AGENDA
GROUNDWATER BANKING JOINT POWERS AUTHORITY
SPECIAL PROJECT COMMITTEE MEETING

March 15, 2021
1:00 PM

Due to COVID-19, this meeting will be conducted as a teleconference pursuant to the provisions of the Governor's Executive Orders N-25-20 and N-29-20, which suspend certain requirements of the Ralph M. Brown Act. Members of the public may not attend this meeting in person.

Participation by members of the Committee will be from remote locations. Public access and participation will only be available telephonically/electronically.

To virtually attend the meeting and to be able to view any presentations or additional materials provided at the meeting, please join online using the link and information below:

Via Web: https://zoom.us/j/88437270100
Meeting Number (Access Code): 884 3727 0100
Meeting Password: 568518
Telephone Dial In: (669) 900-6833

As courtesy to the other participants, please mute your phone when you are not speaking.

PLEASE NOTE: Participants joining the meeting will be placed into the lobby when the Committee enters closed session. Participants who remain in the "lobby" will automatically be returned to the open session of the Committee once the closed session has concluded. Participants who join the meeting while the Committee is in closed session will be placed in the waiting room. When the Committee has returned to open session, the participants will be automatically added to the meeting.

CALL TO ORDER 1:00 PM

ROLL CALL Jason Selvidge, Doug Reinhart, Dan Bartel, Paul Cook, Cheryl Clary

PUBLIC COMMENT NOTICE

If you wish to address the Committee on any item, please submit a request to speak via the "chat" feature available when joining the meeting virtually. Remarks are limited to three minutes per speaker on each subject. You may also submit a public comment in advance of the meeting by emailing mmisuraca@rrbwsd.com before 5:00 pm. on Friday, March 12, 2021.

ALL VOTES SHALL BE TAKEN BY A ROLL CALL VOTE.

1. **Consideration and Possible Action on Approval of Technical Memos 4-5**

2. **Update on DWR Agreements**

3. **Closed Session**

   a) CLOSED SESSION CONFERENCE WITH REAL PROPERTY NEGOTIATORS – Pursuant to Government Code Section 54956.8:

      Property: Parcels 103-110-02; 103-110-04; 103-110-09; 103-120-14; 103-120-15; 103-120-16; 103-120-17; 103-130-01; 103-130-03; 103-130-05; 103-130-07; 103-140-02; 103-140-05; 103-140-06; 103-140-12; 103-140-15; 103-140-16; 103-140-17; 103-140-18; 103-140-19; 103-180-01; 103-180-05; 103-180-07; 103-190-13; 103-190-14; 103-200-23; 103-200-25; 103-200-26; 103-200-27; 103-200-28; 103-200-29, County of Kern

      Agency negotiators: Dan Bartel

      Negotiating parties: Belluomini Ranches, LP, Tech Ag Financial Group, Inc., Diamond Farming, McCaslin, Bolthouse Properties and Rosedale-Rio Bravo Water Storage District

      Under negotiation: Price and Terms of Payment

   b) CLOSED SESSION CONFERENCE WITH REAL PROPERTY NEGOTIATORS – Pursuant to Government Code Section 54956.8:

      Property: Various Parcels

      Agency negotiators: Dan Bartel

      Negotiating parties: Various parties and Groundwater Banking Joint Powers Authority

      Under negotiation: Price and Terms of Payment

4. **Adjournment**

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Availability of agenda materials: Agenda exhibits and other writings that are disclosable public records distributed to all or a majority of the members of the above-named Committee in connection with a matter subject to discussion or consideration at an open meeting of the Committee are available for public inspection by contacting Megan Misuraca at mmisuraca@rrbwsd.com. If such writings are distributed to members of the Committee less than 72 hours prior to the meeting, they will be available to the public at the same time as they are distributed to Committee Members, except that if such writings are distributed one hour prior to, or during, the meeting, they will be available electronically during the meeting.

Accommodations: Upon request, the Committee will provide for written agenda materials in appropriate alternative formats, and reasonable disability-related modification or accommodation to enable individuals with disabilities to participate in and provide comments at the meeting. Please submit a request, including your name, phone number and/or email address, and a description of the modification, accommodation, or alternative format requested at least two days before the meeting. Requests should be emailed to mmisuraca@rrbwsd.com. Requests made by mail must be received at least two days before the meeting. Requests will be granted whenever possible and resolved in favor of accessibility.

GBJPA

Groundwater Banking
Joint Powers Authority

Kern fan groundwater storage project

Design, Engineering, ROW Acquisition, and Construction Team

Dan Bartel (Staff)
Ray Bennet (Staff)
Markus Nygren (Staff)
Curtis Skaggs (Consultant)
Bill Zeiders (Consultant)

On Behalf of Groundwater Banking Joint Powers Authority

849 Allen Road
Bakersfield, CA 93314

Technical memoranda

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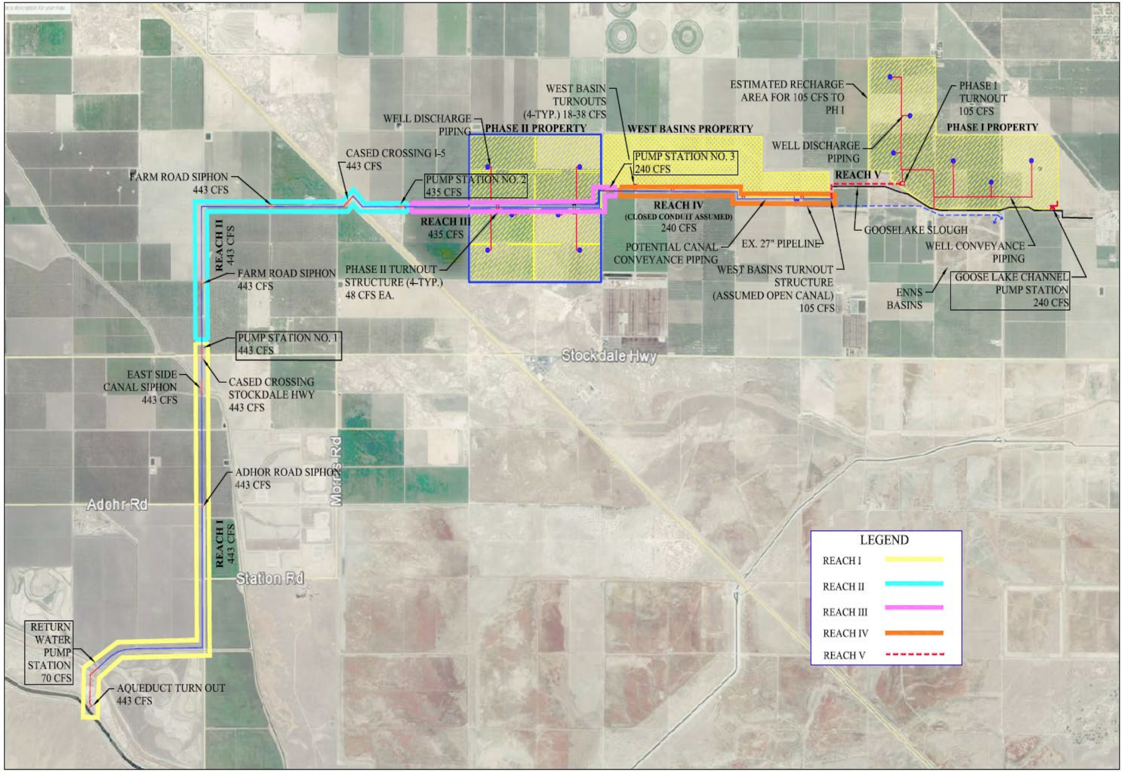

Purpose of Technical Memoranda

- Document the previously developed preliminary design work provided by Dee Jaspar & Associates, Inc. as part of the Grant Application processes.
- Incorporate RRBWSD and IRWD design, construction, and operational experience into the Design Process.
- Provide a forum for agreement by the District's on design decisions prior to the hard engineering design process.
- Perform Value Engineering as previously discussed by both District's.
- Provide thorough project documentation of JPA expectations to be used for the RFP and final design purposes.

Technical memoranda

Priority 1	Status
1. Project Phasing and Design / Contractor Selection	95% Ready for Consideration
2. Conveyance Capacity Requirements	95% Ready for Consideration
3. Pipeline Requirements	95% Ready for Consideration
4. Pump Station Requirements	95% Ready for Consideration
Priority 2	
5. Geotechnical Report	95% Ready for Consideration
6. Canal Liner and Turnout Requirements	80%
7. Well Drilling and Equipping Requirements	25%
8. ROW Acquisitions	10%
Priority 3	
9. Recharge Basin Requirements	10%
10. Facility Operation and SCADA Requirements	10%
11. Engineer's Estimates	10%

Tm#4 – pump station requirements

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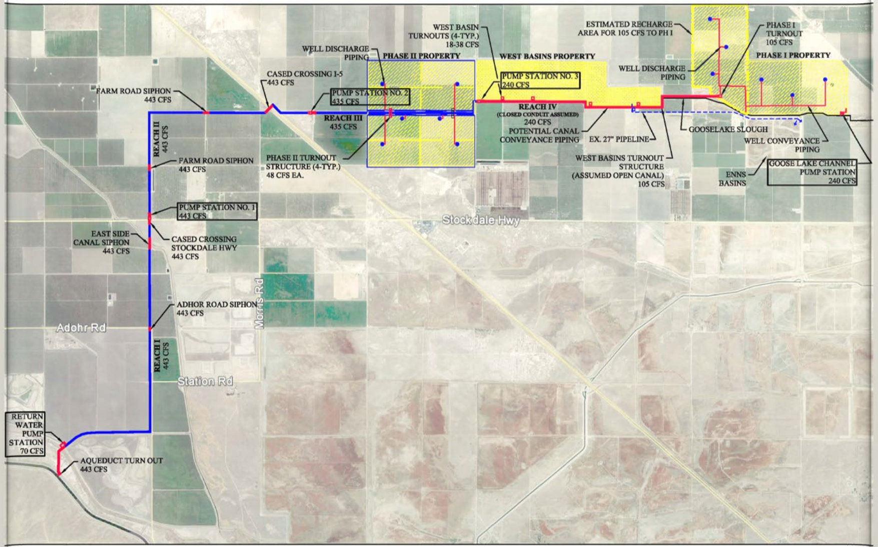
Purpose

Outline in general the minimum pump station design standards, evaluate alternatives for pump station configurations and the associated costs, discuss special considerations and other pertinent items such as physical modeling, electrical service, control building design, and the pump station control philosophy.

Project Pump Stations

- Pump Station No. 1 at Stockdale Highway (443cfs)
- Pump Station No. 2 at I-5 Freeway (435cfs)
- Pump Station No. 3 at west end of West Basins (240cfs)
- Return Water Pump Station (70 cfs)
- Goose Lake Channel Pump Station (240cfs)



Pump station criteria

Description

- Design for a minimum flowrate of 30 cfs
- Design for the full range of flow from 30 cfs to the maximum specified design rate in 5 cfs increments
- Size pumps and pump bays to standardize on two stoplog slot dimensions
- Size pumps to provide interchangeability between pump stations
- Provide pump redundancy

Pump Configurations Evaluated

- Pump Stations No. 1 and No. 2
  - (6) Pump Configuration
  - (4) Pump Configuration

- Pump Station No. 3
  - (6) Pump Configuration
  - (4) Pump Configuration
  - (3) Pump Configuration

Pump Station Summary				
Pump Station Facility	Capacity	Pump Configuration	36-42 cfs Pumps	80-90 cfs Pumps
Pump Station No. 1	443 cfs	Six (6) Pumps	Two	Four
Pump Station No. 2	435 cfs	Six (6) Pumps	Two	Four
Pump Station No. 3	240 cfs	Four (4) Pumps	Two	Two
Pump Station No. 4	129 cfs	If Necessary		
Goose Lake Channel Pump Station	240 cfs	Four (4) Pumps	Two	Two
Return Water Pump Station	72 cfs	Three (3) Pumps	Three	

Pump stations no. 1 & no. 2

(6) Pump Configuration

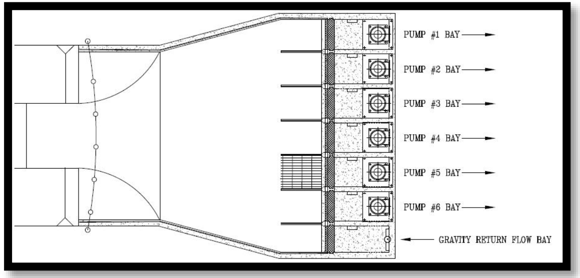
- PS #1- 443 cfs Capacity
  - Two (2) 42cfs Pumps
  - Four (4) 90 cfs Pumps

- PS #2- 435 cfs Capacity
  - Two (2) 40 cfs Pumps
  - Four (4) 89cfs Pumps

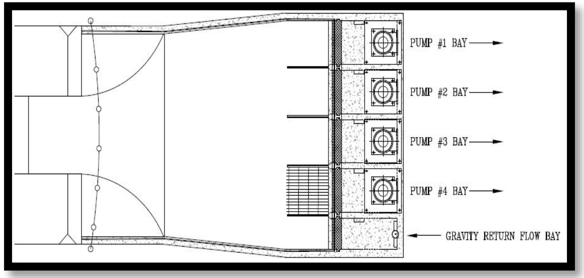
(4) Pump Configuration

- PS #1- 443 cfs Capacity
  - Two (2) 75cfs Pumps
  - Two (2) 147cfs Pumps

- PS #2- 435 cfs Capacity
  - Two (2) 73cfs Pumps
  - Two (2) 145cfs Pumps



Conceptual layout - (6) Pump Configuration



Conceptual layout - (4) Pump Configuration

Pump stations no. 1 & no. 2

(6) Pump Configuration

- PS #1- 443 cfs Capacity
  - Two (2) 42cfs Pumps
  - Four (4) 90 cfs Pumps
- PS #2- 435 cfs Capacity
  - Two (2) 40 cfs Pumps
  - Four (4) 89cfs Pumps

Pump Station No. 1 and No. 2 with 6 Pump Configuration						
Pump Station Demand	40-42 cfs Pump[1]	40-42 cfs Pump[1]	89-90 cfs Pump[2]	89-90 cfs Pump[2]	89-90 cfs Pump[2]	89-90 cfs Pump[2]
30-45 cfs	x					
50-80 cfs	x	x				
85-90 cfs			x			
95-130 cfs	x		x			
135-170 cfs	x	x	x			
175-215 cfs	x		x	x		
220-260 cfs	x	x	x	x		
265-310 cfs	x		x	x	x	
315-350 cfs	x	x	x	x	x	
355-400 cfs	x		x	x	x	x
405-443 cfs	x	x	x	x	x	x

[1]Pump range with VFD estimated as 27 cfs to 42 cfs.

[2]Pump range with VFD estimated as 59 cfs to 90 cfs.

(4) Pump Configuration

- PS #1- 443 cfs Capacity
  - Two (2) 75cfs Pumps
  - Two (2) 147cfs Pumps
- PS #2- 435 cfs Capacity
  - Two (2) 73cfs Pumps
  - Two (2) 145cfs Pumps

Pump Station No. 1 and No. 2 with 4 Pump Configuration				
Pump Station Demand	73-75 cfs Pump[1]	73-75 cfs Pump[1]	145-147 cfs Pump[2]	145-147 cfs Pump[2]
30 cfs				
35 cfs				
40 cfs				
45 cfs				
50-80 cfs	x			
85 cfs				
90 cfs				
95-145 cfs			x	
150-220 cfs	x		x	
225-295 cfs	x	x	x	
300-365 cfs	x		x	x
370-443 cfs	x	x	x	x

[1]Pump range with VFD estimated as 48 cfs to 75 cfs.

[2]Pump range with VFD estimated as 96 cfs to 145 cfs.

(shaded) Pumps may not be able to match these flow rates.

Pump stations no. 1 & no. 2

Recommendation

The recommendation is a six pump configuration:

- 6 Pump Config. = $8,605,000.00
- 4 Pump Config. = $7,447,000.00

Redundancy is built-in by nature of the 1.5 filling factor that is being utilized for the recharge areas. If filling at 435-443 cfs and the largest pump is out-of-service, pump station capacity will be at 346 cfs to 353 cfs (67% to 90% capacity).

During long term maintenance rates or average recharge rates (282 cfs), the pump station will still meet 100% capacity with the largest pump out-of-service (350 cfs).

- PS #1- 443 cfs Capacity
  - Two (2) 42cfs Pumps
  - Four (4) 90 cfs Pumps

- PS #2- 435 cfs Capacity
  - Two (2) 40 cfs Pumps
  - Four (4) 89cfs Pumps

Kern Fan Project				
Pump Stations No. 1 and No. 2 - 6 Pump Configuration				
Item Description	Unit	Quantity	Unit Cost	Extended Cost
Earthwork & Site Ground Cover	1	LS	$ 215,000.00	$ 215,000.00
Reinforced Concrete Structure	1	LS	$ 920,000.00	$ 920,000.00
Miscellaneous Steel & Trashracks	1	LS	$ 215,000.00	$ 215,000.00
Pumps and Motors	1	LS	$ 2,222,000.00	$ 2,222,000.00
30" Discharge Piping & Appurtenances	2	EA	$ 394,000.00	$ 788,000.00
42" Discharge Piping & Appurtenances	4	EA	$ 485,000.00	$ 1,940,000.00
Variable Frequency Drives	1	LS	$ 700,000.00	$ 700,000.00
Electrical and Controls	1	LS	$ 995,000.00	$ 995,000.00
Electrical Control Building & Foundation	1	LS	$ 380,000.00	$ 380,000.00
Cathodic Protection	1	LS	$ 25,000.00	$ 25,000.00
Gravity Bypass Pipeline & Slide Gate	1	LS	$ 205,000.00	$ 205,000.00
			Total 6 Pump Configuration Estimate:	**$ 8,605,000.00**

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Pump station no. 3

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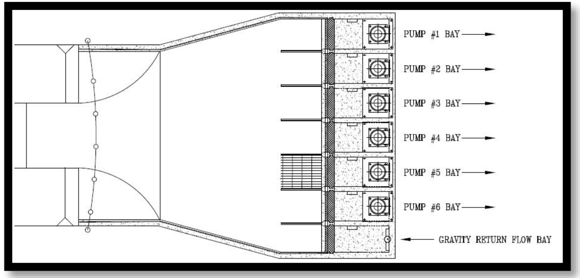
(6) Pump Configuration

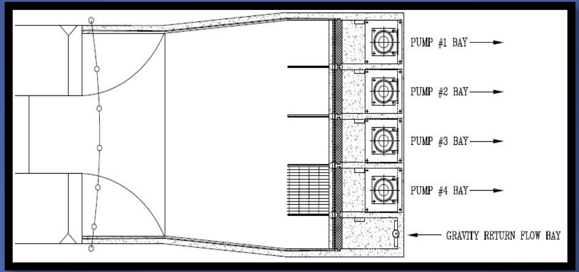
- PS #3- 240 cfs Capacity
  - Six (6) 40cfs Pumps



Conceptual layout - (6) Pump Configuration

(4) Pump Configuration

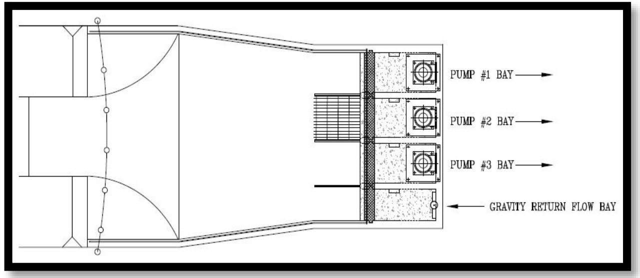
- PS #3- 240 cfs Capacity
  - Two (2) 40 cfs Pumps
  - Two (2) 80 cfs Pumps



Conceptual layout - (4) Pump Configuration

(3) Pump Configuration

- PS #3- 240 cfs Capacity
  - Three (3) 80 cfs Pumps



Conceptual layout - (3) Pump Configuration

Pump station no. 3

GBJPA

(6) Pump Configuration

- PS #3- 240 cfs Capacity
  - Six (6) 40cfs Pumps

Pump Station No. 3 with 6 Pump Configuration						
Pump Station Demand	40 cfs Pump[1]	40 cfs Pump[1]	40 cfs Pump[1]	40 cfs Pump[1]	40 cfs Pump[1]	40 cfs Pump[1]
30-45 cfs	X					
50-80 cfs	X	X				
85-120 cfs	X	X	X			
125-160 cfs	X	X	X	X		
165-200 cfs	X	X	X	X	X	
205-240 cfs	X	X	X	X	X	X

[1]Pump range with VFD estimated as 26 cfs to 40 cfs.

Pump staging (6) Pump Configuration

(4) Pump Configuration

- PS #3- 240 cfs Capacity
  - Two (2) 40 cfs Pumps
  - Two (2) 80 cfs Pumps

Pump Station No. 3 with 4 Pump Configuration				
Pump Station Demand	40 cfs Pump[1]	40 cfs Pump[1]	80 cfs Pump[2]	80 cfs Pump[2]
30-45 cfs	X			
50-80 cfs	X	X		
85-120 cfs	X		X	
125-160 cfs	X	X	X	
165-200 cfs	X		X	X
205-240 cfs	X	X	X	X

[1]Pump range with VFD estimated as 26 cfs to 40 cfs.

[2]Pump range with VFD estimated as 53 cfs to 80 cfs.

Pump staging (4) Pump Configuration

(3) Pump Configuration

- PS #3- 240 cfs Capacity
  - Three (3) 80 cfs Pumps

Pump Station No. 3 with 3 Pump Configuration			
Pump Station Demand	80 cfs Pump[1]	80 cfs Pump[1]	80 cfs Pump[1]
30 cfs			
35 cfs			
40 cfs			
45 cfs			
50 cfs			
55-85 cfs	x		
90 cfs			
95 cfs			
100 cfs			
105-160 cfs	x	x	
165-240 cfs	x	x	x

[1]Pump range with VFD estimated as 53 cfs to 80 cfs.

Pumps may not be able to match these flow rates.

Pump staging (3) Pump Configuration

Pump station no. 3

Recommendation

The recommendation is a four pump configuration. Six pumps is more expensive than the four pump configuration, while the four pump arrangement still meets all the design criteria.

- 6 Pump Config. = $7,328,000.00
- 4 Pump Config. = $6,150,000.00
- 3 Pump Config. = $5,298,500.00

Redundancy is built-in by nature of the 1.5 filling factor that is being utilized for the recharge areas. If filling at 240 cfs and the largest pump is out-of-service, pump station capacity will be 160 cfs to 200 cfs (67% to 90% of capacity).

During long term maintenance rates or average recharge rates (160 cfs), the pump station will still meet 100% capacity with the largest pump out-of-service, i.e. 240cfs – 80 cfs (160cfs).

- PS #3- 240 cfs Capacity

  - Two (2) 40 cfs Pumps
  - Two (2) 80 cfs Pumps

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Kern Fan Project					
Pump Stations No. 3 - 4 Pump Configuration					
Item Description	Unit	Quantity		Unit Cost	Extended Cost
Earthwork & Site Ground Cover	1	LS	$	200,000.00	$ 200,000.00
Reinforced Concrete Structure	1	LS	$	800,000.00	$ 800,000.00
Miscellaneous Steel & Trashracks	1	LS	$	175,000.00	$ 175,000.00
Pumps and Motors	1	LS	$	1,287,000.00	$ 1,287,000.00
30" Discharge Piping & Appurtenances	2	EA	$	394,000.00	$ 788,000.00
42" Discharge Piping & Appurtenances	2	EA	$	485,000.00	$ 970,000.00
Variable Frequency Drives	1	LS	$	420,000.00	$ 420,000.00
Electrical and Controls	1	LS	$	900,000.00	$ 900,000.00
Electrical Control Building & Foundation	1	LS	$	380,000.00	$ 380,000.00
Cathodic Protection	1	LS	$	25,000.00	$ 25,000.00
Gravity Bypass Pipeline & Slide Gate	1	LS	$	205,000.00	$ 205,000.00
				Total 4 Pump Configuration Estimate:	**$ 6,150,000.00**

Goose lake channel pump station

GBJPA

Recommendation

The recommendation is a four pump configuration. Six pumps is more expensive than the four pump configuration, while the four pump arrangement still meets all the design criteria.

Redundancy is built-in by nature of the 1.5 filling factor that is being utilized for the recharge areas. If filling at 240 cfs and the largest pump is out-of-service, the pump station capacity will be 160 cfs to 200 cfs (67% to 90%).

During long term maintenance rates or average recharge rates (160 cfs), the pump stations will still meet 100% capacity with the largest pump out-of-service, i.e. 240cfs – 80 cfs (160cfs).

- GLC Pump Station- 240 cfs Capacity
  - Two (2) 40 cfs Pumps
  - Two (2) 80 cfs Pumps

Kern Fan Project
Pump Stations No. 3 - 4 Pump Configuration

Item Description	Unit	Quantity	Unit Cost	Extended Cost
Earthwork & Site Ground Cover	1	LS	$ 200,000.00	$ 200,000.00
Reinforced Concrete Structure	1	LS	$ 800,000.00	$ 800,000.00
Miscellaneous Steel & Trashracks	1	LS	$ 175,000.00	$ 175,000.00
Pumps and Motors	1	LS	$ 1,287,000.00	$ 1,287,000.00
30" Discharge Piping & Appurtenances	2	EA	$ 394,000.00	$ 788,000.00
42" Discharge Piping & Appurtenances	2	EA	$ 485,000.00	$ 970,000.00
Variable Frequency Drives	1	LS	$ 420,000.00	$ 420,000.00
Electrical and Controls	1	LS	$ 900,000.00	$ 900,000.00
Electrical Control Building & Foundation	1	LS	$ 380,000.00	$ 380,000.00
Cathodic Protection	1	LS	$ 25,000.00	$ 25,000.00
Gravity Bypass Pipeline & Slide Gate	1	LS	$ 205,000.00	$ 205,000.00
			Total 4 Pump Configuration Estimate:	**$ 6,150,000.00**

Return water pump station

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Criteria

- Minimum Flow Rate = 24 cfs (Appr. 4 Wells)
- Capacity of 24 cfs to 72 cfs in 5 cfs increments
- Full Pump Redundancy, if largest pump or motor fails

Evaluation

- Two Pumps
  - Two (2) 72cfs Pumps
- Three Pumps
  - Three (3) 36cfs Pumps

Recommendation

The recommendation is a three pump configuration each 36 cfs.

- Allows for returning the maximum design flow to Aqueduct with largest pump or motor out of service
- Allows for three pumps to be similar to 40 cfs size pumps at other Pump Stations for possible interchangeability
- Achieves a minimum flow rate of 24 cfs
- Achieves 5 cfs increment from 24 cfs to 72 cfs

Pump station considerations

- Pump Station Design per HIS ANSI/HI 9.8-Most Recent Edition for Pump Intake Design
- Pump Station Design shall allow for Gravity Return Line for returning water to Aqueduct
- Reinforced Concrete Structures with dividing walls for Pump Bays and maximum 1.5 fps
- Combination of Reinforced Concrete and Heavy Bar Steel Grating for Pump Deck
- Stop Logs for Isolation of Pump Bays – Try and Limit to Two Stop Log Sizes
- Trashracks – Hot Dip Galvanized and Inclined – Minimum Five Pump Bell Diameters upstream of Pumps
- Handrailing around Pump Station Deck for Safety
- Pump Stations, Pumps, & Motors, designed for State of California Seismic Requirements
- Cathodic Protection for Submerged Pump Columns, Trashracks, and Underground Piping
- Discharge Piping with ARV, Check Valve, Dresser Coupling, BFV, and Flow Meter
- Variable Frequency Drives on each Motor
- All-Weather Surfacing around Pump Station, Control Building, etc.
- Site Lighting around the Pump Station
- Site Security in form of Fencing with large Drive Gates and Personnel Gates
- Low Voltage vs Medium Voltage Electrical Service
- Utility Interface (PG&E)
- Control Building – Masonry or Pre-Cast Concrete

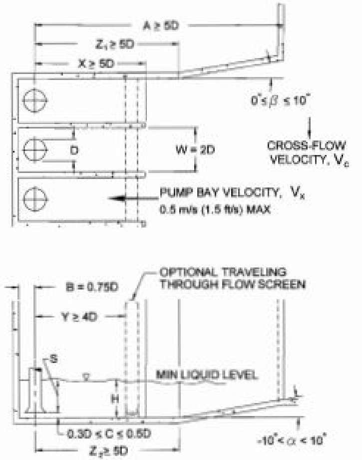


Figure 4. Recommended Intake Structure Layout. (Courtesy Hydraulic Institute)

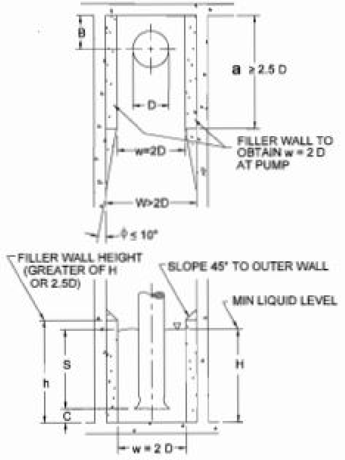


Figure 5. Filler Wall Details for Proper Bay Width. (Courtesy Hydraulic Institute)

Pump station modeling

- Physical Modeling recommended based on size of Pump Stations

- Recommended to prepare Preliminary Design of Pump Stations for Modeling
- Perform Physical Modeling of Pump Stations using Scale Model
- Finalize Design of Pump Stations based on results and recommendations of Modeling

- Physical Modeling to ensure Pump Stations:
  - Meet the Established Design Criteria
  - Prevent Accumulation of Sediment and Debris
  - Avoid Pump Cavitation and Vortices
  - Optimize Hydraulic Performance and Efficiency
  - Reduce Maintenance Requirements

- Reputable Firms or Laboratories:
  - Utah Water Research Laboratory (UWRL)
  - US Bureau of Reclamation Hydraulics Laboratory
  - Clemson Engineering Hydraulics (CEH)
  - Northwest Hydraulic Consultants (NHC)

- Model Testing
  - Testing to include all possible scenarios of pump operation

Pump station control philosophy

- Control Philosophy developed during the detailed design phase

- Ability to Control, Monitor, and Operate Pump Stations both Locally and Remote through SCADA
- Ability to Turn Pumps On and Off
- Monitor Water Levels in each Forebay and Afterbay
- Monitor Flow Readings from each individual Flow Meter
- Communicate Alarms – Power Failure, Motor Failure, VFD Failure, Water Levels, High Pressure, Intrusion

- Pump Control:
  - Modulate and Control Pumps based on Flow Settings
  - Modulate and Control Pumps based on Water Levels
  - Combination Flow and Level

Tm#5 – geotechnical investigation

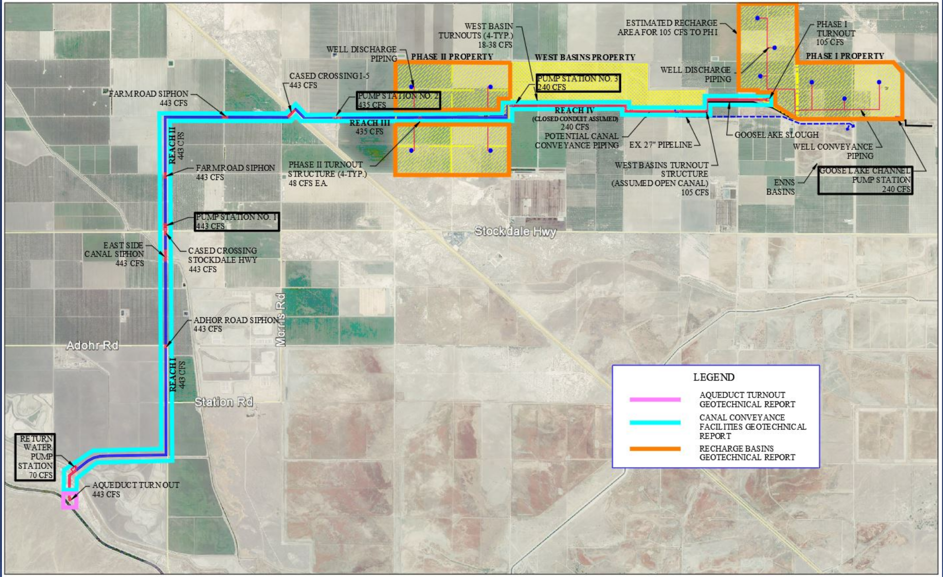
GBJPA

<u>Project Phasing – Anticipated Geotechnical Work</u>

- Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures

- Aqueduct Turnout Facility

- Conveyance Facilities including Turnouts and Pump Stations



Recharge facility soils work

- Geotechnical Investigation and Report for Recharge Facilities including field work, sampling, testing, and final report summarizing findings, conclusions, and recommendations.

- Review Available Data

- Field Exploration

- Site Conditions

- Seismic Design Parameters

- Design Recommendations

  - Earthwork Recommendations – Subgrade Preparation and Keyways
  - Borrow Areas – Material Evaluation and Compaction Criteria
  - Levee Construction Earthwork
  - Soil Permeability
  - Permanent and Temporary Slopes
  - Interbasin Structures and Pipes

Aqueduct turnout soils work

- Geotechnical Investigation and Report for Aqueduct Turnout including field work, sampling, testing, and final report summarizing findings, conclusions, and recommendations.
- Review Available Data
- Field Exploration
- Site Conditions
- Seismic Design Parameters
- Design Recommendations

  - Earthwork Recommendations – Subgrade Preparation
  - Borrow Areas – Material Evaluation and Compaction Criteria
  - Structure Design Parameters
  - Pipe Design Parameters
  - Braced Cuts
  - Concrete Corrosion Potential
  - Dewatering

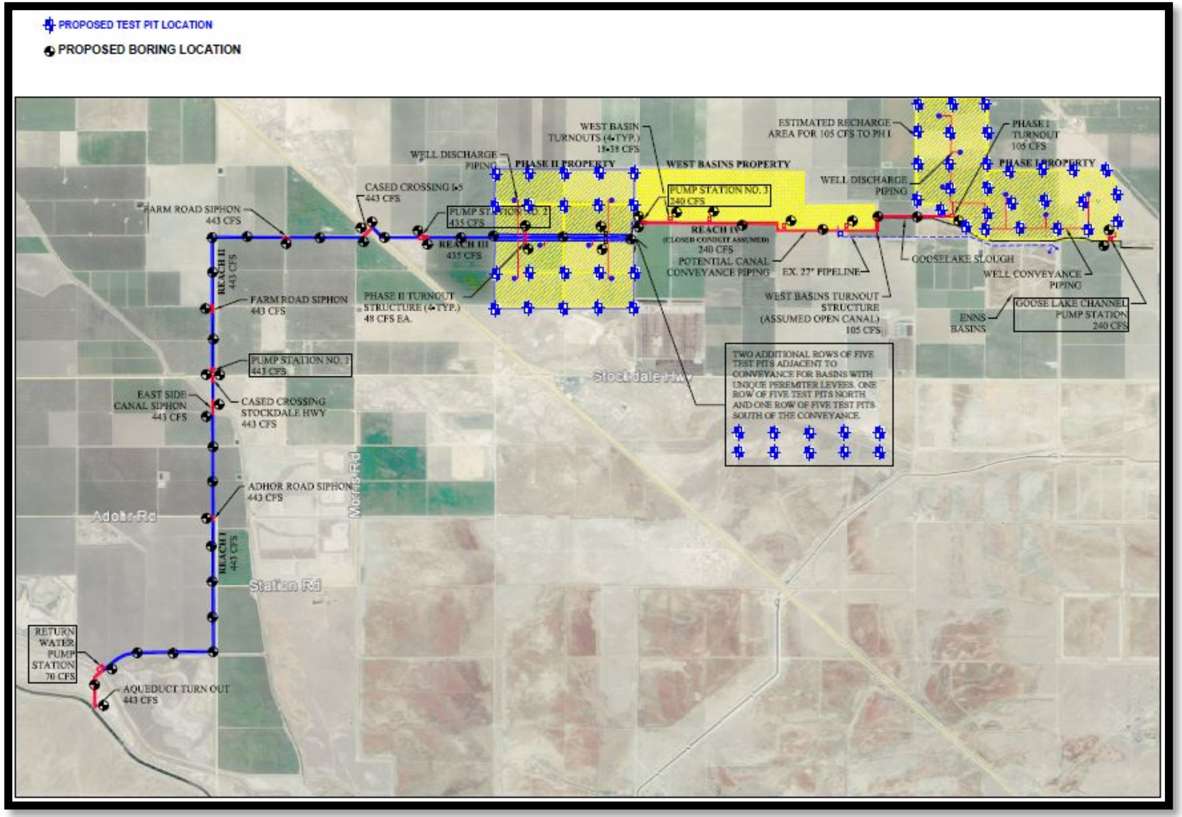
conveyance facilities soils work

GBJPA

- Geotechnical Investigation and Report for Conveyance Facilities including field work, sampling, testing, and final report summarizing findings, conclusions, and recommendations.
- Review Available Data
- Field Exploration
- Site Conditions
- Seismic Design Parameters
- Design Recommendations

  - Earthwork Recommendations – Subgrade Preparation and Keyways
  - Borrow Areas – Material Evaluation and Compaction Criteria
  - Canal Levee Construction Earthwork
  - Slope Stability, Permanent, and Temporary Slopes
  - Braced Cuts, Concrete Corrosion Potential, and Dewatering
  - Structure Design Parameters
  - Bridge Structure Parameters
  - Pipe Design Parameters
  - Jacking & Tunneling Design Parameters

Geotechnical requirements summary



Geotechnical Investigation and Report for Design Phases including field work, sampling, testing, and final report summarizing findings, conclusions, and recommendations. See map below of estimated field sampling and matrix of estimated laboratory testing.

Geotechnical requirements summary

GBJPA

KERN FAN GROUNDWATER STORAGE PROJECT - GEOTECHNICAL INVESTIGATION OF PROJECT COMPONENTS AND LABORATORY TESTING

Reach	Structure Type	Structure Name	Approximate No. of Borings/Test Pits[A]	Comments on Minimum Depth of Exploration (ft)	Approximate No. of Temporary Piezometers[D]	Laboratory Testing[E]												
						Moisture Content (ASTM D2216)	Unit weight (ASTM D2937)	Sieve Analysis (ASTM C136), (ASTM D422), (ASTM D1140)	Dispersive Characteristics of Clay Soil by Double Hydrometer (ASTM D4221)	Atterberg Limits (ASTM D4318)	Modified Proctor (ASTM D1557)	Expansion Index (ASTM D4829)	Soluble Sulfate & Soluble Chloride Contents (California Test Method No's 417 & 422)	pH and Minimum Resistivity (California Test Method No. 643)	Strength Testing - Direct Shear (ASTM D3080) or Unconfined Compressive Strength (ASTM D2166)	Flexible Wall Permeability (ASTM D5084)	Consolidation (ASTM D2435) - Clayey Soil	Collapse Potential (ASTM D5333)
Reaches 1 - 3	Conveyance	Conveyance (Canal)	19[B]	5 feet below invert		X	X	X	X	X	X	X			X		X	X
Reach 1	Conveyance	Aqueduct Turnout	1	10 feet below invert of structure	1	X	X	X		X	X				X	X		
Reach 1	Pump Station	Return Water Pump Station	1	10 feet below invert of pumping bay	1	X	X	X		X	X				X			
Reach 1	Conveyance	Adhor Road Siphon	1	10 feet below invert of structure		X	X	X		X	X				X			
Reach 1	Conveyance	East Side Canal Siphon	2	10 feet below invert of structure		X	X	X		X	X				X			
Reaches 1/2	Conveyance	Stockdale Cased Crossing	2	10 feet below invert		X	X	X		X	X		X	X	X			
Reach 2	Conveyance	Pump Station No. 1	2	10 feet below invert of pumping bay	1	X	X	X		X	X				X		X	X
Reach 2	Conveyance	Farm Road Siphon	1	10 feet below invert of structure		X	X	X		X	X				X			
Reaches 2/3	Conveyance	Interstate 5 Cased Crossing	3	10 feet below invert	2	X	X	X		X	X		X	X	X	X		
Reach 3	Pump Station	Pump Station No. 2	2	10 feet below invert of pumping bay	1	X	X	X		X	X				X		X	X
Reach 3	Conveyance	Phase 2 Property - Turnout 1	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 3	Conveyance	Phase 2 Property - Turnout 2	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 3	Conveyance	Phase 2 Property - Turnout 3	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 3	Conveyance	Phase 2 Property - Turnout 4	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 3	Recharge Facility	Phase 2 Property	30[C]	5 to 10 feet		X	X	X	X	X	X	X	X	X	X	X		X
Reach 4	Conveyance	Conveyance (Pipeline)	4[B]	5 feet below invert		X	X	X	X	X	X				X			
Reach 4	Pump Station	Pump Station No. 3	2	10 feet below invert of pumping bay	1	X	X	X		X	X				X		X	X
Reach 4	Conveyance	West Basins Property - Turnout 1	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 4	Conveyance	West Basins Property - Turnout 2	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 4	Conveyance	West Basins Property - Turnout 3	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 4	Conveyance	West Basins Property - Turnout 4	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 4	Conveyance	Phase 1 Property - Turnout 1	1	5 feet below invert of structure		X	X	X		X	X		X	X	X	X		X
Reach 4	Recharge Facility	Phase 1 Property	28[C]	5 to 10 feet		X	X	X	X	X	X	X	X	X	X	X		X
Reach 4	Pump Station	Goose Lake Channel Pump Station	2	10 feet below invert of pumping bay		X	X	X		X	X				X			

[A]All explorations shall be measured horizontally and vertically by a licensed surveyor.
[B]Explorations advanced along the conveyance and earthen embankments shall be spaced approximately every ¼ mile, unless coincident with a project structure.
[C]Test pit explorations shall be advanced in areas of geologic interest, i.e. historic channels and seepage paths, based on a review of aerial photography, geologic mapping, Transient Electromagnetic (TEM) resistivity correlations, and readily available data.
[D]Piezometers to be installed where groundwater is encountered.
[E]Actual type of laboratory tests and frequency to be determine by site conditions and project needs.

Summary

- Any questions or comments on the items covered or discussed in the two TM's?
- Next Steps…..

- Currently working on Technical Memorandum #6 – Canal Liner & Turnout Requirements

- Will soon begin working to complete the following memoranda:

  - TM#7 – Well Drilling and Equipping Requirements
  - TM#8 – ROW Acquisitions

- Final memoranda will include the Recharge Basins, SCADA, and a detailed Engineer's Estimate

- Preparation of RFP/RFQ's

GBJPA

Groundwater Banking Joint Powers Authority

THANK YOU

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KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 4
(Pump Station Requirements)

PREPARED FOR: Groundwater Banking Joint Powers Authority (JPA)
PREPARED BY: Curtis Skaggs, P.E.
DATE: January 28, 2021

SUBJECT: ***Pump Station Requirements***

I. Executive Summary

There are currently five pump stations illustrated for the project:

1. Pump Station No. 1 at Stockdale Highway for the Conveyance Canal (Capacity = 443 cfs)

2. Pump Station No. 2 at the I-5 Freeway for the Conveyance Canal (Capacity = 435 cfs)

3. Pump Station No. 3 at the west end of the West Basins for the Conveyance Canal (Capacity = 240 cfs)

4. Return Water Pump Station to convey recovered water to the California Aqueduct (Capacity = 70 cfs)

5. Goose Lake Channel Pump Station to convey water from Cross Valley Canal or Kern River Water to the Phase I Property (Capacity = 240 cfs)

See Figure 1 below for the approximate location of each of the above referenced pump stations. The exact number of pump stations, locations of the pump stations, and pump station capacities are subject to change based upon the actual conveyance alignment, Phase I and Phase II property locations, and the design of the conveyance channel.

A Pump Station No. 4 may be necessary at the easterly end of the conveyance channel to lift 129 cfs to the Phase I Property, however this pump station has not been considered herein. This pump station is considered small enough that it may not require physical modeling provided it is designed as outlined herein.

The goal for sizing the pump station pumps and motors is to achieve the following:

- Design for a minimum flowrate of 30 cfs.
- Design for the full range of flow from 30 cfs to the maximum specified design rate in 5 cfs increments.
- Size pumps and pump bays to standardize on two stoplog slot dimensions.
- Size pumps to provide interchangeability between pump stations.

This memorandum serves to outline in general the minimum pump station design standards, evaluate alternatives for pump station configurations and the associated costs, discuss special considerations and other pertinent items such as physical modeling, electrical service, control building design, and the pump station control philosophy. The following outlines the memorandum sections:

Below is a summary of the recommended pump configurations for each pump station facility.

Pump Station Summary				
Pump Station Facility	Capacity	Pump Configuration	36-42 cfs Pumps	80-90 cfs Pumps
Pump Station No. 1	443 cfs	Six (6) Pumps	Two	Four
Pump Station No. 2	435 cfs	Six (6) Pumps	Two	Four
Pump Station No. 3	240 cfs	Four (4) Pumps	Two	Two
Pump Station No. 4	129 cfs	If Necessary		
Goose Lake Channel Pump Station	240 cfs	Four (4) Pumps	Two	Two
Return Water Pump Station	72 cfs	Three (3) Pumps	Three	

The pump station design shall be governed by the Hydraulic Institute Standards ANSI/HI 9.8-Most Recent Edition for Pump Intake Design and then the final design requirements determined by physical modeling as described herein. The physical modeling shall be performed prior to finalizing the design of the pump stations, however preliminary design will need to be completed prior to conducting any modeling.

Redundancy has been accounted for in the three conveyance canal pump stations and the Goose Lake Slough pump station. Redundant capacity is built-in by nature of the 1.5 filling factor from Technical Memorandum No. 2 "Conveyance

Capacity Requirements" that is being utilized for the short-term filling of recharge areas. This filling rate allows for the recharge basins to be filled in approximately three (3) to seven (7) days. It is believed that if a pump is out-of-service during the initial recharge filling period, that the pump stations will still be at 67% to 100% of their pumping capacity and that the filling rate can temporarily be reduced until the appropriate repairs are made. However, during the long-term recharge operations the pump stations will still be able to meet approximately 100% of the average maintenance rates for recharge with the largest pump out-of-service.

The Return Water Pump Station is recommended to be designed with a three pump configuration that will have one of the pumps solely for redundancy. Each pump would be sized for 36 cfs. The anticipated capacity of the pump station for returning water is approximately 72 cfs which leaves the third pump for redundancy or extreme conditions when the District may be returning more water than 72 cfs.

The pump and motor sizes utilized herein and the associated costs are preliminary and only for purposes of the preliminary engineering work. It is understood that the actual pump and motor sizes will be determined during the engineering design phase based on the actual hydraulic conditions of the conveyance facilities and that updated pricing will be evaluated.

The designer shall evaluate pumps from several reputable pump manufacturer's to determine the typical pump suction bell diameters for the design pump conditions. The pump suction bell diameters will be critical in the proper design of the pump station and pump bays.

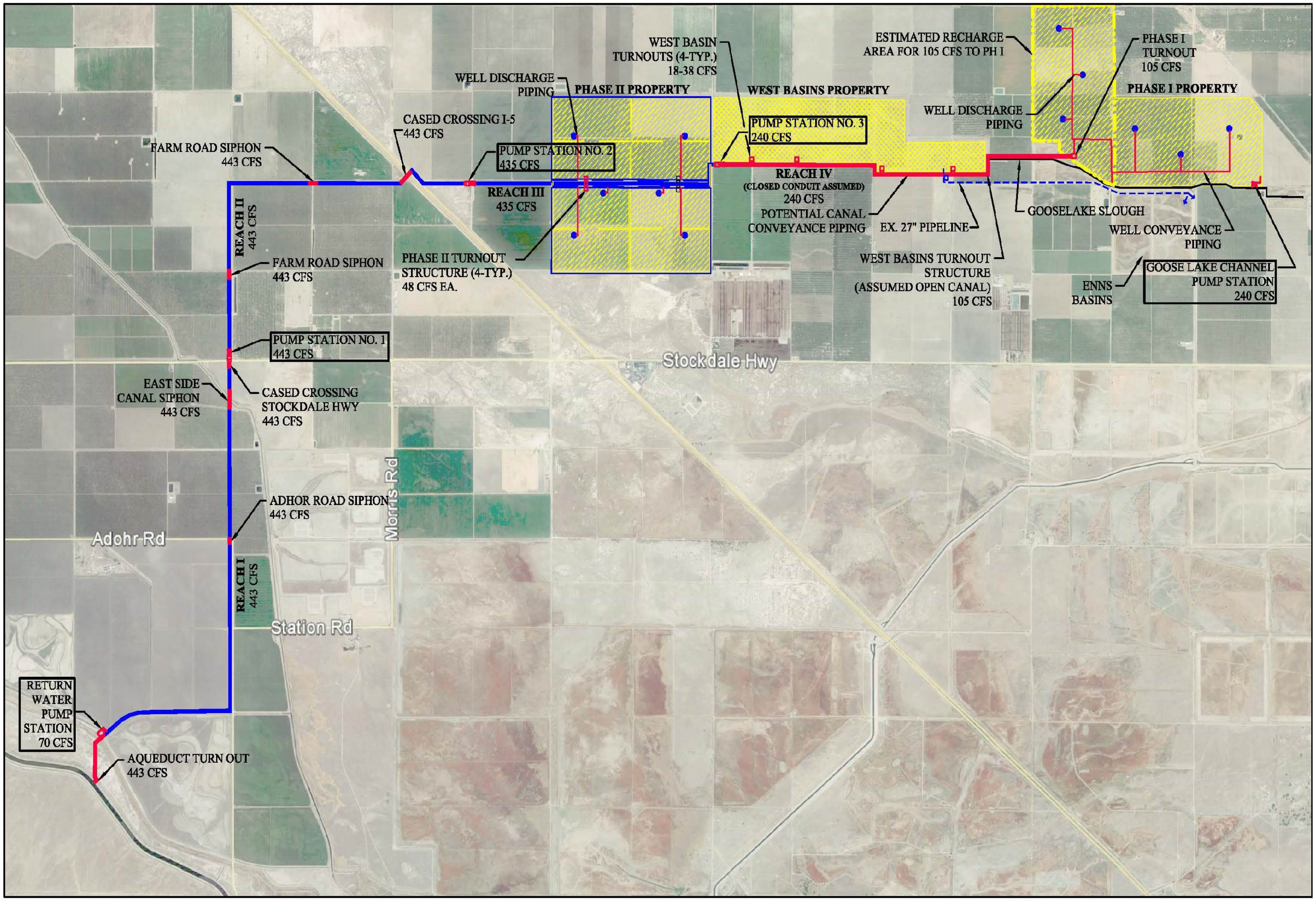

Figure 1: Pump Station Overview Map

II. Pump Station Design Standard

The pump station design shall be governed by the Hydraulic Institute Standards ANSI/HI 9.8-Most Recent Edition for Pump Intake Design.

The intake structure shall be designed to allow the pumps to achieve their optimum hydraulic performance for all operating conditions. The characteristics of the flow approaching an intake structure is one of the most critical considerations. The pump intake structure shall be designed in-line with the canal to provide a uniform approach to the pumps and the geometry of the intake structure should endeavor to limit the cross-flows that create asymmetrical flow patterns approaching any of the pumps.

The pump station shall be a rectangular intake design that is based on the design pump inlet bell diameter. The pump station shall be designed to mitigate or minimize adverse hydraulic performance resulting from the following:

- Submerged Vortices
- Free-Surface Vortices
- Excessive Pre-Swirl of Flow Entering the Pump
- Non-Uniform Spatial Distribution of Velocity at the Impeller Eye
- Excessive Variations in Velocity and Swirl with Time
- Entrained Air or Gas Bubbles

The conveyance canal pump station capacities will range from 240 cfs (107,712 gpm) to 443 cfs (198,818 gpm). These large flow capacities warrant hydraulic model testing. This is discussed further in Item VI below.

In addition, each conveyance canal pump station shall have a gravity return line for returning water to the California Aqueduct and have an approximate capacity of 70 cfs. This shall include a means of isolation via a slide gate or butterfly valve.

III. Pump Configuration

Pump stations shall be an open structure with reinforced concrete dividing walls between each of the pumps. The approach velocities to each pump shall be limited to a maximum of 1.5 ft per second within each pump bay per the Hydraulic Institute Standards. The pump bay width and depth shall be designed to limit the maximum pump approach velocities as well as providing a narrow and long channel flow toward each pump for uniformity and laminar flow.

Careful attention shall be paid to the minimum submergence of the pump bell or intake to reduce the possibility that unacceptable free-surface air core vortices occur. The minimum required submergence shall be determined using the ANSI Pump Intake Design manual, however if a submergence greater than that calculated is required by the pump manufacturer to provide the required NPSH, then the greater submergence shall govern.

A combination of reinforced concrete and heavy bar steel grating shall be designed and constructed for the pump deck that is suitable for a H20 loading. This will allow equipment to utilize the deck for the removal and installation of pumps and motors as well as for cleaning of trashracks while allowing for visibility down into each pump bay and convenient access to the pumps.

The pump stations shall include stop log slots for isolation of a pump bay while the remainder of the pump station is in operation, trashracks, ladder access, and safety grating and guardrailing. The District would prefer to have two sizes of steel stop logs that fit all the pump station bays. The location of stop logs within each pump bay shall take into consideration the need for future diffusing structures or other mitigation measures that could be implemented at the stop log slots.

Several combinations of pumps are evaluated below that consist of a six (6) pump and four (4) pump configuration. An eight (8) pump configuration was also considered during the preliminary engineering work, however the use of VFD's will allow the pumps to cover a wider range of flows and help in reducing the number of pumps needed. The conveyance canal pump stations shall be designed such that they can reach a minimum flow rate of 30 cfs, can cover the full range of flows from 30 cfs to the maximum specified design rate in 5 cfs increments, and minimize the number of pumps. The District would prefer to have consistency of pumps with respect to the size and capacity across all pump stations for ease of operations, maintenance, and pump interchangeability.

An example of this is outlined below with:

A. Pump Stations #1 and #2 with a Six (6) Pump Configuration and a Four (4) Pump Configuration

B. Pump Stations #3 with a Six (6) Pump, Four (4) Pump, and a Three (3) Pump Configuration

A. Pump Station No. 1 and No. 2 Pump Configurations

The Pump Stations No. 1 and No. 2 are essentially the same size at 435 cfs and 443 cfs. A four pump or six pump configuration could be utilized at these stations which would consist of high capacity, low lift pumps and motors. Below is a six pump configuration.

a) Six (6) Pump Configuration

The pump capacities are sized to endeavor to cover the majority of flow possibilities between 30 cfs to 443 cfs in 5 cfs increments.

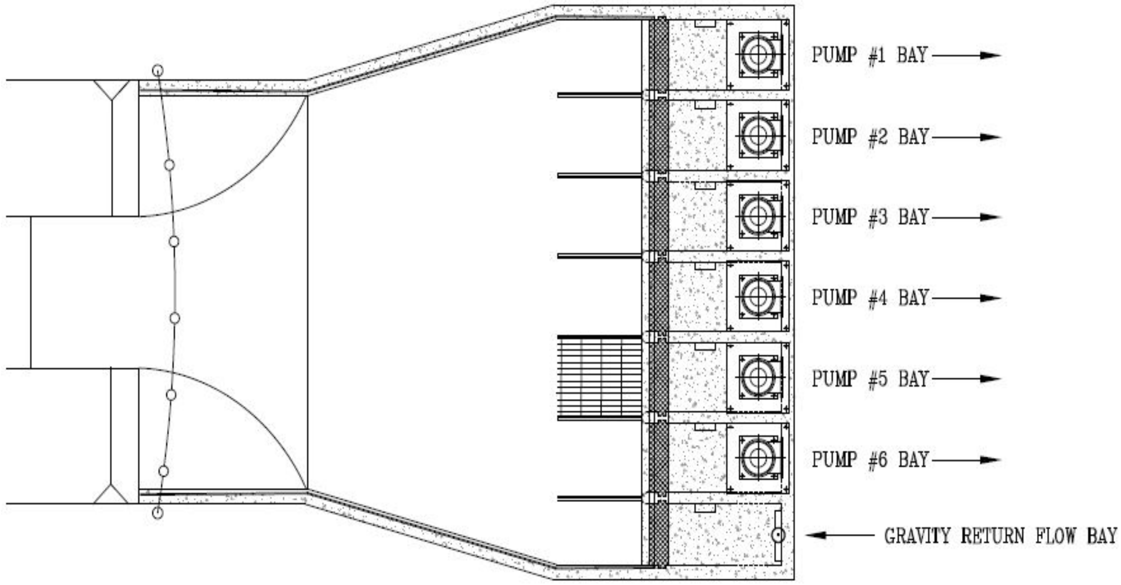

Figure 2: Pump Stations No. 1 and No. 2 Configuration with 6 Pumps

The pump station layout illustrated in Figure 2 above and in subsequent figures is conceptual to represent the number of pump bays and not intended to define the actual pump station design.

Pump Station No. 1 and No. 2 could have the following size pumps in a six pump configuration. Table 1 below illustrates the range of the pump station and its ability to meet the 5 cfs incremental criteria.

Pump Station No. 1

443 CFS Capacity
(2) 42 cfs Pumps
(4) 90 cfs Pumps

Pump Station No. 2

435 CFS Capacity
(2) 40 cfs Pumps
(4) 89 cfs Pumps

The two smaller pumps have an approximate 40 to 42 cfs capacity and the four larger pumps have an approximate 89-90 cfs capacity. It is estimated that the slower speed pumps will be able to reduce their capacity to approximately two-thirds with the use of a variable speed drive (VFD).

Table 1

Pump Station No. 1 and No. 2 with 6 Pump Configuration						
Pump Station Demand	40-42 cfs Pump[1]	40-42 cfs Pump[1]	89-90 cfs Pump[2]	89-90 cfs Pump[2]	89-90 cfs Pump[2]	89-90 cfs Pump[2]
30-45 cfs	x					
50-80 cfs	x	x				
85-90 cfs			x			
95-130 cfs	x		x			
135-170 cfs	x	x	x			
175-215 cfs	x		x	x		
220-260 cfs	x	x	x	x		
265-310 cfs	x		x	x	x	
315-350 cfs	x	x	x	x	x	
355-400 cfs	x		x	x	x	x
405-443 cfs	x	x	x	x	x	x

[1]Pump range with VFD estimated as 27 cfs to 42 cfs.

[2]Pump range with VFD estimated as 59 cfs to 90 cfs.

Table 2 below provides a cost estimate for the six (6) pump configuration.

Table 2

Kern Fan Project Pump Stations No. 1 and No. 2 - 6 Pump Configuration				
Item Description	Unit	Quantity	Unit Cost	Extended Cost
Earthwork & Site Ground Cover	1	LS	$ 215,000.00	$ 215,000.00
Reinforced Concrete Structure	1	LS	$ 920,000.00	$ 920,000.00
Miscellaneous Steel & Trashracks	1	LS	$ 215,000.00	$ 215,000.00
Pumps and Motors	1	LS	$ 2,222,000.00	$ 2,222,000.00
30" Discharge Piping & Appurtenances	2	EA	$ 394,000.00	$ 788,000.00
42" Discharge Piping & Appurtenances	4	EA	$ 485,000.00	$ 1,940,000.00
Variable Frequency Drives	1	LS	$ 700,000.00	$ 700,000.00
Electrical and Controls	1	LS	$ 995,000.00	$ 995,000.00
Electrical Control Building & Foundation	1	LS	$ 380,000.00	$ 380,000.00
Cathodic Protection	1	LS	$ 25,000.00	$ 25,000.00
Gravity Bypass Pipeline & Slide Gate	1	LS	$ 205,000.00	$ 205,000.00
	Total 6 Pump Configuration Estimate:			**$ 8,605,000.00**

Footnote: Costs are for purposes of comparison between pump configurations and not intended to be inclusive of all pump station costs.

b) Four (4) Pump Configuration

The four pump configuration is illustrated below. The pump capacities are sized to endeavor to cover the majority of flow possibilities between 50 cfs to 443 cfs in 5 cfs increments. The limitation of this configuration is that the pump station minimum flow is not as low as the six pump configuration.

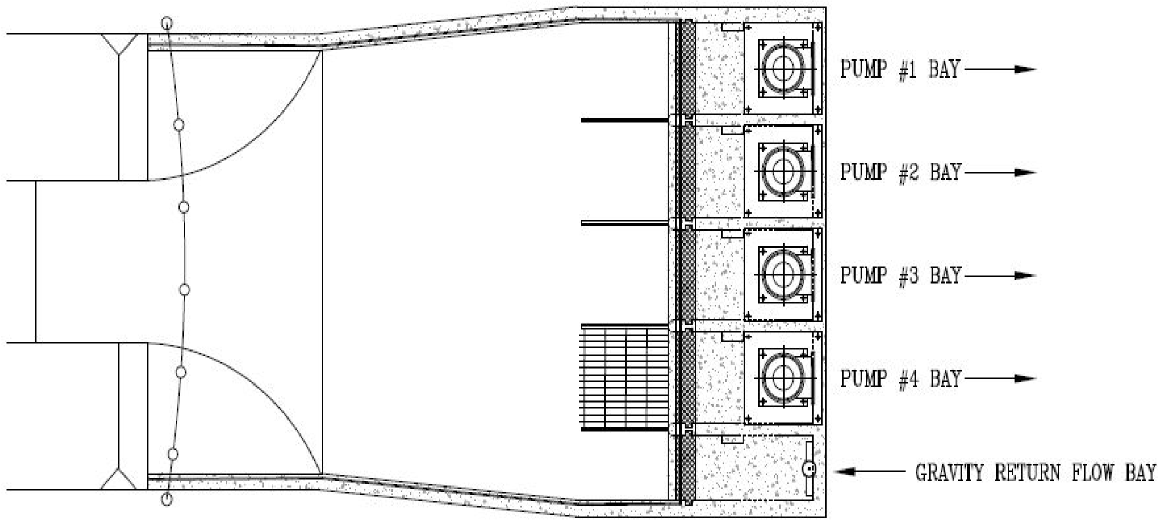

Figure 3: Pump Stations No. 1 and No. 2 Configuration with 4 Pumps

Pump Station No. 1 and No. 2 could have the following size pumps in a four pump configuration. Table 3 below illustrates the range of the pump station and its ability to meet the 5 cfs incremental criteria.

Pump Station No. 1

443 CFS Capacity
(2) 75 cfs Pumps
(2) 147 cfs Pumps

Pump Station No. 2

435 CFS Capacity
(2) 73 cfs Pumps
(2) 145 cfs Pumps

The two smaller pumps have an approximate 73 to 75 cfs capacity and the two larger pumps have an approximate 145-147 cfs capacity. It is estimated that the slower speed pumps will be able to reduce their capacity to approximately two-thirds with the use of a variable speed drive (VFD).

Table 3

Pump Station No. 1 and No. 2 with 4 Pump Configuration				
Pump Station Demand	73-75 cfs Pump[1]	73-75 cfs Pump[1]	145-147 cfs Pump[2]	145-147 cfs Pump[2]
30 cfs				
35 cfs				
40 cfs				
45 cfs				
50-80 cfs	x			
85 cfs				
90 cfs				
95-145 cfs			x	
150-220 cfs	x		x	
225-295 cfs	x	x	x	
300-365 cfs	x		x	x
370-443 cfs	x	x	x	x

[1]Pump range with VFD estimated as 48 cfs to 75 cfs.

[2]Pump range with VFD estimated as 96 cfs to 145 cfs.

(shaded) Pumps may not be able to match these flow rates.

Table 4 below provides a cost estimate for the four (4) pump configuration.

Table 4

Kern Fan Project Pump Stations No. 1 and No. 2 - 4 Pump Configuration				
Item Description	Unit	Quantity	Unit Cost	Extended Cost
Earthwork & Site Ground Cover	1	LS	$ 200,000.00	$ 200,000.00
Reinforced Concrete Structure	1	LS	$ 816,000.00	$ 816,000.00
Miscellaneous Steel & Trashracks	1	LS	$ 175,000.00	$ 175,000.00
Pumps and Motors	1	LS	$ 1,881,000.00	$ 1,881,000.00
42" Discharge Piping & Appurtenances	2	EA	$ 485,000.00	$ 970,000.00
54" Discharge Piping & Appurtenances	2	EA	$ 600,000.00	$ 1,200,000.00
Variable Frequency Drives	1	LS	$ 600,000.00	$ 600,000.00
Electrical and Controls	1	LS	$ 995,000.00	$ 995,000.00
Electrical Control Building & Foundation	1	LS	$ 380,000.00	$ 380,000.00
Cathodic Protection	1	LS	$ 25,000.00	$ 25,000.00
Gravity Bypass Pipeline & Slide Gate	1	LS	$ 205,000.00	$ 205,000.00
	Total 4 Pump Configuration Estimate:			**$ 7,447,000.00**

Footnote: Costs are for purposes of comparison between pump configurations and not intended to be inclusive of all pump station costs.

c) Pump Station No. 1 and 2 Recommendations

The six (6) pump configuration is better from the standpoint of being able to meet a minimum pump station capacity of 30 cfs and being able to match flows in 5 cfs increments from 30 cfs to 443 cfs. The four (4) pump configuration may have a difficult time matching flows below 50 cfs and even some flows between 80 to 95 cfs. However, the six pump configuration is estimated to be approximately $1,158,000 more in capital cost due to a little bigger structure and more pumps, motors, and electrical.

It is recommended that Pump Stations No. 1 and No. 2 have six pumps and motors each with two (2) 40 to 42 cfs pumps and four (4) 89 to 90 cfs pumps. This will allow pump bay widths to be similar for utilizing two standard stop log slot dimensions and also for providing interchangeability between pumps across all three conveyance canal pump stations.

Redundancy for theses two conveyance canal pump stations is built-in by nature of the 1.5 filling factor that is being utilized for the recharge areas. It is believed that if a pump is out-of-service during the initial recharge filling period at Pump Stations No. 1 and 2, that the pump stations will still be at 67% to 90% capacity and that recharge can temporarily be reduced until the appropriate repairs are made. However, during the long term maintenance rates or average recharge rates, Pump Stations No. 1 and No. 2 would be at 100% capacity with the largest pump out-of-service, i.e. 440 cfs – 90 cfs Pump = 350 cfs > 282 cfs average rate from Technical Memorandum No. 2 “Conveyance Capacity”.

The pump and motor sizes utilized herein and the associated costs are preliminary and only for purposes of the preliminary engineering work. It is understood that the actual pump and motor sizes will be determined during the engineering design phase based on the actual hydraulic conditions of the conveyance facilities and that updated pricing will be evaluated.

B. Pump Station No. 3 Pump Configurations

The Pump Station No. 3 capacity is 240 cfs. A three pump, four pump, or six pump configuration would consist of high capacity, low lift pumps and motors. Below is a six pump configuration. The pump capacities are sized to endeavor to cover the majority of flow possibilities between 30 cfs to 443 cfs in 5 cfs increments.

Pump Station No. 3 supplies Reach 4 of the conveyance facilities. Reach 4 may be an open channel design or closed conduit design. Technical Memorandum No. 3 “Pipeline Requirements” considered Reach 4 as a closed conduit design. The pump configurations described herein would still be appropriate for this condition, however the pumps may pump at a higher head and not really be as interchangeable with the pumps from Pump Stations No. 1 and No. 2. As a closed conduit design, Reach 4 would convey approximately 105 cfs to the West Basins, approximately 129 cfs to the Phase I Property (105 cfs to Phase I & 24 cfs to Enns), and approximately 6 cfs to in-lieu lands.

In an open channel design it is anticipated that Reach 4 will convey water to the east end of the West Basins thus delivering 105 cfs to the West Basins and 6 cfs to in-lieu lands. However, a Pump Station No. 4 would then likely be required to convey 129 cfs to the Phase I Property. This could be achieved by conveying 105 cfs to the Phase I Property and 24 cfs to the Enns Basins through the existing WB Pipeline. This pump station has not been considered at this time, but is considered a small enough pump station that it will likely not require physical modeling, provided it is designed as outlined herein.

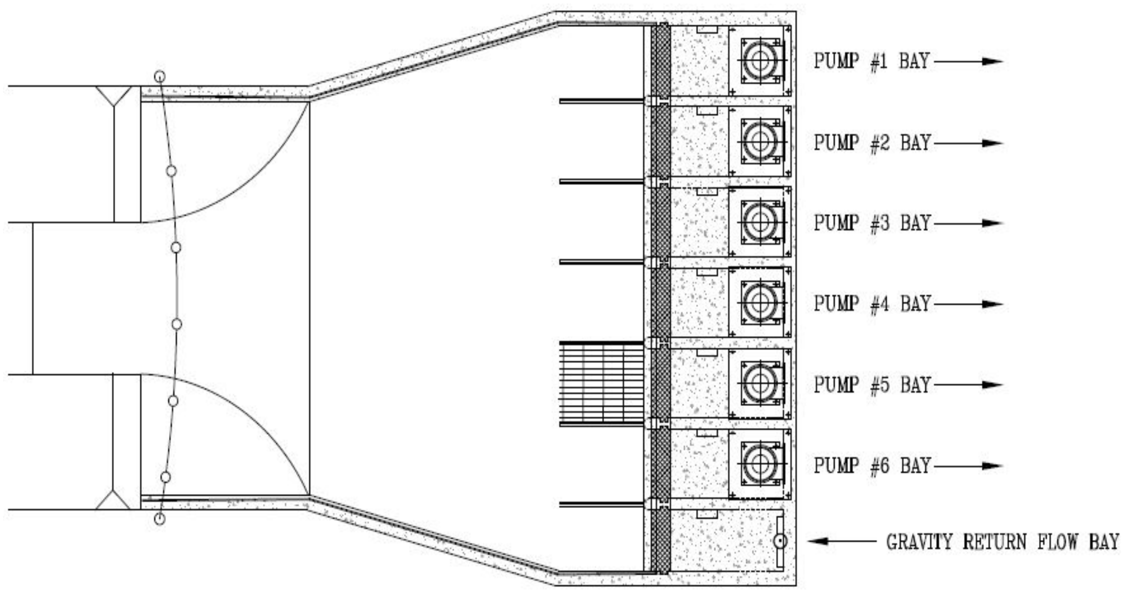

Figure 4: Pump Station No. 3 Configuration with 6 Pumps

a) Six (6) Pump Configuration

Pump Station No. 3 could have the following size pumps in a six pump configuration. Table 5 below illustrates the range of the pump station and its ability to meet the 5 cfs incremental criteria.

Pump Station No. 3

240 CFS Capacity
(6) 40 cfs Pumps

The pump configuration could also be two 25 cfs pumps and four 48 cfs pumps, for example, however the six 40 cfs pumps still allows the pump station to achieve the minimum flowrate of 30 cfs while utilizing pumps of a similar size and capacity as those of the options for Pump Stations No. 1 and No. 2.

It is estimated that the range of a 40 cfs pump will be approximately 26 cfs to 40 cfs based on an estimate of the VFD being able to ramp down to approximately two-thirds of the pump design capacity.

Table 5

Pump Station No. 3 with 6 Pump Configuration						
Pump Station Demand	40 cfs Pump[1]	40 cfs Pump[1]	40 cfs Pump[1]	40 cfs Pump[1]	40 cfs Pump[1]	40 cfs Pump[1]
30-45 cfs	x					
50-80 cfs	x	x				
85-120 cfs	x	x	x			
125-160 cfs	x	x	x	x		
165-200 cfs	x	x	x	x	x	
205-240 cfs	x	x	x	x	x	x

[1]Pump range with VFD estimated as 26 cfs to 40 cfs.

Table 6 below provides a cost estimate for the six (6) pump configuration.

Table 6

Kern Fan Project				
Pump Station No. 3 - 6 Pump Configuration				
Item Description	Unit	Quantity	Unit Cost	Extended Cost
Earthwork & Site Ground Cover	1	LS	$ 200,000.00	$ 215,000.00
Reinforced Concrete Structure	1	LS	$ 900,000.00	$ 920,000.00
Miscellaneous Steel & Trashracks	1	LS	$ 200,000.00	$ 215,000.00
Pumps and Motors	1	LS	$ 1,584,000.00	$ 1,584,000.00
30" Discharge Piping & Appurtenances	6	EA	$ 394,000.00	$ 2,364,000.00
Variable Frequency Drives	1	LS	$ 540,000.00	$ 540,000.00
Electrical and Controls	1	LS	$ 880,000.00	$ 880,000.00
Electrical Control Building & Foundation	1	LS	$ 380,000.00	$ 380,000.00
Cathodic Protection	1	LS	$ 25,000.00	$ 25,000.00
Gravity Bypass Pipeline & Slide Gate	1	LS	$ 205,000.00	$ 205,000.00
	Total 6 Pump Configuration Estimate:			$ 7,328,000.00

Footnote: Costs are for purposes of comparison between pump configurations and not intended to be inclusive of all pump station costs.

b) Four (4) Pump Configuration

The four pump configuration would consist of four high capacity, low lift pumps and motors. The pump capacities are sized to endeavor to cover the majority of flow possibilities between 30 cfs to 240 cfs in 5 cfs increments. Table 7 below illustrates the range of the pump station and its ability to meet the 5 cfs incremental criteria.

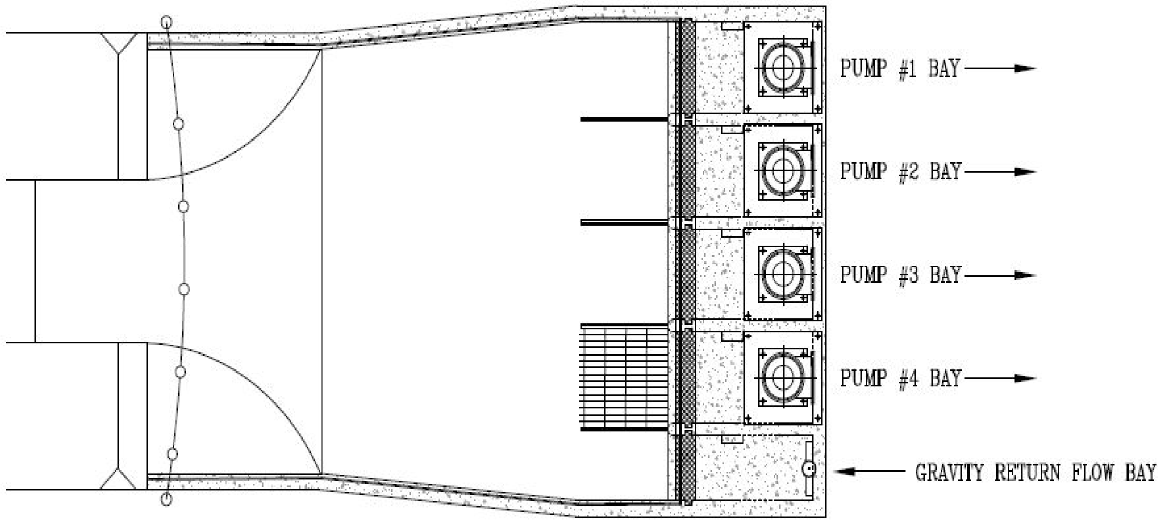

Figure 5: Pump Station No. 3 Configuration with 4 Pumps

Pump Station No. 3

240 CFS Capacity
(2) 40 cfs Pumps
(2) 80 cfs Pumps

The two smaller pumps have an approximate 40 cfs capacity and the two larger pumps have an approximate 80 cfs capacity. It is estimated that the slower speed pumps will be able to reduce their capacity to approximately two-thirds with the use of a variable speed drive (VFD).

Table 7

Pump Station No. 3 with 4 Pump Configuration				
Pump Station Demand	40 cfs Pump[1]	40 cfs Pump[1]	80 cfs Pump[2]	80 cfs Pump[2]
30-45 cfs	x			
50-80 cfs	x	x		
85-120 cfs	x		x	
125-160 cfs	x	x	x	
165-200 cfs	x		x	x
205-240 cfs	x	x	x	x

[1]Pump range with VFD estimated as 26 cfs to 40 cfs.
[2]Pump range with VFD estimated as 53 cfs to 80 cfs.

Table 8 below provides a cost estimate for the four (4) pump configuration.

Table 8

Kern Fan Project				
Pump Stations No. 3 - 4 Pump Configuration				
Item Description	Unit	Quantity	Unit Cost	Extended Cost
Earthwork & Site Ground Cover	1	LS	$ 200,000.00	$ 200,000.00
Reinforced Concrete Structure	1	LS	$ 800,000.00	$ 800,000.00
Miscellaneous Steel & Trashracks	1	LS	$ 175,000.00	$ 175,000.00
Pumps and Motors	1	LS	$ 1,287,000.00	$ 1,287,000.00
30" Discharge Piping & Appurtenances	2	EA	$ 394,000.00	$ 788,000.00
42" Discharge Piping & Appurtenances	2	EA	$ 485,000.00	$ 970,000.00
Variable Frequency Drives	1	LS	$ 420,000.00	$ 420,000.00
Electrical and Controls	1	LS	$ 900,000.00	$ 900,000.00
Electrical Control Building & Foundation	1	LS	$ 380,000.00	$ 380,000.00
Cathodic Protection	1	LS	$ 25,000.00	$ 25,000.00
Gravity Bypass Pipeline & Slide Gate	1	LS	$ 205,000.00	$ 205,000.00
	Total 4 Pump Configuration Estimate:			$ 6,150,000.00

Footnote: Costs are for purposes of comparison between pump configurations and not intended to be inclusive of all pump station costs.

c) Three (3) Pump Configuration

The three pump configuration would consist of three high capacity, low lift pumps and motors. The pump capacities are sized to endeavor to cover the majority of flow possibilities between 50 cfs to 240 cfs in 5 cfs increments. Table 9 below illustrates the range of the pump station and its ability to meet the 5 cfs incremental criteria.

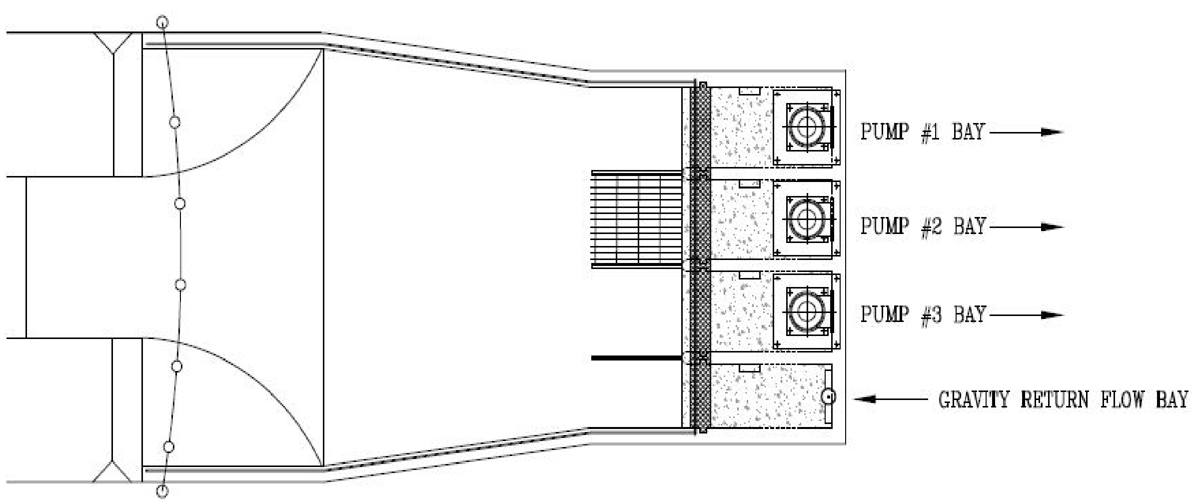

Figure 6: Pump Station No. 3 Configuration with 3 Pumps

Pump Station No. 3

240 CFS Capacity
(3) 80 cfs Pumps

It is estimated that the range of a 80 cfs pump will be approximately 53 cfs to 80 cfs based on an estimate of the VFD being able to ramp down to approximately two-thirds of the pump design capacity.

Table 9

Pump Station No. 3 with 3 Pump Configuration			
Pump Station Demand	80 cfs Pump[1]	80 cfs Pump[1]	80 cfs Pump[1]
30 cfs			
35 cfs			
40 cfs			
45 cfs			
50 cfs			
55-85 cfs	x		
90 cfs			
95 cfs			
100 cfs			
105-160 cfs	x	x	
165-240 cfs	x	x	x

[1]Pump range with VFD estimated as 53 cfs to 80 cfs.

(shaded) Pumps may not be able to match these flow rates.

Table 10 below provides a cost estimate for the three (3) pump configuration.

Table 10

Kern Fan Project				
Pump Stations No. 3 - 3 Pump Configuration				
Item Description	Unit	Quantity	Unit Cost	Extended Cost
Earthwork & Site Ground Cover	1	LS	$ 185,000.00	$ 185,000.00
Reinforced Concrete Structure	1	LS	$ 700,000.00	$ 700,000.00
Miscellaneous Steel & Trashracks	1	LS	$ 150,000.00	$ 150,000.00
Pumps and Motors	1	LS	$ 1,138,500.00	$ 1,138,500.00
42" Discharge Piping & Appurtenances	3	EA	$ 485,000.00	$ 1,455,000.00
Variable Frequency Drives	1	LS	$ 360,000.00	$ 360,000.00
Electrical and Controls	1	LS	$ 700,000.00	$ 700,000.00
Electrical Control Building & Foundation	1	LS	$ 380,000.00	$ 380,000.00
Cathodic Protection	1	LS	$ 25,000.00	$ 25,000.00
Gravity Bypass Pipeline & Slide Gate	1	LS	$ 205,000.00	$ 205,000.00
			Total 3 Pump Configuration Estimate:	$ 5,298,500.00

Footnote: Costs are for purposes of comparison between pump configurations and not intended to be inclusive of all pump station costs.

d) Pump Station No. 3 Recommendations

The six (6) pump configuration is sufficient from the standpoint of being able to meet a minimum pump station capacity of 30 cfs and being able to match flows in 5 cfs increments from 30 cfs to 240 cfs. However, it is approximately $1,178,000.00 more in capital cost than a four (4) pump configuration. The four (4) pump configuration is also able to meet a minimum pump capacity of 30 cfs while matching flows in 5 cfs increments from 30 cfs to 240 cfs. The three (3) pump configuration is the least capital cost, however it will have difficulty meeting the minimum flow requirements and matching flow rates in 5 cfs increments particularly in the ranges of 30 cfs to 50 cfs and 90 cfs to 100 cfs.

Pump Station No. 3 is recommended to have four pumps and motors with two (2) 40 cfs pumps and two (2) 80 cfs pumps. This will allow pump bay widths to be similar for utilizing two standard stop log slot dimensions and also for providing interchangeability between pumps across all three conveyance canal pump stations.

Redundancy for this conveyance canal pump station is built-in by nature of the 1.5 filling factor that is being utilized for the recharge areas. It is believed that if a pump is out-of-service during the initial recharge filling period at Pump Station No. 3, that the pump station will still be at 67% to 90% capacity and that recharge can temporarily be reduced until the appropriate repairs are made. However, during the long term maintenance rates or average recharge rates, Pump Station No. 3 would be at 90-100% capacity with the largest pump out-of-service, i.e. 240 cfs – 80 cfs Pump = 160 cfs ≤ 170 cfs average rate from Technical Memorandum No. 2 “Conveyance Capacity”.

The pump and motor sizes utilized herein and the associated costs are preliminary and only for purposes of the preliminary engineering work. It is understood that the actual pump and motor sizes will be determined during the engineering design phase based on the actual hydraulic conditions of the conveyance facilities and that updated pricing will be evaluated.

C. Goose Lake Channel Pump Station

The Goose Lake Channel Pump Station will be utilized to convey water to the proposed Phase I property via the Goose Lake Channel from the Cross Valley Canal (CVC) or the Kern River.

The initial fill rate of the Phase I property has been estimated as 240 cfs. In Technical Memorandum No. 2 (Conveyance Capacity), approximately 129 cfs of this demand will be exchanged with capacity from the east that has historically been delivered to the West Basins and the Enns Basins.

The remaining 111 cfs demand will consist of in-lieu water and water from the California Aqueduct (105 cfs) delivered to the Phase I property.

Given the above criteria, the Goose Lake Channel pump station would be designed for approximately 129 cfs, however it is recommended to design for the initial fill rate of 240 cfs in the event that quantity of water is available from the Goose Lake Channel.

Goose Lake Channel Pump Station Recommendation

A 240 cfs pump station was evaluated under Section B "Pump Station No. 3 Pump Configurations" for a three pump, four pump, and six pump configuration. It is recommended to utilize a four pump configuration with two 40 cfs pumps and two 80 cfs pumps in an effort to standardize the pump sizes.

Redundancy for the Goose Lake Channel Pump Station is built-in by nature of the 1.5 filling factor that is being utilized for the recharge areas. It is believed that if a pump is out-of-service during the initial recharge filling period at the Goose Lake Channel Pump Station, that the pump station will still be at 67% to 90% capacity and that recharge can temporarily be reduced until the appropriate repairs are made. However, during the long term maintenance rates or average recharge rates, the Goose Lake Channel Pump Station would still be at 100% capacity with the largest pump out-of-service, i.e. 240 cfs – 80 cfs Pump = 160 cfs = 160 cfs average rate from Technical Memorandum No. 2 "Conveyance Capacity".

D. Return Water Pump Station

The Return Water Pump Station will be utilized to convey recovered water from the Phase II Property, the West Basins, and the Phase I property as necessary up to the California Aqueduct. The project is anticipated to include up to twelve (12) recovery wells each with a capacity of 5 to 6 cfs for a total return flow capacity of 60 cfs to 72 cfs.

The criteria for the Return Water Pump Station includes:

- Minimum Flow Rate = 24 cfs (Approx. 4 wells)
- Capacity of 24 cfs to 72 cfs in 5 cfs increments
- Full Pump Redundancy if Largest Pump fails

A two pump and three pump configuration has been evaluated with and without pump redundancy:

a) Two Pump Configuration without redundancy

A two pump configuration without redundancy will consist of two pumps each with a capacity of approximately 36 cfs.

72 CFS Capacity
(2) 36 cfs Pumps

b) Two Pump Configuration with redundancy

A two pump configuration with redundancy will consist of two pumps each designed to convey the design flowrate of 72 cfs.

72 CFS Capacity
(2) 72 cfs Pumps

c) Three Pump Configuration without redundancy

A three pump configuration without redundancy will consist of three pumps each with a capacity of approximately 24 cfs.

72 CFS Capacity
(3) 24 cfs Pumps

d) Three Pump Configuration with redundancy

A three pump configuration with redundancy will consist of three pumps each designed to convey the design flowrate of 72 cfs between two pumps.

72 CFS Capacity
(3) 36 cfs Pumps

Return Water Pump Station Recommendation

A three pump configuration with redundancy, i.e. three (3) 36 cfs pumps is recommended. This design will:

- Allow for returning the maximum design flow to the California Aqueduct with one pump or motor out of service.
- Allow for the possibility of the three pumps to be an equivalent size to the 40 cfs pumps utilized at the Conveyance Canal Pump Stations and the Goose Lake Channel Pump Station.
- Achieve an approximate minimum flowrate of 24 cfs.
- Achieve 5 cfs increments from approximately 24 cfs to 72 cfs with the exception of the 40 cfs and 45 cfs increments. However, the canal will act as storage for minor variations in matching of flow rates.

The District will typically utilize the majority of the recovery wells when operating in a recovery mode. It appears unlikely that the District would operate less than four (4) wells when returning water to the California Aqueduct.

The mismatch in flows around the 40 cfs and 45 cfs increments is minor and can be accommodated by utilizing the available storage that is in the canal prism during recovery operations.

In the occasional event whereby there is shallow water at the commencement of recovery operations and the wells are over-performing, the third pump provided for redundancy could be utilized, i.e. 12 wells operating at 7.5 cfs instead of 6 cfs equals 90 cfs < 3 pumps at 36 cfs equating to 108 cfs.

IV. Discharge Pipe Sizing

The pump discharge piping sizes were evaluated in Technical Memorandum No. 3 (Pipeline Requirements). A summary of the sizes is listed below.

Capacity (cfs)	Discharge Pipe Size (in.)
125	48
100	48
90	42
80	42
75	42
65	36
60	36
50	36
40	30
30	24
20	20

The above ground pump discharge piping is anticipated to be fusion bonded epoxy lined and coated steel pipe. The principal advantages of steel pipe include high strength, the ability to deflect without breaking, ease of installation, shock resistance, availability of special configurations and modifications by welding.

It is anticipated that each pump discharge pipe will be independent and discharge directly to the downstream reach of the conveyance canal (pump station afterbay).

V. Special Considerations

A. Trashrack Style

Trashracks shall be utilized to prevent the passage of objectionably large floating and submerged objects or debris that could cause damage or operational problems for the pumps or downstream equipment.

The trashracks shall consist of rows of parallel vertical flat bars with a clear opening between flat bars that is as large as possible yet consistent with the features and equipment to be protected as well as the equipment that the District will use to clean the trashracks.

It is anticipated that the District will manually clean and rake the trashracks.

The trashracks shall be fabricated from structural steel and be hot-dip galvanized for corrosion protection. They shall be end bearing trashracks installed in the inclined position with the bars running from top to bottom and carrying the loads to the reinforced concrete structure. The trashracks shall be designed to provide a maximum approach velocity of 1 to 2 feet per second for the design flows. This slow approach velocity reduces the tendency to collect debris against the racks, minimizes the possibility of trashrack vibration, and makes them easier to clean.

Trashracks shall be installed a minimum of five pump bell diameters ahead of the pump intake.

B. Pump Station Deck

A combination of reinforced concrete and heavy bar steel grating shall be designed and constructed for the pump deck that is suitable for a H20 loading. This will allow equipment to utilize the deck for the removal and installation of pumps and motors as well as for cleaning of trashracks while allowing for visibility down into each pump bay and convenient access to the pumps. The minimum deck width for access shall be a clear width of 16’-0” from the largest pump discharge head and sole plate to the edge of the deck or handrailing.

Handrailing shall be installed around the pump station deck where adjacent to open pump bays or forebays for safety. Railings shall be installed in a manner that they are removable, if necessary, for access to stop log slots, trashracks, and for clean-out of the pump bays and forebay.

The pump station structure and pumps and motors shall be designed for State of California seismic requirements per the 2019 California Building Code (CBC) and ASCE 7-16.

Each pump shall be equipped with a pump mounting pad. The pumps will include a permanently anchored and grouted in place soleplate onto which the pump discharge head will be mounted. It is proposed that the reinforced concrete pump station structures will be constructed as part of the conveyance facility construction and that a separate contract will be issued to equip the pump stations with pumps, motors, discharge piping and appurtenances, and electrical and controls. The reinforced concrete pump station, miscellaneous steel embeds such as ladder rungs, stop log slots, grating, and handrailing, and steel trashracks will be installed as part of the Conveyance Facilities scope of work along with the conveyance canal earthwork and lining work. The “Pump Station Equipping” scope of work will include the pump sole plates, the pump assembly, pump discharge head, pump anchorage, motor, discharge piping, electrical, control building, site lighting, and site development.

C. Cathodic Protection

Cathodic protection shall be provided for buried steel structures and piping at the pump station as well as the submerged steel structures and pumps in order to prevent corrosion. The following items shall have cathodic protection, at a minimum:

- Underground steel pump discharge piping
- Submerged pump column piping
- Submerged steel trashracks

The cathodic protection system shall be designed by a company specializing in impressed current systems.

Anode assemblies shall be mounted in each pump bay within one pipe diameter of the pump column piping and within five-feet of the trashrack. The assembly shall be supported by anode supports for mounting on a concrete deck. The bottom of the anodes shall be one-foot (1') above the structure floor. The copper cables shall be routed to a pole mounted anode junction/resistance box. The anode junction box shall be connected to a wall mounted air-cooled rectifier (40V, 30 Amp) in the electrical/control building. As an alternative, a passive cathodic protection system can be installed utilizing zinc anode ribbons strapped to the pump column piping and trashrack structures or approved equal.

The underground steel pipelines shall be protected by an impressed current system. The soil anodes shall be constructed near the pipeline as directed by the Cathodic Protection specialist. A cathodic protection test station shall be installed as directed by the Cathodic Protection specialist.

D. Flow Meters

It is recommended to install individual flow meters at each pump discharge line so that the performance of the individual pumps and motors can be evaluated. The discharge pipe sizes vary but are expected to range between 30-inch and 54-inch diameter.

There are different types of meters available in these size ranges which are noted below. It is recommended that these meter options be evaluated further during the design phase of the pump stations to select the best meter for the application. The brands and models noted below are for reference, however other meters that are comparable may be considered.

1. Mag Meters (Full Body)

   Mag Meters are available up to 48-inch diameter and flows up to 420 cfs. These are flanged meters that do not have any moving parts and are easy to maintain. These are supplied by McCrometer out of Hemet, California.

2. Mag Meter (Insertion Probe)

   An insertion electromagnetic flow sensor is available from Seametrics. The Model EX210 meter adjusts for pipe sizes from 10-inch to 48-inch diameter and flows up to 250 cfs.

3. Ultrasonic Meter

   An ultrasonic flow transducer is available from Rittmeyer and has several different types that can be utilized, all of which are for pipes flowing full whether above ground or below ground. They provide clamp-on meters or transducers that can be installed through the pipe wall. They are suitable for a full range of pipe diameters, can be replaced with the pipelines in operation, and have a high accuracy. In addition, they make a flow controller / display that can monitor multiple pipes/meters at the same time which is ideal for a pump station facility.

4. Doppler Velocity Meter

   Flow meters utilizing a doppler velocity sensor and depth sensor can provide flow measurement in large diameter pipes for full-pipe flow or partial pipe flow. These are supplied by SonTek, a xylem brand.

E. Valve and Appurtenances

1. Air Release Valve

   An air release and vacuum relief valve is necessary to release air upon start-up or the slow build up of air and to prevent vacuum conditions in the pipeline from developing in the event of a power failure or pump shutdown. The valve shall be designed to allow large quantities of air to escape out of the orifice when filling the pipeline and to close watertight when the liquid enters the valve. The valve shall also permit large quantities of air to enter through the orifice when the pipeline is being drained to break the vacuum.

2. Check Valve

   A check valve is utilized to prevent reverse flow and prevent runaway reverse pump speeds when the pump is shut off. It is common to use a slanting disc check valve in these applications. A slanting disc check valve contains a disc balanced on a pivot. Instead of being perpendicular to the longitudinal axis in conventional swing check valves, the seat is at an angle of 50 to 60 degrees from the valve longitudinal axis. The advantages of this type of valve include low headloss, top-mounted oil dashpots that can be used to control the opening and closing speeds, and the ability to adjust the valve controls in the field. The top-mounted oil dashpot system allows both the opening and closing speeds of the disc to be adjusted over the full range it travels.

3. Dresser Coupling

    A sleeve coupling with AWWA M11 joint restraint harness shall be installed on the discharge piping near the pump discharge head. The coupling provides a flexible connection to the pump discharge head and pump station structure in the event of a seismic event and it is also serves as a convenience for breaking the pipe apart to remove the pump from the pump station, if necessary.

4. Butterfly Valve

    A butterfly valve is recommended as the isolation valve to be installed on each pump discharge line. The isolation valve is either fully opened or fully closed. The valve can be used to isolate the pump discharge piping from the system in the event repairs or maintenance need to be performed.

F. Variable Frequency Drives

The pump station motors will each be equipped with variable speed drives (VFD's). The VFD drives shall be equipped with harmonic protection and include proper shielding and protections from PG&E power variations. These drives shall be the Yaskawa U1000 Industrial Matrix Drive, or approved equal, for ultra-low harmonics, full continuous regeneration, and high efficiency.

G. Site Development

Each of the pump station sites shall have all-weather surfacing installed around the pump station, control building, site lighting, electrical transformer, and site ingress and egress routes.

Site lighting (exterior) with electrical outlets shall be installed around the pump station facilities and control building in a manner that will ensure the entire pump station facility and appurtenances are adequately covered with light and auxiliary power. Type IV light distribution fixtures shall be utilized that cast light 2.75 times wider than their height but produce a more rounded distribution pattern that pushes the light outward. The site lighting shall be LED lighting, include an electrical outlet at the base of the pole, have a photocell for automatic operation, and a switch for manual off, manual on, and operation based on the photocell.

Site security shall consist of fencing around the pump station facilities as well as intrusion alarms at each of the control buildings at access doors. It is anticipated that barbed wire and field fencing will be installed around the conveyance canal. This fencing shall encompass the pump station facilities along the conveyance canal, i.e. Return Water Pump Station, Pump Stations No. 1 – No. 3, and a potential Pump Station No. 4. This fencing shall include multiple access points to the pump station facilities utilizing large drive gates for access with cranes and other large equipment and personnel gates that are 4-feet wide. Double-wide access gates shall be utilized with a minimum 24-ft wide overall opening. It is anticipated that 6-ft tall chainlink fencing with three strands of barbed wire will be installed around the Goose Lake Pump Station Facility and include large drive gates and personnel gates.

VI. Physical Hydraulic Modeling

Physical modeling of the conveyance canal pump station facilities shall be performed by reputable firms or laboratories such as the Utah Water Research Laboratory at Utah State University, the US Bureau of Reclamation Hydraulics Laboratory in Denver, the Clemson Engineering Hydraulics (CEH) in South Carolina, or Northwest Hydraulic Consultants (NHC) Laboratory in Canada or Seattle. Selection of the modeling laboratory should be based on qualifications, experience, costs, and availability and be subject to the approval of the JPA.

In addition to the physical modeling, numerical modeling using Computational Fluid Dynamics (CFD) shall be provided by the laboratory. The design firm shall be responsible for modeling of the entire canal network and structures utilizing HEC-RAS or equivalent to determine operating water levels and velocities for all flow conditions.

It is recommended that hydraulic modeling be performed for the three in-line pump stations along the conveyance canal. Hydraulic modeling may not be required for the Goose Lake Channel Pump Station, the Return Water Pump Station, or a fourth in-line Pump Station at the end of the conveyance channel (if necessary), however this will be at the discretion of the design firm and JPA. The fourth in-line Pump Station (if necessary) and the Return Water Pump Station are believed to be small enough that they do not warrant hydraulic modeling provided they are designed in accordance with the Hydraulic Institute Standards. The Goose Lake Channel Pump Station is equal in capacity to the Conveyance Canal Pump Station No. 3, but can be designed to utilize information from the Pump Station No. 3 modeling and will have a large pool to pump from given the Goose Lake Channel and a new weir structure. However, the necessity for modeling the Goose Lake Channel Pump Station will be at the discretion of the project design firm and the JPA.

The Pump Station facility shall be evaluated at an appropriate scale and be studied to ensure the pump stations:

- Meet the established design criteria
- Prevent accumulation of sediment and debris
- Avoid pump cavitation and vortices
- Optimize hydraulic performance and efficiency
- Reduce maintenance requirements

The hydraulic modeling shall provide recommendations for the overall pump station configuration, curtain walls, fillets, center splitters, and other mitigation measures,

Utah Water Research Laboratory (UWRL)

The UWRL has been building and testing physical scale models since its commissioning in 1965. They build geometrically scaled models and utilize essential scaling parameters to accurately prototype flow conditions. They have the space to accommodate large model scales and thus reduce the potential for size scaling effects.

UWRL offers a composite model approach that couples physical modeling with numerical modeling that is highly effective in solving a wide array of difficult hydraulic problems. The numerical modeling is performed using Computational Fluid Dynamics (CFD).

US Bureau of Reclamation Hydraulics Laboratory

The US Bureau of Reclamation is capable of conducting large scale physical hydraulic models for conveyance channels and pump stations.

Clemson Engineering Hydraulics (CEH)

Clemson Engineering Hydraulics was first established as a research program at Clemson University in 2000 and then was launched as CEH in 2005 as a private commercial venture to fill the modeling needs of clients regionally, nationally, and worldwide.

The CEH physical modeling facility is a state of the art laboratory with 60,000 square feet of modeling space located near Anderson, South Carolina. The CEH team has extensive modeling experience with over 1,000 model studies of a wide range of hydraulic structures including pump intakes, siphon discharge systems, outfalls, and control structures.

Northwest Hydraulic Consultants (NHC)

NHC performs physical hydraulic modeling as well as numerical modeling using Computational Fluid Dynamics (CFD). These models are complex and sophisticated numerical tools used to investigate flow patterns and velocities in three dimensions and provide a detailed visual representation of the modelled system to address hydraulic issues or concerns. They have facilities in Vancouver, Edmonton, and Seattle.

A. Model Construction

A scale model of the proposed pump station shall be constructed in the selected laboratory. It is assumed at this time that the design of all three pump stations will be similar with the exception of the pump and motor sizes. If any special circumstances exist with one or more of the pump stations, then these special circumstances shall be captured in the model testing.

The layout of the physical modeling shall be based on the preliminary design drawings for the pump stations and the canal conveyance channel. All portions of the pump station that may affect the flow uniformity or the performance of the pumps shall be included in the physical model. The model shall accurately reflect the orientation and configuration of the forebays and the afterbays at the pump station.

B. Model Testing

Model testing will begin with the proposed engineering design for the pump station, the canal approach, the forebay, and the afterbay and then the channel and forebay geometry will be modified in the physical model until the velocity profiles entering each pump bay are as uniform as possible. The proposed pumps and pump bell data should be known and provided so that the actual flow distribution, velocity profiles, vortices, velocity fluctuations, and general pump bay flow conditions can be measured at each respective pump and pump bay. The testing will need to include all possible scenarios of pump operation and at a minimum, shall include:

- Evaluation of discharge flow conditions to the afterbay specifically with regard to erosion and the need for energy dissipation.
- All pumping configurations shall be tested (i.e., three different flow rates (443 cfs, 435 cfs, and 240 cfs) at the possible pump combinations when pumps are on/off).
- A proposed test iteration is noted below:

Table 11

Test No.	Total Pump Flow Rate (cfs)[1]	Pumps Operating	WS Elev. at Pump (ft)[1]	Test Configuration
1	normal	All	normal	Pump Config. 1
2	low	All	high	Pump Config. 1
3	normal	All	low	Pump Config. 1
4	high	All	low	Pump Config. 1
5	high	All	normal	Pump Config. 1
6	high	All	high	Pump Config. 1
7	normal	One Pump Off	normal	Pump Config. 2
8	low	One Pump Off	high	Pump Config. 2
9	normal	One Pump Off	low	Pump Config. 2
10	high	One Pump Off	low	Pump Config. 2
11	high	One Pump Off	normal	Pump Config. 2
12	high	One Pump Off	high	Pump Config. 2

[1]Specific flow and water surface elevations corresponding to low, normal, and high will be provided during the model construction.

VII. Low Voltage versus Medium Voltage Service

The pump station electrical service may be low voltage or medium voltage depending on the total horsepower of the pump station.

Low voltage service is considered 480 volt service. Medium voltage service is considered 4,160 volt service. PG&E will typically not allow medium voltage service if the load is less than 600 hp.

Low voltage service is recommended under the following two circumstances:

1. Using solid-state reduced voltage starters (SSRV) and load is less than 600 hp.
2. Using variable speed drives (VFD) and the load is less than 2000 hp.

The benefits to low voltage service include the following:

1. Lower equipment cost
2. More familiar to maintenance personnel
3. Easier to obtain parts

The benefits to medium voltage service include the following:

1. Lower amperage
2. Lower energy losses

However, medium voltage service has a greater safety hazard.

At the larger horsepowers, an economic analysis shall be prepared that compares the starter costs, VFD costs, cable costs, etc. between the low voltage and the medium voltage services.

VIII. Utility Interface

PG&E will be the power service provider for the Pump Stations. It will be critical to involve them in the design process early. These will be large horsepower pump stations in the range of 800 hp to 1,600 hp and PG&E may need to make infrastructure upgrades to adequately support and serve these facilities.

It will be prudent to furnish PG&E with information and estimates of all the project loads and to provide an overall map that illustrates the locations of such loads.

Furthermore, the starting of these large motors at the Pump Stations may cause voltage drops or "flicker" and PG&E may require the installation of variable speed drives (VFD's) for each pump and motor. The use of VFD's at the Pump

Stations will also afford the JPA greater flexibility in matching flows and reducing the starting and stopping of pumps.

IX. Control Building Design

An electrical control building will be constructed at each Pump Station to house the electrical, control, and SCADA equipment. It is anticipated that the control building will be either a masonry building or a pre-cast concrete building.

The designer shall ensure the building is adequately sized to hold all the electrical and control equipment and provide adequate clearances for access and maintenance. The minimum ceiling height shall be 10-feet. Door openings shall be large enough for the removal of the largest piece of equipment or the roof shall be removable.

The building shall be climate controlled, the VFD units shall be vented to the building exterior and a means incorporated to minimize the AC loading in the building by utilizing outside (unconditioned) air for cooling the VFD units, and the roof shall be sloped appropriately with runoff away from the building ingress and egress. In addition, the building shall have intrusion alarms installed at all doors and access points for building security.

X. Pump Station Control Philosophy

The pump station control philosophy for each pump station facility will be developed during the detailed design of the conveyance canal and pump stations.

The pump stations will need to be capable of being controlled, monitored, and operated both locally and remote through SCADA. The operators shall have the flexibility to turn on pumps and turn off pumps as necessary. In addition, the SCADA system shall provide for water level monitoring in each pump forebay and afterbay as well as indicating the pump flow readings from the flow meters. The SCADA system shall communicate alarms at a minimum for power failure, motor failure, water level alarms, and high pressure alarms.

The Conveyance Canal Pump Station motors will be equipped with variable speed drives and will be able to modulate to maintain flow or level. The canal may be desired to be controlled based on flow or level. It may be advantageous to set the flow rate at each pump station and have the pumps modulate to maintain the flow set point while utilizing the water level as a secondary means of control in the event of high water levels or low water levels that could compromise the performance of the pump based on low submergence. Protective measures such as water level sensors shall be duplicated for redundancy.

The Goose Lake Channel Pump Station and Return Water Pump Station motors will be equipped with variable speed drives and will be able to modulate to maintain flow or level. It is anticipated that the Goose Lake Channel Pump Station and Return Water Pump Station will be operated for long periods of time or turned off for long periods of time. Override protective measures will be designed such as a low water level cutoff in the event the pump submergence is compromised or a high pressure switch at the pump discharge in the event of a closed valve or blockage. Protective measures such as water level sensors shall be duplicated for redundancy.

XI. Summary

Each pump station shall be designed, at a minimum, in accordance with the Hydraulic Institute Standards ANSI/HI 9.8-Most Recent Edition for Pump Intake Design. Additionally, the conveyance canal pump stations shall have physical modeling and numerical modeling using CFD performed due to the large capacities of these pump stations.

It is recommended that Pump Stations No. 1 and No. 2 have six pumps and motors each with two (2) 40 to 42 cfs pumps and four (4) 89 to 90 cfs pumps. Pump Station No. 3 is recommended to have four pumps and motors with two (2) 40 cfs pumps and two (2) 80 cfs pumps.

In addition, the Goose Lake Channel Pump Station is recommended to have four pumps and motors with two (2) 40 cfs pumps and two (2) 80 cfs pumps and the Return Water Pump Station is recommended to have three (3) 36 cfs pumps. This will allow pump bay widths to be similar for utilizing two standard stop log slot dimensions and also for providing interchangeability between pumps across all pump stations.

A Pump Station No. 4 may be necessary at the easterly end of the conveyance channel to lift 129 cfs to the Phase I Property, however this pump station has not been considered herein. This pump station is considered small enough that it may not require physical modeling provided it is designed as outlined herein.

Table 12

Pump Station Summary				
Pump Station Facility	Capacity	Pump Configuration	36-42 cfs Pumps	80-90 cfs Pumps
Pump Station No. 1	443 cfs	Six (6) Pumps	Two	Four
Pump Station No. 2	435 cfs	Six (6) Pumps	Two	Four
Pump Station No. 3	240 cfs	Four (4) Pumps	Two	Two
Pump Station No. 4	129 cfs	If Necessary		
Goose Lake Channel Pump Station	240 cfs	Four (4) Pumps	Two	Two
Return Water Pump Station	72 cfs	Three (3) Pumps	Three	

The pump stations shall be equipped with galvanized steel trashracks, decks designed for H2O loadings to allow for cleaning of trashracks and removal of pumps/motors, cathodic protection, stilling wells for water level monitoring, and access to the pump forebay behind the trashracks and stoplog slots.

The pump motors will be equipped with variable speed drives. The pump discharge piping shall be equipped with air release valves, check valves, butterfly valves, dresser couplings, and flow meters as appropriate for the application.

The electrical service shall be coordinated early in the design process with PG&E and is anticipated to be a low voltage service (480V). The electrical equipment shall be designed in an electrical control building that is climate controlled to protect the equipment from the elements and vandalism.

XII. <u>Related Work Specified Elsewhere</u>

A. TM 2 – Conveyance Capacity Requirements
B. TM 3 – Pipeline Requirements
C. TM 5 – Geotechnical Investigation
D. TM 6 – Canal Liner and Turnout Requirements
E. TM 10 – Facility Operation and SCADA Requirements
F. TM 11- Engineer's Estimates

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KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 5
(Geotechnical Investigation)

PREPARED FOR: Groundwater Banking Joint Powers Authority (JPA)
PREPARED BY: Curtis Skaggs, P.E.
DATE: February 10, 2021

SUBJECT: ***Geotechnical Investigation***

I. Executive Summary

This memorandum serves to outline the general requirements for geotechnical investigation work and preparation of project soils reports. The requirements outlined herein should be considered recommendations and an estimate of the work that needs to be included, however the design firm shall ultimately be responsible for ensuring that adequate soils investigation is performed so that all facets of the project can be properly designed to minimize potential failures or problems.

Based on the Technical Memorandum No. 1 "Project Phasing and Design/Contractor Selection", it is envisioned that a Geotechnical Investigation and Soils Report will be necessary for each of the following phases:

- Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures

- Aqueduct Turnout Facility

- Conveyance Facilities including Turnouts & Pump Stations

A map overview of the project and the associated geotechnical portions is illustrated in Figure 1 below.

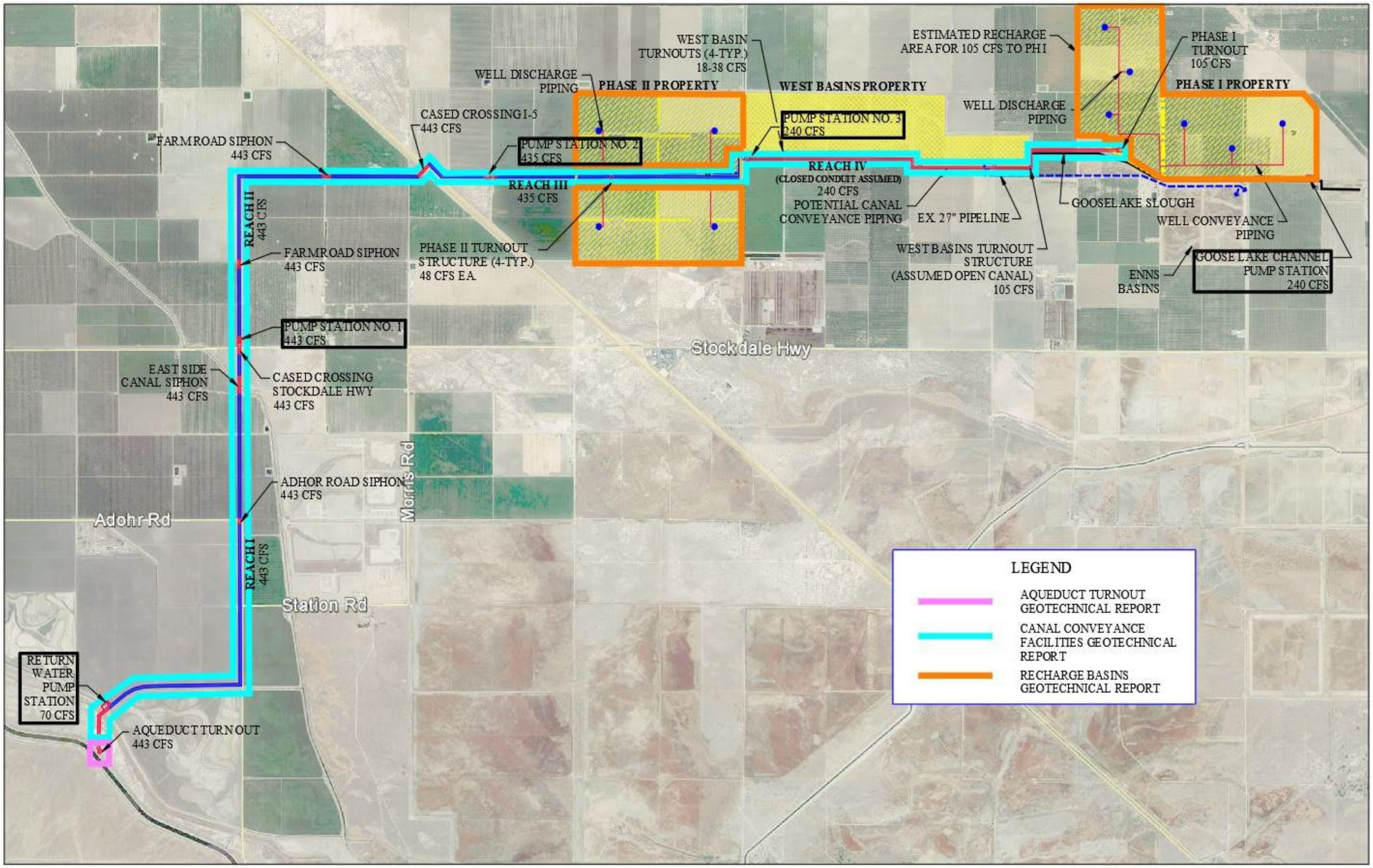

Figure 1: Project Geotechnical Overview

An outline of the memorandum is shown below:

f. Soil Permeability
  i. In-situ
  ii. Levee Materials
g. Braced Cuts
  i. Bracing
  ii. Shoring

F. Earthwork
  a. Preparation of Subgrade/Keyways
  b. Borrow Areas
    i. Suitability of Borrow Materials as Levee Fill
      1. Expansive Potential
      2. Dispersiveness
      3. Gradations
      4. Remolded Permeability
    ii. Compaction Criteria
      1. Relative Compaction and Compaction Moisture
      2. Compaction Methods
    iii. Need for Blending of Levee Fill Materials

A. Review of Available Data
  a. Existing Borings
  b. Well Completion Reports
  c. Groundwater Data
  d. Aerial Photography
  e. Geologic Mapping

B. Field Exploration
  a. Soil Borings at Structure and Along Turnout Alignment
  b. Laboratory Testing
  c. In-situ Testing
  d. Temporary Piezometer

C. Site Conditions
  a. Turnout
  b. Along Turnout Alignment

D. Engineering Seismology
  a. Seismic Parameters for Engineering Design
    i. American Society of Civil Engineers (ASCE) 7-16
    ii. 2019 California Building Code (CBC)
  b. Liquefaction

C. Site Conditions
  a. Turnouts
  b. Siphons
  c. Along Alignment

D. Engineering Seismology
  a. Seismic Parameters for Engineering Design
    i. American Society of Civil Engineers (ASCE) 7-16
    ii. 2019 California Building Code (CBC)
  b. Liquefaction

E. Design Recommendations
  a. Structure Design
    i. Lateral Earth Pressures
    ii. Resistance to Lateral Loading,
    iii. Bearing Capacity
    iv. Settlement
  b. Bridge Structures
    i. Vertical Capacity
    ii. Lateral Capacity
    iii. Seismic Design
    iv. Construction Considerations
  c. Pipe Design
    i. Soil Properties
    ii. Vertical Loading
    iii. Soil Friction, E’
      1. Native
      2. Backfill
    iv. Compaction Criteria
      3. Pipe Zone
      4. Trench Zone
  d. Jacking & Tunneling Design
    i. Anticipated Soil Stratigraphy
    ii. Tunnel Construction
    iii. Need for Soil Stabilization
  e. Canal Levee Construction
    i. Relative Compaction and Compaction Moisture
    ii. Compaction Methods
    iii. Slope stability
    iv. Permanent Piezometers
  f. Slope Stability
  g. Permanent Slopes
    i. Static Stability
    ii. Seismic Stability
    iii. Maximum Inboard and Outboard Gradients
  h. Temporary Slopes

i. Slope Stability and Maximum Slope Gradients

i. Braced Cuts

i. Bracing

ii. Shoring

j. Concrete Corrosion Potential

i. Sulfate Reaction

ii. Other Design Considerations

k. Dewatering

i. Temporary Piezometers

F. Earthwork

a. Preparation of Subgrade/Keyway

b. Borrow Areas

i. Suitability of Borrow Materials as Fill

1. Expansion Potential

2. Dispersiveness

ii. Gradations

c. Compaction Criteria

i. Relative Compaction and Compaction Moisture

ii. Compaction Methods

iii. Need for Blending of Levee Fill Materials

V. Summary Page 14

These soils reports will become the property of the JPA. As such, the JPA will be permitted to provide copies of the soils reports as necessary to other design firms, general contractors, and subcontractors as required for other phases of the project.

II. Recharge Facility Soils Work

A geotechnical investigation and report is necessary for the recharge facility projects listed in the design phase "Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures. The investigation work is considered the field work, sampling, and testing while the report is considered the final report summarizing the findings, conclusions, and recommendations.

This work will include a review of available data, field exploration, a description of site conditions, an outline of seismic parameters, and design and earthwork recommendations as outlined below.

This information will be necessary for the recharge facility earthwork, the design of earthen levees, the design of interbasin structures, the design of conveyance pipelines, and the design of other associated structures.

A. Review of Available Data

A review of available data in the area of the proposed recharge basins shall be performed. This shall include, but not be limited to, a review of existing borings, well completion reports, groundwater data, historic aerial photographs, geologic mapping, and transient electromagnetic (tTEM) surveys.

It is anticipated that the District will perform tTEM surveys on the Phase I and Phase II properties as part of the due diligence in purchasing the properties. The tTEM survey method measures the electrical resistivity of the earth and these resistivities are translated to soil lithology for a better understanding of the formations below the ground surface.

B. Field Exploration

The field exploration within the proposed recharge basin properties shall consist of test pits, borings, and laboratory testing.

It is anticipated that test pits shall be excavated across the properties of the Phase I and Phase II recharge areas to depths of approximately 5-feet to 10-feet. It is anticipated that up to 30 test pits, or approximately 1 test pit per 20 acres, could be excavated and that these would be performed in areas of geologic interest such as historic channels and seepage paths based upon the review of available data.

The actual depth and quantity of test pits, however, will be dependent on the property, the data review, and the discretion of the soils firm and design firm.

It may also be desirable to perform a few deep borings for correlation with the tTEM survey data.

Soil samples shall be collected from the test pits or borings and the following testing considered:

- Moisture Content (ASTM D2216)
- Unit Weight (ASTM D2937)
- Sieve Analysis (ASTM C136, D422, D1140)
- Dispersive Characteristics of Clay Soil by Double Hydrometer (ASTM D4221)
- Atterberg Limits (ASTM D4318)
- Standard Proctor (ASTM D698) or Modified Proctor (ASTM D1557) as appropriate
- Expansion Index (ASTM D4829)
- Soluble Sulfate & Soluble Chloride Contents (California Test Method No.'s 417 & 422)
- pH and Minimum Resistivity (California Test Method No. 643)
- Strength Testing – Direct Shear (ASTM D3080) or Unconfined Compressive Strength (ASTM D2166)
- Flexible Wall Permeability (ASTM D5084)
- Collapse Potential (ASTM D5333)

C. Site Conditions

The report shall outline the existing site conditions. This shall include background data on the properties and a description of subsurface conditions including obstructions and earth materials.

D. Seismic Design Parameters

The report shall outline the seismic design parameters for engineering design of structures and facilities within the project areas. The seismic parameters shall be in accordance with ASCE 7-16 and the 2019 California Building Code (CBC).

E. Design Recommendations

The report shall outline design recommendations for site earthwork, levee subgrade preparation, embankment construction, structure backfill, and structure design.

This shall include a recommendation of materials, compaction efforts, slope stability, permeability, bearing capacity, settlement, lateral earth pressures, lateral resistance, and pipe design parameters such as E_b', backfill internal friction, active coefficient, and frictional coefficient.

III. Aqueduct Turnout Facility

A geotechnical investigation and report is necessary for the Aqueduct Turnout Facility.

This work will include a review of available data, field exploration, a description of site conditions, an outline of seismic parameters, and design and earthwork recommendations as outlined below.

This information will be necessary for the turnout facility excavation, subgrade preparation, structure design, turnout piping design, and the structure and pipe backfill and compaction.

A. Review of Available Data

A review of available data in the area of the proposed Aqueduct Turnout shall be performed. This shall include, but not be limited to, a review of existing borings, well completion reports, groundwater data, historic aerial photographs, and geologic mapping.

B. Field Exploration

The field exploration at the Aqueduct Turnout shall consist of a minimum of one boring at the site and laboratory testing.

It is anticipated that the boring will extend to a minimum 10-feet below the planned invert of the turnout structure. It should also be considered to convert this boring into a piezometer for monitoring groundwater levels in the area of the turnout structure pre-construction, during construction, and post-construction of the turnout.

Soil samples shall be collected from the boring and the following testing considered:

- Moisture Content (ASTM D2216)
- Unit Weight (ASTM D2937)
- Sieve Analysis (ASTM C136, D422, D1140)
- Atterberg Limits (ASTM D4318)
- Modified Proctor (ASTM D1557)
- Soluble Sulfate & Soluble Chloride Contents (California Test Method No.'s 417 & 422)
- pH and Minimum Resistivity (California Test Method No. 643)
- Strength Testing – Direct Shear (ASTM D3080) or Unconfined Compressive Strength (ASTM D2166)
- Flexible Wall Permeability (ASTM D5084)

C. Site Conditions

The report shall outline the existing site conditions. This shall include background data on the turnout property and a description of subsurface conditions including obstructions and earth materials.

D. Seismic Design Parameters

The report shall outline the seismic design parameters for engineering design of the structure and appurtenances. The seismic parameters shall be in accordance with ASCE 7-16 and the 2019 California Building Code (CBC).

E. Design Recommendations

The report shall outline design recommendations for earthwork excavation, dewatering if necessary, turnout subgrade preparation, structure design, turnout piping design, and structure and pipe backfill and compaction.

This shall include a recommendation of materials, compaction efforts, dewatering, bearing capacity, seismic design, settlement, lateral earth pressures, lateral resistance, concrete corrosion potential, and pipe design parameters such as E_b', backfill internal friction, active coefficient, and frictional coefficient.

IV. Conveyance Facilities Soils Work

A geotechnical investigation and report is necessary for the Conveyance Facilities listed under the design phase "Conveyance Facilities including Turnouts & Pump Stations".

This work will include a review of available data, field exploration, a description of site conditions, an outline of seismic parameters, and design and earthwork recommendations as outlined below.

This information will be necessary for project earthwork, excavation, dewatering, subgrade preparation, levee embankment construction, structure design, bridge structures or culvert crossings, jacking and tunneling design, turnout design, pipeline design, and the associated backfill and compaction requirements.

A. Review of Available Data

A review of available data in the area of the proposed Conveyance Facility alignment and facilities shall be performed. This shall include, but not be limited to, a review of existing borings, well completion reports, groundwater data, historic aerial photographs, geologic mapping, and correlation with tTEM survey data.

B. Field Exploration

The field exploration for the Conveyance Facilities shall consist of approximately 48 to 50 borings along the conveyance alignment and at critical facilities as well as laboratory testing. It is estimated that borings would be performed at approximate quarter-mile increments along the conveyance canal unless coincident with a project structure. The actual depth and quantity of borings, however, will be dependent on the actual alignment, the data review, and the discretion of the soils firm and design firm.

It is anticipated that the borings will extend to a minimum 10-feet below the planned invert of structures such as the pump stations and the culvert or pipe crossings. It is anticipated that the borings will extend to a minimum of 5-feet below the invert for the conveyance canal as well as for borings at canal turnout structures. It should also be considered to convert some of the borings into piezometers for monitoring groundwater levels in the area of the canal or some structures that are adjacent to recharge facilities or locations with high ground water. Piezometers are estimated at the Return Water Pump Station and Reach 1 of the canal that are adjacent to the Buena Vista Water Storage District recharge area; Pump Station No. 1; the I-5 Cased Crossing; Pump Station No. 2; the portion of Reach 3 of the canal adjacent to the Phase II Recharge Property; Pump Station No. 3; and the portion of Reach 4 of the canal (if open channel) adjacent to the West Basins Property.

Soil samples shall be collected from the borings and the following testing considered:

- Moisture Content (ASTM D2216)
- Unit Weight (ASTM D2937)
- Sieve Analysis (ASTM C136, D422, D1140)
- Dispersive Characteristics of Clay Soil by Double Hydrometer (ASTM D4221)
- Atterberg Limits (ASTM D4318)
- Modified Proctor (ASTM D1557)
- Expansion Index (ASTM D4829)
- Soluble Sulfate & Soluble Chloride Contents (California Test Method No.'s 417 & 422)
- pH and Minimum Resistivity (California Test Method No. 643)
- Strength Testing – Direct Shear (ASTM D3080) or Unconfined Compressive Strength (ASTM D2166)
- Flexible Wall Permeability (ASTM D5084)
- Consolidation – Clayey Soil (ASTM D2435)
- Collapse Potential (ASTM D5333)

C. Site Conditions

The report shall outline the existing site conditions for the conveyance canal alignment, pump stations, turnouts, cased crossings and culvert or siphon crossings. This shall include background data on the project properties and a description of subsurface conditions including obstructions and earth materials.

D. Seismic Design Parameters

The report shall outline the seismic design parameters for engineering design of the structures and appurtenances. The seismic parameters shall be in accordance with ASCE 7-16 and the 2019 California Building Code (CBC).

E. Design Recommendations

The report shall outline design recommendations for earthwork excavation, dewatering if necessary, subgrade preparation, levee embankments, borrow areas, structure design, bridge structures, box culverts, jacking and tunneling design, pump stations, turnouts, pipeline design, and structure backfill and compaction.

Report considerations shall include:

a. Structure Design

The geotechnical report shall provide information for reinforced concrete structure design that includes recommendations for excavation work, dewatering (if necessary), liquefaction, subgrade preparation, backfill and compaction, slope stability for temporary and permanent slopes, braced cuts and shoring, seismic design, concrete corrosion potential, lateral earth pressures, resistance to lateral loading, bearing capacity, and estimated settlement.

b. Bridge Structures

The geotechnical report shall provide information for bridge structure design that includes recommendations for excavation work, dewatering (if necessary), liquefaction, subgrade preparation, backfill and compaction, slope stability for temporary and permanent slopes, braced cuts and shoring, concrete corrosion potential, vertical capacity, lateral capacity, seismic design, and construction considerations.

c. Cased Crossings

The geotechnical report shall provide information for cased crossing design for jack and bore installation as well as the tunnel boring method. This shall include anticipated soil stratigraphy and recommendations for excavation work, dewatering (if necessary), backfill and compaction, slope stability for temporary and permanent slopes, braced cuts and shoring, concrete corrosion potential, tunnel construction, and the need for soil stabilization.

d. Culvert and Pipe Crossings

The geotechnical report shall provide information for culvert design, siphon design, and buried pipe design. This shall include soil properties and recommendations for excavation work, dewatering (if necessary), slope stability for temporary and permanent slopes, braced cuts and shoring, backfill and compaction, concrete corrosion potential, vertical loading, soil friction for native and backfill material, and pipe zone compaction efforts.

e. Conveyance Canal Design

The geotechnical report shall provide information for the conveyance canal earthwork. This shall include soil properties and recommendations for excavation work, dewatering (if necessary), subgrade preparation, suitability of borrow areas, levee embankment fill, compaction methods, relative compaction and compaction moisture, slope stability for temporary and permanent slopes, braced cuts and shoring, backfill and compaction, concrete corrosion potential, and piezometers for shallow groundwater areas.

Areas of potential borrow material for construction of the conveyance canal will need to be evaluated for their suitability with respect to soil characteristics, gradations, expansive potential, and dispersiveness.

V. Summary

This information herein serves to outline the general requirements for geotechnical investigation work and preparation of project soils reports. The requirements outlined herein should be considered recommendations and an estimate of the work that needs to be included, however the design firm shall ultimately be responsible for ensuring that adequate soils investigation is performed so that all facets of the project can be properly designed to minimize potential failures or problems.

Based on the Technical Memorandum No. 1 “Project Phasing and Design/Contractor Selection”, it is envisioned that a Geotechnical Investigation and Soils Report will be necessary for each of the following phases:

- Phase I Recharge Basins & Goose Lake Channel Pump Station, Check Structure, Interbasin Structures, and Well Pipelines Intertie; Phase II Recharge Basins & Phase II Well Pipelines and Interbasin Structures

- Aqueduct Turnout Facility

- Conveyance Facilities including Turnouts & Pump Stations

These soils reports will become the property of the JPA. As such, the JPA will be permitted to provide copies of the soils reports as necessary to other design firms, general contractors, and subcontractors as required for other phases of the project.

A map of the proposed boring and test pit locations is illustrated in Figure 2 below. This is considered preliminary and subject to change based upon the actual Phase I and Phase II property locations, the actual conveyance canal alignment, and the needs and discretion of the design firm.

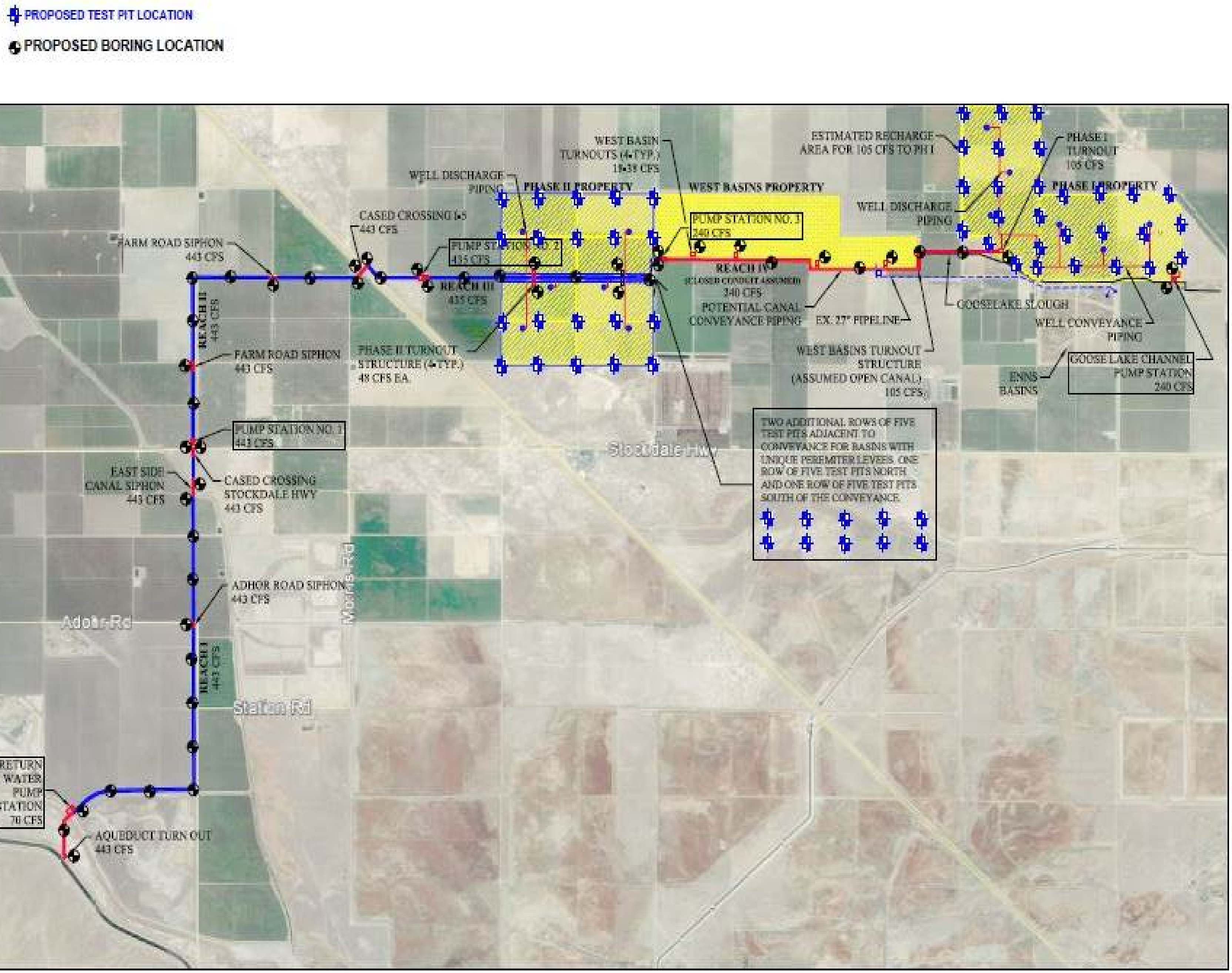

Figure 2: Preliminary Boring and Test Pit Location Map

In addition, below in Table 1 is a matrix table summarizing the proposed project components and the recommended laboratory testing. The actual type of laboratory tests and frequency shall be determined by the site conditions, the project needs, and the design firm.

Table 1

KERN FAN GROUNDWATER STORAGE PROJECT - GEOTECHNICAL INVESTIGATION OF PROJECT COMPONENTS AND LABORATORY TESTING

Reach	Structure Type	Structure Name	Approximate No. of Borings/Test Pits[A]	Comments on Minimum Depth of Exploration (ft)	Approximate No. of Temporary Piezometers[D]	Laboratory Testing[E]												
						Moisture Content (ASTM D2216)	Unit weight (ASTM D2937)	Sieve Analysis (ASTM C136), (ASTM D422), (ASTM D1140)	Dispersive Characteristics of Clay Soil by Double Hydrometer (ASTM D4221)	Atterberg Limits (ASTM D4318)	Modified Proctor (ASTM D1557)	Expansion Index (ASTM D4829)	Soluble Sulfate & Soluble Chloride Contents (California Test Method No's 417 & 422)	pH and Minimum Resistivity (California Test Method No. 643)	Strength Testing - Direct Shear (ASTM D3080) or Unconfined Compressive Strength (ASTM D2166)	Flexible Wall Permeability (ASTM D5084)	Consolidation (ASTM D2435) - Clayey Soil	Collapse Potential (ASTM D5333)
Reaches 1 - 3	Conveyance	Conveyance (Canal)	19[B]	5 feet below invert		X	X	X	X	X	X	X			X		X	X
Reach 1	Conveyance	Aqueduct Turnout	1	10 feet below invert of structure	1	X	X	X		X	X				X	X		
Reach 1	Pump Station	Return Water Pump Station	1	10 feet below invert of pumping bay	1	X	X	X		X	X				X			
Reach 1	Conveyance	Adhor Road Siphon	1	10 feet below invert of structure		X	X	X		X	X				X			
Reach 1	Conveyance	East Side Canal Siphon	2	10 feet below invert of structure		X	X	X		X	X				X			
Reaches 1/2	Conveyance	Stockdale Cased Crossing	2	10 feet below invert		X	X	X		X	X		X	X	X			
Reach 2	Conveyance	Pump Station No. 1	2	10 feet below invert of pumping bay	1	X	X	X		X	X				X		X	X
Reach 2	Conveyance	Farm Road Siphon	1	10 feet below invert of structure		X	X	X		X	X				X			
Reaches 2/3	Conveyance	Interstate 5 Cased Crossing	3	10 feet below invert	2	X	X	X		X	X		X	X	X	X		
Reach 3	Pump Station	Pump Station No. 2	2	10 feet below invert of pumping bay	1	X	X	X		X	X				X		X	X
Reach 3	Conveyance	Phase 2 Property - Turnout 1	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 3	Conveyance	Phase 2 Property - Turnout 2	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 3	Conveyance	Phase 2 Property - Turnout 3	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 3	Conveyance	Phase 2 Property - Turnout 4	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 3	Recharge Facility	Phase 2 Property	30[C]	5 to 10 feet		X	X	X	X	X	X	X	X	X	X	X		X
Reach 4	Conveyance	Conveyance (Pipeline)	4[B]	5 feet below invert		X	X	X	X	X	X				X			
Reach 4	Pump Station	Pump Station No. 3	2	10 feet below invert of pumping bay	1	X	X	X		X	X				X		X	X
Reach 4	Conveyance	West Basins Property - Turnout 1	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 4	Conveyance	West Basins Property - Turnout 2	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 4	Conveyance	West Basins Property - Turnout 3	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 4	Conveyance	West Basins Property - Turnout 4	1	5 feet below invert of structure		X	X	X		X	X				X			
Reach 4	Conveyance	Phase 1 Property - Turnout 1	1	5 feet below invert of structure		X	X	X		X	X		X	X	X	X		X
Reach 4	Recharge Facility	Phase 1 Property	28[C]	5 to 10 feet		X	X	X	X	X	X	X	X	X	X	X		X
Reach 4	Pump Station	Goose Lake Channel Pump Station	2	10 feet below invert of pumping bay		X	X	X		X	X				X			

[A]All explorations shall be measured horizontally and vertically by a licensed surveyor.

[B]Explorations advanced along the conveyance and earthen embankments shall be spaced approximately every ¼ mile, unless coincident with a project structure.

[C]Test pit explorations shall be advanced in areas of geologic interest, i.e. historic channels and seepage paths, based on a review of aerial photography, geologic mapping, Transient Electromagnetic (TEM) resistivity correlations, and readily available data.

[D]Piezometers to be installed where groundwater is encountered.

[E]Actual type of laboratory tests and frequency to be determine by site conditions and project needs.

VI. Related Work Specified Elsewhere

A. TM 1 – Project Phasing & Design/Contractor Selection
B. TM 2 – Conveyance Capacity Requirements
C. TM 3 – Pipeline Requirements
D. TM 4 – Pump Station Requirements
E. TM 6 – Canal Liner and Turnout Requirements
F. TM 9 – Recharge Basin Requirements
G. TM 11- Engineer's Estimates