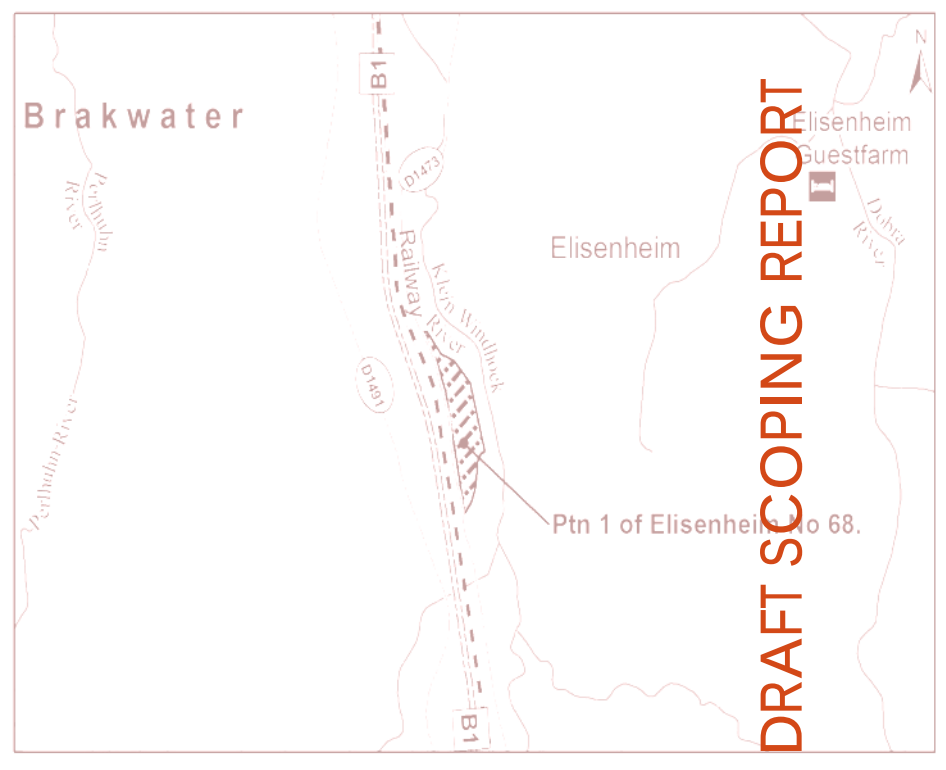
ENVIRONMENTAL ASSESSMENT OF THE PROPOSED TANNERY ESTATE WINDHOEK



DRAFT SCOPING REPORT

ENVIRO DYNAMICS
Environmental Management Consultants

PROJECT NAME	Environmental Assessment of the proposed Tannery Estate on Portion 1 of Elisenheim No 68.
STAGE OF REPORT	Draft Scoping Report
CLIENT	Tannery Estate (Pty) Ltd. Attention: Dirk Mudge
CONSULTANT	Enviro Dynamics cc Enquiries: Stephanie van Zyl Tel: +264 (0) 61 223 336 E-Mail: Stephanie@envirod.com
DATE OF RELEASE	November 2016
AUTHOR MAPPING	Stephanie van Zyl Eddy Kuliwoye

ENVIRONMENTAL ASSESSMENT PRACTITIONER DECLARATION

I hereby declare that I do/will:

(a) Have knowledge of and experience in conducting assessments, including knowledge of the Environmental Management Act (Act 7 of 2007) and the Regulations and Guidelines that have relevance to the proposed activity;

(b) Perform the work relating to the application in an objective manner, even if these results in views and findings that is not favourable to the applicant;

(c) Comply with the abovementioned Act, its Regulations, Guidelines and other applicable laws.

I also declare that there is, to my knowledge, no information in my possession that reasonably has or may have the potential of influencing –

(I) any decision to be taken with respect to the application in terms of the Act and its Regulations; or

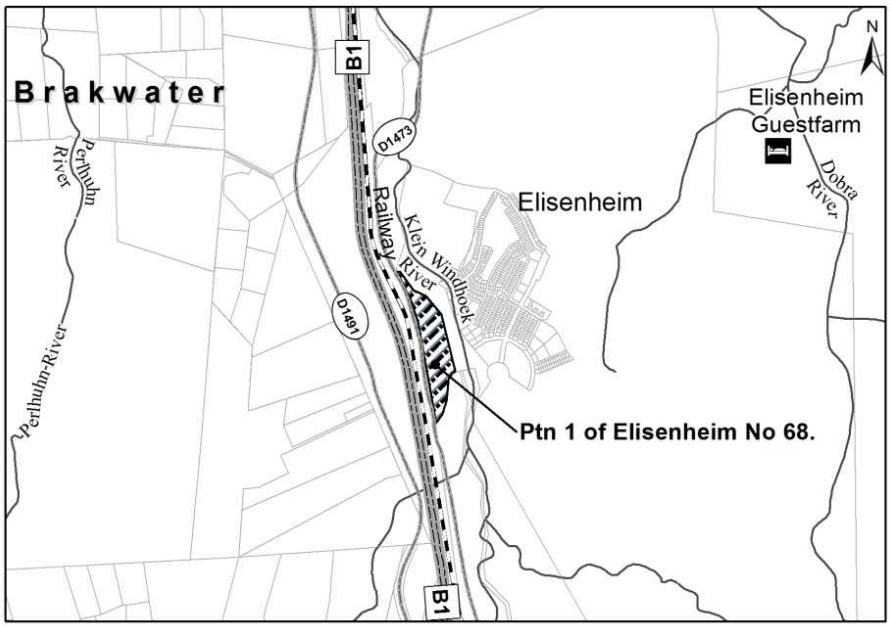
(ii) The objectivity of this report, plan or document prepared in terms of the Act and its Regulations.

Stephanie van Zyl

Environmental Assessment Practitioner

Executive summary

Namibia Tannery (Pty) Ltd intends developing a residential and business estate (Tannery Estate) on Portion 1 of Elisenheim No 68, as shown below. The area is wedged between the Klein Windhoek River and Elisenheim Estate to the east, and the railway line and the B1 highway to the west. Access to the site is via the D1473 which runs parallel to and east of the B1.



Locality of Portion 1 of Elisenheim No 68 - the proposed Tannery Estate site.

An Environmental Assessment is required for the project in terms of the Environmental Management Act (2007) and its regulations (2012).

This is the Scoping Report; the document which contains the results of the study for scrutiny by interested and affected parties and the Department of Environmental Affairs.

Scope of work

The consultant is expected to conduct all the necessary work in order to meet the requirements for obtaining environmental clearance for the project. An environmental scoping study was undertaken, including the following tasks:

- Project description
- Review of legal environmental requirements

- Consultation with interested and affected parties and authorities
- Site visit, tree survey and gathering of available baseline information
- Identification and assessment of potential biophysical and socio-economic impacts
- Environmental Management Plan
- Reporting (this report)
- Submissions to the Department of Environmental Affairs and reception of Environmental Clearance on behalf of the Developer.

Methodology

The vegetation on site, notably the trees were surveyed using hand-held GPS. This was later more accurately surveyed with surveying equipment.

A pollution risk assessment, to determine existing risk caused by historic activities, was undertaken by Geopollution Technologies, using sampling techniques described in the applicable report (Appendix A).

A flood analysis was done by Windhoek Consulting Engineers, using applicable software (Appendix B).

Besides these specific areas of study, secondary information and extensive knowledge of the area was used to compile the baseline study and the impact assessment.

Baseline

Ecologically, the site is situated on the alluvial plains of the Klein Windhoek River, with a mix of protected species, notably Camelthorn and Prosopis. The site is situated outside the 1:50000 year floodline. Shallow sheet flow currently occurs on the site due to a tributary that has formed from a culvert of the B1.

Land use comprises the transport corridors namely the B1 highway, the district road, and the railwayline to the west. Elisenheim's land lies to the west, and north. Municipal land adjoins the site to the south.

Public Consultation

The only direct neighbours include Elisenheim (Trustco), TransNamib and the City of Windhoek. They, together with the Brakwater Residents Association, and applicable authorities, notably applicable divisions of the City of Windhoek were consulted through electronic means. A consultation meetings was held with City of Windhoek officials to discuss water supply, the historical contamination from the old tannery and how this was resolved, and sewage.

Impact Assessment

The positive impacts associated with this development include the addition of a residential and business development that will add to the amenity of Windhoek and particularly the northern areas. It is the upgrade of a neglected area from a pollution and visual quality point of view. The additional housing will assist in reducing the pressure on the inflated housing market and this is positive for the economy.

The following is a summary of the key negative impacts which need to be addressed during planning, construction and operation of the estate.

Planning Phase

- Potential groundwater and surface water pollution caused by historic tannery activities. The pollution risk assessment conducted for groundwater and surface water pollution shows that contamination levels are within acceptable standards. Potential pollution and human health risk caused by possible leaching from historic contamination from the tannery ponds should be monitored carefully. All sources of contamination, notably the contents of the ponds were disposed of at the Kupferberg Waste Disposal Site. Follow up sampling and continued monitoring is required. This impact is rated medium to low and will be reduced to low if the process is completed, as described in the Pollution Risk Assessment (Appendix A) and the Environmental Management Plan (Appendix C).

Construction Phase

The construction phase consists of those activities that will occur during the construction of the infrastructure, as well as those associated with the construction of the individual buildings on the estate by each owner.

- Waste, noise, dust, traffic congestion, Hydrocarbon Spills and sewerage leakages that end up in the run-off and the groundwater via the surface drainage system and so cause a defaced terrain, surface and groundwater pollution, unhygienic conditions and social inconveniences and dissatisfaction. These issues required tight management and requirements in the Environmental Management Plan.
- Increased water demand and additional pressure on already overutilised water resource (Windhoek aquifer). Planned utilisation of licenced on-site borehole water for non-potable use would reduce demand and pressure on the aquifer. If this is not yet in place during the construction phase, then semi-purified water should be obtained for construction purposes.
- Social impacts, including, job creation, informal settlement, contribution to the spread of HIV/AIDS, occurrence of disorderly unhygienic markets, safety and security issues, etc. The Environmental Management Plan addresses these issues which need to be managed well through the implementation of the Plan.

- Loss of *Acacia erioloba* and other protected tree species. The Developer has made considerable effort though the surveying of the trees and incorporating these into the design, to ensure that they are conserved. It is inevitable that a limited number of the trees will be lost during construction, in order to fit in the roads and buildings. However, in order to minimise this, the Developer needs to include adequate building lines and conservation zones/footprints for buildings on sale contracts and in Title Deeds to ensure the trees remain a priority for conservation. On erven with large numbers of trees, buildings should rather be double story to avoid a large footprint and trees list. New owners need to prove to the Developer and the Home Owners Association that the design has endeavoured to incorporate trees as far as possible on each site, with only limited trees lost where there is no other option. During Construction, contactors need to be informed of the seriousness of removing trees without permission, and should be fined accordingly. These details are provided in the Environmental Management Plan.
- Changed ecological conditions, erosion and scouring as a result of changed flow patterns (relayed tributary). The tributary has formed as a result of stormwater from the B1 highway. It is therefore a man-made feature. The channelling of the water will cause increased flow velocity and force, currently flowing across a large area. The channelling of the tribuatory should be done using natural materials that reduce velocity and protect against erosion.

Operational phase

- Hydrocarbon Spills and sewerage leakages that end up in the run-off and the groundwater via the surface drainage system. The proposed pumpstation is a particular source of concern as far as sewerage leakage is concerned. The Engineering team should reconsider gravitation feed. However, should the pump station prove to be the only solution, then it needs to be removed from and placed downstream from the boreholes.
- Flood risk associated with changed flow patterns caused by climate change – increased irregular, yet high intensity floods. Even though the development is situated outside the existing 1:50 year flood line, it is suggested that monitoring be done of the flood lines for planning and management purposes should significant changes be noticed.
- Increased traffic causing congestion on the D 1743. The Development contributes a relatively minor traffic load when compared to other larger developments. Nevertheless, the Developer will be implementing traffic solutions, notable changes to the existing access road, in line with the Traffic Master Plan for the area.
- Increased water demand and additional pressure on already over utilised water resource (Windhoek aquifer) – the estimated 303.6 kl/day, or 110,814 kl/year will place an increased pressure on the water crisis situation. By the time this development is

approved a permanent water supply solution is unlikely to be in place, with heavy reliance on the Windhoek aquifer, but with mitigating effects of planned use of on-site licensed borehole water for non-potable uses.

- This is a relatively small size development but will still increase the pressure on the existing water supply. It is recommended that the City approve the use of the existing boreholes on the site for irrigation purposes. Alternatively the reuse of grey water for irrigation should be considered. In addition, gardens need to be drought tolerant, with restricted lawns. Water saving cisterns, tap features, and other water saving design features need to be prescribed. The Drought Response Plan off the City needs to be implemented. Water saving needs to be integral to the management of the estate. The Environmental Management Plan contains the steps needed in this regard.

The above impacts are all of low significance if they are managed through the provisions mentioned and as contained in the Environmental Management Plan. It is recommended that the Proponent further develops the Environmental Management Plan and particularly the design principles for the erven, closer to implementation.

It is also recommended that the Developer appoints someone from his team to oversee the implementation of the EMP on site.

Table of Contents

Abbreviations & Acronyms

ADT	Annual Daily Traffic
AADT	Annual Average Daily Traffic
BID	Background Information Document
DEA	Directorate of Environmental Affairs
ECA	Environmental Clearance Application
ECC	Environmental Clearance Certificate
ED	Enviro Dynamics cc
EIA	Environmental Impact Assessment
EMA	Environmental Management Act, 2007 (Act no. 7 of 2007)
GIS	Geographic Information System
MET	Ministry of Environment and Tourism
MME	Ministry of Mines and Energy
NGO	Non-Government Organisation
PPE	Personal Protective Equipment

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1 INTRODUCTION

1.1 This Report

Namibia Tannery (Pty) Ltd intends developing a residential and business estate (called Tannery Estate) on Portion 1 of Elisenheim No 68, as shown in Figure 1 below. The area is wedged between the Klein Windhoek River and Elisenheim Estate to the east, and the railway line and the B1 highway to the west. Access to the site is via the D1473 which runs parallel to and east of the B1.

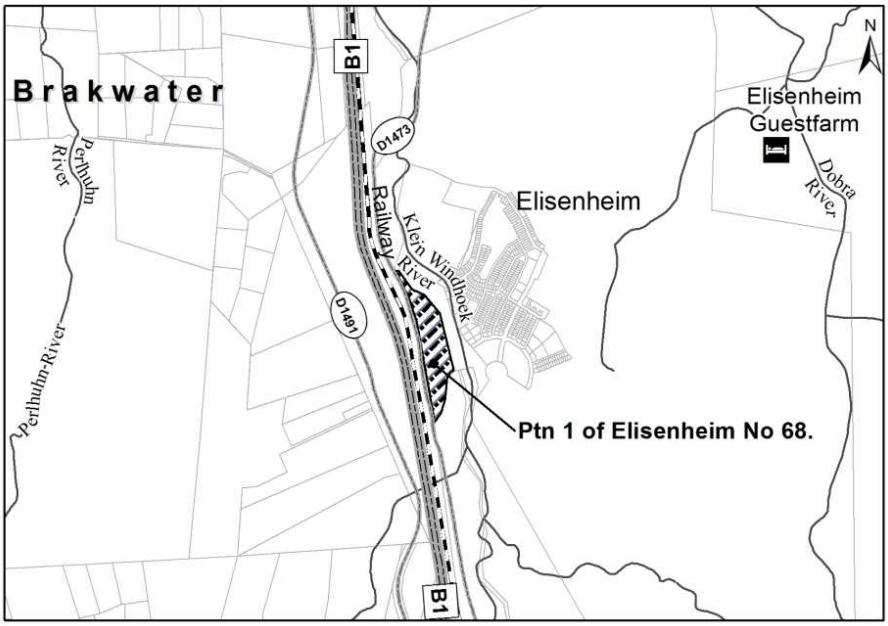

Figure 1: Locality of Portion 1 of Elisenheim No 68 - the proposed Tannery Estate site.

An Environmental Assessment is required for the project in terms of the Environmental Management Act (2007) and its regulations (2012).

This is the Scoping Report; the document which contains the results of the study for scrutiny by interested and affected parties and the Department of Environmental Affairs.

1.2 Scope of work

The consultant is expected to conduct all the necessary work in order to meet the requirements for obtaining environmental clearance for the project. An environmental scoping study was undertaken, including the following tasks:

- Project description
- Review of legal environmental requirements
- Consultation with interested and affected parties and authorities
- Site visit, tree survey and gathering of available baseline information
- Identification and assessment of potential biophysical and socio-economic impacts
- Environmental Management Plan
- Reporting (this report)
- Submissions to the Department of Environmental Affairs and reception of Environmental Clearance on behalf of the City of Windhoek

1.3 Methodology

The vegetation on site, notably the trees were surveyed using hand-held GPS. This was later more accurately surveyed with surveying equipment.

A pollution risk assessment, to determine existing risk caused by historic activities, was undertaken by Geopollution Technologies, using sampling techniques described in the applicable report (Appendix A).

A flood analysis was done by Windhoek Consulting Engineers, using applicable software (Appendix B).

Besides there specific areas of study, secondary information and extensive knowledge of the area was used to compile the baseline study and the impact assessment.

1.4 Legal Requirements

The Environmental Management Act has a list of activities which require environmental clearance. They need to undergo an environmental assessment process for consideration of this clearance. There are a number of components of this project that are listed, namely the following:

- The rezoning of land – this is a large scale rezoning and requires environmental assessment
- Construction of canals and channels including the diversion of the normal flow in a riverbed.
- Construction and other activities in water courses within flood lines.
- The construction of public roads
- Water supply pipelines
- Pipelines associated with sewer treatment

This environmental assessment process therefore deals with not only the proposed township, but with the infrastructure associated with it.

The Developer is responsible for the direct capital costs to construct the water, sewer and electrical infrastructure within the estate and outside the estate where it connects to existing networks. This EIA covers this infrastructure, the routes which are shown on Figure 3.

Even though the Developer and the eventual development will contribute to the construction and maintenance of the bulk infrastructure, including the water reservoir, sewerage treatment plant, substations, and associated bulk distribution networks, these fall outside of the ambit of this Environmental Impact Assessment and its Environmental Management Plan which will become mandatory and legally enforceable during implementation.

The scope of this EIA therefore covers the internal services of the estate as well as the water, sewer and electrical lines leading to the connections outside of the estate.

2 PROJECT DESCRIPTION

2.1 Philosophy

The Developer has the vision of creating a mixed use estate, with higher density properties (i.e. smaller single residential erven and apartments) conveniently situated close to businesses. The estate is being planned to capitalise on the existing character of the area, made up of the existing tannery building, and the river corridor with its camel thorn trees on the alluvial plains.

2.2 Land use

Consult Figure 2 below. The tannery estate will be a mixed use estate, with business, single residential (average size 500 m^2), general residential (high density apartments), and open spaces to accommodate stormwater and for recreational purposes. The old tannery building (special zoning) will be renovated and used as a restaurant and conference venue. See the layout plan showing the zonings and various erf sizes allocated (Figure 2).

We confirm that although there were historically industrial uses (tannery activities) and are currently light industrial uses on the site, the proposal does not include any form of industrial or light industrial use. The proposed uses are restricted to residential, business, office and related uses.

The erven will be sold to buyers who will be restricted to these uses in the Town Planning Scheme. Although the specific businesses are not known, they will all be exempt from environmental assessment unless they propose an activity for which consent is needed. In such cases, environmental assessment will be required and community consultation sought.

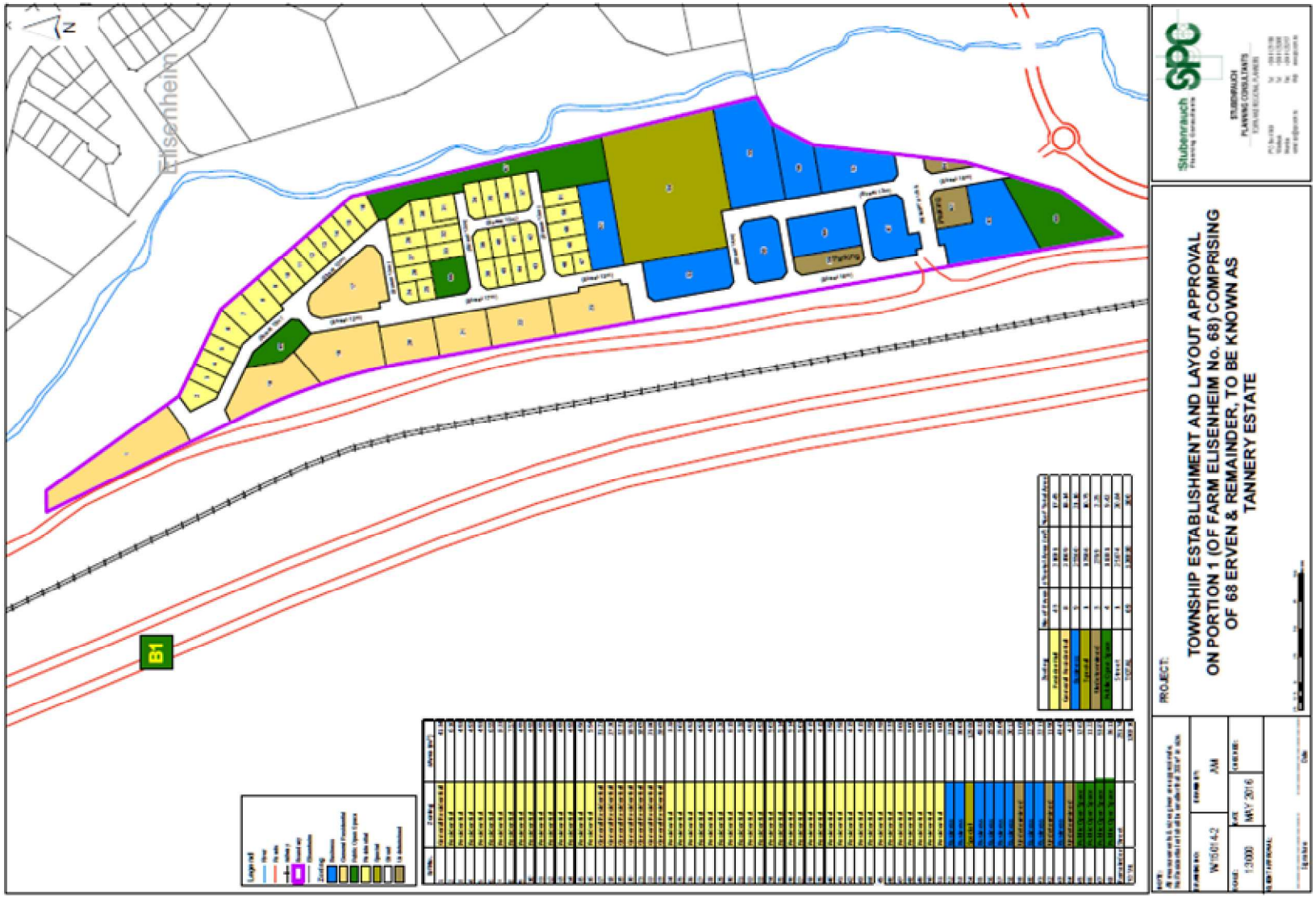

Figure 2: The proposed layout of the Tannery Estate

These zonings are allocated according to the Windhoek Town Planning Scheme, which determines the land use rights (primary uses, consent uses, parking requirements, density, bulk, etc.) for each property.

2.3 Proposed Services

The information in this section has been provided by Windhoek Consulting Engineers (WCE).

2.3.1 Water supply

Currently there is no bulk water infrastructure in the development area. The existing City of Windhoek Bulk Water Infrastructure will therefore have to be extended to accommodate the newly proposed development.

2.3.2 Existing Bulk Water Infrastructure

It is planned to supply the estate with water from the existing Elisenheim reservoir through a network of 250mm to 315mm Ø uPVC pipes. These pipelines will connect with the existing Elisenheim pipe network.

Water Demand Requirements

The average annual water demand (AAWD) for the development based on widely acknowledged design standards, calculated by the engineering team, is 303.6 kl/day, or 110,814 kl/year.

Internal water supply network

The layout and design of the internal infrastructure will follow the City of Windhoek guidelines and policies. Preliminary designs indicate a combination of 110mmØ, 160mmØ, 200mmØ and 250mmØ distribution mains. Discussions will be held with the Bulk Water Department to ensure all design guidelines and specifications has of the City of Windhoek are followed.

2.3.3 Sewer drainage and treatment

Currently there is no bulk sewer infrastructure or effluent treatment facility in the development area.

Elisenheim Property Development Company is currently in the process of upgrading the existing Elisenheim Waste Water Treatment Plant. The internal sewer infrastructure will be designed to connect to the mentioned infrastructure which is planned to be completed by the time the development commences.

2.3.4 Electrical infrastructure

The total power supply for the development is calculated at 1046.7 kVA. This supply will require a connection from an 11kV Distribution Substation. The Elisenheim Estate Nubuamis 11kV Distribution Substation is located approximately 100 meters east of the development. An underground ring network is proposed from the Nubuamis Distribution Substation.

A NamPower 11kV overhead powerline supplies power to existing structures on the development. As the development falls within the extended City boundaries, a power supply from the City of Windhoek is proposed. The NamPower supply will need to be disconnected and overhead structures will need to be decommissioned and removed. Further investigation is required to determine the extent of the existing internal electrical infrastructure.

The infrastructure as explained is shown in Figures 3 and 4.

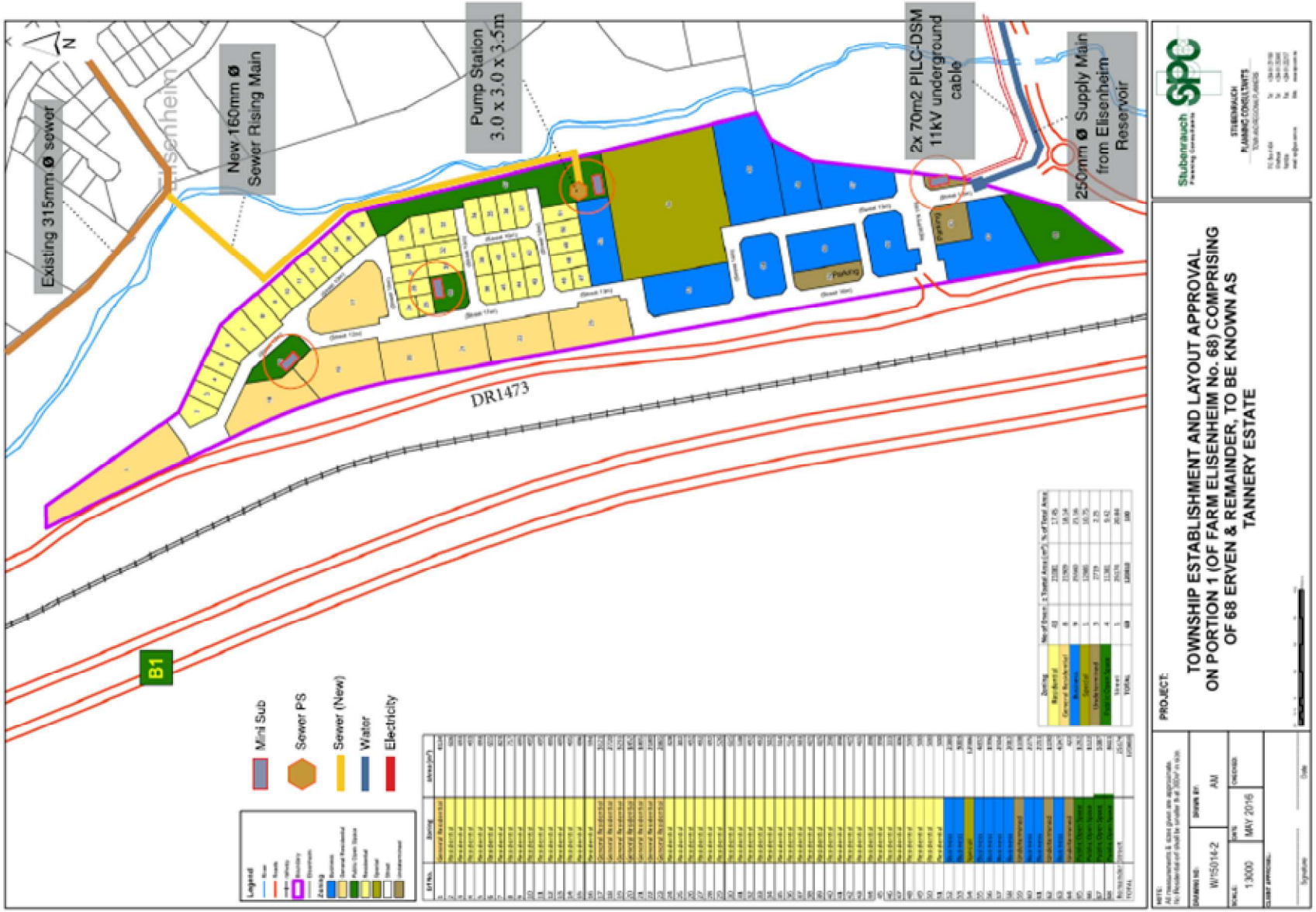

Figure 3: Proposed bulk infrastructure connections to the Tannery Estate.

Figure 4: Bulk water, power and sewerage supply to the estate.

2.3.5 Town Planning Process

The Subdivision of Land Ordinance requires that when a subdivision is large-scale, with the creation of roads, that a process of Township Establishment be followed.

An application to establish a township needs to be, along with a motivation detailing the Need and Desirability of the proposed township. The Need and Desirability application considers the following questions.

- Need: Is this particular land use proposal necessary for the receiving community now?
- Desirability: Does this land use proposal fit the current institutional, social, biophysical, and economic frameworks?

This application is submitted to the Ministry of Regional Local Government, Housing, and Rural Development (MRLGHRD) who refers the application to the Namibia Planning Advisory Board (NAMPAB) for consideration. Once approved, an application will also be submitted to the Townships Board for approval of the proposed layout, where the technical details of the township is being scrutinised.

3 LEGAL AND REGULATORY REQUIREMENTS

This section provides a review summary (Table 1) of applicable environmental legislation pertaining to the project, both international and national.

3.1 Legal instruments

Table 1: Relevant provisions from applicable legal instruments

LEGISLATION/ POLICY/ GUIDELINE	RELEVANT PROVISIONS	IMPLICATIONS FOR THIS PROJECT
INTERNATIONAL		
Convention on Biological Diversity (1992)	Article 6 (b) provides for the explicit consideration of "the conservation and sustainable use of biological diversity into relevant... plans, programmes and policies"	General principle to be applied in the development, applicable to the protected tree species on the site, and the river ecology to be conserved.
NATIONAL		
Namibian Constitution First Amendment Act 34 of 1998	Chapter 11 Article 95: Promotion of the Welfare of the People	Ecological sustainability should inform and guide this project. Avoidance of ecologically sensitive areas should be a priority.
Environmental Management Act (No 7 of 2007)	• Requires that projects with significant environmental impact are subject to an environmental assessment process (Section 27). • Details principles which are to guide all EAs.	The Environmental Management Act and its regulations should inform and guide this EIA process.
EIA Regulations GN No 28-30 (GG No 4878)	• Details requirements for public consultation within a given environmental assessment process (GN No 30 S21). • Details the requirements for what should be included in a Scoping Report (GN No 30 S8) an EIA report (GN No 30 S15).	Public consultation is being conducted according to these requirements, see Section 36, principles in this regard should be followed up by the

LEGISLATION/ POLICY/ GUIDELINE	RELEVANT PROVISIONS	IMPLICATIONS FOR THIS PROJECT
		Developer during construction and operation.
Forestry Act 12 of 2001 Nature Conservation Ordinance 4 of 1975	• Tree species and any vegetation within 100 m from a watercourse may not be removed without a permit (Forestry Act S22(1)). • Prohibits the removal of and transport of various protected plant species.	Certain tree species occurring in the area are protected under this Act and require a permit from the Directorate of Forestry for removal. Care needs to be taken at river crossings. Protected plants to be identified and avoided.
Labour Act 11 of 2007	• Details requirements regarding minimum wage and working conditions (S39-47).	Developer and eventual governing body should ensure that all contractors involved during the construction, operation and maintenance of the estate comply with the provisions of these legal instruments.
Health and Safety Regulations GN 156/1997 (GG 1617)	• Details various requirements regarding health and safety of labourers.	
Public Health Act 36 of 1919	• Section 119 states that "no person shall cause a nuisance or shall suffer to exist on any land or premises owned or occupied by him or of which he is in charge any nuisance or other condition liable to be injurious or dangerous to health."	
Water Act 54 of 1956	The Water Resources Management Act 24 of 2004 is presently without regulations; therefore the Water Act No 54 of 1956 is still in force: • Prohibits the pollution of underground and surface water bodies. • Liability of clean-up costs after closure/ abandonment of an activity. • A water abstraction permit is required if boreholes are to be developed.	The protection of ground and surface water resources should be a priority. The Developer is responsible to clean up the existing hazardous material that has caused pollution on the site (Appendix A). This has been completed, with evidence available.
Town Planning Ordinance 18 of 1954	Subdivision of land situated in any area to which an approved Town Planning Scheme	The land uses of the area need to be considered vs

LEGISLATION/ POLICY/ GUIDELINE	RELEVANT PROVISIONS	IMPLICATIONS FOR THIS PROJECT
	applies must be consistent with that scheme.	the impact the road alignment would have on them.
Windhoek Town Planning Scheme	• Various Town Planning regulations to be met, i.e. density, parking, land use, nuisances, flood lines, etc. The following sections are highlighted, although the Developer and the HOA have the responsibility to oversee the entire scheme, with the legal enforcement of it residing with the City of Windhoek. 26 Danger to life, health and amenity. 27 Removal of injurious conditions – general health and safety provisions. 29 Prohibited plants – Prosopis Species are not allowed to grow on the site and should be removed. 37 Drilling of water – Council has to give permission for the drilling and use of borehole water.	Consider the implications of the proposed densities and land uses on the future of the existing trees, integrity of the river, etc. Make recommendations where necessary. Include specific environmental specifications in the Environmental Management Plan.
National Heritage Act 27 of 2004	• Section 46 prohibits the disturbance in any form of heritage resources declared as protected. • Section 48 (1) states that "A person may apply to the [National Heritage] Council for a permit to carry out works or activities in relation to a protected place or protected object"	All protected heritage resources (e.g. human remains etc.) discovered, need to be reported immediately to the National Heritage Council (NHC) and require a permit from the NHC before they may be relocated. Heritage resurces need to be condidired by a heritage specialist.

The most important legal instruments for this project include those protecting vegetation, river beds, water sources, and provide health and safety provisions and working conditions during construction. These provisions have all been included in the Environmental Management Plan (Appendix C).

It should further be noted that the Environmental Management Act currently requires that projects be submitted to the Department of Environmental Affairs every 3 years. Should this project not be implemented within 3 years, a renewal process will be due. Furthermore, the Act and its regulations are currently being revised. All revisions need to be taken into account in future for this project.

3.2 Regulatory planning instruments

There are three regulatory planning instruments which guide and direct development of the study area. These are the Windhoek Structure Plan, the Brakwater Guide Plan (details for Brakwater, in line with the Windhoek Structure Plan) and the Windhoek Environmental Structure Plan.

According to the Brakwater Guide Plan, the area falls within a zone within which a mix of business, residential and industrial use is promoted.

The Windhoek Environmental Structure Plan indicates that the site falls within a water protection area. It is an area of moderate sensitivity, with limited assessment required. Water is the focus of assessment in the area and to be addressed in the study.

The Biodiversity Inventory of the City of Windhoek further guides development according to habitat sensitivity. This document is discussed under Section 4.2.

4 ECOLOGICAL AND SOCIAL CHARACTERISTICS

4.1 Overview

The development is being planned on the historic alluvial plains of the Klein Windhoek River, but outside the 1:50 year flood line. The site hosts numerous large Camelthorn and limited other indigenous trees that are conservation worthy. There is also a large concentration of *prosopis spp.*, which has spread as seed is carried along via the river. Neighbouring land use includes the Elisenheim Estate to the East, North and south, and the railway line and B1 Highway to the west.

The following sections describe the pertinent features of this overview in more detail.

4.2 Baseline socio-economic and ecological characteristics

4.2.1 Climate

The climate data below is typical for the Windhoek area, as derived from the Meteorological Services data for the central area of Namibia (Windhoek weather station, (Namibia Meteorological Service, 2015).

Classification of climate:	semi-arid highland savannah
Average rainfall:	350 to 400mm per year
Precipitation:	sporadic and unpredictable, high intensity, highly localised storm events between October and April. Evaporation exceeds precipitation by approximately 93%.
Temperatures:	Highest temperatures are measured in December with an average daily maximum of 31°C and minimum of 17,3°C; the coldest temperatures are measured in July with an average daily maximum of 20,4°C and minimum of 6,4°C.
Wind direction:	Predominantly easterly, southerly and south-easterly. Southerly and north-easterly airflow is also common. Dry and dusty westerly winds blow in the afternoons and evenings in early summer. Localised wind directions for the area have not been recorded.

The most prominent message for planners and designers with regard to climate is the changing trends measured and expected in ensuing years for Namibia, following global patterns. Predictions indicate that there will be more frequent and intense heavy precipitation, longer drought periods which will increase in intensity, as well as an increase in warm spells and heat waves over most land areas (Working Group to IPCC, 2013).

This goes hand in hand with the current predicament that the central area of Namibia's storage capacity in its dams and other water sources can no longer meet the water demands of the growing industires and population (Ministry of Agriculture, Water and Forestry, 2015). Water shortages are therefore a reality.

For Namibia and the study area, this means water resources will be under increased pressure. The responsibility is therefore on all project planners to ensure water supply sources are not impinged in any way by the development of projects.

The implications of changes in precipitation is also that previous flood lines may change in future. If intensity increases, then flood lines will shift. A management strategy should be considered for this along the Klein Windhoek River.

Table 2: Sensitivities related to climate

Environmental Feature	Description	Sensitivities
Semi-arid conditions	Evaporation exceeds precipitation Drought periods to increase in frequency and intensity (climate change) Supply demand exceeds capacity	Capacity of the environment to absorb impacts is low and decreasing. The surface water resource and the aquifer associated with the riverbed is a valuable commodity.
Precipitation	Localised storm events	High velocity run-off makes the area susceptible to erosion and will increase with climate change. Pollutants from contaminated surfaces wash away fast toward river beds and into underground reservoirs. The clean –up of the developer of previous noxious land use has honoured this requirement. Management requirements for future activities to be include in the EMP.
Wind direction	Mostly from the east, south-east and south. Strong westerly in Spring.	Locality of sensitive receptors particularly of noise and dust need to be considered.

4.3 Habitat and vegetation

The Windhoek Biodiversity Inventory (Enviro Dynamics, 2012) provides a guide for identifying sensitive habitat and the species occurring in each, in the study area.

The proposed road lies adjacent to the Klein Windhoek River, of which the riverbed itself has been classified by the above as riverine thicket habitat. In these habitats, soils are sandy and low in nutrients. Large quantities of organic material are not available due to arid conditions and little decomposition of plant material.

The riverine thickets provide stability and protect the river banks from erosion. The river banks on the other hand protect the alluvial plains and lowlands adjacent to the rivers from erosion by preventing the formation of erosion channels. Erosion channels within the alluvial plains will increase the speed of water run-off through canalisation and will put the ecosystem function of water infiltration into the aquifer, at risk (Ströhbach, quoted in Enviro Dynamics, 2012). This habitat has been damaged in the past through land uses in the area, notably industrial activities, sewerage leakage, alien invasive plant species spreading down the river, waste dumping and general neglect. At the site the river course itself is still fairly intact and is a visual and ecological relief to the east.

This habitat may be influenced indirectly through indiscriminate construction activity and pollution draining toward its catchment area, but is not directly in the way of the development.

Adjoining the riverine thicket habitat of the Klein Windhoek River, lies the Windhoek valley habitat. This habitat extends into the Brakwater valley toward Rehoboth. It includes a sub-habitat which is found in the study area, namely alluvial plains associated with the Klein Windhoek River. These plains support *Acacia erioloba* (Camelthorn) woodland (Figure 6). This habitat also supports a high diversity of herbaceous and geophytic vegetation. As mentioned, alien invasive species notably Prosopis are common (Figure 5), transported through their seeds along the river system and are widespread. This is particularly so in the study area.

Besides this natural habitat, an area of the site has been influenced by sheet flow originating from a tributary shaped by a culvert in the B1 to the west (Appendix B). On this portion, vegetation growth is limited and dominated largely by grass cover (Figure 7).

A survey of the tree species occurring on the site was done the results are given in Appendix D. Figure 8 shows the spread of trees with varying levels of conservation status on the site.

Figure 5: Prosopis thickets on the site

Figure 6: Camelthorn trees are to be incorporated into the design and conserved

Figure 7: Large area dominated by grass cove; tree cover associated with alluvial plains in the background

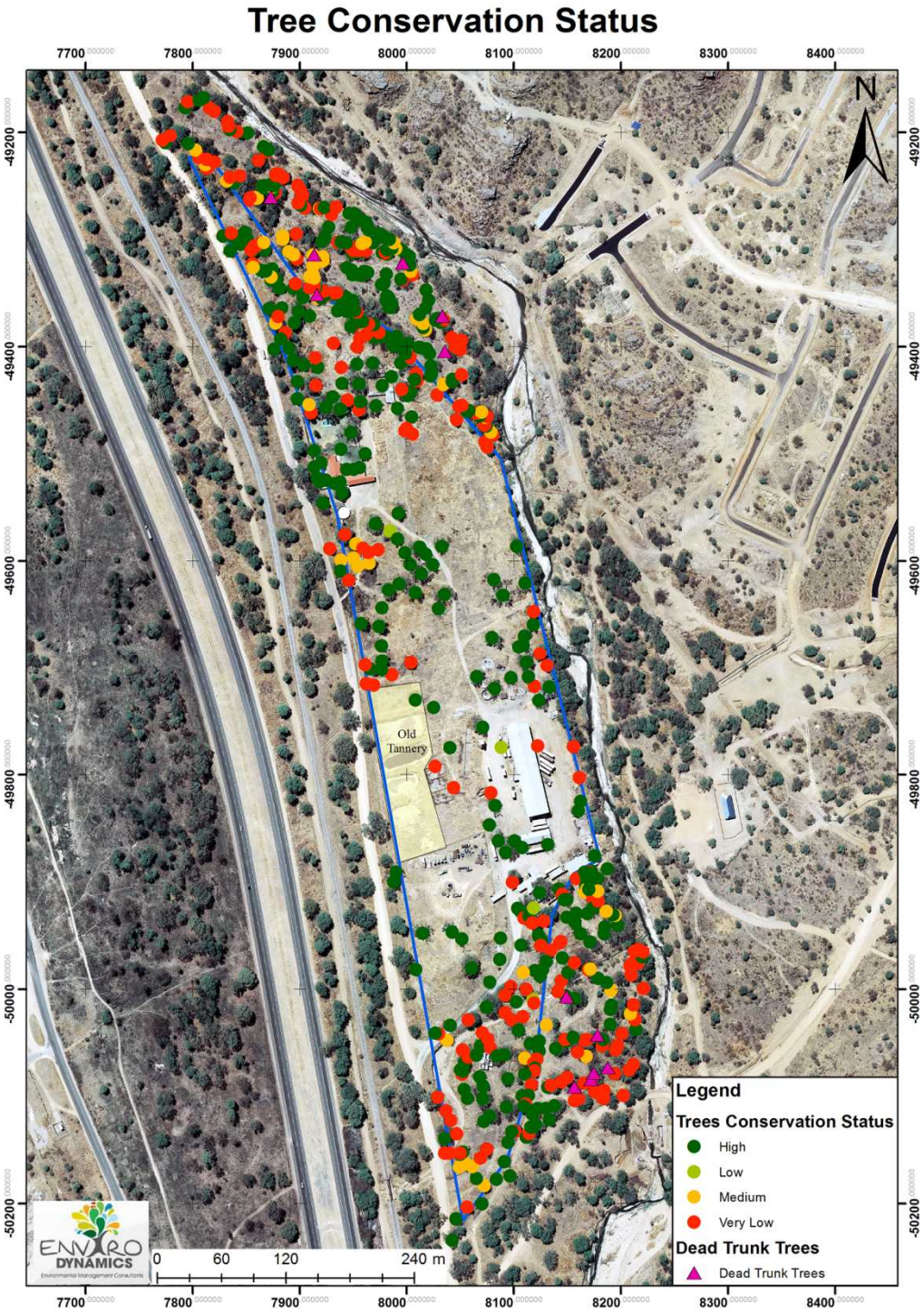

Figure 8: Trees identified with varying degrees of conservation status.

Table 3: Sensitivities of habitat, fauna and flora in the study area

ENVIRONMENTAL FEATURE	DESCRIPTION	SENSITIVITIES
Single species of camelthorn	Protected Species Aesthetic appeal and relief Ecological function Wood source	Protected trees, notably Camelthorn to be preserved, Prosopis to be removed. (see Appendix C).
Riverine thicket (Klein Windhoek River)	The riverine component of the riverbed including the riverbanks.	Plays important ecosystem function including erosion protection, water carrier, water infiltration, water purifier, social function as a relief and recreational resource for urban inhabitants. Indirect impacts e.g. dumping, wood collecting, pollution to be addressed. Banks of the river to be protected.
Windhoek valley with alluvial plains	Flat plains alongside the riverbeds.	Plays important ecosystem function for flooding regulation, water infiltration, hosts camelthorn trees which are an important resource, social function as a relief and recreational resource for urban inhabitants. Water flow function to be retained, vegetation to be protected.

4.4 GEOHYDROLOGY AND SURFACE DRAINAGE

Surface drainage is toward the Klein Windhoek River due East of the site. There is an existing tributary in the southern end of the site, which drains to the Klein Windhoek River. This tributary has formed largely as a result of the stormwater structures of the B1 Highway directing water flow. A large portion of the site is subject to sheet flow in the rainy season due to lower lying land and water flowing from the tributary. Appendix B shows the area of the site subject to sheet flow, in relation to the 1:50 flood area of the Klein Windhoek River.

Detail about the geology and aquifers present on site can be studied in a report by Mr. Pierre Botha of Geo Pollution Technologies (Pty) Ltd, 2015 (Appendix A). The soil cover on the site is mainly weathered mica schist and sand, with areas consisting of large quartz pebbles and boulders. Mica Schist of the Kuiseb Formation underlies the surface and it outcrops to the east of the site. Windhoek's geology was shaped by numerous folding and faulting episodes, including thrusting and rifting.

Two main aquifer types are found in the area, namely secondary (fractured rock) aquifers in the mica schist of the Kuiseb Formation and primary (unconsolidated sediment) aquifers in the Klein Windhoek River valley alluvial. The groundwater flows from south to north, including the study area. Local flow patterns, however, may vary due to abstraction from boreholes. Botha (2016) expects the groundwater flow to take place through primary porosity in the surface cover, and along fractures, faults, and other geological structures (secondary porosity) within the underlying formations. He reports that there are 22 known boreholes within a 2km radius from the property boundary, but that none of these are City of Windhoek production boreholes. The private usage of private boreholes is unknown but should be considered at risk if pollution of the aquifer takes place. Groundwater in Brakwater is generally used for domestic and small scale agricultural purposes. Water in the area is often brackish and is possibly contaminated by run-off and sewerage seapage in the Klein Windhoek River. The Government controls groundwater in this area – it is part of the Windhoek-Gobabis Subterranean Water Control Area.

Table 4: Surface and groundwater sensitivities on the site.

ENVIRONMENTAL FEATURE	DESCRIPTION	SENSITIVITIES
Surface drainage	Drainage is towards the Klein Windhoek River and eventually the Swakoppoort Dam.	Existing pollution on site could continue polluting the groundwater and should be monitored. New activities have limited potential for surface and groundwater pollution – to be addressed in the Environmental Management Plan.
Groundwater	Alluvium in the Klein Windhoek River hosts groundwater even though brackish and perhaps already contaminated. The water is utilised upstream.	Limited potential for contribution to groundwater pollution via drainage toward the river aquifer. To be addressed in the EMP.

4.5 SOCIO ECONOMIC STATUS QUO

4.5.1 Land use

The valley in Brakwater along the main B1 route has some heavy industrial uses, with small scale agriculture and residential uses on the periphery. The immediate site was used for heavy industrial purposes (tannery) with evidence of pollution on the site remaining and which has been removed and to be monitored into the future. The Elisenheim farm to the North-East is being developed for large scale residential purposes.

The buildings on the site are currently being leased mainly for residential purposes and light industrial purposes, e.g. oil salvaging and processing, storage, etc. (Figure 9 - Figure 10).

Figure 9: Existing structures and activities on the site, indicating which are to be retained and which removed.

Figure 10: Some of the uses currently accommodated on the site

Figure 11: The main old tannery building

4.5.2 Salient socio-economic features of Windhoek and the region

The table below provides the significant socio-economic features of Windhoek and the region.

Table 5: Socio-economic sensitivities

Feature	Khomas Region and Windhoek (Sources: (Government of the Republic of Namibia, 2015) (Government of Namibia, 2013.) (Government of Namibia, 2013) (Government of Namibia, 2015)
Population	Windhoek 325 858 (2011) Khomas 342 141 Male 49.6 % Female 50.4 % Growth rate: 3.1% Urban population 95% Rural population 5% Projection for 2016: 415 780 Projection for 2030: 645 355
Population growth since 2001	3.1%
Literacy and Employment rate	Literacy rate above the age of 15: 97% Employment rate 70%
Labour Force	74%
Health data	2 hospitals, 2 health centres, 7 clinics Besides spontaneous delivery and c-sections, HIV/AIDS has been the main case of hospitalisation from 2010-2013. However, there is a steady decline in the number of people visiting hospital as a result of HIV/AIDS. In 2014 the HIV prevalence rate for Windhoek (Windhoek Central hospital) was 4.1% compared to the overall rate for Namibia of 16.9%. This figure for Windhoek has declined from 10% in 2002 (considered the overall peak year for HIV prevalence in Namibia).

Environmental Feature	Description	Sensitivities/opportunities.
Job creation	Windhoek is a magnet for employment seekers.	Job opportunities during construction. Informal settlement and business near the construction activities.
HIV/AIDS	Declined from peak prevalence in the past.	Continued contribution of construction projects to the spread of HIV/AIDS.
Land delivery and Housing	Limited housing and serviced land, increased informal settlement and socio-economic disparities.	Opportunity to provide housing to the medium income bracket.
Past and existing land use	Polluting activities of industrial and light industrial nature. Environment degraded.	Opportunity to uplift the area through new development that is aesthetically pleasing and clean-up efforts.

5 PUBLIC CONSULTATION CONDUCTED TO DATE

5.1 Introduction

The project is located on a relatively remote site where a limited number of receptors may be directly influenced by construction and operational impacts. Indirectly the community may be affected by effects on the river and its resources.

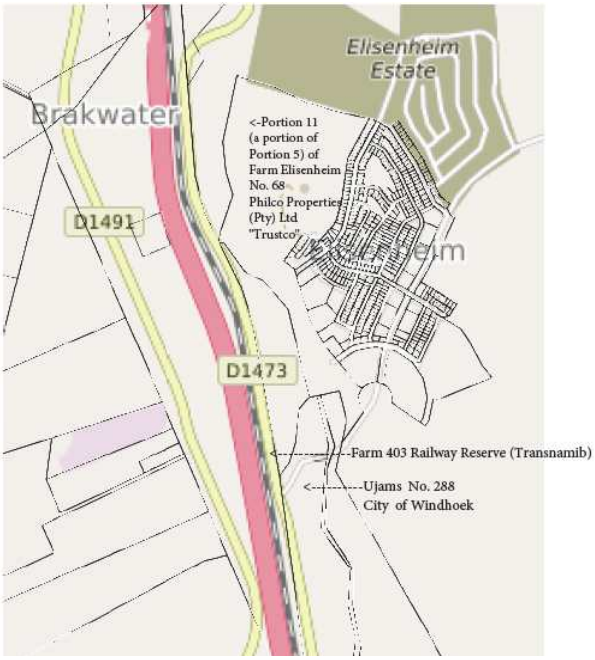

Figure 12: Neighbouring properties

Stakeholder mapping revealed that the following organisations who occupy or plan activities in the area need to be engaged:

- The City of Windhoek under whose jurisdiction the area falls, including the Planning Division, the Bulk Water and Waste Water Division and the Waste Management Division.
- The neighbouring properties including the owner/,managing agent of Elisenheim (Trustco), and TransNamib to the west. Neighbouring land to the south is owned by the City of Windhoek (Figure 12).
- In order to obtain representation of the Brakwater community, the Brakwater residents' association was added to the stakeholders list.
- To ensure wider consultation, newspaper notices were placed in the Namibian and the Republikein on Thursday 14 September 2016 and Thursday 21 September 2016 (Appendix E).

The list of identified stakeholders, including those who registered in response to the adverts are listed in Appendix F.

A Background Information Document was sent to the distribution list. The comments that were received are included in Appendix G. These were mainly questions regarding the meaning of the zonings, and the need and desirability of the proposal, and since answers could be provided as per the appendix, they mostly do not represent real potential issues.

A consultation meeting was also held with Municipal officials to discuss potential issues (see the minutes in Appendix H). Water supply alternatives, the clean-up of

the tannery contamination were the key topics discussed at the meeting and they relevant details are incorporated into this report.

5.2 Summary of issues

The issues listed here are based on the experience of the constant, coupled with comments/questions raised during consultation.

- A mixture of Camelthorn and Prosopis trees are predominant on the site. The trees have been surveyed and the development planned to protect the Camel thorns and other conservation worthy species as far as possible. Since they will greatly enhance the ambience and quality of the estate, and legally protected, they are to be retained as far possible. This needs to be stipulated in the Environmental Management Plan for implementation throughout the project.
- The site is relatively isolated from other residences and activities. Nevertheless, construction related impacts i.e. excessive dust creation, noise proliferation, personnel safety, security aspects, etc. all need to be addressed in the Environmental Management Plan.
- In order to establish the risk of the historical tannery activities (which have caused water and soil contamination and associated risk to human health and ecological function), soil and water samples were taken and a risk analysis done by Geopollution Technologies. These results, together with proposed remedial measures, should be included in the Scoping Report and the Environmental Management Plan.
- Potential alteration of water flow and downstream consequences. There is a tributary on site (channelled stormwater from the B1 Highway) which is proposed to be relayed. The impacts of this should be considered in the study. The site is situated outside the 1:50 year flood of the Klein Windhoek River.
- Sustainable resource use (i.e. energy and water) amidst a global and local water and energy crisis. The proposal is to abstract groundwater and to use such for irrigation of the gardens. The City of Windhoek indicated that a proposal for this needs to be submitted for consideration.
- Need and desirability of the proposed land use, i.e. there are industrial erven made available in the areas that are not selling. This was a question from an interested and affect party, however, industrial erven are not proposed. Residential erven are in high demand and the development can only assist in stabilising the market.
- Increased traffic congestion. A traffic master plan has been compiled for the area and changes will be made according to it.

6 IDENTIFICATION OF IMPACTS

This section provides a list of key impacts for the proposed estate, with an assessment of the likely significance of each.

To fully understand the significance of each of the potential impacts, it is necessary to subject each to a range of assessment criteria. The application of these criteria, in determining the significance of potential impacts, uses a balanced combination of duration, extent, and intensity/magnitude, modified by probability, cumulative effects, and confidence. The definitions of each of the criteria are contained in Table 6 below.

Table 6: Definitions of the criteria used

DESCRIPTION	
NATURE	Reviews the type of effect that the proposed activity will have on the relevant component of the environment and includes "what will be affected and how?"
EXTENT	Geographic area. Indicates whether the impact will be within a limited area (on site where construction is to take place); local (limited to within 15 km of the area); regional (limited to ~100 km radius); national (limited to the national borders); or international (extending beyond Namibia's borders).
DURATION	Whether the impact will be temporary (during construction only), short term (1-5 years), medium term (5-10 years), long term (longer than 10 years, but will cease after operation) or permanent.
INTENSITY	Establishes whether the magnitude of the impact is destructive or innocuous and whether or not it exceeds set standards, and is described as none (no impact); low (where natural/ social environmental functions and processes are negligibly affected); medium (where the environment continues to function but in a noticeably modified manner); or high (where environmental functions and processes are altered such that they temporarily or permanently cease and/or exceed legal standards/requirements).
PROBABILITY	Considers the likelihood of the impact occurring and is described as uncertain, improbable (low likelihood), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of prevention measures).
SIGNIFICANCE	Significance is given before and after mitigation. Low if the impact will not have an influence on the decision or require to be significantly

DESCRIPTION	
	accommodated in the project design, Medium if the impact could have an influence on the environment which will require modification of the project design or alternative mitigation (the route can be used, but with deviations or mitigation) High where it could have a "no-go" implication regardless of any possible mitigation (an alternative route should be used).
STATUS OF THE IMPACT	A statement of whether the impact is positive (a benefit), negative (a cost), or neutral. Indicate in each case who is likely to benefit and who is likely to bear the costs of each impact.
DEGREE OF CONFIDENCE IN PREDICTIONS	Is based on the availability of specialist knowledge and other information.

The significance of the impacts is rated high, medium or low as follows.

"High" significance means that it is an impact that will have a regional and or permanent impact.

- "Medium" significance is an impact of moderate severity and may have a local or regional impact but not of permanent duration.
- "Low" significance would be allocated to impacts of any severity but at a local scale and temporary duration.

The tables overleaf provide the impact assessment for the proposed tannery estate.

Table 7: Impact assessment for the proposed Bavaria Road.

Nature	Extent	Duration	Intensity	Probability	Degree of Conf. in predictions	Mitigation	Significance without and with mitigation
PLANNING PHASE							
Groundwater and surface water pollution and human health risk caused by continued leaching from historic contamination from the tannery ponds. (See Appendix A)	Regional(drains to Swakoppoort Dam) Sampling showed that contamination were all within acceptable levels.	Long Term (even though traces of contamination have ceased at the removal of the waste, the groundwater assessment warns that monitoring should continue, any possible contamination would continue on a long term basis.	Low	Low	High	Clean up already undertaken Carry out last sampling set and keep records for baseline. Continue with monitoring and testing as contained in the Geopollution Technologies Report (Appendix A).	Medium to low Low

Nature	Extent	Duration	Intensity	Probability	Degree of Conf. in predictions	Mitigation	Significance without and with mitigation
CONSTRUCTION PHASE							
Hydrocarbon Spills and sewerage leakages that end up in the run-off and the groundwater via the surface drainage system.	Regional (drains to the Swakoppoort Dam)	Short term	Medium	Highly probable	Medium	General housekeeping issues in the Environmental Management Plan for the construction phase.	Medium to Low Low
Increased water demand and additional pressure on already overutilised water resource (Windhoek aquifer)	Regional Large volumes required for construction	Short term	High	High	High	Use of on-site licensed boreholes for non-potable purposes. If this is not yet in place during construction, use semi-purified water for construction purposes.	Medium to high Medium
Loss of *Acacia erioloba* and other protected tree species	Local, but concentrated, protected species	Permanent	High	Certain	High	Environmental Management Plan Ensure that design incorporates trees as far as possible	High Low
General waste, soil pollution, noise, dust, traffic congestion,	Local	Short term	Medium	Highly probable	High	Environmental Management Plan	Medium to low Low

Nature	Extent	Duration	Intensity	Probability	Degree of Conf. in predictions	Mitigation	Significance without and with mitigation
etc. during construction							
Social impacts, including, job creation, informal settlement, increased HIV/AIDS, increased disorderly unhygienic markets, safety and security issues	Local Ongoing during construction of infrastructure and beyond when houses are constructed	Medium term	Low	High	High	Encourage the use of local labour and SMEs Measures in the EMP, including no workforce to be accommodated on site, accommodate a market place at camp, training and support on HIV/AIDS.	Low positive (job opportunities) Medium positive Medium negative (social issues) Medium to low negative
Changed ecological conditions, erosion and scouring as a result of changed flow patterns (relayed tributary), i.e. increased flow intensity and velocity.	Local and downstream (See Appendix B) Klein Windhoek 1:50 year flood not affected	Long term	Medium	High	High	Avoid the use of concrete Use gabions or other design solutions to slow down water flow and to “design with nature”.	Medium-low Low

Nature	Extent	Duration	Intensity	Probability	Degree of Conf. in predictions	Mitigation	Significance without and with mitigation
OPERATIONAL PHASE							
Hydrocarbon Spills and sewerage leakages that end up in the run-off and the groundwater via the surface drainage system.	Regional (drains to the Swakoppoort Dam)	Short term	Medium	Highly probable	Medium	Re-consider gravitational feed to avoid the pump station. IF this is not possible, place the pump station of the sewerage system downstream and away from any future boreholes. Maintenance plan for the sewerage system, especially the pump station. General housekeeping issues in the Environmental Management Plan for the operational phase.	
Flood risk associated with changed flow patterns with climate change – increased irregular, yet high intensity floods	Local	Long terms	High	Probable	Low	Monitor flood patterns, precipitation, on site, keep long term records. Introduce flood protection	Medium-low Low

Nature	Extent	Duration	Intensity	Probability	Degree of Conf. in predictions	Mitigation	Significance without and with mitigation
						should this become necessary.	
Increased traffic causing congestion on the D 1743	Local (Road has not reached capacity)	Long term	Medium	Probable	High	Improve access point to the estate, as per the proposal. Follow recommendations of the traffic master plan.	Medium - low Low
Reduced pressure on housing market	Regional	Long term	Medium	High	High	Continue investigating the affordability of the housing	Medium Positive
Increased water demand and additional pressure on already overutilised water resource (Windhoek aquifer)	Regional	Long term	High	High	Definite	Ensure that the development can absorb the requirements of the Drought Response Plan Limit the lawns and allow only water wise gardens and drought tolerant, indigenous plants and trees. Enforce water saving measures during construction. Monitor water use in the estate	Medium to High Medium

Nature	Extent	Duration	Intensity	Probability	Degree of Conf. in predictions	Mitigation	Significance without and with mitigation
						and police water saving. Further investigate the use of borehole water for irrigation, with water saving measures included vs recycling of grey water. Develop and implement a water conservation plan for the operation phase, to be enforced throughout the estate.	

7 CONCLUSION AND RECOMMENDATIONS

The positive impacts associated with this development include the addition of a residential and business development that will add to the amenity of Windhoek and particularly the northern areas. It is the upgrade of a neglected area from a pollution and visual quality point of view. The additional housing will assist in reducing the pressure on the inflated housing market and this is positive for the economy.

The following is a summary of the key negative impacts which need to be addressed during planning, construction and operation of the estate.

Planning Phase

- Potential groundwater and surface water pollution caused by historic tannery activities. The pollution risk assessment conducted for groundwater and surface water pollution shows that contamination levels are within acceptable standards. Potential pollution and human health risk caused by possible leaching from historic contamination from the tannery ponds should be monitored carefully. All sources of contamination, notably the contents of the ponds were disposed of at the Kupferberg Waste Disposal Site. Follow up sampling and continued monitoring is required. This impact is rated medium to low and will be reduced to low if the process is completed, as described in the Pollution Risk Assessment (Appendix A) and the Environmental Management Plan (Appendix C).

Construction Phase

The construction phase consists of those activities that will occur during the construction of the infrastructure, as well as those associated with the construction of the individual buildings on the estate by each owner.

- Waste, noise, dust, traffic congestion, Hydrocarbon Spills and sewerage leakages that end up in the run-off and the groundwater via the surface drainage system and so cause a defaced terrain, surface and groundwater pollution, unhygienic conditions and social inconveniences and dissatisfaction. These issues required tight management and requirements in the Environmental Management Plan.
- Increased water demand and additional pressure on already overutilised water resource (Windhoek aquifer). Planned utilisation of licenced on-site borehole water for non-potable use would reduce demand and pressure on the aquifer. If this is not yet in place during the construction phase, then semi-purified water should be obtained for construction purposes.
- Social impacts, including, job creation, informal settlement, contribution to the spread of HIV/AIDS, occurrence of disorderly unhygienic markets, safety and security issues, etc. The Environmental Management Plan addresses these issues which need to be managed well through the implementation of the Plan.

- Loss of *Acacia erioloba* and other protected tree species. The Developer has made considerable effort though the surveying of the trees and incorporating these into the design, to ensure that they are conserved. It is inevitable that a limited number of the trees will be lost during construction, in order to fit in the roads and buildings. However, in order to minimise this, the Developer needs to include adequate building lines and conservation zones/footprints for buildings on sale contracts and in Title Deeds to ensure the trees remain a priority for conservation. On erven with large numbers of trees, buildings should rather be double story to avoid a large footprint and trees list. New owners need to prove to the Developer and the Home Owners Association that the design has endeavoured to incorporate trees as far as possible on each site, with only limited trees lost where there is no other option. During Construction, contactors need to be informed of the seriousness of removing trees without permission, and should be fined accordingly. These details are provided in the Environmental Management Plan.
- Changed ecological conditions, erosion and scouring as a result of changed flow patterns (relayed tributary). The tributary has formed as a result of stormwater from the B1 highway. It is therefore a man-made feature. The channelling of the water will cause increased flow velocity and force, currently flowing across a large area. The channelling of the tribuatory should be done using natural materials that reduce velocity and protect against erosion.

Operational phase

- Hydrocarbon Spills and sewerage leakages that end up in the run-off and the groundwater via the surface drainage system. The proposed pumpstation is a particular source of concern as far as sewerage leakage is concerned. The Engineering team should reconsider gravitation feed. However, should the pump station prove to be the only solution, then it needs to be removed from and placed downstream from the boreholes.
- Flood risk associated with changed flow patterns caused by climate change – increased irregular, yet high intensity floods. Even though the development is situated outside the existing 1:50 year flood line, it is suggested that monitoring be done of the flood lines for planning and management purposes should significant changes be noticed.
- Increased traffic causing congestion on the D 1743. The Development contributes a relatively minor traffic load when compared to other larger developments. Nevertheless, the Developer will be implementing traffic solutions, notable changes to the existing access road, in line with the Traffic Master Plan for the area.
- Increased water demand and additional pressure on already over utilised water resource (Windhoek aquifer) – the estimated 303.6 kl/day, or 110,814 kl/year will place an increased pressure on the water crisis situation. By the time this development is approved a permanent water supply solution is unlikely to be in place, with heavy reliance on the Windhoek aquifer, but with mitigating effects of planned use of on-site licensed borehole water for non-potable uses.

- This is a relatively small size development but will still increase the pressure on the existing water supply. It is recommended that the City approve the use of the existing boreholes on the site for irrigation purposes. Alternatively the reuse of grey water for irrigation should be considered. In addition, gardens need to be drought tolerant, with restricted lawns. Water saving cisterns, tap features, and other water saving design features need to be prescribed. The Drought Response Plan off the City needs to be implemented. Water saving needs to be integral to the management of the estate. The Environmental Management Plan contains the steps needed in this regard.

The above impacts are all of low significance if they are managed through the provisions mentioned and as contained in the Environmental Management Plan. It is recommended that the Proponent further develops the Environmental Management Plan and particularly the design principles for the erven, closer to implementation.

It is also recommended that the Developer appoints someone from his team to oversee the implementation of the EMP on site.

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STONE PROJECTS IN WINDHOEK

ENVIRONMENTAL CONDITIONS ASSESSMENT

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March 2014

Project:	**ENVIRONMENTAL CONDITIONS ASSESSMENT FOR THE STONE PROJECTS IN WINDHOEK AS ON 29 MARCH 2015**	
Report Version/Date	Final 05 August 2015	
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Cite this document as:	**Botha P, 2015 March; Environmental Conditions Assessment for Old Tannery - Stone Projects Namibia (Pty)Ltd of Windhoek as on 29 March 2015**	
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Appendix A

1. Introduction

Geo Pollution Technologies was requested by Stone Projects to perform an Environmental Conditions Assessment at the old Tannery Site north of Windhoek. This survey was conducted on 29 March 2015.

The site was utilised as a tannery in the past and some evaporation ponds are still present on the site. The new owners plan to develop this property and would like to determine remediation actions needed to ensure the land is safe for future land use.

2. Scope of Work

The aims of the survey were to:

1) Sample groundwater;
2) Sample soil from disposal dams and surrounding area;
3) Analyse water and soil samples to establish contaminant levels;
4) Conclude on results found.

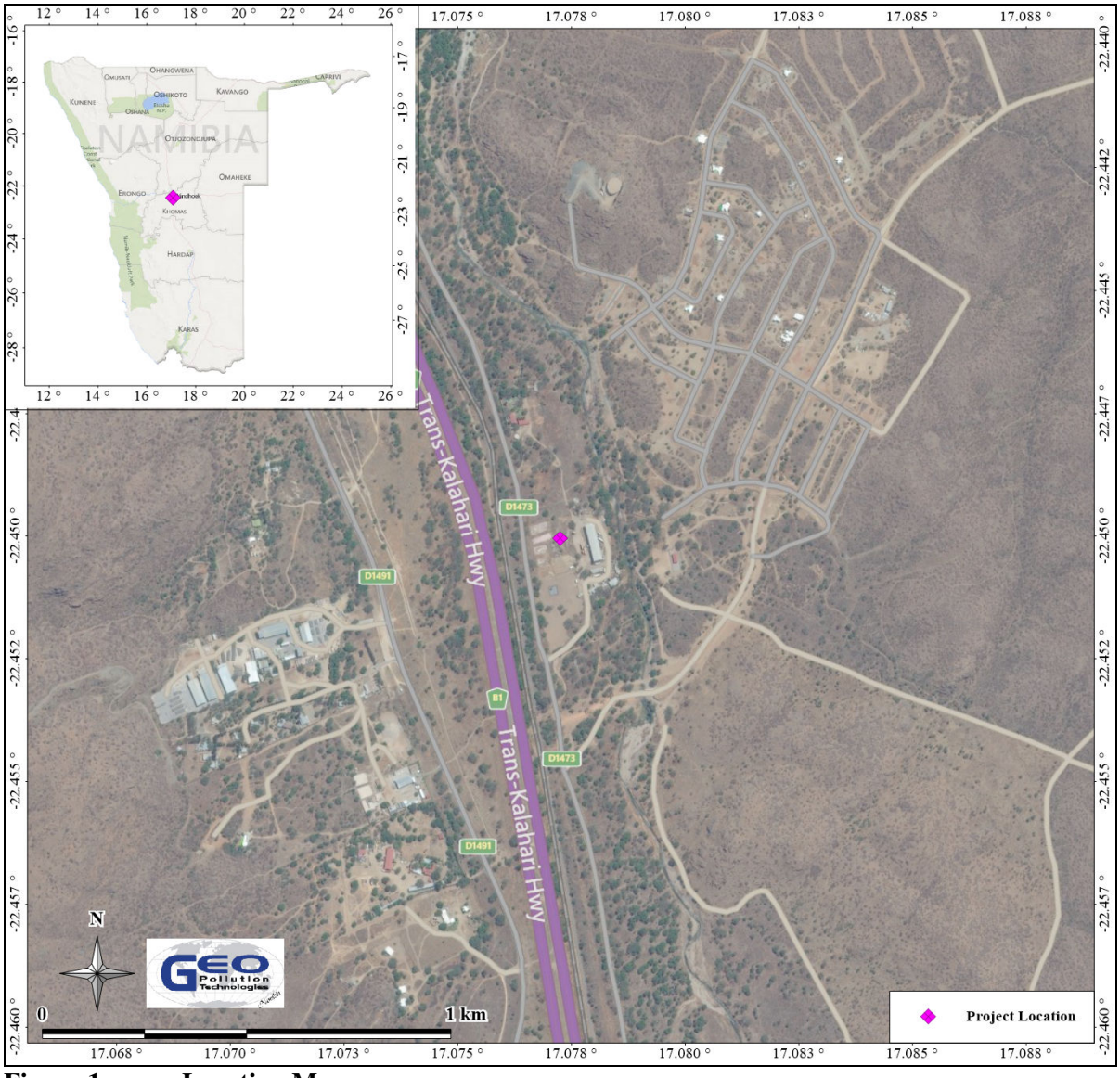


Figure 1. Location Map

3. Methodology

The survey consisted of a site walkover to determine visual signs of pollution and to identify possible sources of pollution. Followed by drilling of 4 auger holes for soil sampling of which 3 were collected as composite soil samples. One groundwater sample was collected from a borehole present on the site.

Soil sampling sites were selected to provide a good indication of the condition of contamination in the soil. Hand auger drilling was chosen as the method of drilling at selected points as guided by the outcome of the site walkover survey. The purpose of the auger holes were to evaluate the vertical profile of the soil and collect soil samples for analyses of chemicals of concern.

One groundwater water sample was collected from the borehole to test for chemicals of concern.

4. Description of Natural Environment

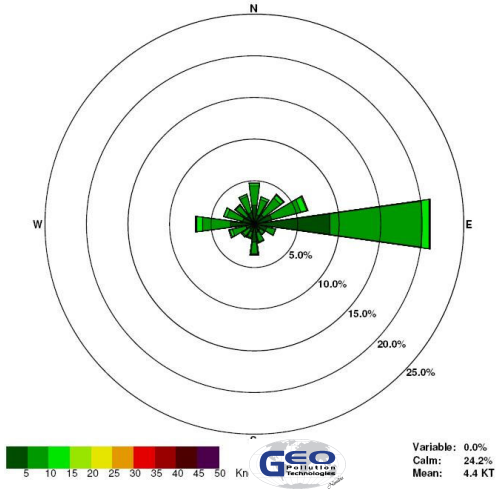
4.1. Locality

The site (17.0775°S; -22.4500°E) is situated north of Windhoek, east of the B1 Trans-Kalahari Highway and west of the Elisenheim Township. Land use is described as being industrial with a residential component.

4.2. Climate

Relevant climate data is presented in Table 1.

Table 1. Climatic Data

Classification of climate	Semi-arid highland savannah
Precipitation	Average annual rainfall 300-350mm/a. Sporadic and unpredictable, high intensity, highly localised storm events between October and April.
Variation in annual rainfall (%)	30-40
Average annual evaporation (mm/a)	3000-3200
Water deficit (mm/a)	1701-1900
Temperature	Highest temperatures are measured in December with an average daily maximum of 31°C and minimum of 17.3°C; the coldest temperatures are measured in July with an average daily maximum of 20.4°C and minimum of 6.4°C.
Windhoek Wind Summary 1957 - 2011	

4.3. Topography and Drainage

The landscape is classified as being in the Khomas Hochland Plateau region, having rolling hills in the west with many adjacent summit heights reflecting older land surfaces. The site is located in the relative flat valley floor of the Klein Windhoek River, with a steep valley side further to the

east. The Windhoek Graben, which strikes in a northern direction, is primarily responsible for forming the valley side. Drainage takes place to the east of the site into the Klein Windhoek River, a tributary of the Swakop River.

4.4. Geology and Hydrogeology

Surface geology consists mainly of a surficial soil cover (Qa) of Quaternary age, consisting mainly of weathered mica schist and sand, with areas having large amounts of quartz pebbles and large boulders. Mica schist from the Kuiseb Formation (Nks) underlies this surface cover of unknown thickness and crops out to the east. The complex geology of the Windhoek area is a result of numerous folding and faulting episodes, including thrusting and rifting, to which the area has been subjected. Metasedimentary rocks of the Swakop Group, which is part of the Damara Sequence, constitute the Windhoek Aquifer. A number of north- to north-westerly striking faults and joints found in Windhoek form the major underground water conduits and hence determine the conditions of the aquifer. Secondary porosity giving rise to high aquifer transmissivity is best developed in faults with post-hydrothermal alteration brecciation in quartzitic environments. Moreover host rock fracturing along fault planes results in better development of secondary porosity in quartzite compared to schistose terrain such that the aquifer reaches its maximum potential in this type of setting. The metasedimentary formations of the study area strike in an east-north-easterly direction and dip 15-35° to the north-northwest. The more competent quartzite is subject to brittle deformation and thus exhibits relatively high secondary porosity and permeability due to jointing. The joints of the quartzite show evidence of fluid flow by carbonate and quartz infill and iron staining. Micaceous schist on the other hand, which is prone to plastic deformation rather than brittle fracturing, exhibits significantly lower secondary porosity and permeability.

Two main aquifer types are found in the area, namely secondary (fractured rock) aquifers hosted in the mica schist of the Kuiseb Formation, and primary (unconsolidated sediment) aquifers formed in the Klein Windhoek River valley alluvial (Qa). Windhoek has a regional groundwater flow from south to north. Groundwater flow is expected to take place through primary porosity in the surface cover, while it is expected to flow along fractures, faults and other geological structures (secondary porosity) present within the underlying formations (hard rock formations). Groundwater flow from the site can be expected in a northerly direction. Local flow patterns may vary due to groundwater abstraction. Water is utilized in the area, with 22 boreholes known of within a 2km radius from the property boundary. Table 2 presents groundwater statistics of boreholes contained in the Department of Water Affairs (DWA) database. Note that this database is generally outdated and more boreholes might be present.

No Municipal production boreholes are situated closer than 2 kilometres from the site. The usage of private boreholes is not clear but they should be considered to be at risk if pollution of the aquifer takes place. In the greater Brakwater area, groundwater is used primarily for domestic and small scale farming activities.

Water in the area is often Brackish and may be contaminated by runoff from the Klein Windhoek River which flows through the city.

This area falls within the Windhoek-Gobabis Subterranean Water Control Area (Extension) - Government Notice 47 of 26 March 1976. This means that Government controls groundwater usage in this area.

Table 2. Groundwater Statistics

Query Centre:	Stone Projects; -22.45°S; 17.0775°E							Query Box Radius: 2.0km	
	NUMBER OF KNOWN BOREHOLES	DEPTH (mbs)	YIELD (m3/h)	WATER LEVEL (mbs)	WATER STRIKE (mbs)	TDS (ppm)	SULPHATE (ppm)	NITRATE (ppm)	FLUORIDE (ppm)
Data points	**22**	12	10	7	2	22	22	22	22
Minimum		37	1	12	24	365	4	0	0
Average		91	8	18	40	1415	340	4	1
Maximum		191	23	37	55	6238	2500	20	5
Group A		8.33%	40.00%	0.00%	0.00%	36.36%	45.45%	90.91%	72.73%
Limit		50	>10	10	10	1000	200	10	1.5
Group B		58.33%	10.00%	100.00%	50.00%	40.91%	45.45%	9.09%	18.18%
Limit		100	>5	50	50	1500	600	20	2.0
Group C		33.33%	50.00%	0.00%	50.00%	13.64%	0.00%	0.00%	4.55%
Limit		200	>0.5	100	100	2000	1200	40	3.0
Group D		0.00%	0.00%	0.00%	0.00%	9.09%	9.09%	0.00%	4.55%
Limit		>200	<0.5	>100	>100	>2000	>1200	>40	>3

Statistical grouping of parameters is for ease of interpretation, except for the grouping used for sulphate, nitrate and fluoride, which follow the Namibian guidelines for the evaluation of drinking-water quality for human consumption, with regard to chemical, physical and bacteriological quality. In this case the groupings has the following meaning:
Group A: Water with an excellent quality
Group B: Water with acceptable quality
Group C: Water with low health risk
Group D: Water with a high health risk, or water unsuitable for human consumption.

4.5. Site Description

The study site is located 20 km north of Windhoek near the Elisenheim Township. Next to the Trans- Kalahari B1 highway. The Klein Windhoek River is located to the east of the workshop area (see Figure 2). A workshop is located on the site where the tannery operation used to operate. A borehole is located near the workshop towards the left in a westerly direction where the water sample was collected. An oil waste collection point is located south of the disposal dams, located over some of the old dams.

About 77 metres from the workshop building towards the west are four visible dams where waste from the tannery operation was pumped to. Evaluation of historic images indicated that in 2004, 7 disposal dams were visible on site. Over time some of the dams were covered with soil as can be seen in the images from the period 2004 – 2015, see Figure 3.

All the dams were found to be lined with a thin plastic liner to reduce infiltration into the subsurface. Muddy material containing hair and salt deposit is present in the dams.

Figure 2. Site Overview

Figure 3. Historic to recent images of project site

5. Site Assessment

5.1. Visual Extend

The site surrounding is generally clean. Oil stains from the nearby waste oil collection operation has contaminated the top surface of the dam directly to the north of their operation. One such oil stain can be seen in Photo 1 where sample A1 (8551539) was collected.

Some of the dams has a salt layer (Photo 2) with water present in part of the dam surfaces (Photo 3). The pinkish salt colour is similar to that of Cr(VI) salts.

Photo 1. Staining at Sample Point A1

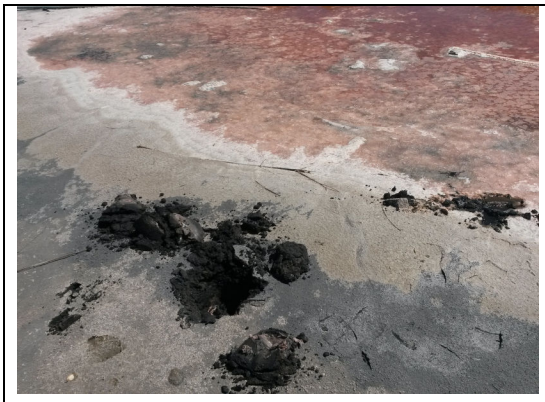


Photo 2. Salt surface layer and sludge

Photo 3. Water in dams

5.2. Sampling

Four sediment samples and one water sample was collected during the survey.

Sample Point A1 was made through augering into a partially covered dam. The surface was hard and drilling difficult to penetrate. The hole was drilled up to 0.5 m when a plastic liner was intersected. Soil was dry at 0 m but clayey deeper down the hole. Oil stains are visible on surface in Photo 4. Auger hole A1 was used to take sample number 8551539 at 0.5 m.

Sample Point A2 consisted of two soil samples combined as indicated in Figure 4. The soil was sludgy and had a strong odour. Soil was collected at surface. Composite soil from the two locations was used to take sample number 8551540.

Sample Point A3 consisted of two soil samples combined as indicated in Figure 4. The soil was sludgy and had a strong odour. Soil was collected at surface. Composite soil from the two locations was used to take sample number 8551541.

Sample Point A4 was made close to the brick production area and downstream of the old tannery buildings. This sample point is to evaluate possible contamination from the operations in the tannery buildings. Soil was slightly dry and sandy and drilled to a depth of 0.7 m. Auger hole A4 was used to take sample 8551542 at 0.7 m.

Groundwater Sampling took place from an existing borehole present between the evaporation dams and the workshop. Field measurements made during sampling recorded a pH of 6.7 and Eh of -68 mV. The water temperature was 25 °C. A water sample (8551544) was collected after more than 20 minutes of pumping once field measurements stabilized.

Figure 4. Sample Locations

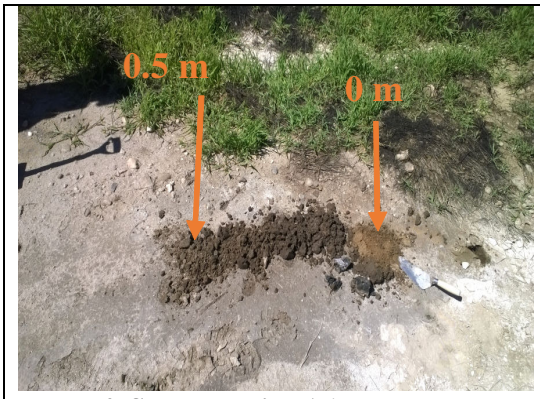


Photo 4. Sample Point A1

Photo 5. Sample Point A2

Photo 6. Sample Point A3

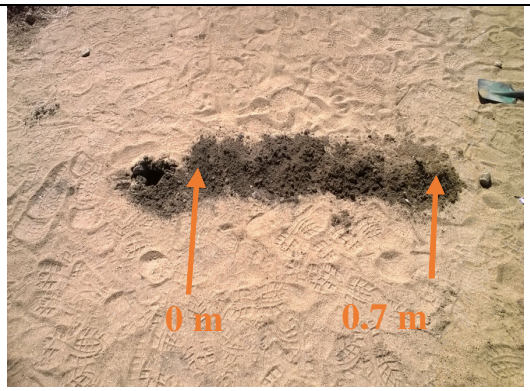


Photo 7. Sample Point A4

5.3. Soil Sample Analysis Results

The analysis indicated that a number of metals were detected in the analysis. Concentrations of chromium and barium is prominent. This is expected as both chromium and barium is used in leather tanning.

It is interesting to note that sample points A2 and A3 contain only barium and cadmium while sample points A1 and A4 contain more metals in a similar range, except for A1 that contains much higher chromium concentrations. It should be kept in mind that the deposits in the dam where sample point A1 was made was partially covered by soil, probably from the area near sample point A4. The sample however contains a mixture of the cover material and the dam deposits.

All of the dams sampled contained hydrocarbon contamination. Notable is the presence of phenol compounds. Phenols, specifically chlorinated phenols, are used in the curing and storage phases of the hides to preserve the hides. Samples from A2 and A3 also respectively contains 14 % and 29 % organic material.

See Table 3 for a summary of detected chemical of concern soil sample analysis results. Also included in Table 3 is the soil screening values for contaminated land from South Africa (DEA 2010). Full results are included in Appendix A.

Table 3. Soil Analysis Results

Source/Map#	G218-1/A1 Sample Point A1	G218-1/A2 Sample Point A2	G218-1/A3 Sample Point A3	G218-1/A4 Sample Point A4	Soil Maximum Detected	Soil Screening Values				
Certificate1	**2015046015/1**	**2015046015/1**	**2015046015/1**	**2015046015/1**						
Sample Date	29-Mar-2015	29-Mar-2015	29-Mar-2015	29-Mar-2015		**South Africa** *(Framework for the Management of Contaminated Land - May 2010)*				
Sample#	**8551539**	**8551540**	**8551541**	**8551542**					Water Resource Protection	
Material	**Soil**	**Soil**	**Soil**	**Soil**		**Soil Informal Residential**	**Soil Land Use Standard Residential**	**Soil Industrial/ Commercial**	**Soil Protection of Human Health (drinking water usage)**	**Soil Protection of Ecosystem Health**
Sample Depth (mbs)	**0.5**	**0.1**	**0.1**	**0.7**						
Units (except where indicated below)	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Dry weight (% m/m)	78	49.3	50.5	94						
Clay Content (% m/m)	3.6	8.4	11.9	2.6						
Organic matter (loss of ignition) (% m/m)	6	14.3	29.3	0.8						
Metals										
Arsenic	<3	<60	<3	<3		23	48	150	5.8	580
Barium	83	62	<5	110	110					
Chromium	5300	18000	14000	31	18000	46000	96000	790000		
Cobalt	7	<40	<2	6.7	7	300	630	5000		22000
Copper	19	<60	<3	13	19	1100	2300	19000	200	16
Lead	8.9	<60	<3	4.5	8.9	110	23	1900	20	100
Nickel	20	<40	<2	18	20	620	1200	10 000	91	1400
Vanadium	34	<40	<2	38	38	150	320	2600	2000	
Zinc	60	<200	<10	41	60	9200	19000	150 000	3700	240
Aromatic Compounds										
Mono Aromatic Hydrocarbons										
1,2,4-Trimethylbenzene	<0.05	0.1	<0.5	<0.05	0.1					
p-Isopropyltoluene	<0.05	0.06	<0.5	<0.05	0.06					
Phenols										
Phenol	<0.01	12	8	<0.01	12					
p-Cresol	<0.01	11	0.91	<0.01	11					
Cresols (sum)		11	0.91		11					
PAHs										
Naphthalene	0.04	0.96	20	<0.01	20	28	33	290		28
Fluorene	0.01	0.02	<0.1	<0.01	0.02					
Phenanthrene	0.14	0.15	<0.1	<0.01	0.15					
Fluoranthene	0.01	0.01	<0.1	<0.01	0.01					
Pyrene	0.02	0.02	<0.1	<0.01	0.02	920	1900	15000		5.3
PAHs (sum 10 Dutch VROM)	0.18	1.1	20		20					
PAHs (sum 16 US EPA)	0.22	1.2	20		20					
Chlorinated Phenols										
2,4/2,5-Dichlorophenol	<0.001	0.002	<0.01	<0.001	0.002					
Dichlorophenols (sum)		0.002			0.002					
2,3,4-Trichlorophenol	<0.001	<0.01	<0.1	<0.01						
Trichlorophenols (sum)		0.03			0.03					
2,3,4,5-Tetrachlorophenol	<0.002	0.012	<0.02	<0.002	0.012					
Tetrachlorophenols (sum)		0.01			0.01					
Pentachlorophenol	<0.001	0.021	<0.01	<0.001	0.021					
4-Chloro-3-methylphenol	<0.001	0.14	<0.01	<0.001	0.14					
Miscellaneous HCs										
Biphenyl	0.006	0.008	<0.05	<0.005	0.008					
Bis(ethylhexyl)phthalate	1.9	2.2	<50	<5	2.2					
Di-n-octylphthalate	<0.2	<0.2	<2	<0.2						
Total Petroleum Hydrocarbons										
C10-C12	<3	25	45	<3	45					
C12-C16	8	26	15	<5	26					
C16-C21	170	200	75	<6	200					
C21-C30	99	93	76	<12	99					
C30-C35	160	220	140	<6	220					
C35-C40	21	54	24	<6	54					
TPH (sum C10-C40)	460	620	370	<38	620					
Notes:										
Exceed detection limit										

5.1. Water Sample Analysis Results

From the analysis all metals are well below the Namibian guideline for drinking water. However, the conductivity values indicates water is slightly brackish falling into Group B according to the Namibian guideline. See Table 4 for a summary of detected chemical of concern water sample analysis results. Full results are included in Appendix A.

Table 4. Water Analysis Results

Source/Map#	**G218-1/water**
Certificate1	**2015046016/1**
Analysis Version	**7.23**
Sample Date	29-Mar-2015
Sample#	**8551544**
Material	**Water**
Units (except where indicated below)	**ppm**
Characteristics	
pH	7.5
Conductivity (mS/m)	300
Metals	
Barium	0.058
Chromium	0.0051
Cobalt	0.006
Copper	0.0042
Molybdenum	0.0038
Nickel	0.014
Vanadium	0.012
Aromatic Compounds	
Mono Aromatic Hydrocarbons	
Styrene	0.00027
Chlorinated Phenols	
p-Chlorophenol	0.00003
Notes:	
Exceed Detection Limit - No Guideline Value	
Exceed Detection Limit - Group A	
Exceed Detection Limit - Group B	
Exceed Detection Limit - Group C	
Exceed Detection Limit - Group D	

6. Risk Analysis

The Risc 4.04 software was utilized to determine the risk to human health according to the Risk Based Corrective Action (RBCA) principles. TIER 1 level assumptions was used to quantify the worst risk scenario. This approach represents a streamlined approach for the assessment of and response to potential risk from hydrocarbon releases. RBCA integrates the U.S. EPA risk assessment process with site investigation data. RBCA also determines which native media, i.e. soil, air, surface water and groundwater represent the greatest risk, and therefore the most cost-effective measures for protection

of human health and environmental resources. The RBCA framework allows regulators and responsible parties to establish their position in the decision-making process and to assess what remedial action needs to be taken. A RBCA approach to site remediation provides guidance to manage risk to human health, ecosystems, and groundwater users.

For carcinogenic substances, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. This risk is referred to as the individual excess lifetime cancer risk, or just carcinogenic risk. The hazard index is an indication of the potential for adverse non-carcinogenic effects, and is not a probabilistic risk.

The highest chemicals of concern concentrations, measured in the samples collected, were utilized to compare to the Tier 1 risk based screening levels (RBSL). See Table 5 and Table 6 for risk based screening (RBS) hereof.

Considering the data in both these tables it is evident that none of the concentrations are considered to pose a threat to human health for the chemicals of concern analysed for. It is important to note that Cr(VI) was not analysed for and that this might pose a significant risk if Cr(VI) is present. It is suspected that a significant concentration of Cr(VI) would be present in the evaporation dams.

Table 5. Soil Sample Analysis Maximum Value Risk Based Screening

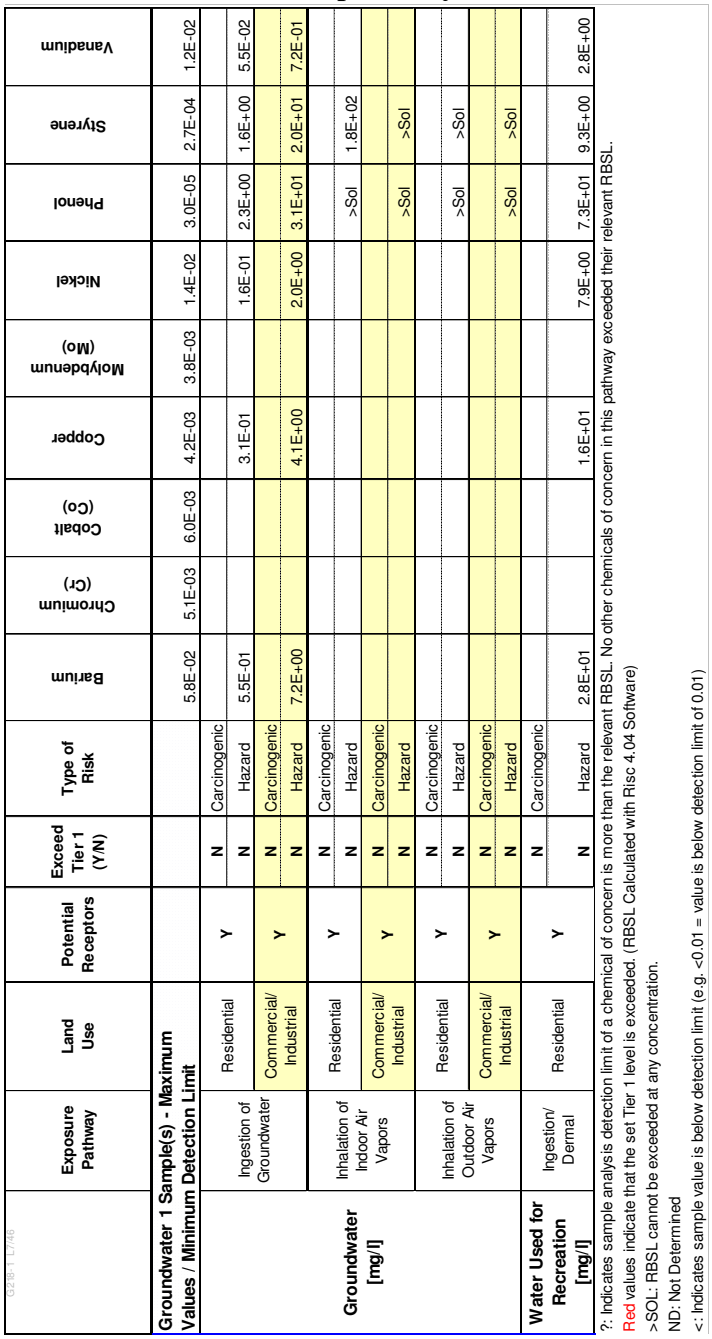
	Exposure Pathway	Land Use	Potential Receptors	Exceed Tier 1 (Y/N)	Type of Risk	Barium	Chromium (Cr)	Cobalt (Co)	Copper	Cresol(p)	Fluoranthene	Fluorene	Lead	Naphthalene	Nickel	Phenanthrene	Phenol	Pyrene	Vanadium	Zinc
Surficial Soil 1 Sample(s) - Maximum Values / Minimum Detection Limit						1.1E+02	1.8E+04	7.0E-03	1.9E+01	1.1E+01	1.0E-02	2.0E-02	8.9E+00	2.0E+01	2.0E+01	1.5E-01	1.2E+01	2.0E-02	3.8E+01	6.0E+01
Surficial Soil [mg/kg]	Ingestion/ Dermal/ Inhalation	Residential	N	N	Carcinogenic										1.0E-07					
				N	Hazard	5.4E+03			3.1E+03	3.2E+02	2.6E+03	2.6E+03	2.8E+02	5.6E+02	1.5E+03		1.9E+04	1.9E+03	5.4E+02	2.3E+04
		Commercial/ Industrial	Y	N	Carcinogenic										2.2E-08					
				N	Hazard	1.2E+05			6.6E+04	3.1E+03	2.5E+04	2.4E+04	6.0E+03	3.2E+03	3.3E+04		1.7E+05	1.8E+04	1.2E+04	5.0E+05

?: Indicates sample analysis detection limit of a chemical of concern is more than the relevant RBSL. No other chemicals of concern in this pathway exceeded their relevant RBSL.

Red values indicate that the set Tier 1 level is exceeded. (RBSL Calculated with Risc 4.04 Software)

<: Indicates sample value is below detection limit (e.g. <0.01 = value is below detection limit of 0.01)

Table 6. Water Sample Anlaysis Maximum Value Risk Based Screening



G2181-1 L7/46	Exposure Pathway	Land Use	Potential Receptors	Exceed Tier 1 (Y/N)	Type of Risk	Barium	Chromium (Cr)	Cobalt (Co)	Copper	Molybdenum (Mo)	Nickel	Phenol	Styrene	Vanadium
Groundwater 1 Sample(s) - Maximum Values / Minimum Detection Limit						5.8E-02	5.1E-03	6.0E-03	4.2E-03	3.8E-03	1.4E-02	3.0E-05	2.7E-04	1.2E-02
Groundwater [mg/l]	Ingestion of Groundwater	Residential	Y	N	Carcinogenic									
				N	Hazard	5.5E-01			3.1E-01		1.6E-01	2.3E+00	1.6E+00	5.5E-02
		Commercial/ Industrial	Y	N	Carcinogenic									
				N	Hazard	7.2E+00			4.1E+00		2.0E+00	3.1E+01	2.0E+01	7.2E-01
	Inhalation of Indoor Air Vapors	Residential	Y	N	Carcinogenic									
				N	Hazard							>Sol	1.8E+02	
		Commercial/ Industrial	Y	N	Carcinogenic									
				N	Hazard							>Sol	>Sol	
	Inhalation of Outdoor Air Vapors	Residential	Y	N	Carcinogenic									
				N	Hazard							>Sol	>Sol	
		Commercial/ Industrial	Y	N	Carcinogenic									
				N	Hazard							>Sol	>Sol	
Water Used for Recreation [mg/l]	Ingestion/ Dermal	Residential	Y	N	Carcinogenic									
				N	Hazard	2.8E+01			1.6E+01		7.9E+00	7.3E+01	9.3E+00	2.8E+00

?: Indicates sample analysis detection limit of a chemical of concern is more than the relevant RBSL. No other chemicals of concern in this pathway exceeded their relevant RBSL.
Red values indicate that the set Tier 1 level is exceeded. (RBSL Calculated with Risc 4.04 Software)
>SOL: RBSL cannot be exceeded at any concentration.
ND: Not Determined
<: Indicates sample value is below detection limit (e.g. <0.01 = value is below detection limit of 0.01)

7. Conclusion

Assuming that no Cr(VI) is present in the tannery sludge in the evaporation dams, then it can be concluded that based on the extensive list of chemicals of concern analysed for, that the risk to human health is below the levels of concern as per the South African Framework for Contaminated Land and also based on The RISC screening values.

Due to the risk of leaching of the salts from the evaporation dams as well as the possible presence of Cr(VI) in the sediments it is advised that the contents of the dams be removed to the Hazardous waste site. Back filling with clean soil should form a buffer between remaining pollutants and possible receptors. When handling the salts it is important that workers wear suitable protective gear to specifically avoid dust inhalation as this is a major pathway for the carcinogenic Cr(VI) compounds.

It is advised that the soil and groundwater be analysed for the presence of Cr(VI).

8. References

South Africa Department of Environmental Affairs; 2010 May; Framework For the Management of Contaminated Land

SPENCE, L.R; 2001; Risk-Integrated Software for Clean-Ups; RISC 4 User's Manual.

Appendix A

Source/Map#	G218-1/A1 Sample Point A1	G218-1/A2 Sample Point A2	G218-1/A3 Sample Point A3	G218-1/A4 Sample Point A4	Soil Maximum Detected
COC#	**L7/47/1**	**L7/47/2**	**L7/47/3**	**L7/47/4**	
Certificate1	**2015046015/1**	**2015046015/1**	**2015046015/1**	**2015046015/1**	
Analysis Version	**7.23**	**7.23**	**7.23**	**7.23**	
Sample Date	29-Mar-2015	29-Mar-2015	29-Mar-2015	29-Mar-2015	
Sample#	**8551539**	**8551540**	**8551541**	**8551542**	
Material	**Soil**	**Soil**	**Soil**	**Soil**	
Sample Depth (mbs)	**0.5**	**0.1**	**0.1**	**0.7**	
Units (except where indicated below)	ppm	ppm	ppm	ppm	ppm
Characteristics					
Dry weight (% m/m)	78	49.3	50.5	94	
Clay Content (% m/m)	3.6	8.4	11.9	2.6	
Organic matter (loss of ignition)	6	14.3	29.3	0.8	
Metals					
Arsenic	<3	<60	<3	<3	
Antimony	<3	<60	<3	<3	
Barium	83	62	<5	110	110
Beryllium	<1	<20	<1	<1	
Cadmium	<0.3	<6	<0.3	<0.3	
Chromium	5300	18000	14000	31	18000
Cobalt	7	<40	<2	6.7	7
Copper	19	<60	<3	13	19
Mercury	<0.05	<1	<0.05	<0.05	
Lead	8.9	<60	<3	4.5	8.9
Molybdenum	<1	<20	<1	<1	
Nickel	20	<40	<2	18	20
Selenium	<5	<100	<5	<5	
Tin	<5	<100	<5	<5	
Vanadium	34	<40	<2	38	38
Zinc	60	<200	<10	41	60
Aromatic Compounds					
Mono Aromatic Hydrocarbons					
Benzene	<0.1	<0.1	<1	<0.1	
Ethylbenzene	<0.2	<0.2	<2	<0.2	
Toluene	<0.2	<0.2	<2	<0.2	
o-Xylene	<0.2	<0.2	<2	<0.2	
m/p-Xylene	<0.1	<0.1	<1	<0.1	
Xylenes (sum)					
Styrene	<0.2	<0.2	<2	<0.2	
1,2,4-Trimethylbenzene	<0.05	0.1	<0.5	<0.05	0.1
1,3,5-Trimethylbenzene	<0.05	<0.05	<0.5	<0.05	
n-Propylbenzene	<0.05	<0.05	<0.5	<0.05	
Isopropylbenzene	<0.05	<0.05	<0.5	<0.05	
n-Butylbenzene	<0.05	<0.05	<0.5	<0.05	
sec-Butylbenzene	<0.05	<0.05	<0.5	<0.05	
tert-Butylbenzene	<0.05	<0.05	<0.5	<0.05	
p-Isopropyltoluene	<0.05	0.06	<0.5	<0.05	0.06
Phenols					
Phenol	<0.01	12	8	<0.01	12
o-Cresol	<0.01	<0.01	<0.1	<0.01	
m-Cresol	<0.01	<0.01	<0.1	<0.01	
p-Cresol	<0.01	11	0.91	<0.01	11
Cresols (sum)		11	0.91		11
2,4-Dimethylphenol	<0.01	<0.01	<0.1	<0.01	
2,5-Dimethylphenol	<0.01	<0.01	<0.1	<0.01	
2,6-Dimethylphenol	<0.01	<0.01	<0.1	<0.01	
3,4-Dimethylphenol	<0.01	<0.01	<0.1	<0.01	
o-Ethylphenol	<0.02	<0.02	<0.2	<0.02	
m-Ethylphenol	<0.01	<0.01	<0.1	<0.01	
Thymol	<0.01	<0.01	<0.1	<0.01	
4-Ethyl/2,3 ; 3,5 Dimethylphenol	<0.01	<0.01	<0.1	<0.01	
PAHs					
Naphthalene	0.04	0.96	20	<0.01	20
Acenaphthylene	<0.01	<0.01	<0.1	<0.01	
Acenaphthene	<0.01	<0.01	<0.1	<0.01	

Source/Map#	G218-1/A1 Sample Point A1	G218-1/A2 Sample Point A2	G218-1/A3 Sample Point A3	G218-1/A4 Sample Point A4	Soil Maximum Detected
Fluorene	0.01	0.02	<0.1	<0.01	0.02
Phenanthrene	0.14	0.15	<0.1	<0.01	0.15
Anthracene	<0.01	<0.01	<0.1	<0.01	
Fluoranthene	0.01	0.01	<0.1	<0.01	0.01
Pyrene	0.02	0.02	<0.1	<0.01	0.02
Benzo(a)anthracene	<0.01	<0.01	<0.1	<0.01	
Chrysene	<0.01	<0.01	<0.1	<0.01	
Benzo(b)fluoranthene	<0.01	<0.01	<0.1	<0.01	
Benzo(k)fluoranthene	<0.01	<0.01	<0.1	<0.01	
Benzo(a)pyrene	<0.01	<0.01	<0.1	<0.01	
Benzo(ghi)perylene	<0.01	<0.01	<0.1	<0.01	
Dibenzo(ah)anthracene	<0.01	<0.01	<0.1	<0.01	
Indeno(123cd)pyrene	<0.01	<0.01	<0.1	<0.01	
PAHs (sum 10 Dutch VROM)	0.18	1.1	20		20
PAHs (sum 16 US EPA)	0.22	1.2	20		20
Halogenated Hydrocarbons					
Tetrachloromethane (tetra)	<0.05	<0.05	<0.5	<0.05	
1,2 Dichloroethane 0,1 0,1	<0.1	<0.1	<1	<0.1	
1,1,1-Trichloroethane	<0.05	<0.05	<0.5	<0.05	
1,1,2-Trichloroethane	<0.05	<0.05	<0.5	<0.05	
Trichloroethanes (sum)					
1,1,1,2-Tetrachloroethane	<0.05	<0.05	<0.5	<0.05	
1,1,2,2-Tetrachloroethane	<0.05	<0.05	<0.5	<0.05	
Tetrachloroethanes (sum)					
Trichloroethene	<0.2	<0.2	<2	<0.2	
Tetrachloroethene	<0.2	<0.2	<2	<0.2	
1,2-Dichloropropane	<0.05	<0.05	<0.5	<0.05	
1,3-Dichloropropane	<0.05	<0.05	<0.5	<0.05	
1,2,3-Trichloropropane	<0.05	<0.05	<0.5	<0.05	
1,1-Dichloropropylene	<0.1	<0.1	<1	<0.1	
cis 1,3-Dichloropropylene	<0.05	<0.05	<0.5	<0.05	
trans 1,3-Dichloropropylene	<0.05	<0.05	<0.5	<0.05	
1,3-Dichloropropylenes (sum)					
Dibromomethane	<0.05	<0.05	<0.5	<0.05	
1,2-Dibromoethane	<0.05	<0.05	<0.5	<0.05	
Tribromomethane (Bromoform)	<0.05	<0.05	<0.5	<0.05	
Bromodichloromethane	<0.1	<0.1	<1	<0.1	
Dibromochloromethane	<0.05	<0.05	<0.5	<0.05	
1,2-Dibromo-3-chloropropane	<0.05	<0.05	<0.5	<0.05	
Bromobenzene	<0.05	<0.05	<0.5	<0.05	
Chlorinated Benzenes					
Monochlorbenzene	<0.01	<0.01	<0.1	<0.01	
1,2-Dichlorobenzene	<0.01	<0.01	<0.1	<0.01	
1,3-Dichlorobenzene	<0.01	<0.01	<0.1	<0.01	
1,4-Dichlorobenzene	<0.01	<0.01	<0.1	<0.01	
Dichlorobenzenes (sum)					
1,2,3-Trichlorobenzene	<0.01	<0.01	<0.1	<0.01	
1,2,4-Trichlorobenzene	<0.01	<0.01	<0.1	<0.01	
1,3,5-Trichlorobenzene	<0.003	<0.003	<0.03	<0.003	
Trichloorbenzene (sum)					
1,2,3,4-Tetrachlorobenzene	<0.003	<0.003	<0.03	<0.003	
1,2,3,5/1,2,4,5-Tetrachlorobenzene	<0.002	<0.002	<0.02	<0.002	
Tetrachlorobenzenes (sum)					
Pentachlorobenzene	<0.002	<0.002	<0.02	<0.002	
Hexachlorobenzene	<0.002	<0.002	<0.02	<0.002	
Chlorinated Phenols					
o-Chlorophenol	<0.001	<0.01	<0.1	<0.01	
m-Chlorophenol	<0.001	<0.01	<0.1	<0.01	
p-Chlorophenol	<0.001	<0.01	<0.1	<0.01	
Monochlorophenols (sum)					
2,3-Dichlorophenol	<0.002	<0.002	<0.02	<0.002	
2,4/2,5-Dichlorophenol	<0.001	0.002	<0.01	<0.001	0.002
2,6-Dichlorophenol	<0.001	<0.001	<0.01	<0.001	
3,4-Dichlorophenol	<0.002	<0.002	<0.02	<0.002	
3,5-Dichlorophenol	<0.001	<0.001	<0.01	<0.001	
Dichlorophenols (sum)		0.002			0.002

Source/Map#	G218-1/A1 Sample Point A1	G218-1/A2 Sample Point A2	G218-1/A3 Sample Point A3	G218-1/A4 Sample Point A4	Soil Maximum Detected
2,3,4-Trichlorophenol	<0.001	<0.01	<0.1	<0.01	
2,3,5-Trichlorophenol	<0.001	0.029	<0.01	<0.001	0.029
2,3,6-Trichlorophenol	<0.001	<0.001	<0.01	<0.001	
2,4,5-Trichlorophenol	<0.001	<0.001	<0.01	<0.001	
2,4,6-Trichlorophenol	<0.001	<0.001	<0.01	<0.001	
3,4,5-Trichlorophenol	<0.002	<0.002	<0.02	<0.002	
Trichlorophenols (sum)		0.03			0.03
2,3,4,5-Tetrachlorophenol	<0.002	0.012	<0.02	<0.002	0.012
2,3,4,6/2,3,5,6-Tetrachlorophenol	<0.01	<0.01	<0.1	<0.01	
Tetrachlorophenols (sum)		0.01			0.01
Pentachlorophenol	<0.001	0.021	<0.01	<0.001	0.021
4-Chloro-3-methylphenol	<0.001	0.14	<0.01	<0.001	0.14
PCB					
PCB 28	<0.002	<0.002	<0.02	<0.002	
PCB 52	<0.002	<0.002	<0.02	<0.002	
PCB 101	<0.002	<0.002	<0.02	<0.002	
PCB 118	<0.002	<0.002	<0.02	<0.002	
PCB 138	<0.005	<0.005	<0.05	<0.005	
PCB 153	<0.005	<0.005	<0.05	<0.005	
PCB 180	<0.002	<0.002	<0.02	<0.002	
PCB (sum 6)					
PCB (sum 7)					
Chloronitrobenzenes					
o/p-Chloronitrobenzene	<0.01	<0.01	<0.1	<0.01	
m-Chloronitrobenzene	<0.01	<0.01	<0.1	<0.01	
Monochloronitrobenzenes (sum)					
2,3 / 3,4-Dichloronitrobenzene	<0.01	<0.01	<0.1	<0.01	
2,4-Dichloronitrobenzene	<0.02	<0.02	<0.2	<0.02	
2,5-Dichloronitrobenzene	<0.01	<0.01	<0.1	<0.01	
3,5-Dichloronitrobenzene	<0.02	<0.02	<0.2	<0.02	
Dichloronitrobenzenes (sum)					
Miscellaneous Chlor, HCs					
2-Chlorotoluene	<0.01	<0.01	<0.1	<0.01	
4-Chlorotoluene	<0.01	<0.01	<0.1	<0.01	
Chlorotoluenes (sum)					
1-Chloronaphthalene	<0.005	<0.005	<0.05	<0.005	
Pesticides					
Chlorine Pesticides					
4,4-DDE	<0.001	<0.001	<0.01	<0.001	
2,4-DDE	<0.001	<0.001	<0.01	<0.001	
4,4-DDT	<0.002	<0.002	<0.02	<0.002	
4,4-DDD/2,4-DDT	<0.001	<0.001	<0.01	<0.001	
2,4-DDD	<0.001	<0.001	<0.01	<0.001	
DDT/DDE/DDD (sum)					
Aldrin	<0.002	<0.002	<0.02	<0.002	
Dieldrin	<0.002	<0.002	<0.02	<0.002	
Endrin	<0.005	<0.005	<0.05	<0.005	
Drins (sum)					
alfa-HCH	<0.05	<0.05	<0.5	<0.05	
beta-HCH	<0.005	<0.005	<0.05	<0.005	
gamma-HCH	<0.005	<0.005	<0.05	<0.005	
delta-HCH	<0.02	<0.02	<0.2	<0.02	
HCH (sum)					
Alfa-endosulfan	<0.01	<0.01	<0.1	<0.01	
Alfa-endosulfansulphate	<0.02	<0.02	<0.2	<0.02	
Alfa-chlordane	<0.002	<0.002	<0.02	<0.002	
Gamma-chlordane	<0.002	<0.002	<0.02	<0.002	
Chlordanes (sum)					
Heptachlor	<0.002	<0.002	<0.02	<0.002	
Heptachloroepoxide	<0.005	<0.005	<0.05	<0.005	
Hexachlorobutadiene	<0.002	<0.002	<0.02	<0.002	
Isodrin	<0.005	<0.005	<0.05	<0.005	
Telodrin	<0.005	<0.005	<0.05	<0.005	
Tedion	<0.005	<0.005	<0.05	<0.005	

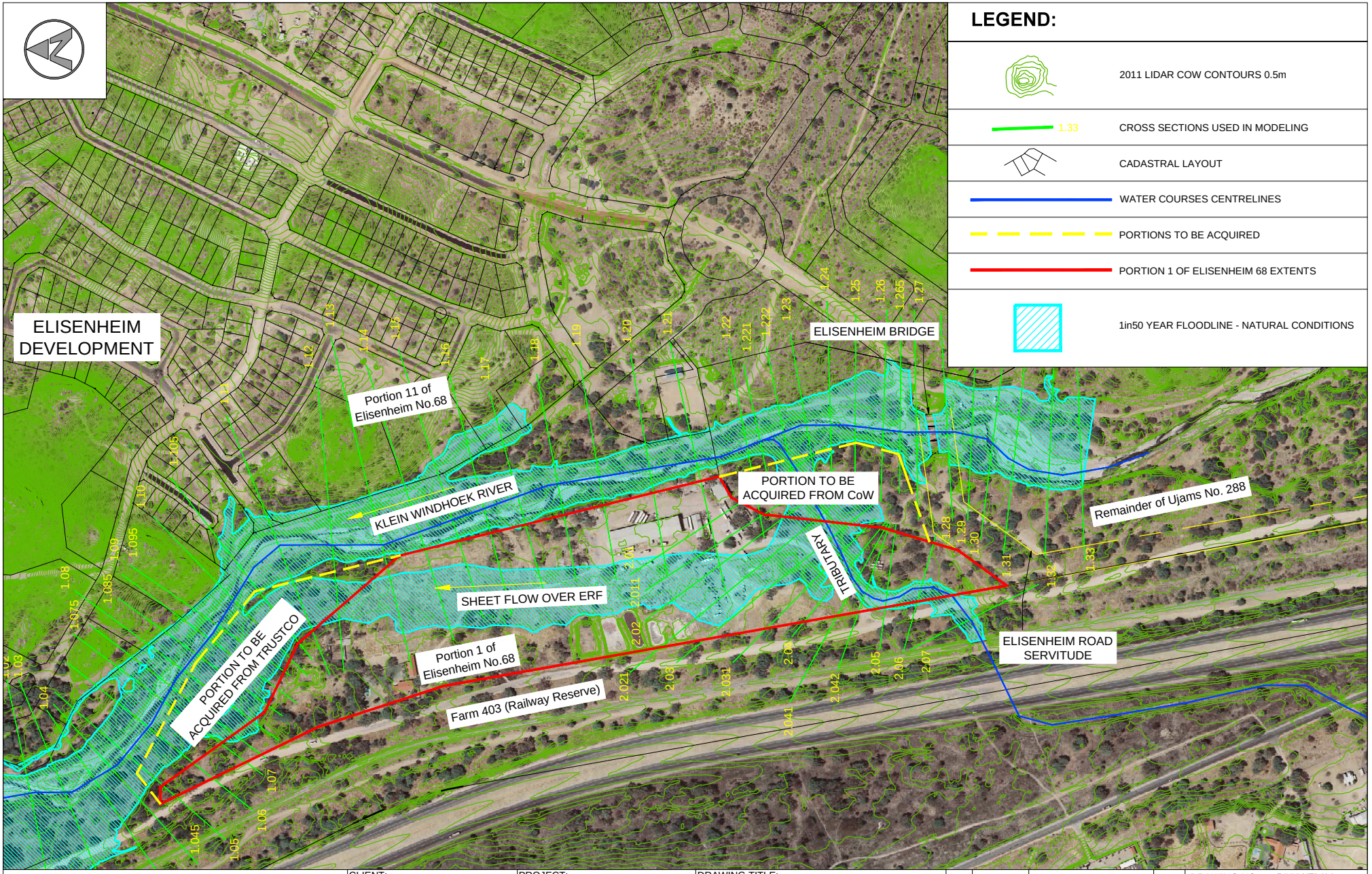
Source/Map#	G218-1/A1 Sample Point A1	G218-1/A2 Sample Point A2	G218-1/A3 Sample Point A3	G218-1/A4 Sample Point A4	Soil Maximum Detected
Phosphor Pesticides					
Azinphos-ethyl	<0.005	<0.005	<0.05	<0.005	
Azinphos-methyl	<0.005	<0.005	<0.05	<0.005	
Bromophos-ethyl	<0.02	<0.02	<0.2	<0.02	
Bromophos-methyl	<0.02	<0.02	<0.2	<0.02	
Chloropyrophos-ethyl	<0.01	<0.01	<0.1	<0.01	
Chloropyrophos-methyl	<0.01	<0.01	<0.1	<0.01	
Cumaphos	<0.005	<0.005	<0.05	<0.005	
Demeton-S /Demeton-O (ethyl)	<0.02	<0.02	<0.2	<0.02	
Diazinon	<0.005	<0.005	<0.05	<0.005	
Dichlorovos					
Disulfoton	<0.02	<0.02	<0.2	<0.02	
Fenitrothion	<0.005	<0.005	<0.05	<0.005	
Fenthion	<0.002	<0.002	<0.02	<0.002	
Malathion	<0.005	<0.005	<0.05	<0.005	
Parathion-ethyl	<0.005	<0.005	<0.05	<0.005	
Parathion-methyl	<0.01	<0.01	<0.1	<0.01	
Pyrazophos	<0.005	<0.005	<0.05	<0.005	
Triazophos	<0.02	<0.02	<0.2	<0.02	
Nitrogen Pesticides					
Ametryne	<0.01	<0.01	<0.1	<0.01	
Atrazine	<0.02	<0.02	<0.2	<0.02	
Cyanazine	<0.02	<0.02	<0.2	<0.02	
Desmetryne	<0.005	<0.005	<0.05	<0.005	
Prometryne	<0.02	<0.02	<0.2	<0.02	
Propazine	<0.02	<0.02	<0.2	<0.02	
Simazine	<0.02	<0.02	<0.2	<0.02	
Terbuthylazine	<0.02	<0.02	<0.2	<0.02	
Terbutryne	<0.05	<0.05	<0.5	<0.05	
Miscellaneous Pesticides					
Bifenthrin	<0.005	<0.005	<0.05	<0.005	
Cypermethrin (A,B,C,D)	<0.01	<0.05	<0.5	<0.05	
Deltamethrin	<0.01	<0.01	<0.1	<0.01	
Permethrin					
Permethrin (sum)	<0.01	<0.01	<0.1	<0.01	
Propachloor	<0.02	<0.02	<0.2	<0.02	
Trifluralin	<0.005	<0.005	<0.05	<0.005	
Miscellaneous HCs					
Biphenyl	0.006	0.008	<0.05	<0.005	0.008
Nitrobenzene	<0.1	<0.1	<1	<0.1	
Dibenzofurane	<0.01	<0.01	<0.1	<0.01	
Phthalates					
Dimethylphthalate	<0.2	<0.2	<2	<0.2	
Diethylphthalate	<0.2	<0.2	<2	<0.2	
Di-isobutylphthalate	<0.5	<0.5	<5	<0.5	
Dibutylphthalate	<0.5	<0.5	<5	<0.5	
Butylbenzylphthalate	<0.2	<0.2	<2	<0.2	
Bis(ethylhexyl)phthalate	1.9	2.2	<50	<5	2.2
Di-n-octylphthalate	<0.2	<0.2	<2	<0.2	
Phthalates (sum)	1.9	2.2			2.2
Total Petroleum Hydrocarbons					
C10-C12	<3	25	45	<3	45
C12-C16	8	26	15	<5	26
C16-C21	170	200	75	<6	200
C21-C30	99	93	76	<12	99
C30-C35	160	220	140	<6	220
C35-C40	21	54	24	<6	54
TPH (sum C10-C40)	460	620	370	<38	620
Notes:					
Exceed detection limit					

Source/Map#	G218-1/water
COC#	**L7/46**
Certificate1	**2015046016/1**
Analysis Version	**7.23**
Sample Date	29-Mar-2015
Sample#	**8551544**
Material	**Water**
Units (except where indicated below)	**ppm**
Characteristics	
Dry weight (% m/m)	
Clay Content (% m/m)	
Organic matter (loss of ignition)	
pH	7.5
Conductivity (mS/m)	300
Metals	
Arsenic	<0.003
Antimony	<0.005
Barium	0.058
Beryllium	<0.001
Cadmium	<0.0004
Chromium	0.0051
Cobalt	0.006
Copper	0.0042
Mercury	<0.00004
Lead	<0.003
Molybdenum	0.0038
Nickel	0.014
Selenium	<0.005
Tin	<0.005
Vanadium	0.012
Zinc	<0.005
Aromatic Compounds	
Mono Aromatic Hydrocarbons	
Benzene	<0.0001
Ethylbenzene	<0.0001
Toluene	<0.0001
o-Xylene	<0.0001
m/p-Xylene	<0.0001
Xylenes (sum)	
Styrene	0.00027
1,2,4-Trimethylbenzene	<0.0001
1,3,5-Trimethylbenzene	<0.0001
n-Propylbenzene	<0.0001
Isopropylbenzene	<0.0001
n-Butylbenzene	<0.0001
sec-Butylbenzene	<0.0001
tert-Butylbenzene	<0.0001
p-Isopropyltoluene	<0.0001
Phenols	
Phenol	<0.0005
o-Cresol	<0.0003
m-Cresol	<0.0003
p-Cresol	<0.0002
Cresols (sum)	
2,4-Dimethylphenol	<0.00002
2,5-Dimethylphenol	<0.00002
2,6-Dimethylphenol	<0.00003
3,4-Dimethylphenol	<0.00002
o-Ethylphenol	<0.00003
m-Ethylphenol	<0.00002
Thymol	<0.00001
4-Ethyl/2,3 ; 3,5 Dimethylphenol	<0.00002
PAHs	
Naphthalene	<0.0004
Acenaphthylene	<0.00004
Acenaphthene	<0.0001
Fluorene	<0.00001
Phenanthrene	<0.00002
Anthracene	<0.00001
Fluoranthene	<0.00002

Source/Map#	G218-1/water
Pyrene	<0.00006
Benzo(a)anthracene	<0.00004
Chrysene	<0.00002
Benzo(b/k)fluoranthene	<0.00006
Benzo(b)fluoranthene	
Benzo(k)fluoranthene	
Benzo(a)pyrene	<0.0001
Benzo(ghi)perylene	<0.0001
Dibenzo(ah)anthracene	<0.00008
Indeno(123cd)pyrene	<0.00006
PAHs (sum 10 Dutch VROM)	
PAHs (sum 16 US EPA)	
Halogenated Hydrocarbons	
Chloromethane	<0,0002
Dichloromethane	<0,0002
Vinylchlorine	<0,0002
1,1 Dichloroethene	<0,0001
tr-1,2 Dichloroethene	<0,0001
cis -1,2 Dichloroethene	<0,0001
Chloroethane	<0,0001
Trichlorofluoromethane	<0,0001
Trichloromethane (chloroform)	<0,0002
Tetrachloromethane (tetra)	<0.0001
1,1 Dichloroethane	<0,0001
1,2 Dichloroethane 0,1 0,1	<0.0001
1,1,1-Trichloroethane	<0.0001
1,1,2-Trichloroethane	<0.0001
Trichloroethanes (sum)	
1,1,1,2-Tetrachloroethane	<0.0001
1,1,2,2-Tetrachloroethane	<0.0001
Tetrachloroethanes (sum)	
Trichloroethene	<0.0001
Tetrachloroethene	<0.0001
2,2-Dichloropropane	<0.0001
1,2-Dichloropropane	<0.0001
1,3-Dichloropropane	<0.0001
1,2,3-Trichloropropane	<0.0001
1,1-Dichloropropylene	<0.0001
cis 1,3-Dichloropropylene	<0.0001
trans 1,3-Dichloropropylene	<0.0001
1,3-Dichloropropylenes (sum)	
Bromomethane	<0.0001
Bromochloromethane	<0.0001
Dibromomethane	<0.0001
1,2-Dibromoethane	<0.0001
Tribromomethane (Bromoform)	<0.0001
Bromodichloromethane	<0.0001
Dibromochloromethane	<0.0001
1,2-Dibromo-3-chloropropane	<0.0001
Bromobenzene	<0.0001
Chlorinated Benzenes	
Monochlorbenzene	<0.00005
1,2-Dichlorobenzene	<0.0001
1,3-Dichlorobenzene	<0.0001
1,4-Dichlorobenzene	<0.0001
Dichlorobenzenes (sum)	
1,2,3-Trichlorobenzene	<0.0001
1,2,4-Trichlorobenzene	<0.0001
1,3,5-Trichlorobenzene	<0.00001
Trichloorbenzene (sum)	
1,2,3,4-Tetrachlorobenzene	<0.00002
1,2,3,5/1,2,4,5-Tetrachlorobenzene	<0.00002
Tetrachlorobenzenes (sum)	
Pentachlorobenzene	<0.00001
Hexachlorobenzene	<0.00003
Chlorinated Phenols	
o-Chlorophenol	<0.0001
m-Chlorophenol	<0.00002
p-Chlorophenol	0.00003
Monochlorophenols (sum)	
2,3-Dichlorophenol	<0.00002

Source/Map#	G218-1/water
2,4/2,5-Dichlorophenol	<0.00001
2,6-Dichlorophenol	<0.00003
3,4-Dichlorophenol	<0.00002
3,5-Dichlorophenol	<0.00003
Dichlorophenols (sum)	
2,3,4-Trichlorophenol	<0.00002
2,3,5 / 2,4,5-Trichlorophenol	<0.00002
2,3,5-Trichlorophenol	
2,3,6-Trichlorophenol	<0.00001
2,4,5-Trichlorophenol	
2,4,6-Trichlorophenol	<0.00005
3,4,5-Trichlorophenol	<0.00001
Trichlorophenols (sum)	
2,3,4,5-Tetrachlorophenol	<0.00001
2,3,4,6/2,3,5,6-Tetrachlorophenol	<0.00002
Tetrachlorophenols (sum)	
Pentachlorophenol	<0.00001
4-Chloro-3-methylphenol	<0.00002
PCB	
PCB 28	<0.00001
PCB 52	<0.00001
PCB 101	<0.00001
PCB 118	<0.00001
PCB 138	<0.00001
PCB 153	<0.00001
PCB 180	<0.00001
PCB (sum 6)	
PCB (sum 7)	
Chloronitrobenzenes	
o/p-Chloronitrobenzene	<0.0002
m-Chloronitrobenzene	<0.0002
Monochloronitrobenzenes (sum)	
2,3 / 3,4-Dichloronitrobenzene	
2,3-Dichloronitrobenzene	<0.0001
2,4-Dichloronitrobenzene	<0.0001
2,5-Dichloronitrobenzene	<0.0001
3,4-Dichloronitrobenzene	<0.0001
3,5-Dichloronitrobenzene	<0.00006
Dichloronitrobenzenes (sum)	
Miscellaneous Chlor, HCs	
2-Chlorotoluene	<0.0001
4-Chlorotoluene	<0.0001
Chlorotoluenes (sum)	
1-Chloronaphthalene	<0.00002
Pesticides	
Chlorine Pesticides	
4,4-DDE	<0.00001
2,4-DDE	<0.00001
4,4-DDT	<0.0002
4,4-DDD/2,4-DDT	<0.00002
2,4-DDD	<0.00001
DDT/DDE/DDD (sum)	
Aldrin	<0.00002
Dieldrin	<0.00002
Endrin	<0.00002
Drins (sum)	
alfa-HCH	<0.00008
beta-HCH	<0.00007
gamma-HCH	<0.0001
delta-HCH	<0.00004
HCH (sum)	
Alfa-endosulfan	<0.00005
Alfa-endosulfansulphate	<0.00003
Alfa-chlordane	<0.00001
Gamma-chlordane	<0.00001
Chlordanes (sum)	
Heptachlor	<0.00001
Heptachloroepoxide	<0.00003
Hexachlorobutadiene	<0.0001
Isodrin	<0.0001

Source/Map#	G218-1/water
Telodrin	<0.00007
Tedion	<0.00007
Phosphor Pesticides	
Azinphos-ethyl	<0.0001
Azinphos-methyl	<0.00007
Bromophos-ethyl	<0.00007
Bromophos-methyl	<0.00006
Chloropyrophos-ethyl	<0.00006
Chloropyrophos-methyl	<0.0001
Cumaphos	<0.00002
Demeton-S /Demeton-O (ethyl)	<0.0001
Diazinon	<0.00004
Dichlorovos	<0.0001
Disulfoton	<0.00004
Fenitrothion	<0.0001
Fenthion	<0.0001
Malathion	<0.0001
Parathion-ethyl	<0.0002
Parathion-methyl	<0.0002
Pyrazophos	<0.0002
Triazophos	<0.0002
Nitrogen Pesticides	
Ametryne	<0.0001
Atrazine	<0.00008
Cyanazine	<0.0001
Desmetryne	<0.0001
Prometryne	<0.0001
Propazine	<0.00008
Simazine	<0.0002
Terbuthylazine	<0.00006
Terbutryne	<0.0001
Miscellaneous Pesticides	
Bifenthrin	<0.00008
Carbaryl	<0.0001
Cypermethrin (A,B,C,D)	<0.0002
Deltamethrin	<0.0002
Linuron	<0.0001
Permethrin	
Permethrin A	<0.00006
Permethrin B	<0.00006
Permethrin (sum)	
Propachloor	<0.00002
Trifluralin	<0.00002
Miscellaneous HCs	
Biphenyl	<0.00001
Nitrobenzene	<0.0003
Dibenzofurane	<0.0001
Total Petroleum Hydrocarbons	
C10-C12	<0.01
C12-C16	<0.015
C16-C21	<0.015
C21-C30	<0.020
C30-C35	<0.020
C35-C40	<0.020
TPH (sum C10-C40)	<0.10
Notes:	
Exceed Detection Limit - No Guideline Value	
Exceed Detection Limit - Group A	
Exceed Detection Limit - Group B	
Exceed Detection Limit - Group C	
Exceed Detection Limit - Group D	



LEGEND:

- 2011 LIDAR COW CONTOURS 0.5m
- 1.33 CROSS SECTIONS USED IN MODELING
- CADASTRAL LAYOUT
- WATER COURSES CENTRELINES
- PORTIONS TO BE ACQUIRED
- PORTION 1 OF ELISENHEIM 68 EXTENTS
- 1in50 YEAR FLOODLINE - NATURAL CONDITIONS

WINDHOEK CONSULTING ENGINEERS
P.O. Box 2484
WINDHOEK
TEL: (061) 370 900 FAX: (061) 238 880

CLIENT: STONE PROJECTS NAMIBIA

PROJECT:
NEW MIXED USE DEVELOPMENT ON PORTION 1 OF ELISENHEIM RE/68, WINDHOEK
1 in 50 YEAR FLOODLINE INVESTIGATION OF THE KLEIN WINDHOEK RIVER AND TRIBUTARY

DRAWING TITLE: 1in50 YEAR FLOODLINE - NATURAL CONDITIONS

DESIGNED	APPROVED	SCALE
JS	TEB:	1:4000

NO.	DATE	REVISION	INIT.
A	09-11-2015	FOR APPROVAL	JS

DRAWING NO. **P7551/FL/01**
ACCEPTED ON BEHALF OF CLIENT:
NAME & SIGN:
DATE:
REVISION A

TRIBUTARY CHANNELISATION SETTING OUT COORDINATES L022/17

Y	X	DESCRIPTION
-8036.278	50166.326	A
-8112.067	50131.240	B
-8202.731	50108.628	C

TRIBUTARY CHANNEL GEOMETRY DETAILS

Cross Section	Centreline Point Coordinates Y	X	INVERT LEVEL
2.18	-8036.278	50166.326	1562.000
2.17	-8040.815	50164.225	1561.915
2.16	-8049.890	50160.024	1562.000
2.15	-8058.965	50155.823	1561.830
2.14	-8068.040	50151.622	1561.745
2.13	-8077.114	50147.421	1561.659
2.12	-8086.189	50143.220	1561.574
2.11	-8095.264	50139.019	1561.489
2.10	-8104.339	50134.818	1561.404
2.09	-8119.232	50129.453	1561.266
2.08	-8128.935	50127.033	1561.183
2.07	-8138.637	50124.613	1561.096
2.06	-8148.340	50122.193	1561.013
2.05	-8158.043	50119.774	1560.927
2.04	-8167.746	50117.354	1560.842
2.03	-8177.448	50114.934	1560.757
2.02	-8187.151	50112.514	1560.672
2.01	-8196.854	50110.094	1560.587

ELISENHEIM DEVELOPMENT

ELISENHEIM BRIDGE

Portion 11 of Elisenheim No.68

KLEIN WINDHOEK RIVER

PORTION TO BE ACQUIRED FROM CoW

Remainder of Ujams No. 288

LOW ARES ON ERF FILLED

TRIBUTARY NATURAL WATER COURSE FILLED

PORTION TO BE ACQUIRED FROM TRUSTCO

Portion 1 of Elisenheim No.68

Farm 403 (Railway Reserve)

TRIBUTARY CHANNEL MIN BOTTOM WIDTH - 4m MIN SERVITUDE WIDTH - 8m

ELISENHEIM ROAD SERVITUDE

LEGEND:

- 2011 LIDAR COW CONTOURS 0.5m
- 2.01 CROSS SECTIONS USED IN MODELING
- CADASTRAL LAYOUT
- WATER COURSES CENTRELINES
- PORTIONS TO BE ACQUIRED
- EROSION PROTECTION EXTENTS
- 1in50 YEAR FLOODLINE NATURAL CONDITIONS
- 1in50 YEAR FLOODLINE - TRIBUTARY CHANNELISATION ADDITIONAL PORTIONS AND PROTECTIVE EMBANKMENT
- TRIBUTARY CHANNELISATION

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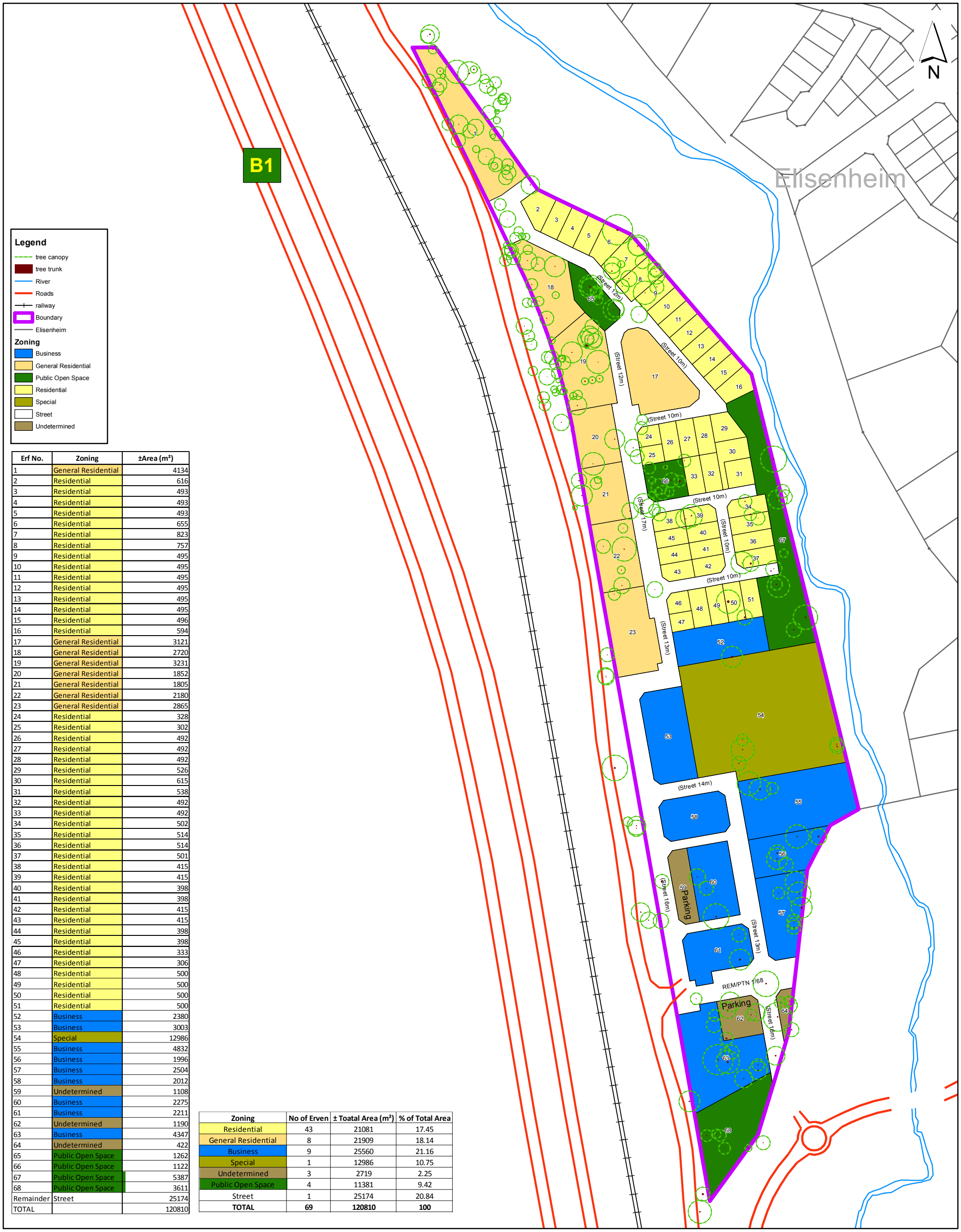
1 in 50 YEAR FLOODLINE INVESTIGATION OF THE KLEIN WINDHOEK RIVER AND TRIBUTARY

DRAWING TITLE:
1in50 YEAR FLOODLINE - TRIBUTARY CHANNELISATION, ADDITIONAL PORTIONS AND PROTECTIVE EMBANKMENT

DESIGNED	APPROVED	SCALE
JS	TEB:	1:4000

NO.	DATE	REVISION	INIT.
A	09-11-2015	FOR APPROVAL	JS

DRAWING NO. **P7551/FL/02**
ACCEPTED ON BEHALF OF CLIENT:
NAME & SIGN:
DATE:
REVISION A



Erf No.	Zoning	±Area (m²)
1	General Residential	4134
2	Residential	616
3	Residential	493
4	Residential	493
5	Residential	493
6	Residential	655
7	Residential	823
8	Residential	757
9	Residential	495
10	Residential	495
11	Residential	495
12	Residential	495
13	Residential	495
14	Residential	495
15	Residential	496
16	Residential	594
17	General Residential	3121
18	General Residential	2720
19	General Residential	3231
20	General Residential	1852
21	General Residential	1805
22	General Residential	2180
23	General Residential	2865
24	Residential	328
25	Residential	302
26	Residential	492
27	Residential	492
28	Residential	492
29	Residential	526
30	Residential	615
31	Residential	538
32	Residential	492
33	Residential	492
34	Residential	502
35	Residential	514
36	Residential	514
37	Residential	501
38	Residential	415
39	Residential	415
40	Residential	398
41	Residential	398
42	Residential	415
43	Residential	415
44	Residential	398
45	Residential	398
46	Residential	333
47	Residential	306
48	Residential	500
49	Residential	500
50	Residential	500
51	Residential	500
52	Business	2380
53	Business	3003
54	Special	12986
55	Business	4832
56	Business	1996
57	Business	2504
58	Business	2012
59	Undetermined	1108
60	Business	2275
61	Business	2211
62	Undetermined	1190
63	Business	4347
64	Undetermined	422
65	Public Open Space	1262
66	Public Open Space	1122
67	Public Open Space	5387
68	Public Open Space	3611
Remainder	Street	25174
TOTAL		120810

Zoning	No of Erven	± Toatal Area (m²)	% of Total Area
Residential	43	21081	17.45
General Residential	8	21909	18.14
Business	9	25560	21.16
Special	1	12986	10.75
Undetermined	3	2719	2.25
Public Open Space	4	11381	9.42
Street	1	25174	20.84
TOTAL	**69**	**120810**	**100**

25 12.5 0 25 50 75 100 Meters

NOTE:
All measurements & sizes given are approximate.
No Residential erf shall be smaller that 300m² in size.

DRAWING NO:	DRAWN BY:
W/15014-7	AM

SCALE:	DATE	CHECKED:
1:3000	OCT 2016	

CLIENT APPROVAL:

Signature Date

PROJECT:

TREE SURVEY MAP

TOWNSHIP ESTABLISHMENT AND LAYOUT APPROVAL ON PORTION 1 (OF FARM ELISENHEIM No. 68) COMPRISING OF 68 ERVEN & REMAINDER, TO BE KNOWN AS TANNERY ESTATE

Stubenrauch Planning Consultants SPC

STUBENRAUCH
PLANNING CONSULTANTS
TOWN AND REGIONAL PLANNERS

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