



Centro Nacional de Tecnologias Limpas SENAI - CNTL

## PHASE 02 - ENVIRONMENTAL AUDITING REPORT

### CELULOSA ARAUCO Y CONSTITUCIÓN S.A VALDIVIA MILL, CHILE

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- CNTL SENAI -

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Centro Nacional de Tecnologías Limpas SENAI - CNTL

## Part I

### An evaluation of the legislated parameters issued by CONAMA – Chile to Valdivia Mill wastewaters



In this chapter, the auditing team will evaluate each one of the specified wastewater control parameters. The purpose is to compare them with other legislation in the world, and to comment about them. CONAMA Chile has been very effective on proposing limits for the water effluents discharged by the CELCO Valdivia Mill (VM). The objective of this report step is to check if they are being strict or not in order to fulfil the aim they are required to.

#### Items legislated by CONAMA to Valdivia Mill effluents and their limits

It is important to recognize that legislation must be efficacious and efficient to propose limits for controlling the wastewater quality. It is also important that these limits do not discourage the controlled mill. A good control is the one that provides motivation for continuous improvements in the controlled industrial unit.

The controlled unit must feel oriented for continuous improvements and to search environmental sustainability. In opposition, very strict limiting measures sometimes are not effective, because the controlled organization feels like having a “gum pointed to its head” and do not feel encouraged to work for further improvements, as a result of its own environmental awareness. The great wisdom in this process is to understand the main environmental components involved in the entity being controlled, and to establish the control indicators and limits to guarantee an efficient control to minimize its impacts. It is important not to have some limits too much strict and others too much easy or loose.

For pulp mills, as the case of the Valdivia Mill, the majority of the worldwide legislation is comparable in the basis of discharges of contaminants by air-dry ton of finished product. The pollutants are transformed in this unit, considering the authorized flow of effluents, the authorized concentrations and the daily pulp production. The result is expressed as kg/adt. Air dry ton is a unit measure of weight, resulting from the correction of the actual weight of the pulp to 10% moisture content (90% dryness). This correction is needed because pulp is a hydrophilic material and it holds moisture in different levels. A correction is needed to standardize weights for sales and to compare productions. The comparison of pollutants in terms of charges per air-dry ton gives a very good reference to evaluate one mill to another one, or a legislation to another. Anyhow, as far the effluent flows, concentrations and authorized productions are combined; it is very simple to calculate the pollution charges in kg/adt. Once more, the legislator is advised not to blend parameters very strict, with others not so much. This gives a result that the controlled organization may utilize compensation procedures. It is the case when high effluent flows are authorized, but very strict limits are imposed to contaminant concentrations and final effluent temperature. The mill personnel, as a consequence, do not feel motivated to close the water cycle and to reduce water consumption. In some cases, this is the situation for some parameters in Valdivia Mill (VM), as it will be presented later in this report. On the other hand, when a mill production is controlled by the legislator below the designed capacity, some of the equipment will be running below their optimum speed. The possibility is that they may not operate as well as in the designed capacity, and the result may be deleterious to the environment. One of the items that suffer this influence is the water consumption by the pulp mill. In general, in a pulp mill, the sealing and refrigeration water flows are independent of operational production. They exist independent of the running speed of the machines and production levels. Today, the Valdivia Mill is operating below designed capacity, having an authorization to manufacture 440,000 adt/year. The CONAMA Resolution 279/98 gives reference to a production of 550,000 adt/year. The comments in this section are taking into account these differences. It was

understood that CELCO is willing to come back to the reference production, and this will be allowed under new legislation/resolutions scope.

Several indicators and concentration limits will be commented in this report. Comparisons and comments will be made related to Valdivia Mill. In the item “Virtual Literature References”, some links are provided where some important referred data may be accessed.

**Limits for Valdivia Mill treated effluents**

(CONAMA EXENTA RESOLUTION N°279/98 in 30/OCTOBER/1998)

[http://www.e-seia.cl/externos/admin\\_seia\\_web/archivos/25\\_19981030\\_RE.doc](http://www.e-seia.cl/externos/admin_seia_web/archivos/25_19981030_RE.doc)

| Parameter                     | mg/L    |
|-------------------------------|---------|
| COD                           | 313     |
| BOD <sub>5</sub>              | 50      |
| AOX                           | 7.6     |
| ClO <sub>3</sub> <sup>-</sup> | 17      |
| Suspended Solids              | 50      |
| Total Nitrogen                | 4.2     |
| Total Phosphorous             | 0.33    |
| Color                         | 367     |
| Fatty Acids                   | 0.27    |
| Resinic Acids                 | 0.033   |
| Chlorophenols                 | 0.067   |
| Arsenic                       | 0.001   |
| Cadmium                       | 0.01    |
| Copper                        | 0.07    |
| Chromium                      | 0.05    |
| Iron                          | 1.3     |
| Mercury                       | 0.005   |
| Molybdenum                    | 0.05    |
| Nickel                        | 0.06    |
| Lead                          | 0.03    |
| Zinc                          | 1.0     |
| Temperature, °C               | ≤ 30 °C |

**Limits for Valdivia Mill treated effluents (considering pulp mill production of 550,000 adt/year)**

CONAMA EXENTA RESOLUTIONS N° 377 in 06/JUNE/2005, N° 461 in 22/JULY/2005 and N° 513 in 11/AUGUST/2005

Limiting values will be based both in concentrations and total allowances/permits for daily discharges.

Condensed text in the following URL address:

[http://www.conama.cl/portal/1255/articles-33573\\_textorefundidoRCA.pdf](http://www.conama.cl/portal/1255/articles-33573_textorefundidoRCA.pdf)

**Volumes of effluents allowed to be discharged by Valdivia Mill in Rio Cruces:**

- Total flows are allowed to a maximum of 1,150 liters/second, what corresponds to a daily flow of 99,360 m<sup>3</sup>/day. For the today's production of 440,000 adt/year, the specific flows are very high for the different product runs the mill manufactures: 65 m<sup>3</sup>/adt for eucalyptus e 73.6 m<sup>3</sup>/adt for pine. For 550,000 adt/day, these specific flows will be reduced to 52 m<sup>3</sup>/adt e 58.9 m<sup>3</sup>/adt, respectively to eucalyptus and e pine. Valdivia mill is consuming 60% of the authorized daily flow, what is a clear demonstration that the authorized hydric effluent flow is excessive and inappropriate.
- Under the new resolutions the mill will be allowed again to manufacture 550,000 adt/year of market pulp. The daily average flow under consideration will be 60,000 m<sup>3</sup>/day. Although the legislated limit remains 1,150 m<sup>3</sup>/sec, the reference flow for CONAMA will be 60,000 m<sup>3</sup>/day.

☞ **Comments about the limits legislated by CONAMA (as a function of the concentrations and daily discharges according to the resolutions 279, 377, 461, and 513)**

Comparisons for some of the legislated parameters are based on the kg/adt unit, as mentioned earlier. This is the most common unit to compare values in a world basis, for BOD<sub>5</sub>, COD, TSS, Color, and AOX. Others, such as metal ions, are based on concentrations or maximum discharged released per working day, as it is the Chile CONAMA case.

For the Valdivia Mill, we have typically two situations:

- The today's limits for some of the legislated parameters, all in ppm (mg/L), when converted to kg/adt, become somewhat poorly restricted as a function of the high effluent flow allowed to the mill.
- The new restrictions for daily discharges, very strict for some parameters in the new Resolutions (377, 461 e 513), were considered, in some extent, somewhat exaggerated in some cases. This will be later discussed.

## **1. Final treated effluent flows and water consumption by Valdivia Mill**

The new pulp mills in the world, using the “best available technologies”, are being allowed to discharge something in between 20 to 50 m<sup>3</sup> of effluent per air dry ton of manufactured product. Those located in “fragile environment” or using water bodies already close to their pollution limits, they are authorized to use less water and to discharge less effluent (20 to 35 m<sup>3</sup>/adt). Those in less polluted environment and having voluminous water bodies, they receive authorization for higher water flows (40 to 50 m<sup>3</sup>/adt). These authorizations are understood for average days of operation, since in abnormal conditions, with shorter productions, the flows in m<sup>3</sup>/adt may exceed these figures. However, in these cases, there is also a total effluent flow that is legislated per operating day (m<sup>3</sup>/day), no matter the pulp production level. .

Considering the authorized flows to Valdivia Mill, the CONAMA limits are less restricted than those found in world-class mills with the same type of technologies. They are 65 to 73.6 m<sup>3</sup>/adt, depending the mill is running eucalyptus or pine. Although this CONAMA generosity in the parameter, the Valdivia mill is running with 40 to 44 m<sup>3</sup>/adt, about 60% of the permitted flow. It is important to mention that in a pulp mill, we always have a water intake that is about 5 to 8% higher than the effluent output. This is due to water evaporation, lost moisture in smokes and fumes, pulp, etc. According to the Valdivia Mill technology, these figures for effluent flows may be easily reduced to about 35 m<sup>3</sup>/adt. In reality, the very much-restricted limits placed to effluent temperature, and other pollutants concentrations (arsenic, cadmium, lead, molybdenum, nickel, nitrogen, chromium, aluminum, and chlorate), they are an incentive to the mill not to reduce water consumption. For this reason, we believe that a better balance should be adopted in terms of water permission, and effluent concentrations. Some flexibility, under an optimized environmental performance target, would be welcome. The final result surely will be better to the environment and to the system eco-efficiency.

The new CONAMA Resolutions are suggesting reference values close to 60,000 m<sup>3</sup>/day, what gives specific flows of 31.4 m<sup>3</sup>/adt (eucalyptus) and 35.5 m<sup>3</sup>/adt (pine). Although not treated as a limit, but as reference, these figures are

more realistic with the international effluent flows allowed to mills as modern as Valdivia Mill. For this reason, a proposal for limiting the effluent flow in these levels is recommended. They are more compatible in a world basis. However, they should be applicable, having in mind some flexibility in the concentrations of some exaggerated restricted pollutants. We shall not include and measure as process effluent, the water originated by rainfalls (pluvial effluent). As mentioned in our previous report, the water from rain could be designated to the water intake, and becomes part of the water intake to the mill.

## **2. COD**

For COD we have a situation that we could consider interesting. The today legislated limits in kg/adt are not strict at all. This is due to the high effluent flow allowed, and also due to the not so exigent COD concentration in the treated effluent (authorized maximum of 313 mg/L by Resolution 279/98). When these figures are converted to specific charge (kg/adt), the results are not so demanding in relation to other strict international environmental permits. Although comparable to other country's limits, they are in the upper levels.

Valdivia Mill, under the values provided by Resolution 279/98 are in a limiting value of 16.4 kg COD/adt for eucalyptus runs, and 18.3 kg COD/adt for pine.

In most of the countries having strict environmental legislation, the permits for this parameter are in the range 10 a 25 kg COD/adt. Depending on the fragility of the environment where effluents are discharged, such as the Aracruz Guaiba mill in Brazil, the limits are further below this range. The mentioned Aracruz mill has a limit of 5.1 kg COD/adt, but it has no problems to fulfil because its tertiary level wastewater treatment plant. Aracruz mill in Guaiba has an authorized maximum flow of 35 m<sup>3</sup> effluent/adt and a maximum concentration of COD corresponding to 145 mg/L.

The new standards to Valdivia mill in the three new CONAMA Resolutions are: 13.5 tons of COD/day (daily maximum), but semester average of 8.3 ton COD/day. It is obvious that the mill needs to work based on the maximum value for semester average (8.3 ton COD/day). Based on the new authorized production of 550,000 adt/year, the specific COD charges will be a maximum average of 4.3 to 4.9 kg COD/adt, according to the wood raw material supply (eucalyptus or pine, respectively). These figures are in the level of the most restricting in the world, for similar type of manufacturing industry. They are only possible to be achieved in mills having tertiary level wastewater with flocculation/clarification. Considering the Valdivia Mill performance till now, the mill has the potential to fulfil this stringent parameter, even being one of the lowest in the world. The consequence

that may happen, as an indirect factor, is that the company may feel obliged to force the tertiary treatment, using more chemicals than it should be demanded, in case the limits could be somewhat more flexible. Today, these limits are being proved to be achievable by Valdivia Mill, and there are no suspects that the mill will not cover them. However, the use of aluminum sulfate may be higher. A suggested measure is the mill start searching for other flocculant and/or polymers, to reduce its dependence on  $Al_2SO_4$ .

### **3. BOD<sub>5</sub>**

For the same reasons mentioned for COD, the limits of BOD<sub>5</sub> (in kg/adt) imposed today to Valdivia Mill are not included in the most stringent in the world. The high authorized effluent flow cannot compensate the low concentration permit for BOD<sub>5</sub> (50 mg/L). The resulting specific charges are 2.63 kg BOD<sub>5</sub>/adt for eucalyptus runs and 2.95 kgBOD<sub>5</sub>/adt for pine.

The most stringent permits in a world basis are in the range 1.2 to 3.0 kg/adt.

However, the new restrictions released in the new CONAMA resolutions, based on maximum discharges per day, are very strict. They are possible to be achieved only in mills with tertiary level wastewater treatments and/or very sophisticated and efficient secondary level treatments. These limits are in the range: 0.47 to 0.53 kg BOD<sub>5</sub>/adt. They will be for sure one of the most stringent in the world. Even so hard and difficult, Valdivia Mill will be able to fulfil them, thanks to the available technology, and operational capability.

### **4. AOX**

For AOX, both the maximum concentration level (7.6 mg/L), and the authorized effluent flow lead to a high specific charge maximum permit for AOX: 0.40 kg AOX/adt for eucalyptus and 0.45 kg/adt for pine.

International legislation is limiting AOX in values ranging from 0.1 to 0.2 kg/adt

The new values extracted from the three new CONAMA Resolutions are stricter, and in accordance to today's trends: between 0.08 and 0.09 kg AOX/adt. They are possible to be achieved by Valdivia Mill, even being so low for an ECF bleaching sequence.

## **5. True color**

The specifications and limits for color are very strict today. The stringent color concentration (367 mg/L) leads to specific color charges of 19.3 kg Color/adt for eucalyptus and 21.6 kg/adt for pine.

The international strict legislation is placing true color limits in the range from 8 to 45 kg/adt.

The new CONAMA Resolutions are placing the color limits among the lowest in the world for specific charges: 4.2 kg Color/adt for eucalyptus and 4.7 kg/adt for pine. This situation may not be completely desirable. The quest for low color levels may bring to an exaggeration in the tertiary treatment. The controlled company has to pay attention not to overcharge chemicals in the wastewater treatment. This aspect is suggested to be taken into account by CONAMA. A very strict color limit could eventually bring some side effects: high aluminum sulfate and polymer charges, etc. Valdivia mill has the capability to fulfil the new limits, however, CONAMA is advised to pay attention to the best eco-efficiency and not only to the minimum color limits.

It should be reminded that when someone talk about color legislation, some different approaches might be found. Some legislators demand that the receiving water body should not change its color. Other legislators are sensitive to apparent color, or the color measured with the suspended solids present in the effluent. Others, such as CONAMA, are legislating the true color, what means the measured color of the liquid without the influence or interference of the suspended solids. In the case of Valdivia Mill, the new values will be one of the lowest being practiced in a pulp mill. Recently, the mill has added a final filter to remove suspended micro-flocs from the effluent. For this reason, the final Valdivia Mill effluent apparent color is very close to the true color.

## **6. Total suspended Solids (TSS)**

Despite the high-authorized flows for effluents, today's exigencies of CONAMA are already very strict. These demands to CELCO Valdivia Mill are being fulfilled thanks to a sophisticated wastewater treatment plant, with a performant tertiary treatment, followed by a disc filter for solids removal. The international exigencies for suspended solids are getting stricter due to the accumulation of these solids as sediments in the rivers and lakes. In some cases, the mills have to add a polishing lagoon, disc filters or sand filters to get approval for they performance. In the case of Valdivia Mill, the WTP (wastewater treatment plant) capability was upgraded with the addition of a new filtration system after the tertiary treatment. This means that the wastewater treatment plant is now working

with a quaternary stage of filtration. The most strict international legislation place limits for TSS in the range: 1.5 to 8.5 kg/adt. Today's values for TSS in Valdivia Mill are 2.63 and 2.95 kg TSS/adt, for eucalyptus and pine respectively. The new restrictions coming from the three new CONAMA Resolutions are reducing these levels even further: 1.30 kg TSS/adt (eucalyptus) and 1.48 kg SST/adt (pine). These levels will be among the lowest in the world for similar bleached kraft market pulp mills. Valdivia mill has the capability to fulfil these new maximum limit levels, thanks to the technologies and operating qualifications.

### **7. Total Nitrogen (maximum 0.12 ton/day Total Nitrogen, equivalent to 0.06 a 0.07 kg/adt)**

Total Nitrogen legislations to fragile ecosystems, as the Cruces River wetland, are in the range 2 to 10 mg/L. The new exigencies from CONAMA are in accordance to these figures. However, this is being one of the legislated parameters that Valdivia Mill is having more difficulties to fulfil. Part is because the exigencies placed to the biological activated sludge, to reduce COD and BOD<sub>5</sub>. The optimization of the wastewater plant is under investigation, but nitrogen is an essential nutrient to the microorganisms. Since they are being promoted to grow, more nitrogen is demanded in the secondary treatment. The utilization of an artificial wetland, after the wastewater treatment plant could solve this residual nitrogen problem. Valdivia mill has plans to add an experimental artificial wetland for evaluating some parameters, being this one of them. Since this is an important parameter, and some weakness is being noticed in the capability of Valdivia Mill to fulfill it, our suggestion is that more attention should be placed in developing a limit more compatible to other similar mills in the world. For example, the limit for Aracruz Guaiba mill in Brazil is 9 mg/L.

### **8. Total Phosphorous (0.33 mg/L, maximum 0.03 ton/day)**

Today's and future exigencies from CONAMA are compatible to the most stringent legislation in an international overview. Valdivia Mill is able to fulfil these limits.

### **9. Fatty Acids (0.27 mg/L)**

This parameter is seldom used for controlling pollution in pulp mills. Sometimes, it is given as a reference, but not imposed as a limit for issuing an environmental permit. Since Valdivia Mill is fulfilling it, it is important to keep an

eye on it, monitoring its behavior and establishing targets for continuous improvements.

#### **10. Resinic Acids (0.033 mg/L)**

This parameter is not regularly used as a legislated limit in worldwide pulp mills. It is important to monitor it and to set targets for continuous improvements.

#### **11. Chlorophenols (0.067 mg/L)**

Some legislators include chlorophenols and trihalomethanes together, with limits in the range 1 to 2 mg/L. The most stringent legislation for chlorophenols is in the range 0.1 to 0.4 mg/L. Sometimes, there is an important division of the chlorophenols: mono, di, tri, tetra and penta chlorophenols. The pentachlorophenol is the one considered more toxic. The limit in international environmental laws varies in each case: (trichlorophenols are maximum 0.35 mg/L and pentachlorophenol maximum 0.05 mg/L). CONAMA is today issuing a limit placing all chlorophenols together, but this limit is sufficiently strict. The most desirable should be evaluating the different components of the chlorophenols. This would enable CONAMA to better understand this pollution contribution, and to eventually reset the permitting limit.

#### **12. Arsenic (0.001 mg/L)**

The today's limit is very much strict, even difficult to be justified. The best quality rivers, from where water is almost drinkable, the limit imposed by international legislators are 0.1 mg/L. The American EPA has a limit for drinking water for humans in the range 0.010 a 0.050 mg/L.

#### **13. Cadmium (0.01 mg/L)**

This value is very much strict. Good quality rivers, with potential to be used as watery/swimming place or to supply drinking water for humans with minimum treatment are accepted to contain maximum of 0.2 mg Cadmium/L. The American EPA has a limit of 0.005 mg/L for drinking water.

#### **14. Copper (0.07 mg/L)**

For drinking water, the EPA limit in USA is 1.3 mg/L, and to watery-place rivers, the limit is from 1 to 1.5 mg/L.

#### **15. Chromium (0.05 mg/L)**

This value, placed as limit by CONAMA, corresponds to the half of the limit for drinking water in USA, according to the American EPA (0.1 mg/L).

#### **16. Iron (1.3 mg/L)**

Nature is rich on iron and iron compounds, as iron oxides. Iron is abundant in soils and in waters. The iron exigencies from CONAMA should be comparable to the iron content in the receiving water, or in the water of the Cruces River, prior to the water intake in the mill. Also, the utilization of aluminum sulfate with some iron may eventually be a source of iron to the effluent. There are several measurements in the monitoring system established to evaluate the Valdivia Mill ecosystem impacts where the iron content of the Cruces River is being shown to be higher than the limit placed to Valdivia Mill. There are several cases in the international legislation for excellent quality rivers and for drinking water, where the limits are not so stringent as those placed in the CONAMA Resolutions. The iron limits for drinking water in USA is about 0.3 mg/L.

#### **17. Mercury (0.005 mg/L)**

This limit is compatible to other international legislations, oriented to fragile and sensitive ecosystems as the Cruces River.

#### **18. Molybdenum (0.05 mg/L)**

This parameter very seldom is referred as a limit for this type of industry. In a world basis, it is not placed as a controlled parameter. In the proposed limiting concentration, it would have the ability to act as a micronutrient to the aquatic flora.

#### **19. Nickel (0.06 mg/L)**

This limit is very stringent. There are many references in the world legislation in which the limit for good quality rivers is 2 mg/L.

#### **20. Lead (0.03 mg/L)**

The limits issued by the American EPA for drinking water are a maximum of 0.015 mg/L. For high quality rivers, used as watery-places for swimming, the

American limits are 0.5 mg/L. Thus, the restrictions from CONAMA are also very stringent.

### **21. Zinc (1.0 mg/L)**

CONAMA limits are compatible with other world legislations.

### **22. Temperature (lower or equal to 30°C)**

The limit for temperature seems to be low in relation to other world strict legislations. There are cases where this limit may reach values over 60°C. To define the limit for temperature, it should be considered the river temperature and the temperature in the mixing zone. In the case of Cruces River, its temperature is low along the year. In general, many legislators assume that in the mixing zone, the river temperature should not raise more than 3 to 5°C. The use of appropriate diffusers takes this role, dispersing the effluent and helping to keep low the gap between blended effluent and river temperatures. River flow and river turbulence are also factors to influence the temperature equalization in the river. It should be important to monitor the Cruces River temperature in the effluent mixing zone, and below this point to check the possibility to have some flexibility in this control parameter. It was mentioned before, that a low temperature limit does not motivate the controlled company to reduce the water consumption, and to close the water cycle in its operations.

### **23. Aluminum (maximum 60 kg/day in the semester average)**

Nature is also rich in aluminum. Also rich in aluminum are the soils and the natural waters. The new restrictions for aluminum are to limit the concentration in aluminum at a maximum of 1 mg/L. This limit is very low to a mill using aluminum sulfate in the tertiary treatment. Since part of the aluminum is present in the micro-flocs accompanying the effluent, the utilization of the filters to remove a great amount of them is to help to reduce aluminum levels to a good quality level. Even so, the Valdivia Mill is searching other type of flocculant, with reduced aluminum content. The American EPA limits the aluminum content in drinking water in the range 0.05 to 0.2 mg/L. In Brazil, the limit for aluminum in drinking water is 0.2 mg/L. Once more, this auditing team is reinforcing that the legislation, to be feasible, should balance the control limits to avoid an excessive control in some parameters. The very strict limits in one or another parameter may cause an uneven balance and a disequilibrium in the mill being controlled.

#### **24. Chlorate (today limit equal to 17 mg/L; future maximum load of 100 kg/day)**

This type of contaminant is not very often legislated. However, due to the increased utilization of ECF bleaching sequences in a worldwide basis, the chlorates are becoming a controlled parameter by the legislators. In general, the suggested maximum concentrations are in a range from 10 to 20 mg/L. It is well known that microorganisms, mainly those living in anaerobic conditions, decompose the chlorate ion. In an aerobic activated sludge treatment, the anoxic phase is able to destroy a great percentage of the chlorate ions. There are studies showing reductions of 90 to 100% of the chlorate ion, as far as the biological treatment is appropriate. There are suggestions in the world to use anaerobic treatment only oriented to the effluents coming from the bleaching line. When biological treatments are not available, there is a chance to destroy chlorates using a chemical reaction with the addition of SO<sub>2</sub>. The chlorate ion may be converted to chlorite or hypochlorite ions, more reactive with organic matter. In summary, there are ways to control chlorates in wastewaters. For this reason, the limitation of chlorates established by CONAMA is acceptable. What seems to be stringent is the limit of 100 kg per day, which corresponds to a concentration of 1.7 mg/L in the treated effluent. As a suggestion, it should be interesting to monitor the efficiency of the Valdivia Mill wastewater treatment plant to reduce the chlorate ions to this level. Since an anoxic phase is available, it should be optimized for this particular issue.

#### **25. Conductivity (4000 μS/cm)**

This is an interesting control parameter to be used in a continuous way, as recommended by CONAMA. The limit is valid and appropriate. It provides good indication of chemical charges and overloads in the wastewater chemical treatment.

#### **26. Chlorides (referenced value of 400 mg/L, maximum 24 ton/day)**

CONAMA limits are compatible to other world international legislation.

#### **27. pH ( from 6 to 8.5)**

CONAMA limits are compatible to other world international legislation.

### **28. Manganese ( 0.3 mg/L)**

This parameter is also a new control to Valdivia Mill. It is being brought by the new three CONAMA Resolutions. Manganese is a common ion in Nature. In some other world legislation, the acceptable limit is 1.0 mg/L. The limit posed to Valdivia Mill is stringent, but the plant seems able to fulfil it.

### **29. Phenols (0.5 mg/L)**

It is also a new parameter to be controlled, but in a first evaluation, the limit seems to be appropriate.

### **30. Sulfates ( total daily load of 50 tons)**

This limit will bring the sulfate concentration in the treated effluent to 0.8 a 0.9 grams/L. Sulfates are related to the emission of odor in anaerobic environments. It was not found references of legislation for similar pulp mills in the world. Unless the receiving river be very anaerobic and with very low oxygen content, sulfates are not considered to be a problem. They may eventually be a problem in the emergency pond, providing release of odor due to anaerobiosis.

### **☞ Other items of water pollution that are being legislated in other countries, but not included in the CONAMA Resolutions to CELCO Valdivia Mill**

- Dissolved oxygen content in the treated effluent (mg/L)
- Chloroform content in the final effluent, and/or in the bleaching line filtrates (mg/L)
- Individualized contents of tri-chlorophenol and penta-chlorophenol in the treated effluents and in the bleaching line filtrates (mg/L)
- Dioxins and furans content (2,3,7,8 TCDD & 2,3,7,8 TCDF) in raw and treated effluents, and also in the pulp mill sludges. In parallel to the evaluation of 2,3,7,8 TCDD & 2,3,7,8 TCDF, the total list of congeners is advisable to be measured, calculating the total toxic equivalent for these important pollutants. Valdivia Mill has presented adequate results on these pollutants, perfectly framed to the international recommendations for them and with valid detection limits, as suggested by USEPA (U.S Environmental Protection Agency).

- Sulfide content (mg/L), due to the high sulfide content in condensates, filtrates and liquors coming from spills
- Acute and chronic ecotoxicity through the utilization of bio-assays with *Daphnia* and/or *Ceriodaphnia* or Microtox.
- Mutagenicity tests using the Ames test and/or the Mutatox.
- Follow up and fulfillment of the recommendations coming from the 2001 Stockholm POP's Convention (recommendations being released on 2004): POP's - Persistent Organic Pollutants - with regard to wastewaters/effluents

**Part II**  
**Specified controls and limits established by CONAMA for the air emissions  
 in the Valdivia Mill**

☞ **Limits for air emissions**

(RESOLUCIÓN EXENTA N°279/98 in 30/OCTOBER/1998)

**Air emissions total allowance/ permit for daily discharges**

| Pollutants                        | Daily Permit<br>(ton/day) |
|-----------------------------------|---------------------------|
| Particulate matter                | 2,24                      |
| Sulfur dioxide (SO <sub>2</sub> ) | 3,04                      |
| Nitrogen Oxide (NO <sub>x</sub> ) | 4,69                      |
| Total Reduced Sulfur (TRS)        | 0,25                      |

☞ **Comments about air emissions at Valdivia Mill**

Odor and particulate matter are not being relevant to Valdivia Mill. The mill performance is being very good in this respect. The daily allowance for the most important items is a way to show to the mill that the individual restrictions cannot

exceed a total permitted load. This is also known as “the bubble concept”. All equipment’s considered to be sources of odor and air emissions are taken together and the sum of the individual contributions cannot exceed this daily limit.

In parallel to this, the environmental air quality is monitored in several locations in the Valdivia Mill surroundings. The concept is very valid and it is working fine and fairly. The allowances are restrictive and stringent. As it happens in all legislation applicable to pulp mills, each source of air emissions is considered individually. The concentration of pollutants is restricted in each one. An important factor is the correction of these concentrations to a pre-specified level of residual oxygen (3%, 8% or 10%). From the authorized concentrations, flows of gases and residual level of oxygen in the stack gases, each source of emissions receive an authorization for a maximum load of pollutants per day. It is also important, as it is done in Chile, to control the total load and concentrations for each one of the pollutants at each of the individual sources. Finally, the values may also be reported in kg of each pollutant per air dry ton of manufactured pulp.

International legislation allows from 50 to 200 kg of TRS for similar mills. This is equivalent to 45 to 150 g TRS/adt. Although the CONAMA limits are not so stringent, the performance of Valdivia Mill is far below these limits, and no odor problems have been mentioned. Equally low are the emissions of particulate matter. In summary, the Valdivia Mill performance in terms of air emissions is excellent.

#### ☞ Examples of restrictions for air pollutants in the international legislation

**Lime kiln (10% O<sub>2</sub>, dry air):** 4 to 8 ppm TRS; 50 to 150 mg/Nm<sup>3</sup> particulate; from 50 to 100 ppm NO<sub>x</sub>; 5 to 10 ppm SO<sub>2</sub>

**Recovery boiler (8% O<sub>2</sub>, dry air):** 2 to 5 ppm TRS; 50 to 120 mg/Nm<sup>3</sup> particulate; 30 to 50 ppm NO<sub>x</sub>; 10 to 100 ppm SO<sub>2</sub>

**Power boiler (3% O<sub>2</sub>, dry air):** 40 to 250 ppm SO<sub>2</sub>; 50 to 150 mg/Nm<sup>3</sup> particulate; 100 to 200 ppm NO<sub>x</sub>

#### ☞ Other air emissions relevant items not being controlled by the CONAMA Resolutions in the Valdivia Mill

- Dioxins and furans in the combustion gases: recovery boiler, lime kiln and power boiler
- VOC’s (Volatile Organic Compounds) in the mill work-place
- Chlorine dioxide gas concentration in the mill work-place
- Follow up and fulfillment of the recommendations coming from the 2001 Stockholm POP’s Convention (recommendations being released

on 2004): POP's - Persistent Organic Pollutants - with regard to air emissions

**Part III**  
**Legislated controlled parameters for solid residues generated, handled and disposed by Valdivia Mill**

The restrictions coming from CONAMA over the generation, handling and disposal of solid residues are very simple and weak. They need improvements as soon as possible because solid residues are generated in huge amounts every single working day by the mill. The main issue we suggest to be adjusted is the concept. We recommend moving from the concept to dispose in landfills to the double concept of controlling in the source, and to recycle what is possible to be recycled. The main modification is on top of the conceptual management. The most modern legislators establish a plan of targets with the mill to reduce the landfilling to a minimum. Recycling and utilization of the residues, when they are safe to be used, is the today's trend. The solid residues are potential to be converted into by-products in the pulp mill. Only hazardous wastes, hospital wastes and other difficult to be recycled wastes would go to special landfills and deposits. And these deposits and landfills are to be clean and organized. There are many pulp mills in the world recovering over 95% of the daily-generated solid residues. In a pulp mill, having and owning forests in its surroundings, the better and viable recommended management for solid organic wastes and ashes is to compost them and to use as a fertilizer or soil corrector in the forests. This is something to be implemented as soon as possible, based in a good evaluation and research project. It is our understanding that Valdivia Mill is implementing a project in this way. The first goal is the reduction in the generation of wastes in the plant, and the next is to compost and to use the compost in the agriculture and forestry. As a suggestion, the following internet link gives access to an state environmental agency (FEPAM/RS/Brazil) allowing Aracruz Guaiba mill to have a composting and recycling facility in Brazil:

<http://eta.fepam.rs.gov.br:81/doclics/173812.pdf>

**Part IV**  
**Valdivia Mill capability to fulfil the restrictions in  
the environmental permits issued by CONAMA**

☞ **Valdivia Mill environmental performance**

CELCO Valdivia Mill has been shown very good efficiency to fulfil the environmental requirements placed by CONAMA. Most of the items have been achieved with very good competence. Even the new stringent standards coming with the recent resolutions are being faced with optimism in the company. However, in case of some parameters, these new limits may cause a disequilibrium and to affect the pulp mill runnability. It is clear that Valdivia Mill has a good operation team, good technological capability and good potential to be one of the world leaders in pulp mills environmental performance. Among the most stringent and difficult to be fulfilled items we may name: arsenic, cadmium, chromium, molybdenum, nickel, iron, chlorate, total nitrogen, aluminum, and lead. The truth in controlling environmental parameters is that an excess in some items has, as reflex, a lack of motivation to reduce water consumption, and to close water cycles. The controlled company may keep more attention in figures and limits and less in to walk towards eco-efficiency and sustainability.

The analysis of the environmental performance of Valdivia Mill, as provided in several tables and in attachment 01, shows that the company is improving and controlling efficiently the legislated items. There is some variability in the data, but this variability part is due to the way of switching from eucalyptus runs to pine ones. Also, in the attached graphs, it is clear that these variabilities have been substantially reduced.

Some graphs are showed to prove these statements. As a comparison for standards, the limits were added for two cases: the RCA Valdivia Mill limits and the limits imposed to Aracruz Guaiba mill in Brazil, one of the leading companies in wastewater treatment and control. This Brazilian mill is renowned because the stringent control parameters appyed to it, and by the environmental performance it has.

It is important to mention that the great improvements that may be seen in the wastewater quality from VM is due not only to the reduced running production by Valdivia Mill, but also due to the new technological upgrades in the mill, and also due to the better care in the operations by the Valdivia Mill team.

Figure 01: COD concentration in final treated and discharged effluent

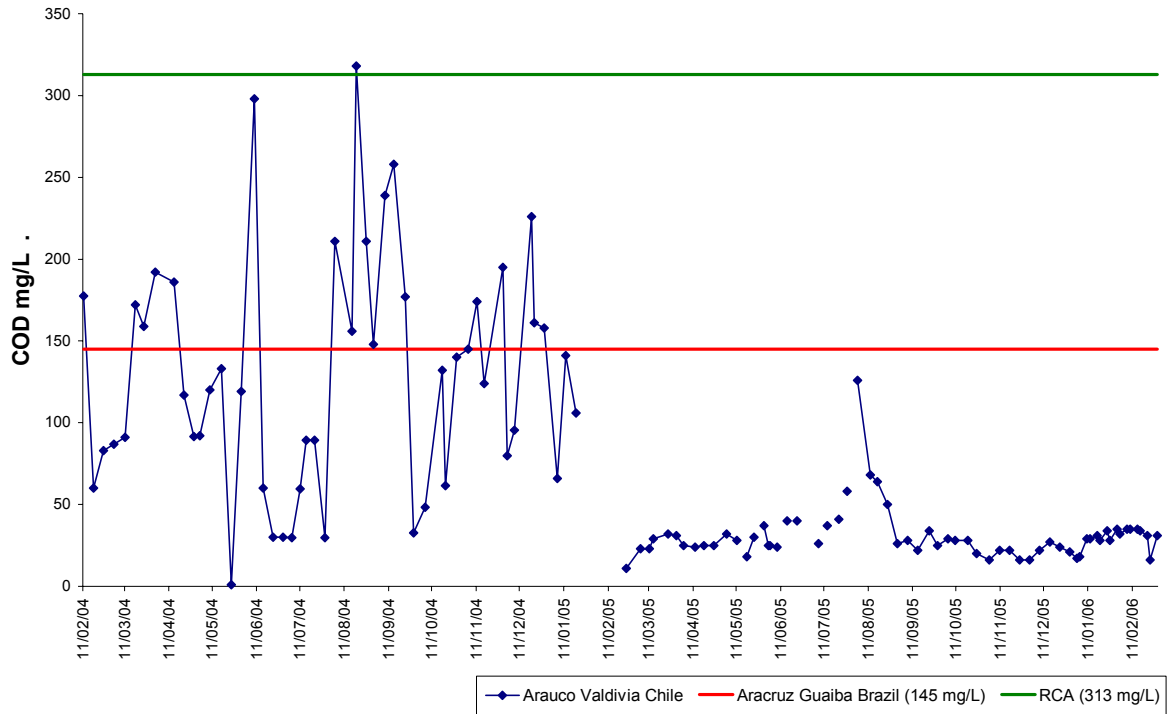


Figure 02: BOD<sub>5</sub> concentration in final treated and discharged effluent

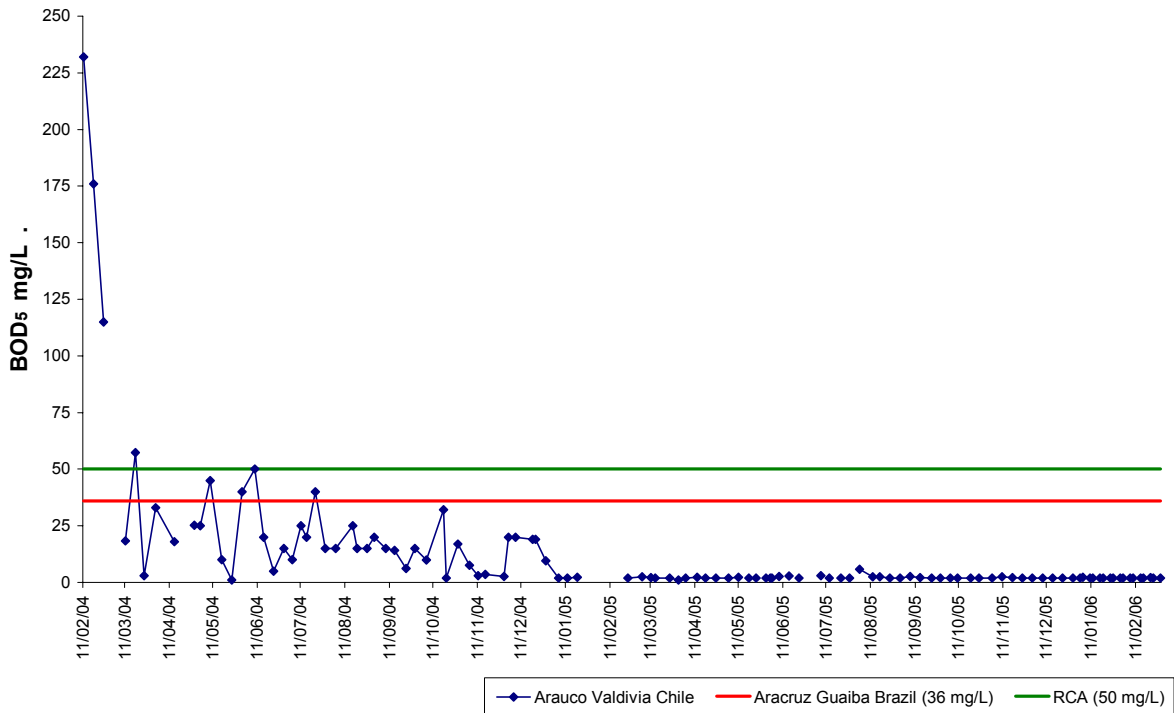


Figure 03: AOX concentration in final treated and discharged effluent

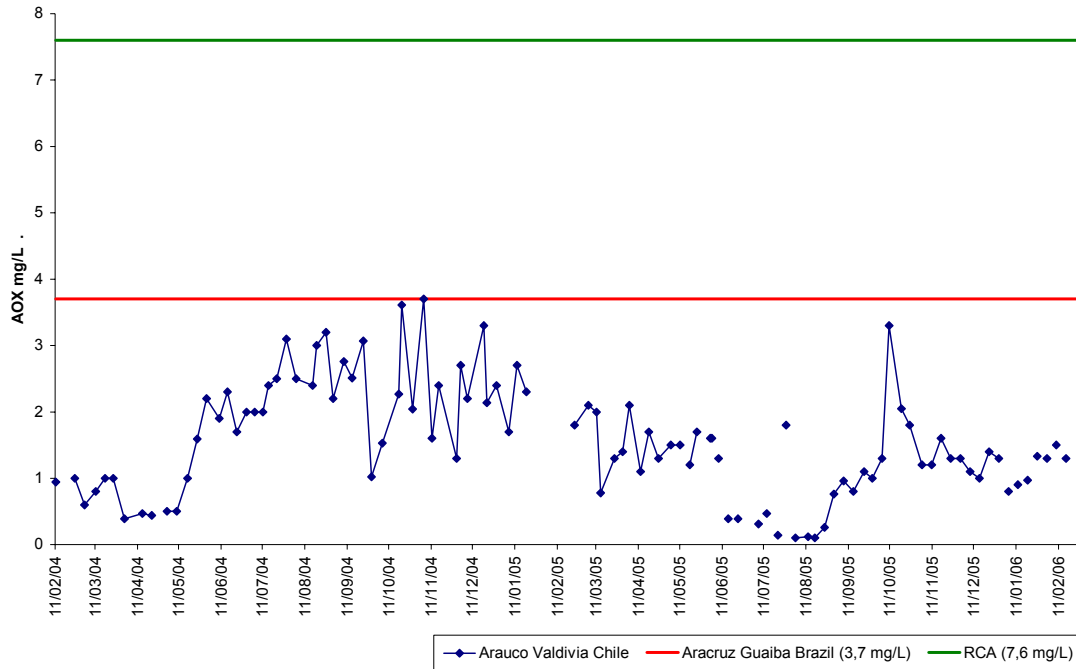


Figure 04: True Color concentration in final treated and discharged effluent

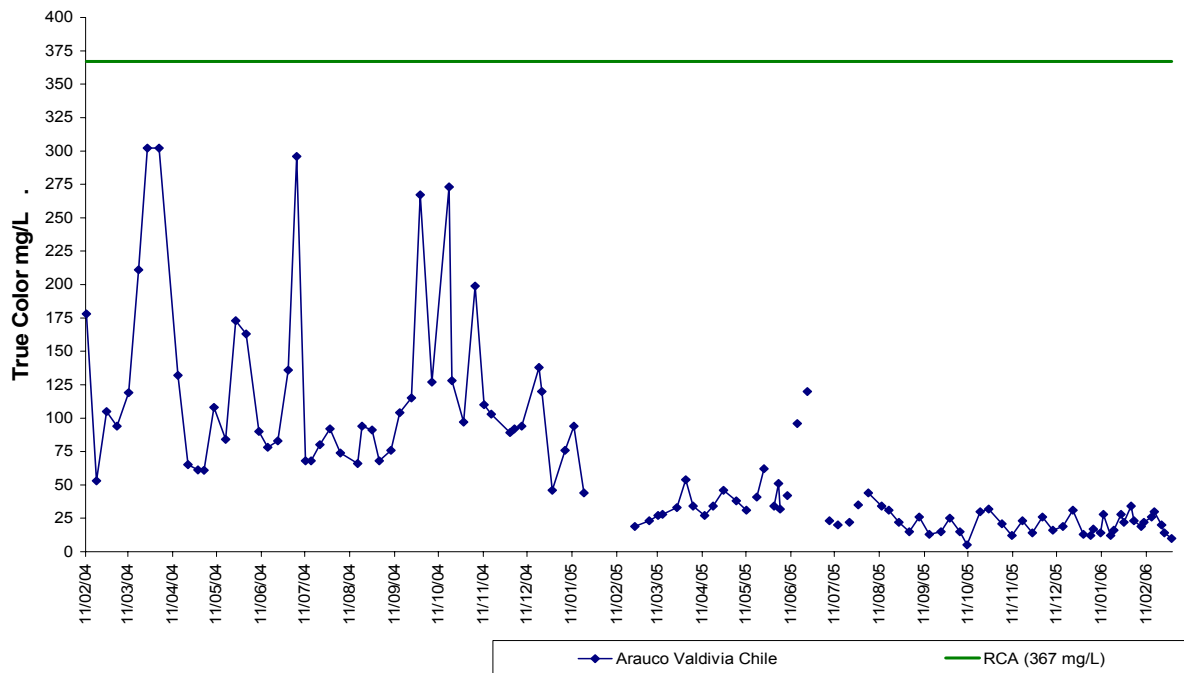


Figure 05: Total Suspended Solids concentration in final treated and discharged effluent

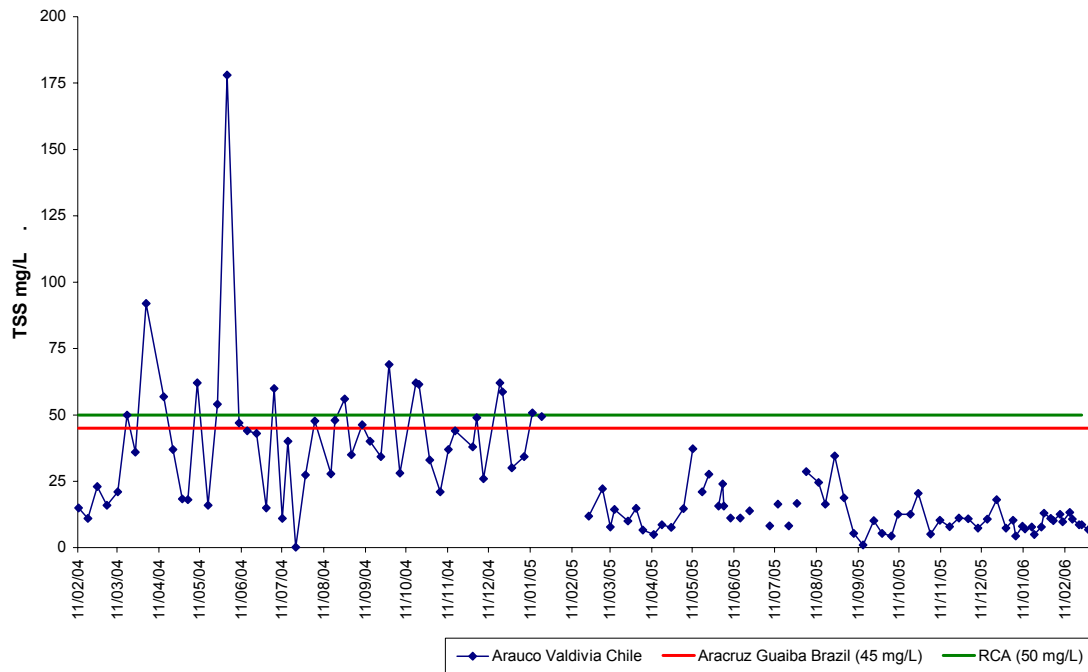


Figure 06: Total Nitrogen concentration in final treated and discharged effluent

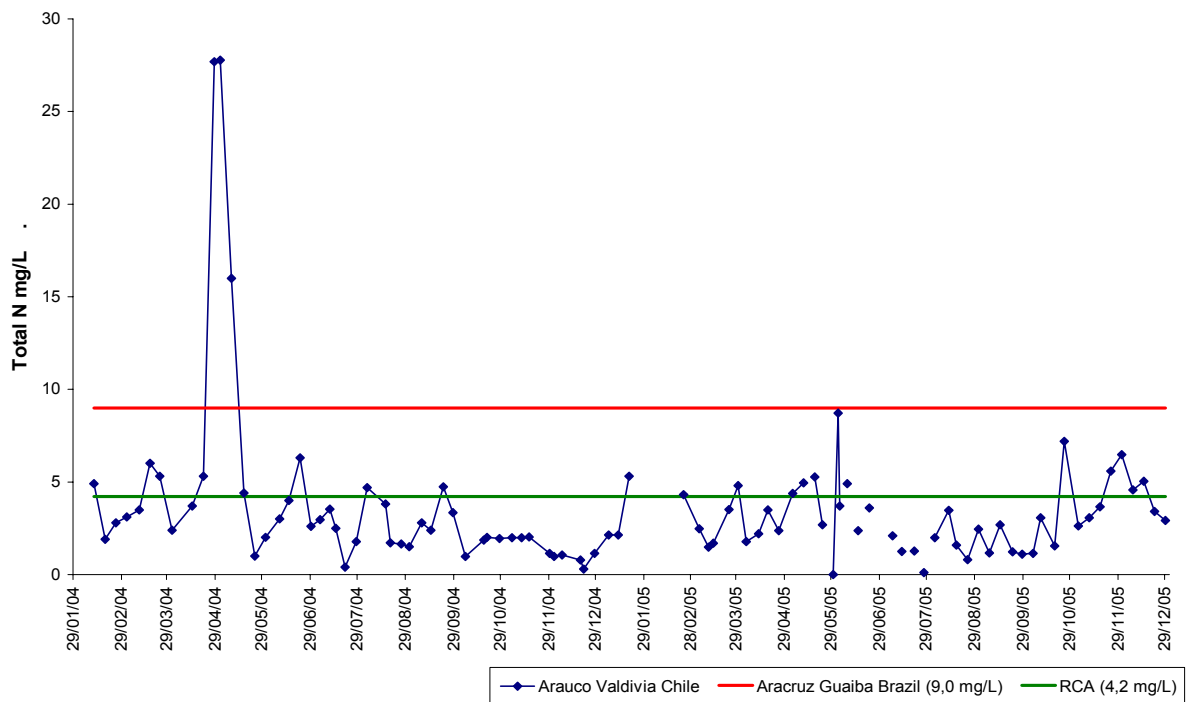


Figure 07: Phosphorous concentration in final treated and discharged effluent

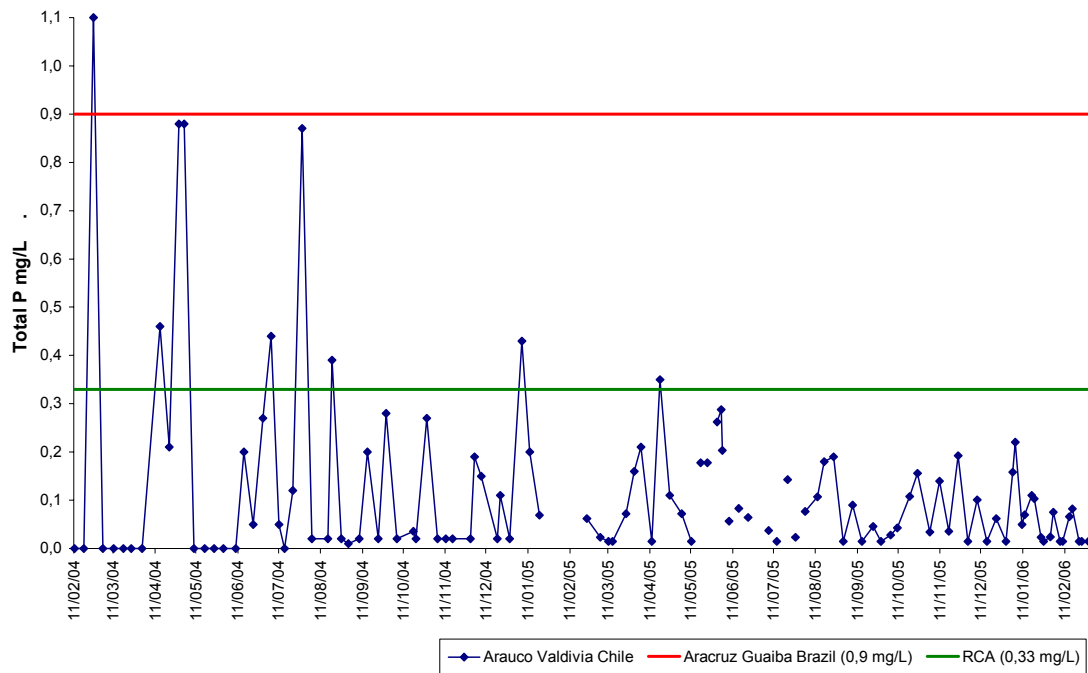
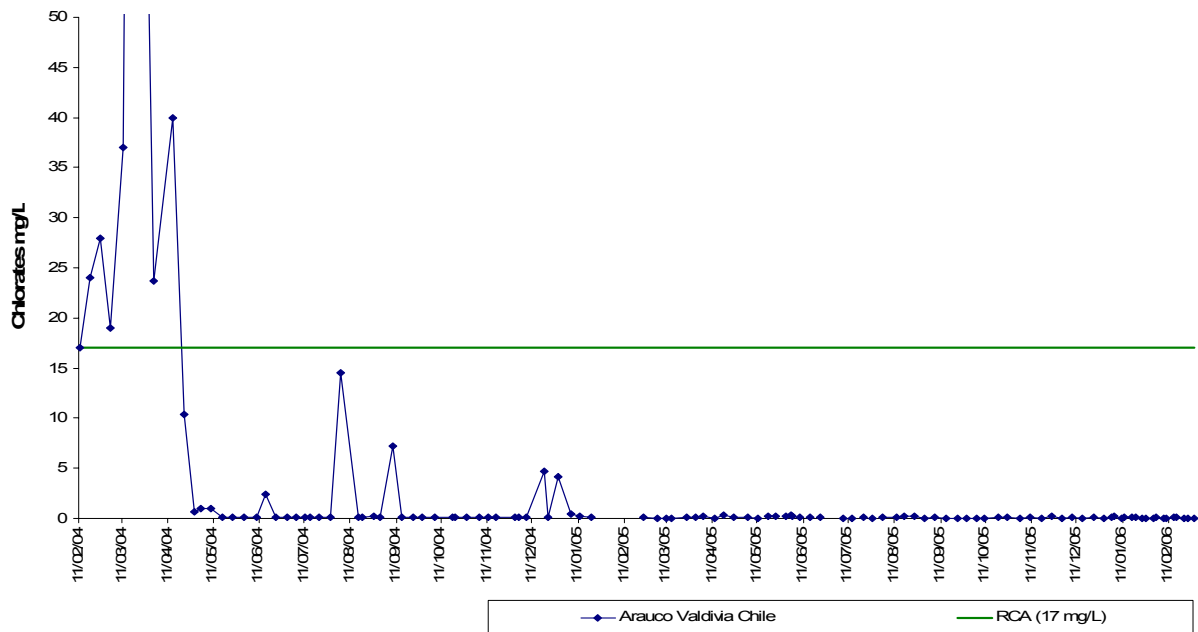


Figure 08: Chlorates concentration in final treated and discharged effluent



## **☞ Comments about the Attachment 01 (requested to be filled and completed by Valdivia Mill) from the phase 01 of this auditing procedure (in Annex)**

CELCO Valdivia Mill filled the requested questionnaire from phase 01 in the due time. This questionnaire with answers and attachments are added as annexes from this auditing report. From the data, it is possible to conclude that Valdivia Mill has an excellent environmental performance, outstanding in some cases. The mill is very efficient and may be referred as one of the most performant in terms of environmental control parameters, in a world basis. Although the well-known problems with the Cruces River and the black neck swam, still not clear in details and origin, the pulp mill, as a bleached kraft pulp mill, has an outstanding environmental performance. It could be operating according to the most stringent legislation for pulp mills in the world. However, it is clear that the Cruces River and its wetland are a fragile ecosystem. Also clear, that even being so outstanding the mill environmental performance, the real impact of the mill in this environment is far from being fully understood. For these reasons, the doubts from the society remain, and more monitoring and evaluations are required. It is also understood that CONAMA is doing well its role as a control agency. The next step is really to establish a very good ecological monitoring plan for Cruces River. Only with this in mind it will be possible to get closer to the full understanding of the impacts and consequences of Valdivia Mill in this sensitive ecosystem.

Further improvements in mill performance may be obtained. The first challenge is to reduce the water consumption and discharge of final effluent. This auditing team is suggestion values for effluents in the range 30 – 35 m<sup>3</sup>/adt, as monthly average. Another improvement is the reduction in environmental data variability. This may be achieved through more personnel training, more automation, and more efficient utilization of the spill recovery system the mill has: tanks, towers, ponds, recycles. Furthermore, the designed capacity of the mill certainly may provide better environmental performance. The better the mill runs close to the designed production, the more efficient it tends to be. Also, the mill is recommended to keep constant production rates, avoiding switching running speeds. A program for variability reduction is recommended. This program may starts by the calibration of analytical methodologies, sampling procedures, calculation of the sustainable equipment performance, etc.

## **☞ Recent technological upgrades in the Valdivia Mill**

The recent additions in the mill technology are really very positive. The result on the mill environmental performance may be seen in the figures 01 to 08. The following upgrades have been considered relevant by the CNTL auditing team:

- reduction in the bleaching line effluent
- improvements in the evaporation line
- reduction on the wood storage
- chlorination / dechlorination of sanitary effluent
- improvements in the environmental control laboratory, in the sampling in several points in the mill, and in the automation of measurements for environmental items.
- neutralization of the demineralization plant effluent
- improvements in the sand filters back-washing
- improvements in some of the spill recovery basins, tanks, and ponds, “but there is room for further improvements”
- modifications in the system to reduce wastewater temperature (cooling equipment also after the tertiary treatment)
- bleaching line Eop filtrate recirculation
- improvements in handling, management and disposal of chemicals
- recovery and incineration of odorous gases from smelt dissolving tank
- construction of a hazardous wastes deposit

Moreover, there are also some good projects under way, that this auditing team encourages the completion as soon as possible:

- experimental wetland in pilot scale (“humedal construido”)
- solid residues management plan, oriented to composting and recycling
- further improvements in the recovery system for spills
- physical chemical and biological monitoring plan and implementation for the Cruces River

**Part V**  
**Suggestions to CELCO Valdivia Mill and CONAMA**

**☞ Suggestions of new items to be evaluated in the medium or long-term by CELCO Valdivia Mill**

This auditing team suggests the evaluation in the next coming semester for the following new items by CELCO Valdivia. Some of these items are legislated in environmental leading countries for pulp mills. For this reason, the CNTL suggests that the values be obtained for comparison reasons. In the phase 03 of this international auditing, it would be interesting to have representative figures about

most of them, except for those demanding long-term follow-up. The purpose is to understand and to know their potential environmental impacts in the ecosystems.

- Dissolved oxygen content in the treated effluent (mg/L)
- Chloroform content in the final treated effluent, and in the bleaching line filtrates (mg/L)
- Individualized contents of tri-chlorophenol and pentachlorophenol in the treated effluent and in the bleaching line filtrates (mg/L)
- Dioxins and furans content in raw and treated effluents, and also in the pulp mill sludges.
- Sulfide content (mg/L)
- Acute and chronic ecotoxicity through the utilization of bio-essays with *Daphnia* and/or *Ceriodaphnia* or Microtox.
- Mutagenicity tests using the Ames test (minimum 4 strands) and/or the Mutatox.
- Follow up and fulfillment of the recommendations coming from the 2001 Stockholm POP's Convention (recommendations being released on 2004): POP's - Persistent Organic Pollutants - with regard to wastewaters/effluents
- Dioxins and furans in the combustion gases: recovery boiler, lime kiln and power boiler
- VOC's (Volatile Organic Compounds) in the mill work-place
- Chlorine dioxide gas concentration in the mill work-place
- Follow up and fulfillment of the recommendations coming from the 2001 Stockholm POP's Convention (recommendations being released on 2004): POP's - Persistent Organic Pollutants - with regard to air emissions
- AOX content in primary, secondary and tertiary sludges
- Evaluation of the chlorinated organics components on the AOX (effluents and sludges) , both for eucalyptus and pine pulp runs
- Evaluation of the quality of the water evaporated in the cooling towers, and that eventually may be an important pollutant in the mill neighborhood due to its discharge to the air: AOX and COD
- Evaluate the impact of composting the organic solid residues: generated effluents, groundwater contamination, possible utilization of the generated biogas, evaluation of the potential methane and CO<sub>2</sub> generation to the air, etc.
- Evaluate the positive and negative points for the addition of the composted solid residues in the forest soils
- Evaluate the model of accumulation of the chlorinated organic compounds in the Cruces River environment (long-term project)

- Calculate, in the format of a mill and operation mass balance (per year), all potential impact of the gases emitted by Valdivia Mill, and that may affect: acid rain, greenhouse effect, and ozone layer.
- Evaluate the utilization of an artificial wetland “under the mill fences” to reduce the environmental impact in the Cruces River wetland (long term project)

#### ☞ **Suggestions to CONAMA for reviewing some of the controlled items limits**

There are several controlled parameters that are being restricted in very stringent levels. Certainly CONAMA knows better than this auditing team the peculiarities of the affected area. The following parameters are suggested to be re-evaluated in terms of maximum limits in the case of Valdivia Mill: arsenic, cadmium, chromium, iron, molybdenum, nickel, total nitrogen, lead, chlorate, aluminum, and final effluent temperature. In some extent, the level of true color could also be analyzed, since the search for very clean and no-colored effluent, may be less eco-efficient, due to the use of excessive chemical dosages in the wastewater treatment plant. For two other parameters, fatty acids and resinic acids, our suggestion is only to monitor them, but not to have as restrictions, unless it becomes required due to poor performance. This is not being the case for Valdivia Mill.

In addition to this flexibilization in concentration of some of the legislated parameters, Valdivia Mill could receive some stricter restrictions on the water consumption and discharged flow of effluents. Our suggestion is to reduce the average effluent flow to the level of 30 – 35 m<sup>3</sup>/adt in a monthly average basis. The water from rainfalls should not be included in this flow, since the mill has no control over this. An additional suggestion, already mentioned, is that Valdivia Mill could evaluate the possibility to redirect the pluvial effluent to the water intake.

#### ☞ **Suggestions for improvements in the monitoring and in the way the Valdivia Mill infringements are being considered**

We suggest:

- Start referring the detection limits in all chemical analysis being performed and expressed in concentrations
- For the analysis of ions (very low concentrations), start to evaluate in parallel two reference samples for double-checking. One could be an

artificially made solution of the chemical being analysed, with the concentration in the limit proposed by CONAMA. Another solution could be artificially made with all chemicals being evaluated altogether, each one in the limit concentration restricted by CONAMA. This last solution could cover and show the interference of one ion in another, during the chemical evaluation of their concentrations. This procedure would enable to evaluate the quality of the analysis being performed. We understand that some of the today's variability on these data could be eventually due to analytical methodologies.

- For each of the major pollutants, CONAMA is suggested to place two limits: one for the day, and other for the monthly or semester average. In some extent, this is being adopted with the new CONAMA resolutions, and it is very important. Since pulp mills have some variabilities in the operation due to production levels, or transition phases during different types of productions, some flexibilities have to be considered. This type of procedure with double limits for each pollutant is very frequent in countries as USA and Canada. It is also important to define how many times the pulp mill may exceed the lower limit, but not the higher. In some legislation, this is allowed no more than 3% of the time. As an example: suppose the lower limit for BOD<sub>5</sub> is 50 mg/L and the upper 65 mg/L. This means that in 100 tested values for BOD<sub>5</sub>, the mill may have three values in the range 50 to 65, but none exceeding 65 mg/L.

## ☐ **Suggestions for monitoring plans**

It is important that Valdivia Mill implements a series of monitoring evaluations in the natural environment and ecosystems in the mill surroundings. We understand that this is being made, but the audit team would like to reinforce this measure.

As a suggestion for monitoring plans we add:

- Physical chemical, biological and ecotoxicological monitoring in the Cruces River and in the Calle Calle River. The second river could be included as a reference (blank) for checking the influence of the discharged effluents from Valdivia Mill in the Cruces River.
- Hydrodynamic modeling for the Cruces River and the wetland. This model would enable to predict the more affected zones by the

wastewater discharges, and to allow elaboration of plans for mitigation.

- Elaboration of regular mass balances for the whole mill taking into account the most important contaminants: COD, BOD<sub>5</sub>, Color, Chlorate, AOX, Aluminum, TRS, SO<sub>2</sub>, NO<sub>x</sub>, particulate, etc.
- Definition of a medium and long-term target plan for each of the contaminant and residues generated by the Valdivia Mill operation.
- Implementation of a clean production concept for the operations.
- Development of contingency plans for abnormal situations internally inside the mill fences, or involving impacts in the surroundings. Abnormal situations are being considered as fires, explosions, spills of hazardous or radioactive wastes, etc.

#### **☞ Suggestions for medium & long-term improvements in the pulp mill technologies**

Market pulp mills are required to be competitive. Part of this competitiveness is obtained through production capacities and operational speeds. The limitation of the production level for Valdivia Mill may be painful to the mill competitiveness. It may even condemn the mill in the long-term. One way to face this problem is to search new environmentally sound technologies to allow the mill to grow with minimum environmental impacts.

For these reasons, CNTL recommends that CELCO Valdivia Mill, with the follow up from CONAMA, searches for new less impacting technologies to grow in the medium and long term. Some of these potential technologies or technical operating procedures are:

- Improvements in the bleaching sequence, by replacing some of the chlorine dioxide charges by oxygen compounds (ozone or hydrogen peroxide) or acids. This would convert the today's classic ECF bleaching sequence in an ECF-light sequence. The increased costs in bleaching chemicals are compensated by reductions in water consumption and bleaching line effluent quality.
- Utilization of a constructed artificial wetland for polishing the treated effluent quality prior to the discharge in the Cruces River.
- Evaluation of the recovery boiler temperature profiles to reduce the emissions of odor and hazardous gases.
- Improvements in the automation of the production process in situations of more potential contamination or spill generation.

- Implementation of a careful study for all operational areas in the Valdivia Mill to define the sustainable capacity for each one, and to discover bottlenecks that are sources of mis-operation and potential impacts to environment.
- Improvements in the today's spill collecting system are required, both in the concept and in the system by itself.

### ☞ **Some proposals to be evaluated till phase 03 of the CNTL international environmental audit in Valdivia Mill**

Phase 03 for this international audit would be recommended to happen till the end of the year 2006, more specifically in November or December 2006. Along the next semester, CONAMA and Valdivia mill could evaluate all of the CNTL suggestions in the report of phases 01 and 02, and data could be obtained by VM for the suggested analysis and requested studies.

Next steps could be as follows:

- New environmental data could be obtained by Valdivia mill
- New monitoring plans and environmental studies could be defined and prepared by Valdivia mill
- CONAMA is suggested to re-evaluate some of the control parameters, mainly those recommended in this report.
- Valdivia mill could evaluate a series of new technological upgrades for its operation to be implemented in the medium and long term with the aim of production capacity increases. Having in mind the sustainability concept, the three columns of the sustainable development have to be privileged: the economic, the environmental and the social. The economic pillar needs that Valdivia Mill be competitive and profitable, but respecting the other two.

In the phase 03 of this CNTL International Audit Procedure, to happen in CELCO Valdivia Mill, our team is to propose new environmental, technological and monitoring measures and procedures to Valdivia Mill. In phase 04, a final report will be written, with recommendations and conclusions from all these auditing phases. Phase 03 will be at Chile, in a new visit of the auditors to Valdivia Mill and CONAMA. Phase 04 will be only a final writing phase, to happen in Brazil, in CNTL office. The final report for all phases will be them completed. It is not budgeted or projected a visit of the auditors to Chile to explain the conclusions and recommendations of phase 02 or phase 04 reports. However, the CNTL team will be available to negotiate this as an extension to these phases.

Apart the technological issues involved, the communications of the conclusions of the auditing procedure are also important. As it happened in phase 01, it is important that the auditing report and conclusions be informed to the interested parties. In case CONAMA may will to discuss the possibility of presenting the audit results in open forums in Chile, the CNTL team will also be available, under an extension of the present services.

## Annexes

### Virtual Literature References

- CONAMA Resolutions - Chile to CELCO Valdivia Mill

[http://www.e-seia.cl/externos/admin\\_seia\\_web/archivos/25\\_19981030\\_RE.doc](http://www.e-seia.cl/externos/admin_seia_web/archivos/25_19981030_RE.doc)

[http://www.conama.cl/portal/1255/articles-33573\\_textorefundidoRCA.pdf](http://www.conama.cl/portal/1255/articles-33573_textorefundidoRCA.pdf)

- United States of America legislation for pulp and paper mills and drinking water

<http://www.epa.gov/waterscience/pulppaper>

<http://www.epa.gov/OGWDW/consumer/2ndstandards.html>

<http://www.epa.gov/OGWDW/standards.html>

<http://www.epa.gov/fedrgstr/EPA-WATER/1998/April/Day-15/w9821.htm>

<http://www.epa.gov/waterscience/pulppaper/frc415.pdf>

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<http://www.epa.gov/international/toxics/pop.htm#stockholm>

- Canadian legislation data

<http://www.ec.gc.ca/nopp/docs/rpt/pper/en/pper.pdf>

<http://lois.justice.gc.ca/en/F-14/SOR-92-269/121652.html>

<http://www.ekono.com/EnvStudyAbstract2004.pdf>

<http://www.canadianenvironmental.com/legislation/item.cfm?RecordID=81&Topic=Legislation%20%26%238211%3B%20Federal>

[http://www.hc-sc.gc.ca/ewh-semt/alt\\_formats/hecs-sesc/pdf/pubs/contaminants/psl1-lsp1](http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/contaminants/psl1-lsp1)

[http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/psl1-lsp1/pulp\\_mill\\_effluents\\_pate\\_blanchie/index\\_e.html](http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/psl1-lsp1/pulp_mill_effluents_pate_blanchie/index_e.html)

- Data about ECF and TCF bleaching sequences

[http://www.aet.org/science\\_of\\_ecf/eco\\_risk/sap97sec3.html](http://www.aet.org/science_of_ecf/eco_risk/sap97sec3.html)

- A comparative study commenting world legislation for pulp and paper mills: Tasmanian Government / Australia

<http://www.pulpmill.tas.gov.au/EmissionGuidelines.htm>

<http://www.pulpmill.tas.gov.au/Vol1.pdf>

<http://www.pulpmill.tas.gov.au/Vol2.pdf>

- Studies and Stockholm World Convention about POPs- Persistent Organic Pollutants

<http://www.pops.int>

[http://www.pops.int/documents/meetings/cop\\_1/meetingdocs/en/default.htm](http://www.pops.int/documents/meetings/cop_1/meetingdocs/en/default.htm)

[http://www.pops.int/documents/meetings/cop\\_1/meetingdocs/en/inf\\_7/INF-7.pdf](http://www.pops.int/documents/meetings/cop_1/meetingdocs/en/inf_7/INF-7.pdf)

[http://www.oztoxics.org/waigani/pops\\_c4.htm](http://www.oztoxics.org/waigani/pops_c4.htm)

[http://www.pops.int/documents/guidance/beg\\_guide.pdf](http://www.pops.int/documents/guidance/beg_guide.pdf)

- Brazilian CONAMA Resolution 357

<http://www.mma.gov.br/conama/res/res05/res35705.pdf>

- Environmental operational permits issued by the Rio Grande do Sul state control agency (FEPAM) to Aracruz – Guaiba, in Brazil

<http://eta.fepam.rs.gov.br:81/doclics/173812.pdf>

<http://eta.fepam.rs.gov.br:81/doclics/188846.pdf>

<http://eta.fepam.rs.gov.br:81/doclics/172283.pdf>

- **Attachment 01 from Environmental Auditing Phase 01, filled by CELCO Valdivia Mill, as requested in the previous audit**

- **Photos and other complementary information to Attachment 01 report/questionnaire**

Documents are provided in electronic format in other files.