



CASE HISTORIES

ReNew™ and RxDP™ – Sodium Soil Amendment Products

The following are case histories where *ReNew™* and *RxDP™* were used for the in-situ remediation of salt (sodium) soil contaminated sites. Treatments rates were based on the analytical data derived from soil samples taken at each site.

Remediation of Salt Contaminated Soils – West Texas

Dawson County, Texas – In this case, salt contamination was due to an underground pipeline leak located in cotton and peanut fields. The salt affected crops were destroyed. The salt damage ranged from 1-2 ft. depths. At the time of treatment tilling of the soil was not possible. Water from an existing irrigation system was used in the application of *ReNew™*. Rainwater was the only source of post treatment irrigation of the treated soil. Test results are summarized below:

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>Na (mg/Kg)</u>		<u>% Na Reduction</u>
		<u>Before</u>	<u>After</u>	
1	Clayey Loam	1660	173	89.5
2	Clayey Loam	750	218	70.9
3	Clayey Loam	1770	860	51.4
4	Clayey Loam	530	220	58.4
5	Clayey Loam	3370	68	97.9

The contaminated area was completely restored and normal crop growth was observed the following growing season.

Scurry County, Texas – In this case, salt contamination was due to an underground pipeline break located in a native grass pasture where the salt destroyed the vegetation. Total contaminated surface area was approximately 4.8 acres. Salt damage ranged in depth from surface to 18". The contaminated area was tilled prior to treatment. Based on contamination levels, *ReNew™* was applied and followed by fresh water irrigation using portable spray trailers. Rainwater was the other source of post treatment irrigation. Test results are summarized below:

<u>Sample</u>	<u>Soil Type/CEC*</u>	<u>ESP**</u>		<u>% ESP Reduction</u>
		<u>Before</u>	<u>After</u>	
1	18.4 meq/100g	30	5.7	81.0
2	28.8 meq/100g	23.7	4.8	79.7
3	25.9 meq/100g	19	4.3	77.4
4	23.1 meq/100g	25.3	7.6	69.9
5	16.3 meq/100g	28.1	6.2	77.9
6	23.3 meq/100g	15.1	4.5	70.1

Within 60 days of treatment, the site was reseeded with a combination of native grasses from the CRP program. Some vegetation including non-desirables (weeds) had covered the contaminated area within 6 months of the treatment. Within the following 12 month period, native grass from the reseeded area was observed. Within 20 months of treatment full native vegetation had been established. It was noticed the area of contamination which had been treated with *ReNew™* had a higher degree of vegetation coverage than the areas not contaminated.

* CEC – Cation Exchange Capacity - the total number of cations which a soil can absorb.

** SAR - Sodium Absorption Ration – the degree of saturation of the soil exchange complex with sodium

Scurry County, Texas – In this case, salt contamination was due to an underground pipeline break located in a native grass pasture. Salt contamination had destroyed the native grass vegetation. Total contaminated surface area was approximately 6 acres. Salt damage ranged from surface to 12". At the landowner's request, the area was not tilled. Based on contamination levels, *ReNew™* was applied and fresh water irrigation was provided using a portable spray trailer. Rainwater was the only post treatment source of irrigation. Multiple samples were taken because of the size of the site. Test results are summarized below:

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>ESP</u>		<u>% ESP Reduction</u>
		<u>Before</u>	<u>After</u>	
1	27.6 meq/100g	25.9	4.6	82.2
2	24.3 meq/100g	22.7	4.2	81.5
3	29.8 meq/100g	29.6	5.3	82.1
4	27.4 meq/100g	23.4	4.9	79.1

The contaminated area was not reseeded and allowed to return to natural vegetation (at the request of the landowner). Within 18 months of treatment the site was covered with native grass and undesirables (weeds).

Remediation of Salt Contaminated Soils – Southern Texas

Padre Island National Seashore – In this case, the salt contamination occurred from an abandoned production facility located within the National Park. Total contaminated area was approximately 3/4 acres. Salt damage ranged from surface to 12". Although the area is very sandy with low CEC values, the area of concern contained some clay that had been used in the pad site construction of the previous production facility. No vegetation existed on the site. The site was tilled deep to help blend the contaminated clays with the sandy base (soil sampling was conducted prior to tilling). Based on contamination levels, *ReNew™* was applied to the affected area and was followed by fresh water irrigation using portable spray trailers. Rainwater was the only source of post treatment irrigation of the treated soil. Test results are summarized below:

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>ESP</u>		<u>% ESP Reduction</u>
		<u>Before</u>	<u>After</u>	
1	14.3 meq/100g	21.4	4.1	80.8
2	12.7 meq/100g	19.3	4.6	76.1

The sodium contaminated area was completely restored within 30 days of treatment. Because the area is located in the Padre Island National Park seeding for new vegetation was not allowed and the site was left for natural re-vegetation.

Harris County, Texas – In this case, salt contamination occurred from various pipeline leaks located in 2 separate grassland areas. Each site was approximately 1/2 acres in size. All vegetation was killed as direct results of the salt spills. The site was not tilled. Samples were taken to a depth of 12". Based on contamination levels, *ReNew™* was applied and fresh water irrigation was provided using a portable spray trailer. Rainwater was the only post treatment source of irrigation.

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>Na (mg/Kg)</u>		<u>% Na Reduction</u>
		<u>Before</u>	<u>After</u>	
1	Clayey Loam	842	120	85.7
2	Clayey Loam	1190	218	81.7

Sodium levels were reduced in 45 days with total vegetation being restored to the site within 4 months.

Hidalgo County, Texas – In this case, salt contamination was due to two separate incidents. The first involved an abandoned production facility pad site, 90'x 90' in size, where produced salt water had been stored. The second involved approximately 140 yards of sodium contaminated soil that had been hauled into the company's yard and stockpiled. Samples were taken from each area and tested for sodium contamination. The stockpiled soil was spread evenly across the pad site. The pad site was then tilled, blending the various sodium contaminated soils. Additional sampling was performed and tested for sodium contamination to a depth of 18". Based on the contamination levels, *ReNew™* was applied to the affected area. Fresh water irrigation, from an on-site fresh water well, followed product application. Post treatment irrigation continued utilizing the on-site well. Test results are summarized below:

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>ESP</u>		<u>% ESP Reduction</u>
		<u>Before</u>	<u>After</u>	
1	25.6 meq/100g	24.3	3.9	83.9
2	22.8 meq/100g	22.9	2.7	88.2
3	19.3 meq/100g	17.6	<1	99.9
4	22.1 meq/100g	19.8	2.3	88.3

Following treatment and approximately 4 weeks irrigation, the site was seeded with a combination of rye and common Bermuda grass. Within 6 weeks the site was covered with vegetation.

Remediation of Salt Contaminated Soils – East Texas

Rusk County, Texas – In this case, the contamination occurred as the result of a leaking salt water storage tank. The spill area was approximately 15,000 sq. ft. in size and was native grassland. The site was tilled deep to break the crust which had formed due to the salt spill having occurred many years prior to treatment. Based on contamination levels, *ReNew™* was applied, followed immediately by fresh water irrigation from an adjacent pond. In this case, a set of samples were collected, after only 3 hours of the chemical application, from the top 6" of the soil. This was done to check the time it takes *ReNew™* to exchange with the sodium. The test results shown below indicate that within a short period of three hours, there were significant reductions in the sodium content of the treated soil. This suggests a rapid rate of interaction between *ReNew™* and the soil system.

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>ESP</u>		<u>% ESP Reduction</u>
		<u>Before</u>	<u>After</u>	
1	27.5 meq/100g	75.2	4.6	93.8
2	25.7 meq/100g	41.3	8.7	78.9

Vegetation was completely restored to the site within 6 months of treatment.

Madison County, Texas – In this case, the contamination occurred as the result of a produced water injection system leak. Salt contamination caused severe damage to the vegetation on the adjacent property. Total area affected was approximately 1.12 acres. Salt damage ranged from surface to 12". The area was tilled prior to product application. Based on contamination levels, *ReNew™* was applied and fresh water irrigation was provided using a portable spray trailer. Rainwater was the only post treatment source of irrigation. Test results are summarized below:

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>ESP</u>		<u>% ESP Reduction</u>
		<u>Before</u>	<u>After</u>	
1	9.1 meq/100g	47.6	<1	99.9
2	8.7 meq/100g	49.5	2.3	95.4

The contaminated area was seeded with rye grass and complete vegetation was restored within 45 days.

Panola County, Texas – In this case, salt contamination was due to an underground pipeline break located in a Bermuda grass pasture. Salt contamination destroyed the vegetation. Total contaminated surface area was approximately 1/2 acre. Soil samples were collected to a depth of 12". The area was tilled. Based on contamination levels, *ReNew™* was applied and fresh water irrigation was provided using a portable spray trailer. Rainwater was the only post treatment source of irrigation. Test results are summarized below:

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>ESP</u>		<u>% ESP Reduction</u>
		<u>Before</u>	<u>After</u>	
1	8.2 meq/100g	51.7	4.3	91.6
2	8.2 meq/100g	41.2	4.1	90.0

The area was not seeded, however, within 4 months Bermuda grass had covered the site, with complete coverage within 6 months of treatment.

Panola County, Texas – In this case, salt contamination was due to an underground pipeline break located in a Bermuda grass pasture. Salt contamination destroyed the vegetation. Total contaminated surface area was approximately 1/4 acre. Soil samples were collected to a depth of 12". The area was tilled. Based on contamination levels, *ReNew™* was applied and fresh water irrigation was provided using a portable spray trailer. Rainwater was the only post treatment source of irrigation. Test results are summarized below:

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>ESP</u>		<u>% ESP Reduction</u>
		<u>Before</u>	<u>After</u>	
1	9.5 meq/100g	52.9	<1	99.9
2	8.7 meq/100g	59.3	2.6	95.6

The area was not seeded. Within 4 months of treatment the site had complete coverage of Bermuda grass and undesirable (weeds) vegetation.

Remediation of Salt Contaminated Soils – New Mexico

Eddy County, New Mexico – In this case, 20 drilling reserve pits contaminated with sodium salts were addressed. The pits had been backfilled with sodium/bentonite clay based drilling fluids. Samples taken from each pit area indicated very high levels of sodium contamination. Company personnel did not want to remove all the contaminated material, so it was determined the top 24” would be treated for salt contamination. Based on contamination levels, *ReNew™* was applied and followed by fresh water irrigation using portable spray trailers. Rainwater was the other source of post treatment irrigation. A few of the representative test results are summarized below:

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>ESP</u>		<u>% ESP Reduction</u>
		<u>Before</u>	<u>After</u>	
1	17.8 meq/100g	39.9	4.6	88.6
2	15.5 meq/100g	27.3	3.7	86.4
3	16.9 meq/100g	62.3	7.8	87.5
4	16.6 meq/100g	44.0	3.3	92.5
5	17.7 meq/100g	42.4	4.3	89.9

None of the treated pit areas were seeded. Also, due to the low annual rainfall for the area, less than 12” per year, vegetation was slow to recover. Some coverage was observed within 12 months and coverage comparable with the surrounding area was observed within 24 months.

Lea County, New Mexico – In this case, salt contamination was due to an underground pipeline break located in a native pasture. Vegetation in the area was stressed. Total contaminated surface area was approximately 1/4 acre. Samples were taken to a depth of 12”. The site was tilled. Based on contamination levels, *ReNew™* was applied and followed by fresh water irrigation using portable spray trailers. Rainwater was the other source of post treatment irrigation. Test results are summarized below:

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>ESP</u>		<u>% ESP Reduction</u>
		<u>Before</u>	<u>After</u>	
1	11.7 meq/100g	29.5	3.8	87.1
2	11.7 meq/100g	16.6	1.7	89.8

The area was not seeded. As with other sites in this area, the annual rainfall is low which hinders quick growth of native vegetation. Some coverage was observed within 12 months of treatment.

Remediation of Salt Contaminated Soils – Oklahoma

Dewey County, Oklahoma – In this case, salt contamination was due to a leaking drilling reserve pit. After drilling operations it was observed the pit had been leaking and salt water had contaminated an area adjacent to the drill site. The contaminated area was approximately 3.8 acres. Samples were taken from a depth of 24". The site was tilled. With approval of the Oklahoma Corporation Commission, the attorney for the surface owner, and utilizing the laboratory analysis for treatment rates, *ReNew™* was applied and followed by fresh water irrigation using portable spray trailers. Rainwater was the other source of post treatment irrigation. Representative test results are summarized below:

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>ESP</u>		<u>% ESP Reduction</u>
		<u>Before</u>	<u>After</u>	
1	23.7 meq/100g	78.3	7.2	90.8
2	24.9 meq/100g	89.6	6.4	92.9
3	22.8 meq/100g	65.5	4.3	93.4
4	19.7 meq/100g	35.6	3.7	89.6

The site was seeded and fertilized upon recommendation of the Soil Conservation Service. A native grass mixture was used in conjunction with a nitrogen based fertilizer. Complete vegetation coverage was observed within 6 months. The site was approved and closed by the Oklahoma Corporation Commission.

Remediation of Salt Contaminated Soils – Louisiana

Webster Parish, Louisiana – In this case, salt contamination was due to uncontrolled runoff of saltwater during oil and gas operations, many years prior to treatment dates. The salt damage had destroyed all vegetation. A drainage system, five feet below the surface, was installed across the site to allow for the containment of any leaching of sodium contaminated fluids. Many soil samples were taken prior to treatment. Based on these soil samples, the site was deep plowed and hay was used as a bulking agent for the soil. *RxDP™* and *ReNew™* were applied and followed by fresh water irrigation using portable spray trailers. Rainwater was the other source of post treatment irrigation. Drainage into the two (2) sumps, installed in the drainage system, were pumped out and monitored for sodium levels. Once the levels were reduced, the site was resampled and deemed closed. With too many samples to list, the following summarizes the range of test results:

<u>Analysis</u>	<u>Before</u>	<u>After</u>
Cation Exchange Capacity (CEC)	6-15 meq/100g	-----
Electrical Conductivity (EC)	17-49 mmhos/cm	1-10
Sodium Absorption Ratio (SAR)	12-64	4-13
Exchangeable Sodium Percentage (ESP)	17-52	3-15

The site was seeded with rye grass and replanted with seedlings of pine. Complete coverage of vegetation was observed in 36 months.

Terrebonne Parish, Louisiana – In this case, salt contamination was due to an abandoned saltwater pit. Very little vegetation was present on the site, due to the high concentrations of sodium. Samples were taken to determine sodium concentrations. The site was tilled and *ReNew™* was applied. This application was followed by fresh water irrigation using portable spray trailers. Rainwater was the other source of post treatment irrigation. Test results are summarized below:

<u>Analysis</u>	<u>Before</u>	<u>After</u>
CEC	46	-----
EC	20	<4
SAR	30	<12
ESP	43	<15

The site was seeded with native grass following the treatment and complete vegetation coverage was observed within 18 months.

Remediation of Salt Contaminated Soils – Kansas

Stanton County, Kansas – In this case, salt contamination was due to an underground pipeline leak located in a wheat field. The leak was several years old. Previous treatment attempts using gypsum had failed. The site was approximately 1/4 acre. Samples were taken to a depth of 24". The site was tilled and a dike was built around the perimeter to contain the amendments. Based on the contamination levels, *ReNew™* was applied followed by heavy irrigation from an on-site irrigation well. The on-site irrigation was also a source for additional irrigation of the site. Test results are summarized below:

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>ESP</u>		<u>% ESP Reduction</u>
		<u>Before</u>	<u>After</u>	
1	13.9 meq/100g	32.7	<1	99.9

The following planting season, approximately 3 months after treatment, the site was seeded with wheat. It was observed during the growing season and during harvest, the yield of the treated area was greater than the offset areas, which had not been affected by the salt spill.

Haskell County, Kansas – In this case, salt contamination was due to an underground pipeline leak located in a wheat field. The site was approximately 1/2 acre. Samples were taken to a depth of 24". The site was tilled and based on contamination levels; *ReNew™* was applied and followed by fresh water irrigation using portable spray trailers. Rainwater was the only other source of post treatment irrigation. Test results are summarized below:

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>ESP</u>		<u>% ESP Reduction</u>
		<u>Before</u>	<u>After</u>	
1	13.1 meq/100g	39	3.6	90.7

The site was planted with wheat during the following planting season, approximately 3 months after treatment. Normal growth at the site was observed and average yield was also observed during harvest.

Grant County, Kansas – In this case, salt contamination was the result of a saltwater evaporation pond used in conjunction with a gas plant operation. The site was approximately 4.65 acres. Samples were taken to a depth of 24”, as required by the Kansas Corporation Commission (KCC) and the Kansas Department of Health and Environment (KDHE). The site was deep plowed and native grass hay was incorporated into the soil to improve texture and drainage. Based on contamination levels, *RxDP™* and *ReNew™* were applied along with liberal fresh water irrigation. Repeated irrigation was done with the use of portable spray trailers during the following 2 week period. Rainwater was the only other source of post treatment irrigation. With too many samples to list, the following summarizes the test results:

<u>Sample</u>	<u>Soil Type/CEC</u>	<u>ESP</u>		<u>% ESP Reduction</u>
		<u>Before</u>	<u>After</u>	
1	24.3 meq/100g	23.6	3.7	84.3
2	22.8 meq/100g	22.3	3.3	85.2

Complete vegetation coverage was observed after only 4 months since treatment. After an on-site visit from representatives of the Kansas Department of Health and Environment, “Notice of Approval for Closure” was issued.

SUMMARY

The case histories included above, represent the various geographical areas where *ReNew™* and *RxDP™* were used successfully to provide for on-site remediation of sodium (salt) contaminated soils. Each case was treated as site specific with regards to remediation procedures. Treatment rates of the product *ReNew™* and *RxDP™* were calculated based on soil analysis from each particular site. The formula used in each case is as follows:

$$\text{Gallons/Acre/Ft.} = (\text{ESP} - X) * \text{CEC} * 6.5$$

Where – ESP = Exchangeable Sodium Percentage
 X = Desired ESP level in the soil (this is usually 12 or less)
 CEC = Cation Exchange Capacity, meq/100g
 6.5 = A constant

Please Note: Names of the Owner and/or Operator of the contaminated sites are withheld as part of a confidentiality agreement.