 298 |
| 1900 | 269 |
| 2000 | 239 |
| 2100 | 208 |

| Head grid line below curve | Distance up to curve |
|---|---|
| 560 | 0.3434 |
| 520 | 24.1892 |
| 520 | 16.06 |
| 520 | 8.5154 |
| 520 | 1.2663 |
| 480 | 28.1317 |
| 480 | 20.7931 |
| 480 | 13.0956 |
| 480 | 6.2731 |
| 440 | 34.1957 |
| 440 | 28.7589 |
| 440 | 17.935 |
| 440 | 3.8155 |
| 400 | 21.7688 |
| 400 | 2.5377 |
| 360 | 16.2367 |
| 320 | 28.3601 |
| 320 | 4.8405 |
| 280 | 15.878 |
| 240 | 25.378 |
| 200 | 33.6124 |
| 200 | 6.9596 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Hopi 4 Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/21/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 100 | gpm | |
| Head: | 40 | ft | 25.0213 |

| **PUMP CURVE** | |
|---|---|
| Flow (gpm) | Head (ft) |
| 0 | 562 |
| 100 | 549 |
| 200 | 540 |
| 300 | 531 |
| 400 | 520 |
| 500 | 514 |
| 600 | 506 |
| 700 | 497 |
| 800 | 488 |
| 900 | 481 |
| 1000 | 475 |
| 1100 | 462 |
| 1200 | 446 |
| 1300 | 426 |
| 1400 | 404 |
| 1500 | 380 |
| 1600 | 354 |
| 1700 | 327 |
| 1800 | 299 |
| 1900 | 270 |
| 2000 | 240 |
| 2100 | 209 |

| Head grid line below curve | Distance up to curve |
|---|---|
| 560 | 1.0812 |
| 520 | 18.2875 |
| 520 | 12.5655 |
| 520 | 6.9822 |
| 520 | 0.0134 |
| 480 | 21.3218 |
| 480 | 16.0589 |
| 480 | 10.5558 |
| 480 | 5.0216 |
| 480 | 0.8634 |
| 440 | 21.9937 |
| 440 | 13.9211 |
| 440 | 3.4895 |
| 400 | 16.3031 |
| 400 | 2.5082 |
| 360 | 12.4251 |
| 320 | 21.4626 |
| 320 | 4.2979 |
| 280 | 11.912 |
| 240 | 18.8255 |
| 240 | 0.1529 |
| 200 | 5.5577 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Hopi 5 Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/18/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 100 | gpm | |
| Head: | 15 | ft | 26.1365 |

| **PUMP CURVE** | | | |
|---|---|---|---|
| Flow (gpm) | Head (ft) | Head grid line below curve | Distance up to curve |
| 0 | 222 | | |
| 100 | 218 | 210 | 13.968 |
| 200 | 214 | 210 | 7.3003 |
| 300 | 210 | 210 | 0.7451 |
| 400 | 207 | 195 | 20.9637 |
| 500 | 204 | 195 | 15.1685 |
| 600 | 200 | 195 | 9.1126 |
| 700 | 196 | 195 | 2.5699 |
| 800 | 193 | 180 | 22.9733 |
| 900 | 190 | 180 | 17.8603 |
| 1000 | 187 | 180 | 12.165 |
| 1100 | 182 | 180 | 3.073 |
| 1200 | 175 | 165 | 17.7694 |
| 1300 | 167 | 165 | 3.9135 |
| 1400 | 158 | 150 | 14.102 |
| 1500 | 148 | 135 | 23.1224 |
| 1600 | 137 | 135 | 4.3353 |
| 1700 | 126 | 120 | 11.2465 |
| 1800 | 115 | 105 | 17.4696 |
| 1900 | 103 | 90 | 22.618 |
| 2000 | 91 | 90 | 1.2848 |
| 2100 | 78 | 75 | 5.0897 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Hopi 6 Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/18/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 100 | gpm | |
| Head: | 15 | ft | 29.9259 |

| **PUMP CURVE** | | Head grid line | Distance up |
|---|---|---|---|
| Flow (gpm) | Head (ft) | below curve | to curve |
| 0 | 218 | 210 | 15.5698 |
| 100 | 213 | 210 | 6.9107 |
| 200 | 210 | 195 | 29.6838 |
| 300 | 206 | 195 | 22.2246 |
| 400 | 203 | 195 | 15.4527 |
| 500 | 199 | 195 | 8.3442 |
| 600 | 196 | 195 | 1.6419 |
| 700 | 192 | 180 | 24.7623 |
| 800 | 189 | 180 | 18.3721 |
| 900 | 186 | 180 | 12.6724 |
| 1000 | 183 | 180 | 5.9642 |
| 1100 | 178 | 165 | 26.4391 |
| 1200 | 171 | 165 | 12.2143 |
| 1300 | 163 | 150 | 26.1924 |
| 1400 | 154 | 150 | 7.5098 |
| 1500 | 144 | 135 | 17.5344 |
| 1600 | 133 | 120 | 26.5668 |
| 1700 | 122 | 120 | 4.3579 |
| 1800 | 111 | 105 | 11.2665 |
| 1900 | 99 | 90 | 17.4544 |
| 2000 | 87 | 75 | 23.0877 |
| 2100 | 74 | 60 | 27.1702 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Hopi 7 Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/18/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 100 | gpm | |
| Head: | 15 | ft | 18.5377 |

| PUMP CURVE | | Head grid line below curve | Distance up to curve |
|---|---|---|---|
| Flow (gpm) | Head (ft) | | |
| 0 | 211 | 210 | 1.3544 |
| 100 | 207 | 195 | 14.8316 |
| 200 | 203 | 195 | 10.3973 |
| 300 | 200 | 195 | 5.9307 |
| 400 | 197 | 195 | 2.0662 |
| 500 | 193 | 180 | 16.2671 |
| 600 | 190 | 180 | 12.2958 |
| 700 | 186 | 180 | 7.9887 |
| 800 | 183 | 180 | 4.3159 |
| 900 | 181 | 180 | 0.8451 |
| 1000 | 177 | 165 | 14.9489 |
| 1100 | 172 | 165 | 8.8068 |
| 1200 | 165 | 165 | 0.018 |
| 1300 | 157 | 150 | 8.6322 |
| 1400 | 148 | 135 | 15.94 |
| 1500 | 138 | 135 | 3.4758 |
| 1600 | 127 | 120 | 9.0787 |
| 1700 | 116 | 105 | 13.8248 |
| 1800 | 105 | 90 | 18.3411 |
| 1900 | 93 | 90 | 3.8095 |
| 2000 | 81 | 75 | 7.2625 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Hopi 8 Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/18/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 100 | gpm | |
| Head: | 40 | ft | 8.7896 |

| **PUMP CURVE** | |
|---|---|
| Flow (gpm) | Head (ft) |
| 0 | 505 |
| 100 | 499 |
| 200 | 496 |
| 300 | 493 |
| 400 | 492 |
| 500 | 490 |
| 600 | 488 |
| 700 | 483 |
| 800 | 477 |
| 900 | 469 |
| 1000 | 456 |
| 1100 | 441 |
| 1200 | 421 |
| 1300 | 398 |
| 1400 | 370 |
| 1500 | 338 |
| 1600 | 301 |
| 1700 | 260 |

| Head grid line below curve | Distance up to curve |
|---|---|
| 480 | 5.5179 |
| 480 | 4.1776 |
| 480 | 3.4632 |
| 480 | 2.8406 |
| 480 | 2.6426 |
| 480 | 2.1034 |
| 480 | 1.7093 |
| 480 | 0.5591 |
| 440 | 8.1967 |
| 440 | 6.2861 |
| 440 | 3.4564 |
| 440 | 0.1184 |
| 400 | 4.6771 |
| 360 | 8.303 |
| 360 | 2.2677 |
| 320 | 3.9244 |
| 280 | 4.6115 |
| 240 | 4.3465 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Hopi 9 Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/18/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 50 | gpm | |
| Head: | 30 | ft | 2.9374 |

| PUMP CURVE | | Head grid line below curve | Distance up to curve |
|---|---|---|---|
| Flow (gpm) | Head (ft) | | |
| 0 | 432 | 420 | 1.1677 |
| 50 | 430 | 420 | 0.98 |
| 100 | 429 | 420 | 0.8401 |
| 150 | 427 | 420 | 0.6492 |
| 200 | 426 | 420 | 0.6045 |
| 250 | 425 | 420 | 0.4592 |
| 300 | 424 | 420 | 0.3613 |
| 350 | 422 | 420 | 0.1764 |
| 400 | 420 | 390 | 2.9368 |
| 450 | 418 | 390 | 2.7598 |
| 500 | 415 | 390 | 2.4034 |
| 550 | 410 | 390 | 1.9458 |
| 600 | 405 | 390 | 1.4881 |
| 650 | 399 | 390 | 0.8376 |
| 700 | 391 | 390 | 0.1085 |
| 750 | 383 | 360 | 2.2055 |
| 800 | 373 | 360 | 1.2515 |
| 850 | 361 | 360 | 0.1429 |
| 900 | 349 | 330 | 1.8793 |
| 950 | 336 | 330 | 0.5477 |
| 1000 | 320 | 300 | 2.0055 |
| 1050 | 304 | 300 | 0.4125 |
| 1100 | 287 | 270 | 1.7054 |
| 1150 | 269 | 240 | 2.8824 |
| 1200 | 250 | 240 | 1.0203 |
| 1250 | 231 | 210 | 2.0258 |
| 1300 | 210 | 210 | 0.0378 |
| 1350 | 190 | 180 | 0.9666 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Hopi 10 Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/18/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 25 | gpm | |
| Head: | 40 | ft | 1.4664 |

| **PUMP CURVE** | | | |
|---|---|---|---|
| Flow (gpm) | Head (ft) | Head grid line below curve | Distance up to curve |
| 0 | 722.6 | 720 | 0.0966 |
| 25 | 717.3 | 680 | 1.3681 |
| 50 | 709.6 | 680 | 1.0839 |
| 75 | 703.6 | 680 | 0.8649 |
| 100 | 698.6 | 680 | 0.6804 |
| 125 | 691.5 | 680 | 0.4219 |
| 150 | 684.7 | 680 | 0.1731 |
| 175 | 677.0 | 640 | 1.3563 |
| 200 | 667.3 | 640 | 1 |
| 225 | 656.3 | 640 | 0.5988 |
| 250 | 642.2 | 640 | 0.0792 |
| 275 | 625.6 | 600 | 0.9372 |
| 300 | 607.3 | 600 | 0.2671 |
| 325 | 586.2 | 560 | 0.962 |
| 350 | 560.9 | 560 | 0.0346 |
| 375 | 534.2 | 520 | 0.5193 |
| 400 | 504.7 | 480 | 0.9041 |
| 425 | 472.4 | 440 | 1.189 |
| 450 | 436.9 | 400 | 1.354 |
| 475 | 400.0 | 400 | 0.0014 |
| 500 | 360.4 | 360 | 0.0152 |
| 525 | 319.2 | 280 | 1.4375 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Hotevilla Booster Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/18/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 50 | gpm | |
| Head: | 10 | ft | 28.0471 |

| PUMP CURVE | | Head grid line below curve | Distance up to curve |
|---|---|---|---|
| Flow (gpm) | Head (ft) | | |
| 0 | 147 | 140 | 19.9859 |
| 50 | 144 | 140 | 12.52 |
| 100 | 142 | 140 | 5.5871 |
| 150 | 140 | 140 | 0.4102 |
| 200 | 139 | 130 | 24.3638 |
| 250 | 137 | 130 | 20.1469 |
| 300 | 136 | 130 | 17.0848 |
| 350 | 135 | 130 | 13.4012 |
| 400 | 134 | 130 | 10.4909 |
| 450 | 132 | 130 | 6.6995 |
| 500 | 131 | 130 | 1.9232 |
| 550 | 129 | 120 | 25.1731 |
| 600 | 127 | 120 | 18.9955 |
| 650 | 125 | 120 | 13.1712 |
| 700 | 123 | 120 | 7.6589 |
| 750 | 120 | 110 | 27.0533 |
| 800 | 116 | 110 | 16.4217 |
| 850 | 111 | 110 | 3.4298 |
| 900 | 106 | 100 | 17.3804 |
| 950 | 101 | 100 | 1.6095 |
| 1000 | 95 | 90 | 13.2765 |
| 1050 | 88 | 80 | 23.5504 |
| 1100 | 82 | 80 | 5.5199 |
| 1150 | 75 | 70 | 14.6548 |
| 1200 | 68 | 60 | 22.7954 |
| 1250 | 61 | 60 | 2.1771 |
| 1300 | 53 | 50 | 8.6797 |
| 1350 | 45 | 40 | 14.0789 |
| 1400 | 36 | 30 | 18.0002 |

**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Orabi Spur Booster Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked:**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 2.5 | gpm | |
| Head: | 2 | ft | 30.6493 |

| **PUMP CURVE** | | Head grid line | Distance up |
|---|---|---|---|
| Flow (gpm) | Head (ft) | below curve | to curve |
| 0 | 30 | 28 | 24.4333 |
| 2.5 | 30 | 28 | 24.5247 |
| 5 | 29 | 28 | 20.7179 |
| 7.5 | 29 | 28 | 16.9405 |
| 10 | 29 | 28 | 12.74 |
| 12.5 | 29 | 28 | 8.6522 |
| 15 | 28 | 28 | 4.3301 |
| 17.5 | 28 | 28 | 0.1294 |
| 20 | 28 | 26 | 26.3642 |
| 22.5 | 27 | 26 | 22.2319 |
| 25 | 27 | 26 | 17.8095 |
| 27.5 | 27 | 26 | 13.5553 |
| 30 | 27 | 26 | 9.2223 |
| 32.5 | 26 | 26 | 4.7981 |
| 35 | 26 | 26 | 0.4354 |
| 37.5 | 26 | 24 | 26.7748 |
| 40 | 25 | 24 | 22.2285 |
| 42.5 | 25 | 24 | 17.6264 |
| 45 | 25 | 24 | 12.7372 |
| 47.5 | 24 | 24 | 7.3882 |
| 50 | 24 | 24 | 1.0307 |
| 52.5 | 24 | 22 | 24.316 |
| 55 | 23 | 22 | 15.2775 |
| 57.5 | 22 | 22 | 5.0935 |
| 60 | 22 | 20 | 24.6721 |
| 62.5 | 21 | 20 | 12.1818 |
| 65 | 20 | 18 | 29.8362 |
| 67.5 | 19 | 18 | 16.1336 |
| 70 | 18 | 18 | 1.7339 |
| 72.5 | 17 | 16 | 17.9503 |
| 75 | 16 | 16 | 1.87703 |
| 77.5 | 15 | 14 | 17.434 |

| | |
|---|---|
| 80 | 14 |
| 82.5 | 13 |
| 85 | 12 |

| | |
|---|---|
| 14 | 1.485 |
| 12 | 15.9097 |
| 10 | 30.4668 |

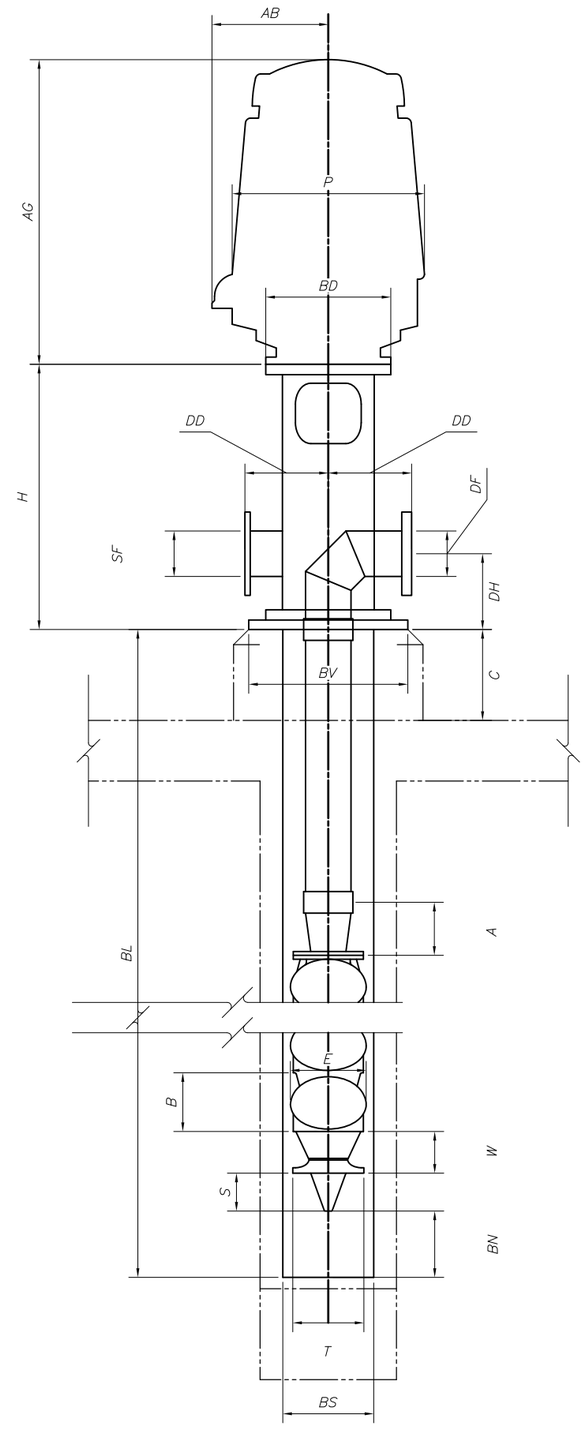
**Project: North Central Arizona Water Supply Study**
**Feature: Pumping Plants**
**Details: Shungopavi Booster Pumping Plant**
**Design Level: Feasibility**
**By: Alan McCann 06/14/2016**
**Checked: Matthew Shaw 06/18/2016**

| **Grid Scale** | | | Distance |
|---|---|---|---|
| Flow: | 25 | gpm | |
| Head: | 20 | ft | 30.5191 |

| PUMP CURVE | | Head grid line below curve | Distance up to curve |
|---|---|---|---|
| Flow (gpm) | Head (ft) | | |
| 0 | 263 | 260 | 5.1544 |
| 25 | 261 | 260 | 1.8473 |
| 50 | 258 | 240 | 27.9249 |
| 75 | 255 | 240 | 22.7658 |
| 100 | 252 | 240 | 18.1624 |
| 125 | 249 | 240 | 14.1004 |
| 150 | 247 | 240 | 10.569 |
| 175 | 245 | 240 | 7.987 |
| 200 | 243 | 240 | 4.5863 |
| 225 | 241 | 240 | 1.1346 |
| 250 | 238 | 220 | 26.8384 |
| 275 | 235 | 220 | 23.2545 |
| 300 | 231 | 220 | 17.5421 |
| 325 | 227 | 220 | 11.3516 |
| 350 | 223 | 220 | 4.5974 |
| 375 | 217 | 200 | 26.5185 |
| 400 | 211 | 200 | 16.7322 |
| 425 | 204 | 200 | 5.9881 |
| 450 | 197 | 180 | 25.9812 |
| 475 | 189 | 180 | 13.7856 |
| 500 | 180 | 180 | 0.7119 |
| 525 | 171 | 160 | 17.5386 |
| 550 | 162 | 160 | 3.6868 |
| 575 | 153 | 140 | 19.6685 |
| 600 | 143 | 140 | 3.9079 |
| 625 | 132 | 120 | 18.9952 |
| 650 | 122 | 120 | 2.5413 |
| 675 | 111 | 100 | 16.5277 |
| 700 | 100 | 80 | 30.1742 |
| 725 | 89 | 80 | 13.7577 |
| 750 | 78 | 60 | 27.2681 |

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | PMP-2 | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 4 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 20MKL |
| Speed | 1775 | RPM |
| Number of Stages: | 4 | |
| Rated Flow: | 5611.44 gpm | 12.5 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 579 ft | 250 psi |
| Shutoff Head: | 913 ft | 400 psi |
| Brake Horsepower: | 1010 hp | |
| Pump Weight: | 8300 lbs | |
| Motor Horsepower: | 1250 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 4160 V | |
| Motor Enclosure: | WP-II | |
| Motor Frame: | US Motors 6808P | |
| Motor Efficency: | Premium | |
| Motor Weight: | 8500 lbs | |
| Total Unit Dry Weight (Each): | 16800 lbs | |

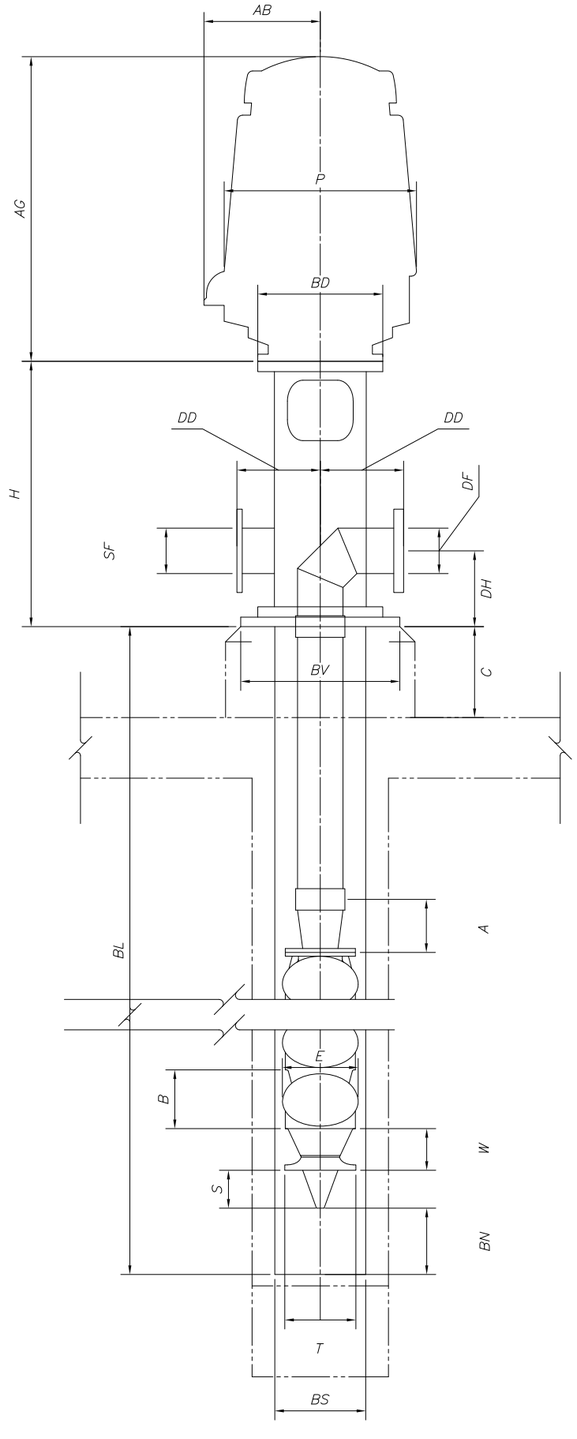
| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 40.8125 | | Can | BL | 152.75 |
| Motor | AG | 87.5625 | | Can | BN | 13 |
| Motor | BD | 30.5 | | Can | BP | 25.5 |
| Motor | P | 42.5 | | Can | BS | 36 |
| Discharge Head | DD | 25 | | Can | BV | 48 |
| Discharge Head | DF | 16 | | Can | BY | 1.75 |
| Discharge Head | DH | 17 | | Stage | A | 11.75 |
| Discharge Head | H | 43 | | Stage | B | 14.625 |
| Discharge Head | SF | 24 | | Stage | E | 20 |
| Pedestal | C | 14 | | Stage | S | 6 |
| | | | | Stage | T | 21 |
| | | | | Stage | W | 9.5 |




Estimated By _Matthew Shaw 05/23/2016_
CHECKED _Alan McCann 05/24/2016

| | | |
|---|---|---|
| *Project:* | *North Central Arizona Water Supply Study* | |
| *Feature:* | *Pumping Plants* | |
| *Details:* | *PMP-3* | |
| *Design Level:* | *Feasibility* | |
| *Number of Active Pumps:* | *4* | |
| *Number of Spare Pumps:* | *1* | |
| *Pump Selection:* | *Weir-Floway* | *18MKH* |
| *Speed* | *1755* | *RPM* |
| *Number of Stages:* | *5* | |
| *Rated Flow:* | *4624.7 gpm* | *10.3 cfs* |
| *Flow Includes a Wear Factor of:* | *3%* | |
| *Rated Total Head:* | *554 ft* | *240 psi* |
| *Shutoff Head:* | *847.7 ft* | *370 psi* |
| *Brake Horsepower:* | *780 hp* | |
| *Pump Weight:* | *6900 lbs* | |
| *Motor Horsepower:* | *900 hp* | |
| *Motor Speed:* | *1800 RPM* | *Fixed Induction* |
| *Motor Voltage:* | *4160 V* | |
| *Motor Enclosure:* | *WP-II* | |
| *Motor Frame:* | *US Motors 5012P* | |
| *Motor Efficency:* | *Premium* | |
| *Motor Weight:* | *5900 lbs* | |
| *Total Unit Dry Weight (Each):* | *12800 lbs* | |

| *Feature* | *Letter* | *Dim (in.)* | | *Feature* | *Letter* | *Dim (in.)* |
|---|---|---|---|---|---|---|
| *Motor* | *AB* | *36.5* | | *Can* | *BL* | *151.5* |
| *Motor* | *AG* | *78.88* | | *Can* | *BN* | *10* |
| *Motor* | *BD* | *24.5* | | *Can* | *BP* | *21* |
| *Motor* | *P* | *71* | | *Can* | *BS* | *30* |
| *Discharge Head* | *DD* | *21* | | *Can* | *BV* | *40* |
| *Discharge Head* | *DF* | *16* | | *Can* | *BY* | *1.5* |
| *Discharge Head* | *DH* | *21* | | *Stage* | *A* | *10.5* |
| *Discharge Head* | *H* | *62* | | *Stage* | *B* | *12.5* |
| *Discharge Head* | *SF* | *20* | | *Stage* | *E* | *17.375* |
| *Pedestal* | *C* | *10* | | *Stage* | *S* | *9.5* |
| | | | | *Stage* | *T* | *21* |
| | | | | *Stage* | *W* | *8.5* |

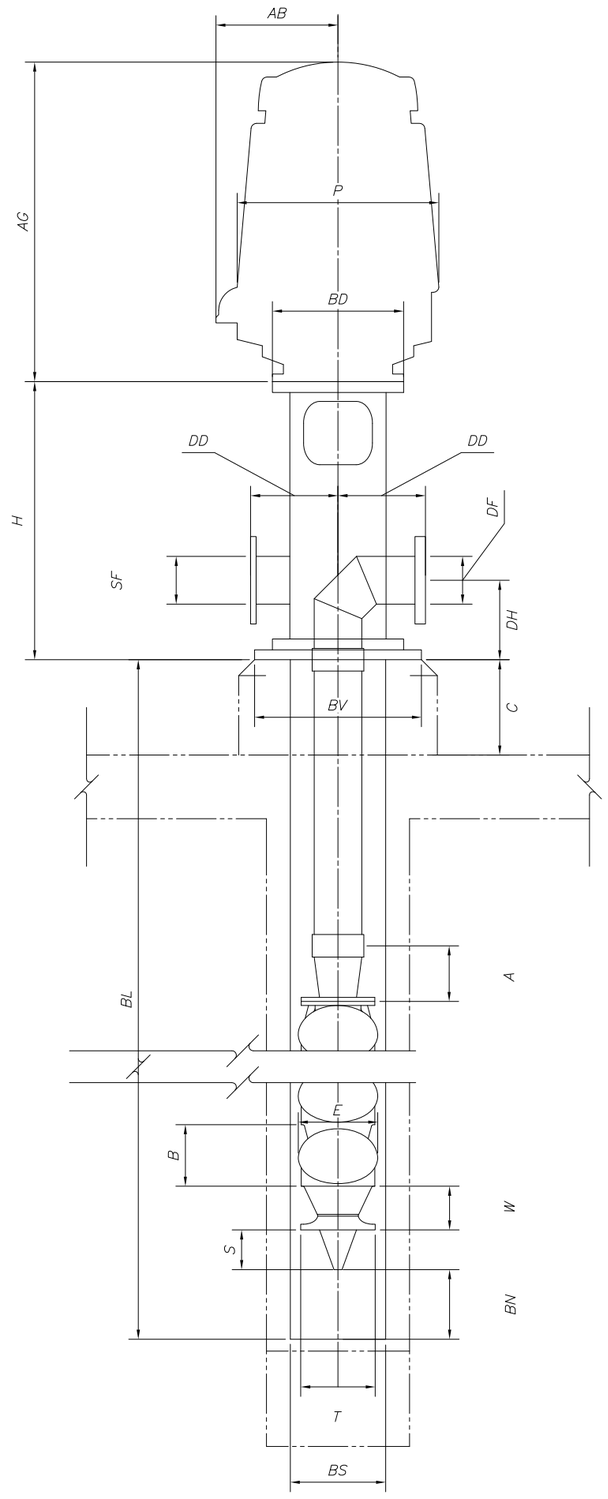



*Estimated By* _ Matthew Shaw 06/06/2016

*CHECKED* _ Alan McCann 06/06/2016

| | | |
|---|---|---|
| *Project:* | *North Central Arizona Water Supply Study* | |
| *Feature:* | *Pumping Plants* | |
| *Details:* | *PMP-4* | |
| *Design Level:* | *Feasibility* | |
| *Number of Active Pumps:* | *3* | |
| *Number of Spare Pumps:* | *1* | |
| *Pump Selection:* | *Weir-Floway* | *18MKH* |
| *Speed* | *1755* | *RPM* |
| *Number of Stages:* | *5* | |
| *Rated Flow:* | *4922.37 gpm* | *10.97 cfs* |
| *Flow Includes a Wear Factor of:* | *3%* | |
| *Rated Total Head:* | *620.5 ft* | *270 psi* |
| *Shutoff Head:* | *966.8 ft* | *420 psi* |
| *Brake Horsepower:* | *930 hp* | |
| *Pump Weight:* | *6900 lbs* | |
| *Motor Horsepower:* | *1000 hp* | |
| *Motor Speed:* | *1800 RPM* | *Fixed Induction* |
| *Motor Voltage:* | *4160 V* | |
| *Motor Enclosure:* | *WP-II* | |
| *Motor Frame:* | *US Motors 5012P* | |
| *Motor Efficency:* | *Premium* | |
| *Motor Weight:* | *5900 lbs* | |
| *Total Unit Dry Weight (Each):* | *12800 lbs* | |

| *Feature* | *Letter* | *Dim (in.)* | | *Feature* | *Letter* | *Dim (in.)* |
|---|---|---|---|---|---|---|
| *Motor* | *AB* | *36.5* | | *Can* | *BL* | *151.5* |
| *Motor* | *AG* | *78.88* | | *Can* | *BN* | *10* |
| *Motor* | *BD* | *24.5* | | *Can* | *BP* | *21* |
| *Motor* | *P* | *71* | | *Can* | *BS* | *30* |
| *Discharge Head* | *DD* | *21* | | *Can* | *BV* | *40* |
| *Discharge Head* | *DF* | *16* | | *Can* | *BY* | *1.5* |
| *Discharge Head* | *DH* | *21* | | *Stage* | *A* | *10.5* |
| *Discharge Head* | *H* | *62* | | *Stage* | *B* | *12.5* |
| *Discharge Head* | *SF* | *20* | | *Stage* | *E* | *17.375* |
| *Pedestal* | *C* | *11* | | *Stage* | *S* | *9.5* |
| | | | | *Stage* | *T* | *21* |
| | | | | *Stage* | *W* | *8.5* |

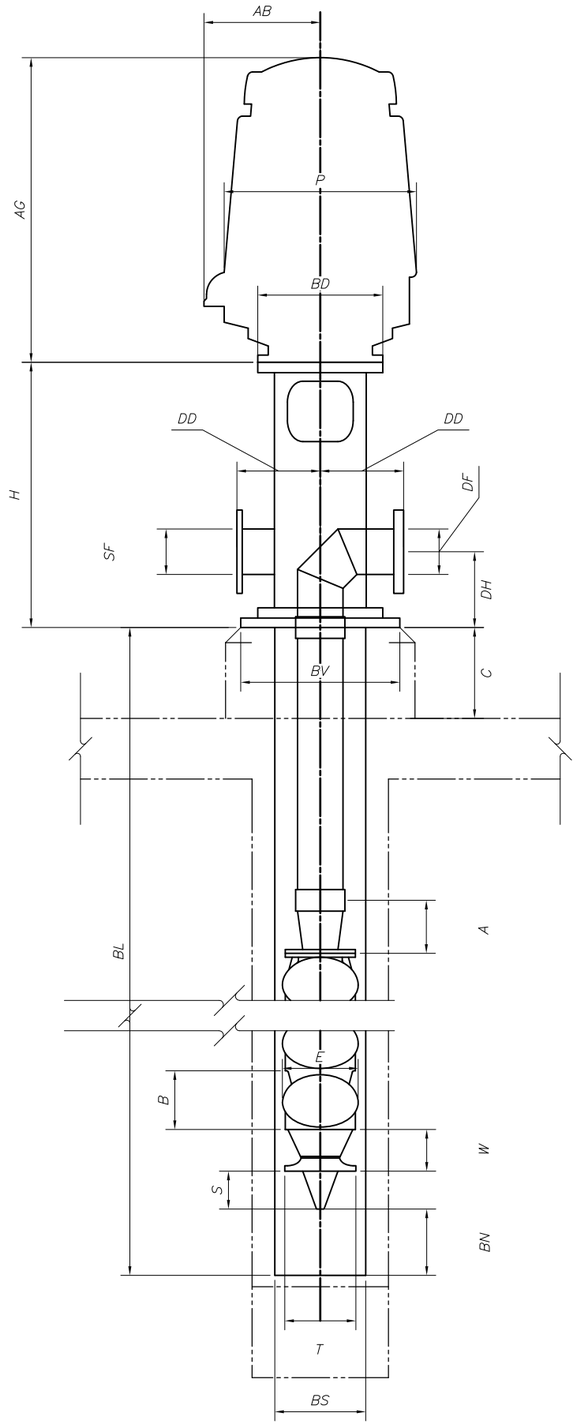



Estimated By _ Matthew Shaw 06/06/2016

CHECKED _ Alan McCann 06/06/2016

| | | |
|---|---|---|
| *Project:* | *North Central Arizona Water Supply Study* | |
| *Feature:* | *Pumping Plants* | |
| *Details:* | *Pumping Plant 5* | |
| *Design Level:* | *Feasibility* | |
| *Number of Active Pumps:* | *4* | |
| *Number of Spare Pumps:* | *1* | |
| *Pump Selection:* | *Weir-Floway* | *16DKH* |
| *Speed* | *1770* | *RPM* |
| *Number of Stages:* | *5* | |
| *Rated Flow:* | *3691.52 gpm* | *8.22 cfs* |
| *Flow Includes a Wear Factor of:* | *3%* | |
| *Rated Total Head:* | *454 ft* | *200 psi* |
| *Shutoff Head:* | *740.1 ft* | *320 psi* |
| *Brake Horsepower:* | *520 hp* | |
| *Pump Weight:* | *5300 lbs* | |
| *Motor Horsepower:* | *600 hp* | |
| *Motor Speed:* | *1800 RPM* | *Fixed Induction* |
| *Motor Voltage:* | *460 V* | |
| *Motor Enclosure:* | *WP-II* | |
| *Motor Frame:* | *GE L511TP24* | |
| *Motor Efficency:* | *Premium* | |
| *Motor Weight:* | *4380 lbs* | |
| *Total Unit Dry Weight (Each):* | *9680 lbs* | |

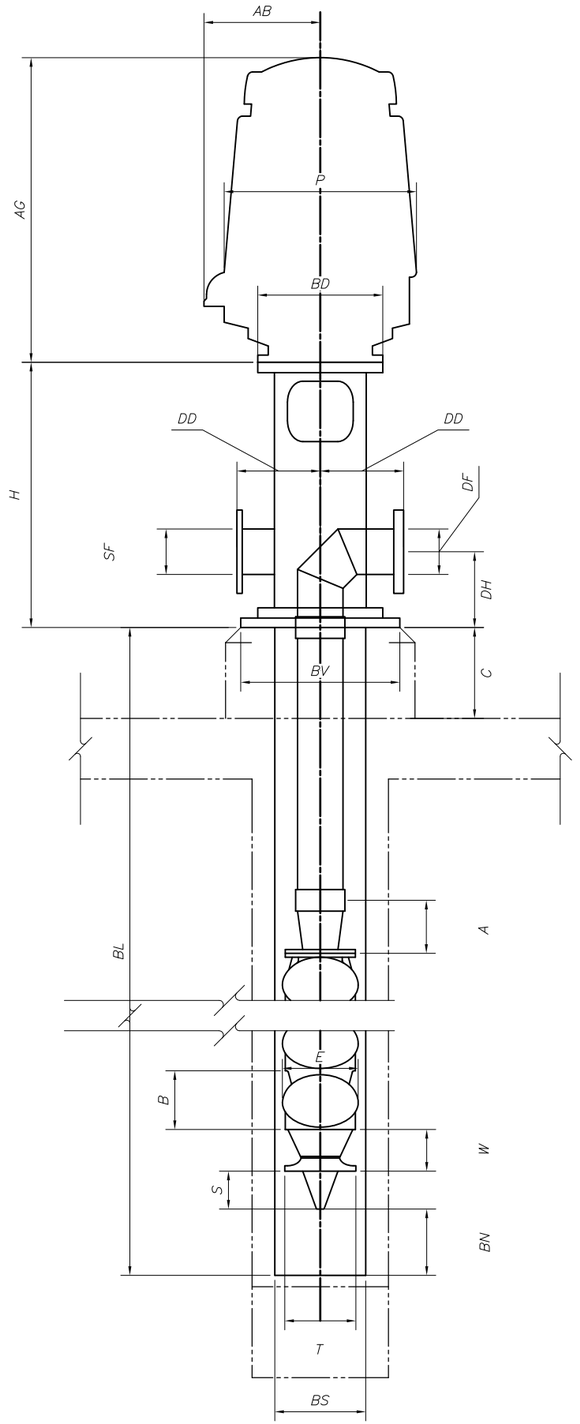
| *Feature* | *Letter* | *Dim (in.)* | | *Feature* | *Letter* | *Dim (in.)* |
|---|---|---|---|---|---|---|
| *Motor* | *AB* | *28.82* | | *Can* | *BL* | *162.5* |
| *Motor* | *AG* | *74.32* | | *Can* | *BN* | *11.5* |
| *Motor* | *BD* | *24.5* | | *Can* | *BP* | *20* |
| *Motor* | *P* | *33.8* | | *Can* | *BS* | *30* |
| *Discharge Head* | *DD* | *21* | | *Can* | *BV* | *40* |
| *Discharge Head* | *DF* | *14* | | *Can* | *BY* | *1.5* |
| *Discharge Head* | *DH* | *16* | | *Stage* | *A* | *10* |
| *Discharge Head* | *H* | *42* | | *Stage* | *B* | *14.875* |
| *Discharge Head* | *SF* | *20* | | *Stage* | *E* | *16* |
| *Pedestal* | *C* | *13* | | *Stage* | *S* | *8.0625* |
| | | | | *Stage* | *T* | *17.375* |
| | | | | *Stage* | *W* | *6.625* |




Estimated By _Alan_McCann_06/08/2016_
CHECKED _Matthew Shaw_06/18/2016_

| | | |
|---|---|---|
| *Project:* | *North Central Arizona Water Supply Study* | |
| *Feature:* | *Pumping Plants* | |
| *Details:* | *Pumping Plant 6* | |
| *Design Level:* | *Feasibility* | |
| *Number of Active Pumps:* | *1* | |
| *Number of Spare Pumps:* | *1* | |
| *Pump Selection:* | *Weir-Floway* | *12DKL* |
| *Speed* | *1770* | *RPM* |
| *Number of Stages:* | *7* | |
| *Rated Flow:* | *1049.57 gpm* | *2.34 cfs* |
| *Flow Includes a Wear Factor of:* | *3%* | |
| *Rated Total Head:* | *304 ft* | *130 psi* |
| *Shutoff Head:* | *572.5 ft* | *250 psi* |
| *Brake Horsepower:* | *100 hp* | |
| *Pump Weight:* | *2800 lbs* | |
| *Motor Horsepower:* | *100 hp* | |
| *Motor Speed:* | *1800 RPM* | *Fixed Induction* |
| *Motor Voltage:* | *460 V* | |
| *Motor Enclosure:* | *WP-I* | |
| *Motor Frame:* | *GE L404TP16* | |
| *Motor Efficency:* | *Premium* | |
| *Motor Weight:* | *1560 lbs* | |
| *Total Unit Dry Weight (Each):* | *4360 lbs* | |

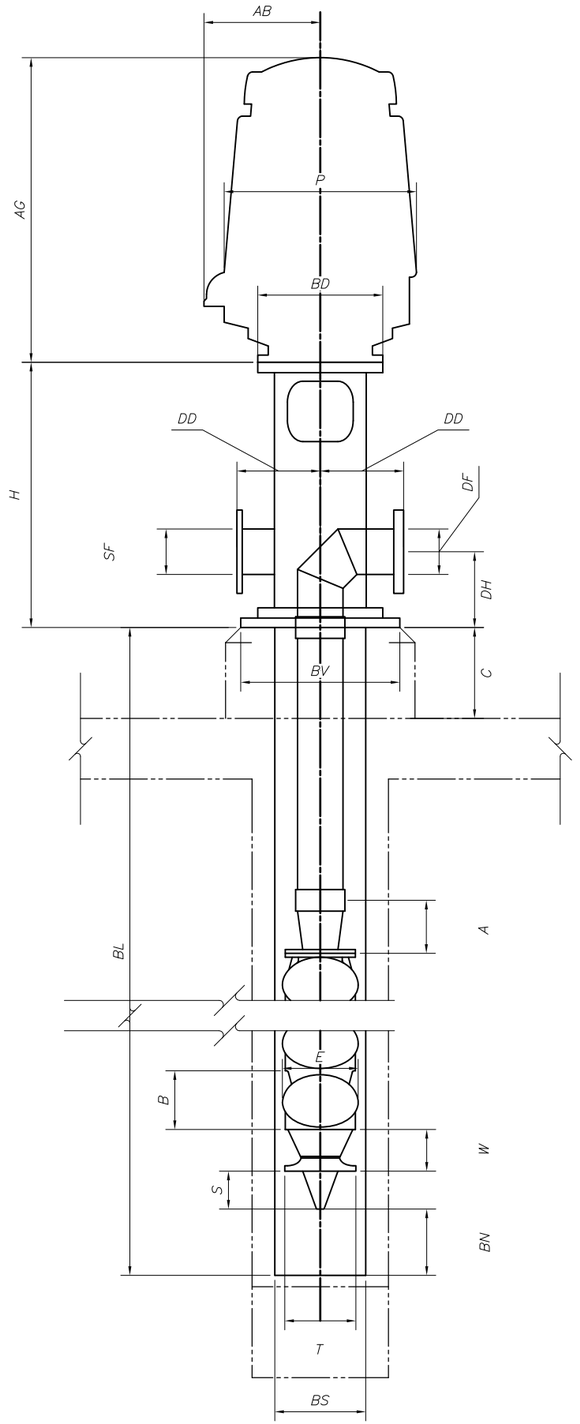
| *Feature* | *Letter* | *Dim (in.)* | | *Feature* | *Letter* | *Dim (in.)* |
|---|---|---|---|---|---|---|
| *Motor* | *AB* | *19.68* | | *Can* | *BL* | *157.25* |
| *Motor* | *AG* | *45.26* | | *Can* | *BN* | *12.5* |
| *Motor* | *BD* | *16.5* | | *Can* | *BP* | *20.75* |
| *Motor* | *P* | *28.02* | | *Can* | *BS* | *18* |
| *Discharge Head* | *DD* | *15* | | *Can* | *BV* | *27* |
| *Discharge Head* | *DF* | *8* | | *Can* | *BY* | *1.25* |
| *Discharge Head* | *DH* | *13* | | *Stage* | *A* | *7* |
| *Discharge Head* | *H* | *34* | | *Stage* | *B* | *10.25* |
| *Discharge Head* | *SF* | *10* | | *Stage* | *E* | *11.375* |
| *Pedestal* | *C* | *11* | | *Stage* | *S* | *8.75* |
| | | | | *Stage* | *T* | *11.25* |
| | | | | *Stage* | *W* | *6* |




Estimated By _Alan_McCann_06/07/2016_
CHECKED _Matthew_Shaw_06/17/2016_

| | | |
|---|---|---|
| *Project:* | *North Central Arizona Water Supply Study* | |
| *Feature:* | *Pumping Plants* | |
| *Details:* | *Pumping Plant 7* | |
| *Design Level:* | *Feasibility* | |
| *Number of Active Pumps:* | *1* | |
| *Number of Spare Pumps:* | *1* | |
| *Pump Selection:* | *Weir-Floway* | *7YKL* |
| *Speed* | *1770* | *RPM* |
| *Number of Stages:* | *22* | |
| *Rated Flow:* | *31.93 gpm* | *0.07 cfs* |
| *Flow Includes a Wear Factor of:* | *3%* | |
| *Rated Total Head:* | *384.02 ft* | *170 psi* |
| *Shutoff Head:* | *491.9 ft* | *210 psi* |
| *Brake Horsepower:* | *5.9 hp* | |
| *Pump Weight:* | *2000 lbs* | |
| *Motor Horsepower:* | *7.5 hp* | |
| *Motor Speed:* | *1800 RPM* | *Fixed Induction* |
| *Motor Voltage:* | *460 V* | |
| *Motor Enclosure:* | *WP-I* | |
| *Motor Frame:* | *GE L213TP10* | |
| *Motor Efficency:* | *Premium* | |
| *Motor Weight:* | *172 lbs* | |
| *Total Unit Dry Weight (Each):* | *2172 lbs* | |

| *Feature* | *Letter* | *Dim (in.)* | | *Feature* | *Letter* | *Dim (in.)* |
|---|---|---|---|---|---|---|
| *Motor* | *AB* | *9.41* | | *Can* | *BL* | *184.125* |
| *Motor* | *AG* | *22.44* | | *Can* | *BN* | *7.9375* |
| *Motor* | *BD* | *10* | | *Can* | *BP* | *12.0625* |
| *Motor* | *P* | *14.78* | | *Can* | *BS* | *12.75* |
| *Discharge Head* | *DD* | *11* | | *Can* | *BV* | *21* |
| *Discharge Head* | *DF* | *4* | | *Can* | *BY* | *1.25* |
| *Discharge Head* | *DH* | *10* | | *Stage* | *A* | *7.375* |
| *Discharge Head* | *H* | *27* | | *Stage* | *B* | *4.8125* |
| *Discharge Head* | *SF* | *4* | | *Stage* | *E* | *6.8125* |
| *Pedestal* | *C* | *12* | | *Stage* | *S* | *3.8125* |
| | | | | *Stage* | *T* | *6.75* |
| | | | | *Stage* | *W* | *2.9375* |

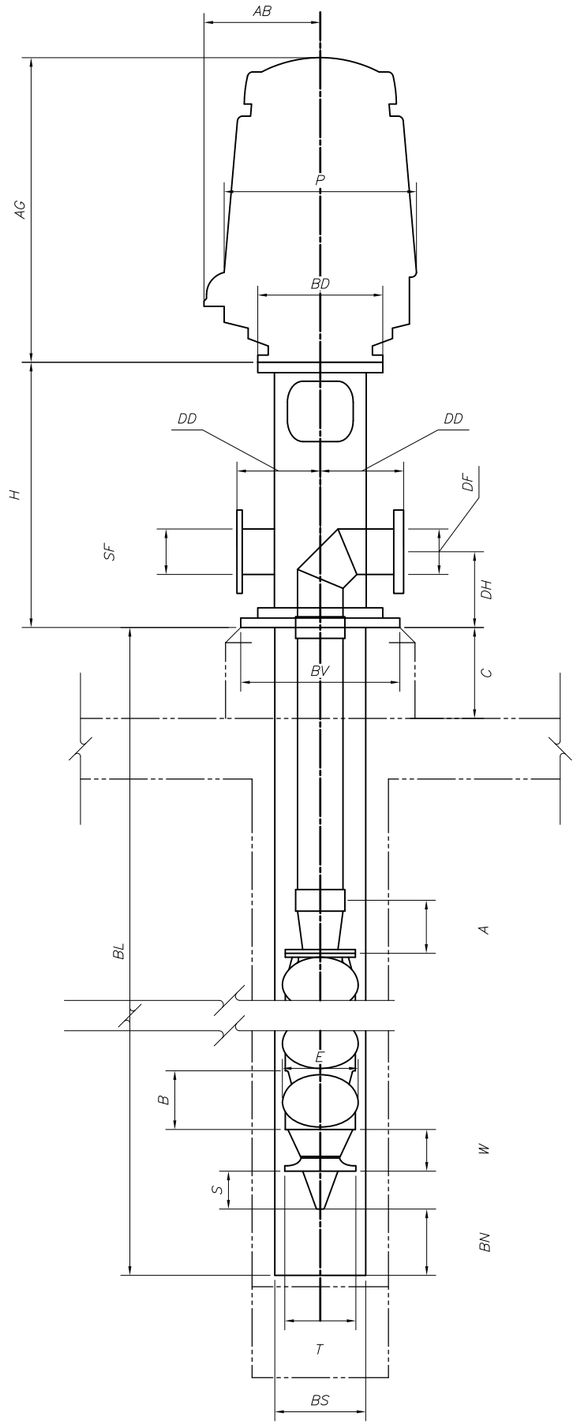



*Estimated By* _ Alan McConn 06/07/2016

*CHECKED* _ Matthew Shaw 06/17/2016 _

| | | |
|---|---|---|
| *Project:* | *North Central Arizona Water Supply Study* | |
| *Feature:* | *Pumping Plants* | |
| *Details:* | *Bitter Springs* | |
| *Design Level:* | *Feasibility* | |
| *Number of Active Pumps:* | *1* | |
| *Number of Spare Pumps:* | *1* | |
| *Pump Selection:* | *Weir-Floway* | *10JKL* |
| *Speed* | *1770* | *RPM* |
| *Number of Stages:* | *14* | |
| *Rated Flow:* | *457.32 gpm* | *1.02 cfs* |
| *Flow Includes a Wear Factor of:* | *3%* | |
| *Rated Total Head:* | *584 ft* | *250 psi* |
| *Shutoff Head:* | *780.7 ft* | *340 psi* |
| *Brake Horsepower:* | *90 hp* | |
| *Pump Weight:* | *2700 lbs* | |
| *Motor Horsepower:* | *100 hp* | |
| *Motor Speed:* | *1800 RPM* | *Fixed Induction* |
| *Motor Voltage:* | *460 V* | |
| *Motor Enclosure:* | *WP-I* | |
| *Motor Frame:* | *GE L404TP16* | |
| *Motor Efficency:* | *Premium* | |
| *Motor Weight:* | *1560 lbs* | |
| *Total Unit Dry Weight (Each):* | *4260 lbs* | |

| *Feature* | *Letter* | *Dim (in.)* | | *Feature* | *Letter* | *Dim (in.)* |
|---|---|---|---|---|---|---|
| *Motor* | *AB* | *19.68* | | *Can* | *BL* | *203.5* |
| *Motor* | *AG* | *45.26* | | *Can* | *BN* | *11.25* |
| *Motor* | *BD* | *16.5* | | *Can* | *BP* | *17.75* |
| *Motor* | *P* | *28.02* | | *Can* | *BS* | *14* |
| *Discharge Head* | *DD* | *12* | | *Can* | *BV* | *23* |
| *Discharge Head* | *DF* | *6* | | *Can* | *BY* | *1.25* |
| *Discharge Head* | *DH* | *12* | | *Stage* | *A* | *8* |
| *Discharge Head* | *H* | *29* | | *Stage* | *B* | *8.5* |
| *Discharge Head* | *SF* | *8* | | *Stage* | *E* | *9.8125* |
| *Pedestal* | *C* | *10* | | *Stage* | *S* | *7.5* |
| | | | | *Stage* | *T* | *9.375* |
| | | | | *Stage* | *W* | *5.25* |

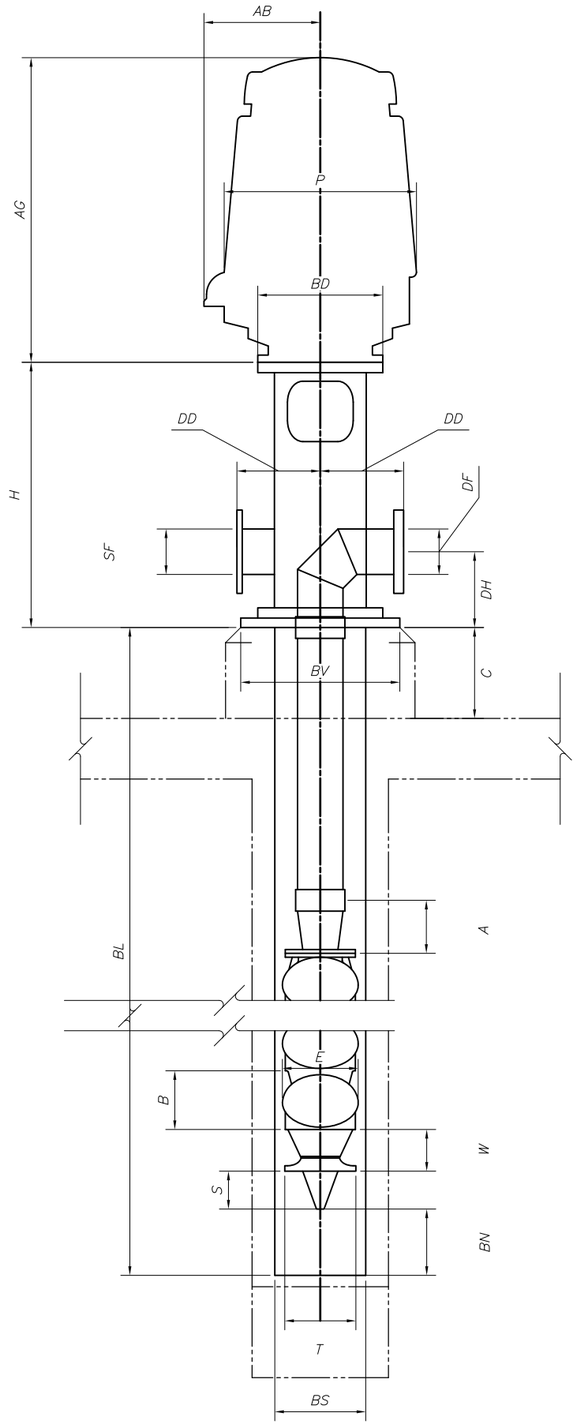



*Estimated By* _Alan_McCann_06/07/2016_

*CHECKED* _Matthew_Shaw_06/17/2016_

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | Cedar Ridge Turnout Booster | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 1 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 6JKH |
| Speed | 1760 | RPM |
| Number of Stages: | 10 | |
| Rated Flow: | 139.05 gpm | 0.31 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 139 ft | 60 psi |
| Shutoff Head: | 205.2 ft | 90 psi |
| Brake Horsepower: | 6.8 hp | |
| Pump Weight: | 1200 lbs | |
| Motor Horsepower: | 7.5 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 460 V | |
| Motor Enclosure: | WP-I | |
| Motor Frame: | GE L213TP10 | |
| Motor Efficency: | Premium | |
| Motor Weight: | 172 lbs | |
| Total Unit Dry Weight (Each): | 1372 lbs | |

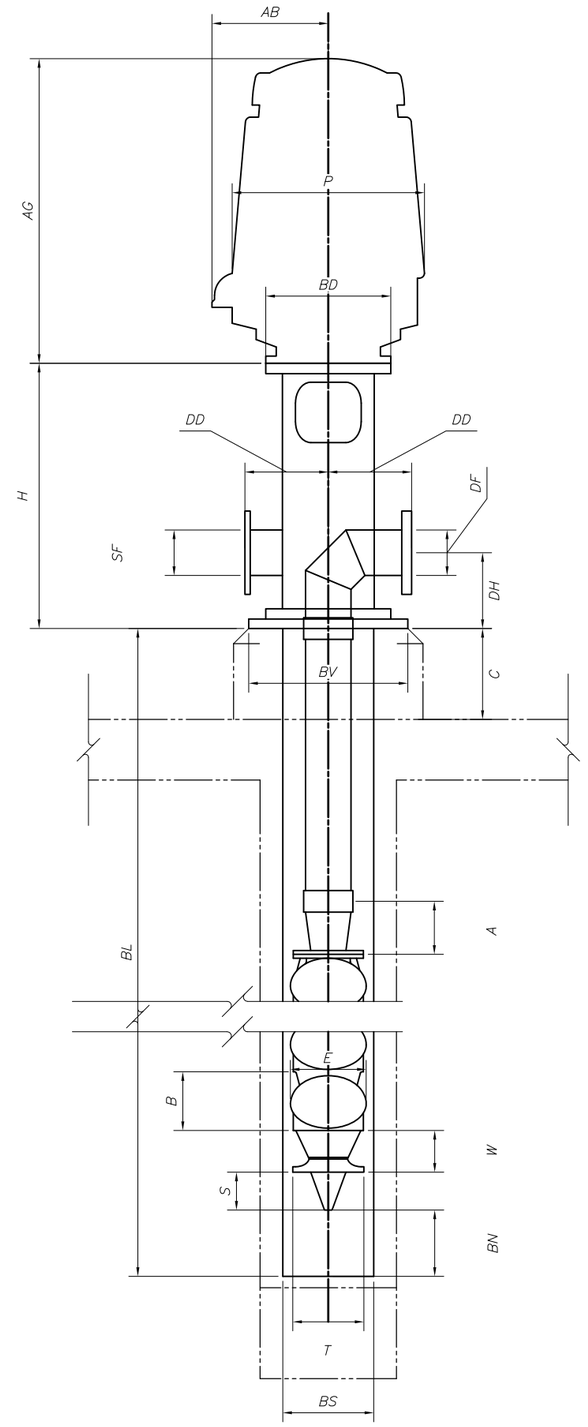
| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 9.41 | | Can | BL | 128.4375 |
| Motor | AG | 22.44 | | Can | BN | 6.875 |
| Motor | BD | 10 | | Can | BP | 11.625 |
| Motor | P | 14.78 | | Can | BS | 10.75 |
| Discharge Head | DD | 10 | | Can | BV | 18 |
| Discharge Head | DF | 4 | | Can | BY | 1.25 |
| Discharge Head | DH | 10 | | Stage | A | 8.75 |
| Discharge Head | H | 27 | | Stage | B | 5 |
| Discharge Head | SF | 6 | | Stage | E | 5.875 |
| Pedestal | C | 12 | | Stage | S | 3.375 |
| | | | | Stage | T | 5.8125 |
| | | | | Stage | W | 2.8125 |




Estimated By _ Alan McCann 06/07/2016
CHECKED _ Matthew Shaw 06/15/2016 _

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | Coppermine Turnout Booster | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 1 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 8JKH |
| Speed | 1760 | RPM |
| Number of Stages: | 5 | |
| Rated Flow: | 351.23 gpm | 0.78 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 128.97 ft | 60 psi |
| Shutoff Head: | 188 ft | 80 psi |
| Brake Horsepower: | 14.9 hp | |
| Pump Weight: | 1500 lbs | |
| Motor Horsepower: | 20 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 460 V | |
| Motor Enclosure: | WP-I | |
| Motor Frame: | GE L256TP10 | |
| Motor Efficency: | Premium | |
| Motor Weight: | 315 lbs | |
| Total Unit Dry Weight (Each): | 1815 lbs | |

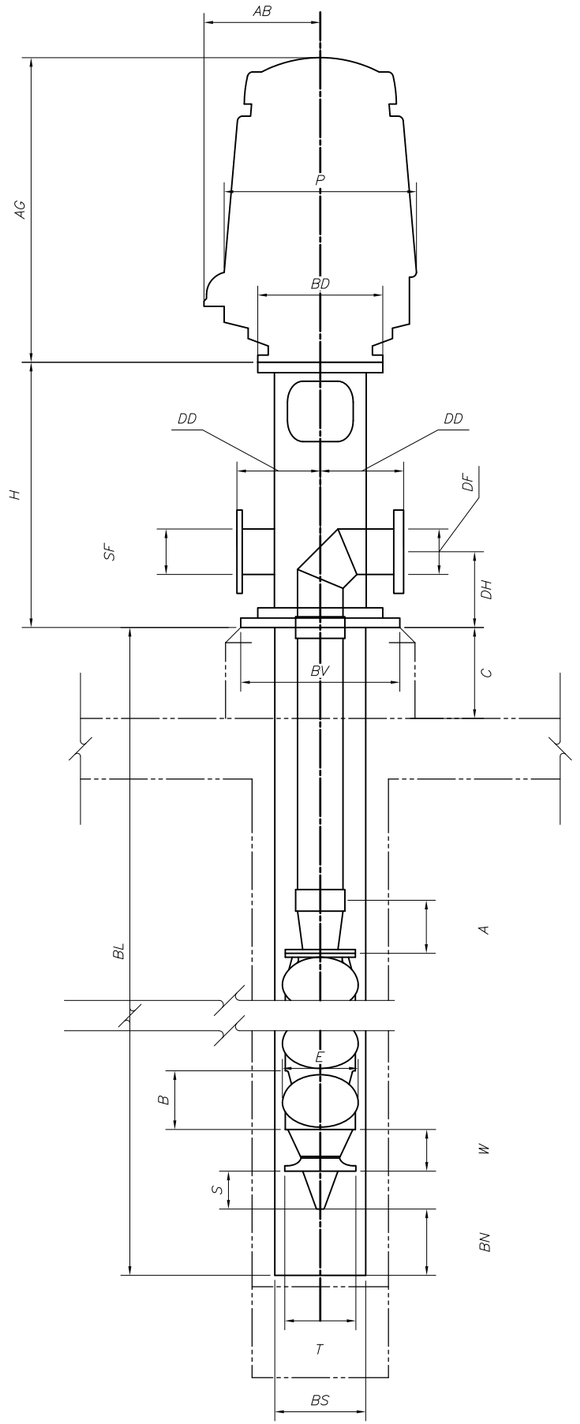
| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 11.4 | | Can | BL | 114.75 |
| Motor | AG | 26.72 | | Can | BN | 8 |
| Motor | BD | 10 | | Can | BP | 13.75 |
| Motor | P | 17.2 | | Can | BS | 14 |
| Discharge Head | DD | 12 | | Can | BV | 23 |
| Discharge Head | DF | 6 | | Can | BY | 1.25 |
| Discharge Head | DH | 10 | | Stage | A | 7.375 |
| Discharge Head | H | 27 | | Stage | B | 7.25 |
| Discharge Head | SF | 6 | | Stage | E | 7.75 |
| Pedestal | C | 12 | | Stage | S | 4.5 |
| | | | | Stage | T | 7.75 |
| Note: Discharge Head | BD | 12 | | Stage | W | 3.125 |




Estimated By __ Alan McCann 06/07/2016
CHECKED __ Matthew Shaw 06/15/2016 __

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | Hopi 1 | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 4 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 16DKL |
| Speed | 1770 | RPM |
| Number of Stages: | 2 | |
| Rated Flow: | 3066.31 gpm | 6.83 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 187 ft | 80 psi |
| Shutoff Head: | 302.1 ft | 130 psi |
| Brake Horsepower: | 180 hp | |
| Pump Weight: | 3400 lbs | |
| Motor Horsepower: | 200 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 460 V | |
| Motor Enclosure: | WP-I | |
| Motor Frame: | GE L445TP20 | |
| Motor Efficency: | Premium | |
| Motor Weight: | 1890 lbs | |
| Total Unit Dry Weight (Each): | 5290 lbs | |

| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 20.94 | | Can | BL | 117.875 |
| Motor | AG | 53.44 | | Can | BN | 11.5 |
| Motor | BD | 16.5 | | Can | BP | 20 |
| Motor | P | 31.44 | | Can | BS | 24 |
| Discharge Head | DD | 20 | | Can | BV | 34 |
| Discharge Head | DF | 12 | | Can | BY | 1.5 |
| Discharge Head | DH | 14 | | Stage | A | 10 |
| Discharge Head | H | 46 | | Stage | B | 14.875 |
| Discharge Head | SF | 20 | | Stage | E | 16 |
| Pedestal | C | 14 | | Stage | S | 8.0625 |
| | | | | Stage | T | 17.375 |
| | | | | Stage | W | 6.625 |

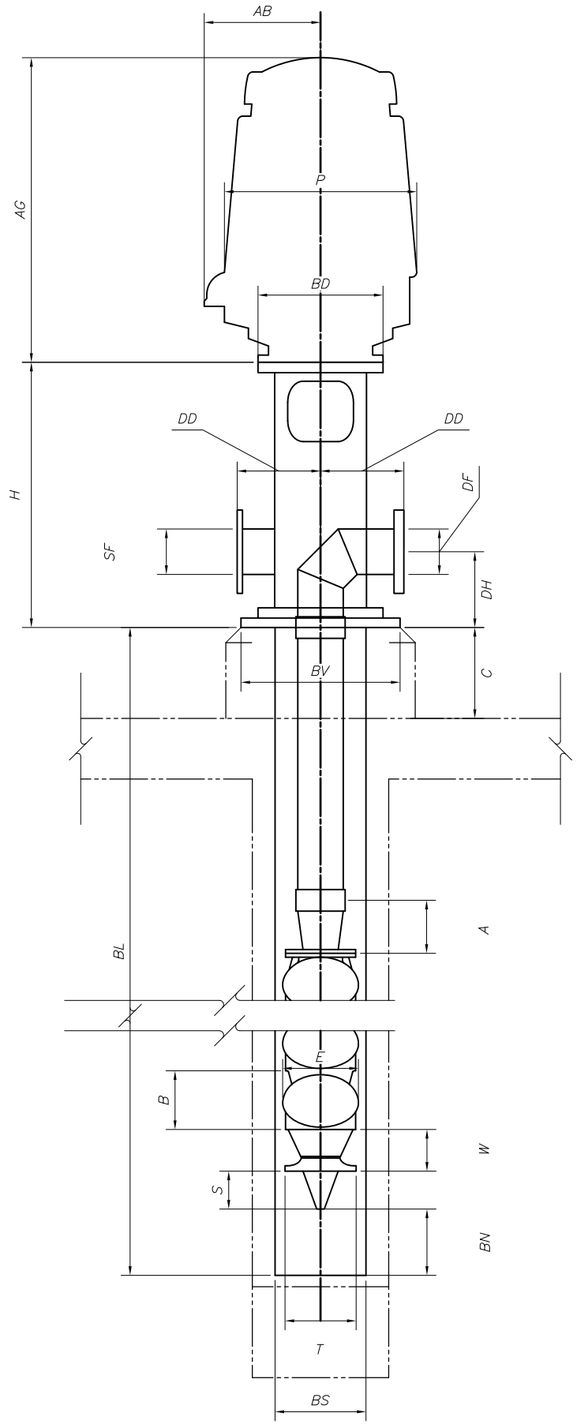



Estimated By _ Alan McCann 06/07/2016

CHECKED _ Matthew Shaw 06/14/2016 _

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | Hopi 2 | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 3 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 14JKL |
| Speed | 1770 | RPM |
| Number of Stages: | 6 | |
| Rated Flow: | 1397.71 gpm | 3.11 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 501 ft | 220 psi |
| Shutoff Head: | 690.4 ft | 300 psi |
| Brake Horsepower: | 210 hp | |
| Pump Weight: | 3800 lbs | |
| Motor Horsepower: | 250 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 460 V | |
| Motor Enclosure: | WP-I | |
| Motor Frame: | GE L447TP20 | |
| Motor Efficency: | Premium | |
| Motor Weight: | 2580 lbs | |
| Total Unit Dry Weight (Each): | 6380 lbs | |

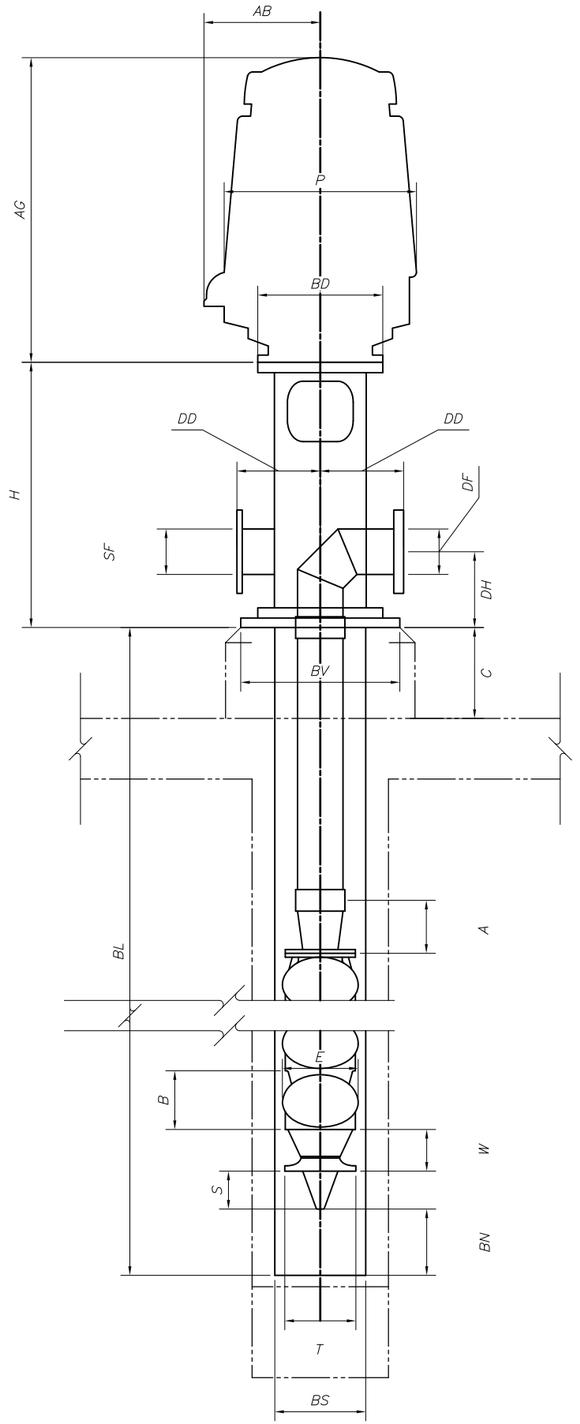
| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 20.94 | | Can | BL | 163.25 |
| Motor | AG | 61.94 | | Can | BN | 11.75 |
| Motor | BD | 20 | | Can | BP | 20 |
| Motor | P | 31.44 | | Can | BS | 20 |
| Discharge Head | DD | 16 | | Can | BV | 29 |
| Discharge Head | DF | 10 | | Can | BY | 1.5 |
| Discharge Head | DH | 15 | | Stage | A | 10 |
| Discharge Head | H | 37 | | Stage | B | 12.5 |
| Discharge Head | SF | 12 | | Stage | E | 14.0625 |
| Pedestal | C | 11 | | Stage | S | 7.75 |
| | | | | Stage | T | 13.0625 |
| | | | | Stage | W | 6.5 |




Estimated By _ Alan McConn 06/07/2016
CHECKED _ Matthew Shaw 06/14/2016 _

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | Hopi 3 | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 3 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 14JKL |
| Speed | 1770 | RPM |
| Number of Stages: | 5 | |
| Rated Flow: | 1397.71 gpm | 3.11 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 404 ft | 170 psi |
| Shutoff Head: | 561.2 ft | 240 psi |
| Brake Horsepower: | 170 hp | |
| Pump Weight: | 3600 lbs | |
| Motor Horsepower: | 200 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 460 V | |
| Motor Enclosure: | WP-I | |
| Motor Frame: | GE L445TP20 | |
| Motor Efficency: | Premium | |
| Motor Weight: | 1890 lbs | |
| Total Unit Dry Weight (Each): | 5490 lbs | |

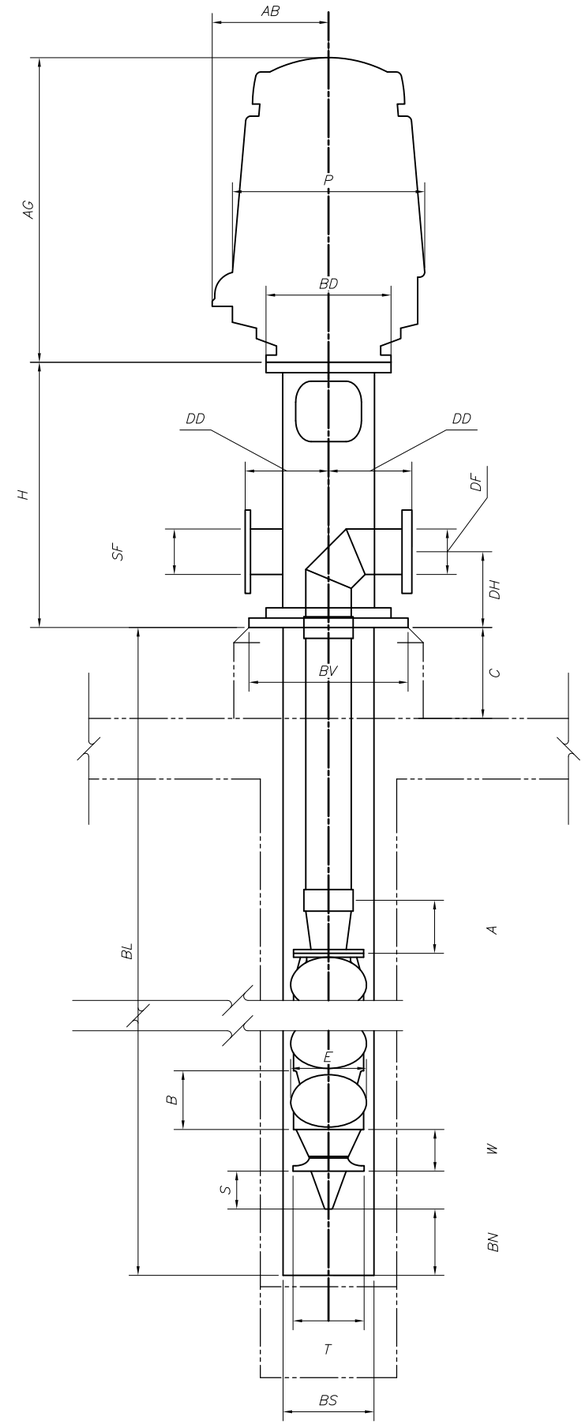
| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 20.94 | | Can | BL | 150.75 |
| Motor | AG | 53.44 | | Can | BN | 11.75 |
| Motor | BD | 16.5 | | Can | BP | 20 |
| Motor | P | 31.44 | | Can | BS | 20 |
| Discharge Head | DD | 16 | | Can | BV | 29 |
| Discharge Head | DF | 10 | | Can | BY | 1.5 |
| Discharge Head | DH | 15 | | Stage | A | 10 |
| Discharge Head | H | 37 | | Stage | B | 12.5 |
| Discharge Head | SF | 12 | | Stage | E | 14.0625 |
| Pedestal | C | 11 | | Stage | S | 7.75 |
| | | | | Stage | T | 13.0625 |
| | | | | Stage | W | 6.5 |




Estimated By _ Alan McCann 06/07/2016
CHECKED _ Matthew Shaw 06/15/2016 _

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | Hopi 4 | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 3 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 14JKL |
| Speed | 1770 | RPM |
| Number of Stages: | 5 | |
| Rated Flow: | 1397.71 gpm | 3.11 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 404 ft | 170 psi |
| Shutoff Head: | 561.2 ft | 240 psi |
| Brake Horsepower: | 170 hp | |
| Pump Weight: | 3600 lbs | |
| Motor Horsepower: | 200 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 460 V | |
| Motor Enclosure: | WP-I | |
| Motor Frame: | GE L445TP20 | |
| Motor Efficency: | Premium | |
| Motor Weight: | 1890 lbs | |
| Total Unit Dry Weight (Each): | 5490 lbs | |

| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 20.94 | | Can | BL | 150.75 |
| Motor | AG | 53.44 | | Can | BN | 11.75 |
| Motor | BD | 16.5 | | Can | BP | 20 |
| Motor | P | 31.44 | | Can | BS | 20 |
| Discharge Head | DD | 16 | | Can | BV | 29 |
| Discharge Head | DF | 10 | | Can | BY | 1.5 |
| Discharge Head | DH | 15 | | Stage | A | 10 |
| Discharge Head | H | 37 | | Stage | B | 12.5 |
| Discharge Head | SF | 12 | | Stage | E | 14.0625 |
| Pedestal | C | 11 | | Stage | S | 7.75 |
| | | | | Stage | T | 13.0625 |
| | | | | Stage | W | 6.5 |

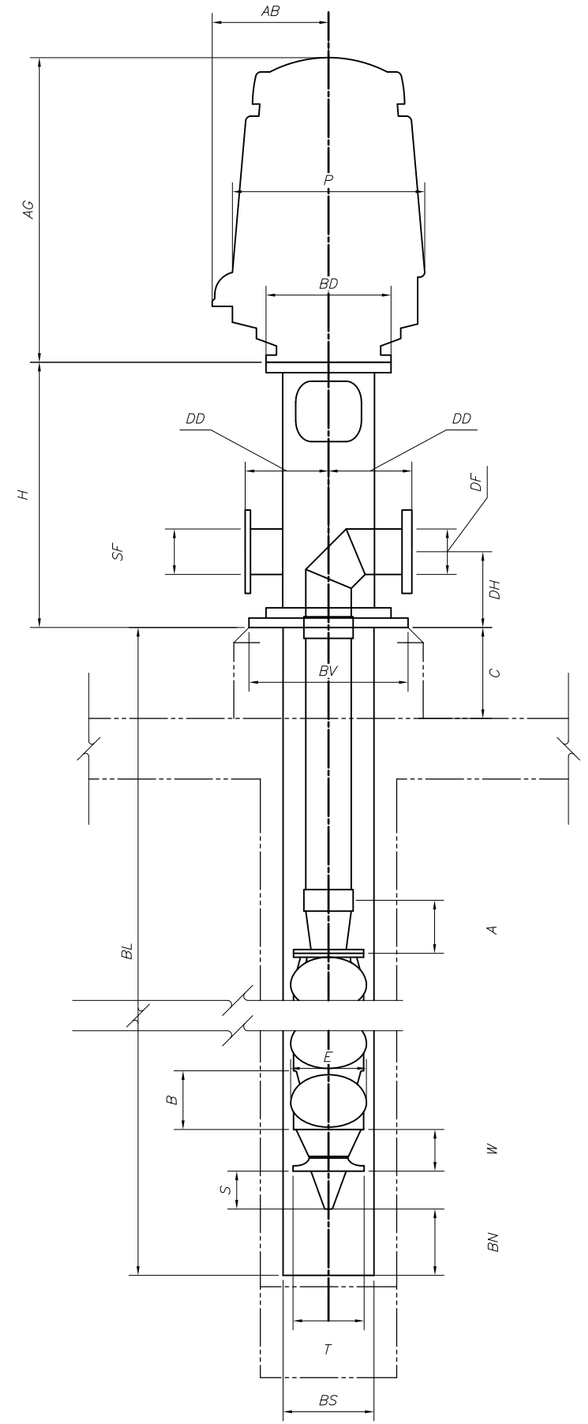



Estimated By _ Alan McConn 06/07/2016

CHECKED _ Matthew Shaw 06/08/2016 _

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | Hopi 5 | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 3 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 14JKL |
| Speed | 1770 | RPM |
| Number of Stages: | 2 | |
| Rated Flow: | 1332.82 gpm | 2.97 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 164 ft | 70 psi |
| Shutoff Head: | 222.4 ft | 100 psi |
| Brake Horsepower: | 70 hp | |
| Pump Weight: | 2900 lbs | |
| Motor Horsepower: | 75 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 460 V | |
| Motor Enclosure: | WP-I | |
| Motor Frame: | GE L365TP16 | |
| Motor Efficency: | Premium | |
| Motor Weight: | 1060 lbs | |
| Total Unit Dry Weight (Each): | 3960 lbs | |

| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 15.36 | | Can | BL | 113.25 |
| Motor | AG | 40.21 | | Can | BN | 11.75 |
| Motor | BD | 16.5 | | Can | BP | 20 |
| Motor | P | 25.38 | | Can | BS | 20 |
| Discharge Head | DD | 16 | | Can | BV | 29 |
| Discharge Head | DF | 10 | | Can | BY | 1.5 |
| Discharge Head | DH | 15 | | Stage | A | 10 |
| Discharge Head | H | 37 | | Stage | B | 12.5 |
| Discharge Head | SF | 12 | | Stage | E | 14.0625 |
| Pedestal | C | 11 | | Stage | S | 7.75 |
| | | | | Stage | T | 13.0625 |
| | | | | Stage | W | 6.5 |

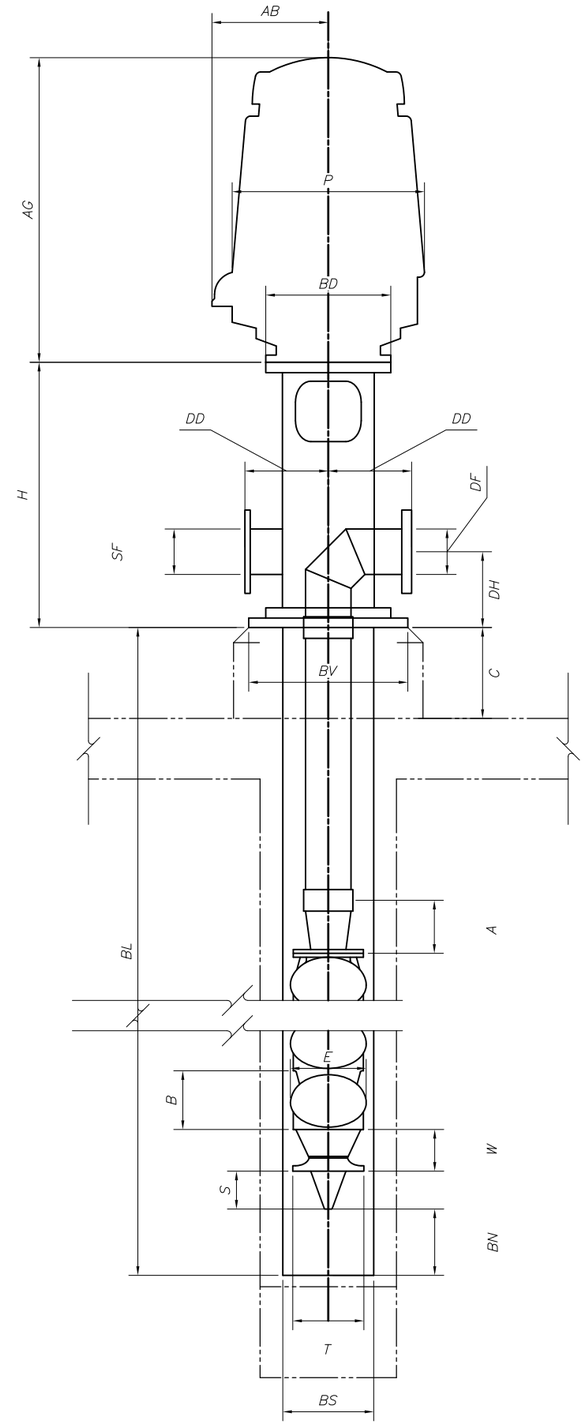



Estimated By _ Alan McConn 06/07/2016

CHECKED _ Matthew Shaw 06/08/2016 _

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | Hopi 6 | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 3 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 14JKL |
| Speed | 1770 | RPM |
| Number of Stages: | 2 | |
| Rated Flow: | 1332.82 gpm | 2.97 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 160 ft | 70 psi |
| Shutoff Head: | 218 ft | 90 psi |
| Brake Horsepower: | 70 hp | |
| Pump Weight: | 2900 lbs | |
| Motor Horsepower: | 75 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 460 V | |
| Motor Enclosure: | WP-I | |
| Motor Frame: | GE L365TP16 | |
| Motor Efficency: | Premium | |
| Motor Weight: | 1060 lbs | |
| Total Unit Dry Weight (Each): | 3960 lbs | |

| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 15.36 | | Can | BL | 113.25 |
| Motor | AG | 40.21 | | Can | BN | 11.75 |
| Motor | BD | 16.5 | | Can | BP | 20 |
| Motor | P | 25.38 | | Can | BS | 20 |
| Discharge Head | DD | 16 | | Can | BV | 29 |
| Discharge Head | DF | 10 | | Can | BY | 1.5 |
| Discharge Head | DH | 15 | | Stage | A | 10 |
| Discharge Head | H | 37 | | Stage | B | 12.5 |
| Discharge Head | SF | 12 | | Stage | E | 14.0625 |
| Pedestal | C | 11 | | Stage | S | 7.75 |
| | | | | Stage | T | 13.0625 |
| | | | | Stage | W | 6.5 |

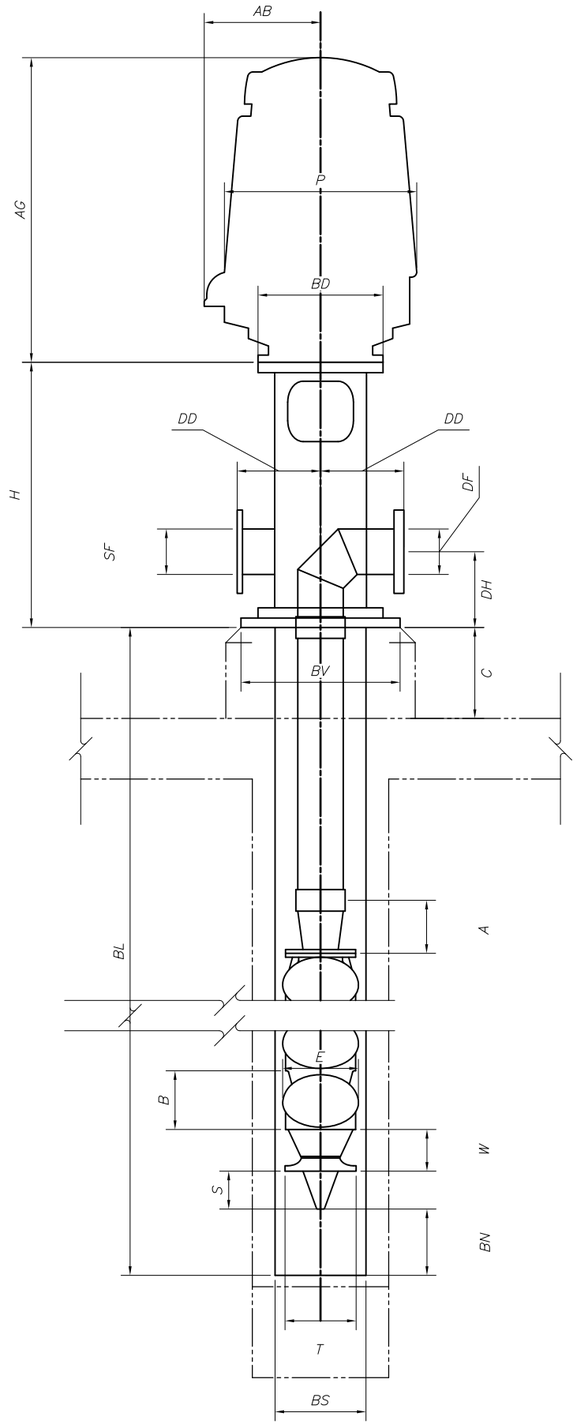



Estimated By _ Alan McCann 06/07/2016

CHECKED _ Matthew Shaw 06/08/2016 _

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | Hopi 7 | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 3 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 14JKL |
| Speed | 1770 | RPM |
| Number of Stages: | 2 | |
| Rated Flow: | 1332.82 gpm | 2.97 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 154 ft | 70 psi |
| Shutoff Head: | 211.3 ft | 90 psi |
| Brake Horsepower: | 60 hp | |
| Pump Weight: | 2900 lbs | |
| Motor Horsepower: | 75 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 460 V | |
| Motor Enclosure: | WP-I | |
| Motor Frame: | GE L365TP16 | |
| Motor Efficency: | Premium | |
| Motor Weight: | 1060 lbs | |
| Total Unit Dry Weight (Each): | 3960 lbs | |

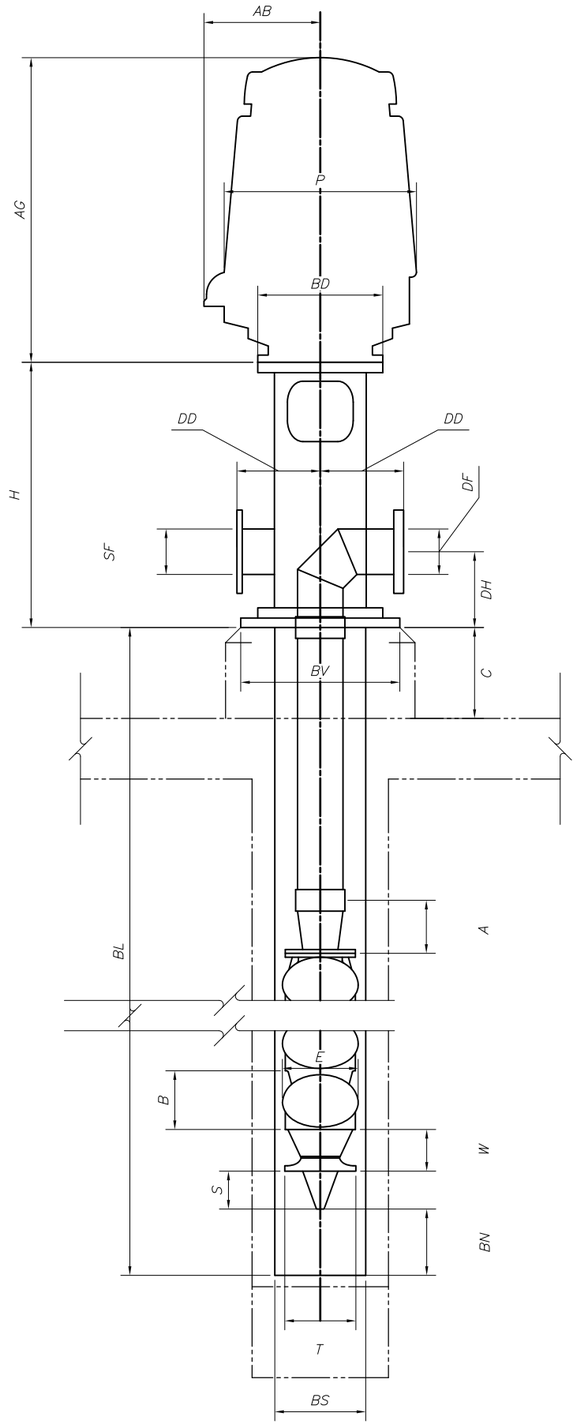
| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 15.36 | | Can | BL | 113.25 |
| Motor | AG | 40.21 | | Can | BN | 11.75 |
| Motor | BD | 16.5 | | Can | BP | 20 |
| Motor | P | 25.38 | | Can | BS | 20 |
| Discharge Head | DD | 16 | | Can | BV | 29 |
| Discharge Head | DF | 10 | | Can | BY | 1.5 |
| Discharge Head | DH | 15 | | Stage | A | 10 |
| Discharge Head | H | 37 | | Stage | B | 12.5 |
| Discharge Head | SF | 12 | | Stage | E | 14.0625 |
| Pedestal | C | 11 | | Stage | S | 7.75 |
| | | | | Stage | T | 13.0625 |
| | | | | Stage | W | 6.5 |




Estimated By _ Alan McConn 06/07/2016

CHECKED _ Matthew Shaw 06/08/2016 _

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | Hopi 8 | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 3 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 14LKM |
| Speed | 1770 | RPM |
| Number of Stages: | 5 | |
| Rated Flow: | 1274.11 gpm | 2.84 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 404 ft | 170 psi |
| Shutoff Head: | 505.4 ft | 220 psi |
| Brake Horsepower: | 160 hp | |
| Pump Weight: | 3400 lbs | |
| Motor Horsepower: | 200 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 460 V | |
| Motor Enclosure: | WP-I | |
| Motor Frame: | GE L445TP20 | |
| Motor Efficency: | Premium | |
| Motor Weight: | 1890 lbs | |
| Total Unit Dry Weight (Each): | 5290 lbs | |



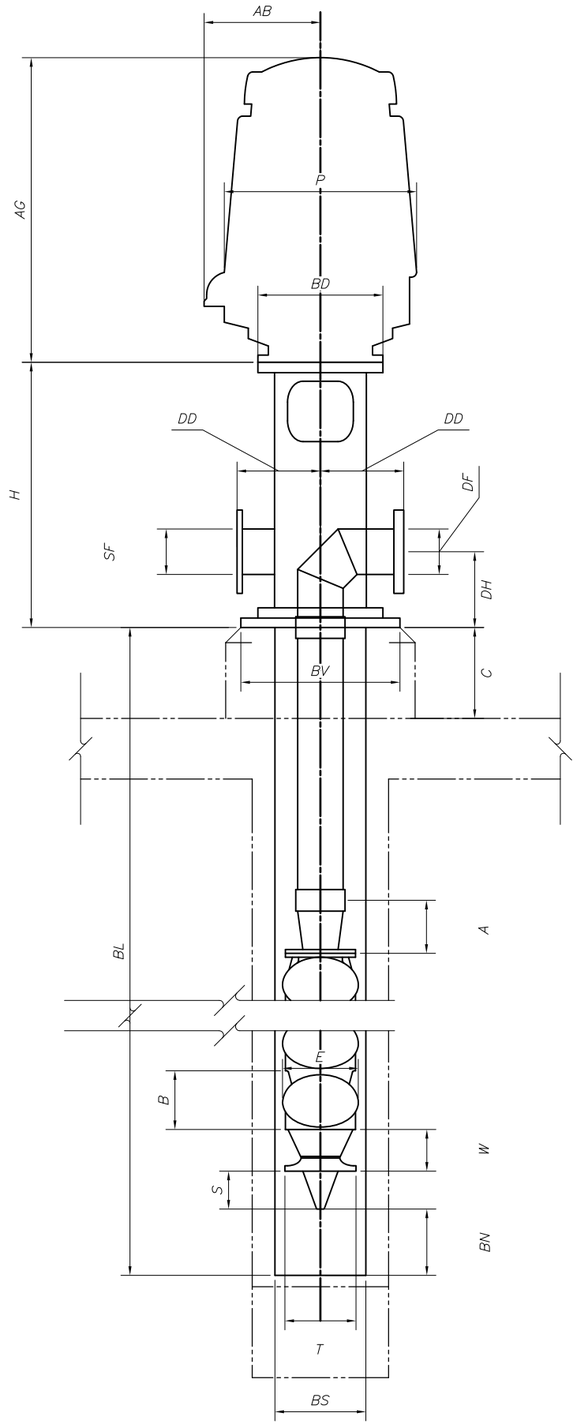

| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 20.94 | | Can | BL | 134.875 |
| Motor | AG | 53.44 | | Can | BN | 10.25 |
| Motor | BD | 16.5 | | Can | BP | 19.25 |
| Motor | P | 31.44 | | Can | BS | 20 |
| Discharge Head | DD | 16 | | Can | BV | 29 |
| Discharge Head | DF | 10 | | Can | BY | 1.5 |
| Discharge Head | DH | 15 | | Stage | A | 8.25 |
| Discharge Head | H | 37 | | Stage | B | 9.875 |
| Discharge Head | SF | 12 | | Stage | E | 13.75 |
| Pedestal | C | 11 | | Stage | S | 6.5 |
| | | | | Stage | T | 13.0625 |
| | | | | Stage | W | 7 |

Estimated By _ Alan McCann 06/06/2016

CHECKED _ Matthew Shaw 06/08/2016 _

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | Hopi 9 | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 3 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 11JKH |
| Speed | 1770 | RPM |
| Number of Stages: | 6 | |
| Rated Flow: | 841.51 gpm | 1.87 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 364 ft | 160 psi |
| Shutoff Head: | 432.9 ft | 190 psi |
| Brake Horsepower: | 90 hp | |
| Pump Weight: | 2600 lbs | |
| Motor Horsepower: | 125 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 460 V | |
| Motor Enclosure: | WP-I | |
| Motor Frame: | GE L405TP16 | |
| Motor Efficency: | Premium | |
| Motor Weight: | 1590 lbs | |
| Total Unit Dry Weight (Each): | 4190 lbs | |

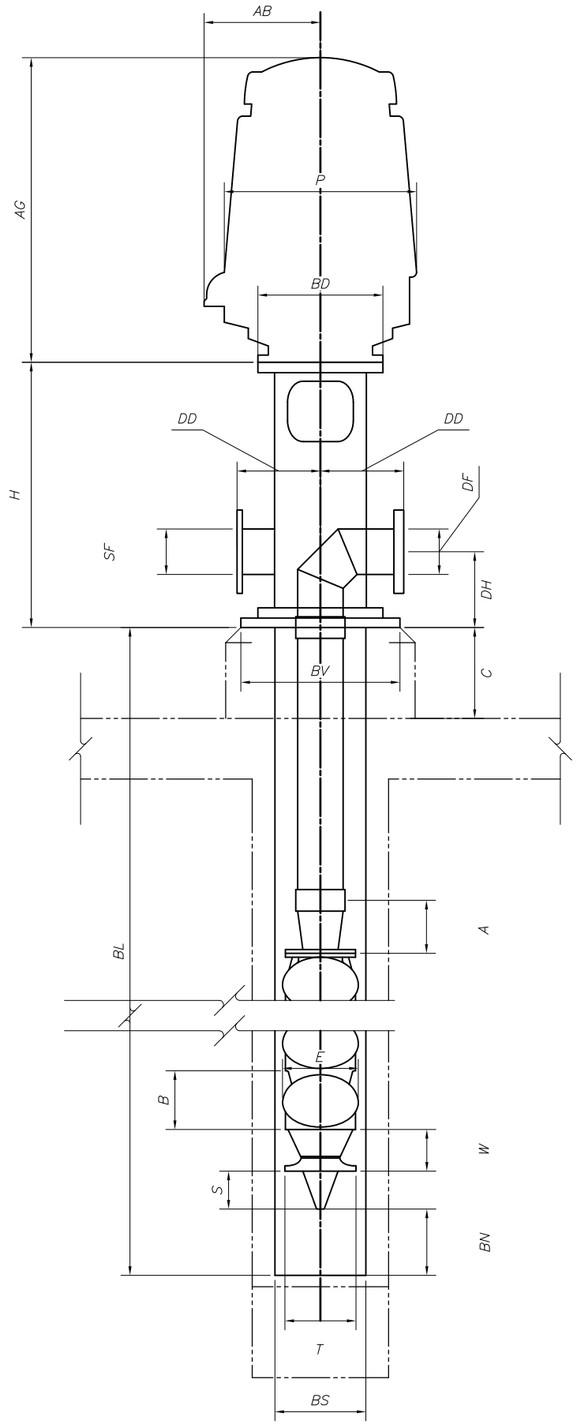
| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 19.68 | | Can | BL | 145.8125 |
| Motor | AG | 45.26 | | Can | BN | 9.625 |
| Motor | BD | 16.5 | | Can | BP | 19.25 |
| Motor | P | 28.02 | | Can | BS | 18 |
| Discharge Head | DD | 15 | | Can | BV | 27 |
| Discharge Head | DF | 8 | | Can | BY | 1.25 |
| Discharge Head | DH | 13 | | Stage | A | 8.75 |
| Discharge Head | H | 34 | | Stage | B | 9.875 |
| Discharge Head | SF | 10 | | Stage | E | 11 |
| Pedestal | C | 11 | | Stage | S | 3.5 |
| | | | | Stage | T | 11.25 |
| | | | | Stage | W | 8.1875 |




Estimated By _ Alan McConn 06/06/2016
CHECKED _ Matthew Shaw 06/07/2016 _

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | Hopi 10 | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 1 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 11XKL |
| Speed | 1770 | RPM |
| Number of Stages: | 10 | |
| Rated Flow: | 392.43 gpm | 0.87 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 514 ft | 220 psi |
| Shutoff Head: | 725.1 ft | 310 psi |
| Brake Horsepower: | 60 hp | |
| Pump Weight: | 2600 lbs | |
| Motor Horsepower: | 75 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 460 V | |
| Motor Enclosure: | WP-I | |
| Motor Frame: | GE L365TP16 | |
| Motor Efficency: | Premium | |
| Motor Weight: | 1060 lbs | |
| Total Unit Dry Weight (Each): | 3660 lbs | |

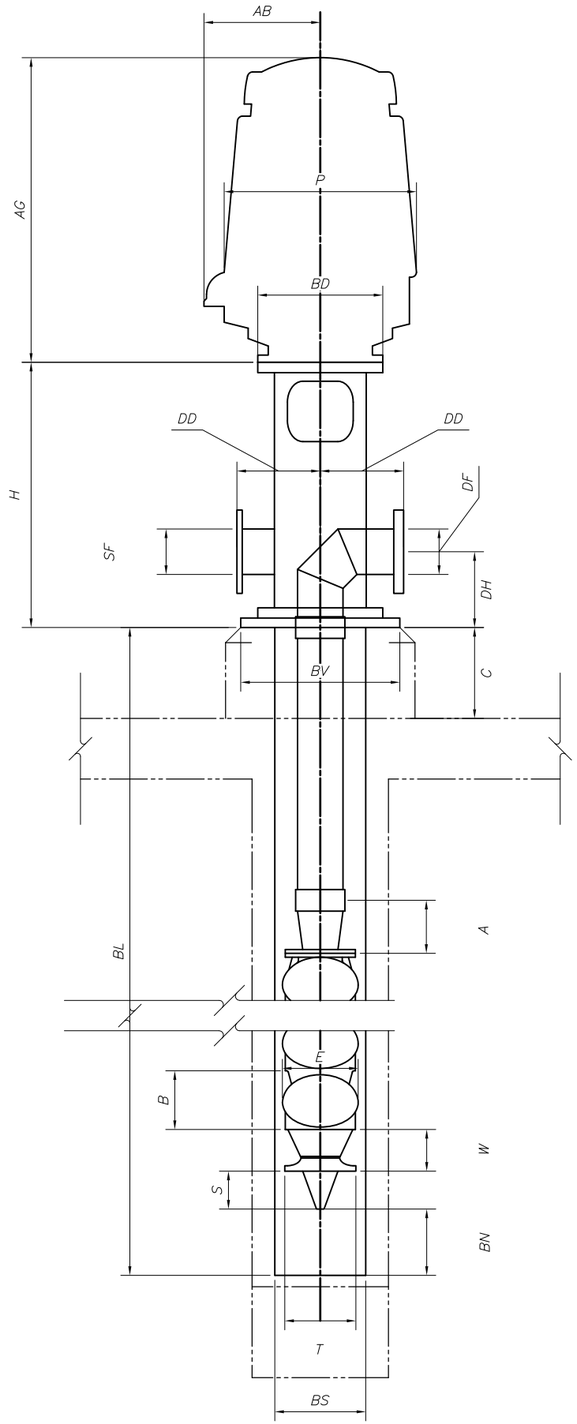
| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 15.36 | | Can | BL | 153.375 |
| Motor | AG | 40.21 | | Can | BN | 7.375 |
| Motor | BD | 16.5 | | Can | BP | 13.125 |
| Motor | P | 25.38 | | Can | BS | 16 |
| Discharge Head | DD | 14 | | Can | BV | 25 |
| Discharge Head | DF | 6 | | Can | BY | 1.25 |
| Discharge Head | DH | 12 | | Stage | A | 9 |
| Discharge Head | H | 29 | | Stage | B | 7.25 |
| Discharge Head | SF | 8 | | Stage | E | 10.875 |
| Pedestal | C | 10 | | Stage | S | 3.125 |
| | | | | Stage | T | 11.25 |
| | | | | Stage | W | 4.5 |




Estimated By _ Alan McConn 06/06/2016
CHECKED _ Matthew Shaw 06/07/2016 _

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | Hotevilla Booster Plant | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 1 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 12LKM |
| Speed | 1770 | RPM |
| Number of Stages: | 2 | |
| Rated Flow: | 929.06 gpm | 2.07 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 103 ft | 40 psi |
| Shutoff Head: | 147.3 ft | 60 psi |
| Brake Horsepower: | 30 hp | |
| Pump Weight: | 1900 lbs | |
| Motor Horsepower: | 40 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 460 V | |
| Motor Enclosure: | WP-I | |
| Motor Frame: | GE L324TP16 | |
| Motor Efficency: | Premium | |
| Motor Weight: | 700 lbs | |
| Total Unit Dry Weight (Each): | 2600 lbs | |

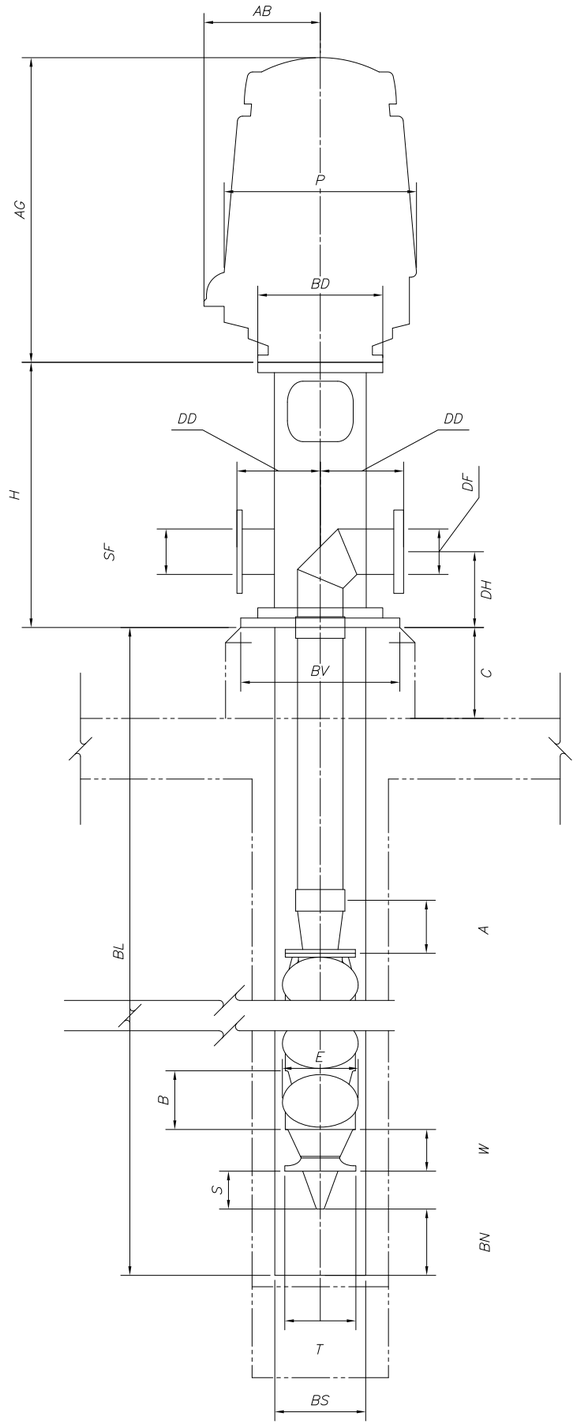
| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 15.36 | | Can | BL | 100.75 |
| Motor | AG | 36.93 | | Can | BN | 10 |
| Motor | BD | 16.5 | | Can | BP | 16.4375 |
| Motor | P | 22.1 | | Can | BS | 18 |
| Discharge Head | DD | 15 | | Can | BV | 27 |
| Discharge Head | DF | 8 | | Can | BY | 1.25 |
| Discharge Head | DH | 13 | | Stage | A | 7 |
| Discharge Head | H | 34 | | Stage | B | 9.375 |
| Discharge Head | SF | 10 | | Stage | E | 11.625 |
| Pedestal | C | 11 | | Stage | S | 6.25 |
| | | | | Stage | T | 11.25 |
| | | | | Stage | W | 5 |




Estimated By _ Alan McCann 06/06/2016
CHECKED _ Matthew Shaw 06/07/2016 _

| | | |
|---|---|---|
| *Project:* | *North Central Arizona Water Supply Study* | |
| *Feature:* | *Pumping Plants* | |
| *Details:* | *Orabi Spur Booster Plant* | |
| *Design Level:* | *Feasibility* | |
| *Number of Active Pumps:* | *1* | |
| *Number of Spare Pumps:* | *1* | |
| *Pump Selection:* | *Weir-Floway* | *6LKM* |
| *Speed* | *1760* | *RPM* |
| *Number of Stages:* | *2* | |
| *Rated Flow:* | *50.47 gpm* | *0.11 cfs* |
| *Flow Includes a Wear Factor of:* | *3%* | |
| *Rated Total Head:* | *24 ft* | *10 psi* |
| *Shutoff Head:* | *31.01 ft* | *10 psi* |
| *Brake Horsepower:* | *0.5 hp* | |
| *Pump Weight:* | *600 lbs* | |
| *Motor Horsepower:* | *0.75 hp* | |
| *Motor Speed:* | *1800 RPM* | *Fixed Induction* |
| *Motor Voltage:* | *460 V* | |
| *Motor Enclosure:* | *TEFC* | |
| *Motor Frame:* | *Baldor 56C* | |
| *Motor Efficency:* | *Premium* | |
| *Motor Weight:* | *37 lbs* | |
| *Total Unit Dry Weight (Each):* | *637 lbs* | |

| *Feature* | *Letter* | *Dim (in.)* | | *Feature* | *Letter* | *Dim (in.)* |
|---|---|---|---|---|---|---|
| *Motor* | *AB* | *5.74* | | *Can* | *BL* | *87.875* |
| *Motor* | *AG* | *13.41* | | *Can* | *BN* | *6* |
| *Motor* | *BD* | *6.51* | | *Can* | *BP* | *10.25* |
| *Motor* | *P* | *6.62* | | *Can* | *BS* | *10.75* |
| *Discharge Head* | *DD* | *10* | | *Can* | *BV* | *18* |
| *Discharge Head* | *DF* | *4* | | *Can* | *BY* | *1.25* |
| *Discharge Head* | *DH* | *10* | | *Stage* | *A* | *9.75* |
| *Discharge Head* | *H* | *27* | | *Stage* | *B* | *4.75* |
| *Discharge Head* | *SF* | *6* | | *Stage* | *E* | *5.625* |
| *Pedestal* | *C* | *12* | | *Stage* | *S* | *2.5* |
| | | | | *Stage* | *T* | *5.8125* |
| | | | | *Stage* | *W* | *2.625* |

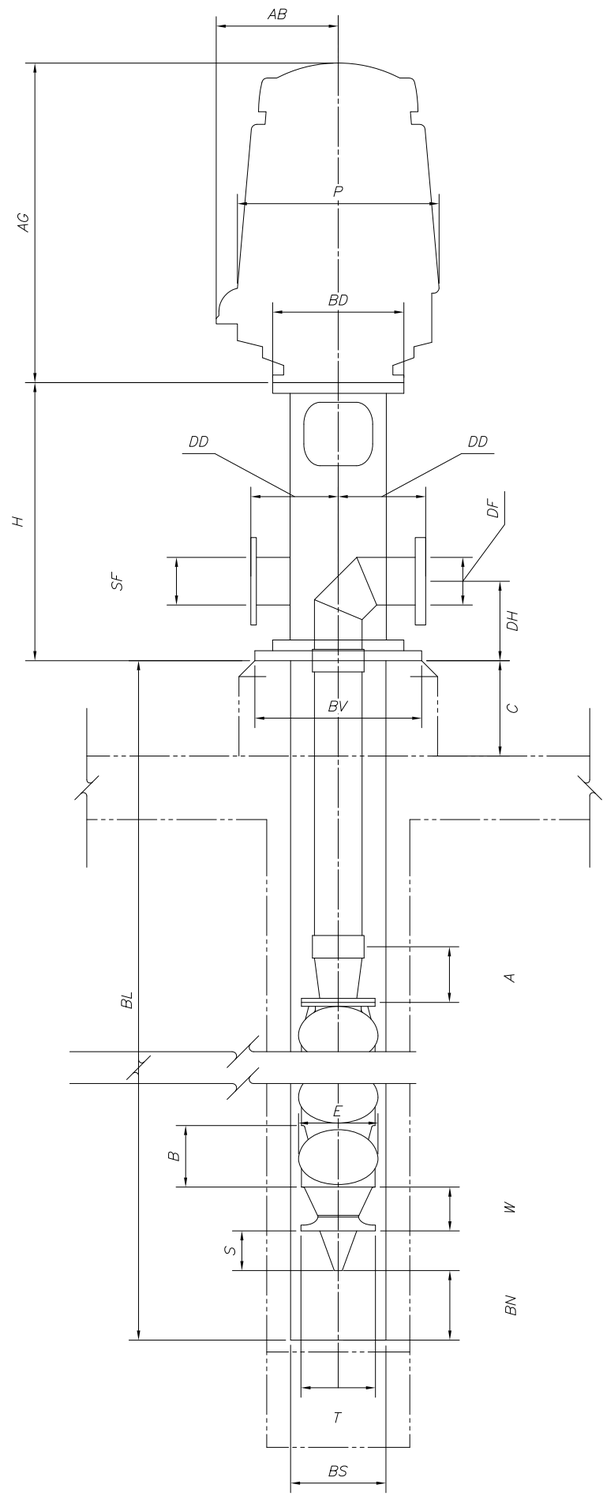



*Estimated By* _ Alan McCann 06/08/2016

*CHECKED* _ TBD

| | | |
|---|---|---|
| Project: | North Central Arizona Water Supply Study | |
| Feature: | Pumping Plants | |
| Details: | Shungopavi Booster Plant | |
| Design Level: | Feasibility | |
| Number of Active Pumps: | 1 | |
| Number of Spare Pumps: | 1 | |
| Pump Selection: | Weir-Floway | 10JKL |
| Speed | 1770 | RPM |
| Number of Stages: | 5 | |
| Rated Flow: | 503.67 gpm | 1.12 cfs |
| Flow Includes a Wear Factor of: | 3% | |
| Rated Total Head: | 179 ft | 80 psi |
| Shutoff Head: | 263.5 ft | 110 psi |
| Brake Horsepower: | 30 hp | |
| Pump Weight: | 1800 lbs | |
| Motor Horsepower: | 30 hp | |
| Motor Speed: | 1800 RPM | Fixed Induction |
| Motor Voltage: | 460 V | |
| Motor Enclosure: | WP-I | |
| Motor Frame: | GE L286TP16 | |
| Motor Efficency: | Premium | |
| Motor Weight: | 470 lbs | |
| Total Unit Dry Weight (Each): | 2270 lbs | |

| Feature | Letter | Dim (in.) | | Feature | Letter | Dim (in.) |
|---|---|---|---|---|---|---|
| Motor | AB | 12.79 | | Can | BL | 127 |
| Motor | AG | 29.57 | | Can | BN | 11.25 |
| Motor | BD | 16.5 | | Can | BP | 17.75 |
| Motor | P | 19.28 | | Can | BS | 14 |
| Discharge Head | DD | 12 | | Can | BV | 23 |
| Discharge Head | DF | 6 | | Can | BY | 1.25 |
| Discharge Head | DH | 12 | | Stage | A | 8 |
| Discharge Head | H | 29 | | Stage | B | 8.5 |
| Discharge Head | SF | 8 | | Stage | E | 9.8125 |
| Pedestal | C | 10 | | Stage | S | 7.5 |
| | | | | Stage | T | 9.375 |
| | | | | Stage | W | 5.25 |




Estimated By _ Alan McCann 05/31/2016

CHECKED _ Matthew Shaw 05/31/2016 _