AGENDA
GROUNDWATER BANKING JOINT POWERS AUTHORITY
PROJECT COMMITTEE MEETING

April 26, 2021
12:00 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/88978273459
Meeting Number (Access Code): 889 7827 3459
Meeting Password: 446275
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 12:00 PM

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

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, April 23, 2021.

ALL VOTES SHALL BE TAKEN BY A ROLL CALL VOTE.

1. **Consideration and Approval of Committee Meeting Minutes**
    a. Special Project Committee Meeting- December 02, 2020
    b. Special Project Committee Meeting- March 15, 2021

2. **Consideration and Possible Action of TM6 Canal Liner Approval (Dan/Curtis)**

3. **Consideration and Possible Action of TM7 Wells Approval (Dan/Curtis)**

4. **Consideration and Possible Action of RFP Preparation Proposal (Dan)**

5. **Update on DWR Agreements (Fiona)**

6. **Closed Session**

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

Property: Kern County Assessor Parcel Numbers: 103-170-09,12,14,15 25-32; 103-270-01, 06, 07,15; 104-240-18, 22, 30, 31; 104-250-20, 21; 104-260-08; 104-270-28; 104-280-01, 02, 07, 18, 19, 24, 25, 27, and 28-35; 104-291-07; 104-292-09; 105-250-18, 20, 21; 160-010-66, 71, 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

Agency negotiators: Dan Bartel

Negotiating parties: Groundwater Banking Joint Powers Authority and Various Landowners / Lessees: Edward J. and Katherine Kosareff; Li Hsia Yang Yu; Nina Estill; Boozer Family, LP; Bettie Smith; Loh Investments LP; Edward Kosareff; M. Juan Alejandro Delgadillo; Alborz Farms LLC; AJB Land LLC; Rosedale Kern Properties LLC; Bolthouse Land Company, LLC; Bidart Dairy III, LLC; Marc McCaslin; Enns 2016 Trust; Bos Legacy LP; Diamond M. Properties LLC; Lonnie Dillard; Aera Energy, LLC; Other Identities Unknown, Belluomini Ranches, LP, Tech Ag Financial Group, Inc.

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

7. 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.

BOARD OF DIRECTORS
GROUNDWATER BANKING JOINT POWERS AUTHORITY
MINUTES OF THE SPECIAL PROJECT COMMITTEE MEETING

December 02, 2020
10:00 AM

Note: This meeting was conducted by teleconference pursuant to and in conformance with Executive Order N-29-20 relating to public meetings during the State of Emergency that was declared as a result of COVID-19.

Committee Members and Alternates Present

Jason Selvidge
Doug Reinhart
Dan Bartel
Paul Cook
Eric Averett

Committee Members and Alternates Absent

Others Present

Doug Gosling- Braun Gosling, ALC
Megan Misuraca- RRBWSD
Rob Jacobson- IRWD
Fiona Sanchez- IRWD
Cheryl Clary- IRWD
Curtis Skaggs- Dee Jaspar & Associates
Jennifer Jacobus- ESA
William Zeiders- Bill Zeiders Consulting
Paul Weghorst-IRWD
Peer Swan- IRWD
Markus Nygren- RRBWSD
Ray Bennett- IRWD

Call to Order

Director Selvidge called the meeting to order at approximately 10:00 a.m.

Public Comment Notice

There were no public comments.

1. **Consideration of Technical Memos 1-3**-

   Mr. Bartel introduced the Design, Engineering, ROW Acquisition & Construction Team. Mr. Skaggs of Dee Jaspar and Associates presented a detailed PowerPoint presentation highlighting Technical Memorandums 1 – 3. A motion was made by Mr. Cook with a second by Director Selvidge to receive and file technical memos 1 – 3 at 95% with modifications to be made subject to property acquisition. A roll call vote was taken and the motion was unanimously passed.

2. **Overview of Key Comments on Kern Fan Project Draft EIR (Jennifer Jacobus)**-

   Mr. Averett suggested this item be taken up first on the agenda and the Committee concurred. Ms. Jacobus with Environmental Science Associates briefed the Board on the 8 comment letters received on the Kern Fan Project Draft EIR.

3. **Closed Session**

   At 12:11 p.m. Director Selvidge announced the Committee would meet in closed session. The Committee reconvened at 12:53 p.m. and Mr. Gosling reported staff was instructed to continue negotiations related to real property.

4. **Adjournment**

   The meeting was adjourned at 12:54 p.m.

ATTEST:

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Authority Secretary

BOARD OF DIRECTORS
GROUNDWATER BANKING JOINT POWERS AUTHORITY
MINUTES OF THE SPECIAL PROJECT COMMITTEE MEETING

March 15, 2021
1:00 PM

Note: This meeting was conducted by teleconference pursuant to and in conformance with Executive Order N-29-20 relating to public meetings during the State of Emergency that was declared as a result of COVID-19.

Committee Members and Alternates Present

Jason Selvidge
Doug Reinhart
Dan Bartel
Paul Cook
Cheryl Clary

Committee Members and Alternates Absent

Others Present

Doug Gosling- Braun Gosling, ALC
Dan Raytis- Belden, Blaine, Raytis
Megan Misuraca- RRBWSD
Rob Jacobson- IRWD
Fiona Sanchez- IRWD
Curtis Skaggs- Dee Jaspar & Associates
Jennifer Jacobus- ESA
William Zeiders- Bill Zeiders Consulting
Paul Weghorst-IRWD
Peer Swan- IRWD
Markus Nygren- RRBWSD
Ray Bennett- IRWD
Mike Ming- Alliance Ag Services
George Ming- Alliance Ag Services

Call to Order

Director Selvidge called the meeting to order at approximately 1:00 p.m.

Public Comment Notice

There were no public comments.

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

   Mr. Bartel gave a brief introduction and overview before turning the meeting over to Mr. Skaggs of Dee Jaspar and Associates. Mr. Skaggs presented detailed PowerPoint presentation highlighting Technical Memorandums 4 – 5. A motion was made by Director Reinhart with a second by Mr. Cook to approve Technical Memorandums 4-5 to be considered at the next regularly scheduled GBJPA Board meeting. A roll call vote was taken and the motion was unanimously passed.

2. **Update on DWR Agreements**-

   Ms. Sanchez briefed the Board on the status of DWR Agreements and reviewed the requirements to be met for project funding.

3. **Closed Session**

   At 2:45 p.m. Director Selvidge announced the Committee would meet in closed session. The Committee reconvened at 3:06 p.m. and Mr. Gosling reported staff was instructed to continue negotiations related to real property.

4. **Adjournment**

   The meeting was adjourned at 3:06 p.m.

ATTEST:

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Authority Secretary

GBJPA

Groundwater Banking
Joint Powers Authority

Kern fan groundwater storage project

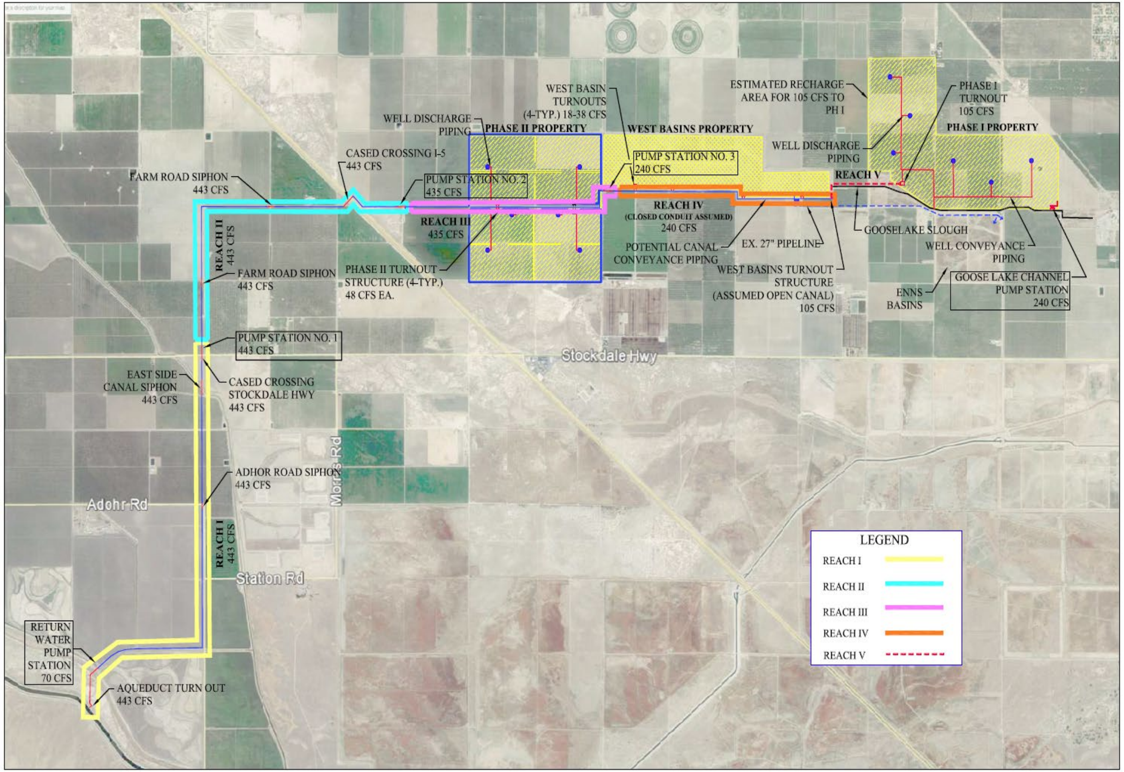
Design, Engineering, ROW Acquisition, and Construction Team

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



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	JPA Approved
2. Conveyance Capacity Requirements	JPA Approved
3. Pipeline Requirements	JPA Approved
4. Pump Station Requirements	Committee Approved
Priority 2	
5. Geotechnical Report	Committee Approved
6. Conveyance and Turnout Requirements	95% Ready for Consideration
7. Well Drilling and Equipping Requirements	95% Ready for Consideration
8. ROW Acquisitions	50%
Priority 3	
9. Recharge Basin Requirements	10%
10. Facility Operation and SCADA Requirements	10%
11. Engineer's Estimate	10%

Tm#6 – conveyance and turnout requirements

GBJPA

Purpose

To evaluate conveyance facility alternatives for open canal or pipeline including canal lining alternatives, capital costs, and operations & maintenance costs over a fifty-year period.

Alternatives Considered:

1. Earth Lined Canal
   1a. Earth Lined Canal with Return Water Pipeline
   1b. Earth Lined Canal with Bentonite Lining

2/3. Poly Lined Canal
   2. High Density Polyethylene (HDPE)
   3. Reinforced Polyethylene (RPE)

4. Shotcrete Lined Canal

5. Concrete Lined Canal

6. Conveyance Pipeline

Summary of Conveyance Alternatives

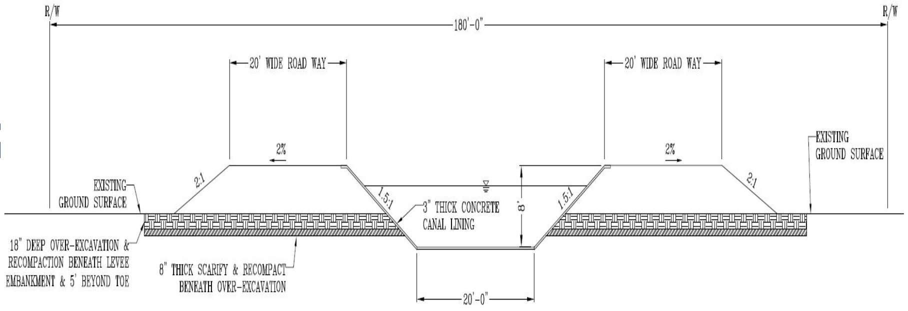
Ranking by Present Worth	Alternative No.	Alternative	Earthwork & Conveyance Facility Costs[2]	Pump Station Costs[3]	Right-of-Way Costs[4]	Lining Cost or Earth Canal Option Costs[5]	Total Conveyance Cost w/ Pump Stations[6]	Present Worth on 50 Yr Basis[7]
1	6	Pipeline	$62,242,300	$13,383,200	$3,750,000	NA	$79,375,500	$182,191,000
2	1a	Earth Lined w/Return Pipeline	$22,193,716	$28,945,000	$5,625,000	$10,519,000	$67,282,716	$188,594,201
3	2/3	HDPE/RPE Lined	$20,750,355	$28,945,000	$5,000,000	$5,596,190	$60,291,545	$190,764,330
4	4	Shotcrete Lined	$20,750,355	$28,945,000	$5,000,000	$14,818,490	$69,513,845	$191,170,614
5	5	Concrete Lined	$20,750,355	$28,945,000	$5,000,000	$16,001,690	$70,697,045	$191,481,030
6	1	Earth Lined[1]	$22,193,716	$28,945,000	$5,625,000	NA	$56,763,716	$197,012,451
7	1b	Earth Lined w/Bentonite Liner	$22,193,716	$28,945,000	$5,625,000	$15,135,216	$71,898,932	$202,678,919

[1] Earth Lined canal does not include a lining. There is additional earthwork and associated costs which are included under "Earthwork & Conveyance Facility Costs".
[2] Earthwork and conveyance costs based upon Tables 1 - 4 and include earthwork, facility relocations, fencing, spillways, and road crossings.
[3] Pump Station costs based on those developed in TM #4 plus a 15% contingency to account for unknowns and PG&E electrical service costs.
[4] Right-of-way costs estimated at $25,000 per acre.
[5] Costs from the liner alternatives evaluation in Sections III thru VI
[6] Total conveyance cost includes earthwork & conveyance facilities, pump stations, R/W, and linings.
[7] Present worth analysis based on 50 year period - see Exhibit C for spreadsheets.

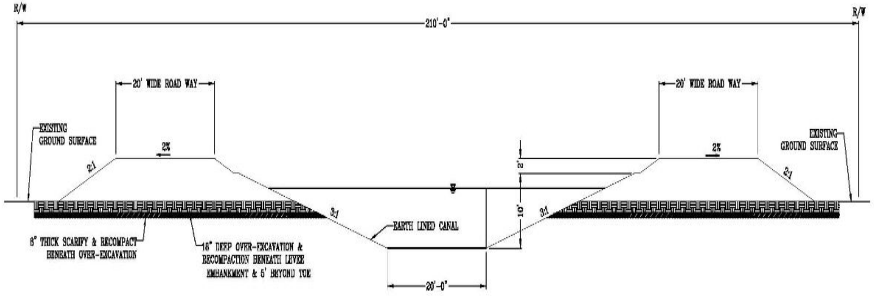
OPEN CANAL ALTERNATIVES

Description

- Conveyance alignment estimated as 46,400-ft or 8.80 miles in length. Extends from end of Aqueduct Turnout Piping to the east end of the RRBWSD West Basins.
- Lined canal options have an estimated cross section with 20-ft wide bottom, 1.5:1 side slopes, and 8-ft depth.
- Lined canal right-of-way estimated as 180-ft width and approximately 200 acres. Land costs estimated at $25,000 per acre for a total cost of $5,000,000.
- Unlined canal option has an estimated cross section with 20-ft wide bottom, 3:1 side slopes, and 10-ft depth.
- Unlined canal right-of-way estimated as 210-ft width and approximately 225 acres. Land costs estimated at $25,000 per acre for a total cost of $5,625,000.



Typical Lined Canal Cross-Section



Typical Unlined Canal Cross-Section

OPEN CANAL ALTERNATIVES

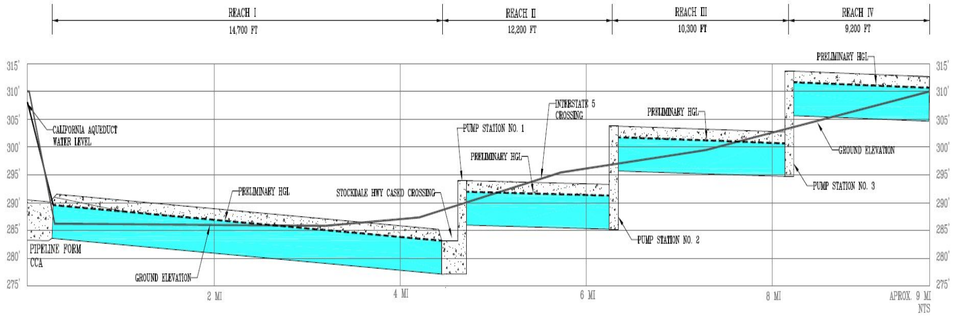
Description

- Canal earthwork volumes for 1.5:1 side slope cross-section estimated at 244,227 cy cut and 716,381 cy fill. Total earthwork cost estimate for clearing and grubbing, subgrade preparation, cut/fill, and levee embankment construction is $5,705,205.

- Canal cost estimate for 1.5:1 side slopes, excluding canal linings, pump stations, and R/W is approximately $20,750,355. This cost includes earthwork, facility relocations, safety features, road surfacing, fencing, road crossings, emergency spillways, and transition structures.

- Canal earthwork volumes for 3:1 side slope cross- section estimated at 472,615 cy cut and 783,801 cy fill. Total earthwork cost estimate for clearing and grubbing, subgrade preparation, cut/fill, and levee embankment construction is $7,148,566.

- Canal cost estimate for 3:1 side slopes, excluding canal linings, pump stations, and R/W is approximately $22,193,716. This cost includes earthwork, facility relocations, safety features, road surfacing, fencing, road crossings, emergency spillways, and transition structures.



Preliminary Canal Profile

Earth lined canal capital

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Earth Lined Canal

- Capital Cost

  Estimated = $56,763,716
  R/W = $5,625,000
  Canal Conveyance = $22,193,716
  Pump Stations (4) = $28,945,000

- Seepage Losses (Recovery)

  - Return 50,000 ac-ft in a dry year
  - Estimate 30% seepage losses
  - Requires 16 wells at 6cfs each
  - Estimated O&M of $4,902,912.00

- Advantages
  - Capital cost

- Disadvantages
  - Seepage losses particularly when recovering water for return to Aqueduct
  - Increased canal maintenance
    Levee monitoring for rodent holes & erosion
    Weed control
    Removal of sediment and debris

Earth Lined Canal w/Return Water Pipeline

- Capital Cost

  Estimated = $67,282,716
  R/W = $5,625,000
  Canal Conveyance = $22,193,716
  Pump Stations (4) = $28,945,000
  Pipeline (45,000-ft – 54") = $10,519,000

- Seepage Losses (Recovery)

  - Return 50,000 ac-ft in a dry year
  - Estimate 0% seepage losses
  - Requires 12 wells at 6cfs each
  - Estimated O&M of $3,677,184.00

- Advantages
  - Eliminates seepage losses

- Disadvantages
  - Increased canal maintenance
    Levee monitoring for rodent holes & erosion
    Weed control
    Removal of sediment and debris

Earth Lined Canal w/Bentonite Lining

- Capital Cost

  Estimated = $71,898,932
  R/W = $5,625,000
  Canal Conveyance = $22,193,716
  Pump Stations (4) = $28,945,000
  Clay Lining = $15,135,216

- Seepage Losses (Recovery)

  - Return 50,000 ac-ft in a dry year
  - Estimate 15% seepage losses
  - Requires 14 wells at 6cfs each
  - Estimated O&M of $4,290,048.00

- Advantages
  - Reduces seepage losses

- Disadvantages
  - Increased canal maintenance
    Levee monitoring for rodent holes & erosion
    Weed control
    Removal of sediment and debris

Earth lined canal - o&m

Earth Lined Canal

- O&M Costs – 50 year basis

  PW Operations Costs estimated = $140,248,735
  Recovery Well Pumping Costs (Dry Years)
  Canal Operations Costs (Idle, Wet, Dry)
  Pump Station Replacement Costs (Every 25yrs)

- Idle Year (5 out of 10 years)
  - Approximately $138k per year inflated at 3% per year.
  - Cost includes field staff time, equipment cost, weed control, rodent control, maintenance, and PG&E standby costs.

- Dry Year (3 out of 10 years)
  - Recovery well pumping costs for 16 wells at $4,902,912 and inflated at 3% per year.
  - Canal operation costs and PG&E costs for 12 months.

- Wet Year (2 out of 10 years)
  - Canal operation costs, PG&E costs, and DWR Conveyance costs for 4 months plus 8 months idle costs.

Earth Lined Canal w/Return Water Pipeline

- O&M Costs – 50 year basis

  PW Operations Costs estimated = $121,311,485
  Recovery Well Pumping Costs (Dry Years)
  Canal Operations Costs (Idle, Wet, Dry)
  Pump Station Replacement Costs (Every 25yrs)

- Idle Year (5 out of 10 years)
  - Approximately $138k per year inflated at 3% per year.
  - Cost includes field staff time, equipment cost, weed control, rodent control, maintenance, and PG&E standby costs.

- Dry Year (3 out of 10 years)
  - Recovery well pumping costs for 12 wells at $3,677,184 and inflated at 3% per year.
  - Canal operation costs and PG&E costs for 12 months.

- Wet Year (2 out of 10 years)
  - Canal operation costs, PG&E costs, and DWR Conveyance costs for 4 months plus 8 months idle costs.

Earth Lined Canal w/Bentonite Lining

- O&M Costs – 50 year basis

  PW Operations Costs estimated = $130,779,987
  Recovery Well Pumping Costs (Dry Years)
  Canal Operations Costs (Idle, Wet, Dry)
  Pump Station Replacement Costs (Every 25yrs)

- Idle Year (5 out of 10 years)
  - Approximately $138k per year inflated at 3% per year.
  - Cost includes field staff time, equipment cost, weed control, rodent control, maintenance, and PG&E standby costs.

- Dry Year (3 out of 10 years)
  - Recovery well pumping costs for 14 wells at $4,290,048 and inflated at 3% per year.
  - Canal operation costs and PG&E costs for 12 months.

- Wet Year (2 out of 10 years)
  - Canal operation costs, PG&E costs, and DWR Conveyance costs for 4 months plus 8 months idle costs.

lined canal Options – capital

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Poly Lined Canal

- Capital Cost

  Estimated = $60,291,545
    R/W = $5,000,000
    Canal Conveyance = $20,750,355
    Pump Stations (4) = $28,945,000
    Poly Lining = $5,596,190

- Advantages
  - Eliminates seepage losses
  - Improved hydraulic properties
  - Ease of installation

- Disadvantages
  - Subject to UV and wind damage
  - Subject to damage by animals
  - Subject to rodent damage
  - Difficult to clean without damaging
  - Subject to cost volatility based on petroleum products and materials

Shotcrete Lined Canal

- Capital Cost

  Estimated = $69,513,845
    R/W = $5,000,000
    Canal Conveyance = $20,750,355
    Pump Stations (4) = $28,945,000
    Shotcrete Lining = $14,818,490

- Advantages
  - Eliminates seepage losses
  - Good durability
  - Long useful life

- Disadvantages
  - Requires skilled construction personnel including certified nozzleman.
  - Requires significant quality control measures for rebound, thickness, and uniformity.
  - Less durable than conventional concrete.
  - Subject to damage from settlement, shrinkage, and hydrostatic pressure.

Concrete Lined Canal

- Capital Cost

  Estimated = $70,697,045
    R/W = $5,000,000
    Canal Conveyance = $20,750,355
    Pump Stations (4) = $28,945,000
    Concrete Lining = $16,001,690

- Advantages
  - Eliminates seepage losses
  - Good durability
  - Long useful life

- Disadvantages
  - High capital cost
  - Subject to damage from settlement, shrinkage, and hydrostatic pressure

lined canal Options - o&m

Poly Lined Canal

- O&M Costs

  PW Operations Costs estimated = $130,472,785
  Recovery Well Pumping Costs (Dry Years)
  Canal Operations Costs (Idle, Wet, Dry)
  Pump Station Replacement Costs (Every 25yrs)
  Liner Replacement (Patches every 5yrs and complete liner replacement every 20 yrs)

- Idle Year (5 out of 10 years)
  - Approximately $70k per year inflated at 3% per year.
  - Cost includes field staff time, equipment cost, weed control, rodent control, maintenance, and PG&E standby costs.

- Dry Year (3 out of 10 years)
  - Recovery well pumping costs for 12 wells at $3,677,184 and inflated at 3% per year.
  - Canal operation costs and PG&E costs for 12 months.

- Wet Year (2 out of 10 years)
  - Canal operation costs, PG&E costs, and DWR Conveyance costs for 4 months plus 8 months idle costs.

Shotcrete Lined Canal

- O&M Costs

  PW Operations Costs estimated = $121,656,769
  Recovery Well Pumping Costs (Dry Years)
  Canal Operations Costs (Idle, Wet, Dry)
  Pump Station Replacement Costs (Every 25yrs)
  Liner Replacement (Repairs every 3 yrs)

- Idle Year (5 out of 10 years)
  - Approximately $70k per year inflated at 3% per year.
  - Cost includes field staff time, equipment cost, weed control, rodent control, maintenance, and PG&E standby costs.

- Dry Year (3 out of 10 years)
  - Recovery well pumping costs for 12 wells at $3,677,184 and inflated at 3% per year.
  - Canal operation costs and PG&E costs for 12 months.

- Wet Year (2 out of 10 years)
  - Canal operation costs, PG&E costs, and DWR Conveyance costs for 4 months plus 8 months idle costs.

Concrete Lined Canal

- O&M Costs

  PW Operations Costs estimated = $120,783,985
  Recovery Well Pumping Costs (Dry Years)
  Canal Operations Costs (Idle, Wet, Dry)
  Pump Station Replacement Costs (Every 25yrs)
  Liner Replacement (Repairs every 5 yrs after 15 years)

- Idle Year (5 out of 10 years)
  - Approximately $70k per year inflated at 3% per year.
  - Cost includes field staff time, equipment cost, weed control, rodent control, maintenance, and PG&E standby costs.

- Dry Year (3 out of 10 years)
  - Recovery well pumping costs for 12 wells at $3,677,184 and inflated at 3% per year.
  - Canal operation costs and PG&E costs for 12 months.

- Wet Year (2 out of 10 years)
  - Canal operation costs, PG&E costs, and DWR Conveyance costs for 4 months plus 8 months idle costs.

GBJPA

pipeline ALTERNATIVE

Description

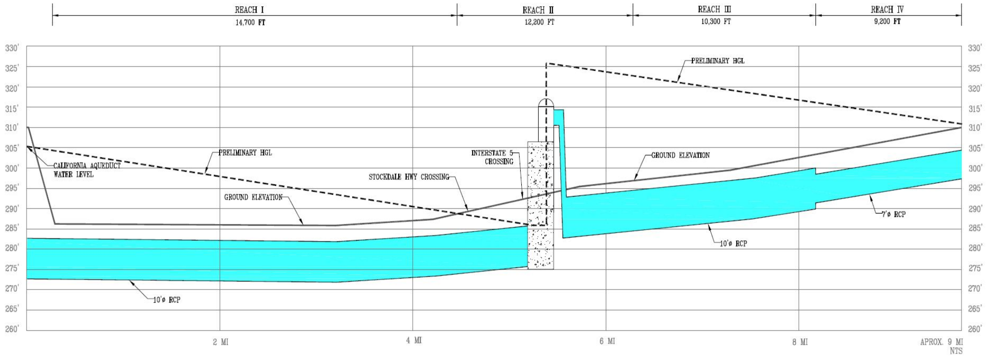
- Conveyance alignment estimated as 46,400-ft or 8.80 miles in length. Extends from end of Aqueduct Turnout Piping to the east end of the RRBWSD West Basins.

- Estimated 10-ft Diameter RCP Pipeline for canal equivalents of Reach 1, 2, and 3, and a 7.5-ft diameter RCP Pipeline for Reach 4.

- Pipeline right-of-way estimated as 140-ft width and approximately 150 acres. Land costs estimated at $25,000 per acre for a total cost of $3,750,000.

- Single pump station and bypass with an estimated cost of $13,383,200.

- Pipeline alternative allows for smaller R/W, less obtrusive to property owners, less maintenance, 1 pump station versus 3, and ability to float off static water level in Aqueduct at Pump Station.



Typical Pipeline Profile

Pipeline alternative

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Pipeline – Capital Costs

- Estimated = $79,375,500

  R/W = $3,750,000
  Pipeline Conveyance = $58,964,900
  Road Crossings = $3,277,400
  Pump Station & Bypass = $13,383,200

- Advantages
  - Smaller R/W than canal
  - Less obtrusive to property owners
  - Less maintenance than canal
  - One pump station instead of three for canal
  - Ability to float off static water level or operating water surface of California Aqueduct up to the Pump Station which eliminates risk of flooding if slide gate fails or a levee embankment breaches.

- Disadvantages
  - Higher capital cost than a canal
  - Higher energy costs due to friction head

Pipeline – O&M Costs

- PW Operations Costs estimated = $102,815,500

  Recovery Well Pumping Costs (Dry Years)
  Pipeline Operations Costs (Idle, Wet, Dry)
  Pump Station Replacement Costs (Every 25yrs)

- Idle Year (5 out of 10 years)
  - Approximately $35k per year inflated at 3% per year.
  - Cost includes field staff time, equipment cost, general maintenance, and PG&E standby costs.

- Dry Year (3 out of 10 years)
  - Recovery well pumping costs for 12 wells at $3,677,184 and inflated at 3% per year.
  - Pipeline operation costs and PG&E costs for 12 months.

- Wet Year (2 out of 10 years)
  - Pipeline operation costs, PG&E costs, and DWR Conveyance costs for 4 months plus 8 months idle costs.

summary

Summary of Conveyance Alternatives								
Ranking by Present Worth	Alternative No.	Alternative	Earthwork & Conveyance Facility Costs[2]	Pump Station Costs[3]	Right-of-Way Costs[4]	Lining Cost or Earth Canal Option Costs[5]	Total Conveyance Cost w/ Pump Stations[6]	Present Worth on 50 Yr Basis[7]
1	6	Pipeline	$62,242,300	$13,383,200	$3,750,000	NA	$79,375,500	$182,191,000
2	1a	Earth Lined w/Return Pipeline	$22,193,716	$28,945,000	$5,625,000	$10,519,000	$67,282,716	$188,594,201
3	2/3	HDPE/RPE Lined	$20,750,355	$28,945,000	$5,000,000	$5,596,190	$60,291,545	$190,764,330
4	4	Shotcrete Lined	$20,750,355	$28,945,000	$5,000,000	$14,818,490	$69,513,845	$191,170,614
5	5	Concrete Lined	$20,750,355	$28,945,000	$5,000,000	$16,001,690	$70,697,045	$191,481,030
6	1	Earth Lined[1]	$22,193,716	$28,945,000	$5,625,000	NA	$56,763,716	$197,012,451
7	1b	Earth Lined w/Bentonite Liner	$22,193,716	$28,945,000	$5,625,000	$15,135,216	$71,898,932	$202,678,919

[1] Earth Lined canal does not include a lining. There is additional earthwork and associated costs which are included under "Earthwork & Conveyance Facility Costs".

[2] Earthwork and conveyance costs based upon Tables 1 - 4 and include earthwork, facility relocations, fencing, spillways, and road crossings.

[3] Pump Station costs based on those developed in TM #4 plus a 15% contingency to account for unknowns and PG&E electrical service costs.

[4] Right-of-way costs estimated at $25,000 per acre.

[5] Costs from the liner alternatives evaluation in Sections III thru VI

[6] Total conveyance cost includes earthwork & conveyance facilities, pump stations, R/W, and linings.

[7] Present worth analysis based on 50 year period - see Exhibit C for spreadsheets.

Recommendations

- Earth lined canal not recommended due to cost, maintenance, and concerns with embankment breaches or rodent holes.
- Poly lined and concrete lined canal alternatives recommended for an open channel. Recommend bid alternates.
- Pipeline option most expensive capital cost, but most economical over 50 year present worth cost basis. This alternative als o eliminates risk associated with slide gate failure at Aqueduct or embankment failure.
- Recommended that in the design phase (once Phase I and II properties are acquired, alignments fixed, and topographical survey ing completed) the design firm perform updated value engineering work for final decision by JPA.

Tm#7 – Well drilling and equipping requirements

- Estimated to be up to twelve (12) recovery water wells constructed with up to six (6) at Phase I property and up to six (6) at Phase II property.
- Wells anticipated to have a capacity of 5 to 6 cfs.
- Wells to be drilled by the reverse -rotary drilling method and to be constructed in similar fashion to previous District wells.
- Wells to be equipped with vertical turbine pumps, electric motors, and variable frequency drives (VFD's). The discharge piping, valves, and electrical to be constructed in similar fashion to previous District wells.

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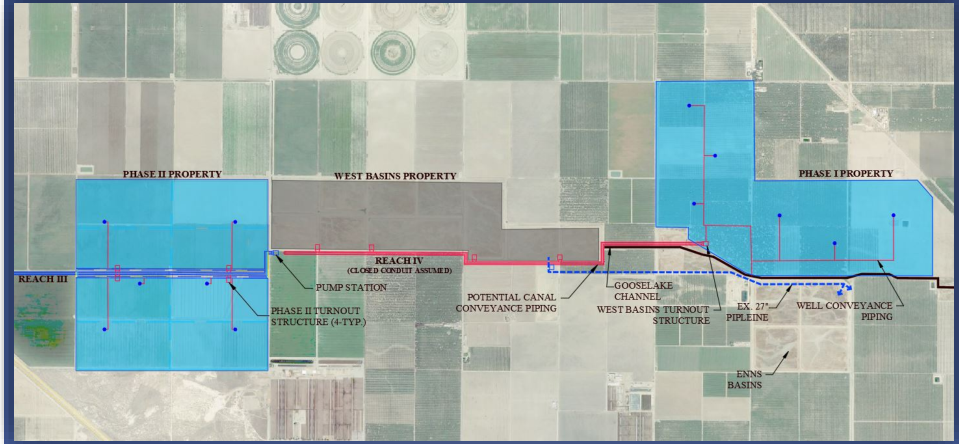
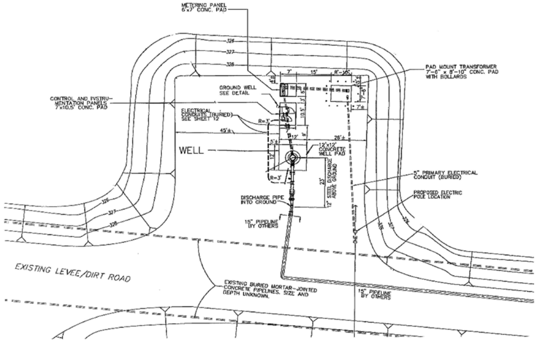
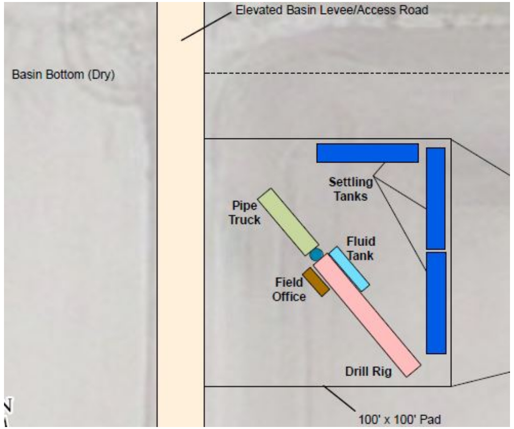


Well layout requirements

- Minimum well spacing of approximately 1,320 -ft between recovery wells and neighboring wells.
- Well pads to be constructed with the recharge basin earthwork and be a minimum 100 -ft by 100-ft.
- Equipment to be maintained on the well pad. If equipment or materials are stored down in the basin bottoms, Contractor shall clean and rip any areas disturbed in the basin bottoms at the conclusion of his work.
- Water to be supplied for drilling operations and dust control.
- Drill cuttings to be contained on -site during drilling operations and shall be dried out and spread uniformly on levee slopes or as directed by District.
- At completion of drilling and development, all casings and tubings shall be covered or welded shut to prevent access.



Typical Well Site Layout



Typical Well Construction Layout

Well design requirements

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Design Criteria

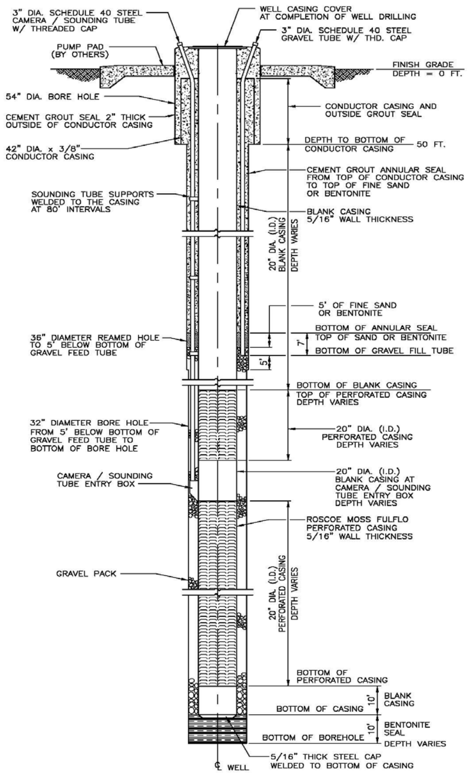
- Minimum 50 -ft deep conductor casing for borehole stability and near-surface sanitary seal.
- Drill 17.5-inch pilot hole with composite soil samples every 10-ft in depth and deviation surveys at every 100 -ft in depth.
- Geophysical logging of pilot hole with e -log (SP, short normal, long normal, & laterolog), gamma ray, sonic log, and deviation survey.
- Water quality zone testing to be performed in select wells. These wells are anticipated to be representative for the recharge and recovery area and will sample 1,2,3-TCP, Arsenic, Nitrate, TDS, EC, pH, General Mineral and Physical, EDB, DBCP, and Gross Alpha.
- Reamed pilot hole to specified depth and diameter based on formation samples, geophysical logs, and water quality. Caliper log & deviation survey.
- Blank and Perforated casing to be 20-inch diameter by 5/16" wall Rosco Moss High-Strength, Low Alloy casing. Perforated casing to be "ful-flo" louvered screen.
- Install 3-inch gravel feed tube and 3-inch camera tube to the specified depths.
- Install filter pack to specified depth and cement annular seal to ground surface. Filter pack sized based on formation sieve analyses.
- Well development by airlifting and swabbing using a dual swab tool and clay-dispersing agent such as Aqua-Clear PFD.
- Well development by pumping and surging using a VTP with a capacity of 4,000 gpm at 600-ft TDH and clay-dispersing agent such as Mud-Nox.
- Well testing with a minimum three step step -drawdown test and a minimum 24 hr constant rate test. Spinner survey and Title 22 water quality analysis.
- Well Video and Casing Alignment Survey

Design Estimates

The following sizes, depths, diameters, lengths, and durations were approximated for purposes of preparing cost estimates and will be included in Technical Memorandum #11 "Engineers Estimate".

The well design parameters and specifications will be prepared by the design engineer and project hydrogeologist. The plans and specifications will detail the well design based on the actual project locations. The actual field conditions encountered during drilling and development will dictate the well design.

- Conductor = 42" x 3/8" Steel, 50-ft deep
- Pilot Hole = 17.5" diameter to approx. 970-ft.
- Geophysical Logging & Deviation Survey
- Reamed Hole = 36" diameter to approx. 320-ft and 32" diameter from 320 -ft to 970-ft
- Caliper Log & Deviation Survey
- Blank Casing = 20" x 5/16" Steel, 420-ft
- Perforated Casing = 20" x 5/16" Steel, 510-ft
- Gravel Feed Tube = 3" Sch 40 Steel, 315-ft
- Camera Tube = 3" Sch 40 Steel, 405-ft
- Filter Pack = 313-ft to 970-ft
- Cement Annular Seal = 0-ft to 313-ft
- Airlifting and Swabbing = 48 hours
- Pumping and Surging = 60 hours
- Production Testing = 36 hours
- Well Video & Final Testing



Typical Well Cross -Section

Well equipping requirements

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- Vertical Turbine Pump rated for approximately 3,000 gpm at 400-ft pumping water level. Pump capacity with range of 2,250 gpm to 4,000 gpm and 12” column pipe, 2-3/16” lineshaft, and 3-1/2” enclosing tubing.
- Vertical Hollowshaft Electric Motor – 400 to 500 hp
- Yaskawa U1000 Variable Frequency Drives
- 12” FBEL&C Steel Pipe with Valves and Appurtenances
- Electrical Gear with Main Switchboard and Motor Control Center
- Instrumentation and Controls – Well Level, HPS, Pressure and Flow
- Well Motor Enclosures
- Electrical Shade Structure
- Site Lighting and Site Ground Cover
- Site Security – Locking Cross-Bar at Electrical Equipment and Enclosure Hut at Deep Well Motor
- Wells Manually Operated. Ability to monitor well run status, groundwater level, well discharge pressure, well discharge flow, and any alarms.

Typical Well Site

Summary

- Any questions or comments on the items covered or discussed in the two TM's?
- Next Steps…..
- Preparation of RFP/RFQ's
- Currently working on Technical Memorandum #8 – Right of Way Acquisitions
- Will soon begin working to complete the final three memoranda:

  - TM#9 – Recharge Basin Requirements
  - TM#10 – Facility Operation and SCADA Requirements
  - TM#11– Engineer's Estimate

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Groundwater Banking
Joint Powers Authority

THANK YOU

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KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 6
(Conveyance and Turnout Requirements)

PREPARED FOR: Kern Fan Joint Powers Authority (JPA)
PREPARED BY: Curtis Skaggs, P.E.
DATE: March 25, 2021

SUBJECT: ***Conveyance and Turnout Requirements***

I. Executive Summary

This memorandum serves to consider the conveyance facility alternatives including potential canal lining alternatives, capital costs, and operations and maintenance costs over a fifty-year period. The canal lining alternatives considered herein include:

1. Earth Lined Canal (with mitigation options – see below)
2. High-Density Polyethylene (HDPE) Lined Canal
3. Reinforced Polyethylene (RPE) Lined Canal
4. Shotcrete Lined Canal
5. Concrete Lined Canal

In addition, a pipeline alternative (Alternative No. 6) has also been considered herein.

The outline of the memorandum includes the following:

The conveyance facility will cross recharge facilities, agricultural lands, private property, County roads, Stockdale Highway, and the I-5 Freeway. The conveyance facility is also planned to be utilized in the reverse direction during recovery operations for returning water to the California Aqueduct.

In order to prepare an Engineer's Estimate for the proposed project, preliminary quantities needed to be estimated. Elevations along the canal alignment were estimated using Google Earth and a preliminary conveyance canal line and grade established. Canal cross-sections and earthwork quantity estimates were prepared for the canal conveyance alignment and are attached in Appendix A and B. The canal alignment, elevations, grades, slopes, and quantities are all estimates and are outlined herein for purposes of showing what the cost estimates are based upon. However, the quantities are merely for purposes of the cost estimate in Technical Memorandum No. 11 and no representations are made beyond that. The actual alignment, elevations, grades, slopes, and quantities may be very different once design information is obtained and layout completed.

Section II of this memorandum provides detail for the conveyance canal facility including the proposed preliminary alignment and canal profile. The conveyance canal is estimated as approximately 8.80 miles long or 46,400-ft. The canal cross-section for the lined canal options is estimated to be 8-ft deep with a 20-ft wide bottom and 1.5:1 side slopes. This section of the memorandum outlines the anticipated earthwork associated with the conveyance canal construction, the estimated earthwork volumes, the estimated right-of-way required, and the conveyance canal features. Tables 1 through 4 therein provide the capital cost estimate for the conveyance facilities while excluding any lining costs, pump station costs, or right-of-way acquisition. The earthwork cost estimate for the above described canal prism is $5,705,205 and the conveyance canal costs as outlined in Table 1 through 4 are estimated at $20,750,355.

Section III of this memorandum considers the earth lined canal and the sub-alternates that include mitigation efforts such as a return water pipeline or bentonite lining. The earth lined canal alternative is estimated to be a 20-ft wide bottom with 3:1 side slopes and an approximate 10-ft depth. This requires additional earthwork and increases the earthwork costs from $5,705,205 to approximately $7,148,566. This in turn increases the conveyance canal costs outlined in Tables 1 through 4 from $20,750,355 to approximately $22,193,716.

Sections IV through VI serve to evaluate the canal lining options such as poly linings, shotcrete lining, and conventional concrete canal lining. The construction methods are discussed therein, the hydraulic impacts are addressed, capital costs for each lining are developed, and the advantages and disadvantages are discussed. The lining capital costs are summarized below:

1. Earth Lined Canal	$NA
1a. Earth Lined Canal with Return Water Pipeline	$10,519,000
1b. Earth Lined Canal with Bentonite Lining	$15,135,216
2/3. Poly Lined Canal - High-Density Polyethylene (HDPE) Lined Canal or Reinforced Polyethylene (RPE) Lined Canal	$5,596,190

4. Shotcrete Lined Canal	$14,818,490
5. Concrete Lined Canal	$16,001,690

Section VII summarizes the canal lining alternatives and discusses the present worth analysis. Four canal lining alternatives and one pipeline alternative were evaluated:

1. Earth Lined Canal (see mitigation options below)
2/3. Poly Lined Canal - High-Density Polyethylene (HDPE) Lined Canal or Reinforced Polyethylene (RPE) Lined Canal
4. Shotcrete Lined Canal
5. Concrete Lined Canal
6. Conveyance Pipeline

In addition, two additional alternatives were considered as part of mitigation efforts with an earth lined canal:

1a. Earth Lined Canal with Parallel Return Water Pipeline
1b. Earth Lined Canal with Bentonite Lining

The capital costs were considered for each of the above alternatives including earthwork and conveyance facility costs, pump station costs, right-of-way costs, and canal lining costs.

The right-of-way costs are estimated as follows:

> Canal with 1.5:1 Side Slopes – 180 ft Permanent R/W or approximately 200 acres at $25,000 per acre…………………………………..…..$5,000,000
>
> Canal with 3:1 Side Slopes – 210 ft Permanent R/W or approximately 225 acres at $25,000 per acre……………………………………..$5,625,000
>
> Closed Conduit – 140 ft Permanent R/W or approximately 150 acres at $25,000 per acre…………………………………………...$3,750,000

The pump station costs for the conveyance canal alternatives include three pump stations along the alignment and a return water pump station. The costs from Technical Memorandum No. 4 “Pump Station Requirements” have been utilized for the pump stations. Pump Station No. 1 and No. 2 are estimated as $8,605,000 each, Pump Station No. 3 is estimated as $6,150,000 and the Return Water Pump Station is estimated as $2,081,000. The total pump station costs are approximately $28,945,000 which includes an approximate 15% contingency to account for unknowns and PG&E service costs.

The capital costs, including earthwork costs, conveyance facilities, pump stations, and right-of-way acquisition (not including lining or mitigation costs), are summarized below:

Earth Lined Alternatives (1, 1a, and 1b)	$56,763,716
Lined Alternatives (2, 3, 4, and 5)	$54,695,355

Section VIII evaluates a pipeline alternative for the conveyance facility. Alternative No. 6 is a conveyance pipeline, however due to the capacity and size of the pipeline, it is a much more significant capital cost. The capital cost for the pipeline, including the pump station, pipeline right-of-way, and road crossing work at Adohr Road, Stockdale Hwy, and the I-5 Fwy, is approximately $79,375,500.00.

In addition, a present worth analysis was performed that considered the well pumping costs during recovery periods, conveyance canal operational costs in an idle year, dry year, and wet year, and also the canal lining replacement costs and pump station replacement costs over a fifty-year (50) period. Below is a summary of the conveyance alternative costs and a ranking based upon a fifty (50) year present worth analysis.

Summary of Conveyance Alternatives

Ranking by Present Worth	Alternative No.	Alternative	Earthwork & Conveyance Facility Costs[2]	Pump Station Costs[3]	Right-of-Way Costs[4]	Lining Cost or Earth Canal Option Costs[5]	Total Conveyance Cost w/ Pump Stations[6]	Present Worth on 50 Yr Basis[7]
1	6	Pipeline	$62,242,300	$13,383,200	$3,750,000	NA	$79,375,500	$182,191,000
2	1a	Earth Lined w/Return Pipeline	$22,193,716	$28,945,000	$5,625,000	$10,519,000	$67,282,716	$188,594,201
3	2/3	HDPE/RPE Lined	$20,750,355	$28,945,000	$5,000,000	$5,596,190	$60,291,545	$190,764,330
4	4	Shotcrete Lined	$20,750,355	$28,945,000	$5,000,000	$14,818,490	$69,513,845	$191,170,614
5	5	Concrete Lined	$20,750,355	$28,945,000	$5,000,000	$16,001,690	$70,697,045	$191,481,030
6	1	Earth Lined[1]	$22,193,716	$28,945,000	$5,625,000	NA	$56,763,716	$197,012,451
7	1b	Earth Lined w/Bentonite Liner	$22,193,716	$28,945,000	$5,625,000	$15,135,216	$71,898,932	$202,678,919

[1]Earth Lined canal does not include a lining. There is additional earthwork and associated costs which are included under "Earthwork & Conveyance Facility Costs".

[2]Earthwork and conveyance costs based upon Tables 1 - 4 and include earthwork, facility relocations, fencing, spillways, and road crossings.

[3]Pump Station costs based on those developed in TM #4 plus a 15% contingency to account for unknowns and PG&E electrical service costs.

[4]Right-of-way costs estimated at $25,000 per acre.

[5]Costs from the liner alternatives evaluation in Sections III thru VI

[6]Total conveyance cost includes earthwork & conveyance facilities, pump stations, R/W, and linings.

[7]Present worth analysis based on 50 year period - see Exhibit C for spreadsheets.

Of the alternatives evaluated herein, the earth lined canal is not considered a good alternative due to concerns with rodent holes and piping failures, liability due to adjacent landowners, and overall increased canal maintenance with weed control, sedimentation, and rodent hole control. In addition, seepage losses are a concern when returning water to the California Aqueduct. In order to mitigate canal seepage when returning water to the Aqueduct, a return water pipeline or bentonite clay liner has been included in the cost. The earth lined canal alternative with a return water pipeline has the lowest present worth among the canal options, however it is not the recommended alternative for the reasons outlined above.

The poly lined and concrete lined alternatives are very similar in present worth over a fifty-year period and either alternative would be a good option for the conveyance canal. The HDPE or RPE canal lining has the best hydraulic properties and is easier to maintain than an earth lined canal. The drawback to the HDPE or RPE canal lining is the estimated useful life of 10 to 20 years for the San Joaquin Valley, however the present worth analysis demonstrates that this is a viable alternative over a fifty-year period. The concrete linings are also economical when evaluating the present worth over a fifty-year period and are more durable when performing canal cleaning and maintenance. Both of these lining systems are quality canal linings and result in a long useful life, however the shotcrete lining requires greater skill and quality control during application.

The pipeline alternative has the most expensive capital cost, however, it does allow for the elimination of a couple of pump stations and lower operations and maintenance expenses, therefore, over a fifty-year life cycle the closed conduit alternative actually becomes economical.

In addition, the pipeline alternative provides the added safety benefit of minimizing risks of levee breaches or flooding in Reach 1 or 2 as a result of the elevated head of the California Aqueduct above those reaches of an open channel. The pipeline alternative could place a single pump station on the east side of the I-5 Freeway which is at an elevation that would allow for it to float off the Aqueduct at the static or operating level of the California Aqueduct.

If the conveyance canal alternative is selected for design then the conventional concrete, shotcrete, and poly liners are all reasonable options as they are very similar in present worth based upon a fifty-year (50) period. In that event it is recommended that the “Conveyance Facilities including Turnouts & Pump Stations” bid package include bid alternates for the three types of canal linings. This will provide competitive pricing for each alternative, account for market fluctuations in material pricing, and allow the JPA to evaluate the lining costs in light of the total overall project costs.

However, the pipeline alternative is the most economical alternative when factoring in the operational, maintenance, and replacement costs over a fifty-year (50) period. In view of the operational and safety benefits, it is recommended that a pipeline alternative be considered in the design phase.

It is recommended that once the Phase I and Phase II properties are acquired, alignments fixed, and topographical survey completed, that the design firm perform updated value engineering work for the conveyance canal verses pipeline alternatives as well as considering hybrid approaches that utilize both reaches of conveyance canal and reaches of pipeline. At that time the JPA can evaluate the capital costs, the present worth, and the benefits of each alternative in making their final decision.

II. <u>Open Channel Canal</u>

A. Constructability/Methods

The primary purpose of this memorandum is to evaluate lining alternatives for the conveyance canal, however there are many other aspects of the project that will contribute to the overall costs of the canal. These include the earthwork, drainage systems (if necessary), transition structures, facility relocations, canal safety features, road surfacing, and fencing.

The conceptual conveyance alignment is shown in Figure 1. This alignment is subject to change as the JPA begins to acquire property and right-of-way.

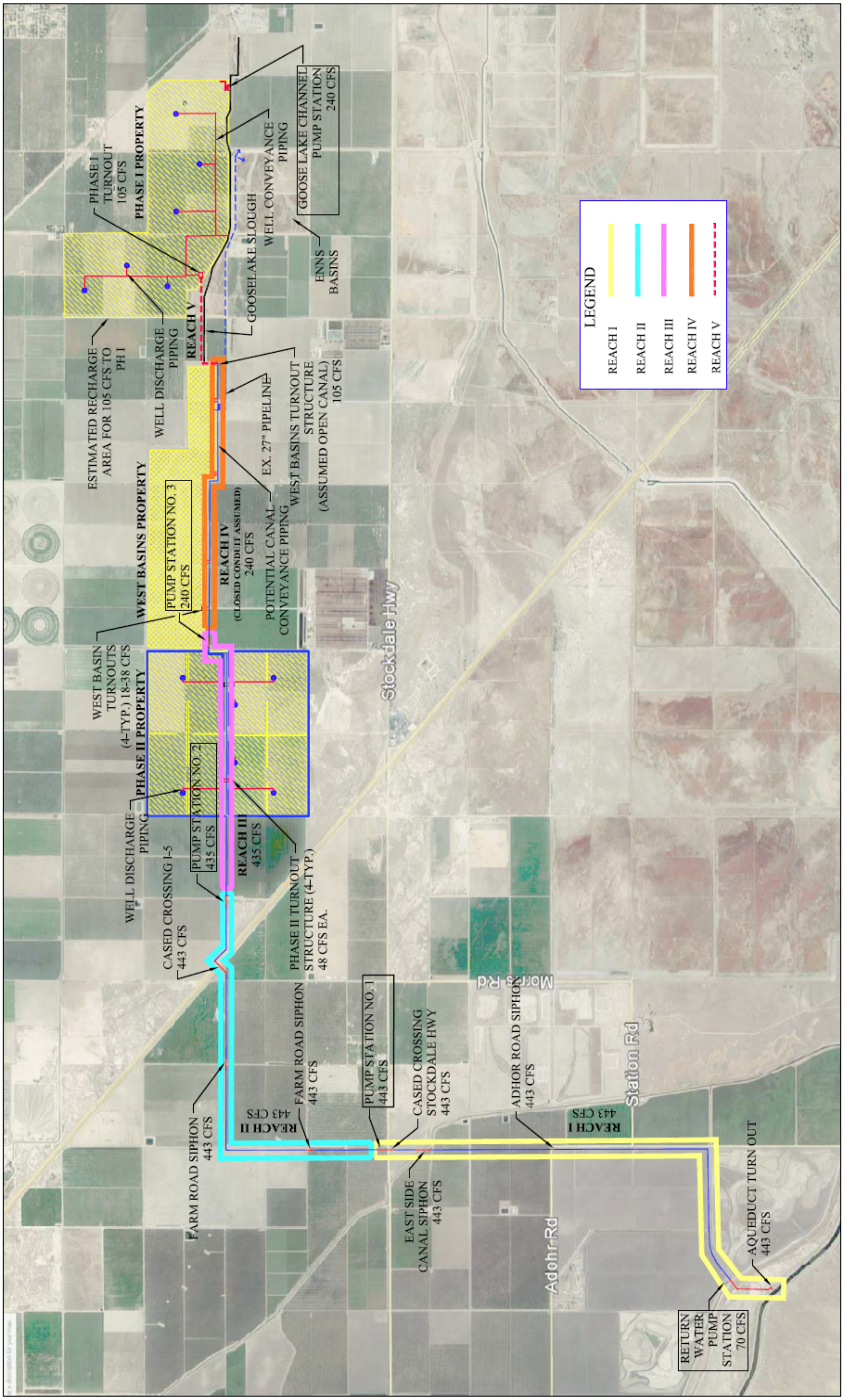


Figure 1: Preliminary Conveyance Alignment

The conceptual canal profile is shown in Figure 2. The elevations, slopes, and cross-sections of the canal are subject to change as well. The design firm will be responsible for value engineering the conveyance design.

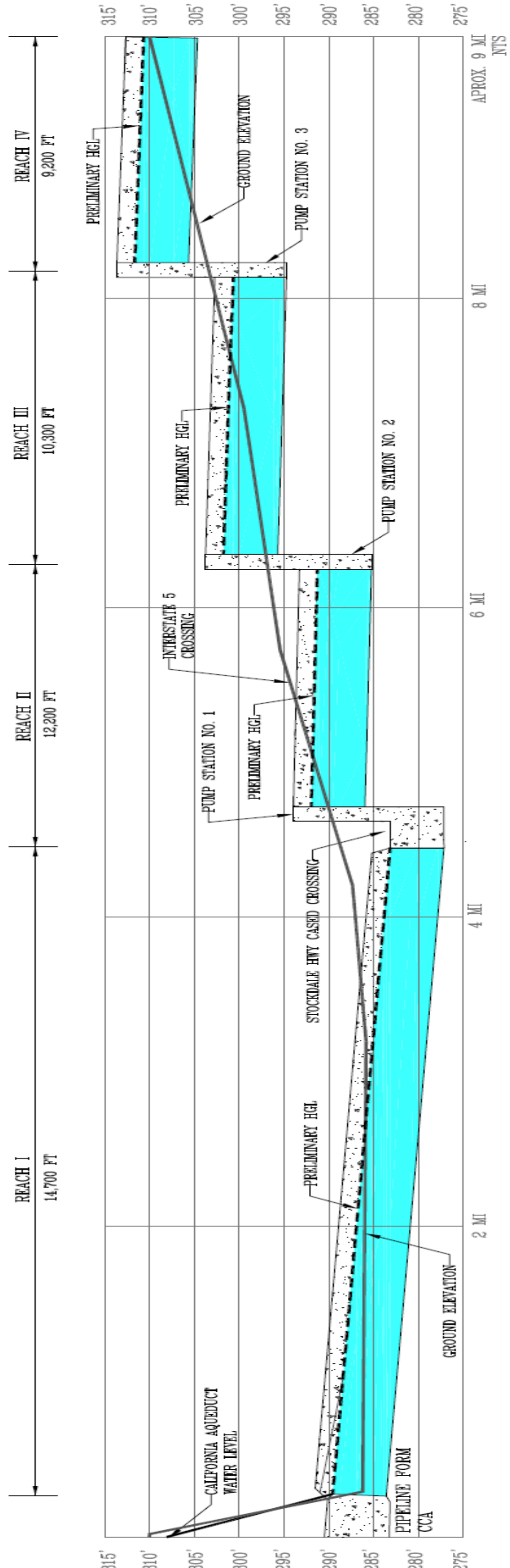


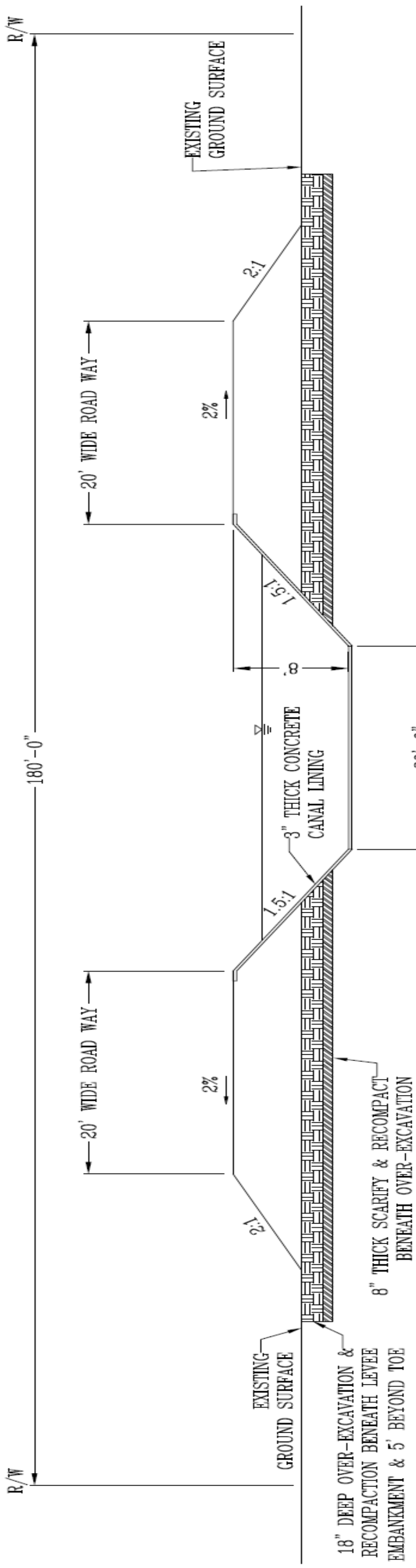
Figure 2: Preliminary Canal Profile

The elevations, slopes, and cross-sections identified herein are preliminary and for purposes of developing the preliminary Engineer's Estimates. These will be finalized during the design phase once the alignment is determined, detailed project surveying is performed, and detailed hydraulic analyses are completed.

Preliminary hydraulic modeling was performed utilizing Hec-Ras 5.0.7. The side slopes of a lined canal are anticipated to be 1.5:1 as originally outlined above. The canal cross-section is estimated as 8-ft deep with a 20-ft wide bottom. The pump stations along the conveyance canal have been estimated to have an approximate 15-ft to 20-ft total dynamic head at each station for the design capacities discussed in Technical Memorandum No. 4 "Pump Station Requirements". An earth-lined canal will have a different cross-section that has been estimated as 10-ft deep with a 20-ft wide bottom and 3:1 side slopes.

The earthwork of the canal will likely require borrow material of a suitable nature as determined by the soils firm and design firm. Potential borrow areas will be identified along the canal alignment and may include existing recharge areas of the Buena Vista Water Storage District, the West Kern Water Storage District, the Kern Water Bank Authority, as well as the Phase II property and the West Basins. The earthwork will involve clearing and grubbing of the right-of-way and the borrow areas. The subgrade will require excavation and re-compaction beneath the canal and the embankment levees. If a canal lining is constructed, the canal final grade must be flat and smooth, dry and free of rocks, rubble, roots, vegetation, debris, voids, protrusions, and any other objects. The earth material for the canal shall not be expansive or dispersive. The soils should have less than 15% finer than a 5 micron sieve so that there is not too much clay but also greater than 20% material finer than a 75 micron sieve so that there are fine sands and silts that provide good cohesion. The canal and levee material are estimated to be compacted to a minimum 90% relative compaction and graded to provide a smooth and uniform surface.

An approximate 180-ft wide permanent right-of-way has been estimated for the conveyance canal alignment and an approximate 260-ft wide temporary right-of-way. The conceptual canal cross-section includes an approximate 20-ft wide access road on each side of the canal for maintenance and operations. In addition, the right-of-way includes space for vehicular access along the outside toe of the exterior levee slopes for maintenance and weed abatement. See the canal cross-section below in Figure 3. This equates to an approximate land acquisition of 200 acres for canal right-of-way (with 1.5:1 side slopes), i.e. 180-ft by 46,400-ft = 8,352,000 sf or 192 acres. The land costs have been estimated at $25,000 per acre.



<u>**Figure 3: Preliminary Canal Cross-Section with 1.5:1 Side Slopes**</u>

Earthwork calculations were performed for the preliminary canal alignment for cost estimating purposes. Cross-sections were prepared for each reach of the lined canal options at approximate 1,000-ft intervals and illustrate the estimated "neat-line" cut and fill area for the conveyance canal and levee embankments/roads. The earthwork volume calculations utilizing the average end area method are attached in Appendix B. The calculations demonstrate the estimated cut and fill volumes for each reach of the canal resulting in a total of 244,227 cubic yards of cut and 716,381 cubic yards of fill for the entire conveyance canal. In addition, calculations for the subgrade preparation (over-excavation and re-compaction beneath the canal and embankments) have been prepared and estimate a "neat-line" volume of 226,189 cubic yards for the entire conveyance canal.

Where areas of the conveyance canal are in cut and adjacent to recharge operations, it may be necessary to install piezometers and a drainage system, add recharge basin setbacks or acquire additional conveyance right-of-way, put limits on recharge when groundwater levels are too shallow, or some combination thereof. The piezometers can be utilized to monitor the groundwater levels to ensure that water levels are maintained below the invert of the canal particularly if the canal is concrete lined. This is due to concerns with damaging concrete panels from a difference in hydrostatic pressure from the back side of the panel to the canal side. The drainage system can also provide mitigation in these situations as it collects water along the backside of the canal liner and allows for it to flow into the canal through a flapper valve if there is a difference in hydrostatic pressure.

It is also anticipated at this time that there will be canal safety features, all-weather road surfacing on the top of embankment levees, and canal fencing. The canal safety features include ladder rungs and safety buoys at the upstream and downstream side of siphon or culvert crossings and pump stations and ladder rungs at approximate quarter-mile distances in long stretches of the canal.

In addition, emergency spillways are recommended in reaches of the canal adjacent to recharge properties where water could be spilled over in the event of pump station problems or other issues. Reach 1 of the canal is well below the California Aqueduct elevation and if the turnout slide gate were to fail or not close it would be problematic. Therefore, it is recommended to provide an emergency spillway in Reach 1 of the canal that could discharge to the Buena Vista Water Storage District recharge basins, the West Kern Water District recharge basins, and/or the East Side Canal. Agreements with those agencies would be required. Emergency spillways could also be provided in Reach 3 that would discharge to the Phase II property and in Reach 4 that would discharge to the West Basins property.

The top of levee embankments are anticipated to provide for access along the canal and for canal maintenance. The levee embankment roads are estimated at 20-ft wide with a 16-ft wide all-weather road surfacing. The canal fencing is estimated to run parallel to the canal on each side and consist of barbed wire fencing with t-posts and chainlink access drive gates and personnel gates where appropriate.

The estimated capital costs for each reach of the canal are estimated in Tables 1 through 4 below. These costs are for the items discussed above and do not yet include costs for canal lining or right-of-way acquisition.

Table 1

Conveyance Canal				
Reach 1 - Approx. 14,700 LF				
Description	Quantity	Unit	Unit Cost	Extended Cost
Canal Clearing and Grubbing	90	AC	$1,200.00	$108,000.00
Subgrade Preparation	73,763	CY	$4.60	$339,309.80
Canal Earthwork-Cut	71,517	CY	$4.50	$321,826.50
Canal Earthwork-Fill	264,090	CY	$4.50	$1,188,405.00
Ladder Rungs	22	EA	$2,500.00	$55,000.00
Safety Buoys	8	EA	$10,000.00	$80,000.00
Facility Relocations	3	EA	$50,000.00	$150,000.00
Road Surfacing	4,400	CY	$50.00	$220,000.00
Barbed Wire Fencing	29,400	LF	$7.50	$220,500.00
Aqueduct Turnout Afterbay	1	LS	$283,000.00	$283,000.00
Emergency Spillway	1	LS	$168,750.00	$168,750.00
Adohr Road Crossing	1	LS	$954,400.00	$954,400.00
East Side Canal Crossing	1	LS	$1,429,000.00	$1,429,000.00
Stockdale Hwy Cased Crossing	1	LS	$1,529,000.00	$1,529,000.00
			Subtotal:	$7,047,191.30
			Cost per LF:	$479.40

*Earthwork quantities above are for the lined canal options with 1.5:1 side slopes.
**The costs do not include any lining options.

Table 2

Conveyance Canal				
Reach 2 - Approx. 12,200 LF				
Description	Quantity	Unit	Unit Cost	Extended Cost
Canal Clearing and Grubbing	75	AC	$1,200.00	$90,000.00
Subgrade Preparation	54,931	CY	$4.60	$252,682.60
Canal Earthwork-Cut	68,876	CY	$4.50	$309,942.00
Canal Earthwork-Fill	188,724	CY	$4.50	$849,258.00
Ladder Rungs	18	EA	$2,500.00	$45,000.00
Safety Buoys	8	EA	$10,000.00	$80,000.00
Facility Relocations	7	EA	$50,000.00	$350,000.00
Road Surfacing	3,650	CY	$50.00	$182,500.00
Barbed Wire Fencing	24,400	LF	$7.50	$183,000.00
Pump Station No. 1 Afterbay	1	LS	$427,000.00	$427,000.00
Farm Road Crossing No. 1	1	LS	$764,000.00	$764,000.00
Farm Road Crossing No. 2	1	LS	$764,000.00	$764,000.00
I-5 Fwy Cased Crossing	1	LS	$2,374,000.00	$2,374,000.00
			Subtotal:	$6,671,382.60
			Cost per LF:	$546.83

*Earthwork quantities above are for the lined canal options with 1.5:1 side slopes.
**The costs do not include any lining options.

Table 3

Conveyance Canal				
Reach 3 - Approx. 10,300 LF				
Description	Quantity	Unit	Unit Cost	Extended Cost
Canal Clearing and Grubbing	65	AC	$1,200.00	$78,000.00
Subgrade Preparation	60,331	CY	$4.60	$277,522.60
Canal Earthwork-Cut	68,073	CY	$4.50	$306,328.50
Canal Earthwork-Fill	149,708	CY	$4.50	$673,686.00
Ladder Rungs	16	EA	$2,500.00	$40,000.00
Safety Buoys	8	EA	$10,000.00	$80,000.00
Facility Relocations	5	EA	$50,000.00	$250,000.00
Road Surfacing	3100	CY	$50.00	$155,000.00
Barbed Wire Fencing	20600	LF	$7.50	$154,500.00
Emergency Spillway	1	LS	$168,750.00	$168,750.00
Pump Station No. 2 Afterbay	1	LS	$427,000.00	$427,000.00
Farm Road Crossing No. 3	1	LS	$764,000.00	$764,000.00
Farm Road Crossing No. 4	1	LS	$764,000.00	$764,000.00
			Subtotal:	$4,138,787.10
			Cost per LF:	$401.82

*Earthwork quantities above are for the lined canal options with 1.5:1 side slopes.
**The costs do not include any lining options.

Table 4

Conveyance Canal				
Reach 4 - Approx. 9,200 LF				
Description	Quantity	Unit	Unit Cost	Extended Cost
Canal Clearing and Grubbing	55	AC	$1,200.00	$66,000.00
Subgrade Preparation	37,164	CY	$4.60	$170,954.40
Canal Earthwork-Cut	35,761	CY	$4.50	$160,924.50
Canal Earthwork-Fill	113,859	CY	$4.50	$512,365.50
Ladder Rungs	14	EA	$2,500.00	$35,000.00
Safety Buoys	6	EA	$10,000.00	$60,000.00
Facility Relocations	5	EA	$50,000.00	$250,000.00
Road Surfacing	2,800	CY	$50.00	$140,000.00
Barbed Wire Fencing	18,400	LF	$7.50	$138,000.00
Pump Station No. 3 Afterbay	1	LS	$427,000.00	$427,000.00
Farm Road Crossing No. 5	1	LS	$764,000.00	$764,000.00
Emergency Spillway	1	LS	$168,750.00	$168,750.00
			Subtotal:	$2,892,994.40
			Cost per LF:	$314.46

*Earthwork quantities above are for the lined canal options with 1.5:1 side slopes.
**The costs do not include any lining options.

Table 5 summarizes the canal costs absent of any canal linings which will be discussed in detail below.

Table 5

Conveyance Canal		
Cost Summary (w/o Canal Linings)		
Reach No.	Earthwork Cost Estimate	Total Cost Estimate
Reach 1	$1,957,541	$7,047,191
Reach 2	$1,501,883	$6,671,383
Reach 3	$1,335,537	$4,138,787
Reach 4	$910,244	$2,892,994
Total (w/o Canal Linings):	$5,705,205	$20,750,355

*Earthwork quantities above are for the lined canal options with 1.5:1 side slopes.
**The costs do not include any lining options.

III. Earth Lined Canal

A. Constructability/Methods

i) Earth Lined Canal

The earth lined canal is estimated to be constructed to the lines and grades established during the design phase. The side slopes of an earth lined canal shall be revised to be 3:1 in order to alleviate erosion and provide for canal maintenance. The material for the canal shall not be expansive or dispersive. Expansive soils could result in swelling, drying, and shrinkage that results in cracking and problems with seepage or a levee breach. Dispersive soils can pose a threat as they move away from water and could result in piping or a levee breach. The soils should have less than 15% finer than a 5 micron sieve so that there is not too much clay but also greater than 20% material finer than a 75 micron sieve so that there are fine sands and silts that provide good cohesion. The canal and levee material are anticipated to be compacted to a minimum 90% relative compaction.

The quantities for an earth lined canal with 3:1 side slopes is approximately 472,615 cubic yards of cut and 783,801 cubic yards of fill for the entire conveyance canal. In addition, the quantity for the subgrade preparation of an earth lined canal is approximately 254,216 cubic yards for over-excavation and re-compaction, see Appendix B. The quantities noted herein are subject to change based on the final alignment, recharge locations, and final design. Borrow material is anticipated to be obtained from areas in close proximity to the canal including, but not limited to, the Buena Vista Water Storage District recharge basins, the West Kern Water District recharge basins, the Phase II recharge basins, and the West Basins. Costs associated with the borrow material have been included in the unit prices utilized for the earthwork cut, fill, and subgrade preparation.

An approximate 210-ft wide permanent right-of-way has been estimated for the conveyance canal alignment and an approximate 290-ft wide temporary right-of-way. The conceptual canal cross-section includes an approximate 20-ft wide access road on each side of the canal for maintenance and operations. In addition, the right-of-way includes space for vehicular access along the outside toe of the exterior levee slopes for maintenance and weed abatement. See the canal cross-section below in Figure 4. This equates to an approximate land acquisition of 225 acres for canal right-of-way (with 3:1 side slopes), i.e. 210-ft by 46,400-ft = 9,744,000 sf or 224 acres. The land costs have been estimated at $25,000 per acre.

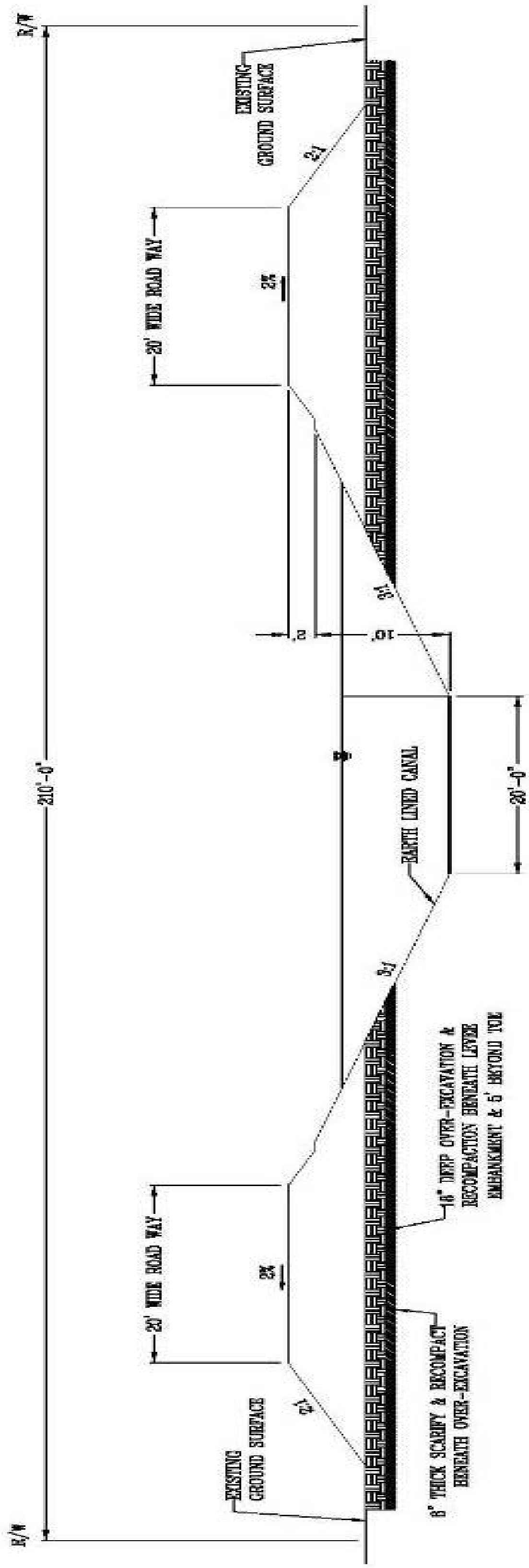


Figure 4: Preliminary Canal Cross-Section with 3:1 Side Slopes

For an earth lined canal there are concerns with rodent holes, piping, and levee breaches particularly in areas of levee embankment fill. In order to mitigate these concerns, a synthetic sheet piling could be utilized, or high risk areas of the canal could be lined, or increased maintenance could be implemented.

ii) Earth Lined Canal with Return Water Pipeline

Seepage losses are a concern with an earth lined canal. The seepage during recharge operations is not so much a concern as it can be counted as groundwater recharge, however it is a concern when operating the canal in the reverse direction for recovery of water and the return of water to the California Aqueduct. This could be mitigated with either a parallel return water pipeline or a special clay or bentonite liner.

In reverse flow operations, the Return Water Pump Station has been estimated to have an approximate 25-ft to 30-ft total dynamic head to return approximately 72 cfs to the California Aqueduct. If a parallel return water pipeline were utilized then this pump station could be eliminated and the water discharged directly to the California Aqueduct. The parallel return pipeline is estimated to be a 48" PVC or 54" HDPE pipeline for conveying 72 cfs based on Technical Memorandum No. 3 "Pipeline Requirements".

iii) Earth Lined Canal with Bentonite Liner

If a bentonite liner were utilized it is estimated that it would be a 1-ft thick liner in the earthen canal prism with a minimum clay content of 12% to 15%. Fill material that has a clay content less than this will require some form of soil amendment or importation of a soil with adequate clay content. Powdered bentonite could be used as a soil amendment. The percentage of bentonite added would be the difference between the natural site clay content and the required minimum clay content. The minimum pounds of bentonite per square foot of amended area will be the percentage bentonite times the compacted dry density of the site soil times the liner thickness. Bentonite shall be evenly spread by a computerized spreading truck which is directly fed by the bulk delivery truck. Spread rate shall be confirmed by a pan test. The amended area shall be uniformly mixed and moisture conditioned by a cross-shafted mixer directly connected to the water truck. This equipment is standard for a specialty soil stabilization contractor. Stabilization contractors typically only spread the amendment, moisture condition, and compact the amended soil. They do not move material to achieve rough grade or fine grade, therefore they generally subcontract to a general earthwork contractor. However, in some instances soil amendment can be performed in-place for a liner thickness up to 1.5 feet with the typical cross-shafted mixer and open-hub compactors and this may be an option.

B. Capital Cost Estimate

i) Earth Lined Canal

The earthwork for the conveyance canal has been considered separately and will be roughly the same for any of the above lining alternatives. The earth lined canal is planned to have 3:1 side slopes to reduce velocities and minimize erosion and sediment transport. Typically, seepage in the earth lined canal for this project would not be a concern since the seepage can be accounted for as groundwater recharge under the project. However, seepage is a concern when operating the canal in the reverse direction for recovery of water and the return of water to the Aqueduct. Therefore, a return pipeline would need to be constructed parallel to the canal or a special earth liner such as a clay liner or bentonite liner constructed. The capital cost estimates compare the costs of different lining materials. However, the earth lined canal will require a different canal cross-section in order to mitigate soil erosion and prevent seepage. Therefore, capital costs for the additional canal earthwork are also included.

The capital cost estimate for the canal earthwork with 3:1 side slopes is $7,148,566. This adds approximately $1,443,361 ($7,148,566 - $5,705,205) to the cost of the earthwork over and above the cost for the canal earthwork on the other lining alternatives because of the wider canal cross-section.

Additional Earthwork	$1,443,361

This alternative, as noted previously, would result in seepage losses. This is not a primary concern when recharging water as the JPA would account for the losses and include it with the overall recharge operations. However, during recovery operations the JPA would need to pump additional well water to overcome those losses. If the goal were to return 50,000 ac-ft in a dry year, and assuming 30% seepage losses, then it is estimated that 71,500 ac-ft would need to be pumped.

Monthly RRBWSD Operation & Maintenance Cost per well:	$1,333.00
Monthly PG&E Pumping Cost per well:	$24,150.00
Monthly Mission Unit O&M Cost per well:	$53.00
Subtotal Monthly Cost per well:	$25,536.00
Subtotal Annual Cost per well:	$306,432.00

It is estimated that it would require sixteen (16) recovery wells at 6 cfs each to return 71,500 ac-ft in one year. This is estimated to result in an annual O&M cost for sixteen wells of approximately $4,902,912.00. This is approximately $98.00 per ac-ft for returning 50,000 ac-ft.

ii) Earth Lined Canal with Return Water Pipeline

One of the recommended mitigation measures for the earth lined canal option is a parallel return water pipeline. The option to install a return water pipeline and not line the earthen canal involves installing approximately 45,000 feet of 48” to 54” pipe which at $280/lf equates to approximately $12,600,000. However, this does eliminate the need for the Return Water Pump Station in turn saving approximately $2,081,000. This results in an additional cost of $10,519,000 or $12,600,000 - $2,081,000.

Return Water Pipeline	$10,519,000
Additional Earthwork	$1,443,361
Total Earth Lined Canal with Pipeline:	$11,962,361

This alternative would avoid seepage losses during recovery operations. The estimated O&M costs are listed below for returning 50,000 ac-ft in a dry year.

Monthly RRBWSD Operation & Maintenance Cost per well:	$1,333.00
Monthly PG&E Pumping Cost per well:	$24,150.00
Monthly Mission Unit O&M Cost per well:	$53.00
Subtotal Monthly Cost per well:	$25,536.00
Subtotal Annual Cost per well:	$306,432.00

It is estimated that it would require twelve (12) recovery wells at 6 cfs each to return 50,000 ac-ft in one year. This is estimated to result in an annual O&M cost for twelve wells of approximately $3,677,184.00. This is approximately $73.54 per ac-ft for returning 50,000 ac-ft.

iii) Earth Lined Canal with Bentonite Liner

Another potential mitigation measure is to line the earth canal with a bentonite liner approximately 1-ft thick. The soil amendment cost to treat/amend, mix, and compact the soil for a 1-ft thick liner is estimated at $3.93 per square foot. There are approximately 83 sf/lf x 46,400 lf or 3,851,200 square feet.

1-ft Thick Clay Liner at $3.93/sf	$15,135,216
Additional Earthwork	$1,443,361
Total Earth Lined Canal with Bentonite:	$16,578,577

This alternative would reduce the seepage losses, however it is estimated that there would still be some seepage. For purposes of this memorandum, an estimated seepage loss of 15% has been used. During recovery operations the JPA would need to pump additional well water to overcome those losses. If the goal were to return 50,000 ac-ft in a dry year, and assuming 15% seepage losses, then it is estimated that 58,850 ac-ft would need to be pumped.

Monthly RRBWSD Operation & Maintenance Cost per well:	$1,333.00
Monthly PG&E Pumping Cost per well:	$24,150.00
Monthly Mission Unit O&M Cost per well:	$53.00
Subtotal Monthly Cost per well:	$25,536.00
Subtotal Annual Cost per well:	$306,432.00

It is estimated that it would require fourteen (14) recovery wells at 6 cfs each to return 58,850 ac-ft in one year. This is estimated to result in an annual O&M cost for fourteen wells of approximately $4,290,048.00. This is approximately $85.80 per ac-ft for returning 50,000 ac-ft.

iv) Earth Lined Canal Summary

A summary of the costs for the earth lined canal options is provided in Table 6. A capital cost estimate is provided for the earth lined canal earthwork and then the additional capital costs are shown for adding a parallel pipeline or adding a bentonite liner. In addition, the operations and maintenance (O&M) costs are shown for each option and are based on the number of recovery wells necessary to return 50,000 ac-ft per year in a dry year while accounting for seepage losses. A present worth value is shown for the O&M costs as well as for the capital and O&M costs.

A present worth analysis was evaluated based on a capital recovery of 20 years and O&M costs for recovery operations anticipated to be approximately three years out of every ten years. The O&M costs were increased over a 20 year period at an inflation rate of 3% per year. The present worth values shown below are over a 20 year period.

Table 6

Conveyance Canal				
Cost Summary (w/o Canal Linings)				
Earth Lined Canal Options	Capital Cost Estimate	O&M Cost Estimate ($/yr)	Present Worth O&M Cost	Present Worth Capital & O&M Cost
Earth Lined Canal	$7,148,566	$4,902,912	$30.3 M	$37.5 M
Including Return Water Pipeline	$17,667,566	$3,677,184	$22.7 M	$40.4 M
Including Bentonite Liner	$22,283,782	$4,290,048	$26.5 M	$48.8 M

C. Hydraulic Impacts of Friction Losses

The earth lined canal has a 20-ft wide bottom with 3:1 side slopes. A Manning's coefficient of 0.022 to 0.040 was utilized which is a range for an earth lined canal that is maintained with short grass and few weeds to an unmaintained canal with a clean bottom and brush on the side slopes. The velocities of an earth lined canal are less than that of a lined canal and have been maintained in the range of 1.0 to 2.5 fps to minimize erosion and sediment transport. The water depth varies from approximately 6-ft to 8.22-ft. This increases the canal depth from 8-ft to approximately 10-ft as a result of the higher Manning's coefficient.

D. Advantages and Disadvantages

An earth lined canal is, generally speaking, the most economical conveyance canal since it does not require the additional cost associated with a canal lining. However, there are characteristics of the earth lined canal that are a concern. These include the following:

- There are portions of the canal that may be elevated above the natural ground surface. In addition, there may be long periods of time where this canal is not being utilized and is in a dry condition thus providing suitable habitat for rodents. The major concern is with rodent holes over time that could lead to piping and a levee breach and the potential for property damage to adjacent agricultural crops, homes, equipment, etc.
- Seepage losses particularly when recovering water for return to the California Aqueduct.
- Increased canal maintenance

In order to mitigate the above concerns with rodent holes, synthetic sheet piling could be considered, or concrete lining in high risk areas, or implementation of increased canal and levee maintenance to minimize rodent holes and seepage paths.

Seepage losses could be mitigated by constructing a 1-ft or 2-ft thick clay liner in the conveyance canal for the canal bottom and side slopes or a return water pipeline could be installed parallel to the canal for use during recovery operations.

In addition, an earth lined canal will require greater maintenance in general. The maintenance includes:

- Levee monitoring for rodent holes and areas of significant erosion that require earthwork maintenance
- Weed control on levee slopes and the canal bottom
- Removal of sediment and debris potentially at siphon crossings, turnouts, and pump station forebays

IV. Poly Lined Canal

A. Constructability/Methods

The poly lined canal will be constructed to the lines and grades established during the design phase. The side slopes of a poly lined canal are anticipated to be 1.5:1 as discussed above in Section II. The subgrade for the lining must be flat and smooth, dry and free of rocks, rubble, roots, vegetation, debris, voids, protrusions, and any other objects that can potentially puncture the liner over time. In some cases, a compacted bedding may be necessary. The subgrade material for the canal shall not be expansive or dispersive. The soils should have less than 15% finer than a 5 micron sieve so that there is not too much clay but also greater than 20% material finer than a 75 micron sieve so that there are fine sands and silts that provide good cohesion. The canal and levee material are estimated to be compacted to a minimum 90% relative compaction and graded to provide a smooth and uniform surface for the installation of the poly lining.

An anchor trench will need to be excavated parallel to the canal on each side of the conveyance canal, the poly liner installed in the trench, and the trench backfilled and compacted. In addition, the poly liner will need to be connected to the concrete at all structures, turnouts, and lift stations. See figures 5 and 6 for examples of typical installations.

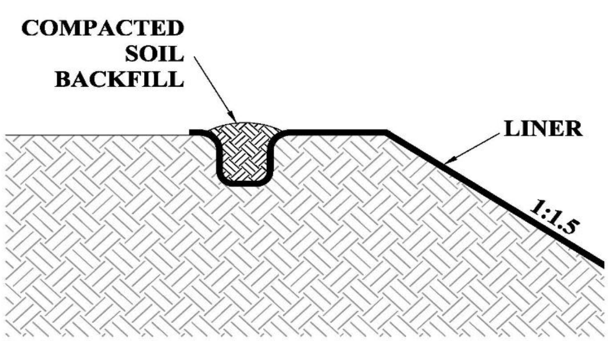


Figure 5: Typical Anchor Trench Detail

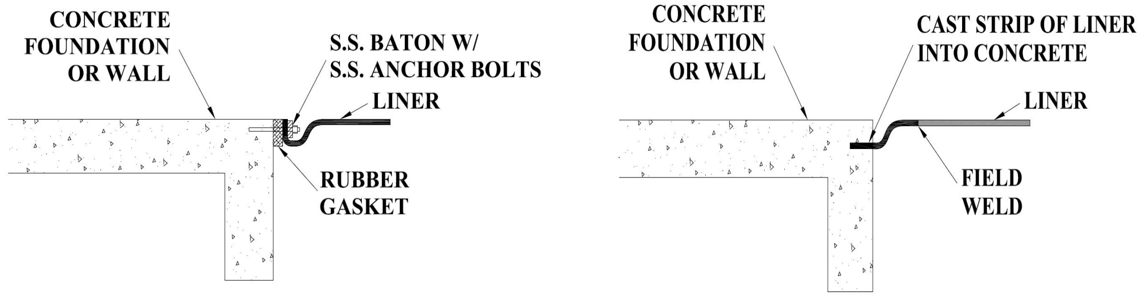


Figure 6: Typical HDPE Fastening to Concrete Structures Detail

B. Poly Liner Options

The two primary poly liners are a High Density Polyethylene (HDPE) lining and a Reinforced Polyethylene lining (RPE).

The high density polyethylene lining is a thick and durable liner that can be installed in exposed applications. HDPE liners should be installed by trained installers. The HDPE liner thickness of 40 mil and 60 mil can be utilized, however a 60 mil thickness is recommended for this application. The common HDPE properties are listed below:

- Nominal Thickness (ASTM D5199) 60 mil
- Density (ASTM D792) > 0.94 mg/l
- Tensile Strength (ASTM D6693) 126 lb/in
- Tear Resistance (ASTM D1004) 42 lbs
- Puncture Resistance (ASTM D4833) 108 lbs

The reinforced polyethylene is a combination of polyethylene reinforcement and co-extrusion in a special weave pattern which enhances thickness, flatness, tear properties, and UV resistance. The RPE lining comes in 30 mil thickness and 40 mil thickness. The 40 mil lining is the recommended thickness for canal lining installations. The common RPE properties are listed below:

- Nominal Thickness (ASTM D1777) 40 mil
- Weight 20.8 oz/yd^2
- Mullen Burst (ASTM D751) 800 psi
- Hydrostatic Resistance (ASTM D751) 769 psi
- Permeability (ASTM D4491) 2.06×10^{-12} cm/s
- Puncture Resistance (ASTM D4833) 243 lbs

C. Capital Cost Estimate

A 60 mil thick membrane HDPE lining or a 40 mil thick RPE lining is recommended for canal conveyance. The poly lining material will be approximately 2,830,400 sf based upon a canal length of 46,400 ft and a cross sectional area of 61 sf/ft which includes an anchor trench on each side of the canal.

The capital cost estimates compare the costs of different lining materials. The poly lined canal is estimated to utilize approximately 2,830,400 sf of material. In addition, there will be locations where the lining must be connected to the concrete structures in the canal such as the transition structures, turnouts, and pump stations. This is estimated to be approximately 1,500 lineal feet. There will also be the need for underdrains where the canal is in cut adjacent to recharge basins.

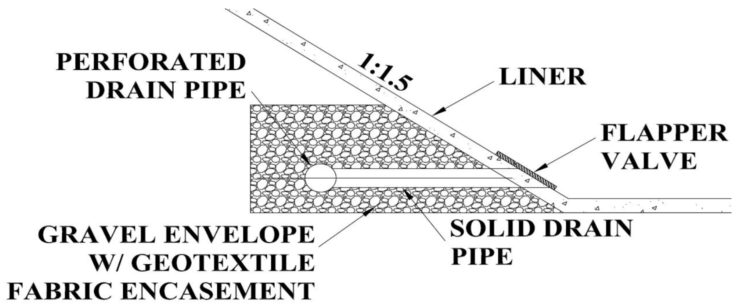


Figure 7: Typical Underdrain System

The capital cost estimate for the canal earthwork is approximately $5,705,205 and for the total canal without lining is $20,750,355. The cost of adding a Poly Lining adds $5,596,190 as presented below and summarized in Table 7 - Canal Lining Alternatives.

Poly Lining at $1/sf	$2,830,400
Poly Anchor Trench Installation	$928,000
Connection to Structures at $23/lf	$34,500
Underdrain System	$1,803,290
Total Poly Lining:	$5,596,190

D. Hydraulic Impacts of Friction Losses

The Manning's coefficient utilized for a poly lined canal is 0.010 and represents a well maintained canal. The velocities of the poly lined canal range from approximately 2.0 fps to 3.5 fps. The water depth varies from approximately 6-ft to 6.76-ft. This maintains a minimum of 1-ft of freeboard from the top of canal lining for an 8-ft deep canal cross-section.

E. Advantages and Disadvantages

A poly lined canal is an economical alternative and worth considering. It is less expensive than concrete lining and has other advantages as well as outlined below:

- Eliminates seepage losses
- Improved hydraulic properties with coefficient of friction of 0.10

- Ease of installation
- Less installation time

However, the poly lining can be prone to surface deterioration and tearing from UV damage and wind. The disadvantages are listed below:

- Subject to UV and wind damage
- Subject to damage by animals such as cattle or sheep
- More difficult to clean the canal of sediment and tumble weeds while not damaging lining
- Subject to rodent damage
- Petroleum product material cost volatility is greater than the concrete lining options

If the side slopes of the canal are 1.5:1 it is recommended that the lining be installed perpendicular to the canal conveyance direction. . Furthermore, the addition of future pipelines to the canal or well discharges would likely require concrete splash pads if discharging over the liner or a poly boot if penetrating the liner. The canal will have long periods of time when it is not in operation and is empty thus subject to sun exposure, wind, and damage. The anticipated useful life of a typical poly liner that is exposed to the elements in the San Joaquin Valley is 10 to 20 years. The Canal Lining Demonstration Project – Year 25 Durability Report by the Bureau of Reclamation estimated the useful life of an exposed geomembrane liner to be approximately 15 to 30 years.

V. Shotcrete Lined Canal

A. Constructability/Methods

The shotcrete lined canal is estimated to be constructed to the lines and grades established during the design phase. The side slopes of a shotcrete lined canal shall be 1.5:1 as discussed above in Section II. The subgrade material for the canal shall not be expansive or dispersive. The soils should have less than 15% finer than a 5 micron sieve so that there is not too much clay but also greater than 20% material finer than a 75 micron sieve so that there are fine sands and silts that provide good cohesion. The canal and levee material are estimated to be compacted to a minimum 90% relative compaction and graded to provide a smooth and uniform surface for the installation of the shotcrete lining.

The application of shotcrete is highly specialized and requires a certified nozzleman in order to ensure against rebound which results from a portion of the mortar bouncing away from the surface to which it is applied. It is recommended that the shotcrete lining have a smooth trowel surface in order to improve the hydraulic characteristics.

B. Capital Cost Estimate

Shotcrete is a pneumatically applied Portland cement mortar lining. The shotcrete lining is recommended to have a minimum 3" thickness. The shotcrete lining material would be approximately 2,366,400 sf based upon a canal length of 46,400 ft and a cross sectional area of 51 sf/ft. (Approximately 21,911 cubic yards).

The capital cost estimates compare the costs of different lining materials only. The shotcrete lined canal is estimated to utilize approximately 2,366,400 sf of material. There will also be the need for underdrains where the canal is in cut adjacent to recharge basins.

The capital cost estimate for the canal earthwork is $5,705,205 and for the total canal without lining is $20,750,355. The cost of adding a shotcrete lining adds $14,818,490 as presented below and summarized in Table 7 - Canal Lining Alternatives.

Shotcrete Lining at $5.50/sf	$13,015,200
Underdrain System	$1,803,290
Total Shotcrete Lining:	$14,818,490

C. Hydraulic Impacts of Friction Losses

The Manning's coefficient utilized for a shotcrete lined canal is between 0.025 to 0.030 per the Hydraulic Design Handbook. The Manning's coefficient assumes that the shotcrete surface will not be as smooth as conventional concrete placement and finishing. The velocities of the shotcrete lined canal range from approximately 2.0 fps to 3.0 fps. The water depth varies from approximately 6-ft to 7.33-ft. This would require the canal depth to be increased by approximately 0.5-ft to 1.0-ft in some locations to an 8.5-ft to 9.0-ft depth in order to maintain the minimum of 1-ft of freeboard to the top of canal lining.

D. Advantages and Disadvantages

A shotcrete lined canal is an economical alternative and worth considering. The shotcrete lining has the following advantages:

- High tensile strength
- Good durability
- Low permeability
- Long useful life

However, in general this type of lining is only slightly more economical than formed in place concrete when considering long, un-impacted stretches of canal. The disadvantages of shotcrete lining include:

- The shotcrete lining requires skilled operating personnel including a certified nozzleman
- Additional quality control measures to ensure against excessive rebound and to ensure application at the proper thickness and uniformity
- Less durable than conventional concrete lining
- Subject to damage from settlement, shrinkage, and hydrostatic pressure

If a concrete lined canal is the selected alternative, it is recommended that the concrete lining be allowed to be constructed by shotcrete application, slip-form placed, or formed in place.

VI. <u>Conventional Concrete Lined Canal</u>

A. Constructability/Methods

The concrete lined canal is estimated to be constructed to the lines and grades established during the design phase. The side slopes of a concrete lined canal are estimated to be 1.5:1 as discussed above in Section II. The subgrade material for the canal shall not be expansive or dispersive. The soils should have less than 15% finer than a 5 micron sieve so that there is not too much clay but also greater than 20% material finer than a 75 micron sieve so that there are fine sands and silts that provide good cohesion. The canal and levee material are estimated to be compacted to a minimum 90% relative compaction and graded to provide a smooth and uniform surface for the installation of the concrete lining.

B. Capital Cost Estimate

Concrete lining can be placed by slip-lining, using a rolling screed, or by cast in place methods. The concrete lining is recommended to have a minimum 3" thickness and crack control spacing at approximate 10'-0" spacing. The concrete lining material would be approximately 2,366,400 sf based upon a canal length of 46,400 ft and a cross sectional area of 51 sf/ft. (Approximately 21,911 cubic yards).

The capital cost estimates compare the costs of different lining materials only. The concrete lined canal is estimated to utilize approximately 2,366,400 sf of material. There will also be the need for underdrains where the canal is in cut adjacent to recharge basins.

The capital cost estimate for the canal earthwork is $5,705,205 and for the total canal without lining is $20,750,355. The cost of adding a concrete lining adds $16,001,690 as presented below and summarized in Table 7.

Concrete Lining at $6/sf	$14,198,400
Underdrain System	$1,803,290
Total Concrete Lining:	$16,001,690

C. Hydraulic Impacts of Friction Losses

Canal Hydraulics:

The Manning's coefficient utilized for the concrete lined canal is 0.012 to 0.016 per the Hydraulic Design Handbook. The velocities of the concrete lined canal range from approximately 2.0 fps to 3.2 fps. The water depth varies from approximately 6-ft to 7-ft. This maintains a minimum of 1-ft of freeboard from the top of canal lining and has better hydraulic characteristics than the shotcrete lining.

D. Advantages and Disadvantages

A concrete lined canal is an expensive alternative, but also is the most durable and has the longest useful life. The advantages include:

- High tensile strength
- Good durability for cleaning and maintenance
- Low permeability
- Long useful life

The disadvantages of concrete lining include:

- High capital cost
- Subject to damage from settlement, shrinkage, and hydrostatic pressure

Concrete lining has a typical useful life of beyond 60 years if well maintained and protected. The concrete lined canal will also require the smallest amount of maintenance for the canal lining alternatives and has better hydraulic characteristics than the shotcrete lining. Typical maintenance is the cleaning and removal of sediment and mud, if applicable, and then the replacement of cracked panels if it occurs.

VII. Canal Lining Summary/Present Worth Analysis

Six lining options (four canal lining options and two mitigation options for the earth lined canal) for the conveyance canal were evaluated. Below is a summary of the options:

Table 7
Canal Lining Alternatives

Conveyance Canal			
Lining Alternative	Estimated Liner Unit Cost per SF	Estimated Liner Unit Cost per LF	Estimated Liner or Earth Canal Total Cost
Earth Lined[1]	NA	NA	$1,443,361
HDPE/RPE Lined	$1.98	$121	$5,596,190
Earth Lined with Return Pipeline	NA	NA	$11,962,361
Shotcrete Lined	$6.26	$319	$14,818,490
Concrete Lined	$6.76	$345	$16,001,690
Earth Lined with Bentonite Liner	$4.30	$357	$16,578,577

[1]The earth lined alternative does not have a lining, however the cost shown is the estimate of additional earthwork necessary for 3:1 side slopes.

Table 8
Canal Lining Alternatives

Conveyance Canal			
Lining Alternative	Estimated Liner or Earth Canal Cost	Estimated Canal Unit Cost per LF	Estimated Canal Total Cost w/o Pump Stations
Earth Lined	$1,443,361	$478	$22,193,716
HDPE/RPE Lined	$5,596,190	$568	$26,346,545
Earth Lined with Return Pipeline	$11,962,361	$705	$32,712,716
Shotcrete Lined	$14,818,490	$767	$35,568,845
Concrete Lined	$16,001,690	$792	$36,752,045
Earth Lined with Bentonite Liner	$16,578,577	$805	$37,328,932

The estimated total canal cost above in Table 8 is the conveyance canal cost from Tables 1 through 4 in the amount of $20,750,355 plus the estimated liner cost or earth canal plus mitigation costs.

In addition, a present worth analysis was performed for each of the alternatives. The present worth analysis considered the project capital cost for each lining option. The capital cost included the conveyance canal costs from Tables 1 through 4, the estimated liner costs or mitigation costs, the right-of-way acquisition, and the estimated pump station costs for three pump stations and a return water pump station. The capital recovery for these costs was estimated at a 3% interest rate over a twenty (20) year period.

The cost of the conveyance canal including the three pump stations and the return water pump station as well as right-of-way procurement is as follows:

Conveyance Canal Cost Estimate (w/ 1.5:1 Slopes)	$20,750,355
Three Pumps Stations & Return Water Pump Station	$28,945,000
Right-of-Way Cost Estimate	$5,000,000
Conveyance Canal Estimate (w/ 1.5:1 Slopes)	$54,695,355

The estimated cost of the earthen conveyance canal with 3:1 side slopes including the three pump stations and the return water pump station as well as right-of-way procurement is as follows:

Conveyance Canal Cost Estimate (w/ 3:1 Slopes)	$22,193,716
Three Pumps Stations & Return Water Pump Station	$28,945,000
Right-of-Way Cost Estimate	$5,625,000
Conveyance Canal Estimate (w/ 3:1 Slopes)	$56,763,716

The pump station costs are based upon the cost estimates from Technical Memorandum No. 4 “Pump Station Requirements” which estimated $8,605,000 for Pump Station No. 1, $8,605,000 for Pump Station No. 2, and $6,150,000 for Pump Station No. 3. A cost estimate of $2,081,000 has been used for the Return Water Pump Station. Each of these pump station cost estimates have been increased by 15% to account for unknowns and PG&E service costs.

The operations and maintenance (O&M) costs were also included for each option and include the recovery well pumping costs, the canal operation costs for idle years, wet years, and dry years, and the liner replacement or repair costs. It has been estimated that there will be two wet years and three dry years out of every ten years and the remaining years will be idle years. The recovery well pumping costs in dry years are the same for the lined canal options whereby 72 cfs is being recovered from approximately twelve (12) wells. However, the earth lined canal alternative with bentonite liner estimates utilizing fourteen (14) wells to recover 84 cfs as a result of seepage losses while returning water to the California Aqueduct. Also the earth lined canal alternative estimates utilizing sixteen (16) wells to recover 96 cfs as a result of seepage losses while returning water to the California Aqueduct. The canal operations costs consist of RRBWSD operations and maintenance costs, electricity costs, mission unit costs, and DWR conveyance costs. These costs are similar for most of the options with the exception that the idle year costs for the earth lined canal options (1, 1a, and 1b) are more for the RRBWSD maintenance costs as they have to perform weed and rodent control along the conveyance canal. Pump station replacement costs have been included for items such as the pumps, the motors, the VFD’s, electrical gear, and cathodic protection. It has been estimated that these items will be replaced every twenty-five (25) years and include an inflate rate of 3% per year. The liner replacement and repair costs are included for the poly lined canal, shotcrete lined canal, and the concrete lined canal. The poly lined canal estimates minor patches or repairs about every five years at a cost of $25,000 per year and inflation at 3% per year. The shotcrete lined canal estimates panel replacements about every three years for approximately 1,200 lineal feet of side slope panels at a cost of $129,549 per year and inflation at 3% per year. The concrete lined canal estimates that it will be more durable than a shotcrete lined canal and panel replacements will not be necessary for the first 10 to 15 years. The concrete lined canal estimates panel replacement about every five years, beginning in year fifteen, for approximately 1,200 lineal feet of side slope panels at a cost of $150,000 per year and inflation at 3% per year. The present worth values are summarized in the table below.

Table 9

Summary of Conveyance Canal Alternatives					
Ranking by Present Worth	Alternative No.	Alternative	Lining Cost or Earth Canal Option Costs[2]	Total Conveyance Cost w/ Pump Stations[3]	Present Worth
1	1a	Earth Lined w/Return Pipeline	$11,962,361.00	$67,282,716	$188,594,201
2	2/3	HDPE/RPE Lined	$5,596,190.00	$60,291,545	$190,764,330
3	4	Shotcrete Lined	$14,818,490.00	$69,513,845	$191,170,614
4	5	Concrete Lined	$16,001,690.00	$70,697,045	$191,481,030
5	1	Earth Lined[1]	$1,443,361.00	$56,763,716	$197,012,451
6	1b	Earth Lined w/Bentonite Liner	$16,578,577.00	$71,898,932	$202,678,919

[1]Earth Lined lining cost is the increased cost related to earthwork for a larger canal cross section (3:1 side slopes).

[2]Costs from the liner alternatives evaluation in Sections III thru VI

[3]Total conveyance cost includes pump stations, road crossings, and return water pipelines.

The earth lined canal is not considered a good alternative due to concerns with rodent holes and piping failures, liability due to adjacent landowners, and overall increased canal maintenance with weed control, sedimentation, and rodent hole control. In addition, seepage losses are a concern when returning water to the California Aqueduct. In order to mitigate canal seepage when returning water to the Aqueduct, a return water pipeline or bentonite clay liner has been included in the cost. The earth lined canal alternative with a return water pipeline has the lowest present worth over a fifty-year (50) period, however it is not the recommended alternative for the reasons outlined above.

The HDPE or RPE canal lining is an economical alternative, has the best hydraulic properties, and is easier to maintain than an earth lined canal. The drawback to the HDPE or RPE canal lining is the estimated useful life of 10 to 20 years for the San Joaquin Valley. However, the present worth analysis still demonstrates it is a viable and economical alternative.

The cost difference between the shotcrete lining and the concrete lining is also not very significant. Both of these lining systems are quality canal linings and result in a long useful life, however the shotcrete lining requires greater skill and quality control during application. It is recommended that the conventional concrete lining be selected between these two options, however the contract documents could allow for both application methods and the most economical alternative could be selected at bid time.

The conventional concrete, shotcrete, and poly liners are all very similar in present worth value over a fifty-year (50) period. If the conveyance canal alternative is selected, it is recommended that the "Conveyance Facilities including Turnouts & Pump Stations" bid package include bid alternates for the three types of canal linings. This will provide competitive pricing for each alternative, account for market fluctuations in material pricing, and allow the JPA to evaluate the lining costs in light of the total overall project costs.

VIII. Pipeline Option

A. Constructability/Methods

Technical Memorandum No. 3 "Pipeline Requirements" serves to evaluate the various pipe options and provides estimates of pipeline sizes and cost estimates.

The conveyance facility for the project could be a pipeline and if so, it is anticipated that it would be reinforced concrete pipe (RCP). For cost estimating purposes, the cost for dry cast RCP was utilized. The conveyance reach capacities are shown below in Table 10 along with the pipe size and type from Technical Memorandum No. 3.

Table 10

Conveyance Pipe Options				
Conveyance Reach	Reach Capacity	Pipe Size	Pipe Type	Material & Installation Cost
No. 1	443 cfs	120-in	RCP	$1,365/LF
No. 2	443 cfs	120-in	RCP	$1,365/LF
No. 3	435 cfs	120-in	RCP	$1,365/LF
No. 4	240 cfs	90-in	RCP	$727/LF
No. 5, if necessary	105 cfs	60-in	HDPE or PVC	$333/LF

Figure 8 is a conceptual illustration of the conveyance pipeline and includes a single pump station near the I-5 Freeway to pump the water to the Phase I, Phase II, and West Basin recharge properties. A pipeline bypass around the pump station could be constructed with valving such that the pressure from the well pumping could be maintained when returning water during recovery operations to the California Aqueduct.

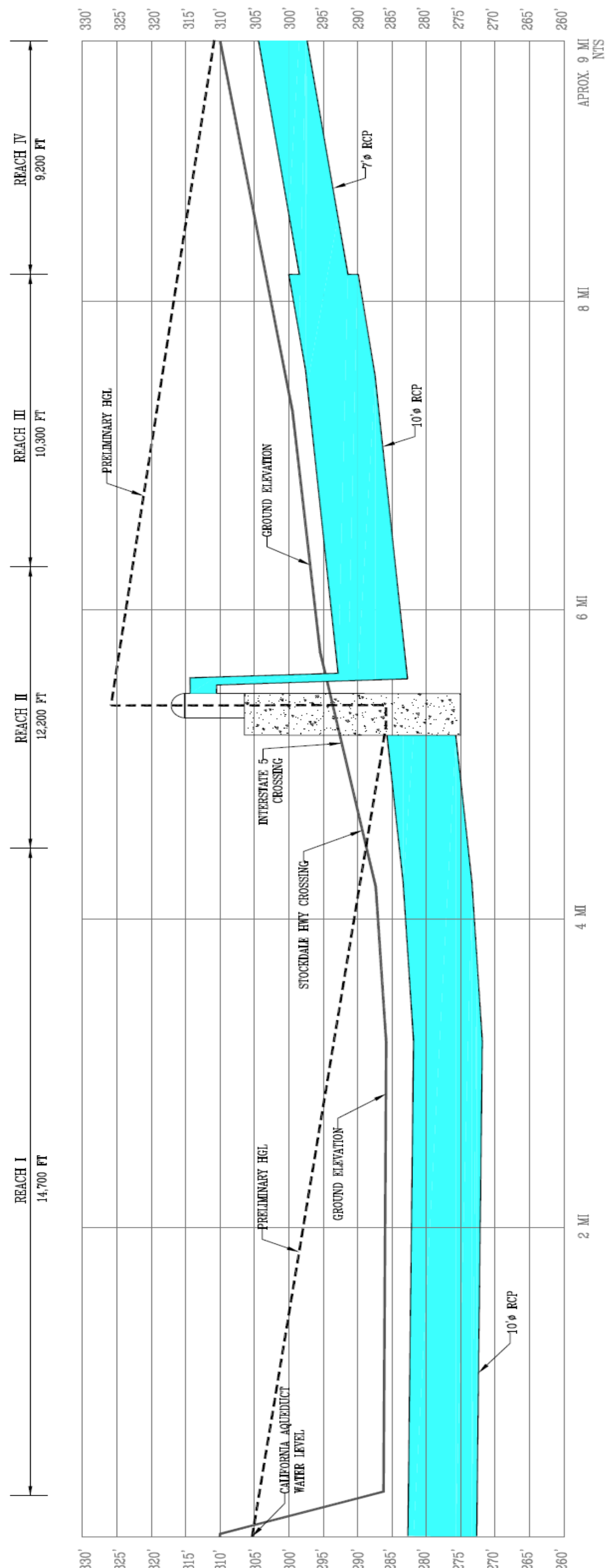


Figure 8: Preliminary Pipeline Profile

B. Capital Cost Estimate

The capital cost estimate for an underground pipeline is shown below in Table 11. The cost estimate is itemized for each reach of the conveyance and includes material and installation costs, however it does not take into account any special crossings, road crossings, or structures.

Table 11

Conveyance Pipe Options			
Conveyance Reach	Reach Length	Pipe Unit Cost	Pipeline Total Cost
No. 1	14,700-ft	$1,365/LF	$20,065,500
No. 2	12,200-ft	$1,365/LF	$16,653,000
No. 3	10,300-ft	$1,365/LF	$14,059,500
No. 4	9,200-ft	$727/LF	$6,688,400
No. 5, if necessary	4,500-ft	$333/LF	$1,498,500
		Total not including Reach 5:	$57,466,400
		Total including Reach 5:	$58,964,900

Table 12 compares the pipeline cost with the canal alternative costs for each reach of canal and the total cost as well. The pipeline alternative is much more expensive in the first three reaches of the canal. The pipe size and capacity reduces significantly in Reach No. 4 which brings the cost more in line with an open channel design, however it is still the most expensive alternative. In Reach 5, the pipe size and type are such that a pipeline is the most economical.

Table 12

Summary of Conveyance Alternative Capital Costs w/o Pump Stations						
Alternative	Reach No. 1	Reach No. 2	Reach No. 3	Reach No. 4	Reach No. 5, if necessary	Total Cost
Earth Lined	$7,504,463.00	$7,050,887	$4,459,188	$3,179,178	$1,498,500	$23,692,216
HDPE/RPE Lined	$8,820,122.00	$8,142,795	$5,381,045	$4,002,584	$1,498,500	$27,845,046
Earth Lined w/Return Pipeline	$10,836,991.00	$9,816,659	$6,794,225	$5,264,842	$1,498,500	$34,211,217
Shotcrete Lined	$11,741,842.00	$10,567,624	$1,428,236	$5,831,143	$1,498,500	$31,067,345
Earth Lined w/Bentonite Liner	$12,299,456.00	$11,030,405	$7,818,945	$6,180,126	$1,498,500	$38,827,432
Concrete Lined	$12,116,692.00	$10,878,724	$7,690,886	$6,065,743	$1,498,500	$38,250,545
Pipeline	$20,065,500.00	$16,653,000	$14,059,500	$6,688,400	$1,498,500	$58,964,900

There may be opportunities to design the conveyance facilities as a hybrid approach. For instance, Reach No. 1 and Reach No. 2 of the conveyance could be a pipeline due to the energy, O&M, and safety benefits, while Reach No. 3 could be open canal. Reach No. 4 and Reach No. 5, if necessary, could then be a pipeline. However, there are off-setting benefits. The savings by utilizing Reach No. 3 as a canal is approximately $7 to $9M, however it requires a second pump station installed instead of just one pump station for the pipeline alternative which minimizes the true capital cost savings. The design firm should evaluate and consider a hybrid approach as part of the value engineering work.

The estimated overall capital cost for a pipeline, including the pump station, right-of-way, and road crossings, is as follows:

Conveyance Pipeline	$58,964,900
Adhor Road Earthwork	$216,000
Adhor Pavement Repair	$50,400
East Side Canal Earthwork	$216,000
Stockdale Cased Crossing	$975,000
I-5 Fwy Cased Crossing	$1,820,000
Pump Station & Bypass	$13,383,200
Right-of-Way Acquisition	$3,750,000
Total Pipeline Cost:	$79,375,500

C. O&M Impacts – Energy Costs related to Friction Losses

For purposes of this memorandum it has been estimated that a 120-inch diameter RCP pipeline would be installed from the California Aqueduct to the east side of the I-5 Freeway. A pump station would be constructed on the east side of the I-5 Freeway and pump approximately 435 cfs at a total dynamic head of approximately 50-ft. This is an approximate 3,800 hp pump station. It is estimated that the energy costs would be approximately $1,240,615 to convey approximately 112,500 ac-ft during a recharge year.

A present worth analysis was performed for the pipeline alternative. The present worth analysis considered the project capital cost of $79,375,500. The capital recovery for this cost was estimated at a 3% interest rate over a twenty (20) year period.

The operations and maintenance (O&M) costs were also included for this alternative and include the recovery well pumping costs and the pipeline operation costs in idle years, wet years, and dry years. It has been estimated that there will be two wet years and three dry years out of every ten years and the remaining years will be idle years. The recovery well pumping costs in dry years are the same for the lined canal options whereby 72 cfs is being recovered from approximately twelve (12) wells. The pipeline operations costs consist of RRBWSD operations and maintenance costs, electricity costs, mission unit costs, and DWR conveyance costs. A pipeline design is anticipated to include a single pump station with an approximate 50-ft TDH and also a smaller return water pump station. Pump station replacement costs have been included that account for replacing pumps, motors, VFD’s, electrical gear, and cathodic protection every twenty-five (25) years. These costs have been inflated at 3% per year.

D. Advantages and Disadvantages

A pipeline alternative has been considered herein. The pipeline sizes and types have been based on the recommendations outlined in Technical Memorandum No. 3. The advantages to a pipeline for the conveyance facilities include:

- Smaller temporary and permanent right-of-way than an open channel design
- Less obtrusive to nearby properties and farming operations
- Less maintenance
- System operation simplified by one pumping station instead of three for conveyance canal
- Ability to float off static water level or operating water level of California Aqueduct from Aqueduct to Pump Station which eliminates risk of open canal design and flooding if slide gate fails or a levee embankment breaches.

The disadvantages of a pipeline include the following:

- Higher capital cost
- Higher energy cost due to friction head

IX. Turnout Requirements

A. Turnout Locations and Capacities

Technical Memorandum No. 3 “Pipeline Requirements” serves to evaluate the various turnout pipe options and provides estimates of the turnout pipeline sizes and cost estimates. These are summarized briefly below in Table 13.

Table 13

Turnout Locations and Capacities		
Turnout Location	Turnout Capacity	Turnout Size
Phase II Property	48 cfs	48"
West Basins Property	18 to 38 cfs	36"
Phase I Property	105 cfs	54"
In-Lieu Farmer Properties	5 to 20 cfs	24"

The turnout structures will be prefabricated structures that are the same size for uniformity and ease when replacing. The turnout structures will have 24” diameter pipes for the in-lieu farmer turnouts and 36” and 48” diameter pipes for the recharge basins. It is anticipated that the conveyance pipeline over to the Phase I property will be a 54” pipeline where it discharges to the Phase I property.

B. Turnout Pipe Materials

The proposed turnout pipeline materials are discussed in Technical Memorandum No. 3 “Pipeline Requirements”. These are summarized briefly below in Table 14.

Table 14

Turnout Pipe Type		
Turnout Location	Turnout Capacity	Turnout Pipe Material
Phase II Property	48 cfs	ADS N12 WT HDPE
West Basins Property	18 to 38 cfs	DR41 HDPE
Phase I Property	105 cfs	DR41 HDPE
In-Lieu Farmer Properties	5 to 20 cfs	ADS N12 WT HDPE

C. Turnout Metering

It is recommended to install individual flow meters at each turnout facility so that the flow rates and recharge performance can be monitored. The turnout pipe sizes vary but are expected to range between 24-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 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. Ultrasonic Meter

   An ultrasonic flow transducer is available from Rittmeyer for measurement in a circular pipe under partially filled conditions. They are suitable for a full range of pipe diameters, can be replaced with the pipelines in operation, and have a high accuracy. The flow in closed pipes is able to be measured either with sensors mounted to the inside or outside of the pipe as well as non-invasive sensors installed on a mounting frame on the outside of the pipe. In addition, they make a flow controller / display that can monitor multiple pipes/meters at the same time which is ideal for a multiple barrel turnout facility.

2. 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.

X. Summary

The conveyance facility is estimated to be approximately 8.80 miles long or approximately 46,400-ft. This conveyance facility will cross recharge facilities, agricultural lands, private property, County roads, Stockdale Highway, and the I-5 Freeway. This facility is also planned to be utilized in the reverse direction during recovery operations for returning water to the California Aqueduct.

The cost of a conveyance canal is estimated to be approximately \$20,750,355 for canal options with 1.5:1 side slopes to \$22,193,716 for unlined earth canal options with 3:1 side slopes. This does not include any canal linings, however the cost does include earthwork, facility relocations, safety features, road surfacing, barbed wire perimeter fencing, and canal structures such as road crossings, see Tables 1 through 4. However, the cost estimate does not include the purchase of easements or rights-of-way.

The cost of the conveyance canal increases when including the three pump stations and the return water pump station as well as right-of-way procurement.

Conveyance Canal Cost Estimate (w/ 1.5:1 Slopes)	\$20,750,355
Three Pumps Stations & Return Water Pump Station	\$28,945,000
Right-of-Way Cost Estimate	\$5,000,000
Conveyance Canal Estimate (w/ 1.5:1 Slopes)	\$54,695,355

The estimated cost of the earthen conveyance canal with 3:1 side slopes increases when including the three pump stations and the return water pump station as well as right-of-way procurement.

Conveyance Canal Cost Estimate (w/ 3:1 Slopes)	\$22,193,716
Three Pumps Stations & Return Water Pump Station	\$28,945,000
Right-of-Way Cost Estimate	\$5,625,000
Conveyance Canal Estimate (w/ 3:1 Slopes)	\$56,763,716

Four canal lining alternatives were evaluated:

1. Earth Lined Canal
2/3. Poly Liners (HDPE or RPE)
4. Shotcrete Lined Canal
5. Concrete Lined Canal

In addition, two additional alternatives were considered as part of mitigation efforts with an earth lined canal:

1a. Earth Lined Canal with Parallel Return Water Pipeline
1b. Earth Lined Canal with Bentonite Lining

The capital costs, O&M costs, present worth values, and advantages/disadvantages were considered for each alternative and are shown in Table 15 below.

A sixth alternative was also considered which is a pipeline, however due to the capacity and size of the pipeline, it is a much more significant capital cost. The capital cost for the pipeline, including the pump station, pipeline right-of-way, and road crossing work at Adohr Road, Stockdale Hwy, and the I-5 Fwy is approximately $79,375,500. However, as a result of eliminating some pump stations and having a reduced O&M cost, the pipeline becomes more economical over a fifty (50) year life cycle.

The conveyance costs are estimated for each alternative in Table 15 below. This includes the lining cost as well as the total cost and includes the conveyance canal costs from Tables 1 through 4 in the amount of $20,750,355 plus the right-of-way costs, the pump station costs, and the estimated liner cost.

A present worth analysis was performed for each of the alternatives including the pipeline alternative. The present worth analysis considered the project capital cost for each alternative. The capital cost for the conveyance canal options includes the conveyance canal costs from Tables 1 through 4, the estimated liner costs, right-of-way acquisition, and the estimated pump station costs for three pump stations and a return water pump station.

The capital cost for the pipeline option includes the pipeline costs, road crossings, pump station costs for one pump station, right-of-way acquisition, and a return water pump station. The capital recovery for these costs was estimated at a 3% interest rate over a twenty (20) year period.

The operations and maintenance (O&M) costs were also included for each alternative and include the recovery well pumping costs, the canal operation costs for idle years, wet years, and dry years, and the liner replacement or repair costs. It has been estimated that there will be two wet years and three dry years out of every ten years and the remaining years will be idle years. The recovery well pumping costs in dry years are the same for the lined canal options and the closed conduit option whereby 72 cfs is being recovered from approximately twelve (12) wells. However, the earth lined canal alternative with bentonite liner estimates utilizing fourteen (14) wells to recover 84 cfs as a result of seepage losses while returning water to the California Aqueduct. Also the earth lined canal alternative estimates utilizing sixteen (16) wells to recover 96 cfs as a result of seepage losses while returning water to the California Aqueduct. The canal operations costs consist of RRBWSD operations and maintenance costs, electricity costs, mission unit costs, and DWR conveyance costs. These costs are similar for most of the options with the exception that the idle year costs for the earth lined canal options (1, 1a, and 1b) are more for the RRBWSD maintenance costs as they have to perform weed and rodent control along the entire conveyance canal. Also the idle year maintenance costs for the closed conduit option have been reduced as a result of the RRBWSD maintenance being minimized with a pipeline. Pump Station replacement costs have been included and account for pump, motor, VFD, electrical gear, and cathodic protection replacement every twenty-five (25) years. The liner replacement and repair costs are included for the poly lined canal, shotcrete lined canal, and the concrete lined canal. The poly lined canal estimates minor patches or repairs about every five years at a cost of $25,000 per year and inflation at 3% per year. The shotcrete lined canal estimates panel replacements about every three years for approximately 1,200 lineal feet of side slope panels at a cost of $129,549 per year and inflation at 3% per year. The concrete lined canal estimates that it will be more durable than a shotcrete lined canal and panel replacements will not be necessary for the first 10 to 15 years. The concrete lined canal estimates panel replacement about every five years, beginning in year fifteen, for approximately 1,200 lineal feet of side slope panels at a cost of $150,000 per year and inflation at 3% per year. The present worth values are summarized in the table below.

Table 15

Summary of Conveyance Alternatives

Ranking by Present Worth	Alternative No.	Alternative	Earthwork & Conveyance Facility Costs[2]	Pump Station Costs[3]	Right-of-Way Costs[4]	Lining Cost or Earth Canal Option Costs[5]	Total Conveyance Cost w/ Pump Stations[6]	Present Worth on 50 Yr Basis[7]
1	6	Pipeline	$62,242,300	$13,383,200	$3,750,000	NA	$79,375,500	$182,191,000
2	1a	Earth Lined w/Return Pipeline	$22,193,716	$28,945,000	$5,625,000	$10,519,000	$67,282,716	$188,594,201
3	2/3	HDPE/RPE Lined	$20,750,355	$28,945,000	$5,000,000	$5,596,190	$60,291,545	$190,764,330
4	4	Shotcrete Lined	$20,750,355	$28,945,000	$5,000,000	$14,818,490	$69,513,845	$191,170,614
5	5	Concrete Lined	$20,750,355	$28,945,000	$5,000,000	$16,001,690	$70,697,045	$191,481,030
6	1	Earth Lined[1]	$22,193,716	$28,945,000	$5,625,000	NA	$56,763,716	$197,012,451
7	1b	Earth Lined w/Bentonite Liner	$22,193,716	$28,945,000	$5,625,000	$15,135,216	$71,898,932	$202,678,919

[1] Earth Lined canal does not include a lining. There is additional earthwork and associated costs which are included under "Earthwork & Conveyance Facility Costs".

[2] Earthwork and conveyance costs based upon Tables 1 - 4 and include earthwork, facility relocations, fencing, spillways, and road crossings.

[3] Pump Station costs based on those developed in TM #4 plus a 15% contingency to account for unknowns and PG&E electrical service costs.

[4] Right-of-way costs estimated at $25,000 per acre.

[5] Costs from the liner alternatives evaluation in Sections III thru VI

[6] Total conveyance cost includes earthwork & conveyance facilities, pump stations, R/W, and linings.

[7] Present worth analysis based on 50 year period - see Exhibit C for spreadsheets.

The earth lined canal is not considered a good alternative due to concerns with rodent holes and piping failures, liability due to adjacent landowners, and overall increased canal maintenance with weed control, sedimentation, and rodent hole control. In addition, seepage losses are a concern when returning water to the California Aqueduct. In order to mitigate canal seepage when returning water to the Aqueduct, a return water pipeline or bentonite clay liner has been included in the cost. The earth lined canal alternative with a return water pipeline has the lowest present worth among canal alternatives, however it is not the recommended alternative for the reasons outlined above.

The poly lined and concrete lined alternatives are very similar in present worth over a fifty-year period. The HDPE or RPE canal lining is an economical alternative, has the best hydraulic properties, and is easier to maintain than an earth lined canal. The drawback to the HDPE or RPE canal lining is the estimated useful life of 10 to 20 years for the San Joaquin Valley. However, the present worth analysis demonstrates that this is still a viable alternative.

The cost difference between the shotcrete lining and the concrete lining is also not very significant. Both of these lining systems are quality canal linings and result in a long useful life, however the shotcrete lining requires greater skill and quality control during application. The concrete lined canal alternative, however, is the most expensive lining alternative.

If the conveyance canal alternative is selected for design then the conventional concrete, shotcrete, and poly liners are all reasonable options as they are very similar in present worth based upon a fifty-year (50) period. In that event it is recommended that the "Conveyance Facilities including Turnouts & Pump Stations" bid package include bid alternates for the three types of canal linings. This will provide competitive pricing for each alternative, account for market fluctuations in material pricing, and allow the JPA to evaluate the lining costs in light of the total overall project costs.

However, the pipeline alternative appears to be the most economical over a 50 year period based upon the present worth analysis and therefore should be considered. There are significant benefits to the pipeline alternative that pertain to energy savings, operational and maintenance savings, reduced infrastructure, reduced right-of-way, and safety. The primary safety benefit is the pipeline alternative could place a single pump station on the east side of the I-5 Freeway which is at an elevation that would allow for it to float off the Aqueduct at the static or operating level of the California Aqueduct. This eliminates risks associated with canal levee breaches or overflows.

It is recommended that once the Phase I and Phase II properties are acquired, alignments fixed, and topographical survey completed, that the design firm perform updated value engineering work for the conveyance canal verses pipeline alternatives as well as considering hybrid approaches that utilize both reaches of conveyance canal and reaches of pipeline. At that time the JPA can evaluate the capital costs, the present worth, and the benefits of each alternative in making their final decision.

XI. Related Work Specified Elsewhere

A. TM 2- Conveyance Capacity Requirements
B. TM 3 – Pipeline Requirements
C. TM 4 – Pump Station Requirements
D. TM 5 – Geotechnical Investigation
E. TM 8 - ROW Acquisition
F. TM 10 – Facility Operation and SCADA Requirements
G. TM 11- Engineer's Estimates

Appendices

Appendix A – Canal Cross Sections
Appendix B – Quantity Calculations
Appendix C – Present Worth Analysis

Appendix A
Canal Cross Sections

REACH 1

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

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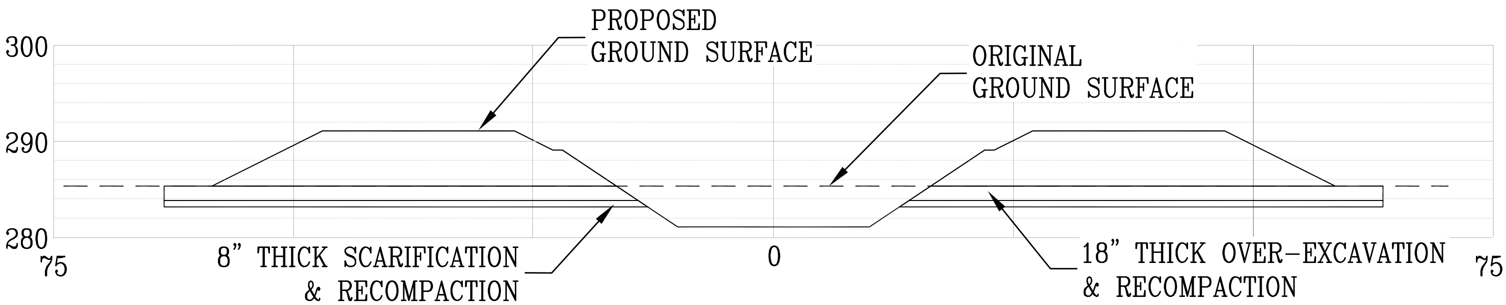
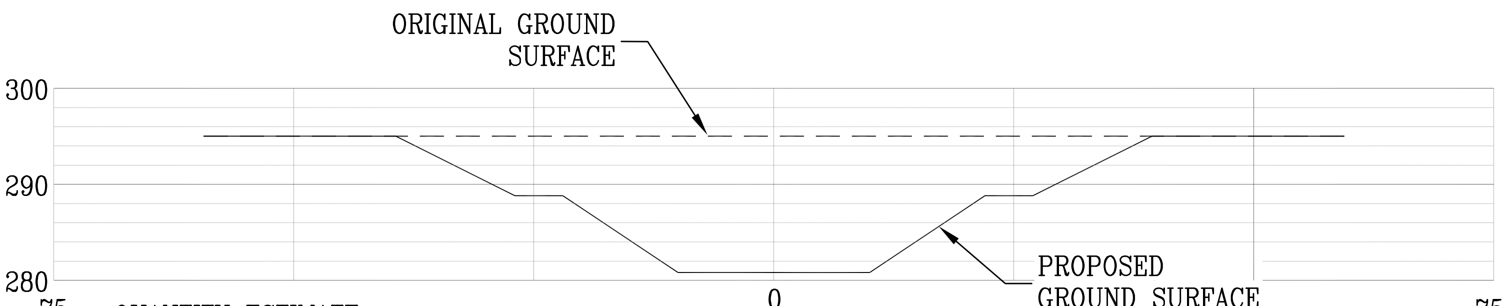


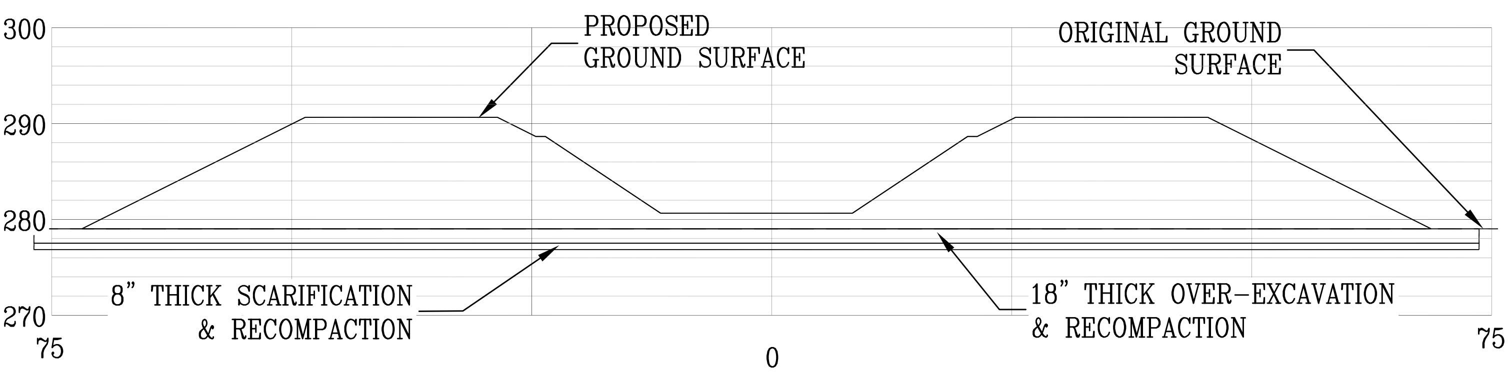
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 112.1 CF/LF
"NEAT LINE" FILL AREA 362.7 CF/LF
OVER-EXCAVATION 144.8 CF/LF

STA 0+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 667.7 CF/LF
"NEAT LINE" FILL AREA 0 CF/LF
OVER-EXCAVATION 0 CF/LF

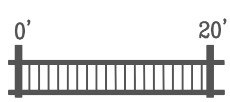
STA 6+04



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 1007.7 CF/LF
OVER-EXCAVATION 225.8 CF/LF

STA 12+04

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS



SCALE: 1"= 20'

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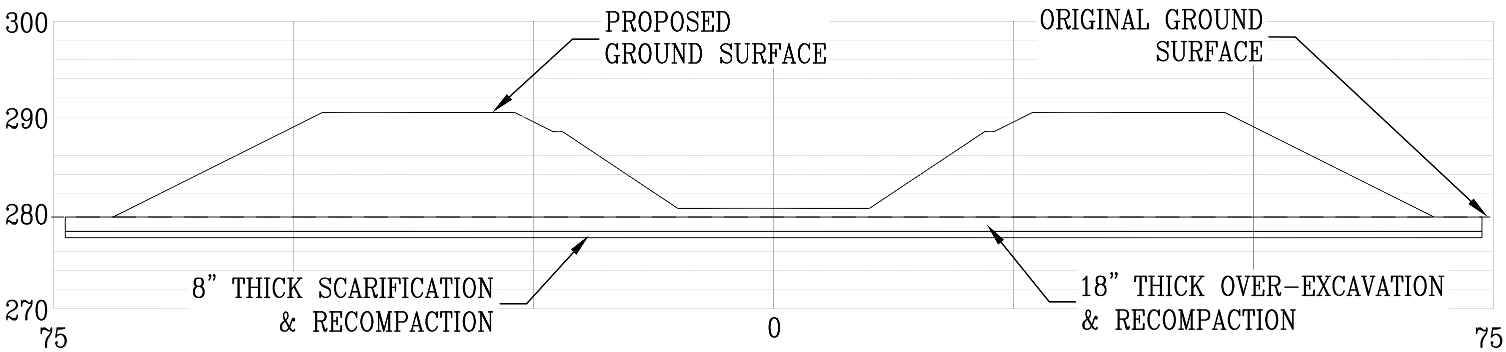
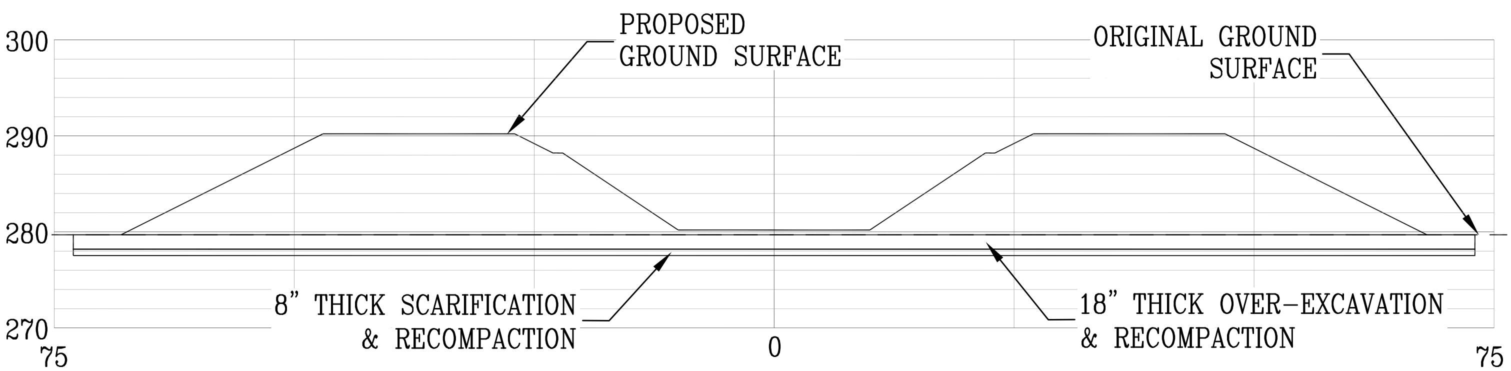


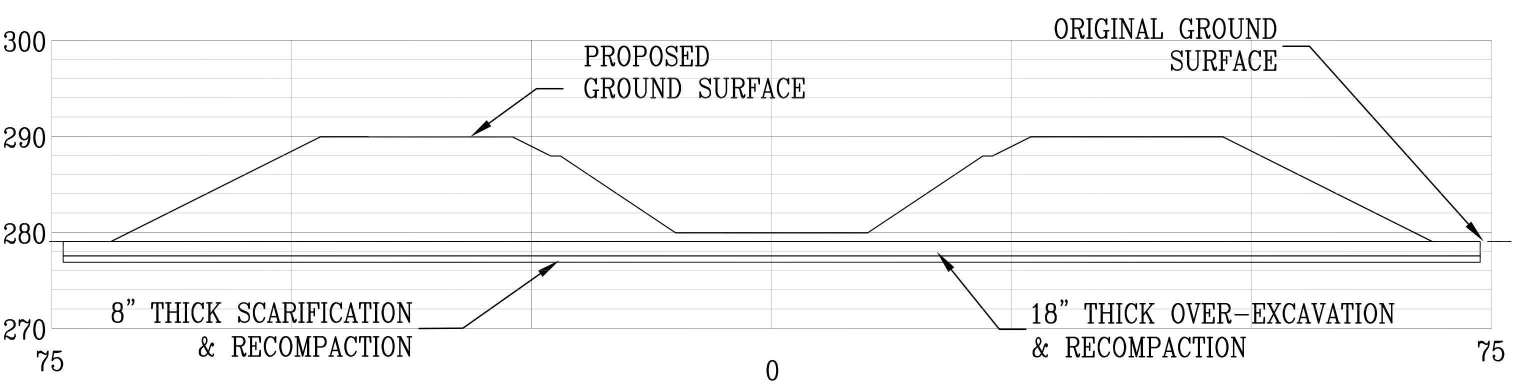
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 906.2 CF/LF
OVER-EXCAVATION 221.4 CF/LF

STA 18+04



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 851.5 CF/LF
OVER-EXCAVATION 219.0 CF/LF

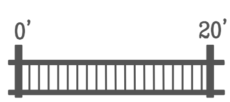
STA 28+04



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 906.2 CF/LF
OVER-EXCAVATION 221.4 CF/LF

STA 38+04

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS



SCALE: 1"= 20'

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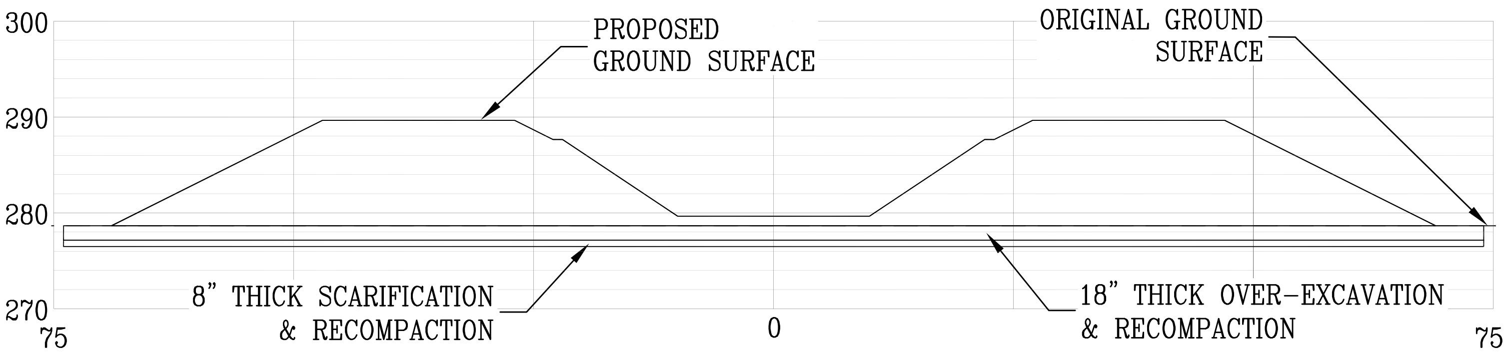
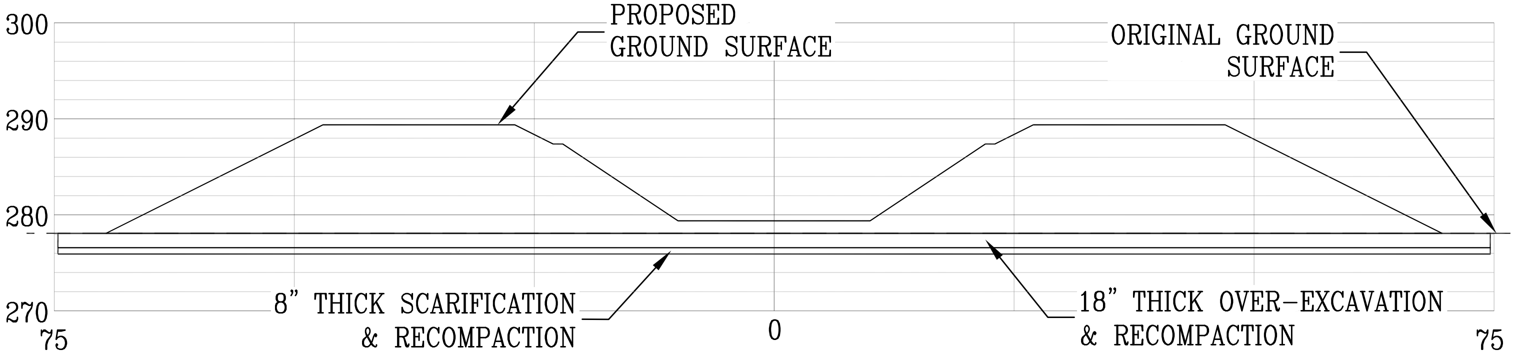


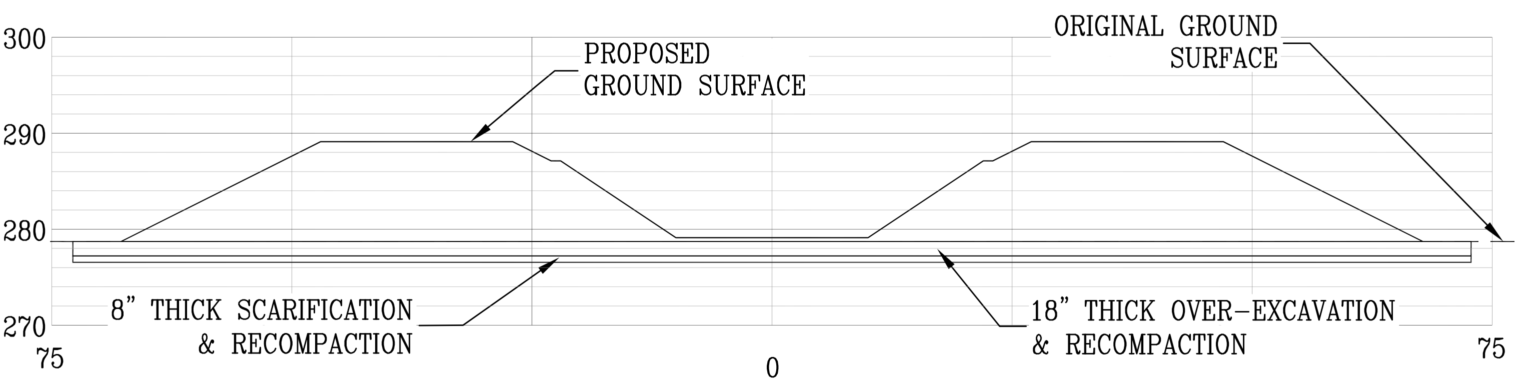
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 920.0 CF/LF
OVER-EXCAVATION 222.0 CF/LF

STA 48+04



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 961.6 CF/LF
OVER-EXCAVATION 223.8 CF/LF

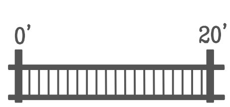
STA 58+04



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 837.9 CF/LF
OVER-EXCAVATION 218.4 CF/LF

STA 68+04

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS



SCALE: 1"= 20'

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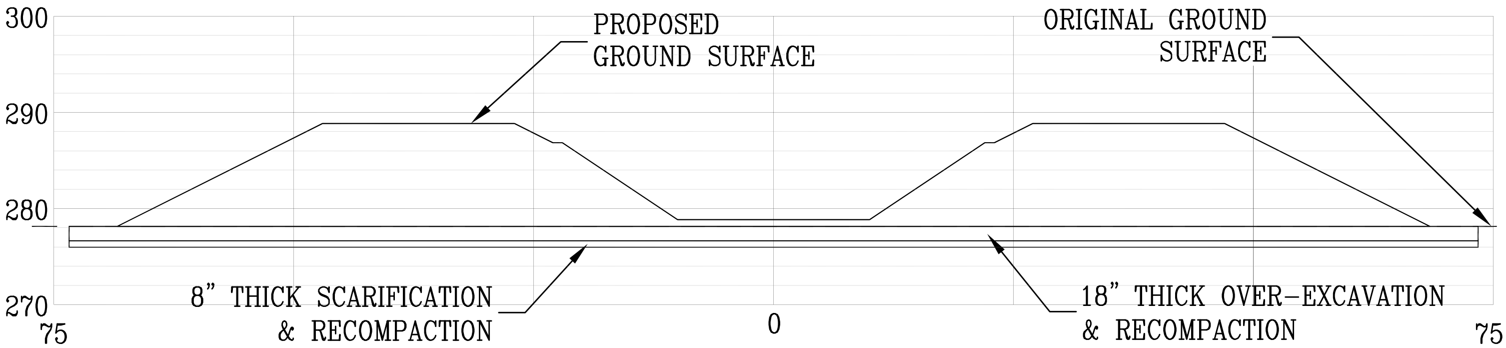
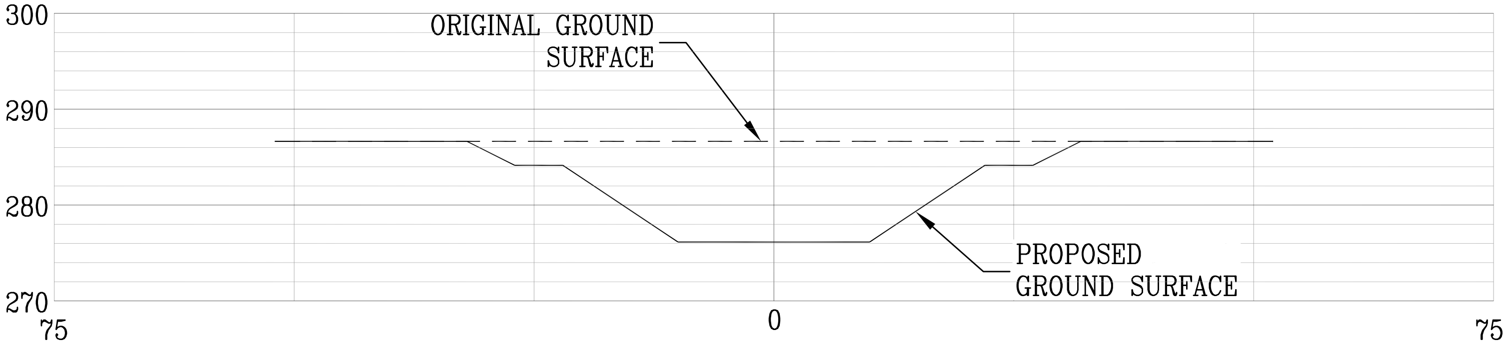


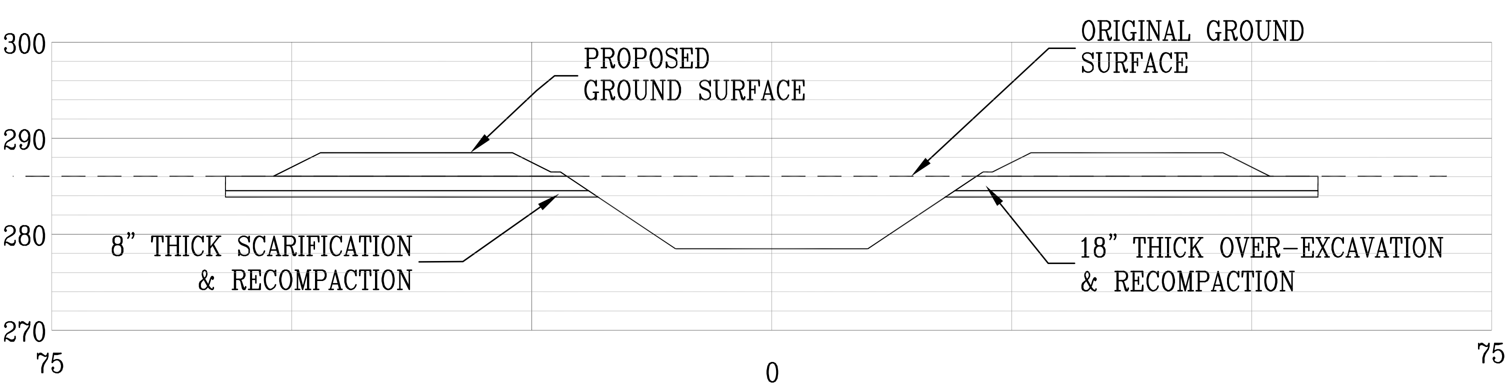
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 878.8 CF/LF
OVER-EXCAVATION 220.2 CF/LF

STA 78+04



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 403.5 CF/LF
"NEAT LINE" FILL AREA 0 CF/LF
OVER-EXCAVATION 0 CF/LF

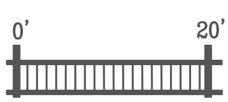
STA 85+80



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 236.5 CF/LF
"NEAT LINE" FILL AREA 122.8 CF/LF
OVER-EXCAVATION 110.1 CF/LF

STA 89+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS



SCALE: 1"= 20'

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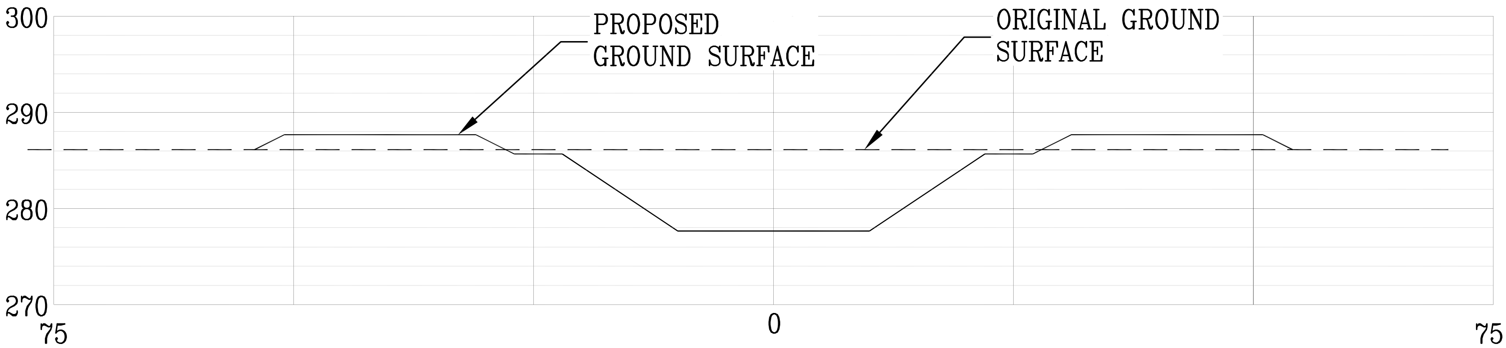
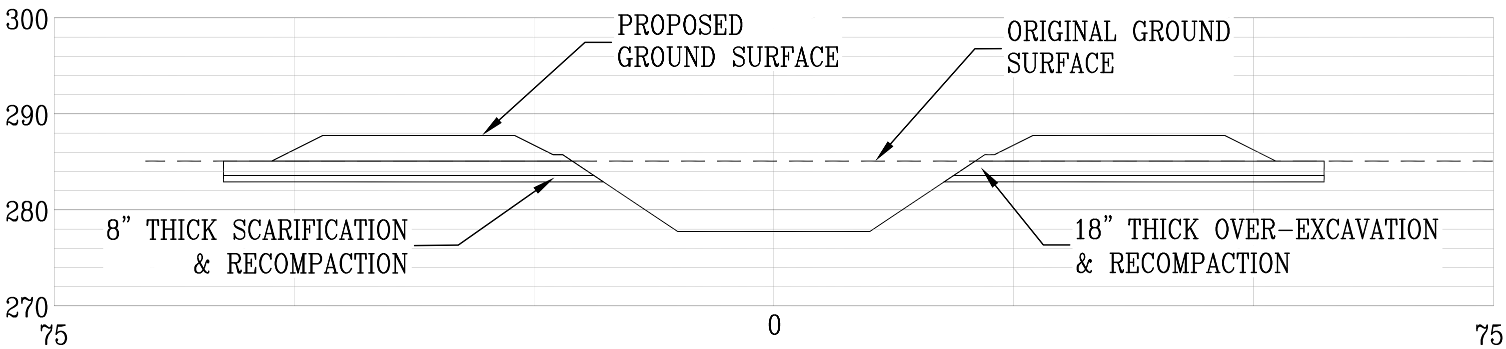


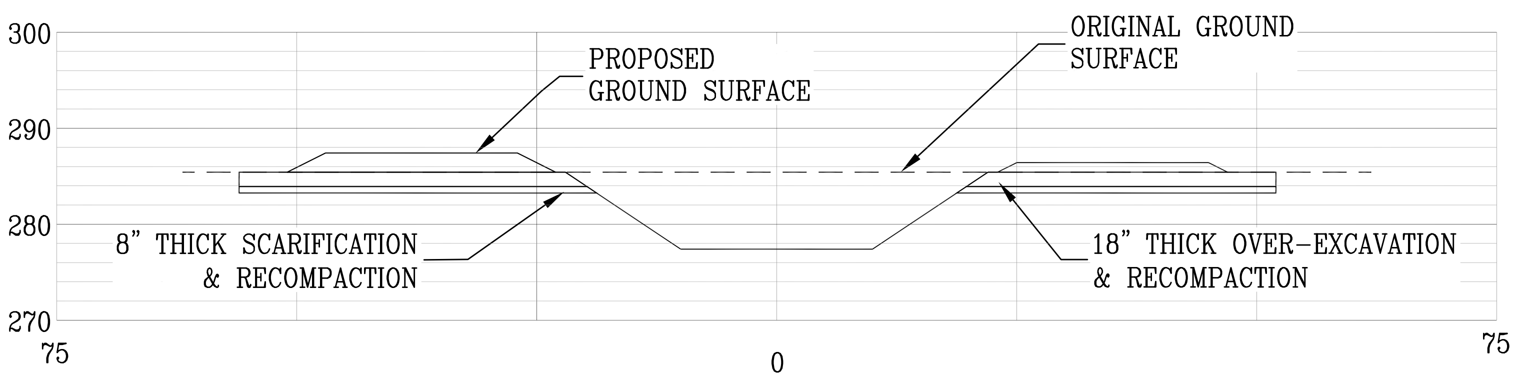
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 281.3 CF/LF
"NEAT LINE" FILL AREA 71.0 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 99+55



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 227.2 CF/LF
"NEAT LINE" FILL AREA 136.4 CF/LF
OVER-EXCAVATION 112.4 CF/LF

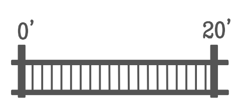
STA 109+75



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 256.0 CF/LF
"NEAT LINE" FILL AREA 96.0 CF/LF
OVER-EXCAVATION 105.4 CF/LF

STA 119+75

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS



SCALE: 1"= 20'

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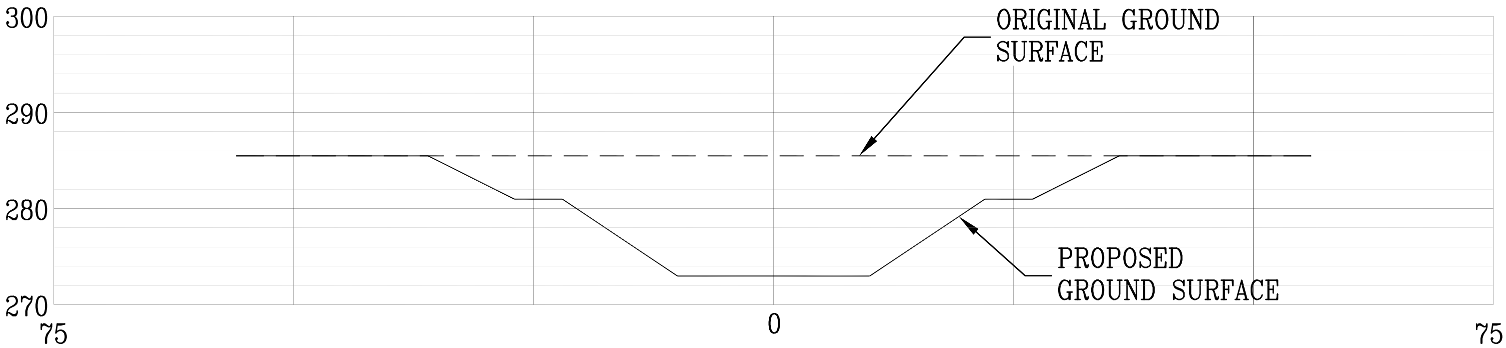
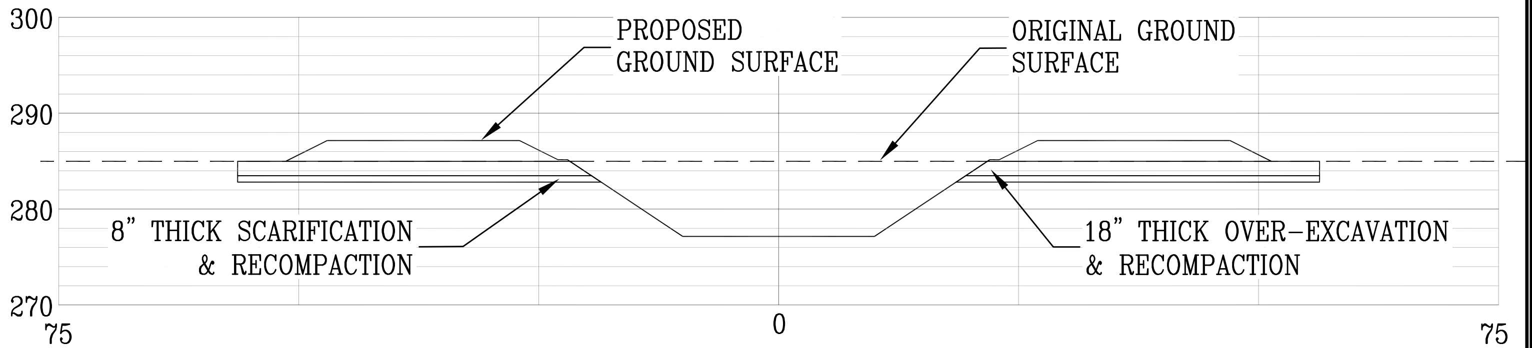


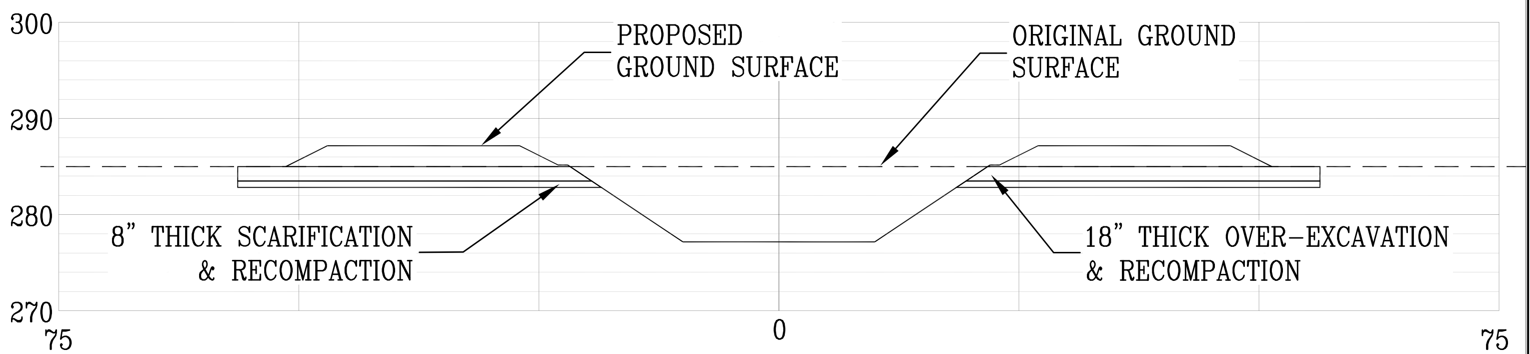
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 539.5 CF/LF
"NEAT LINE" FILL AREA 0 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 130+10



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 248.6 CF/LF
"NEAT LINE" FILL AREA 106.0 CF/LF
OVER-EXCAVATION 107.2 CF/LF

STA 133+35



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 248.6 CF/LF
"NEAT LINE" FILL AREA 106.0 CF/LF
OVER-EXCAVATION 107.2 CF/LF

STA 138+60

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

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REACH 2

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
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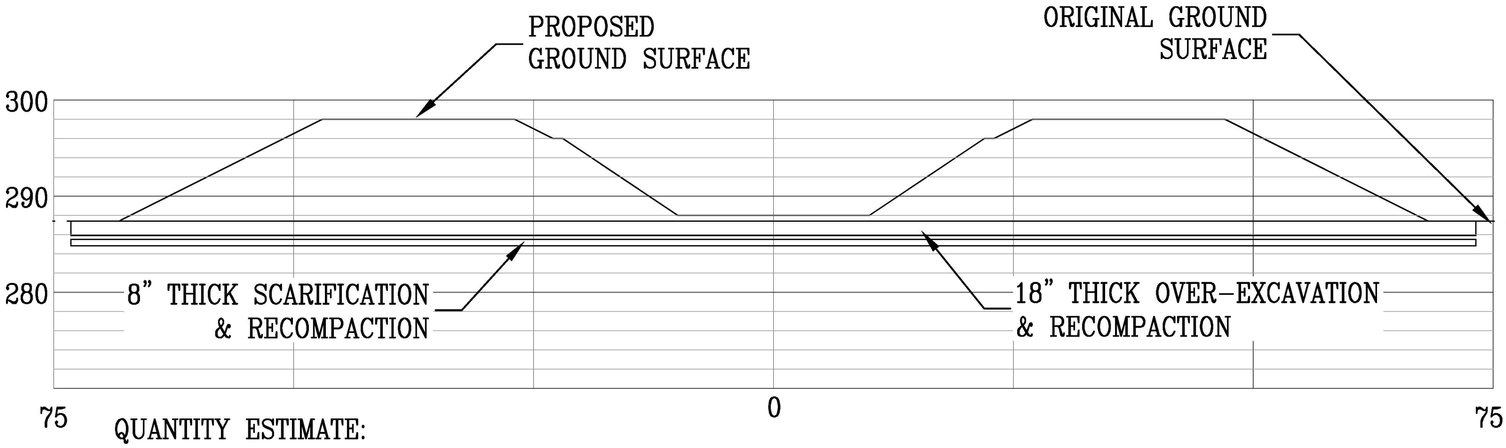
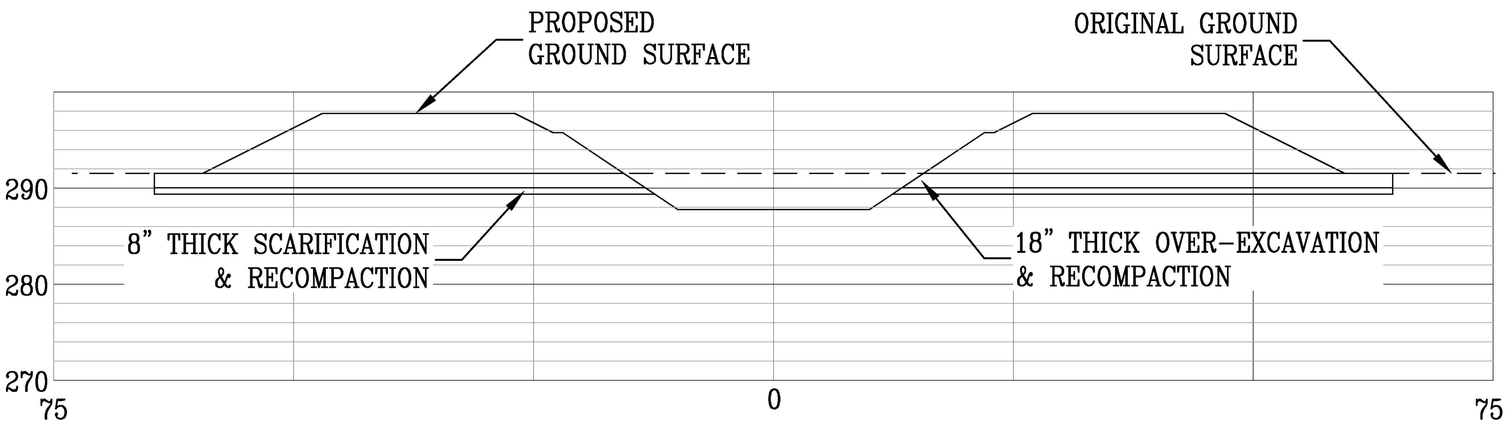


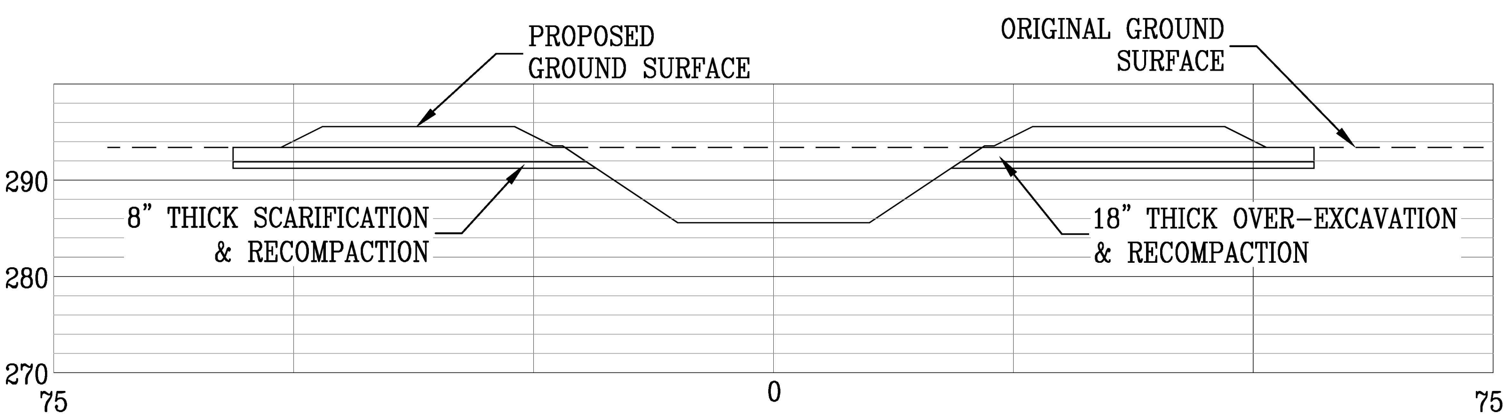
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 865.4 CF/LF
OVER-EXCAVATION 219.6 CF/LF

STA 143+40



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 96.1 CF/LF
"NEAT LINE" FILL AREA 405.7 CF/LF
OVER-EXCAVATION 150.0 CF/LF

STA 153+40



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 249.4 CF/LF
"NEAT LINE" FILL AREA 104.8 CF/LF
OVER-EXCAVATION 107.0 CF/LF

STA 163+40

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

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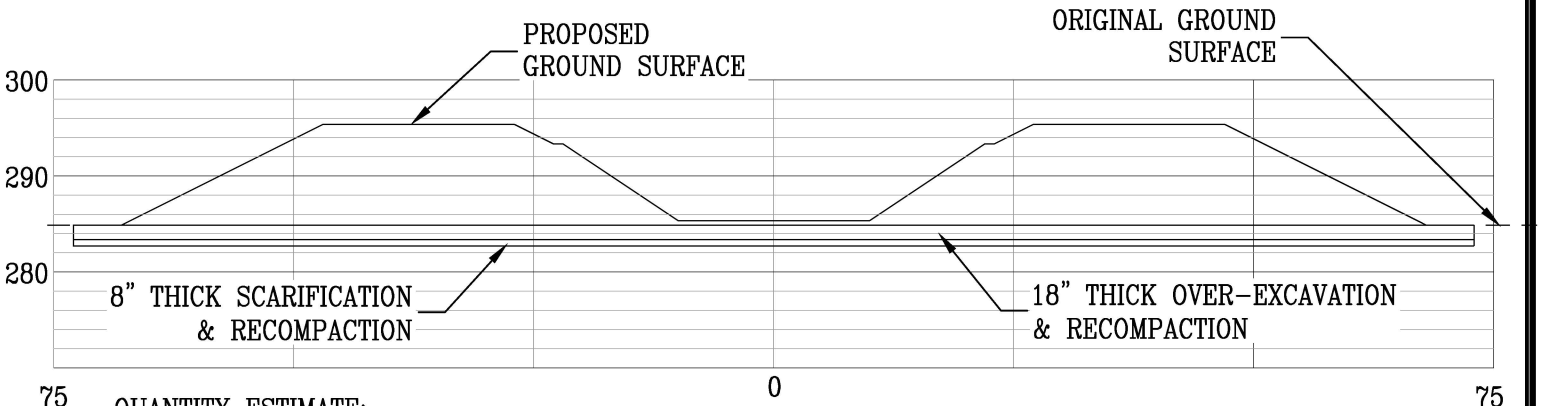
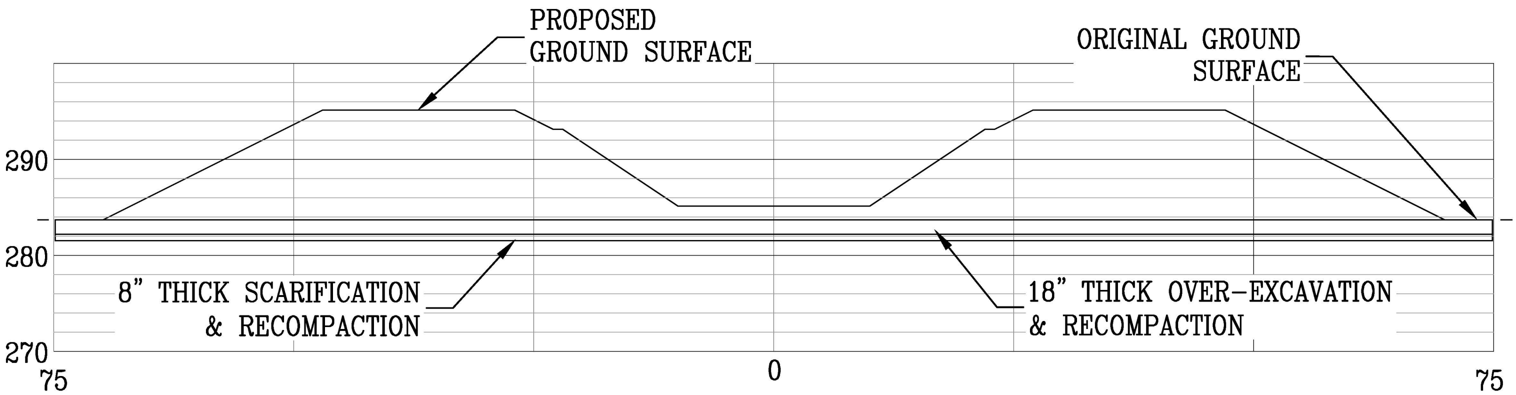


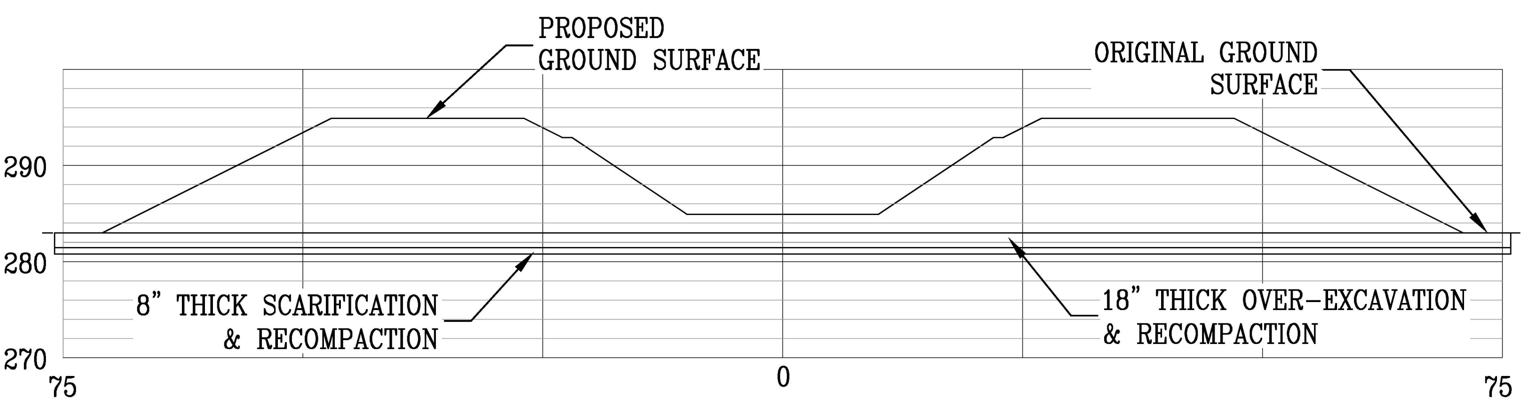
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 847.0 CF/LF
OVER-EXCAVATION 218.9 CF/LF

STA 173+40



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 979.9 CF/LF
OVER-EXCAVATION 224.6 CF/LF

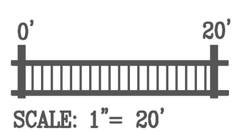
STA 183+40



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 0 CF/LF
"NEAT LINE" FILL AREA 1,051.5 CF/LF
OVER-EXCAVATION 287.4 CF/LF

STA 193+40

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS



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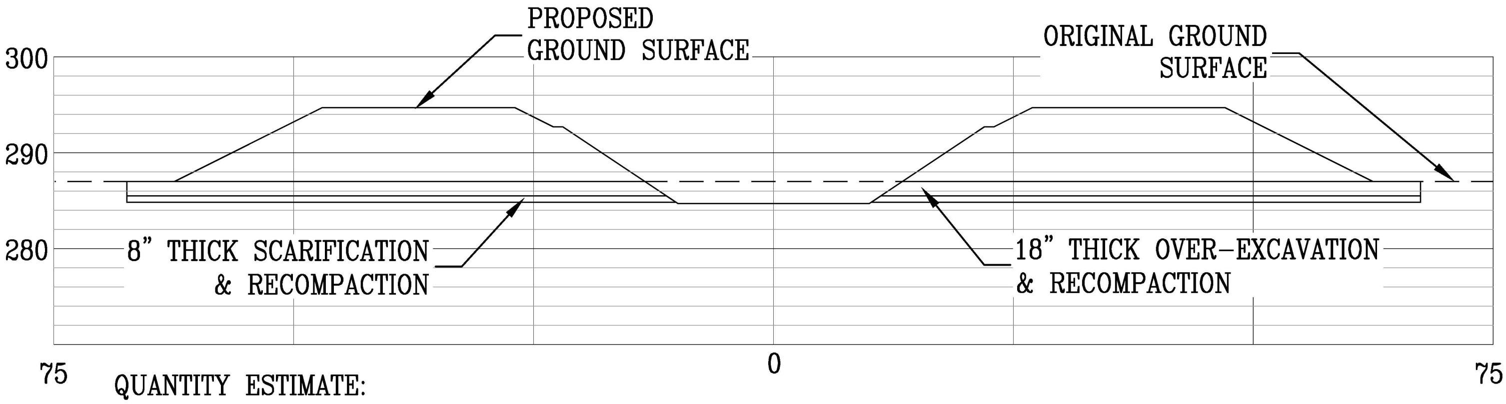
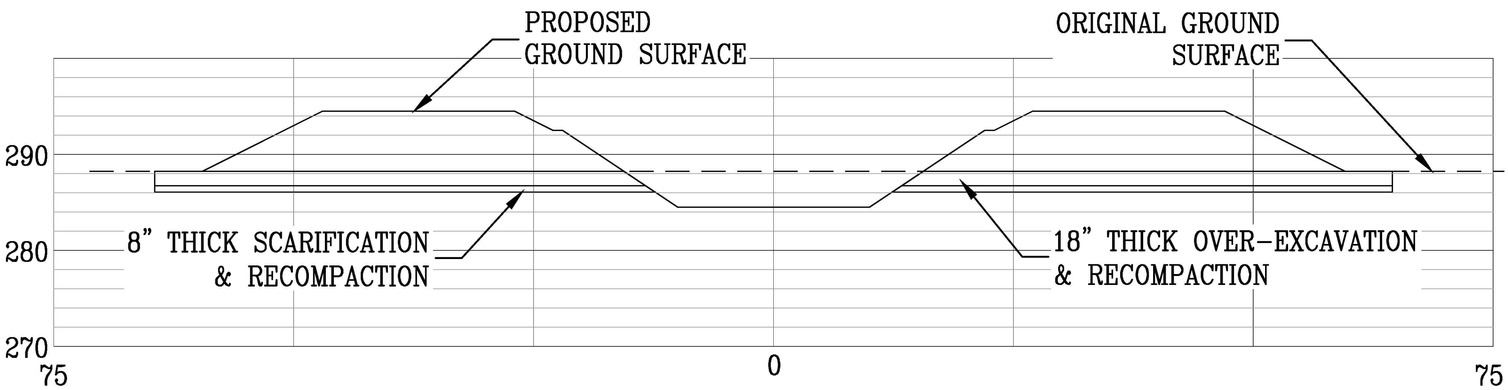


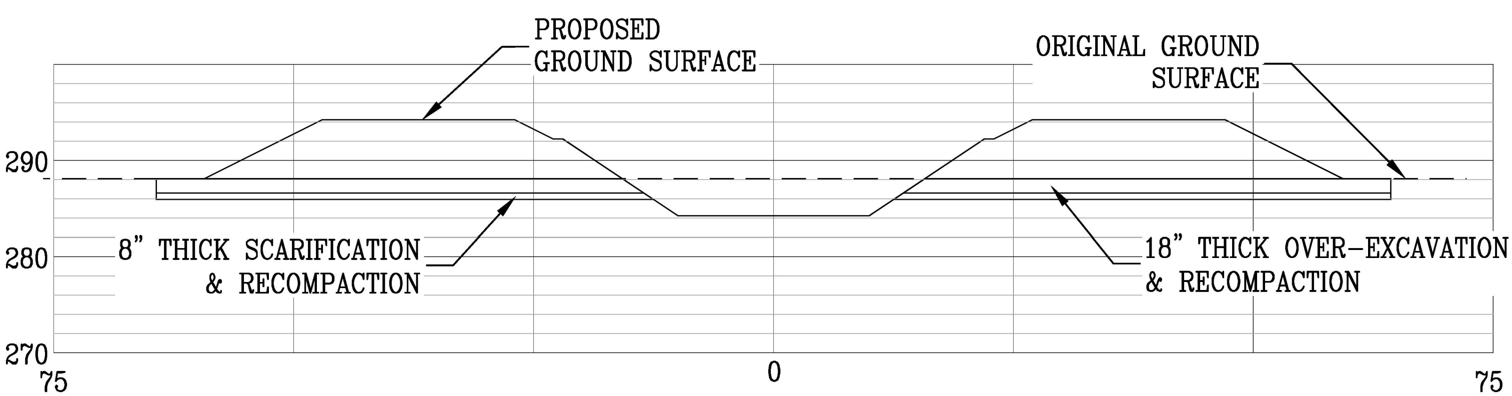
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 53.9 CF/LF
"NEAT LINE" FILL AREA 540.0 CF/LF
OVER-EXCAVATION 165.2 CF/LF

STA 203+40



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 96.1 CF/LF
"NEAT LINE" FILL AREA 405.7 CF/LF
OVER-EXCAVATION 150.0 CF/LF

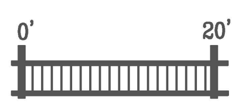
STA 217+70



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 99.2 CF/LF
"NEAT LINE" FILL AREA 397.0 CF/LF
OVER-EXCAVATION 149.0 CF/LF

STA 221+90

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS



SCALE: 1"= 20'

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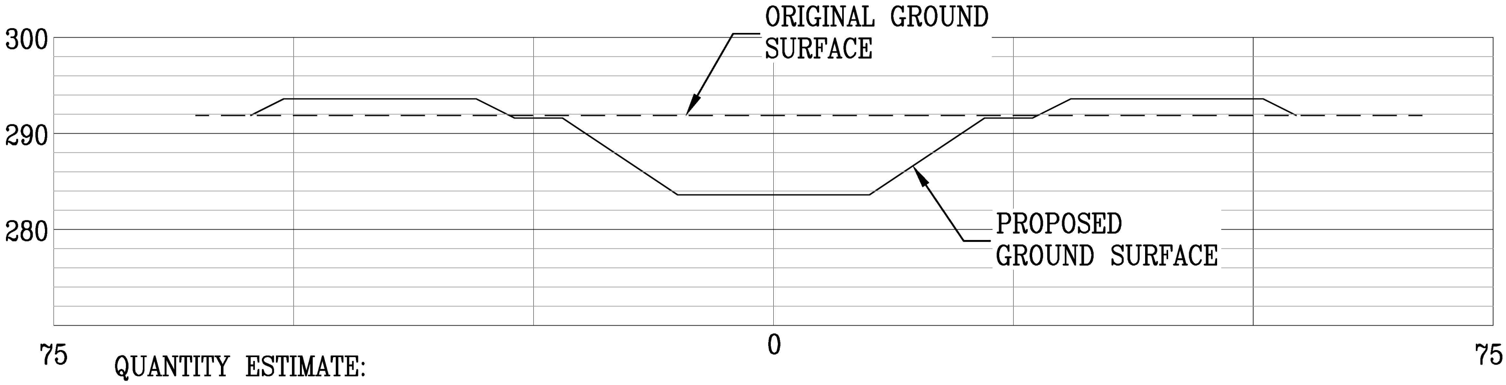
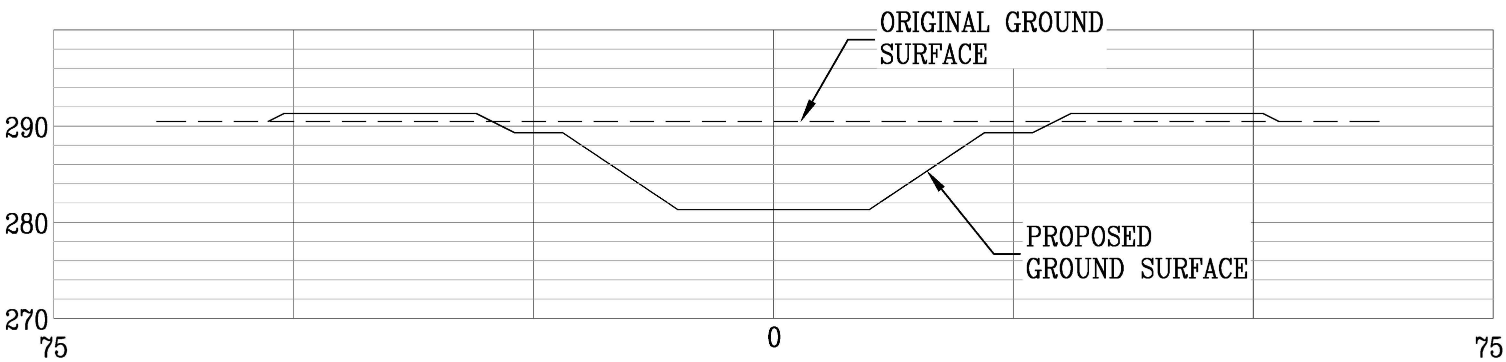


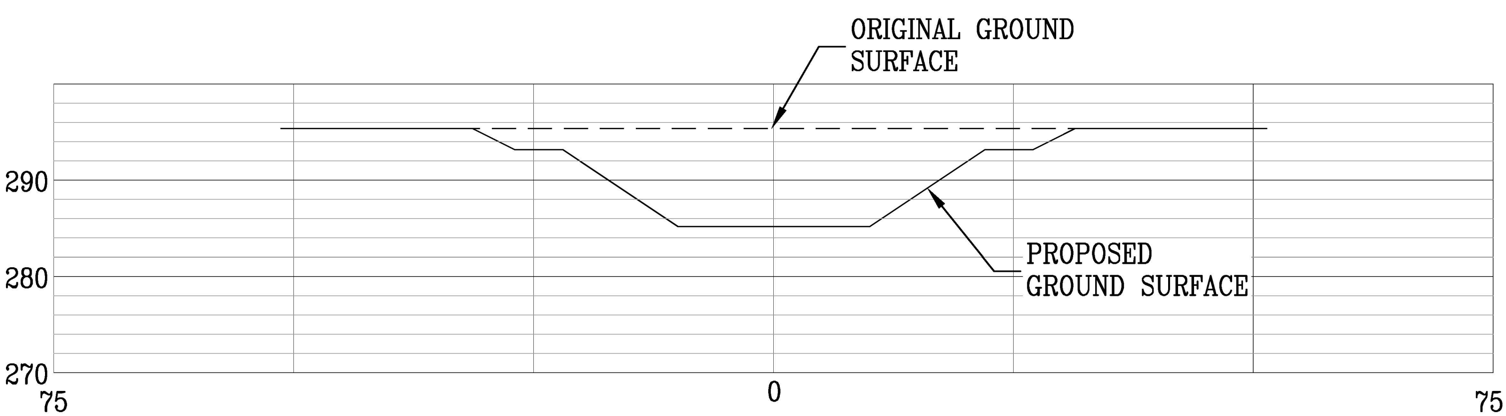
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 269.6 CF/LF
"NEAT LINE" FILL AREA 82.2 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 232+30



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 320.7 CF/LF
"NEAT LINE" FILL AREA 36.9 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 242+30



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 384.5 CF/LF
"NEAT LINE" FILL AREA 0 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 252+70

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

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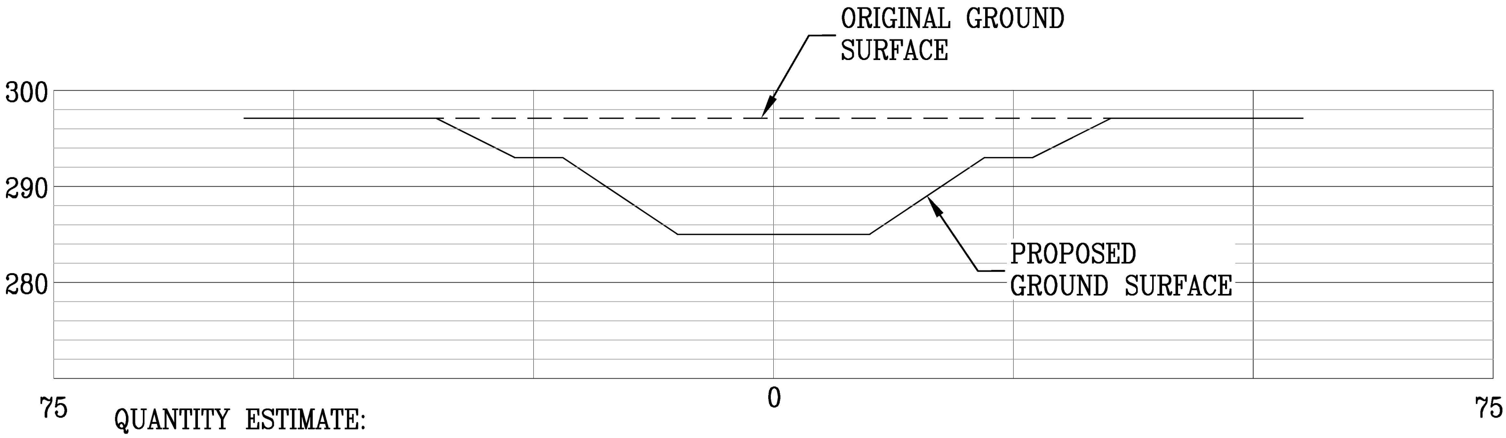
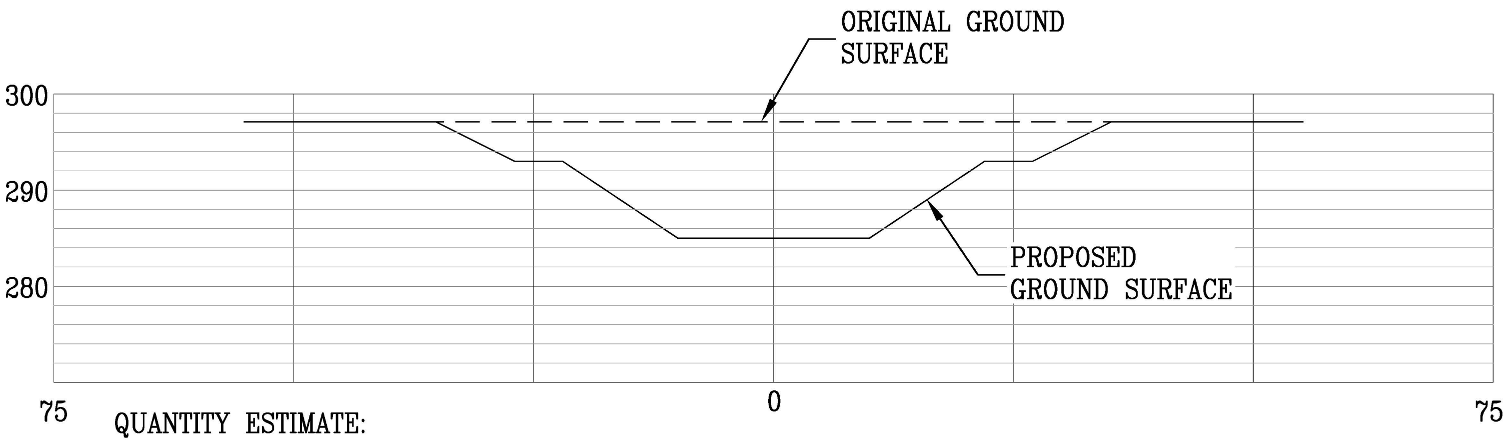


QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 511.0CF/LF
"NEAT LINE" FILL AREA 0 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 256+90



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 511.0CF/LF
"NEAT LINE" FILL AREA 0 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 267+20

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
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FAX 661 393-4799
639 N MAIN STREET, #B
PORTERVILLE, CALIFORNIA 93257
PHONE 559 791-9286
FAX 559 783-9275

REACH 3

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
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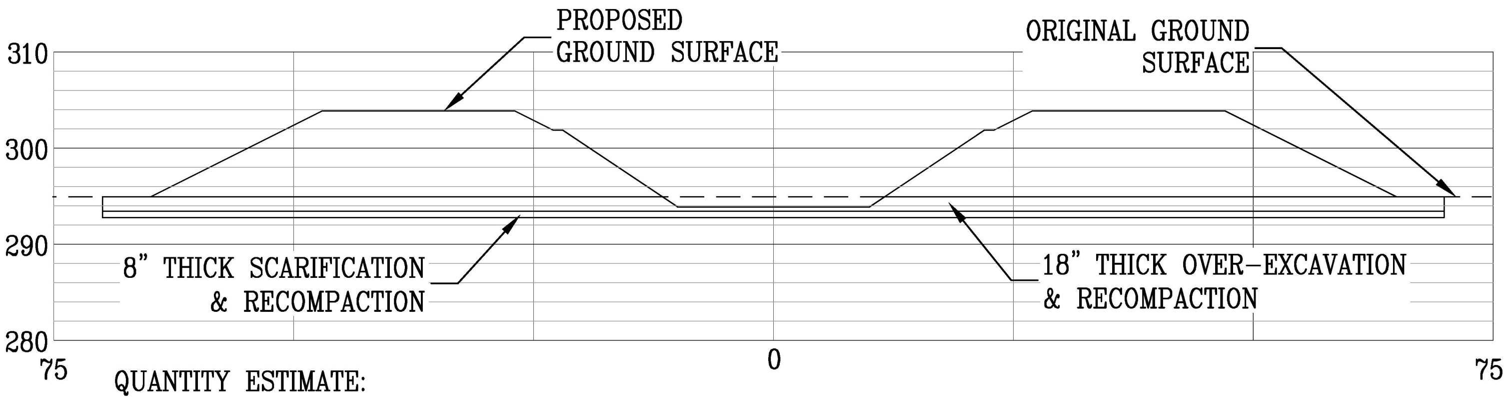
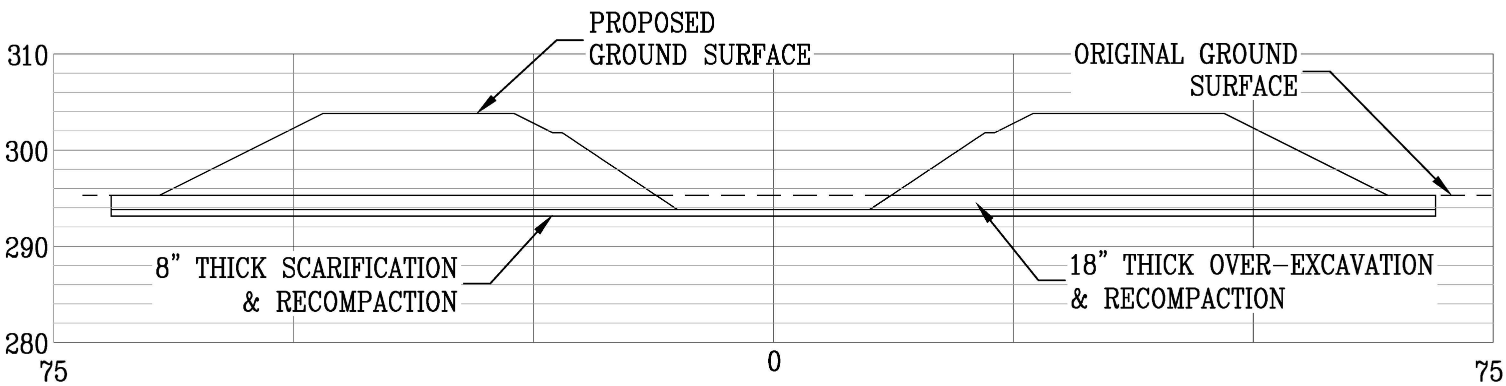
FAX 559 783-9275



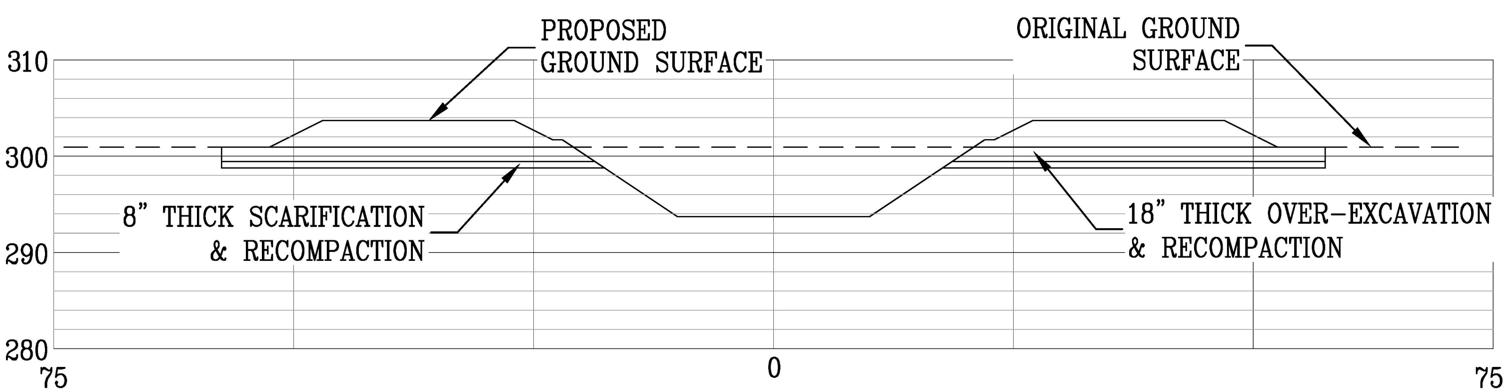
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 22.7 CF/LF
"NEAT LINE" FILL AREA 668.2 CF/LF
OVER-EXCAVATION 187.0 CF/LF

STA 267+20



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 33.4 CF/LF
"NEAT LINE" FILL AREA 620.8 CF/LF
OVER-EXCAVATION 173.8 CF/LF

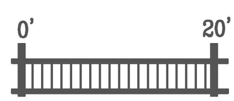
STA 278+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 223.8 CF/LF
"NEAT LINE" FILL AREA 141.4 CF/LF
OVER-EXCAVATION 113.2 CF/LF

STA 288+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS



SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
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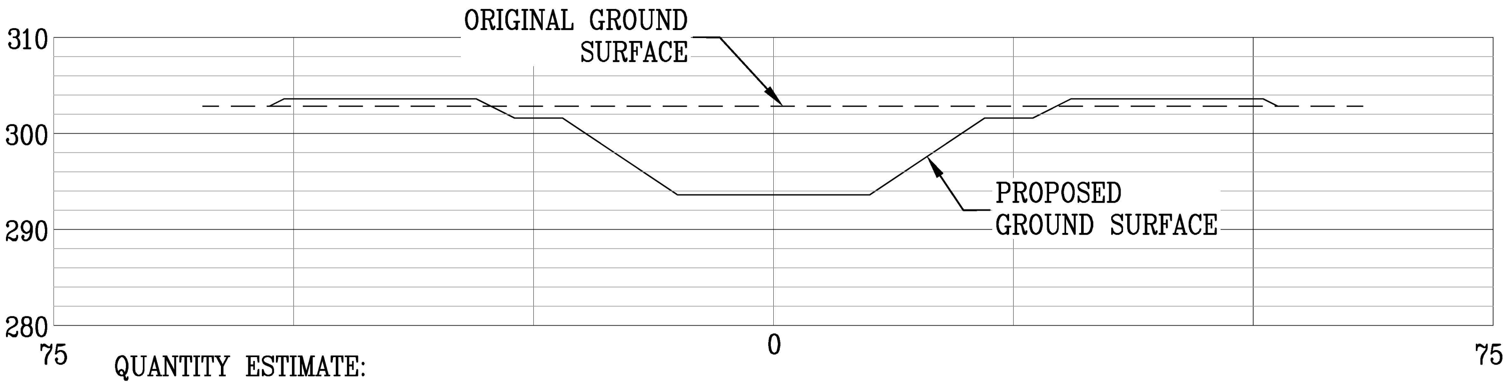
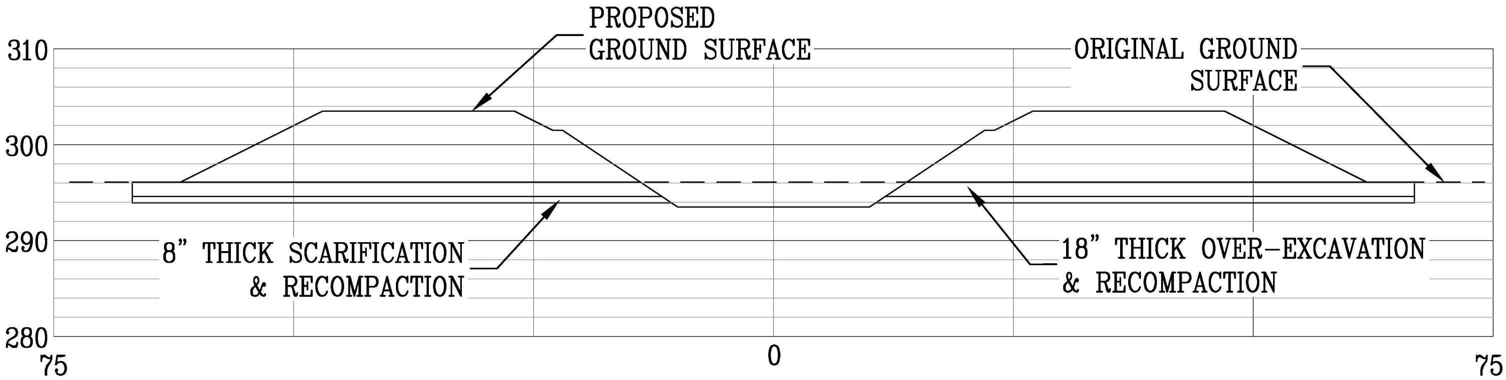


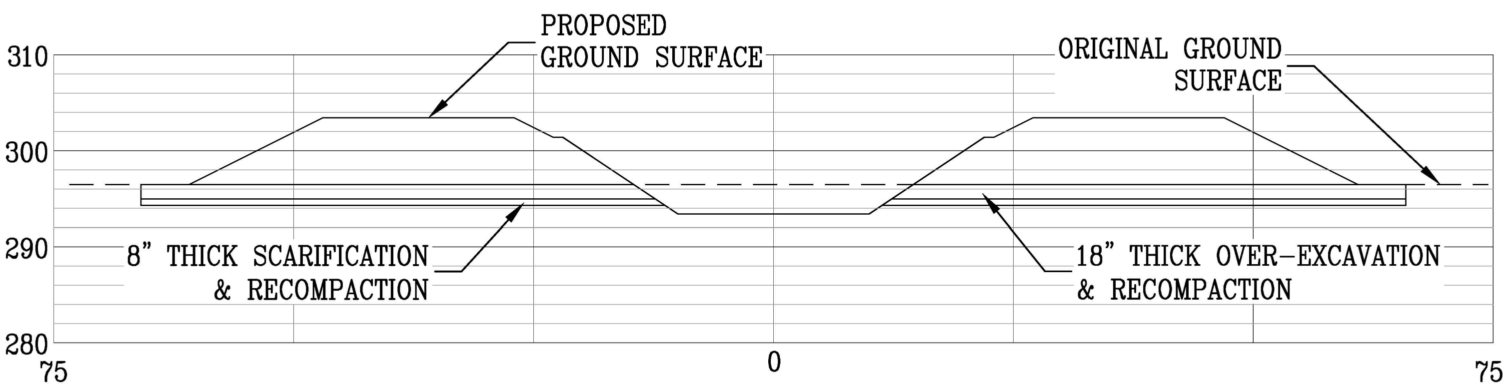
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 326.6 CF/LF
"NEAT LINE" FILL AREA 32.2 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 298+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 62.1 CF/LF
"NEAT LINE" FILL AREA 511.2 CF/LF
OVER-EXCAVATION 162.0 CF/LF

STA 308+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 75.0 CF/LF
"NEAT LINE" FILL AREA 448.8 CF/LF
OVER-EXCAVATION 161.4 CF/LF

STA 318+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
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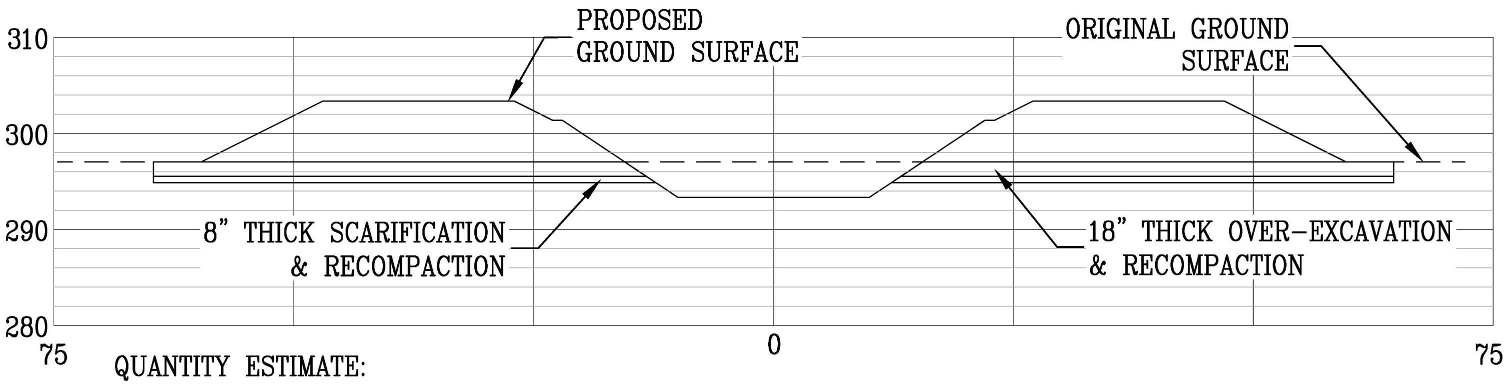
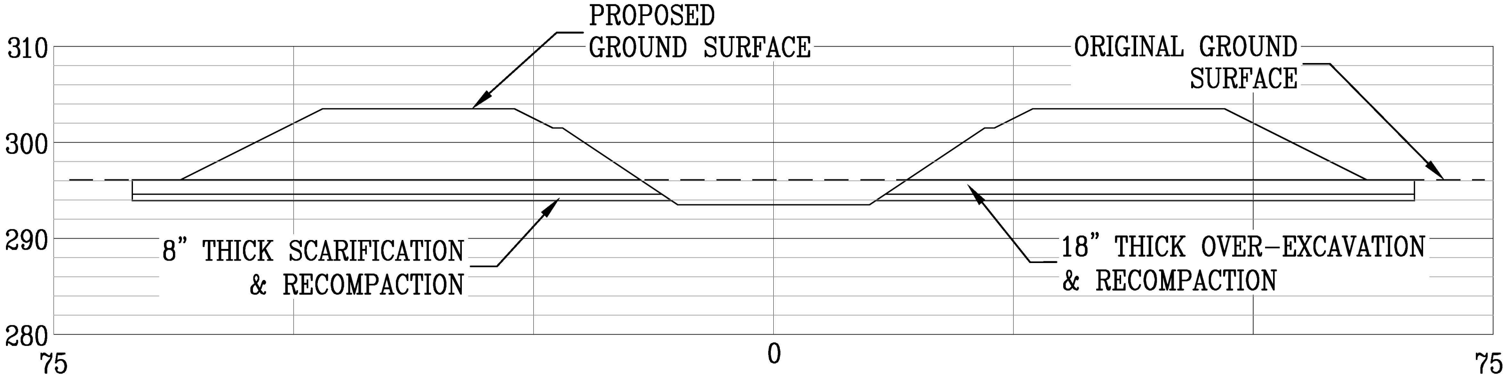


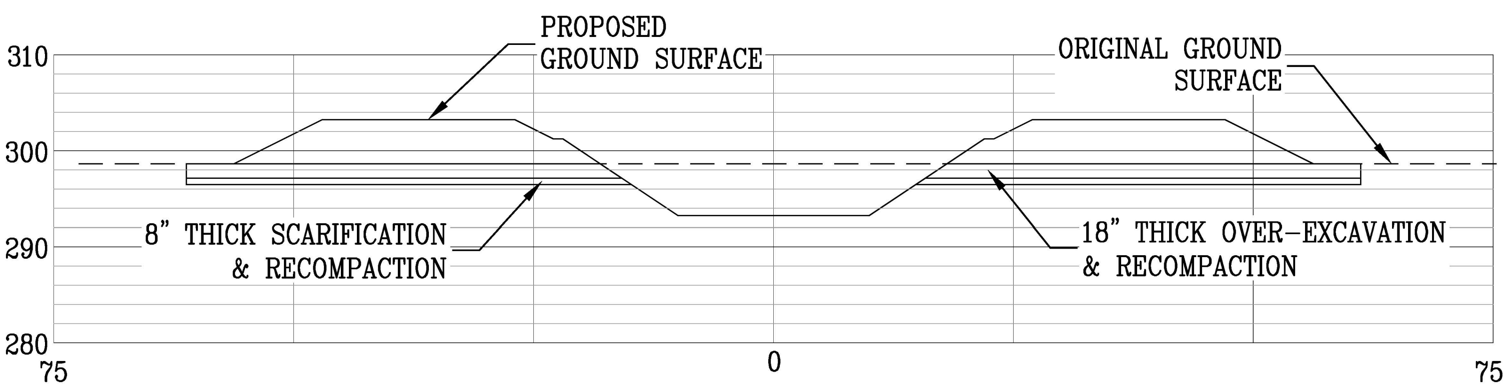
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 94.5 CF/LF
"NEAT LINE" FILL AREA 410.1 CF/LF
OVER-EXCAVATION 150.5 CF/LF

STA 328+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 91.4 CF/LF
"NEAT LINE" FILL AREA 419.0 CF/LF
OVER-EXCAVATION 151.6 CF/LF

STA 338+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 151.7 CF/LF
"NEAT LINE" FILL AREA 270.6 CF/LF
OVER-EXCAVATION 132.6 CF/LF

STA 348+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
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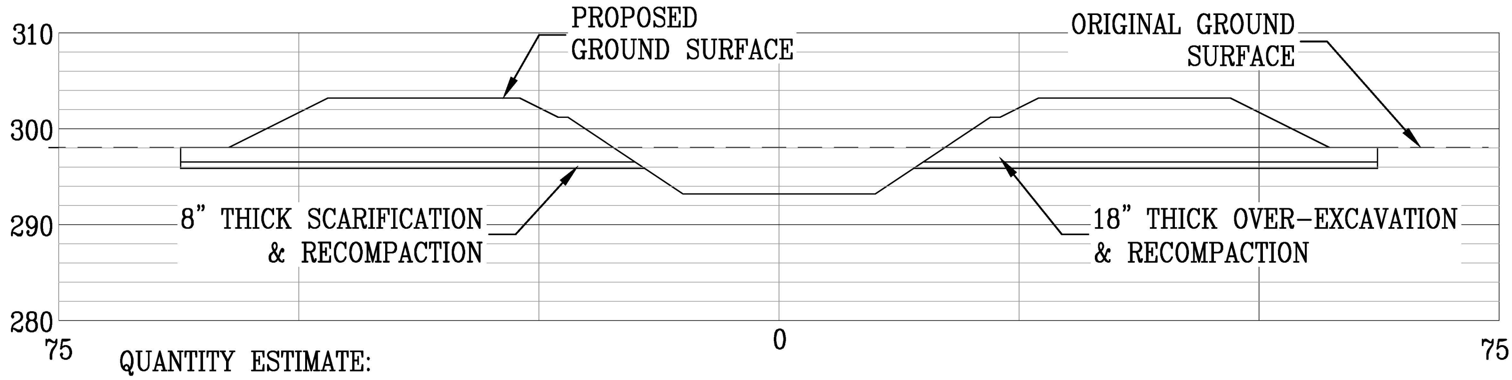
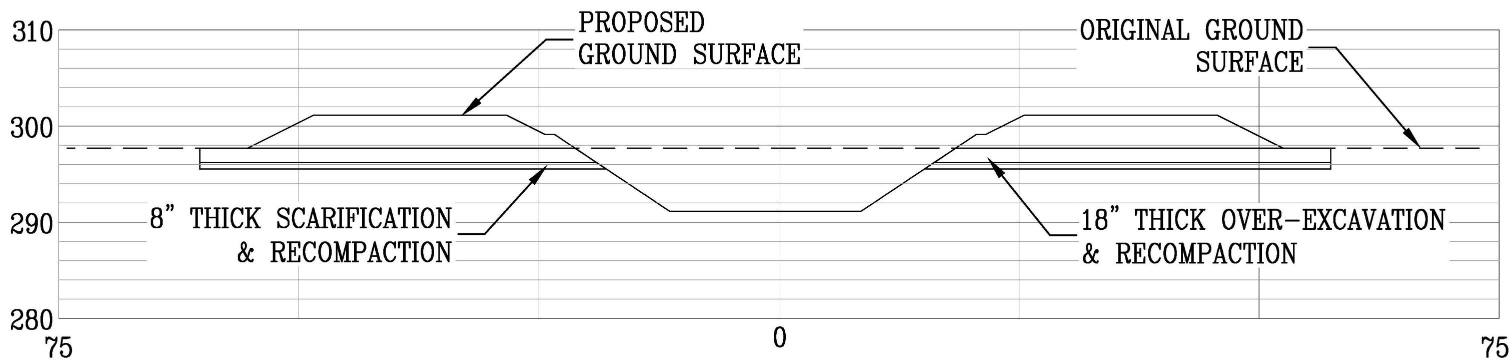
FAX 559 783-9275



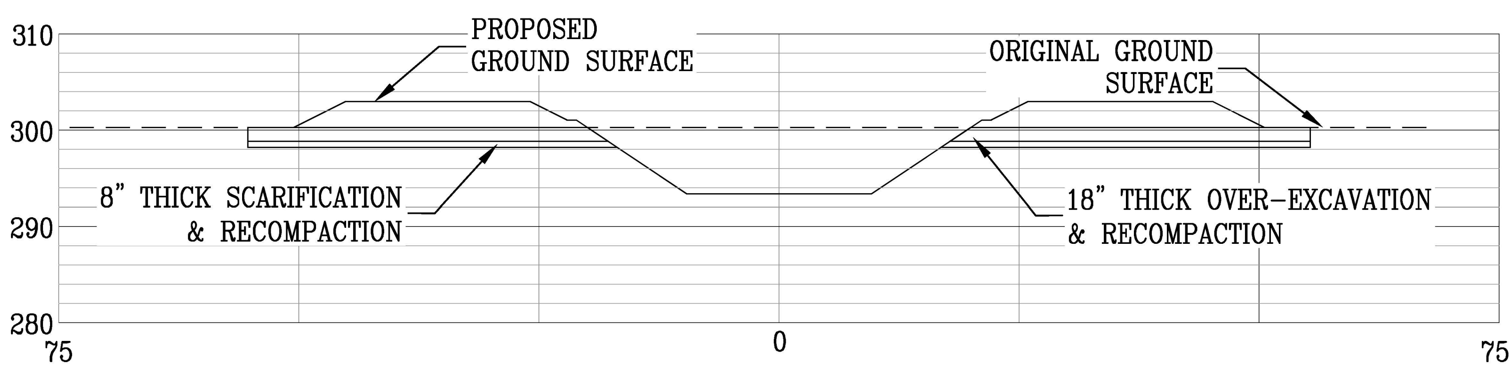
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 132.3 CF/LF
"NEAT LINE" FILL AREA 313.4 CF/LF
OVER-EXCAVATION 138.4 CF/LF

STA 358+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 195.4 CF/LF
"NEAT LINE" FILL AREA 187.4 CF/LF
OVER-EXCAVATION 120.6 CF/LF

STA 368+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 221.8 CF/LF
"NEAT LINE" FILL AREA 144.6 CF/LF
OVER-EXCAVATION 103.8 CF/LF

STA 378+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

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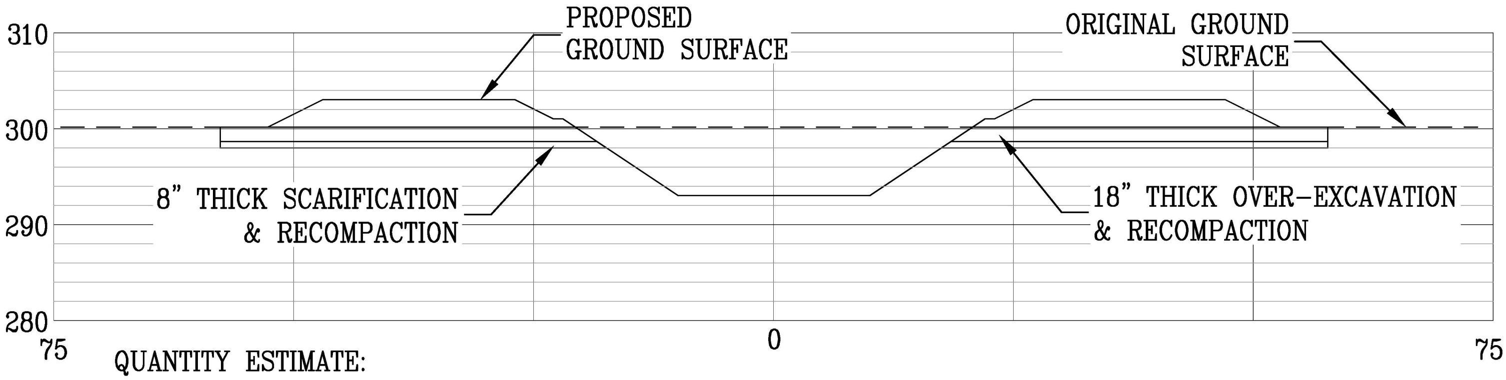

QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 219.7 CF/LF
"NEAT LINE" FILL AREA 147.8 CF/LF
OVER-EXCAVATION 114.3 CF/LF

STA 392+80

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
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REACH 4

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
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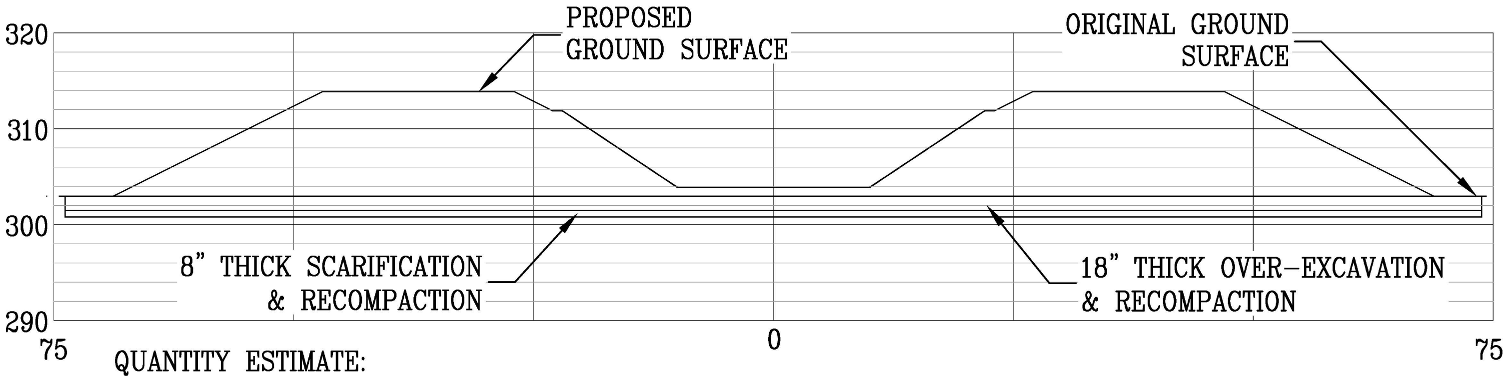
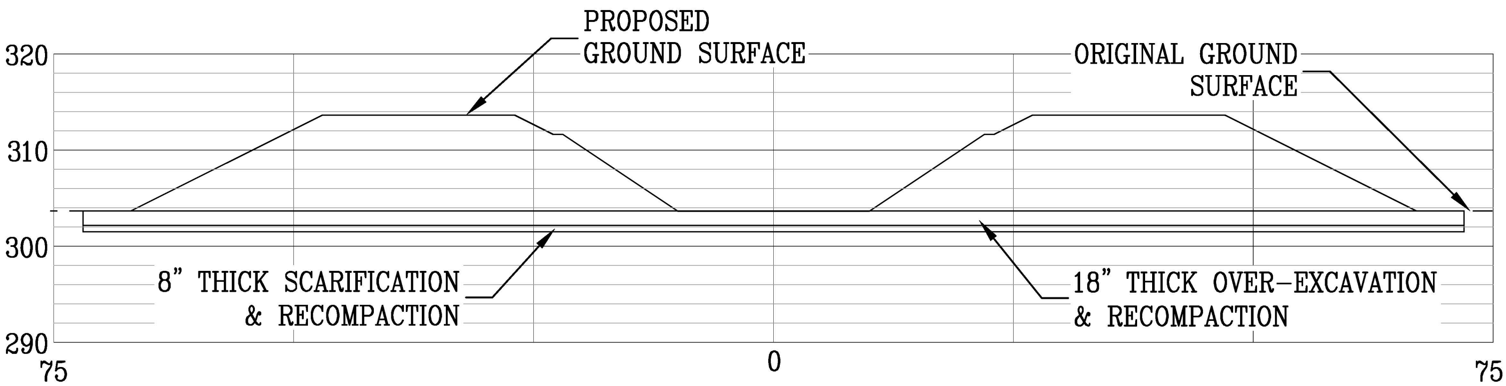
FAX 559 783-9275



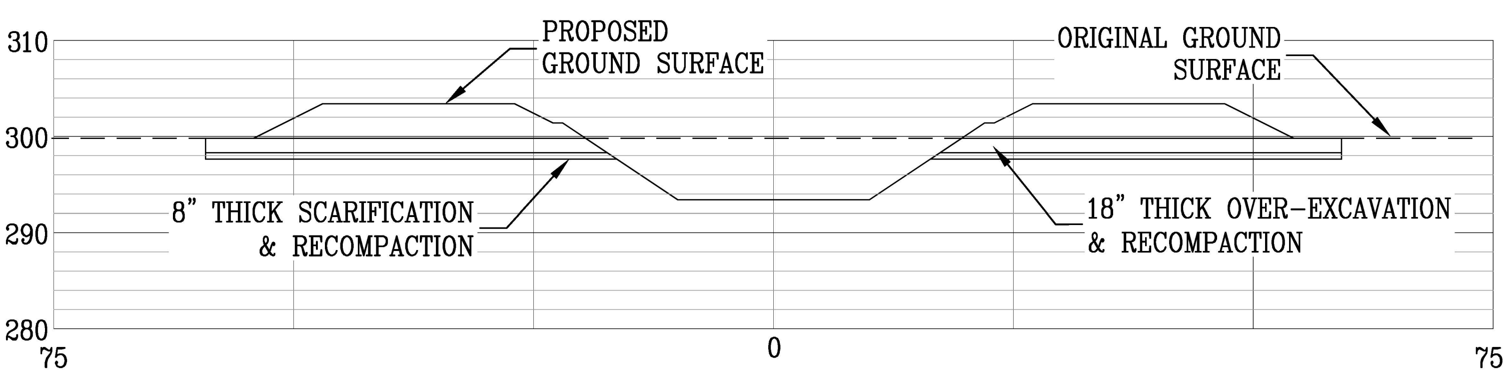
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA <u>0 CF/LF</u>
"NEAT LINE" FILL AREA <u>906.2 CF/LF</u>
OVER-EXCAVATION <u>221.4 CF/LF</u>

STA 393+60



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA <u>0 CF/LF</u>
"NEAT LINE" FILL AREA <u>781.7 CF/LF</u>
OVER-EXCAVATION <u>215.9 CF/LF</u>

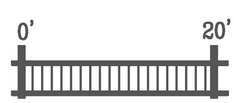
STA 406+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA <u>189.4 CF/LF</u>
"NEAT LINE" FILL AREA <u>197.8 CF/LF</u>
OVER-EXCAVATION <u>122.2 CF/LF</u>

STA 416+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS



SCALE: 1"= 20'

DEE JASPAR & ASSOCIATES, INC.
CIVIL • ENGINEERS
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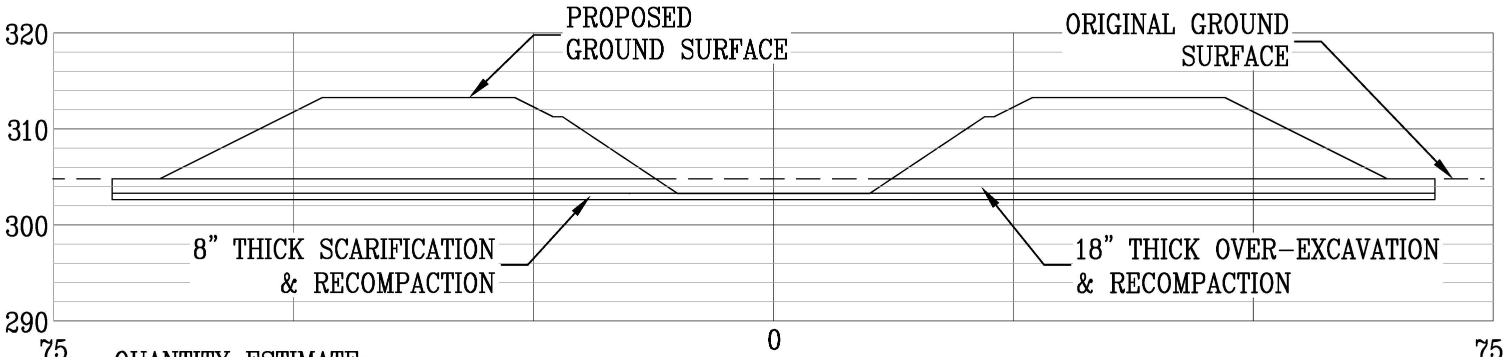
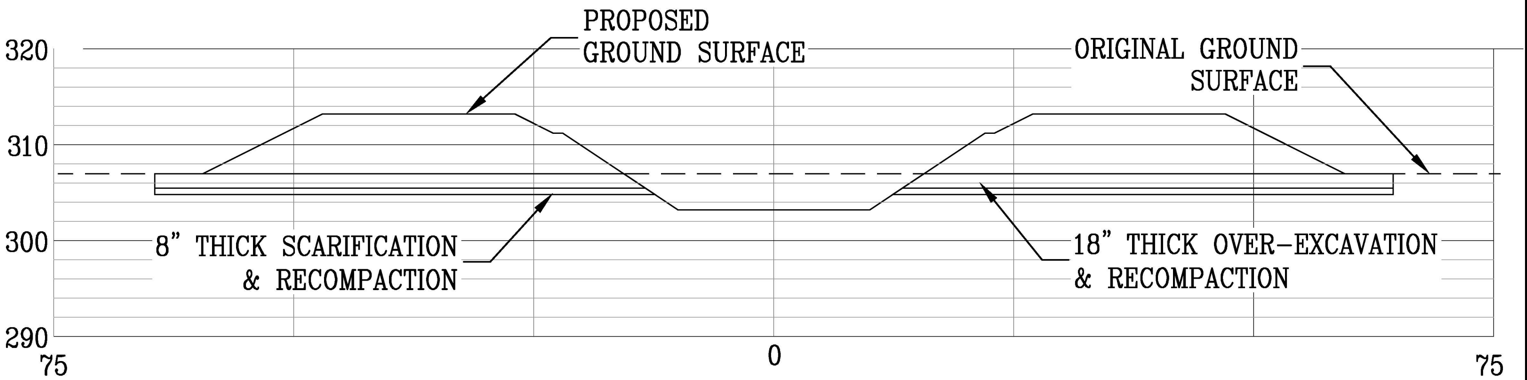


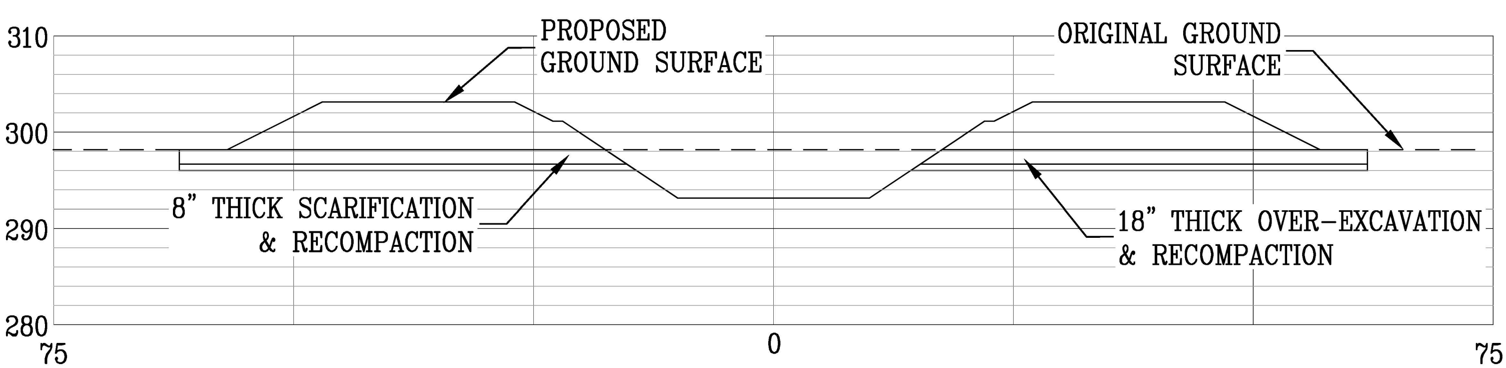
QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 34.4 CF/LF
"NEAT LINE" FILL AREA 616.7 CF/LF
OVER-EXCAVATION 161.2 CF/LF

STA 426+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 96.1 CF/LF
"NEAT LINE" FILL AREA 405.7 CF/LF
OVER-EXCAVATION 150.0 CF/LF

STA 436+00



QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 139.3 CF/LF
"NEAT LINE" FILL AREA 297.6 CF/LF
OVER-EXCAVATION 136.4 CF/LF

STA 446+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

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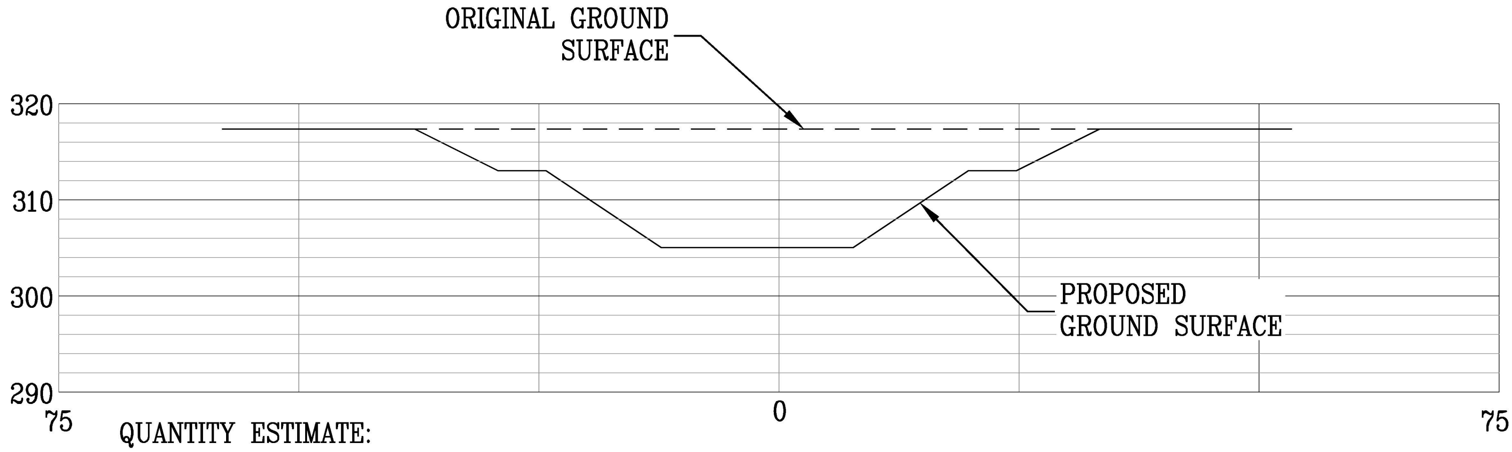

QUANTITY ESTIMATE:
"NEAT LINE" CUT AREA 528.7 CF/LF
"NEAT LINE" FILL AREA 0 CF/LF
OVER-EXCAVATION 0 CF/LF

STA 464+00

Kern Fan Groundwater Storage Project
CANAL CROSS-SECTIONS

0' 20'
SCALE: 1"= 20'

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Appendix B

Quantity Calculations

IRVINE RANCH / ROSEDALE RIO BRAVO WATER STORAGE DISTRICT								
KERN FAN GROUNDWATER STORAGE PROJECT - CONVEYANCE CHANNEL (1.5:1 SLOPES)								
EARTHWORK VOLUME CALCULATIONS								
			END AREA		AVG END AREA		VOLUME	
STATION	DESC	DIST	CUT (ft2)	FILL (ft2)	CUT (ft2)	FILL (ft2)	CUT (yd3)	FILL (yd3)
-	BEGIN CANAL		112.1	362.7				
		604			389.9	181.4	8,722	4,057
604			667.7	-				
		600			333.9	503.9	7,419	11,197
1,204			-	1,007.7				
		600			-	957.0	-	21,266
1,804			-	906.2				
		1,000			-	878.9	-	32,550
2,804			-	851.5				
		1,000			-	878.9	-	32,550
3,804			-	906.2				
		1,000			-	913.1	-	33,819
4,804			-	920.0				
		1,000			-	940.8	-	34,844
5,804			-	961.6				
		1,000			-	899.8	-	33,324
6,804			-	837.9				
		1,000			-	858.4	-	31,791
7,804			-	878.8				
		776			201.8	439.4	5,798	12,629
8,580	BEGIN SIPHON		403.5	-				
8,900	END SIPHON		236.5	122.8				
		1,055			258.9	96.9	10,116	3,786
9,955			281.3	71.0				
		1,020			254.3	103.7	9,605	3,918
10,975			227.2	136.4				
		1,000			241.6	116.2	8,948	4,304
11,975			256.0	96.0				
		1,035			397.8	48.0	15,247	1,840
13,010	BEGIN SIPHON		539.5	-				
13,335	END SIPHON		248.6	106.0				
		525			248.6	106.0	4,834	2,061
13,860	BEGIN SIPHON		248.6	106.0				
14,185	END SIPHON		297.6	56.2				
		75			297.6	56.2	827	156
14,260	PP#1 FOREBAY		297.6	56.2				
					REACH 1 SUBTOTAL		71,517	264,090
14,340	PP#1 AFTERBAY		-	865.1				
		1,000			48.1	635.4	1,780	23,533
15,340			96.1	405.7				
		1,000			172.8	255.3	6,398	9,454
16,340			249.4	104.8				
		1,000			124.7	475.9	4,619	17,626
17,340			-	847.0				
		1,000			-	913.5	-	33,831
18,340			-	979.9				
		1,000			-	1,015.7	-	37,619
19,340			-	1,051.5				
		1,000			27.0	795.8	998	29,472
20,340			53.9	540.0				
		1,430			75.0	472.9	3,972	25,044
21,770	BEGIN SIPHON		96.1	405.7				

			END AREA		AVG END AREA		VOLUME	
STATION	**DESC**	**DIST**	**CUT (ft2)**	**FILL (ft2)**	**CUT (ft2)**	**FILL (ft2)**	**CUT (yd3)**	**FILL (yd3)**
22,190	END SIPHON		99.2	397.0				
		1,040			184.4	239.6	7,103	9,229
23,230			269.6	82.2				
		1,000			295.2	59.6	10,931	2,206
24,230			320.7	36.9				
		1,040			352.6	18.5	13,582	711
25,270	BEGIN SIPHON		384.5	-				
25,690	END SIPHON		511.0	-				
		1,030			511.0	-	19,494	-
26,720	PP#2 FOREBAY		511.0	-				
						REACH 2 SUBTOTAL	68,876	188,724
26,700	PP#2 AFTERBAY		22.7	668.2				
		1,100			28.1	644.5	1,143	26,257
27,800			33.4	620.8				
		1,000			128.6	381.1	4,763	14,115
28,800			223.8	141.4				
		1,000			275.2	86.8	10,193	3,215
29,800			326.6	32.2				
		1,000			194.4	271.7	7,198	10,063
30,800			62.1	511.2				
		1,000			68.6	480.0	2,539	17,778
31,800			75.0	448.8				
		1,000			84.8	429.5	3,139	15,906
32,800			94.5	410.1				
		1,000			93.0	414.6	3,443	15,354
33,800			91.4	419.0				
		1,000			121.6	344.8	4,502	12,770
34,800			151.7	270.6				
		1,000			142.0	292.0	5,259	10,815
35,800			132.3	313.4				
		1,000			163.9	250.4	6,069	9,274
36,800			195.4	187.4				
		1,000			208.6	166.0	7,726	6,148
37,800			221.8	144.6				
		1,480			220.8	146.2	12,100	8,014
39,280	PP#3 FOREBAY		219.7	147.8				
						REACH 3 SUBTOTAL	68,073	149,708
39,360	PP#3 AFTER BAY		-	906.2				
		1,240			-	844.0	-	38,759
40,600			-	781.7				
		1,000			94.7	489.8	3,507	18,139
41,600			189.4	197.8				
		1,000			111.9	407.3	4,144	15,083
42,600			34.4	616.7				
		1,000			65.3	511.2	2,417	18,933
43,600			96.1	405.7				
		1,000			117.7	351.7	4,359	13,024
44,600			139.3	297.6				
		1,800			320.0	148.8	21,333	9,920
46,400			528.7	-				
						REACH 4 SUBTOTAL	35,761	113,859
						TOTALS	244,227	716,381

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IRVINE RANCH / ROSEDALE RIO BRAVO WATER STORAGE DISTRICT
KERN FAN GROUNDWATER STORAGE PROJECT - SUBGRADE PREPARATION (1.5:1 SLOPE)
EARTHWORK VOLUME CALCULATIONS

			END AREA		AVG END AREA		VOLUME	
STATION	**DESC**	**DIST**	**CUT (ft2)**	**FILL (ft2)**	**CUT (ft2)**	**FILL (ft2)**	**CUT (yd3)**	**FILL (yd3)**
-	BEGIN CANAL		144.8	144.8				
		604			72.4	72.4	1,620	1,620
604			-	-				
		600			112.9	112.9	2,509	2,509
1,204			225.8	225.8				
		600			223.6	223.6	4,969	4,969
1,804			221.4	221.4				
		1,000			220.2	220.2	8,156	8,156
2,804			219.0	219.0				
		1,000			220.2	220.2	8,156	8,156
3,804			221.4	221.4				
		1,000			221.7	221.7	8,211	8,211
4,804			222.0	222.0				
		1,000			222.9	222.9	8,256	8,256
5,804			223.8	223.8				
		1,000			221.1	221.1	8,189	8,189
6,804			218.4	218.4				
		1,000			219.3	219.3	8,122	8,122
7,804			220.2	220.2				
		776			110.1	110.1	3,164	3,164
8,580	BEGIN SIPHON		-	-				
8,900	END SIPHON		110.1	110.1				
		1,055			55.1	55.1	2,151	2,151
9,955			-	-				
		1,020			56.2	56.2	2,123	2,123
10,975			112.4	112.4				
		1,000			108.9	108.9	4,033	4,033
11,975			105.4	105.4				
		1,035			52.7	52.7	2,020	2,020
13,010	BEGIN SIPHON		-	-				
13,335	END SIPHON		107.2	107.2				
		525			107.2	107.2	2,084	2,084
13,860	BEGIN SIPHON		107.2	107.2				
14,185	END SIPHON		-	-				
		75			-	-	-	-
14,260	PP#1 FOREBAY		-	-				
					REACH 1 SUBTOTAL		73,763	73,763
14,340	PP#1 AFTERBAY		219.6	219.6				
		1,000			184.8	184.8	6,844	6,844
15,340			150.0	150.0				
		1,000			128.5	128.5	4,759	4,759
16,340			107.0	107.0				
		1,000			163.0	163.0	6,035	6,035
17,340			218.9	218.9				
		1,000			221.8	221.8	8,213	8,213
18,340			224.6	224.6				
		1,000			226.0	226.0	8,370	8,370
19,340			227.4	227.4				
		1,000			196.3	196.3	7,270	7,270
20,340			165.2	165.2				
		1,430			157.6	157.6	8,347	8,347
21,770	BEGIN SIPHON		150.0	150.0				

			END AREA		AVG END AREA		VOLUME	
STATION	**DESC**	**DIST**	**CUT (ft2)**	**FILL (ft2)**	**CUT (ft2)**	**FILL (ft2)**	**CUT (yd3)**	**FILL (yd3)**
22,190	END SIPHON		149.0	149.0				
		1,040			74.5	74.5	2,870	2,870
23,230			-	-				
		1,000			-	-	-	-
24,230			-	-				
		1,040			-	-	-	-
25,270	BEGIN SIPHON		-	-				
25,690	END SIPHON		-	-				
		1,030			-	-	-	-
26,720	PP#2 FOREBAY		-	-				
						REACH 2 SUBTOTAL	52,709	52,709
26,700	PP#2 AFTERBAY		187.0	187.0				
		1,100			180.4	180.4	7,350	7,350
27,800			173.8	173.8				
		1,000			143.5	143.5	5,315	5,315
28,800			113.2	113.2				
		1,000			56.6	56.6	2,096	2,096
29,800			-	-				
		1,000			81.0	81.0	3,000	3,000
30,800			162.0	162.0				
		1,000			161.7	161.7	5,989	5,989
31,800			161.4	161.4				
		1,000			156.0	156.0	5,776	5,776
32,800			150.5	150.5				
		1,000			151.1	151.1	5,594	5,594
33,800			151.6	151.6				
		1,000			142.1	142.1	5,263	5,263
34,800			132.6	132.6				
		1,000			135.5	135.5	5,019	5,019
35,800			138.4	138.4				
		1,000			129.5	129.5	4,796	4,796
36,800			120.6	120.6				
		1,000			112.2	112.2	4,156	4,156
37,800			103.8	103.8				
		1,480			109.1	109.1	5,978	5,978
39,280	PP#3 FOREBAY		114.3	114.3				
						REACH 3 SUBTOTAL	60,331	60,331
39,360	PP#3 AFTER BAY		221.4	221.4				
		1,240			218.7	218.7	10,042	10,042
40,600			215.9	215.9				
		1,000			169.1	169.1	6,261	6,261
41,600			122.2	122.2				
		1,000			141.7	141.7	5,248	5,248
42,600			161.2	161.2				
		1,000			155.6	155.6	5,763	5,763
43,600			150.0	150.0				
		1,000			143.2	143.2	5,304	5,304
44,600			136.4	136.4				
		1,800			68.2	68.2	4,547	4,547
46,400			-	-				
						REACH 4 SUBTOTAL	37,164	37,164
						TOTALS	223,967	223,967

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IRVINE RANCH / ROSEDALE RIO BRAVO WATER STORAGE DISTRICT								
KERN FAN GROUNDWATER STORAGE PROJECT - CONVEYANCE CANAL (EARTHLINED 3:1 SLOPES)								
EARTHWORK VOLUME CALCULATIONS								
			END AREA		AVG END AREA		VOLUME	
STATION	**DESC**	**DIST**	**CUT (ft2)**	**FILL (ft2)**	**CUT (ft2)**	**FILL (ft2)**	**CUT (yd3)**	**FILL (yd3)**
-	BEGIN CANAL		242.2	383.8				
		604			688.6	191.9	15,403	4,293
604			1,134.9	-				
		600			571.4	559.1	12,697	12,424
1,204			7.8	1,118.2				
		600			16.7	1,063.3	371	23,628
1,804			25.6	1,008.3				
		1,000			31.2	979.3	1,156	36,270
2,804			36.8	950.3				
		1,000			31.2	979.3	1,156	36,270
3,804			25.6	1,008.3				
		1,000			24.3	1,015.7	900	37,617
4,804			23.0	1,023.0				
		1,000			19.3	1,045.5	713	38,720
5,804			15.5	1,067.9				
		1,000			27.6	1,002.0	1,022	37,109
6,804			39.7	936.0				
		1,000			35.4	957.5	1,311	35,463
7,804			31.1	979.0				
		776			384.3	489.5	11,045	14,069
8,580	BEGIN SIPHON		737.5	-				
8,900	END SIPHON		464.6	123.1				
		1,055			503.2	97.1	19,662	3,792
9,955			541.8	71.0				
		1,020			494.8	104.1	18,691	3,931
10,975			447.7	137.1				
		1,000			473.9	116.6	17,550	4,317
11,975			500.0	96.0				
		1,035			722.8	48.0	27,705	1,840
13,010	BEGIN SIPHON		945.5	-				
13,335	END SIPHON		486.5	106.0				
		525			486.5	106.0	9,460	2,061
13,860	BEGIN SIPHON		486.5	106.0				
14,185	END SIPHON		568.6	56.2				
		75			568.7	56.2	1,580	156
14,260	PP#1 FOREBAY		568.8	56.2				
					REACH 1 SUBTOTAL		140,421	291,960
14,340	PP#1 AFTERBAY		33.9	964.6				
		1,000			124.1	698.7	4,594	25,878
15,340			214.2	432.8				
		1,000			351.2	268.8	13,006	9,956
16,340			488.1	104.8				
		1,000			262.8	525.7	9,733	19,470
17,340			37.5	946.6				
		1,000			25.0	1,017.1	924	37,670
18,340			12.4	1,087.6				
		1,000			6.2	1,127.1	230	41,743
19,340			-	1,166.5				
		1,000			70.8	877.8	2,620	32,511
20,340			141.5	589.1				
		1,430			177.9	511.0	9,419	27,061
21,770	BEGIN SIPHON		214.2	432.8				

			END AREA		AVG END AREA		VOLUME	
STATION	**DESC**	**DIST**	**CUT (ft2)**	**FILL (ft2)**	**CUT (ft2)**	**FILL (ft2)**	**CUT (yd3)**	**FILL (yd3)**
22,190	END SIPHON		219.8	422.8				
		1,040			371.2	252.5	14,298	9,726
23,230			522.6	82.2				
		1,000			564.4	59.3	20,902	2,196
24,230			606.1	36.4				
		1,040			656.9	18.2	25,303	701
25,270	BEGIN SIPHON		707.7	-				
25,690	END SIPHON		902.6	-				
		1,030			902.6	-	34,433	-
26,720	PP#2 FOREBAY		902.6	-				
						REACH 2 SUBTOTAL	135,462	206,912
26,700	PP#2 AFTERBAY		88.9	740.6				
		1,100			97.9	712.4	3,986	29,024
27,800			106.8	684.2				
		1,000			274.3	413.3	10,157	15,306
28,800			441.7	142.3				
		1,000			528.7	87.3	19,580	3,231
29,800			615.6	32.2				
		1,000			385.6	293.6	14,280	10,874
30,800			155.5	555.0				
		1,000			166.5	530.3	6,167	19,641
31,800			177.5	505.6				
		1,000			194.5	471.7	7,204	17,470
32,800			211.5	437.8				
		1,000			208.8	442.9	7,733	16,404
33,800			206.1	448.0				
		1,000			259.2	364.3	9,600	13,493
34,800			312.3	280.6				
		1,000			295.1	304.5	10,928	11,276
35,800			277.8	328.3				
		1,000			334.1	259.5	12,372	9,609
36,800			390.3	190.6				
		1,000			414.1	168.1	15,337	6,226
37,800			437.9	145.6				
		1,480			436.1	147.3	23,902	8,071
39,280	PP#3 FOREBAY		434.2	148.9				
						REACH 3 SUBTOTAL	141,246	160,625
39,360	PP#3 AFTER BAY		25.6	1,008.2				
		1,240			39.1	942.7	1,796	43,294
40,600			52.6	877.2				
		1,000			216.2	539.4	8,006	19,978
41,600			379.7	201.6				
		1,000			244.1	440.5	9,039	16,315
42,600			108.4	679.4				
		1,000			161.3	556.1	5,974	20,596
43,600			214.2	432.8				
		1,000			252.2	371.7	9,339	13,767
44,600			290.1	310.6				
		1,800			320.0	155.3	21,333	10,353
46,400			929.3	-				
						REACH 4 SUBTOTAL	55,486	124,303
						TOTALS	472,615	783,801

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IRVINE RANCH / ROSEDALE RIO BRAVO WATER STORAGE DISTRICT								
KERN FAN GROUNDWATER STORAGE PROJECT - SUBGRADE PREPARATION (3:1 SLOPE)								
EARTHWORK VOLUME CALCULATIONS								
			END AREA		AVG END AREA		VOLUME	
STATION	**DESC**	**DIST**	**CUT (ft2)**	**FILL (ft2)**	**CUT (ft2)**	**FILL (ft2)**	**CUT (yd3)**	**FILL (yd3)**
-	BEGIN CANAL		265.0	165.0				
		604			132.5	82.5	2,964	1,846
604			-	-				
		600			136.0	136.0	3,022	3,022
1,204			272.0	272.0				
		600			260.9	260.9	5,798	5,798
1,804			249.8	249.8				
		1,000			243.1	243.1	9,002	9,002
2,804			236.3	236.3				
		1,000			243.1	243.1	9,002	9,002
3,804			249.8	249.8				
		1,000			251.4	251.4	9,311	9,311
4,804			253.0	253.0				
		1,000			257.7	257.7	9,543	9,543
5,804			262.3	262.3				
		1,000			248.6	248.6	9,206	9,206
6,804			234.8	234.8				
		1,000			239.0	239.0	8,850	8,850
7,804			243.1	243.1				
		776			121.6	121.6	3,493	3,493
8,580	BEGIN SIPHON		-	-				
8,900	END SIPHON		115.5	115.5				
		1,055			57.8	57.8	2,257	2,257
9,955			-	-				
		1,020			59.4	59.4	2,244	2,244
10,975			118.8	118.8				
		1,000			113.8	113.8	4,215	4,215
11,975			108.8	108.8				
		1,035			54.4	54.4	2,085	2,085
13,010	BEGIN SIPHON		-	-				
13,335	END SIPHON		111.3	111.3				
		525			111.3	111.3	2,164	2,164
13,860	BEGIN SIPHON		111.3	111.3				
14,185	END SIPHON		-	-				
		75			-	-	-	-
14,260	PP#1 FOREBAY		-	-				
					REACH 1 SUBTOTAL		83,155	82,037
14,340	PP#1 AFTERBAY		239.7	239.7				
		1,000			206.1	206.1	7,633	7,633
15,340			172.5	172.5				
		1,000			141.8	141.8	5,250	5,250
16,340			111.0	111.0				
		1,000			173.4	173.4	6,422	6,422
17,340			235.8	235.8				
		1,000			251.0	251.0	9,294	9,294
18,340			266.1	266.1				
		1,000			273.3	273.3	10,120	10,120
19,340			280.4	280.4				
		1,000			237.4	237.4	8,791	8,791
20,340			194.3	194.3				
		1,430			183.4	183.4	9,713	9,713
21,770	BEGIN SIPHON		172.5	172.5				

			END AREA		AVG END AREA		VOLUME	
STATION	**DESC**	**DIST**	**CUT (ft2)**	**FILL (ft2)**	**CUT (ft2)**	**FILL (ft2)**	**CUT (yd3)**	**FILL (yd3)**
22,190	END SIPHON		171.0	171.0				
		1,040			85.5	85.5	3,293	3,293
23,230			-	-				
		1,000			-	-	-	-
24,230			-	-				
		1,040			-	-	-	-
25,270	BEGIN SIPHON		-	-				
25,690	END SIPHON		-	-				
		1,030			-	-	-	-
26,720	PP#2 FOREBAY		-	-				
					REACH 2 SUBTOTAL		60,518	60,518
26,700	PP#2 AFTERBAY		213.0	213.0				
		1,100			209.7	209.7	8,541	8,541
27,800			206.3	206.3				
		1,000			163.2	163.2	6,043	6,043
28,800			120.0	120.0				
		1,000			60.0	60.0	2,222	2,222
29,800			-	-				
		1,000			94.9	94.9	3,515	3,515
30,800			189.8	189.8				
		1,000			186.4	186.4	6,904	6,904
31,800			183.0	183.0				
		1,000			178.2	178.2	6,598	6,598
32,800			173.3	173.3				
		1,000			174.1	174.1	6,446	6,446
33,800			174.8	174.8				
		1,000			161.3	161.3	5,974	5,974
34,800			147.8	147.8				
		1,000			151.9	151.9	5,626	5,626
35,800			156.0	156.0				
		1,000			143.3	143.3	5,306	5,306
36,800			130.5	130.5				
		1,000			125.7	125.7	4,654	4,654
37,800			120.8	120.8				
		1,480			121.2	121.2	6,641	6,641
39,280	PP#3 FOREBAY		121.5	121.5				
					REACH 3 SUBTOTAL		68,469	68,469
39,360	PP#3 AFTER BAY		249.8	249.8				
		1,240			239.2	239.2	10,983	10,983
40,600			228.5	228.5				
		1,000			180.7	180.7	6,691	6,691
41,600			132.8	132.8				
		1,000			169.3	169.3	6,269	6,269
42,600			205.7	205.7				
		1,000			189.1	189.1	7,004	7,004
43,600			172.5	172.5				
		1,000			162.8	162.8	6,028	6,028
44,600			153.0	153.0				
		1,800			76.5	76.5	5,100	5,100
46,400			-	-				
					REACH 4 SUBTOTAL		42,074	42,074
					TOTALS		254,216	253,098

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Appendix C

Present Worth Analysis

Kern Fan Proje

Earth Lined Can

Alternative No. 1 - Earth Lined Canal (3:1 Side Slopes)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
CAPITAL COST	**$ 56,763,716**																					
O&M COSTS	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
Recovery Well Pumping Costs[1]	$ -	$ -	$ -	$ -	$ 5,683,819	$ 5,854,333	$ 6,029,963	$ -	$ -	$ -	.	$ -	$ -	$ -	$ 7,638,577	$ 7,867,734	$ 8,103,766	$ -	$ -	$ -	$ -	$ -
Canal Operation Costs[2]	$ 138,200	$ 142,346	$ 3,382,929	$ 151,015	$ 419,019	$ 431,590	$ 444,537	$ 169,969	$ 4,039,394	$ 180,320	$ 185,729	$ 191,301	$ 4,546,374	$ 202,951	$ 563,127	$ 580,020	$ 597,421	$ 228,424	$ 5,428,608	$ 242,335	$ 249,605	$ 257,093
Pump Station No. 1 Replacement Costs[3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 2 Replacement Costs[3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 3 Replacement Costs[4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Return Water Pump Station Replacement Costs[5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Liner Replacement or Repairs[6]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Operating Cost	$ 138,200	$ 142,346	$ 3,382,929	$ 151,015	$ 6,102,838	$ 6,285,923	$ 6,474,501	$ 169,969	$ 4,039,394	$ 180,320	$ 185,729	$ 191,301	$ 4,546,374	$ 202,951	$ 8,201,704	$ 8,447,755	$ 8,701,187	$ 228,424	$ 5,428,608	$ 242,335	$ 249,605	$ 257,093
Capital Recovery @ 3.0% / 20yrs.	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ 3,815,413	$ -	$ -
Total Annual Costs	$ 3,953,613	$ 3,957,759	$ 7,198,342	$ 3,966,428	$ 9,918,251	$ 10,101,336	$ 10,289,914	$ 3,985,382	$ 7,854,807	$ 3,995,733	$ 4,001,143	$ 4,006,714	$ 8,361,787	$ 4,018,365	$ 12,017,117	$ 12,263,168	$ 12,516,601	$ 4,043,837	$ 9,244,021	$ 4,057,748	$ 249,605	$ 257,093
Average Monthly Cost	$ 329,468	$ 329,813	$ 599,862	$ 330,536	$ 826,521	$ 841,778	$ 857,493	$ 332,115	$ 654,567	$ 332,978	$ 333,429	$ 333,893	$ 696,816	$ 334,864	$ 1,001,426	$ 1,021,931	$ 1,043,050	$ 336,986	$ 770,335	$ 338,146	$ 20,800	$ 21,424
Equivilant Average Monthly Cost	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ 1,103,528	$ -	$ -
Present Worth of Op. Costs @ 3%	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 5,422,292	$ 5,422,292	$ 5,422,292	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 5,422,292	$ 5,422,292	$ 5,422,292	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200
Present Worth of Op. Costs	**$ 140,248,735**																					
Present Worth of Capital + Op. Costs	**$ 197,012,451**																					

[1]Recovery well pumping costs in dry year estimated as $4,902,912 per Section III. for 16 wells and increased for inflation at 3% per year.

[2]Canal operation costs based on 1) Idle Year = O&M Cost Estimate $69,100 per year x 2 due to increased canal maintenance for tumbleweeds and rodent holes; 2) Wet Year = O&M Cost Estimate based on $9,000 per month, $158.33 per month, and $404,296.88 per month for four months plus energy costs for three pump stations each with a 20-ft lift to move 112,500 ac-ft = $1,488,848 plus 8 idle months of $46,067; and 3) Dry Year = O&M Cost Estimate based on $8,000 per mo

[3]Pump Station replacement costs include pump and motor replacement at $2,222,000, VFD's at $700,000, electrical and control equipment at $900,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[4]Pump Station replacement costs include pump and motor replacement at $1,287,000, VFD's at $420,000, electrical and control equipment at $565,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[5]Pump Station replacement costs include pump and motor replacement at $540,000, VFD's at $150,000, electrical and control equipment at $565,000, and cathodic protection at $15,000. Costs increased for inflation at 3% per year.

[6]No liner replacement or repairs as part of the earth lined canal alternative.

ct

al

23	24	25	26	27	28	29	30	31
2042	2043	2044	2045	2046	2047	2048	2049	2050
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year
$ -	$ -	$ 10,265,609	$ 10,573,577	$ 10,890,785	$ -	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 756,795	$ 779,499	$ 802,884	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 5,350,314	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 2,581,649	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 34,980,915	$ 11,353,076	$ 11,693,668	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 34,980,915	$ 11,353,076	$ 11,693,668	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448
$ 509,162	$ 22,729	$ 2,915,076	$ 946,090	$ 974,472	$ 25,582	$ 607,966	$ 27,140	$ 27,954
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,188,735	$ 138,200	$ 17,208,292	$ 5,422,292	$ 5,422,292	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200

32	33	34	35	36	37	38	39	40
2051	2052	2053	2054	2055	2056	2057	2058	2059
Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ -	$ -	$ -	$ 13,796,120	$ 14,210,004	$ 14,636,304	$ -	$ -	$ -
$ 345,511	$ 8,211,257	$ 366,553	$ 1,017,069	$ 1,047,581	$ 1,079,009	$ 412,558	$ 9,804,670	$ 437,683
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 345,511	$ 8,211,257	$ 366,553	$ 14,813,189	$ 15,257,585	$ 15,715,312	$ 412,558	$ 9,804,670	$ 437,683
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 345,511	$ 8,211,257	$ 366,553	$ 14,813,189	$ 15,257,585	$ 15,715,312	$ 412,558	$ 9,804,670	$ 437,683
$ 28,793	$ 684,271	$ 30,546	$ 1,234,432	$ 1,271,465	$ 1,309,609	$ 34,380	$ 817,056	$ 36,474
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 138,200	$ 3,188,735	$ 138,200	$ 5,422,292	$ 5,422,292	$ 5,422,292	$ 138,200	$ 3,188,735	$ 138,200

41	42	43	44	45	46	47	48	49	50
2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ -	$ -	$ -	$ -	$ 18,540,832	$ 19,097,057	$ 19,669,968	$ -	$ -	$ -
$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 1,366,856	$ 1,407,862	$ 1,450,098	$ 554,444	$ 13,176,656	$ 588,210
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,202,370
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,405,399
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 19,907,688	$ 20,504,918	$ 21,120,066	$ 554,444	$ 13,176,656	$ 50,752,012
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 19,907,688	$ 20,504,918	$ 21,120,066	$ 554,444	$ 13,176,656	$ 50,752,012
$ 37,568	$ 38,695	$ 919,604	$ 41,051	$ 1,658,974	$ 1,708,743	$ 1,760,005	$ 46,204	$ 1,098,055	$ 4,229,334
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 5,422,292	$ 5,422,292	$ 5,422,292	$ 138,200	$ 3,188,735	$ 11,924,200

nth, $52.78 per month, and energy cost for Return Water Pump Station for 25-ft lift to move 50,000 ac-ft = $275,660.00. Costs increased for inflation at 3% per year.

Kern Fan Proje

Earth Lined Canal with Ret

Alternative No. 1a - Earth Lined Canal (3:1 Side Slopes) with Return Pipeline	1	2	3	4	5	6	7	8	9	10	11
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CAPITAL COST	**$ 67,282,716**										
O&M COSTS	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ -	$ 4,262,883	$ 4,390,769	$ 4,522,492	$ -	$ -	$ -	.
Canal Operation Costs [2]	$ 138,200	$ 142,346	$ 3,382,929	$ 151,015	$ 419,019	$ 431,590	$ 444,537	$ 169,969	$ 4,039,394	$ 180,320	$ 185,729
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Pump Station No. 2 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Pump Station No. 3 Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Return Water Pump Station Replacement Costs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Liner Replacement or Repairs [6]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Total Annual Operating Cost	$ 138,200	$ 142,346	$ 3,382,929	$ 151,015	$ 4,681,902	$ 4,822,359	$ 4,967,029	$ 169,969	$ 4,039,394	$ 180,320	$ 185,729
Capital Recovery @ 3.0% / 20yrs.	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455
Total Annual Costs	$ 4,660,655	$ 4,664,801	$ 7,905,384	$ 4,673,470	$ 9,204,357	$ 9,344,814	$ 9,489,485	$ 4,692,424	$ 8,561,849	$ 4,702,775	$ 4,708,185
Average Monthly Cost	$ 388,388	$ 388,733	$ 658,782	$ 389,456	$ 767,030	$ 778,735	$ 790,790	$ 391,035	$ 713,487	$ 391,898	$ 392,349
Equivilant Average Monthly Cost	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374
Present Worth of Op. Costs @ 3%	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 4,159,809	$ 4,159,809	$ 4,159,809	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200
Present Worth of Op. Costs	**$ 121,311,485**										
Present Worth of Capital + Op. Costs	**$ 188,594,201**										

Alternative No. 1a - Earth Lined Canal (3:1 Side Slopes) with Return Pipeline	12	13	14	15	16	17	18	19	20	21	22
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
O&M COSTS	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ 5,728,958	$ 5,900,827	$ 6,077,851	$ -	$ -	$ -	$ -	$ -
Canal Operation Costs [2]	$ 191,301	$ 4,546,374	$ 202,951	$ 563,127	$ 580,020	$ 597,421	$ 228,424	$ 5,428,608	$ 242,335	$ 249,605	$ 257,093
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 2 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 3 Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Return Water Pump Station Replacement Costs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Liner Replacement or Repairs [6]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Operating Cost	$ 191,301	$ 4,546,374	$ 202,951	$ 6,292,084	$ 6,480,847	$ 6,675,272	$ 228,424	$ 5,428,608	$ 242,335	$ 249,605	$ 257,093
Capital Recovery @ 3.0% / 20yrs.	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ 4,522,455	$ -	$ -
Total Annual Costs	$ 4,713,756	$ 9,068,829	$ 4,725,407	$ 10,814,540	$ 11,003,302	$ 11,197,728	$ 4,750,879	$ 9,951,063	$ 4,764,790	$ 249,605	$ 257,093
Average Monthly Cost	$ 392,813	$ 755,736	$ 393,784	$ 901,212	$ 916,942	$ 933,144	$ 395,907	$ 829,255	$ 397,066	$ 20,800	$ 21,424
Equivilant Average Monthly Cost	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ 1,056,374	$ -	$ -
Present Worth of Op. Costs @ 3%	$ 138,200	$ 3,188,735	$ 138,200	$ 4,159,809	$ 4,159,809	$ 4,159,809	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200

[1]Recovery well pumping costs in dry year estimated as $3,677,184 per Section III. for 12 wells due to pipeline and increased for inflation at 3% per year.

[2]Canal operation costs based on 1) Idle Year = O&M Cost Estimate $69,100 per year x 2 due to increased canal maintenance for tumbleweeds and rodent holes; 2) Wet Year = O&M Cost Estimate based on $9,000 per month, $158.33 per month, and $404,296.88 per month for four months plus energy costs for three pump stations each with a 20-ft lift to move 112,500 ac-ft = $1,488,848 plus 8 idle months of $46,067; and 3) Dry Year = O&M Cost Estimate based on $8,000 per mo

[3]Pump Station replacement costs include pump and motor replacement at $2,222,000, VFD's at $700,000, electrical and control equipment at $900,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[4]Pump Station replacement costs include pump and motor replacement at $1,287,000, VFD's at $420,000, electrical and control equipment at $565,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[5]Pump Station replacement costs include pump and motor replacement at $540,000, VFD's at $150,000, electrical and control equipment at $565,000, and cathodic protection at $15,000. Costs increased for inflation at 3% per year.

[6]No liner replacement or repairs as part of the earth lined canal alternative.

ct

turn Pipeline

23	24	25	26	27	28	29	30	31	32	33	34	35	36
2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year
$ -	$ -	$ 7,699,240	$ 7,930,217	$ 8,168,124	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,347,135	$ 10,657,549
$ 6,109,946	$ 272,750	$ 756,795	$ 779,499	$ 802,884	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511	$ 8,211,257	$ 366,553	$ 1,017,069	$ 1,047,581
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 5,350,314	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 2,581,649	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 32,414,547	$ 8,709,716	$ 8,971,008	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511	$ 8,211,257	$ 366,553	$ 11,364,204	$ 11,705,130
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 32,414,547	$ 8,709,716	$ 8,971,008	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511	$ 8,211,257	$ 366,553	$ 11,364,204	$ 11,705,130
$ 509,162	$ 22,729	$ 2,701,212	$ 725,810	$ 747,584	$ 25,582	$ 607,966	$ 27,140	$ 27,954	$ 28,793	$ 684,271	$ 30,546	$ 947,017	$ 975,428
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,188,735	$ 138,200	$ 15,945,809	$ 4,159,809	$ 4,159,809	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 4,159,809	$ 4,159,809

37	38	39	40	41	42	43	44	45	46	47	48	49	50
2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ 10,977,276	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,905,684	$ 14,322,855	$ 14,752,540	$ -	$ -	$ -
$ 1,079,009	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 1,366,856	$ 1,407,862	$ 1,450,098	$ 554,444	$ 13,176,656	$ 588,210
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,202,370
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,405,399
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 12,056,284	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 15,272,540	$ 15,730,716	$ 16,202,638	$ 554,444	$ 13,176,656	$ 50,752,012
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 12,056,284	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338	$ 11,035,242	$ 492,616	$ 15,272,540	$ 15,730,716	$ 16,202,638	$ 554,444	$ 13,176,656	$ 50,752,012
$ 1,004,690	$ 34,380	$ 817,056	$ 36,474	$ 37,568	$ 38,695	$ 919,604	$ 41,051	$ 1,272,712	$ 1,310,893	$ 1,350,220	$ 46,204	$ 1,098,055	$ 4,229,334
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 4,159,809	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 4,159,809	$ 4,159,809	$ 4,159,809	$ 138,200	$ 3,188,735	$ 11,924,200

nth, $52.78 per month, and energy cost for Return Water Pump Station for 25-ft lift to move 50,000 ac-ft = $275,660.00. Costs increased for inflation at 3% per year.

Kern Fan Proje

Earth Lined Canal with Ber

Alternative No. 1b - Earth Lined Canal (3:1 Side Slopes) with Bentonite Liner	1	2	3	4	5	6	7	8	9	10	11
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CAPITAL COST	**$ 71,898,932**										
O&M COSTS	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year
Recovery Well Pumping Costs[1]	$ -	$ -	$ -	$ -	$ 4,973,341	$ 5,122,542	$ 5,276,218	$ -	$ -	$ -	.
Canal Operation Costs[2]	$ 138,200	$ 142,346	$ 3,382,929	$ 151,015	$ 419,019	$ 431,590	$ 444,537	$ 169,969	$ 4,039,394	$ 180,320	$ 185,729
Pump Station No. 1 Replacement Costs[3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Pump Station No. 2 Replacement Costs[3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Pump Station No. 3 Replacement Costs[4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Return Water Pump Station Replacement Costs[5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Liner Replacement or Repairs[6]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Total Annual Operating Cost	$ 138,200	$ 142,346	$ 3,382,929	$ 151,015	$ 5,392,360	$ 5,554,131	$ 5,720,755	$ 169,969	$ 4,039,394	$ 180,320	$ 185,729
Capital Recovery @ 3.0% / 20yrs.	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738
Total Annual Costs	$ 4,970,938	$ 4,975,084	$ 8,215,667	$ 4,983,752	$ 10,225,098	$ 10,386,869	$ 10,553,493	$ 5,002,706	$ 8,872,132	$ 5,013,057	$ 5,018,467
Average Monthly Cost	$ 414,245	$ 414,590	$ 684,639	$ 415,313	$ 852,092	$ 865,572	$ 879,458	$ 416,892	$ 739,344	$ 417,755	$ 418,206
Equivilant Average Monthly Cost	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267
Present Worth of Op. Costs @ 3%	$ 138,200	$ 138,200	$ 3,188,735	$ 138,200	$ 4,791,042	$ 4,791,042	$ 4,791,042	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200
Present Worth of Op. Costs	**$ 130,779,987**										
Present Worth of Capital + Op. Costs	**$ 202,678,919**										

Alternative No. 1b - Earth Lined Canal (3:1 Side Slopes) with Bentonite Liner	12	13	14	15	16	17	18	19	20	21	22
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
CAPITAL COST											
O&M COSTS	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
Recovery Well Pumping Costs[1]	$ -	$ -	$ -	$ 6,683,755	$ 6,884,268	$ 7,090,796	$ -	$ -	$ -	$ -	$ -
Canal Operation Costs[2]	$ 191,301	$ 4,546,374	$ 202,951	$ 563,127	$ 580,020	$ 597,421	$ 228,424	$ 5,428,608	$ 242,335	$ 249,605	$ 257,093
Pump Station No. 1 Replacement Costs[3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 2 Replacement Costs[3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 3 Replacement Costs[4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Return Water Pump Station Replacement Costs[5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Liner Replacement or Repairs[6]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Operating Cost	$ 191,301	$ 4,546,374	$ 202,951	$ 7,246,882	$ 7,464,288	$ 7,688,217	$ 228,424	$ 5,428,608	$ 242,335	$ 249,605	$ 257,093
Capital Recovery @ 3.0% / 20yrs.	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ 4,832,738	$ -	$ -
Total Annual Costs	$ 5,024,039	$ 9,379,111	$ 5,035,689	$ 12,079,619	$ 12,297,026	$ 12,520,954	$ 5,061,161	$ 10,261,345	$ 5,075,072	$ 249,605	$ 257,093
Average Monthly Cost	$ 418,670	$ 781,593	$ 419,641	$ 1,006,635	$ 1,024,752	$ 1,043,413	$ 421,763	$ 855,112	$ 422,923	$ 20,800	$ 21,424
Equivilant Average Monthly Cost	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ 1,135,267	$ -	$ -
Present Worth of Op. Costs @ 3%	$ 138,200	$ 3,188,735	$ 138,200	$ 4,791,042	$ 4,791,042	$ 4,791,042	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200
Present Worth of Op. Costs											
Present Worth of Capital + Op. Costs											

[1]Recovery well pumping costs in dry year estimated as $4,290,048 per Section III. for 14 wells and increased for inflation at 3% per year.

[2]Canal operation costs based on 1) Idle Year = O&M Cost Estimate $69,100 per year x 2 due to increased canal maintenance for tumbleweeds and rodent holes; 2) Wet Year = O&M Cost Estimate based on $9,000 per month, $158.33 per month, and $404,296.88 per month for four months plus energy costs for three pump stations each with a 20-ft lift to move 112,500 ac-ft = $1,488,848 plus 8 idle months of $46,067; and 3) Dry Year = O&M Cost Estimate based on $8,000 per mo

[3]Pump Station replacement costs include pump and motor replacement at $2,222,000, VFD's at $700,000, electrical and control equipment at $900,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[4]Pump Station replacement costs include pump and motor replacement at $1,287,000, VFD's at $420,000, electrical and control equipment at $565,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[5]Pump Station replacement costs include pump and motor replacement at $540,000, VFD's at $150,000, electrical and control equipment at $565,000, and cathodic protection at $15,000. Costs increased for inflation at 3% per year.

[6]No liner replacement or repairs as part of the earth lined canal alternative.

ct

ntonite Liner

23	24	25	26	27	28	29	30	31	32
2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
$ -	$ -	$ 8,982,408	$ 9,251,880	$ 9,529,436	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 756,795	$ 779,499	$ 802,884	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 5,350,314	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 2,581,649	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 33,697,714	$ 10,031,379	$ 10,332,320	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 272,750	$ 33,697,714	$ 10,031,379	$ 10,332,320	$ 306,982	$ 7,295,595	$ 325,677	$ 335,448	$ 345,511
$ 509,162	$ 22,729	$ 2,808,143	$ 835,948	$ 861,027	$ 25,582	$ 607,966	$ 27,140	$ 27,954	$ 28,793
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,188,735	$ 138,200	$ 16,577,042	$ 4,791,042	$ 4,791,042	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200

33	34	35	36	37	38	39	40	41	42
2052	2053	2054	2055	2056	2057	2058	2059	2060	2061
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
$ -	$ -	$ 12,071,605	$ 12,433,753	$ 12,806,766	$ -	$ -	$ -	$ -	$ -
$ 8,211,257	$ 366,553	$ 1,017,069	$ 1,047,581	$ 1,079,009	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 8,211,257	$ 366,553	$ 13,088,674	$ 13,481,334	$ 13,885,774	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 8,211,257	$ 366,553	$ 13,088,674	$ 13,481,334	$ 13,885,774	$ 412,558	$ 9,804,670	$ 437,683	$ 450,814	$ 464,338
$ 684,271	$ 30,546	$ 1,090,723	$ 1,123,445	$ 1,157,148	$ 34,380	$ 817,056	$ 36,474	$ 37,568	$ 38,695
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,188,735	$ 138,200	$ 4,791,042	$ 4,791,042	$ 4,791,042	$ 138,200	$ 3,188,735	$ 138,200	$ 138,200	$ 138,200

43	44	45	46	47	48	49	50
2062	2063	2064	2065	2066	2067	2068	2069
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ -	$ -	$ 16,223,228	$ 16,709,925	$ 17,211,222	$ -	$ -	$ -
$ 11,035,242	$ 492,616	$ 1,366,856	$ 1,407,862	$ 1,450,098	$ 554,444	$ 13,176,656	$ 588,210
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,202,370
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,405,399
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 11,035,242	$ 492,616	$ 17,590,084	$ 18,117,786	$ 18,661,320	$ 554,444	$ 13,176,656	$ 50,752,012
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 11,035,242	$ 492,616	$ 17,590,084	$ 18,117,786	$ 18,661,320	$ 554,444	$ 13,176,656	$ 50,752,012
$ 919,604	$ 41,051	$ 1,465,840	$ 1,509,816	$ 1,555,110	$ 46,204	$ 1,098,055	$ 4,229,334
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,188,735	$ 138,200	$ 4,791,042	$ 4,791,042	$ 4,791,042	$ 138,200	$ 3,188,735	$ 11,924,200

nth, $52.78 per month, and energy cost for Return Water Pump Station for 25-ft lift to move 50,000 ac-ft = $275,660.00. Costs increased for inflation at 3% per year.

Kern Fan Proje

Poly Lined Cana

Alternative No. 2/3 - HDPE Lined Canal or RPE Lined Canal	1	2	3	4	5	6	7	8	9	10	11
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CAPITAL COST	**$ 60,291,545**										
O&M COSTS	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ -	$ 4,262,883	$ 4,390,769	$ 4,522,492	$ -	$ -	$ -	.
Canal Operation Costs [2]	$ 69,100	$ 71,173	$ 3,382,929	$ 75,507	$ 419,019	$ 431,590	$ 444,537	$ 84,984	$ 4,039,394	$ 90,160	$ 92,865
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Pump Station No. 2 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Pump Station No. 3 Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Return Water Pump Station Replacement Costs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Liner Replacement or Repairs [6]	$ -	$ -	$ -	$ -	$ 28,982	$ -	$ -	$ -	$ -	$ 33,598	.
Total Annual Operating Cost	$ 69,100	$ 71,173	$ 3,382,929	$ 75,507	$ 4,710,884	$ 4,822,359	$ 4,967,029	$ 84,984	$ 4,039,394	$ 123,758	$ 92,865
Capital Recovery @ 3.0% / 20yrs.	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539
Total Annual Costs	$ 4,121,639	$ 4,123,712	$ 7,435,468	$ 4,128,046	$ 8,763,422	$ 8,874,898	$ 9,019,568	$ 4,137,523	$ 8,091,933	$ 4,176,297	$ 4,145,403
Average Monthly Cost	$ 343,470	$ 343,643	$ 619,622	$ 344,004	$ 730,285	$ 739,575	$ 751,631	$ 344,794	$ 674,328	$ 348,025	$ 345,450
Equivilant Average Monthly Cost	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530
Present Worth of Op. Costs @ 3%	$ 69,100	$ 69,100	$ 3,188,735	$ 69,100	$ 4,185,559	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 94,850	$ 69,100
Present Worth of Op. Costs	**$ 130,472,785**										
Present Worth of Capital + Op. Costs	**$ 190,764,330**										

Alternative No. 2/3 - HDPE Lined Canal or RPE Lined Canal	12	13	14	15	16	17	18	19	20	21	22
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
CAPITAL COST											
O&M COSTS	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ 5,728,958	$ 5,900,827	$ 6,077,851	$ -	$ -	$ -	$ -	$ -
Canal Operation Costs [2]	$ 95,651	$ 4,546,374	$ 101,476	$ 563,127	$ 580,020	$ 597,421	$ 114,212	$ 5,428,608	$ 121,167	$ 124,802	$ 128,546
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 2 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 3 Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Return Water Pump Station Replacement Costs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Liner Replacement or Repairs [6]	$ -	$ -	$ -	$ 38,949	$ -	$ -	$ -	$ -	$ -	$ 9,647,163	$ -
Total Annual Operating Cost	$ 95,651	$ 4,546,374	$ 101,476	$ 6,331,034	$ 6,480,847	$ 6,675,272	$ 114,212	$ 5,428,608	$ 121,167	$ 9,771,965	$ 128,546
Capital Recovery @ 3.0% / 20yrs.	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ 4,052,539	$ -	$ -
Total Annual Costs	$ 4,148,189	$ 8,598,913	$ 4,154,015	$ 10,383,572	$ 10,533,386	$ 10,727,811	$ 4,166,751	$ 9,481,147	$ 4,173,706	$ 9,771,965	$ 128,546
Average Monthly Cost	$ 345,682	$ 716,576	$ 346,168	$ 865,298	$ 877,782	$ 893,984	$ 347,229	$ 790,096	$ 347,809	$ 814,330	$ 10,712
Equivilant Average Monthly Cost	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ 1,068,530	$ -	$ -
Present Worth of Op. Costs @ 3%	$ 69,100	$ 3,188,735	$ 69,100	$ 4,185,559	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 69,100	$ 5,410,500	$ 69,100

[1]Recovery well pumping costs in dry year estimated as $3,677,184 per Section III. for 12 wells and increased for inflation at 3% per year.

[2]Canal operation costs based on 1) Idle Year = O&M Cost Estimate $69,100 per year; 2) Wet Year = O&M Cost Estimate based on $9,000 per month, $158.33 per month, and $404,296.88 per month for four months plus energy costs for three pump stations each with a 20-ft lift to move 112,500 ac-ft = $1,488,848 plus 8 idle months of $46,067; and 3) Dry Year = O&M Cost Estimate based on $8,000 per month, $52.78 per month, and energy cost for Return Water Pump Station for 2

[3]Pump Station replacement costs include pump and motor replacement at $2,222,000, VFD's at $700,000, electrical and control equipment at $900,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[4]Pump Station replacement costs include pump and motor replacement at $1,287,000, VFD's at $420,000, electrical and control equipment at $565,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[5]Pump Station replacement costs include pump and motor replacement at $540,000, VFD's at $150,000, electrical and control equipment at $565,000, and cathodic protection at $15,000. Costs increased for inflation at 3% per year.

[6]Liner replacement or repairs estimated as minor patches at $25,000 every five years and complete liner replacement after 20 years at 40 years. Costs increased for inflation at 3% per year.

ct

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23	24	25	26	27	28	29	30	31	32	33	34	35	36
2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year
$ -	$ -	$ 7,699,240	$ 7,930,217	$ 8,168,124	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,347,135	$ 10,657,549
$ 6,109,946	$ 136,375	$ 756,795	$ 779,499	$ 802,884	$ 153,491	$ 7,295,595	$ 162,839	$ 167,724	$ 172,756	$ 8,211,257	$ 183,276	$ 1,017,069	$ 1,047,581
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 5,350,314	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 2,581,649	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 52,344	$ -	$ -	$ -	$ -	$ 60,682	$ -	$ -	$ -	$ -	$ 70,347	$ -
$ 6,109,946	$ 136,375	$ 32,466,891	$ 8,709,716	$ 8,971,008	$ 153,491	$ 7,295,595	$ 223,520	$ 167,724	$ 172,756	$ 8,211,257	$ 183,276	$ 11,434,551	$ 11,705,130
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 136,375	$ 32,466,891	$ 8,709,716	$ 8,971,008	$ 153,491	$ 7,295,595	$ 223,520	$ 167,724	$ 172,756	$ 8,211,257	$ 183,276	$ 11,434,551	$ 11,705,130
$ 509,162	$ 11,365	$ 2,705,574	$ 725,810	$ 747,584	$ 12,791	$ 607,966	$ 18,627	$ 13,977	$ 14,396	$ 684,271	$ 15,273	$ 952,879	$ 975,428
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,188,735	$ 69,100	$ 15,971,559	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 94,850	$ 69,100	$ 69,100	$ 3,188,735	$ 69,100	$ 4,185,559	$ 4,159,809

37	38	39	40	41	42	43	44	45	46	47	48	49	50
2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ 10,977,276	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,905,684	$ 14,322,855	$ 14,752,540	$ -	$ -	$ -
$ 1,079,009	$ 206,279	$ 9,804,670	$ 218,842	$ 225,407	$ 232,169	$ 11,035,242	$ 246,308	$ 1,366,856	$ 1,407,862	$ 1,450,098	$ 277,222	$ 13,176,656	$ 294,105
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,202,370
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,405,399
$ -	$ -	$ -	$ -	$ 17,423,849	$ -	$ -	$ -	$ 94,540	$ -	$ -	$ -	$ -	$ 109,598
$ 12,056,284	$ 206,279	$ 9,804,670	$ 218,842	$ 17,649,255	$ 232,169	$ 11,035,242	$ 246,308	$ 15,367,080	$ 15,730,716	$ 16,202,638	$ 277,222	$ 13,176,656	$ 50,567,505
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 12,056,284	$ 206,279	$ 9,804,670	$ 218,842	$ 17,649,255	$ 232,169	$ 11,035,242	$ 246,308	$ 15,367,080	$ 15,730,716	$ 16,202,638	$ 277,222	$ 13,176,656	$ 50,567,505
$ 1,004,690	$ 17,190	$ 817,056	$ 18,237	$ 1,470,771	$ 19,347	$ 919,604	$ 20,526	$ 1,280,590	$ 1,310,893	$ 1,350,220	$ 23,102	$ 1,098,055	$ 4,213,959
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 4,159,809	$ 69,100	$ 3,188,735	$ 69,100	$ 5,410,500	$ 69,100	$ 3,188,735	$ 69,100	$ 4,185,559	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 11,880,850

25-ft lift to move 50,000 ac-ft = $275,660.00. Costs increased for inflation at 3% per year.

Kern Fan Proje

Shotcrete Lined Ca

Alternative No. 4- Shotcrete Concrete Liner	1	2	3	4	5	6	7	8	9	10	11
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CAPITAL COST	**$ 69,513,845**										
O&M COSTS	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ -	$ 4,262,883	$ 4,390,769	$ 4,522,492	$ -	$ -	$ -	.
Canal Operation Costs [2]	$ 69,100	$ 71,173	$ 3,382,929	$ 75,507	$ 419,019	$ 431,590	$ 444,537	$ 84,984	$ 4,039,394	$ 90,160	$ 92,865
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Pump Station No. 2 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Pump Station No. 3 Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Return Water Pump Station Replacement Costs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Liner Replacement or Repairs [6]	$ -	$ -	$ 137,439	$ -	$ -	$ 150,183	$ -	$ -	$ 164,109	$ -	$ -
Total Annual Operating Cost	$ 69,100	$ 71,173	$ 3,520,367	$ 75,507	$ 4,681,902	$ 4,972,542	$ 4,967,029	$ 84,984	$ 4,203,503	$ 90,160	$ 92,865
Capital Recovery @ 3% / 20yrs.	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422
Total Annual Costs	$ 4,741,522	$ 4,743,595	$ 8,192,790	$ 4,747,930	$ 9,354,324	$ 9,644,964	$ 9,639,452	$ 4,757,407	$ 8,875,925	$ 4,762,582	$ 4,765,287
Average Monthly Cost	$ 395,127	$ 395,300	$ 682,732	$ 395,661	$ 779,527	$ 803,747	$ 803,288	$ 396,451	$ 739,660	$ 396,882	$ 397,107
Equivilant Average Monthly Cost	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806
Present Worth of Op. Costs @ 3%	$ 69,100	$ 69,100	$ 3,318,284	$ 69,100	$ 4,159,809	$ 4,289,358	$ 4,159,809	$ 69,100	$ 3,318,284	$ 69,100	$ 69,100
Present Worth of Op. Costs	**$ 121,656,769**										
Present Worth of Capital + Op. Costs	**$ 191,170,614**										

Alternative No. 4- Shotcrete Concrete Liner	12	13	14	15	16	17	18	19	20	21	22
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
CAPITAL COST											
O&M COSTS	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ 5,728,958	$ 5,900,827	$ 6,077,851	$ -	$ -	$ -	$ -	$ -
Canal Operation Costs [2]	$ 95,651	$ 4,546,374	$ 101,476	$ 563,127	$ 580,020	$ 597,421	$ 114,212	$ 5,428,608	$ 121,167	$ 124,802	$ 128,546
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 2 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 3 Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Return Water Pump Station Replacement Costs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Liner Replacement or Repairs [6]	$ 179,326	$ -	$ -	$ 195,954	$ -	$ -	$ 214,125	$ -	$ -	$ 233,980	$ -
Total Annual Operating Cost	$ 274,977	$ 4,546,374	$ 101,476	$ 6,488,039	$ 6,480,847	$ 6,675,272	$ 328,337	$ 5,428,608	$ 121,167	$ 358,782	$ 128,546
Capital Recovery @ 3% / 20yrs.	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ 4,672,422	$ -	$ -
Total Annual Costs	$ 4,947,399	$ 9,218,796	$ 4,773,898	$ 11,160,461	$ 11,153,269	$ 11,347,695	$ 5,000,759	$ 10,101,030	$ 4,793,590	$ 358,782	$ 128,546
Average Monthly Cost	$ 412,283	$ 768,233	$ 397,825	$ 930,038	$ 929,439	$ 945,641	$ 416,730	$ 841,753	$ 399,466	$ 29,899	$ -
Equivilant Average Monthly Cost	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ 1,070,806	$ -	$ -
Present Worth of Op. Costs @ 3%	$ 198,649	$ 3,188,735	$ 69,100	$ 4,289,358	$ 4,159,809	$ 4,159,809	$ 198,649	$ 3,188,735	$ 69,100	$ 198,649	$ 69,100

[1]Recovery well pumping costs in dry year estimated as $3,677,184 per Section III. for 12 wells and increased for inflation at 3% per year.

[2]Canal operation costs based on 1) Idle Year = O&M Cost Estimate $69,100 per year; 2) Wet Year = O&M Cost Estimate based on $9,000 per month, $158.33 per month, and $404,296.88 per month for four months plus energy costs for three pump stations each with a 20-ft lift to move 112,500 ac-ft = $1,488,848 plus 8 idle months of $46,067; and 3) Dry Year = O&M Cost Estimate based on $8,000 per month, $52.78 per month, and energy cost for Return Water Pump Station for 2

[3]Pump Station replacement costs include pump and motor replacement at $2,222,000, VFD's at $700,000, electrical and control equipment at $900,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[4]Pump Station replacement costs include pump and motor replacement at $1,287,000, VFD's at $420,000, electrical and control equipment at $565,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[5]Pump Station replacement costs include pump and motor replacement at $540,000, VFD's at $150,000, electrical and control equipment at $565,000, and cathodic protection at $15,000. Costs increased for inflation at 3% per year.

[6]Liner replacement or repairs estimated as replacing 1,200-ft of lining at $129,549 every three years. Costs increased for inflation at 3% per year.

Kern Fan Proje

Concrete Lined Ca

Alternative No. 5- Conventional Concrete Liner	1	2	3	4	5	6	7	8	9	10	11
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CAPITAL COST	**$ 70,697,045**										
O&M COSTS	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ -	$ 4,262,883	$ 4,390,769	$ 4,522,492	$ -	$ -	$ -	.
Canal Operation Costs [2]	$ 69,100	$ 71,173	$ 3,382,929	$ 75,507	$ 419,019	$ 431,590	$ 444,537	$ 84,984	$ 4,039,394	$ 90,160	$ 92,865
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Pump Station No. 2 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Pump Station No. 3 Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Return Water Pump Station Replacement Costs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Liner Replacement or Repairs [6]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Operating Cost	$ 69,100	$ 71,173	$ 3,382,929	$ 75,507	$ 4,681,902	$ 4,822,359	$ 4,967,029	$ 84,984	$ 4,039,394	$ 90,160	$ 92,865
Capital Recovery @ 3% / 20yrs.	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952
Total Annual Costs	$ 4,821,052	$ 4,823,125	$ 8,134,881	$ 4,827,459	$ 9,433,854	$ 9,574,311	$ 9,718,981	$ 4,836,936	$ 8,791,346	$ 4,842,112	$ 4,844,817
Average Monthly Cost	$ 401,754.33	$ 401,927	$ 677,907	$ 402,288	$ 786,154	$ 797,859	$ 809,915	$ 403,078	$ 732,612	$ 403,509	$ 403,735
Equivilant Average Monthly Cost	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544
Present Worth of Op. Costs @ 3%	$ 69,100	$ 69,100	$ 3,188,735	$ 69,100	$ 4,159,809	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 69,100	$ 69,100
Present Worth of Op. Costs	**$ 120,783,985**										
Present Worth of Capital + Op. Costs	**$ 191,481,030**										

Alternative No. 5- Conventional Concrete Liner	12	13	14	15	16	17	18	19	20	21	22
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
CAPITAL COST											
O&M COSTS	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
Recovery Well Pumping Costs [1]	$ -	$ -	$ -	$ 5,728,958	$ 5,900,827	$ 6,077,851	$ -	$ -	$ -	$ -	$ -
Canal Operation Costs [2]	$ 95,651	$ 4,546,374	$ 101,476	$ 563,127	$ 580,020	$ 597,421	$ 114,212	$ 5,428,608	$ 121,167	$ 124,802	$ 128,546
Pump Station No. 1 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 2 Replacement Costs [3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Pump Station No. 3 Replacement Costs [4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Return Water Pump Station Replacement Costs [5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Liner Replacement or Repairs [6]	$ -	$ -	$ -	$ 226,888	$ -	$ -	$ -	$ -	$ 263,026	$ -	$ -
Total Annual Operating Cost	$ 95,651	$ 4,546,374	$ 101,476	$ 6,518,973	$ 6,480,847	$ 6,675,272	$ 114,212	$ 5,428,608	$ 384,193	$ 124,802	$ 128,546
Capital Recovery @ 3% / 20yrs.	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ 4,751,952	$ -	$ -
Total Annual Costs	$ 4,847,602	$ 9,298,326	$ 4,853,428	$ 11,270,925	$ 11,232,799	$ 11,427,224	$ 4,866,164	$ 10,180,560	$ 5,136,145	$ 124,802	$ 128,546
Average Monthly Cost	$ 403,967	$ 774,860	$ 404,452	$ 939,244	$ 936,067	$ 952,269	$ 405,514	$ 848,380	$ 428,012	$ 10,400	$ -
Equivilant Average Monthly Cost	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ 1,072,544	$ -	$ -
Present Worth of Op. Costs @ 3%	$ 69,100	$ 3,188,735	$ 69,100	$ 4,309,809	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 219,100	$ 69,100	$ 69,100

[1] Recovery well pumping costs in dry year estimated as $3,677,184 per Section III. for 12 wells and increased for inflation at 3% per year.

[2] Canal operation costs based on 1) Idle Year = O&M Cost Estimate $69,100 per year; 2) Wet Year = O&M Cost Estimate based on $9,000 per month, $158.33 per month, and $404,296.88 per month for four months plus energy costs for three pump stations each with a 20-ft lift to move 112,500 ac-ft = $1,488,848 plus 8 idle months of $46,067; and 3) Dry Year = O&M Cost Estimate based on $8,000 per month, $52.78 per month, and energy cost for Return Water Pump Station for 2

[3] Pump Station replacement costs include pump and motor replacement at $2,222,000, VFD's at $700,000, electrical and control equipment at $900,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[4] Pump Station replacement costs include pump and motor replacement at $1,287,000, VFD's at $420,000, electrical and control equipment at $565,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[5] Pump Station replacement costs include pump and motor replacement at $540,000, VFD's at $150,000, electrical and control equipment at $565,000, and cathodic protection at $15,000. Costs increased for inflation at 3% per year.

[6] Liner replacement or repairs estimated as replacing 1,200-ft of lining at $150,000 every five years after the first 15 years. Costs increased for inflation at 3% per year.

ct

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23	24	25	26	27	28	29	30	31	32	33	34	35	36
2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year
$ -	$ -	$ 7,699,240	$ 7,930,217	$ 8,168,124	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,347,135	$ 10,657,549
$ 6,109,946	$ 136,375	$ 756,795	$ 779,499	$ 802,884	$ 153,491	$ 7,295,595	$ 162,839	$ 167,724	$ 172,756	$ 8,211,257	$ 183,276	$ 1,017,069	$ 1,047,581
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 5,350,314	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 2,581,649	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 304,919	$ -	$ -	$ -	$ -	$ 353,485	$ -	$ -	$ -	$ -	$ 409,786	$ -
$ 6,109,946	$ 136,375	$ 32,719,466	$ 8,709,716	$ 8,971,008	$ 153,491	$ 7,295,595	$ 516,324	$ 167,724	$ 172,756	$ 8,211,257	$ 183,276	$ 11,773,990	$ 11,705,130
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 136,375	$ 32,719,466	$ 8,709,716	$ 8,971,008	$ 153,491	$ 7,295,595	$ 516,324	$ 167,724	$ 172,756	$ 8,211,257	$ 183,276	$ 11,773,990	$ 11,705,130
$ 509,162	$ 11,365	$ 2,726,622	$ 725,810	$ 747,584	$ 12,791	$ 607,966	$ 43,027	$ 13,977	$ 14,396	$ 684,271	$ 15,273	$ 981,166	$ 975,428
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,188,735	$ 69,100	$ 16,095,809	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 219,100	$ 69,100	$ 69,100	$ 3,188,735	$ 69,100	$ 4,309,809	$ 4,159,809

37	38	39	40	41	42	43	44	45	46	47	48	49	50
2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069
Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ 10,977,276	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,905,684	$ 14,322,855	$ 14,752,540	$ -	$ -	$ -
$ 1,079,009	$ 206,279	$ 9,804,670	$ 218,842	$ 225,407	$ 232,169	$ 11,035,242	$ 246,308	$ 1,366,856	$ 1,407,862	$ 1,450,098	$ 277,222	$ 13,176,656	$ 294,105
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,202,370
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,405,399
$ -	$ -	$ -	$ 475,054	$ -	$ -	$ -	$ -	$ 550,718	$ -	$ -	$ -	$ -	$ 638,433
$ 12,056,284	$ 206,279	$ 9,804,670	$ 693,896	$ 225,407	$ 232,169	$ 11,035,242	$ 246,308	$ 15,823,258	$ 15,730,716	$ 16,202,638	$ 277,222	$ 13,176,656	$ 51,096,340
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 12,056,284	$ 206,279	$ 9,804,670	$ 693,896	$ 225,407	$ 232,169	$ 11,035,242	$ 246,308	$ 15,823,258	$ 15,730,716	$ 16,202,638	$ 277,222	$ 13,176,656	$ 51,096,340
$ 1,004,690	$ 17,190	$ 817,056	$ 57,825	$ 18,784	$ 19,347	$ 919,604	$ 20,526	$ 1,318,605	$ 1,310,893	$ 1,350,220	$ 23,102	$ 1,098,055	$ 4,258,028
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 4,159,809	$ 69,100	$ 3,188,735	$ 219,100	$ 69,100	$ 69,100	$ 3,188,735	$ 69,100	$ 4,309,809	$ 4,159,809	$ 4,159,809	$ 69,100	$ 3,188,735	$ 12,005,100

25-ft lift to move 50,000 ac-ft = $275,660.00. Costs increased for inflation at 3% per year.

ct

anal

23	24	25	26	27	28	29	30	31	32
2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
$ -	$ -	$ 7,699,240	$ 7,930,217	$ 8,168,124	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 136,375	$ 756,795	$ 779,499	$ 802,884	$ 153,491	$ 7,295,595	$ 162,839	$ 167,724	$ 172,756
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 8,013,274	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 5,350,314	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 2,581,649	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ 255,676	$ -	$ -	$ 279,384	$ -	$ -	$ 305,291	$ -	$ -
$ 6,109,946	$ 392,051	$ 32,414,547	$ 8,709,716	$ 9,250,392	$ 153,491	$ 7,295,595	$ 468,129	$ 167,724	$ 172,756
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 6,109,946	$ 392,051	$ 32,414,547	$ 8,709,716	$ 9,250,392	$ 153,491	$ 7,295,595	$ 468,129	$ 167,724	$ 172,756
$ 509,162	$ 32,671	$ 2,701,212	$ 725,810	$ 770,866	$ 12,791	$ 607,966	$ 39,011	$ 13,977	$ 14,396
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,188,735	$ 198,649	$ 15,945,809	$ 4,159,809	$ 4,289,358	$ 69,100	$ 3,188,735	$ 198,649	$ 69,100	$ 69,100

33	34	35	36	37	38	39	40	41
2052	2053	2054	2055	2056	2057	2058	2059	2060
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year
$ -	$ -	$ 10,347,135	$ 10,657,549	$ 10,977,276	$ -	$ -	$ -	$ -
$ 8,211,257	$ 183,276	$ 1,017,069	$ 1,047,581	$ 1,079,009	$ 206,279	$ 9,804,670	$ 218,842	$ 225,407
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 333,599	$ -	$ -	$ 364,533	$ -	$ -	$ 398,335	$ -	$ -
$ 8,544,856	$ 183,276	$ 11,364,204	$ 12,069,663	$ 12,056,284	$ 206,279	$ 10,203,005	$ 218,842	$ 225,407
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 8,544,856	$ 183,276	$ 11,364,204	$ 12,069,663	$ 12,056,284	$ 206,279	$ 10,203,005	$ 218,842	$ 225,407
$ 712,071	$ 15,273	$ 947,017	$ 1,005,805	$ 1,004,690	$ 17,190	$ 850,250	$ 18,237	$ 18,784
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 3,318,284	$ 69,100	$ 4,159,809	$ 4,289,358	$ 4,159,809	$ 69,100	$ 3,318,284	$ 69,100	$ 69,100

42	43	44	45	46	47	48	49	50
2061	2062	2063	2064	2065	2066	2067	2068	2069
Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ -	$ -	$ -	$ 13,905,684	$ 14,322,855	$ 14,752,540	$ -	$ -	$ -
$ 232,169	$ 11,035,242	$ 246,308	$ 1,366,856	$ 1,407,862	$ 1,450,098	$ 277,222	$ 13,176,656	$ 294,105
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,778,017
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,202,370
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,405,399
$ 435,272	$ -	$ -	$ 475,633	$ -	$ -	$ 519,737	$ -	$ -
$ 667,441	$ 11,035,242	$ 246,308	$ 15,748,173	$ 15,730,716	$ 16,202,638	$ 796,959	$ 13,176,656	$ 50,457,907
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 667,441	$ 11,035,242	$ 246,308	$ 15,748,173	$ 15,730,716	$ 16,202,638	$ 796,959	$ 13,176,656	$ 50,457,907
$ 55,620	$ 919,604	$ 20,526	$ 1,312,348	$ 1,310,893	$ 1,350,220	$ 66,413	$ 1,098,055	$ 4,204,826
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 198,649	$ 3,188,735	$ 69,100	$ 4,289,358	$ 4,159,809	$ 4,159,809	$ 198,649	$ 3,188,735	$ 11,855,100

25-ft lift to move 50,000 ac-ft = $275,660.00. Costs increased for inflation at 3% per year.

Kern Fan Proje
Closed Conduit Pip

Alternative No. 6- Closed Conduit Pipeline	1	2	3	4	5	6	7	8	9	10	11
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CAPITAL COST	**$ 79,375,500**										
O&M COSTS	Idle Year	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year
Recovery Well Pumping Costs[1]	$ -	$ -	$ -	$ -	$ 4,262,883	$ 4,390,769	$ 4,522,492	$ -	$ -	$ -	.
Pipeline Operation Costs[2]	$ 34,550	$ 35,587	$ 3,119,132	$ 37,754	$ 232,879	$ 239,865	$ 247,061	$ 42,492	$ 3,724,407	$ 45,080	$ 46,432
Pump Station No. 1 Replacement Costs[3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Return Water Pump Station Replacement Costs[4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	.
Liner Replacement or Repairs[5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Operating Cost	$ 34,550	$ 35,587	$ 3,119,132	$ 37,754	$ 4,495,762	$ 4,630,635	$ 4,769,554	$ 42,492	$ 3,724,407	$ 45,080	$ 46,432
Capital Recovery @ 3% / 20yrs.	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280
Total Annual Costs	$ 5,369,830	$ 5,370,867	$ 8,454,412	$ 5,373,034	$ 9,831,042	$ 9,965,915	$ 10,104,834	$ 5,377,773	$ 9,059,687	$ 5,380,360	$ 5,381,713
Average Monthly Cost	$ 447,485.87	$ 447,572	$ 704,534	$ 447,753	$ 819,254	$ 830,493	$ 842,069	$ 448,148	$ 754,974	$ 448,363	$ 448,476
Equivilant Average Monthly Cost	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508
Present Worth of Op. Costs @ 3%	$ 34,550	$ 34,550	$ 2,940,081	$ 34,550	$ 3,994,426	$ 3,994,426	$ 3,994,426	$ 34,550	$ 2,940,081	$ 34,550	$ 34,550
Present Worth of Op. Costs	**$ 102,815,500**										
Present Worth of Capital + Op. Costs	**$ 182,191,000**										

Alternative No. 6- Closed Conduit Pipeline	12	13	14	15	16	17	18	19	20	21	22
	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
CAPITAL COST											
O&M COSTS	Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
Recovery Well Pumping Costs[1]	$ -	$ -	$ -	$ 5,728,958	$ 5,900,827	$ 6,077,851	$ -	$ -	$ -	$ -	$ -
Pipeline Operation Costs[2]	$ 47,825	$ 4,191,852	$ 50,738	$ 312,970	$ 322,359	$ 332,030	$ 57,106	$ 5,005,291	$ 121,167	$ 62,401	$ 64,273
Pump Station No. 1 Replacement Costs[3]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Return Water Pump Station Replacement Costs[4]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Liner Replacement or Repairs[5]	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Operating Cost	$ 47,825	$ 4,191,852	$ 50,738	$ 6,041,928	$ 6,223,186	$ 6,409,881	$ 57,106	$ 5,005,291	$ 121,167	$ 62,401	$ 64,273
Capital Recovery @ 3% / 20yrs.	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ 5,335,280	$ -	$ -
Total Annual Costs	$ 5,383,106	$ 9,527,133	$ 5,386,018	$ 11,377,208	$ 11,558,466	$ 11,745,162	$ 5,392,386	$ 10,340,571	$ 5,456,448	$ 62,401	$ 64,273
Average Monthly Cost	$ 448,592	$ 793,928	$ 448,835	$ 948,101	$ 963,205	$ 978,763	$ 449,366	$ 861,714	$ 454,704	$ 5,200	$ -
Equivilant Average Monthly Cost	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ 1,020,508	$ -	$ -
Present Worth of Op. Costs @ 3%	$ 34,550	$ 2,940,081	$ 34,550	$ 3,994,426	$ 3,994,426	$ 3,994,426	$ 34,550	$ 2,940,081	$ 69,100	$ 34,550	$ 34,550

[1] Recovery well pumping costs in dry year estimated as $3,677,184 per Section III. for 12 wells and increased for inflation at 3% per year.

[2] Pipeline operation costs based on 1) Idle Year = O&M Cost Estimate $69,100 per year divided by 2 because there will be less maintenance than a canal; 2) Wet Year = O&M Cost Estimate based on $9,000 per month, $52.78 per month, and $404,296.88 per month for four months plus energy costs for one pump station with a 50-ft lift to move 112,500 ac-ft = $1,240,615 plus 8 idle months of $46,067; and 3) Dry Year = O&M Cost Estimate based on $8,000 per month, $52.78 per n

[3] Pump Station replacement costs include pump and motor replacement at $2,800,000, VFD's at $840,000, electrical and control equipment at $1,500,000, and cathodic protection at $25,000. Costs increased for inflation at 3% per year.

[4] Return Water Pump Station replacement costs include pump and motor replacement at $500,000, VFD's at $120,000, electrical and control equipment at $500,000, and cathodic protection at $15,000. Costs increased for inflation at 3% per year.

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eline

23	24	25	26	27	28	29	30	31	32
2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year	Idle Year
$ -	$ -	$ 7,699,240	$ 7,930,217	$ 8,168,124	$ -	$ -	$ -	$ -	$ -
$ 5,633,499	$ 68,187	$ 420,605	$ 433,224	$ 446,220	$ 76,746	$ 6,726,693	$ 81,419	$ 83,862	$ 86,378
$ -	$ -	$ 10,499,382	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ 2,307,221	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 5,633,499	$ 68,187	$ 20,926,449	$ 8,363,441	$ 8,614,344	$ 76,746	$ 6,726,693	$ 81,419	$ 83,862	$ 86,378
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 5,633,499	$ 68,187	$ 20,926,449	$ 8,363,441	$ 8,614,344	$ 76,746	$ 6,726,693	$ 81,419	$ 83,862	$ 86,378
$ 469,458	$ 5,682	$ 1,743,871	$ 696,953	$ 717,862	$ 6,395	$ 560,558	$ 6,785	$ 6,988	$ 7,198
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 2,940,081	$ 34,550	$ 10,294,426	$ 3,994,426	$ 3,994,426	$ 34,550	$ 2,940,081	$ 34,550	$ 34,550	$ 34,550

33	34	35	36	37	38	39	40	41
2052	2053	2054	2055	2056	2057	2058	2059	2060
Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year	Idle Year
$ -	$ -	$ 10,347,135	$ 10,657,549	$ 10,977,276	$ -	$ -	$ -	$ -
$ 7,570,952	$ 91,638	$ 565,259	$ 582,216	$ 599,683	$ 103,140	$ 9,040,112	$ 109,421	$ 112,703
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 7,570,952	$ 91,638	$ 10,912,394	$ 11,239,765	$ 11,576,958	$ 103,140	$ 9,040,112	$ 109,421	$ 112,703
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 7,570,952	$ 91,638	$ 10,912,394	$ 11,239,765	$ 11,576,958	$ 103,140	$ 9,040,112	$ 109,421	$ 112,703
$ 630,913	$ 7,637	$ 909,366	$ 936,647	$ 964,747	$ 8,595	$ 753,343	$ 9,118	$ 9,392
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 2,940,081	$ 34,550	$ 3,994,426	$ 3,994,426	$ 3,994,426	$ 34,550	$ 2,940,081	$ 34,550	$ 34,550

42	43	44	45	46	47	48	49	50
2061	2062	2063	2064	2065	2066	2067	2068	2069
Idle Year	Wet Year	Idle Year	Dry Year	Dry Year	Dry Year	Idle Year	Wet Year	Idle Year
$ -	$ -	$ -	$ 13,905,684	$ 14,322,855	$ 14,752,540	$ -	$ -	$ -
$ 116,085	$ 10,174,726	$ 123,154	$ 759,660	$ 782,450	$ 805,923	$ 138,611	$ 12,149,155	$ 147,052
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 21,983,373
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,830,809
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 116,085	$ 10,174,726	$ 123,154	$ 14,665,344	$ 15,105,305	$ 15,558,464	$ 138,611	$ 12,149,155	$ 26,961,235
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 116,085	$ 10,174,726	$ 123,154	$ 14,665,344	$ 15,105,305	$ 15,558,464	$ 138,611	$ 12,149,155	$ 26,961,235
$ 9,674	$ 847,894	$ 10,263	$ 1,222,112	$ 1,258,775	$ 1,296,539	$ 11,551	$ 1,012,430	$ 2,246,770
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 34,550	$ 2,940,081	$ 34,550	$ 3,994,426	$ 3,994,426	$ 3,994,426	$ 34,550	$ 2,940,081	$ 6,334,550

nonth, and energy cost for Return Water Pump Station for 10-ft lift to move 50,000 ac-ft = $110,277.00. Costs increased for inflation at 3% per year.

Irvine Ranch Water District

Operation & Maintenance Cost Estimate

Phase I Well Field Operation Costs

Type of Year	Monthly RRBWSD Operation Cost[1,2]	Monthly PG&E Cost[3,5]	Monthly Mission Unit Cost[4]	DWR Conveyance Cost	Total Monthly Cost	Total Annual Cost if Utilized for 12 Months[6]	Average Cost per Ac-Ft[7]
Dry Year (Pumping Wells)	$ 8,000.00	$ 144,900.00	$ 316.67	$ -	$ 153,216.67	$ 1,838,600.00	$ 73.54
Wet Year (Recharging Water)	$ 9,000.00	$ 1,500.00	$ 316.67	$ -	$ 10,816.67	$ 90,600.00	$ 1.61
Idle Year	$ 4,100.00	$ 1,500.00	$ 316.67	$ -	$ 5,916.67	$ 71,000.00	

1. Rosedale's operation cost includes pond maintenance, oil for reservoirs, field staff time, equipment cost, weed control cost, rodent control cost, office staff, overhead cost, etc.
2. Cost includes one additional piece of equipment for property maintenance
3. Monthly PG&E cost to operate (6) 400 hp wells
4. Average monthly cost for cellular service to (6) Mission Units
5. Assumed 35 cfs flow rate for a 30 day month for a total of 2,083 ac-ft of water recovered per month or 25,000 ac-ft/yr
6. Dry year annual cost based on operating 12 months out of the year. Wet year annual cost based on 4 months of recharging water up to 56,250 ac-ft and 8 months at idle costs.
7. Dry year pumping 25,000 ac-ft and a wet year recharging 56,250 ac-ft.

Canal Operation Costs

Type of Year	Monthly RRBWSD Operation Cost[1,2]	Monthly PG&E Cost[3]	Monthly Mission Unit Cost[4]	DWR Conveyance Cost[5]	Total Monthly Cost	Total Annual Cost[6]	Average Cost per Ac-Ft[7]
Dry Year (Pumping Wells)	$ 8,000.00	$ 14,040.00	$ 158.33	$ -	$ 22,198.33	$ 266,380.00	$ 10.66
Wet Year (Recharging Water)	$ 9,000.00	$ 230,400.00	$ 158.33	$ 404,296.88	$ 643,855.21	$ 2,621,487.50	$ 46.60
Idle Year	$ 4,100.00	$ 1,500.00	$ 158.33	$ -	$ 5,758.33	$ 69,100.00	

1. Rosedale's operation cost includes pond maintenance, oil for reservoirs, field staff time, equipment cost, weed control cost, rodent control cost, office staff, overhead cost, etc.
2. Cost includes one additional piece of equipment for canal maintenance
3. Monthly PG&E cost to operate two lift stations moving 230 cfs at a 20-ft TDH each, Total 56,250 ac-ft / year for wet years. Monthly PG&E cost to operate Return Water Lift Station moving 35 cfs at a 25-ft TDH, total 25,000 ac-ft/yr.
4. Average monthly cost for cellular service to (3) Mission Units
5. Article 21 water cost estimated at $23.00/AF for 112,500 ac-ft, however IRWD's share (37.5%) is paid through agreement with Metropolitan Water District. Therefore the estimated monthly water costs include $23/AF for 70,312.5 ac-ft.
6. Dry year annual cost based on operating 12 months out of the year. Wet year annual cost based on 4 months of recharging water up to 56,250 ac-ft and 8 months at idle costs.
7. Dry year conveying 25,000 ac-ft to aqueduct and a wet year recharging 112,500 ac-ft

Goose Lake Channel Turnout Operation Costs

Type of Year	Monthly RRBWSD Operation Cost[1]	Monthly PG&E Cost[2]	Monthly Mission Unit Cost[3]	DWR Conveyance Cost	Total Monthly Cost	Total Annual Cost[4]	Average Cost per Ac-Ft[5]
Dry Year (Pumping Wells)	$ 1,500.00	$ 300.00	$ 52.78	$ -	$ 1,852.78	$ 22,233.33	$ 0.89
Wet Year (Recharging Water)	$ 4,000.00	$ 52,500.00	$ 52.78	$ -	$ 56,552.78	$ 237,033.33	$ 4.21
Idle Year	$ 1,000.00	$ 300.00	$ 52.78	$ -	$ 1,352.78	$ 16,233.33	

1. Rosedale's operation cost includes pond maintenance, oil for reservoirs, field staff time, equipment cost, weed control cost, rodent control cost, office staff, overhead cost, etc.
2. Monthly PG&E cost to operate (4) 200 hp lift pumps moving 240 cfs, Total 56,250 ac-ft / year
3. Average monthly cost for cellular service to (1) Mission Units
4. Dry year annual cost based on operating 12 months out of the year. Wet year annual cost based on 4 months of recharging water up to 56,250 ac-ft and 8 months at idle costs.
5. Dry year pumping 25,000 ac-ft and a wet year recharging 56,250 ac-ft.

Phase II Well Field Operation Costs

Type of Year	Monthly RRBWSD Operation Cost[1,2]	Monthly PG&E Cost[3]	Monthly Mission Unit Cost[4]	DWR Conveyance Cost	Total Monthly Cost	Total Annual Cost if Utilized for 12 Months[6]	Average Cost per Ac-Ft[7]
Dry Year (Pumping Wells)	$ 8,000.00	$ 144,900.00	$ 316.67	$ -	$ 153,216.67	$ 1,838,600.00	$ 73.54
Wet Year (Recharging Water)	$ 9,000.00	$ 1,500.00	$ 316.67	$ -	$ 10,816.67	$ 90,600.00	$ 1.61
Idle Year	$ 4,100.00	$ 1,500.00	$ 316.67	$ -	$ 5,916.67	$ 71,000.00	

1. Rosedale's operation cost includes pond maintenance, oil for reservoirs, field staff time, equipment cost, weed control cost, rodent control cost, office staff, overhead cost, etc.
2. Cost includes one additional piece of equipment for property maintenance
3. Monthly PG&E cost to operate (6) wells
4. Average monthly cost for cellular service to (6) Mission Units
5. Assumed 35 cfs flow rate for a 30 day month for a total of 2,083 ac-ft of water recovered per month or 25,000 ac-ft/yr
6. Dry year annual cost based on operating 12 months out of the year. Wet year annual cost based on 4 months of recharging water up to 56,250 ac-ft and 8 months at idle costs.
7. Dry year pumping 25,000 ac-ft and a wet year recharging 56,250 ac-ft.

Total Project Operation Costs

Type of Year	Monthly RRBWSD Operation Cost[1,2]	Monthly PG&E Cost[3]	Monthly Mission Unit Cost[4]	DWR Conveyance Cost	Total Monthly Cost	Total Annual Cost if Utilized for 12 Months[6]	Average Cost per Ac-Ft[7]
Dry Year (Pumping Wells and Returning Water)	$ 25,500.00	$ 304,140.00	$ 844.44	$ -	$ 330,484.44	$ 3,965,813.33	$ 79.32
Wet Year (Conveying and Recharging Water)	$ 31,000.00	$ 285,900.00	$ 844.44	$ 404,296.88	$ 722,041.32	$ 3,039,720.83	$ 27.02
Idle Year	$ 13,300.00	$ 4,800.00	$ 844.44	$ -	$ 18,944.44	$ 227,333.33	

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KERN FAN GROUNDWATER STORAGE PROJECT

TECHNICAL MEMORANDUM NO. 7
(Well Drilling and Equipping Requirements)

PREPARED FOR: Kern Fan Joint Powers Authority (JPA)
PREPARED BY: Curtis Skaggs, P.E.
DATE: April 16, 2021

SUBJECT: ***Well Drilling and Equipping Requirements***

I. Executive Summary

It is anticipated that there will be up to a total of twelve (12) recovery water wells constructed as part of this project with up to six (6) wells on the Phase I Property and up to six (6) wells on the Phase II Property. Each of these wells are anticipated to have an approximate capacity of 5 to 6 cfs.

The wells will be drilled using the fluid reverse-rotary drilling method. A surface conductor will be installed to a depth of 50-ft. For purposes of planning-level cost estimates, a pilot hole will be drilled to an approximate depth of 970-ft with formation samples every 10-ft and geophysical logging performed in the completed pilot hole. Water quality depth sampling will be performed in select wells. The wells will then be reamed to their final diameter and 20” I.D. HSLA steel casing installed along with a 3” gravel feed tube, a 3” sounding tube, gravel pack and a cement annular seal from ground surface to an approximate depth of 305-ft. Special testing requirements during the well drilling and development process are outlined in Section III.G.

The depths and diameters of the conductor casing, pilot holes and reamed holes; the lengths of casing, tubing, gravel pack, and cement seals; and the duration of well development methods are merely estimates based upon past experience and have been approximated for cost estimating purposes as part of Technical Memorandum No. 11 “Engineer’s Estimate”. The well design parameters and specifications will be prepared by the design engineer and project hydrogeologist. The plans and specifications will detail the well design based on the actual project location.

The actual field conditions encountered during the well drilling and development process will dictate the completed well design.

The wells are planned to be equipped with 12-inch column piping, 3 1/2-inch enclosing tubing, 2 3/16-inch lineshaft and a 500 hp motor with variable speed drive. The well will include 12-inch diameter fusion bonded epoxy lined and coated steel discharge piping with valves, fittings, supports, and instrumentation. The well will be protected with a pre-fabricated steel motor enclosure. The well site electrical gear will be free-standing and mounted to a concrete foundation with a galvanized steel shade structure and security locking gate beam across the front of the electrical equipment. Two flood lights will be mounted on the shade structure and one directed to face the electrical equipment and one directed to face the well pump and motor. Well site security and a SCADA system for remote monitoring will be included.

The project is not anticipated to negatively impact neighboring wells or recharge and recovery projects. Potential changes in groundwater levels predicted for project recovery scenarios were analyzed using a calibrated numerical groundwater flow model. The groundwater model used for the analysis was previously developed to evaluate groundwater level changes in the vicinity of banking projects along the Kern River west of Bakersfield, California. The results of this modeling are discussed in the Kern Fan Groundwater Storage Project EIR dated December 2020 and demonstrate that the regional pumping of wells for the project will not negatively impact neighboring wells or neighboring recharge and recovery projects. Anticipated static and pumping water levels for the region are discussed herein based on historical records and may be used for the design of the project pumps and motors.

If the actual well field configurations end up being moderately different from the configurations previously modeled, then the well impact analysis will be re-evaluated and updated as necessary.

In the event that groundwater levels are drawn near established minimum thresholds under SGMA, it is anticipated that groundwater recovery can be shifted to areas where groundwater levels are not near minimum thresholds. The District production wells cover an area of almost 18 square miles providing potential flexibility to shift pumping as needed.

This memorandum addresses the following:

II. Well Layout Requirements

The Phase I and Phase II Property locations have not been finalized yet, but property locations have been assumed as part of this preliminary engineering work. These property locations are shown in Figure 1 below.

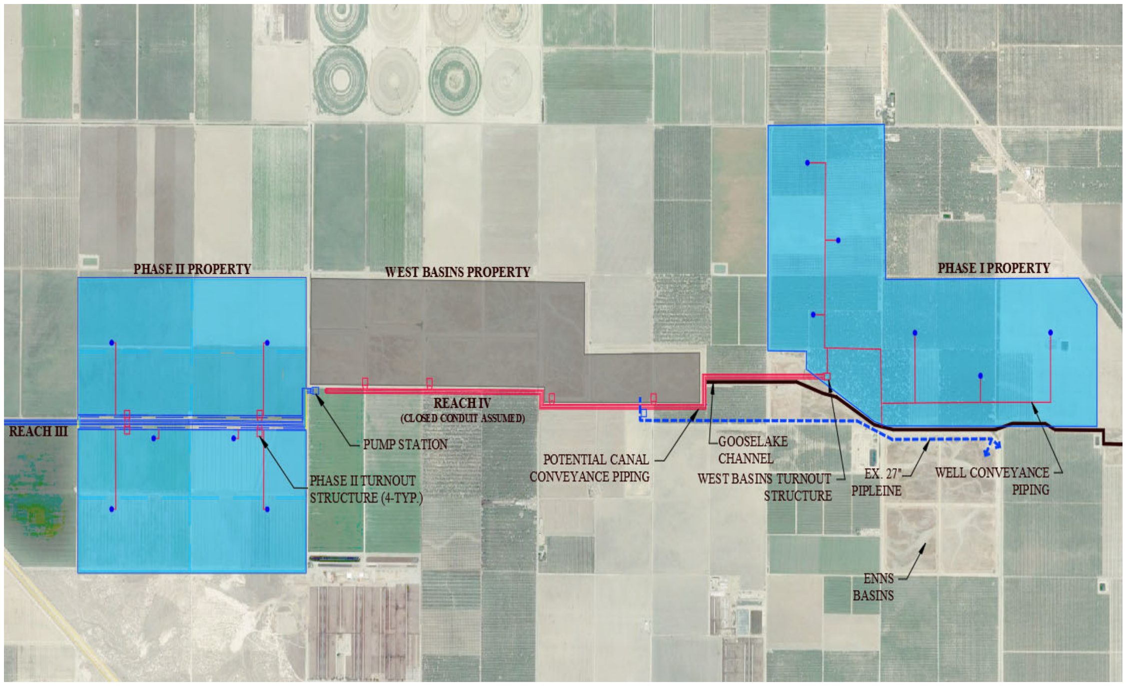

Figure 1: Phase I and Phase II Properties

A. Well Spacing and Setback Requirements

A preliminary layout has been estimated for approximately six (6) recovery water wells on each of the Phase I and Phase II Recharge Properties. The layout estimates a minimum 1,320-ft spacing in between recovery wells and from neighboring wells to minimize drawdown and interference. See Figure 2a and 2b below for a typical preliminary well layout.

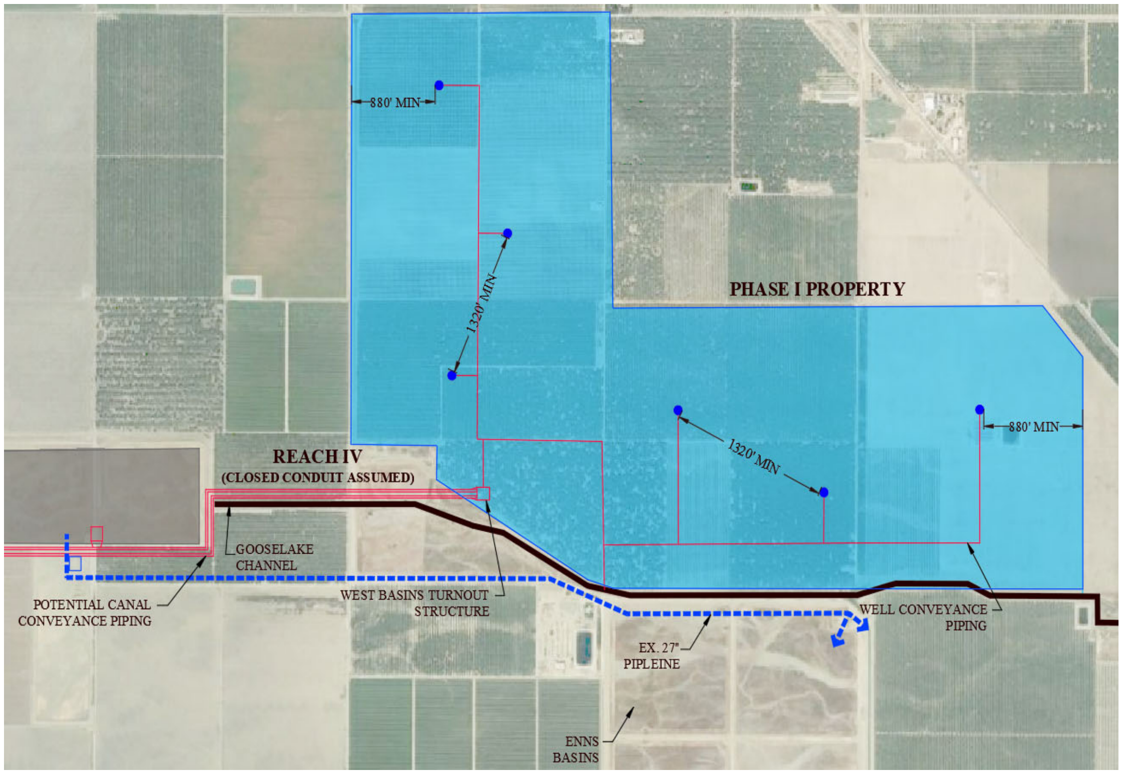

Figure 2a: Preliminary Well Layout for Phase I Property

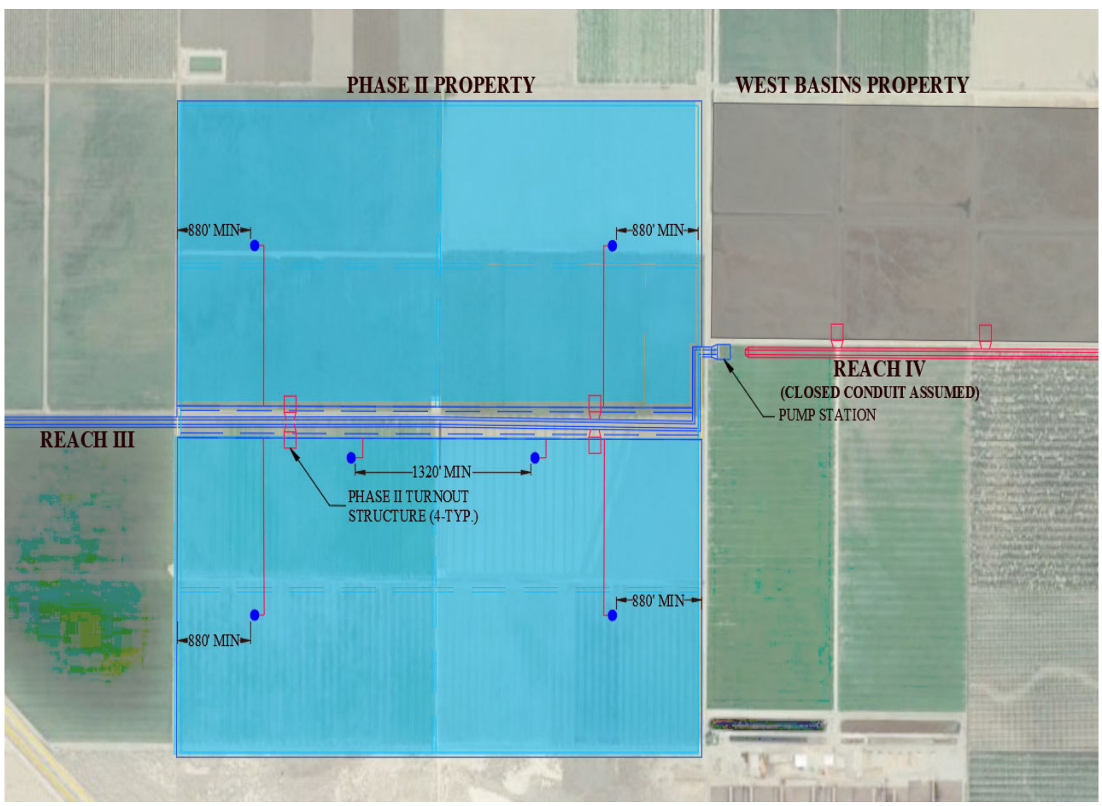

Figure 2b: Preliminary Well Layout for Phase II Property

B. Site Layout

A typical well site layout (an example from the RRBWSD Stockdale East Well Facilities) is illustrated in Figure 3 below. It is anticipated that earth well pads will be graded and prepared as part of the recharge facility earthwork project. The well pads will be approximately 100-ft by 100-ft. These well pads will be utilized for the drilling, construction, and development operations associated with the well construction.

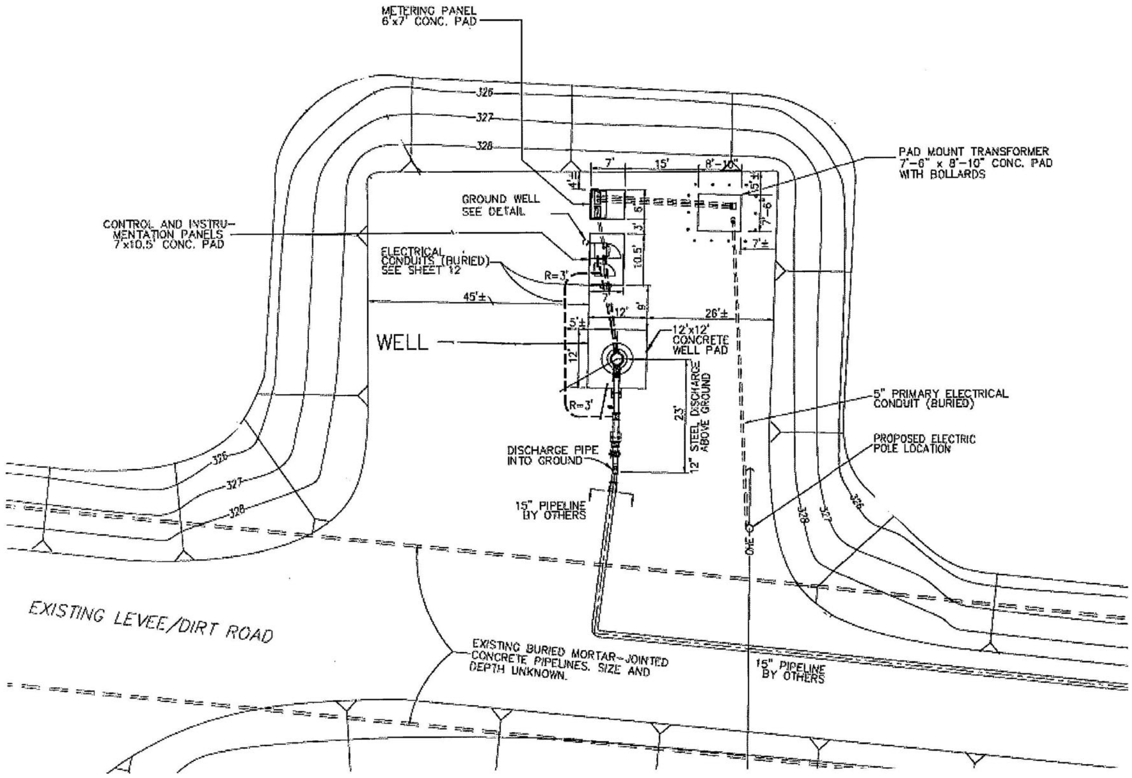

Figure 3: Well Site Layout

The well pad will accommodate the well drilling rig, pipe trailer, field office, mud pits, and settling tanks as well as all ancillary equipment and materials. A preliminary well construction layout is illustrated in Figure 4 below. Equipment may also be stored down in the recharge basin bottoms, however any use or disturbance to the basin bottoms shall be cleaned and ripped at the completion of the project.

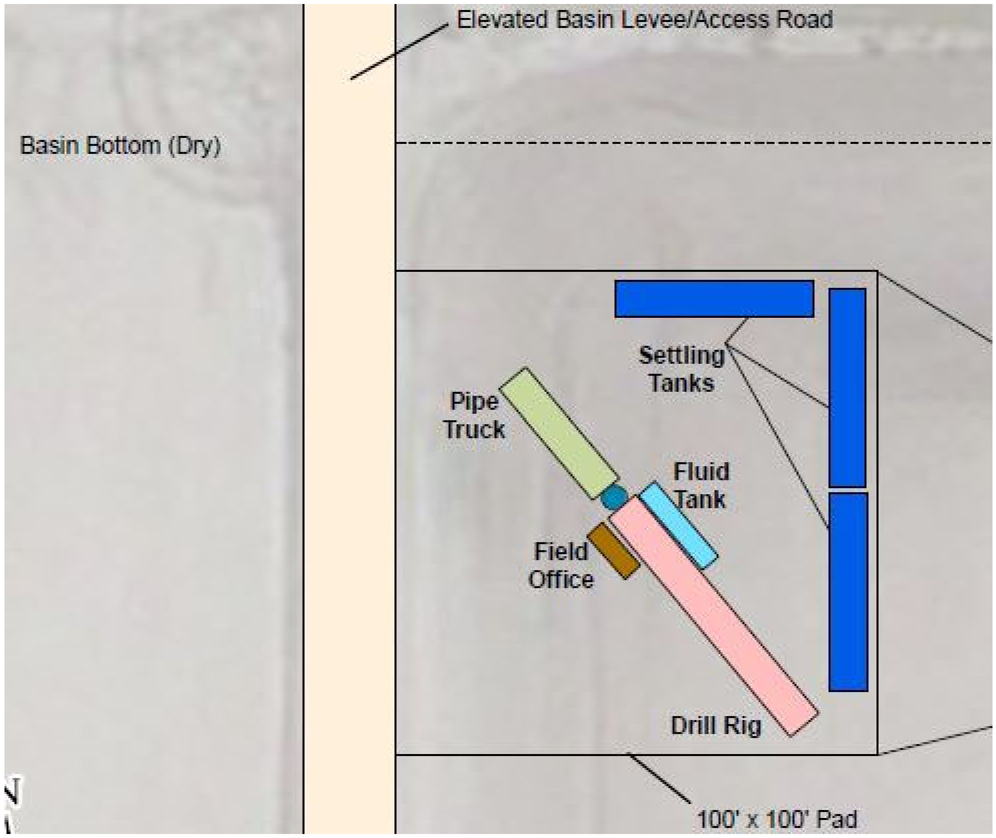

Figure 4: Well Construction Layout

C. Impact Analysis

a. Impact of Well Layout (Localized)

- Sound mitigation is not anticipated to be necessary given the remote location of the well sites relative to homes.

- Turbid groundwater generated during well development and testing will be clarified in a series of 20,000 gallon tanks prior to discharging to a nearby surface basin where it will be allowed to infiltrate into the subsurface. All discharge water will be carefully controlled to prevent runoff to adjacent properties, roads, etc.

- Water for use during the drilling operation will be supplied by the District within one-half (1/2) mile of the drilling location. Only groundwater of suitable quality, approved by the District, will be allowed for use during drilling operations.

- Drilling fluids and cuttings generated during drilling shall be contained on-site during construction. They shall be dried out and then they will be allowed to be uniformly and evenly spread out on-site or on recharge pond levee slopes as directed by the District.

- All access roads and site areas will be sprayed with water regularly to prevent dust generation as a result of the drilling operation and for dust control.

- Upon completion of well construction, the site will be graded level and the top of well casing will be welded shut to prevent access until the permanent pump is installed.

b. Impact of Well Pumping (Regional)

Potential changes in groundwater levels predicted for project recovery scenarios were analyzed using a calibrated numerical groundwater flow model. The groundwater model used for the analysis was previously developed to evaluate groundwater level changes in the vicinity of banking projects along the Kern River west of Bakersfield, California. The model was developed using MODFLOW, a block centered, finite difference groundwater flow modeling code developed by the United States Geological Survey (USGS) for simulating groundwater flow (McDonald and Harbaugh, 1988).[1] MODFLOW is one of the most widely used and critically accepted model codes available (Anderson and Woessner, 2002).[2] The results of this modeling are discussed in the Kern Fan Groundwater Storage Project EIR dated December 2020 and demonstrate that the regional pumping of wells for the project will not negatively impact neighboring wells or neighboring recharge and recovery projects. Anticipated static and pumping water levels for the region are discussed herein based on historical records and may be used for the design of the project pumps and motors.

If the actual well field configurations end up being moderately different from the configurations previously modeled, then the well impact analysis will be re-evaluated and updated as necessary.

In the event that groundwater levels are drawn near established minimum thresholds under SGMA, it is anticipated that groundwater recovery can be shifted to areas where groundwater levels are not near minimum thresholds. The District production wells cover an area that includes several square miles providing potential flexibility to shift pumping as needed.

[1] McDonald, M.G., and Harbaugh, A.W., 1988. A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model: in Techniques of Water-Resources Investigations of the United States Geological Survey; Book 6 Modeling Techniques.

III. Well Design Requirements

The depths and diameters of the conductor casing, the pilot holes and reamed holes; the lengths of casing, tubing, gravel pack, and cement seals; and the duration of well development methods are merely estimates based upon past experience and have been approximated for cost estimating purposes as part of Technical Memorandum No. 11 "Engineer's Estimate". The well design parameters and specifications will be prepared by the design engineer and project hydrogeologist. The plans and specifications will detail the well design based on the actual project location. The actual field conditions encountered during the well drilling and development process will dictate the well design.

A. Borehole Drilling and Testing Procedures

Each well construction will include a minimum 50-ft deep steel conductor casing to serve as a near-surface sanitary seal and to provide borehole stability during drilling operations. The conductor casing will be set within a nominal 54-inch diameter borehole drilled using a bucket auger to a depth of 50-ft. For planning purposes, it is anticipated that the steel conductor will consist of a mild steel, 42-inch outside diameter casing with a 3/8-inch wall. The annular space between the steel conductor casing and the borehole wall will be filled with a 10.5-sack cement sand slurry to ground surface.

A pilot hole, approximately 17.5-inch diameter, will be drilled to the specified depths using the fluid reverse-rotary drilling method. For purposes of the planning-level cost estimates, each borehole will be drilled to a depth of 970-ft. Composite soil samples shall be collected throughout each 10-ft depth interval of drilling for visual description in the field. Drilling fluids and cuttings will be managed using an above-ground tank. Deviation surveys shall be performed at every 100-ft depth during drilling to verify a plumb pilot hole using an approved mechanical drift indicator. The maximum tolerance for the deviation surveys shall be ½-degree from vertical per 100-feet. At the completion of the pilot hole, geophysical logging shall be performed that includes:

- Gamma Ray
- Sonic Velocity Variable Density
- Spontaneous Potential
- Short Normal Resistivity
- Long Normal Resistivity
- Laterolog Resistivity
- Deviation Survey

The maximum allowable horizontal deviation (drift) from the vertical shall be 6-inches per 100-feet for the well deviation survey.

It is anticipated that isolated aquifer zone testing will be performed in boreholes at selected locations. It is not envisioned to conduct this testing at every well location given their relatively close proximity (approximately six wells per 640 acres). The design firm and hydrogeologist will select the drilling locations at which isolated aquifer zone testing will be conducted to provide the best representation of water quality in the recharge and recovery area. At each borehole selected for testing, the design firm and hydrogeologist will select the number and depth of isolated aquifer zones based on a review of the geophysical logs and log of soil cuttings.

Upon completion of the pilot hole and any aquifer zone testing, the design firm and hydrogeologist will prepare a final well design. The well design will specify the final casing diameter and material, perforation interval, slot size, filter pack gradation, filter pack interval, annular seal interval, sounding tube diameter and entry depth, and gravel feed tube diameter and depth. For planning purposes, the casing is anticipated to be 20-inches in diameter with a 5/16-inch wall thickness. The pilot hole will be enlarged to 36-inches in diameter to accommodate the casing, camera access/sounding tube, and gravel feed tube. The borehole diameter may be reduced to 32-inch diameter from the bottom of the gravel feed tube to the bottom of the borehole. At the completion of the reamed hole, a caliper log and deviation survey shall be performed.

B. Water Quality Testing Strategy

Groundwater quality testing will be conducted at selected well locations. For those locations where isolated aquifer zone testing is specified, the analytical testing suite will be focused on water quality constituents of concern.

Water quality concerns in the area include:

- 1,2,3-TCP (SRL 524M Low Level Test)
- Arsenic
- Nitrate

Nitrate is commonly detected in the shallow aquifer while the Arsenic concentration typically increases with depth. The perforated intervals for each well will be designed, based on the data collected, to avoid these constituents, if possible. It is estimated that three to five zone tests would be performed in select wells and that at least one of the initial wells would have zones in the deeper aquifer from 700-ft to 900-ft to verify the Arsenic concentrations.

Other water quality constituents to be included in the isolated aquifer zone testing suite will include:

- Total dissolved solids,
- pH

- General physical properties (color, odor, turbidity)
- General minerals (cations and anions)
- Ethylene dibromide (EDB)
- Dibromochloropropane (DBCP)
- Gross alpha

The design firm and/or hydrogeologist may select other constituents for analysis as needed.

Upon completion of development and testing of each well, groundwater samples will be collected for analysis of a full Title 22 water quality suite.

C. Casing Material and Size

The recovery well casing and screen is to be manufactured by Roscoe Moss Company of Los Angeles, California. For planning purposes, the casing is anticipated to be constructed of 20-inch I.D. high-strength, low-alloy (HSLA) steel with a 5/16-inch wall thickness. For cost estimating purposes, the blank casing length has been estimated as 420-ft.

The perforated interval lengths and depths as well as the slot size will be determined based upon the formation samples, geophysical logs, depth to water, and water quality data for each well. For cost estimating purposes, a perforated length of 510-ft has been estimated. The perforations are anticipated to be horizontal louvers in the "Ful-Flo" pattern.

D. Filter Pack and Annular Seals

The filter pack shall be designed based on sieve analysis for selected soil samples that are collected during the drilling of the pilot hole. The gravel material shall be composed of sound, durable, well rounded natural particles and be free of organic matter, clay balls, and other deleterious substances. The filter pack shall be placed by pumping into the annular space through a tremie pipe and shall not be allowed to free fall from more than 30-ft below the bottom of tremie pipe. For cost estimating purposes a filter pack length of 665-ft has been used.

The annular seal shall consist of a 10.5 sack cement sand slurry and shall be placed in the annular space from the top of the gravel pack and fine sand to the ground surface. The annular seal shall be placed by pumping into the annular space through a tremie pipe. For cost estimating purposes, a cement annular seal depth of 405-ft has been used.

E. Tubing Material and Sizes

The well installation shall include a gravel feed tube and a sounding tube or camera tube.

The gravel feed tube shall be a 3-inch Schedule 40, ASTM A53 Grade B steel tube. The depth of the feed tube shall be determined at the time of the final casing design, however for cost estimating purposes a depth of 315-ft has been used.

The sounding tube or camera tube shall be a 3-inch Schedule 40, ASTM A53 Grade B steel tube. The sounding tube shall be installed outside of the casing in the annular space and terminate in a fabricated steel box welded to an opening in the well casing at the depth determined at the time of the final casing design. For cost estimating purposes a depth of 405-ft has been used.

A typical well cross-section is illustrated below in Figure 5 and illustrates the conductor casing, blank casing, perforated casing, tubing, gravel pack, and cement annular seal.

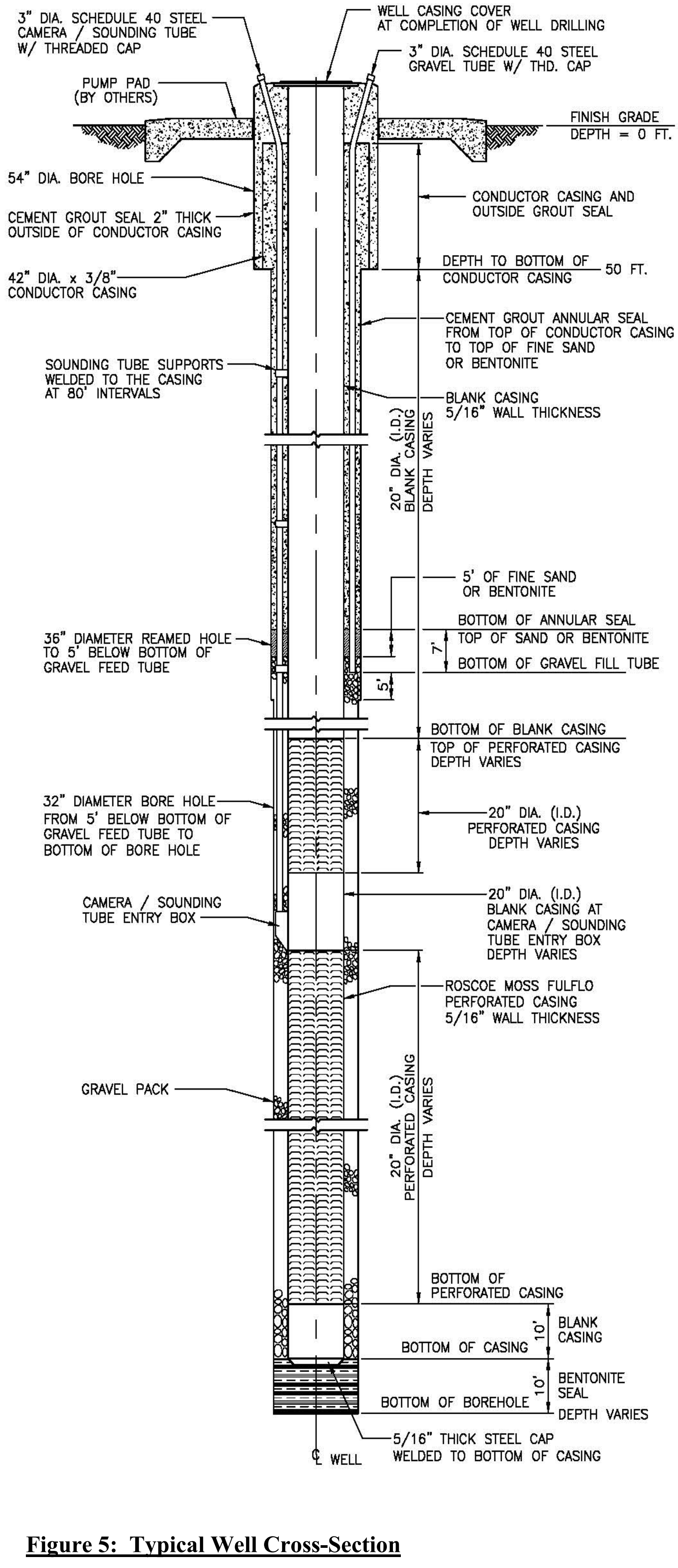

Figure 5: Typical Well Cross-Section

F. Well Development Procedures

Well development shall be performed in a two-stage process that includes initial development by airlifting and swabbing, followed by development by pumping and surging.

The initial development shall be performed using a dual swab tool that has swab flanges no more than 10-feet apart. The outside diameter of the swab rubber wipers shall be no more than one-half inch less than the inside diameter of the well screen. Initially, the well casing shall be airlifted with an open-ended single swab attached to the end of the drill pipe to remove sediment and materials from the bottom of the well. The screened interval of the well shall be swabbed in short screen intervals of no more than 20-feet. The swabbing and airlifting shall be performed to remove mud, sediment, and sand from the gravel pack and continue until the airlifted water is relatively clear.

If the Contractor uses a drilling mud additive at any time during the well construction, then chemical development shall be required in addition to the mechanical development. The chemicals to be utilized shall be a clay-dispersing agent approved by the hydrogeologist.

Pumping and surging development shall be conducted using a vertical turbine test pump. The pump capacity is anticipated to be approximately 4,000 gpm at a 600-ft TDH. The test pump shall be installed to the depth specified by the design firm and hydrogeologist. The quantity of water being pumped during development shall begin at a low volume and gradually increase as development continues. The well shall be thoroughly developed so that it will produce a maximum specific capacity based on the consideration of depth and nature of the water bearing formations and so that it will not produce an amount of fine sand in excess of the sand production limitations.

Chemical development shall be performed during development by pumping and surging using a clay-dispersing agent such as Mud-Nox.

In addition, final well development shall be performed as directed by the design firm and hydrogeologist and include a minimum of three flowrates (steps) for the step-drawdown test and a minimum 24-hr constant rate discharge test.

G. Special Testing Requirements

The minimum well testing requirements are outlined below:

- Deviation surveys (Mechanical Drift Indicator) every 100-ft depth of pilot hole
- Geophysical logs upon completion of pilot hole
  -Sonic Log
  -E-Log/Gamma Ray
  -Deviation Survey (Gyroscopic Survey)
- Isolated Aquifer Zone Test Water Quality Sampling (selected locations)
- Caliper log and Deviation survey (Gyroscopic Survey) upon completion of reamed hole
- Formation sieve analysis
- Gravel sieve analysis
- Well Development Specific Capacity, Turbidity and Sand Content
- Step-Drawdown Pumping Test (Minimum of three steps)
- Constant Rate Pumping Test (Minimum 24hr test)
- Dynamic Flowmeter (Spinner) Survey
- Gyroscopic Well Alignment Survey
- Well Video
- Title 22 Water Quality Analysis

IV. Well Equipping Requirements

A. Vertical Turbine Pump Design Range

a. Historic Water Levels

Water levels were reviewed from August 2013 through March 2021 in the area of the Kern Fan Groundwater Storage Project. Two wells were selected from the Strand Ranch Project, SREX-1 (north side of CVC) and SREX-7 (south side of CVC); two wells from the Stockdale West Project, SWEX-2 and SWEX-3; and three wells from the Drought Relief Project, SUP-1, SUP-5, and the Matuk Well.

The static water levels were low in 2013 through 2016 as a result of the drought. The lowest static water level observed in these wells was approximately 320-ft at SREX-7 around May of 2016. The static water levels then began to trend upwards as a result of groundwater recharge to their peak around January 2020. The shallowest static water level observed was approximately 87-ft at SWEX-3. See the graph of static water levels in Figure 6 below.

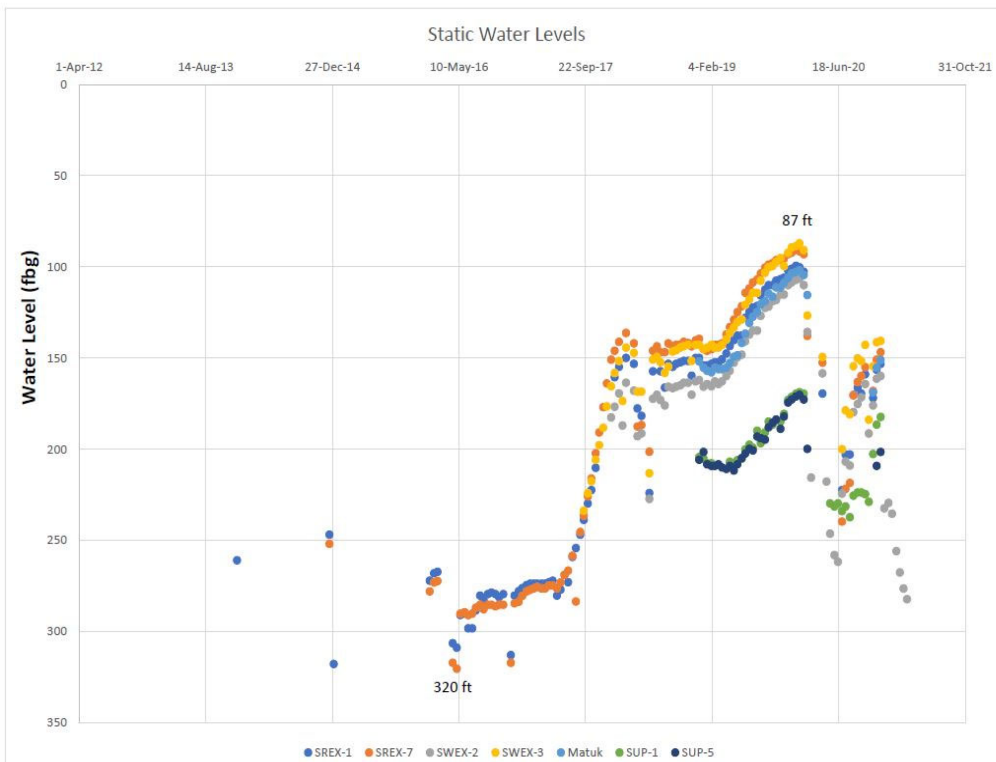

Figure 6: Historic Static Water Levels

The pumping water levels were also low in 2013 through 2016 as a result of the drought. The deepest pumping water level observed in these wells during the drought was approximately 440-ft at SREX-7 around April of 2016. The pumping water levels then began to trend upwards as a result of groundwater recharge to their peak around February 2018. The shallowest pumping water level observed was approximately 277-ft at SREX-1. See the graph of pumping water levels in Figure 7 below.

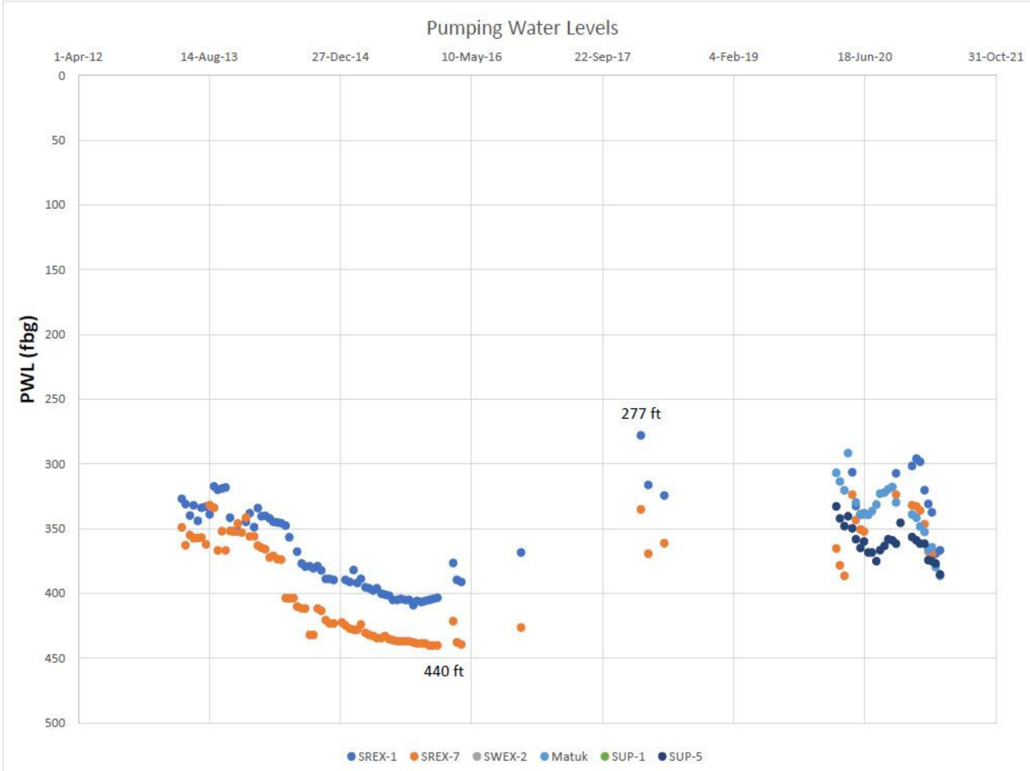

Figure 7: Historic Pumping Water Levels

b. Pump Design Criteria

The actual pump design point will be based upon the results of the well drilling and development, however the historical water level data in the area shall be used to provide a range of water levels for purposes of the pump design. It is recommended that the pump and motor be designed to provide the design flow rate at the deeper pumping water levels and then the VFD can be utilized to operate the pump at slower speeds, if necessary, when water levels are shallow.

The range observed for pumping water levels in the area is approximately 275-ft to 450-ft.

The design operating point for shallow pumping water levels (after recharge periods) would be approximately 4,000 gpm (9.0 cfs) at a pumping water level of 275-ft with a minimum bowl efficiency of 75%. In selecting the actual pump, the engineer will need to take into consideration column friction losses, discharge pipeline losses, and minor losses.

The design operating point for deeper pumping water levels (during sustained dry years) would be approximately 2,250 gpm (5 cfs) at a pumping water level of 450-ft with a minimum bowl efficiency of 68.0%.

In selecting the actual pump, the engineer will need to take into consideration column friction losses, discharge pipeline losses, and minor losses.

The preliminary design operating point for the pump is approximately 3,000 gpm (6.7 cfs) at an approximate pumping water level of 400-ft with a minimum bowl efficiency of 80.0%.

c. Pump Assembly

A vertical turbine pump shall be installed for each well. The size, capacity, and depth of pump setting will be determined based on the results of the final well development. The pump assembly will be oil-lubricated and include a 10 gallon oil reservoir with solenoid valve and manual bypass.

For cost estimating purposes, the pump has been estimated to include 12-inch column pipe, 3 1/2-inch enclosing tubing, and 2 3/16-inch lineshaft. The line shaft shall be Type 416 stainless steel with Type 316 stainless steel shaft couplings and bronze lineshaft bearings. The column piping shall also include a 5-ft section installed just above the pump and a 5-ft section installed just below the pump head. The pump assembly shall include a 5-ft long suction pipe with a stainless steel cone strainer. The depth of the pump setting will be dependent on the design of the well casing (install where adjacent to blank sections of casing), however it is anticipated to be set below a depth of 550-ft.

The pump discharge head shall sit on a reinforced concrete foundation. The camera tube, gravel feed tube, and casing shall be extended or trimmed as necessary to conform to the concrete foundation. In addition, a 3-inch casing vent shall be installed that is screened and extends 3-feet above the foundation.

B. Well Motor Type

The well motor shall be a vertical hollow shaft electric motor. The motor horsepower has been estimated as 400 to 500 hp.

C. Variable Speed Drives

A variable speed drive shall be installed at each well pump and motor. The variable speed drive is more energy efficient, reduces the motor starting voltages and flicker issues with the power supply grid, and provides more pumping flexibility with varying groundwater levels.

The variable speed drive is to be a Yaskawa U1000 Industrial Matrix Drive. This drive has ultra-low harmonics, full continuous regeneration, and high-efficiency.

D. Discharge Pipe Size and Appurtenances

The discharge piping is to be 12-inch fusion bonded epoxy lined and coated steel discharge piping as outlined in Technical Memorandum No. 3 “Pipeline Requirements”.

The well discharge shall include the following at a minimum:

- a deep well air release and vacuum relief valve (Waterman AV-150 Air Vent with Vacuum Relief or approved equal)
- a sleeve coupling with joint harness (Dresser or approved equal)
- a high pressure switch (Mercoid or approved equal)
- pressure transmitter (Smar Technology or approved equal)
- sample port
- wafer check valve (Fresno Valve or approved equal)
- pressure gauge (Ashcroft or approved equal)
- magnetic flow meter (Seametrics or approved equal)
- combination air vent and vacuum relief valve assembly (Waterman CR101 or approved equal)
- butterfly valve (Grayline Valve or approved equal) and
- pipe supports

E. Electrical Service & Switchgear

The electrical service is anticipated to be provided by PG&E. A pad mounted transformer, as approved by PG&E, will be installed at each well site with bollards.

Each well site will have a main switchboard section with pull section, meter section, and main breaker. The motor control center will include security power, RTU panel, the well motor starter, 5 kVA transformer, a load panel (circuit breakers), a well level indicator screen, low well level alarm light and reset alarm button. The electrical equipment shall also be equipped with interior lighting and receptacles. The orientation of the electrical gear shall face north or east, as reasonable when designing the site layout, to minimize the direct sunlight on the face of the equipment.

The RTU unit is discussed in Technical Memorandum No. 10 (SCADA) and will be work performed by others. The motor control center (MCC) shall include a spare bucket or cabinet for installation of the RTU and I/O devices.

The electrical gear shall be enclosed in NEMA 3R equipment and shall be fully rated for continuous operation at 50° C ambient conditions within the electrical equipment for outdoor installation. Digital displays shall be installed between a height of 48-inches to 60-inches and be protected from direct sunlight.

F. Instrumentation & Controls

The instrumentation and controls will be utilized for well operation, safety features, and monitoring. The instrumentation and controls shall include the following devices:

- Well Level Transducer (4-20 ma) for monitoring groundwater levels (Endress + Hauser or approved equal). The estimated cost for the transducer is $1,500.00.
- Solenoid for oil drip to deep well pump.
- High Pressure Switch to protect piping from over-pressurizing (Mercoid or approved equal). The estimated cost for the high pressure switch is $1,200.00.
- Pressure Transmitter (4-20 ma) for monitoring discharge pressure (Smar Technology or approved equal). The estimated cost for the pressure transmitter is $1,000.00.
- Flow Meter signal (4 – 20 ma) for monitoring well flow (Seametrics Mag Meter with power supply – not battery)

G. Well Enclosures

The well motor enclosure consists of a 14-ft diameter welded steel hut. The enclosure shall have a cone roof and be tall enough to provide a minimum 24-inch clearance above the top of the well motor. The enclosure shall be made out of 2x2 square tubing, galvanized sheet metal, and 2x2 square welded wire fabric. The enclosure shall include a 31-inch wide by 84-inch tall access door and the enclosure shall be removable for times when the well, pump, and motor need to be serviced.

H. Equipment Security

Site security is important at these well sites to prevent theft and vandalism. Site security includes, site lighting, well motor enclosure, and electrical equipment locking gate beams.

I. Shade Structure

A pre-engineered electrical equipment canopy or shade structure shall be installed at each well site. The shade structure shall consist of steel square tubing for the frame and weather panel material for the roofing and siding. All material shall be hot-dip galvanized steel. The structure shall be anchored to the concrete foundation and designed for seismic and wind loading in accordance with ASCE 7-16 and the 2019 California Building Code (CBC).

The size and height of the shade structure shall be coordinated with the electrical gear dimensions and provide for a minimum 4-ft covered clear space in front of the electrical gear and a minimum 2-ft clearance around the sides and back of the gear.

J. Control Philosophy and Monitoring

The wells are operated during recovery operations and are manually operated. They are turned on manually and turned off manually unless shutdown on a power failure, equipment failure, or high pressure switch. The operation, control, and monitoring of the well facilities is discussed further in Technical Memorandum No. 10 Facility Operation and SCADA Requirements.

The monitoring devices send information via 4-20 ma signals to the RTU panel or a Mission Unit. The RTU or Mission Unit is a remote monitoring device that displays the following:

- Well Status
- Groundwater Level
- Well Discharge Pressure
- Well Discharge Flow
- Any Alarms

V. Well Site Requirements

A. Site Fencing & Security

Site security is an important feature of these well sites as they are located in remote areas and are often not visible to the public and routine traffic.

Security will need to be provided for the electrical equipment and the well as the most vulnerable well site feature is the copper wiring to the motor.

The security for the electrical equipment shall include a locking cross bar that runs across the front of the electrical gear to prevent it from being opened. It includes steel posts, hinges, gate beams, support beams, and a lock box.

The well motor security consists of a 14-ft diameter welded steel enclosure hut. The enclosure shall have a cone roof and be tall enough to provide a minimum 24-inch clearance above the top of the well motor. The enclosure shall be made out of 2x2 square tubing, galvanized sheet metal, and 2x2 square welded wire fabric. The enclosure shall include a 31-inch wide by 84-inch tall access door and the enclosure shall be removable for times when the well, pump, and motor need to be serviced.

B. Site Lighting

Site lighting is another security feature due to the remote location of these well sites. It is helpful to have them well lit at night to deter trespassing and to aid in visibility for working at night, if necessary. It is estimated that a minimum of two flood lights will be installed at each well site on the shade structure with motion sensors and photo cells. The lighting will be directed to the motor control center and the well pump and motor.

C. Site Ground Surfacing

All-weather surfacing is a requirement for these sites to minimize maintenance for weeds and to provide good access to equipment. It is estimated that the all-weather surfacing will be 4-inch thick, ¾-inch Class II aggregate base.

VI. Related Work Specified Elsewhere

A. TM 1 – Project Phasing and Design/Contractor Selection
B. TM 3 – Pipeline Requirements
C. TM 5 – Geotechnical Investigation
D. TM 9 – Recharge Basin Requirements
E. TM 10 – Facility Operation and SCADA Requirements
F. TM 11- Engineer's Estimates

DEE JASPAR & ASSOCIATES, INC.
CONSULTING CIVIL ENGINEERS
2730 UNICORN ROAD, BLDG A
BAKERSFIELD, CA 93308
PHONE (661) 393-4796
FAX (661) 393-4799

April 7, 2021

Dan Bartel
Groundwater Banking JPA
c/o Rosedale-Rio Bravo Water Storage District
849 Allen Road
Bakersfield, CA 93314

RE: Kern Fan Groundwater Storage Project
Proposal for Engineering Design RFP

Mr. Bartel,

Attached is a cost proposal for providing engineering services to prepare the Request for Proposals (RFP) for the design phases of the above referenced project. It is anticipated that one RFP will be prepared which will include a proposal form with five different design packages that each proposer can propose on. The RFP will include language stating the JPA can select and award any of the design packages or combination thereof at their discretion.

Task #1 is for the preparation of the RFP and includes:

- General correspondence and discussions
- Prepare a draft RFP for review and comment
- Incorporate comments and issue a second draft RFP for review and comment
- Incorporate comments and issue a final draft RFP

Task #2 is for assistance during the RFP review and selection process and includes:

- Facilitating a pre-proposal project meeting
- Responding to proposal RFI's
- Preparation of proposal addenda as necessary (Estimate of three addenda)
- Participation in firm interviews and correspondence
- Review of proposals and preparation of recommendations
- Assistance with firm selection and agreements

The work will be billed on a time and material basis in accordance with our 2021 Rate Schedule. The cost proposal is a not-to-exceed amount of $55,529.00 as presented in the attached budget.

Please let me know if you have any questions, concerns, or need anything else. Thank you for the opportunity to serve the District on this project.

Thanks,

Curtis Skaggs

Curtis M. Skaggs, PE

Groundwater Banking Joint Powers Authority (JPA)
Kern Fan Groundwater Storage Project

Request for Proposals (RFP) Preparation

	Principal Engineer	Registered Engineer	Staff Engineer	Draftsperson	Secretary	
	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Estimated Time (hrs)	Total
Task 1. Preparation of RFP						
General RFP Correspondence and Discussions	4	8	8			$2,996
Preparation of Draft RFP for Review and Comment	2	40	12			$8,014
Incorporate Comments and Issue Second Draft RFP for Review and Comment	2	24	8			$5,064
Incorporate Comments and Issue Final Draft RFP	2	8	4			$2,114
Subtotal:						*$18,188*
Task 2. RFP Review, Interviews, and Recommendations						
Facilitate Pre-Proposal Project Meeting	2	6	4			$1,806
Review RFI's and Discuss	2	20	20			$5,906
Prepare Proposal Addenda as necessary. Estimate (3) Addenda.	3	24	12			$5,748
Participate in Firm Interviews and Correspondence	20	30	15			$10,403
Prepare Firm Recommendations	4	20	12			$5,330
Assistance with Firm Selection and Agreements	8	30	16			$8,148
Subtotal:						*$37,341*
Total Hours Estimated:	49	210	111	0	0	
Total Engineering Estimate:	$9,702	$32,340	$13,487	$0	$0	***$55,529***