

US EPA ARCHIVE DOCUMENT

**SODIUM DICHROMATE LISTING BACKGROUND
DOCUMENT
FOR THE INORGANIC CHEMICAL
LISTING DETERMINATION**

This Document Does Not Contain Confidential Business Information

August 2000

U.S. ENVIRONMENTAL PROTECTION AGENCY
ARIEL RIOS BUILDING
1200 PENNSYLVANIA AVENUE, N.W.
WASHINGTON, D.C. 20460

TABLE OF CONTENTS

1.	SECTOR OVERVIEW	1
1.1	SECTOR DEFINITION, FACILITY NAMES AND LOCATIONS	1
1.2	 PRODUCTS, PRODUCT USAGE, AND MARKETS	1
1.3	PRODUCTION CAPACITY	4
1.4	PRODUCTION, PRODUCT AND PROCESS TRENDS	4
2.	ELEMENTIS CHROMIUM	5
2.1	PRODUCTION PROCESS DESCRIPTION	5
2.2	PRODUCTION TRENDS, CHANGES AND IMPROVEMENTS	7
2.3	RESIDUAL GENERATION AND MANAGEMENT	7
2.3.1	Spent Post-Neutralization Ore Residue	7
2.3.2	Caustic Filter Sludge	9
2.3.3	Sodium Dichromate Evaporation Unit Wastewater	10
2.3.4	Sodium Chromate Evaporation Unit Wastewater	10
2.3.5	Reduced Chromium Treatment Residues from Spent Ore Residue Treatment Unit	11
2.3.6	Reduced Chromium Treatment Residues from Wastewater Treatment Unit	12
2.3.7	Commingled Treated Wastewaters	13
2.3.8	Process Filters, Membranes, Baghouse Bags and Chromium-Contaminated Empty Containers and Other Plant Wastes	14
2.3.9	Spent Sand Filter Sands	15
2.4	CALCULATION OF CHROMIUM LOADING TO ELEMENTIS SURFACE IMPOUNDMENT	16
3.	OCCIDENTAL CHEMICAL (“OxyChem”)	17
3.1	PRODUCTION PROCESS DESCRIPTION	17
3.2	PRODUCTION TRENDS, CHANGES, AND IMPROVEMENTS	20
3.3	RESIDUAL GENERATION AND MANAGEMENT	22
3.3.1	Spent Post-Neutralization Ore Residue	22
3.3.2	Spent Post-Leach Ore Residue	23
3.3.3	Saltcake Drier Scrubber Wastewater	24
3.3.4	Waste Heat Boiler Washout	25
3.3.5	Reduced Chromium Treatment Residues	26
3.3.6	Commingled Treated Wastewaters	27
3.3.7	Chromium-contaminated Filters, Membranes, and Other Plant Wastes	28
3.3.8	Spent Sand Filter Sands	29
3.4	CALCULATION OF CHROMIUM LOADING TO OXYCHEM ONSITE DISPOSAL UNITS	30

Appendix A: Summary of Waste Generation and Management

- Appendix B: Occidental Chemical Corporation TCLP Analyses (Weekly Composite and Grab Samples) 1/1/98-12/31/98
- Appendix C: Human Health Benchmarks and Ambient Water Quality Criteria Screening Levels

LIST OF TABLES

Table 1.1 Sodium Dichromate Producers	1
Table 1.2 Sodium Dichromate Production Capacity	4
Table 2.1 Chromium Levels in Reduced Chromium Treatment Residue	12
Table 2.2 Chromium Contributions by Wastes Disposed in Elementis' On-Site Surface Impoundment	6
Table 3.1 Chemical Composition of Spent Post-Neutralization Ore Residue	23
Table 3.2 Chemical Composition of Spent Post-Leach Ore Residue	24
Table 3.3 Chemical Composition of Reduced Chromium Treatment Residues	27
Table 3.4 Chemical Composition of Spent Filter Sands from Spent Ore Residue Treatment Unit	29
Table 3.5 Chromium Contributions of Wastes Disposed in OxyChem's OnSite Disposal Unit	30

LIST OF FIGURES

Figure 1.1 Geographical Distribution of Sodium Dichromate Producers ¹	3
Figure 2.1 Elementis Chromium's Process Flow Diagram.....	8
Figure 3.1 Oxychem's Process Flow Diagram.....	21

1. SECTOR OVERVIEW

1.1 SECTOR DEFINITION, FACILITY NAMES AND LOCATIONS

Sodium dichromate is currently manufactured in the United States by two facilities. **Table 1.1** gives the names and locations of the two producers.¹ **Figure 1.1** shows the geographical location of the facilities. The numbers on the map correspond to the facilities' numbers in Table 1.1.

Table 1.1 Sodium Dichromate Producers

Facility Number	Facility Name	Facility Location
1	Elementis Chromium, LP ²	3800 Buddy Lawrence Drive Corpus Christi, Texas 78407
2	Occidental Chemical Corporation- Oxychem-Castle Hayne Plant ("OxyChem")	5408 Holly Shelter Road Castle Hayne, North Carolina 28429

1.2 PRODUCTS, PRODUCT USAGE, AND MARKETS

Sodium dichromate is also commonly referred to as sodium bichromate or sodium bichromate dihydrate and is known technically as sodium dichromate dihydrate. The chemical formula for the compound is $\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$.³ In crystalline form, the chemical is bright orange and has a molecular weight of 298 grams/mol (g/mol). It is highly soluble in water.⁴ The chemical is sold in both solution and crystalline forms.

According to 1997 figures, 66% of sodium dichromate is used in chromic acid manufacture, 13% in leather tanning, 9% in chromic oxide production, 6% in pigments manufacture, and 6% in the manufacture of various other items including wood preservatives, paints, drilling muds, and metal

¹ Unless noted otherwise, the sources for information in this technical background document are the respective sodium dichromate facilities' responses to the Environmental Protection Agency's 1998 RCRA §3007 Survey of the Inorganic Chemicals Industry.

² Elementis Chromium LP operated under the name American Chrome and Chemicals until 1998. See <http://www.chemexpo.com/news/profile971110.cfm>.

³ http://www.oxychem.com/products/chrome/manufacturing_process.html

⁴ http://www.oxychem.com/products/sodium_bichromate/products.html

treatment agents.⁵

Chromic acid is used in the metal finishing industry to produce resistant coatings for a variety of base metals. Other uses include decorative plating, conversion coatings, and metal coloring compounds.⁶ Chromic oxide, in combination with copper, aluminum and other oxides, is used as a catalyst in organic reactions such as hydrogenation, dehydrogenation, polymerization, and catalytic reforming. Sodium dichromate is also used to make chrome sulfate tanning compounds for the leather tanning industry.⁷

In the pigment industry, sodium dichromate is used to manufacture lead chromate compounds which are then used in manufacturing paints, printing inks, paper coloring, and floor coverings. Other chromium compounds containing zinc, calcium, strontium or barium form pigments with corrosion-inhibiting qualities which are desirable in paint primers for metals. Chromic green oxide, another sodium dichromate derived pigment, is resistant to light, heat, acids and alkalis and is used in rubber, roofing shingles, cement, ceramics and chemical-resistant paints. Sodium dichromates are also used in textile dyeing operations or in the production of the textile dyes themselves.⁸

In oil well drilling muds, sodium dichromate is used to create soluble chromates for corrosion control and chrome lignosulfates for deflocculation and thinning agents which help control drilling mud viscosity. Sodium dichromate is also used in the manufacture of photographic films, flavors, essential oils, saccharin, pharmaceuticals,⁹ pyrotechnics, explosives, safety matches, chrome glues and adhesives, wood stains, poison fly paper, process engraving and lithography, synthetic perfumes, chrome alum manufacture, alloys, ceramic products, depolarizers in dry cell batteries, bleaching fats and waxes.¹⁰

⁵ <http://www.chemexpo.com/news/profile971110.cfm> and
http://www.oxychem.com/products/chrome/manufacturing_process.html

⁶ <http://www.oxychem.com/products/chrome/default.html>

⁷ http://www.oxychem.com/products/sodium_bichromate/default.html

⁸ <http://www.oxychem.com/products/chrome/default.html>

⁹ http://www.oxychem.com/products/sodium_bichromate/default.html

¹⁰ Lewis, Richard J. - *Hawley's Condensed Chemical Dictionary*, 12th Edition, 1993.

Figure 1.1 Geographical Distribution of Sodium Dichromate Producers¹



¹ See **Table 1.1** for facility names and locations.
 Facility numbers on map match facility numbers in table.

1.3 PRODUCTION CAPACITY

As of 1997, the maximum production capacity in the United States was approximately 156,100 metric tons per year.¹¹ (See **Table 1.2**)

Table 1.2 Sodium Dichromate Production Capacity

Facility Name	Facility Location	Capacity (metric tons/yr) ¹²
Elementis Chromium, LP ¹³	Corpus Christi, Texas	49,900
Occidental Chemical Corporation--- OxyChem-Castle Hayne Plant ("OxyChem")	Castle Hayne, North Carolina	106,200

1.4 PRODUCTION, PRODUCT AND PROCESS TRENDS

Demand for sodium dichromate grew from 136,000 metric tons in 1996 to 141,000 metric tons in 1997. Demand is projected to be 154,000 metric tons in 2001. Historically (1987-1996), sodium dichromate sales have grown 1% annually. Through the year 2001, 1.8% annual growth is expected.¹⁴

Growth in demand for sodium dichromate is expected to be supported largely by increases in the need for chromic acid in the manufacture of wood preservatives. Such growth has taken place at the expense of creosote and pentachlorophenol products. Markets for chromium-based preservatives, primarily chromated copper arsenate (CCA), have fluctuated in tandem with the pace of new home construction. However, wood treatments for home remodeling, utility poles, highway sound barriers, marine and other uses provide other sources of demand for the chemical.

The use of sodium dichromate in leather tanning compounds is expected to grow minimally and the rates of use in most other applications is in decline. Environmental concerns spurred a decrease in the use of chromium-based pigments in the mid-1980s and continue to restrict the market. In addition, efforts are underway in the construction industry to find substitutes for lumber, which can be costly, and to find environmentally sound alternatives to chromium-based wood preservatives.¹⁵

¹¹ <http://www.chemexpo.com/news/profile971110.cfm>

¹² Ibid

¹³ Elementis Chromium LP operated under the name American Chrome and Chemical until 1998. See <http://www.chemexpo.com/news/profile971110.cfm>.

¹⁴ Ibid

¹⁵ Ibid

2. ELEMENTIS CHROMIUM, LP

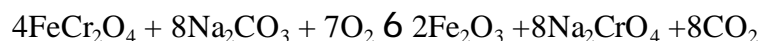
The Elementis Chromium, LP facility in Corpus Christi, Texas produces several chromium compounds in addition to sodium dichromate. These compounds include sodium chromate, chrome hydrate, chromium, chromium oxides¹⁶ and chromic acid. Various owners have manufactured chromium chemicals at the Elementis Corpus Christi facility site since 1962.

2.1 PRODUCTION PROCESS DESCRIPTION

Figure 2.1 presents the process flow diagram for Elementis Chromium's sodium dichromate manufacturing process.

Chromite ore imported from the Transvaal region of South Africa, the primary feedstock for the Elementis facility¹⁷, is typically 46% chromium oxide (Cr_2O_3). Impurities in the ore include oxides of silica, iron, calcium, manganese, titanium, vanadium, as well as phosphorous and sulfur.¹⁸ Magnesium, aluminum, and nickel can also be present in the ore.¹⁹

Chromite ore is dried and ground and then fed into the hearth system where it is mixed with soda ash (sodium carbonate) and then heated to approximately 2000°F. This treatment oxidizes the chromite ore, converting the majority of the chromium in the ore from trivalent to hexavalent chromium.²⁰ The basic reaction taking place is:



Baghouses on both the ore grinding unit and the soda ash delivery unit capture airborne residuals and return them directly to the units from which they originated. An air pollution control system on the hearth system sends captured residues directly to a weak chromate solution system which provides chromate solutions to the hearth system and the quench tank.

After roasting, the ore typically contains 20-40% hexavalent chromium as sodium chromate and 10-20% trivalent chromium as Cr_2O_3 .²¹ The chromite ore exiting the hearth is quenched with water in the facility's quench tank and the resulting slurry goes through a series of rotary filters to filter and purify the sodium chromate. The air pollution control system on the quench tank captures airborne residues and returns them to the manufacturing process through the quench tank.

The series of rotary filters remove solid aluminum, vanadium, and calcium residues. Sodium

¹⁶ <http://www.hoovers.com/co/corptech/9/0,2282,44469,00.html>

¹⁷ 64 FR 8774-8779

¹⁸ Occidental Chemical Follow-up response to EPA's 1998 RCRA §3007 Survey of the Inorganic Chemicals Industry. Further information on South African chromite ore is available in this source.

¹⁹ 64 FR 8774-8779

²⁰ 64 FR 8774-8779

²¹ See "Chromium Accounting in the Sodium Dichromate Production Process," Appendix B of "Engineering Site Visit Report--Elementis Chromium, LP, Corpus Christi, Texas, EPA ID: TXD098818339," Final Report, June 12, 2000, USEPA.

dichromate is added to the ore slurry to aid in the removal of aluminum. Calcium hydroxide (lime) is added to remove vanadium. Soda ash solution is added to remove calcium. The baghouse on the impurity treatment and filtration units captures airborne residuals and returns them directly to the impurity treatment and filtration units.

Some of the impurities from the impurity treatment and filtration unit are placed in a kiln and quench system with sodium hydroxide and additional chromite ore for another round of chromium recovery. Roasted and quenched ore from the kiln travels to impurity treatment and filtration units for the same purification process described above for materials from the hearth unit. A baghouse on the kiln and quench system captures airborne residuals and returns them directly to the kiln and quench system. Spent ore materials from the impurity treatment and filtration unit are referred to as spent post-neutralization ore residue in this document and travel to the spent ore residue treatment unit for treatment and routing to their final disposal unit.

Debris containing damaged refractory bricks and concrete are disposed of from the hearth and kiln systems every 6 to 18 months.

The purified sodium chromate solution travels from the impurity treatment and filtration system to the electrolytic cell system for electrolytic acidification. Water is added to the electrolytic cells as well. This process converts the sodium chromate solution to sodium dichromate solution. An air pollution control system on the electrolytic cell system captures airborne residues from the unit and returns them directly to the electrolytic cell system. Hydrogen and oxygen from the electrolytic cell unit vent to the atmosphere. The sodium dichromate can be sold or used on-site in the production of chromic oxide or chromic acid.

Some sodium chromate solution travels not to the electrolytic cell system, but to a sodium chromate crystallization, evaporation, and drying unit to produce sodium chromate crystals. These crystals are then packaged for sale. Some sodium dichromate solution is also sent to a sodium dichromate crystallization, evaporation, and drying unit for production of sodium dichromate crystals. The crystals are sent to a packaging unit for packaging before sale. The crystallization, evaporation, and drying units for the sodium chromate and sodium dichromate solutions share an air pollution control system which sends captured residues directly to the weak chromate system described above. The two units also generate a wastewater of which 10% derives from the sodium chromate crystallization process (referred to as sodium chromate evaporation unit wastewater) and of which 90% derives from the sodium dichromate crystallization process (referred to as sodium dichromate evaporation unit wastewater). This wastewater travels to the facility's wastewater treatment unit for treatment and routing to final disposal.

A sodium hydroxide solution is incidentally produced during the electrolytic acidification step in the electrolytic cell system which converts sodium chromate to sodium dichromate. The sodium hydroxide from the unit is treated with ferrous chloride, filtered, and then evaporated to produce a 50% sodium hydroxide solution which the facility sells.²² The sodium hydroxide is stored in tanks prior to being loaded for shipment. The material is used as a reagent in an inorganic chemical manufacturing facility.²³ Treatment and filtration of the sodium hydroxide produces a caustic filter sludge which the

²² See "Elementis Chromium-Corpus Christi, Sodium Dichromate Production Process," Appendix B of "Engineering Site Visit Report--Elementis Chromium, LP, Corpus Christi, Texas, EPA ID: TXD098818339," Final Report, June 12, 2000, USEPA

²³ July 24, 2000 Phone Log—Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

facility sends to the on-site spent ore residue treatment unit for treatment and routing to final disposal. An air pollution control unit on the sodium hydroxide treatment and filtration unit captures airborne residues and returns them directly to the treatment and filtration unit.

Process filters and membranes, baghouse bags, and other chromium-contaminated debris are generated throughout the sodium dichromate production process. Chromium-contaminated empty bags are generated from the packaging units.²⁴ All of these wastes are managed as D007 wastes and are sent off-site for treatment and disposal. Unused empty bags which have not been contaminated with chromium (i.e., have not come into contact with sodium chromate or sodium dichromate product) are also generated from the packaging unit. The facility also disposes of insulation which may have been contaminated with chromium, plant trash which have not been contaminated with chromium, non-hazardous laboratory waste, and waste hose from transport of treated ore residue.

2.2 PRODUCTION TRENDS, CHANGES AND IMPROVEMENTS

At this time, Elementis uses a hearth and kiln in series to roast chromite ore for the production of sodium dichromate. In the year 2000, Elementis will replace the hearth with a second kiln.

2.3 RESIDUAL GENERATION AND MANAGEMENT: Electrolytic production process at Elementis Chromium, LP

The following discussions detail the generation, characterization, and management of residuals from the production of sodium dichromate by the electrolytic production process at Elementis Chromium, LP. Only wastes within the scope of the consent decree governing the inorganic chemicals industry listing are described below.²⁵ For a more detailed discussion of the scope of the consent decree, please refer to the relevant preamble sections of the inorganic chemical industry listing proposal.

Appendix A presents a complete summary of the wastestreams generated by Elementis and their management.

2.3.1 Spent Post-Neutralization Ore Residue

Waste Generation

Ore residues and impurities from the impurity treatment and filtration process described in the process description (Section 2.1) which are not suitable for further roasting and leaching are generated in the impurity treatment and filtration unit during a series of purification and filtration steps. This waste is generated continuously. The facility reported generating 60,000

²⁴ May 23, 2000 Phone Log—Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

²⁵ Wastes from sodium dichromate production by the electrolytic process falling outside the scope of the inorganic chemical industry consent decree include: spent refractory brick and concrete debris, empty bags which have not come into contact with chromium product, non-hazardous lab wastes, transport hose for treated ore residue, insulation debris, and contaminated media such as stormwater and remediation groundwater. See Appendix A.

MT of this residue in 1998.

Waste Management

Spent post-neutralization ore residue travels directly from the impurity treatment and filtration unit to the spent ore residue treatment unit. This treatment unit consists of five equal-sized tanks. The tanks have covers and secondary containment. The ore residue commingles with caustic filter sludge (see Section 2.3.2) in the treatment unit and is treated with sodium sulfide in order to reduce hexavalent chromium in the waste to trivalent chromium. The pH of the treated mixture is adjusted with sulfuric acid.

After these treatment steps, the waste is referred to as “Reduced chromium treatment residues from spent ore residue treatment unit” (see Section 2.3.5).

Waste Characterization

The residue, before treatment, typically consists of 15-20% trivalent chromium as Cr_2O_3 and 0.3-1.0% hexavalent chromium as sodium chromate.²⁶ In their RCRA §3007 survey response, the facility stated that the residue contains chromium at a level of 109,000 mg/kg (10.9%). This residue carries the D007 (chromium toxicity) RCRA hazardous waste code at the point of generation. The waste has a pH of 8.7 and consists of 30% moisture and 70% solids. The waste does not contain any volatile constituents of concern.

2.3.2 Caustic Filter Sludge

Waste Generation

Sodium hydroxide is generated in the electrolytic cells during the conversion of sodium chromate solution to sodium dichromate solution. The sodium hydroxide is treated, filtered, and evaporated prior to being sold. The treatment and filtration steps generate a caustic filter sludge. This waste is generated continuously. Elementis reported generating 80 MT of caustic filter sludge in 1998.

Waste Management

The caustic filter sludge travels directly from the sodium hydroxide treatment and filtration unit to the spent ore residue treatment unit. This treatment unit consists of five equal-sized tanks with a total volume of 27,000 gallons. The tanks have covers and secondary containment. The ore residue commingles with spent post-neutralization ore residue (see Section 2.3.1) in the treatment unit and is treated with sodium sulfide in order to reduce hexavalent chromium in the waste to trivalent chromium. The pH of the treated mixture is adjusted with sulfuric acid.

After these treatment steps, the waste is referred to as “Reduced chromium treatment residues from spent ore residue treatment unit” (see Section 2.3.5).

Waste Characterization

This residual has a pH of 14. The facility reported the D002 (corrosivity) RCRA hazardous waste code for this residue. The residue has a total sodium hydroxide concentration of 200,000 mg/kg,

²⁶ See “Chromium Accounting in the Sodium Dichromate Production Process,” Appendix B of “Engineering Site Visit Report--Elementis Chromium, LP, Corpus Christi, Texas, EPA ID: TXD098818339,” Final Report, June 12, 2000, USEPA

a total iron concentration of 400 mg/kg, and a total chromium concentration of 20 mg/kg. The waste consists of 20% moisture and 80% solids. The waste does not contain any volatile constituents of concern.

2.3.3 Sodium Dichromate Evaporation Unit Wastewater

Waste Generation

The sodium dichromate crystallization, evaporation and drying unit at the Elementis facility converts sodium dichromate solution to crystalline sodium dichromate. This wastewater is generated every 1 to 7 days. This process produced approximately 2500 MT of chromium-contaminated wastewater in 1998. In their original RCRA §3007 survey response, the facility reported the volume of this wastewater as part of the volume of the combined mass of sodium dichromate evaporation unit and sodium chromate evaporation unit wastewater. The combined mass of the two wastestreams is 2800 MT. According to the facility, approximately 90% of the combined wastestream derives from the sodium dichromate evaporation unit.²⁷ This translates into a mass of approximately 2500 MT for this wastestream.

Waste Management

The wastewater is piped directly from the sodium dichromate crystallization, evaporation, and drying unit to an onsite wastewater treatment unit. The wastewater commingles there with sodium chromate evaporation unit wastewater (see Section 2.3.4), stormwater, and remediation groundwater. The unit consists of two equal-sized tanks with a total volume of 75,000 gallons. The treatment tanks do not have covers or secondary containment. The wastewaters are treated with sodium sulfide solution to reduce hexavalent chromium to trivalent chromium and with sulfuric acid to adjust the pH of the wastewaters.

After these treatment steps, the wastewaters are referred to as “Reduced chromium treatment residues from wastewater treatment unit” (see Section 2.3.6).

Waste Characterization

The characterization data available for this waste is actually the characterization data for the commingled mass of sodium dichromate evaporation unit wastewater and sodium chromate evaporation unit wastewater. The waste contains only 0.01% solids and has a pH of 8. The total chromium concentration is 0.5 mg/kg. The wastewater does not exceed the TC level for any constituent, nor does not contain any volatile constituents of concern.

2.3.4 Sodium Chromate Evaporation Unit Wastewater

Waste Generation

The sodium chromate crystallization, evaporation and drying unit at the Elementis facility converts sodium chromate solution to crystalline sodium chromate. This wastewater is generated every 1 to 7 days. This process produced approximately 300 MT of chromium-contaminated wastewater in 1998. In their original RCRA §3007 survey response, the facility reported the volume of this

²⁷ May 23, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

wastewater as part of the volume of the combined mass of sodium dichromate evaporation unit and sodium chromate evaporation unit wastewater. The combined mass of the two wastestreams is 2800 MT. According to the facility, approximately 10% of the combined wastestream derives from the sodium chromate evaporation unit.²⁸ This translates into a mass of approximately 300 MT for this wastestream.

Waste Management

The wastewater is piped directly from the sodium chromate crystallization, evaporation, drying unit to an onsite wastewater treatment unit. The wastewater commingles there with sodium dichromate evaporation unit wastewater (see Section 2.3.3), stormwater, and remediation groundwater. The unit consists of two equal-sized treatment tanks with a total volume of 75,000 gallons. The treatment tanks do not have covers or secondary containment. The wastewaters are treated with sodium sulfide solution to reduce hexavalent chromium to trivalent chromium and with sulfuric acid to adjust the pH of the wastewaters.

After these treatment steps, the wastewaters are referred to as “Reduced chromium treatment residues from wastewater treatment unit” (see Section 2.3.6).

Waste Characterization

This wastestream has a total chromium concentration of 0.5 mg/kg. The wastewater does not exceed the TC level for any constituent, nor does it contain any volatile constituents of concern.

2.3.5 Reduced Chromium Treatment Residues from Spent Ore Residue Treatment Unit

Waste Generation

A commingled mass of spent post-neutralization ore residue (see Section 2.3.1.) and caustic filter sludge (see Section 2.3.2) is treated with sodium sulfide to reduce hexavalent chromium in the waste to trivalent chromium. The pH of the waste is then adjusted with sulfuric acid. The treatment process takes place in 5 equal-sized tanks. The waste is generated continuously. The facility reported generating 60,000 MT of this residue in 1998.

Waste Management

The spent ore residue treatment unit sludge is piped directly from the spent ore residue treatment unit to an onsite, industrial, Subtitle D, HDPE double-lined surface impoundment for final disposal. The surface impoundment has a total area of 131,690 m². The waste commingles in this unit with reduced chromium treatment residues from the wastewater treatment unit (see Section 2.3.6). Over time, the residues in the unit dewater. Dewatering waters are referred to as “Commingled treated wastewaters” and are discussed in Section 2.3.7.

Waste Characterization

This solid wastestream contains several metals, including iron, aluminum, calcium, magnesium, sodium, silica, potassium, chromium, vanadium, nickel, zinc, barium, and copper. This wastestream is a mixture of Bevilled wastestreams and non-Bevilled wastestreams. The residue does not exceed the TC

²⁸ May 23, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

level for any constituent and it does not contain any volatile constituents of concern.

The facility states that the treated ore residue typically contains 15-20% trivalent chromium as Cr₂O₃ and no detectable hexavalent chromium in an aqueous leach analysis.²⁹ The facility also states that the treated residue is periodically tested and is consistently below the criteria for D007 wastes.

Elementis analyzes the chromium content in their treatment residues with a company-modified version of the TCLP. The protocol for this version of the TCLP has been placed in the docket for this rulemaking.³⁰ Elementis submitted the data presented in **Table 2.1** on the chromium levels present in their reduced chromium residues:

Table 2.1 Chromium Levels in Reduced Chromium Treatment Residue³¹

Sample Composite Date	Modified TCLP Chromium (mg/L)
10/1/98-10/8/98	1.67
10/9/98-10/16/98	1.52
10/17/98-10/24/98	0.2
10/24/98-10/30/98	1.75
11/1/98-11/8/98	0.96
11/9/98-11/16/98	0.16
11/16/98-11/23/98	1.02
11/24/98-11/30/98	0.94
12/1/98-12/4/98	1.5
12/10/98-12/16/98	0.71
12/16/98-12/23/98	1.3
12/24/98-12/31/98	0.39

2.3.6 Reduced Chromium Treatment Residues from Wastewater Treatment Unit

Waste Generation

This residue is produced through the commingling and treatment of wastewaters from the sodium chromate and sodium dichromate crystallization, evaporation, and drying units with stormwater and remediation well water. Elementis reported that the incoming stormwater contains approximately

²⁹ See "Chromium Accounting in the Sodium Dichromate Production Process," Appendix B of "Engineering Site Visit Report--Elementis Chromium, LP, Corpus Christi, Texas, EPA ID: TXD098818339," Final Report, June 12, 2000, USEPA

³⁰ Fax from R.H. Jackson (Elementis Chromium, LP) to Ashley Allen (EPA). June 13, 2000. See Elementis Chromium LP, Corpus Christi, ISO Procedures, Extractable Chromium in Solids (ECCC-TC): Protocol and 10/1/98-12/31/98 treated chromium residue analyses results

³¹ Fax from R.H. Jackson (Elementis Chromium, LP) to Ashley Allen (EPA). June 13, 2000.

1-4 ppm chromium and that the remediation well water contains approximately 500 ppm chromium. However, the chromium content of the waters being treated in the tanks at any one point in time varies.³²

The commingled wastewaters are treated with sodium sulfide to reduce hexavalent chromium to trivalent chromium and with sulfuric acid to adjust pH. This waste is generated continuously. Elementis produced approximately 30,000 MT of this residue in 1999. The 30,000 MT figure was calculated using the the facility's statement that the average flow rate through the treatment unit in 1999 was 15 gallons per minute.³³

Waste Management

The mixture of treatment solids and treatment wastewaters from the wastewater treatment unit is piped directly to an onsite, industrial, Subtitle D, HDPE double-lined surface impoundment for dewatering and disposal.³⁴ The surface impoundment has a total area of 131,690 m². This is the same surface impoundment in which reduced chromium treatment residues from the spent ore residue treatment unit are disposed. The surface impoundment has an NPDES-permitted outflow. Waters exiting the surface impoundment pass through sand filters before passing through the NPDES discharge point. The unit has an estimated total active life of ten years. Wastes in the impoundment will be left in the impoundment upon its closing.³⁵

Waste Characterization

This waste has a pH of 8. The facility reported no other characterization information for this wastestream. The facility states that this wastestream does not exceed the TC level for chromium.³⁶ The facility did not report exceedance of the TC level for any other constituent in this wastestream.

2.3.7 Commingled Treated Wastewaters

Waste Generation

Reduced chromium treatment residues from the spent ore residue treatment unit and the wastewater treatment unit (see Sections 2.3.5 and 2.3.6) commingle in the on-site, Subtitle D, HDPE double-lined surface impoundment. Over time, the commingled residues settle and dewater. The waters from dewatering are known as commingled treated wastewaters and discharge from the surface impoundment. The facility reported generating 511 MT per day of this residue in 1998³⁷, yielding an annual generation rate of 186,515 MT.

³² May 23, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

³³ May 23, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

³⁴ May 23, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

³⁵ May 23, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

³⁶ July 24, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

³⁷ August 16, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

Waste Management

The commingled treated wastewaters are passed from the surface impoundment through a series of tank-based sand filters in order to remove any fine, residual solids (see Section 2.3.9). These sand filters are contained in columns which are not land-based.³⁸ From the sand filters, the wastewaters pass directly to an internal NPDES permitted outfall (Outfall 101) emptying into a retention basin where it mixes with seawater³⁹ and from there discharges through another NPDES discharge point to the Tule Lake Shipping Channel. The facility's NPDES discharge number is TX0004685.

Waste Characterization

This waste has a pH of 6. The facility reported no other characterization information for this wastestream. The facility did not state that this wastestream exceeds the TC level for any constituent.

NPDES compliance monitoring data for this facility is available to the public through the EPA Envirofacts database.⁴⁰ A copy of the pertinent data for this waste characterization has also been placed in the docket for today's rulemaking. The NPDES compliance monitoring data for 1998 for the 101 Outfall at this facility provides monthly levels of hexavalent chromium exiting the outfall. Summing and taking the average of the twelve monthly figures for 1998 indicates that the facility released hexavalent chromium through Outfall 101 at an average rate of 0.018 pounds/day in 1998 (levels below the detection limit were included in the calculation at half the level of the detection limit). The total amount of hexavalent chromium released, therefore, in 1998 was 3×10^{-3} MT. Given a total discharge of 186,515 MT of effluent in 1998, the facility therefore released hexavalent chromium through their NPDES outfall at an average concentration of 0.016 ppm.

The NPDES monthly compliance monitoring data for 1998 for this facility also indicates that the facility released total chromium through Outfall 101 at an average rate of 0.46 pounds/day. The total amount released, therefore, in 1998 was 0.08 MT. Given a total discharge of 186,515 MT of effluent in 1998, the facility released chromium (total) through their NPDES outfall at an average concentration of 0.41 ppm.

Ambient Water Quality Criteria and Human Health Benchmarks are available for comparison with this information in **Appendix C**.

2.3.8 Process Filters, Membranes, Baghouse Bags and Chromium-Contaminated Empty Containers and Other Plant Wastes

Waste Generation

Process filters, membranes, and baghouse bags are generated at several points in the Elementis sodium dichromate production process. This wastestream also includes chromium-contaminated empty containers from the sodium chromate and sodium dichromate packaging units and other chromium-contaminated plant wastes. These wastes are generated every 2 to 6 months. The facility reported generating 24 MT of this residue in 1998.

³⁸ June 13, 2000 Phone Log---Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

³⁹ May 23, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

⁴⁰ http://www.epa.gov/enviro/index_java.html

Waste Management

This wastestream is stored on-site in a closed, 25 cubic yard volume roll-off box before being sent offsite for treatment by encapsulation and disposal in a Subtitle C landfill. Elementis' RCRA Hazardous Waste Generator Identification Number is TXD098818339. The facility to which they send this wastestream is Texas Ecologists in Robstown, Texas.

Waste Characterization

The facility reported the D007 RCRA hazardous waste code (> 5 mg/L chromium TCLP). Elementis Chromium reported a total chromium concentration of 100 mg/kg and a TCLP concentration of 5 mg/L. The waste has a pH of 9 and consists of 95% solids and 5% moisture. This residual does not contain volatile constituents of concern.

2.3.9 Spent Sand Filter Sands

Waste Generation

Elementis disposes of reduced chromium treatment residues from both their spent ore residue treatment unit and their wastewater treatment unit (see Sections 2.3.5 and 2.3.6) in an on-site surface impoundment. Liquids exited the surface impoundment at a rate of 511 metric tons per day in 1998 through sand filters before discharging through an NDPEs-permitted discharge. The purpose of the sand filters is to remove any residual solids which fail to settle in the surface impoundment. Since the majority of the solids settle in the surface impoundment, the sand filters capture relatively smaller amounts of reduced chromium treatment residues. The Elementis facility disposes of spent sand from one sand filter unit approximately once every two years. Each sand filter unit contains approximately 2 cubic yards of sand, generating approximately 2 MT of spent sand filter media during each cleaning, or, on average, approximately 1 MT of spent sand filter media per year.⁴¹

Waste Management

The spent sand filter sand is placed in a non-hazardous waste bin with other waste soils from on-site activities. The co-mingled soils are sampled to ensure that they are non-hazardous. The contents of the waste bin are then sent to Texas Ecologists in Robstown, Texas who dispose of the material in a non-hazardous industrial waste landfill.⁴²

Waste Characterization

Elementis claims that the spent sand filter media is non-hazardous (does not exhibit levels of any constituent above the Toxicity Characteristic level according to TCLP leachate analysis). Residues from treatment of caustic filter sludge, sodium chromate evaporation unit wastewaters, and sodium dichromate evaporation unit wastewaters are the only residues contributing to the potential constituent of concern levels in the spent sand filters. All other wastes are either Bevill-exempt wastes or treatment

⁴¹ May 23, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP) and June 13, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

⁴² June 13, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

residues from contaminated media, neither of which falls within the scope of the consent decree.

Chromium is the only potential constituent of concern detected in the wastes within the scope of the consent decree.

2.4 CALCULATION OF CHROMIUM LOADING TO ELEMENTIS SURFACE IMPOUNDMENT

Table 2.2 presents information on the nature of the wastes whose treatment residues contribute to the wastes disposed of in Elementis' on-site surface impoundment. This information includes waste mass, concentration of chromium in the waste, and total contribution of mass of chromium by the waste to chromium mass in the surface impoundment.

Table 2.2 Chromium Contributions by Wastes Disposed in Elementis' On-Site Surface Impoundment

Waste Name	Mass Generated in 1998	Waste Chromium Concentration	Total Chromium Contribution
Spent Post-Neutralization Ore Residue	60,000 MT	109,000 mg/kg	6,540,000 kg
Caustic Filter Sludge	80 MT	20 mg/kg	1.6 kg
Sodium Dichromate Evaporation Unit Wastewater	2500 MT	0.5 mg/kg	1.25 kg
Sodium Chromate Evaporation Unit Wastewater	300 MT	0.5 mg/kg	0.15 kg
Remediation Well Water and Stormwater	27,200 MT*	10 mg/kg**	272 kg

*Mass based on 1999 data⁴³

** Estimated concentration. Elementis reported that remediation well water averages 500 mg/kg chromium and stormwater averages 1-4 mg/kg chromium. The facility was not able to provide relative volumes of the remediation well water and the stormwater so a more accurate chromium concentration for the commingled wastewaters could not be calculated.⁴⁴

The basic formula for calculating the total chromium contribution from any one wastestream is as follows:

$$T = \frac{GC \text{ (kg}^2\text{)}}{1000 \text{ (MT mg)}}$$

⁴³ May 23, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

⁴⁴ May 23, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

Where:

T=total chromium mass contribution from the wastestream

G=mass of the wastestream generated in 1998 (or 1999)

C=concentration of chromium in the wastestream

and where kg (kilograms), MT (metric tons), and mg (milligrams) are unit conversion factors.

The values derived from this calculation for each of the wastestreams are listed in the final column of **Table 2.1**. Utilizing the numbers in the table above, the percent contribution of chromium by wastestreams within the scope of the consent decree (caustic filter sludge, sodium chromate evaporation unit wastewater, and sodium dichromate evaporation unit wastewater—see discussions of scope in the proposed rule preamble) to the total mass of chromium entering Elementis' surface impoundment is 0.00004% or 4×10^{-5} %.

3. OCCIDENTAL CHEMICAL (“OxyChem”)

The Occidental facility is located ten miles north of Wilmington in New Hanover County, North Carolina. The facility began operations in 1971 as a Diamond Shamrock Chemicals facility and became an Occidental Chemical facility in 1986. The facility site occupies 150 acres.⁴⁵ In addition to sodium dichromate, the facility also produces chromic acid.

3.1 PRODUCTION PROCESS DESCRIPTION

Figure 3.1 is OXYChem's process flow diagram for sodium dichromate manufacturing.

The main feedstock for the OxyChem sodium dichromate manufacturing process, chromite ore imported from the Transvaal region of South Africa, is typically 45-46% chromium oxide. Impurities in the ore include oxides of silica, iron, calcium, manganese, titanium, vanadium, phosphorous and sulfur. Other elements which can be present in the ore are magnesium, aluminum, and nickel.⁴⁶

Chromite ore is dried and ground to size the ore. An air pollution control system (cyclone) on the ore drying and grinding units captures airborne residues and returns them directly to the drying and grinding units for reinsertion to the manufacturing process. Additional residues pass from this air pollution control system on the drying and grinding unit to a second air pollution control system (dry electrostatic precipitators). In this second air pollution control system, several airborne residues mix, including residues from the ore drying and grinding units, the roasting kiln waste heat boilers, the ore mixing unit and roasting kiln, and the air pollution control system on the post-leach ore residue drying unit. Residue from this second air pollution control unit travels directly to the mixing and roasting kiln units for insertion to the manufacturing process.

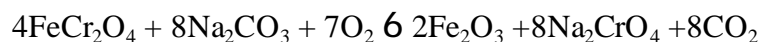
After drying and grinding, the chromite ore is mixed with sodium carbonate (soda ash), limestone, and post-leach ore residue (unconverted materials from previously roasted and leached chromite ore) to form the roasting kiln feed. The kiln feed is fed to rotary kilns in which the chromite

⁴⁵

http://www.chemicalguide.com/Public_Pages/What_We_Do.cfm?Params=Occidental%20Chemical=Castle%20Hayne

⁴⁶ 64 FR 8774-8779

ore is heated to approximately 2000°F⁴⁷. This treatment oxidizes the chromite ore, converting the majority of the chromium in the ore from trivalent to hexavalent chromium.⁴⁸ The basic reaction taking place at this point is:



The hot gasses generated in the kilns are sent to waste heat boilers for energy recovery. Periodically, the facility cleans the waste heat boilers to remove built-up residues deposited from the hot kiln gasses onto the internal components. This wastestream is referred to here as waste heat boiler washout. This wastestream is sent directly to the onsite spent ore residue treatment unit for treatment and disposal. Airborne residues from the waste heat boilers travel to the air pollution control system (dry electrostatic precipitators) described in the paragraph above and are ultimately returned to the manufacturing process. The mix and kiln unit also sends additional airborne residues to either the same air pollution control system described in the paragraph above or to an air pollution control system dedicated to the mix and kiln unit. The latter air pollution control system returns captured residues directly to the mix and kiln unit.

Spent kiln brick is generated intermittantly from the kiln and is discarded.

After exiting the kiln, the hot kiln roast is quenched and leached with hot water in tanks in order to dissolve the water-soluble sodium chromate and form a sodium chromate slurry. An air pollution control system (cyclonic scrubbers and wet electrostatic precipitators) on this leach and filter unit captures airborne residues and returns them directly to the leach and filter unit. Approximately once a year, this system is cleaned out to remove scale and buildup. This residue is placed in a hopper and reinserted to the manufacturing process at the leach and filter unit once the clean-out is complete.

The sodium chromate slurry is sent to a recycle unit where hydroclones separate unconverted ore residue from the sodium chromate solution. The unconverted post-leach ore residue is washed and filtered on a filter belt. The washwaters are immediately returned to the leach and filter unit.

The majority of the washed post-leach ore residue is sent to a drier and recycled to the kiln unit. A small percentage is transferred directly to the spent ore residue treatment unit for treatment and disposal and is referred to here as spent post-leach ore residue. An air pollution control system on the ore residue drier (cyclone and dry electrostatic precipitators) captures airborne residues and returns them directly to the drier unit.

After leaching and filtering, the raw sodium chromate product stream proceeds through a series of pH adjustment and filtration steps utilizing sodium carbonate and sulfuric acid to remove impurities such as iron, aluminum, and other oxides from the sodium chromate solution.⁴⁹ The sodium chromate solution is neutralized to a pH of 8.5 to precipitate and allow filtration of the remaining ore residues which are then sent to the facility's on-site spent ore residue treatment unit for treatment and disposal. These residues are referred to here as spent post-neutralization ore residues. This wastestream is washed and sent directly to the spent ore residue treatment unit for treatment and disposal. The

⁴⁷ 64 FR 8774-8779

⁴⁸ 64 FR 8774-8779

⁴⁹ http://www.oxychem.com/products/chrome/manufacturing_process.html

washwaters are inserted directly into the leach and filtration unit. During the neutralization step, soluble calcium impurities form in the sodium chromate liquor. The sodium chromate liquor is mixed with a soda ash solution in the calcium precipitator unit to precipitate the calcium as calcium carbonate. The sodium chromate liquor is then filtered to remove the calcium carbonate. These calcium carbonate residuals are recycled within the filtration and precipitation unit until they are eventually purged from the manufacturing process as part of the spent post-neutralization ore residue wastestream. An air pollution control system (demisters) on the precipitation and filtration unit captures airborne residues and returns them directly to the precipitation and filtration unit.

In the acidification unit, the filtered raw sodium chromate liquor is acidified to a pH of 4.0 with sulfuric acid⁵⁰ to produce sodium dichromate. The basic reaction taking place at this point is as follows:



This solution is partially evaporated to 85% concentration⁵¹ and then centrifuged to separate sodium sulfate (saltcake) from the sodium dichromate solution. An air pollution control system on these units (demisters) captures airborne residues and returns them directly to the same units.

Some of the salt cake slurry travels to a drying unit. An air pollution control system on this drying unit (scrubber) captures airborne residues and sends them directly to the spent ore residue treatment unit for treatment and disposal. This wastestream is referred to here as saltcake drier scrubber wastewater. This unpurified sodium sulfate is dried and sold as sodium sulfate “saltcake.” Sodium sulfate “saltcake” is used as a sulfur source for the Kraft Paper manufacturing process and as a sodium electrolyte source for efficiency enhancement of dry electrostatic precipitators, particularly those used by coal fired power plants.⁵²

A portion of the salt cake slurry is sent to a salt cake purification unit for purification and then sold as purified sodium sulfate. A wastewater residue from the salt cake purification unit is reinserted to the manufacturing process at the leach and filter unit. Purified sodium sulfate is used to facilitate the uptake and consistency of dyes in textile operations, as an ingredient in glass, and as a performance enhancing agent in dry detergents.

Once dried, sodium sulfate “salt cake” and purified salt cake are stored in silos at the OxyChem facility for bulk loading of railcars and trucks. Sodium sulfate is also warehoused off-site in order to facilitate international shipments requiring large volumes of the material. Purified sodium sulfate can also be shipped to a contract bagger for bagging of the material prior to its sale on the open market by a

⁵⁰ http://www.oxychem.com/products/chrome/manufacturing_process.html

⁵¹ http://www.oxychem.com/products/chrome/manufacturing_process.html

⁵² http://www.oxychem.com/products/sodium_sulfate_anhydrous/default.html and
http://www.oxychem.com/products/sodium_sulfate_anhydrous/literature.html and
<http://www.chemexpo.com/news/PROFILE980817.cfm>

broker.⁵³ The facility has a yearly sodium sulfate saltcake capacity of 126,000 short tons.⁵⁴ As part of their response to the RCRA Section 3007 survey, the facility supplied MSDS sheets for these two materials.

After separation from the salt cake, the sodium dichromate product solution is either stored in tanks from which, after dilution to the appropriate concentration,⁵⁵ it is either sold as sodium dichromate product liquor or used as feedstock in the facility's onsite chromic acid plant. An air pollution control system on the sodium dichromate storage tanks (demisters) captures airborne residues and sends them directly to the acidification unit. Sodium dichromate liquor is transported by tank rail car or tank truck as a 69-85% solution.

Some of the sodium dichromate solution is crystallized, centrifuged, and dried to form sodium dichromate crystalline product. Crystalline sodium dichromate is produced by cooling sodium dichromate liquor under controlled conditions.⁵⁶ Sodium dichromate crystals are shipped in bags or supersacks.⁵⁷ An air pollution control system on the crystallization unit (scrubber) captures airborne residues and sends them directly to the acidification unit. Oversized crystals from the crystallization unit are dissolved, commingled with air pollution control residues from the sodium dichromate solution storage tanks, and travel with them directly to the acidification unit.

Waste paint, solvents, used rags, and used rollers are generated as a result of plant maintenance.

3.2 PRODUCTION TRENDS, CHANGES, AND IMPROVEMENTS

OxyChem did not report any plans for changes in the near future in their production or waste management processes.

⁵³ See Occidental Chemical Corporations's Follow-up Response to EPA's 1998 RCRA §3007 Survey of the Inorganic Chemical Industry for the MSDSs for sodium sulfate "salt cake" and purified sodium sulfate. November 23, 1999.

⁵⁴

http://www.chemicalguide.com/Public_Pages/What_We_Do.cfm?Params=Occidental%20Chemical=Castle%20Hayne

⁵⁵ http://www.oxychem.com/products/chrome/manufacturing_process.html

⁵⁶ http://www.oxychem.com/products/chrome/manufacturing_process.html

⁵⁷ http://www.oxychem.com/products/chrome/manufacturing_process.html,
http://www.oxychem.com/products/sodium_bichromate/default.html, and
http://www.oxychem.com/products/sodium_bichromate/handling_storage.html

3.3 RESIDUAL GENERATION AND MANAGEMENT—Acidification Process

The following discussions detail the generation, characterization and management of residuals from the production of sodium chromate by the acidification production process at Oxychem. Only wastes within the scope of the consent decree governing the inorganic chemicals industry listing are described below.⁵⁸ For a more detailed discussion of the scope of the consent decree, please refer to the relevant preamble section of the inorganic chemical industry listing proposal.

Appendix A presents a complete summary of the wastestreams generated and their management at the Oxychem facility.

3.3.1 Spent Post-Neutralization Ore Residue

Waste Generation

After leaching and filtering, the sodium chromate product stream proceeds through a series of pH adjustment and filtration steps utilizing sodium carbonate and sulfuric acid to remove impurities such as iron, aluminum, and other oxides from the sodium chromate solution.⁵⁹ The sodium chromate solution is neutralized to a pH of 8.5 to precipitate and filter the remaining ore residues which are sent directly to the facility's on-site spent ore residue treatment unit for treatment and disposal. These residues are referred to here as spent post-neutralization ore residues. This wastestream is washed and sent directly to the spent ore residue treatment unit for treatment and disposal. This wastestream is generated continuously. 146,937 metric tons of this residue was generated in 1998.

Waste Management

The residue is sent to an onsite, tank-based spent ore residue treatment unit where it is commingled with spent post-leach ore residue, waste heat boiler washout, remediation well water, storm water, cooling tower blowdown, and salt cake drier scrubber wastewater. The residue is sent directly from its point of generation to the treatment unit without intervening storage. The entire treatment process takes place in a series of tanks with secondary containment, some of which are covered. Treatment consists of conversion of hexavalent chromium in the wastes to trivalent chromium with pickle liquor (ferrous chloride reducing agent). The residue is then neutralized with lime slurry in order to help precipitation of trivalent chromium compounds out of solution. Passing through a thickener circuit for light solids and a hydroclone circuit for heavy solids, the treatment residues are washed free of chlorides and other dissolved solids and thickened. The overflow is referred to as commingled treated wastewaters and is discussed in Section 3.3.6 below. Crushed limestone is added to the thickened sludge to further stabilize chromium and other metals. River water or water from the final disposal unit for the sludge is used to slurry the sludge and move it to a retention tank. From this tank, the slurried waste is sent to one of two abandoned quarries for final disposal.

Waste Characterization

⁵⁸ Secondary materials from sodium dichromate manufacturing falling outside the scope of the inorganic chemical industry consent decree include: spent kiln brick, paint wastes, and contaminated media such as stormwater and remediation well water. See Appendix A.

⁵⁹ http://www.oxychem.com/products/chrome/manufacturing_process.html

The waste is D007 at the point of generation and has a pH of 9.8. It consists of 50% moisture and 50% solids. The residue does not contain volatile constituents of concern. The facility provided the information presented in **Table 3.1** on the chemical composition of the wastestream:

Table 3.1 Chemical Composition of Spent Post-Neutralization Ore Residue

Chemical Component	Total Concentration (mg/kg)
CaCO ₃	5104
Fe ₂ O ₃	22,615
Al ₂ O ₃ •H ₂ O	13,775
MgO	154
SiO ₂	832
Na ₂ CrO ₄	23

3.3.2 Spent Post-Leach Ore Residue

Waste Generation

After exiting the kiln, the hot kiln roast is quenched and leached with hot water in tanks in order to dissolve the water-soluble sodium chromate and form a sodium chromate slurry. The sodium chromate slurry is sent to a recycle unit where hydroclones separate unconverted ore residue from the sodium chromate solution. The unconverted post-leach ore residue is washed and filtered on a filter belt. The majority of the washed post-leach ore residue is sent to a drier and recycled to the kiln unit. A smaller percentage is transferred directly to the spent ore residue treatment unit for treatment and disposal and is referred to here as spent post-leach ore residue. This waste is generated continuously. 25,930 metric tons of this residue was generated in 1998.

Waste Management

The residue is sent to an onsite, tank-based spent ore residue treatment unit where it is commingled with spent post-leach ore residue, remediation well water, storm water, cooling tower blowdown, and salt cake drier scrubber wastewater. The residue is sent directly from its point of generation to the treatment unit without intervening storage. The entire treatment process takes place in a series of tanks with secondary containment, some of which are covered. Treatment consists of conversion of hexavalent chromium in the wastes to trivalent chromium with pickle liquor (ferrous chloride reducing agent). The residue is then neutralized with lime slurry in order to help precipitation of trivalent chromium compounds out of solution. Passing through a thickener circuit for light solids and a hydroclone circuit for heavy solids, the treatment residues are washed free of chlorides and other dissolved solids and thickened. The overflow is referred to as commingled treated wastewaters and is discussed in Section 3.3.6 below. Crushed limestone is added to the thickened sludge to further stabilize chromium and other metals. River water or water from the final disposal unit for the sludge is

used to slurry the sludge and move it to a retention tank. From this tank, the slurried waste is sent to one of two abandoned quarries for final disposal.

Waste Characterization

This waste is D007 at the point of generation and has a pH of 11-12. It consists of 11% moisture and 89% solids. The waste does not contain volatile constituents of concern. The facility provided the information in **Table 3.2** on the chemical composition of the wastestream:

Table 3.2 Chemical Composition of Spent Post-Leach Ore Residue

Chemical Component	Total Concentration (mg/kg)
Unreacted Ore*	88,110
Fe ₂ O ₃	447
Al ₂ O ₃ •H ₂ O	274
MgO	154
SiO ₂	15
Na ₂ CrO ₄	46

* See MSDS for chromite ore in OxyChem's RCRA §3007 survey response.

3.3.3 Saltcake Drier Scrubber Wastewater

Waste Generation

In the acidification unit, the filtered raw sodium chromate liquor is acidified to a pH of 4.0 with sulfuric acid⁶⁰ to produce sodium dichromate. Sodium sulfate (saltcake) forms simultaneously. The product solution is partially evaporated to 85% concentration⁶¹ and then centrifuged to separate sodium sulfate (saltcake) from the sodium dichromate solution. Some of the saltcake slurry travels to a drying unit. An air pollution control system on this drying unit (scrubber) captures airborne residues and sends them directly to the spent ore residue treatment unit for treatment and disposal. This wastestream is referred to here as saltcake drier scrubber wastewater. 13,851 metric tons of this residue was generated in 1998. The wastestream is produced continuously.

Waste Management

The residue is sent to an onsite, tank-based spent ore residue treatment unit where it is commingled with spent post-neutralization ore residue, waste heat boiler washout, remediation well water, storm water, cooling tower blowdown, and spent post-leach ore residue. The residue is sent directly from its point of generation to the treatment unit without intervening storage. The entire

⁶⁰ http://www.oxychem.com/products/chrome/manufacturing_process.html

⁶¹ http://www.oxychem.com/products/chrome/manufacturing_process.html

treatment process takes place in a series of tanks with secondary containment, some of which are covered. Treatment consists of conversion of hexavalent chromium in the wastes to trivalent chromium with pickle liquor (ferrous chloride reducing agent). The residue is then neutralized with lime slurry in order to help precipitation of trivalent chromium compounds out of solution. Passing through a thickener circuit for light solids and a hydroclone circuit for heavy solids, the treatment residues are washed free of chlorides and other dissolved solids and thickened. The overflow is referred to as commingled treated wastewaters and is discussed in Section 3.3.6 below. Crushed limestone is added to the thickened sludge to further stabilize chromium and other metals. River water or water from the final disposal unit for the sludge is used to slurry the sludge and move it to a retention tank. From this tank, the slurried waste is sent to one of two abandoned quarries for final disposal.

Waste Characterization

The salt cake drier scrubber solution is a liquid (<1% solids) with a pH of 3. The waste has a total sodium sulfate (Na_2SO_4) concentration of 120,000 mg/kg and a total chromium trioxide (Cr_2O_3) concentration of 9 mg/kg. This waste is D007 at the point of generation. The residue does not contain volatile constituents of concern.

3.3.4 Waste Heat Boiler Washout

Waste Generation

The hot gasses generated in the roasting kilns are sent to waste heat boilers for energy recovery. Periodically, the facility cleans the waste heat boilers to remove built-up residues from the internal components. This wastestream is referred to here as waste heat boiler washout. 70 metric tons of this residue was generated in 1998. The waste is generated every 8-31 days.

Waste Management

The residue is sent to an onsite, tank-based spent ore residue treatment unit where it is commingled with spent post-leach ore residue, spent post-neutralization ore residue, remediation well water, storm water, cooling tower blowdown, and salt cake drier scrubber wastewater. The residue is sent directly from its point of generation to the treatment unit without intervening storage. The entire treatment process takes place in a series of tanks with secondary containment, some of which are covered. Treatment consists of conversion of hexavalent chromium in the wastes to trivalent chromium with pickle liquor (ferrous chloride reducing agent). The residue is then neutralized with lime slurry in order to help precipitation of trivalent chromium compounds out of solution. Passing through a thickener circuit for light solids and a hydroclone circuit for heavy solids, the treatment residues are washed free of chlorides and other dissolved solids and thickened. The overflow is referred to as commingled treated wastewaters and is discussed in Section 3.3.6 below. Crushed limestone is added to the thickened sludge to further stabilize chromium and other metals. River water or water from the final disposal unit for the sludge is used to slurry the sludge and move it to a retention tank. From this tank, the slurried waste is sent to one of two abandoned quarries for final disposal.

Waste Characterization

This waste is a solid and is a D007 waste at the point of generation. The waste does not contain volatile constituents of concern. The facility reported that this wastestream consists of 1.00% Na_2CrO_4 , 8.13% Na_2CO_3 , 0.30% Ca, 35.00% Cr_2O_3 (unoxidized), and 56.00% inert mineral oxides.

3.3.5 Reduced Chromium Treatment Residues

Waste Generation

The ore that is no longer feasible for roasting is sent to treatment along with residuals resulting from ore treatment to remove impurities. The treatment residue is a mixture of treated ore residue, which is Bevill exempt, and other treatment residues which are not Bevill-exempt (residues from treatment of contaminated media and of manufacturing wastes other than those from roasting/leaching of chromite ore). In 1998, 129,503 MT of this residue were generated. This waste is produced continuously.

Waste Management

The sludge is slurried with either river water or water from the quarry disposal units and carried from the spent ore residue treatment unit and is discharged to an onsite Subtitle D disposal unit, one of two abandoned quarries. One unit has a surface area of 96.9 acres and a total capacity of 3.9×10^6 cubic yards. Remaining capacity at the beginning of 1998 was 439,106 cubic yards. The second unit has a surface area of 70.6 acres and a total capacity of 3.0×10^6 cubic yards. Remaining capacity as of the beginning of 1998 was 3.0×10^6 cubic yards. The units do not have liners. Residual water from the quarries is used to slurry reduced chromium spent ore residue treatment unit residues so as to move them more easily to the disposal unit.

Waste Characterization

This waste, according to the facility, does not exceed the TC level for any constituent, including chromium (see **Appendix B**). This waste does not contain volatile constituents of concern. OxyChem provided the information in **Table 3.3** on the composition of the reduced chromium spent ore residue treatment unit residues:

Table 3.3 Chemical Composition of Reduced Chromium Treatment Residues

Chemical Component	Total Concentration (mg/kg)	EP TOX Concentration (mg/L)
Cr	45,400	See TCLP results in Appendix B
V	227	<0.010
Ni	1120	0.109
Zn	770	0.015
Ba	137	0.109
Cu	46	0.045
As	9	<0.010
Se	5	<0.010
Sb	<158	<0.005
Pb	<30	<0.100
Ag	<16	<0.010
Cu	<16	<0.010
Fe	214,000	---
Al	99,200	---
Ca	91,600	---
Mg	47,700	---
Si	31,200	---
Na	11,300	---
K	2,600	---

3.3.6 Commingled Treated Wastewaters

Waste Generation

These wastewaters are generated as a result of the treatment process for various chromium-containing wastes in OxyChem's spent ore residue treatment unit. The wastes are treated with ferrous chloride reducing agent to reduce hexavalent chromium in the wastes to trivalent chromium. Lime slurry is used to adjust the pH of the waste. A series of thickeners and hydrocyclones separate the solids from the liquids and wash the solids free of chlorides and other dissolved solids. The separated liquids are referred to here as commingled treated wastewaters.

The facility reported generating 920,161 MT of this residual in 1998.

Waste Management

The separated liquids are passed through a series of closed, tank-based sand filters in order to

capture residual fine solids (spent sand filter sands are discussed in Section 3.3.8), and are then discharged under NPDES permit to the Northeast Cape Fear River. The facility's NPDES discharge permit number is NC0003875. Some of the wastewaters are not discharged under NPDES but travel instead to on-site disposal units along with the reduced chromium treatment residues (Section 3.3.5).

Waste Characterization

The waste has a pH of 6-9. The facility did not report any exceedances of the TC for this wastestream.

NPDES permit and compliance monitoring data for this facility is available to the public through the EPA Envirofacts database.⁶² A copy of the pertinent data has also been placed in the docket for today's rulemaking. The NPDES compliance monitoring data for 1998 for the 001 Outfall at this facility provides monthly measurements of hexavalent chromium exiting the outfall. Zero hexavalent chromium was detected in 1998. The facility is permitted to release 0.31 pounds/day of hexavalent chromium, or 0.051 MT/year. Given a total discharge of 920,161 MT of effluent in 1998, the facility was therefore permitted to release hexavalent chromium through their NPDES outfall at an average concentration of up to 0.056 ppm.

The NPDES monthly compliance monitoring data for 1998 for this facility also provided monthly measurements of total chromium exiting Outfall 001. Summing the twelve monthly measurements and taking the average indicates an average total chromium release rate of 0.0433 pounds/day. The permitted release rate for total chromium is 2.72 pounds/day, or 0.450 MT/year. Given a total discharge of 920,161 MT of effluent in 1998, the facility was therefore permitted to release total chromium through their NPDES outfall at an average concentration of up to 0.490 ppm.

Ambient Water Quality Criteria and Human Health Benchmarks are available for comparison in **Appendix C**.

3.3.7 Chromium-contaminated Filters, Membranes, and Other Plant Wastes

Waste Generation

This wastestream includes spent filters, membranes, and other various kinds of wastes such as sample jars, paper towels and other plant trash contaminated with chromium.⁶³ In 1998, 67 MT of this residue were generated. The wastestream is produced continuously.

Waste Management

This wastestream is stored on-site in a closed, 20 cubic yard, roll-off bin for less than 90 days and then sent offsite to a Subtitle C facility for microencapsulation⁶⁴ and disposal in a Subtitle C landfill. The Subtitle C facility is Chemical Waste Management in Emelle, Alabama. OxyChem's RCRA Hazardous Waste Generator ID Number is NCD057454670.

Waste Characterization

⁶² http://www.epa.gov/enviro/index_java.html

⁶³ May 18, 2000 Phone Log, Ashley L. Allen (EPA) and Frank Barone (OxyChem)

⁶⁴ May 18, 2000 Phone Log, Ashley L. Allen (EPA) and Frank Barone (OxyChem)

This wastestream is characteristically hazardous waste for chromium (D007). OXYChem reports a TCLP concentration for chromium of >5 ppm. This waste does not contain volatile constituents of concern and is a solid.

3.3.8 Spent Sand Filter Sands

Waste Generation

Treated liquid effluent from the spent ore residue treatment unit is filtered through closed, tank-based sand filters⁶⁵ before being discharged under an NPDES permit. In 1997, 21.7 MT of this residue were generated. The purpose of the sand filters is to remove any residual solids which the treatment unit clarifiers fail to remove upstream in the treatment process. Since the clarifiers capture the majority of the solids, the sand filters capture smaller amounts of treatment residue. The sand filters are cleaned periodically. The last filter media disposal took place in 1997. The filters are cleaned as needed.

Waste Management

The waste is stored onsite, closed, non-hazardous waste 55 gallon drums or 20 cubic yard roll-off bins before disposal in an offsite industrial Subtitle D landfill. The landfill is run by Browning Ferris Industries in Roseboro, North Carolina.

Waste Characterization

This wastestream is a solid and is predominately silica oxide (99.2-99.9%). According to data submitted by OxyChem the only constituent detected using the TCLP was chromium at 0.200 mg/L (see **Table 3.4**). This waste does not exceed the TC level for any constituent. This waste does not contain volatile constituents of concern.

Table 3.4 Chemical Composition of Spent Filter Sands from Spent Ore Residue Treatment Unit

Chemical Component	TCLP Leachate Concentration (mg/L)
As	<0.005
Ba	<0.020
Cd	<0.005
Cr	0.200
Pb	<0.010
Hg	<0.0002
Se	<0.005

⁶⁵ May 18, 2000 Phone Log, Ashley L. Allen (EPA) and Frank Barone (Oxychem)

Chemical Component	TCLP Leachate Concentration (mg/L)
Ag	<0.010

3.4 CALCULATION OF CHROMIUM LOADING TO OXYCHEM ONSITE DISPOSAL UNITS

Table 3.5 presents information on the nature of the wastes whose treatment residues contribute to the wastes disposed of in Oxychem’s on-site surface impoundments. This information includes waste mass, concentration of chromium in the waste and total contribution of chromium mass by the waste to chromium mass in the surface impoundment.

Table 3.5 Chromium Contributions of Wastes Disposed in OxyChem’s OnSite Disposal Unit

Waste Name	Mass Generated in 1998	Total Chromium Concentration	Total Chromium Contribution
Reduced chromium treatment residues	129,503 MT	45,400 mg/kg	5,880,000 kg
Saltcake drier scrubber wastewater	13,851 MT	6 mg/kg*	80 kg

* This concentration was calculated from the facility-reported Cr₂O₃ concentration for this waste of 9 mg/kg Cr₂O₃.

The basic formula for calculating the total chromium contribution from any one wastestream is as follows:

$$T = \frac{GC}{1000} \text{ (kg}^2\text{)}$$

Where:

T=total chromium mass contribution from the wastestream

G=mass of the wastestream generated in 1998 (or 1999)

C=concentration of chromium in the wastestream

and where kg (kilograms), MT (metric tons), and mg (milligrams) are unit conversion factors.

The values derived from this calculation for each of the wastestreams in listed in the final column of Table 3.5. Utilizing the numbers in the table above, the percent contribution of chromium by wastestreams within the scope of the consent decree (saltcake drier scrubber wastewater—see discussions of scope in the preamble to today’s rulemaking) relative to the total mass of chromium entering Occidental’s disposal unit is 0.001%.

APPENDIX A

Summary of Waste Generation and Management

Wastestream	Facility	RIN/ RCRA Waste Code	Volume (Mt/yr)	Management
Spent post-neutralization ore residue	Elementis Chromium, LP	RIN 9/ D007	60,000	Sent to spent ore residue treatment unit. Treated for hexavalent chromium and pH in tanks.
Caustic filter sludge	Elementis Chromium, LP	RIN 10/ D002	80	Sent to spent ore residue treatment unit. Treated for hexavalent chromium and pH in tanks.
Sodium dichromate evaporation unit wastewater	Elementis Chromium, LP	RIN 7/ NR	~2500	Sent to waste water treatment unit. Treated in tanks for hexavalent chromium and pH.
Sodium chromate evaporation unit wastewater	Elementis Chromium, LP	RIN 7/ NR	~300	Sent to waste water treatment unit. Treated in tanks for hexavalent chromium and pH.
Reduced chromium treatment residues from spent ore residue treatment unit	Elementis Chromium, LP	RIN 1/ NR	60,000	Discharged to onsite HDPE double-lined surface impoundment.
Reduced chromium treatment residues from wastewater treatment unit	Elementis Chromium, LP	RIN 11/ NR	~30,000	Discharged to onsite HDPE double-lined surface impoundment.
Commingled treated wastewaters	Elementis Chromium, LP	RIN 12/ NR	186,515	Passed through sand filters and discharged under NPDES permit
Process filters and membranes, bagouse bags, chromium-contaminated containers and other plant wastes	Elementis Chromium, LP	RIN 6/ D007	24	Treatment offsite at Subtitle C facility and disposal in Subtitle C landfill.
Spent sand filter sands	Elementis Chromium, LP	NR /NR	~1	Sent offsite to landfill for disposal as non-hazardous waste
Spent post-neutralization ore residue	Occidental Chemical, Corp.	RIN 2/ D007	146,937	Sent to spent ore residue treatment unit. Treated for hexavalent chromium and pH in tanks.
Spent post-leach ore residue	Occidental Chemical, Corp.	RIN 1A/ D007	25,930	Sent to spent ore residue treatment unit. Treated for hexavalent chromium and pH in tanks.
Saltcake drier scrubber wastewater	Occidental Chemical, Corp.	RIN 4/ D007	13,851	Sent to spent ore residue treatment unit. Treated for hexavalent chromium and pH in tanks.
Waste heat boiler washout	Occidental Chemical, Corp.	RIN 24/ D007	70	Sent to spent ore residue treatment unit. Treated for hexavalent chromium and pH in tanks.

Wastestream	Facility	RIN/ RCRA Waste Code	Volume (Mt/yr)	Management
Reduced chromium treatment residues	Occidental Chemical, Corp.	RIN 8/ NR	129,503	Discharged to onsite Subtitle D disposal unit.
Commingled treated wastewaters	Occidental Chemical, Corp.	NR/ NR	920,161	Discharged under NPDES permit to Northeast Cape Fear River
Chromium-contaminated filters, membranes, and other plant wastes	Occidental Chemical, Corp.	RIN 6/ D007	67	Treatment offsite at Subtitle C facility and disposal in offsite Subtitle C landfill.
Spent sand filter sands	Occidental Chemical, Corp.	RIN 9/ NR	21.7 (1997)	Disposal in offsite industrial Subtitle D landfill.

NR=None Reported

Residuals Beyond the Scope of the Consent Decree

Wastestream	Facility	RIN/ RCRA Code	Volume (Mt/yr)	Management
Debris containing refractory bricks and concrete	Elementis Chromium, LP	RIN2/ D007	31.8	Stored onsite in a closed roll-off box, then sent to an offsite Subtitle C facility for stabilization and final disposal in a Subtitle C landfill
Insulation Debris	Elementis Chromium, LP	RIN3/ D007	0.1	Stored onsite in a closed roll-off box, then sent to an offsite Subtitle C facility for encapsulation and final disposal in a Subtitle C landfill
Non-Hazardous Debris (PVC pipe used for carrying treated ore residue and non-hazardous lab waste) ⁶⁶	Elementis Chromium, LP	RIN4/ NR	48	Stored onsite in a closed roll-off box, then sent to an offsite Subtitle C facility for final disposal in a Subtitle C landfill
Debris—Empty Bags not contaminated with chromium and unused ⁶⁷	Elementis Chromium, LP	RIN5/ NR	4.2	Stored onsite in a closed roll-off box, then sent to an offsite Subtitle C facility for final disposal in a Subtitle C landfill

⁶⁶ May 23, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

⁶⁷ May 23, 2000 Phone Log, Ashley L. Allen (EPA) and Robbin Jackson (Elementis Chromium, LP)

Wastestream	Facility	RIN/ RCRA Code	Volume (Mt/yr)	Management
Chrome Contaminated Brick	Occidental Chemical, Corp.	RIN5/ D007	270	Stored in a closed roll-off box for less than 90 days onsite then sent to offsite Subtitle C landfill for final disposal
Paint Waste—waste paint, solvents, used rags and used rollers	Occidental Chemical, Corp.	RIN7/ D007, F003, F005	0.77	Stored in a closed 55 gallon drum for less than 90 days onsite then sent to offsite Subtitle C incinerator for final disposal

NR=None Reported

APPENDIX B

Occidental Chemical Corporation TCLP Analyses (Weekly Composite and Grab Samples) 1/1/98-12/31/98

Appendix C

Human Health Benchmarks and Ambient Water Quality Criteria Screening Levels

Human Health Benchmarks and Ambient Water Quality Criteria (AWQC) Screening Levels⁶⁸

Substance	Health Based Limit: Drinking Water Ingestion (mg/L)	AWQC: CCC-Fresh Water (mg/L)	AWQC: Human Health (mg/L)
Aluminum	16	0.087	NA
Antimony	0.0063	NA	0.014
Arsenic	0.00074	0.15	0.000018
Barium	1.1	NA	1
Beryllium	0.031	NA	NA
Boron	1.4	NA	NA
Cadmium	0.0078	0.0022	NA
Chromium (VI)	0.047	0.011	NA
Chromium (III)	23	0.74	NA
Cobalt	0.94	NA	NA
Copper	NA	0.0090	1.3
Iron	5	1	0.3
Lead	NA	0.0025	NA
Manganese	0.73	NA	0.05
Mercury (II)	0.0047	0.00077	0.000050
Nickel	0.31	0.052	0.61
Selenium	0.078	0.0050	0.17
Silver	0.078	0.0034	NA
Thallium	0.0013	NA	0.0017
Vanadium	0.14	NA	NA
Zinc	4.7	0.12	9.1

⁶⁸ See the risk assessment background document for today's proposal, Risk Assessment for the Listing Determinations for Inorganic Chemical Manufacturing Wastes (August 2000)