ASCE | PIPELINES 2012 CONFERENCE
MIAMI BEACH, FLORIDA • AUGUST 19-22, 2012

Innovations in Design, Construction, Operations and Maintenance
Doing More with Less

Recycled Water for the Thirsty High Desert

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Recycled Water for the Thirsty High Desert

Stephen Shumaker, PE; Randall Hill, PE; Jason Yoshimura, PE; Genevieve Osmena, PE; and Sami Kabar, PE

Presented by

Genevieve Osmeña **Stephen Shumaker**

LOS ANGELES COUNTY PUBLIC WORKS Public Service That Works

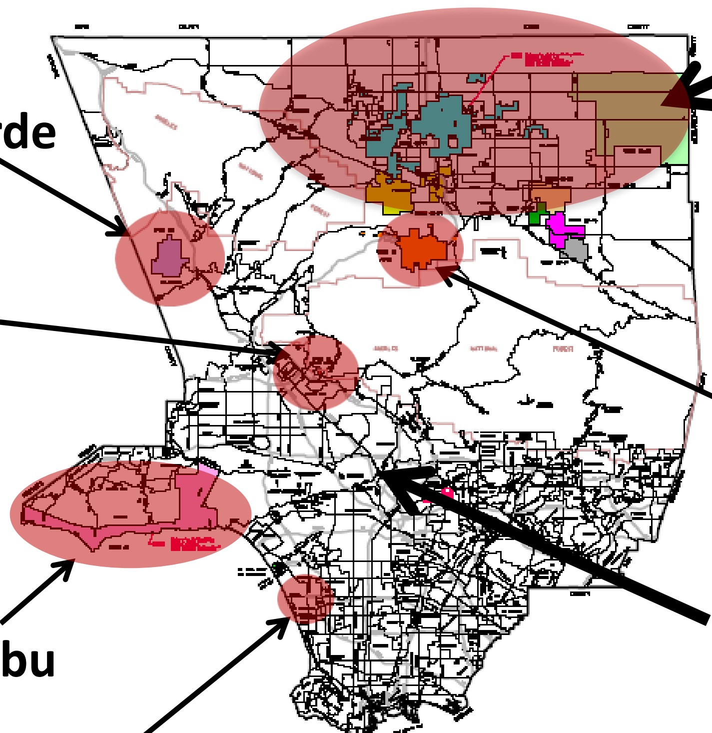
LACWD LOS ANGELES COUNTY WATERWORKS DISTRICTS

CDM Smith listen. think. deliver.

Presentation Outline for Background and Planning

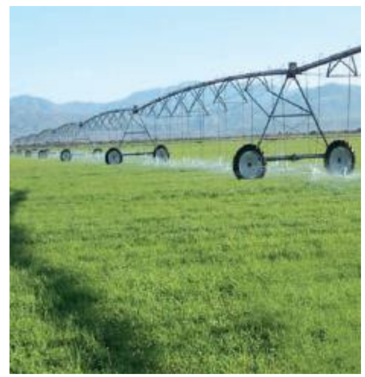
- Introduction to LA County Waterworks Districts and the Antelope Valley
- Water Supply Challenges for the Region
- Regional Planning Efforts
- Recycled Water Backbone Pipeline Project

LA County Waterworks Districts



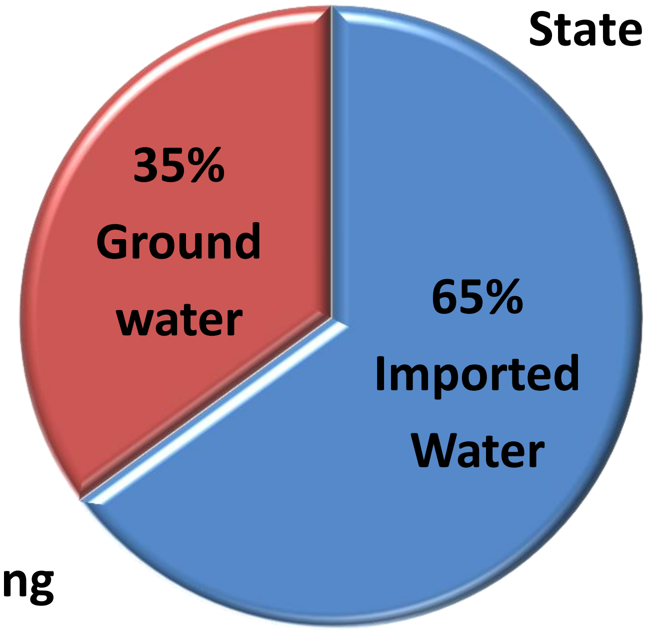
- **Approx. 180,000 customers**
- **Approx. 56,000 connections**

The Antelope Valley



Existing Water Supplies for the Region

Groundwater Wells



State Water Project / CA Aqueduct

- Historical Over-Pumping
- Un-Adjudicated Basin
- Once Adjudicated – Significant reduction in all pumping
- Judge says safe yield is 110,000 ac-ft/yr

- Based on Annual Snow and Rainfall
- 2009 – Our allocations reduced from 72% to 60%
- Delta Smelt and Chinook Salmon
- Damaged or Aging Infrastructure

Antelope Valley Regional Water Management Group (RWMG)

City of Lancaster

LACWD
LOS ANGELES COUNTY WATERWORKS DISTRICTS

PALMDALE WATER DISTRICT
PWD
ESTABLISHED 1918

PALMDALE
a place to call home

ROSAMOND
COMMUNITY SERVICES DISTRICT

SANITATION DISTRICTS OF LOS ANGELES COUNTY

ANTELOPE VALLEY - EAST KERN WATER AGENCY
AVEK
ESTABLISHED 1959
A PUBLIC AGENCY

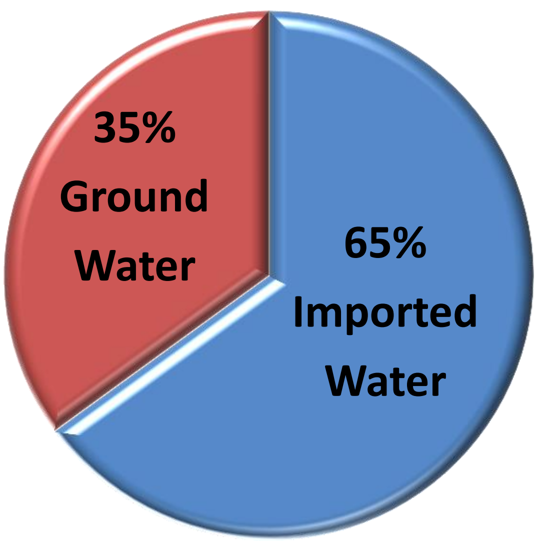
QUARTZ HILL WATER DISTRICT
ESTABLISHED 1954

FOUNDED 1892
LITTLEROCK CREEK
IRRIGATION DISTRICT

Additional Water Supplies for the Region

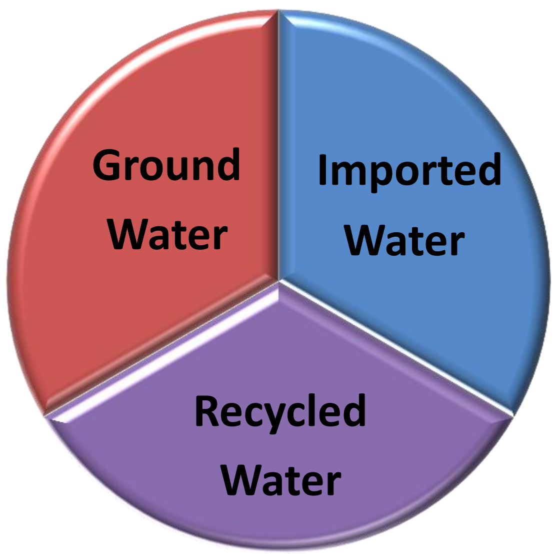
Existing Demands

(Adequate Supplies)



Existing Demands

(Reduced Supplies)



Future Demands

(Additional Supplies)

Recycled Water Timeline

1995
- RWMG Formed

2005
- CSD Started Updating Its Treatment Plants

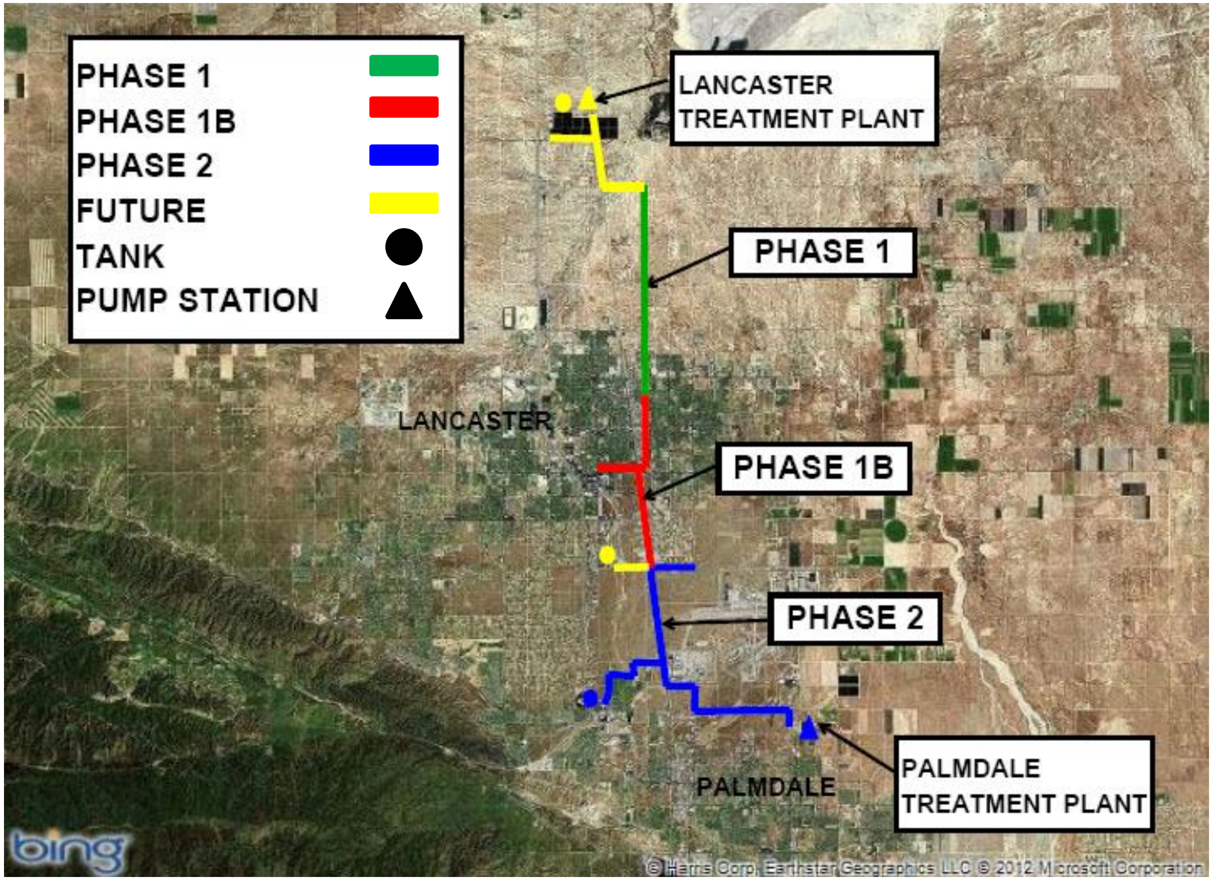
2006
- Recycled Water Facilities Study Completed

2007
- Phase 1 Completed

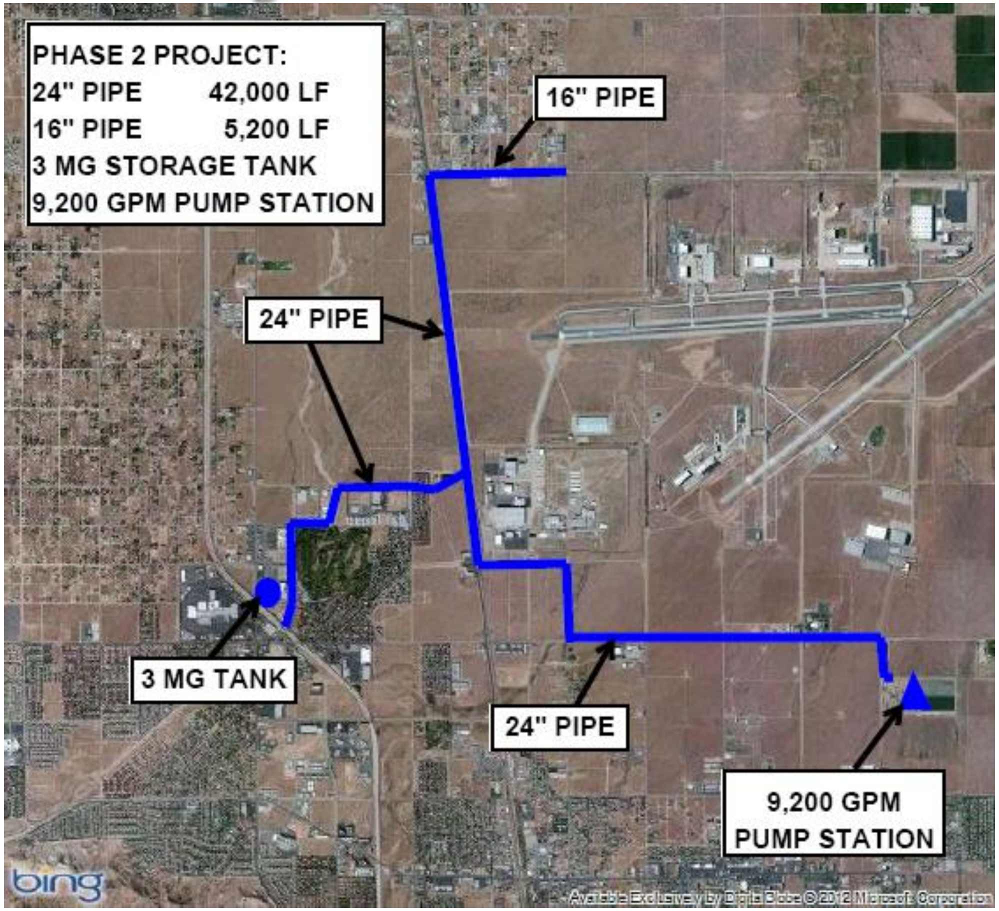
2010
- Phase IB Constructed

2012
- CDM Smith submits Final Design of Phase 2

Recycled Water System Backbone Alignment

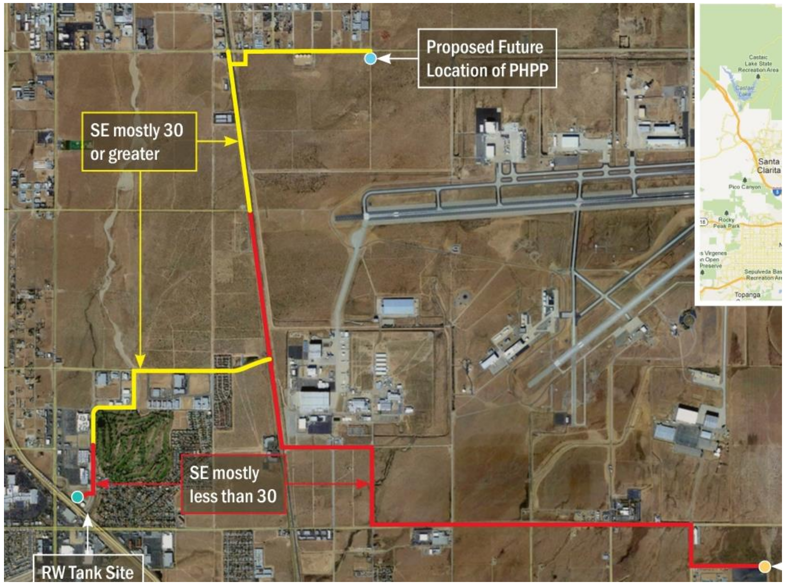


Recycled Water Backbone Project – Phase 2



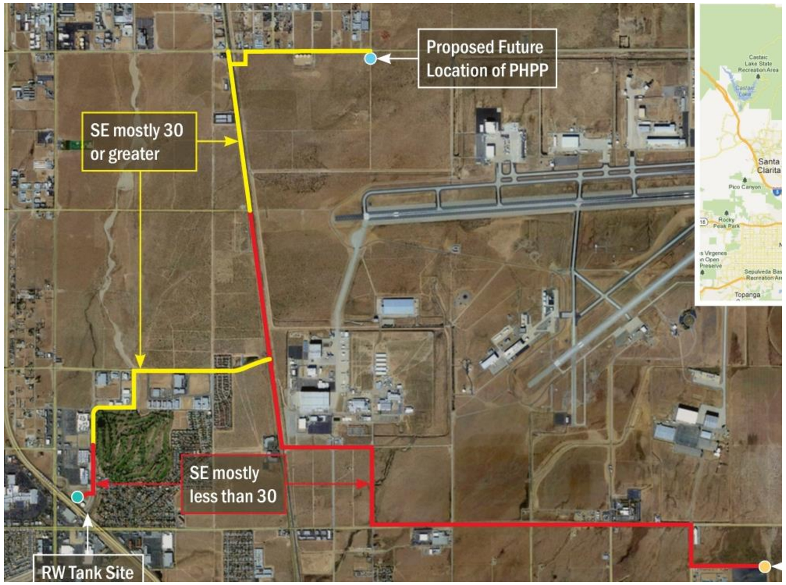
Pipeline Alignment Characteristics

- Uniform grades sloping southwest to northeast
- Low - 2,500 ft MSL at the future Palmdale Hybrid Power Plant site,
- High - 2,660 ft MSL near the water storage tank site.



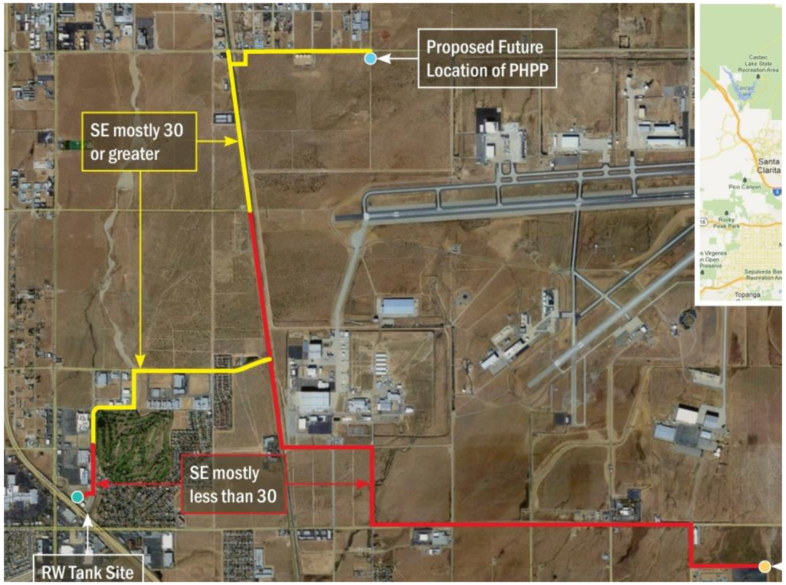
Pipeline Alignment Characteristics

- Rural desert
- Pockets of residential, commercial, and industrial development



Pipeline Alignment Characteristics

- Most of the pipeline alignments are along existing roads.
- Where practical, broad dirt shoulders along most of these roads were used.
- Congested with utilities.



Pipeline Alignment Characteristics

- Approximately 1 mile of the alignment runs along the Amargosa Creek flood control channel.

Key Design Decisions

System Hydraulics

System Hydraulics

- Maximum initial design flow of 4,600 gpm
- Ultimate flow of 9,200 gpm
- At ultimate flow, velocity through a 24-inch pipe is 6.5 feet per second (ft/s), resulting in fairly high friction headlosses.
- Therefor the system was also analyzed based on a 30-inch pipeline.

System Hydraulics

Pump Operating Points and Power Requirements for the PWRP Pump Station				
Description	**Flow (gpm)**	**Total Dynamic Head (ft)**	**Operating Load (hp)**	**Total Connected Load (hp)**
24-inch Pipeline	4,600	181	300	450
24-inch Pipeline	9,200	300	1,000	1,250
30-inch Pipeline	4,600	149	250	375
30-inch Pipeline	9,200	182	300	450

System Hydraulics

- 30-inch provides a slight reduction in headlosses and power requirements for initial maximum, but large reduction in headlosses and power requirement for ultimate.
- However, there is uncertainty that capacity beyond the initial maximum capacity will be required.

System Hydraulics

- Given the expense of constructing a larger pipeline (approximately $1,000,000 cost increase) to accommodate hydraulic conditions that may not occur, the District decided that a more economical 24-inch pipeline was appropriate for this project.

Key Design Decisions

Pipe Material Selection

Pipe Material Selection

- The District's preference for the project was welded steel pipe.
- However, District staff asked CDM Smith to perform a brief evaluation of PVC, DIP, and HDPE pipeline materials for suitability for this project.
- The evaluations were general in nature and did not include life-cycle cost analyses.

Pipe Material Selection: Steel

- High strength, flexibility, and durability.
- Field welded joints typically used in western US require more labor than gasketted push-on typical of other pipe materials.
- Requires corrosion protection.
  - Cement mortar lining and coating
  - Cathodic protection

Pipe Material Selection: Ductile Iron (DIP)

- High strength, durability, and impact resistance.
- Requires corrosion protection.
  - Polyethelyne encasement
  - Cathodic protection in severe conditions
- Push-on gasket joints or mechanical joints
- Restrained push-on and MJ available

Pipe Material Selection: PVC

- Typically, less labor to install than welded joint pipe particularly in utility-dense areas.
- Requires no corrosion protection.
- Push-on gasket joints
- After-market joint restraint for thrust
- Pressure classes exceeding 235 psi - sufficient for ultimate pressures

Pipe Material Selection: HDPE

- Durable, ductile, and flexible material.
- Requires no corrosion protection.
- In sizes required for this project, available in pressure classes up to 200 psi, sufficient for maximum initial design pressures.
- Joint cooling time up to 90 s/in dia. = 36 minutes; for DR9 thickness > 2" and 100 summer heat, additional cooling time is likely

Pipe Material Selection: HDPE (Continued)

- Long strings of fused pipe can be lowered into trench, ideal for long stretches with few crossing utilities, such as many areas along the proposed alignment
- Areas with many crossing utilities require special techniques and materials (electrofusion couplings)

Pipe Material Selection

- Any of these materials are suitable for the initial maximum flow condition of this project.
- District chose to use steel due to high strength, durability, and long service life.
- Also, the District's familiarity with steel throughout it's existing potable system will allow the new recycled water backbone system to be easily incorporated into the District's operations and maintenance program.

Key Design Decisions

Pipe Joints

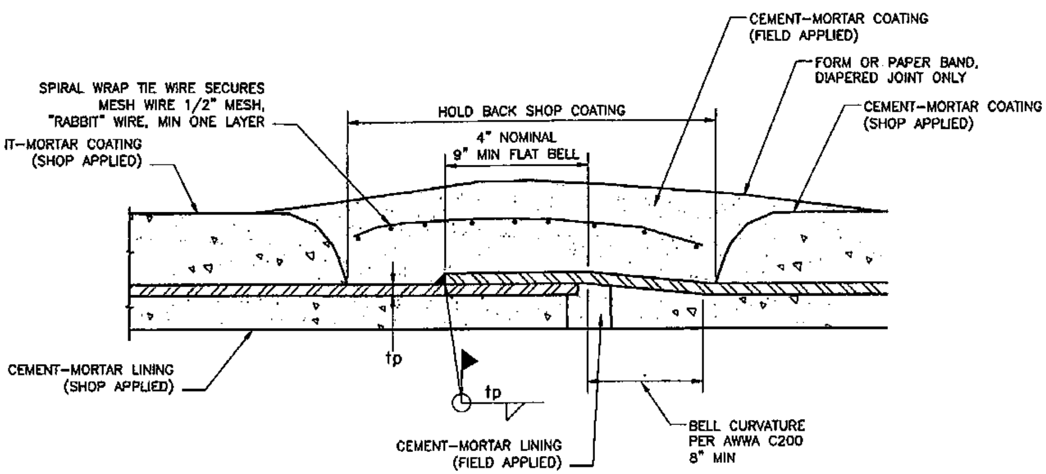
Pipe Joints

- In the western US, steel pipelines are commonly installed with welded joints.
- Welded joints provide benefits such as no leakage and thrust restraint.
- However, the effort and time required to weld the joints adds cost and can slow the contractor's production rate, further increasing construction cost.

Pipe Joints

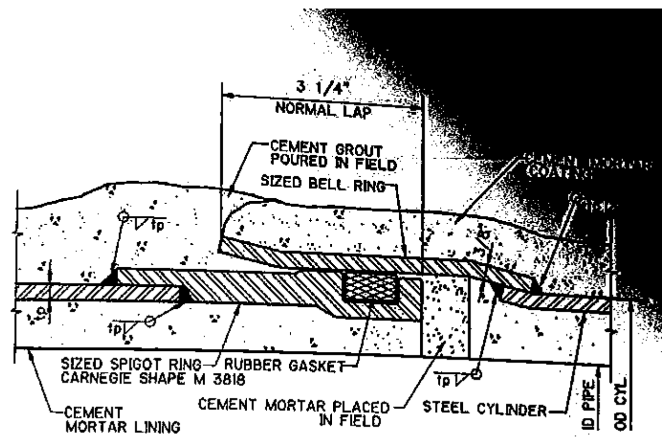
- Significant portions of the pipeline alignments for this project include long straight runs of pipe, which do not require thrust restraint.
- In order to realize potential cost savings, the bid documents will allow contractors to bid the project with either all-welded joints, or with gasketted bell and spigot joints for portions not requiring thrust restraint.

Pipe Joints



ES:

FIELD WELDED LAP JOINT



GASKETED CARNEGIE BELL AND SPIGOT JOINT

Key Design Decisions

Native Material as Backfill

Native Material as Backfill

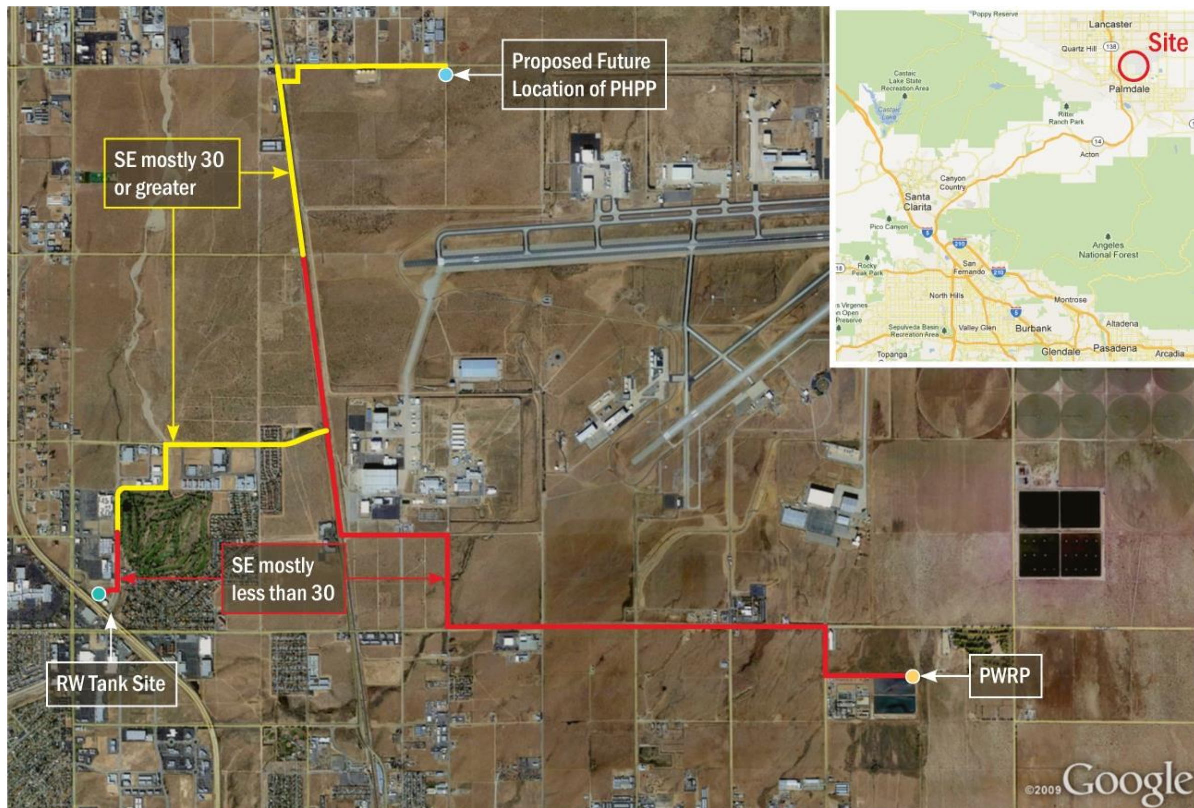
- The soils along the alignment are suitable for trench-zone backfill.
- Substantial cost savings are possible if the native material from the trench excavation can be used for backfill in the pipe zone.
- The majority of the on-site granular soils with a sand equivalent (SE) greater than 30 are suitable for bedding and pipe zone backfill.

Native Material as Backfill – Sand Equivalent (SE)

- SE is determined by ASTM Test Method D2419-91
- SE test can be done in less than 1 hour in the field
- Soil passing No. 4 sieve is mixed with a flocculating solution in a graduated cylinder.
- After settling, SE is measured as the ratio (in %) of the height of sand to the height of flocculated clay.
- High ratio indicates low clay fraction, resulting in ease of compaction and therefore better suitability as a bedding and pipe zone material.

Native Material as Backfill – SE

- Where is SE greater than 30?
- Geotechnical sampling for SE was performed at intervals of approximately 1,000 ft.



Key Design Decisions

Corrosion Protection

Corrosion Protection – Soil Corrosivity

Soil Corrosivity to Steel

Location	As-recv'd Resistivity (Ohm-cm)	Saturated Resistivity (Ohm-cm)	Chlorides (mg/kg)	Sulfates (mg/kg)	Corrosivity Classification
Avenue M	300,000 to 1,200,000	9,200 to 13,600	1.1 to 3.6	2.6 to 11	Moderately corrosive to ferrous metals
Sierra Highway	22,400 to 1,200,000	3,840 to 13,600	1.1 to 223	0.8 to 135	Corrosive to ferrous metals
Avenue P	8,000 to 400,000	960 to 12,800	1.4 to 223	4.3 to 135	Severely corrosive to ferrous metals
Avenue O	22,400 to 340,000	3,200 to 8,400	2.3 to 13	3.2 to 63	Moderately corrosive to ferrous metals

Corrosion Protection

- Although the soils are considered moderately to severely corrosive, deep groundwater levels and typically dry desert soils allow cement-mortar coated steel.
- Corrosion monitoring test stations at 500 ft.
- Pipeline joints welded or to facilitate future cathodic protection if necessary.
- Factory applied coating for Copper pipe (AV piping)

Key Design Decisions

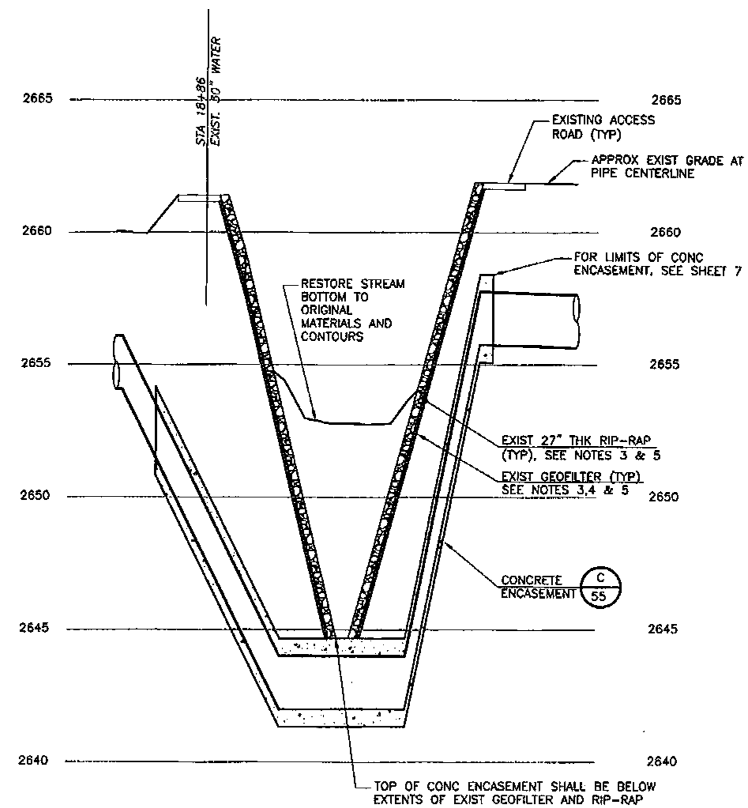
Railroad and Creek Crossings

Railroad Crossings

- Two crossings of the SCRRA railroad
- Typical jacked steel casing, 36-inch diameter
- Sufficient depth (minimum 3.5 casing diameters to springline) to prevent surface deformation

Amargosa Creek Crossing

- Channel characteristics at crossing:
  - Soft bottom
  - Rip rap over geotextile embankment reinforcement
  - Downstream scour control
- Reinforced concrete encasement of pipeline
- Keep encased pipeline below extents of embankment reinforcement



AMARGOSA CREEK CROSSING

Summary

Key Lessons Learned

Summary

- Key Lessons Learned during planning and design for the Phase 2 Recycled Water System:
  - Recycled water can provide relief to a growing arid area with an increasingly-unreliable water supply.
  - Regional water supply solutions require careful coordination with affected water agencies and communities
  - Designing recycled water facilities for an uncertain hypothetical ultimate flow may not be the best use of current resources; nearer-term reliable projections of maximum use can provide a more cost effective design.

Summary

- Key Lessons Learned (Continued):
  - Consideration should be given to owner/operator's preferences and familiarity when evaluating materials of construction.
  - Take advantage of suitable native soils for bedding and pipe-zone material.
  - Consider typical soil moisture conditions when assessing the need to install cathodic protection.
  - Open cut construction of stream crossings can still be a viable option in the 21st century.

Questions?